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**LA THÈSE A ÉTÉ
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Buccherio Sottile:
A Study of Technical Evolution.

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March 1979
Ottawa,
Ontario

Thesis presented to the School of Graduate Studies,
University of Ottawa in fulfillment of requirements
for a Master of Arts Degree.

Abstract.

Bucchero Sottile: A Study of Technical Evolution.

Master's Thesis presented to the School of
Graduate Studies, University of Ottawa by
James B. Gallagher. March 1979.

The thesis explores the techniques employed for manufacturing an Etruscan pottery fabric known as bucchero sottile. It is important to establish the exact nature of the technical processes used for making this lustrous, black pottery since superficial similarities between bucchero and Greek pottery have led some scholars to credit Greek craftsmen with developing bucchero sottile. The discussion attempts to assess the validity of this view by evaluating possible contributions from both the Italic pottery tradition and the Greek pottery tradition to the bucchero manufacturing process. This assessment has been accomplished by comparing results from published analyses of bucchero with similar data available on contemporary Greek and Italic types of pottery. Analytical data have been supplemented by evidence obtained from modern attempts to reproduce bucchero and by information resulting from observation of American Indian potters working with primitive methods.

Specialists have also shown that some bucchero forms and decoration derive from Near Eastern and from Greek artistic traditions. There are also demonstrable similarities between bucchero pottery and objects made in metal and ivory. The thesis does not attempt to amplify these findings or reinvestigate the origins of particular bucchero shapes and decorative motifs. However, conclusions reached by scholars who

have studied these topics; are discussed with respect to the aims of bucchero craftsmen.

Although there are problems with establishing an exact date for the beginnings of bucchero sottile production, the pottery first appears during the second quarter of the 7th century B.C. At this time there is evidence for the presence of foreign artisans, including Greek potters, in Etruria. This fact tends to support the theory that bucchero might have been developed by Greek potters residing in Etruria.

Discussion of the available information on the techniques used by Italic and Greek potters indicates one may reasonably suspect that potters in Etruria learned to improve the quality of their pottery through increased familiarity with Greek pottery types and from direct observation of immigrant Greek craftsmen at work in Etruria. Greek potters probably introduced the potter's wheel to Etruria. They may have shown Italic potters better methods for refining clay and improved techniques for finishing the surface of pottery vases. There is also the possibility that bucchero craftsmen adopted their kiln design from the Greek example, although further research is needed in this area. On the other hand, examination of analytical data for Bucchero and for Greek pottery reveals fundamental differences between the process used for making bucchero and the technique utilized for making Greek pottery.

Greek potters manufactured a polychrome fabric. The process involved coating portions of the pottery surface with an iron containing slip, leaving the remaining areas unpainted.

The pottery was then subjected to a multistage firing. Reducing conditions converted iron in the slip and in the clay body to its black oxides. The slip sintered, protecting the iron it contained from further alteration. The kiln atmosphere was then changed, creating oxidizing conditions. The iron in the clay body was subsequently converted to red, ferric oxide. The slip remained black, thus yielding a polychrome effect.

Bucchero craftsmen, in contrast, deliberately produced a monochromatic, black pottery, while employing lower temperatures than their Greek counterparts. Bucchero was also reduced but unlike the Greek pottery, bucchero was not reoxidized. Black oxides of iron, formed during firing, do contribute to the coloration of bucchero. However, the absorption of carbon during firing was essential for producing the typical bucchero coloration. This was not the case for Greek pottery. Since pottery made during the Iron Age in Italy was also fired at low temperatures and depended to some degree on the absorption of carbon for its coloration, it seems that bucchero represents a continuation of a technical tradition developed in Italy, rather than being a product introduced by Greek craftsmen. Bucchero incorporates some advances in technique introduced by Greek potters or adopted in response to competition from the higher quality Greek pottery; but bucchero craftsmen preserved the fundamental aims and basic technical process established by their Iron Age predecessors.

Not all aspects of bucchero manufacture can be fully understood from the experimental data currently at hand. Thus

a section of the thesis is devoted to suggestions for future research. The proposed investigations would ideally include additional analyses, both of bucchero and of Greek pottery. It is also suggested that Italic impasto pottery needs to receive considerable attention in order to determine its physical and chemical characteristics with greater precision. These data would then allow a more exact evaluation of the technical relationship between bucchero and its impasto precursors. Testing clays from Etruria would constitute a vital adjunct to the analytical examination of the various pottery fabrics.

Consideration of previous findings concerning bucchero forms and decoration suggests that other views concerning bucchero should be reconsidered. There have been suggestions that bucchero was made as a cheap substitute for metal vessels. However, examination of the forms and decoration of bucchero seems to indicate a desire on the part of bucchero workshops to respond to fashions determined by ivory objects and pottery, as well as metal vessels, rather than demonstrating that bucchero was deliberately made to recreate the appearance of metalware. However, some bucchero was coated with precious metal. Such vessels do seem to imitate metal prototypes. This practice also raises several unanswered questions concerning the techniques of bucchero fabrication, and could indicate that some bucchero craftsmen were trained in metalworking techniques.

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Chapter I.

Introduction

The thin-walled, lustrous black pottery known as "bucchero sottile" has long attracted the interest of collectors and scholars acquainted with the Etruscan culture.(1) The name was adopted from the Spanish term bucaro which had been used to describe a type of Central American pottery resembling bucchero, introduced into Europe during the 17th and 18th centuries. It had become common to refer to the Etruscan pottery as bucchero by the middle of the 18th century.(2) The upsurge of excavation in Etruscan cemeteries during the 19th century provided a growing number of bucchero vessels which found their way into private collections and museums throughout the world.(3)

Although a considerable amount of this pottery has accumulated, comprehensive study has only begun in recent decades. The reason for this is twofold. Dispersal of material from individual tombs and particular sites, often accompanied by the loss of information about provenience and circumstances of the original discovery, has slowed the progress of scholarship. This difficulty has been aggravated by a conspicuous lack of adequately illustrated and annotated catalogues of museum collections,

(1) Defosse (1975a) 1073 n.3, considers that Ristoro d'Arezzo, writing in the 13th century A.D., referred to bucchero when describing some fragments of ancient pottery found near Arezzo. However, Charleston (1958) 5, seems to feel that Ristoro was describing Arretine sigillata since he spoke of 'figures in relief' on the pottery in question.

(2) Mazzoni, G. (1934) 165-167. For additional comments on nomenclature, see infra pp. 7 and pp. 31 ff.

(3) DePuma (1976) 220-228. The opening chapters of J. Wellard's The Search for the Etruscans. (1973), gives insight into the attitudes of and methods used by the antiquarians of the 18th and 19th centuries. See also Pallottino (1975) 105 ff., and Strom (1971) 140 ff.

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virtually making important material inaccessible.(4) The second major obstacle has been the tendency to ignore bucchero, while concentrating discussion on the more spectacular tomb furnishings in precious metals and the Greek painted pottery found in the same tombs. The lack of interest stems in part from the monotony of many undecorated bucchero vessels. Like other sorts of native Etruscan art, bucchero has been considered aesthetically inferior to contemporary Greek achievements, particularly with regard to painted pottery production.(5)

The state of neglect and disorder which has hampered bucchero research and Etruscan studies in general has changed rapidly during recent years.(6) Numerous articles and monographs devoted to identifying individual bucchero workshops and to presentation of museum holdings are currently available.(7) Archaeological excavations have also yielded new, well documented material for the study of bucchero manufacture.(8)

(4) This is not intended to depreciate the important contributions to the study of Etruscan culture by Martha, Montelius, Ducati and others. None the less, a considerable amount of bucchero remains unpublished. For example, in 1975 it was noted that 1332 bucchero vessels at the Louvre along with thousands of fragments comprises a body of material "quasiment inédit". Defosse (1975a) 1073 n.1.

(5) DePuma (1976) 223, and Defosse (1975a) 1073 n.1. The unfavorable view is succinctly expressed by John Boardman in The Greeks Overseas (2) (1973) 196, who terms Etruscan art in general as "the showy blend of Greek, Oriental and barbarian taste which can still inspire or impress those who cannot come to terms with the more controlled achievements of Greek art". Similar circumstances retarded serious study of Hellenistic black-gloss pottery. See Morel (1963) 8, and Cook (1972) 203.

(6) See Pallottino (1974) 23-31.

(7) For a bibliography see DePuma (1976) 228, and Defosse (1975b) 485-486, (1974) 150-152. Relevant articles are cited throughout the present text.

(8) Especially the excavations at Murlo which have yielded much stratified material, especially from the early 6th century. See Nielsen, E. and Phillips, K. AJA 81:1 (1977) 85-100 for the most recent report and bibliography of earlier campaigns.

Much of the most recent scholarship deals primarily with stylistic developments in bucchero production associated with particular workshops, selected vessel types or material from separate geographical regions.(9) However, questions related to the manufacturing technique used by bucchero workshops are also receiving attention. There have been occasional exposés on how the pottery may have been fired and colored, but the application of modern analytical procedures has provided particularly relevant data.(10)

The combined activities of specialists in the humanities and physical sciences have therefore yielded evidence which can be applied to a reassessment of views on some fundamental aspects of bucchero manufacture. Among these topics which have occupied researchers, the present investigation will examine three questions concerning bucchero manufacture:

1. The origins of the techniques employed.
2. Contributions from local and foreign artistic traditions to the shapes and decoration of bucchero.
3. The importance of metalware and other pottery fabrics as prototypes for bucchero vessels.

It is intended to examine these specific topics in order to obtain a more comprehensive understanding of the degree to which Etruscan potters drew on foreign expertise and artistic tradition when developing bucchero and to examine the influence exerted by other types of pottery and objects in different materials on bucchero shapes and decoration.

(9) There is also a growing body of material on the export of bucchero. See Defosse (1975a) 1074.

(10) Mariani and Storti (1953) 81 and 91 n. 24. Refer to some of the early experiments with reduced fabrics. See infra pp. 118ff.

Research has established that the shapes and decoration employed by bucchero workshops can be traced in many cases to prototypes occurring in Near Eastern and Greek art. (See Appendix I.) The present discussion will not attempt to amplify the existing results of stylistic and typological investigations. However, there will be discussion of the interpretations placed on these findings with respect to the aims of bucchero craftsmen.

It has also been demonstrated that bucchero often duplicates the form and decorative schemes found on metalware and ivory objects, of foreign and local manufacture. (See Appendix I.) A reassessment of the scholarly attempts to trace the evolution of particular motifs and styles will not be attempted here. There will be, on the other hand, discussion of the validity of certain assumptions based on similarities between bucchero and objects in metal and ivory made about the intentions of bucchero craftsmen.

Bucchero from Caere (Cerveteri) provides the basis for discussing the implications of vase forms and decoration chosen by bucchero workshops, although reference to pottery and other material from different sites affords necessary comparative data. It was decided to limit discussion to bucchero from one site in order to keep the present discussion within reasonable bounds. The bucchero from Caere is quite appropriate for this study of the origins of bucchero production since it is believed that the earliest workshops were located at Caere.(11) Bucchero sottile from Caere has also been subjected to a typological study of its forms, thus making it especially useful in the present context.(12)

(11) Ramage (1970) 2.

(12) ibid. 1-61.

This investigation will only consider the first phase of bucchero production during which time vessels with especially thin walls, (ca. 1 mm. thick), were being made.(13) This limitation does not hamper discussion since it is the origins of bucchero manufacture which are the primary concern.

The major portion of this investigation will be devoted to the technical aspects of both fabrication and decoration of bucchero. This choice has been made because it is in this area that scientific research conducted during the past few years seems to offer definite solutions to previously unresolved problems. Elucidating the details of the bucchero manufacturing process offers more than a purely academic knowledge of the capabilities of Etruscan potters. Misunderstanding the technical processes used for bucchero manufacture has contributed to what seems to be a misleading impression of the impact which contact with the Greek ceramic tradition exercised on pottery making methods in Etruria.

It has been claimed that the bucchero coloration was obtained by the same procedure which Greek potters employed for producing a black-firing slip. This assumption has led some scholars to suggest that bucchero was actually made by Greek potters working in Etruria.(14) The distinct possibility that workshops manufacturing Greek type pottery were established in Etruria by Greek immigrants, (*infra* pp. 16 ff.), would tend to support the suggestion that Greek potters could have originated the bucchero sottile fabric. However, there is now a growing body of evidence which indicates that the technique used to color bucchero was not identical to the methods used by Greek craftsmen to produce black

(13) Not all of the earliest vessels were equally delicate. On the chronology of bucchero production see *infra* pp. 7 ff.

(14) Banti (1969) 73.

color. Thus there is reason to question the view that bucchero manufacture depended on Greek expertise for its technical and artistic success.

The present discussion will attempt to determine how closely the bucchero technique actually follows Greek pottery production methods and methods used by Italic potters in order to evaluate the potential contribution from Greek ceramic technology to the development of bucchero sottile. This will be accomplished by comparing results from published analyses of bucchero with results from similar experiments with Greek pottery. Analytical data will be supplemented by findings from attempts to reproduce bucchero and by observations obtained from viewing primitive pottery production techniques in use today.

Before commencing the discussion of bucchero manufacturing techniques a few remarks are warranted on the topics of bucchero chronology and on the archaeological context in which bucchero first appears. This commentary is important for two reasons. Assumptions about the derivation of bucchero sottile also derive in part from various types of evidence for contact between the Hellenic civilization and the Iron Age culture of Etruria. Therefore to understand the basis for these assumptions, some appreciation is needed of cultural and historical phenomena observable in Etruria during the period when bucchero was developed. The second purpose of this brief digression is to define what is meant by the adjective 'Etruscan' in the present discussion. It is necessary to comment on this topic because the term 'Etruscan' has not always been used consistently or with the desired precision when describing the evolution of Iron Age society in Etruria.

Bucchero sottile was first made during the 7th century.** The

** All dates are henceforth B.C. unless otherwise indicated.

variety with the thinnest walls was made only for a short period of time, perhaps 25 years. Toward the end of the 7th century, vessel walls became thicker and remained so until sottile production ended, probably in the early 5th century.(15) A thick-walled variety of bucchero, 'bucchero pesante', which frequently had elaborate, molded decoration, also emerged during the second half of the 7th century and continued to be made until the beginning of the 4th century.(16)

Although it is possible to give a broad outline of bucchero chronology, affixing a specific date to the earliest phase of bucchero production is fraught with difficulty. Problems arise from three sources: the fact that bucchero chronology has been based on finds from tomb groups; disagreement over what absolute dates should be assigned to Greek pottery which provides the basis for bucchero chronology; and the incomplete or faulty documentation of bucchero finds.

The essential difficulty involved with establishing chronology on the evidence afforded by tomb groups is always the same. There is always the possibility that some of the grave offerings were obtained at the time of burial, while others were acquired by the deceased's household at some indeterminate time before his interment. There is an example of a pottery vessel which was kept for about 80 years at a sanctuary, before being discarded;(17) so it may be that private households occasionally reserved objects for a generation or more before including them in a group of burial offerings.

(15) Ramage (1970) 3.

(16) Ramage (1970) 3, DeIChiario (1966) 98-103.

(17) Boardman and Hayes (1966) 21. The vase was a Middle Protocorinthian oinochoi, apparently kept until the mid 6th century.

It has been suggested that a Greek vase in an Italic context might tend to be treated as an heirloom, being sufficiently esteemed as an imported object of high technical quality to be passed from generation to generation.⁽¹⁸⁾ Accepting this assumption could lead to the conclusion that bucchero found in association with Greek pottery should be assigned a later date than the imported vessels. However, it has been pointed out, with ample justification, that there is every reason to expect owners of bucchero sottile would attach as much value to these excellent vases as they would to Greek painted pottery found in the same tomb groups.⁽¹⁹⁾

One could suggest that bucchero be assigned a later date than the Greek pottery found with it on the grounds that allowance should be made to compensate for the time elapsed before new pottery styles in Greece and Magna Graecia were exported to Etruria. It is difficult to know how to estimate the time interval for such a transfer. However, since there are many indications that contact between the coast of Southern Etruria and the Western Greek colonies was quite regular during the 7th century, (*infra* pp. 21 ff.) it can be assumed that the time-lag in question was minimal.^(20a)

Although it seems reasonable to suspect that bucchero sottile vessels were made at the same time as the earliest Greek pottery found in association with them, there is not always agreement on what date should be attributed to the Greek vessels, themselves. The generally accepted chronological sequence for Protocorinthian pottery is based primarily on

⁽¹⁸⁾ See Ridgway (1968) 239 on the inadmissibility of evidence based on the heirloom argument.

⁽¹⁹⁾ Ramage (1970) 14.

^(20a) Pohl (1972) 278.

finds from the Greek mainland. However, it now seems that changes in style may have occurred at a different rate at some sites in Magna Graecia. (20b) Since some of the Protocorinthian pottery used to date bucchero may have come from Western Greek colonies, it would be hazardous to date bucchero unconditionally on the basis of associated pottery imports. (20c) The determination of absolute dates for tombs with bucchero by reference to Protocorinthian pottery is also complicated by the fact that the rather simple geometric decoration applied to the earliest Protocorinthian vases was not abandoned when figural decoration was introduced. (21) Since Greek vessels with geometric decoration provide the reference points for dating the earliest examples of bucchero sottile, it is not surprising to find different dates proposed for the beginning of bucchero production.

The problems encountered because of the dependence on Greek pottery for establishing fixed dates in the bucchero chronological sequence are compounded by the haphazard procedures employed by those who discovered many of the Etruscan tombs. Material from several of the tombs which provide evidence for bucchero chronology is incomplete because all of the finds were not kept, not properly recorded, or both. There have also been

(20b) Pohl (1972) 296. Until such potential discrepancies are clarified, one has little choice but to accept the chronology developed by Payne. See infra n. 41.

(20c) It would be useful to analyze some of the Protocorinthian vessels found in association with bucchero to assist in identifying their source of manufacture.

(21) Weinberg (1941) 40, observes that vases were decorated with the same geometric designs until the end of the 7th century while the figural style evolved along side. New forms were also added to the repertoire. See Payne (1930) 1-15. Pohl (1972) 296, comments on the longevity of the Middle Protocorinthian ovoid aryballos.

instances when furnishings from individual tombs, or from separate burials within a large tomb, were mixed with extraneous finds.(22) It has been securely established that the earliest chamber tombs in Southern Etruria and Latium do not contain bucchero;(23) but since some of the tomb groups datable to the first half of the 7th century were not preserved intact, (24) it is difficult to be sure when bucchero was first made.

The bucchero vessels from the right-hand chamber of the Regolini-Galassi tomb at Caere are generally considered as belonging to the initial phase of bucchero production.(25) There is not, however, agreement on what absolute dates should be attached to the Protocorinthian pottery found in association with the bucchero.(26) Those favoring a 'high' chronology consider ca. 675 as an appropriate date,(27) while a date

(22) A recent discussion on the status of the major Orientalizing tombs along with a critique of attempts to reconstruct some major tomb groups is given by Strom (1971) 140-170. See also Ramage (1970) 11-15.

(23) Such as the Bocchoris tomb and Warrior tomb at Tarquinia. On the Bocchoris tomb see Hencken (1968) 374-176, Strom (1971) 149-150, and Ramage (1970) 2. On the Warrior tomb see Hencken (1968) 201-220, and Strom (1971) 141-145. The earliest tombs at Poggio Buco do not contain bucchero. See Matteucig (1951) 54-64 and 70, and Bartoloni (1972) 221 ff. See also Pohl (1968) 264 ff. and infra n. 33.

(24) Strom (1971) 155, notes that no pottery whatsoever was kept from the Castellani tomb at Praeneste which is approximately contemporary with the Bernardini and Barbarini tombs datable to the first half of the 7th century. ibid. 154-159. It was thought that some bucchero sherds were found in the Bernardini tomb at Praeneste but Curtis (1919) 10 ff. and 87 ff., indicates they may have been mixed with the finds at a later date. See Strom (1971) 151.

(25) Ramage (1970) 11-12. However they may not be the earliest pieces of bucchero. See Bonamici (1974) 87, and infra n. 27.

(26) Pohl (1972) 274, n. 69, maintains that, "There is almost no pottery in the Regolini-Galassi tomb which can with certainty be attributed to the chamber, (i.e. the right-hand burial), owing to the circumstances of excavation".

(27) Colonna (1968) 268.

during the third quarter of the 7th century has also been proposed for this burial.(28)

The discovery of a tomb at Ceri, some 5 km. East of Caere, containing impasto, early bucchero and Protocorinthian pottery seems to favor the higher chronology.(29) An impasto amphora from the tomb has been compared to another such vase found in a burial at Pithekoussai, which could be as early as the first decade of the 7th century.(30) A Cumaeian oinochoe with herons portrayed on the neck and an aryballos both resemble Early Protocorinthian types but may well be Middle Protocorinthian versions of the earlier style.(31)

A 'tall kotyle' from the Ceri tomb is considered as Early Protocorinthian by some.(32) A kotyle from the right-hand chamber of the Regolini-Galassi tomb has been cited as another contemporary example of the kotyle from Ceri.(33) However, another author prefers to assign the Regolini-Galassi kotyle, along with the rest of the Protocorinthian pottery from this burial, to the Late Protocorinthian period.(34) There is also a difference of opinion on where to place two Protocorinthian skyphoi from

(28) Strom (1971) 168, would date the chamber to this period.

(29) The contents are briefly described and partially illustrated by Colonna (1968) 268 and figs. 3 and 4, pp. 269-270. But see also infra n.35.

(30) Ridgway (1973) 16 and 28, places the Pithekoussai burial in the Early Protocorinthian period, (720-690). He suggests a date for the Ceri burial "in the region of 700-690", in Ridgway (1974) 48.

(31) Colonna (1968) 271.

(32) Ridgway (1974) 48 and Colonna (1968) 271.

(33) Colonna (1968) 271.

(34) Ramage (1970) 2 and 12.

the Ceri tomb in the Protocorinthian sequence. (35)

As yet there is not complete publication of the Ceri material so there should be some reservation about interpreting the find irrespective of which chronology one chooses to accept for the Protocorinthian pottery. The tomb was apparently a single chamber, but not of the earliest type known. (36) There is no mention of the number of burials, (37) and it seems possible that the tomb had been disturbed. (38) It is also possible that a bucchero amphora from the Ceri group is not true bucchero but a 'buccheroid' fabric, (39) which may have been a precursor to bucchero sottile. (See infra pp. 31, 58-59 ff.)

Given the uncertainty about the process governing the selection of material for burial, the doubtful integrity of some major tomb groups and

(35) Ramage (1970) 14, describes material on display from Tomb 2 in the Cerveteri Museum. Her brief description of the bucchero and other pottery indicate that she is speaking about material listed by Colonna as derived from the Ceri tomb. However, Ramage does not mention the Cumaeian oinochoe illustrated by Colonna. It may be that some material was overlooked by Ramage, or possibly there has been a mixing of the Ceri material. Hopefully this confusing situation can be resolved by full publication of the tomb group.

The two Protocorinthian skyphoi could be of post 650 date, according to Ramage (1970) 14; Ridgway (1974) 16 and 28, suggests a date between 700 and 690; Colonna (1968) 271, considers the finds cannot be later than the end of the first quarter of the 7th century and cites a globular aryballos made in bucchero which he also feels should be at least as early as the bucchero from the Ceri tomb.

(36) Colonna (1968) 268, gives no illustration but notes that the tomb was a "hypogaeum" without a bench as opposed to the earlier "semihypogaeum" variety. See also supra n. 23.

(37) Colonna (1968) 268.

(38) Ramage (1970) 14, mentions that Tomb 2 of the Cerveteri Museum was "not intact". See also supra n. 35.

(39) Ramage (1970) 14, says the amphora none the less "looks like real bucchero". Colonna (1968) 268, ~~described all three vessels~~ as "reddened during firing" which makes them sound more like buccheroid than true bucchero.

the imprecision inherent in relying on Protocorinthian pottery for absolute chronology, it is impossible to assign a finite date to the earliest examples of bucchero sottile. On the one hand, there seems to be ample evidence that bucchero manufacture had begun by the Late Protocorinthian period, (40) which according to the traditional chronology began at about 650. (41) On the other hand, the Protocorinthian pottery and impasto amphora from the Ceri tomb group suggest that the bucchero from this tomb is earlier. However, the upper limit of 690 B.C. proposed for the Ceri burial appears rather extreme in light of the other evidence. It has recently been suggested that a compromise date for the beginning of bucchero production, ca. 660, would be a suitable choice for the present, until a comprehensive review of the chronology for the entire period is possible. (42) Since this proposal conforms reasonably well with existing evidence, it is considered that bucchero sottile emerged as a distinct fabric at about the middle of the second quarter of the 7th century for the purposes of the present study. It is none the less recognized that this approximate date may need revision when new evidence is brought to

(40) Ramage (1970) 11-14. In addition to the tombs cited by Ramage, Tomb 75, Zone A, of the Banditaccia necropolis at Caere contained early bucchero along with an ovoid aryballos and a piriform aryballos. See Ricci (1955) fig. 115, 4-5. Both the forms and decoration of these two vases are comparable to Late and Transitional Protocorinthian types, respectively, as illustrated by Cook (1972) fig. 5, p. 50. See Pohl (1972) 264 ff. on the chronology of four tombs from the Sorbo necropolis, (See fig. 267), two of which contain bucchero.

Bucchero also makes its first appearance at Veii with Late Protocorinthian pottery in the Monte Michele tombs. The chronology developed for the Iron Age necropolis of Quattro Fontanili places bucchero in the later part of Phase IIIA which spans the years between 700 and 630. Cristofani (1969) 70. See also Close-Brooks (1967) 323 ff.

(41) Payne (1930) 16, and Cook (1972) 53 and 338.

(42) Gran Aymerich (1972) 55, n.3. A similar date has been suggested for the earliest bucchero at Veii. See Cristofani (1969) 70.

bear on the problem. (43)

Accepting a date in the second quarter of the 7th century places the upper limit of bucchero production within the "Orientalizing Period" in Etruria. The Orientalizing Period is generally subdivided into an "Early" and a "Late" phase. The Early Orientalizing Period, which corresponds to Pallottino's Phase III of the Iron Age chronological sequence in Etruria, (44) begins during the closing years of the 8th century, or perhaps slightly later at some sites. (45)

It is difficult to assign an absolute date to the beginning of the Late Orientalizing period for two reasons. The principal reason derives from the fact that there is a gradual transformation of the Early Orientalizing material culture with no single event which provides a convenient starting point. One is also faced with problems analogous to those encountered when trying to fix an absolute chronology for bucchero since chronological reference points are once again based on Protocorinthian pottery predominately found in tomb groups. There is some agreement that a date during the second half of the 7th century is desirable for the end of the Early Orientalizing Period in Southern Etruria. The interval between 650 and 630 which corresponds roughly to the time span allocated

(43) Gran Aymerich (1972) 55, feels that a detailed study of stylistic evolution in bucchero and other pottery types in Etruscan contexts is needed to resolve chronological difficulties. However, it seems more likely that excavation of habitation areas yielding well stratified material, such as those at Poggio Civitate, (See *supra* n. 8), would provide a more reliable chronology than material from tomb groups subjected to typological analysis.

(44) Pallottino (1974) 48-49, and (1939) 108-117.

(45) Coastal towns in Etruria seem to display Orientalizing characteristics before inland sites. Pallottino *supra* n. 44.; Strom (1971) 201; Cristofani (1969) 67-70.

to the Late and Transitional Protocorinthian styles, offers an acceptable compromise.(46) Thus the appearance of bucchero occurs during the closing years of the Early Orientalizing Period.

The nomenclature used to denote this chronological period reflects the appearance of objects imported from the Near East and Greece in archaeological contexts in Etruria and Southern Italy.(47) The term 'orientalizing' also refers to the fact that pottery and metalware made by craftsmen in Etruria often derive their style and motifs from Near Eastern and Greek artistic traditions. The Early Orientalizing Period is distinguished by the predominance of inhumation over cremation burials, the construction of chamber tombs and tumuli, as well as by the inclusion of ivory and metal objects of oriental character in these burials.(48)

These phenomena continue during the Late Orientalizing Period, Pallottino's Phase IV. However, Greek pottery imports and local fabrics which copy them to a greater or lesser degree become much more plentiful. This prevalence of Greek elements over those derived from the Near Eastern tradition, which is apparent both in ceramic production and the other plastic arts, is considered the hallmark of the Late Orientalizing Period.(49)

(46) Strom (1971) 201, suggests the middle of the 7th century. Cristofani (1969) 70, suggests 630 on the basis of Close-Brooks' chronology for Veii, Period III. Pallottino (1939) 127, and Brown (1960) 46, give the 'late 7th century' as the cut-off date. On the Late and Transitional Protocorinthian chronology, see Strom (1971) 110-111, and supra n. 41.

(47) The period between 700 and 550 is also known as the "Archaic Period". Matteucig (1951) 79, and Richardson (1976) 43-62.

(48) Pallottino (1939) 108 ff., Strom (1971) 11. See also Brown (1960) 1-45, and Richardson (1976) 43-62.

(49) Pallottino (1939) 115 ff., Brown (1960) 46-90, and Ramage (1970) 4-11. Among the other numerous publications which discuss the influence of Oriental traditions on both Greek and Etruscan art see: Akurgal (1968), Demargne (1964), Blakeway (1933), Colonna (1961), Dumbabin (1948), Mansuelli (1965) and Whittaker (1974).

One of the principal issues concerning both the development of the orientalizing styles and the origins of bucchero sottile is the possibility that foreign craftsmen settled in Etruria during the Orientalizing Period. It is not intended to resolve the question at this time, but to explore the implications for bucchero manufacture by citing some of the evidence used to support the hypothesis that foreign craftsmen came to Etruria.

Metalware from various tombs provides evidence for the presence of Oriental craftsmen in Etruria. Silver bowls, including one from the Regolini-Gelassi tomb, have engraved decoration showing procesions of warriors and hunting scenes which link them with similar vessels from the Near East and Cyprus.(50) There is agreement that these bowls were in most cases produced by Phoenician craftsmen.(51) It is also argued that some details in composition betray attempts by immigrant craftsmen working in Etruria to include Etruscan elements in scenes which are otherwise oriental in content and style.(52) On the other hand, the validity of this evidence has been challenged.(53)

The combination of Oriental subjects and stylistic conventions rendered according to Etruscan practice have also led specialists to the conclusion that immigrant artisans, probably from Syria, produced the silver panels decorating a cista from the Castellani tomb.(54) At least

(50) Hopkins (1965) 191-201.

(51) Randall-MacIver (1972) 106-108, Hopkins (1965) 203, Strom (1971) 123 ff., and Brown (1960) 27-30.

(52) Hopkins (1965) 200-203.

(53) Strom (1971) 126-127.

(54) Cristofani Martelli (1973) 118-119, draws attention to the motif of the dancing soldiers as a local element, See also Strom op.cit. 212-214.

some of the gold jewellery found in Chamber tombs of the late 8th and early 7th century could be considered as resulting from "a co-operation of immigrated Syrian and local Etruscan craftsmen".(55) A final piece of evidence for the presence of foreign metalworkers in Etruscan towns consists of examples of bronze plaques with iron inlay.(56) As this technique was commonly practiced in the Caucasus, it has been postulated that craftsmen from this area introduced the new technique to Etruria during the Early Orientalizing Period.(57)

Ivory objects with carved and incised decoration furnish additional testimony supporting the idea that artisans came from abroad and established workshops in Etruria. The ivory carvings included animal figurines and pyxides which can be traced to the traditions of Syrian workshops. The earliest examples look like imports but the gradual abandonment of Oriental conventions suggests local apprentices took over establishments founded by Near Eastern immigrants in Etruria.(58) The fact that ivory

(55) Strom (1971) 211-212.

(56) The plaques or chariot fittings from Populonia are illustrated by Minto (1954) fig. 19, p. 317. A protome or 'pole end', reputedly found at Praeneste was also made with this technique. Brown (1960) 21 and Pl.Xa.

(57) Brown.(1960) 21-22, notes the scarcity of comparative material. Boardman (1973) 62, cites pendants and figurines of Caucasian flavor in Greece during the 8th century.

Bronze cauldrons with protome attachments and single protomes from Etruscan tombs have parallels in the Orient and Greece. See Amandry (1956) 239-261; and Maxwell-Hyslop (1956) 150-167. It is held that these objects were imported into Etruria from North Syria or perhaps Greece. See Strom (1971) 131-134, Boardman (1973) 62-66. However, if Syrians can be credited with founding ivory and precious metal workshops in Etruria, it seems hard to dismiss Maxwell-Hyslop's suggestion, *op.cit.* 161 and 165 that immigrant bronze workers from this region also went West to Italy. See also Hopkins AJA 64 (1960) 368-370.

(58) Brown (1960) 2 6-8 and 32-34. Some objects also show Phoenician influence. Strom (1971) 203, accepts Brown's ideas.

was not a native material in Italy certainly strengthens the probability that Syrians initiated the local industry. (59)

The appearance of what seems to be locally made pottery with painted decoration and shapes which basically copy Greek fabrics, (see *infra* pp. 60 ff.), also leads to the conclusion that immigrant craftsmen settled in Etruria during the Orientalizing Period. A crater from Caere with panels showing the blinding of Polyphemos and a naumachia may have been made locally by the Greek Aristonophos, (or Aristonothos), whose signature appears on the vase. (60) His style and the shape of the crater have led to the theory that he worked first in an Athenian workshop, then moved West to Syracuse and finally settled at Caere, or Cumae, toward the middle of the 7th century. (61) The possibility that he established a pottery shop in Etruria is strengthened by the discovery of another crater at Caere painted either by Aristonophos or someone trained by him. (62)

The archaeological evidence for the presence of foreign craftsmen resident in Etruria during the first half of the 7th century, (63), although impressive, is not yet conclusive. On the other hand, literary sources corroborate these findings. There is an anecdote which claims a certain Demaratus of Corinth left Greece and settled at Tarquinia when Cypselus

(59) Brown (1960) 2, Ramage (1970) 5, and Strom (1971) 203, follow Brown. Boardman (1973) 60, postulates Oriental ivory workers at Athens.

(60) von Vacano (1965) figs. 19-20. Demargne (1964) figs. 532-533. See also *infra* p. 62.

(61) von Vacano (1965) 77. Bonfante (1960) 168 n.41.

(62) Bonfante ~~supra~~ n. 61. Cristofani Martelli (1973) 111; and Cristofani (1969) 62 n.5. The vase is still unpublished.

(63) In addition to what has already been noted, two newly discovered stone statues from the vicinity of Caere may be the work of immigrants. See Ridgway (1974) 48.

came to power in 657.(64) The story adds that he brought craftsmen with him who introduced terra cotta manufacturing and painting techniques to the local populace.(65)

Two inscriptions in Etruscan on pottery vessels from Etruscan sites also seem to indicate Greeks living among the local populace. The first from Tarquinia, presumably identifies rutile hipocrates as the owner of the vessel. Conceivably, Rutilius was the son of a Greek, Hippocrates, who married an Etruscan woman as did the sons of Demaratus, according to the literary tradition.(66) A bucchero aryballos from a tomb near Caere gives the name of someone who appears to be another "etruscanized Greek", Telecles.(67) These graffiti considered in conjunction with the ivory, metalware and pottery from Etruscan tombs leave hardly any choice but to accept the substance, but not necessarily all the details, of the Demaratus legend.(68)

More concrete proof of Greeks living in Etruria after the Early Orientalizing Period has also become available with the discovery of a

(64) Dion H. 3.46; Livy I. 34; Pliny N.H. 35.43.152; Herodotus 5.92. Cited by Richardson (1976) 89 and 118.

(65) Pliny N.H. 35.43 151-153 and 35.5.16. Cited by Richardson *supra* n.64.

(66) Richardson (1976) 66.

(67) Colonna (1968) 271. The full reading is *mi larthaia telicles lextumu(za)*; Colonna (1973-1974) 143-144, *lextumuza* referring to the vase type. Telicles may have taken the name Larth upon receiving Etruscan citizenship; Colonna (1970) 649 and 649 n.4. Possibly the owner was Larthia, a feminine descendant of Telecles. See Pallottino 212-214, on the irregular formation of feminine names and on gentilitial names.

(68) Mansuelli (1965) 64; Richardson (1976); and von Vacano 118. Such immigrants would presumably have promoted the adoption of the Cumaean Greek script used in the earliest Etruscan inscriptions. See Pallottino (1976) 209-211; and Heurgon (1969) 118-119; and Hencken (1968) 616.

sanctuary at Graviscae, the port of Tarquinia. The structure, built according to Greek methods, contained votive offerings with Greek graffiti and a cippus dedicated to the Aeginetan Apollo.(69) This sacred building was erected around the year 580,(70) and thus predates the peripteral temple at Pyrgi near Caere which had previously been thought of as the earliest architectural testimony of Greek metoichoi in Etruscan Ports.(71)

Essentially, it seems that Greek artisans reached Etruscan sites in increasing numbers during the course of the Early Orientalizing Period. The establishment of Euboean settlements at Pithekoussai on Ischia and at Cumae during the second quarter of the 8th century and the subsequent foundation of Greek colonies in Sicily, no doubt accounts for much of the Orientalizing art reaching Etruria. The artifacts of both Italic and Phoenician origin which have been found at Pithekoussai,(72) provide testimony of the role played by the colony on Ischia and its sister city at Cumae as the Western terminus of trade routes from the emporium at Al Mina in North Syria where Greek traders had established themselves by the early 8th century.(73) There is also evidence from Pithekoussai for the manufacture of bronze jewellery and for the processing of iron brought from Elba.(74) Thus one can easily imagine Greek traders and craftsmen calling at

(69) Torelli NSc (1971) 195-299, Ridgway (1974) 49-51 and figs. 9-11.

(70) Ridgway (1974) 49-51.

(71) Pallottino (1975) 87 and 111-112.

(72) Ridgway (1973) 13 ff. and fig. 2.

(73) On the importance of Ischia, see Buchner (1966) 4-12, and (1971) 63-67; Ridgway (1973); Boardman (1973) 37 ff., and (1965) 12-15.

(74) Klein (1971) 34-39, and Ridgway (1973) 18.

Etruscan coastal sites as ships made the voyage northward from Ischia to obtain supplies of iron.(75)

While the importance of the emporium at Ischia is beyond question, its existence need not preclude visits from Phoenician traders or the arrival of Near Eastern craftsmen in Etruria. If all trade goods passed through the Greek colonies, it is hard to explain why some types of metalware commonly found in Greece and Syria do not appear in Etruria.

(76) Also, since Phoenician imports are plentiful in Etruria during the Early Orientalizing Period,(77) it is possible that Phoenician traders were calling at Etruscan ports. The bucchero vessels found at Carthage were presumably obtained during one of these Phoenician voyages to Etruria.(78)

However, there seems to be no evidence that Phoenician pottery reached Etruria. Greek wares did. This seems to imply that if Phoenician boats visited the coast of Etruria, they did so less frequently than those manned by Greek sailors. There is always the possibility that Phoenician merchantmen transported Greek pottery along with objects of Near Eastern manufacture. Indeed, Protocorinthian pottery from Carthage (79) strengthens this possibility. Essentially, one can not always know who occupied the ships which brought Oriental and Greek objects to.

(75) Of course, Etruscan boats could have visited Ischia or relayed iron and imported objects up and down the coast. See Strom (1971) 201.

(76) Strom (1971) 205-206.

(77) Ramage (1970) 6-8; Strom (1971) 206-216; and supra n. 45-48.

(78) Turfa (1977) 368 ff.

(79) See supra n. 78. The bucchero and Corinthian pottery is currently on display in the Bardo Museum, Tunis.

Etruria, but regardless of this uncertainty, it can be seen that regular commercial contact existed between the Orient and Etruria during the Early Orientalizing period. Even if Syrian or Phoenician immigrants did not arrive in their own vessels, they would presumably have been able to book passage on Greek merchant ships heading West.(80)

This exposé devoted to the evidence for foreign craftsmen in Etruria during the Early Orientalizing period is not intended as an attempt to resolve the much-debated issue of Etruscan origins.(81) Investigating this topic is not necessary for a discussion of the development of bucchero sottile since the first examples of the fabric appear after the clearly recognizable, particular traits which characterize the Etruscan culture become evident. Chamber tombs, tumuli and fossa graves containing locally made red and white pottery, as well as metalware and weapons of local manufacture, often accompanied by imported objects of orientaling character, appear during the second half of the 8th century at Caere and other major Etruscan sites. Specialists are often somewhat vague, but generally speak of 'Etruscans', as opposed to 'Villanovans', (the Iron Age inhabitants of Etruria), as soon as the period of chamber tomb construction begins.(82) Even though inscriptions in the Etruscan language occur

(80) The Assyrian takeover of Syria and Phoenicia during the 8th century provides a motive for craftsmen to migrate. Brown (1960) 1-2, Strom (1971) 216, and Hencken (1968) 597.

(81) On this question see Pallottino (1975) 64 ff., Heurgon (1969) 363-371, Hencken (1968) 603 ff., and Piganiol (1973) 16-48.

(82) Pallottino (1975) 71-75, Strom (1971) 11 ff., Richardson (1976) 48 ff. Hencken (1968) 753-758, unlike Strom, places the Warrior's tomb in his 'Villanovan II' phase, but bucchero is not found in the earliest tombs of his 'Period III' which he considers the first Etruscan era.

somewhat later than the first tombs, (83) the uninterrupted burial sequence and simultaneous, gradual evolution of tomb types, (84) indicate that it is appropriate to consider the earliest chamber tombs as those of Etruscans.

Although we have noted that the chronology for this period needs further revision, (85) it is clear that bucchero does not occur in the earliest chamber tombs of Etruscan cemeteries. (86) Certain elements of decoration and some of the forms used by bucchero workshops seem to derive from Greek and Near Eastern tradition, (87) but the fabric and ensemble of bucchero shapes indicate that production was initiated within the geographical boundaries of Etruscan territory as established by archaeological and historical criteria.

While this is not the place to debate the origins of the Etruscans, it is necessary to define more clearly what is meant by the phrase 'Etruscan craftsmen' as it is used in this study. This definition requires a brief discussion of the Iron Age complex of Caere. Craftsmen at Caere who developed bucchero were exposed not only to Oriental and Greek artistic conventions, but also to those used by the Iron Age Italic populace.

The Sorbo necropolis at Caere contained both cremation burials and biconical urns such as those found at other Villanovan sites, as well as

(83) See Colonna (1968) 271; and supra n.82.

(84) Although development of tomb architecture is not uniform throughout Etruria. See Pallottino (1975) 159; Colonna (1967) 1 ff. The sequence at Poggio Buco from simple chamber to multi-chambered tombs is discussed by Matteucig (1951) 1-10.

(85) supra. pp. 7 ff.

(86) supra. n.82.

(87) Ramage (1970) 19 ff., and Bonamici (1974) 87 ff.

inhumations in trench graves of the type encountered in the Fossa Culture of Central and Southern Italy.(88) This would suggest that two separate ethnic groups inhabited Caere during the Iron Age. However, the tomb furnishings from both types of burial, essentially impasto pottery and and fibulae, are considered uniform in style. This seems to indicate that if different ethnic population elements originally came to Caere, they had already formed an integrated culture by the late 9th or early 8th century, the period when the Sorbo cemetery was inaugurated.(89)

The Iron Age grave goods from Caere also display similarities with archaeological material from Latium. The biconical ossuaries are considered more closely related to those used in other parts of southern Etruria than to those used further north at sites such as Tarquinia. Other vessels used for cremation burial along with other pottery offerings and fibulae resemble material normally found in the Fossa culture burials in Latium.(90) This cultural 'affinity' with Latium is not a phenomenon peculiar to Cerveteri since parallels in Iron Age pottery types, burial practices and hut construction are visible between Latium and other sites such as Veii and Falerii in Southern Etruria.(91)

(88) Description of the Sorbo material is taken from Pohl (1972).

(89) Pohl (1972) 293. Although not questioning this particular conclusion per se, Delpino (1973) 555 ff., finds the methodology used by Pohl for determining stylistic evolution too subjective. See also Gañtz (1973) for a less critical review of Pohl's study.

(90) Pohl (1972) 293. Delpino (1973) 558-559, thinks that the similarities between the Sorbo material and finds from Latium are overemphasized, noting that the geometric designs decorating impasto from Caere have many similarities with material from Tarquinia.

(91) Gierow (1966) 483 ff; Gjerstad (1966) 241 ff. Colonna (1967) 16-18.

The material from later Iron Age burials in the Sorbo necropolis can be divided into two distinct groups. The first division includes Primitive Impasto pottery and various types of fibulae which continue the styles manifest in the earliest cremation and inhumation burials in the cemetery. The second category of artifacts occurs in a few fossae and a large number of chamber tombs from the same necropolis. This material includes pottery and jewellery which is normally considered typical of the Etruscan culture. The Etruscan fibulae are more elaborate,(92) and the pottery includes red and white painted vessels as well as impasto pottery whose shapes are not found in the Iron Age fossae and pozzi. Buchero of the early variety appears in some of the fossae along with other Etruscan material.(93)

The obvious differences which distinguish the Etruscan graves from the other contemporary burials have been interpreted as demonstrating that the Etruscans were a new population element, arriving at Caere in the late 8th or early 7th century.(94) Whether or not one chooses to accept this demographic interpretation of the Sorbo finds,(95) there are other important conclusions which can be drawn from the two categories of Late Iron

(92) Pohl (1972) 279-292 and figs. 272-275.

(93) Pohl (1972) 264 ff. The four fossae containing Etruscan material are modestly furnished in comparison with the Regolini-Galassi tomb from the Sorbo, or with other chamber tombs from Caere which date to the first half of the 7th century.

(94) Pohl (1972) 264 ff.

(95) As the vast amounts of material from other Iron Age and Etruscan tombs at Caere is still unpublished, Pohl (1972) 293, notes that present interpretations may have to be changed. Interpreting the material of the Etruscan type as an indication of the arrival of new population elements is challenged by Delpino (1973) 559-562. See also Colonna (1967) 18 ff.

Age burials. The grave furnishings demonstrate that at Caere, as at San Giovenale where Iron Age huts and Etruscan houses apparently coexisted, (96) the Iron Age pottery tradition was not abandoned immediately with the beginning of the Orientalizing Period. A significant portion of the population continued to follow Iron Age fashions. It is also apparent that the distinction between the Late Iron Age burials and burials containing Etruscan material reflects economic differences within Caeretan society.

When one compares the size and furnishings of Etruscan tombs with the simple fossae containing meager offerings of Iron Age impasto, it is easy to accept the proposition that the late Iron Age burials belonged to a lower class of society at Caere. (97) The material from the Sorbo cemetery does not permit a thorough understanding of the social and economic position held by the poorer segment of the Caeretan population which preserved the Iron Age pottery tradition. (98) However, it is plausible that members of this lower economic class became potters serving the wealthier members of the community at Caere.

Pohl sees the homogeneous character of the impasto from Iron Age burials of the Sorbo cemetery as indicating that individual clans or families did not make their own pottery but relied on professional

(96) Pohl (1972). 294 and 294 n.4. Villanovan pottery also continued to be made at Tarquinia during the Early part of the Orientalizing Period, the first Etruscan phase, Hencken (1968) 578-586.

(97) Pohl (1972) 294-295.

(98) Pohl supra n.97. It should also be pointed out that one cannot identify specific racial characteristics for either the Iron Age or the 'Etruscan' sectors of the Caeretan populace on the basis of the evidence currently available from the Sorbo burials.

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 potters.(99) The material illustrated from the Sorbo necropolis, mostly burial urns, hardly justifies this conclusion for the earliest period, since the hand-built vessels show considerable variability in their profiles. It is suggested that women of the households supplied their families' pottery before the advent of the wheel at Tarquinia and Rome, by analogy with primitive tribes observed by modern anthropologists.(100) The physical appearance of the earliest impasto from Caere could lead to a similar conclusion.

However, at Caere, as at Tarquinia and various sites in Latium, a transformation of impasto pottery occurs during the later part of the 8th century which enables one to distinguish between Primitive and Advanced Impasto fabrics. (*infra* pp. 52 ff.) Advanced Impasto incorporates improvements in technique including the use of more refined clay and more uniform coloration. Advanced Impasto was also often wheel-made, unlike the earlier hand-built variety. As would be expected with pottery made on a potter's wheel, the Advanced Impasto shapes are more standardized. These characteristics make it seem likely that professional potters were responsible for Advanced Impasto manufacture. The appearance at this time of other fabrics with standardized forms and decoration increases the likelihood that the pottery industry in Etruria came under the control of professional potters during the Early Orientalizing Period.(101)

(99) Pohl (1972) 293.

(100) Hencken (1968) 657-658.

(101) Hencken *supra* n.100, finds Gjerstad's criteria for Advanced Impasto too subjective. However, Ridgway (1968) 237, justifiably finds the classification "acceptable". On the other varieties of pottery, see *infra*. pp. 59 ff.

Although Advanced Impasto can be distinguished from earlier Iron Age pottery, its shapes and decoration were often derived from the Primitive Impasto tradition. Furthermore, the technique used to color the Advanced variety was essentially the same as that previously used by Italic potters. (*infra* pp.53 ff.) The producers of Advanced Impasto merely adopted more sophisticated fabrication methods while preserving the basic techniques inherited from their Italic predecessors. Advanced Impasto is commonly found in Etruscan chamber tombs at Caere and elsewhere along with imported Greek pottery and other locally made fabrics including bucchero. (102) Thus it becomes clear that potters raised in the Iron Age tradition supplied pottery for the more prosperous segment of the population in Etruscan towns.

It certainly seems reasonable to refer to potters working in the Iron Age tradition as 'Etruscan' along with the wealthier members of society at Caere. These artisans were not merely onlookers, but participants in the economy and society of Etruscan cities, regardless of their humble origins or the exact nature of their ethnic background. (103) Thus when Etruscan potters are mentioned in this discussion of bucchero manufacturing, one is intended to think of people raised in the cultural milieu of Etruscan cities, descended from the Iron Age population whose pottery tradition they continue. This includes artisans making impasto pottery, those making pottery with red and white decoration which does

(102) For example, Tomb 75 of the Banditaccia necropolis reported by Ricci (1955) 486-490. See *infra* pp. 52 ff. for the discussion of Advanced Impasto.

(103) Especially since there is no proof that the Iron Age population spoke a different language or that the wealthier people buried in chamber tombs were not descended from families once less wealthy of Villanovan ancestry.

not duplicate Greek fabrics, and the craftsmen making bucchero sottile.

However, there is another group of craftsmen who can be considered 'Etruscan' potters. It is customary to attribute production of fabrics similar to those made in Greek cities, but in a less competent manner and with stylistic idiosyncracies which are non-Greek, to "Etruscan" artisans.

(104) It is assumed that these artisans were local inhabitants trained by Greek potters. (*infra* pp. 62 ff.) Certainly some potters could have been the offspring of immigrant potters like Aristonophos. One can not be certain that siblings trained to make Greek fabrics did not participate in production of Italic impasto pottery, but as the techniques used by Greek potters were quite different, (*infra* pp. 63 ff.) it seems unlikely. (105) If potters with a direct knowledge of Greek pottery production methods worked in shops making impasto pottery or the local painted fabric, their influence might have helped refine some aspects of production. (*infra* pp. 66-67 ff.) Their hypothetical participation does not seem to have altered the fundamental technical processes used in Etruria during the Iron Age.

Although it is clear that the Iron Age pottery tradition was not broken by the intervention of Oriental and Greek artistic ideas during the early phases of the Etruscan cultural sequence, we have seen that there is ample evidence to suggest that immigrants from Greece and the Near East established themselves in Etruscan towns, including Caere. As

(104) It is possible that immigrants were given citizen status by Etruscan cities. See Colonna (1970) 649 and 649, n.4. and *supra* n.67.

(105) One should note that Amasis, who may have introduced the Egyptian form of stone alabastron into the black-figure vase repertoire, was possibly an Egyptian immigrant working at Athens. See Boardman, (1973) 150.

it seems probable that highly skilled Greek potters were among these newcomers, it is easier to understand why scholars have credited them with developing bucchero, since the methods used to make the bucchero are thought to duplicate those employed for making contemporary Greek painted pottery.

Having considered the evidence which has been adduced for the activity of Greek potters in Etruria at the time when bucchero manufacture began, we shall now attempt to determine how closely bucchero fabrication techniques actually conform to the process employed by Greek potters.

Chapter II

Physical Description of
Bucchero and Contemporary Fabrics

It has been noted that the term 'bucchero' was adopted for the Etruscan fabric on the basis of its physical resemblance to a variety of Precolumbian pottery. (supra p. 1) Unfortunately, as in the case of 'Samian ware' and other types of pottery made in classical antiquity, (104) the label 'bucchero' has been applied rather loosely to various fabrics with black or grey coloration. (105) Among the types of pottery which share some physical characteristics with bucchero, impasto pottery vessels from Etruria made before and during the time when bucchero was produced often have shapes similar to those occurring in bucchero. These impasto vessels often have a lustrous black surface as well, which makes them difficult to distinguish from bucchero sottile. (infra pp. 58-59) This phenomenon has led to the suggestion that use of the term 'bucchero' should be restricted to Etruscan pottery with both a black surface and a black core. (106)

Customarily, the adjective 'buccheroid' is applied to other Etruscan fabrics which have shapes and/or decoration resembling what one finds in bucchero, but which do not duplicate exactly the typical bucchero fabric color scheme. (107) Pottery of the buccheroid category includes vessels with

(104) On the problem of confusion arising from the use of 'Samian', 'terra sigillata' and 'Arretine'; see Wells (1972) 254-256, and Charleston (1958) 9ff.

(105) One finds the term applied to prehistoric pottery from the Troad, as well as to Archaic Greek pottery from Asia Minor and the Sporades. See Forsdyke (1914) 126-156.

(106) Ramage (1970) 3-4.

(107) For example, Gjerstad (1966) 110, who emphasizes the similarity in shape. Also Ramage (1970) 3-4.

a completely black surface and reddish or dark brown core as well as vessels which combine dark brown, reddish or grey cores with brown, reddish or mottled surfaces.(108)

Since pottery of the bucceroid variety combines some qualities found in local impasto and others embodied in buccero, there is a tendency to regard bucceroid fabrics as an intermediate technical stage between local impasto and buccero, before buccero sottile emerged as a distinct type. There have been objections raised to this view of bucceroid vessels,(109) but further discussion of the question will be postponed until the fabrics have been described in detail.(110)

The nomenclature used for a group of vases in a grey fabric, and which might properly fit under the bucceroid heading, is another potential source for confusion. This pottery, isolated from the other material found in the chamber tombs at Poggio Buco, has been dubbed 'Grey Buccero' as it may represent an early phase of buccero production.(111) Objections raised because buccero pesante (which supersedes sottile production) often has this title(112) seem well founded.

True buccero sottile is thus clearly distinguishable from earlier local fabrics by its uniformly black, very lustrous surface, and black interior. The pottery was wheel-

(108) The adjective has also been applied to Hellenistic pottery. See Lamboglia (1952).

(109) Ramage (1970) 3-4, Dohan (1942) 3-5.

(110) *infra* pp. 54 ff.

(111) Matteucig (1951) 14-15. See also *infra* pp.58 ff.

(112) Ramage (1970) 3-4.

made for the most part, although apparently some early pieces were hand built.(113) Frequently for the more imaginative pieces, molded parts were grafted to portions made on the wheel.

The excellent qualities of the bucchero finish are recognized by all commentators, but disagreement among specialists over the exact physical nature of the glossy surface remains unresolved. Certain authors refer to a slip covering the bucchero surface,(114) while others make no mention of such a feature.(115) An examination of some pieces of bucchero in the Royal Ontario Museum collection with the naked eye and a pocket magnifying glass (4x) gave no indication that a slip was present. This is in contrast to Protocorinthian ware from approximately the same period, and also to black-figure and red-figure pottery of Greek and Italic origin, in which one can easily distinguish the thin coating of clay on vessel surfaces.(116) The fact that the

(113) There is a model boat with incised decoration on display in the Museum of Fine Arts, Boston, Mass. which is described as 'impasto'. The object, #01.8064, was apparently constructed from slabs. The high lustre and uniform color make it look very much like true bucchero, although one would need to examine the core to see if the vessel was completely reduced during firing. In any case the vessel must be considered bucceroid rather than impasto, if it is not true bucchero.

(114) Gjerstad (1966) 119. Also DelChiaro (1966) 100.

(115) Matteucig (1951) 14-15, Lollini (1959) 203ff. and Ramage (1970) 1ff.

(116) I wish to express my gratitude to Dr. John Hayes for allowing me free access to the bucchero and other pottery in the Royal Ontario Museum. His comments were also extremely helpful, although opinions put forth in this paper concerning the pottery in question should not be attributed to Dr. Hayes, but to myself. I also wish to thank Dr. Martin Kilmer,

bucchero fabric is black throughout might make a thin coating more difficult to perceive, whereas the difference in color between the biscuit and slip of black-figure pottery facilitates making such a distinction.

It is clear that there are usually two and occasionally more zones of color visible in the walls of bucchero vessels.

(117a) However; these are not thin enough to represent an application of a slip. (117b) We will examine this phenomenon in detail at a later point, but it can be observed now that spectrographic analysis of samples from the exteriors and interiors of several individual bucchero vessels showed no difference in the content of major inorganic components. (118) Thus, if a slip was normally added to bucchero it must have been made from the same clay as that used for the body of the

University of Ottawa, who took the time to examine many of the pieces which I had examined in the ROM collection and for subsequently sharing his insights with me. Dr. Kilmer, after using a pair of 6x magnifying glasses to achieve 12x magnification; was also unable to distinguish any slip on the bucchero he examined.

(117a) See *infra* pp. 84 ff. Examination of bucchero in the ROM revealed that sometimes four or five zones of color could be ascertained on the basis of different intensity.

(117b) The term 'slip' generally is used to refer to a covering of refined clay applied to a given vessel before firing. Shephard (1954) 66. An excellent discussion of the French terminology related to surface coatings on pottery is given by Picon (1973) 37ff. The slip applied to Greek pottery which produces a red or black color, depending on the firing atmosphere (*infra* pp. 73 ff.), is sometimes called a 'paint', other times a 'glaze', and occasionally a 'gloss'. Opinions vary on which term is most suitable. See Noble (1965) 36-37, Moevs (1973) 119-120, Farnsworth and Wisely (1963) 389, and Bimson (1956) 200ff. See also *infra* n. 140.

(118) Leoni and Trabucchi (1962) 259, conducted tests with four chalice fragments. Their results were confirmed by Cesareo and Guidobaldi (1972) 514, but only using one sample vase from Caere.

pottery. This was also the case for Attic black-figure, but apparently not for Corinthian pottery.(119) It seems that only a thorough microscopic and chemical study of the surface and cross-section of bucchero is needed to settle the question of whether or not the fabric was slipped.

The possibility, discussed previously, that Etruscan potters adopted Greek practices for bucchero manufacture would tend to favor the hypothesis that a carefully prepared slip accounts for the bucchero lustre.(120) That is because the sheen of the Greek black-gloss results in part from the effect of firing on the carefully prepared slip used in Corinthian and Attic workshops.(121) However, it will become apparent that one can not assume bucchero was fired in the same manner as Greek pottery.(infra pp. 92 ff.) Furthermore, there are other factors such as burnishing and clay composition which can affect the degree of lustre on pottery, independent of the application of a slip.

Whether or not bucchero sottile was burnished provides another source of contention among pottery specialists, although this aspect of the production process is often discussed in a perfunctory fashion.(122) Generally,

(119) See infra pp. 89 ff.

(120) This is clearly the assumption, although not always expressed, made by some commentators. See Richter (1936) 61, and DelChiaro (1966) 98-110.

(121) Noble (1965) 36-37, Farnsworth and Simmons (1963) 389, Cook (1972) 242-243, and Folsom (1975) 11.

(122) Matteucig (1951) 15, calls the surface 'well polished'. Richter (1936) does not discuss the question but refers to Greek methods for obtaining a black-firing slip.

'burnishing', is used to denote a process whereby the surface of a vessel is rubbed or smoothed with a tool. Implements used for this purpose can be quite simple: a smooth pebble or a stick sufficing in some instances. Swabs made from bits of cloth or hide can also be employed.(123)

Before burnishing, gross irregularities must be removed by scraping or rubbing the vessel while the clay is still plastic. The burnishing process can then be carried out immediately, but frequently burnishing is conducted after the pottery has partially dried to the 'leather hard' state. Once dry, the vessel exterior is wetted again and rubbed vigorously with a hard or soft polishing tool.(124) Rather than simply wetting the surface before burnishing, vessels may be coated with a slip and subsequently burnished. The latter practice was apparently followed by Greek potters.(125)

Burnishing not only gives a very uniform, smooth surface but imparts lustre as long as the pottery does not shrink excessively with further drying or from the effects of heat during firing.(126) A well refined clay, such as

(123) Randall-MacIver (1921) 87, Shepard (1954) 67, includes flat bones in the list of burnishing implements.

(124) Shepard (1954) 66-67, 124 and 188ff. For excellent photographs of the process see Noble (1965) Figs. 61-62, p. 126.

(125) Cook (1972) 242-243. See also Noble (1965) 36-37, and Folsom (1975) 11.

(126) The smooth burnished surface plane reflects light like a mirror (i.e. in parallel rays). Excessive shrinkage wrinkles the surface, thus destroying the lustre. See Shepard (1954) 123-124 and 190.

that used for bucchero, is a definite asset if a glossy surface is desired, since there are few granular impurities which can protrude and interrupt the reflection of light from the mirror-like surface. In fact when fine textured clay is polished (or even carefully smoothed) when plastic, the finer particles 'float' to the surface, sometimes giving the impression that a slip was applied.(127) The investigators Leoni and Trabucchi seem to suggest that such a process accounts for the extremely smooth bucchero finish. They attribute the formation of an exterior layer of fine clay distinguishable from the less compact core to 'auto levigazione' rather than a deliberate attempt to polish the pottery after it had dried to the leather hard state.(128)

One observer has categorically denied that any visible sign of burnishing can be detected on bucchero.(129) However, there are unmistakable tool marks on a number of bucchero specimens in the Royal Ontario Museum.(130) A particularly good example is a chalice with a rouletted processional frieze,(131) whose interior and exterior surfaces preserve traces of working with a thin, slightly

(127) Shepard (1954) 191-192.

(128) Leoni and Trabucchi (1962) 261.

(129) DelChiario (1966) 100.

(130) The bulk of the collection is from Orvieto and Chiusi. Hayes (1975) 97.

(131) The chalice, #920x92.103, was made in two pieces, foot and socketed bowl. The frieze, showing a seated figure, women holding hands, and a flute player, suggests that the piece is related to others in the ROM collection datable to the early 6th century, which were made in Orvieto. See Hayes (1975) 98.

rounded tool. Horizontal wheel marks, clearly visible on the underside of the trumpet-shaped foot, were not visible on the exterior; but roughly parallel, horizontal marks made by the smoothing tool could be detected in places. There were also traces of horizontal markings on the interior vertical sides of the chalice bowl. Similar slightly concave markings, which remained in the bottom of the chalice bowl, were made in straight lines. Hence they must have been made after the piece had been thrown and the wheel stopped, probably after the vessel had been removed from the wheel.

This tooling occurred when the clay could still take an impression, but it is not obvious whether the vessel was allowed to dry to the leather hard state or if the clay was more plastic when smoothed. There is some indication that further polishing or smoothing took place following treatment with the rounded tool. This appears on the exterior of the foot where the ridges between the roughly parallel tool marks seem to have been smoothed flat. It is likely that from what one can observe from modern potters working in rather primitive conditions, this bucchero vase was wetted and wiped with a soft sponge or swab, or possibly with a flat tool, giving a final polishing to the surface.

Given the exceptional uniformity standard in the bucchero finish, one suspects the final polishing was normally carried out on a potter's wheel. This supposition seems to be confirmed by another chalice in the Royal Ontario

Museum.(132) Examination of the underside of the foot revealed that the clay surface was matt grey and exhibited wheel marks except for a circular band about 1 mm. wide whose lustrous black color contrasted sharply with the rest of the surface. The lustre was confined to a slight concave, uniform depression which, being perfectly concentric with the base, could hardly have been made without using the wheel.

One might suppose that this lustrous circle on a normally invisible part of the vessel was made as a casual gesture, but it could easily have been made by the potter to determine if the vase was properly centered before commencing the burnishing operation on the exterior of the chalice. The potter could also have traced the band in order to determine if the base had reached the proper state of hardness for burnishing, or he could have been testing a new tool.

While this band of color provides clear evidence that craftsmen sometimes used the potter's wheel when burnishing bucchero, its appearance also indicates that the bucchero lustre could apparently be obtained without application of a slip. This conclusion results from the fact that only the narrow band compacted by a tool displayed the typical bucchero lustre, while the remaining surface area on the underside of the foot, which had not been smoothed at all,

(132) The vase, #CA 208, is currently on display in the Etruscan collection. It forms part of a group discussed by Hayes (1975) 98-99.

displayed no lustre whatsoever.(133)

Further evidence that Etruscan potters relied on burnishing alone to obtain a glossy surface was visible on a bucchero kotyle, also in the ROM collection.(134) The exterior of the vessel displayed the typical bucchero finish, but only a portion of the cup's interior displayed the usual glossy black color. The interior surface of the cup was smooth and lustrous only on the upper portion adjacent to the lip. Below this smooth zone wheel marks were still visible, indicating that this lower portion of the vessel interior had not been burnished. This unburnished area was dark grey and unlustrous, and lacking any obvious signs that a slip had been applied.

It is possible that a slip was applied to all but the unburnished part of the vessel and so perfectly burnished that the lustre appears to result only from mechanical pressure. On the other hand, in order to coat this cup with slip over the entire exterior but only the upper portion of the interior, finger marks would presumably have been left at the lip or on the foot. There was no sign of such blemishes on the cup, although any marks could have been wiped away. However, one normally finds production potters

(133) It may also be observed that the stamped guilloche band on the exterior of the foot is less lustrous than the rest of the vessel surface. This is presumably because the decoration could not be burnished without destroying its detail. Tool marks elsewhere on the exterior surface suggest that the clay was burnished where possible.

(134) The kotyle is number CA 404 (941.58.1).

using the most efficient procedures possible. One could argue that this kotyle is an exception to the rule. But, since both the interior of this kotyle and the underside of the chalice discussed above are lustrous only where the clay surface has been burnished, it seems the bucchero artisans could have avoided using a slip to enhance lustre, and relied solely on burnishing for obtaining a glossy finish.

Admittedly these observations concerning the surface treatment of bucchero are based on a limited sample and thus need not apply to all cases.(135) One can still conclude without hesitation that Etruscan potters brought consummate skill and attention to bear when placing the final touches on bucchero sottile. Their success is attested by the fact that generally no trace of the burnishing process is obvious to observers.(136) Clearly in this respect their ability is equal to that of the Greek potters who rarely left a trace of their tool markings on the finished product:(137)

A further contributing factor to the high lustre of bucchero lies with the mineralogical composition of the clay.

(135) DelChiaro (1966) 98-100, suggests that not all workshops used the same technique for finishing the bucchero surface, but he does not discuss the reasons behind his suspicion.

(136) Signs of burnishing can also be found on bucchero pesante. In this context I wish to offer thanks to Dr. D. Brearley, Chairman, Department of Classical Studies, University of Ottawa, for his attempt to procure some examples of bucchero sottile for the departmental museum in order to assist my research. This aim was not achieved, but the two pesante vessels which Dr. Brearley did obtain provided useful comparative material.

(137) Richter (1972) 25.

Often one can observe shiny flecks in the bucchero surface and core. Analysis has shown them to be platelets of illite (a clay mineral containing mica).(138) This clay mineral tends to yield pottery with a glossy appearance as its platelets easily align themselves to produce a mirror-like surface. The high sheen of the classical Greek pottery, as well as the Hellenistic black-wares and terra sigillata, was possible in part because this mineral was present in the paste.(139) The lustre of these wares was further enhanced by physio-chemical changes provoked during firing.(140) This does not mean bucchero would necessarily have been fired in exactly the same manner as these other fabrics. The very presence of sufficient amounts of illite in clay is sufficient to produce some lustre.(141) The natural tendency of the micaceous clay to display a shiny finish would have been heightened by mechanically polishing the fine grained clay used for bucchero production.

In summary, it is important to realize that the bucchero lustre could be obtained without addition of a

(138) Illite is the generic name for clay minerals formed by the alteration of mica and feldspar minerals. Muscovite, the form of mica which often occurs in transparent particles; is found in Attic pottery and also in bucchero. See Farnsworth (1964) 222, Bimson (1956) 201, and Whitten and Brooks (1972) 84-85 and 290-291.

(139) Folsom (1975) 11, and Bimson (1956) 204.

(140) Heating until a Glanztonfilm, i.e. a partially vitrified coating, formed on the slip covering the pottery increased the lustre. This process is also commonly called sintering. Moevs (1973) 119 n.1. See also supra ns. 119, 125, 126 and 139.

(141) Bimson (1956) 201.

specially prepared slip such as that perfected by Greek potters who brought black-figured pottery to the Western Mediterranean. The clay used by the Etruscans was inherently lustrous and we can see that at least in some cases they used burnishing to augment the clay's naturally inherent qualities. In this respect they continued to exploit techniques used by Iron Age potters in Italy who burnished their pottery as well. (See infra pp. 50 ff.)

While the polished bucchero surface is normally hard and nonporous, one can frequently observe some small (less than one millimeter in diameter) pits in this finish. These apparently represent, in some cases, lost pieces of grit. The inclusions could have been lost when the pottery was smoothed or scraped during attempts at evening the surface before the final polishing. As the examples examined from the ROM collection showed no signs of marks produced by pulling grains of temper along the surface, the loss of these inclusions must have occurred after the clay was sufficiently dry to be non-plastic.(142) A second type of pit was also observed which, unlike the irregular concave holes left by lost temper, became wider as they deepened. These cavities in all probability originated when small organic inclusions

(142) See Shepard (1954) 187ff., on the effects of scraping. It should be noted that Shepard loc. cit. considers scraping an essential step if a fine finish is desired.

burned out during firing.(143)

Regardless of what one can deduce about the process used to shape and finish bucchero sottile on the basis of a simple visual examination there remains a greater than desirable degree of uncertainty concerning the methods used to obtain the bucchero surface finish. Some additional discussion of these questions appears under the section of this paper devoted to pigmentation (infra 69ff.), but it is very clear that only systematic microscopic and chemical investigations could establish whether or not a slip was applied. It should also be possible to evaluate the contribution made by polishing to the degree of surface lustre through experiments with test pieces made from Tuscan clays with essentially the same mineralogical composition as the bucchero body.

The uniform, lustrous surface of bucchero sottile lends a considerable amount of aesthetic appeal to the pottery. However, the Etruscan craftsmen also added various types of supplementary decoration. This topic is discussed in detail elsewhere (See Appendix I), but in order to compare the bucchero technique with methods used for making

(143) This need not imply that such organic material was deliberately added to the clay. See infra pp. 101ff. Actually the chalice in the ROM bears a roughly U-shaped blemish on its foot which looks as though it were made by a hair presumably destroyed when the vessel was fired. One could also grant the possibility that polishing after scraping might partially close the tops of some cavities left by removed grit, giving the impression that the inclusions had been burned out.

other contemporary fabrics, a few observations can be made at this point in the discussion. Bucchero potters most often relied on incised decoration to enhance the appearance of their pottery. Thin horizontal lines added singly or in groups were most often employed during the initial phase of bucchero production, although figural motifs were also incised into the surface of the pottery. Frequently, incised decoration was accompanied by semicircular 'fans' composed of dotted lines radiating from a common center. (See Figure VI) Simple geometric designs were applied with stamps. Some rather elaborate relief decoration was obtained through the use of molds. Individual vessels were also embellished by covering all or part of the surface with a thin coating of metal.

Having considered the nature of the bucchero surface, attention can be turned to the qualities of the clay body. The core of bucchero sottile, like the surface, is completely black, although somewhat less intense than the exterior. Silvery flecks of mica are plentiful but the interior zone cannot be termed lustrous. The small size of the visible inorganic impurities and the scarcity of large air holes set bucchero apart from the earlier impasto fabrics and contemporary coarse wares. Clearly a major achievement on the part of the bucchero workshops was the implementation of procedures for refining clay.

The non-plastic material identified in the bucchero body includes grains of muscovite (mica), quartz and

feldspar. One laboratory observed that a significant amount (some 80%) of these inclusions had been produced by 'crushing'. (144) This could indicate that the potters prepared their temper by pulverizing mineral rocks instead of utilizing particular deposits of sand or alluvium as they naturally occurred. A rather unusual feature in the chemical composition of bucchero is the high percentages of calcite in some samples from Pyrgi and Veii. One sample from the first site had 15.98% calcite, setting it apart from most of the other 33 sherds tested at the same time. Only 11 of the 34 samples had more than 1% calcite by weight. (145) A comparison of the values given in Table I shows that the relatively small amount of calcite in most bucchero clays sets them apart from those used for Protocorinthian and the pottery from the classical workshops at Athens. Otherwise the principal chemical constituents of bucchero are present in amounts essentially comparable to those available in Greece and Italy.

Determinations for the major mineral components in a selection of bucchero sherds from 19 sites in Etruria showed that the composition of the clay body was relatively consistent. Most sherds had from 60% to 80% quartz, 10%-30%

(144) According to DeAngelis (1960) 199: "La parte smagante per i quattro quindi è un prodotto di frantumazione..."; but he does not indicate whether he considers this to be the result of a natural weathering process or the effects produced by the deliberate crushing of larger stones by the potters.

(145) Francaviglia et al. (1975) 229-230, and Table 2.

sanidine and 5%-20% illite. The alkali feldspar (sanidine) is considered typical of the weathered tuff found 'throughout Etruria', and can be interpreted as showing that such mineral deposits supplied temper for the bucchero paste. (146) The uniformity of composition displayed by samples from relatively distant sites seems to indicate that the bucchero craftsmen deliberately selected clay of a specific type. (147)

Published technical data of desirable quality pertaining to the physical characteristics of Iron Age and Etruscan pottery from Southern Etruria is scarce. (148) This deficiency makes it difficult to elucidate clearly any advances in ceramic technology which are related to the emergence of bucchero sottile. Measurements of apparent porosity do show that a bucchero sherd from Chiusi was two or three times less porous than several samples of Neolithic, Bronze Age and Iron Age impasto fabrics from Northern Italian sites. (149) Measurements of this parameter do not seem to be available for Greek pottery of the Orientalizing period so that one can not gauge porosity differences between bucchero and

(146) Francaviglia et al. (1975) 228-229 and Fig. 4.

(147) This is implied, although not actually suggested by Francaviglia et al. (1975) 228.

(148) The efforts of Parlati (1929) 413-425, are not especially useful for comparative purposes as his descriptions of the cultural context of the examples are very incomplete.

(149) The bucchero sherd had an apparent porosity of 6.70 which can be contrasted to a value of 22.20 obtained with a fragment of impasto from Sasso di Furbara in Latium. These results are presented in an article summarizing several years' research by a group of investigators. See Mariani et al. (1960) 185ff. Physical and chemical parameters are summarized in Table I, p. 202 of the article.

contemporary Greek pottery.

The best Protocorinthian pottery of the period does appear to be made with a clay still more refined than that used for bucchero. Although the finish of bucchero is very durable and uniform, bucchero gives a dull sound when tapped sharply with a hard object. The same is true for impasto. Contemporary Greek pottery, on the other hand, gives a sharper sound when tapped, reflecting a more dense body. This greater resonance probably results from the fact that the Greek pottery was fired at a higher temperature. (150)

Having completed a physical description of bucchero sottile we shall now offer a brief discussion of local and foreign pottery types available in Etruria during the period when bucchero first emerged as a distinct fabric. This description is needed since one of our essential questions is how much the development of bucchero sottile owes to the established Italic ceramic tradition and to the Greek tradition, respectively. Differences and similarities between bucchero and these potential technical prototypes will become more obvious when the evidence for the technique used to color bucchero is discussed in detail.

(150) A temperature range of between 800°C and 900°C was necessary to make modern reproductions of Attic black-figure pottery. Noble (1965) 75-76. As the firing procedure used during the sixth century was apparently the same as that employed by Greek potters as early as the tenth century it seems logical to expect that Protocorinthian pottery was fired at similar temperatures. Farnsworth (1960) 72ff. Bucchero was fired at temperatures sometimes below 750°C. See infra pp. 116ff.

The most common type of local pottery available during the period immediately preceding the manufacture of bucchero is known as impasto. This term has been applied to hand built pottery made over an extremely broad chronological range including both the Bronze Age and Iron Age.(151) Most often, however, it is used to describe fabrics made between the 11th and 7th centuries.(152)

Unfortunately the impasto from Villanovan and Etruscan contexts in Etruria has not been studied in detail. However, the work of Gjerstad and Gierow with material from Latium(153) provides a framework for discussion. Although this is not an ideal situation, it is an acceptable compromise since there were strong cultural affinities between Southern Etruria and Latium during the Iron Age and Orientalizing periods. (supra p. 27)

The earliest Iron Age impasto has a relatively coarse texture and relatively large amounts of impurities. Mica and hornblende gravel have been identified among the inorganic inclusions in specimens from Etruria.(154) Examination of impasto fragments from Latium during the course of refiring experiments showed that the pottery had been subjected to

(151) Lollini (1961) 122-123, considers the term applicable to "the most ancient type of pottery", which would presumably refer to Neolithic pottery as well as Bronze Age and Iron Age pottery.

(152) Matteucig (1951) 55, applies the term to pottery made between the 11th and 7th centuries.

(153) Gjerstad (1966) and Gierow (1966).

(154) Dohan (1942) 3.

uneven temperatures during firing.(155)

The cores of impasto pottery vary in color from brown to grey or grey-black, sometimes showing a gradation from grey-black to brown between the core and surface. Coloration of the surface is also not consistent. Shades of red, red-brown and grey are common but mottled surfaces are frequently observed.(156)

There is definite agreement that impasto vessels were frequently, but not always, burnished. Opinions are, however, divided on whether or not a slip was generally applied. Those who deny the presence of a slip maintain that the gravitation of finer clay particles to the surface forms a thin film that closely resembles a true slip.(157) This effect seems to be further heightened by the color differential between this "mechanical slip" which results from burnishing and the clay body.(158) As in the case of bucchero, microscopic and physiochemical tests are needed to resolve this disagreement.

The earliest Iron Age impasto variety was made until the last quarter of the 7th century at Rome according to

(155) Gjerstad (1966) 71 and 71 n.1, reports that 'the interior of the sherds' was 'not baked sufficiently.' He does not explain what is meant by this phrase but the tests did show that the vessel exteriors were not subjected to temperatures above 800°C.

(156) Matteucig (1951) 12-13, and Gjerstad (1966) 71 n.1. See also Barnabei (1894) cols. 168ff.

(157) Dohan (1942) 3-4, and Matteucig (1951) 12-13 contra Gjerstad (1966) 71, and Gierow (1966) 91.

(158) Dohan (1942) 4.

Gjerstad's chronology.(159) This 'Primitive Impasto' can be subdivided into three groups according to variations in the basic forms common to all of them.(160) These can be differentiated from other varieties that were definitely coated with a purified clay slip.(161) Vessels treated in this fashion were decorated by adding designs in white over a red slip or by reversing the color scheme.(162) This pottery appears in the Poggio Buco tombs just prior to the earliest local attempts to copy Greek vessels with linear decoration.(163) This painted fabric which has a clay body essentially the same as primitive impasto is thus reasonably thought of as representing a transition between impasto proper and 'Italo-Geometric' pottery (supra pp. 62 ff.) as local potters adopted the use of slips.(164)

Primitive Impasto was decorated with a variety of techniques, although most often ornamentation was accomplished through mechanical manipulation of the pottery surface. Knobs and parallel ridges (ribbing) were often

(159) Gjerstad (1966) 207-320.

(160) Gjerstad (1966) 68. See also Gjerow (1966) 91-92 on the categories of Primitive Impasto.

(161) Dohan (1942) 4.

(162) Matteucig (1951) 14. Dohan (1942) 4 and 27-28 describes examples from Narce. A rather fine example with figural decoration is on display in the Royal Ontario Museum, and illustrated by Hayes (1975) Tab. XXVI, 1.

(163) That is no later than the first quarter of the 7th century, but possibly earlier. The pottery occurs in tombs with furnishings typical of Pallottino's facies III. See Matteucig (1951) 55ff. and 79. It seems that some of these impasto vases could be included in Gjerow's 'Italo-Geometric B' category. See Gjerow (1966) 292.

(164) Matteucig (1951) 13.

applied to the pottery surface. Geometric patterns were obtained with incision alone or in combination with grooves, impressions and dots made by pressing either blunt or sharp instruments against the vessel body.(165) The effect of incised decoration was sometimes intensified by filling the lines with white calcium carbonate.(166) Occasionally bronze studs and thin bands of metal were attached to impasto vessels.(167) There are also individual pieces bearing simple patterns in fugitive, white paint.(168)

More refined varieties of monochromatic impasto pottery emerge during the early 7th century. This 'Advanced Impasto' has a finer texture and fewer impurities in its clay than the Primitive type. The vessel walls of Advanced Impasto are also noticeably thinner than the walls of Primitive Impasto pottery. The coloration also tends to be more uniform in both the surface and core of Advanced Impasto. The core is generally red-brown. The surface is often grey-black, but reddish and brown tones occur as well.(169) Advanced Impasto may have been slipped, but laboratory confirmation would be highly desirable. In addition to the use of more refined clay, the frequent use of the potter's wheel demonstrates a technological advance over Primitive Impasto. Advanced

(165) Hencken (1968) 28-33, Gierow (1966) 218ff.

(166) von Vacano (1960) 57 and 103.

(167) Bartoloni (1954) 181, and Hencken (1968) 228. An example of Caere is illustrated by Pohl (1972) fig. 225, p. 256.

(168) Hencken (1968) 27-28, and Gierow (1966) 229.

(169) Gierow (1966) 244.

Impasto was also fired to a harder consistency than its predecessor, indicating an improved pyrotechnology.(170)

The Advanced Impasto pottery from Latium can be divided into four subgroups on the basis of shape and fabric color. Two of the groups consist of vessels whose forms are related to those of the earlier impasto type. These tended to be hand made as were their predecessors. A third variety shares its primarily wheel-made forms with another local pottery fabric colored red or red-brown.(171)

The fourth subgroup of Advanced Impasto is distinguished primarily by the fact that its shapes 'recur in Bucchero Ware', (172) hence it is also referred to as buccheroid impasto. The physical qualities of buccheroid impasto are not very homogeneous. Color ranges from black to red-brown and both thin-walled and thick-walled vessels are found. While its appearance is reminiscent of Primitive Impasto, buccheroid was almost exclusively wheel-made unlike the earlier impasto fabric.(173)

All of the decorative techniques used for ornamenting Advanced Impasto were previously employed for decorating Primitive Impasto. However, none of the Advanced Impasto vessels identified from finds in Latium were decorated with

(170) Gjerstad (1966) 107.

(171) Gierow (1966) 244.

(172) loc.cit.

(173) loc.cit.

bronze rivets.(174) Certain motifs appear on both Primitive and Advanced Impasto, while other motifs were used exclusively on either the earlier or the later variety.(175) In spite of these differences it seems clear that Advanced Impasto, including the bucceroid variety, embodies a continuation of the decorative techniques developed during the earlier part of the Iron Age in Etruria and Latium. The fact that new motifs are introduced for decorating Advanced Impasto, while some of the older designs were spurned by Advanced Impasto craftsmen is a phenomenon which would be anticipated during the evolution of any pottery fabric. Advanced Impasto reflects changing fashions as well as advances in manufacturing technique. However, the Advanced Impasto fabrics do not represent an interruption in the Italic ceramic tradition, but rather demonstrate the survival of the local pottery making procedures during the Orientalizing Period.

The bucceroid impasto subgroup of the Advanced Impasto category merits further comment. It is suggested that bucceroid impasto vessels are imitations of contemporary bucchero shapes since profiles of the impasto pottery resemble those found in bucchero.(176) More will be said about this topic but it may be pointed out that the existing

(174) Gierow (1966) 264. He also notes that excised decoration and open-work construction, which were both used on Primitive Impasto, were not encountered in the Advanced Impasto from Latium.

(175) Gierow (1966) 273-276.

(176) Gjerstad (1966) 112-114.

chronology for impasto and bucchero suggests this view is incorrect. Buccherooid impasto appears at sites outside Rome before bucchero sottile.(177) This is also true at Rome where buccheroid finds predate those of bucchero in the Esquiline tombs.(178)

While it has been admitted that buccheroid impasto was made before bucchero sottile in shapes that "tend to be at an earlier stage of development,"(179) it is argued that the impasto should not be considered "an attempt to make bucchero, but is a distinct type of pottery, indeed the two fabrics are made contemporaneously for a few years and both are sometimes found within one tomb..."(180)

Without good stratigraphical evidence on which to base the relative chronology of the two pottery types one can not be sure how long the Advanced Impasto fabric continued to be manufactured. The fact that both types of pottery appear in the same tomb may simply be explained as another example of an individual's personal possessions several years older than the most current tomb furnishings being buried with the deceased. However, we have already observed that generally one can not decide objectively which objects in a given tomb group are heirlooms and which objects are not. (*infra* pp. 8-9) It must be pointed out that fashions need not change

(177) Gjerow (1966) 381-390.

(178) Gjerstad (1966) 208.

(179) Ramage (1970) 3.

(180) *ibid.* 3-4.

overnight. Thus it is quite conceivable that a workshop might continue making the bucceroid fabric for its more conservative clients, even though the craftsmen possessed the ability to make buccero sottile. Indeed it seems a similar conservative outlook must account for the survival of particular geometric decorative patterns in Protocorinthian pottery for nearly a century alongside the new figural styles which also enjoyed considerable popularity. (181) (supra pp. 8-11.) Furthermore, one should not expect to see a new technique adopted immediately by all local pottery shops since it would take time for the proliferation of the appropriate innovations. Thus there seems to be no compelling reason for accepting the arguments which have been used to show that bucceroid impasto should be thought of as an attempt to copy the buccero fabric. In fact, the shapes encountered in bucceroid impasto could be more reasonably seen as precursors to the buccero vessels which duplicate the same basic forms.

Further consideration of the methods used to produce impasto illuminates its relationship to buccero. The number of vessels with variegated surfaces suggests the primitive impasto was not fired in a closed kiln but in an open fire. The fact that some of this pottery had incompletely fired

(181) The invention of the red-figure technique offers another example of this phenomenon, since black-figure continued to be manufactured. In fact one finds some painters working in both media, sometimes on the same vase. See Boardman (1974) 103ff. and figs. 161-162.

cores also points to such a conclusion. By comparing refired sherds with unfired bits of impasto a laboratory estimated the original temperature never exceeded 800°C further suggesting that a kiln was not used.(182) Indeed, observation of contemporary American Indian tribes firing pottery in an open fire has shown that even though firing temperatures did not exceed this limit, perfectly usable pottery resulted. (infra pp. 111ff.)

The color variation in impasto presumably results from iron oxides in the clay body being exposed differentially to oxygen from the air and reducing gases in the smoke.(183) Analyses of a random sample of Bronze Age and Iron Age pottery from Etruria have shown that the clay contained enough iron oxide to impart color. The researchers also detected carbon in amounts varying from 0.19 - 3.96 percent by weight.(184) (See Figure II.) Given the somewhat perfunctory nature of the tests one can not determine if the carbon was present in the clay body before firing, or the extent to which it influenced the color of the vessels. Researchers investigating the composition of Iron Age pottery in Northern Italy did conclude that carbon was not deposited in the clay accidentally, and that the carbonaceous material played a major role in coloring the fabric.(185) This possibility

(182) Gjerstad (1966) 71 n.1.

(183) Matteucig (1951) 13. An explanation of the role of iron oxide as a colorant appears below. See infra pp. 75ff.

(184) Parlati (1929) 413-425.

(185) Mariani and Storti (1953) 82ff., and DeAngelis (1958) 159-160.

cannot be ruled out in the case of impasto made in Etruria. One can be sure that the grey cores and surfaces of impasto resulted from an oxygen deficiency during firing. (A detailed explanation of the reasons for this is given on pp. 73 ff).

While there seems to have been little control of firing atmosphere for the manufacture of Primitive Impasto, there does seem to be a consistent attempt to produce a grey-black surface color in three of the four types of Advanced Impasto. One variety of reddish impasto can be distinguished on the basis of both color and shape. (186) The variable quality and color of bucceroid impasto from Rome and the Alban Hills certainly suggests an effort to perfect the reduction firing procedure. (187) When one considers that buccero was definitely fired in a reducing atmosphere (infra pp. 94 ff.) and that some buccero shapes seem to have developed from bucceroid forms, it seems reasonable to see bucceroid impasto as potentially the direct ancestor of buccero sottile. In addition to bucceroid impasto already described a rather special group of vessels which could also correspond to a transitional fabric between impasto and buccero has been

(186) Gierow (1966) 244 and 276.

(187) A similar situation in which imperfectly fired fabrics were produced in quantity existed in Italy prior to the development of Arretine sigillata. In this instance the first century workshops produced pottery which seems to represent intermediaries between black-gloss and terra sigillata. See Goudineau (1968) 63, 238 and 318ff. See also Py (1976) and Morel (1963) 55-58.

isolated from finds at Poggio Buco. These have a grey surface and grey core indicating a moderate but uniform reduction atmosphere during firing.(188) Some of the vessels made in this fabric were also made in bucchero, while other examples of this 'buccheroid' fabric have no parallels in the bucchero repertoire.(189) The 'buccheroid' fabric, which has been called 'grey bucchero', occurs in the tombs at Poggio Buco before bucchero sottile.(190)

Unfortunately there is only a meager amount of sound technical data on which one can base a comparison between bucchero and any of its impasto predecessors. Yet when one considers the refinements gradually introduced into the production of Italic Iron Age pottery bucchero seems to represent the culmination of a trend to produce a monochromatic reduced fabric. However, this evolution took place in the presence of increasing influence from foreign artistic and technical traditions. Greek pottery, in fact, was having obvious effects on local ceramic production prior to the emergence of bucchero sottile.

There are four distinct varieties of pottery which manifest the Greek tradition in Etruria.(191) The first consists of vessels imported from Greek cities. The earliest

(188) This is the 'grey bucchero' fabric described by Matteucig (1951) 13, 65ff. and 84-85.

(189) For example the 'pot stand', Matteucig (1951) Pl.II,14.

(190) Matteucig (1951) 54ff. and 84-85.

(191) These categories are outlined by Blakeway (1935) 129ff.

examples are Middle Geometric skyphoi found at Veii which are datable to the first half of the 8th century B.C..(192) These skyphoi are of two types; the 'Cycladic cups' or 'chevron skyphoi' distinguished by a band of vertical chevrons between the handles,(193) and those with a panel containing pendant semicircles.(194) Some of the chevron skyphoi may be of Attic origin,(195) while the one example of the second type has a fabric identical to Euboean pottery from Pithekoussai. (196) These Middle Geometric imports are followed by vessels of the Late Geometric style (197) and these in turn by representatives from the Protocorinthian workshops.

The Greek imports are wheel-made and well executed in fine textured clay. The Geometric examples and their Protocorinthian successors all have light colored clay bodies with buff and pink tones predominating. The Greek pottery was decorated with dark colors (browns, reds and later, purple

(192) Ridgway (1973) 25-27.

(193) For example see Weinberg (1941) Figs. 1, 16, 17, 22, 24 and 25. See also Coldstream (1968a), and (1971) 86ff

(194) Ridgway and Dickinson (1973) 191-192, have published the one example from Veii. This was a surface find. See also Cook (1972) Fig. 2, p. 10.

(195) Ridgway (1973) 25-27.

(196) Ridgway and Dickinson (1973) 191-192.

(197) A list of sites appears in Blakeway (1935) 130. Many of the so-called Cretan or 'Cycladic' vessels may well be examples of a fabric made at the Euboean colony of Pithekoussai. See Ridgway (1973) 37 n. 2., Büchner (1971) 66-67 and Coldstream (1971) 86-96. See also Hencken (1968).

hues) on the buff ground.(198) The bichrome color scheme used for Geometric pottery and Protocorinthian was achieved by the technique of reservation, i.e. covering large areas of the vessel surface with black-firing slip (often referred to as paint), while leaving bands or panels unpainted so that the pale clay body was visible. Linear patterns and eventually silhouette birds, animals and occasionally human subjects filled the reserved areas. White color was sometimes used for bands and in a few instances small incisions gave detail to the monochrome figures.(199) Sometimes the Geometric vessels appear to have been coated with a thin wash of pale clay before the addition of the black-firing slip, giving the light areas an ivory tint.(200)

The scheme of dark paint on a light ground continued with the Protocorinthian style which began in the last quarter of the 8th century,(201) but with the emergence of the Middle Protocorinthian style during the first half of the 7th century (c. 690-650),(202) incision was no longer used only for details. The aryballois, characteristic of this period, were decorated with miniature animal figures

(198) On the Geometric fabrics see Ridgway *supra* n. 194, Close-Brooks (1967) 323ff. and Weinberg (1941) 42-43, Cook (1972) 28-29, Johansen (1923) 7, 36 and 112.

(199) Johansen (1923) 76, 112 and Cook (1972) 28.

(200) Johansen (1923) 7 and 36. A light colored slip was apparently applied to reserved areas alone in some Euboean Geometric cups according to Cook (1972) 28.

(201) Cook (1972) 47 and Coldstream (1971) 10.

(202) Cook (1972) 48 and Payne (1930) 10 and 16.

completely outlined with incision before being filled with dark paint. Detail within the painted decoration was achieved with additional incision and application of white and purple color. This procedure constitutes the basis for the black-figure technique elaborated during the 6th century. (203)

Along with the imported Greek vessels three other categories of pottery linked to the Greek tradition are identifiable on the basis of their fabric and painting style. These are: first, vases made by Greeks working in Etruria; second, those made by local artisans obviously copying Greek originals with varying degrees of success, and last, vessels made by Etruscan potters which use Greek motifs in unconventional ways. (204) There is uncertainty about the origin of vases in the first category such as the crater from Caere painted in the first half of the 7th century by Aristonophos, (205) but as we have observed (supra pp. 16 ff.) there is reason to believe that foreign craftsmen of several types were working in Etruria at this time.

The pottery, which so skillfully duplicates Greek shape and style is distinguished from imports by the physical

(203) Payne (1930) 19 and Cook (1972) 49-50.

(204) Blakeway (1935) 132. Matteucig (1951) 16-17, follows these categories. For numerous illustrations of Italic vessels with geometric decor see Akerstrom (1943) 50-100.

(205) Cook (1972) 39 and 93 who has little 'doubt' that the crater was made in Italy, and vonVacano (1965) 77ff. Boardman (1973) 191, sees it as an import from Syracuse.

appearance of its clay and black slip. The fabrics made by Etruscan potters following Greek models have a similar appearance, their quality being rather inferior to the Greek. The clay body of Geometric vases made in Italy is light colored, sometimes white like the imports, but generally it has a yellowish tint unlike the Greek wares. The dark slip, usually matt, is most often brick red but otherwise brown or black. The color was applied over a buff or cream-colored slip. (206a) The Etruscan versions of pottery in the Corinthian style are typified by their brownish paint and the 'muddy' cast of the brown to pale pink clay body. (206b) There appear to be variations in color which could be explained by differences in clay used by local workshops, (207) but it is not essential to elucidate them for the present study.

What this brief description of the essential characteristics associated with Greek imports and the Etruscan fabrics should make clear is that their clay and decoration have a totally different physical appearance from that of bucchero sottile. On this basis alone it becomes clear that bucchero was not manufactured in complete accordance with procedures

(206a) Cook (1972) 39, Blakeway (1935) 130, and Gierow (1966) 292 and 298. Lustrous brown paint has been noted on local vases in the Protocorinthian style from Rome, Gjerstad (1966) 122.

(206b) Payne (1930) 208, and Cook (1972) 63-64 and 148-151.

(207) At Poggio Buco pinkish clays are encountered in the Protocorinthian style Etruscan pottery. Also not all of the Italic imitations of Geometric pottery were coated with a wash or 'dressing'. Matteucig (1951) 16-17.

copied from Greek craftsmen.

There are certain similarities between bucchero sottile and the so-called 'Aeolic' or 'Lesbian' bucchero made in Asia Minor during the 7th and 6th centuries. This pottery, which continued a long standing tradition of grey colored pottery in the Troad, was made with a micaceous clay displaying a grey core and silver grey to black surface. There are examples with both burnished and matt surfaces.(208) While the overall physical characteristics have been cited as evidence that bucchero sottile descended directly from the Aeolic ware,(209) it is pointed out that the fabric and particularly the shapes of the Etruscan pottery are distinctly different.(210) It should also be noted that there seem to be no examples of Aeolic grey ware from Etruria during the period in question, although pottery of this variety has been identified in 6th century contexts in Southern Italy. (211)

There has not been any attempt to compare contemporary pottery fabrics made in the Near East and Cyprus with bucchero sottile and the Italic Impasto fabrics. Quite apart

(208) Lamb (1932) 1-3. See also Zancani-Montuoro (1972) 373-376, who discusses some 6th century vases from Southern Italy and others' descriptions of the fabric. See also Dunbabin (1948) 232.

(209) Winter (1957) 28, and Cook (1972) 319-320, who traces the issue, and rejects the view that bucchero was derived from the Aeolic fabric.

(210) Ramage (1970) 4, and Cook (1972) 151. See also Zancani-Mantuoro's description, *supra* n. 208.

(211) Zancani-Mantuoro (1972) 373-376.

from the desire to keep the length of this investigation within reasonable bounds, there seems to be no reason to suspect that pottery manufactured in Etruria would have been affected significantly by Phoenician or Syrian methods. Although ivory and metalware of Near Eastern manufacture was imported into Etruria, (212) there seem to be no examples of imported Phoenician pottery in Etruscan contexts. Moreover, it is Greek Late Geometric and Protocorinthian pottery which was not only imported in quantity but copied on a large scale by workshops operating in Etruria. Thus it seems most logical to look for technical parallels between Etruscan and Greek fabrics.

The obvious differences between bucchero sottile and the local fabrics copied from Greek painted pottery result not only from different aesthetic concepts (i.e. monochrome as opposed to polychrome decoration), but also from variant firing procedures. Greek painted pottery was normally fired to temperatures significantly higher than those employed for bucchero manufacture. (*infra* pp.116 ff.) Furthermore, at least the final stage of the bucchero firing was carried out under reducing conditions, whereas the polychrome pottery was exposed to an excess of oxygen during the closing portion of the firing which rendered the reserved areas of the body a light color. (*infra* pp.74ff.) However, since the production of dark color in the painted decoration of Greek pottery

(212) See *supra* pp. 16ff.

depends on the reduction of iron compounds during the intermediate firing phase, one might suspect that Etruscan potters were applying some Greek methods.

There can be no doubt that Etruscan potters adopted without modification the Greek process for making Geometric and Protocorinthian imitations. Moreover, since the previously discussed transformations occurring in the Italic impasto tradition (from which bucchero seems to derive) coincide with the importation and local manufacture of Greek fabrics, it seems logical to see a direct cause and effect relationship.

(213) The most obvious borrowing from Greek craft procedures would be the potter's wheel as it had been used for centuries in Greece before its adoption by impasto workshops around the beginning of the 7th century. The use of more finely purified clays for the bodies of impasto was probably inspired by the Greek example, although the local workshops could have worked out their own procedures by trial and error. The application of purified clay washes and slips to Italic impasto was also presumably adopted from the example provided by Greek pottery imports, or from observing immigrant potters. However, we have observed that analytical work is needed to determine when slips first appear on impasto pottery. It is worth mentioning at this juncture that our understanding of the relationship between bucchero and other contemporary Etruscan fabrics could be greatly increased if

(213) As does Cook (1972) 147.

laboratory testing were conducted to determine whether or not the same clay sources were used for bucchero as were employed for other local pottery types.

Another development in impasto production which follows the introduction of Greek pottery types is the tendency to make more uniformly fired vessels. Dohan sees the production of mottled vessels alongside monochromatic ones as an indication that Italic potters could control their 'kilns' at will. (214) However, the multi-colored pottery much more likely reflects a lack of control over the amount of air reaching the impasto during firing. This is apparent because the other refinements in impasto production parallel the increased incidence of more evenly fired surfaces and cores. More will be said on the subject of kilns (*infra* pp. 125ff.), but one observation is relevant here. One would expect that Etruscan potters making Protocorinthian type pottery adopted Greek type kilns along with the rest of the newly acquired method. This need not be true for the impasto workshops which could have devised their own means for obtaining a more constant kiln atmosphere in response to the consistent uniformity of Greek fabrics but without copying the Greek practice per se.

Nonetheless, given the rather substantial list of significant improvements in Italic ceramic technology which can reasonably be attributed to the indirect influence and

(214) Dohan (1942) 5.

presumably the direct participation of Greek potters in ceramic production in Etruria, it is not surprising to find specialists who view the bucchero color process as something borrowed from Greek craft procedures.

Chapter III

BUCCHERO COLORATION

The color of bucchero sottile has been a subject discussed for a century.(215) Unfortunately even in recent decades speculations have often occupied a much more prominent place than have results from scientific research. Ironically had there been more emphasis on the latter type of information, speculative discussions would have had more and better fuel for consumption. This inequality admittedly and unavoidably applies to the present discussion as well, although it is hoped that suggestions for both the general direction and specific goals of future research will compensate for this deficiency to some degree.'

Research and experimentation has certainly answered several key questions concerning bucchero coloration. On the other hand, there are questions which have not been satisfactorily answered and still others which have not previously been asked. Among the reasons why efforts have been insufficient, the failure to coordinate experimental attempts at reproducing the bucchero fabric with thorough quantitative analyses and the tendency to place too much trust in superficial similarities between bucchero and ceramics resembling it, both stand out as obstacles to sound experimental design. One may contrast this situation to the case of the products from the classic Greek workshops. The application of chemical and mineralogical analyses, combined with experimentation utilizing suitable local clays, yielded an understanding of the process used to obtain the Greek black-gloss. Scrutiny of archaeological and historical evidence then allowed convincing reconstruction of the techniques employed

(215) Randall-MacIver (1921) 86-88, DelVita (1927) 186-187 mentions 19th century opinions. As do Mariani and Storti (1953) n. 24. See also Winter (1957) 28-29, and Defosse (1975) 1074-1075.

in black-figure and red-figure workshops. (216) The lucid and precise documents presented on the subject of Greek pottery making techniques cannot be duplicated for bucchero sottile since the basic research is still deficient.

The central question concerning bucchero manufacture is the nature of the coloration of the pottery's surface and core. There are two aspects to this problem of surface coloration: first, identifying the pigment responsible for the deep black color; and second, deciding how the high lustre was achieved. The second problem, as was already observed (*supra* pp. 33 ff.), needs further exploration. There has been very useful research on the pigmentation of bucchero, but a number of details remain obscure.

Three pigments have been named on different occasions as the substance responsible for the black color of the bucchero surface and core: manganese dioxide (MnO_2), the black oxides of iron, and carbon. The principal proponent of the theory that manganese oxide was deliberately added to the clay, noted its apparent availability in Etruria where the mineral form, pyrolusite, exists as veins in the tuff bedrock. It seemed reasonable to suspect that the Etruscans who made liberal use of this stone for building had also encountered the substance and discovered its potential as a colorant. (217)

(216) For a recent, well illustrated account with detailed references: Noble (1965). Current reports of analytical data for both Attic and less common wares include Boardman and Schweizer (1973) 267-283, Stern and Descœudrès (1977) 73-86.

(217) DelVita (1927) 191-192, and Noble (1965) 93 n. 1.

Potters of the ancient civilizations in the Mediterranean basin as well as modern forgers of terracotta 'antiquities' used MnO_2 for a pigment. (218) It has been clearly demonstrated that this oxide was used to produce black coloration of pottery in Greece as early as the Neolithic period, although there is no indication that potters on the Greek mainland ever relied on the material after the Bronze Age. (219) On the other hand, analysis of a 6th century B.C. sherd from Gordion revealed that a 27% concentration of manganese dioxide accounted for its black color. (220a) The amounts of MnO_2 measured in prehistoric sherds from Greek sites varied but were an order of magnitude lower than this Lydian example. (220b) Manganese has only been found in trace amounts in bucchero (220c), while researchers who attempted to reproduce the bucchero finish

(218) Noble (1965) 93 n. 1.

(219) Farnsworth and Simmons (1963) 396. In the same article the authors repeat reported indications of selective mining of manganese ore during an indeterminate "ancient" period at Eleusis. *ibid.* 394. They also give MnO_2 concentrations of 8.8% and 1.3% as accounting for the coloration of the "Early Iron Age sherds from Cyprus..." *ibid.* 396, which the authors did not illustrate or describe.

(220a) Farnsworth and Simmons (1963) 392 and 394.

(220b) *ibid.* 392.

(220c) Fracaviglia et al (1975) 224-225 and Table 1. One of the 23 samples is listed in the table as having 6.09% MnO_2 . However, since the associated text says that the amounts of this constituent "ranged between a minimum of 0.09% and a maximum of 0.33%" the high value listed in the table may be a misprint. Otherwise it seems reasonable to suspect that the fragment in question was not actually bucchero or had been tampered with by collectors, dealers, or museum personnel. The practice of adding pigment or polish to improve the appearance of pottery was noted by MacIver (1921) 88 and Dr. John Hayes informs me that a number of the bucchero vases in the collection of the Royal Ontario Museum were at one time 'restored' by coating the surface with a substance of the consistency and color of shoe polish. Regarding the concentrations of MnO_2 reported by Fracaviglia et al (1975) 224-225, the authors add that the values "are in agreement with those measured for various clays analysed for comparative purposes", but they give no other information about the particular clays, their origins, or their degree of refinement, nor do they suggest why these clays were chosen for comparison.

by mixing measured amounts of MnO_2 with the clay, found that the oxide needed to reach concentrations of at least 10% before what they considered a satisfactory duplicate could be obtained.(221)

Pyrolusite mixed with potters clay retains its color when subjected to temperatures within the range attainable by ancient potters regardless of the amount of oxygen or reducing gases in the kiln atmosphere during firing.(222) Thus if a sample of black pottery heated in an oxygen-rich atmosphere subsequently changes color, manganese dioxide cannot have been present in sufficient amounts to have colored the fabric.(223) Various investigators have observed that bucchero becomes completely red when subjected to this qualitative test.(224) It is therefore quite clear that the minute amounts of manganese dioxide present in bucchero sottile must constitute a natural impurity which had no discernable impact on the color of the pottery.

The fact that bucchero loses its black color when refired in an atmosphere containing oxygen leaves iron oxides and carbonaceous matter as the two potential candidates which could give the pottery its original pigmentation. Since bucchero sherds refired in an oxidizing atmosphere

(221) Francaviglia et al (1975) 224-225.

(222) Farnsworth and Simmons (1963) 392 ff.

(223) If iron is also present in sufficient quantities, a black oxide could easily be formed if the test were conducted without oxygen in the atmosphere. The presence of other chemical compounds such as lime or aluminum hydroxide in the clay can alter the color produced by iron alone. Shepard (1954) 24-25, and Picon and Vichy (1974) 43 n.13. Thus qualitative tests based on color must be supplemented by analytical determinations. Iron is generally present in significant quantities in clays from the Mediterranean region that were used in pottery making, even when manganese was deliberately chosen for the pigment. See Farnsworth and Simmons (1963):

(224) Richter (1936) 61, and especially Leoni and Trabucchi (1962) 257-266.

become red one might suspect that iron compounds are indeed the colorant in question.

Iron compounds constitute perhaps the most common coloring agent of ancient pottery. Very often iron oxides occur as 'impurities' in the clay. One may add pulverized iron minerals to clay or prepare a pigment from these materials which is then painted on the surface of a vessel.

(225) Although there are many compounds formed with the elements iron and oxygen, the three known to play a principal role as ceramic colorants are ferric oxide, ferro ferric oxide and ferrous oxide. The first of these compounds is the essential constituent of the mineral hematite, the red oxide known universally as rust. The term 'ochre', which corresponds to the miltos used by classical Greek potters, refers to a friable, earthy form of hematite. (226) As ferric oxide, Fe_2O_3 , is heated to temperatures above 300°C when reducing gases such as carbon monoxide or hydrogen are present in greater quantity than oxygen, the ferric oxide molecules lose oxygen, being converted to the ferro ferric oxide, magnetite. Magnetite, Fe_3O_4 or $\text{Fe}(\text{FeO}_2)_2$, which is also found naturally, can be distinguished from hematite by its black color and magnetic properties. The latter characteristic also accounts for its other common name, lodestone. Magnetite represents an intermediate stage between the red ferric oxide and ferrous oxide, FeO . If magnetite is exposed to reducing conditions, or if contact between ferric oxide and reducing gases is maintained, at sufficiently high temperatures,

(225) Shepard, (1954), 18, 103 ff., and 387.

(226) Farnsworth and Wisely (1958) 169-170. Shepard (1954) 37, considers that 'ochre' refers to a mixture of clay and hematite.

magnetite loses oxygen atoms forming ferrous oxide. FeO is also black, although often less intense than magnetite, sometimes having a brownish tone.(227) Its high chemical reactivity distinguishes ferrous oxide from both magnetite and hematite. The oxide can act as a flux, lowering the melting point of clay when present in relatively small quantities. Such a capability appears to make ferrous oxide a key ingredient in the successful production of Greek black-figure vases.(228a)

Greek potters produced their polychrome fabrics by subjecting vessels to a three stage firing. During the first phase the pottery was exposed to oxidizing conditions until a sufficiently high temperature was reached. (See infra pp. 1116ff.) At that point reducing conditions were created, converting the iron in the clay body and in the slip to its black oxides. The slip, composed of finer clay particles (infra pp. 89 ff.), sintered. That is to say quartz crystals in the slip melted sufficiently to encase the black oxides in a protective layer. Ferrous oxide presumably catalyzed the sintering reaction. The pottery was then exposed to oxidizing conditions during the final firing phase. The black oxides in the reserved part of the vessels were thus reconverted to red ferric oxide. The black oxides in the slip retained their black color, being protected from reoxidation because the slip had sintered. Thus the finished pottery had a polychrome color scheme.(228b)

This simplified explanation of the relationship between the major iron oxides has been included to clarify the discussion which follows.

(227) Latimer and Hildebrand (1951) 401ff.; Noble, (1965) 32-33. Shepard (1954) 38, 103-104.

(228a) Farnsworth (1960) 72.

(228b) Noble (1965) 32-33, and Farnsworth (1960) 72.

There are a number of factors affecting the chemical reactions involved and mixtures of all three oxides, and with other iron compounds as well, are encountered regularly in mineral deposits, including clay beds, and in fired ceramics. (229) It is also important to realize that the reaction pathway described above for the reduction of ferric oxide to ferrous oxide is completely reversible at relatively low temperatures, unless sintering has occurred. If the black color of a slip is protected by sintering, the iron oxides can only be converted to red ferric oxide by heating the pottery to temperatures at which the protective quartz layer melts.

Laboratory experiments have demonstrated that bucchero sherds heated in air turn reddish. This color change is brought about by production of ferric oxide. Iron compounds have been detected in bucchero as well as in other pottery from Etruria that occurs in earlier and later chronological contexts. The comparative data provided below, (see Table I and Figure II) show that the amount of iron in bucchero is of the same order of magnitude as encountered in ancient pottery from other parts of Italy and Greece. No other element among those detected in these clays could account for the red color created by refiring fragments of bucchero.

One should note that the data provided here have not all been reported with an equal degree of clarity nor have analysts always used

(229) Bimson (1956) 203. The sintered lustrous black slip is also known as a Glanztonfilm; see supra n. 117b.

exactly the same laboratory procedures. (230) It is obvious from Table I that considerable variation can occur within a given fabric. (231) While a wide range of values listed for one of the components in a particular type of pottery might be interpreted as reflecting irregularities in the preparation of clay, fluctuations of considerable magnitude do arise within a given clay deposit. (232) In fact, differences between clays from

(230) Quantitative analytical procedures used to determine the composition of ceramics are based on those developed for other purposes where the same kinds of distinctions are not necessary for industrial operations. The quantitative methods normally used do not distinguish between magnetite and ferrous oxide. The combined amount of these two black oxides can, however, be measured separately from that of ferric oxide. The total ferrous iron content is usually expressed as the difference between two individual determinations for the amount of ferric iron. The first measurement, ('Total Iron' determination), is made after all the iron in one portion of a sample has been converted to the chemical species found in Fe_2O_3 . The second determination is made on an untreated portion of the sample where any iron in the reduced state, (the species occurring in the black oxides), will not be measured. The weight of iron in the ferrous state is then calculated by subtracting the results from the second ferric iron determination from those obtained in the 'Total Iron' determination. One can alternately measure ferric iron indirectly by using two analogous determinations in which only ferrous iron content is determined. In both cases it is the accepted convention to report Total Iron as ferric oxide. See Latimer and Hildebrand (1951) and Willard *et al* (1957) 167 ff. Very often the iron content of a given clay is reported simply as "% Fe_2O_3 " without any indication of whether or not any attempt to measure the amount of reduced iron had been made.

Indeed, not all of the iron need be present originally as ferric or ferrous oxides, since the chemical species of iron in these compounds are found combined with other elements forming carbonates, hydroxides, etc. which also occur in clays.

Although the accuracy and precision of various analytical methods vary, the results obtained for clays of the Mediterranean basin by different researchers should be sufficiently reliable for general comparative purposes.

(231) Variation can sometimes occur because of the analytical procedure used. If one sample includes a portion of an iron rich slip such as that apparently used by classical Greek potters, while another is composed only of clay from the un-enriched body of the vessel, different values for the iron content would be anticipated. For this sort of distortion in data obtained spectrographically see Farnsworth and Wisely

(1958) 391.

(232) Stern and Descœudres (1977), 73.

different regions can not be detected unless data are derived from a sufficiently large sample for establishing representative concentration ranges and local anomalies.

Even allowing for the degree of incompatibility of information on composition derived from published technical data, the iron content of examined bucchero sherds seems to lie below or within the lower half of the range reported for Protocorinthian and Attic black-figure, (the two Greek fabrics approximately contemporary with bucchero sottile production for which technical data is available). (See Table I). It is possible that the lower concentrations of iron found in bucchero sherds would not have been sufficient for the consistent production of a black surface. However, surface texture, density and other physical and chemical factors affect color, so that minor differences in pigment content observed between two individual clays may result in no visible color difference. In fact clay containing only 6.45% Fe_2O_3 was found to be capable of producing a black-figure coloration comparable to that produced by clay from a different source which contained about 10% ferric oxide.(233) In any case the production of black-figure vases in Etruria, at least by the latter half of the 6th century B.C., demonstrates the suitability of local clays for duplicating the Greek color scheme. Successful variants of the Protocorinthian fabric occur in Etruria during the 7th century B.C., as noted above. Since this type of pottery, at least in Greek workshops, depended of the same basic technique as was used for black-figure,(234) it seems that appropriate clays had been located in Etruria

(233) Farnsworth Wisely (1958) 171.

(234) Farnsworth and Simmons (1963). See also Farnsworth (1960) 72-75 where Protocorinthian test pieces are shown.

which could be used for making pottery colored black through the formation of the black oxides of iron by the time when bucchero first appeared.

Refiring experiments discussed ~~below~~ (infra pp. 82 ff.) illuminate the behavior of iron in samples of the bucchero fabric, but the reported total iron content of bucchero deserves a final comment. The values for this parameter do not suggest enrichment of the clay used for bucchero pottery with an iron compound such as ochre, a practice apparently employed by Greek potters for making a red-firing slip used during the 5th century B.C. (235) Others have previously suggested that no addition of pigment to the raw clay seems likely since the Fe_2O_3 concentration in bucchero approximates that encountered in naturally occurring clays. (236) The values listed in Table I show that this correspondence holds when comparing the assays from pottery sherds with those from clays sampled in Northern and Southern Italy as well as in Greece. However, one can not determine if the raw clay used for bucchero was modified, or if local clays with relatively high iron content were deliberately selected by Etruscan potters without analysis of clays found at locations where bucchero was actually made. (237)

The key role of black iron oxides in the black-figure process has been firmly demonstrated by experiments with local Attic clays and other

(235) Farnsworth and Wisely (1958) 166.

(236) Francaviglia et al (1975) 225.

(237) Although Francaviglia et al, (1975) 225, mention that clays were analysed for comparative purposes they do not give any information about source locations. There is also no indication of whether the clay samples were simply obtained from commercial suppliers or by field sampling of local deposits.

clays with similar composition. The experimental results have been confirmed analytically, providing a body of knowledge which serves as a model when considering technical characteristics of other fabrics. The presence of the intermediate oxide of iron, magnetite, has been established in the black 'glaze' used by classical Greek potters through the use of a magnetic field to collect particles from a powdered sample of the 'glaze', itself. Subsequent x-ray analysis of this magnetic portion yielded the diffraction pattern associated with Fe_3O_4 , confirming the discovery of this black oxide.(238) Independent x-ray examinations of other black-figure fragments revealed the presence of ferrous oxide as the glaze colorant in one instance. Diffraction patterns obtained in the other two trials of this series could not be identified.(239) Such determinations indicate the incomplete state of knowledge concerning the chemical and physical processes responsible for the black color of Greek pottery, even though the basic steps are well documented. It is significant that these analytical results show that neither of the two black oxides, FeO or Fe_3O_4 , was the sole agent of the black color. Some expect that the latter, magnetite, is most often the compound responsible, but admit the necessity for analytical verification.(240)

Magnetic separation followed by x-ray diffraction has also identified magnetite in a ground aliquot from a bucchero sottile vessel.(241) This finding was interpreted as indicating the absence of ferrous oxide

(238) Farnsworth and Wisely (1958) 172.

(239) Bimson (1956) 203. Also Farnsworth and Wisely (1958) 172.

(240) Farnsworth and Wisely (1958) 172. Shepard (1954) 38., suspects that a mixture of Fe_3O_4 and FeO often colors black pottery but can give no supporting data. See also *infra* n. 244.

(241) Leoni and Trabucchi (1962) 262 and Fig. 3.

not only from the sample tested but from bucchero sottile in general. A single analytical determination can not, by itself, justify a universal application of the results. While it was assumed that the high reactivity of FeO would preclude its permanent formation, the evidence for the presence of ferrous oxide in Greek black-figure should amply illustrate the need for testing the hypothesis that magnetite was the only black oxide of iron occurring in bucchero. (242)

The assumption that all ferrous iron in bucchero occurs as magnetite, Fe_3O_4 , was applied to the quantitative data reported by Leoni and Trabucchi after their qualitative analysis of a single bucchero sherd revealed that magnetite was present. (See Table II). (243) Calculations based on their data show that not all of the elemental iron in bucchero was in the reduced state. In fact between 35 and 45 percent of the total iron present in bucchero tested was apparently in the ferric state, possibly as the red ferric oxide. (244) (See Table II). Unfortunately no one seems to have examined the question of what quantity of either ferrous oxide or magnetite is required to mask a given quantity of red

(242) loc. cit.

(243) The Total Iron determination measures iron in the +3 oxidation state, Fe^{+3} , the ferrous determination that in the +2 state, Fe^{+2} . Magnetite is thought to contain one Fe^{+2} and two Fe^{+3} atoms in each molecule. Thus if one assumes all Fe^{+2} atoms of iron in a bucchero sample are contained in magnetite the amount of iron represented by magnetite will be three times greater than the amount of ferrous iron alone. See also supra n. 230.

(244) As noted in the previous paragraph magnetite is not always found in the Greek black-firing slip, thus it is not possible to assume that magnetite is always the black oxide occurring in bucchero. Indeed, recent analyses carried out on Hellenistic 'black gloss' pottery suggests that hercynite, $\text{FeO}(\text{Fe}, \text{Al})_2\text{O}_3$, is often responsible for coloring pottery fired under reducing conditions. However, if all or part of the ferrous iron measured by Leoni and Trabucchi was present as magnetite in all of their samples, the amount of ferric iron which could exist as ferric oxide would be reduced, possibly considerably. See supra n. 243.

ferric oxide, (Fe_2O_3), when both occur simultaneously. In spite of the amount of research on the pigmentation of Greek pottery there seem to be no reports which attempt to distinguish any ferric oxide in the fired black 'glaze'. Thus it can not be determined at present if the amount of black iron oxide in bucchero is comparable to the amount of black iron oxide normally present in the black-firing slip used on Greek pottery.

While it is evident from a comparison between the composition of clays used to fabricate Greek pottery and modern replicas made under conditions simulating the ancient process that magnetite occurs in sufficient quantities to give bucchero its black color in some instances, it is by no means certain that all of Fe_3O_4 was produced by the firing procedure. Ferrous iron, the variety found in FeO but in other iron compounds as well, should account for about 25% of the elemental iron in Attic clay according to the published formula.(245) However, it is not mentioned whether or not there have been attempts to detect magnetite in Attic clay which does contain red ferric oxide as an impurity. Obviously, additional laboratory experimentation will be necessary before the role of the iron oxides as pigments for bucchero can be quantitatively assessed. On the other hand some investigations carried out with pieces from actual vessels give qualitative indications of how iron in the fabric behaves under different firing conditions.

(245) The formula proposed for Attic clay, see Noble (1962) 40, indicates that some ferrous iron occurs in chemical combination but not as a mixture of magnetite and clay.

Testing carried out with a ground sample from a bucchero sottile kantharos showed that the iron it contained could easily be oxidized or reduced. By exposing the material to an excess of oxygen and an excess of hydrogen during alternating periods of 2 hours and weighing the sample after each different exposure it was apparent that the observed weight changes resulted from the complete conversion of the elemental iron in the powdered clay to red Fe_2O_3 and black FeO , respectively. The reaction was completely reversible at 500°C . (246) Discussion of firing methods, (*infra* pp. 113ff.) will be postponed momentarily, but it should be noted that potters making bucchero should have been able to maintain this temperature for such a short period of time. One can also see from the fact that the color of the ground fraction could be reversibly altered at this temperature, that the clay had not originally sintered. Had this been the case it would not have been possible to convert the iron oxides present to another form without heating the clay to a much higher temperature. (*supra* p. 78) The observation that bucchero had not sintered is born out by the changes observed when fragments of bucchero were heated in air to between 800 and 1000°C by the same investigators. The refired sherds took on a darker red color and acquired "sonority". (247) The color change and increased density of the clay, (evident from the sharp sound produced when striking sintered pottery as opposed to the dull, low pitched sound obtained when tapping bucchero sottile) are what is normally encountered when sintering does occur. (248)

(246) Leoni and Trabucchi (1962) 261-262.

(247) Leoni and Trabucchi (1962) 259.

(248) Shepard (1954) 23-24 and 223.

Although the firing tests conducted with pulverized bucchero confirm that the pottery had not sintered, they do not necessarily mean that bucchero was colored black only because iron in the clay had been converted to black ferrous oxide (or to magnetite). The examiners were justified in concluding "the variation which we observed in the color of the powder was caused by the quantitative oxidation and reduction of ferric oxide (red) to ferrous oxide (black)..." (249), but the results show only that the iron in the clay used to make bucchero could be converted to the black oxide at reasonably low temperatures. Furthermore, heating the powdered pottery to 500°C in order to remove volatile matter and subsequently obtain constant weight prior to the oxidation and reduction of the sample would have removed any carbon which could have contributed to the coloration of the original bucchero.

Subjecting intact fragments of bucchero to a similar cycle of oxidation and reduction did show it was possible to render the pottery black by conversion of the iron to its reduced oxide, but it was not possible to reproduce the original color scheme. A large fragment from a bucchero sottile kantharos was chosen for examination which displayed the typical bucchero trait of an outer zone of intense black

(249) Leoni and Trabucchi (1962) 262, "che le variazioni di colore della polvere da noi osservata erano dovute alla ossidazione e riduzione quantitativa degli ossidi di ferro da ferrici (rossi) a ferrosi (neri) ..."

color and an inner zone of a less intense black. The fragment was divided into two sections. The first was reserved as a control while the second was heated to 500°C in air. At the completion of this oxidation the two zones were still visible. The core had become "ocra chiaro" while the outer zone was "piu chiaro." (250) The refired, oxidized portion was then cut in two. One of the pieces was reduced by heating to 500°C in a hydrogen enriched atmosphere for three hours. These conditions should have sufficed for reducing any iron in the clay to black FeO, as demonstrated by the tests with a powdered sample. If this pigment was responsible for the typical buccero coloration one would expect that reduction of the piece of oxidized buccero would recreate more or less the appearance of the control section. Both the core and surface layer of the test piece did turn black, but the core was a more intense color than the peripheral zone, exactly the opposite situation from what was visible in the unadulterated control piece of buccero. (251)

Since the refiring apparatus certainly did not reproduce the exact conditions under which the pottery was originally prepared one might not be surprised that the laboratory experiment did not duplicate the characteristic coloration. The failure of the oxidized test piece to regain the same distribution of tones might also be accounted for by

(250) Leoni and Trabucchi (1962) 259-260.

(251) loc. cit.

some irreversible chemical or physical transformation induced by exposure to oxygen, or in the original firing cycle, which affected the mutability of the iron compounds responsible for the red and black color. It has been observed that the Greek red gloss cannot be reversibly converted from its black counterpart without some darkening of the red.(252) However, the Greek pottery was sintered. This was not the case with bucchero which, as we observed, (subra pp. 82 ff.), could be reoxidized at a temperature which should have been low enough to preclude the possibility that the iron in the bucchero test piece had undergone irreversible changes during the experiment.

As it was established that iron oxides were responsible for the coloration of the refired bucchero sherds one could reasonably ask if differences in the intensity of color after both oxidation and reduction resulted from differences in iron concentration. Analyses of samples taken separately from the surface and core of the sherds used in the refiring tests showed that there were essentially equal amounts of iron in the two parts of the fabric.(253) Another, more recent, investigation using X-ray fluorescence confirmed that the iron oxide content was the same in both the surface and the core of bucchero from a tomb at Caere.(254) These findings could lead one to suspect that some other chemical

(252) Bimson (1956) 203.

(253) Leoni and Trabucchi (1962) 259.

(254) Cesareo and Guidobaldi (1972) 514.

constituent in the surface layer or core might account for the lighter color of the exterior zone following oxidation as well as after reduction.

It is an established fact that the presence of calcium can mask the black color of oxidized or reduced iron oxides if temperatures reached during firing are sufficiently high.

(255) Examination of bucchero vessels found in a chamber tomb at Caere could indicate that bucchero potters sometimes had to confront this problem. The investigators noted that several of the bucchero vases were less black than the rest of the group. Subsequent analyses showed that the lighter colored vessels displayed higher calcium concentrations than the more black examples. (256) This led them to the logical conclusion that the colorant potential of the iron oxides in the light colored group was diminished by calcium in the fabric. (257) However, this explanation cannot be applied to the refiring experiment which failed to reproduce the bucchero coloration, since spectrographic analyses revealed "no appreciable difference" in calcium content between the surface and core of the sherds subjected to oxidation and reduction in

(255) Picon (1973) 66 and 71ff.

(256) Cesareo and Guidobaldi (1972) 519.

(256) Cesareo and Guidobaldi (1972) 519. It may also be noted that elevated calcium concentrations in bucchero were observed independently, Francaviglia *et al.* (1975) 229-230; but in this latter case there was no mention of the relative color intensity of the material. The high calcium content of clays in the vicinity of Corinth may have led the Greek potters in that city to import clay from Aegina for making the black-firing slip. See Farnsworth (1970) 18ff..

the laboratory.(258) In fact the spectrographic examination revealed not only that iron and calcium concentrations were the same, but that amounts of the other inorganic elements detected in the bucchero sherds were essentially the same in both the interior and exterior zones.(259)

Thus there seem to be no chemical constituents which could interfere with the color produced by iron oxides when bucchero sherds were refired in oxygen and hydrogen, respectively. Since iron was present in equal amounts in both the surface and the core of the refired bucchero, another explanation must be sought to account for the difference in color intensity between the two zones after oxidation and after reduction of the test pieces. The absence of chemical anomalies suggests a physical explanation for this phenomenon.

Indeed, it seems likely that the surface zone was lighter than the interior of the pieces refired in oxygen even though equal amounts of red ferric oxide pigment were present in each zone because of the difference in texture caused by compaction of the surface layer either by the pressure exerted during the shaping process(260) or by burnishing.

(258) Leoni and Trabucchi (1962) 259, concluded there was "... alcuna differenza di composizione, sia fra le zone superficiali ed interne ..." in concentrations of the major inorganic constituents which they measured, but they do not report the quantitative data on which they base their remarks.

(259) loc. cit.

(260) Leoni and Trabucchi (1962) 261, suggest that "auto-levigazione" rather than a deliberate attempt to burnish the surface was responsible for compacting the exterior. (See also supra pp. 35ff.)

(See also supra pp. 39ff.) While the physical effects of fabrication techniques clearly account for color differences in separate parts of fully oxidized bucchero containing equal amounts of iron oxide pigments, the outcome of the refiring trials has not been completely explained. One must still account for the fact that complete conversion of the iron in the test pieces to its black oxide did not produce a black coloration in the surface layer as intense as the original, untreated portion of the bucchero sherd. But before considering how to interpret this experimental result some comments on the respective roles of iron oxide pigments in bucchero and in Greek pottery are warranted.

It has already been observed (supra p. 77) that the iron content of the bucchero fabric is within the range normally found in Greek pottery, and that artificial addition of iron compounds to the bucchero clay seems unlikely since similar amounts of iron commonly occur in raw clays available in Italy and Greece. The measurements of iron oxide concentrations in the core and surface of bucchero permit even more precise observations. Not only does it appear that the bucchero coloration was not dependent on the application of an iron-enriched slip, but there was apparently no attempt at using clays with relatively high iron content for coating the surface of bucchero, while using a clay with a lower iron content for the main body of the fabric. There are indications that this constitutes a difference between the practices used by Greek potters and those employed for bucchero

manufacture.

Enhancing the intensity of red accessory color through deliberate addition of pure iron oxide to a slip prepared from local clay was apparently the usual practice in 5th century Attic red-figure workshops.(261) It is also presumed that Protocorinthian potters had already developed this technique for coloring portions of their vessels.(262) However, specialists who have successfully reproduced the black-firing slip used by Greek potters during the Geometric, Archaic and Classical periods do not propose that the amount of iron present in clay as a natural impurity was augmented deliberately.(263) Experimentation has shown that a suitable slip could be prepared by mixing the clay used for the vessel bodies with water, allowing the coarse particles to settle and then taking the liquid fraction which consisted of a suspension of the finer clay particles for the black "glaze." (264)

While spectrographic analysis has shown that the clay used for the slip and body of some Greek black-figure pottery was apparently derived from the same deposit,(265) examination

(261) Farnsworth and Wisely (1958) 165-166, analysis and experimentation led them to conclude that enough ochre was added to raise the iron content to ca. 11%, i.e. 15.75% Fe_2O_3 .

(262) Farnsworth (1960) 73-74.

(263) Farnsworth (1964) and (1960), Noble (1965) and Bimson (1956).

(264) Farnsworth and Wisely (1958) 166. The suspension was thickened by evaporation.

(265) Noble (1965) 39 and 212; although the spectra he reports seem to show a slightly higher concentration of iron and "heavier elements" in the slip.

of a Greek type cup from an Etruscan tomb revealed that the black-painted portion contained more iron and calcium than the reserved part of the surface.(266)

This difference in iron concentration might have resulted from the preparation of the slip used for decoration if the iron in the clay tended to be associated with the finer clay particles. Preparation of the suspension would then effectively concentrate iron in the portion used for the paint. This hypothesis requires experimental verification. Another explanation would be that a different clay, with a higher iron content, was used to make the black-firing slip applied to the cup in question. It is known that Greek potters did not always use the same clay for both vessel bodies and slip,(267) and there are variations in the iron content of the clays used to make Greek and Etruscan pottery. (See Tbl. II) At present there is not enough comparative data to determine whether or not potters working at particular centers during the Orientalizing period deliberately sought out clays with relatively high concentrations of iron oxide for preparing black-firing slips.(268)

Thus it cannot be decided at present if the Greek type cup from Etruria was produced by a workshop where clays used

(266) Cesareo and Guidobaldi (1972) 514.

(267) Farnsworth and Simmons (1963) 389-390, and Farnsworth (1970) 18ff.

(268) Farnsworth (1960) 74, describes sherds on which tests to observe the behavior of both black and red firing slips were conducted by Protocorinthian potters.

for slips were consciously selected on the basis of their colorant potential or if the Greek procedures for slip preparation normally yielded higher iron concentrations in the black colored portions of the pottery. If it could be shown that Greek painted pottery usually has higher iron concentrations in the black-firing slip than in the clay body, one could be quite certain that bucchero potters did not adopt the Greek techniques for slip preparation, if they applied any slip at all, since there seems to be no difference between the amount of iron in the bucchero finish and that occurring in the core. However, as in the case of Greek pottery, the experimental data on which this observation is based have been acquired from a very limited sample. Until more extensive testing is conducted with both Greek fabrics and bucchero, an unconditional statement on the use of slips with higher iron content to achieve black coloration cannot be made at present. On the other hand we do have indications that Greek pottery was sometimes decorated with such slips, while available analytical data show that bucchero craftsmen did not rely on this mechanism for coloring their pottery.

The analytical tests and refiring experiments reported above do affirm that there are sufficient amounts of iron in bucchero to produce a black coloration and that the appropriate oxides occur in bucchero sottile. Certainly magnetite, and perhaps in some instances ferrous oxide, cause a portion of the black color in both the surface and core of bucchero. But the fact that attempts to reproduce the original color of

bucchero by converting all the iron in a test piece to black ferrous oxide were unsuccessful, indicates some other variable must account for this failure of the refiring experiment.

A visual examination of the bucchero sherds which provided material for these laboratory firings allowed the observers to conclude that the intensity of surface coloration was not proportional to the iron content measured experimentally.(269) (See Table II) This suggested that some other pigment plays a key role in giving bucchero its characteristic coloration. Since there was no other evidence for the presence of an inorganic component other than iron which could have affected the color of the original or refired sherds, it seemed reasonable to suspect that organic material contributed to the typical bucchero coloration. Quantitative measurements for carbonaceous matter in the sherds used for the refiring experiments confirmed the presence of carbon in the untreated bucchero fragments in amounts between 0.73% and 1.12% by weight.(270) (See Table II)

Analyses carried out independently from the refiring experiments of the Italian team also revealed carbon in the bucchero sherds tested in amounts of about 1.2% by weight. These investigations found the material was almost exclusively contained in the surface layer of the vessel wall.(271)

There is also evidence that carbon was sometimes present in

(269) Leoni and Trabucchi (1962) 258-259 and 264.

(270) Leoni and Trabucchi (1962) 258-259 and 264.

(271) Sankowsky (1952) col. 83.

the core of bucchero pottery.(272) If this organic material was acquired by smudging or some such technique which would tend to concentrate carbon near the surface of bucchero, (infra pp. 111ff.) the presence of carbon helps to explain why the refiring experiments did not reproduce the original bucchero coloration.

The initial step of the refiring procedure, conducted at 500°C in the presence of oxygen, would have removed carbon in the bucchero fabric while converting any black oxides of iron to red ferric oxide. (See Figure III) The second and final step would have reconverted ferric oxide to black ferrous oxide, but the outer layer which had a more intense black color before treatment was now less black than the core. This would be expected if carbon accounted for much of the coloration in the bucchero before refiring, since carbon removed by refiring in air could not have been replaced by the hydrogen gas used as the reducing agent for the second stage of the refiring experiment.

Additional evidence indicating that iron oxides, alone, do not account for the coloration of bucchero sottile has been obtained through attempts to remove the pigment in this pottery by chemical means. Application of hydrochloric acid to a bucchero sherd for the purpose of extracting iron oxide failed to remove the black coloration.(273) As this reagent

(272) infra pp. 106 ff.

(273) Francaviglia et al. (1975) 225.

is normally used for dissolving iron and its compounds in analytical procedures it would appear that some other substance was causing the black color. Had sintering occurred when the pottery was fired, magnetite or ferrous oxide could potentially have been protected from the action of the acid by a layer of quartz crystals. Under such conditions it would be reasonable to expect that any black color resulting from these oxides could remain unaffected by the acid.(274) However, we have already discussed testing which showed that bucchero clay was not sintered,(275) and there is further evidence which shows iron oxides were not the principal agent producing the black color.

After extraction with hot HCl to remove iron oxides, several bucchero sherds were treated with hydrofluoric acid. Exposure to the second reagent, which can release material bound by silica, yielded a black residue. The x-ray diffraction pattern observed for the extract gave no indication that iron was present while exhibiting no "appreciable" reflection. This absence of reflection infers that an organic compound or elemental carbon was present in the extract, and therefore responsible for the black color. The probability that a carbon-based material would give this sort of diffraction pattern was explored by performing x-ray diffraction analysis with aliquots of charcoal. The patterns obtained in this way

(274) Shepard (1954) 33-35.

(275) See also the discussion of sintering, supra pp. 82ff., and possible firing techniques used for bucchero, infra pp. 113 ff.

were "similar" to those "from the residue obtained from the bucchero" by acid extraction.(276)

Quantitative determinations of carbon content in bucchero sottile have given values as high as 1.2%. (See Table I)(277) The essential rôle played by carbonaceous material in coloring the pottery is apparent from the data presented in Table II which shows a direct correspondence between intensity of black and increasing carbon content.(278) This can be contrasted to the lack of any proportional relationship between the iron oxide concentration and the degree of coloration. The weight percentages of carbon listed in Table II for the four bucchero sherds were determined by combustion of extracts obtained with hydrochloric acid extraction alone. (279) If hydrofluoric acid had been used in these analyses to remove carbon from the pottery, as it was in more recent experiments, higher percentages of carbon might have been observed.(280)

The behavior of the carbonaceous material in bucchero can be clearly seen from the results of differential thermal

(276) Francaviglia et al. (1975) 226-228. It is worth noting that there is no mention of any analyses carried out on the HCl extract to determine the amount of iron actually removed or if any carbonaceous material was present in this extract. Other researchers were able to extract carbonaceous material with HCl, infra n. 278.

(277) A sample of bucchero pesante held 1.62% carbon by weight; Sunkowsky (1952) col. 83.

(278) Leoni and Trabucchi (1962) 264.

(279) loc. cit.

(280) This hypothesis needs experimental confirmation. Unfortunately Francaviglia et al. (1975), did not fully exploit the possibilities for subjecting their samples to qualitative and quantitative analysis.

analysis carried out on 21 different bucchero fragments. Exothermic peaks observed between 400°C and 500°C along with corresponding weight losses must represent the combustion of a carbon-based substance in the fabric. The volatilization of water was indicated by an endothermic peak at 120°C.(281) These features of the DTA curves for bucchero sottile are paralleled in an investigation conducted with prehistoric sherds from Tepe Sialk. The curves for sherds which displayed "unoxidized" black or "dark" cores reminiscent of bucchero had peaks showing the loss of water and of organic material at the same points as those on the curves obtained with bucchero sherds.(282)

From the evidence available on the amount and behavior of carbonaceous material in bucchero, it is obvious that the change from black to red when the pottery is refired in air results not only from the oxidation of black iron oxides, but also from the combustion of carbonized organic material. One can indeed go as far as maintaining that the black color characteristic of bucchero depends primarily on the presence of carbon. Without the carbon-containing pigment, especially in the surface layer, it appears that the iron compounds in the clay do not provide the means of creating the appropriate relative intensities of color. This does not mean that

(281) Francaviglia et al. (1975) 225-226 and Fig. 2. CO₂ from decomposition of CaCO₃ normally peaks at a higher temperature. See Tite (1972) 295-297.
(282) Kingery (1974) 110-111.

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magnetite and/or ferrous oxide make no contribution to the color of the bucchero fabric, although it is not possible to quantify the amount of color derived from these oxides (or from carbonaceous matter) without further testing. But it seems clear that reliance on carbon to furnish the desired bucchero finish must have involved a deliberate choice on the part of the craftsmen. It cannot yet be established to what extent the black oxides of iron were a necessary byproduct of the reducing conditions needed to produce or preserve the carbon-based pigment.

The evidence, already reviewed from analyses and experimentation, seems to provide irrefutable proof that the black color of the slip used to decorate Greek pottery was dependent on the deliberate reduction of iron to its black oxides. This conclusion is confirmed by analysis of samples taken from the slip applied to Attic pottery which failed to detect any carbon. (283) This is not surprising since it has been established that the final portion of the firing cycle for Greek painted pottery was conducted under oxidizing conditions. (supra pp. 74 & 84) Thus any carbon absorbed during the reduction phase from kiln gases would have been removed by combustion. It would be useful to conduct microscopic and chemical examination on a larger sample population of various Greek pottery styles, including especially misfired vessels and kiln wasters, for the carbon content of both the black-

(283) Farnsworth and Wisely (1958) 172.

firing slip and clay body. This data would give an indication of whether or not Greek firing procedures were capable of impregnating pottery with amounts of carbon comparable to those found in bucchero.(284) Such a comparison would help scholars evaluate the possible influence from Greek firing techniques on those used for bucchero manufacture.

A recent proposal that carbonaceous material might have played an indirect role in producing the black color of the Greek black-gloss also warrants discussion at this juncture. Analysis of the black-fired slip on a Corinthian style vessel found in a tomb at Caere, which also contained bucchero, revealed a relatively greater calcium concentration (as well as a greater amount of iron oxide) with respect to the amount of calcium found in the unpainted portion of the pottery surface.(285) It was suggested that this material could have derived from "an organic substance" added to the slip to promote reduction of the iron to its black oxides.(286)

This theory seems highly implausible for several reasons. Most importantly, it has been clearly demonstrated that the Greek black-gloss can be consistently produced without resorting to such measures.(287) Furthermore, analysis has shown that clays used by potters in Greece and Italy

(284) This possibility arose during a conversation with Dr. John Hayes of the Royal Ontario Museum whose acumen has again been very useful.

(285) Cesareo and Guidobaldi (1972) 514.

(286) Cesareo and Guidobaldi (1972) 514.

(287) Farnsworth and Wisely (1958) 166; Noble (1965) 31ff.

often had naturally high calcium content, (288) and that potters working at Corinth, and no doubt elsewhere as well, used a clay for the black-firing slip which was different from the clay used for the body of their pottery. (289). Since greater amounts of both iron and calcium were detected in the painted decoration on the vessel from Caere one need not attribute the variation in the amount of these constituents between the painted and unpainted areas of the surface to any cause other than differences in composition which could be expected from the utilization of clays from different deposits. (290)

Furthermore, it is difficult to understand why researchers would associate higher calcium concentrations with the addition of organic material. Normally organic substances are composed primarily of carbon, hydrogen, oxygen and nitrogen which would burn away during firing. Inorganic elements are often present in more complex organic substances, but generally in relatively minute quantities. (291) The inorganic fraction would remain after combustion, but a relatively large volume of organic material containing the inorganic

(288) Prag et al. (1974) 171-172, and Picon and Chapotat (1971) 82-88.

(289) Farnsworth and Simmons (1963) 389-390, note that the black-gloss had a different coefficient of expansion from the body.

(290) Cesareo and Guidobaldi (1972) 511, after examining other vessels from the same tomb concluded that different clays had been employed for separate parts of the body of one vase on the basis of observed differences in calcium concentration.

(291) An obvious exception would be blood, which contains iron.

elements would have to be mixed with the clay slip before a significant increase in the amount of calcium or another inorganic element would be observed.(292) As those who proposed that the calcium content of the black-gloss was increased by addition of organic material do not suggest a particular substance which could furnish especially large amounts of calcium,(293) more detailed discussion would be inappropriate at present. Essentially there is no sound theoretical basis and no apparent practical reasons which justify the hypothesis that Greek potters added combustible material to their black-firing slip with the aim of promoting reducing conditions. We have also seen that any carbon which might have been absorbed by Greek painted pottery fabrics during the reduction firing phase was apparently removed during the final stage of firing when oxygen was present in sufficient amounts to permit combustion of any organic substances and to oxidize the unpainted portions of the surface. Thus the coloration of the Greek black-gloss was entirely dependent on the amount of reduced iron oxides present. This is in contrast to the bucchero sottile color scheme which depended on the presence of carbon in addition to reduced iron oxides for its typical appearance.

(292) Cesareo and Guidobaldi (1972) did not try to determine if any carbon residue remained in the slip.

(293) Noble (1965) 58, notes that modern potters commonly add some honey to slips to increase adhesion to the body of the vessel being decorated and used this technique with success when reproducing the black-figure decoration. One would not expect honey, which is primarily sugar, to increase calcium content even if it was used in antiquity.

Chapter IV

Mechanisms for Coloring and Firing Bucchero

While it seems certain that carbonaceous material provided the major constituent of the bucchero finish, there is less certainty about how the colorant was introduced. The investigators who observed that acid extracts from bucchero gave diffraction patterns similar to those for charcoal seem to favor the hypothesis that "charcoal was probably used as the pigment material," (295) noting that powdered charcoal might have been added to the clay. (296)

As the authors do not speculate on the details of how such a pigment was introduced and the pottery subsequently treated, it is difficult to evaluate the merits of this proposal. One can nonetheless observe that if powdered charcoal or carbon black was mixed with the clay before it was formed into the desired shapes, and if it was fired at a relatively low temperature for a short enough period of time, enough carbon could conceivably remain unoxidized to yield the bucchero coloration. But, if carbon dispersed in the clay was responsible for the black color of bucchero one would certainly expect the intensity of color in the center of the vessel walls to be equal to or greater than that at the surface, since the interior of the body would be less easily oxidized than the exterior. The opposite appears to be true for the bucchero analyzed to date. (*infra* pp. 92 ff.)

(295) Francaviglia et al. (1975) 226.

(296) If only the surface was carbon enriched one wouldn't expect the center of the body to display a more intense color. See *infra* p. 92. See also Figure III.

Pottery made from carbon-containing clays is known to display bloated walls and 'vesicular' cores caused by trapped gases when the kiln temperature rises too quickly.(297)

There seem to be no reports of such phenomena associated with bucchero vessels, although such failures would be less likely to have been kept for sale. Unlike Attic pottery little attention has been paid to pieces of bucchero which seem to be kiln rejects. It is reported that bucchero 'wasters' have been found at Caere(298) but no description of these vessels has been provided. A careful examination of them could possibly clarify our understanding of the bucchero technique.

One can occasionally see bits of carbon (charcoal?) in bucchero as well as pits in the surface which seem to have been caused when such material was burned out. These do not occur as often as could reasonably be expected if ground charcoal had been mixed with the clay.(299)

The strongest arguments against the theory that elemental carbon was blended purposefully with the clay are perhaps found when it is recognized that bucchero can be most properly seen as the culmination of a gradual development in a technique which does not seem to rely on such a mechanism. Furthermore, potters could have obtained consistent results

(297) Shepard (1954) 21.

(298) Ramage (1970) 19.

(299) Vases from the Royal Ontario Museum, generously made accessible by John Hayes, have these features. Most of those examined were reputedly from Tarquinia.

much more simply.

It should be mentioned that the presence of naturally occurring organics in the clay selected by bucchero makers has been cited as possibly contributing to the black color of this pottery. It has been assumed that beds of sedimentary clays from coastal marsh lands which do tend to contain organic material(300) would have been used for manufacturing bucchero.(301) It is not unreasonable to suppose that Etruscan potters were capable of making this selection since mineralogical studies of bucchero indicate no major regional variations in the composition of the bucchero clay body.

(supra p.47) However, without reliable data on the composition and actual occurrence of such clays in Etruria one can not confirm or refute this theory. One should keep in mind, on the other hand, that bucchero was very probably produced at inland sites(302) where clays of a somewhat different character would presumably have been available. Furthermore, the observed distribution of carbon in the bucchero fabric argues against the presence of organic material in the clay body before firing. (supra pp.92 ff.)

(300) Shepard (1954) 11.

(301) Winter (1957) 29.

(302) Inland manufacture, thought to have taken place around Chiusi, Vulci and Orvieto, begins at a later date. DePuma (1976) 223. It may be significant that the currently available analytical data shows that the inorganic inclusions and composition of the paste remain fairly constant in sherds from both inland and coastal sites, see Francaviglia et al. (1975) 228, so that it seems probable that there was a deliberate selection in the type of clay used for bucchero.

An alternative method for coloring pottery black depends on the use of a carbon 'paint'. Observation of modern-day potters belonging to some Indian tribes of the Americas has yielded considerable information on the procedures of this decorative method. Prior to firing, a liquid 'paint' prepared from plant extract is applied to the surface of each pot. This organic material chars during firing, leaving a black deposit. The success of this technique requires maintaining either a balance between the reducing gases and oxygen in the kiln atmosphere, or an excess of the former, in order to avoid the complete combustion of the colorant.(303)

A 'paint' of this sort may also be applied after an initial firing has hardened the clay. A second exposure to heat in neutral or reducing conditions is then needed to convert the paint material to carbon. The color derived from this two-stage process tends to be less resistant to oxidation than that obtained when the pigment is applied to unfired pottery clay. This is reasonably explained by the relative impermeability of the fired clay. Researchers have noted that treatment with hydrofluoric acid is frequently needed to loosen the clay matrix before the black color resulting from the one-step process can be removed by a blow pipe flame. Such pretreatment is not normally needed to assist the oxidation of carbon paint from the two-stage

(303) Shepard (1954) 33-35.

method.(304)

If the surface coloration of bucchero could be attributed to charred organic colorant prepared from plant juices or even elemental carbon,(305) the fact that HF was required to liberate at least part of the carbonaceous pigment in bucchero samples could be cited as evidence that the single-step method of paint application was used. However, one is hard pressed to find any concrete evidence supporting the hypothesis that a paint of this sort was used at all to color bucchero. If a carbon pigment was applied to the bucchero surface with a brush one would expect to find spots where brush marks could be seen, especially at the interface between matt and lustrous portions such as those discussed above. (supra pp. 43ff.)

If bucchero had been dipped in a carbon paint there should be some instances where paint dribbled under the foot, or where finger marks remain. Rather than signs of this sort one observes blemishes on bucchero that are indistinguishable from the patches of color commonly found on Italic impasto. It is true that there are instances when Iron Age Italic potters used applied color,(306) but the stylistic and

(304) ibid. 34.

(305) There appears to have been sporadic use of a resinous coating on pottery made during the Iron Age and later in Liguria. Moevs (1973) 93-94. Presumably by charring this material one might obtain a black color. It is not impossible to suppose that such a process inspired the potters in neighboring Etruria to experiment further.

(306) See Matteucig (1951) 14ff. for a discussion of vases from Etruscan contexts painted with geometric designs in red and white. See also supra pp. 51ff.

technical links with the impasto tradition make it most improbable that a carbon paint was used to color bucchero. It seems likely that a much simpler process was adopted.

The possibility that a charred coating of organic material accounts for the bucchero finish also fails to explain the dark core of this type of pottery. It could be maintained that black oxides of iron were formed throughout the clay body while reducing conditions were promoted in order to char an organic paint, thus producing a difference in color between surface and core. The presence of such a pigment on the surface alone should yield a pronounced excess of elemental carbon in the surface layer. Test results from one laboratory do purportedly show that the approximately 2% of carbon found in the bucchero tested was concentrated "almost exclusively in the vessel surface area". (307) This led to the conclusion that a pigment made from grease and soot had been used to color Etruscan bucchero. (308) A confirmatory microscopic examination failed to locate any carbon fragments in the core of the pieces examined. Unfortunately no mention is made of the relative frequency with which such particles occurred in the surface of the pottery sampled. (309)

One is obliged to question the results of this microscopic examination since they are contradicted by results

(307) Sankowsky (1952) col. 83.

(308) ibid. col. 87.

(309) ibid. col. 83.

published by Italian researchers. The Italian group examined a bucchero chalice from Chiusi and observed 'nodules' of a black substance which could be "carbon black" (nero fumo), "randomly" distributed throughout the clay body.(310)

Although the material provided by these two investigations offers a relatively small sample population it seems possible to reconcile the seemingly disparate results obtained by the two separate laboratories.

The distribution of carbon in the bucchero samples studied to date seems to indicate that carbon was not present in the clay used for bucchero manufacture either as a natural impurity or as the result of deliberate mixing of carbonaceous material with the clay. If such material was present one could expect to find it throughout the fabric but not only at the surface. This is because under oxidizing conditions the carbon near the exterior would burn out first, leaving the organic material at the core intact as long as the firing stopped before combustion of all the carbon was completed.(311) Conversely, if the carbon in bucchero derived from the combustion of an organic paint applied to the surface before firing one would not expect to find carbon in the interior of such vessels. One might wonder whether

(310) DeAngelis (1960) 199, "in tutta la massa qua e là si osservano disordinatamente disseminati noduli più anneriti, cioè più ricchi di sostanza nera (nero fumo?)."

(311) Bucchero, as we already observed, supra pp. 65 ff., was fired under reducing conditions, so that oxidation of the carbonaceous material would have resulted only in the event of an accident during firing.

the combustion of an externally applied organic paint during firing could introduce carbon into the core of the vessel as well as the surface since the fabric would still be relatively porous at the temperatures needed to trigger combustion. Actually it seems more feasible to expect volatile tars would be expelled away from the surface along the path of least resistance, but if reducing conditions produced with smoke created an equilibrium state in the kiln, tars might be driven into the clay body. However, it would appear that the use of an organic paint can be excluded on the basis of the previously discussed lack of other physical evidence for such a process. (supra pp. 5-6)

Thin sections of North Italian Iron Age Golasecca pottery viewed with a microscope revealed that in some cases 'small nuclei' of carbon were distributed throughout the vessel wall, in others the carbon was found only at the surface, and in a third group carbon deposits occurred only at the core.(312) This phenomenon was interpreted as reflecting variations in the porosity of the samples and in the intensity of reducing conditions which affected the amount and extent of carbon deposition during firing.(313) The degree to which Golasecca potters consciously manipulated the composition of their clay need not concern us here, but the conclusion that carbon in their pottery was absorbed from

(312) DeAngelis (1958) 159.

(313) Mariani and Storti (1953), and DeAngelis (1958) 159.

kiln gases under conditions deliberately engineered to promote this occurrence(314) suggests an explanation for the observed distribution of carbon in bucchero pottery.

The presence of carbon in the surface layer alone or in both the surface and core of bucchero conforms to what one would expect if this material was deposited during firing. Contact with soot and tars in kiln gases would have left the surface of bucchero black. If these gases succeeded in penetrating the clay body carbon would have been deposited in the core as well. As carbon could not reach the core without passing through the surface zone one would not anticipate finding carbon only in the core of bucchero, unless oxidation of the carbon in the surface occurred accidentally after it had already been deposited. If oxidation took place after carbon deposition, one should not find the typically deep black bucchero finish, since it is clear that carbon in the surface is essential for its coloration. (See also supra pp. 94 ff. and Figure III.)

The fact that one finds bucchero with carbonaceous material concentrated in the exterior zone of the fabric is best explained by the filtering action of the polished, and therefore compacted, surface of fine clay particles.(315) The porosity of the surface would be influenced by the characteristics of the clay as well as the amount of pressure

(314) DeAngelis (1958) 160.

(315) Winter (1957) 28-29.

applied when burnishing the exterior. Penetration of carbon containing gases into the clay body would depend not only on the porosity of the surface but also on the amount and particle size distribution of the carbonaceous material in the kiln gases, firing temperature and the length of time during which these gases came in contact with the pottery. Certainly bucchero potters would have utilized a standard, empirically controlled procedure, but it is likely that one or more of these variables were not always controlled with consistent precision by individual workshops or by potters from different production centers. If bucchero was impregnated with carbon during firing the vessels would have been susceptible to the deviations which would normally be associated with fabrication procedures and/or with the physiochemical nature of this firing process. It should not be surprising to find that the carbon content of bucchero was not always uniform under such circumstances.

The evidence provided by the distribution of carbon in bucchero and the physical characteristics of the bucchero finish therefore allows one to conclude that this material was not derived from natural impurities, from the deliberate mixing of carbon with the paste, or from the application of an organic paint. Unfortunately, the evidence itself comes from a relatively limited sample which makes additional analysis and experimentation under controlled conditions essential before any lingering doubts can be dispelled.

While the results of microscopic examinations seem to eliminate mechanical addition of carbon before firing and natural impurities as sources for the carbon in bucchero sottile they are consistent with what one would expect if carbonaceous matter was acquired during firing. An alternate method for coloring pottery black which is congruent with this latter possibility depends on the deposition of colloidal-sized particles of carbon and tars contained in the gases and smoke which contact the pottery during firing. This technique, known as 'smudging' or 'fumigation', has been very well documented among several Amer-Indian tribes, (316) and is clearly the sort of process which Etruscan potters could have developed and perfected independently.

The most basic procedure begins by stacking sun-dried pots on the ground or on a raised grate. Once in place, the pottery is covered with fuel such as wood, bark or manure. Fuel is placed under the pots in some cases. A fire is lighted and allowed to reach the desired intensity. At an empirically determined point the fire is smothered with a combustible material which produces thick smoke. The fire is allowed to die as the pottery is bathed in carbon-rich vapors. (317) This type of firing can be considered as having two distinct phases; the initial one when oxidizing or

(316) Shepard (1954) 85ff.

(317) Shepard (1954) 85, 87-89. The color and resonance of the pottery were criteria for determining when the fumigation should start.

neutral conditions prevail and the final stage when reducing gases generated by the freshly added fuel are present in excess of oxygen.(318)

Fine, loose dung was chosen as the fuel for the second phase by most Pueblo Indian potters, who made sure the material was pushed up against the stacked vessels, thus insuring a close contact with the carbon-producing fuel and sealing out unwanted oxygen.(319) This particular fuel is very well suited for smudging as it forms a natural blanket over the pottery.(320)

Potters were apparently well aware of the necessity to keep the covering intact once the initial flames had been smothered, since any resurgent pockets of fire were immediately damped. Such flaring could create localized oxidizing conditions with the risk of marking the black finish with patches of red color.(321)

The Indian firings observed and documented with pyrometric analytical monitoring lasted from 340 to 114 minutes with the smudging phase accounting for between 15 minutes and one hour of the total period. The timing for commencement of the reducing phase is very critical as the temperature should not exceed certain limits before the smudging begins. In the

(318) Although in one instance the phases were reversed. Smudging took place in the initial stage and when flames were visible the firing terminated immediately before the deposited carbon burned out. Shepard (1954) 90.

(319) Shepard (1954) 88 and 90.

(320) ibid. 75-76.

(321) ibid. 88.

event that the temperature becomes high enough to cause shrinkage before fumigation starts, the attendant reduction in pore size inhibits adhesion of the absorbed pigment. This can be expected to result in a less lustrous surface.(322)

The addition of fresh fuel, dung, vegetable matter etc., at the beginning of the smudging phase produces a strong reducing atmosphere. Analysis of gas samples from a Pueblo firing in a pit kiln with juniper wood fuel showed that carbon monoxide, carbon dioxide and hydrogen were present in considerably greater amounts than oxygen when the fuel was first added.(323) An oxidizing atmosphere or neutral conditions, a balance of oxygen and reducing gases, prevailed when the wood had been transformed to charcoal.(324) Carbon, present in the clay before firing or absorbed from the kiln gases, would remain unaltered under neutral as well as reducing conditions. Thus if smudged pottery could be protected from excess amounts of oxygen, its black color would be preserved. Reducing conditions would also convert iron oxide to its black forms contributing to the intensity of color in the pottery.

While it has long been recognized that pottery fired in this manner often has physical characteristics similar to those of bucchero,(325) more recent experimentation with Iron

(322) loc.cit.

(323) Shepard (1954) 217- and Tbl. 10, p. 218.

(324) loc.cit.

(325) Mariani and Storti (1953) 81.

Age pottery from Lombardy has led researchers to propose a more complete explanation for how the process functions. Essentially, large hydrocarbon molecules in smoke derived from the fuel decompose, eventually yielding carbon which is deposited on the pottery surface and in the interior. The decomposition of kiln gases in contact with the pottery exterior and penetrating the clay body is probably catalyzed by alumina and iron oxide in the clay body. Microscopic examination of this Iron Age pottery shows that carbon tended to be deposited around particles of mineral inclusions.(326) A similar process, sometimes utilizing alumina as a catalyst, is used by modern industry to 'crack' heavier petroleum compounds into less complex chemicals.(327)

The fumigation phase of the Pueblo firings began between 10 and 30 minutes after the firings commenced. At this time the temperatures reached their maximum, ranging from 625°C to slightly above 750°C.(328) Experiments carried out by German investigators have recently shown that some clays colored black by the smudging technique displayed the greatest surface lustre when fired at about 700°C. The lustre was diminished noticeably when fumigation was conducted at temperatures below 650°C.(329)

Higher temperatures were achieved by Pueblo Indian potters using open fires to make oxidized, red wares. The

(326) DeAngelis (1958) 159.

(327) Mariani and Storti (1953) 81 ff. and 92 n.31.

(328) Shepard (1954) Tbl. 3, p. 87 and Fig. 6, p. 89.

(329) Winter (1957) 29.

maximum range, 770°C to 940°C, (330) was greater than that of the fumigation firings because the fires were not smothered prematurely. Sheep manure was the fuel which yielded the highest temperature. By using a pit dug in the ground, firing temperatures between 1000°C and 1200°C were obtained. (331)

Iron age pottery made by the Golasecca potters of Northern Italy with a fumigation technique was apparently fired at temperatures similar to those used for American Indian pottery. Refiring experiments with selected sherds and local clays, coupled with measurements of the acid-soluble alumina and iron oxide content in the pottery, showed that this material from Lombardy may have been heated to temperatures in excess of 650°C but certainly not above 750°C. (332)

Refiring sherds of Primitive Impasto from Rome and observing changes in their physical appearance over a wide temperature range led to the conclusion that this pottery was originally fired to temperatures below 800°C. (333) This observation, in addition to the fact that the cores had hardly been altered from the raw state, was considered as indicating that the vessels could have been fired over an open fire. (supra pp. 56 ff.) Thus the information available on the techniques used during the Iron Age by Northern Italic potters and their contemporaries in Etruria and Latium shows

(330) The pottery was set on a raised grate. Shepard (1954) 85.

(331) Shepard (1954) 217-218.

(332) Mariani and Storti (1953) 78-81.

(333) Gjerstad (1966) 71 n. 1.

that a tradition for making low fired, fumigated pottery was firmly established before the development of bucchero sot-tile.(334)

This is clearly in contrast to the Greek pottery tradition where the final stage of firing was carried out in an oxidizing atmosphere. The temperatures used by Greek potters were also higher than those for producing the earliest type of impasto. The imported Greek pottery, and presumably Etruscan fabrics which duplicate Greek models, were heated to temperatures between 825°C and about 1000°C.(335)

Although it seems no one has published detailed studies using techniques such as thermal expansion or pore size distribution in an attempt to determine bucchero firing temperatures,(336) estimates have been made which are comparable to the temperatures used by Pueblo potters and to those suggested for Iron Age Italic pottery. The presence of caliche in sherds of bucchero from Pyrgi, Veii and some other sites could suggest that they were fired to temperatures below 750°C.(337)

(334) There are, as already noted (*supra* pp.66 ff.), no technical data available for the Advanced Impasto fabrics which would allow a complete evaluation of the relationship between bucchero and these fabrics, although the physical appearance of the later impasto varieties indicates they were subjected to a reduction firing.

(335) Noble (1965) 75-76; Bimson (1956) 200-204; Farnsworth and Wisely (1958) 166.

(336) On thermal expansion see Tite (1972) 298-300. Pore size distribution has been shown to correlate very well with firing temperature by Morariu et al. (1977) 187-192.

(337) Francaviglia et al. (1975) 230.

Calcite, CaCO_3 , begins to decompose rapidly when heated to temperatures between 700°C and 800°C , (338) but the conversion to calcium oxide, CaO , and carbon dioxide, CO_2 , may not be completed until a temperature of about 900°C is reached. If sufficient amounts of carbon dioxide are present in the kiln atmosphere the breakdown of calcite can be retarded. (339) The data obtained from Pueblo firings shows that carbon dioxide does indeed occur in relatively large amounts during fumigation, so that the occurrence of unaltered calcite in bucchero is not conclusive proof that the pottery in question was not fired to temperatures above 750°C .

Other authors have nonetheless reported that bucchero was fired at temperatures between 700°C and 800°C . Unfortunately, the literature does not describe the means used to obtain these values. (340) Conclusions drawn from such estimates must remain somewhat tentative but we have already considered evidence which confirms that bucchero was fired at

(338) Shepard (1954) 30. Francaviglia et al. (1975) 230. concluded from DMT curves obtained from calcareous clays that 'extensive heating at 750°C showed the disappearance of calcite.'

(339) Shepard (1954) 217 and Tbl. 10, p. 218.

(340) Peco (1960) Tbl. II, p. 203 gives 750°C as the firing temperature for bucchero. However, there is no discussion of the procedure used to obtain this value for bucchero sottile. Firing temperature estimates for a number of prehistoric fabrics from Northern Italy cited in the same table were obtained from analysis of acid soluble Al_2O_3 and Fe_2O_3 in the sherds. See Mariani and Storti (1953) 73-92. In a recent review, DeFosse (1975a) 1076, it is reported that M. Picon considers the firing range of bucchero as being between 700°C and 800°C . The means used to reach this conclusion are not presented.

temperatures below those obtained by Greek potters.

The refiring experiments of Leoni and Trabucchi revealed that bucchero sherds became resonant when heated to temperatures between 800°C and 1000°C.(341) Thus even though one cannot evaluate the accuracy of some firing temperature estimates for bucchero, it seems clear that the Etruscan potters worked within the range attained by the American potters and their Iron Age predecessors in Italy. It is of course possible that the temperatures to which bucchero pottery was exposed during firing exceeded these limits, but that the vessels were not heated for a period long enough to allow the internal temperature to rise above 800°C. However, it would seem likely that relatively low temperatures were consistently and deliberately utilized, since one can reasonably assume the Etruscan potters were aware that higher temperatures were not only unnecessary, but might jeopardize the production of a lustrous black color. (See supra pp. 111 ff.)

While it seems clear that Etruscan potters intentionally subjected bucchero to fumigation during the final stage of firing, one can only speculate on the exact procedure. Modern researchers have in fact tried to duplicate the bucchero fabric and their endeavors suggest some of the avenues potentially open to craftsmen manufacturing bucchero. Results from experiments attempting to recreate early

(341) Leoni and Trabucchi (1962) 259.

Egyptian pottery were thought applicable to an understanding of the bucchero technique. Trial firings were conducted with vessels fashioned from Pennsylvania clay. The surfaces were coated with ochre and burnished when leather hard ('half-dry') with bits of glass. The pottery was then partially buried in pine sawdust which ignited during firing. The submerged portion turned black while the rest of the vessel, exposed to oxidizing conditions, turned red.(342) It was noted that the black part of pottery was not as lustrous as Etruscan bucchero,(343) even though the surface of the experimental vessels had been burnished.

The researchers proposed that a coating of wax or oil might have been applied to bucchero when it was still hot from the fire to increase the exterior sheen.(344) However, the hypothesis was not tested. The failure to reproduce the typical bucchero finish in this instance may well reflect the characteristics of the local clay used to make the test vessels.(345) Possibly some other parameter such as the length or temperature of the trial firing did not duplicate these aspects of the procedure normally used by Etruscan potters.

A rather ingenious method for reproducing the deep black finish of bucchero sottile involved packing individual

(342) Randall-MacIver (1921) 87-88.

(343) ibid. 88.

(344) loc. cit.

(345) On the composition of bucchero clay see supra pp. 45 ff. Randall-MacIver does not discuss the composition of the clay used in his experiment.

vessels in peat within a fireproof container, a saggar, which was then sealed, placed in a kiln and heated to 900°C. The peat charred during firing generating a reduction atmosphere rich in carbonaceous matter which produced a very uniform, high surface lustre and a black colored core. Although slipped vessels had a higher lustre, those which had only been polished gave 'very satisfactory results.' (346)

This procedure, which is currently used by German craftsmen for the manufacture of clay pipes, was adopted when earlier attempts to recreate the bucchero finish by exposure to thick smoke in an open kiln chamber blackened only the surface of the test vessels. The researchers altered not only their earlier firing procedure but substituted a German swamp clay with natural organic impurities for the clay formerly used for the bodies of test vessels. After these modifications the fabric acquired its characteristics as the organic material in the clay body charred during firing leaving the core black, while the surface obtained its uniform coloration through direct contact with the peat. (347)

It is rather difficult to evaluate how closely this experimental procedure approximates that used by Etruscan potters since the clays used were not from Tuscany, (348) and no data were acquired from analyses of the reproductions which could be compared with the available results from

(346) Winter (1957) 29.

(347) ibid. 28-29.

(348) The individual characteristics of local clays must always be considered.

physical and chemical testing of actual bucchero sherds. But, even though the experiments succeeded in making a fabric which appears to duplicate bucchero sottile, (349) there are reasons to suspect that Etruscan potters did not rely completely on the same procedures. The possibility that bucchero sottile was packed in sealed containers with organic material when fired cannot be proven without archaeological confirmation. Since no bucchero workshop has been securely identified, the hypothesis cannot be verified at present. On the other hand numerous Greek and Etruscan pottery workshops and kiln sites have been excavated, (*infra* pp. 125ff.) without any signs that saggars were employed to create reducing conditions. Indeed, the success of the American Indian potters demonstrates that such containers are not necessary if appropriate clays and firing procedures are utilized. (350)

We have also observed that organic material was probably not present in the bucchero clay body prior to firing on the basis of the distribution of carbon in bucchero sherds subjected to microscopic examination. (*supra* pp. 106ff.) Thus it seems Etruscan potters did not depend on clays such as those used in the experiments with peat-filled saggars.

Another attempt to duplicate the bucchero fabric was recently described at a colloquium devoted to problems related to various aspects of bucchero pottery production.

(349) A photograph of one of the modern reproductions of bucchero is given by Winter (1957) 29.
(350) Shepard (1954) 85ff.

One cannot give a full evaluation of experimental procedures employed since only a brief summary was reported.(351) It is noteworthy that conclusions reached from these experiments were based in part on the examination of clay from the vicinity of Caere. The researchers should be congratulated for realizing the importance of utilizing material from a site where bucchero was actually manufactured for investigations of this sort. From their remarks it seems that trial firings enabled them to create a fabric identical to bucchero by fumigating specimens with wood fuel for 'several days' at temperatures around 600°C.(352)

One can hardly do justice to this recent experiment given the extreme brevity of the published results. There are, nonetheless, reasons to reject the idea that these procedures duplicate those used by bucchero workshops. Since previous estimates for the temperatures utilized by Etruscan potters lie in the 700°C to 800°C range,(353) it seems

(351) DeFosse (1975a) 1075-1076, published the following 'resumé' of the communication to the Table Ronde: 'che il bucchero é stato cotto ad una temperatura di circa 600°C, in ambiente chiuso ed in presenza di legna, per alcuni giorni. É stato dimostrato, inoltre, che la tipica colorazione nera é dovuta esclusivamente a carbonio elementare prodottosi per "cracking" e riduzione delle molecole degli idrocarburi del CO e del CO₂, distillate dal legno, diffuse nelle porosità dell'impasto ceramico ed assorbite dall'argilla. Osservazioni ottiche roengenografiche, termiche ad alla microsonda elettronica hanno mostrato l'identità del bucchero etrusco con i campioni costituiti da argilla, proveniente dalla zona di Cerveteri (Lazio, Italia), preparati con la tecnica suddetta.'

(352) See text reproduced supra n. 351.

(353) supra pp. 116ff. Although one must admit that confirmation of these values is needed.

probable that bucchero was not fired at temperatures as low as those used in this experiment (i.e. ca. 600°C).

The suggestion that bucchero was fired for a period of several days does not sound reasonable. Not only does this sound uneconomical, but the discussion of primitive firing methods (supra pp. 111ff.) indicated that much shorter firings of the fumigation type can yield pottery with the physical appearance of bucchero. It has also been noted that fuels other than 'legna' (354) give satisfactory results. (355)

When the experimental attempts to reproduce bucchero are considered in conjunction with the information obtained from scientific examination of real bucchero, it is apparent that no one has yet duplicated the process originally employed by Etruscan artisans. On the other hand, analytical data supplemented by results from modern efforts to recreate bucchero and by those obtained by Amer-Indian potters (supra 111ff.) indicate three of the essential aspects of the bucchero technique. The existing sources of information lead to the conclusions that Etruscan craftsmen relied on fumigation for making bucchero; that the pottery and fuel were in close proximity and probably in direct contact with one.

(354) supra n. 351.

(355) M. Picon reports that pine needles are a suitable fuel for producing fumigated pottery. DeFosse (1975a) 1076, n.10. I have also been able to examine first hand a vessel made by Robert Bowers of Toronto, Ont. which perfectly duplicates the bucchero surface color and lustre, and gives the typically dull sound of low-fired pottery when tapped. This and other vessels were burnished and placed in a pit filled with a mixture of charcoal and powdered manure. The fuel was ignited and allowed to burn overnight.

another, and that bucchero was normally fired to temperatures in the 700°C to 800°C range. This can be contrasted to Greek pottery production methods in use during the same period which required an oxidizing atmosphere for the final phase of firing and demanded temperatures in excess of those used for making bucchero. (supra pp. 116 ff.)

On the other hand, a strong reducing atmosphere was required during the intermediate firing stage to convert red ferric oxide in the Greek slip to its black forms. This could lead one to suspect that Etruscan potters working in the impasto tradition might have adopted the means used by Greek potters to create effective reducing conditions. Specialists agree that Greek artisans must have obtained a reducing atmosphere by introducing smoke into the kiln chamber while closing vents to insure that an excess of reducing gases was maintained. When the potters judged the reduction complete, (356) the vents were opened and fumigation stopped, allowing oxidation conditions to prevail during the last part of the firing. (357) If carbon was absorbed by the Greek

(356) Noble (1965) 77-78, and Bimson (1956) 200-201.

(357) Reducing conditions were probably created by using wet fuel or combustables such as those already listed in descriptions of American Indian smudging techniques could have been used to generate smoke (see Noble (1965) 77). A more clean burning fuel could have been added or the smoldering fire raked to permit complete combustion in order to obtain oxidizing conditions for the final firing phase. One means of monitoring conditions in the firing chamber of Greek kilns employed small sherds of pottery removed from the kiln at critical points. Farnsworth (1960) 72-75.

pottery during the reduction phase, one would expect it to burn out during the final oxidizing phase.

This supposition has been confirmed by one test for carbon content in Attic black-figure pottery, but it seems only the black glaze was analyzed. (358) Some further investigation to determine carbon content in ProtoCorinthian pottery could be useful for discovering whether or not Greek firing methods impregnated their wares with carbon to the same extent as bucchero which would in turn give some indication of how closely Etruscan procedures followed those of the Greeks. However, the fact remains that bucchero workshops deliberately prevented reoxidation of their smudged fabric and relied on the deposition of carbon for achieving the characteristic coloration. Thus the aim of the Etruscan craftsmen was fundamentally different from the intentions of their Greek counterparts, regardless of how much impact Greek practices might have had on the perfection of the bucchero technique.

If it were possible to document changes in kiln design in Etruria during the Orientalizing Period it might be possible to detect specific contributions from Greek technology to the evolution of firing methods used by Etruscan potters. Circular kilns built above ground with clay were

(358) Farnsworth and Wisely (1958) 172.

in use in Greece as early as the Geometric Period, (359) and were used by the potters making black-figure and red-figure vases during the Archaic and Classical period. The basic design has been reconstructed from evidence furnished by actual remains and representations on painted pottery and clay plaques. (360) The illustration in Figure IV shows the typical arrangement of the assorted elements. A circular, domed chamber often about one meter in diameter enclosed the pottery during firing. Vessels were placed on a raised grate isolating them from direct contact with the fuel, and providing good circulation of heat. A fire was built in an adjacent longitudinal chamber. The hot gases drawn from this fire box into the kiln chamber heated the pottery.

Although there seem to be no Greek kilns which can be dated to the interval between the 8th and early 6th centuries, it seems reasonable to assume such kilns were used during the Orientalizing Period since pottery production depended on the same basic technique for producing wares with a black-firing slip on a light ground throughout the interval in question.

(supra pp. 73 ff.)

(359) An example from the Athenian agora is illustrated by Thompson (1940) 6-7 and Figs. 4-5. The objection raised by Villard and Vallet (1953) 17, n. 2, that since no wasters were found the structure may not have been a potter's kiln, is justified but, since the kiln resembles other positively identified examples and as 'a clay-lined basin such as is used in modern Greek potteries for the washing of clay' was discovered nearby, it is highly probable that the kiln belonged to a pottery shop of the Geometric period. Thompson loc. cit.

(360) See Cook (1961) 64-67 and Noble (1965) 73-74 and Figs. 230-236.

Kilns of the circular variety found at Gela and Megara Hyblaea have been dated to the early 6th century, (361) but presumably the 8th century colonists brought the design with them to Pithekoussai and the other Western colonies. One would expect that immigrant potters used the same design in Etruria for the production of Greek type fabrics during the 7th century, (362) but archaeological evidence is needed to substantiate this supposition. As yet no kilns have been found which can be linked to the production of Iron Age, Villanovan impasto. It was noted that the earliest variety was probably fired without being enclosed in a semi-permanent structure (supra pp. 113 ff.), but the increased uniformity of the Advanced Impasto fabrics suggests that kilns came into use by the late 8th or early 7th centuries. (363) One might suspect that local potters working in the impasto tradition adopted this method of controlling firing conditions from the Greek example, given the impact which Greek pottery had on the decorative aspect of pottery production in Etruria. But for the present, the lack of the necessary archaeological testimony makes the evolution of kiln design in Etruria a matter of speculation.

(361) Villard and Vallet (1953) 14-17 on Megara. The Gela furnace could be as early as the late 7th century on the basis of the sherd found with it: Adamesteanu (1956) 277-279; but the lack of a clear stratigraphical sequence makes it safer to assign an early 6th century date.

(362) See supra pp. 59 ff. for discussion of Greek fabrics made in Etruria.

(363) See supra pp. 52 ff.

The oldest kiln remains in Etruria are those of the circular 'a pipa' Greek type. The earliest example found at the coastal site of Roselle was used during the 6th century B.C..(364) The absence of wasters in some instances makes it impossible to decide what sort of pottery was fired in the kilns, and in certain cases refuse from metalworking suggests that the structures were actually metallurgical furnaces designed in a manner similar to the pottery kilns.(365) If the a pipa kiln was being used by workshops making Greek type fabrics in Etruria during the 7th century the design could have been copied by Bucchero craftsmen.

Misfired bucchero vessels, 'wasters,' have been reported from Caere.(366) The earliest kiln remains from this site have been dated to the 6th century, but apparently cannot be linked to bucchero manufacture.(367) The excavations at Marzabotto have unearthed the remnants of several pottery-making installations, one of which might have been utilized for the manufacture of bucchero during the 6th century.(368) The atelier in question contained a circular kiln of the Greek variety. Excavators found a number of pottery vessels in the vicinity of the kiln including a number of ciotole, or bowls, in a 'fine very dark grey fabric

(364) Curri & Sorbelli (1973) 250-251.

(365) ibid. 247ff.

(366) Ramage (1970) 19.

(367) Curri and Sorbelli (1973) 252, the installation was apparently used for architectural terra cotta manufacture.

(368) Saronio (1965) 385ff.

similar to buccero'.(369) A ciotola of reddish brown color and another of a 'buccheroid' fabric were found with four of the grey bowls and a dolia in a deposit of charcoal and small bone fragments.(370) More bowls, also of the grey type, were found mixed with cinders nearby the kiln remains.(371)

As yet the ceramic material has not been studied or illustrated.(372) However, on the basis of the preliminary report it is by no means certain that true buccero was manufactured at this workshop. The ciotole found with the dolia, charred wood and bone fragments may not have been made there. This particular assemblage could have been deposited haphazardly, but could also be interpreted as the remains of culinary activities by the artisans.(373) The bowls found near the kiln in a stratum of cinders certainly appear to be rejected waste material from the kiln.

However, the grey bowls may well be misfired examples of the red-colored bowls, such as the one found with the dolia in the workshop and which have been reported among finds at Marzabotto and other sites in Northern Etruria.(374)

(369) ibid. 390.

(370) ibid. 390, and Fig. 4, p. 394.

(371) ibid. 393.

(372) Only a schematic drawing showing the location of the pottery appears in the preliminary report. See supra n. 371. Mansuelli (1972) 125-126, reports the pottery in question has not yet been studied.

(373) During a visit to a pottery workshop in Bizerte, Tunisia in July, 1977 the two potters lighted a small fire in the mouth of their wood-fired kiln on which they cooked their noon meal.

(374) See Sandri (1972) 319-340 for discussion of these bowls.

If the grey-colored bowls from the Marzabotto workshop were deliberately colored black and fired in the circular kiln, it is definitely possible that they were not produced in the same manner as bucchero sottile. While the physical appearance of the ciotole resembles that of the bucchero fabric, it has already been shown that superficial similarities do not provide sufficient criteria for deciding if black coloration was produced by reduction of iron oxides alone or by the bucchero technique.

Analysis of five sherds of the true bucchero fabric which were found at Marzabotto(375) showed that the clay body contained a quartz-feldspar mineral (sanidine) in amounts approximately equivalent to the amount of this material occurring in samples of bucchero from various other sites in Southern, Central and Northern Etruria.(376)

Sanidine, derived from weathering of volcanic tuff, is found in deposits throughout the region bounded by the Arno and Tiber rivers. The use of sands containing the mineral as temper for the bucchero paste explains its presence in the pottery. Since geological deposits including sanidine apparently do not occur in the Marzabotto area, it has been suggested that the bucchero analyzed was either made with temper imported by the workshops, or the pottery itself brought to Marzabotto from another location.(377)

(375) Francaviglia et al. (1975) 228-229 and Fig. 4.

(376) loc.cit.

(377) ibid. 229.

The results from the mineralogical examination of the bucchero sherds from Marzabotto are not directly applicable to the grey-colored ciotole from the Marzabotto kiln site, but they underscore the need to verify analytically whether or not these bowls were made according to the bucchero technique. The presence of bucchero at Marzabotto which might have been imported does not preclude local bucchero sottile manufacture, but until scientific testing of the grey bowls has been undertaken it cannot be assumed that the pottery installation excavated at Marzabotto was producing true Etruscan bucchero during the 6th century.

Although bucchero craftsmen may have adopted the Greek kiln design, analogous to the Marzabotto example, it must be remembered that on the basis of current knowledge Greek fabrics were fired to temperatures significantly higher than bucchero sottile. This fact alone need not mean bucchero was definitely fired in another sort of kiln. Presumably Etruscan potters could have used the a pipa kiln but purposefully kept temperatures lower than those employed for manufacturing Greek pottery. However, the evidence available from the experimental attempts to reproduce bucchero and from observation of the techniques used by potters employing primitive fumigation firings strongly suggests that bucchero was fired in contact with the fuel. (supra pp. 118ff.) It has been pointed out that the Greek kiln design incorporated structural elements which effectively isolated pottery from the fuel. Therefore if bucchero artisans adopted the Greek

design, they may well have made structural modifications or added combustible material to the chamber containing the pottery in order to maximize impregnation of the bucchero vessels with carbonaceous matter.

Since the bucchero firing temperature could have been reached with a simple fire or by placing the pottery and fuel in a pit below ground level, in accordance with procedures used by Amer-Indian potters, the possibility must be considered that bucchero was not fired in a semi-permanent structure such as those used by the Greeks. The fact that there is good reason to consider bucchero as the culmination of the trend toward production of uniformly reduced impasto also suggests this possibility. It was observed that the estimated firing temperature and physical qualities of Primitive Impasto led to the conclusion that this pottery was baked in an open fire. (supra p.56) However, without testing the later Advanced Impasto fabrics which were produced before and during the period of bucchero sottile manufacture, one cannot be sure how long the most rudimentary firing procedure was used in Etruria. (378)

If one knew whether or not the workshops which made bucchero also made impasto fabrics, the possibility that bucchero was fired in a more primitive fashion than Greek

(378) It is believed that the Golasecca potters of Northern Italy used "un vero e proprio forno, con controllo della temperatura e dell'ambiente." Peco (1960) 205; but the hypothesis is not discussed. This assertion also lacks archaeological confirmation.

fabrics could have a more sound theoretical basis. This intriguing question is unanswerable at present since the necessary technical data has not been sought for the impasto fabrics. It would not be surprising to find bucchero craftsmen making both oxidized and reduced types of impasto, since bucchero seems to represent a refinement in the process used for making a reduced impasto fabric.(379) However, the increased uniformity of coloration visible in the Advanced Impasto fabrics could certainly indicate improved methods for controlling firing atmosphere. The consistently homogeneous appearance of both the surface and core of bucchero strongly suggest that the most primitive firing procedures had been abandoned for the production of bucchero.

Even though bucchero was probably fired in a more sophisticated manner than those used by Italic potters of the pre-Orientalizing era and the Pueblo potters, bucchero craftsmen could have employed less sophisticated kilns than those used by Greek potters. Conceivably, Etruscan potters developed rudimentary structures of non-durable materials for firing bucchero sottile. Kilns built with pieces of turf by pre-Flavian potters in the Nene Valley of Britain provide a plausible alternative to a bonfire or the Greek type of kiln fashioned from clay. The Nene Valley kilns (See Figure V) often left only shallow, blackened depressions and bits of fire-hardened turves. Eventually the discovery

(379) supra pp. 54 ff.

of kiln furniture and sherds along with the turves provided the clue necessary for reconstructing the original plan.(380) A kiln built in this manner in 1972 generated temperatures between 750°C and 800°C when fired with wood,(381) temperatures compatible with those estimated for bucchero firings. (supra pp. 116 ff.) Had bucchero been fired in kilns of this sort, such scanty and nondescript remains could well have escaped discovery or identification,(382) but it is probably more reasonable to assume that chance and the emphasis on excavating Etruscan burial grounds rather than habitation sites have reduced the likelihood of finding a bucchero workshop or kiln in 7th century contexts.(383)

The evidence examined above indicates that both the aim of bucchero craftsmen and methods they employed were fundamentally different from the intent and process used by Greek potters. Yet when confronted with obvious signs of Greek influence on painted pottery production in Etruria and similarities in some shapes and decoration between bucchero and Protocorinthian pottery, (see Appendix I) one could still wonder if a knowledge of practices used to produce pottery of the Greek type enabled Etruscan workshops to arrive at an appropriate firing procedure for bucchero.

(380) Woods (1974) 263-286.

(381) ibid. 269.

(382) Some 47 acres of ground had to be excavated before 'conclusive evidence' on the structure of the Nene Valley kilns was found. Woods (1974) 265.

(383) The Marzabotto kiln cannot be securely regarded as part of a bucchero workshop. (supra pp. 113 ff.)

The point definitely shared by both Protocorinthian and bucchero manufacturing procedures is the maintenance of a well-controlled, strongly reducing atmosphere during part of the firing. The Greek painted pottery was reoxidized during the final firing phase, the bucchero pottery was not. Nonetheless, obtaining reducing conditions was critical to the successful preparation of both fabrics.⁽³⁸⁴⁾ It is not certain to what extent bucchero workshops adopted features of Greek kiln design, but since direct contact with the fuel seems to be a requirement for reproducing the typical bucchero fabric, it follows that the Etruscan potters did not simply mimic the means used by Greek potters for creating reducing conditions. Possibly observation of Greek pottery production led Etruscan potters to adopt the use of kilns of their own design or to modify the venting system or some other structural feature of kilns developed at an earlier time for the firing of later varieties of impasto. Possibly Greek potters introduced new types of fuel better suited for the fumigation process. Given the present state of knowledge on these subjects such speculations can neither be confirmed nor rejected, but it must be recognized that Etruscan potters could have altered the impasto fabrication process on their own. In fact the lack of uniformity in the bucceroid impasto fabric suggests attempts to perfect a new firing

⁽³⁸⁴⁾ supra pp. 98 ff. This is true whether or not bucchero was covered with a clay slip.

process, (supra p.58) rather than simply adopting another one.

On the other hand, if the potters who first perfected bucchero did so after observing other craftsmen, it is conceivable that they could have profited from the expertise of Etruscan metallurgists instead of, or in addition to, potters working in the Greek ceramic tradition. An adequate reducing atmosphere forms an essential step in separating both iron and copper from their ores.(385) Separation was carried out during the prehistoric period and the Iron Age by placing ore in direct contact with charcoal fuel ~~in~~ clay-lined pits or simple one-chambered furnaces.(386) This arrangement rather closely resembles the fumigation procedure which conforms to what can be elucidated about the probable bucchero fumigation technique. This need not imply that the bucchero potters or metallurgists understood the chemistry of the reduction process in other than practical terms, but that the makers of bucchero could have been enterprising enough to experiment with other methods in order to produce uniformly fired pottery.

(385) The oxides of iron and copper carbonates must be reduced. The sulphide ores of these metals must be roasted in air, then reduced to liberate the metal. See Hildebrand and Latimer (1951) 102-105 and 402-405 and infra n. 52-53.
(386) Maddin et al. (1977) 122-131; Coghlan (1956) 87-88 and Forbes (1958) 74-77. The ore and fuel were sometimes placed in alternating layers, otherwise the charcoal and ore were mixed together.

The remains of rudimentary stone furnaces at Populonia show that iron was smelted in Etruria using the procedure described above.(387) These particular installations seem to be of post 5th century date,(388) although Iron Age examples of such furnaces are known elsewhere in Europe.(389) There are also remains of furnaces used for copper smelting at Populonia which might have been operating as early as the 8th or the 7th century.(390) These are of a more complex structure and of more durable construction than those used for iron smelting. The most well-preserved example was built in the shape of an inverted cone (1.8 m. inside diameter at the base) with stone blocks and lined with refractory clay. A raised floor, perforated with circular openings and supported by a central pillar, separated the furnace into two chambers.(391) This construction may have

(387) Minto (1954) 308 and (1929) 397-404.

(388) Minto (1954) 307.

(389) Davies (1935) 42ff., and Coghlan (1956) 87ff.

(390) Minto (1954) 301-303, illustrates the scanty dating material which includes impasto sherds, bronze rings and rochetti. Hus (1975) 13, suggests the 8th century date. Although the artifacts are typical of the Villanovan era, rochetti (clay weights) do occur in 7th century contexts as well. For example at Poggio Buco, Tomb B. See Matteucig (1951) 28, 58-59 and Pl. XIII, Ns. 13-14. The stratigraphy reported after the Populonia excavation is not as illuminating as could be hoped. The dating material was mixed with large quantities of smelting waste which had apparently been used for land fill under one of the furnaces in order to provide a level space on the hillside where the furnaces were installed. See Blanc (1937) 317-323. Thus one can hardly accept the earliest date of the furnaces with complete certainty.

(391) For plans and reproductions see Minto (1954) Fig. 4, p. 299 and Fig. 6, p. 301. See also Blanc (1937) Figs. 3-4, and Figs. 5-6, p. 321. An untitled photograph of one of the furnace interiors is given by Modona (1955) 97.

permitted the simultaneous separation of copper and iron when locally available calcopyrite was smelted, with the copper draining into the lower chamber. (392) The raised floor may have been a feature designed to create a better, more even draft in order to reach higher temperatures. (393) If the potters who developed bucchero had seen such installations, they could have adapted appropriate structural features or smelting procedures to suit their particular requirements.

The temperatures needed to smelt copper and iron ores are much higher than those used for making bucchero or Greek pottery, (394) but there is no reason why potters would have been obliged to seek such temperatures, even if they used metallurgical furnaces or procedures as models. Metallurgists used charcoal for fuel and were obliged to use forced air to reach the temperatures required for smelting copper and iron. (395) There is an illustration of a 6th century plaque which shows a Greek potter adding sticks of wood to an a pipa kiln, (396) but charcoal might have been used if only for

(392) Heurgon, J. cited by Hus (1975) 13. This view apparently summarizes the comments made by Rossini (1937) 329-330. See also Minto (1954) 301.

(393) Another Etruscan furnace of this type, also used for copper smelting, was excavated at Marzabotto. See infra n. 399.

(394) Temperatures between 1100°C and 1150°C are needed for smelting iron and copper ores. Maddin et al. (1977) 122-124, and Coghlan (1956) 39.

(395) See Maddin et al. (1977). Tuyères were found at Populonia. Minto (1954) 304. Examination of charcoal for Populonia showed that *Pirus Aucuparia*, *Quercus Robur* and *Quercus Ceris* were used for fuel. Tongiorgi (1937) 331-333.

(396) Noble (1965) Fig. 235, p. 199.

part of the firing cycle. In any case it is clear that Etruscan potters never fired bucchero to temperatures as great as those employed for smelting. What the bucchero craftsmen could have adopted from metallurgical techniques, as easily as they might have learned from Greek potters, was the practice of packing their pottery more carefully in a blanket of fuel or the idea of enclosing their fire in a pit or kiln. These procedures would have enabled them to maintain greater control over the fumigation process vital to the production of the bucchero fabric.(397)

Similarities in pottery kiln design and smelting furnaces have been interpreted as indicating that Near Eastern metallurgists were able to smelt copper by adopting ceramic kiln design.(398) The resemblance between the ceramic kilns in Etruria with their raised perforated floors, and the copper smelting furnaces at Populonia and elsewhere,(399) has led to the suggestion that such furnaces could theoretically have been used simultaneously for pottery production and metal-working.(400) The furnaces at Populonia seem to indicate that metallurgical furnaces were of a more advanced design than the kilns used contemporaneously for producing

(397) It is also possible that Etruscan potters modified the methods used to fire impasto after observing the preparation of charcoal which proceeds by smothering burning wood. They might have deduced empirically that if the wood turned black, their pottery would as well.

(398) Coghlan (1952) 22ff.

(399) Blanck (1968) 609 and Fig. 76, p. 608, illustrates another copper furnace of this type from Marzabotto.

(400) Curri and Sorbelli (1973) 250 n. 10.

impasto, if kilns were used at all for the production of this type of pottery. Thus it seems that if techniques exploited in one craft influenced developments in the other, Etruscan potters could have benefited from the process used for smelting to improve earlier firing practices and thus perfect the bucchero technique.

There is a notable increase in bronze and iron objects in burials throughout Etruria during the 8th century, (401) and some bucchero shapes and decorative techniques indicate an awareness on the part of bucchero craftsmen of metalware vessels and metalworking procedures. The relationship between bucchero sottile and metalware is discussed above, but it can be mentioned at this point that the familiarity with materials other than pottery strengthens the hypothesis that development of the fumigation process used by bucchero potters may have resulted from a knowledge of smelting techniques rather than an acquaintance with Greek ceramic production methods.

One could dismiss the similarity between the smelting process for iron and copper and the fumigation procedure apparently utilized for bucchero as merely coincidental. This would seem reasonable if one chooses to place greater emphasis on the growing awareness of Greek pottery styles and techniques in Etruria during the Orientalizing Period,

(401) Pallottino (1939) 100-102 and 108-109, Ridgway (1973) 26..

than on the similarities between metallurgical techniques and firing procedures which impregnate pottery with carbon. Given the lack of archaeological and technical data concerning the development of metallurgy in Etruria and unresolved questions about bucchero sottile manufacture, conclusions on the relationship between the two industries must remain speculative.

There is also a degree of uncertainty about the extent of the debt which bucchero sottile owes to the Greek pottery tradition. As presentation of the potential bucchero firing procedures and kiln design completes discussion of the basic techniques employed in bucchero fabrication, it is now possible to summarize the conclusions drawn from this discussion and evaluate the apparent contributions from various sources to the development of the bucchero technique.

Chapter V

Summary and Conclusions

The information available at the present time indicates that the origins of bucchero sottile cannot be linked directly to the Greek pottery making tradition, although adoption of some Greek technical procedures may have assisted the Etruscan potters in perfecting certain aspects of their technique. Bucchero incorporated advances in ceramic technology such as the utilization of refined clay and the potter's wheel which had become part of the process employed by Italic potters making impasto fabrics. It seems likely that these innovations were introduced along with decorative motifs of Greek origin as importation of Greek pottery and production of Greek fabric types in Etruria expanded during the Orientalizing Period.

Some procedures were apparently taken directly from the Greek tradition without modification, and probably learned by observing immigrant Greek potters. On the other hand the improved quality of the burnishing applied to impasto and the tendency to produce vessels with thinner walls may well represent the culmination of efforts by impasto workshops seeking to emulate the overall superior character of Greek pottery. Since advanced techniques for preparing clay and fabricating vessels had become part of the stock in trade of Etruscan potters before bucchero sottile was perfected, it seems reasonable to assume that basic procedures for making bucchero, including the dependence on carbon for coloration, were inherited from the local pottery tradition rather than resulting from the participation of

Greek potters in bucchero production, or from the tutelage of foreign craftsmen.

The principal characteristic which separates bucchero from the bucceroid impasto fabric is the uniformity of its surface color combined with a completely reduced, black core. This strongly suggests that bucchero originated when alterations in the firing procedure used to make bucceroid impasto allowed Etruscan potters to achieve better control of their firing atmosphere, while creating conditions which insured reduction of the core as well as the vessel surface. It appears that whatever the exact nature of this modification, it enabled the potters to create fumigation conditions of sufficient intensity to impregnate the surface and often the core of bucchero with carbon and simultaneously reduce iron in both portions of the fabric to its black oxides. If the technical advance which made bucchero production possible resulted from observation of Greek pottery firing methods, one can at least be certain that bucchero potters did not simply copy the Greek procedure. This is apparent since the temperatures and firing cycle necessary for producing a sintered, black-firing slip on an oxidized clay body are different from those used to make bucchero.

It is possible that Etruscan potters were able to perfect their fumigation process by adopting the Greek a pipa kiln. It is not known when kilns first began to be used by local potters in Etruria. Primitive Impasto may have been fired without the benefit of this device, but the local

production of Greek fabrics would have necessitated the use of a kiln, presumably of the Greek type. Since Advanced Impasto is generally more uniformly colored than the primitive variety it would not be surprising to learn that a kiln was employed for making impasto pottery before bucchero emerged as a distinct fabric. At present it cannot be determined whether bucchero workshops inherited the potter's kiln along with the rest of its technical processes derived from the impasto tradition or if bucchero craftsmen learned to use kilns from the example afforded by local production of Greek fabrics.

We do not know what features were included in the kilns used for firing bucchero. Possibly bucchero potters used a much less sophisticated structure than the a pipa kiln which they could have designed independently in accordance with the exigencies of fumigation firing. Alternatively, the Etruscan craftsmen might have used the a pipa kiln with all of its structural elements while adding fuel to the chamber containing pottery in order to improve smudging conditions. But given the fact that the bucchero firing cycle and temperatures were not the same as those used for Greek pottery, it is likely that if the a pipa kiln was used to fire bucchero, the Etruscan artisans altered the internal design to permit closer contact with the fuel. While one might expect potters would be more inclined to profit from the expertise of artisans practicing the same craft, it is conceivable that bucchero potters were able to perfect their

fumigation procedure or kiln design by adopting certain aspects of metallurgical procedures which they had seen being used.

In summary, examination of the available experimental data and comparative material indicates that bucchero sottile originated with Etruscan craftsmen making impasto pottery according to the indigenous Italic tradition. Exposure to Greek pottery and the associated techniques gave Iron Age and Etruscan potters some of the means to improve the quality of impasto fabrics along with the incentive to develop their own ways of standardizing and perfecting impasto production methods. It may be that by adopting the Greek kiln design Etruscan potters were able to make the transition from bucceroid fabrics to bucchero sottile. However, the monochromatic, lustrous surface and reliance on carbon deposition for coloration sets bucchero apart from the Greek pottery tradition. Etruscan potters no doubt benefited from the sophisticated ceramic technology necessary for making Greek painted pottery, but the craftsmen who made bucchero selected the appropriate elements of Greek pottery technology and modified them to suit their own ends. Bucchero did not originate from the desire to copy Greek pottery but from an attempt to perfect a fabric whose aesthetic qualities and technical principles were rooted in the impasto tradition.

The data available from physical and chemical examinations of impasto, bucchero and of Greek pottery and information obtained from observation of primitive firing techniques

permits the following conclusions regarding the bucchero manufacturing process:

1. Bucchero sottile which was made with thin walls from a well refined clay represents a considerable advancement in fabric quality over the early Iron Age impasto fabrics made in Etruria. These features were not initiated by bucchero workshops, but were incorporated by potters making Advanced Impasto, including the bucceroid variety, before the emergence of bucchero sottile. The gradual introduction of refinements in technical quality and the increased use of the potter's wheel parallel the importation of Greek pottery and the growth of local production of Greek type fabrics. Since Greek potters had previously mastered the potter's wheel and processes for refining raw clay it seems reasonable to suspect that Advanced Impasto workshops acquired these superior techniques from observing immigrant potters at work or at least from questioning sailors and traders about the methods used to make Greek pottery. Bucchero potters should thus be seen as continuing to use some practices adopted earlier by potters working in the Italic tradition, and not necessarily as acquiring methods of clay preparation or throwing techniques directly from Greek craftsmen.

2. Bucchero potters used a paste with relatively constant composition, apparently adding temper obtained from local deposits of weathered quartz. This indicates that the

artisans were selective in their choice of primary materials. However, without mineralogical study of impasto fabrics and locally made pottery of the Greek type it cannot be ascertained how closely bucchero potters may have followed the preferences of impasto potters or immigrant craftsmen in their choice of clay and temper.

3. The lustrous bucchero finish resulted in part from deliberately burnishing the fabric surface. This action enhanced the naturally glossy appearance of the illitic clay used to make bucchero. Burnishing was commonly used by Iron Age Italic potters in Etruria so that bucchero artisans presumably inherited this procedure from the local pottery making tradition. Possibly observation of Greek potters helped bucchero craftsmen attain a greater degree of precision. This could have involved the modification of tools used by Italic potters for polishing. The use of the potter's wheel would have permitted a more uniform application of pressure and decreased the time needed for the burnishing procedure, although we have seen that some bucchero potters continued to burnish manually. However, the skill with which many bucchero vessels were finished need not indicate that the Etruscan potters learned to perfect their burnishing technique from foreign craftsmen. It is equally plausible to suspect that they were capable of adapting manual procedures to the mechanical requirements of the wheel through trial and error.

4. It is not certain if a slip was applied to bucchero sottile, but it appears that the mechanical action of polishing the clay would have been sufficient for creating the compacted surface zone of bucchero while imparting lustre to the exterior. Since slips had been applied to some impasto vessels, bucchero workshops need not have drawn on the example afforded by Greek pottery for this procedure.

5. Inorganic chemical analysis indicates that if a slip was used on the bucchero surface, it was prepared from the same clay as that utilized for the clay body. As the amount of iron and other major inorganic elements was essentially equal in both the surface and core, it seems that if a slip was applied, bucchero craftsmen did not adopt the preparation methods used by Greek potters which resulted in higher concentrations of iron oxide in the black-firing slip than in the reserved areas of Greek pottery.

6. Since carbon is present in the surface and in some instances the core of bucchero sottile in addition to black oxides of iron, the final phase of firing was carried out under reducing conditions. This indicates that bucchero potters did not adopt the Greek firing cycle in which the final stage was carried out under oxidizing conditions.

7. The fact that the black oxides of iron in bucchero were not protected from reoxidation by sintering constitutes another intentional departure from Greek procedures on the part of bucchero craftsmen.

8. The deep black color of bucchero is caused by the presence of both carbonaceous material and black oxides of iron but the presence of carbon in the surface of bucchero is absolutely essential for creating the typical bucchero coloration. This is apparent since refired bucchero, colored only by conversion of the iron in the fabric to black ferrous oxide, did not display as intense a color as untreated bucchero containing carbon along with black oxides of iron. The dependence on carbon for obtaining the bucchero coloration is not accidental, but represents a deliberate choice by bucchero potters to use methods fundamentally different from those used by contemporary Greek potters whose fabrics derived their black color from iron oxide alone.

9. Examination of Iron Age pottery from Northern Italy indicates that Golasecca potters relied on the presence of carbon to achieve the desired black coloration of their vessels. The presence of carbon in Bronze Age and Villanovan impasto from Etruria suggests that similar procedures were employed in Etruria prior to the emergence of bucchero sotile as a distinct fabric. The role of carbon in coloring impasto needs further investigation, but the presence of this organic material in impasto and the trend toward the production of impasto with a uniform black surface in the period immediately preceding the development of bucchero leads to the conclusion that bucchero represents the culmination of attempts by local potters to produce a monochromatic fabric whose black color derives from the presence of carbon in the

pottery.

10. The physical qualities of bucceroid impasto strongly suggest that this fabric was the technical precursor to bucchero sottile. Scientific examination of bucceroid vessels is needed to illuminate technical similarities between the two pottery types. It also seems likely that some bucceroid vessels are actually misfired bucchero or bucchero produced by less-skilled craftsmen than those producing the highest quality bucchero sottile. Bucceroid vases with lustrous black surfaces but with unreduced cores would be obvious candidates for these two categories. However, the form of such vessels would have to be compared with bucchero sottile analogues to determine if the former could have been made by contemporary bucchero workshops.

11. The carbon in bucchero originated during the firing cycle as was the case in production of Golasecca pottery. Although experimental verification is needed it seems likely that the carbon in impasto made in Etruria was also deposited in the fabric during firing. The firing temperature range for bucchero is also comparable to the values for this parameter determined for Golasecca pottery and Iron Age impasto from Latium. The presence of carbon absorbed during firing and the firing temperature range for Iron Age Italic pottery and bucchero sottile suggest that these fabrics were produced by a fumigation process such as that employed by modern Amer-Indian potters. Attempts to reproduce the bucchero fabric support this conclusion.

However, archaeological evidence is needed to elucidate the details of the fumigation procedure used by bucchero potters.

12. It appears that intimate contact with the fuel is essential for successful fumigation firing. This insures even carbon deposition and at the same time reduces iron oxide to its black forms. If bucchero was fired in this manner it seems unlikely that the Etruscan artisans adopted their fumigation technique from Greek potters, since the latter isolated their pottery from contact with the fuel in order to insure a uniform oxidation atmosphere during the final phase of firing. However, analysis of Greek pottery should be conducted to determine if the reduction phase of the Greek firing cycle impregnated vessels with amounts of carbon comparable to those measured in bucchero.

13. The homogeneous quality of the bucchero coloration suggests that the potters controlled their firings by enclosing their pottery in a kiln of some fashion. This seems to represent an advance over the techniques employed for the manufacture of Primitive Impasto, although it is possible that Etruscan potters making Advanced Impasto fabrics had already begun using kilns rather than open fires. The kilns used for firing bucchero may have been rather rudimentary in design and possibly built from non-durable materials.

14. Bucchero craftsmen may have adopted the a pipa kiln which Greek potters apparently introduced into Etruria. However, since the bucchero firing procedure differs

Appendix I

Bucchero Forms and Decoration

significantly from that used by Greek potters it would not be surprising if the Etruscan craftsmen altered the design of the Greek kiln. It is also possible that bucchero craftsmen constructed kilns resembling the a pipa variety through observation of procedures used for smelting copper or iron ore, rather than following the example of potters producing Greek type fabrics.

Research devoted to the typology and decoration of bucchero sottile has established two basic phenomena. First, it can be shown that the shape and decoration of bucchero embodies elements of Italic, Near Eastern and Greek artistic traditions. Second, there are often similarities between both the form and the decoration of bucchero vessels and the shape and ornament of metalware and ivory work. These topics cannot be dealt with in detail within the confines of the present study; however, a brief summary of the principal findings of specialists in this area of study is warranted in order to clarify the aims of bucchero craftsmen.

A detailed typological study of bucchero pottery from Caere indicates that bucchero shapes can be traced to three different cultural traditions: Italic, Near Eastern and Greek. (402) Table III catalogues material primarily from Caere, and shows that many of the rare forms made during the earliest production phase disappeared after the middle of the 7th century. (403) Many of the abandoned types were among

(402) Ramage (1970) 1-61.

(403) The forms not included in the list given by Ramage have not all been attested at Caere but have been included for comparative purposes. Forms attested at Caere but not cited by Ramage are the situla and stamnoid olla. Gran Aymerich (1972) illustrates one impasto situla and three bucchero situlae. Two of the bucchero situlae are from Caere. On the olla see: Bonamici (1974) 26, 54, 56-57 and Pls. XXXI, XXXV and XXXVI, Cristofani (1969) 62-64, and Fig. 26. Dohan (1942) Pl. XLVII illustrates a ribbed bucchero example. Matteucig (1951) illustrates numerous impasto examples. A model boat in bucchero, or perhaps bucceroid impasto, (supra p.33,n.113) of unknown origin is in the Boston Museum of Fine Arts, No. 01.8064. There is an impasto example from Caere illustrated by Pohl (1972) 133-

those thought to derive from Near Eastern prototypes. The forms which were not made after the middle of the 7th century were replaced by newer Greek shapes. This coincides with the increased influence from Greek culture at the expense of Near Eastern influence, (404) observed at the close of the Early Orientalizing period. (405) Although not all forms were kept in the bucchero repertoire, Italic vase types as well as some Greek and Oriental types continued to be manufactured. Thus the bucchero craftsmen preserved the local ceramic tradition while responding quickly to changes in current fashion. (406) The fact that all of the principal bucchero shapes were represented in other local and imported pottery fabrics should also be noted since this phenomenon is significant when considering the influence exerted by metalware and ivory objects on bucchero manufacture. (407)

Bucchero decoration, as noted previously, (408) was achieved primarily with tools which either cut the surface of the pottery or left impressions in the clay. Geometric designs predominated during the earliest phase of production. The most frequently encountered type of decoration consisted of thin horizontal lines, used singly or arranged in bands at

(403)(cont'd) 134, and Fig. 111.4. Bronze examples found in Etruria were apparently imported from Sardinia. See Torelli and Lulliu (1971).

(404) Greek influence on Etruscan pottery manufacture can be seen in the adoption of vase names derived from names used by Greeks. See Colonna (1973-1974) 132ff.

(405) Ramage (1970) 4-5. See also supra pp. 15ff.

(406) ibid. 10.

(407) infra pp. 164 ff.

(408) supra pp. 44ff.

intervals on the vessel surface. (See Figure VI) Incision was also used for vertical striations on the body of globular forms, (409) and for rays often added above the base of cups and oinochai. (See Figure VI) Small rosettes, S-shaped motifs and lozenges were added to bucchero sottile with stamps. (410) However, the stamped ornaments were not used as frequently as incised bands and dot patterns. (411)

Patterns composed of series of dotted lines were an especially popular mode of decoration on bucchero sottile. Single lines and 'fan' patterns have been classified as a form of 'rouletting', (412) although this may be a misnomer in some cases. The semicircular 'fans' and wedge-shaped segments which belong to this category consist of dotted lines radiating from a central point. (See Figure VI) They were apparently made with a straight, toothed implement which was pivoted about a point thus duplicating the same dot pattern in each component line. A toothed wheel may have been used in some cases. (413) Long dotted lines were presumably made with a tool incorporating a wheel-shaped die. A similar tool with diagonally set teeth was probably employed

(409) Ramage (1970) 15ff. and Figs. 10, 11, 12, 20, 21 and 23.

(410) ibid. 16.

(411) In addition to the material illustrated by Ramage the illustrations given by Gierow (1966) Fig. 86, and by Gjerstad (1966) 87-88 and the associated commentaries provide useful comparative material.

(412) Ramage (1970) 16.

(413) Ramage (1970) 16, Gierow (1966) 290, DelChiaro (1966) 101, and Richter (1936) 63-65. An example of a dot pattern whose dots were punched individually is given by Dohan (1942) Pl. LII.5.

for adding a rouletted spiral design to the body of an early bucchero amphora.(414) The fan patterns were freely combined with various other types of decoration.

Ribbing was commonly employed to embellish the lower portions of the bodies of chalices and kyathoi (small carinated cups). This device, which consisted of raised parallel ridges arrayed vertically, was often produced by molding the entire body of individual vessels. The procedure depended on the use of a mold with the desired features cut in negative relief on the inside surface. This mold was then placed on the potter's wheel and its interior lined with clay. As the wheel turned clay was forced into the pattern, imparting an impression on the exterior of the finished pottery.(415)

There also seem to be some examples of bucchero with ribbing formed by adding rolled lengths of clay to the pottery surface, or by shaping the plastic clay surface manually.(416)

There are also a few examples of more complex relief and plastic decoration which were made during the early period of bucchero production. Three small bucchero situlae, including two from Caere,(417) are rather unique. Their principal figural decoration, which includes animal and vegetal subjects

(414) Ramage (1970) 14, observes that this is unusual, the spiral was normally incised. The amphora is illustrated by Colonna (1968) Fig. 3.

(415) Richter (1936) 63-65. The technique was widely used for bucchero pesante.

(416) A vessel illustrated by Ramage (1979) Fig. 5.4, looks as though this technique was used although there is no discussion given.

(417) Gran Aymerich (1972) 58, proposes dates in about the third quarter of the 7th century.

was obtained by cutting and sculpting the clay with tools analogous to the instruments used by modern potters and sculptors.(418) Another series of bucchero objects from the Calabresi tomb at Caere which belong to the early period of bucchero manufacture have copious plastic decoration. These include two pyxides with sculpted animal head protomes and rings of horizontal projecting knobs around the main bodies of the vessels.(419) This tomb also contained separate protomes carved in the round and a vessel with a man perched atop an imaginary animal.(420) Before the end of the 7th century human figures in low relief were sculpted or partially molded onto vertical supports attached to high-footed bucchero chalices.(421)

Another technique used for decorating bucchero, unlike those previously described, did not depend on mechanical alteration of the clay itself. The decorative method involved the addition of silver and gold coatings to embellish bucchero. Small thin strips were added in some instances, while it appears that other vessels were entirely covered with precious metal.(423) This decorative technique has not been studied in detail and raises several important questions.

(418) Gran Aymerich (1972) 13-18 and Figs. 1-5 and 12-13.

(419) Ramage (1970) 12 and Fig. 6.3. See also von Vacano (1960) Fig. 24, p. 103.

(420) See Mansuelli (1965) Fig. 22, p. 59.

(421) Ramage (1970) 25-27. See also Bonamici (1974) 20-33, and Pl. XV.

(422) Nicosia (1974) 59-60, and Pl. XXXI.

(423) Ramage (1970) 17, and Barnabei (1894) Col. 307.

A number of vessels from Caere show traces of a red substance which was apparently used as an adhesive for the metal covering. Analysis of this material from one such vase revealed the presence of mercury, although the precise composition of the compound was not reported.(424) It seems that a mercury-based adhesive was used for attaching a coating of tin to a Mycenaean cup made in about 1400 B.C., (425) so a similar procedure was apparently known to Etruscan potters of the 7th century. However, there were possibly other types of adhesive used for this purpose by bucchero workshops. Italian researchers have identified traces of lead on a bucchero vase from Caere,(426) Although it is not clear if this metal was used to hold a coating of silver in place or if the lead itself constituted the applied decoration.(427) Excavators at Caere have observed that often when bucchero vases are removed from the earth a silvery stain remains behind.(428) The evidence for the presence of lead on bucchero sottile suggests one cannot be sure that these stains always represent silver plating on the original pottery.

How these adhesive 'solders' of lead and mercury were used for bucchero manufacture is not known at present. While their exact composition is not known, it seems plausible to

(424) loc. cit.

(425) Higgins (1967) 113-114, and Fig. 131. Ramage (1970) 18.

(426) Cesereo and Guidobaldi (1972) 514.

(427) loc. cit.

(428) Ramage (1970) 18.

suspect that they were sometimes a mixture of metal salts such as the chrysocollo, 'gold glue', mentioned by ancient authors. Such a compound, which melted on heating, was probably used for granulation at about this time.(429)

Thin plaques of lead were also attached to impasto pottery in Italy. The Iron Age artisans seem to have used resinous cement for this purpose but further qualitative and quantitative analysis would be desirable to determine the exact nature of the Iron Age adhesives.(430) Lead was either poured or forced into holes on some impasto vessels.(431) It is possible that silver foil was used to decorate some Advanced Impasto pottery. An impasto situla from Caere contained a few fragments of silver foil but no trace of an adhesive was noticed on the pottery surface.(432) If the foil was originally attached, it may have simply been forced into the incisions of the linear pattern cut in the surface of the situla.(433)

It is believed that precious metal decoration was applied to bucchero pottery before firing and then incised with various motifs. This seems plausible since the motifs visible on some of the vases which had a metal coating are

(429) Carroll (1974) 37-38. An analogous process was used for making niello. Higgins (1967) 147ff.

(430) Bertolone (1954) 180ff., mentions both a resinous adhesive and a black cement but makes no reference to analyses of either substance.

(431) Matteucig (1951) 25, and Pl. IV.21.

(432) Gran Aymerich (1972) 33, n. 1.

(433) loc. cit.

not complete.³ Presumably all of the lines are not preserved because the pressure exerted when engraving the metal coating was not always sufficiently great to leave an impression in the clay beneath the metal.(434) Since bucchero was fired to temperatures between 700°C and 800°C the silver or gold should have remained intact, their melting points being 960°C and 1063°C, respectively.(435)

However, pottery shrinks during firing; thus one might expect that a covering of metal might either draw away from the pottery surface or wrinkle if the adhesive held it to the surface.(436) It has been shown that gold leaf satisfactorily survived firings simulating conditions of the procedure used to make Greek black-figure pottery,(437) so the small plaques of silver on some bucchero vessels could have been attached before firing. It remains to be demonstrated that a metal foil covering the entire surface of a bucchero vessel would retain its shape or remain in place when subjected to a similar test.

It is also difficult to reconcile such a procedure with what is known about the techniques used to fire and color bucchero. It is clear that the bucchero coloration depends on the absorption of carbon during firing. (supra pp. 98 ff.) If the bucchero surface were covered with metal,

(434) Ramage (1970) 18.

(435) Latimer and Hildebrand (1951) 577ff.

(436) However, if the pottery had dried sufficiently before the decoration was applied further shrinkage during firing might have been negligible.

(437) Noble (1965) 55, n. 19, and 63-64.

it is hard to see how carbon could permeate the clay beneath to any appreciable extent. On the other hand, reduction of the iron oxide in the clay could still take place and produce a black coloration. However, such vessels would presumably not duplicate exactly the intensity and lustre normally associated with the bucchero fabric.(438)

If the metal decoration was added after the bucchero had undergone a fumigation firing, a second heating would have been required to melt the adhesive compound and bond the plating to the pottery surface. Subjecting pottery to a second firing seems like a rather uneconomical procedure, so it seems likely that it would have been avoided if possible. On the other hand, vessels plated with gold or silver would probably have commanded sufficiently high prices to justify the extra expenditure of time and energy.

At present there is hardly enough evidence to decide whether metal decoration was added before or after bucchero was fired. Analysis is needed to identify the adhesive compounds used for plating bucchero and to evaluate the effect of such procedures on carbon absorption.

The techniques used to decorate bucchero represent a continuation of those used during the Iron Age by impasto potters, although refinements were introduced by bucchero

(438) It may be noted that the fired pottery would have been less likely to take the impression of a scribe through the metal coating, than a vessel which had only become leather hard through drying in air.

craftsmen. However, the way in which the bucchero potters used their techniques indicates that they were influenced by both local and foreign traditions. Specialists have recognized the same three cultural traditions in bucchero decoration which are apparent in the ensemble of bucchero vase forms. An example of a decorative motif inherited from the Italic tradition is afforded by the double spiral design usually found on the bellies of bucchero amphorae. This motif was often accompanied by an incised drawing of a bird. Both the decorative scheme and form of these 'spiral amphorae' can be traced to Iron Age impasto prototypes.(439)

The arrangement of incised lines in bands on the bodies of many bucchero vessels is thought to derive from the decorative scheme of Protocorinthian pottery with geometric decoration. The bands of incisions were often accompanied by incised rays (See Figure VI), creating a combination particularly reminiscent of the Protocorinthian style vessels made in Greece and in Etruria.(440) Although the linear decoration of bucchero pottery often recalls Protocorinthian stylistic conventions, imported Greek pottery, local varieties of Protocorinthian, and the red and white impasto pottery which had become common in Etruria before the development of the bucchero fabric, had popularized many of

(439) Ramage (1970) 19-20, Gjerstad (1966) 280-281, Dohrn (1965) illustrates numerous examples.

(440) Ramage (1970) 15. See Payne (1930) 7-27, and Cook (1972) 47-55 on Protocorinthian decoration.

the decorative elements used by Greek potters.(441) Thus it seems much of the bucchero decoration which parallels Greek pottery features had already become part of the Italic tradition which bucchero potters inherited.(442)

Although figural decoration was not common on the earliest bucchero, there are indications that both Near Eastern and Greek subjects provided models used by bucchero craftsmen. Examples of the dependence on Greek prototypes for both the content and style of zoomorphic decoration on bucchero have been discussed by various commentators,(443) and need not be discussed further at present. Near Eastern influence has also been detected in bucchero figural decoration. Recent study of a group of bucchero situlae with relief decoration has identified similarities between content and style of the Etruscan motifs and Near Eastern ivory carving and metalwork embellished with scenes showing processions of various types of animals and human figures.(444) The sculpted bucchero caryatids discussed above (supra pp. 156-157), have also been cited as further examples of influence from Oriental ivories on bucchero ornamentation.(445)

(441) supra pp. 59 ff. See also Ramage (1970) 15. Examples of red and white impasto are illustrated by Vighi (1955), Ricci (1955), Pohl (1972), Dohan (1942), and Ricci Portoghesi (1968).

(442) Ramage (1970) 15.

(443) See Bonamici (1974) 87ff., Hencken (1968) 588, and Cristofani (1970) 107-108.

(444) Gran Aymerich (1972), Thuillier (1974) 57. See Ramage (1970) 5-7, for other examples.

(445) Ramage (1970) 24-26. See the comments on parallels between bucchero and ivory by Phillips (1972) 553ff.

However, as with linear incised decoration, plastic decoration had already been used on some impasto pottery, and thus was no longer truly foreign to the Italic ceramic tradition. (446)

The similarities between bucchero and ivory work serve as an appropriate introduction to another phenomenon often mentioned in connection with bucchero sottile. It is frequently observed that bucchero forms and decoration exhibit a dependence on ivory work and especially on metalware. Among the numerous parallels cited to demonstrate this connection, metal skyphoi (tall cups) provide an excellent example. Skyphoi in gold, silver and bronze have been found in Etruscan tombs. The majority of these metal vases have the same basic form as their bucchero analogues. Furthermore, three of the skyphoi have fan motifs composed of individually punched dots arranged horizontally below their lips. (447) This arrangement corresponds precisely to the decoration of numerous bucchero skyphoi. (See Figure VI) The resemblance between bucchero and metal skyphoi has led to the suggestion that the dotted fan motif was adopted by bucchero potters from such metal prototypes. (448) Other bucchero shapes are also found in metal. A silver amphora of the spiral type also featured the incised motif

(446) See Hencken (1968) 588, and Richardson (1976) 58-59.

(447) See Cristofani (1970) 271ff. and Pls. XXIV-XXV, and Ramage (1970) 22.

(448) Ramage (1970) 23, who notes that fan patterns might have derived from corded decoration on impasto pottery.

encountered on many Bucchero amphorae. (449) There are also several examples of bronze oinochoai of the tall-necked 'Phoenician' variety which was often produced in bucchero. (450) There are also metal analogues of bucchero kantharoi, kyathoi and small one-handled jugs. (451)

The frequent correspondence between the shape and decorative features of bucchero and vases in precious metal and bronze has been used as evidence to support the contention that bucchero sottile was made as an intentional 'imitation' of metalware. Since bucchero combines thin lustrous black walls with incised decoration and shapes encountered in metal vases, it is claimed that bucchero was made as a cheap substitute for metal vessels which the less wealthy could afford to buy. (452) Although the physical features of bucchero do seem to conform to this view, closer scrutiny suggests that regarding bucchero as an attempt to recreate the appearance of metalware is an over-simplified explanation of a rather more complex phenomenon.

The highly lustrous, black surface of bucchero might seem to reproduce the finish of polished metalware. Similar characteristics of Hellenistic pottery which combined thin

(449) *ibid.* 20.

(450) See Cristofani (1970) 276ff., Ramage (1970) 32-33.

(451) Ramage (1970) 27-31.

(452) See Mansuelli (1965) 59, Del Chiaro (1966) 141, von Vacano (1960) 102ff., and Ramage (1970) 10. See also Barnabei (1894) cols. 183ff.; who argues that impasto pottery was often modelled after metal vessels which he illustrates. He draws similar parallels for bucchero. *ibid.* cols. 200ff.

walls and high gloss, have been interpreted as indicating that Greek potters of the Hellenistic period sought to make their product resemble metal more closely.(453) However, high lustre on various kinds of material including wood, stone and painted objects is often a quality desired for its own sake and need not signify metal imitation. It is also hard to see why one should associate black color with attempts to duplicate the finish of bronze, gold and silver, the materials used for making metalware during the Etruscan period.(454) In fact, a reddish color would seem more appropriate and was within the bounds of Etruscan potters' technical expertise since monochromatic red impasto was being made in Etruria at the same time as bucchero.(455) Moreover the uniform lustrous finish of bucchero came about through successful attempts to standardize procedures used for making Iron Age pottery in the face of the growing popularity of more technically advanced pottery fabrics. Thus it hardly seems reasonable to see the desire to imitate metalware as the sole explanation for the bucchero surface color.

Similarly, the thin walls of bucchero may be best explained as an attempt to produce a higher quality ceramic

(453) Thompson (1934) 311ff. Hill (1947) 248ff. argues that metal craftsmen would not have been able to manipulate their material as freely as potters, at least before the Hellenistic period. But this view seems extreme. See Cook (1972) 355.

(454) See the commentary on bucchero by Cook (1972) 153.

(455) supra pp. 53ff.

product. Thin light-weight pottery could have its own aesthetic appeal and would also have definite practical advantages for the craftsman. Ultimately thin walls might make the pottery more fragile, but they would also promote rapid, even drying. Evenly dried pottery would be less likely to warp or break if subjected to uneven heating during firing. Reducing the thickness of pottery would also diminish the amount of clay required which would constitute a considerable saving of effort and material for commercial production. Such practical advantages coupled with aesthetic appeal could have encouraged bucchero workshops to make pottery with thin walls.

When one evokes the fact that bucchero shapes and decoration are also found in silver and gold as proof that bucchero potters sought to imitate metalware, this ignores two other important facts mentioned earlier in this discussion. The style and content of bucchero decoration was also apparently inspired by prototypes in ivory and in pottery. The similarities between the bucchero situlae with relief decoration discussed above were so striking that it is suggested the pottery workshop must have been located near an ivory working establishment where the potters could have seen this material being worked. (456) Furthermore, the principal bucchero forms were available in other local and imported pottery fabrics. These pottery prototypes were available in quantity and

(456) Gran Aymerich (1972) 56.

featured the linear designs which were the most common type of incised ornamentation on early bucchero sottile, with the exception of the dotted fan motif.

There is indeed the possibility that metalworkers sometimes imitated pottery models. The silver amphora which duplicates the spiral amphorae so popular in both impasto and bucchero probably constitutes an example of pottery vessels influencing developments in metalware typology.(457) Given the prevalence of incised decoration in the impasto tradition it certainly seems reasonable to suspect that bucchero potters inherited this technique along with certain shapes and basic fabrication methods from the Iron Age potters of Etruria. This is also apparently true for the practice of adding metal foil to bucchero. However, bucchero workshops seem to have developed new procedures and taken the Italic custom further by covering much larger portions of the vessel surface.

It has been pointed out in a recent discussion of terra sigillata manufacture that the use of the word 'imitation' should be restricted to instances where a craftsman has a particular model in mind which he is deliberately trying to duplicate.(458) Certainly metal plated bucchero cups seem to conform to this criteria. Bucchero craftsmen do seem to have tried to reproduce forms and decoration found in contemporary metal objects, but it must be stressed that pottery

(457) Ramage (1970) 20.

(458) Wells (1977) 4.

vessels and ivory carvings could just as easily have served as models.

It can be argued that skyphoi, high-necked oinochoai and other types of bucchero vessels were selected not merely because these vases were also made in metal, but rather because the shapes were part of the current fashion. This is not to say that developments in metalware styles might not influence public taste, but that pottery and ivory objects also played an important role in determining what shapes were fashionable. It seems likely that bucchero craftsmen would have been expected to provide pottery with shapes which were familiar to their customers. Potters and metal craftsmen alike would have had to provide many forms which had come to be associated with specific uses by those who purchased them. Thus in general it seems most reasonable to suggest that the bucchero fabric was not developed as a cheap substitute for metalware but as an expression of the aesthetic tastes of its makers and users, being esteemed for its technical quality and unique character which combined local and foreign elements as well as conventions used by other potters, craftsmen making ivory goods and metalworkers.

The bucchero pottery covered with metal does appear to be an exception to this rule. Further research is needed to determine how often this practice was adopted, but it is worth considering the possibility that plated bucchero was not mass produced. Considering the fact that gold and silver are generally rather valuable commodities, it can be

suggested that bucchero covered with precious metal was normally fabricated at the special request of individual patrons. A similar arrangement between craftsman and client has been postulated for the manufacture of the monumental Cesnola crater, made by a Greek workshop during the Geometric period.(459) Since plating bucchero apparently demanded an extraordinary outlay of materials and possibly an abnormally complicated technical procedure, it would not be surprising if metal covered bucchero was made only when specifically requested by a customer.

Possibly certain workshops specialized in the production of bucchero with applied metal decoration. It has been suggested that some bucchero workshops normally fabricated unusual or exotic varieties of bucchero. The situlae which were decorated in a manner similar to contemporary ivory carvings may be an example of this phenomenon,(460) while the group of bucchero vessels with elaborate plastic decoration from the Calabresi tomb could have been made in a workshop which tended to concentrate on the manufacture of objects with an Oriental flavor.(461)

Clearly some bucchero craftsmen possessed skills which would not necessarily be associated with pottery manufacture.

(459) Coldstream (1971) 11.

(460) Gran Aymerich (1972) 56.

(461) Ramage (1970) 12. The author also suggests that the differences in quality between groups of bucchero from separate tombs could perhaps be explained in some cases by the fact that the level of skill varied from one shop to another.

Bucchero potters may have taught themselves to model clay and attach metal foil to their products by trial and error or by observing other craftsmen. It is conceivable that potters engaged craftsmen with special skills as assistants for filling special orders. Alternatively it seems possible that some of the more exotic bucchero was made by artisans who had been trained in metalworking or the manufacture of ivory objects and then changed their profession. In any event, there seems to be room for more research in areas concerned with the interaction between bucchero craftsmen and artisans skilled in manipulating other materials.

Appendix II

Suggestions for Future Bucchero Research

Further elucidation of the bucchero manufacturing process is not possible with the evidence now available. More data are required to clarify some aspects of the bucchero technique. Additional scientific examination would also be desirable in order to evaluate more thoroughly the possible contributions from Italic and from Greek pottery traditions to the development of the bucchero fabric. Given the uncertainties which still exist with regard to the technical aspects of bucchero production, it seems appropriate to suggest some specific goals and methods for future research which could resolve questions not fully answered in the course of the present discussion.

It was observed previously that poor experimental design has often limited the utility, (although not necessarily the accuracy), of data from analysis of bucchero and its contemporary fabrics. (*supra* pp. 70: ff.). One of the major shortcomings of research conducted on these fabrics has been the failure to obtain statistically valid results. Research with Hellenistic and Roman pottery in particular has clearly demonstrated that when results can be subjected to statistical analysis, specific technical procedures can be assigned to individual fabrics. (462) It is apparent from these analyses of Roman pottery and from other investigations that the essential prerequisite for obtaining statistically reliable data lies with selecting a sample population conforming to the following basic criteria:

1. The sample population must be large enough to provide a truly representative range and distribution of numerical values for any given chemical or physical parameter, such as the concentration of iron oxide. If

(462) Picon, Vichy and Chapotat (1971) 82-88; Picon, Vichy and Meille (1971) 191-208; and Picon and Vichy (1974) 37-59.

the number of samples is too small, the possibility becomes greater that either atypical sherds or experimental error will bias results. (463)

2. Sherds from individual sites should be analyzed separately to eliminate anomalies in composition resulting from regional disparity in geological conditions. (464)

3. Ideally, samples used for analysis should fit within as finite a chronological range as possible, since variations in composition often occur within any given clay bed. (465)

4. It is highly desirable that the samples used for analysis be obtained from fully documented archaeological excavations in order to verify their origin and chronological context as stipulated in criteria two and three. (466)

5. The same techniques should be used for all samples tested when making quantitative measurements of chemical concentrations. This is because resolution and accuracy vary somewhat between different analytical techniques. (467)

A glance at Table I should provide sufficient demonstration of the inadequacies inherent in the available quantitative data on bucchero composition. The sample populations chosen for analysis were often very small. Alternatively, sherds were apparently selected randomly without any attempt to restrict their chronological range. This criticism applies as well to data published for impasto pottery from Etruria. Therefore,

(463) Picon and Vichy (1974) 40 n.9.

(464) Stern and Descœudrès (1977) 73-74. Boardman and Schweizer (1973) 268.

(465) Stern and Descœudrès (1977) 73-74.

(466) ibid. It is also conceivable that potters might change the composition of a particular clay body.

(467) Stern and Descœudrès (1977) 73-74.

although examination of bucchero sottile sherds has provided a satisfactory qualitative picture of the basic aspects of the bucchero manufacturing process, additional research is needed to clarify certain technical aspects and to provide a sufficiently large data base on which reliable quantitative physical and chemical profiles can be constructed.

Bucchero from a single site should be used for this purpose. Caere would be a logical site to choose, since bucchero was probably manufactured there at an early date. However, material from other sites where bucchero manufacture has been postulated could be examined to determine if there were significant differences in the methods used by separate workshops.

(468)

Physical investigation of bucchero should include microscopic examination and physical properties testing. Microscopic observation of bucchero cross-sectional samples from both lustrous and matt portions of several vessels would be highly desirable. This could perhaps confirm whether or not a slip was applied to the bucchero surface, if comparative inspections were conducted on test pieces prepared with clays from the same locality as the bucchero being studied. (See infra pp. 178ff.) A further objective of a microscopic examination should be the verification of previous findings concerning the distribution of carbon in the bucchero surface and core. Also, a more comprehensive catalogue of inorganic inclusions derived from microscopic investigation would be especially helpful for identifying sources of clay and temper used by bucchero craftsmen.

(469) Finally, viewing the core and surface of bucchero under

(468) As there may have been more than one bucchero workshop at Caere, it would seem logical to analyze material from each one on a separate basis. See Ramage (1970) 14-15.

(469) A survey is also needed to locate clay beds which could have provided the raw material for bucchero manufacture.

magnification should reveal any alterations in quartz inclusions which would in turn give an indication of the internal firing temperature of bucchero.

Although differential thermal analysis has provided some indication of the bucchero firing temperature range, (supra p. 116.) supplementary thermal expansion tests should be conducted to confirm these findings. (470). Recent measurement of pore size distribution, (471) has shown that this can be accurately correlated with firing temperature and that individual fabrics tend to exhibit characteristic curves. (472) Thus, results from this analytical test could be useful for comparison of bucchero to other contemporary fabrics.

Additional quantitative spectrographic analysis of bucchero is desirable to substantiate analytical results which have shown that the concentration of iron oxide is the same in both surface and core of bucchero sottile. Similarly, more quantitative determinations of the relative carbon content of the clay body and the surface of bucchero are required so that a truly representative concentration range can be established for this constituent. The quantitative measurements of carbon content should be reported, along with the color intensity of the individual sherds. The color intensity should be measured with reference to a standard grey scale so that the contribution of carbon to the bucchero coloration could be more accurately evaluated. (473)

(470) On thermal expansion, see Tite (1972) 295 ff.

(471) The procedure is described by Morariu et al (1977) 187-221.

(472) ibid. 189-191.

(473) One would also be able to see any proportional relationship between the intensity of coloration and the iron concentration.

While the tests suggested for bucchero sottile are to a large extent needed to supplement previous undertakings, a full quantitative and qualitative testing program is required to alleviate the scarcity of analytical data on impasto fabrics. Reliable physical and chemical profiles for the Advanced Impasto fabrics, especially bucheroid impasto, are necessary in order to determine how closely their manufacturing technique resembles the procedures used for fabricating bucchero sottile.

Microscopic and spectrographic analyses should indicate whether or not the same clay and temper sources were utilized by both bucchero and impasto workshops. Thermal expansion, differential thermal analysis and pore size distribution tests should be employed to see how closely impasto firing temperatures correspond with the temperatures to which bucchero was fired. Quantitative measurement of iron and carbon content in the core and surface of impasto pottery, coupled with refiring experiments such as those conducted on bucchero fragments, (supra pp. 82 ff.), are necessary to verify the supposition that carbon played the same role in coloring impasto which it did in coloring bucchero sottile.

A comprehensive analytical investigation of the ciotole from the Marzabotto kiln site, (supra pp. 127ff.), should be a priority. By determining if these vessels which resemble bucchero display the same physical and chemical characteristics as bucchero sottile, it would be possible to decide whether or not Etruscan potters indeed used kilns similar to the Greek a pipa type for firing bucchero. However, it appears that bucchero craftsmen would have altered the interior design of the Greek type kiln to effectively fumigate bucchero. Therefore, analysis of Greek pottery from the Orientalizing Period is necessary to see if technical differences

can be linked with differences in firing procedures.

Quantitative determinations for the carbon content in the core and black-firing slip of Protocorinthian pottery should indicate if Greek firing procedures impregnated Greek fabrics with amounts of carbon comparable to the amount of carbon found in bucchero. Results of these measurements would suggest whether or not Etruscan potters could have fumigated bucchero sottile by following the same procedure used by Greek potters for creating reducing conditions. Since the final stage of the firing cycle employed for Greek painted pottery was conducted under oxidizing conditions, one would not expect to find substantial amounts of carbon in properly fired Protocorinthian pottery. Therefore, misfired sherds or wasters from Protocorinthian contexts would have to be analyzed. (474) None the less, successfully fired Protocorinthian vases should be tested as a control.

Assessment of the influence exerted by Greek pottery making techniques on the methods employed by bucchero craftsmen would be further enhanced by examining the inorganic constituents in imported Protocorinthian vessels and in pottery made in Etruria which duplicates Protocorinthian wares. The principal aim of this examination would be to determine if the clay used by potters making Greek fabrics was the same as that used for bucchero, and/or Advanced Impasto. Ideally, the appropriate chemical and microscopic techniques would be applied to samples of these various fabrics which were obtained from the same site. By comparing the chemical and mineralogical composition of the clays employed for manufacturing the Italic pottery and the local Protocorinthian pottery, it

(474) Such wasters are available from Sicily. See Adameseanu (1956); and elsewhere, see Farnsworth (1960).

should be possible to see if impasto or bucchero potters could have been induced to change their source of clay and temper by immigrant potters or local potters making fabrics of the Greek type.

Observing similarities and differences in the physical and chemical properties revealed by the laboratory tests enumerated above should permit a more thorough assessment of the technical relationship between bucchero and contemporary local and imported pottery. However, experimental firings would be required to further illuminate details of the bucchero firing procedure. Modern attempts at recreating bucchero have shown that a fumigation process was probably responsible for the bucchero coloration. (475)

While the modern endeavors at reproducing bucchero have provided insight into the principles of fumigation, it has been observed that there are cogent reasons for rejecting the idea that any one of these experiments duplicated exactly the firing method used for making bucchero sotile. (*supra* pp.142ff.) Essentially, the methods used to reproduce bucchero were either unsubstantiated by archaeological evidence or not completely compatible with the evidence obtained from the analysis of bucchero sotile. Furthermore, the experimental designs had two obvious flaws. The composition of the clays used in two instances apparently was not the same as the known composition of the clays used by Etruscan potters. However, the principal deficiency in the trial firing experiments was the failure to conduct physical and chemical analyses on the bucchero reproductions. Therefore, even though the bucchero coloration and lustre were successfully reproduced, one can not gauge how closely the experiments actually duplicated the conditions to which bucchero was subjected during (-475) See *supra* pp. 118ff.) This also conforms to what one would expect from the available technical data.

firing.

Potentially, a properly conducted series of trial firings could confirm conclusions reached from analysis of bucchero sherds and might well provide a credible reconstruction of the bucchero manufacturing process. Such trial firings should utilize test pieces made from clay and temper of the same sort known to have been used for bucchero fabrication. The experimental vessels or tablets could then be fumigated for varying lengths of time both in contact with fuel, (476) and under conditions simulating those prevailing in Greek kilns where the pottery was exposed only to smoke. Varying the surface treatment of the test pieces would make it possible to evaluate more fully the effects of burnishing, both alone and in combination with clay slips, on bucchero coloration. It would also be useful to investigate the behavior of organic pigments when applied to a clay body of the type used to make bucchero.

Evidence obtained from examining bucchero sherds strongly suggests that the bucchero coloration was not dependent on the presence of carbonaceous material in the paste before firing. (supra pp. 101ff.) But since there are those who have proposed that organic material was either deliberately added to the clay used for making bucchero or present in the clay as a natural impurity, it would be useful to examine these possibilities experimentally. The latter alternative could be explored by trial firings utilizing clay to which powdered charcoal or some other organic matter had been added. The hypothesis that carbon was a major constituent of the raw clay used in bucchero manufacture rests on the assumption that Etruscan

(476) A number of different fuels could be used. Sawdust or charcoal prepared from oak would be a logical choice since this wood was used for smelting in Etruria possibly as early as the 7th century. Tongiorgi (1937) 331-333.

potters had access to clays with a high organic content. The availability of such clays needs to be verified by a survey of clay bodies in the vicinity of the sites where bucchero was apparently made. If sources for clays rich in carbonaceous material were located, the behavior of these clays could then be monitored by trial firings.

After firing, the various trial specimens should be subjected to a rigorous physical and chemical investigation in order to determine the amount of carbon absorbed; the distribution of carbonaceous material; the relative contribution of iron and carbon to the intensity of color and the concentrations of magnetite and ferrous oxide produced by the various firing conditions. Differential thermal analysis and measurement of both pore size distribution and thermal expansion should also be carried out on the test pieces. The results of these analyses could then be compared with the corresponding data for bucchero. Through this comparison of the qualitative and quantitative responses displayed by the bucchero reproductions to the responses obtained by testing actual bucchero sherds, one could evaluate how closely experimental techniques conformed to those used by Etruscan potters manufacturing bucchero sottile.

The research outlined above constitutes a rather ambitious undertaking. The expense incurred for the extensive use of laboratory facilities might well discourage anyone who would otherwise be attracted to such an endeavor. On the other hand, access to sufficient amounts of ceramic material which conforms to the criteria established for an appropriate sample population probably presents the most formidable obstacle to the proposed analytical program. Given the existing difficulties, it seems unlikely that a single laboratory or investigative team could be expected to carry out the suggested examinations of bucchero and

its contemporary fabrics in the near future. However, several teams coordinating efforts could conceivably complete the individual portions of the comprehensive analytical program in a relatively short period of time. Proceeding in this manner, it would be possible to obtain the information necessary for resolving the problems concerning the bucchero technique which have been left unanswered by the present discussion.

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Figure IA.
Map of Italy.

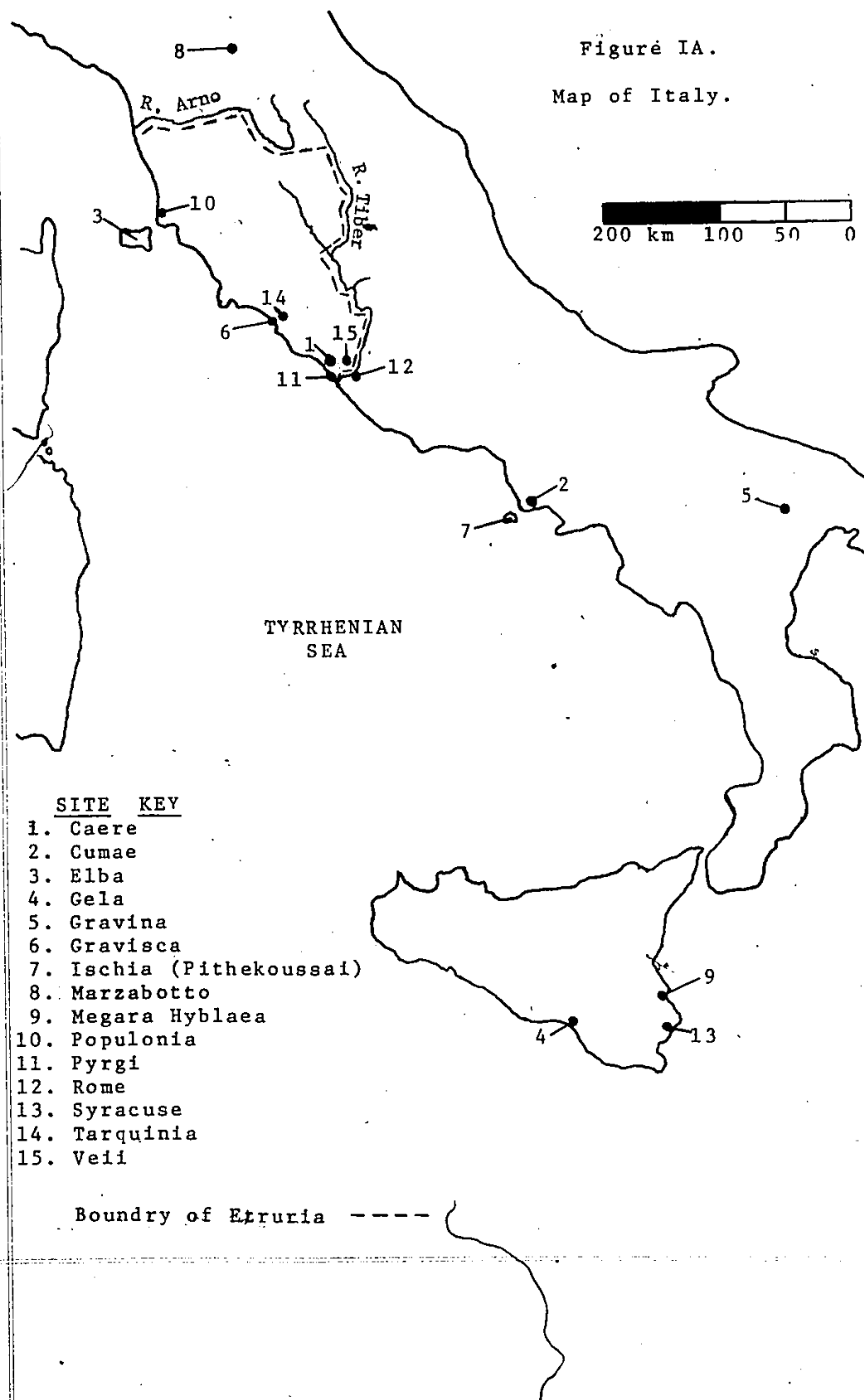


Figure 1B.

The Cemeteries of Caere (Cerveteri)

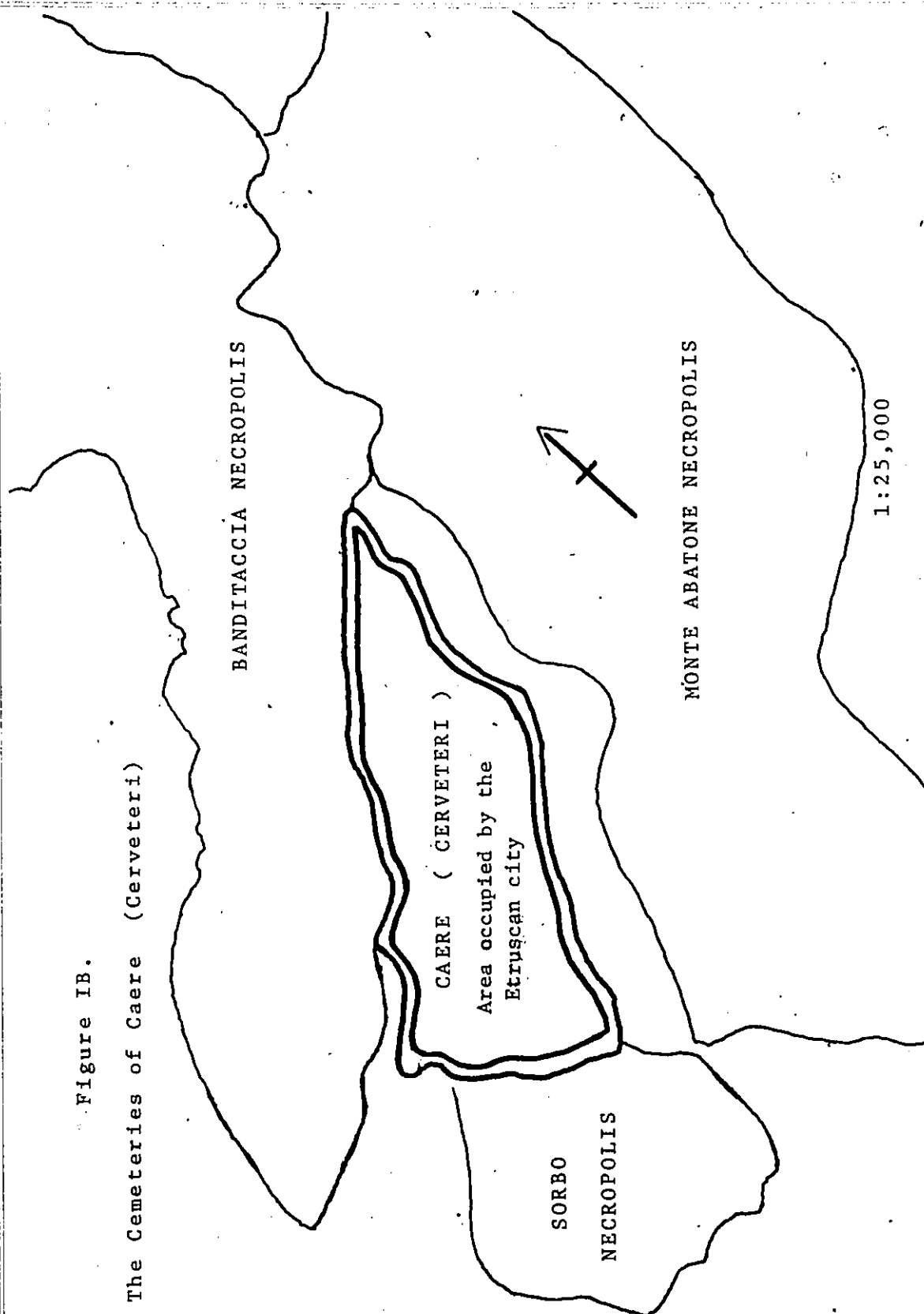


Figure II.

Composition of Villanovan Pottery.

(Range of values for 9 samples of pottery from Villanovan contexts. Reported by Parlati (1929) 413-425.)

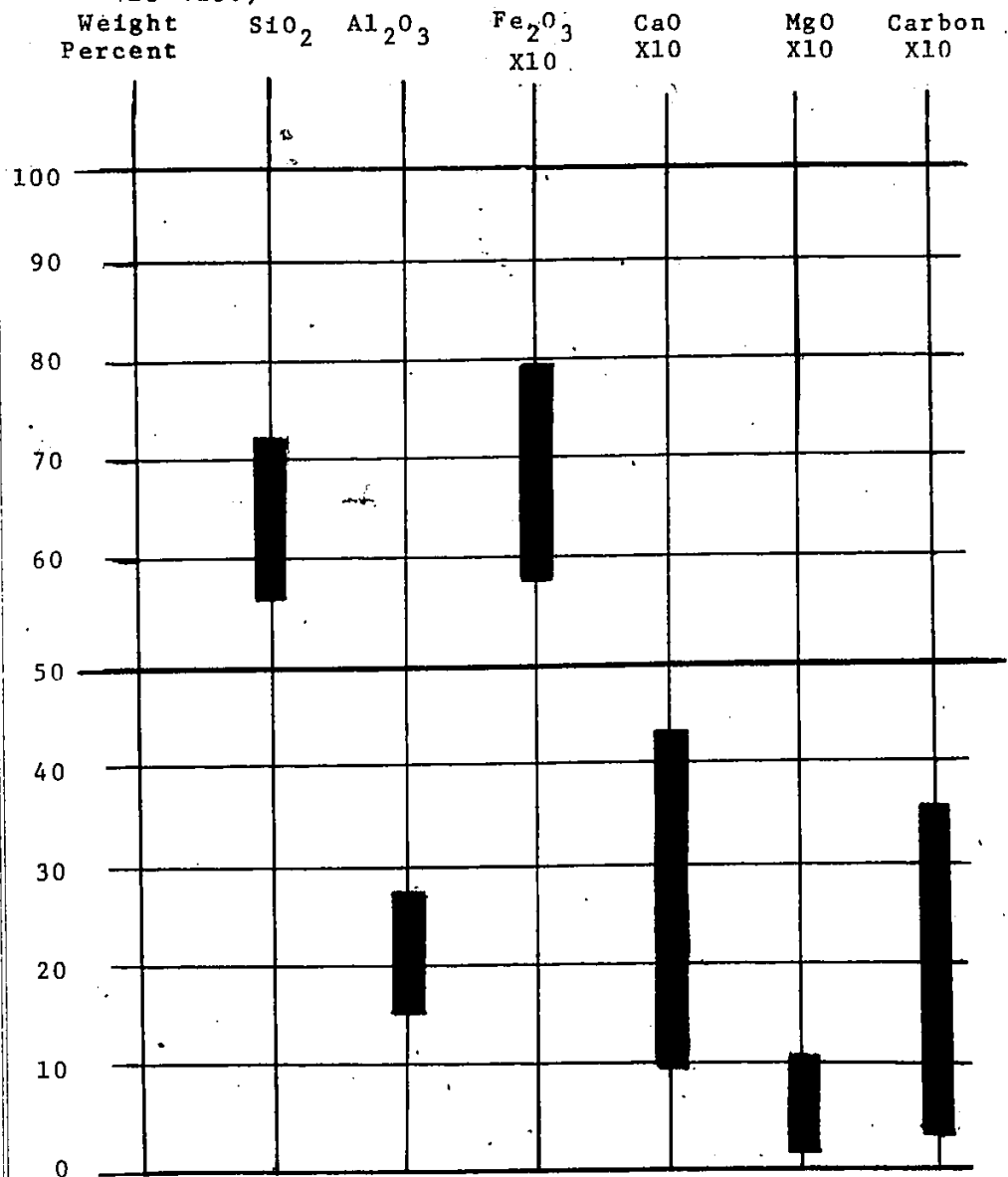
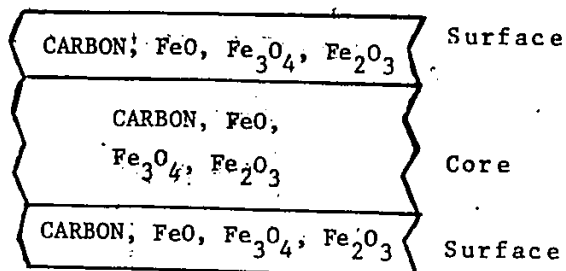


Figure III.

Schematic Representation of Bucchero Refiring Test
(Test described by Leoni and Trabucchi (1962) 258-261. See text pp. 82-85 and 92ff.)

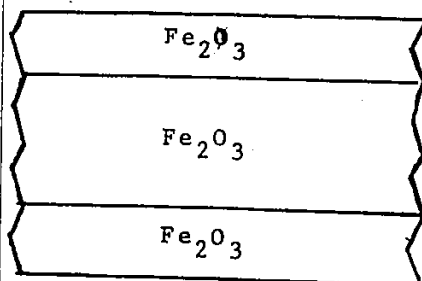
Sherd
Cross Section

Key: FeO - ferrous oxide, black.
Some iron in original sample as
 Fe_3O_4 , magnetite, black and as
 Fe_2O_3 , ferric oxide, red.



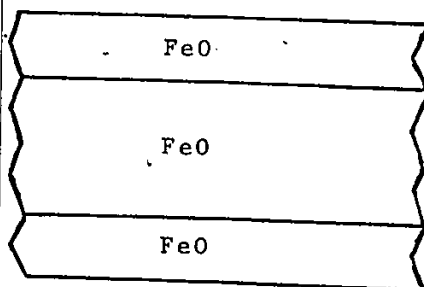
Before Refiring:
Surface black. Color
more intense.
Core black. Color
less intense.

Refired in Oxygen at 500°C.
Carbon lost as CO_2 gas by burning.
FeO and Fe_3O_4 oxidized to Fe_2O_3 .
 Fe_2O_3 unchanged.



After First Refiring:
Surface red. Color
brighter.
Core red. Color
darker.

Refired in Hydrogen at 500°C.
 Fe_2O_3 reduced to FeO.



After Second Refiring:
Surface black: Color
less intense.
Core black: Color
more intense.

Figure IV.

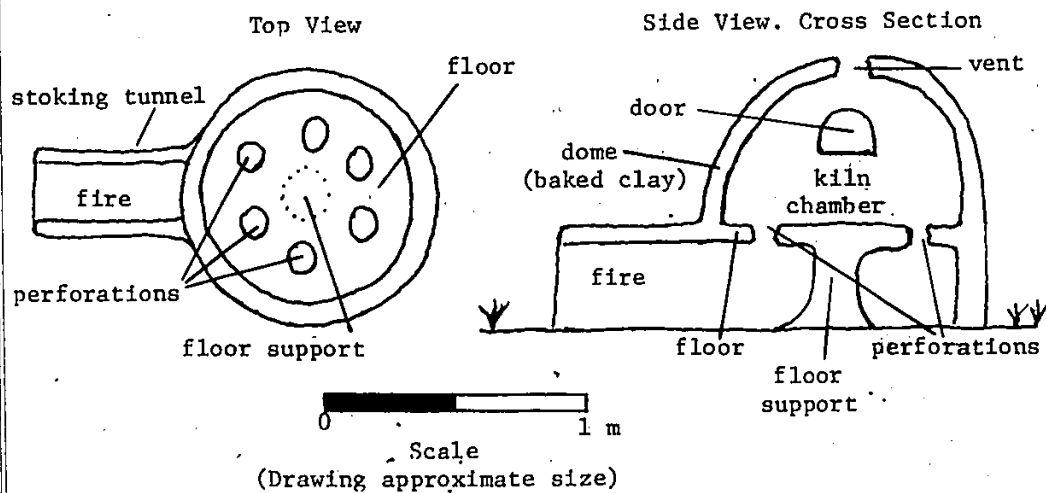
Greek Type or a pipa Kiln.

Figure V.

Belgic Kiln. Nene Valley.

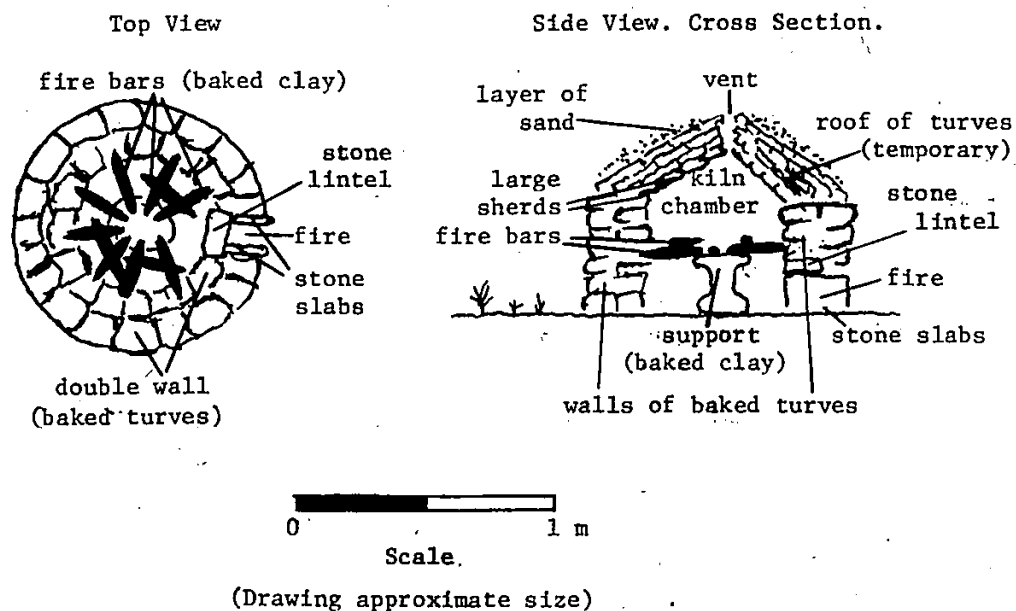


Figure VI.
Bucchero
skyphós

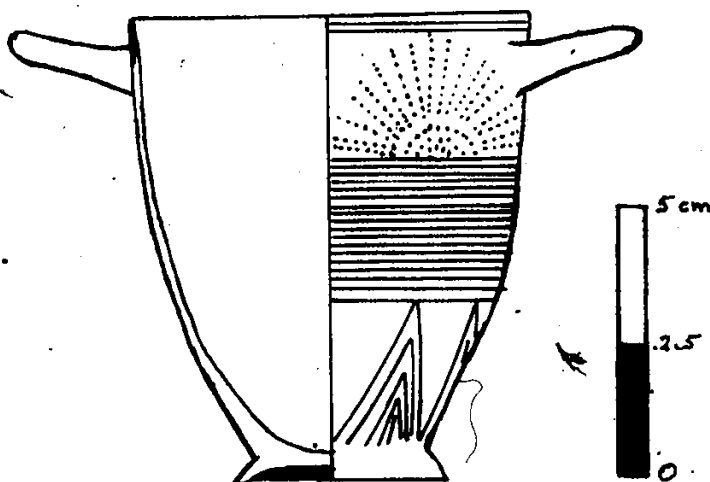
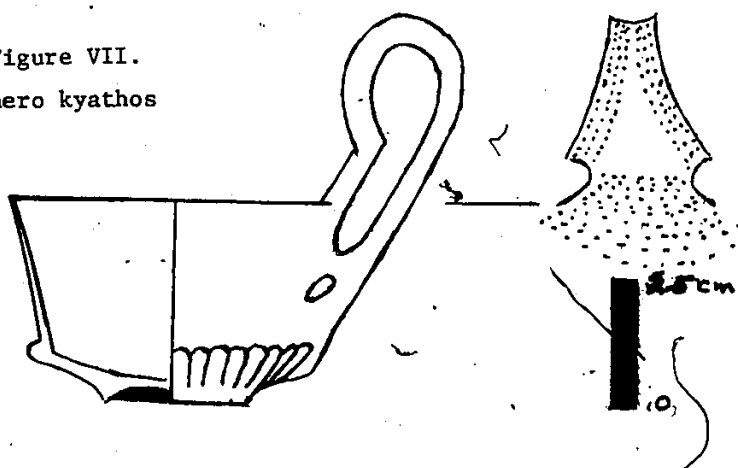


Figure VII.
Buccherio kyathos



Key to Figures. VI and VII:

rouletted lines	
incised lines	————
ribbing	

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TABLE I

Composition of Bucchero, Italic Pottery, Greek Pottery
and Clays from Greece and Italy.*

		N**	%Fe ₂ O ₃	%MnO	%CaO	%SiO ₂	%Al ₂ O ₃	%Carbon	Weight Loss #
Bucchero	A ¹	23	3.32-	0.09-	0.26-	n.t.	n.t.	n.t.	n.t.
			6.94	0.33	15.98				
		Ave.	5.61	0.13	1.55				
			±0.66	±0.03	±1.35				
B ²	1	5.70		n.t.	0.88	60.11	18.54	n.t.	10.84
C ³	n.r.	8.62		n.t.	n.t.	57.58	23.21	1.12	n.t.
D ⁴	4	4.90-		Trace	n.t.	n.t.	n.t.	0.73-	n.t.
			8.76					1.12	
	Ave.		7.32					1.00	
			±1.12					±0.14	
Villanovan ²	1	6.12		n.t.	0.05	64.40	16.20	n.t.	9.76
Golasseca ²	1	6.27		n.t.	0.42	59.10	23.12	n.t.	10.10
Protoeorinthian ⁵	15	7.5-		0.08-	3.0-	n.t.	18.0-	n.t.	n.t.
		12.0		0.15	6.0		25.0		
Attic									
Black-Figure ⁶	12				3.9-	51.2-			
		13	8.3-	n.t.	11.2	69.9	12.5-	n.t.	n.t.
			10.4				17.0		
		Ave.	9.7		5.8	56.0	14.1		
			±0.69		±2.1	±2.70	±1.29		

TABLE I. cont.

	N	%Fe ₂ O ₃	%MnO	%CaO	%SiO ₂	%Al ₂ O ₃	%Carbon	Weight Loss
Clay; Lefkandi, ⁶ Euboea.	1	10.0	0.10	9.0	n.t.	23.0	n.t.	n.t.
Clay; Gravina, ⁷ Apulia.	2	5.8- 2.7	0.086- 0.089	22.0- 24.5	n.t.	19.3- 21.0	n.t.	n.t.
Clay; Pombia, ² (Novara)	1	4.64	n.t.	0.44	64.10	20.20	n.t.	7.46
Clay; Le Groana, ² di Solaro, (Milano)	1	6.05	n.t.	0.70	69.74	21.91	n.t.	1.46

* Data are reported as the range of values for % by weight.

** N is the number of values when known.

Weight Loss after ignition.

n.t. not tested.

n.r. not reported.

1. Francaviglia, V. et al. Archaeometry 17:2 (1975) 223-233.
2. Mariani, E. and Storti, C. Sibirium 1 (1953) 73-93. (See also Figure III)
3. Sunkowsky, R. Ojh 39 (1952) 83-88.
4. Leond, M. and TraBuechi, G. StEtz 30 (1982) 257-266. (See also Table II)
5. Boardman, J. and Schweitzer, F. BSA 68 (1973) 267-283.
6. Stern, W.B. and Descoeudres, J.-P. Archaeometry 19:1 (1977) 73-80.
7. Prag, A.J. et al. Archaeometry 16:2 (1974) 153-188.

TABLE II
Iron Oxide & Carbon Content
in Bucchero Sottile.

Sample Number	Total Iron As Ferric Oxide*	Ferrous Iron Ferric Oxide*	Magnetite**	Ferric Iron Ferric Oxide Equivalent#	Ferric Oxide Ferric Oxide	Carbon Intensity of Color
	%Fe ₂ O ₃	%FeO	%Fe ₃ O ₄	%Fe ₂ O ₃	%Fe ₂ O ₃	%C ^g
2	4.90	1.30	4.13	2.89	2.01	1.12
3	8.29	2.42	7.69	5.35	2.93	1.10
1	7.34	n.d.	n.d.	—	—	1.05
4	8.76	2.17	6.99	4.82	3.94	0.73
Ave.	7.32 ±1.21	—	—	—	—	1.00 ±0.14

* % by weight as reported by Leoni and Trabucchi (1962). The Averages have been calculated from their data.

** % by weight also reported by Leoni and Trabucchi (1962). The authors calculated this value from the results of Total Iron and Ferrous Oxide determinations, assuming that all ferrous iron was present as magnetite. There is not sufficient experimental data to justify this assumption in all cases. (See text of the present discussion.

The Ferrous Oxide Equivalent was calculated from the %FeO reported by Leoni and Trabucchi (1962) through multiplication by the appropriate formula weight ratio.

TABLE II cont.

- f This expresses the weight percent of ferric iron remaining in the original sample. Values were calculated by subtracting the values for the Ferrous Oxide Equivalent from the values for Total Iron.
- g Obtained by gravimetric analysis after combustion of residue from HCl extraction.
- h The samples were ordered with respect to the intensity of their surface coloration by Leoni and Trabucchi (1962) 259. (1 is most intense) They mention no objective standard on which to base this rating.

Table III.

Bucchero Forms: Chronological Table.*

Form/Origin	Occurrence in Etruria		
	Impasto** ca 700B.C.	Bucchero ca 650 B.C.	Bucchero ca 600 B.C.
<u>Near Eastern Origin</u>			
high-necked oinochoi	X	X	X
chalice	X	X	X
pilgrim flask	X	rare	rare
askos	X	X	X
cauldron with protomes	X	protomes only	protomes only
situla	X	X	X
pomegranate vase	X	X	
ring vase	X	X	
vase carrier	X	X	
patera	X	X	
<u>Greek Origin</u>			
skyphos	X	X	X
kylix			
shallow body	X	X	X
deep body	X	X	X
spreading foot		X	X
pyxis	X	X	X
aryballōs			
ovoid	X	X	X
piriform		X	X
olpe		X	X
oinochoi/ piriform		X	X
<u>Italic Origin</u>			
spiral amphora	X	X	X
jug	X	X	X
kyathos	X	X	X
kantharos	X	X	X
bowl	X	rare	rare
olla	X	X	?
boat	X	rare	?

* After Ramage (1970) 9. See text pp. 153-154.

** Forms found in impasto, including the red on white variety, and/ or in Greek type fabrics.