

## Raw Material Use among Nucleated Industry Potters: The Case of Vasanello, Italy

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**ABSTRACT** A program of ethnographic and laboratory analysis has been employed to investigate the relationship between raw material availability and pottery manufacture among nucleated cookware producers at Vasanello, Italy. Compositional analysis (XRD, petrography, NAA) of clays and finished pottery shows that Vasanello potters employed a non-calcareous sedimentary clay containing alkaline volcanic sand to manufacture high quality cookwares that were distributed over much of central Italy from at least the mid-fifteenth to the mid-twentieth century. Nucleated cookware producers at Cascano/Corbara in northwestern Campania employ a similar clay, suggesting that the availability of this discontinuously distributed material has played a significant role in the operation of this mode of production in west-central Italy during the modern period. Archaeological evidence suggests that nucleated cookware industries employing this clay may have first developed in this region during the Roman period.

### INTRODUCTION

While specialized craft production has long been recognized as a characteristic feature of economic organization in complex societies, it is only in the last decade that archaeologists have attempted explicitly to define general modes of specialized craft production and to determine their material correlates (Brumfiel and Earle 1987; Costin 1991; Peacock 1982; Rice 1991; Tosi 1984). Much of the discussion on these topics has drawn heavily on ethnographic and archaeological evidence pertaining to specialized pottery production, and our understanding of the potter's craft has, on this account, played a prominent role in shaping our broader views of economic organization in past complex societies.

One aspect of specialized pottery production that warrants further investigation is the role played by the availability of raw materials in the emergence and operation of nucleated potting industries (i.e., conspicuous concentrations of large numbers of full-time producers). Specifically, it would be interesting to know whether or not nucleated potting industries tended to enjoy exclusive or favored access to raw materials with unusual properties, access to an atypically wide array of raw materials, or unusually convenient or economical ac-

cess to raw materials similar to those available to non-nucleated potters working in other locales. While the emergence of any particular instance of nucleated pottery production was likely determined by the confluence of several conditions, including specific historical circumstances, locational considerations, the size and nature of the local labor force, constraints on local agricultural productivity, and the structure of the regional demand for craft goods, advantageous access to raw materials may have served as a significant enabling condition in many cases. This possibility is of particular importance since, unlike several of the other factors that may have figured in the development of nucleated pottery industries, raw material use is an aspect of pottery production/distribution that is susceptible to direct archaeological evaluation.

Described here is a study of raw material use among nucleated potters in Vasanello, a small town in the Alto Lazio region of west-central Italy, known until recent decades as an important center for cookware production. The principal aim of the research at Vasanello was to document the various raw materials employed by traditional potters in the town and to evaluate the physical basis for these materials' respective properties. It was anticipated that

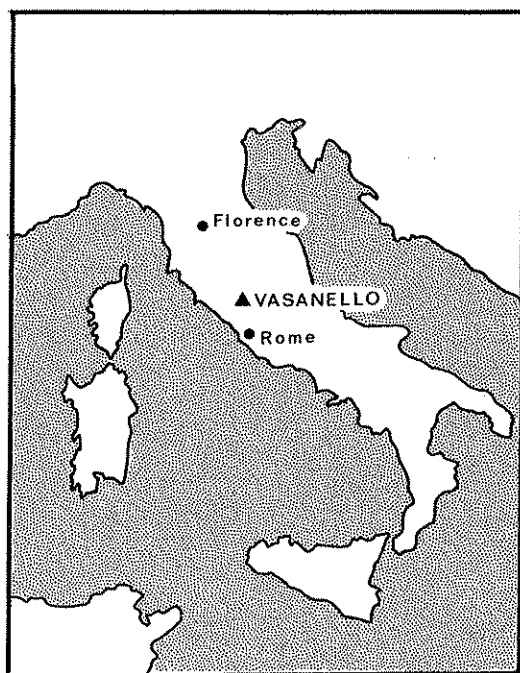


Fig. 1. Map of Italian peninsula and adjacent areas showing location of Vasanello

the results of this work would shed light on some of the specific circumstances that underlay the development and operation of the potting industry at Vasanello, and that this information would prove useful in efforts to interpret the organization of pottery production in west-central Italy during earlier historical periods. It was also hoped that some of the insights gained from this research might contribute to our understanding of the conditions associated with the development and operation of nucleated potting industries in general.

The project was carried out in two stages. In the first, the author interviewed several retired potters from the town about their production practices, with particular attention accorded to the selection, processing, and use of raw materials. In the second, specimens of raw clay and finished pottery collected from these potters were subjected to both physical tests (water of plasticity, shrinkage, and weight loss/color change with firing) and compositional analysis (x-ray diffraction, petrographic, and neutron activation). The results of both stages were

then brought together in order to determine the relationship between the properties of the raw materials used by Vasanello potters and their specific applications, as well as to evaluate the role that these materials played in the development and operation of the town's pottery industry.

#### CERAMIC PRODUCTION AT VASANELLO

Vasanello (population ca. 3,300) lies in the northern portion of the region of Lazio ("Alto Lazio"), approximately 65 km. to the north of Rome (Fig. 1). The town occupies a wedge-shaped plateau measuring roughly 500 m. long by 350 m. wide at the base. It is typical of settlements in the portion of Alto Lazio lying within the area of the Central Italian Volcanic Province, with narrow, irregular streets and tightly clustered houses built in blocks of grayish tuff. Occupation of the plateau dates back at least to the Roman period, when the settlement may have been known as *Castellum Amerinum*. The first known reference to the post-Classical town occurs in an inscription of A.D. 1038, in which its name is given as *Castrum Vassanellum*.

Vasanello was an important center for pottery production from at least the mid-fifteenth century through the post-World War II period.<sup>1</sup> Although there are no longer any active potters in the town, the author was able to interview four men who had previously earned their livings in this occupation.<sup>2</sup> By supplementing the infor-

<sup>1</sup> The earliest reference to Vasanello pottery known to the author occurs in a customs list of 1454 from Tuscania, a town 38 km. to the west of Vasanello (Fig. 3). This document records duties paid by one "Angelo de Vassanello," presumably an itinerant pottery seller, for the sale of three lots of cookpots (Barbone 1978: 129). Several residents of Vasanello stated that the town statute of 1505 includes rules governing the conduct of the potter's craft. A transcription of this document is currently being prepared for publication by Don Delfo Gioacchini, and should add considerably to our knowledge of ceramic production at Vasanello during the pre-modern period. Many of the present-day inhabitants of Vasanello share the belief that the name of their town derives from the Latin word *vas* (vessel), offering this as proof of the important role that pottery production played in the life of the town from very early times. In all likelihood, however, this is a spurious folk etymology. Vasanello, or Bassanello, as the town was officially known until 1946, is almost certainly the diminutive form of Bassano, the name of a town located 6 km. to the north-northwest.

<sup>2</sup> The author interviewed Bruno Orlandi at his disused pottery workshop for three hours on June 20, 1987. He was interviewed a second time, together with his brother, Orlando, for five hours on June 23, 1990. This session included visits to the Source 3 clay deposit, the town antiquarium, where

mation obtained from these informants with material drawn from three published accounts of traditional pottery production in the town (Longo 1988; Palleschi 1983; Silvestrini 1982: 25-28), it has been possible to formulate a generalized picture of the Vasanello pottery industry during the first half of this century.

The bulk of production was carried out by men belonging to a small group of families that were closely identified with the craft. Workshops tended to be staffed by from one to four males, who were usually related by blood or marriage. These men, known both as *pilari* (from *pila*, dialect for cookpot), or *cocciari* (from *coccio*, Italian for earthenware), worked year round on a full-time basis. There was no regularized system of apprenticeship, although the general practice was for boys to begin their training in the family workshop when they were about ten years old. Women played only a limited role in production, occasionally helping with the carving of openwork decoration in leather-hard vessels and the glaze decoration of biscuit wares. The number of men who earned their livings as potters at any one time remains difficult to estimate. An insurance register of 1925 lists nine workshops employing a total of twenty potters (Silvestrini 1982: 26), although it is unclear what proportion of the total number of establishments this represents. One informant stated that during the 1930s there were roughly forty active workshops, employing the labor of well over one hundred men, but it was not possible to verify the accuracy of these figures and they may be greatly exaggerated.

Vasanello potters had no formal craft organization, although they did stage a joint celebration of the feast of San Giuliano, their patron saint, each year on August 8.

there is a small collection of traditional Vasanello pottery, and the workshop where Orlando manufactures art pottery on a part-time basis. By this time the building in which Bruno's workshop was located had been inherited by another member of the family and dismantled. On July 27, 1989, a one hour interview was conducted with Antonio Orlandi, a cousin of Bruno and Orlando, who had worked as an independent potter and then as an employee at the Misciattelli ceramic factory (see *infra*). This interview took place at the Castello Misciattelli, where a large collection of ceramics produced by the Misciattelli concern is still on display. Also on July 27, 1989, a one half hour interview was held with Antonio Fochetti, another former employee of the Misciattelli factory.

Their activity was assisted both by the town government, which, through its *Ente Agraria* (Agriculture Agency), supplied firewood at a subsidized price, and by the *Congregazione di Carità*, a religious organization, which allowed potters to dig clay free of charge on its land. Workshops were scattered throughout the town, which had no specific potters' quarter.

While Vasanello potters manufactured a wide variety of ceramics, ranging from roof tiles to figurines, most workshops concentrated on the production of cookwares (Fig. 2). These were reputed to have exceptional durability, and were distributed throughout much of central Italy (Fig. 3). According to the potters interviewed, the high quality of Vasanello cookwares was attributable to the peculiar properties of the clay obtained from the town's principal clay source. In their view, the only significant competition for this segment of the regional ceramics market came from potters at Vetralla, a town located 25 km. to the west-southwest across the Monti Cimini (Fig. 4).

A variety of methods was employed to distribute Vasanello pottery. The local market was supplied through direct retail at the workshop in transactions that often involved the barter of farm produce for pots. Potters also retailed their products at fairs and festivals throughout the region, and, on rare occasions, women carried small loads of pottery to neighboring towns for sale on regular market days. The bulk of production, however, was marketed by men from the town who worked as itinerant pottery sellers. These middlemen, known as *carrettieri* from the wagons (*carrioli*) that they drove, contracted with workshops for the production of a set number of vessels in standardized shapes and sizes known as *conti*. The *carrettieri* obtained these *conti* at reduced prices and retailed them on marketing rounds that extended into southern Lazio, Umbria, Tuscany, and the Abruzzo. Their selling trips normally lasted six or seven days, but on some occasions might be extended to as long as one month. A partial list of the cities and towns where Vasanello pottery was sold in this fashion includes Terni, Cascia, Norcia, Perugia, Spoleto, and Foligno in Umbria; Massa



Fig. 2. Representative twentieth-century Vasanello cookwares (Paste 3 with lead glaze). Left: casserole (*tegame*; D. 17 cm., H. 6.9 cm.); Right: skillet (*tegamino*; D. 13 cm., H. to rim 4.7 cm.). Both vessels made by Bruno Orlandi, probably during the 1970s

Carrara and Siena in Tuscany; L'Aquila and Teramo in the Abruzzo; and Rome, Anagni, Alatri, and Frosinone in Lazio (Fig. 3).

This production and marketing scheme remained intact until the post-war period, when the potting craft at Vasanello collapsed. The wider availability of aluminum pots and pans reduced the demand for ceramic cookwares, while expanded economic opportunities discouraged young men from following their fathers into the craft, and as the older potters retired, ceramic production went into decline. There were some efforts to revive the craft, including the founding of a vocational school to furnish unemployed men from the town with formal training as potters, and the establishment by the Misciatelli, the family holding the marquisate at Vasanello, of a factory that manufactured fine decorative ceramics for the international market. These initiatives proved unsuccessful, however, and were abandoned. A few independent producers continued to work on and off into

the 1980s, but by the time of the author's first visit in 1987, there were no longer any active full-time potters in the town.

The Vasanello ceramic industry corresponds fairly closely with what Peacock (1982: 40-43) has defined as the "rural nucleated industry" mode of ceramic production. Unlike urban nucleated industries, which tend to manufacture a wide variety of ceramics intended for distribution primarily to the local market, often by direct retail at the workshop, rural nucleated industries frequently concentrate on a restricted range of items (e.g., cookwares, water jars, luxury tablewares, etc.), wholesaling their products to middlemen, who distribute them over a broad geographical area. In this sense many rural industries can themselves be thought of as specialized. The extra costs of middleman distribution are offset by the high quality (real or assumed) of the products and/or economies of scale achieved through intensive production. The attestation in the documentary record of

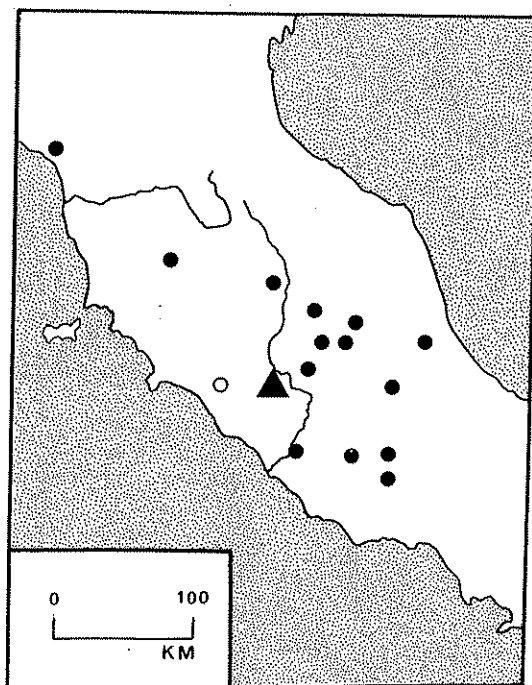


Fig. 3. Map of central Italy showing marketing locations attested for Vasanello pottery. ▲: Vasanello; ○: Tuscania; ●: twentieth-century marketing locations

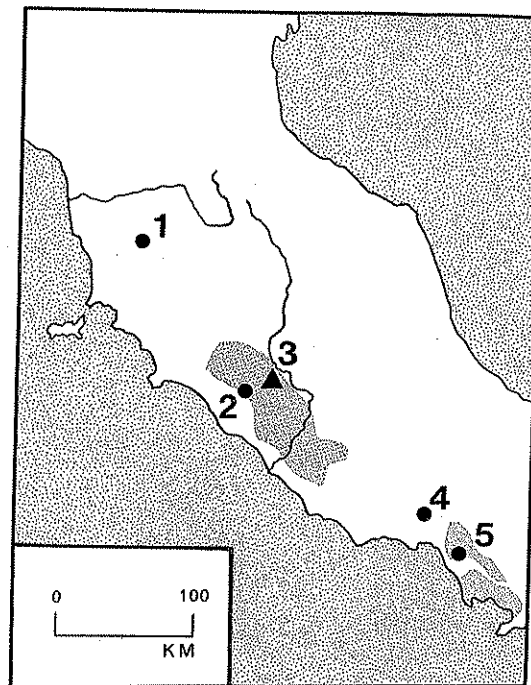


Fig. 4. Map of central Italy showing centers of cookware production mentioned in the text and geographical extent of Central Italian Volcanic Province (shaded area). 1: Colle Val d'Elsa, 2: Vetralla, 3: Vasanello, 4: Pontecorvo, 5: Cascano/Corbara

an itinerant cookware seller from Vasanello active during the 1450s (see Note 1) suggests that some embodiment of this general mode of production had grown up in the town as early as the late Medieval period.

#### PRODUCTION PRACTICES IN THE WORKSHOP OF OVIDIO AND BRUNO ORLANDI

The principal ethnographic informant at Vasanello was Bruno Orlandi (b. 1927), the last resident of the town to work as a full-time potter. The Orlandi are the family in the town most closely identified with the craft, a large proportion of males having earned their living in this occupation for at least the last four generations. Bruno began his career as a potter at age ten, serving as an assistant in the workshop of his father, Ovidio Orlandi (1901–1989). The two men worked together until Ovidio's retirement in 1970, after which time Bruno, a bachelor, continued to labor on his own. Bruno retired in 1978 after repeated complaints from neighbors about the smoke from his kilns led to legal difficulties, forcing him to close

his workshop. Since Bruno left the workshop more or less intact when he retired, he was able to provide the author with demonstrations of various production techniques and furnish examples of both unfired clays and finished pottery. While it was Bruno's opinion that the manufacturing techniques used by the Orlandi were representative of those traditionally employed by Vasanello potters in general, in some instances he was careful to note aspects of production that he considered to be peculiar to his family. Bruno's younger brother, Orlando Orlandi (b. 1937), continues to make art pottery and reproductions of Renaissance maiolicas on a part-time basis, employing a combination of traditional and modern techniques. He labors in a workshop located a short distance from Bruno and Ovidio's old workshop, and was able to donate some additional specimens of traditional raw materials.

Bruno and Ovidio's workshop, located near the scarp at the western edge of the

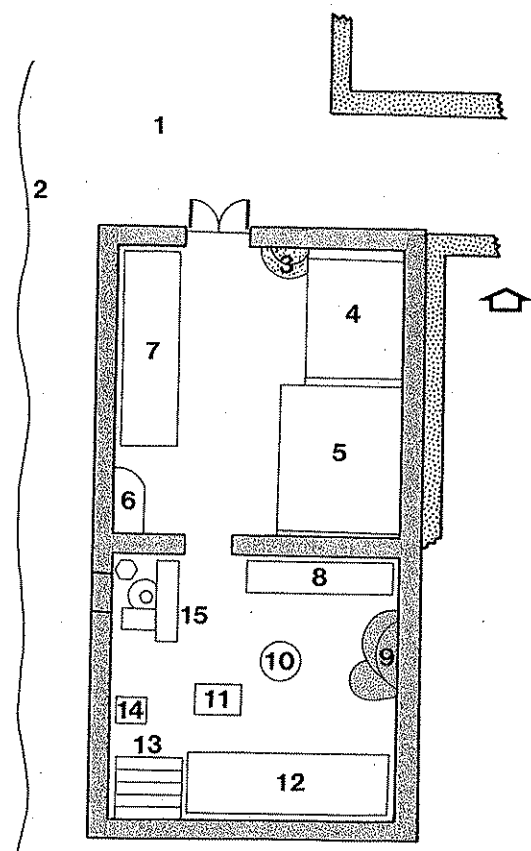


Fig. 5. Schematic plan of Orlandi workshop, June 20, 1987 (not to scale): 1: yard; 2: scarp; 3: waster pile; 4: small kiln; 5: large kiln; 6: basin; 7: wood storage rack; 8: bench for working clay; 9: unprepared clay; 10: clay moistening basin; 11: hand-turned wringer; 12: drying shelves; 13: stairs to mezzanine; 14: wood stove; 15: kickwheel

town, was a two room structure built in blocks of tuff (Fig. 5). One of the rooms (henceforth the "kiln room") housed two kilns and a wood storage area. The other (henceforth the "work room") contained a kickwheel, drying racks, and various other facilities for paste preparation, forming, and decoration. A yard running along the edge of the scarp to the north of the workshop was used for wood storage and drying formed ceramics. In addition to the workshop, Bruno and Ovidio maintained a small storeroom located beneath a private residence a short distance away, which was primarily used for storing finished pottery. The Orlandi residence lay some distance from both facilities in another part of the town.

While Bruno and Ovidio worked on a year-round basis, their rate of production slackened during the winter, when increased humidity lengthened the time required for freshly formed ceramics to dry. The two men manufactured a wide range of items employing four distinct pastes and a variety of forming and decorative techniques. They produced for direct retail to local consumers and wholesale to itinerant middlemen, as well as undertaking special commissions (e.g., relief plaques bearing municipal coats-of-arms for display on public buildings, custom-sized roof tiles) for customers from as far away as Rome.

The Orlandis' selection of raw materials can be understood only against the background of the complex geologic history of the Vasanello area. During the Pliocene and the early Pleistocene, a broad area of the coastal plain in west-central Italy was subject to an episode of marine transgression. This saw the deposition of a thick bed of sediment grading from clay at the bottom of the stratigraphic column to sand near the top. The region was subsequently subjected to a period of extensive volcanism, with large tracts blanketed by *ejecta* erupted from several distinct vent systems. In the vicinity of Vasanello there were two such volcanic complexes, both centered on vents lying 10 to 15 km. to the southwest of the town in what are today the uplands of the Monti Cimini. The older of the two complexes, the Ciminian, is centered on the lava dome of Monte Cimino itself. This complex has an acid chemistry and the formations associated with it are accordingly quartz rich. The younger complex, the Vican, is centered on the large caldera today occupied by Lago di Vico. It has an alkaline chemistry and produced quartz-poor formations, which cover all but a few isolated tracts of the earlier Ciminian material. Between eruptive events and in the post-volcanic period, the formations associated with both complexes have been subject to extensive downcutting by elements of the drainage network. In some areas this has re-exposed underlying sedimentary deposits, producing a complex and sharply dissected landscape. Most notable in this regard has been the cutting of the Tiber Valley

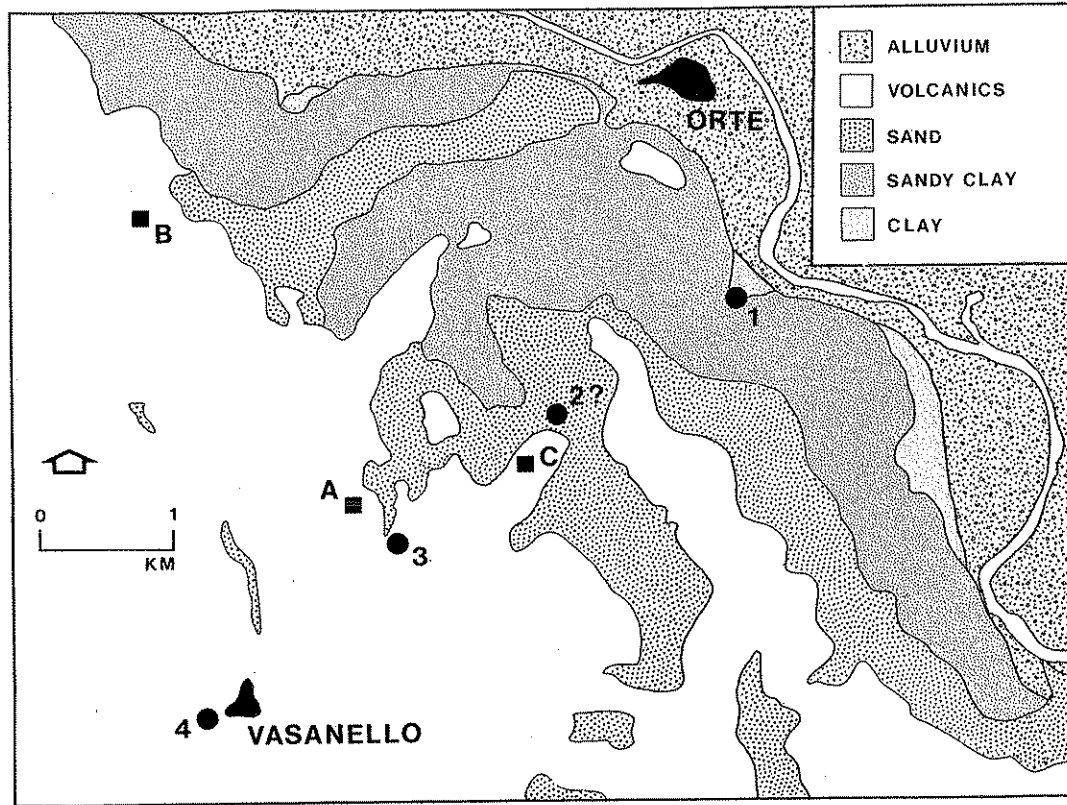


Fig. 6. Map of Vasanello/Orte area showing generalized geological formations, modern clay sources (●), and Roman-period ceramic production workshop sites (■). 1: Source 1; 2: approximate location of Source 2; 3: Source 3; 4: Source 4; A: Poggio Pelato workshop site; B: Poggio del Capitano workshop site; C: San Marco workshop site. Geological formations after Servizio Geologico d'Italia (1970)

along a north-south line passing roughly 5 to 6 km. to the east of Vasanello.

The Orlandi regularly obtained clay from one principal and three secondary sources (Fig. 6). Each yielded a material with distinctive properties which made it appropriate for use with particular forming techniques and for the manufacture of specific functional classes of items. These sources and the clays they yielded are as follows:

*Source 1* (secondary source). This is a large clay pit situated on an isolated outcrop of Pliocene marine clay exposed at the edge of the Tiber Valley near Orte, 5 km. to the northeast of Vasanello. (Servizio Geologico d'Italia 1970, formation p2; Mattias and De Casa 1974: 159) This source yielded a light gray clay with linear drying shrinkage on the order of 8 percent. Until recently this

outcrop and a neighboring exposure belonging to the same formation were worked by large industrial brickworks located directly atop them. These establishments, both of which failed during the 1970s, extracted clay along massive stepped faces cut into the slope at the edge of the Tiber flood plain. Bruno stated that this source was not regularly exploited by other potters from Vasanello, and that members of his family were able to obtain this clay free of charge due to a longstanding arrangement with the landowners.

*Source 2* (secondary source). This was an area of clayey soil in a field lying 3 to 4 km. to the northeast of Vasanello in a locale known as "Terrabella." It yielded a brownish yellow clay with linear drying shrinkage of approximately 13 percent. The precise



location of this source could not be ascertained, but it may correspond to an area marked on the topographic map as "le Pantane" ("the Bogs"). The geological map shows the general area in which the source is located as a zone of Pleistocene sands and sandy clays belonging to a broad band of marine sediments exposed along the western margin of the Tiber Valley (Servizio Geologico d'Italia 1970, formations  $Q_2^c$  and  $Q_1^c$ ). Clay was extracted here without charge, the landowner having no objection since it was taken only in small amounts.

*Source 3* (principal source). This is a sizable deposit of clayey soil situated 1.5 km. to the northeast of Vasanello. It yielded a dark reddish brown clay with roughly 20 percent linear drying shrinkage. This area, a moderately sloping field known as "le Terraie" (roughly translatable as "the Clay Grounds"), was the main clay source for Vasanello potters, who believed that it yielded a material superior to all others available in the region for the manufacture of cookwares. The clay from this source was also believed to have curative properties, aiding in the healing of cuts and sores in both humans and animals. The geologic map shows Source 3 as an area of trachitic-phonolitic tuffs belonging to the Vican complex (Servizio Geologico d'Italia 1970, formation  $t_1$ ). In recent years this land has come under cultivation as a hazelnut orchard and the topography has been extensively modified by both terracing and plowing. A visit to the area revealed no obvious exposures of argillaceous material. The property on which the deposit is located was, until a few years ago, owned by the *Congregazione di Carità*, a religious organization, which permitted potters from the town to dig clay free of charge. Potters usually extracted clay once a year, during either July or August, when the ground was at its driest. On some parts of the hill slope clay could be obtained directly from the surface, while in others it was necessary to first strip away a layer of soil known as *goglio*, which was, according to Bruno, "neither volcanic nor clay." The desired quantity of clay was dug from an open pit, spread out on the ground, and left to dry for two to three days. The dried clay was then loaded into jute sacks in lots

weighing roughly 100 kg., and a sack strapped to the back of a mule for transport to the workshop. The trip, which was normally done at night, required roughly one hour (Silvestrini 1982: 26).

*Source 4* (secondary source): This is a small zone of clayey soil located at the southwestern edge of Vasanello, adjacent to the town *campo santo* (cemetery). It yielded a reddish clay with about 8 percent linear drying shrinkage. The geologic map shows this as an area of trachitic-phonolitic tuffs and ignimbrites (Servizio Geologico d'Italia 1970, formations  $t_1$  and  $\theta$ ). As at Source 2, the landowners permitted clay to be dug without charge since it was taken only in limited quantities.

Bruno stated that there were several other points in the vicinity of the town where it was possible to obtain clay suitable for use in ceramic production, but these materials were inferior to the clays obtained from the sources described above. These other sources were occasionally exploited by Vasanello potters, principally when clay from the normal sources was unavailable.

Bruno and his father employed these four clays to prepare four distinct pastes, each of which was considered appropriate for use with a particular forming technique and/or for the manufacture of a specific functional group of items. While these pastes correspond in a fairly direct fashion to the four source clays described above, the amount of raw material processing undertaken by the Orlandi, though limited, was enough to justify their description under a separate series of headings. These pastes were as follows:

*Paste 1*: This was made entirely with clay from Source 1, although pigments were sometimes added in order to condition the color of the finished piece. This was a fine paste with excellent workability and low shrinkage. Its preparation required a certain amount of care since it was necessary to remove occasional bits of shell from the clay. This paste was used for the manufacture of items requiring a light-colored body, fine wheel-made forms, and items formed using molds, since its drying properties allowed these last to dry without splitting.



*Paste 2:* This was made with a mixture of clays from Sources 1 and 2 combined in varying proportions. This was a moderately fine paste, with good workability and moderate shrinkage. It offered superior resistance to the elements, and was accordingly employed for the manufacture of items meant to be used outdoors, such as flower pots and planters. As with Paste 1, it was essential to remove bits of shell from the Source 1 clay. It should be noted that the Source 2 clay, which was believed to add strength to the paste, was never used by itself.

*Paste 3:* This was made entirely with clay from Source 3. This was a coarse paste, with moderate workability and high shrinkage. It was used for the production of cookwares and other heavy utilitarian forms. High shrinkage meant that care had to be taken when adding handles and making other joins with this paste, since attachments might be weakened or pull apart as drying progressed and the body of the vessel contracted. Attachments of this kind were accordingly added only after drying was partially complete.

*Paste 4:* This was made entirely with clay from Source 4. A very coarse paste with poor workability, it was used to make firebrick, kiln furniture, and any other items requiring refractory properties.

In order to prepare these pastes, the clay was first soaked in water until thoroughly hydrated, a process which normally required two days. This was done in a small vat set in the central area of the work room. If two clays were to be mixed or pigment added, it was done at this point, with proportions determined by feel. The mass of hydrated clay was then transferred to a stone bench set against the north wall of the room and beaten with steel rods in order to break up lumps of unhydrated clay and produce a homogeneous mixture. Beginning in the 1920s the process was completed by forcing the beaten clay through a hand-turned wringer set in the central area of the room. In earlier times, it was the practice to wedge the clay by treading with the feet.

Forming was accomplished using either

a kickwheel or plaster molds. The workshop's single wheel was situated in the northwest corner of the work room, adjacent to its only window. The wheel, which was made by a local carpenter, consisted of a wooden flywheel and wheelhead mounted on a steel axle set in a single bearing. Plaster molds, of which the workshop possessed an extensive collection, were used to make items with relief decoration, including plaques, large flower pots, and rectangular planters.

Vessels were dried either indoors on shelves and a mezzanine set along the south wall of the work room or, during the drier part of the year, in the yard along the edge of the scarp. The amount of time required for an item to dry varied in accordance with the paste used, the thickness of the form, and the season of the year, ranging from as little as five days to as much as one month. During the winter the process was sometimes assisted by the lighting of a small wood-burning stove placed against the west wall of the work room.

Firings were carried out using either of two updraft kilns, one large and one small, located against the east wall of the kiln room. There was no structural or functional difference between the two, which were distinguished only by the quantity of pottery each could accommodate, the smaller holding approximately one month's output and the larger roughly twice that amount. Both were built in blocks of refractory tuff, with the larger kiln showing signs of at least one rebuilding. In either case, the firebox and firing chamber had doors opening directly onto the workspace. Combustion products exited through windows located behind the kilns high up the wall of the room. The kilns were set using props, cockspurs, and sag-gars made in Paste 4. Bruno used firebrick manufactured in Paste 4 to seal the door of the firing chamber. In Ovidio's time, however, Vasanello potters accomplished this by building a wall of discarded cook-pots bonded together with clay. As each pot was added, the potter would dip his finger in clay and trace a cross on the vessel to insure good luck for the firing.

Since the town no longer supplied wood to potters, for fuel Bruno used oak which

he cut himself free of charge in the environs of the town. The wood was subjected to a lengthy aging process, since the presence of even a slight amount of water vapor inside the kiln might cause vessels to rupture during firing. Freshly cut trunks were stacked in the yard outside the workroom and left to sit for at least one year. During the summer of the second year, when the wood was fairly dry, it was moved indoors and loaded into racks along the west wall of the kiln room, where it was left to dry for a second full year.

Bisque firings were carried out roughly once a month, the entire process requiring from six to seven days. Firing began with a period of water-smoking (low temperature heating used to drive off residual water), which lasted for five or six days. This was followed by the *gran fuoco*, or firing proper, which lasted approximately twelve hours. During this period the temperature inside the firing chamber was run up to roughly 750°C, with the progress of the firing checked by means of draw trials. At the conclusion of this phase the kiln was left to cool for approximately fifteen hours. It was then opened and the contents unloaded. Wasters were usually dumped over the scarp outside the workshop, although the author did observe a large mound of misfired pottery on the floor of the kiln room to one side of the kilns. The combined loss rate experienced in drying and firing was in the 10 to 20 percent range.

Following the bisque firing most of the forms produced in Paste 3 and some of those manufactured in Paste 1 were covered with a lead glaze. While Bruno obtained glaze from commercial distributors, Ovidio prepared his from scratch. For the base he employed red lead acquired in ingot form. This was ground up and mixed with sand, then heated in a special oven. In Ovidio's time, Vasanello potters also added small vegetal motifs in green and yellow underglazes, which they manufactured themselves, using a mixture of copper and lime for green and antimony for yellow (Silvestrini 1982: 26). For glaze firings some pieces were set inside tall cylindrical saggars. These firings normally took approximately twenty-four

hours and were carried out at temperatures in the range of 850 to 900°C.

Altogether, the Orlandi produced at least twenty-eight different forms. A listing of these is presented in Appendix A.

#### PROGRAM OF PHYSICAL AND COMPOSITIONAL ANALYSIS

In order to understand better the origins and properties of the various clays employed by Vasanello potters, the specimens of clay and the ceramics collected during the first stage of the project were subjected to a program of physical and compositional analysis. The materials available for analysis included specimens of clay and ceramic collected from Bruno Orlandi (clay from Sources 1, 2, and 3, and examples of Paste 1, 3, and 4 ceramic) and Orlando Orlandi (clay from Sources 2 and 3, and an example of Paste 4 ceramic) and three specimens of clay collected by the author at Source 1.<sup>3</sup> Table 1 provides a summary of the various specimens analyzed and the analyses to which each was subjected.

In the program of physical analysis, a portion of at least one specimen of each of the three source clays collected was hydrated, formed into a briquet, dried, and fired in order to evaluate water of plasticity, linear shrinkage, weight loss, and color change. This was also done with a 1:1 mixture of clay from Sources 1 and 2, since no example of Paste 2 was available for characterization. These procedures were carried out as follows: A quantity of each specimen was heated in an electric oven at 150°C for two hours, allowed to cool, and crushed in a porcelain mortar. Fifty  $\pm$  1 g. of this material were weighed to 0.1 g. and distilled water added until the mixture became fully plastic. The weight of the water added was determined to 0.1 g. and a value calculated for percent water of plasticity. The hydrated clay was then rolled into a disk-shaped briquet, its color recorded using Munsell Soil Color Charts,<sup>4</sup> and two par-

<sup>3</sup> Cobble-sized blocks of clay were collected at three points at 50 m. intervals from among the talus debris at the foot of the clay pit face.

<sup>4</sup> All color readings were taken under fluorescent light, with interpolations made between color chips where possible.

TABLE 1. Clay specimens/ethnographic ceramics and compositional analyses to which they were subjected\*

Specimen number	Clay source	XRD blk	XRD frc	thn sct	NAA raw	NAA 900	Comments
<b>Clay specimens</b>							
So1.1	Source 1	X	X	X	X	X	from B. Orlandi
So1.2	Source 1	X	X	X	X	X	from source
So1.3	Source 1				X	X	from source
So1.4	Source 1				X	X	from source
So2.1	Source 2	X	X	X	X	X	from B. Orlandi
So2.2	Source 2				X	X	from Or. Orlandi
So1.2+2.1	Sources 1 and 2	X		X	X	X	So1.2 and So2.1 in 1:1 mix
So3.1	Source 3	X	X	X	X	X	from B. Orlandi
So3.2	Source 3				X	X	from Or. Orlandi
<b>Ethnographic ceramics</b>							
Va.1	Source 1			X	X		Paste 1 lid made by B. Orlandi
Va.2	Source 3			X	X		Paste 3 skillet made by B. Orlandi
Va.3	Source 4	X		X	X		Paste 4 firebrick made by B. Orlandi
Va.4	Source 4				X		Paste 4 firebrick made by Or. Orlandi

\* blk: bulk; frc: fractioned; thn sct: thin sectioned.

allel lines scribed on the upper surface 3.0 cm. apart. Each briquet was dried at 150°C for eight hours and allowed to cool. The color reading was repeated and the distance between the lines measured in order to determine linear drying shrinkage. Unfortunately, the 3.0 cm. distance between the lines proved to be too short to permit the recording of reliable figures, and the attempt to measure shrinkage was abandoned. Each of the dried briquets was next broken into two roughly equal fragments,

one of which was retained for mineralogical analysis. The other fragment was weighed to 0.1 g. and fired in an electric kiln at 900°C in an oxidizing atmosphere for four hours. This piece was allowed to cool, reweighed, and its color recorded a third time. The fired weight was subtracted from the dried weight and a figure calculated for the percent weight loss in firing. The results of the program of physical analysis are reported in Table 2.

In the program of compositional analysis,

TABLE 2. Water of plasticity, weight loss induced by firing, and color change data for briquets\*

Briquet	So1.1	So1.2	So2.1	So1.2+2.1	So3.1
<b>Weight (grams)</b>					
Crushed clay	50.3	na	50.6	na	50.9
Water	16.0	na	14.7	na	16.5
Percent	31.8	na	29.0	na	32.4
<b>Weight (grams)</b>					
Dried briquet	17.8	20.25	22.1	na	21.6
Fired briquet	14.85	16.9	20.6	na	19.4
Percent loss	16.6	16.5	06.8	na	10.2
<b>Color</b>					
Fresh briquet	2.5Y 4/2 dk. grayish brown	10YR 5.5/1 gray	10YR 4.8/6 yellowish brown	1Y 5/2 grayish brown	6YR 3.2/4 dk. reddish brown
Dried briquet	9YR 7.2/1 lt. gray	10YR 7.5/1 white/lt. gray	9YR 6/6 brownish yellow	1Y 6.2/3 pale brown	9YR 4.2/3 brown
Fired briquet	5YR 7/4 pink	7.5YR 7.5/3 pinkish gray/pink	3YR 5.8/8 lt. red	2YR 5.8/7.8 lt. red	2YR 4.8/8 red

\* na: not ascertained.

TABLE 3. Results of XRD analysis of fine (&lt;2 micron) fractions of unfired clays\*

Specimen	S	I	K	CH	Q	C	Condition
So1.1	+++	+++	++	+	+	++	S, I and K well crystallized
So1.2	+++	+++	++	+	+	++	S, I and K well crystallized
So2.1	+++	++	++		+		S, I and K poorly crystallized
So3.1	+++	++	+++		+		S, I and K poorly crystallized

\* S: smectite; I: illite; K: kaolinite/halloysite; CH: chlorite; Q: quartz; C: calcite; +: trace; ++: moderate; +++: abundant.

a selection of the unfired briquet fragments, fired briquet fragments, and ethnographic ceramics was first characterized by x-ray diffraction (XRD) in order to determine the mineralogical composition of these materials. A single bulk powder analysis was carried out for fired briquet fragments and ethnographic ceramics. For this, a small fragment of the specimen was crushed in a porcelain mortar and approximately 2.2 g. of this material placed in a random orientation powder mount. This was loaded on a Siemens Kristalloflex 810 diffractometer employing a Cu K alpha radiation source set at 50 kV/30 ma and analyzed over a range of 5 to 65 degrees 2 theta. For unfired briquet fragments separate analyses were performed for an oriented sub-two micron fraction and a randomly oriented powder specimen of the residual coarse fraction. These analyses were intended to provide information about the specimen's clay-mineral component and its non-plastic mineralogy, respectively. Sub-two micron fractions of each such specimen were separated by centrifuge and mounted in oriented position on glass slides following procedures described by Moore and Reynolds (1989: 179-201). These were analyzed over a range of 2 to 32 degrees 2 theta using the same parameters as those employed for the analysis of bulk powder specimens. The analysis was then repeated after saturating the specimen with ethylene glycol to facilitate the identification of ex-

pandable clay minerals. Approximately 2.2 g. of each specimen's residual coarse fraction were then placed in a random orientation powder mount and analyzed over the same range as that employed for bulk powder specimens using the same parameters. The results of the program of XRD analysis are summarized in Tables 3 through 5 and portions of selected diffractograms are presented in Figures 7 through 10.

In order to supplement the mineralogical data obtained by XRD, several of the fired briquet fragments and ethnographic ceramics were thin sectioned and analyzed under a petrographic microscope. The results of these analyses are summarized in Table 6 and photomicrographs of selected thin sections are reproduced in Figure 11a-d.

In the final part of the program of compositional analysis, neutron activation analysis (NAA) was employed to characterize the minor constituent and trace element composition of all ethnographic ceramics, raw clay specimens, and fired pellets made from these clays. Raw clay specimens were prepared for analysis by crushing in an agate mortar. For the analysis of fired clays, ca. 5 g. of raw clay were crushed in an agate mortar, de-ionized water added until the clay became plastic, and the mixture rolled into a small cylindrical pellet. The pellets were fired for two hours at 900°C in an oxidizing atmosphere, allowed to cool, and crushed in an agate mortar. Ethno-

TABLE 4. Results of XRD analysis of coarse (&gt;2 micron) fractions of unfired clay\*

Specimen	K	Q	C	D	M	P	O	A
So1.1	+	+++	+++	+	+	+		
So1.2	+	+++	+++	+	+	+		
So2.1		++++			+	+	+	
So3.1	+	+++			+	+	+	+

\* K: kaolinite/halloysite; Q: quartz; C: calcite; D: dolomite; M: muscovite; P: plagioclase; O: orthoclase; A: augite; +: trace; ++: moderate; +++: abundant; ++++: very abundant.

TABLE 5. Results of bulk XRD analysis of briquets and ethnographic ceramics\*

Specimen	Q	P	O	A	H	G	DI
So1.1	+++	+	+		+	++	+
So1.2	+++	+	+		+	++	+
So2.1	++++		+		+		
So1.2+2.1	++++	+	+		+	+	+
So3.1	+++	+	+	+	+		
Va.3	++	+	++		+		

\* Q: quartz; P: plagioclase; O: orthoclase; A: augite; H: hematite; G: gehlenite; DI: diopside; +: trace; ++: moderate; +++: abundant; ++++: very abundant.

graphic ceramic specimens were prepared for analysis by removing the surface with a drill equipped with a tungsten carbide burr, breaking off a small piece of the exposed body, and crushing this fragment in an agate mortar. For all three kinds of specimens, at least 500 mg. of crushed material were dried in an electric oven at 110°C for twenty-four hours and allowed to cool for one hour in a desiccator. One hundred  $\pm$  5 mg. of this material were then transferred to a cleaned polyethylene microcentrifuge tube and weighed to 0.01 mg. The irradiation and counting protocols employed were those described by Blackman and colleagues (1989: 64-65). Concentration data were obtained for twenty-six elements, in-

cluding Na, K, Ca, Sc, Cr, Fe, Co, Zn, As, Rb, Sr, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Th, and U. Tables 7 and 8 present the data obtained by the program of NAA.

#### DISCUSSION OF RESULTS OF PROGRAM OF PHYSICAL AND COMPOSITIONAL ANALYSIS

As anticipated, the results of the program of physical and compositional analysis shed light on the origin of the four source clays employed by the Orlandi and provided insight into the physical basis for the performance characteristics of both the pastes and the finished ceramics made with them.

The mineralogical analysis of the Source

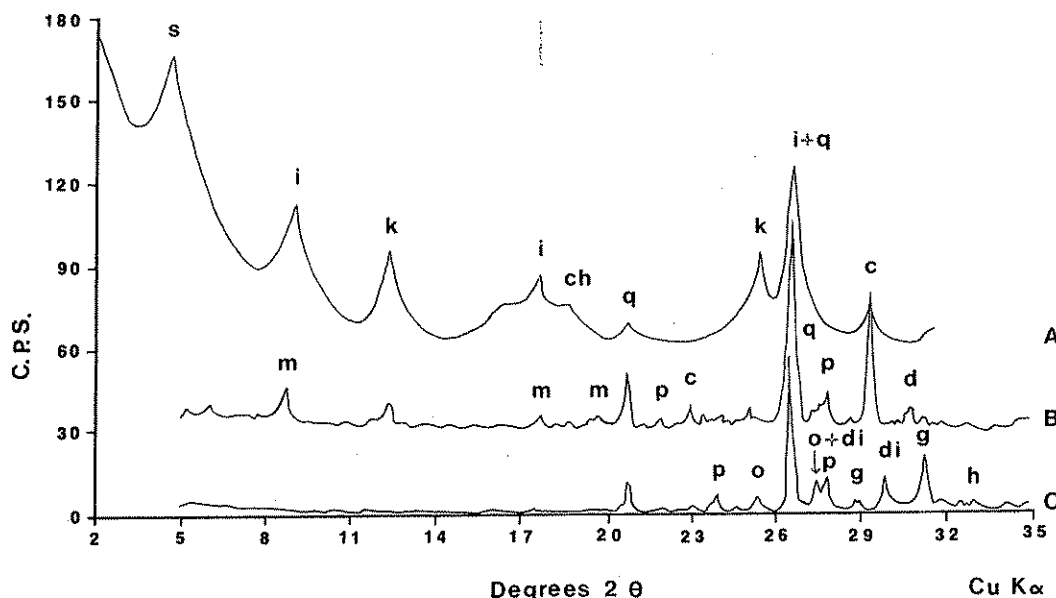


Fig. 7. Diffraction patterns (smoothed) from XRD analysis of unfired clay So1.1 (Source 1) and briquet made from it. A: So1.1 glycolated sub-2 micron fraction (offset +60 c.p.s.), B: So1.1 coarse fraction (offset +30 c.p.s.), C: So1.1 fired briquet. c: calcite; ch: chlorite; d: dolomite; di: diopside; g: gehlenite; h: hematite; i: illite; k: kaolinite/halloysite; m: muscovite; o: orthoclase; p: plagioclase; q: quartz; s: smectite

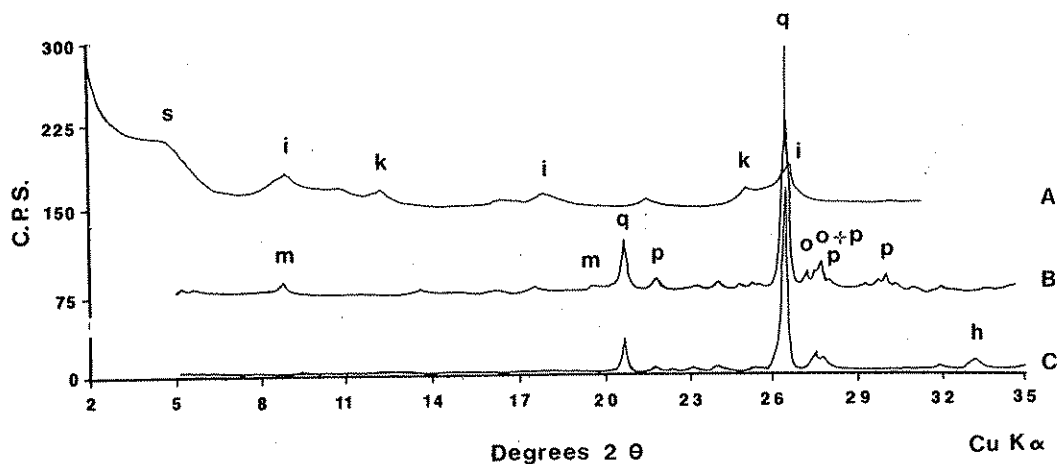


Fig. 8. c: calcite; ch: chlorite; d: dolomite; di: diopside; g: gehlenite; h: hematite; i: illite; k: kaolinite/halloysite; m: muscovite; o: orthoclase; p: plagioclase; q: quartz; s: smectite Fig. 8. Diffractograms (smoothed) from XRD analysis of unfired clay So2.1 (Source 2) and briquet made from it. A: So2.1 glycolated sub-2 micron fraction (offset +150 c.p.s.), B: So2.1 coarse fraction (offset +75 c.p.s.), C: So2.1 fired briquet. h: hematite; i: illite; k: kaolinite/halloysite; m: muscovite; o: orthoclase; p: plagioclase; q: quartz; s: smectite

1/Paste 1 materials revealed a composition consonant with this clay's known marine origin. The XRD analysis of two specimens of Source 1 clay (So1.1 and So1.2) showed a mixture of well-crystallized clay minerals (illite, smectite, either kaolinite or halloysite, and a trace amount of chlorite), a large quantity of calcite in the clay-silt range, an abundance of quartz, and small amounts of muscovite, dolomite and plagioclase. Firing

to 900°C destroyed the muscovite and caused the calcite to break down into carbon dioxide and lime, the lime combining with other constituents of the body to form gehlenite and diopside. Firing also led to the formation of a trace amount of hematite and perhaps some additional plagioclase. In thin section, these materials and ceramic Va.1 showed an abundant scatter of non-plastics in the silt to fine sand range and

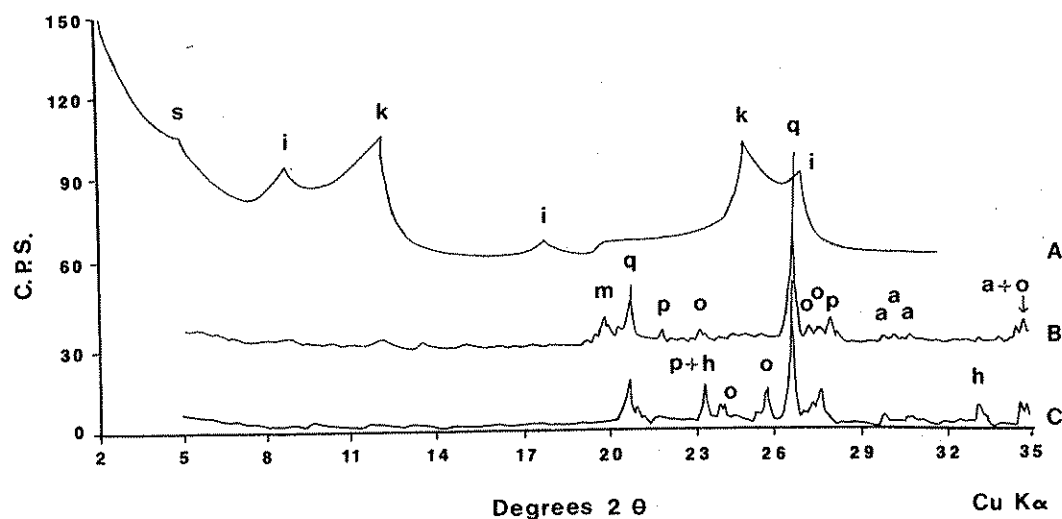
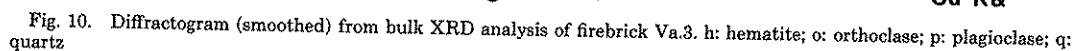


Fig. 9. Diffractograms (smoothed) from XRD analysis of unfired clay So3.1 (Source 3) and briquet made from it. A: So3.1 glycolated sub-2 micron fraction (offset +60 c.p.s.), B: So3.1 coarse fraction (offset +30 c.p.s.), C: So3.1 fired briquet. a: augite; h: hematite; i: illite; k: kaolinite/halloysite; m: muscovite; o: orthoclase; p: plagioclase; q: quartz; s: smectite



The NAA of the four Source 1 clay specimens (So1.1, So1.2, So1.3, and So1.4) and the example of Paste 1 ceramic (Va.1) revealed chemical compositions that are normal for clays of the Plio-Pleistocene marine transgression, with abundant Ca and low to moderate values for most of the other

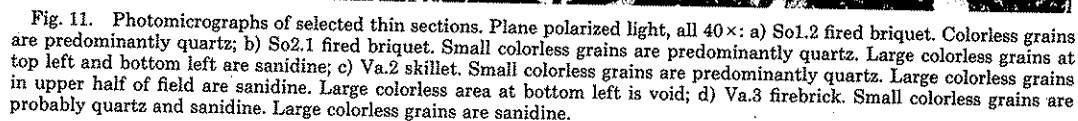




TABLE 6. Results of petrographic analysis of test briquets and ethnographic ceramics\*

Specimen	Non-plastic/void	Abundance	Size	Shape/condition
So1.1	void	3%	<0.125	round and rounded irregular
	quartz	10%	0.05-0.1	angular to rounded
	mica	1%	0.05-0.075	detrital fragments
	iron oxide	1%	0.025-0.05	rounded
So1.2	void	3-5%	0.05-0.1	round
	quartz	10%	0.02-0.1	subangular to rounded
	mica	2%	<0.25	detrital fragments
	iron oxide	1%	0.025-0.075	rounded
	sandstone	tr	0.7	rounded
Va.1	void	3%	<0.50-0.1	rounded irregular
	quartz	10-13%	0.02-0.125	subangular to rounded, some polycrystalline
	mica	1%	0.05-0.125	detrital fragments, 1 book
	iron oxide	1%	0.02-0.05	rounded
	plagioclase	tr	0.1-0.3	angular
	orthoclase?	tr	0.3-0.5	angular
	olivine?	tr	0.3	subrounded
	sandstone?	tr	<0.2	rounded
So2.1	void	tr		
	quartz	25-35%	0.02-0.2	subangular to rounded
	mica	3%	0.05-0.15	detrital fragments
	iron oxide	1%	0.1-0.15	rounded irregular
	orthoclase?	tr	0.25-0.5	subangular to subrounded
	clinopyroxene?	tr	0.25-0.5	subangular to subrounded
	volcanic rock?	tr	0.25-0.5	rounded with rounded colorless inclusions
So1.2+2.1	void	1-2%	0.05-0.10	rounded
	quartz	15-20%	0.02-0.20	angular to rounded
	mica	1%	<0.1	detrital fragments
	iron oxide	1%	0.05-0.1	rounded
	plagioclase	tr	0.07	angular
	orthoclase?	tr	<0.25	angular to rounded
	clinopyroxene?	tr	0.2	angular
	sandstone?	tr	0.25	rounded
So3.1	void	5%	0.05-0.1	rounded
	quartz	10-15%	0.02-0.2	subrounded, some polycrystalline
	mica	1%	0.02-0.25	detrital fragments
	iron oxide	1%	0.02-0.25	angular and rounded
	sanidine	5%	<0.8	angular to subangular
	plagioclase	tr	0.1-0.2	rounded
	clinopyroxene	tr	0.2-0.4	rounded
	volcanic rock	tr	0.4-0.5	rounded with rounded colorless inclusions
Va.2	void	3%	<1.25	round and crack-shaped
	quartz	20%	0.02-0.2	angular to rounded, some polycrystalline
	mica	1%	0.05-0.5	detrital fragments
	iron oxide	1%	0.02-0.2	rounded and angular
	sanidine	5%	<1.5	angular to subangular
	plagioclase	tr	0.2-0.4	angular to subangular
	clinopyroxene	1%	0.2-0.5	angular to subrounded
	volcanic rock	1%	0.3-0.5	rounded with voids and rounded colorless inclusions
Va.3	void	5-10%	<3.0	round, irregular and crack-shaped
	iron oxide	3-5%	0.2-0.25	round
	mica	tr	<2.0	altered books and plates
	sanidine	15-20%	<2.0	angular
	plagioclase	tr	0.4-0.5	angular
	clinopyroxene	tr	0.6	angular
	volcanic material?	tr	<2.0	altered

\* Abundance figures are based on comparison with standardized charts and are approximate. All size measurements in millimeters.  
Tr: trace.

elements measured (Peña and Blackman, in press). The divergence between the specimens consisting of clays So1.1, So1.3 and So1.4, on the one hand, and those consist-

ing of clay So1.2 together with ceramic Va.1, which tend to have somewhat higher values for most of the elements measured, except Ca and Sr, indicates the existence of sig-

TABLE 7. Results of the NAA of raw clays\*

Element	So1.1	So1.2	So1.3	So1.4	So2.1	So2.2	So1.1+ 2.1	So3.1	So3.2
Na (pct)	0.653	0.682	0.486	0.587	0.962	0.525	0.822	0.506	0.522
K (pct)	1.64	2.02	1.76	1.71	1.75	1.91	1.83	1.98	1.95
Ca (pct)	13.7	9.12	11.8	12.4	<dl	<dl	5.73	<dl	<dl
Sc (ppm)	10.9	14.8	12.2	12.0	13.6	13.3	12.3	17.4	14.8
Cr (ppm)	106	142	116	113	125	97.9	113	84.7	105
Fe (pct)	2.79	4.63	3.24	3.48	4.20	4.49	3.55	5.90	4.72
Co (ppm)	13.5	16.4	13.4	13.1	27.9	19.8	17.3	36.7	22.7
Zn (ppm)	89.3	107	98.9	98.9	95.1	82.6	88.9	88.9	100
As (ppm)	6.98	8.15	5.77	6.93	15.1	74.6	10.6	59.8	81.7
Rb (ppm)	115	147	122	121	270	313	189	279	339
Sr (ppm)	502	377	521	508	<dl	<dl	308	344	347
Sb (ppm)	0.579	0.643	0.630	0.542	1.17	5.89	0.815	5.20	6.18
Cs (ppm)	5.61	7.11	6.43	6.07	15.1	148	10.1	93.5	202
Ba (ppm)	261	342	280	245	471	490	237	1040	690
La (ppm)	28.8	33.4	29.0	29.8	71.3	85.5	48.6	135	107
Ce (ppm)	50.2	58.7	50.2	52.0	104	161	75.0	338	182
Nd (ppm)	23.9	28.7	24.6	23.9	51.9	52.2	35.6	101	69.3
Sm (ppm)	4.70	5.57	4.57	4.72	8.17	8.09	6.41	16.6	11.6
Eu (ppm)	0.90	1.11	0.89	0.91	1.50	1.38	1.18	3.00	2.08
Tb (ppm)	0.652	0.824	0.675	0.646	1.11	1.05	0.807	1.63	1.35
Yb (ppm)	2.17	2.71	2.31	2.12	3.44	3.15	2.71	3.92	3.70
Lu (ppm)	0.305	0.399	0.303	0.300	0.598	0.466	0.490	0.598	0.568
Hf (ppm)	3.40	3.48	2.81	3.31	9.68	11.7	6.49	12.2	12.1
Ta (ppm)	0.85	1.02	0.89	0.90	1.21	1.85	1.12	1.92	1.80
Th (ppm)	9.0	10.8	9.1	9.1	17.8	36.6	13.3	71.4	41.4
U (ppm)	2.33	2.31	1.88	1.87	9.64	7.38	3.64	11.4	7.38

\* For the analytical precision of the measurements of the various elements reported, see Blackman, Mery, and Wright (1989: 65, table 1).  
pct: percent; ppm: parts per million; <dl: below detection limit.

nificant compositional variability within this single, fairly small outcrop. This can best be accounted for by supposing that the two groups consist of clay originating in different parts of the stratigraphic column. The pattern of elevated and depleted values in the So1.2/Va.1 group mirrors that displayed by the specimens consisting of a 1:1 mixture of Source 1 and Source 2 clay, suggesting that the stratum in which these specimens originated probably contains an admixture of material similar to the Source 2 clay.

The compositional data indicate an entirely different origin for the Source 2 clay. The XRD analysis of one specimen of this clay (So2.1) revealed a mixture of poorly crystallized clay minerals (smectite, illite, and either kaolinite or halloysite) with very abundant quartz and small amounts of muscovite, orthoclase, and plagioclase. Firing to 900°C destroyed the muscovite and led to the formation of a small amount of hematite. In thin section, this specimen showed an abundant scatter of non-plastics in the silt to medium sand range and sparse rounded voids of the same size. The non-

plastics consisted predominantly of sub-angular to rounded grains of quartz, with a scatter of mica and iron oxide and, in the fine to medium sand range, rare subangular to rounded grains of alkaline volcanic material, including sanidine, augite, and fragments of volcanic rock.

The NAA of the two Source 2 clay specimens (So2.1 and So2.2) revealed fairly high values for several of the elements measured (Co, As, Rb, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu), indicating that both contain a substantial amount of volcanic material.<sup>5</sup> The two specimens differ markedly, with So2.2 displaying significantly higher values for most elements. This specimen shows several points of similarity with the clays from Sources 3 and 4, which are rich in materials of alkaline volcanic origin, and, in all likelihood, the compositional divergence between the two Source 2 specimens derives from the presence of a higher concentration of alkaline volcanic material in So2.2.

The presence in So2.1 of rounded quartz

<sup>5</sup> For concentrations of the rare earth elements in ceramics containing materials from the Central Italian Volcanic Province, see Hancock, Hayes, and Wightman (1984: 78).

TABLE 8. Results of the NAA of fired clay pellets and ethnographic ceramics\*

Element	So1.1	So1.2	So1.3	So1.4	Va.1	So2.1
Na (pct)	0.805	0.787	0.604	0.718	0.745	1.02
K (pct)	2.16	2.34	2.26	2.19	1.98	1.89
Ca (pct)	16.6	10.4	16.4	14.0	7.96	<dl
Sc (ppm)	13.4	17.0	15.1	14.5	13.1	14.2
Cr (ppm)	130	165	144	140	122	136
Fe (pct)	3.45	5.43	4.06	4.32	3.64	4.28
Co (ppm)	16.5	19.0	16.6	15.9	16.5	24.2
Zn (ppm)	104	125	115	113	110	100
As (ppm)	8.17	8.95	7.48	7.98	9.64	16.7
Rb (ppm)	149	165	161	149	179	286
Sr (ppm)	596	412	685	655	429	<dl
Sb (ppm)	0.693	0.771	0.769	0.716	0.923	1.27
Cs (ppm)	6.98	8.22	8.28	7.76	9.04	16.8
Ba (ppm)	428	502	406	375	617	404
La (ppm)	34.0	38.4	35.8	36.3	38.5	75.3
Ce (ppm)	59.0	68.4	62.8	64.1	60.1	112
Nd (ppm)	28.6	29.4	27.3	28.5	27.9	55.1
Sm (ppm)	5.57	6.35	5.66	5.77	5.96	8.57
Eu (ppm)	1.07	1.27	1.13	1.12	1.14	1.54
Tb (ppm)	0.849	0.953	0.851	0.832	0.883	1.23
Yb (ppm)	2.72	2.91	2.72	2.73	2.59	3.37
Lu (ppm)	0.370	0.398	0.367	0.347	0.371	0.565
Hf (ppm)	4.28	4.13	3.57	4.11	4.90	9.73
Ta (ppm)	1.01	1.13	1.11	1.12	1.01	1.24
Th (ppm)	10.5	12.4	11.2	11.2	11.2	19.0
U (ppm)	2.12	2.00	1.91	2.24	2.50	9.06

\* pct: percent; ppm: parts per million; <dl: below detection limit.

grains indicates that this is a sedimentary or secondary clay rather than a primary clay formed *in situ* by the weathering of volcanic parent material. Whether the quartz grains are themselves of volcanic origin or are redeposited pre-volcanic sediment remains uncertain, as the geology of the general locale in which the deposit is situated allows for either possibility. The absence of calcite in So2.1 and the negligible amount of Ca in both specimens (below the detection limit of ca. 0.9 percent), however, indicates that, if this material does contain an appreciable amount of pre-volcanic sediment, this may be of continental rather than marine origin.

The compositional data indicate a similar origin for the Source 3 deposit. The XRD analysis of one of the two specimens of Source 3 clay (So3.1) revealed a mixture of poorly crystallized clay minerals (smectite, illite, and kaolinite or halloysite) along with an abundance of quartz and small amounts of muscovite, orthoclase, plagioclase, and augite. Firing to 900°C destroyed the muscovite and led to the formation of a moderate amount of hematite as well as some additional orthoclase. In thin section, this

specimen and ceramic Va.2 showed an abundant non-plastic component in the silt to coarse sand range, with sparse rounded voids. The non-plastics showed a rough bimodal distribution, with abundant bodies in the silt to fine sand range, including angular to subrounded grains of quartz (some polycrystalline), rare detrital bits of mica, and globules of iron oxide, and frequent sand-sized materials of alkaline volcanic origin, including frequent angular to subrounded grains of sanidine, rare grains of angular to subrounded plagioclase and augite, and rounded fragments of volcanic rock.

The NAA of the two specimens of Source 3 clay (So3.1 and So3.2) and the example of Paste 3 ceramic (Va.2) revealed high to very high values for most elements (Sc, Fe, Co, As, Rb, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Th, and U), stemming from the presence of an appreciable amount of alkaline volcanic material. Particularly noteworthy are the extremely elevated values for Cs, which probably result from the substitution of this element for K in the sanidine.

From the foregoing it can be inferred that

TABLE 8. *Continued*

So2.2	So1.1+2.1	So3.1	So3.2	Va.2	Va.3	Va.4
0.553	0.914	0.546	0.555	0.569	0.693	0.873
2.03	1.96	2.07	2.01	2.00	3.84	3.66
<dl	6.37	<dl	<dl	<dl	<dl	<dl
14.2	13.9	18.8	15.9	15.9	16.9	16.4
105	130	97.3	116	101	85.3	80.0
4.60	4.03	6.22	5.11	5.12	5.87	5.20
21.5	19.6	42.2	24.2	19.5	19.7	28.6
87.3	104	106	113	101	108	96.6
77.8	12.8	64.9	90.0	124	41.8	37.5
327	231	313	367	340	357	341
<dl	378	338	250	295	413	590
6.27	0.991	5.68	7.38	4.93	4.26	3.74
170	11.7	113	245	171	41.8	44.9
596	372	1330	706	845	1500	1730
107	54.3	150	112	103	120	160
196	84.7	406	192	180	218	282
63.2	41.2	104	74.8	72.6	80/9	104
9.46	7.31	18.2	12.4	11.7	14.2	17.2
1.46	1.29	3.31	2.31	2.35	2.82	3.10
0.940	0.962	1.72	1.39	1.39	1.27	1.59
2.93	3.17	4.16	4.15	3.62	3.41	4.04
0.434	0.509	0.695	0.578	0.520	0.501	0.590
12.1	7.29	13.8	12.7	13.3	12.6	15.3
1.76	1.17	2.02	1.82	1.63	1.95	1.95
42.4	14.8	77.8	44.0	46.2	59.6	71.0
7.03	3.27	11.2	7.80	11.7	7.74	9.20

the Source 3 clay is a sedimentary deposit containing a mixture of both alkaline volcanic and pre-volcanic material. In contrast with Source 2, the presence of polycrystalline quartz, which must be of metamorphic origin, allows us to conclude that at least some of the quartz component consists of pre-volcanic sediment. The alkaline volcanic component differs from that in Source 2 in that it is substantially denser and generally less heavily weathered. The geologic map of the area shows a bed of marine sands outcropping along the lower portion of the slope on which Source 3 is located (Servizio Geologico d'Italia 1970, formation Q<sub>2</sub>), and it appears likely that the Source 3 deposit was formed by the mixing of this material with volcanic debris weathering out of the trachitic-phonolitic tuff that forms the upper slopes of the hill. As with Source 2 clay, the low values for Ca in all three specimens and the absence of calcite in So3.1 suggest that the pre-volcanic sediments may have been deposited under continental conditions. If so, it would be necessary to posit the existence in this area of an unmapped sedimentary formation of continental origin interposed between the bed of marine

sands and the overlying formations of volcanic origin.

While the determination of the origin of the Source 4 clay was rendered difficult by the lack of an unfired specimen of this material, the data that were obtained suggest that it was produced under conditions different from those responsible for the formation of the Source 2 and Source 3 deposits. The XRD analysis of one of the two specimens of Paste 4 firebrick (Va.3) revealed moderate amounts of orthoclase and quartz, along with small amounts of plagioclase and hematite. In thin section, this specimen showed an abundant concentration of non-plastic materials in the silt to very coarse sand range and sparse, irregular sand-sized voids. The non-plastic component was noteworthy for the rarity of mineral grains in the fine to medium silt size range. It consisted of frequent coarse silt to very coarse sand-sized angular grains of sanidine, sparse silt to fine sand-sized globules of iron oxide, and rare, sand-sized angular grains of plagioclase and augite. Also present were books of altered mica (probably biotite) and rounded fragments of volcanic rock and altered bodies of probable

volcanic origin. No quartz grains were identified with certainty, and it is not clear in what form this mineral, attested in the diffractogram, occurs in the Source 4 clay. Most likely, some of the smaller among the colorless mineral grains are quartz rather than sanidine.

The chemical analysis of both specimens of Paste 4 ceramic (Va.3 and Va.4) revealed high to very high values for most of the elements measured (K, Sc, Fe, Co, As, Rb, Sr, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Th, and U), with the exception of Cr, reflecting the substantial amount of alkaline volcanic material present in this material. It is interesting to note that, in comparison with the materials from Source 3, these specimens have somewhat higher values for K but less strongly elevated values for Cs. This suggests that Cs substitution is significantly less common in the Source 4 sanidine grains, an indication that this material's volcanic component is probably derived from a different parent material than that present in the Source 3 clay.

The large size and angularity of the non-plastics in Va.3, along with the presence of relatively unresistant materials, such as biotite, indicate that Source 4 is either a primary deposit produced by the *in situ* weathering of alkaline volcanic rock or a sedimentary deposit containing fresh alkaline volcanic material.<sup>6</sup> If the latter, the paucity of silt-sized mineral grains is somewhat unusual, suggesting that the Source 4 material was formed by the deposition of very fine-grained sediments in a low energy environment such as a small lake bed, with a slight admixture of coarser material furnished by occasional high energy events. Depositional circumstances of this kind may have existed in this area during the period of active vulcanism, when the damming of stream valleys by volcanic *ejecta* would probably have resulted in the formation of numerous ponds.<sup>7</sup>

<sup>6</sup> For clay deposits formed by the *in situ* weathering of alkaline volcanics belonging to the neighboring Sabatine complex, see Lenzi and Mattias (1978). For a commercially exploited clay deposit formed by the *in situ* alteration of acid formations belonging to the nearby Caeretan complex, see Mattias and Caneva (1979).

<sup>7</sup> I am indebted to W. Melson for this observation. For a comprehensive study of volcanic sediments in Lago di Monterosi, a small crater lake in the neighboring Sabatine complex, see Hutchinson (1970).

Having reviewed the evidence for the origin of the four source clays, the discussion can now turn to a consideration of the relationship between the compositions of these materials and the properties of the unfired pastes and finished ceramics made with them.

The relatively high value for the Source 1 clay's water of plasticity (31.6 percent) is probably due to two factors. The first is the presence of a significant amount of calcite, which can serve as a flocculant, enhancing the capacity of clay minerals to absorb surface water. The second is the abundance in this material of well-crystallized smectite, a three-layer clay mineral, which not only absorbs surface water as do other clay minerals, but holds interlayer water as well. The Source 1 clay's pronounced decrease in weight with firing (16.5 and 16.6 percent for the two specimens) can be attributed to the driving off of this relatively large amount of water and the loss of carbon dioxide in association with the decomposition of calcite.

The excellent workability displayed by Source 1 clay/Paste 1 is due in large measure to the sparseness and fine particle size of the non-plastic component. This clay's limited amount of drying shrinkage (8 percent) is somewhat surprising in light of its high value for water of plasticity. This may be an indication that a large portion of the water absorbed by Source 1 clay is held as interlayer water in smectite. If so, when hydrated this material would retain a fairly dense arrangement of clay particles and would display only limited shrinkage with drying.

Paste 1 was no doubt preferred for the manufacture of fine wheelmade forms on account of its excellent workability. Its limited drying shrinkage made it a favored material for the manufacture of moldmade items. This is because as moldmade items dry, pronounced moisture gradients may develop across the wall, with the surface exposed to the air losing water much more rapidly and undergoing proportionally greater shrinkage than the surface facing the mold. This differential will generate a considerable amount of stress within the vessel wall, weakening the body and often leading to the formation of cracks. When a

paste's drying shrinkage is low, however, as with Paste 1, the stress generated by moisture gradients will be more limited and crack formation less of a problem.

The moderate value for the Source 2 clay's water of plasticity (29.0 percent) can probably be ascribed to the relatively high proportion of non-plastics to clay minerals, since the former do not absorb surface water as do the latter. Its low value for weight loss with firing (6.8 percent) is due to the fact that it loses only this moderate amount of water and does not contain a significant amount of calcite.

The fact that Source 2 is only moderately workable stems from the high density of non-plastics. Its moderate to high amount of drying shrinkage (ca. 13 percent) can be ascribed to the poor crystallization of the clay mineral component. This is due to the fact that clays consisting predominantly of small, poorly crystallized clay platelets can, on account of these particles' proportionally large amount of surface area, absorb greater amounts of water than can clays containing large, well-developed platelets. Clays containing poorly crystallized clay minerals will accordingly display a fairly loose arrangement of clay particles when hydrated and a correspondingly large amount of shrinkage with drying.

The mineralogical and chemical compositions of the simulated Paste 2 briquet are as would be expected for a material composed of a 1:1 mixture of specimens So1.2 and So2.1. The compositional results suggest two reasons why Paste 2 would yield a ceramic body more resistant to the elements than one consisting of Source 1 clay alone. First, a paste made from a mixture of the two clays would have a lower concentration of calcite than one consisting entirely of Source 1 clay. Not only would this diminish the amount of fatigue caused by the rehydration of lime inclusions after firing, but by reducing the porosity of the resulting body, it would provide fewer loci for attack by weathering agents. Second, the fact that Source 2 clay has a denser, less well-sorted, and somewhat coarser non-plastic component than Source 1 clay means that a mixture of the two would yield a more well-bonded body, less susceptible to crack

propagation during drying, firing, and use of the finished product.

The high value for the Source 3 clay's water of plasticity (32.4 percent) can probably be attributed to the presence of small, poorly crystallized clay minerals, which, as noted above, can surface absorb relatively large amounts of water. The driving off of the large amount of water held by this clay is partially offset by the lack of a significant calcite component, resulting in only a moderate figure for weight loss (10.2 percent).

The only moderate workability associated with Source 3 clay/Paste 3 is due to the presence of a fairly coarse non-plastic component. As was suggested for Source 2 clay, this paste's very high value for drying shrinkage (ca. 20 percent) can be attributed to the poor crystallization of the clay mineral component. In the case of Paste 3, however, this effect would have been more pronounced because of the lower proportion of non-plastics to clay minerals.

The mineralogical data suggest that the exceptional durability of cookwares manufactured in Paste 3 was due to a combination of two factors. The first was the absence of any significant calcite component, since, as noted in the discussion of Paste 2, calcite serves to weaken ceramic bodies. The second factor, and one more specifically relevant to the performance of cookwares, is the texture and composition of this paste's non-plastic component. In general, cookware bodies will offer high resistance to the propagation of cracks produced by thermal stress if the non-plastic component consists of materials distributed over a broad size-range. It is also important that the various kinds of non-plastic materials present in the body have coefficients of thermal expansion close to that of the clay matrix. If not, high levels of thermal fatigue will build up over repeated cycles of heating and cooling, eventually leading to vessel failure. The non-plastic component of Paste 3 satisfies both of these requirements. The presence of both coarse-grained volcanic materials and fine-grained quartz yields a non-plastic component with a relatively wide range of particle sizes. Sanidine, which constitutes the bulk of the volcanic material, has a coefficient of thermal expansion nearly identical to that of potting clay up to temper-

atures at least as high as 900°C (Schuring 1986: 191, fig. 16). While quartz has a coefficient of thermal expansion considerably greater than that of potting clay over the range of temperatures to which cookwares are commonly exposed, laboratory experiments have shown that fine-grained quartz produces no deleterious effects on cookware bodies and can, in fact, display good to excellent performance (Schuring 1986: 190–196; Bronitsky and Hamer 1986: 98). Since non-calcareous clays rich in fine-grained quartz are fairly common in west-central Italy (e.g., Source 2) and can be readily simulated in most areas by the simple expedient of adding sifted quartz sand to a fine-textured non-calcareous clay, it would appear to be the presence of coarse-grained sanidine that made Source 3 clay so unusually effective for the manufacture of cookwares.

The poor workability of the Source 4 clay/Paste 4 is determined by its very coarse non-plastic component. Its relatively low shrinkage value (ca. 8 percent) cannot be adequately accounted for in the absence of information regarding the clay mineral component. If the explanation offered for the considerably higher shrinkage values displayed by the Source 2 and Source 3 clays is correct, however, it would be expected that, unlike these two materials, Source 4 clay contains an abundance of well-crystallized clay minerals.

Since firing temperatures probably did not rise much beyond 900°C in the Orlandi workshop, the most important consideration relative to the performance of refractory items would probably have been their ability to withstand repeated exposure to middle- rather than high-range temperatures. In light of this observation, it can be conjectured that the most significant factor in Paste 4 performance was the large proportion of sanidine to quartz. As already noted, sanidine has a coefficient of thermal expansion very close to that of potting clay up to temperatures of at least 900°C. It does not melt until reaching temperatures above 1100°C, and thus would appear to have offered good performance over the range of temperatures to which refractory items were likely to have been exposed. While fine-

grained quartz offers good performance in cookwares, items of this kind are not usually exposed to temperatures beyond 400°C after their initial firing. At 573°C, however, quartz experiences an inversion from its alpha to its beta form, with grains undergoing a rapid 2 percent increase in volume. With cooling, this effect is reversed, and it seems likely that repeated cycling past 573°C would produce a considerable amount of fatigue in a ceramic body, significantly accelerating its failure. With their high ratio of sanidine to quartz, items made in Paste 4 would have been less susceptible to this problem than those produced in more quartz-rich pastes such as Pastes 2 and 3.

Also perhaps a significant factor in the performance of Paste 4 items was the coarseness of the sanidine grains and the low density of non-plastics overall. These would have yielded a paste with a relatively low porosity. Items manufactured in such a low porosity paste would have developed low moisture gradients during drying and low thermal gradients during use, meaning that it would have been possible to fabricate relatively thick and heavy forms with only limited risk of failure. Low porosity would also have made these items relatively poor insulators. While this would prove an advantage for forms such as saggars, it would have been something of a drawback for firebrick.

#### GENERAL DISCUSSION

The Orlandi enjoyed a highly favorable situation with regard to their raw materials. The characteristics of the four clays available in the vicinity of Vasanello permitted them to manufacture a wide array of products intended for a variety of functions. The cookwares, which were the most important of these functional categories, were recognized by consumers as superior to those manufactured by producers located in other towns within the region. The Orlandi were also able to manufacture their products at relatively low cost in terms of cash outlays, time investment, and effort: all four clays were free for the taking; the principal deposit, Source 3, lay fewer than two kilometers from the Orlandi workshop; and, because it was not necessary to sift, levi-



gate, or add any temper to these clays, paste preparation involved a minimal amount of raw material processing.

It is difficult to specify the extent to which the range of ceramics produced by the Orlandi and the suite of clays they employed were representative of Vasanello production in general, nor is it known how closely twentieth-century production practices in the town resembled those of earlier periods. There is considerable evidence, however, that in earlier times Vasanello potters did, in fact, concentrate on cookware manufacture, and it is reasonably clear that Source 3 was historically the most important clay source for potters in the town. The notable diversity of the Orlandi's output may to some extent have been a response to changed and changing economic and technological conditions of the twentieth century, including the establishment of semi-industrial manufactories for the production of ceramic cookwares, the appearance of affordable cooking vessels in alternative materials, and growth in the demand for craft goods in small towns and rural areas. In short, toward the end of its existence, economic forces may have been impelling the Vasanello industry to take on some of the characteristics of an urban nucleated industry. Of particular interest in this regard is Bruno Orlandi's assertion that other potters at Vasanello did not traditionally employ the Pliocene marine clay that his family obtained at Source 1. Since the Orlandi used Source 1 clay as a standard ingredient for finewares, moldmade vessels, and garden ceramics, this observation, if accurate, would suggest that other Vasanello workshops normally turned out a more limited range of items, concentrating more exclusively on the manufacture of cookwares and heavy utilitarian forms.<sup>8</sup>

Given the importance of cookwares in the Vasanello pottery industry, we should probably focus not on the advantages offered by the wide variety of clays available

to potters in the town, but rather on the peculiar properties of the Source 3 clay if we are to evaluate properly the role that raw materials played in the development and operation of this specific case of nucleated pottery production. As noted in the preceding section, this material, which is a non-calcareous clay containing fine-grained quartz and coarse-grained sanidine, is exceptionally well suited for the production of cooking vessels. Particularly important in this regard is the presence of the sanidine, since this yields a wide distribution of particle sizes while maintaining a close match between the rates of thermal expansion of the clay matrix and the non-plastic component. A survey of nucleated and non-nucleated cookware production in other parts of west-central Italy suggests that clay of this kind, henceforth referred to as "Source 3-type clay," has, in fact, played a significant role in shaping the organization and geography of cookware production within this region during the modern period.

The only other instance of nucleated cookware production attested in west-central Italy involves the neighboring hamlets of Cascano and Corbara in the northwestern corner of Campania (Fig. 4). Producers in these two locales have for at least the last century supplied a large portion of the cookware market in southern Lazio and northern Campania (Hampe and Winter 1965: 48–49; Silvestrini 1982: 41–43), and at least two workshops continue to operate at Cascano. As at Vasanello, Cascano/Corbara potters have used an unmodified sedimentary clay containing a mixture of volcanic and sedimentary material for the manufacture of their cookwares.<sup>9</sup> This clay, which is obtained in several locations in the area of the two hamlets, contains volcanic sand derived from formations belonging to

<sup>8</sup> That clay other than Source 3 clay was in use at Vasanello at the beginning of the twentieth century is indicated by a handwarmer manufactured at Vasanello in the Museo dell'Arte Popolare at Rome, which was acquired during the period 1903–1906 (Silvestrini 1982: fig. 52). This vessel appears to have been made in a fine paste, perhaps consisting of Pliocene clay obtained from Source 1.

<sup>9</sup> Information regarding paste preparation practices at Cascano was obtained in an interview conducted on May 17, 1991, with Giovanni and Carmine Vellone, owners of a pottery workshop located on the outskirts of the hamlet, who provided specimens of cookware made in their workshop. A specimen of raw clay was also obtained from the neighboring Di Cresce workshop. It should be noted that the Vellone workshop supplements its cookware production with the manufacture of tablewares and other items in a commercially prepared, fine-textured calcareous clay from Ogliara, near Salerno.

the Roccamonfina complex, which blankets most of the surrounding territory.<sup>10</sup> Under a binocular microscope, briquets and cookwares made from this clay displayed abundant, fine-grained quartz (some perhaps polycrystalline) and frequent large grains of sanidine. The NAA of these materials revealed a compositional profile similar to, though distinct from, those attested for the Source 3 and Source 4 clays from Vasanello, with no detectable Ca and highly elevated values for most of the other elements measured. As at Vasanello, Cascano potters assert that their source for cookware clay is unique and that it yields a clay superior to all others available in the region for the manufacture of cooking vessels.

Potters at Vetralla, 25 km. to the west-southwest of Vasanello (Fig. 4), who, as previously mentioned, were viewed by Vasanello potters as their only significant rivals for the cookware market, also employ a non-calcareous clay containing coarse alkaline volcanic sand for the manufacture of cookwares.<sup>11</sup> While the precise location of the Vetralla clay source is not known to the author, one local informant stated that it lies about 7 to 8 km. from the town, an indication that it is probably situated either on the western flank of the Vican complex or along the northwestern fringes of the Sabatine complex. The NAA of specimens of this clay revealed a composition similar to but distinct from those obtained for the cookware clays from Cascano and Vasanello.

It is instructive to contrast these uses of Source 3-type clays with clay use among cookware producers situated in parts of west-central Italy lying outside the area of the Central Italian Volcanic Province. The (inappropriately named) Vulcania establishment at Colle Val d'Elsa, in central Tuscany (Fig. 4), is an industrial-scale producer that has turned out high-quality cookwares

for the national market since its founding in 1911. This concern has employed a paste composed of a mixture of three different non-calcareous, non-volcanic clays.<sup>12</sup> These include the coarse alluvial clay that was traditionally used by potters in the town, a clay extremely rich in fine- to medium-grained quartz sand from Altopascio, 65 km. to the northwest, and a fine, highly plastic clay imported from southern France. Both the local and the Altopascio materials require sieving before use, and the three clays must be combined according to a precise set of proportions.

Potters at Pontecorvo, a town in south-eastern Lazio (Fig. 4) that was until recent decades an important nucleated potting center, traditionally practiced a diversified production, of which cookwares represented only a secondary component (Hampe and Winter 1965: 43–48; Silvestrini 1982: 33–35). At Pontecorvo, cooking vessels have been manufactured using a mixture of the locally available gray clay and a reddish clay brought in from some distance away (Hampe and Winter 1965: 44). According to one informant, the latter material is obtained at Spigno Saturnia, 20 km. to the southwest across the Monti Aurunci.<sup>13</sup> The NAA of a specimen of the local gray clay revealed a Ca content of 11.5 percent.<sup>14</sup> Examples of Pontecorvo cookware examined by the author showed, not surprisingly, a remarkably large amount of lime spalling, and it was evident that the durability of these vessels cannot have been very great.<sup>15</sup>

<sup>12</sup> Information regarding paste preparation practices at the Vulcania concern was obtained in an interview conducted on August 8, 1990, with Marco Giacchi, the factory manager. Giacchi supplied specimens of all three of the clays employed by the Vulcania concern and examples of both unfired and finished cookware.

<sup>13</sup> Information regarding traditional paste preparation practices at Pontecorvo was obtained in an interview conducted on May 18, 1991, with Loreto Tordoni, a member of the family that formerly owned the land on which Pontecorvo potters traditionally obtained their gray clay. Specimens of this clay were obtained from the scarp of the abandoned clay pit.

<sup>14</sup> The author has also analyzed a specimen of ceramic clay from Spigno Saturnia, although it is not known if this is from the same source as that used by potters from Pontecorvo or one similar to it. This specimen, obtained from the scarp of an abandoned clay pit near the Saltarelli brickworks, showed a Ca content of 12 percent.

<sup>15</sup> Examples of Pontecorvo cookware were examined in Pontecorvo on May 18, 1991, at the workshop/retail outlet of A. Coccarelli. The low quality of Pontecorvo cookwares is further suggested by the fact that at least one pottery retailer at Pontecorvo obtained her cookwares from producers at Cascano (Silvestrini 1982: 42).

<sup>10</sup> These sources probably lie within a formation composed of tuffite and paleosoils, with intermixed beds of sand and gravel (Servizio Geologico d'Italia 1966: formation t).

<sup>11</sup> Specimens of Vetralla cookware clay were obtained from the workshop of Francesco Ricci on July 27, 1989. Unlike the clays from Vasanello Source 3 and that from Cascano, the Vetralla clay must be crushed and sifted before use. Bruno Orlandi stated that on some occasions potters from Vetralla used to come to Vasanello in order to obtain clay from Source 3, suggesting either that the Vetralla source has been discovered only in recent years or that the clay that it yields is inferior to that from Vasanello.

While it will be necessary to carry out a more extensive survey of raw material use among cookware producers in west-central Italy before it can be demonstrated that these cases are representative of the region as a whole, they do suggest that in the modern period, nucleated cookware production has involved the use of Source 3-type clays for manufacturing high-quality vessels with relatively low levels of labor input. Where such clays are not locally available, the specialized manufacture of high quality cookware has required the use of relatively costly and labor intensive paste preparation practices, as at Colle Val d'Elsa. In some cases, as at Pontecorvo, even with such investments the end product may be of poor quality, and cookware manufacture is carried out as a secondary activity in the context of diversified production.

The frequency and distribution of deposits of Source 3-type clay in west-central Italy are difficult to assess. While the informants at Vasanello and Cascano may be correct in their assertions that deposits of this kind are exceedingly rare, their views may to some extent be rationalizations developed over the course of many generations to explain their town's success as a specialized cookware producer. Certainly there is no *a priori* geological reason why deposits of this kind should not occur at various points inside the area of the Central Italian Volcanic Province and, with perhaps even greater frequency, along its margins, where depositional basins may receive both volcanic weathering products and quartz-rich, non-calcareous sediments derived from pre-volcanic formations. What is crucial, however, is the fact that Source 3-type clays cannot occur outside these areas. Pottery producers situated either within or close to the margins of the Central Italian Volcanic Province thus enjoy the possibility of marketing cookwares offering superior performance to consumers located in areas lying well beyond its borders. It is interesting to note in this connection that nearly all the towns where Vasanello cookwares were retailed by itinerants lie well outside the volcanic tract (Figs. 3, 4). It may be conjectured that it was the ability to manufacture such high quality cookwares that permitted some producers to develop

geographically extensive markets. In some cases this may have been followed by the intensification of cookware production through concentration on the manufacture of this class of pottery, the adoption of new production and distribution techniques, and/or the expansion of the labor force involved in this work.

It would be of interest to know if nucleated cookware industries employing Source 3-type clays or other raw materials existed in central Italy during pre-modern periods, and if so, when, since this mode of production/distribution implies the existence of a well-integrated, region-wide market system. This question might be examined archaeologically either by identifying distinctive classes of cookware and tracing their distributions across the region or by the detailed investigation of production sites. While on neither score is there sufficient information currently in print to permit the definitive identification of nucleated cookware industries, there is a certain amount of evidence suggesting that these may have existed during the Roman period, first appearing during the last centuries B.C. and continuing into the first centuries A.D.

Cooking vessels containing alkaline volcanic sand, generally including coarse-grained sanidine, have been reported from pre-Roman, Roman, and medieval contexts at several archaeological sites in west-central Italy (Murray Threipland and Torelli 1970: 80–85; Papi 1985; D'Ambrosio, Mannoni, and Sfrecola 1986: 602, 605; Schuring 1986: 162–185; 1987; Peña 1987: 390–406, 487–513). Cookwares of this kind have also been reported from first-century B.C. to first-century A.D. contexts at sites situated well outside the Central Italian Volcanic Province, including Luni in northern coastal Tuscany (Gandolfi 1987: 275) and Ventimiglia in Liguria (Olcese 1989: 170–172; 1990). There is, however, too little information currently available to permit the construction of useful distribution maps of these products.<sup>16</sup> One notable exception is the case of internal red-slip cookware (or

<sup>16</sup> See Schuring (1987: figs. 3–8) for distribution maps of Roman and medieval cookware fabrics, most of which contain alkaline volcanic sand, for areas immediately to the north and south of Rome lying within or very close to the volcanic tract. The bulk of these materials were recovered as surface finds during survey work carried out by the British School at Rome.

as it is often called, Pompeian red ware), a distinctive class of cooking pan with matching lid attested in several different fabrics, some of which appear to have been mass produced for distribution over extensive market areas in various parts of the Roman Empire (Peña 1990). The most common of these fabrics consists of a non-calcareous body containing an abundance of fine-grained quartz and coarse alkaline volcanic sand, including a fair amount of sanidine. Internal red-slip cookware pans in this fabric were distributed first throughout central Italy and then over much of the Roman Empire from as early as the third century A.D. to as late as the second or third century A.D. They were presumably manufactured at one or more locations in the area of the Central Italian Volcanic Province, most likely in the vicinity of Cumae in the Phlegraean Fields complex of west-central Campania (Pucci 1975). That this involved specialized cookware producers, perhaps in the context of a rural nucleated industry, would seem a reasonable conjecture.<sup>17</sup> The emergence of such an industry and the diffusion of its products over such a large area may have been connected with the large-scale export of wines from Campania and other parts of west-central Italy during this period.

In this and nearly every other attested instance of alkaline volcanic sand-rich cookwares it is unclear whether the vessels in question were manufactured from unmodified clays containing a natural volcanic component or from fine-textured clays with volcanic material added as temper.<sup>18</sup> The difficulty in making this distinction is highlighted by the petrographic data for ceramics made with the clays from Vasa-

nello Source 3, which offer a clear illustration of how ceramic bodies made from an unmodified sedimentary clay can show a bimodal distribution of non-plastics similar to what one would expect to find in a ceramic body consisting of a fine-textured clay with alkaline volcanic sand temper.

Evidence from several Roman-period pottery workshops located in the area of the Central Italian Volcanic Province can also be brought to bear on the question of when specialized cookware producers using Source-3 type clays were active in the past.<sup>19</sup> In the area immediately to the north of Rome, three first- to second-century A.D. workshops known through their surface remains, one near Prima Porta (Peña 1987: 335–367) and two near Nepi (Peña 1987: 149–183, 197–228), appear to have followed diversified raw material use and production strategies similar to those employed by Bruno and Ovidio Orlandi at Vasanello, manufacturing tablewares with a fine calcareous paste and cookwares in a paste compositionally similar to Vasanello Paste 3. In contrast, from the environs of Vasanello itself comes evidence for specialized cookware production at roughly the same time. Surface remains from a first-second century A.D. pottery workshop have been identified on the summit of Poggio Pelato, a hill situated 300 m. northwest of Source 3 (Fig. 6; Varriale 1979: 141; Peña 1987: 130–132). While there is no detailed information available regarding the pottery manufactured at this establishment, the workshop's output has been characterized as consisting entirely of cooking forms. The surface remains of a similar workshop have also been identified at Poggio del Capitano, about 4 km. north of Vasanello, overlooking the edge of the Tiber Valley (Fig. 6; Varriale 1979: 140–141; Peña 1987: 103–112). The author has carried out neutron activation, XRD, and petrographic analysis for pottery from this site, the results showing that the cookwares produced there were made with a paste compositionally similar to Vasanello Paste 3. In addition, a plowed-

<sup>17</sup> The only production site for internal red-slip cookware that has been identified to date is one located on the outskirts of Gubbio, in Umbria (Cipollone 1988). The workshop in question carried out a diversified production, also manufacturing thin-walled ware tablewares and various other forms of utilitarian pottery, probably during the second half of the first century A.D. The publication of this site includes only a brief and confused description of the internal red-slip cookware fabric produced there (Cipollone 1988: 118). It was apparently a fabric of minor significance, certainly not one of those containing alkaline volcanic sand, and may have enjoyed only a fairly localized distribution.

<sup>18</sup> For further discussion of the use of clays containing volcanic weathering products in central Italy during the Roman and medieval periods, see D'Ambrosio, Mannoni, and Sfrecola (1986: 602; 1989: 275) and Ricq de Bouard and colleagues (1989: 259–260).

<sup>19</sup> Portions of this discussion are based on the results of neutron activation, petrographic, and XRD analyses of Roman workshop materials from the area to the north of Rome carried out by the author subsequent to the completion of Peña (1987).

out group of Roman pottery identified as a dump of workshop materials has been reported from the locale of San Marco, in the same general area as Vasanello Source 2 (Fig. 6; Varriale 1979: 141–142; Peña 1987: 133–134). No information is available regarding either the forms or fabrics represented nor the date of the material. Taken together, these finds suggest that, during the Roman period there might have been a nucleated cookware industry active in the Vasanello area that made use of clays similar to those employed by Vasanello cookware producers in historically recent times.

Differential access to raw materials permitting the manufacture of functionally superior ceramics with low investments of labor may have figured in the emergence and operation of nucleated pottery industries in other times and places. This is likely to have been a particularly important factor in the case of nucleated cookware production, since for this functional class of pottery there is an especially crucial relationship between the physical properties of the raw materials employed and the performance of the finished product.<sup>20</sup>

#### CONCLUSIONS

By combining the ethnographic investigation of traditional potters at Vasanello and other towns in west-central Italy with a program of compositional analysis involving clays collected from these potters, it has been possible to suggest a link between access to particular kinds of raw materials and the emergence and operation of nucleated cookware industries in this region. Vasanello's position in a zone of geological diversity permitted potters located

there to manufacture a wide range of items with different functional characteristics. Most workshops in the town, however, concentrated on the manufacture of cookwares. These vessels, which offered outstanding thermal characteristics, were distributed over a large portion of central Italy. The excellent performance of Vasanello cookwares stemmed from the composition of the clay used in their manufacture. This material, which was obtained from a source situated approximately 1.5 km. from the town, consists of a mixture of alkaline volcanic sediment and quartz-rich sediment of uncertain origin. It is non-calcareous, with a non-plastic component consisting of abundant fine-grained quartz and sparse coarse-grained sanidine. This material requires a minimum of processing and yields a robust ceramic body able to withstand the thermal stress generated by repeated cycles of heating and cooling. The only other instance of nucleated cookware production attested in west-central Italy, at Cascano/Corbara in northwestern Campania, makes use of a compositionally similar clay. This suggests that access to such clays, which have a distribution limited to the Central Italian Volcanic Province and adjacent areas, was a significant factor in the development of nucleated cookware industries in west-central Italy. While it is unclear when nucleated cookware manufacture employing clay of this kind first appeared, the presence of mass produced cooking pans in a similar fabric from as early as the third century B.C. and the surface remains of first- to second-century A.D. workshop sites in the Vasanello area suggest that this mode of production may already have existed by the Roman period. Other instances of favored access to raw materials permitting the manufacture of functionally superior ceramics with low investments of labor may have played a similar role in the development of nucleated potting industries in other times and places.

<sup>20</sup> Elsewhere in Italy, nucleated cookware production similar to that at Vasanello and Cascano/Corbara is attested at Pabillonis, in Sardinia, which distributed its products over nearly the entire island (Annis and Geertman 1987). The origin, composition, and properties of the clay employed by Pabillonis cookware producers have not, to the author's knowledge, been the subject of investigation.

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#### APPENDIX A: FORMS PRODUCED IN THE ORLANDI WORKSHOP

The following is a partial list of the forms produced by Bruno and Ovidio Orlandi in their workshop. Forms are listed by their closest equivalent names in English, followed in parentheses, where known, by the form's name in Italian and local dialect, the paste or pastes in which it was manufactured, and the presence of glazing. This information is followed by miscellaneous comments regarding size, shape, method of manufacture, and use. All forms were thrown on the wheel unless otherwise noted.<sup>21</sup>

1. Cookpot (*pignatta/pila*, paste 3 with lead glaze). Set on top of or against embers for stewing.
2. Casserole (*tegame/cazzarola*, paste 3 with lead glaze; see Fig. 2). Used for baking.
3. Pan (*teglia/testo*, paste 3 with lead glaze). Used for baking, stewing, and boiling.
4. Skillet (*tegamino/tegame*, paste 3 with lead glaze; see Fig. 2). Used for frying eggs and heating sauces.
5. Steaming pan (*bagnomaria/-*, paste 3 with lead glaze). Matching pan and lid used for steaming meat, vegetables, etc.
6. Bowl (*scodella/-*, paste 3 with lead glaze).
7. Lid (*coperchio/cuperchio*, paste 3). Several sizes for various forms.
8. Handwarmer—plain (*scaldino/scalli-*

*no*, paste 3). Bucket shape with high stirrup handle, embers placed inside.

9. Handwarmer—decorated (*scaldino/scallino*, paste 1). Larger, more elaborate version of preceding, with wall decorated with cutaway panels, carving, and/or molded or hand-modeled appliques. Labor intensive form generally produced during winter and often presented as a gift.
10. Milk boiler (*bollitore per latte/-*, paste 3 with lead glaze). Set consisting of pot with perforated lid. Used for making *ricotta*.
11. Jug (*boccale/-*, paste 3 with lead glaze). Produced in various sizes with capacities ranging from 0.5 to 15 liters.
12. Pitcher (*brocca/-*, paste 3 with lead glaze). Produced in various sizes up to 12 to 14 liter capacity. Larger examples used as water jars.
13. Candleholder (*candeliera/-*, paste 3). Tall, funnel-shaped support open at both ends.
14. Candleholder (*candeliera/-*, paste 1). Short, cylindrical support centered on small, shallow base plate, with loop handle.
15. Hunting whistle (*fischietto/-*, paste 1).
16. Toy whistle (*fischietto/-*, paste 3?). Crude representation of San Lanno (patron saint of Vasanello) on horseback. Hand modeled. Sold door-to-door by children, with proceeds donated toward the expenses of the saint's feast, held each year on May 5.
17. Coin bank (*salvadanaio/cepignolo*, paste 1).
18. Oil lamp (*lumino/-*, paste 1).

<sup>21</sup> Much of the information in this section regarding the names and uses of specific forms is taken from Silvestrini (1982: 26).

19. Wine cask cap (*turo* or *tappo di damigiana/trappola*, paste 1). Set atop wine casks to catch overflow in order to permit monitoring of fermentation process.
20. Vase (*contenitore/-*, paste 1).
21. Cup (*coppa/-*, paste 1).
22. Flower pot (*vaso da fiori/-*, paste 2). Exterior of wall decorated in relief with garlands, other vegetal motifs, masks, coats-of-arms, etc. Produced in two-piece mold.
23. Rectangular planter (paste 2). Sides decorated with garlands, etc. Sides formed separately in flat molds, then joined at corners.
24. Pan tile (*tegola/-*, paste 2). Formed in rectangular wooden frame.
25. Cover tile (*coppo/-*, paste 2). Formed over wooden mold in form of half of a tapered cylinder.
26. Relief plaque (*bassorilievo/-*, paste 1, sometimes with pigment added). Variety of items, including street address numbers, coats-of-arms, and religious scenes. Formed in flat molds.
27. Firebrick (*matton refrattario/-*, paste 4). Used to seal door of firing chamber of kiln.
28. Kiln furniture (paste 4). Variety of items, including cockspurs, props, and saggars. Used for setting objects to be fired in kiln.

Other forms produced at Vasanello by traditional potters (although not certainly in the Orlandi workshop) include the following: basin, storage jar, pasta strainer, soup tureen, chamber pot, drain pipe, oven, brazier, wine cask fumigator, and decorated (appliqué and openwork) flower vase.

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