The *Chaîne Opératoire* of Ceramic Manufacture and Production: Preliminary Analysis through Ceramic Petrography at Rancho del Rio, Valle de Cacaulapa, Santa Barbara District, Honduras

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THE *CHAÎNE OPÉRATOIRE* OF CERAMIC MANUFACTURE AND PRODUCTION: PRELIMINARY ANALYSIS THROUGH CERAMIC PETROGRAPHY AT RANCHO DEL RIO, VALLE DE CACAULAPA, SANTA BARBARA DISTRICT, HONDURAS

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Abstract

The following dissertation will report on preliminary petrographic analysis of ceramic samples from the site of Rancho del Rio, Valle de Cacaulapa, Northwestern Honduras. Analysis will involve three stages: 1) preliminary petrographic examination of sherds as a means of adding microscopic data to the current type-variety-mode typology used in the valley in order to investigate the chaîne opératoire of ceramic manufacture and production; 2) comparison of identified petrofabrics with clay 'globules' found on potstands from the site; and 3) an attempt to locate the actual source and/or environment of the clays used in Precolumbian vessel manufacture.

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Chapter 1: Introduction and Research Objectives

Introduction

> The importance of knowledge of the potter's materials is self-evident: The materials set limits within which the potter had to work; the status of the craft has to be judged within these limits. Furthermore, the potter's choice of materials and the ways in which he used them, together with form and style of decoration, are trade marks --- our means, often powerful, of locating centres of production (Shepard 1965: xii).

Using pottery as a means of understanding social concepts, political and economic 'boundaries', and daily activities is a common aspect of Precolumbian Mesoamerican studies. Studying pottery itself, macroscopically, is also a frequent focus, particularly when dealing with forms and decorations. However, research questions that address how and where pottery was manufactured are rarely seen in Mesoamerican studies. The key reasons for ignoring these questions include poor preservation (the major suspect); an inability to efficiently recognize manufacture locations and remains; and a lack of conviction on the part of many archaeologists as to the advantages of archaeometric and geological approaches to the study of Mesoamerican ceramics. Despite the numerous ethnographic studies of pottery-making in Mexico and Central America, literature of the past 80 plus years reveals additional reasons for the omission of archaeometry and geology from such studies. These include an absence of questions posed regarding the chaîne opératoire of ceramic manufacture and production; the focus of excavations on major site epicentres and civic-ceremonial structures, such as temples, in search the search for 'tombs and treasure'; the avoidance of excavations in 'commoner' or 'lower strata' residential areas and large open areas (i.e. courtyards) where much residential activity is likely to have occurred; the belief that archaeological typologies based on macroscopic characteristics can supply significant and abundant information regarding the finished vessels [i.e. typology is an alternative to fabric studies (Wardle 1992:11)]; and finally the lack of communication among material analysts, archaeologists, ethnoarchaeologists, and anthropologists as to the value of inquiries based in archaeometry and geology.

Why study ceramic manufacture and production[1]? Is it important to understand how things were made, where they were made, and by whom? Manufacture and production, or technology, is "not simply a body of explicitly formulated and objectively described knowledge" but "is one of the social processes by which individuals negotiate and define their identities, in terms of gender, age, belief, class, and so on" (Sinclair 2000:196). The techniques involved in both manufacture and production are learned by individuals within their societies as part of the social processes which archaeologists and anthropologists are so keen to understand. Therefore, understanding the manufacture of ceramic vessels can lead to an understanding of the multiple social processes involved in production.

Research Objectives

During the summer of 2004, I was invited to join archaeological excavations at the Precolumbian site of Rancho del Rio, located in the Valley of Cacaulapa in the Santa Barbara District of Northwestern Honduras. The following dissertation is a result of my placement with the project, and serves to begin addressing the question of how and where pottery was manufactured. This work strives to create a base from which the Rancho del Rio investigations into the chaîne opératoire of ceramic manufacture and production (see Chapter 3), and resultant questions concerning economic organization, etc., can be launched. Petrographic analysis will be conducted on ceramic sherds from the rural site of Rancho del Rio, in an attempt to provide microscopic information to complement the current type-variety-mode typology used to identify ceramics in the valley, and to provide information necessary to begin the study of ceramic manufacture. In order to gain insight into the manufacture environment and location, I will also use the microscopic information develop a better understanding of the paste recipes of four common 'paste-groups' found at the site. To identify the proveniences for clay sources, I will compare three local sources with the sherd samples. Finally, I will also compare the petrofabric identities with clay globules found on

[1] Rice (1996: 167) distinguishes between manufacture, "the actual act of fabricating ceramics", and production, "the social and economic organizational arrangements within which pottery manufacture is carried out".

identified 'potstands'; these globules are assumed to have resulted from Late Classic manufacture processes at Rancho del Rio.

Chapter 2: Recognition of Pottery Production in the Archaeological Record

Recognizing Production

The study of ceramics in Mesoamerica is not a recent development. In fact, "the intellectual history of Mesoamerican archaeology is considered largely in terms of ceramic research" (Rands 1991:155). However, this intellectual history has only rarely focused on the recognition of pottery manufacture and its chaîne opératoire as represented in the archaeological record. (Exceptions are seen particularly in various publications by Rice and Shepard). As noted earlier, numerous reasons have been cited for this lack of research; primarily the poor understanding of production remains and a lack of extensive excavation at locations most likely to contain such traces (e.g. lower strata residential remains and open activity areas such as patios and courtyards).

How can archaeologists recognize pottery manufacture from the surviving material records? According to Arnold (1991) there are three classes of data which can potentially serve to identify ceramic manufacture (Arnold uses the term "production") locations in the archaeological record: 1) tools and facilities, 2) mistakes, production residues, etc., and 3) finished products (Arnold 1991: 87; see Rice 1996 for similar classes). The final class, "finished products", can provide important information concerning patterns of distribution, characteristics of consumer population, and most importantly, information on the physical manufacture of the items. In fact, research into manufacture, and eventually into production, is much more effective when one begins from the third class of data and moves to the first. The careful identification and evaluation of the actual manufacture output (i.e. the vessels) is a logical launching point from which to base the study of manufacture and production.

How archaeologists choose to conduct the initial investigations into the study of the final product will have major effects on the future study of related social processes involved in production. Normally in Mesoamerican ceramic studies, typologies of ceramic vessels are created based on macroscopic characteristics such as form and decoration (Gifford 1976;

Henderson and Beaudry-Corbett 1993), with the goal being the creation of a typology that will function primarily as a source of dating contexts such as caches, burials, and architectural stages. The most common typology employed in Mesoamerica is the type-variety or type-variety-mode system (Wheat et al. 1958). Unfortunately such typologies are not always useful for the study of production.

Type-Variety Systems of Typology

The nature of archaeological questions posed at a given time greatly, if not completely, influence how ceramics have been and are analyzed and classified. Between 1914 and 1940, chronological concerns were the primary focus in Mesoamerican archaeology. Elaborate temporal sequences of ceramic styles and types were developed for all Mesoamerican culture regions in an attempt to demonstrate cultural change and ethnic affiliation (Beaudry-Corbett and Henderson 1993:1). These sequences considered the surface finish and decoration (described as 'wares') and the forms of vessels ordered by stratigraphic evidence from different parts of various sites. Each sequence was correlated with those of sites in other regions.

By far the most influential taxonomic system employed in Mesoamerican ceramic studies to-date appeared in the late 1950s and early 1960s: the type-variety system (Rouse 1960; Wheat et al. 1958; see references in Peuramaki-Brown 2004). This system became popular immediately in Eastern Mesoamerican ceramic studies and was "introduced in a quest for a conceptual approach more adequate---especially for improving chronological control---than the 'loosely structured descriptive format of wares, with a primary emphasis on shapes as chronological diagnostics' (Willey et al. 1967:289) that was then traditional" (Beaudry-Corbett et al. 1993:4). It also offered archaeologists a means to deal with the increase in the sheer quantity of ceramic material being excavated and with the demand for ceramic description/information from hundreds of sites (Shepard 1965: xv). The system addressed questions concerning spatial distribution (types and varieties specific to a temporal period and site) and offered a common language based on comparable taxonomic units and terminology with which communication between ceramicists and archaeologists from different projects could be facilitated.

The type-variety system created binomial nomenclature for ceramic complexes, similar to the Linnaean taxonomic system in biology, grouping various attributes, including some macrovisual past characteristics, while concentrating on surface features and the "supposed significance of these factors in relation to broader aspects of Mesoamerican culture and history" (Jones 1986:1). The heavy reliance on surface decoration was responsible for major flaws in the system: for example, two sherds from the same vessel could technically be assigned to two different varieties due to wear, post-depositional effects, origin from a non-decorated part of the vessel, etc. In an area such as the Mesoamerican Lowlands, "low-fired pottery (below 650 ºC), heavy rainfall, and acid soils mitigate against reliance on traditional modes of ceramic analysis, which rely on surface finish and decoration" (Bishop 1994:28). Although the type-variety system does acknowledge paste and technology to a certain degree, "there is still too little careful distinction between what constitutes a single genuine technological trait and what in reality constitutes a similarity in form or finish" (Jones 1986:86). Shepard wisely commented:

> As long as the type is used only for relative chronological ordering, the percentage of error in classification that occurs with favourable samples can be tolerated. When the type is recommended as a means of pursuing broader studies its inadequacies should be understood (Shepard 1965: xv).

Thin Section Petrography

In order to study the manufacture process of ceramic vessels it is necessary to employ techniques which provide greater insight into the physical materials than is provided by traditional type-variety systems. Thin section petrographic analysis is a geological technique used to systematically describe, classify, and identify minerals and rocks (Barclay 2001:9; Bishop et al. 1982:285; Gribble and Hall 1992:6; Peuramaki-Brown 2004; Rice 1987:376; Rye 1981:51-52; Shepard 1965:139; Tite 1999:195; Vince 2003). It is derived from the broader field of petrology "that deals with the origin, occurrence, structure, and history of rocks and includes chemical as well as optical characterizations" (Rice 1987:376). The technique is not complex but requires time to prepare samples in a thin section form [or, less frequently, individual grain mounts (Rice 1987:381)] and to 'perfect' identification skills. Even after many years this technique remains a 'qualitative' and 'individual' method that varies from practitioner to practitioner. For a brief history of the technique, see references in Bishop (1994), Peuramaki-Brown (2004), and Thompson (1991).

The process of thin section petrography first involves preparation of the specimen into a thin section; a slice ideally 0.03mm (30μm) thick cut perpendicularly to the surface (Barclay 2001:9; Vince 2003). If the specimen is found to be brittle or friable, it is often impregnated with epoxy resin prior to grinding/polishing. The 0.03mm section (roughly $2cm^2$) is then glued to a frosted glass slide with epoxy, and later covered with a thin cover slip using Canadian Balsam sap which allows the removal of the slip at a later time if desired (Barclay 2001:9-10; Shepard 1965:139). Although this procedure is technically a destructive technique, the resulting thin section can become part of a semi-permanent collection or record that can be filed and referenced, or exchanged to be compared with thin sections in collections of other individuals and laboratories (Barclay 2001:9; Shepard 1965:139).

The prepared thin section is placed under a polarizing microscope for examination. Light is directed (to vibrate) in a single plane (rather than in multiple planes as it normally travels), by passing it through two polarizers (calcite prism reflectors) (Gribble and Hall 1992:1-4; Rice 1987:377-379). When the light is passed through both prism reflectors (the lower polarizer and the analyzer) the specimen is under a "crossed polarized" condition (Rice 1987:377). Since mineral crystals are distinguished from each other by different internal and external morphologies (faces, planes, axes, cleavage points, etc.), the transmission of the polarized light through the various mineral crystal types produces unique 'images', textures, colours, etc., that can then be interpreted by the analyst to produce an identification/classification (Gribble and Hall 1992; Mason and Berry 1968:12; Rice 1987:376). There are several primary properties that are examined as a means of mineral identification: in plane polarized light, relief, pleochroism, colouration; in crossed-polarized light, birefringence, twinning, isotropism; and, mineral features, including cleavage, fracture, habit (shape), and degradation (Gribble and Hall 1992:6-15; Rice 1987:378-379; Whitbread 1986:79). Simple chemical staining of sections can also be used to differentiate between minerals of similar optical and petrographic appearance (e.g. calcite and dolomite) (Barclay 2001:9).

When dealing with ceramics, petrographic analysis may also lead to the identification of intentionally added materials (temper) as compared to natural inclusions (Barclay 2001:10); thus shedding light on such issues as potting choices, raw material access, paste recipes, etc. The recognition of such characteristics as sorting, shape, roundness and sphericity, and particle density, in addition to mineral types, can also aid in geographically or geologically locating raw material sources or production centres. The application of petrographic analysis to pottery is hinged on the view of ceramics as "an anthropogenic low pressure meta-sediment...an artificial mudstone...usually containing temper...Typically this material is also geological, e.g. sand grains, shells or rock fragments" (Groom 2004; see also Rice 1987:376). Petrography can be used in ceramic analysis for a number of potential purposes: description of fabrics, classification of fabrics, identification of raw materials and paste recipes, prediction of raw material sources, prediction of production locations, technological studies, etc. (Barclay 2001:10; MacSween 1995:135). All of these questions cannot always be answered for all types of ceramics (as will be discussed below); however, "in regions with a relatively complex igneous and metamorphic geology, it is often possible, in the case of coarse-textured pottery, to suggest the general area (or areas) from which the temper could have originated on the basis of petrographic description of the pottery fabric itself" (Tite 1999:196; see also Vince 1995:121). For a good example of an 'ideal' petrographic analysis, see Shepard's work on the ceramics from Pecos in the southwestern United States (Thompson 1991:33; Shepard 1936; Thompson 1991:18) that demonstrated that pottery previously believed to have been made locally had actually been traded in from neighbouring regions.

<u>Petrography in Mesoamerican Ceramic Analyses: Some Case Studies</u>

The 'modern' application of petrography to 'New World' ceramics began in the 1930s with work by Shepard and Matson (Rands 1991); however the use of optical mineralogy, including petrographic analysis, has been largely ignored in Mesoamerican ceramic studies when compared with 'Old World' use of the technique. While volumes relating to the ceramic analyses of individual sites are published yearly, most do not consider microscopic fabric analysis (see for example Willey et al. 1994). In addition, many of these ceramic studies employ highly technical, chemical, and elemental analyses, such as Neutron Activation Analysis (NAA) and x-ray fluorescence (XRF), without indepth microscopic analysis of the mineralogy of the fabrics (or acknowledgement of such an analysis). Lack of basic mineralogical studies can ultimately undermine the reliability of the more sophisticated analyses (Jones 1986:1; for examples of this see Cowgill and Hutchinson 1973; Culbert and Schwalbe 1987; Willey et al. 1994:4).

Reasons for the lack of petrographic analysis in Mesoamerican ceramics are many. The most common justification for its absence is that the geology of the Mesoamerican world, in particular the Lowlands of the Maya realm, is considered to be too homogenous (Iceland and Goldberg 1999:951). The greater focus on 'fine' wares, rather than on 'coarse' wares, may also account for the omission of petrography which is considered by many to be an inappropriate tool for such artifacts (Jones 1986: 1). Both assumptions will be shown to be untrue. Further, the flourishing of ethnographic studies relating to pottery production has been seen as an adequate proxy for technical studies of archaeological ceramics (Jones 1991: 179). The nature of archaeological research may also have contributed to a lack of emphasis on petrographic analysis: until recently, archaeological questions in Mesoamerican ceramic studies have focused on chronologies, spatial distribution of polychrome vessels, and the iconography on vessels. The recent re-appearance of petrographic techniques within Mesoamerican studies may be related to an increased interest in questions relating to technological development, production, consumption, trade, exchange systems, etc. (Bishop 1994:15), as well as to an increase in 'commoner' focused excavations (i.e. residential remains) that have yielded vast amounts of Mesoamerican 'coarse' wares.

Although not numerous, there are a handful of very successful petrographic studies that have been, and are being, conducted on Mesoamerican ceramics, particularly Maya ceramics. I will briefly review some of the petrographic studies from the area considered as 'Maya' (Chiapas, Yucatan Peninsula, Belize, Guatemala, Western Honduras, and El Salvador), including the archaeological area of Western Honduras that is often considered part of the 'Maya Periphery' (a highly debated concept in itself) (Urban and Schortman 1988:233; Urban and Schortman n.d.), due to the presence of similar 'cultural' traits.

Despite the perceived homogeneity of the Maya Lowlands, that has discouraged the application of petrographic analysis, Jones (1986; 1991), in her evaluation of temper used throughout the Maya world, has successfully demonstrated that within this uniformity there is variation that can lead to the study of questions involving exchange, production organization, technological changes, etc. (Iceland and Goldberg 1999:951; Jones 1986; Jones 1991). Her petrographic analysis followed the appearance, change, and disappearance in the use of various tempering materials throughout the Maya world, including carbonates (calcite crystals, shells, etc.), grog, quartz sand, volcanic ash, etc. Her analyses provided distribution maps for the use of these materials over time and space, and examined issues such as availability of resources, suitability of tempers, the relationship between pastes and forms, etc. (Jones 1986; Jones 1991). In fact, her work temporarily discounted previously assumed strong correlations between vessel shape/function and choice of temper, archaeological 'types' and paste, as well as temper use and geographic source proximity (derived from modern ethnographic work) (Jones 1991:177). The two most important points of Jones' study, in my opinion are: 1) that "the analysis of ceramics on this scale has identified certain weaknesses within the general approaches typical in Mesoamerican research" and that "the use of modern data [ethnographic] to formulate predictive models for the archaeological universe is a technique which can produce unreliable results" (Jones 1991:179); and 2) that previously established ceramic typologies are baselines and petrographers should attempt to work with them. Studies such as that of Jones' "provide further evidence that subtle technological differences may contribute to resolving archaeological issues and also that ceramic variability may be greater than previously thought, based on our still extremely limited petrographic data base" (Iceland and Goldberg 1999:951).

In Northern Belize, two petrographic studies of Late-Terminal Classic (680-850 C.E.) sherds from the sites of Colha and Kichpanha (roughly 10 km apart) have provided evidence for technological variability, not only between sites, but within sites as well. Twenty-five sherds of Subin Red Pottery from both sites and twenty-seven sherds of Masson Complex types from Colha, as well as soil samples from the two sites and surrounding region, were examined petrographically (Iceland and Goldberg 1999:953, 959). In the first study of the Subin Red, Goldberg and Iceland demonstrated a shift from a lack of quartz tempering (predominant grog and carbonate tempering) at both sites during the Preclassic and Late Classic periods, as previously demonstrated by Reese-Taylor (1991; Reese-Taylor et al. 1993) and Jones (1986) and which was believed to extend into the Terminal Classic period, to the adoption of a new regional quartz-temper technology, possibly coinciding with the Late-Terminal Classic shift for reasons unknown (functional, aesthetic, cultural, economic, etc.) (Iceland and Goldberg 1999: 959). The second study of the Masson Complex Types at Colha provided evidence for strong associations "between pottery types and technology and the presence at Colha of intra-site patterning in ceramic technology" (Iceland and Goldberg

1999:963) as well as distinctive compositions between types. This opposes Jones' (1986:177) previously noted statements (see above). The second study also suggested a strong correlation between technologies and intra-site distribution/clusters of pottery, and "it seems likely that the spatial clustering evident in this sample reflects local organization of ceramic production and distribution" (Iceland and Goldberg 1999:964).

Finally, various studies have attempted to address the issue of volcanic ash wares, which occur throughout Mesoamerica. While the debate concerning the source of ash used in these vessels, as well as the location of production is ongoing (see Alt 1995; Arnold 1985:59; Chartrand 2004; Ford and Glicken 1985:480; Ford and Rose 1995; Graham 1987:754; Jones 1986:38-56, 87; Peuramaki-Brown 2004; Simmons and Brem 1975:87; Sunahara 2003:123-134), few researchers have applied petrographic analyses to the challenge. Jones' petrographic analysis of common tempers (mentioned above) revealed a variation in size of volcanic ash from reasonably coarse to fine, dusty inclusions (Jones 1991:172), and "in the overwhelming majority of samples, the ash is sufficiently dense, and crisp in outline, to suggest its deliberate addition as a temper" (Jones 1991:172). This observation, in addition to her conclusion that the thick calcareous underslips used on the ash wares indicate local production, point to the possible local manufacture of vessels with the use of imported ash temper (Jones 1991:176).

Chapter 3: The Archaeological Setting

The Valley of Cacaulapa

The site of Rancho del Rio is located in the southern lowlands of Mesoamerica, within Northwestern Honduras, Central America. Honduras (Figure 1) is situated on the Caribbean Plate between the North American and South American plates. For roughly 75 million years (since the mid-Cretaceous era), the pinching of its plate by the two flanking plates has resulted in a rugged topography of hills, mountain ranges, river systems, and valleys (Humphrey 2003: 3).

The Valley of Cacaulapa, in which Rancho del Rio (Figure 2) is situated, is a narrow valley of the Rio Chamelecón and its tributary, the Rio Cacaulapa. The river originates in the igneous and metamorphic highlands to the south, and the valley, with its alternating vegas and terraces, extends along roughly 4km of the Rio Chamelecón and 6km of the Rio Cacaulapa (Small and Shugar 2004; Urban n.d.). The rivers carry water year-round although the volume varies between the wet and dry seasons. The Valley of Cacaulapa is situated at the nexus of three geological zones: the Atima limestone formation (southeast of the valley), igneous rock intrusions and flows (to the south), and an area of sand- and siltstone (Urban n.d.). This unique position provided numerous resources for the Precolumbian populations: copper ores, basalt, perlite, limestone, chert, volcanic tuff/ash, and clay-based soils (those of limestone origins being highly fertile, while others suiting ceramic production).

The Valley of Cacaulapa was first extensively surveyed by Schortman, Urban, and Ausec (Urban et al. 2000; Wells 2003) during the late 1990s. At that time 38 sites were identified. The largest site, El Coyote, in the southern/lower part of the valley, covers approximately 6km² and encompasses a minimum of 360 platform structures, 28 of which form the site epicentre. The site appears to have been occupied from the Middle Preclassic (ca. 600-400 B.C.E.) until the Early Postclassic (900-1100 C.E.), with its strongest period being the Late Classic (650-900 C.E.) and Early Postclassic (900-1100 C.E.) periods (Small and Shugar 2004: Urban n.d.). Other sites in the valley range from those with 22 mounds to those with mere artifact scatters.

Excavations and Preliminary Results

Excavations at the site of Rancho del Rio center on understanding rural economies, especially the production and exchange of rural produced goods. During the 1997 survey, Rancho del Rio was identified and recognized as comprising seven mounds and one unidentified structure (Mound 7 on maps from the 2003 season) (Figure 3). It was believed that the site was likely inhabited by a large, loosely connected group of people (Small and Shugar 2004). The first two seasons of excavation at the site, during the summers of 2003 and 2004, were aimed at determining the extent of site occupation (geographically and temporally); opening the inner courtyard and revealing its relationship with the mounds; and understanding the unusual nature of Mound 7 that appeared, through initial survey, to be a long, low, rectangular structure with no interior room divisions.

During the first season of excavation it was discovered that the ancient inhabitants of Rancho del Rio were possibly engaged in pottery production. Large middens consisting primarily of ceramic debris were encountered during courtyard testing. These included possible ceramic tools: broken sherds used as scrapers, shapers, and smoothers to make pottery, similar to those found at the site of K'axob in Northern Belize (Varela, McAnany, and Berry 2001: 186-187) (Figure 4), and 'potstands': modified jar rims used to support vessels during manufacture. The potstands hold tell-tale signs of pottery manufacture (Figure 5): large pieces of wet clay, which fell off the wet pots as they were being shaped, dried onto these stands and were eventually fired with the pot. Similar potstands have been recovered from the site of Las Canoas in the valley and from various smaller sites (Ed Schortman, personal communication). These stands can provide a potential direct link in the chaîne opératoire, from the raw material through the forming technology to the finished object, since they supply a possible identifiable local fabric.

The goals for the 2004 season were to look for further evidence of pottery manufacture in the presence of kilns or areas of pottery making, and to search for evidence of the storage of large quantities of unfired pottery that would have required thorough drying prior to firing. In reference to the second goal, particular attention was placed on excavating Mound 7, which was outlined in surface survey as a long, low, rectangular mound almost flush with the ground. Ceramic manufacture often includes architectural installations that could serve as workshops or storage and drying sheds (Stark 1985). In the adjacent Naco Valley, Connell (2002; see also Urban, Wells, and Ausec 1997) recently excavated a suspected specialized structure in Site 108 that he identified as a rural ceramic production site. Prior to the 2004 excavations, it was believed that Mound 7 at Rancho del Rio could well have been a non-residential, special-purpose structure. It appeared very different from residential architecture in the region that was generally recognized by stone-faced platforms with a stone core. It did not appear to include a platform of any height: its low platform was faced by only a single course of stones. The 2004 season intended to excavate this structure fully to expose any evidence of ceramic manufacture, such as manufacturing debris within or near the structure; specialized features, such as low platforms or benches, within the structure (as noted by Connell); and any other unique features of construction or design that would correlate with either the ceramic-manufacturing character of the site.

Clearing of the eastern half of the courtyard (Figure 6) did not reveal any identifiable areas of pottery manufacture (e.g. kilns), although it did supply numerous examples of sherds reused in the making of pottery (tools), vitrified ceramic (occasionally labelled as ceramic 'slag'), potstands, clay waste (a 'pinch' of excess clay eventually fired), crushing implements (manos and metates), countless broken sherds of the four paste groups examined in this dissertation, and possible temper blocks of schist (discussed below). Although the courtyard has yet to be carbon dated, it is believed that the level associated with the middens was last used in the transition from the Late Classic to Postclassic periods at Rancho del Rio (based on ceramic dating)[2].

Perhaps the biggest surprise of the 2004 season was in the exploration of Mound 7. Rather than comprising a single structure, Mound 7 was shown to be very complex. During its last phase, in the Early Postclassic, it was possibly comprised of four earlier square platforms, two of which were very closely spaced, joined together to create larger structures with small raised areas -- former individual platforms. This was achieved through the infilling of areas between the smaller structures (Small and Peuramaki-Brown 2004). The practice of infilling areas between small, individual structures to create larger structures with few interior divisions was a common practice in the Valley of Cacaulapa during the Early Postclassic and is seen at other sites in the area (Urban n.d.). Areas excavated between the houses have shown that there are very clear Early Late Classic, Late Late Classic, and Early Postclassic phases to the structure(s)[3]. The mounds that were encountered during excavations were covered by Postclassic additions that gave the mounds a long rectangular appearance. Based on their shapes the mounds date to the Late Late Classic and correlate with the courtyard level exposed by excavations. As mentioned above, the 2004 excavations revealed an earlier Classic period below the courtyard level on the eastern side of the site. What orientation the earlier construction has, and how it relates to the area of the courtyard will have to be determined in another season.

[2] To date there is no significant evidence for an extensive 'Terminal Classic' period for the Valley of Cacaulapa, as is encountered in numerous other areas of Mesoamerica (Urban n.d.).
[3] An associated Postclassic courtyard level could not be distinguished during excavations, perhaps due to previous ploughing in the area of the site.

Figure 1: Map of Honduras, Central America (From www.kenyon.edu/x11629.xml)

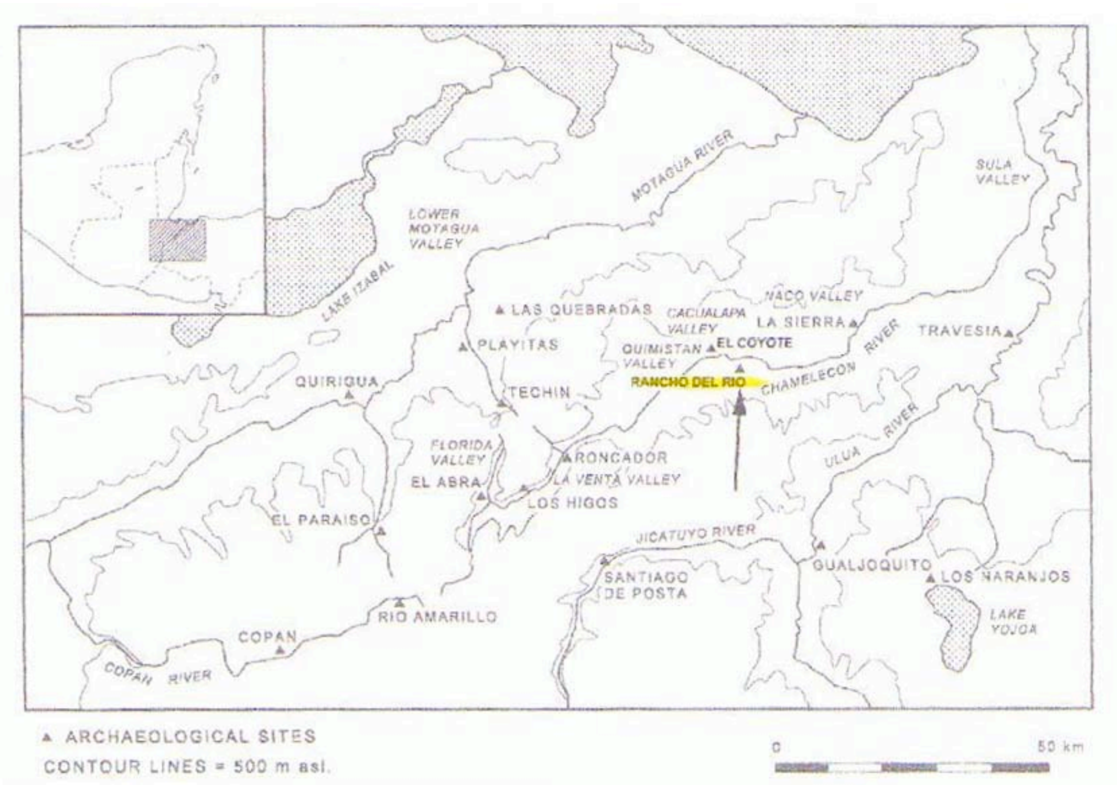

Figure 2: Location of Rancho del Rio in Northwest Honduras (From Small and Shugar 2004: Figure 2)

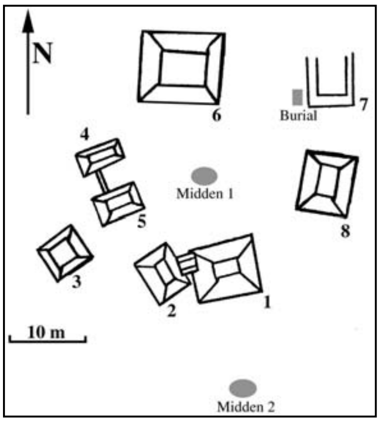

Figure 3: 2003 Plan of Rancho del Rio (From Small and Shugar 2004: Figure 3)

Figure 4: Ceramic scraper (Photo by David Small 2004)

Figure 5: Potstands with clay 'globules' (Photo by David Small 2004)

Figure 6: 2004 Excavations of eastern half of courtyard (Suboperation B) and Mound 7 to the east (Photo by Meaghan Peuramaki-Brown 2004)

Chapter 4: Research and Analytical Methodology

The following analysis addresses the question of whether pottery was being manufactured by the inhabitants of Rancho del Rio during the Late Late Classic Period. Petrographic analysis was chosen above other analytical techniques due to the large number of inclusions found in ceramics from the site. The petrographic analysis is composed of three stages:

1) Stage 1 consists of the preliminary identification and description of the various petrofabrics observed from 20 ceramic sherd samples from Rancho del Rio and their relationship to the established macrovisual type-variety-mode system employed in the Valley of Cacaulapa. This will provide a basis for the further study of the manufacture of ceramic vessels at the site. As mentioned in Chapter 2, sherds comprise a part of Arnold's (1991) third class of data in the identification of ceramic manufacture location.

2) Stage 2 consists of the petrographic analysis of the clay 'globules' found on five identified potstands from the site of Rancho del Rio in attempt to match these globules to the identified petrofabrics. This meets the criteria for Arnold's (1991) first and second classes of data.

3) Stage 3 consists of the identification of the environment and/or source from which the clay and possible tempers used in pottery manufacture at Rancho del Rio were obtained. This stage qualifies as Arnold's (1991) third class of data.

Stage 1: Petrofabric Descriptions

Based on the type-variety-model system developed by Urban and Schortman for the Valley of Cacaulapa, 20 ceramic sherds were selected for petrographic analysis. As differences in paste can occur between different parts of a vessel (e.g. the base versus the rim), only sherds of the same type, in this case rims, were selected for the analysis. This ensured that valid comparisons could be made when the sherds were observed microscopically. The sherds were randomly chosen from units in Suboperation B, next to Mound 7. This location, one quarter of the main courtyard, was the focus of the 2004 excavations. The area yielded numerous ceramic tools, vitrified clay pieces, potstands, possible schist temper blocks, basalt grinding implements, and thousands of sherds. The excavation lots/levels incorporated in the analysis include 003 and 004 from various units. These lots are directly associated with the Late Late Classic courtyard surface, which, in turn is associated with the middens identified during the 2003 season and the Late Late Classic (penultimate) phase of Mound 7.

Prominently represented in the Rancho del Rio ceramic assemblage are four macroscopic paste groups identified in the Valley of Cacaulapa type-variety-mode system. This system was developed by Urban and Schortman and was based primarily on their ongoing excavations at the large site of El Coyote, located in the southern end of the Valley of Cacaulapa. The four paste groups are described by Urban (unpublished manuscript) as follows:

> **Pueblo Nuevo paste:** The paste is tan to medium brown in color. Some temper visible to the naked eye; most of this is white. The temper is fine in size, poorly sorted, and in addition to the white particles contains medium to coarse sand. Particles are sub-angular to sub-rounded. Roundness = 0.7; sphericity = 0.7 (Figure 7).
> **San Joaquin paste:** The paste is dark tan to brown in color, occasionally with an orangish cast. The amount of visible temper is definitely greater than for the Pueblo Nuevo Group; temper is what distinguishes the two. Most of the visible temper is white, and seems to include bits of limestone, volcanic tuff, and quartz. There is also some mica. Particle size is large: 0.24-0.3 cm, although this matches medium on the Archmat categorization chart. The range is fine to very coarse sand. Particles are sub-angular to sub-rounded, with roundness between 0.3 and 0.5; sphericity is 0.6. There is no apparent homogeneity in the distribution of aplastics (Figure 8).
> **Pitones paste:** The paste is orange-brown in color. Moderate texture with some fine inclusions visible to the naked eye; aplastics are white, subrounded; fairly soft and easily eroded; texture is finer than paste of Montura Plain and Monte Grande Red-on-Natural from the Naco Valley, but the two grade into one another (Figure 9).
> **Cacaulapa paste:** Color is orange-brown, with a matrix somewhat coarser than Pitones Group material. Cacaulapa paste is notable for the large number of readily visible inclusions, most of which are white; there is also fine and medium sand, with occasional coarse sand. Inclusions are sub-rounded to sub-angular, and poorly sorted, although the impression is of large pieces (Figure

10) (Urban, unpublished manuscript, descriptions used with permission of author).

Forty rim sherds were initially categorized into the paste groups by me, based on definitions provided by Urban and Schortman. The categorization was then verified by Schortman. Five sherds, all jar rims, except one that was initially identified as a jar but is more likely a deep, open bowl, were randomly chosen from each of the paste groups. The sherds were described macroscopically and illustrated (see Appendix A), photographed, and thin sectioned. This sampling strategy was based on suggestions made in Orton (2000) and Schneider (1995). Time constraints and available funding further restricted the number of samples analyzed.

Petrofabric descriptions were conducted based on qualitative analyses: individual aplastic identification, aplastic abundance (as percentage), and granulometry (inclusion sphericity, size, and degree of sorting). Any changes due to firing were also noted.

Stage 2: Analysis of 'Potstands'

Five potstands with suspected clay 'globules' were chosen for petrographic examination from a selection of ten potstands in the 2004 ceramic assemblage (Figure 11). Of these five, three came from Suboperation B, lots 003 and 004, while two were obtained from Suboperation M, a trench through Mound 7, lot 007 (part of the Late Late Classic phase, associated with the courtyard). The globules on the stands were compared petrographically with the petrofabric types determined in Stage 1, were either assigned to one of these types or were designated a new petrofabric type.

Stage 3: Environmental Sourcing

Based on the descriptions of the petrofabrics represented in the sample, it was expected that the type of environment from which the clay sources originated could be determined. To complement this information, samples from clay sources near the site were collected, made into briquettes, thin sectioned, and examined petrographically. Three clay sources from the Rancho del Rio area were sampled:

Source A is an exposed clay bed on the west side of the Rio Cacaulapa, southeast of the site (Figure 12).

Source B is an exposed clay bed from the north side of the Rio Chamelecón beneath the highway bridge south of the site (Figure 13).

Source C is an open pit in an escarpment approximately 250 metres northwest of the site. The clay from this pit is currently mined as wash for *bajareque* (wattle-and-daub) houses. During Precolumbian times, it was possibly used in a similar fashion, as well as in ceramic production (Figure 14).

Four briquettes were produced for thin sectioning (see Appendix B). These consisted of: three briquettes, each made of a different clay source, and one briquette made with added crushed schist temper (found on site and crushed using a hand-held rock). The addition of crushed schist was by the presence of small clumps of tan/gold brown schist found during excavations of the courtyard, possibly similar to temper blocks encountered at K'axob (Varela et al. 2001: 186). This type of stone has yet to be encountered in any of the architecture of the site or of other sites in the valley (Edward Schortman, personal communication). The nearest known use and source of such a rock is the nearby Naco Valley where it has been encountered in the excavation of mounds. The stone is easily crushed and imparts a 'glittering' effect to the clay due to the high content of muscovite (white) mica.

As no evidence for kilns has been encountered to-date at the site, I chose to fire the briquettes in an open fire using a local hardwood to construct a multi-storied basal platform for the kindling and briquettes and a surrounding 'tipi' (Figure 15). I did not use a thermocouple to record the attained temperatures, however based on the flame colour, the use of hardwood [which burns hotter and longer than softwood (Rice 1987:157)], and the addition of fuel once after 40 minutes, it is likely that temperatures reached 650-700 degrees Celsius. Collapse of the wood tipi occurred an hour after the start of the fire. The briquettes were left for a half hour in the coals. The fire was then covered with sand and left for five and a half hours before the briquettes were dug out of the ashes, still slightly warm.

The sectioned briquettes were examined petrographically in terms of their aplastic content and were compared to the identified petrofabrics to determine whether any similarities existed with the environments. This was a very preliminary comparison: I recommend that numerous additional sources in the area are tested before any firm conclusions are drawn concerning Precolumbian clay sources in the valley.

Figure 7: Pueblo Nuevo sherds (Photo by Meaghan Peuramaki-Brown 2004)

Figure 8: San Joaquin sherds (Photo by Meaghan Peuramaki-Brown 2004)

Figure 9: Pitones sherds (Photo by Meaghan Peuramaki-Brown 2004)

Figure 10: Cacaulapa sherds (Photo by Meaghan Peuramaki-Brown 2004)

Figure 11: 'Potstand' sherds (Photo by Meaghan Peuramaki-Brown 2004)

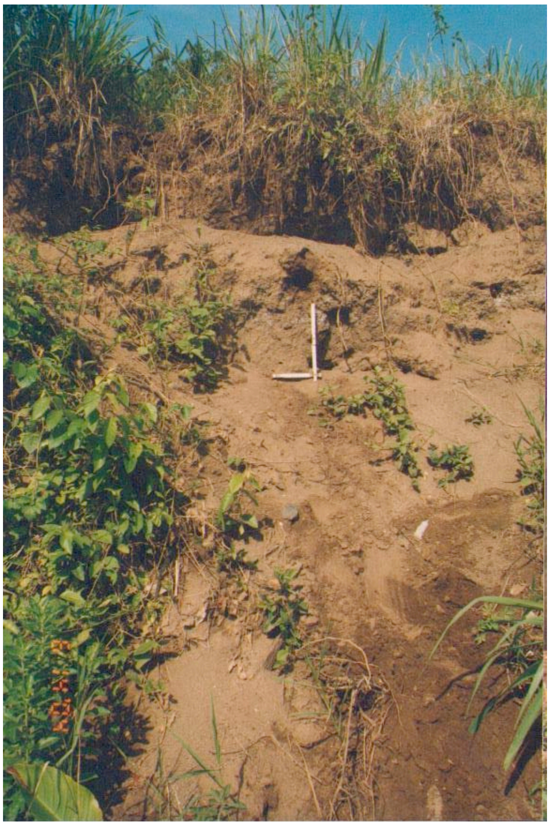

Figure 12: Clay Source A location (Photo by Meaghan Peuramaki-Brown 2004)

Figure 13: Clay Source B location (Photo by Meaghan Peuramaki-Brown 2004)

Figure 14: Clay Source C location (Photo by Meaghan Peuramaki-Brown 2004)

Figure 15: Open fire showing basal platform with briquettes and tipi (Photo by Meaghan Peuramaki-Brown 2004)

Chapter 5: Petrofabric Descriptions

Petrofabric Nomenclature

As is common, petrofabrics[4] tend to be named for their most abundant inclusion (Sunahara 2003:187). As the five petrofabrics which I present all have volcanic ash as their most abundant inclusion, I will be using this 'rule' only for three of the groups, while the other two are named for their next most abundant and important inclusion which distinguishes these groups from the other three. Although I have temporarily identified two of the petrofabrics as potentially manufactured at Rancho del Rio, based on the preliminary analysis of the 'potstands', I will not name the types after the site as I feel much more analysis is required beyond this study. Further investigation may change the petrofabric designations and titles I have assigned.

Petrofabric Descriptions

I have employed three forms of petrographic description for each of the petrofabrics identified: aplastic type; abundance; and granulometry or textural analysis. The aplastic type is simply the identification of rock, mineral, or 'other' inclusions based on their petrographic characteristics. I will be expressing aplastic abundance as a percentage of the total ceramic body; achieved by visually comparing the aplastic grains present in the thin sections with prepared charts illustrating different percentages (Figure 16). Granulometry or textural analysis was performed by the observation of grain size (Figure 17), degree of roundedness (Figure 18), and degree of sorting (Figure 19) for each aplastic type; determined by comparison with charts developed by sedimentologists. These three characteristics can help to distinguish between the different petrofabrics represented in a ceramic assemblage and may also provide clues concerning clay sources, production location, and vessel function. Each description will consist of a brief overview, a macroscopic description [with colour description based on the subsurface margins of the sherds, believed to represent the "natural"

[4] The term 'petrofabric' is used to describe ceramic samples which share similar petrographic characteristics (Mason 1994: 20; Sunahara 2003: 187).

clay colour (see Rye 1981: 119)], and finally a petrographic description. I have set up my descriptions modelling those of Sunahara (2003).

Rancho del Rio Petrofabrics

I have chosen to present the petrographic descriptions in text form as there are many important observations which are not clearly represented in table form. However, charts summarizing the basic elements of each petrofabric description can be found in Appendix B.

VOLCANIC ASH 1

• Overview

Volcanic Ash 1 comprises samples representing jars (everted rim and flared neck) and includes samples from the Urban/Schortman paste groups Pueblo Nuevo and Pitones. It is most likely that this is a mistake in categorization of two samples as they are very different from the other Pueblo Nuevo and Pitones samples. Volcanic Ash 1 differs from the other groups in its overall quantity of ash and the 'fresh' appearance of volcanic ash borders, suggesting possible addition as temper.

• Macroscopic Paste Description

The fabric is porous (numerous small round voids), soft, relatively uniform in appearance, with white and micaceous inclusions. Colour varies from light brown to reddish yellow, Munsell: 7.5 YR 6/4, 5 YR 6/6, and zonation of paste due to reduction and oxidation.

• Petrographic Description

Overall the Volcanic Ash 1 petrofabric is characterized by a rather homogenous appearance, vitreous volcanic ash representing 40% of the paste (Figures 20 and 21). The ash is angular, often displaying odd sickle shapes, and is well sorted. Occasional ash fragments (1%) exhibit vesicular forms, similar to pumice stone, which I have labeled as 'pseudobone' due to characteristics similar to those of bone seen in plane polarized light. Typical grain size for the volcanic ash ranges from fine to medium sand, while the pseudobone ranges from medium to coarse sand. The ash is fresh and glassy and shows no sign of devitrification. The crisp borders of the ash, unlike the other petrofabrics, suggest possible addition as temper.

Also present is muscovite (white) mica as 5% of the fabric. Typically, the laminae are subangular in form, poorly sorted, and of silt to medium sand grain size. It is possible the smaller muscovite grains are part of the original clay body, while larger pieces may be from rock inclusions (e.g. micaceous schist).

Polycrystalline quartz, 5%, is poorly sorted and subangular to angular. Grain size is of very fine to coarse sand. It is possible the smaller grains are part of the original clay body, while larger pieces may be from rock inclusions (e.g. micaceous schist).

Micaceous schist grains (muscovite, plagioclase feldspar, and polycrystalline quartz or metaquartzite), less than 1%, are subrounded (very small fragments) to subangular (larger fragments) and poorly sorted. Grain size ranges from very fine to coarse sand.

Chert is less than 1% of the paste body. Grains are subangular and moderately sorted, ranging from medium to coarse sand size.

Plagioclase feldspar comprises 1%, and is poorly sorted with subrounded to subangular grains. Both fresh and disintegrating plagioclase is present, ranging from very fine to medium sand. It is possible the smaller plagioclase grains are part of the original clay body, while larger pieces are from rock inclusions (e.g. micaceous schist).

Gypsum occurs in trace quantities, less than 1%. It is moderately sorted, of very fine to medium sand grain size, and subangular to angular in shape.

Basalt is also observed in trace quantities, less than 1%. It is moderately sorted, medium to coarse sand grain size, and subangular in shape.

Opaque red-brown (argillaceous) inclusions occur sporadically in trace quantities of less than 1%. They are well sorted, rounded, and of fine to medium sand size.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

VOLCANIC ASH 2

• Overview

Volcanic Ash 2 comprises samples representing jars (neckless and flared neck) and includes samples from the Urban/Schortman paste group Pueblo Nuevo. It differs from the Volcanic Ash 1 petrofabric in its overall quantity of ash (less) and the more 'blending' quality of ash borders, suggesting a natural inclusion of the clay body. It also contains more aplastics and is coarser than Volcanic Ash 1.

• Macroscopic Paste Description

The fabric is somewhat porous (some circular and elongated voids), soft, relatively uniform in appearance, with numerous white and red-brown (argillaceous) inclusions. Colour varies from light brown to pinkish gray, Munsell: 7.5 YR 6/3, 6/4, 7/2, and zonation of paste due to reduction and oxidation.

• Petrographic Description

Overall the Volcanic Ash 2 is characterized by a lesser amount of ash, a less homogenous body, and a generally larger grain size, distinguishing it from Volcanic Ash 1. The volcanic ash is vitreous and makes up 35% of the paste body. It is angular, often displaying odd sickle shapes, and is moderately sorted. Occasional ash fragments (3%) exhibit vesicular pseudobone forms, and is well sorted. The typical grain size for the volcanic ash ranges from fine to coarse sand, while the pseudobone is mostly of coarse sand. The blended borders of the ash, different from Volcanic Ash 1, suggest it to be a natural part of the clay body.

Polycrystalline quartz is the next most abundant inclusion, 10% (visibly more than Volcanic Ash 1), and is poorly sorted. Grains are subangular to angular and of very fine to medium sand size. It is possible the smaller grains are part of the original clay body, while larger pieces are from rock inclusions (e.g. micaceous schist).

Opaque red-brown (argillaceous) inclusions occur as 6% of the paste body, 1% of which is most likely grog (displaying a corona of void and inclusions). Grains are moderately to well sorted, rounded and angular (grog), and of fine to coarse (grog) sand size.

Also present is 5% muscovite (white) mica. The laminae are subangular in form, moderately to well sorted, and of medium sand size. It is possible smaller grains are part of the original clay body, while larger pieces derive from rock inclusions (e.g. micaceous schist).

Micaceous schist comprises 3% of the paste. Fragments are subangular and poorly sorted, their size ranging from very fine to very coarse sand.

Plagioclase feldspar comprises 3% of the fabric, is poorly sorted, and of subangular shape. Both fresh and disintegrating grains are present, varying from very fine to coarse sand. It is possible the smaller grains are part of the original clay body, while larger pieces are from rock inclusions (e.g. micaceous schist).

Gypsum is observed as 1% of the clay body. It is moderately sorted, of very fine to medium sand size, and subangular to angular in shape.

Chert is less than 1% of the paste body. Grains are subrounded to subangular and well sorted; ranging from medium to coarse sand.

Basalt is also observed as less than 1% of the clay body. It is well sorted, medium to very coarse sand size, and subangular in shape.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

VOLCANIC ASH 3

• Overview

Volcanic Ash 3 comprises samples representing jars (undetermined and straight necked types) and includes samples from the Urban/Schortman paste group Pitones. It is very similar to Volcanic Ash 2 although it contains less polycrystalline quartz and muscovite grains.

• Macroscopic Paste Description

The fabric is less porous than Volcanic Ash 2 (circular and elongated voids). It is soft and contains numerous white and red-brown (argillaceous) inclusions. Colour varies from light reddish brown to reddish brown, Munsell: 5 YR 6/4 and 5/4, and zonation of paste due to reduction and oxidation.

• Petrographic Description

Overall the Volcanic Ash 3 petrofabric is characterized by slightly less volcanic ash, a less homogenous body, and a generally larger grain size, distinguishing it from Volcanic Ash 1. However, less polycrystalline quartz and muscovite and slightly finer aplastics differentiate this petrofabric from Volcanic Ash 2. The ash is vitreous and makes up 35% of the paste body. It is angular, often displaying odd sickle shapes, and is moderately sorted. Occasional fragments (3%) exhibit vesicular pseudobone forms, and is well sorted. The typical grain size for the ash ranges from fine to medium sand, while the pseudobone appears as medium to coarse sand. The blended borders of the ash suggest a natural inclusion of the clay body.

Polycrystalline quartz is the next most abundant inclusion, 8%, although less than Volcanic Ash 2, and is poorly sorted and subangular to angular in shape. Grain size is of very fine to fine sand. It is possible the smaller grains are part of the original clay body, while larger pieces are from rock inclusions (e.g. micaceous schist).

Micaceous schist makes up 3% of the paste and is subangular and poorly sorted. Grain size ranges from very fine to coarse sand.

Chert is observed as 3% of the paste body. Grains are subrounded to subangular and well sorted; ranging from medium to coarse sand.

Plagioclase feldspar comprises 3% of the fabric, and is moderately sorted with subangular shape. Much fresh plagioclase is present, although there are some disintegrating pieces. Size varies from very fine to fine sand. It is possible the smaller grains are part of the original clay body while larger pieces are from rock inclusions (e.g. micaceous schist).

Muscovite mica is observed in only 3% of fabric. The laminae are subangular in form, well sorted, and of fine sand size. It is possible the smallest laminae are part of the original clay body while larger pieces are from rock inclusions (e.g. micaceous schist).

Opaque red-brown (argillaceous) inclusions occur as 2% of the paste body, less than 1% of which is most likely grog. They are moderately to well sorted, rounded and angular (grog), and of very fine to medium (grog) sand size.

Basalt is also less than 1% of the clay body. It is well sorted, medium to very coarse sand grain size, and subangular in shape.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

MUSCOVITE 1

• Overview

Muscovite 1 is the first of two petrofabrics containing a large amount of muscovite and micaceous schist, possibly added by the Rancho del Rio potters as temper. It comprises samples representing jars (undetermined and flared neck types) and one bowl (open), and includes samples from the Urban/Schortman paste group San Joaquin. Although volcanic ash is its most abundant aplastic inclusion, it is of significantly less quantity than observed in the Volcanic Ash petrofabrics. The Muscovite petrofabrics also contain a trace amount of chlorite not present in the Volcanic Ash petrofabrics.

• **Macroscopic Paste Description**

The fabric is much less porous than the Volcanic Ash petrofabrics (some circular and elongated voids), is crumbly and thick with aplastic inclusions that are visible to the naked eye throughout the sherds. Colour varies from pink to light yellowish brown to pale brown to very pale brown, Munsell: 5 YR 7/4, 10 YR 6/3 - 6/4 and 7/3, and zonation of paste due to reduction and oxidation.

• **Petrographic Description**

Overall the Muscovite 1 petrofabric is characterized by less volcanic ash than the Volcanic Ash petrofabrics, a high content of coarse inclusions, and an abundance of muscovite, micaceous schist, and polycrystalline quartz. The volcanic ash is vitreous and makes up 30% of the paste body. It is angular, often displaying odd sickle shapes, and is poorly sorted. Occasional ash fragments (5%) exhibit vesicular pseudobone forms, and is well sorted. Ash grain size ranges from fine to very coarse sand, while the pseudobone appears as mainly coarse sand. The blended borders of the ash suggest a natural part of the clay body.

Muscovite (white) mica is the next most abundant inclusion at 15%. Typically, the laminae are more angular than the Volcanic Ash petrofabrics (subangular to angular), are moderately sorted, and of fine to medium sand size. It is possible the smallest laminae are part of the original clay body, while larger pieces may be from rock inclusions/temper (e.g. micaceous schist). The large amount of muscovite may allow for the lighter brown colour of the paste when compared with the Muscovite 2 petrofabric (see Chapter 6).

Polycrystalline quartz represents 15%, is poorly sorted, and subangular to angular in shape. Grain size is of very fine to coarse sand. It is possible the smaller grains are part of the original clay body, while larger pieces are from rock inclusions/temper (e.g. micaceous schist). The large amount of polycrystalline quartz may allow for the lighter brown colour of the paste, when compared with the Muscovite 2 petrofabric (see Chapter 6).

Micaceous schist (muscovite, plagioclase feldspar, polycrystalline quartz, and chlorite) comprises 15% of the fabric. Fragments are subrounded to sharply angular, poorly sorted, and range from medium to very coarse sand size. It is possible that the poorly sorted, angular, and very coarse nature of most of the grains reflects addition as temper (see Chapter 6).

Opaque red-brown (argillaceous) inclusions comprise 8% of the fabric, 2% of which is possibly grog (more than all other petrofabrics). They are moderately sorted, subrounded to angular (grog), and of very fine sand to grit (grog) size.

Chert is observed as 1% of the paste body. Grains are subrounded, poorly sorted, and range from fine to coarse sand size.

Plagioclase feldspar also comprises 1%, is poorly sorted and of angular shape. Fresh and disintegrating grains are present, varying from fine to coarse sand. It is possible the smaller grains are part of the original clay body, while larger pieces are from rock inclusions/temper (e.g. micaceous schist).

Gypsum is observed in less than 1% of the fabric. The gypsum is moderately sorted, of fine to coarse sand grain size and subangular to angular in shape.

Basalt is also less than 1% of the fabric. It is well sorted, coarse to very coarse sand grain size, and subrounded in shape.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

Finally, chlorite is present in the fabric as less than 1%. One piece is observed as part of a micaceous schist grain, therefore it is likely that the remainder also originates from the schist. The chlorite is angular, very well sorted (small amount), and of coarse sand size.

MUSCOVITE 2

• Overview

Muscovite 2 is the second of two petrofabrics containing a large amount of muscovite and micaceous schist, possibly added as temper. It comprises samples representing jars (undetermined, neckless, and flared neck types) and includes sherds from the Urban/Schortman paste groups San Joaquin, Cacaulapa, and Pitones. It is likely that the presence of San Joaquin and Pitones samples is due to incorrect categorization by me following the type-variety paste group descriptions. Although volcanic ash is its most abundant aplastic, it is of significantly less quantity than the Volcanic Ash and Muscovite 1 petrofabrics.

• Macroscopic Paste Description

The fabric is much less porous than the Volcanic Ash petrofabrics (some circular and elongated voids), and is more crumbly and slightly finer in grain size than Muscovite 1. Large aplastics are visible to the naked eye throughout the sherds. Muscovite 2 contains a large amount (although less than Muscovite 1) of coarse, micaceous, white, and red-brown inclusions. Colour varies from pink to light reddish brown to brown to light brown, Munsell: 5 YR 6/4, 6/6 and 7/5 YR 6/4, 5/2, with some zonation of paste due to reduction.

• Petrographic Description

Overall the Muscovite 2 petrofabric contains less volcanic ash than the Volcanic Ash or Muscovite 1 petrofabrics, coarse inclusions, and an abundance of muscovite, micaceous schist, and polycrystalline quartz (although less than Muscovite 1). The volcanic ash is vitreous and makes up 20% of the paste body. It is angular, often displaying odd sickle shapes, and is moderately sorted. Occasional ash fragments (5%) exhibit vesicular pseudobone forms, and is well sorted. Typical grain size for the ash ranges from very fine to medium sand, while the pseudobone is mainly coarse sand. The blended borders of the ash suggest a natural inclusion of the clay body.

Muscovite mica is the next most abundant inclusion, observed as 10% of the fabric. The laminae are angular to subangular in form, moderately sorted, and of fine to medium sand size. It is possible the smallest laminae are part of the original clay body, while larger pieces may be from rock inclusions/temper (e.g. micaceous schist). Less muscovite may allow for the more reddish colour of the paste, when compared with the Muscovite 1 petrofabric (see Chapter 6).

Polycrystalline quartz, 10%, is poorly sorted and subangular to angular in shape. Grain size is of very fine to coarse sand. It is possible the smaller grains are part of the original clay body, while larger pieces may be from rock inclusions/temper (e.g. micaceous schist). Less polycrystalline quartz may allow for the more reddish colour of the paste, when compared with the Muscovite 1 petrofabric.

Micaceous schist comprises 10% of the fabric. Fragments are subrounded to sharply angular, poorly sorted, and of fine to coarse sand size. It is possible that the poorly sorted, angular, and coarse nature of most fragments reflect addition as temper (see Chapter 6).

Opaque red-brown (argillaceous) inclusions comprise 7% of the fabric, less than 1% of which is most likely grog. They are moderately sorted, subrounded to angular (grog), and of very fine to medium (grog) sand size.

Plagioclase feldspar comprises 2%, is poorly sorted and angular. Fresh and disintegrating grains are present, varying from fine to coarse sand. It is possible the smaller grains are part of the original clay body, while larger pieces may be from rock inclusions/temper (e.g. micaceous schist).

Gypsum represents 1% of the fabric. It is moderately sorted, of fine to coarse sand size, and subangular to angular in shape.

Chert is observed as 1% of the fabric. The grains are subrounded and well sorted, ranging from coarse to very coarse sand.

Basalt is less than 1% of the fabric. It is well sorted, of coarse sand size, and subrounded in shape.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

Finally, chlorite is present in the fabric at less than 1%. The chlorite is angular, very well sorted (small amount), and of fine to medium sand size. It is possible that the grains originate from the micaceous schist, as seen in the Muscovite 1 petrofabric.

'Potstand' Globules Petrofabric Descriptions

UNKNOWN 1: POTSTAND SAMPLES 1 TO 3

Three of the five identified 'potstands' (P 1 to P 3) are coated in a light grey film, also found on other sherds and artifacts from courtyard excavations. This material was found in a thin layer over most of the potstand sherd surfaces and in globules along edges. Petrographically this material did not resemble any of the petrofabrics represented in the ceramic sample. It consisted of a dark body with very fine inclusions that could not be identified under the microscope, although it does appear to have high calcite content. The silty material is very different from the large globules found on the other two potstand samples, and occurs only on material from courtyard contexts.

VOLCANIC ASH 2: POTSTAND SAMPLE 4

One of the 'potstand' sherds (P 4) found during Mound 7 excavations (Late Late Classic Phase) bore globules of tan-coloured clay on its exterior surface. When examined petrographically these globules fit descriptions of the Volcanic Ash 2 petrofabric; the same clay body characteristics (mineral/rock content, colour, etc.) and a fine to medium sand grain size. The smaller and less angular grains and lower percentages of aplastics distinguish this petrofabric from the similar Muscovite 1. There are at least two layers of globules on the exterior surface of the potstand, divided by an elongated void, possibly representing multiple use of the stand. However, as this is only one sample I suggest a more extensive study of potstands similar to P 4.

VOLCANIC ASH 3: POTSTAND SAMPLE 5

The P 5 'potstand' sherd, also from Mound 7 excavations, bore globules of a dark tan to orange-coloured clay on its exterior surface. When examined petrographically this fabric fit descriptions of the Volcanic Ash 3 petrofabric; displaying the same clay body characteristics (inclusion content, colour, etc.) and fine to medium sand inclusions (although less abundant than in globules on P 4). The smaller and less angular grains and lower percentages of aplastics distinguish this petrofabric from the similar Muscovite 2. There are at least two layers of globules on the exterior surface of the potstand, divided by an elongated void, possibly representing multiple use of the stand. However, as this is only one sample I suggest a more extensive study of potstands similar to P 5.

Briquette Petrofabric Descriptions

CLAY SOURCE A

• **Macroscopic Description**

This is a dark yellowish brown (Munsell: 10 YR 3/4) clay when wet, retaining the same colour post-firing, with an overall fine texture. There are a few, visible, white inclusions, although considerably fewer than Source C, and it is very plastic when wet. In texture and appearance it is similar to Source B.

• **Petrographic Description**

This is very calcite-rich clay, representing roughly 25% of the fabric. The calcite is likely from river shells, is relatively well sorted, and subrounded to subangular in shape. These are not large 'clasts', as seen in Clay Source C, but are of very fine to medium sand size.

Polycrystalline quartz comprises 7% of the fabric, is angular in shape and poorly sorted. Grain sizes range from very fine to coarse sand.

Plagioclase, both fresh and disintegrating, is 1% of the fabric. It is angular in shape, poorly sorted, and of fine to coarse sand size.

Muscovite mica is 5% of the fabric, and laminae are of subangular shape. It is moderately sorted, ranging from very fine to medium sand size.

Micaceous schist is 3% of the fabric, moderately sorted, and subangular in shape. It is of medium to coarse sand size.

Opaque red-brown (argillaceous) inclusions comprise 3% of the clay body. These are rounded grains that are well sorted, ranging from fine to medium sand.

Basalt represents less than 1% of the fabric. It is well sorted, medium to coarse sand size, and subrounded to subangular in shape.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

Finally a calcareous sandstone, or low grade metamorphic schist, represents less than 1% of the clay. It is subangular in shape, poorly sorted, and medium sand to grit in size.

CLAY SOURCE B

• Macroscopic Description

This is a dark yellowish brown (Munsell: 10 YR 3/4) clay when wet, retaining the same colour post-firing, with a seemingly fine texture. There are a few, visible, white inclusions, although considerably less than Source C, and it is very plastic when wet. In texture and appearance it is similar to Source A.

• Petrographic Description

This clay actually has a greater number and coarser aplastics than Source A when viewed petrographically, and a trace amount of volcanic ash. This is very calcite-rich clay, representing roughly 30-35% of the clay body. The calcite is likely from river shells, is moderately sorted and subrounded to subangular in shape. These are not large 'clasts', as seen in Clay Source C, but are very fine to medium sand size.

Polycrystalline quartz comprises 15% of the fabric, is angular to subangular in shape, and moderately sorted. Grain sizes range from fine to medium sand.

Plagioclase, both fresh and disintegrating, makes up 1% of the clay. It is angular is shape, poorly sorted, and fine to coarse sand size.

Muscovite mica is 7% of the fabric, and laminae are of subangular shape. It is moderately sorted, ranging from very fine to medium sand size.

Micaceous schist is 3% of the clay, moderately sorted, and subangular in shape. It is of medium to coarse sand size.

Opaque red-brown (argillaceous) inclusions comprise 2% of the fabric. These are rounded grains that are well sorted, and of fine sand.

Calcareous sandstone, or low grade metamorphic schist, represents less than 1% of the clay. It is subangular in shape, poorly sorted, and medium sand to grit in size.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

Finally, this is also the only source to have a small amount of volcanic ash within its body, less than 1%. It is angular, well sorted, and of medium sand size. The 'blended' boundaries of the ash demonstrate natural inclusion.

CLAY SOURCE C

• Macroscopic Description

This is a yellow (Munsell: 10 YR 7/6) clay when wet, changing to pink (Munsell: 7.5 YR 7/4) post-firing. It has a 'gritty' texture when handled and there are numerous large, visible, white, and black inclusions. This clay would have been sieved to remove large inclusions if used in ceramic manufacture.

• Petrographic Description

This clay source is most similar to the Rancho del Rio petrofabrics, in terms of the majority of its inclusions; however, it has no volcanic ash and a large amount of calcite.

This is very calcite-rich clay which comprises 30% of the fabric. The calcite is likely from river shells, is poorly sorted, and rounded to subrounded in shape. These are often large 'clasts' of calcite, extremely large when compared with Clay Sources A and B, ranging from very fine sand to grit size.

Polycrystalline quartz comprises 10% of the fabric, is angular to subangular in shape, and poorly sorted. Grain sizes range from fine to coarse sand.

Plagioclase, both fresh and disintegrating, comprises less than 1% of the clay. It is subangular in shape, poorly sorted, and very fine to medium sand size.

Muscovite mica is 10% of the clay, and laminae are of subangular shape. It is moderately sorted, ranging from fine to medium sand size.

Micaceous schist is 5% of the fabric, well sorted, and subangular in shape. It is of fine to medium sand size.

Opaque red-brown (argillaceous) inclusions comprise 7% of the clay body. These are rounded grains that are moderately sorted and of very fine to medium sand.

Gypsum is observed as less than 1% of the clay body. The gypsum is well sorted, of medium sand size, and angular in shape.

A small amount of tectonized granite/gneiss, less than 1%, consists of subangular to angular grains. These are of medium sand size and are well sorted.

Finally, basalt is less than 1% of the fabric. It is subangular in shape, well sorted, and of coarse to very coarse sand size.

CLAY SOURCE C with an easily flaked micaceous schist temper

• Macroscopic Description

Clay Source C (see description above) tempered with an easily flaked micaceous schist (brown to gold in colour with plenty of muscovite mica), has a yellow (Munsell: 10 YR

7/6) colour when wet, changing to a light brown (7.5 YR 6/4) post-firing. The addition of micaceous schist gives the clay a slightly more 'sparkly' appearance. It is interesting to note the change in post-firing colour due to the addition of the schist which is an important observation when considering the schist/muscovite content of the Muscovite petrofabrics (Chapter 6).

• **Petrographic Description**

The addition of micaceous schist to Clay Source C was visible petrographically, both in the increased amount of schist, muscovite, polycrystalline quartz, and plagioclase, but also by the presence of chlorite. This may relate to the chlorite found in the Muscovite petrofabrics.

Polycrystalline quartz is increased to 15%, is subangular to angular in shape, and poorly sorted. Grain sizes range from fine to coarse sand.

Muscovite mica increased to 15% of the fabric, and laminae are now subangular to angular in shape. It is poorly sorted, ranging from fine to coarse sand grain size.

Micaceous schist comprises 10-15% of the clay, is poorly sorted, and subangular to angular in shape. It is of fine to very coarse sand grain size. There may be two different schists present in the body: one with chlorite and the other without. The larger pieces appear to be the added temper (more angular) and at times contain chlorite.

Some individual chlorite grains are observed in the clay, likely crushed out of the easily flaked micaceous schist. This is less than 1% of the fabric, are angular in shape, well sorted, and medium to coarse sand size.

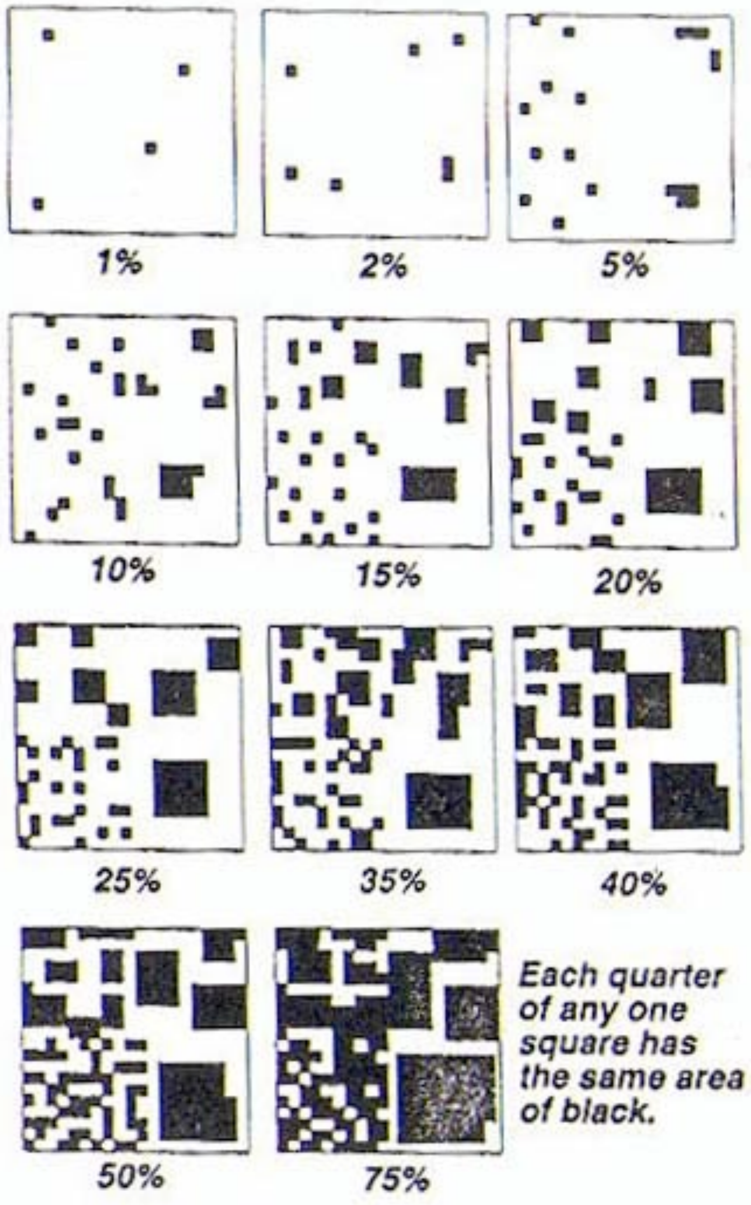

Figure 16: Inclusion percentage diagrams (From Groom 2004)

GRIT	>2.0 mm
VERY COARSE SAND	1.0-2.0 mm
COARSE SAND	0.5-1.0 mm
MEDIUM SAND	1/4-1/2 mm
FINE SAND	1/8-1/4 mm
VERY FINE SAND	1/16-1/8 mm
SILT	<1/16 mm

Figure 17: Grain size chart (From Sunahara 2003: Table 5.1, pp. 90)

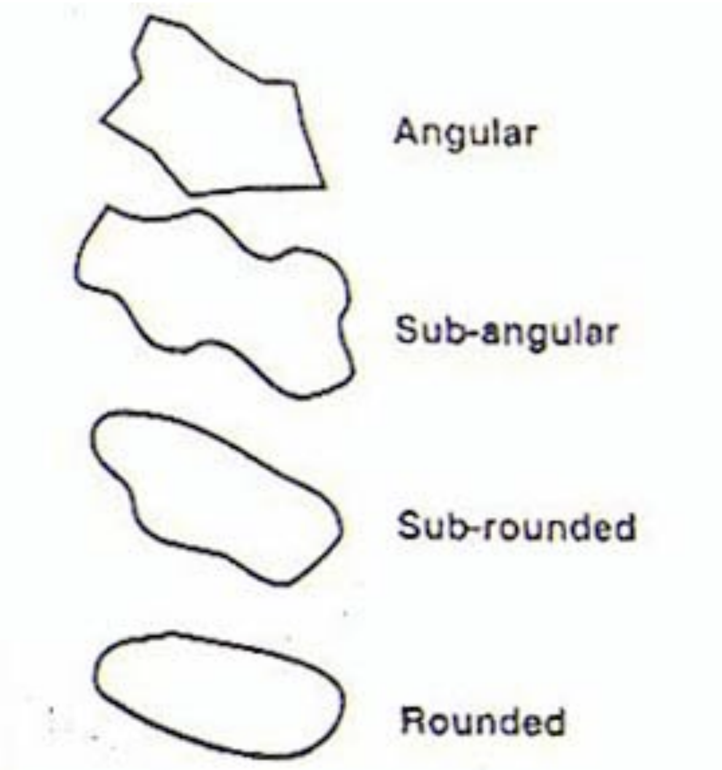

Figure 18: Degree of roundedness diagrams (From Groom 2004)

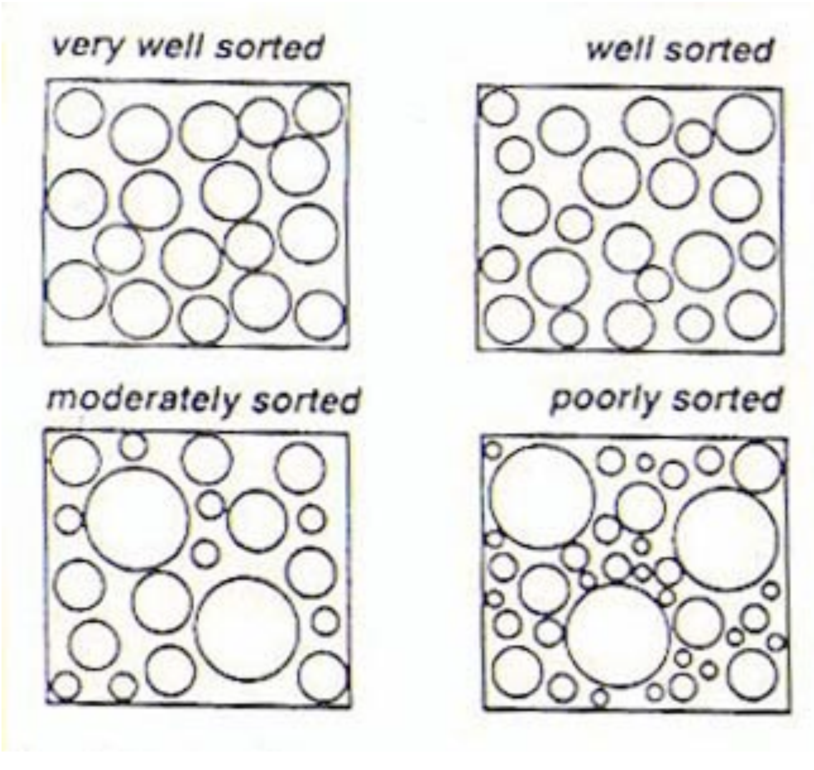

Figure 19: Degree of sorting diagrams (From Groom 2004)

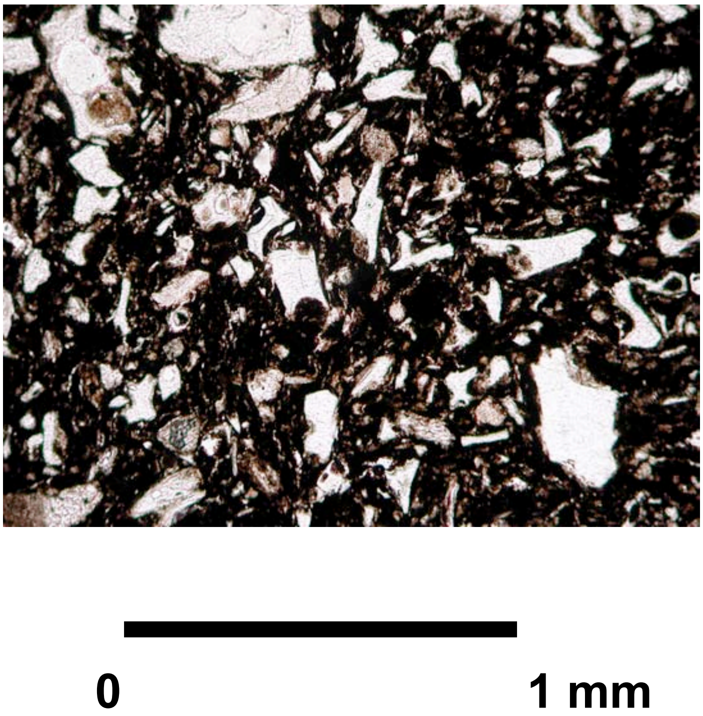

Figure 20: Volcanic Ash 1 petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown, 2004)

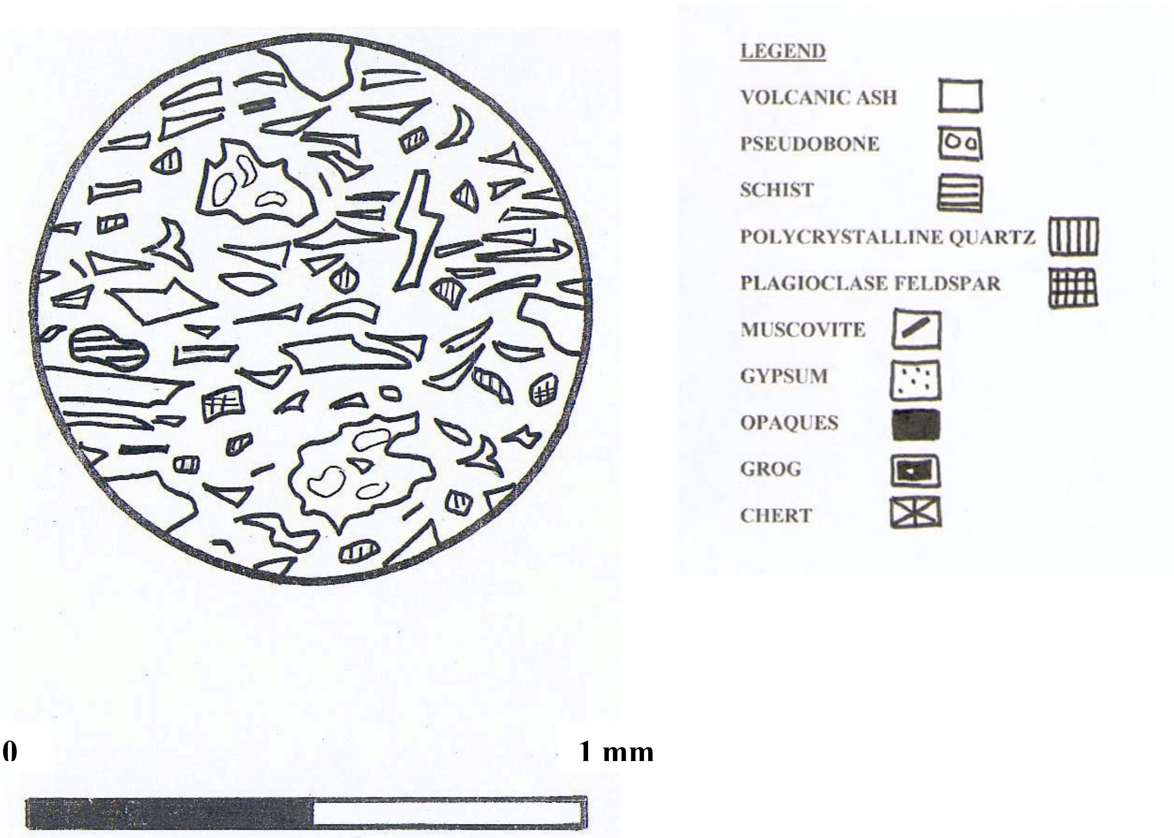

Figure 21: Illustration of Volcanic Ash 1 petrofabric (Illustrated by Meaghan Peuramaki-Brown, 2004)

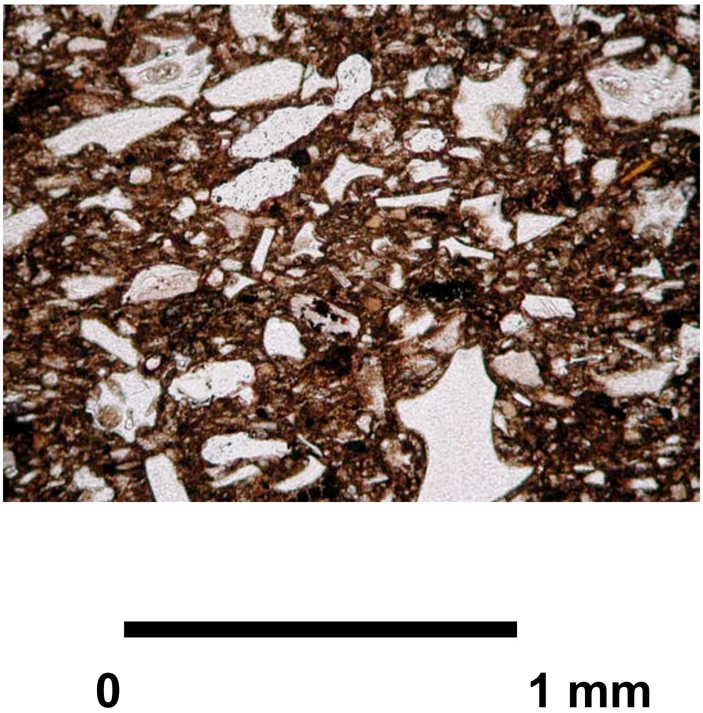

Figure 22: Volcanic Ash 2 petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

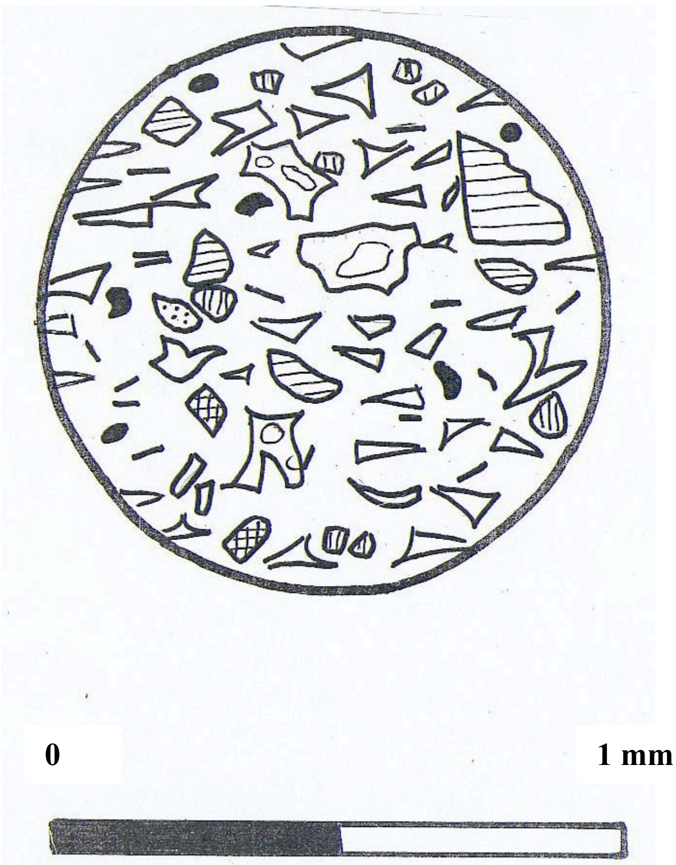

Figure 23: Illustration of Volcanic Ash 2 petrofabric; see legend Figure 21 (Illustrated by Meaghan Peuramaki-Brown)

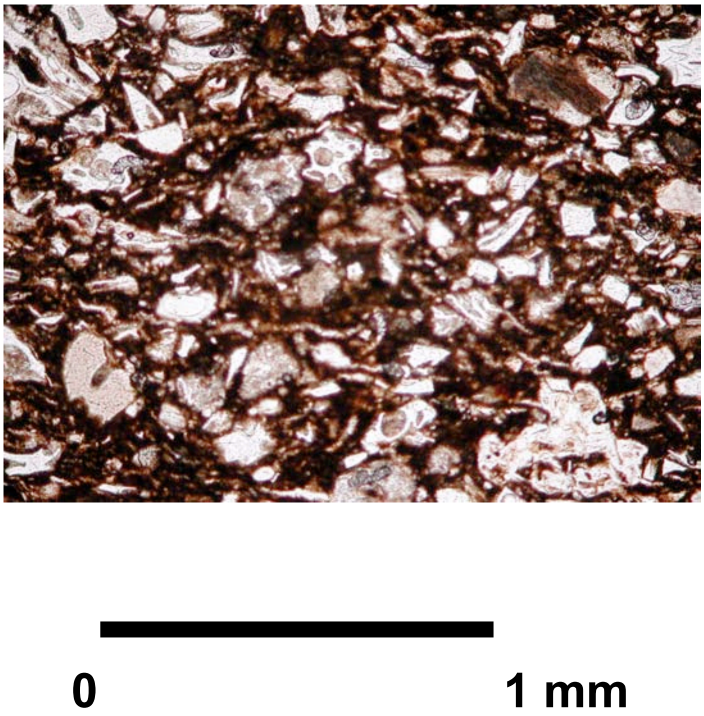

Figure 24: Volcanic Ash 3 petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

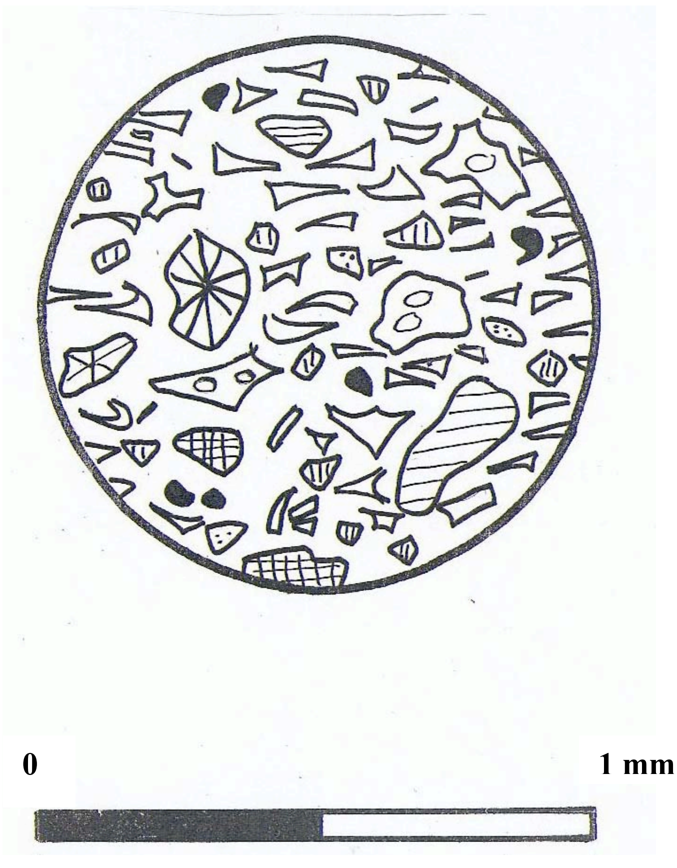

Figure 25: Illustration of Volcanic Ash 3 petrofabric; see legend Figure 21 (Illustrated by Meaghan Peuramaki-Brown)

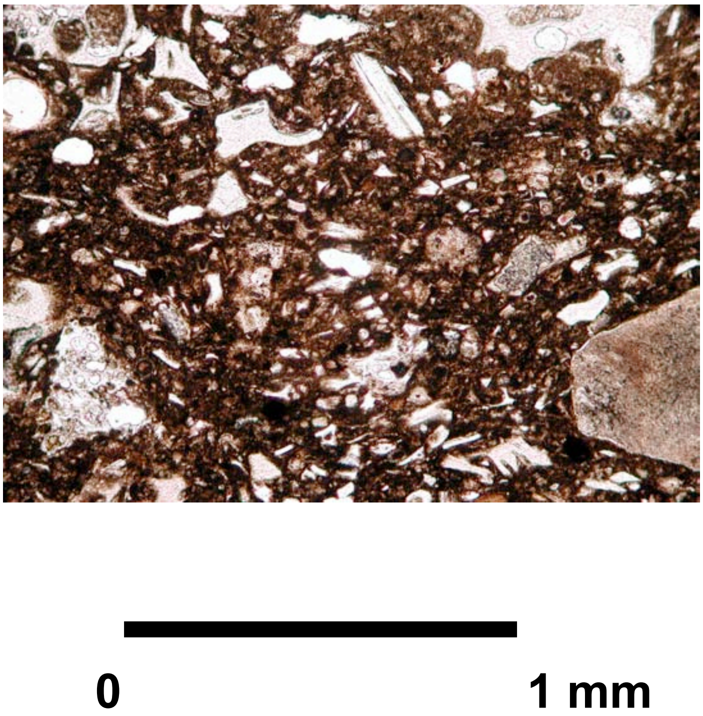

Figure 26: Muscovite 1 petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

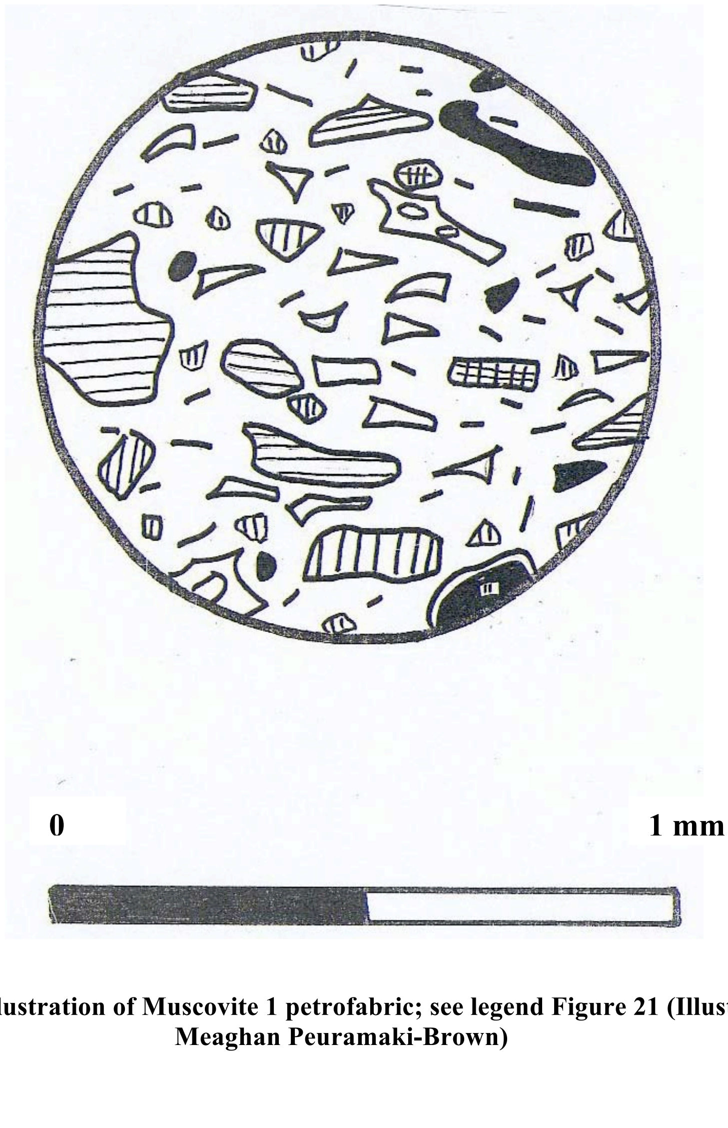

Figure 27: Illustration of Muscovite 1 petrofabric; see legend Figure 21 (Illustrated by Meaghan Peuramaki-Brown)

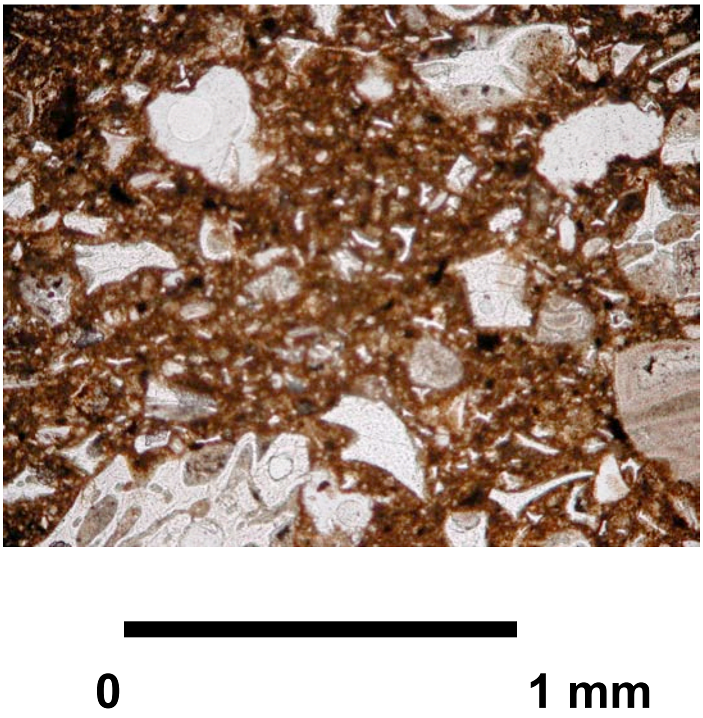

Figure 28: Muscovite 2 petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

Figure 29: Illustration of Muscovite 2 petrofabric; see legend Figure 21 (Illustrated by Meaghan Peuramaki-Brown)

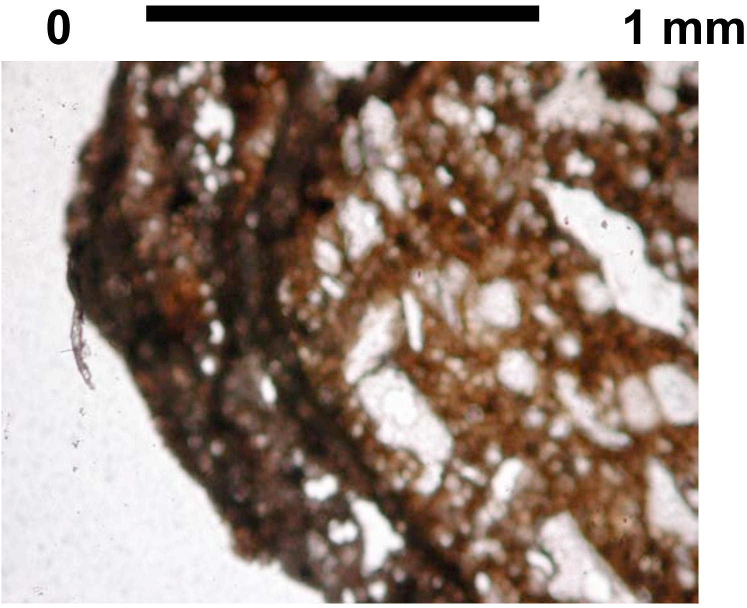

Figure 30: Layer of Unknown 1 petrofabric on "Potstand 3", plane polarized light (Photo by Meaghan Peuramaki-Brown)

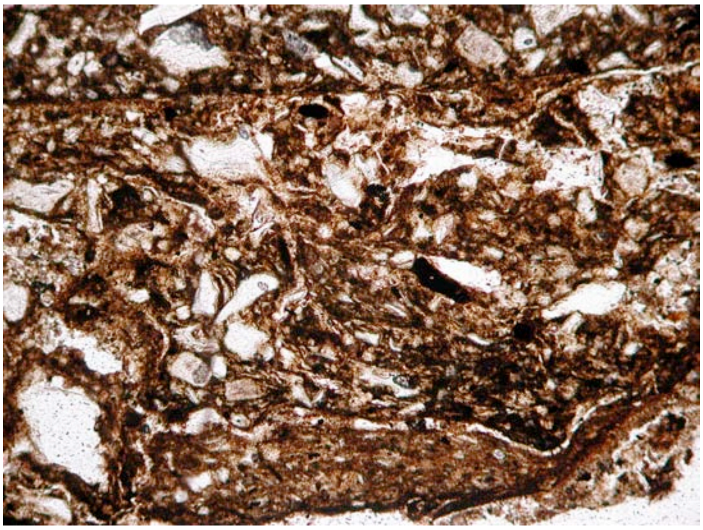

Figure 32: Layers of Volcanic Ash 2 petrofabric on "Potstand 4", plane polarized light (Photo by Meaghan Peuramaki-Brown)

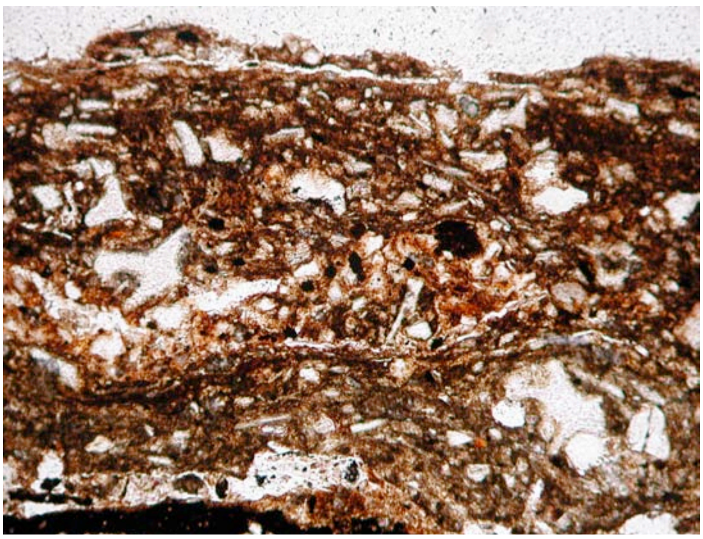

Figure 31: Layers of Volcanic Ash 3 petrofabric on "Potstand 5", plane polarized light (Photo by Meaghan Peuramaki-Brown)

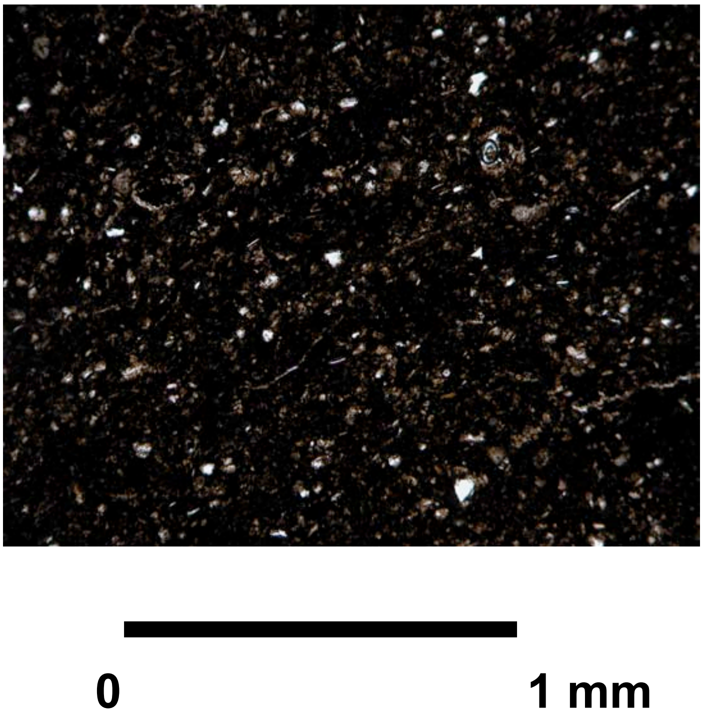

Figure 33: Clay Source A petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

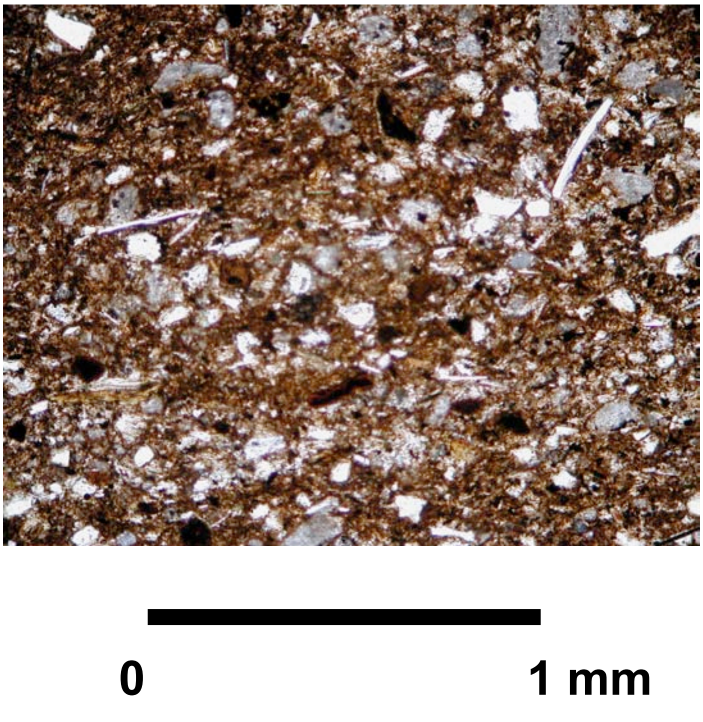

Figure 34: Clay Source B petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

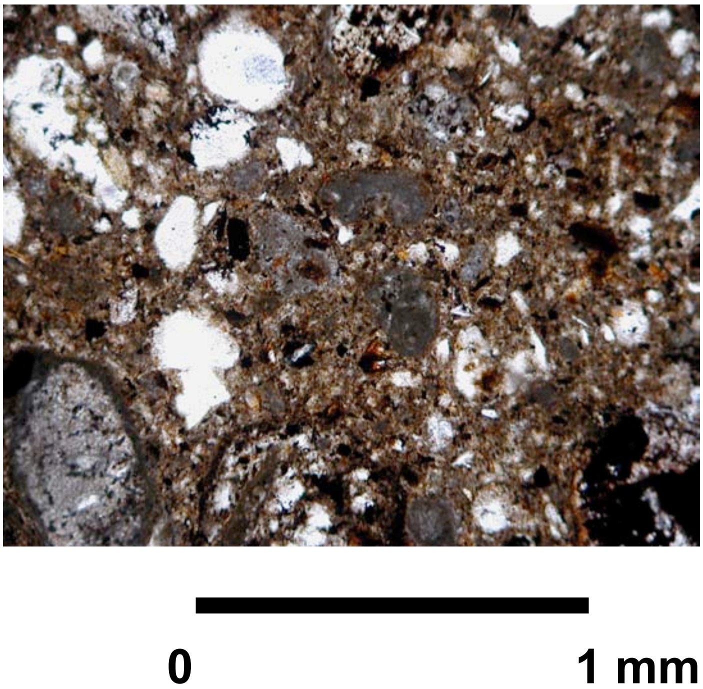

Figure 35: Clay Source C petrofabric, plane polarized light (Photo by Meaghan Peuramaki-Brown)

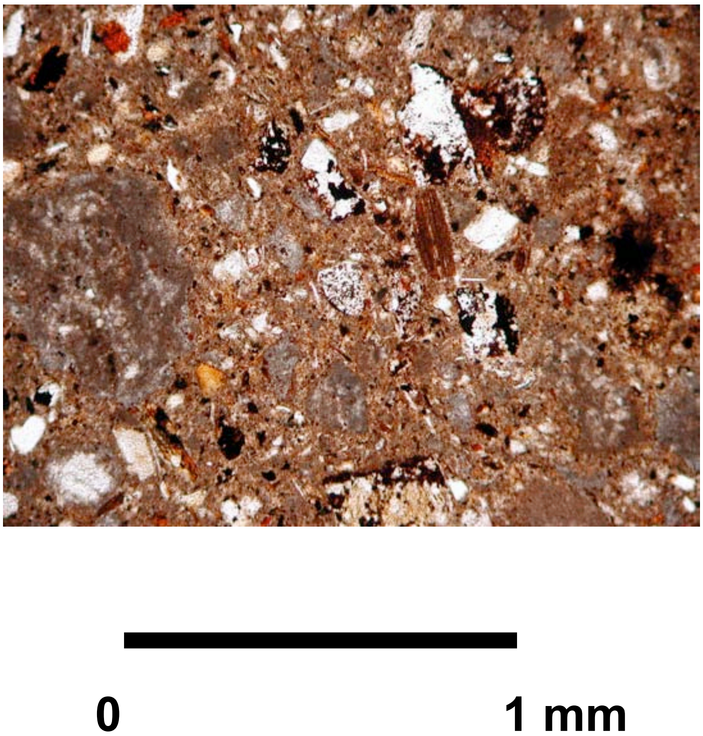

Figure 36: Clay Source C petrofabric with micaceous schist temper, plane polarized light (Photo by Meaghan Peuramaki-Brown)

Chapter 6: Interpretations

Petrofabrics

From the four type-variety paste groups represented in the Rancho del Rio ceramic sample, five petrofabric groups were identified. The clay bodies appear very similar, containing volcanic ash and many fine particles of muscovite and polycrystalline quartz, and are likely derived from similar environments. The clay bodies are secondary and likely of metamorphic and igneous origin, indicated by metamorphic and igneous rock fragments within the clay body (natural inclusions), volcanic ash, and polycrystalline quartz (MacKenzie and Adams 1994: 48,153-155; MacKenzie and Guilford 1980: 71). This would seem typical of river sediments in the area, particularly from the Chamelecón River, which has headwaters in the igneous/volcanic and metamorphic highlands to the south. Unfortunately, good geological maps are not currently available for the valley: the creation of such a map would be a useful future project.

Although very similar in aplastic content, roughly representing a continuum, differences in ratios of aplastics (Figures 37 to 41), grain size, as well as shape, provide rationale for division of the petrographic groups. All contain a high percentage of volcanic ash, though only Volcanic Ash 1 appears to have ash that may have been added as a temper. The 'crisp' edges of the ash within the clay body, unlike the 'blended' ash borders seen in Volcanic Ash 2 and 3 and Muscovite 1 and 2, together with the great abundance of ash, lends credence to this premise (for similar observations, see Jones 1991:172). Volcanic ash is a desirable inclusion in ceramic fabrics: its low level of thermal expansion makes it an ideal temper for cooking vessels that require repeated heating and cooling. Its irregular particle shape also allows for stronger bonds with clay, improving vessel strength (Arnold 1991: 23-24). If more testing of clay sources occurs in the future, it may be possible to trace the chemical signature of the volcanic ash

(Prothero and Schwab 1996:113). Overall, Volcanic Ash 1 is extremely homogenous when compared with the other petrofabrics represented in the sample. The relatively fine grain size of all inclusions and the abundance of volcanic ash suggest that this paste was carefully prepared, possibly by sieving the clay prior to manufacture and/or addition of ash temper. Both of the rims belonging to this petrofabric group are jars with red pigment and tan coloured slip. Since this is such a small sample, nothing further can be said about this fabric.

Volcanic Ash 2 and 3 are similar to Volcanic Ash 1 in their high content of volcanic ash and their relatively porous body; however the ash in these petrofabrics is more similar to that of Muscovite 1 and 2. The borders of the ash are 'blended', making it appear that the ash is a natural part of the clay. They also possess a slightly higher percentage of inclusions (other than ash) when compared with Volcanic Ash 1, though less than the Muscovite petrofabrics. They are relatively fine, although they are slightly coarser than Volcanic Ash 1. The lighter tan colour of Volcanic Ash 2 as compared with Volcanic Ash 1 and 3 may be due to its higher content of muscovite and polycrystalline quartz. When fired, the higher silica content produces a cream to light brown colour (Fuente 2004: 6), such as that noted in the Volcanic Ash 2 samples. When compared with the very coarse nature of the Muscovite petrofabrics, it is possible that these clays were prepared prior to use by sieving. The clay of Volcanic Ash 2 is very similar to that of Muscovite 1, as is the clay of Volcanic Ash 3 to Muscovite 2.

While the most abundant inclusion in Muscovite 1 and 2 is volcanic ash, they differ significantly from their Volcanic Ash counterparts in their very high content of muscovite mica, polycrystalline quartz, and micaceous schist. The presence, although small, of chlorite (likely part of the schist) also distinguishes these petrofabrics from the three Volcanic Ash groups. The abundance of these three inclusions, as well as their more angular and coarse nature when compared with the previous three petrofabrics, suggest their possible addition as temper (Rye 1981: 37). During excavations of the courtyard, lumps of easily flaked, low grade metamorphic, micaceous schist were recovered in association with numerous ceramic sherds, 'potstands', vitrified clay, and ceramic tools. Schist is not seen in the architecture of the Valle de Cacaulapa, nor are known source outcrops been identified to date (Ed Schortman, personal communication). The nearby valley of Naco does have schist sources, and Precolumbian inhabitants there used varieties of the stone in the construction of their structures. As will be explained below, experimentation with the schist found at the site produced results similar to those observed in the Muscovite petrofabrics. The possibility of trade in schist between the two valleys is a subject which could be investigated in the future. Finally, the differences in ratios of muscovite, polycrystalline quartz, and micaceous schist between Muscovite 1 and Muscovite 2 may account for the colour differentiation between the two petrofabrics, as it does between Volcanic Ash 2 and Volcanic Ash 3.

While grog (crushed, recycled ceramic) could add strength to a vessel, due to the angular nature of the crushed particles, and would have been a readily available material at any ceramic manufacture location (Jones 1986: 20), only a small amount of grog is present in four of the five petrofabrics. These pieces were distinguished from other argillaceous inclusions by their angular shape, inclusions (similar to those of the identified petrofabrics, though the clay body appears different), and narrow interface between inclusion and clay body (a corona shaped void) (Jones 1986: 20; Whitbread 1986). Although it is possible that only a small amount of grog was purposely added to these ceramic fabrics, it is also possible that the addition of any grog was not intentional: for example, crushed bits of ceramic on work surfaces could have been accidentally kneaded into the clay bodies during preparation.

Overall, not much can be said concerning the relationship between petrofabrics and vessel forms. All identified petrofabrics included jar forms. Only the Muscovite 2 petrofabric exhibited any possible correlation with form: the flared neck jar representing four of the seven samples (see Appendix B). The small number of samples examined in this study does not permit further observations regarding correlations between vessel form and petrofabric. No evidence as to vessel formation technique was observed within the samples. I suggest that a future project examine such relationships.

Volcanic Ash 2 seems to correlate quite well with the type-variety Pueblo Nuevo paste group, with four of the Pueblo Nuevo samples fitting this petrofabric description. Volcanic Ash 3 possibly matches the type-variety Pitones paste group, comprising three of the Pitones samples. Muscovite 1 seems to correlate quite well with the type-variety San Joaquin paste group, with four of the San Joaquin samples fitting this petrofabric description. Muscovite 2 may match the type-variety Cacaulapa paste group, comprising all five of the Cacaulapa samples. No type-variety paste group description matched the Volcanic Ash 1 petrofabric.

<u>The 'Potstands'</u>

As mentioned in the previous chapter, the material found coating Potstands 1 to 3 did not resemble any of the petrofabrics represented in the Rancho del Rio ceramic thin sections. It is possible that this 'silt' was the result of past flooding in the courtyard, resulting from a rise in water levels in the nearby Chamelecón River. The high quantity of calcite in the silt could be related to the calcite observed in the clay sources analyzed from the valley. If this were the result of flooding, a closer archaeological and geological examination would need to be conducted in order to determine when such an event may have occurred. The absence of a correlation between a petrofabric and the globules emphasizes the importance of petrographic analysis prior to the creation of any firm identification of potstands with manufacture residue.

Potstands 4 and 5 are much more 'typical' of the appearance of potstands with globules observed at other sites in the valley. The matching of the globules with two of the petrofabrics represented in the Rancho del Rio ceramic material suggest that manufacture was indeed occurring at the site; however it is important to remember that these are only preliminary studies and other potstands similar to P 4 and 5 should be analyzed before any firm conclusions are drawn.

<u>The Clay Sources and Test Briquettes</u>

Although none of the clay sources analyzed were an exact match to the ceramic petrofabrics, some similarities were observed. Muscovite, polycrystalline quartz, micaceous schist, plagioclase feldspar, basalt, and gypsum are all rocks and minerals found in both the Rancho del Rio petrofabrics and the three clay sources. The lack of ash within the sources, except for a small amount in Source B, could be due to the temporal distribution of volcanic ash deposits. If sources from different geological times/periods are tested from the valley, it is possible volcanic ash deposits will be located within the sediments. As for the high content of calcite, possibly due to shell within the river sediments, further testing of clay beds is required to determine content over time. Overall, the particular minerals and rocks found within the clay sources (metamorphic and igneous/volcanic), as well as their angularity, suggest a possible match in environmental sourcing. However, there can be no definite conclusion drawn as analysis of more source and sherd samples is required. If pottery manufacture was occurring at the site during the Late Late Classic, it would not be unreasonable to suggest clay sources (deposited by either the Chamelecón or Cacaulapa Rivers) were situated within the valley based on ethnographic studies of distances between clay sources and vessel manufacture locations (Arnold 1971 and 1985).

When some of the easily-flaked muscovite schist (a low grade metamorphic) that was recovered from courtyard excavations was crushed and added to a test briquette with Clay Source C, some interesting observations were made. The overall percentage of muscovite [common in schistose rock (Adams et al 1984: 14)], polycrystalline quartz, and micaceous schist increased. Also present after the addition of the temper was chlorite: found primarily within the identified schist fragments. Therefore, I argue that the presence of this rock associated with pottery sherds, possible ceramic manufacturing tools, and manufacture residue within the Late Late Classic courtyard; the absence of known outcropping in the valley; the lack of use of this type of stone in Late Late Classic valley architecture; and the increased presence of muscovite, polycrystalline quartz, micaceous (muscovite) schist, and chlorite within two of the petrofabrics from the Rancho del Rio sample; and the angular nature of these inclusions, imply addition of this material as temper by Late Late Classic potters. Why this schist was added, given that it has no known advantage in pottery manufacture, is uncertain. It is possible that the additional 'sparkle' which the muscovite in the schist provides may have been a desired characteristic. The presence of high quantities of mica has been noted within the valley ceramics of the Late Classic paste groups Joya, Monte Redondo, and Minitas (Urban, unpublished manuscript). The mica content is so high in these pastes (whether due to micaceous clay or to temper) that the fabrics literally sparkle. Therefore, addition of extremely micaceous schist to a ceramic fabric by the inhabitants of Rancho del Rio during the Late Late Classic would not be unusual. Finally, the addition of the schist to Clay Source C also created a post-firing colour change not observed in the briquette made only of Clay Source C. The colour changed to a light brown from a yellow: similar to the colours of Muscovite 1 and 2, as well as to Volcanic Ash 2, all of which have more schist, muscovite, and polycrystalline quartz than the other petrofabrics.

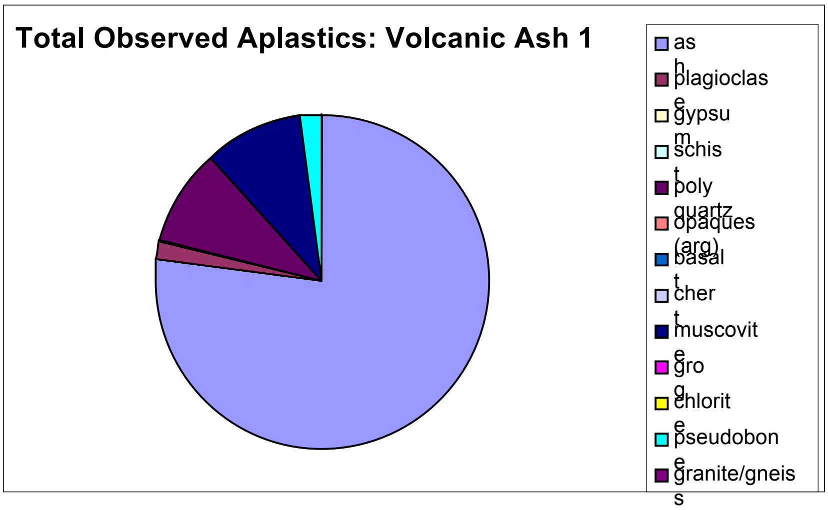

Figure 37: Volcanic Ash 1 aplastic ratios

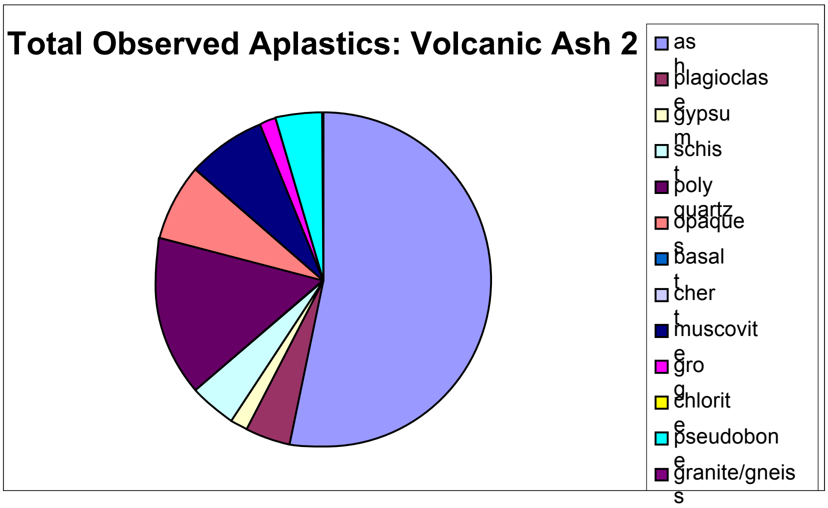

Figure 38: Volcanic Ash 2 aplastic ratios

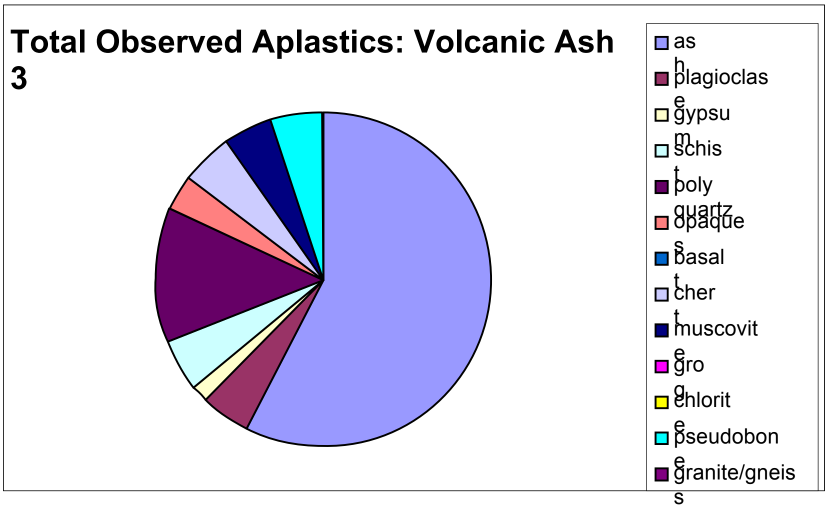

Figure 39: Volcanic Ash 3 aplastic ratios

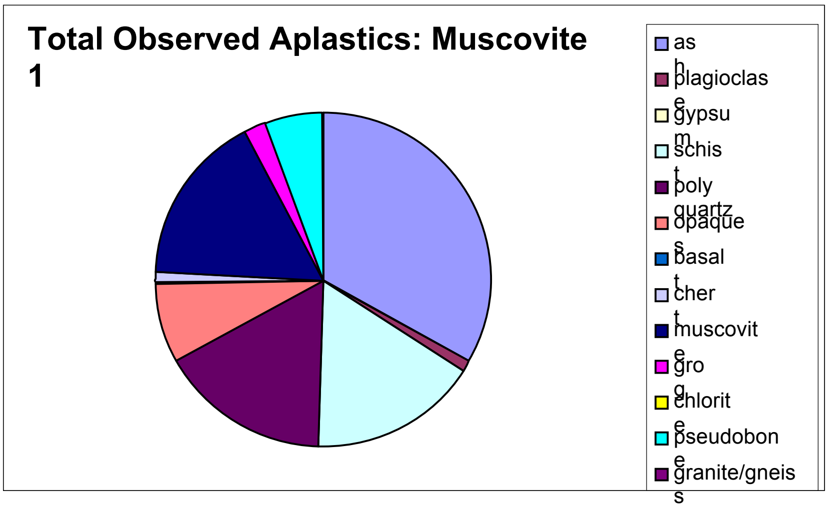

Figure 40: Muscovite 1 aplastic ratios

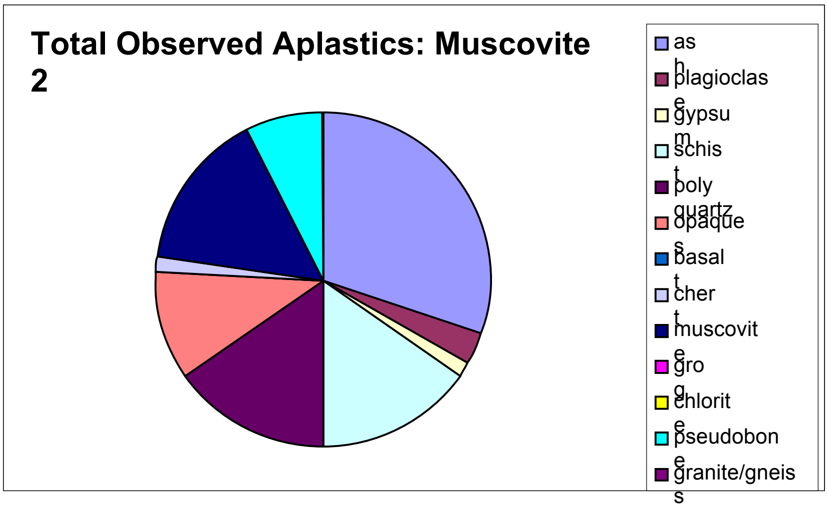

Figure 41: Muscovite 2 aplastic ratios

Chapter 7: Concluding Remarks

Research at the site of Rancho del Rio in the Valle de Cacaulapa, Northwest Honduras has the potential to uncover critical information concerning the chaîne opératoire of ceramic manufacture and production in this corner of the Mesoamerican world. Beginning such a study with the analysis of the 'final product' of manufacture is the most logical starting point. Although traditional type-variety systems of ceramic organization do provide useful information for the study of ceramics in general, more indepth petrological information is required for the study of ceramic manufacture. Although petrographic analysis can be as subjective as type-variety classification, demanding considerable skill on the part of the practitioner in recognizing aplastic characteristics, the information derived from petrography can complement other forms of ceramic typologies and can serve to answer questions previously unaddressed by other typologies.

This dissertation covered three stages of petrographic analysis on ceramics and clays from the site of Rancho del Rio: 1) the creation of petrofabric groups based on 20 ceramic sherds, 2) the comparison of clay 'globules' on manufacture potstands with the identified petrofabrics, and 3) the comparison of the petrofabrics with three clay sources from the valley.

Future research

Although this was a preliminary analysis, the results encourage future investigation into ceramic manufacture and production at the site of Rancho del Rio. Further questions may address the trade of raw materials, such as schist, used in pottery manufacture in the valley, and the degree of production represented in the archaeological record: using petrography to examine the standardization of vessel form with petrofabric as well as the standardization of tool and potstand forms. It would also be useful if additional studies could compare the Rancho del Rio petrofabrics and clay sources petrographically with those of other sites in the valley and in neighbouring valleys. The results would contribute to our understanding of inter- and intra-valley relationships regarding ceramic production in this area, and possibly within Mesoamerica in general.

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Appendix A: Macroscopic description of sherds and illustrations

Hand-held descriptions of paste group rim sherds

PUEBLO NUEVO RIMS

PN 1: Light brown (7.5 YR 6/4) interior and exterior margins (0.5-1.5 MM) and very dark gray (10YR 3/1) core. Tan slip with red pigment on exterior and interior surfaces. Burned patch on exterior. White inclusions (0.5-1mm = coarse sand). Numerous small round voids. Rim diametre = 20 cm. Percentage of rim = 10

PN 2: Light brown (7.5 YR 6/3) interior and exterior margins (1-1.5 mm) and gray (7.5 YR 5/1) core. Numerous circular and elongated voids present. White and red-brown (argillaceous) inclusions (coarse sand) throughout. Rim diametre = 20 cm. Percentage of rim = 10.

PN 3: Light brown (7.5 YR 6/4) interior and exterior margins (1.5-2 mm) and dark gray (10 YR 4/1) core. Some elongated and circular voids present. White and red-brown (argillaceous) inclusions (0.25-0.5 mm = medium sand) throughout. Rim diametre = 18 cm. Percentage of rim = 16.

PN 4: Pinkish gray (7.5 YR 7/2) interior and exterior margins (1-3 mm), fading into a very dark gray (10 YR 3/1) core. Burned patch on exterior surface. Some large (1.5-3 mm = very coarse sand) red-brown (argillaceous) inclusions, as well as white inclusions (medium sand). Rim diametre = 20 cm. Percentage of rim = 12.

PN 5: Pinkish gray (7.5 YR 7/2) interior and exterior margins (1-2 mm) and dark gray (7.5 YR 4/1) core. Red pigment on interior surface. Red-brown (argillaceous) and white inclusions (medium sand), as well as numerous circular voids. Rim diametre = 28 cm. Percentage of rim = 13.

SAN JOAQUIN RIMS

SJ 1: Pink (7.5 YR 7/3) interior margin (0.5 mm) fading into reddish yellow (7.5 YR 7/6) exterior margin (0.5-0.8 mm). White inclusions (very coarse sand) and numerous small round voids. Rim diametre = 26 cm. Percentage of rim = 7.

SJ 2: Very pale brown (10 YR 7/3) exterior and interior margins (2 mm) and gray (10 YR 5/1) core. Slightly micaceous with red-brown (argillaceous) and white inclusions (coarse to very coarse sand). Rim diametre = 32 cm. Percentage of rim = 7.

SJ 3: Light yellowish brown (10 YR 6/4) interior and exterior surfaces (0.5-2 mm) and dark gray (10 YR 4/1) core. Red-brown (argillaceous) and white inclusions (coarse to very coarse sand). Rim diametre = 24 cm. Percentage of rim = 7.

SJ 4: Pink (5 YR 7/4) interior and exterior margins (2-4 mm), fading into dark gray (7.5 YR 4/1) core. Red-brown (argillaceous) and white inclusions (coarse to very coarse sand), as well as mica. Rim diametre = 24 cm. Percentage of rim = 5.

SJ 5: Pale brown (10 YR 6/3) interior margin, fading into light brown (7.5 YR 6/4) exterior margin. Red-brown (argillaceous) and white inclusions (coarse to very coarse sand). Rim diametre = 26 cm. Percentage of rim = 13.

PITONES RIMS

PI 1: Reddish yellow (5 YR 6/6) interior and exterior margins (less than 1mm) and dark gray (7.5 YR 4/1) core. Red pigment on interior surface. Some mica and white inclusions (coarse sand). Rim diametre = 18 cm. Percentage of rim = 11.

PI 2: Light reddish brown (5 YR 6/4) exterior and interior surfaces (2-5 mm) and thin dark gray (7.5 YR 4/1) core. White and red-brown (argillaceous) inclusions (medium sand). Rim diametre = 14 cm. Percentage of rim = 11.

PI 3: Light reddish brown (5 YR 6/4) surfaces (less than 0.5 mm), light brown (7.5 YR 6/4) interior and exterior margins, and dark gray (7.5 YR 4/1) core. Orange slip and red pigment on interior surface. White and red-brown (argillaceous) inclusions (medium sand). Rim diametre = 16 cm. Percentage of rim = 5.

PI 4: Reddish brown (5 YR 5/4) exterior and interior margins (1mm) and dark reddish gray (5 YR 4/2) core. Red pigment on interior surface. Handle joint where break occurred. White inclusions (medium sand). Rim diametre = 18 cm. Percentage of rim = 7.

PI 5: Light reddish brown (5 YR 6/4) exterior and interior margins (3-3.5 mm) and very dark gray (5 YR 3/1) core. Red pigment on interior and exterior surfaces. A few white inclusions (medium sand). Rim diametre = 18 cm. Percentage of rim = 4.

CACAULAPA RIMS

C 1: Reddish yellow (5 YR 6/6) throughout. White and red-brown (argillaceous) inclusions (coarse sand) and white mica throughout. Numerous elongated voids. Rim diametre = 22 cm. Percentage of rim = 11.

C 2: Reddish yellow (5 YR 6/6) exterior and interior margins (1 mm), and light red (2.5 YR 6/6) core. White inclusions (very coarse sand) with some white mica. Rim diametre = 22 cm. Percentage of rim = 5.

C 3: Light reddish brown (5 YR 6/4) interior margin (1-4 mm), light red (2.5 YR 6/6) exterior margin, and red (2.5 YR 5/6) core. White and red-brown (argillaceous) inclusions (very coarse sand) and some white mica. Rim diametre = 22 cm. Percentage of rim = 15.

C 4: Brown (7.5 YR 5/2) exterior and interior margins (1 mm) and red (2.5 YR 5/6) core. Slightly micaceous and white inclusions (coarse to very coarse sand). Rim diametre = 18 cm. Percentage of rim = 5.

C 5: Light brown (7.5 YR 6/4) interior margin and light red (2.5 YR 6/6) exterior margin. Slightly micaceous and white inclusions (coarse to very coarse sand). Rim diametre = 18 cm. Percentage of rim = 4.

Illustration 1:

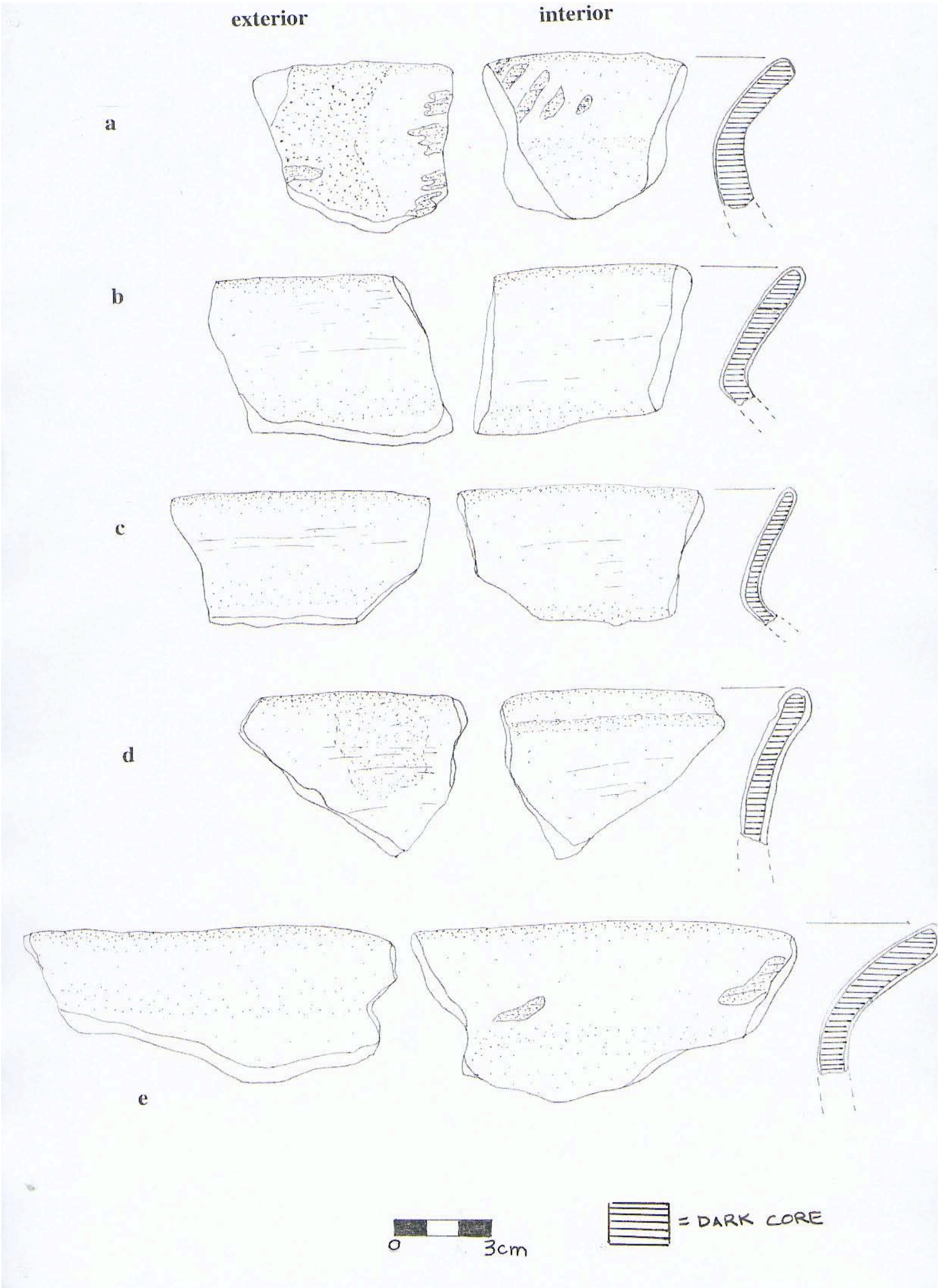


Illustration 2:

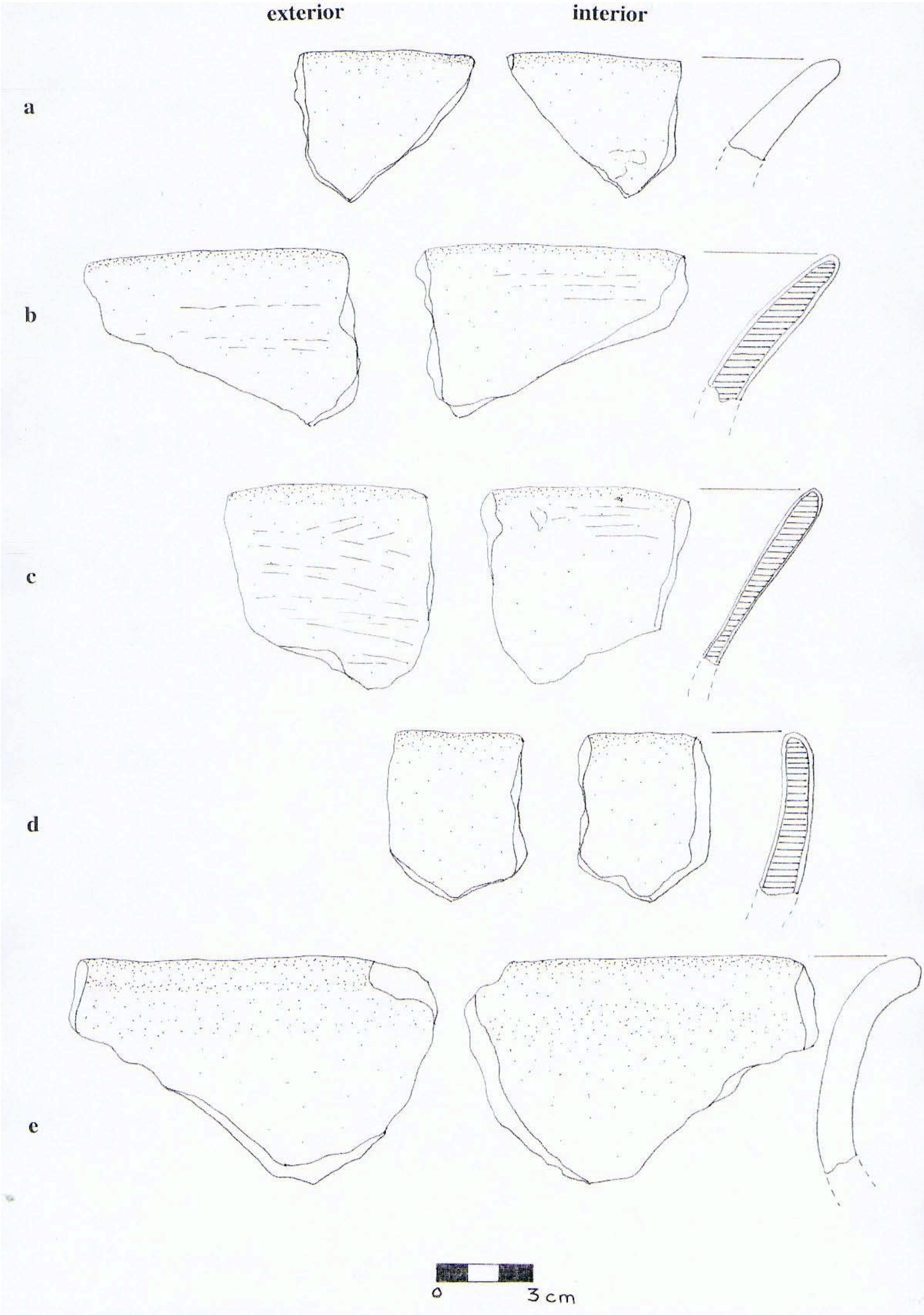


Illustration 3:

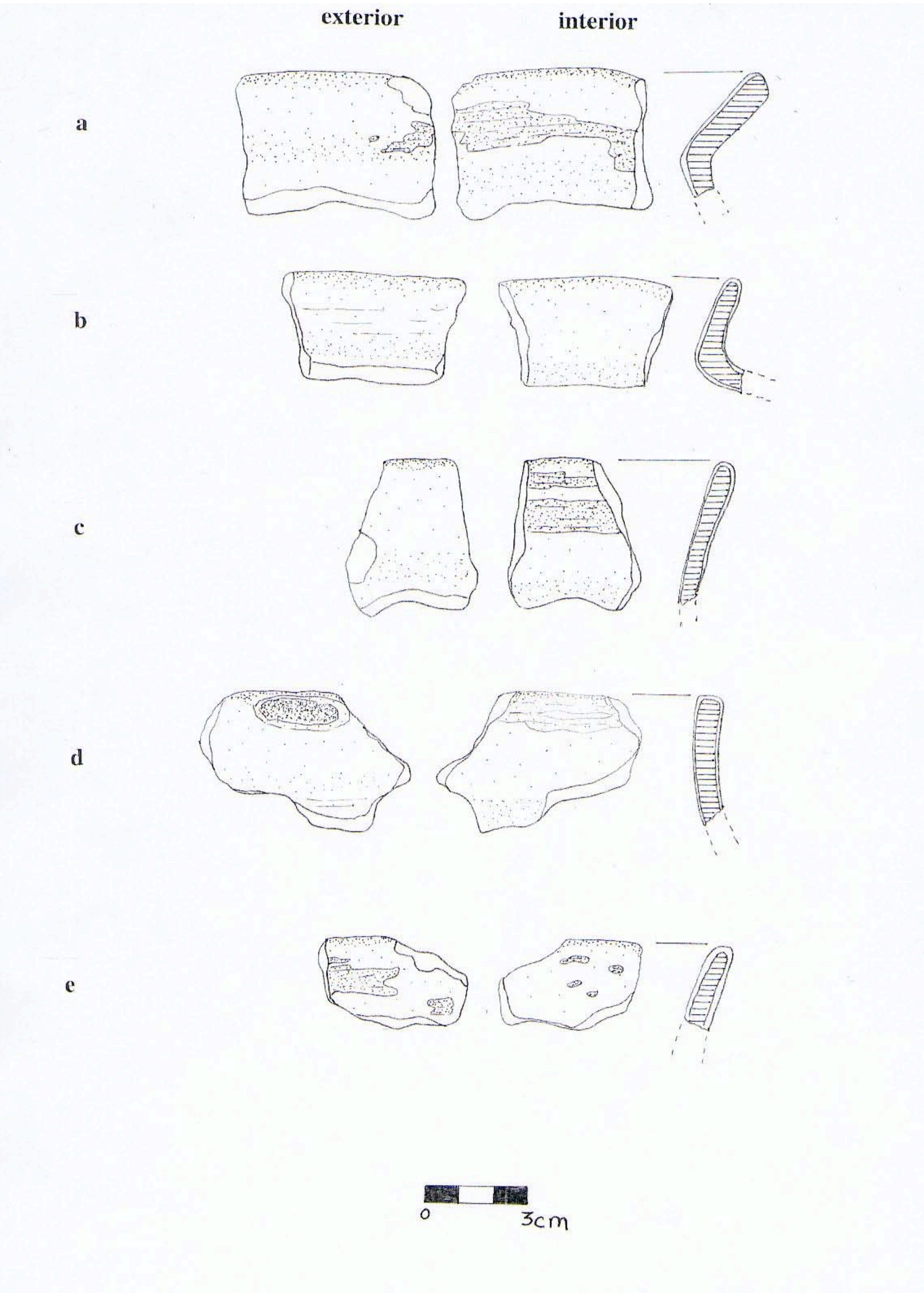


Illustration 4:

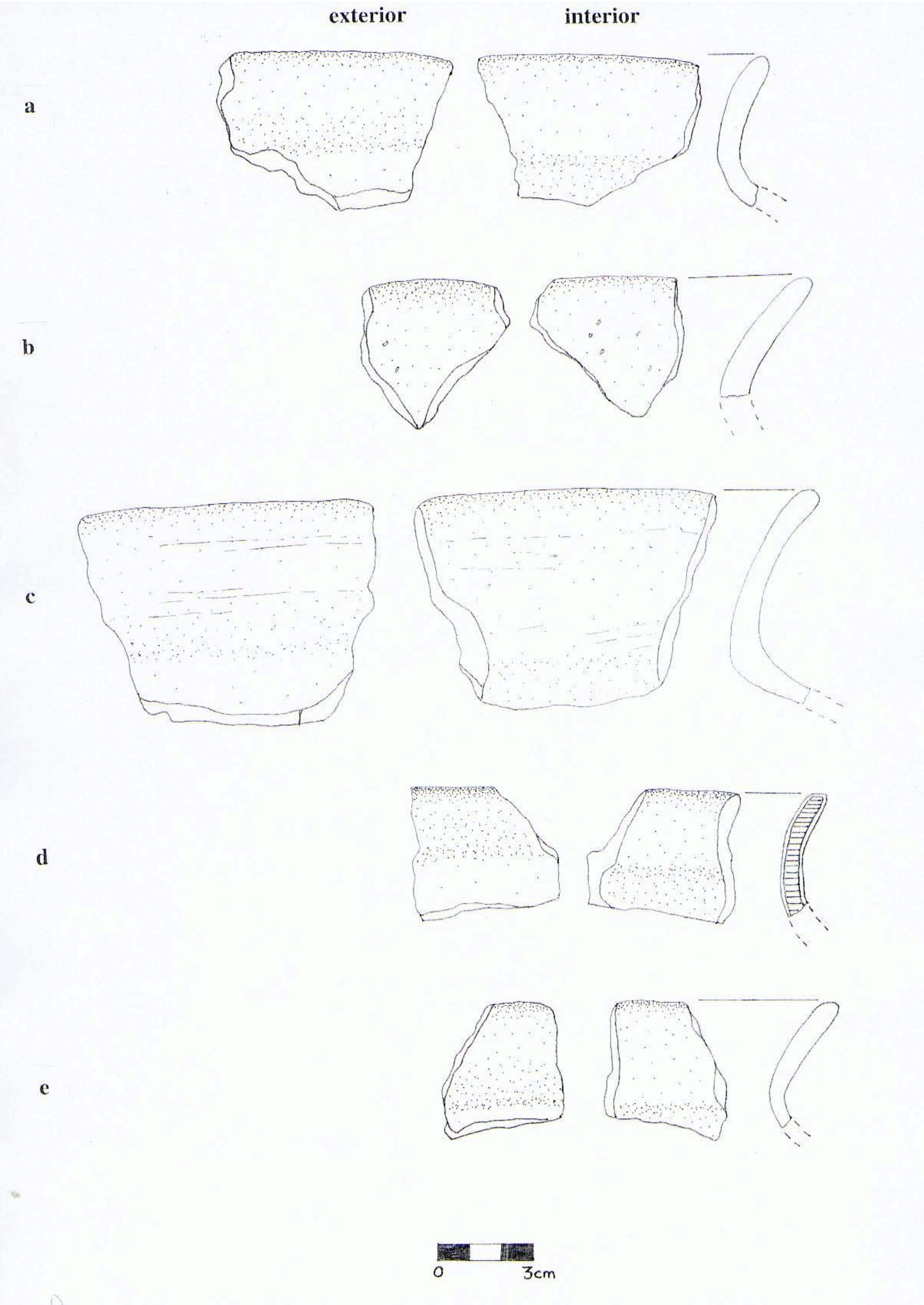
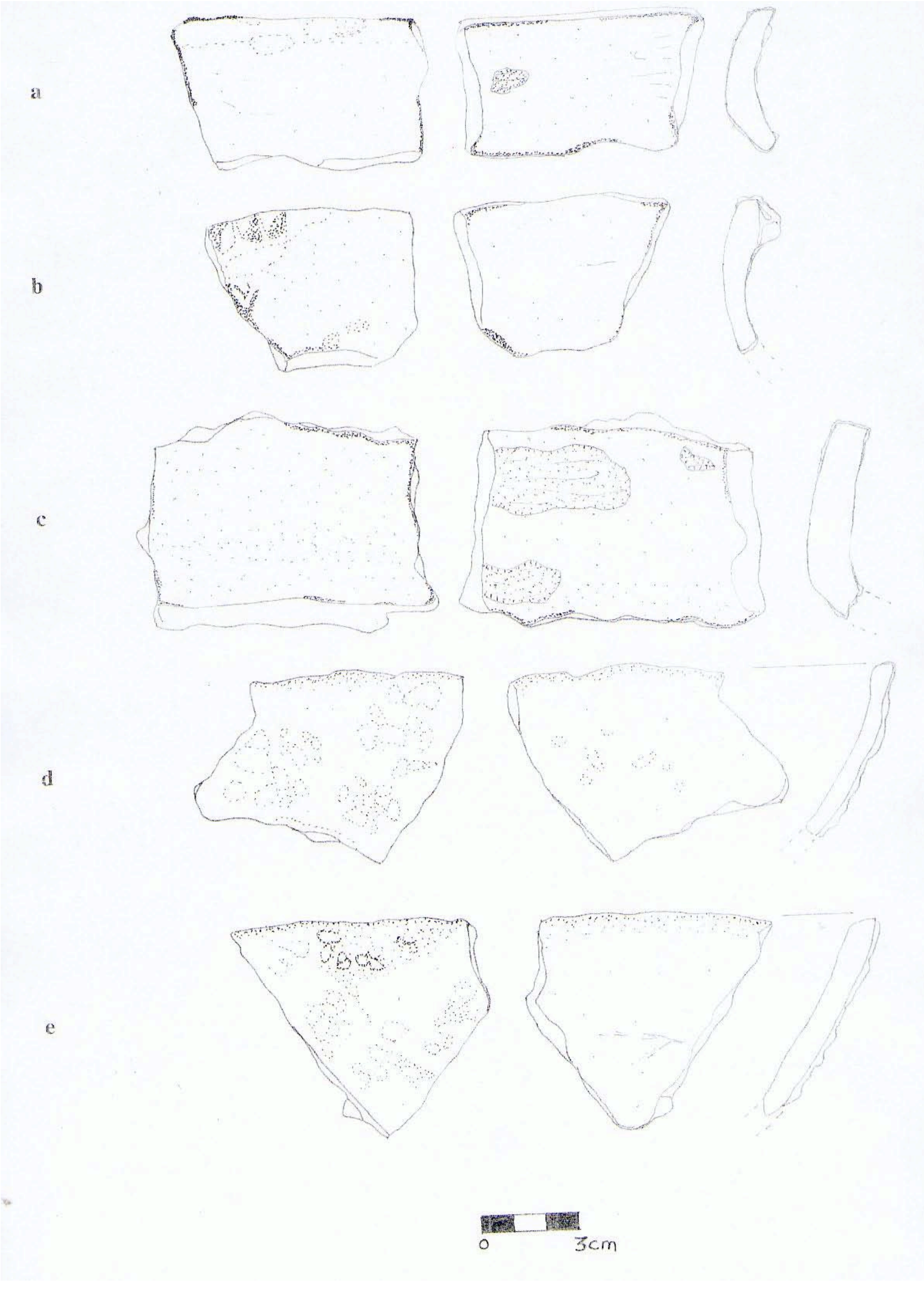


Illustration 5:



Appendix B: Petrographic Analysis Tables

Inventory of thin sectioned paste group sherds

Sherd Code	Context	Vessel Form	Macroscopic Paste Group	Petrofabric Group
PN 1	150 BN3E2/004	Flared neck jar	Pueblo Nuevo	Volcanic Ash 1
PN 2	150 BN5E3/004	Neckless, everted rim jar	Pueblo Nuevo	Volcanic Ash 2
PN 3	150 BN7E6/004	Neckless, everted rim jar	Pueblo Nuevo	Volcanic Ash 2
PN 4	150 BN2E3/003	Undetermined jar type	Pueblo Nuevo	Volcanic Ash 2
PN 5	150 BN3E4/003	Flared neck jar	Pueblo Nuevo	Volcanic Ash 2
SJ 1	150 BN3E4/003	Undetermined jar type	San Joaquin	Muscovite 2
SJ 2	150 BN6E5/004	Undetermined jar type	San Joaquin	Muscovite 1
SJ 3	150 BN5E6/003	Undetermined jar type	San Joaquin	Muscovite 1
SJ 4	150 BN3E4/003	Open bowl	San Joaquin	Muscovite 1
SJ 5	150 BN3E4/003	Flared neck jar	San Joaquin	Muscovite 1
C 1	150 BN4E2/003	Flared neck jar	Cacaulapa	Muscovite 2
C 2	150 BN7E6/004	Undetermined jar type	Cacaulapa	Muscovite 2
C 3	150 BN7E1/003	Flared neck jar	Cacaulapa	Muscovite 2
C 4	150 BN3E4/003	Flared neck jar	Cacaulapa	Muscovite 2
C 5	150 BN7E7/003	Flared neck jar	Cacaulapa	Muscovite 2
PI 1	150 BN3E2/004	Neckless, everted rim jar	Pitones	Volcanic Ash 1
PI 2	150 BN6E5/003	Neckless, everted rim jar	Pitones	Muscovite 2
PI 3	150 BN5E7/003	Undetermined jar type	Pitones	Volcanic Ash 3
PI 4	150 BN6E5/003	Straight neck jar with handle	Pitones	Volcanic Ash 3
PI 5	150 BN6E5/004	Undetermined jar type	Pitones	Volcanic Ash 3

Inventory of thin sectioned "potstand" sherds

Potstand Code	Context	Petrofabric
P 1	150 BN2E5/004	UNKNOWN 1
P 2	150 BN2E3/003	UNKNOWN 1
P 3	150 BN1E5/003	UNKNOWN 1
P 4	150 MN4E12/007	VOLCANIC ASH 2
P 5	150 MN4E12/007	VOLCANIC ASH 3

Inventory of thin sectioned test briquettes

Briquette Code	Clay Source	Temper	Wet Munsell Colour	Fired Munsell Colour	Shrinkage Post-Firing (%)
T 1	C	none	7/6 10YR yellow	7/4 7.5 YR pink	0
T 2	C	tan/gold brown schist	7/6 10YR yellow	6/4 7.5 YR light brown	0
T 3	B	none	3/4 10 YR dark yellowish brown	3/4 10 YR dark yellowish brown	20
T 4	A	none	3/4 10 YR dark yellowish brown	3/4 10 YR dark yellowish brown	20

Petrofabric Summary Charts

Petrofabric	Aplastics	Percentage	Shape	Sorting	Grain size
Volcanic Ash 1	volcanic ash	39	angular	well	fine to medium sand
	plagioclase	1	subrounded to subangular	poorly	very fine to medium sand
	gypsum	less than 1	subangular to angular	moderately	very fine to medium sand
	schist	less than 1	subrounded to subangular	poorly	very fine to coarse sand
	polycrystalline quartz	5	subangular to angular	poorly	very fine to coarse sand
	opaques	less than 1	rounded	well	fine to medium sand
	basalt	less than 1	subangular	moderately	medium to coarse sand
	chert	less than 1	subangular	moderately	medium to coarse sand
	muscovite	5	subangular	poorly	silt to medium sand
	grog	0			
	chlorite	0			
	pseudobone	1	angular	well	medium to coarse sand
	granite/gneiss	less than 1	subangular to angular	well	medium to coarse

Petrofabric	Aplastics	Percentage	Shape	Sorting	Grain size
Volcanic Ash 2	volcanic ash	32	angular	moderately	fine to coarse sand
	plagioclase	3	subangular	poor	very fine to coarse sand
	gypsum	1	subangular to angular	moderately	very fine to medium sand
	schist	3	subangular	poor	very fine to very coarse sand
	polycrystalline quartz	10	subangular to angular	poor	very fine to medium sand
	opaques	5	rounded	moderately	very fine to medium sand
	basalt	less than 1	subangular	well	medium to very coarse sand
	chert	less than 1	subrounded to subangular	well	medium to coarse sand
	muscovite	5	subangular	moderately-well	medium sand
	grog	1	angular	well	medium to coarse sand
	chlorite	0			
	pseudobone	3	angular	well	coarse sand
	granite/gneiss	less than 1	subangular to angular	well	medium to coarse

Petrofabric	Aplastics	Percentage	Shape	Sorting	Grain size
Volcanic Ash 3	volcanic ash	32	angular	moderately	fine to medium sand
	plagioclase	3	subangular	moderately	very fine to fine sand
	gypsum	1	subangular to angular	moderately	very fine to fine sand
	schist	3	subangular	poor	very fine to coarse sand
	polycrystalline quartz	8	subangular to angular	poor	very fine to fine sand
	opaques	2	rounded	moderately	very fine to medium sand
	basalt	less than 1	subangular	well	medium to very coarse sand
	chert	3	subrounded to subangular	well	medium to coarse sand
	muscovite	3	subangular	well	fine sand
	grog	less than 1	angular	well	medium sand
	chlorite	none			
	pseudobone	3	angular	well	medium to coarse sand
	granite/gneiss	less than 1	subangular to angular	well	medium to coarse

Petrofabric	Aplastics	Percentage	Shape	Sorting	Size
Muscovite 1	volcanic ash	25	angular	poorly	fine to very coarse sand
	plagioclase	1	angular	poorly	fine to coarse sand
	gypsum	less than 1	subangular to angular	moderately	fine to coarse sand
	schist	15	subrounded to angular	poorly	medium to very coarse sand
	polycrystalline quartz	15	subangular to angular	poorly	very fine to coarse sand
	opaques	7	rounded to subangular	moderately	very fine to medium sand
	basalt	less than 1	subrounded	well	coarse to very coarse sand
	chert	1	subrounded	poorly	fine to coarse sand
	muscovite	15	subangular to angular	moderately	fine to medium sand
	grog	2	subangular to angular	moderately	fine sand to grit
	chlorite	less than 1	angular	very well	coarse sand
	pseudobone	5	angular	well	coarse sand
	granite/gneiss	less than 1	subangular to angular	well	medium to coarse

Petrofabric	**Aplastics**	**Percentage**	**Shape**	**Sorting**	**Grain size**
Muscovite 2	volcanic ash	15	angular	moderately	very fine to medium sand
	plagioclase	2	angular	poor	fine to coarse sand
	gypsum	1	subangular to angular	moderately	fine to coarse sand
	schist	10	subrounded to angular	poor	fine to coarse sand
	polycrystalline quartz	10	subangular to angular	poor	very fine to coarse sand
	opaques	7	subrounded	moderately	very fine to medium sand
	basalt	less than 1	subrounded	well	coarse
	chert	1	subrounded	well	coarse to very coarse sand
	muscovite	10	subangular to angular	moderately	fine sand
	grog	less than 1	angular	moderately	medium sand
	chlorite	less than 1	angular	very well	fine to medium sand
	pseudobone	5	angular	well	coarse sand
	granite/gneiss	less than 1	subangular to angular	well	medium to coarse