A COMPOSITIONAL ANALYSIS OF PLAIN WARE POTTERY FROM PUEBLO LA PLATA AND RICHINBAR RUIN, AGUA FRIA NATIONAL MONUMENT, ARIZONA

by

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An Honors Thesis Presented in Partial Fulfillment
of Honors College Graduation Requirements
(Department of Thesis Coursework - School of Human Evolution and Social Change)

ARIZONA STATE UNIVERSITY

May 2006

Abstract

Temper analysis of plain ware ceramics from Pueblo La Plata indicates that none of the pottery contains local sand. La Plata is located atop Perry Mesa in central Arizona, where basalt dominates the geology. Petrographic thin-section analysis confirmed the observation that basalt was not present, thereby implying that the tempering materials used to make the pottery were not locally obtained. Unless local potters went far afield to procure their temper, the pueblo residents probably obtained their pots from non-local sources. The petrographic work in conjunction with clay chemistry assays with an electron microprobe suggest that the pottery may derive from at least two sources: one associated with sand containing numerous mafic grains, and another in which mafic grains are few or absent.

Introduction

The nature of the Perry Mesa Tradition (PMT) settlement on the Agua Fria National Monument is not currently well understood. Hypotheses regarding the relationships among PMT communities (see, for example, Wilcox, Robertson, and Wood 2001) have thus far been based largely on surficial similarities and differences in site characteristics, such as diagnostic artifacts, construction materials and methods, site size and distribution, patterns of apparently defensive features, and line-of-sight connections between sites (Stone 2000). Petrographic and chemical analyses of the ceramics at these sites can provide finer grained and more quantitative information regarding the social and economic ties within and among the communities in the Perry Mesa Tradition settlement and beyond.

In a preliminary step toward better understanding the nature of social organization, integration, and interaction on Perry Mesa, I undertook a multi-stage analysis of a large sample of plain ware ceramics from Pueblo La Plata, a 69+ room pueblo (likely having approximately 80 rooms, inclusive of outlying roomblocks) (Mapes 2005), as well as small samples from Richinbar Ruin and Pueblo Pato, two large pueblos approximately 8 and 6 km, respectively, from Pueblo La Plata. These three sites all belong to the Perry Mesa Tradition settlement of the area, which took place largely during the late 13^{th} and early 14^{th} centuries.

Combining data from a number of analyses brings to light patterns of ceramic production and exchange that aid in building a greater understanding of the economic and social relationships that existed within and between communities on Perry Mesa and in the surrounding area. The lines of evidence I draw upon stem from petrographic analyses of the sand temper in the sample sherds, clay chemistry assays using an electron microprobe, and a study of the local geology. The product created through the combination of these activities is a provenance-related temper typology, which can be used to visually sort plain ware sherds according to production source. Patterning in provenance-related sortings can then guide inferences about social and economic relationships.

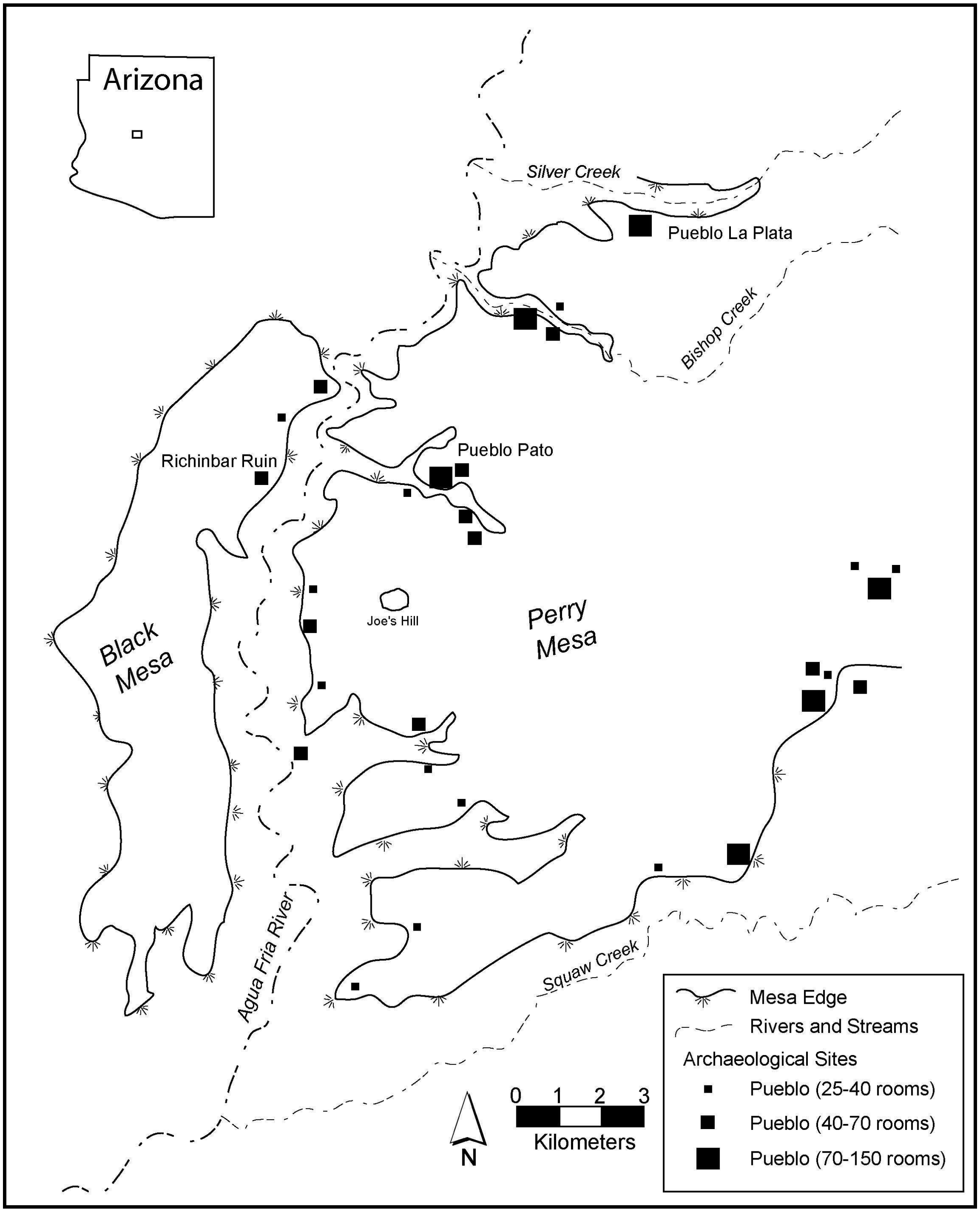
This research constitutes a pilot project, designed to cast light on the variation in mineralogical and chemical composition of the ceramic materials from Pueblo La Plata, and to allow a first look at patterning, both in the composition of the ceramics and in their spatial distribution. The baseline understanding of the plain ware ceramics established by this initial analysis will serve to guide further research in the area.

Background

Pueblo La Plata, the centerpiece of this research, is located on Perry Mesa, on the Agua Fria National Monument, in central Arizona. Over 400 sites have been recorded on the mesa, ranging from small field houses to large masonry pueblos like La Plata (Stone 2000). The major occupation of the area took place between AD 1150 and AD 1400. It was during this time that Pueblo La Plata, Richinbar Ruin, and Pueblo Pato were inhabited, though a recent paper by Wilcox, et al. (2001) suggests that most of these large sites on Perry Mesa post-date AD 1250. Earlier sites on Perry Mesa are few in number. One possible archaic site has been recorded, and about three Preclassic (pre-AD 1150) Hohokam sites have been identified on the southern part of the mesa, though these remain poorly documented (Ahlstrom 1995).

Sites associated with the peak occupation of the area exhibit similar characteristics, which have led to the definition of a Perry Mesa Tradition. Their appearance on the landscape represents a veritable explosion of settlement compared to anything prior to the PMT occupation or following its breakdown. The Perry Mesa Tradition settlement follows widespread trends in eastern and central Arizona, such as aggregation in larger pueblos in upland areas, associated field houses, and defensive site characteristics (Stone 2000; Wilcox, et al. 2001). In particular, the Perry Mesa Tradition is characterized by masonry pueblos, pairing or clustering of sites, terraces and runoff control features, extended burial, a red ware and brown ware ceramic complex, numerous small sites, defensive sites and site characteristics, and odd “racetrack” features whose purposes are currently unknown (Whittlesey et al. 1997). Pueblo La Plata is one of the largest Perry Mesa Tradition sites, and is central to a cluster of sites in the northwest portion of the mesa.

Figure 1. Locations of Sites on Perry Mesa and Black Mesa



Both the beginning and collapse of the Perry Mesa Tradition are hazy at best, but the dates most commonly given show the Perry Mesa Tradition running from about AD 1250 to AD 1450 (Wilcox et al. 2001). These dates are best estimates based upon ceramic assemblages, and are generally supported by the small handful of obsidian hydration dates that have been taken. Some theorists would argue for a narrower span of occupation, beginning around 1300 or so, and lasting until 1450, at least in some of the larger pueblos, such as La Plata (Connie Stone, personal communication 2004).

It is generally thought that the earlier Hohokam settlements on the mesa were too small and too few to have spawned the large Perry Mesa Tradition in situ (Ahlstrom 1995; Stone 2000; Wood 1998). Migration by groups into and out of the area probably played a large part in the development and dissolution of the tradition (Wood 1998). It is unclear what groups might have contributed to the Perry Mesa Tradition population, although the abandonment of the Prescott area at about the time that Perry Mesa villages were established, and the presence of Prescott grey ware pottery at Perry Mesa sites, have led some theorists to hypothesize that many of the migrants may have come from that area (Wilcox et al. 2001). Other non-local pottery types at Perry Mesa Tradition sites, including Pueblo La Plata, indicate some relationships with other outside groups, but these ties are as yet poorly understood (Stone 2000).

La Plata Site History

Pueblo La Plata has a far deeper history of vandalism and pothunting than of scientific investigation. In fact, as of 2000, no scientific excavations had been undertaken at any of the Perry Mesa pueblos with more than 20 rooms (Stone 2000). La Plata is large, visible from a distance, and is not terribly difficult to get to; a dirt road leads almost all the way to the pueblo mound. Ahlstrom, in the 1992 Perry Mesa site vandalism study, termed the pueblo in "poor" condition, with walls blown out, and some pothunter digging in every room (Ahlstrom 1992). Recently, however, the Legacies on the Landscape project, led by a team of archaeologists and ecologists at Arizona State University has initiated scientific archaeological and ecological studies centered around Pueblo La Plata and two other large pueblos on the Agua Fria National Monument: Richinbar Ruin and Pueblo Pato. In addition, the Museum of Northern Arizona has conducted surface collections at many of these sites for the purpose of better dating the occupation of the area. These results are not yet published.

Research Problem

This research was designed as a multi-stage analysis in order to address a number of hierarchically posed questions, with the ultimate goal of gaining an understanding and general characterization of the plain ware ceramics at Pueblo La Plata. To approach this goal, we focused on addressing the question: Are there distinct compositional groups in the sand temper used in the plain ware ceramics at La Plata, and if so, what do these groups suggest regarding social organization and integration within the site? Understanding the compositional characteristics of the plain ware ceramics at La Plata can, through comparison with the local geology and ceramics from other sites, help in discerning the organization of pottery production, where pots were made, and patterns of interaction and exchange. In addition, examining the number and spatial distribution of distinct compositional groups within the site can aid in understanding the nature of occupation at Pueblo La Plata itself. This primary question is addressed by answering a number of secondary questions, each focused on a different dimension of the primary issue, which can be addressed more directly through the archaeological materials.

The first of these secondary questions is: How many varieties of temper are present at La Plata, and how are those varieties defined? An answer to this question is provided by an examination of the rocks and minerals that make up the temper component of each sherd. Second, where were the raw materials for pottery production procured? And, third, were the plain ware ceramics made locally, or were they brought to the site from somewhere else? Temper and clay materials may have been obtained from local or non-local sources, and the production of pottery may also have occurred locally or non-locally. Figuring out where raw material procurement and pottery production took place can help us understand the processes by which these ceramic artifacts reached the locations where they were found.

An examination of the local geology indicates which rock and mineral types are available near La Plata. Perry Mesa is mapped as basalt on the Geologic Map of Arizona (Richard et al. 2000), and a preliminary, unpublished petrofacies map for Perry Mesa (Castro-Reino 2004) also indicates a basalt-dominated landscape. A thick basalt layer caps the mesa and overlies granitic and metamorphosed rock, which are exposed on the mesa slopes. Because of the predominance of basalt in the geology of Perry Mesa, noting the presence or absence of basalt in the sherds is important for determining where the pottery was made. In a preliminary examination of approximately 50 large sherds with a binocular microscope, no basalt was seen in any of the pottery, suggesting that the temper materials at least were brought to the mesa top from somewhere else. Unfortunately, the documentation of the local geology is incomplete. Consequently, only a coarse suggestion of local versus non-local materials is presently possible. Further study and sampling of the local geology may be able to reveal specific resource procurement zones for the sand temper contained in the La Plata plain ware pottery.

The final secondary question is: Are the different temper varieties present in the same proportions at different sample locations around the site, or non-randomly associated with certain parts of the village? This issue is addressed by looking for significant differences in the relative proportions of each temper variety at each sample unit around the site. If the same varieties are present in the same proportion throughout the site, then a sitewide, shared pattern of ceramic access may be inferred. If the varieties were distributed differentially and pots from different sources were used in different places around the site, different people or groups within the site may have had connections to certain production areas that were not common among all the inhabitants of La Plata.

Data Sources

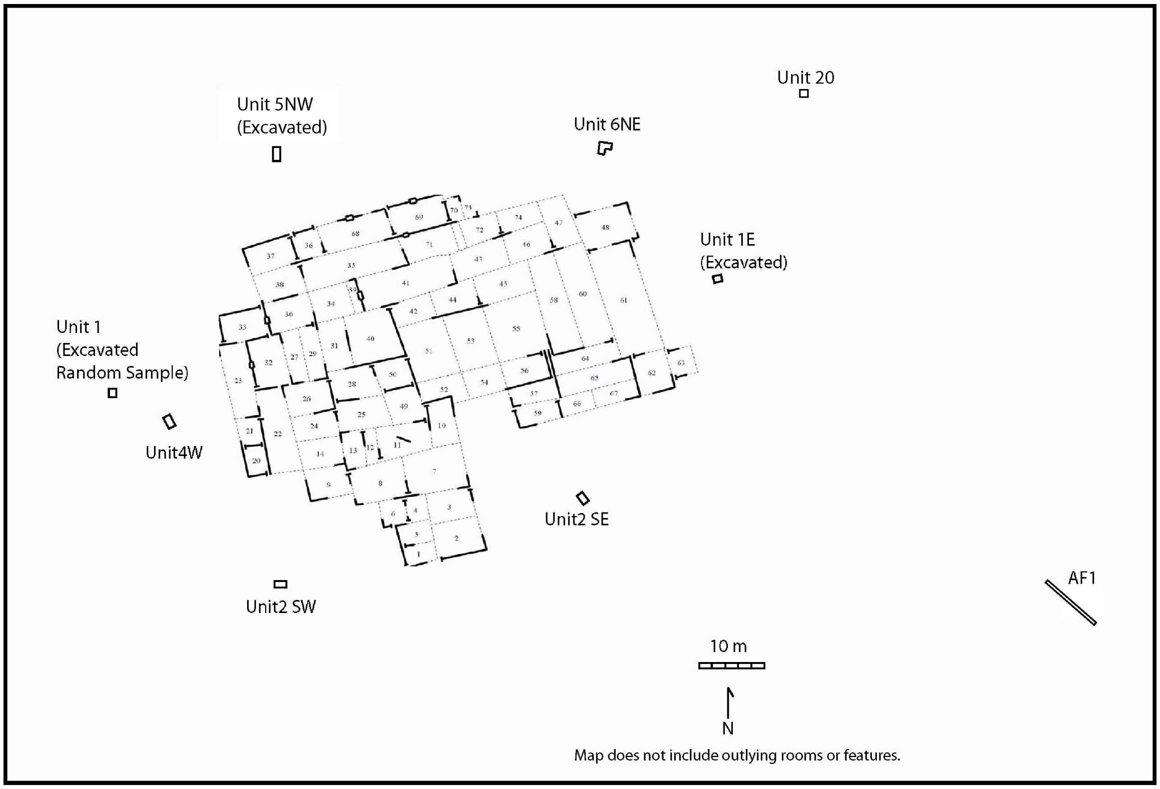
Sherds from Pueblo La Plata came from several surface collections and three excavated 1m x 1m units surrounding the pueblo (Table 1; Figure 2). No excavation has yet taken place inside the pueblo, and no collections were made from its interior. Six complete surface collection units, ranging in size from 1 x 1m to 1 x 3m, were placed in the artifact-rich area surrounding the pueblo. The variation in the size of these collection units was due to the desire for adequate sample sizes. Larger areas were collected where artifact density was lower. Collections from two other units at La Plata, Unit 20 and AF1, were also used in this study. Unit 20 was a 1 x 1m collection unit located some distance from the pueblo, where artifact density was considerably lower. AF1, was a 0.5 x 10m surface collection unit stretching over a small area (consisting of a ring of basalt cobbles and a scatter of artifacts) near the dirt road leading to La Plata.

In addition to these surface collections, materials from three excavated 1 x 1m test units were examined. Two of these units (1E and 5NW) yielded artifacts at some depth, but the other (Unit 1) was abandoned when sterile deposits were encountered at a depth of 12 cm (Kruse and Spielmann 2004).

Table 1. Surface Collection Units at Pueblo La Plata

Surface Collection Unit	**Collection Area**	**Plain Ware Sample Size**
1E	1x1m	90
2SE	1x2m	25
3SW	1x2m	112
4W	1x2m	75
5NW	1x2m	68
6NE	1x2m	63
Unit 1	1x1m	9
Unit 20	1x1m	5
AF1	Transect sample 0.5m x 10m	17
Other collection units		
Richinbar	1x1m	30
Pueblo Pato	1x1m	81

Figure 2. Surface Collection Units at Pueblo La Plata



Samples from Richinbar Ruin and Pueblo Pato each consisted of sherds from a single 1m x 1m surface collection unit. The availability of small samples from Richinbar Ruin and Pueblo Pato allowed for a preliminary comparison of ceramic materials between large PMT sites. However, the small sample sizes from these two sites prevented me from making any bold assertions.

Methods

The questions and issues discussed above were addressed through a multi-stage research process which involved several sequential sortings of the ceramic collections. First, the ceramic materials from the surface collections and excavated units were cleaned and put through a half-inch wire mesh to remove the tiniest sherds. With the aid of a binocular microscope, the remaining sherds were sorted to separate red wares and decorated types from the plain ware sherds. Plain ware is identified by its brown-firing paste and the absence of any slip or painted decoration. Once the plain ware sherds were isolated, all sherds smaller than a dime were removed, and each remaining piece was labeled with a unique number. Each sherd was then assigned to one of three size classes: 1) larger than a dime but smaller than a quarter; 2) between quarter size and 16 cm^2; and 3) larger than 16 cm^2.

In order to determine the number and composition of the temper varieties, a sample of the largest plain ware sherds was selected for thin sectioning and petrographic analysis. The largest cases were visually sorted by looking at the temper under a binocular microscope to gauge the range in variation in the tempering materials. A sample of 22 sherds (20 from La Plata and 2 from Richinbar) was chosen, which appeared to represent the range of different temper types present in the collection. Thin sections were made of these 22 sherds, and they were examined petrographically with polarized light by ASU geologist Gordon Moore, who made a visual approximation of the percentages of different rocks and minerals in the sand temper of each specimen. Differentiation in the proportions of feldspar, mafics, biotite, schist, and opaques seemed to suggest five distinct groups (Tables 2 and 3). The make up of these groups indicated that the presence of schist was an important factor in determining temper group, as had been suggested by J. Scott Wood (1987).

Table 2. Results of Petrographic Analysis

Sample No.	Feldspar	mafics	biotite	schist	opaques
LP001	10	10	<5	tr	<5
LP002	15	5	0	tr	<5
LP003	5	<5	10	15	<5
LP004	15	5	5	tr	<5
LP005	10	10	5	5	<5
LP006	30	tr	<5	tr	<5
LP007	25	5	5	tr	5
LP008	15	5	5	0	tr
LP009	20	5	tr	<5	<5
LP010	15	10	<5	tr	5
LP011	20	5	tr	0	<5
LP012	15	5	tr	0	<5
LP013	15	15	0	0	<5
LP014	10	20	tr	0	10
LP015	20	10	0	0	<5
LP016	25	10	tr	tr	<5
LP017	15	5	0	0	5
LP018	15	tr	0	0	<5
LP019	20	10	tr	0	<5
LP020	20	<5	0	0	<5
RIC01	15	10	0	0	5
RIC02	15	5	0	0	<5

tr = 1-5 grains in slide
<5 = ~1 grain in each field of view (5X mag)
5-100 = estimated vol% in slide relative to LP013

Table 3. Preliminary Temper Groups Based on Petrographic Analysis

Sample No.	Preliminary Temper Group
LP001	1
LP002	1
LP003	1
LP004	1
LP005	1
LP006	1
LP007	1
LP008	2
LP009	1
LP010	1
LP011	5
LP012	5
LP013	2
LP014	4
LP015	3
LP016	1
LP017	5
LP018	3
LP019	3
LP020	5
RIC01	2
RIC02	5

Key

1: schist-bearing
2: moderate felsic, moderate mafic, ± biotite
3: strong felsic, moderate mafic, ± biotite
4: moderate to strong mafic, weak felsic, ± biotite
5: moderate to strong felsic, weak mafic, no or trace biotite

I chose to look at the chemical composition of the clay fraction as a line of evidence complementary to the petrographic analysis of the sherds' temper content. To do this, the clay fraction in each of the same 22 thin-sectioned sherds was analyzed with an electron microprobe. The probe has the capacity to assay very small points on a sample, which allowed compositional analysis of the pottery's clay fraction without the contaminating effects of the temper. This assessment of clay chemistry provided another source of information with which to investigate the compositional variation in the plain ware pottery.

Microprobe Methodology

The microprobe directs a stream of high-energy electrons onto a small spot on the sample's surface and analyzes the wavelengths of emitted x-rays produced by the bombardment. The relative intensities of the x-rays produced at each wavelength indicate the relative abundance of each chemical element in the sample (Birks 1971). The probe's capacity to do microanalysis allows the selection of tiny areas of the sample for analysis, permitting assays of the clay fraction with only minimal contamination from the temper particles. Silt-sized particles are almost always unavoidable. In the analysis of Hohokam plainwares of the Phoenix basin, the effects of these tiny inclusions have been checked experimentally, and were found to be inconsequential (Abbott 1994).

A Joel JXA-8600 electron microprobe with Tracor-Northern TN 5600 automation and energy-dispersive analysis system was used to perform the assays. The thin section slides were all coated with a 400-angstrom-thick layer of carbon. All samples were analyzed using a 15-Kv filament voltage and a 10-nA defocused beam current. The x-ray detector was mounted at a take-off angle of 40°. Matrix effects were corrected with a ZAF algorithm, and the equipment was calibrated with a Kakanui hornblende standard. The detector live-counting time was 50 seconds. All of the assays were performed by David Abbott and Andrew Lack in the Department of Chemistry and Biochemistry at Arizona State University, Tempe.

Five sample spots, approximately 0.109 mm^2 in area (about the size of a period on a printed page), were assayed for each sherd thin section. Sample spots were carefully selected to avoid temper inclusions. The percentages of eight chemical elements (sodium [Na], magnesium [Mg], aluminum [Al], silicon [Si], calcium [Ca], potassium [K], titanium [Ti], and iron [Fe]) were determined. Obvious extreme percentages occurring in sample spots were dropped, and the five assays of each sherd (or fewer, if spots were dropped) were averaged to produce mean percentages of each of the elements measured. A factor analysis with a varimax rotation of the data yielded two factors with eigenvalues greater than 1.0 (Figures 3 and 4, Table 4).

The results of the chemical assays did not co-vary with the petrographic results as I had originally supposed they might. The results of the petrographic analysis had suggested that the presence or absence of schist in the temper was important to distinguishing different temper groups. However, when the schist content was plotted against the clay chemistry results, no distinct groups were visible. Schist-bearing and non-schist-bearing cases were interspersed throughout the plot (Figure 3). The presence or absence of schist, then, did not appear to correspond with any patterning in the clay fraction, as we would expect if the presence or absence of schist were a provenance-related diagnostic.

In contrast, when mafic content was plotted against the chemical results, cases with high mafic content (10% or greater) tended to group in the upper-right-hand corner of the plot (Figure 4). This fit between the petrographic and chemical results suggests that mafic content may be a useful indicator of production source-related temper groups.

Mafic rocks and minerals are relatively rich in heavier elements, especially iron and magnesium, and have a higher specific gravity than silicic rocks and minerals (which are rich in lighter elements such as silica, oxygen, aluminum, and potassium). Mafic rocks and minerals are also usually dark in color, allowing them to be visually identified. The mafic grains in the sherds I examined tended to be angular and black, with a glassy luster.

Figure 3. Schist Content and Clay Chemistry

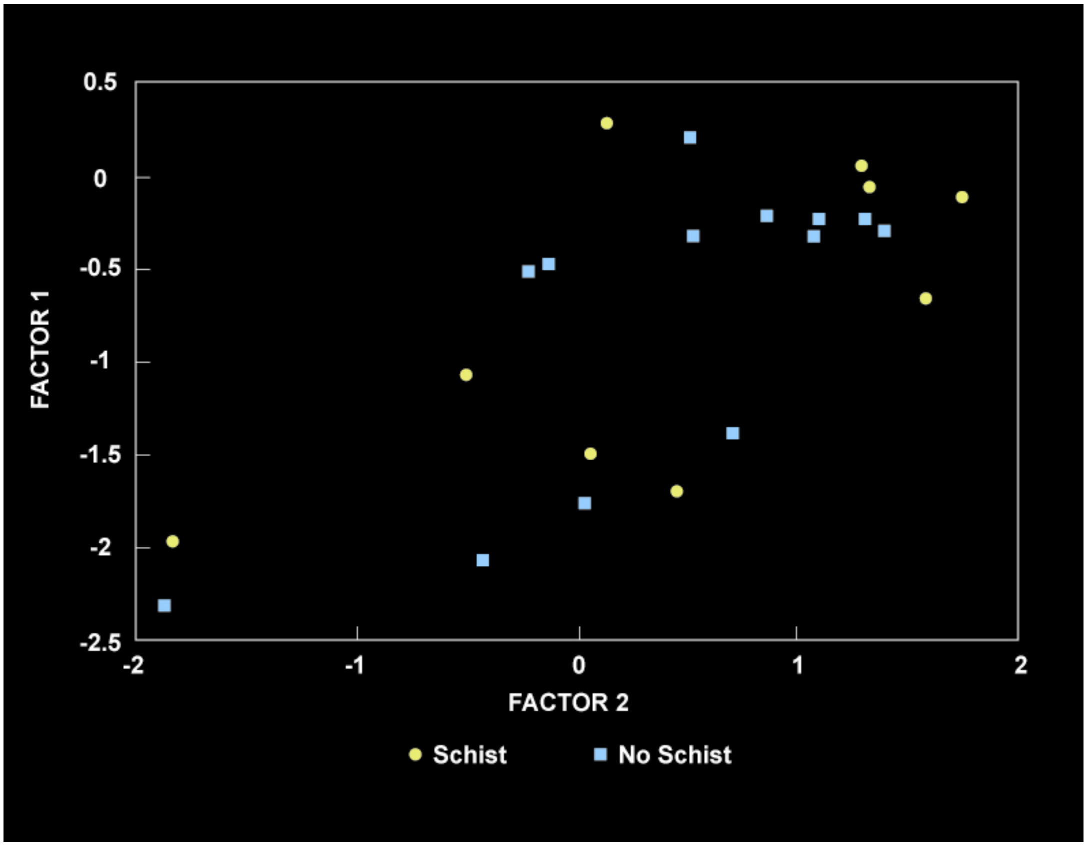


Figure 4. Mafic Content and Clay Chemistry

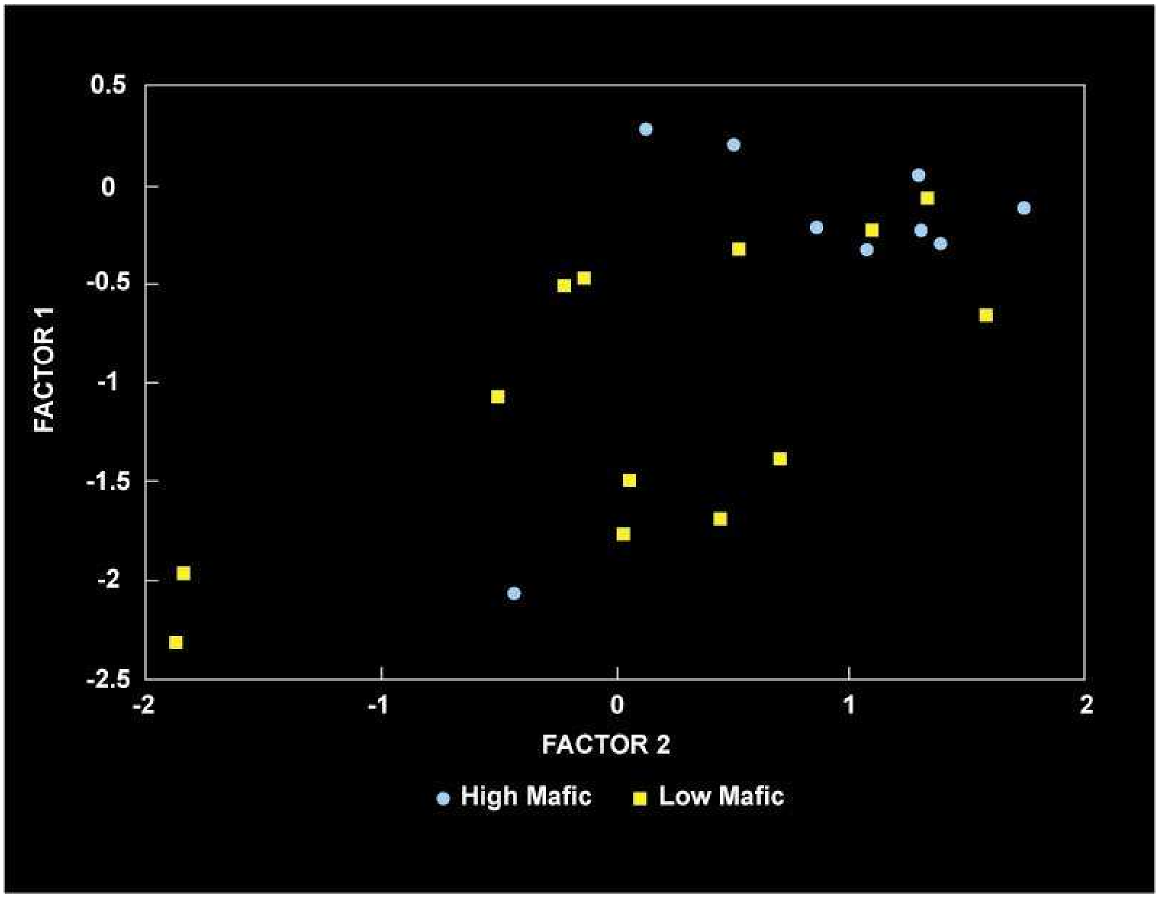


Table 4. Factor Loadings,
Figures 3 and 4

Element	Factor 1	Factor 2
Na	-.80954	-.13516
Mg	.88408	-.07177
Al	-.56642	.67814
Si	.17660	-.89824
K	.07557	.72847
Ca	.69634	-.28270
Ti	.74775	.14368
Fe	.15703	.70734
% of variation	39.0	27.1

The combined results of these analyses were used to determine the sorting criteria to be applied to the entire collection. Since the content of mafic temper particles appeared to best fit with the clay chemistry, the entire collection of sherds was sorted according to the amount of mafic material visible in the temper, using a binocular microscope. Sherds were placed into two temper categories based on the presence or absence of unequivocal mafic grains. The relative proportions in each sample were then compared to determine the extent to which the distribution of temper varieties varied within the site of La Plata, and between La Plata, Richinbar, and Pato.

Results

The results of this analysis indicated that non-mafic temper dominated the collection at all three sites, generally comprising 70-80% where sample sizes were robust. Comparisons of the surface collection units (Table 5) and excavation units (Table 7) at Pueblo La Plata, showed no notable spatial variation in temper type distribution. This result suggests that there was a shared pattern of plain ware ceramic access among the inhabitants of Pueblo La Plata.

Table 5. Plain Ware Temper Category Counts.
Surface Collection Units, Pueblo La Plata

Collection Unit	Mafics Absent	Mafics Present	Unit Total
1E	69 76.67%	21 23.33%	90 100%
2SE	17 68%	8 32%	25 100%
3SW	83 74.11%	29 25.89%	112 100%
4W	50 66.67%	25 33.33%	75 100%
5NW	58 85.29%	10 14.71%	68 100%
6NE	48 76.19%	15 23.81%	63 100%
Unit 1	2 22.22%	7 77.78%	9 100%
Unit 20	3 60%	2 40%	5 100%
AF1	9 52.94%	8 47.06%	17 100%

Comparisons of surface collected materials from La Plata, Richinbar Ruin, and Pueblo Pato (Table 6) did not indicate notable differences in temper type proportions between these sites. Difference of proportions tests among the samples from all three sites (Table 7) indicated that there were no significant differences in the proportions of mafic and non-mafic temper at each site (Hoel and Jessen 1982). However, the samples from Richinbar and Pato are far too limited for us to make any solid inferences at this point.

Additional comparisons of the different levels of each excavated unit at Pueblo La Plata (Table 8) did not indicate that there was any change in the proportion of temper varieties through time.

Table 6. Plain Ware Temper Category Counts.
Surface Collections, All Sites

Site	Mafics Absent	Mafics Present	Totals
La Plata Surface Total	339 73.06%	125 26.94%	464 100%
Richinbar	22 73.33%	8 26.67%	30 100%
Pueblo Pato	54 66.67%	27 33.33%	81 100%

Table 7. Difference of Proportions Tests, All Sites

Site Comparison	z-value	Probability
La Plata- Richinbar	-0.0324	>.05
La Plata- Pueblo Pato	1.135	>.05
Pueblo Pato- Richinbar	0.692	>.05

Table 8. Plain Ware Temper Category Counts.
Excavation Units, Pueblo La Plata

Excavation Unit 1:

Level	Mafics Absent	Mafics Present	Level Total
0	2 22.22%	7 77.78%	9 100%
1	43 58.11%	31 41.89%	74 100%

Excavation Unit 1E:

Level	Mafics Absent	Mafics Present	Level Total
0	69 76.67%	21 23.33%	90 100%
1	120 78.95%	32 21.05%	152 100%
2	172 77.48%	50 22.52%	222 100%
3	61 71.76%	24 28.24%	85 100%
4	1 20%	4 80%	5 100%
Wall Clearing	31 72.09%	12 27.91%	43 100%

Excavation Unit 5NW:

Level	Mafics Absent	Mafics Present	Level Total
0	58 85.29%	10 14.71%	68 100%
1	83 82.18%	18 17.82%	101 100%
2	108 82.44%	23 17.56%	131 100%
3	93 72.09%	36 27.91%	129 100%
4	15 62.50	9 37.50%	24 100%
5	32 78.05%	9 21.95%	41 100%

Conclusions

Chemical and petrographic analyses allowed us to discern two primary varieties of plain ware pottery distinguished by their temper at Pueblo La Plata, Richinbar Ruin, and Pueblo Pato. These varieties are defined by either an absence or presence of mafic grains in the sand temper.

The absence of basalt in all of the sherds indicated that the temper materials were procured from non-local sources. As Perry Mesa is capped by basalt, it did not appear that the temper came from the mesa top, though other sources of temper may exist off the mesa top. A non-local temper source would suggest non-local pottery production, though the temper could have been transported to La Plata as raw material. Better knowledge of the local geology, especially with the possibility of locating specific source areas, would help to better model the organization of ceramic production and distribution on Perry Mesa.

The lack of any notable spatial variation in temper type distributions at La Plata suggested a shared pattern of ceramic access among its inhabitants. That there appears to be a shared use of non-local materials is interesting, though it is not currently possible to suggest where these materials originated or how they came to Pueblo La Plata.

Directions for future research

This study has offered a first look at the variation in mineralogical and chemical composition of the ceramics from Pueblo La Plata, and has also provided an initial glimpse of the compositional variation across space. Although local production of pottery with non-local materials cannot be ruled out, the data are consistent with and seem to be pointing to the acquisition of large amounts of pottery from non-local producers, which implies a significant pattern of interaction. Moreover, the inhabitants of Pueblo La Plata may have acquired their pots from at least two different sources.

The results of this pilot project show that the ceramics could be an invaluable source of information about interaction networks in further studies on Perry Mesa.
Already, this project has served to point future research in several directions.

One of these directions, which is currently being explored, entails chemical analyses of the mafic grains themselves to determine if they were derived from an eroded basalt matrix or from some other parent material, such as granite. Thus far, this analysis suggests that the mafic grains in the temper were derived from a silicic plutonic source (such as a granite) rather than a basaltic, volcanic one. If this idea proves to be correct, it would support the view that the temper materials did not come from the top of Perry Mesa. If sand temper were procured locally from the mesa slopes or valleys (off the mesa top), where granitic rocks are in abundance, one would still expect mafic grains of a basaltic, volcanic origin to be present in the sands, where they would have been carried by erosional forces.

In addition, a larger sample of chemically and petrographically analyzed sherds would help develop a more complete picture of the relationship between the clay chemistry and the mineralogy of the temper fraction. Sand sampling, to find out what is on the ground, would also be quite helpful. Better understanding of the local geology would inform future ceramics research designs, would allow the possibility of linking temper types with source areas on the local landscape, and would help to discern non-local temper varieties.

Appendix 1. Electron Microprobe Data

Sample	**Na**	**Mg**	**Al**	**Si**	**K**	**Ca**	**Ti**	**Fe**	**Spots**
LP001	2.63	2.17	19.76	61.67	2.99	3.19	0.47	6.19	5
LP002	3.62	0.70	21.19	65.95	1.99	1.20	0.22	4.64	5
LP003	1.12	1.80	26.37	59.56	3.07	1.38	0.36	5.90	5
LP004	3.56	0.97	21.62	62.37	2.93	0.88	0.33	6.86	5
LP005	1.51	1.69	22.08	61.93	2.98	1.45	0.56	7.56	4
LP006	2.62	1.30	21.53	61.37	3.27	1.47	0.86	7.06	4
LP007	3.99	1.01	20.38	63.17	2.89	1.12	0.44	6.75	5
LP008	3.08	1.03	19.35	63.79	3.41	2.50	0.56	5.75	5
LP009	3.11	1.17	19.39	64.86	2.72	1.39	0.38	6.55	4
LP010	1.62	1.65	23.09	60.84	3.49	1.23	0.59	7.04	4
LP011	2.87	0.83	21.84	62.90	3.46	0.89	0.40	6.55	5
LP012	1.98	0.91	20.26	63.96	3.28	1.65	0.59	6.95	5
LP013	2.46	1.32	20.48	62.92	3.46	1.45	0.66	6.92	5
LP014	1.49	1.27	21.61	63.40	4.27	1.11	0.52	5.92	5
LP015	2.16	1.38	19.70	63.95	3.19	1.41	0.84	6.78	5
LP016	2.65	1.55	21.72	61.13	3.25	1.39	0.63	7.40	5
LP017	3.23	0.75	21.03	66.34	2.28	1.32	0.31	4.27	3
LP018	3.62	0.92	22.76	62.11	2.66	1.14	0.44	5.71	5
LP019	3.55	1.48	20.76	60.98	3.47	1.45	0.85	7.08	5
LP020	2.66	1.72	20.62	61.85	3.04	1.44	0.54	7.80	5
RIC01	4.50	0.88	22.32	61.98	2.44	1.59	0.40	5.44	4
RIC02	2.79	1.23	20.49	64.19	3.00	1.42	0.75	5.73	5

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