6

Plaquemine Recipes

Using Computer-Assisted Petrographic Analysis to Investigate Plaquemine Ceramic Recipes

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Archaeologists working in the Lower Mississippi Valley (LMV) have focused a great deal of energy on identifying, classifying, and explaining the Plaquemine-Mississippian dichotomy (Phillips 1970; Phillips et al. 1951; Williams and Brain 1983). The primary tool in this investigation has been ceramics, and the principal attribute is the presence or absence of shell tempering (see Rees and Livingood, this volume). Despite the axiomatic role that shell tempering plays in identifying the Plaquemine-Mississippian divide, there are many places and times in the Plaquemine world in which a significant percentage of the ceramic assemblage contains provocative mixtures of shell and grog tempering and in which decorative motifs span temper types. This has led some archaeologists (Hally 1972; Kidder 1998b) to question whether too much interpretive weight has been given to the presence and absence of shell tempering.

One of the challenges faced by archaeologists attempting to study the Plaquemine phases in which shell and grog are both used as tempering agents is that it is not clear that the varieties specified for distinguishing ceramic fabric correspond well to real cultural and technological distinctions made by the potters. Part of the problem is that the type-variety system developed by Ford, Phillips, Williams, and Brain for the LMV is based on macroscopically observed criteria, whereas potters often ground the tempering agents into very small sizes and sometimes mixed tempering agents together in ways that make macroscopic classification challenging and subjective. A cursory glance at the intellectual history of the sorting criteria for plainwares in the Lower Yazoo and Natchez regions reveals how murky these classifications can be.

Addis Plain was originally documented by Quimby (1942:265–266, 1951: 107–109) as a “clay-tempered type” and a major diagnostic of Plaquemine culture. Phillips (1970:48–49) designated Addis as a variety of the type Baytown Plain and defined it as the "clay-tempered plainware of the Mississippi period from the Medora and Plaquemine phases in the Delta and Lower Red River regions to the Mayersville phase in [the Lower Yazoo]." Interestingly, Phillips (1970:60–61) also acknowledged the similarity between his Baytown Plain, *var. Addis* and his Bell Plain, *vars. Holly Bluff* and *St. Catherine,* which contain finely pulverized shell sometimes in quantities so small that their inclusion seems to be "accidental." Williams and Brain (1983:92) retained Addis as a variety of Baytown Plain but used Bell Plain, *var. Greenville* to describe Addis with the addition of shell temper to the paste. They also retained Bell Plain, *var. Holly Bluff* to describe heterogeneous Addis-like sherds in which shell tempering is slightly more prevalent than in Bell Plain, *var. Greenville.* Steponaitis (1974:116) proposed elevating Addis to the level of type and defined it as having a heterogeneous organic grog-tempered paste but allowed for the presence of shell in some types. Steponaitis then relocated the *Greenville* and *St. Catherine* varieties from their position under Bell Plain to be varieties under Addis Plain. The elevation of Addis to the level of type has been made by some archaeologists, particularly those who have worked in the Natchez Bluffs (e.g., Brain 1989; Brain et al. 1994; Brown 1985a) but has not been embraced by others (e.g., Kidder 1993a; Ryan 2004). More recently, Ryan (2004:94) proposes keeping Addis as a variety of Baytown Plain for the analysis of Hedgeland ceramics because of the close relationship between Addis and Baytown Plain, var. *Little Tiger. Little Tiger* is proposed as a transitional ware between earlier Baytown pastes and *Addis* and is differentiated from *Addis* because it has less temper.

There are two fundamental explanations for the tortured history of these types. First, Phillips (1970) and later Williams and Brain (1983) fundamentally viewed the Plaquemine-Mississippian phenomenon as a cultural divide and it was necessary to define phases as either belonging to Mississippian or Plaquemine (Jeter and Williams 1989:212; Rees and Livingood, this volume). The primary tool in this enterprise was ceramic typology and in the hierarchical system of type-variety classification the presence or absence of shell was a first-order attribute. This is entirely understandable from a macroregional perspective, and it explains why Phillips would place the Addis variety under Baytown Plain and the closely related *Holly Bluff* and *St. Catherine* varieties under Bell Plain. However, for archaeologists working in phases in which these closely related types are common, this system of nomenclature can be unwieldy. Another explanation for the difficulties archaeologists have had in defining and arranging these taxa is that in the phases in which potters were freely choosing between shell and grog temper, a larger number of permutations is possible; designing a system to accurately describe these permutations is problematic. Support for this argument can be found from merely counting the number of plainware varieties in use in the LMV. Despite large quantities of coarse shell–tempered ceramics, only three varieties of Mississippi Plain are in common use in the Plaquemine world: *Coker, Mainfort,* and *Yazoo.* However, there are eight varieties commonly used to categorize fine-sized-grog–tempered and grog- and shell-tempered fabrics in the Plaquemine period: Addis Plain, *vars. Addis, Greenville, Junkin, Ratcliffe,* and *St. Catherine,* and Bell Plain, *vars. Bell, Holly Bluff,* and *New Madrid.*

Michael Galaty (2006) has used a ceramic ecology approach to argue that on a regional scale differences in tempering choices in Mississippi might be related to differences in the types of clays and tempering agents available to potters. For example, he argues persuasively that pre-Mississippian period potters in west Mississippi may have lacked access to sand suitable for tempering and relied instead on grog, whereas potters in east Mississippi may have preferred the easily available sand. Although he does not specifically address the regional differences in the use of grog and shell, his work raises the possibility that macroregional differences in temper might be related to ecology, not culture.

However, within a site the variation being reflected in the varieties of Addis Plain and other closely related types originates from the choices made by potters during clay preparation. It is possible that the potters could have been haphazardly adding grog and shell to certain vessels, which would lead to a random-looking distribution of temper frequency. However, it is much more likely that the Plaquemine potters were in fact very careful about clay preparation and the addition of tempering agents, like most ethnographically studied potters (Arnold 1985; Krause 1985). Potters often clean their clays to remove extraneous particles and then add carefully prepared tempering agents. Some potters mix temper with the prepared clays until the paste reaches a desired texture. For example, the Ibibio of Nigeria add grog or sand to the clay until it reaches the correct consistency called *aduang nbibiot* (Nicklin 1981:173; Rice 1987:121). Other potters follow a specific recipe that designates the ratio of clay and temper (Rice 1987:121). For example, some Kavango potters in southern Africa mix two parts grog to three parts clay (Blandino 1997:26), whereas the Shipibo-Conibo of eastern Peru have a ratio of clay to temper of two to three (DeBoer and Lathrap 1979).

The goal of this study is to test a small assemblage of Plaquemine ceramics to see whether it is possible to detect modes in the distribution of temper size and abundance. If there are modes, then these can be used to reconstruct the paste recipes used by the potters. Armed with knowledge of the paste recipes, we can evaluate the utility of the commonly used plainware varieties for classifying the ceramic assemblage. Furthermore, it seems likely that of all of the decisions a potter makes, that of temper is probably one of the most resistant to change over time. Vessel form and decoration can change over decades in pre-state societies, but temper choices typically persist for centuries. In most pre-state societies, pottery production is a household activity (Arnold 1985:100–101; Sinopoli 1991:98–102; van der Leeuw 1977), and it is presumed that knowledge about pottery production is handed down through generations within the household. Whereas more visible aspects of pottery production such as vessel form and decoration might be subject to changing personal or group concepts of pottery construction, less visible and more technological decisions about temper are likely to be more resistant to change. Because of this, with sufficient information about paste recipes it might be possible to tease apart different communities of production, especially when multiple tempering agents encode greater information.

Since the terms used in ceramic studies such as *paste* and *temper* are often defined differently by different authors, it is important to be clear how they are used in this chapter. Following the connotations common to the discussion of LMV ceramics (which differ somewhat from the definitions common to petrographic literature [e.g., Stoltman 1991:109–110]), *temper* refers exclusively to material intentionally added to a clay to improve its physical properties. *Inclusion* refers to all aplastics in a clay, whether they were added deliberately or were naturally occurring. *Paste* is defined as the clay plus all inclusions. Therefore, a *paste recipe* refers to all of the rules a potter follows to create the paste used to form a vessel, including where the clay should be gathered, how it should be processed, what temper should be added and in what quantities, and how the clay should be handled and treated before and during vessel creation.

The Sample

The sample under study comprises 29 sherds from the Pevey (22LW510) and Lowe-Steen (22LW511) sites located on the central Pearl River in Lawrence County, Mississippi. The Pevey site is a large mound site, with nine extant flat-top mounds, located approximately 18 km south of the two-mound Lowe-Steen site. Both sites date primarily to the Winstead phase (Livingood 1999), which is temporally equivalent to the Anna or Winterville phases, and the Pevey site also has a small Pevey phase occupation, which is temporally equivalent to the early Foster or Lake George phases.

The Pevey site was first investigated by Baxter Mann and John Blitz between 1982 and 1984 (Mann 1988). More extensive excavations were carried out at both sites by the University of North Carolina Field Schools in 1993 and 1994 (Livingood 1999), including test units in every mound. In 2000, I returned with volunteers primarily from the University of Michigan to test the plaza area to the west and north of the Pevey site.

The two most common decorated varieties found at the Pevey and Lowe-Steen sites are Anna Incised, *var. Anna* and Plaquemine Brushed, *var. Plaquemine.* Other common decorated types include Carter Engraved, *var. Carter,* Grace Brushed, *var. Grace,* D'Olive Incised, *var. D'Olive,* L'Eau Noire Incised, *var. L'Eau Noire,* Leland Incised, Mound Place Incised, and Parkin Punctated. Most of these types are most commonly found at sites to the west of the Pearl River along the Mississippi River, while other types, such as Mound Place Incised and D'Olive Incised, are more commonly associated with sites to the east such as Bottle Creek or Moundville. Several of the most abundant types represent decorative traditions that span multiple tempers. For example, Anna Incised, *var. Anna* is the type assigned to sherds from shallow bowls or plates with interior decoration if the temper is categorized as being Addis Plain, *var. Addis* or Addis Plain, *var. Greenville.* But if the exact same vessel were tempered more heavily with shell, it would be classified as D'Olive Incised, *var. D'Olive.* Likewise, jars with exterior brushing on Addis or Greenville pastes are called Plaquemine Brushed, *var. Plaquemine,* while jars with shell tempering are called Grace Brushed, *var. Grace.*

The initial analysis and classification of ceramics indicates that middle Pearl potters were making interesting and complex choices with regard to temper. The most common fabric used at the Pevey and Lowe-Steen sites is coarse shell tempering (72 percent of all sherds). However, Pearl River potters assigned special importance to Addis paste sherds because they executed most of their decorative motifs on these wares. Fifty-two percent of all decorated sherds have Addis Plain, *var. Addis* paste, 17 percent of decorated sherds have a Greenville paste, and only 27 percent have a Mississippi Plain paste. Despite the preference for Addis pastes, several decorative techniques crosscut temper types. If we consider all of the interior decorated plates and bowls (Anna Incised and D'Olive Incised) together, 60 percent are executed on Addis paste, 25 percent on Greenville paste, and 14 percent on Mississippi Plain paste. On the basis of these initial observations, it is clear that middle Pearl potters were comfortable using a wide variety of temper combinations. Additionally, it is not obvious whether the plainware varieties developed primarily for the Lower Yazoo and Natchez regions are the most appropriate varieties to classify the ceramics from the middle Pearl River.

All of the 29 sherds selected for this analysis are diagnostic of vessel shape, decoration, or both. The sherds were deliberately chosen to represent the different temper combinations under investigation and to be representative of different vessel forms and functions. Of the 29 sherds in this analysis, 24 were excavated from a single 2-×-2-m unit at the Pevey site designated Unit M. This unit is located approximately 25 m northwest from the base of the site's large mound, Mound E, in a small rise on the edge of the natural terrace. Only four of the sherds from Unit M come from the upper level, which probably has an early Pevey phase assignment while the remaining 20 sherds have a Winstead phase date. Of the sherds not from Unit M, two come from the Mound H excavation and one from the Mound I excavation at the Pevey site, while the final two come from the Feature 1 excavation at the Lowe-Steen site. All have a Winstead phase date.

Methodology

The only technique appropriate to gather data on temper abundance and size from this sample is ceramic petrography, which is the practice of examining ceramics microscopically to study the clay characteristics and inclusions. Hi-tech chemically based approaches such as x-ray diffraction or neutron activation can provide only a partial picture since they are unable to chemically distinguish grog from the clay matrix. Ceramic petrography has been a part of American archaeology since the days of Anna Shepard (Shepard 1976), but most modern analysis owes much to Jim Stoltman, who systematized the use of point-counting techniques borrowed from geological petrography in order to bring a higher level of rigor and accuracy to the field (Stoltman 1989, 1991, 2000). Today, most ceramic petrographers use a point-counting technique to quantify inclusions, which involves overlaying the sample with a grid of points in order to obtain representative counts of constituent particles. This technique is excellent at measuring the abundance of constituent particles, and it remains the gold standard for measuring petrographic data (Cordell and Livingood 2004).

For this study, I have employed computer-assisted petrographic analysis (CAPA) (Livingood 2002, 2004; Velde and Druc 1998). This procedure starts with a digital image of the thin section and uses digital image analysis software to help produce a map of the section identifying the constituent particles. For some particle types, the software can do most of the work. It can be scripted to automatically identify a class of particles with a high degree of accuracy and precision. In other cases, a human operator is required to map the particle types, but the software can help by producing false-color images that make identifying the particles much easier.

CAPA has a few benefits over traditional microscope-based petrographic analysis (Cordell and Livingood 2004). First, it is less expensive under some circumstances, since an inexpensive consumer-quality flatbed scanner has sufficient resolution to identify temper particles. Second, because a complete map of the thin section is produced, far more information is produced. Since every particle is individually identified and measured, every possible metric related to particle count, size, shape, orientation, and location can be generated. Third, under some circumstances, this procedure can be faster than manual point-counting techniques. This is especially true if the samples are relatively homogenous and the features of interest are distinct. Fourth, the digital nature of the analysis makes it much easier to revise and correct analyses and to share results.

For this study each thin section was scanned at 3,200 × 1,600 dpi using an Epson Perfection 1640 scanner with a transparency adapter and polarizing film. Two scans were produced from each thin section: the first scan was produced with plane-polarized light and the second with cross-polarized light (Figures 6.1–6.2). Next, the images were aligned as layers within Adobe Photoshop. Software from Reindeer Graphics called Image Analysis Toolkit (Russ 1999) was used to create derivative images from these two layers by manipulating the information in their color channels (Figure 6.3). If the image can be manipulated in such a way that the desired features are distinguished by color, intensity, or texture, it is possible to automate the process of identifying the pixels corresponding to the features. Under cross-polarized light certain crystals appear to have unusual or bright colors because they split the light into two rays with different refraction indices. This property is referred to as birefringence, and these particles are very easy to identify with the software. In general, the identification of birefringent particles and voids was almost entirely automated, the automatic identification of shell was fairly accurate but required some editing, and the identification of grog was primarily done by hand. The end result of each identification is a series of Boolean images for every type of feature of interest (Figure 6.4). Every pixel in a Boolean image is either black, indicating it is a part of the feature, or white, indicating it is not. A function in the Image Analysis Toolkit produces measurements of the features in the Boolean images for analysis in a spreadsheet or statistical analysis software package.

At a scanning resolution of 1,600 dpi there are approximately 63 pixels per millimeter in the finished scan. Based on the Wentworth scale (Rice 1987:38), silt particles would appear to be 0.2 to 3.9 pixels wide, very fine sand would appear to be 3.9 to 7.9 pixels wide, fine sand 7.9 to 15.7 pixels wide, and medium sand 15.7 to 31.5 pixels wide. Obviously, larger particles are easier to identify and map precisely. However, there are no easy rules to determine the

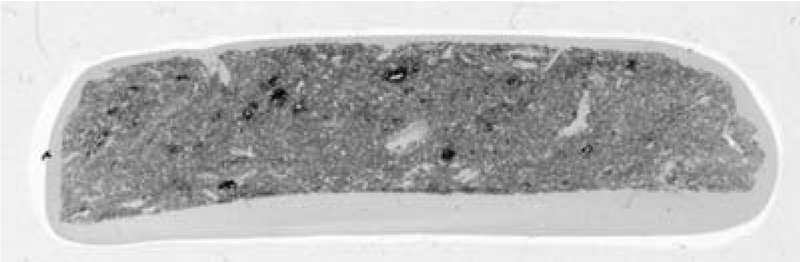

Figure 6.1. Plane-polarized scan of PRP27.

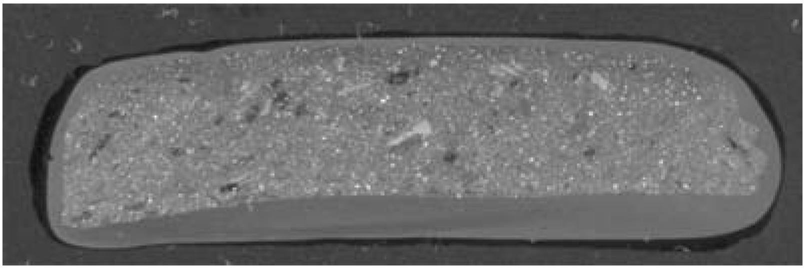

Figure 6.2. Cross-polarized scan of PRP27.

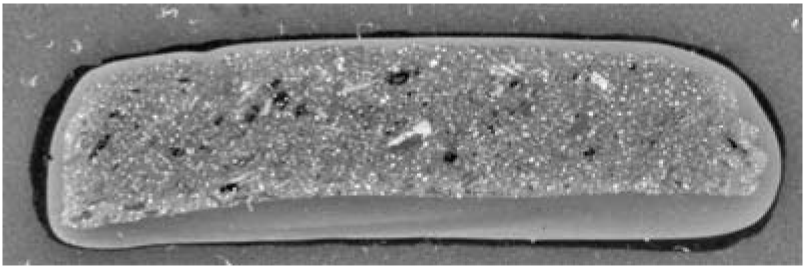

Figure 6.3. Example of a false-color enhanced image of the cross-polarized scan for PRP27.

Figure 6.4. Boolean image of the shell and shell void identifications for PRP27.

minimum size that a feature must be scanned at in order to accurately distinguish it. This size depends on the degree of visual contrast between the particle and the surrounding matrix. However, tests definitively proved that 3,200 × 1,600 dpi is not sufficient to accurately identify particles the size of very fine and fine sand (Cordell and Livingood 2004). Since measuring particles of this size is not crucial to the research goals of this project, all measurements of birefringent particles with an area less than 0.2 mm^2 were discarded from consideration in this study. Therefore, all measurements of birefringent particles in this report pertain only to larger particles.

The majority of birefringent particles in these samples are sand, which appears to be a natural inclusion. However, traditional petrographic analysis by Ann Cordell (2004) also found in some of the samples a small number of naturally occurring constituents such as muscovite mica that also have high birefringent values. Regardless, because they are rare and because they made little difference to the study goals, no effort was made to differentiate different particles with high birefringent values. Furthermore, in order to accurately measure all of the birefringent particles in the sample, it is typically necessary to take two cross-polarized scans, with the sample rotated 90 degrees between scans, and together these will identify all of the birefringent particles. However, since the orientation of birefringent particles is assumed to be random, it is possible to estimate their total abundance by doubling the area measured from a single cross-polarized scan. This produces a reasonably accurate estimate, which is fine for the research goals of this study. Therefore, the values reported in Table 6.1 to measure the abundance of birefringent particles in the sample are most accurately called an estimate of large birefringent particle abundance (ELBPA) and have been calculated by doubling the sum of the area of all birefringent particles at least 0.2 mm^2 in area identified in the analysis of a single cross-polarized image. This estimate avoids making any claims about the abundance of birefringent particles of a smaller size. It can be effectively interpreted as a proxy for the abundance of medium to large sand particles or, more precisely, an estimate of the sum of the surface area of all sand with particle size greater than 0.2 mm^2.

In an earlier study, four samples were measured using CAPA and using traditional microscope-based petrographic point-counting (Cordell and Livingood 2004). Once the problems of identifying smaller birefringent particles using the scanning resolution of 3,200 × 1,600 dpi were controlled for, CAPA was deemed sufficiently accurate to proceed with additional petrographic analyses. In the test, there was one sample for which the grog measurements were significantly different. The problem was that I inaccurately identified some hematitic, ferric concretions, lumps, or stains as grog. Although I was able to fix the problem, it underscored the difficulty of distinguishing grog from other natural stains even when using traditional microscope-based analysis (Di Caprio and Vaughn 1993). Great care has been taken in this analysis to try to ensure that the category of grog measured in Table 6.1 only includes recycled pieces of pottery that were intentionally added as temper. However, these classifications can sometimes be difficult and I expect the range of error to be greater for this temper identification than for shell, voids, or ELBPA.

Following the standards of petrographic point counting (Stoltman 1989, 1991), Table 6.1 reports the size of each thin section and the percentage of nontemper voids inside each sample. The percent abundance of each temper type is the ratio of temper area to matrix area, not including voids. Voids in the sample from leached shell are counted as shell temper.

Analysis

Before presenting any results, it is important to mention a few caveats. First, there is the standard warning that this is a small sample size and any patterns that are discovered must be considered merely suggestive. Second, there is no expectation that any conclusions drawn from these Pearl River ceramics will generalize to the rest of the Plaquemine area or anywhere else. In fact, there are strong reasons to suspect that the Pearl River assemblage might be a unique reflection of the social, historical, and ecological needs of the middle Pearl community.

Figure 6.5 shows the biplot of the percentage of shell and grog with each sample coded by the original plainware variety classification. At first glance, a few important observations can be made. First, there is a single outlier that is a heavily shell-tempered sherd. Second, the graph has a general L shape. Eight of the samples have a relatively high abundance of shell (>10 percent) and low abundance of grog (<6 percent). Another eight of the samples have a relatively high abundance of grog (>8 percent) and a low abundance of shell (<1.2 percent). The remaining 13 samples have relatively small amounts of both grog (<8 percent) and shell (<10 percent). Another observation is that there is limited fit between the macroscopically observed temper and the microscopically measured categories. While the most heavily shell-tempered sherds were all correctly identified as Mississippi Plain and the most heavily grog-tempered sherds were classified as Addis Plain, *var. Addis,* there is a level of murkiness in the middle. Some sherds classified as Mississippi Plain appear to be nearly indistinguishable using abundance measurements from some Bell Plain and Addis, *var. Greenville* sherds. Also, some sherds classified as Addis

Table 6.1. Samples used in the analysis

Sample	Site	Type	Temper Type
PRP1	22LW510	Grace Brushed, *var. Grace*	Mississippi Plain
PRP2	22LW510	Plaquemine Brushed, *var. Plaquemine*	*Addis*
PRP3	22LW510	Anna, *var. Anna*	*Greenville*
PRP4	22LW510	Anna, *var. Anna*	*Greenville*
PRP5	22LW510	Anna, *var. Anna*	*Greenville*
PRP6	22LW510	Anna, *var. Anna*	*Greenville*
PRP7	22LW510	Anna, *var. Anna*	*Greenville*
PRP8	22LW510	Anna, *var. Anna*	*Greenville*
PRP9	22LW510	Bell Plain	Bell Plain
PRP10	22LW510	Mound Place Incised	*Addis*
PRP11	22LW510	Addis Plain, *var. Addis*	*Addis*
PRP12	22LW510	D'Olive Incised, *var. D'Olive*	Mississippi Plain
PRP13	22LW510	D'Olive Incised, *var. D'Olive*	Mississippi Plain
PRP15	22LW510	Mazique Incised, *var. u.*	*Addis*
PRP16	22LW510	Mississippi Plain	Mississippi Plain
PRP17	22LW510	Mississippi Plain	Mississippi Plain
PRP18	22LW510	Mississippi Plain	Mississippi Plain
PRP19	22LW510	Mississippi Plain	Mississippi Plain
PRP20	22LW510	Mississippi Plain	Mississippi Plain
PRP21	22LW510	Plaquemine Brushed, *var. Plaquemine*	*Addis*
PRP22	22LW510	Plaquemine Brushed, *var. Plaquemine*	*Addis*
PRP23	22LW510	Grace Brushed, *var. Grace*	Mississippi Plain
PRP24	22LW510	Grace Brushed, *var. Grace*	Mississippi Plain
PRP25	22LW510	Plaquemine Brushed, *var. Plaquemine*	*Greenville*
PRP26	22LW510	D'Olive Incised, *var. D'Olive*	Mississippi Plain
PRP27	22LW510	Carter Engraved, *var. Carter*	*Greenville*
PRP28	22LW510	Grace Brushed, *var. Grace*	Bell Plain
PRP29	22LW511	Plaquemine Brushed, *var. Plaquemine*	*Addis*
PRP30	22LW511	L'Eau Noire Incised, *var. L'Eau Noire*	Bell Plain

Note: Sample PRP14 was not included in this petrographic analysis.

Plain, *var. Greenville* are quantitatively similar to sherds classified as Addis Plain, *var. Addis*. Clearly the human eye is only moderately successful at assessing temper abundance at these scales when the edges of the categories are so close. This is not an unexpected finding. In a summary of petrographic studies of Mississippi ceramics, Galaty (2006) found that almost every study noted a lack of correspondence between microscopic descriptions of fabric

Sample Area (mm^2)	Nontemper Void Percent	Grog Percent	Shell Percent	ELBPA
271.0	8.70	5.97	15.97	0.60
135.9	13.96	14.44	0	0
196.9	2.93	1.70	0.87	0.53
216.6	6.94	1.92	0.70	0.35
168.4	5.78	11.03	1.03	0.33
140.8	8.39	11.39	0.34	0.36
173.3	8.30	4.40	5.10	0.97
142.4	5.69	1.62	1.88	0.85
130.8	3.56	3.45	1.56	2.32
145.7	9.98	5.99	1.42	6.53
119.4	4.49	20.76	0.86	1.14
89.7	17.01	4.14	19.17	0.21
79.0	6.65	3.05	7.03	0.69
206.1	10.69	10.20	0	0.44
156.2	4.07	1.91	13.63	1.67
140.3	12.51	1.21	10.51	1.98
190.5	2.59	1.77	15.90	3.46
211.8	6.20	3.30	21.80	2.08
158.8	3.92	0	18.02	4.66
192.4	3.99	16.16	0	0.10
137.6	20.50	8.40	1.10	1.50
96.3	2.60	2.00	45.19	0
111.2	11.21	0.36	3.49	2.09
179.0	3.58	5.29	0.58	0.73
114.5	11.30	3.61	5.51	0.60
98.8	6.50	4.20	7.70	5.21
125.2	6.14	0.87	6.72	1.55
121.2	4.15	14.24	0	0.89
154.9	2.61	4.83	0.49	0.29

and ceramic types that were designed to describe macroscopic attributes such as decoration and form.

Other than the abundantly grog-tempered and abundantly shell-tempered samples, it is not immediately clear whether there are any modes present in the data. It is entirely possible that if we increased the sample size we would see a continuous distribution of values and that the reason there are problems

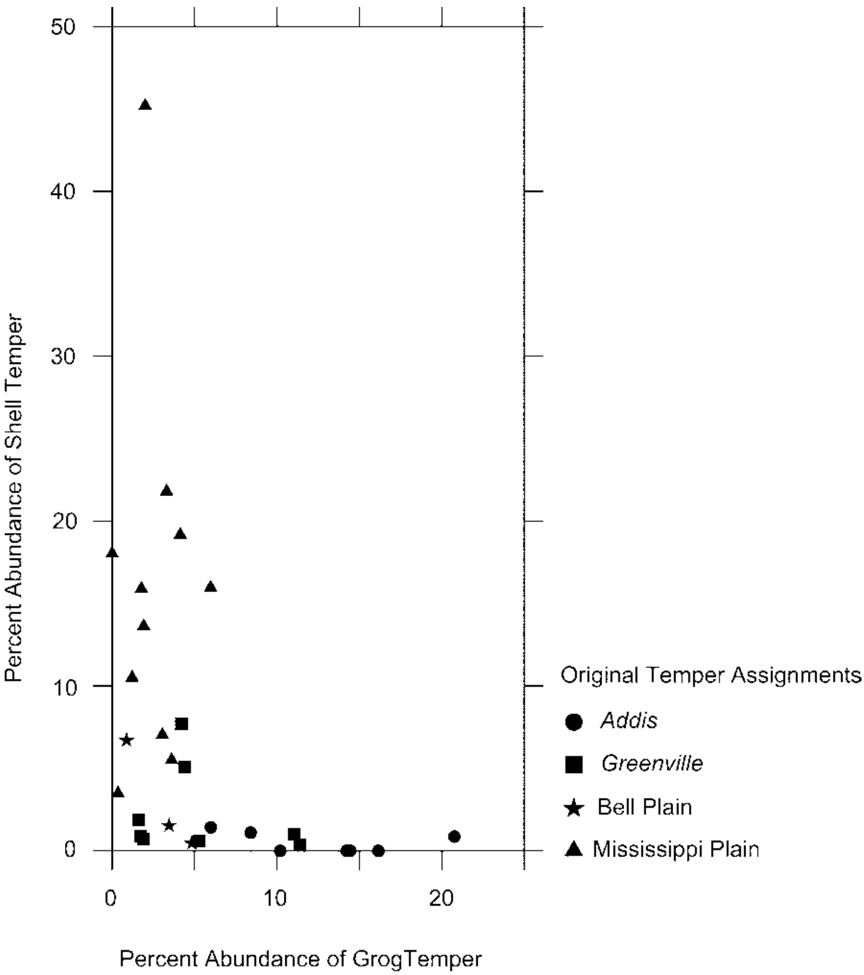

Figure 6.5. Biplot of grog and shell percentages. The shapes of the points correspond to the original temper assignments.

in applying the type-variety system to classifying fabric is that we are trying to apply discrete categories to a continuum. It is also possible that an increase in sample size would help to bring into focus the modes present in the data. Since the middle Pearl River potters took so much care with so many observable aspects of pottery manufacture such as finely grinding temper particles, generally practicing careful incising and engraving techniques, and frequently polishing the finished vessels, it is probably safe to assume that they were careful in their clay preparation and followed some form of paste recipe. If this is the case, here are the modes suggested by the data (Figure 6.6).

The cluster boundaries described below were constructed by considering the results of various cluster analyses, visual inspection of the graphs, a consideration of homogeneity of vessel form and type within clusters, and the analytical utility of proposed cluster definitions. Temper size was also used to construct these clusters, but abundance was found to be a much more useful metric. Generally, sherds with smaller temper sizes also had smaller abundances, while sherds with larger temper particles had higher abundances. Temper size was not as useful as a distinguishing variable for this sample, likely because the sherds were largely constructed during a relatively short period of time. In contrast, Ryan's (2004:93) microscopic analysis of sherds from the Hedgeland site found that grog size was crucially important for differentiating between *Percy Creek, Little Tiger,* and *Addis* varieties. Finally, birefringent particles, which mostly represent quartz sand, are absent from the cluster descriptions because there is little correlation between ELBPA and any of the other major variables and all of the observed birefringent particles seemed to be rounded grains (Rice 1987:410), which suggests that the sand is a naturally occurring aplastic inclusion.

Cluster 1

If we exclude sample 23, which is a clear outlier, the first set of clusters contains sherds with a large quantity of shell and little or no grog. All of the sherds in Clusters 1A, 1B, and 1C have ratios of shell to grog between 5 to 1 and 10 to 1 and could be combined on this basis alone. However, since they also have significantly different amounts of shell and grog and tend to cluster according to vessel type, they are being subdivided as indicated.

Cluster 1A. The sherds in this cluster have shell abundance between 10 percent and 18 percent and grog abundance less than 2 percent. This cluster contains four sherds of Mississippi Plain.

Cluster 1B. This cluster is defined as having a high abundance of shell (15 percent to 22 percent) and moderate amounts of grog (3 percent to 6 percent). The sherds in this sample include one piece of Mississippi Plain, a Grace Brushed, *var. Grace* sherd, and a D'Olive Incised, *var. D'Olive* vessel. When considering the total amount of temper added to the vessel (grog plus shell), this cluster contains the greatest amount of total temper of any of the clusters.

Cluster 1C. The two sherds in this sample are both Grace Brushed, *var. Grace* sherds and have between 3 percent and 7 percent shell and almost no grog.

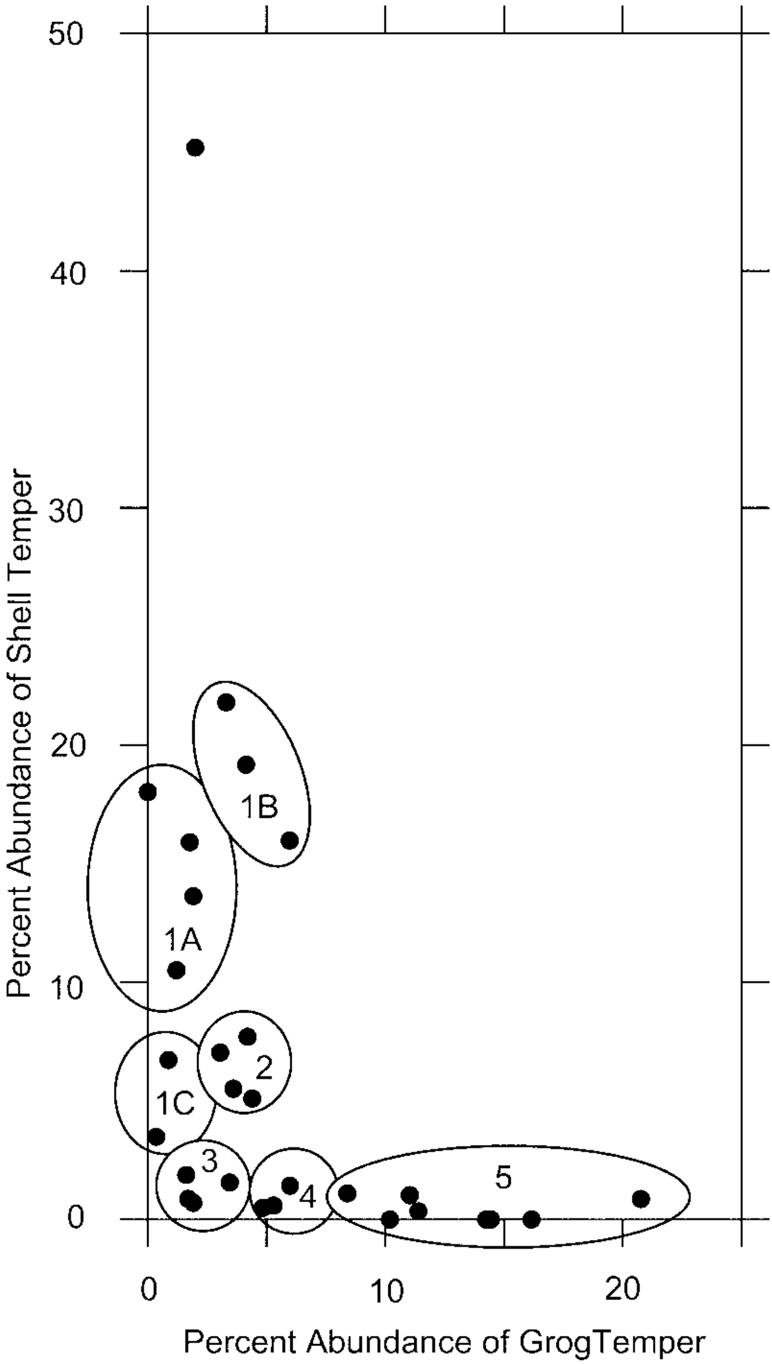

Figure 6.6. Biplot of grog and shell percentages showing clusters determined by analysis of the petrographic data.

Cluster 2

This cluster is defined as having a shell-to-grog ratio between 1 or 2 to 1. This cluster has abundances of grog between 3 percent and 5 percent and of shell between 5 percent and 8 percent. All of the sherds in this sample are highly decorated serving vessels, including one sherd of Anna Incised, *var. Anna,* two sherds of D'Olive Incised, *var. D'Olive,* and one sherd of Carter Engraved, *var. Carter.*

Cluster 3

This cluster contains three sherds that might have been called "untempered" in the nomenclature of Ford or Quimby. All three sherds in this cluster contain less than 2 percent shell and grog and all three sherds come from Anna Incised, *var. Anna* vessels.

Cluster 4

This cluster contains four sherds with moderate amounts of grog tempering (3 percent to 6 percent) and little shell tempering (<2 percent). The vessels in this cluster include examples of Bell Plain, Mound Place Incised, *var. unspecified,* Plaquemine Brushed, *var. Plaquemine,* and L'Eau Noire Incised, *var. L'Eau Noire.*

Cluster 5

This cluster contains all of the highly grog-tempered sherds. With a larger sample size it might be possible to subdivide this cluster, but for now it is left undifferentiated. The sherds in this cluster have between 8 percent and 21 percent grog and less than 1 percent shell. This cluster includes four examples of Plaquemine Brushed, *var. Plaquemine,* two examples of Anna Incised, *var. Anna,* one sherd of Addis Plain, *var. Addis,* and one sherd of Mazique Incised, *var. unspecified.*

If we assume that these clusters are at least partially correct, what is the significance? First, these clay types correspond fairly well to variations in vessel function, which suggests that there may have been widely shared notions that different ratios of grog, shell, and clay were appropriate for different applications. The clays in clusters 2, 3, and 4 were used almost exclusively for serving vessels (plates and shallow bowls and decorated varieties such as Anna Incised, Carter Engraved, L'Eau Noire Incised, Mound Place Incised, D'Olive Incised) and the clays in clusters 1A and 1C were used exclusively for utilitarian vessels.

The clays in clusters 1B, 4, and 5 were used for mixed purposes. Note that there is not a good correspondence between decorative type and cluster. For example, there were six Anna Incised, *var. Anna* sherds in the sample that were constructed using temper combinations from three clusters. Likewise, the five sherds of Plaquemine Brushed, *var. Plaquemine* span two clusters, the three sherds of Grace Brushed, *var. Grace* span two clusters, and the three sherds of D'Olive Incised, *var. D'Olive* span two clusters.

Second, this study found a fairly strong association between high total temper abundance (grog plus shell) and utilitarian tasks while the majority of presumed serving wares have low total temper abundance. This may be explained functionally: coarsely tempered vessels may perform better in cooking and storage tasks. It may also be explained aesthetically: Pearl River potters seemed to prefer a more uniform, polished, "temperless" look for serving ware vessels.

Finally, the data suggest that there were a greater number of temper combinations being used than were described by the original fabric types borrowed from the LMV. Furthermore, the clusters do not map very well to these existing plainware varieties, as shown in Table 6.2. This might indicate that there were different tempering practices being used in the middle Pearl because of cultural or ecological differences or it might indicate the expected lack of correspondence between macroscopic and microscopic categories. In trying to apply these established types, it is interesting to observe that very few samples are completely lacking in grog or shell and there appears to be no real analytical difference between samples that contain trace amounts and those for which a temper is absent. Therefore, the distinction between Addis Plain, *var. Addis* and Addis Plain, *var. Greenville* does not seem very important for this assemblage. However, the ratio between grog and shell and the relative abundance of both do seem to be important. Sherds with lots of shell or lots of grog get assigned to clusters 1 or 5, respectively. The remaining sherds get classified according to whether they are almost "temperless" (cluster 3) or contain slightly more shell than grog (cluster 1C), slightly more grog than shell (cluster 4), or about equal amounts of both (cluster 2).

Conclusion

These results provide empirical evidence that the frustrated efforts to classify the Pearl River ceramics using the four paste categories of Addis Plain, *var. Addis,* Addis Plain, *var. Greenville,* Mississippi Plain, and Bell Plain were like trying to fit a square peg into a round hole. In reality, the categories I should be using rely more on observing the ratio between grog and shell temper.

Table 6.2. Description of the temper clusters

Cluster	Summary Description	Plainware Varieties	Decorated Varieties
1A	Heavy shell temper. All utilitarian vessels.	4 Mississippi Plain	4 Mississippi Plain, undecorated
1B	Heavy shell temper plus moderate amounts of grog. Mixed serving and utilitarian vessels.	3 Mississippi Plain	1 Grace Brushed, *var. Grace,* 1 D'Olive Incised, *var. D'Olive,* 1 Mississippi Plain, undecorated
1C	Moderate shell and no grog. All utilitarian vessels.	1 Mississippi Plain, 1 Bell Plain	2 Grace Brushed, *var. Grace*
2	Nearly equal ratio of grog to shell in moderate amounts. All serving vessels.	2 Addis Plain, *var. Greenville,* 2 Mississippi Plain	2 D'Olive Incised, *var. D'Olive,* 1 Anna Incised, *var. Anna,* 1 Carter Engraved, *var. Carter*
3	Very little temper. All serving vessels.	3 Addis Plain, *var. Greenville*	3 Anna Incised, *var. Anna*
4	Moderate grog temper with little shell temper. Mostly serving vessels.	2 Bell Plain, 1 Addis Plain, *var. Addis,* 1 Addis Plain, *var. Greenville*	1 L'Eau Noire Incised, *var. L'Eau Noire,* 1 Plaquemine Brushed, *var. Plaquemine,* 1 Mound Place Incised, *var. unspecified,* 1 Bell Plain, undecorated
5	Heavy grog tempering. Mixed serving and utilitarian vessels.	6 Addis Plain, *var. Addis,* 2 Addis Plain, *var. Greenville*	4 Plaquemine Brushed, *var. Plaquemine,* 2 Anna Incised, *var. Anna,* 1 Mazique Incised, *var. unspecified,* 1 Addis Plain, undecorated

Like many studies, this one raises more questions than it answers. Many of the questions can probably be answered by increasing the sample size. For example, it would be interesting to see whether an expanded sample from the Pearl River would sharpen the focus of the plots and reveal several closely related temper recipes or whether an expanded sample would blur the relationships and indicate that grog and shell were added haphazardly. It would also be interesting to apply these analyses to other regions in the Plaquemine world where grog and shell tempers are frequently mixed to find out whether potters there were making choices similar to those of the Pearl River potters.

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