

## **A Comparison of Laboratory Results to Archaeological Data: Pottery Surface Treatments in Eastern Missouri**

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*Abstract. A significant but underused aspect of current archaeological research is relating controlled laboratory experiments to the uncontrollable archaeological record. In the example presented here, Schiffer et al. (1994) published results of ceramic technology experiments that can be tested using prehistoric evidence. We compared their findings on spalling frequency versus surface treatment to prehistoric pottery samples from two sites in Missouri. Our data support their conclusion that vessels with roughened surfaces have a statistically lower incidence of spalling than do vessels with smooth surfaces. However, differences in spalling exhibited on vessels of different surface treatment might not*

have been noticeable, or behaviorally significant, to prehistoric potters or users of the vessels. Also, we caution that before laboratory findings be taken for granted, they should be compared against the archaeological record in question, and variances between them should be explored through further archaeological and experimental research.

A recent article by Schiffer et al. (1994) presented results of an experimental archaeology program directed toward understanding how surface treatments affect vessel failure, as observed through incidence of thermal-shock cracking and spalling. The authors found that smooth-surface vessels were more susceptible to spalling than were vessels with textured exterior surfaces and that both incidence of spalling and thermal-shock cracking correlated positively with vessel permeability. They suggested that two kinds of surface treatment—interior-surface application of resin or varnish and exterior-surface texturing—reduce spalling significantly.

We believe that the primary test of such laboratory studies lies in comparing those findings to prehistoric materials, and thus we compared some of Schiffer et al.'s laboratory findings against the archaeological record. We are encouraged that a recent review of ceramic analysis (Rice 1996:143) suggested that such comparisons be made and that effects of surface treatments/construction methods made on pottery from the southwestern United States should be compared to surface-treatment/construction effects exhibited on pottery from the Southeast. We selected sherds from two sites in Missouri—Hoecake (23MI8), a late Baytown- and early Mississippian-period (ca. A.D. 400-1000) site in the Mississippi River valley of southeastern Missouri (Williams 1967, 1974), and Burkemper (23LN104), a Middle Woodland- and early Late Woodland-period (ca. 200 B.C.-A.D. 700) site on the Mississippi River bluffs of northeastern Missouri (O'Brien 1996) (Figure 1). These sites were chosen for analysis because of their relative contemporaneity, their differing clay and temper resources, and the considerable amount of excavated material from each site, which eliminated concerns over limited sample size.

The ceramic assemblage from the Hoecake site consists primarily of late Baytown-period (ca. A.D. 600-900), clay-tempered sherds; the relatively few Mississippian-period, shell-tempered sherds recovered from the site were excluded from our analysis. The clay-tempered sherds are exclusively cordmarked or plain surfaced on the exterior and exhibit smoothed interiors. All Hoecake vessels undoubtedly were produced from Mississippi River alluvial clays prevalent in the area (Brown 1971; O'Brien et al. 1995). By contrast, the Middle Woodland- and Late Woodland-period Burkemper sherds are largely grit-tempered, with granite and sand being the primary tempers. Sherds that exhibited either cordmarking or plain exterior surfaces were the only

materials analyzed for this report. Clay sources in the site area are residual clays from limestone and shale outcrops as well as Pleistocene-till clays and recent alluvial clays (Davis and Saville 1962; McCracken 1961). At each site, both cordmarked and plain-surface vessels apparently were produced contemporaneously. Only sherds from vessels representing the "jar" form—that is, vessels with conoidal or rounded bases, straight or slightly excurving rims, and heights that exceeded orifice diameters—were analyzed in this study. We assume that these vessels were used as cooking pots, based on their similar form and the occasional presence of charred material on vessel interiors.

Obviously, the prehistoric material we analyzed differed from the vessels used in Schiffer et al.'s laboratory experiments. First, clays, temper/inclusions, and firing conditions differed significantly. Second, while only spalls on exterior surfaces were counted in our analysis, postdepositional processes such as frost-induced spalling may have produced features on the Missouri sherds that might mimic Schiffer et al.'s observations. Because we are unaware of a means to distinguish manufacture- and use-related spalling from postdepositional spalling—another fruitful area of experimentation—all spalls observed on Missouri sherd exteriors were considered to be derived from manufacture or use. Third, surface treatments employed on the Missouri vessels (specifically the technique of applying cordmarking and producing plain-surfacing) differed from those used by Schiffer et al. to treat their vessels. Fourth, if organic surface treatments, such as resins or smudging, were applied to Hoecake and Burkemper vessels, postdepositional processes have

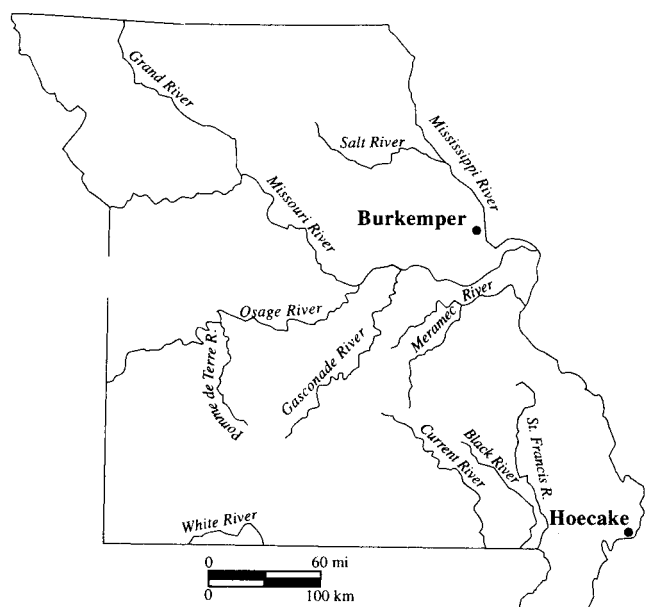


Figure 1. Map of Missouri showing locations of Hoecake and Burkemper.

obliterated any visual evidence. Thus, we cannot discuss the potential influence of organic treatments on our prehistoric samples. Fifth, Schiffer et al. used whole vessels in their experiments; their analysis of thermal-shock breakage relied on having intact sherd edges from vessel failures. Pottery from Hoecake and Burkemper consists entirely of sherds and partially reconstructible vessels—a situation common at most archaeological sites. The underlying cause of breakage on a sherd-by-sherd basis of vessels from Missouri is almost impossible to discern because of erosion of sherd edges; therefore, we cannot discuss thermal-shock cracking.

Spalling, however, is a phenomenon that we *can* recognize on the sherds, and it is on this phenomenon that we focus attention. We used the same definition and description of spalls used by Schiffer et al.: spalls “appear to be caused by steam ‘blowing’ off vulnerable places, usually in the shape of a circle or ellipse, up to about 3 mm in maximum depth and several cm in maximum diameter. Spalls often originate at large temper particles, voids, or other irregularities in the paste” (Schiffer et al. 1994:205; see also Schiffer 1990:376, 378-379; Skibo 1992:134-141). Because we were dealing with sherds, which may exhibit only a partial spall because of breakage across a weakened part of the vessel (see Figures 2 and 3 for examples), our measurements of spall diameters (see below) are occasionally approximate but should give an estimate of the magnitude of the entire spall and its effect on the vessel.

### Analysis

A total of 5,172 Hoecake clay-tempered sherds was inspected for evidence of spalling. Spalling occurred on 58 (1.4 percent) of the 4,049 cordmarked sherds and on 32 (2.8 percent) of the 1,123 plain-surface sherds. Using a one-tailed z-test of proportions<sup>1</sup>, this test confirmed that spalling occurred preferentially on plain-surface sherds ( $z=3.50$ ,  $p<0.05$ ). Similarly, 20 of the 1,488 cordmarked sherds from Burkemper (1.3 percent) exhibited evidence of spalling, and 4 of the 137 plain-surface sherds (2.9 percent) had spalls. Again, a one-tailed z-test of proportions confirmed that the presence of spalling on cordmarked sherds was greater than compared to spalling on plain-surface sherds but at a lower level of significance ( $z=1.46$ ,  $p=0.072$ ). We also calculated mean size of spalls for both prehistoric samples (Schiffer et al. [1994] report only maximum spall size). For both sites, the mean diameter of spalls on cordmarked sherds (12 mm for Hoecake and 30 mm for Burkemper) was greater than that of spalls on plain-surface sherds (10 mm for Hoecake and 8.5 mm for Burkemper), indicating that when spalls do develop on cordmarked vessels, though they occur less frequently, they are larger and potentially more damaging than those on plain-surface vessels.

### Discussion

Our archaeological data support Schiffer et al.’s experimental observations concerning correlations between vessel-surface treatments and spalling: roughened (cordmarked) surfaces apparently reduce the incidence of spalling because they help to permit steam to escape from the interior of a vessel’s paste. But these statistically significant observations might not have been behaviorally significant (*sensu* Schiffer and Skibo 1987). Compared to the number of experimentally derived spalls (379) on 25 vessels (Schiffer et al. 1994:Tables 3 and 4), the number and percentage of spalls on sherds in our Missouri samples are very low and might have been unrecognizable as a reason to modify vessel-production strategies. Some of this difference in spalling frequency might be attributable to the difference in application of experimental versus archaeological surface treatments. Schiffer et al. smoothed externally plain vessel surfaces with a rubber scraper and either rolled a stove bolt across vessel exteriors to produce a shallow-textured surface or striated vessel exteriors with a fork to produce a deep-textured surface on a commercially available clay (Schiffer et al. 1994:201). Inspection of Hoecake and Burkemper sherds indicated that exterior surface treatments were applied by repeated impact of an implement to the vessel surface, by use of either a cord-wrapped paddle or, in the case of plain-surface vessels, a smooth-surface paddle. These prehistoric surface treatments compressed clay particles in the outside portion of vessels, drove temper particles deeper into the vessel body, and therefore may have reduced the possibility of spalling. Schiffer et al.’s rolling of an implement over a vessel surface may have produced some compression effects, but striating the surface would not compress a vessel’s paste to the degree exhibited in the Missouri sherds.

An additional problem with relating experimental findings to archaeological observations is that of equifinality. A host of processes, including postdepositional effects such as frost-induced spalling, can mimic spalling from production and/or use on prehistoric pottery and thereby affect the application of experimental results of spalling frequency compared to observed spalls on prehistoric pottery. We also cannot ignore the fact that some technological variables, such as raw materials, firing temperature, and firing atmosphere, which are easily controlled in the laboratory, cannot be controlled in analysis of prehistoric pottery or can be analyzed only with great difficulty and often with considerable imprecision. For example, in commenting on an earlier draft of this paper, Schiffer pointed out the possibility that the prehistoric Missouri potters in question had sufficient control over paste preparation and firing so that spalling was a minor hazard to vessel firing and use, thus negating our observation that the difference between surface treatments may

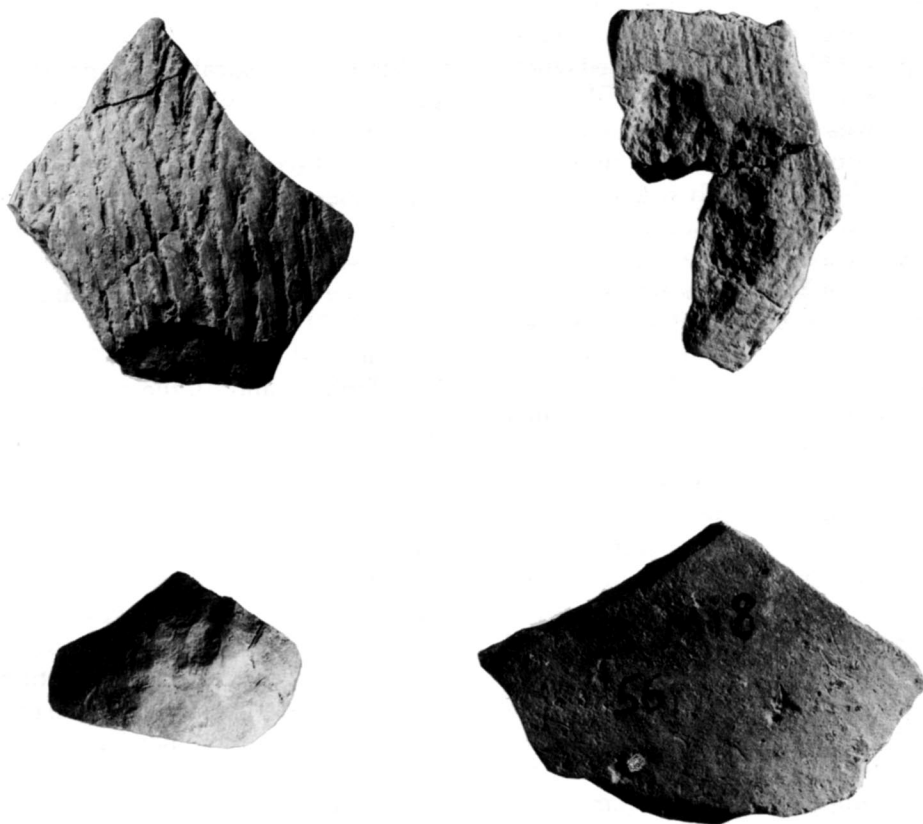


Figure 2. Examples of spalls from Hoecake cordmarked sherds (top row) and plain-surface sherds (bottom row).

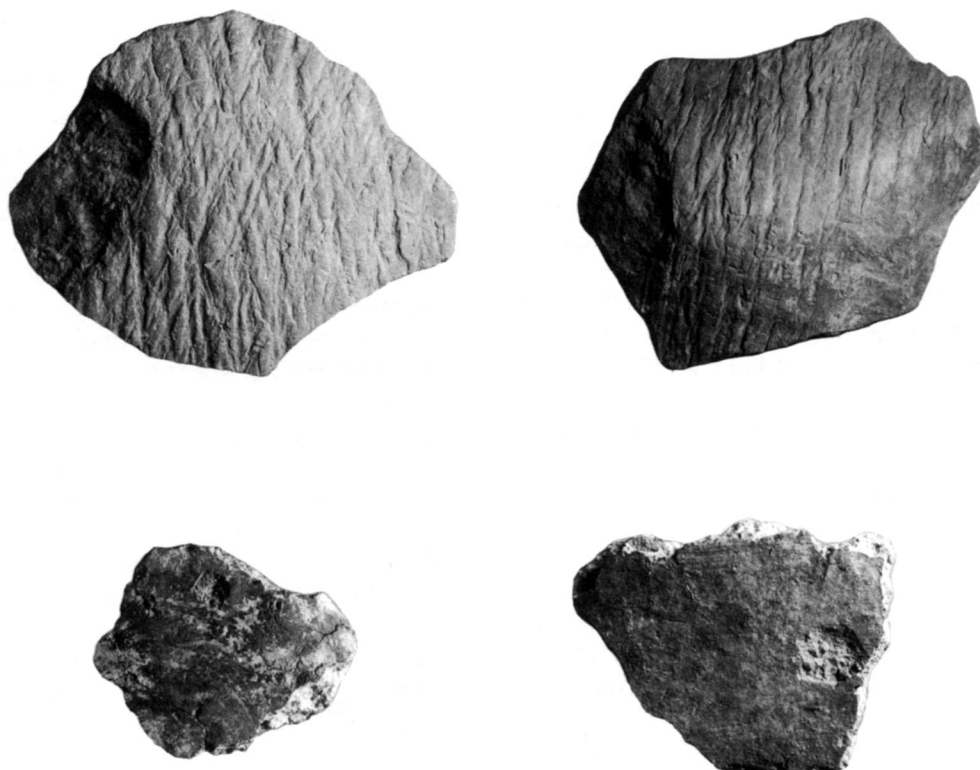


Figure 3. Examples of spalls from Burkemper cordmarked sherds (top row) and plain-surface sherds (bottom row).

not have been behaviorally significant. The question then becomes: How can we test for this prehistoric control? Empirical data from earlier periods in the Missouri research areas, when potters might not have had as much control over production strategies, may show larger overall frequencies of spalling and greater differences between spalling frequencies and exterior surface treatments. Furthermore, more-refined experimental research using clays and tempers that are local to the Missouri research areas (what Skibo [1992] calls "field experiments") could lead to increased understanding of the relation between Schiffer et al.'s general findings and the specific circumstances of the Missouri prehistoric record. We present below some research questions and suggestions for further experimental research.

#### *Continuation of Experimental Research*

Our investigation of Schiffer et al.'s findings and our observations of the archaeological record at two sites in eastern Missouri showed differences between experimental and archaeological data. Furthermore, we found additional areas of investigation that would clarify the ambiguities between these approaches to archaeological explanation.

1. *Why do the prehistoric vessels from eastern Missouri exhibit low percentages of spalling between cordmarked and plain-surface vessels, and why are those percentages so low compared to Schiffer et al.'s findings?*

A protocol of firing replicate vessels in controlled conditions such as in an electric furnace, and also in conditions that simulate prehistoric firing conditions, should produce information on manufacture-related spalling and also produce vessels that can be used to address the following questions:

2. *Can postdepositional spalling be distinguished from manufacture- and use-related spalling?*

Controlled experiments using replicate vessels subjected to simulated cooking cycles and "unused" replicate vessels that are both subjected to effects of burial processes such as freeze-thaw cycles would address this question.

3. *Is the presence of cordmarking on vessels from the research area a response to alleviating thermal stress?*

Effects of thermal stress are not observable on prehistoric sherds from the research area but should be recognizable on replicate vessels subjected to simulated use.

In all the above experiments, the use of clays and temper that are local to the research areas and thus have a likelihood of being the same materials used by the pre-

historic potters, must be employed in this extension of experimental research.

#### *Conclusions*

Our analysis of prehistoric pottery from two sites in Missouri provides empirical support for Schiffer et al.'s experimental results on spalling frequency versus surface treatment: roughened (cordmarked) vessel surfaces exhibit lower frequencies of spalling compared to smooth-surface vessels. When spalls did occur on analyzed prehistoric vessels, they were larger and potentially more damaging on roughened surfaces than those on smooth-surface vessels, which contrasts strongly with Schiffer et al.'s experimental results. However, overall differences in spalling frequencies between these surface treatments are small and might not have been recognizable to the producers and/or users of the pots. Therefore, while recognizing the importance of laboratory-based experiments in suggesting avenues of research in the archaeological record, our analysis indicates that results of such experiments cannot be applied ipso facto to specific circumstances of the archaeological record.

#### *Notes*

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<sup>1</sup> See Armore (1966:377-382) for a discussion of this measure of association.

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