THE DEVELOPMENT OF CORRUGATED POTTERY IN SOUTHWESTERN COLORADO

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ABSTRACT

Archaeological research has documented the broad outlines of the development of corrugated utility pottery from plain and neck-banded antecedents. However, a reliance on typological descriptions has obscured the technological details of this development. An attribute analysis of six well-dated utility-ware assemblages from southwestern Colorado indicates that corrugation appeared first in this region during the eighth century A. D. as wide, non-overlapping coils left unsmoothed around jar necks. During the ninth and tenth centuries, the variety and frequency of neck-banding increased with the introduction of narrower coils, overlapping of adjacent coils, and incising and indenting of coil surfaces. By the early eleventh century, one recent neck-banding variant, narrow, substantially overlapped and indented coils, replaced almost all others, and was extended over the entire exterior surface of jars for the first time. Performance benefits of this full-body, indented corrugation may explain its rapid adoption in southwestern Colorado.

RESUMEN

Investigaciones arqueológicas han documentado esquemas amplios del desarrollo de cerámica utilitaria corrugada de antecedentes simples y de tipos con cuellos enlazados (neck-banded). Sin embargo, una dependencia en descripciones topológicas ha obscurecido los detalles tecnológicos de este desarrollo. Un análisis de los atributos de seis ensambladuras cerámicas utilitarias del suroeste de Colorado indica que la corrugación apareció en esta región durante el siglo ocho d. C. como rollos anchos alrededor de los cuellos de las jarras que no se solapaban y que eran lisos. Durante los siglos nueve y diez, la variedad y frecuencia de cuellos enlazados aumentaron con la introducción de rollos menos anchos, el solape de rollos adyacentes, y incisiones en las superficies del los rollos. A los principios del siglo once, una variedad reciente con cuello estrecho enlazado de rollos bastante solapados con incisiones reemplazó casi todos los otros estilos. Por primera vez se extendieron los rollos solapados con incisiones por toda la superficie exterior de las jarras. Puede ser que las ventajas utilitarias de este tipo de corrugación con incisiones expliquen su adopción rápida en el suroeste de Colorado.

KIVA: The Journal of Southwestern Archaeology and History, Vol. 71, No. 1, (Fall 2005), pp. 79–100.

Southwestern corrugated pottery consists mainly of utilitarian or culinary jars displaying distinctively textured exterior surfaces, but usually lacking slip and paint. The textured surface was produced by leaving the construction coils exposed creating a horizontally ridged, or corrugated appearance. From the late tenth through early thirteenth centuries A. D. , the Anasazi people across most of the northern Southwest adopted a variety of corrugated pottery referred to as all-over, or full-body indented corrugated. This form of corrugation has systematically pinched or indented coils left exposed over the entire exterior surface of the vessel. Precursors to full-body corrugation had unindented exposed coils restricted to the upper portions of the jars, and are referred to as neck-banded pottery. Earlier still, culinary vessels had entirely plain surfaces produced by scraping and smoothing both interior and exterior surfaces until the coils or other construction elements were completely obliterated (Figure 1).

Although deeply textured cooking pots are common world-wide, the use of the corrugation technique by Anasazi people is an unusual and visually striking approach to surface texturing. Consequently, consideration of the causes of this development has a long history (Blinman 1993; Cushing 1886; Gumerman 1984; Holmes 1886; Kidder 1936:300-301; Linton 1944; McGregor 1941; Pierce 1999; Plog 1986; Rice 1987; Schiffer 1990; Schiffer et al. 1994; Vivian 1990; Young and Stone 1990). Even though the general outline of the development of corrugated pottery from plain and neck-banded antecedents has been known since the first quarter of the twentieth century (Kidder 1927:490; Kidder and Guernsey

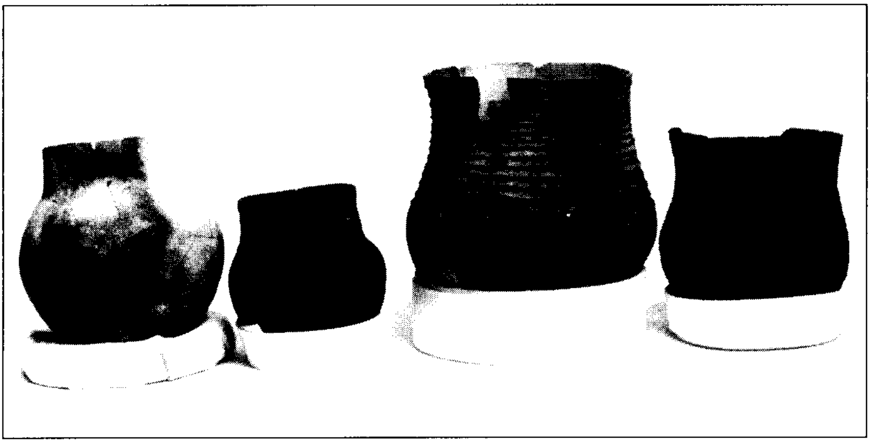

FIGURE 1. Examples of plain, neck-banded, and full-body corrugated vessels from southwestern Colorado. From left to right, the vessels are Chapin Gray (5MT2181, RC1) Moccasin Gray (5MT3868, Vessel # 26), Mancos Gray (5MT89, RC1), and Mancos Corrugated (vessel 2-975 from the Chappell collection). All vessels are curated at the Anasazi Heritage Center in Dolores, Colorado.

1919:141–143; Morris 1917), details of the nature and timing of the technological innovations involved are poorly documented. This is due mainly to the fact that most descriptions of pottery in the Southwest involve assigning individual pottery specimens to types. These types were created to distinguish the temporal order of assemblages, not to track technological changes. Consequently, the types tend to be defined by an uneven and, often, complex mixture of attributes that do not allow one to isolate particular technological features. This is especially true for utility-wares, which are generally given short shrift because of their perceived lack of stylistic content needed to make the finest temporal distinctions.

Understanding the development of corrugated pottery requires, among other things, more thorough knowledge of the technological changes involved. To accomplish this we must look beyond the existing pottery types, and measure selected attributes of plain, neck-banded, and corrugated pottery that more fully document how the pottery was made at different points in time. These observations of attributes and attribute combinations can then be used to complement and enhance previously published data. This paper presents the results of such an analysis of six pottery assemblages from the Mesa Verde region of southwestern Colorado. Although current evidence indicates that the earliest appearance of neckbanding and full-body corrugation occurred elsewhere in the Southwest (Pierce 1999), I focused this study on the Mesa Verde region because the period of change from plain wares to the adoption of full-body corrugation is relatively well documented, and pottery collections appropriate for analysis are readily available. Ideally, this study will encourage others to investigate utility-ware technological changes in additional regions of the Southwest so that a more complete picture of corrugated pottery development and adoption can be drawn.

METHODS

THE POTTERY ASSEMBLAGES

Archaeological research in the Mesa Verde region, particularly the Dolores Archaeological Program and other work associated with the development of McPhee reservoir and related irrigation canals, has generated numerous collections dating to the period of change from completely plain to full-body corrugated vessels. In selecting among these and other collections for inclusion in this study, I strove for assemblages generated by well-dated, functionally equivalent, short duration occupations that provide even coverage of the period from A. D. 750 to 1050. Collections meeting the dating criterion include those with multiple absolute dates, either tree-ring dates, archaeomagnetic dates, or both. In addition, these absolute dates must occur in an understandable and reliable association with the material to be analyzed, and the relative frequencies of painted pottery types in the selected assemblages must produce a properly ordered seriation. To control for functional variation in activities that might bias the formation and composition of the assemblages, I restricted consideration to collections from habitation sites with architectural features and recognizable trash or midden deposits. Finally, I distinguished relatively short duration occupations by a lack of substantial architectural remodeling, and a reasonable clustering of dating evidence.

In addition, because assemblages form the unit of comparison for this study, selected collections must be relatively large, and collected in such a way that they are reasonably representative of the material deposited during the occupation. I used an arbitrary assemblage size cut-off of at least 300 utility-ware fragments. Although probably a higher cut-off than necessary, I wanted to avoid, as much as possible, the disruptive effects of small samples (see Pierce 1999: 58–60 and Appendix A for an analysis of possible sample size and other potential biases in the selected assemblages). Finally, to minimize biases introduced during the collection of the material in the field, selected collections must have been generated by systematic surface collection or screening of excavated deposits sampled in a representative manner.

After I identified collections for inclusion in this study, I further sampled these collections for the actual specimens to be analyzed. To secure samples representative of the occupation as a whole, I selected only material from trash deposits. I focus on trash middens because the chance that individual sherds in the same collection unit derived from the same vessel is greatly reduced relative to assemblages collected from indoor and outdoor use or living surfaces. Thus,

TABLE 1. Characteristics of the six utility-ware assemblages analyzed for this study.

Site	Estimated Age Range	Absolute Dates	N of Sherds Analyzed	Reference
Dos Casas Hamlet 5MT2193	A.D. 760-775	25 Tree-ring	315	Brisbin et al. 1986
Periman Hamlet, Area 1 5MT4671	A.D. 800-850	3 Archeomag.	785	Wilshusen 1986
Duckfoot Site 5MT3868	A.D. 855-880	375 Tree-ring	1504	Lightfoot 1994, Lightfoot & Etzkorn 1993
5MT8371	A.D. 935-945	3 Tree-ring	326	Dykeman 1986
Gnatsville 5MT1786	A.D. 1035-1045	9 Tree-ring, 1 Archeomag.	918	Kent 1989, 1991
Dobbins Stockade 5MT8827	A.D. 1040-1060	31 Tree-ring	326	Kuckelman 1988

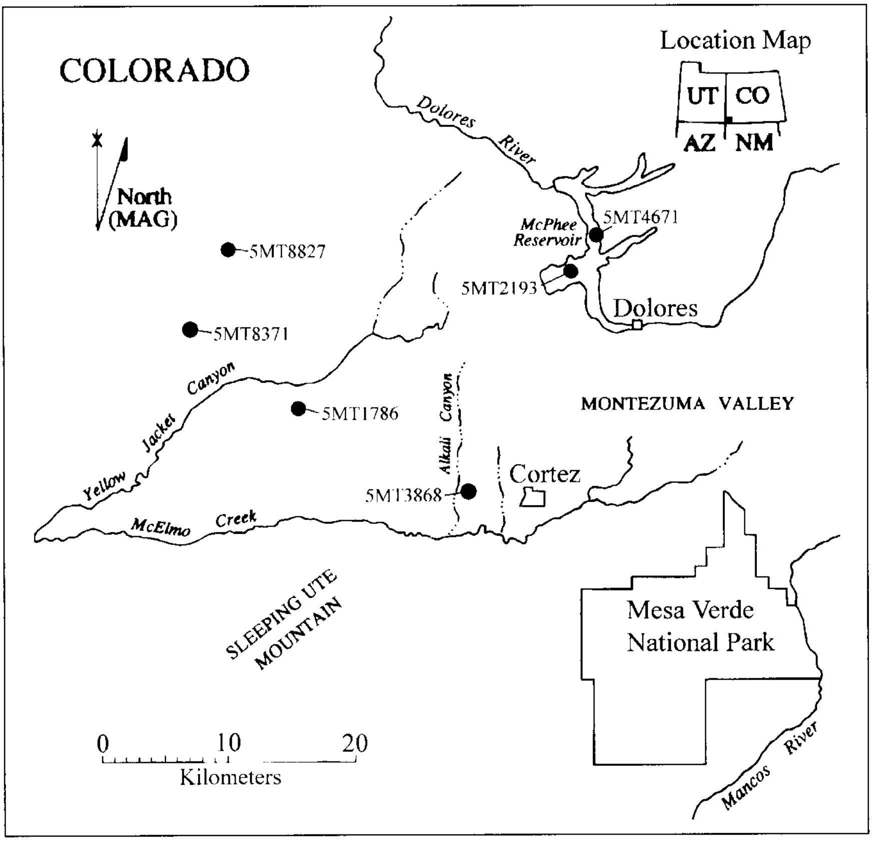

FIGURE 2. Map of the Mesa Verde region sowing the location of the six sites from which utility-ware sherds were analyzed for this study.

trash deposits have a better chance of yielding the maximum amount of data on variation for a given sample size. In addition, the composition of refuse assemblages is less susceptible to distortion by abandonment-related formation processes than exposed activity surfaces (Schiffer 1987). A comparison of variance in three collections under consideration for selection showed that trash deposits contain considerably less within-sample variance in the abundance of pottery types than samples from activity surfaces (Pierce 1999).

Application of these collection and assemblage selection criteria resulted in the inclusion of six utility-ware assemblages from southwestern Colorado in the current study (Table 1, Figure 2). Absolute dates associated with these assemblages indicate that they were deposited between the mid-eighth and the mid-eleventh centuries. A well-ordered seriation of the painted pottery from these

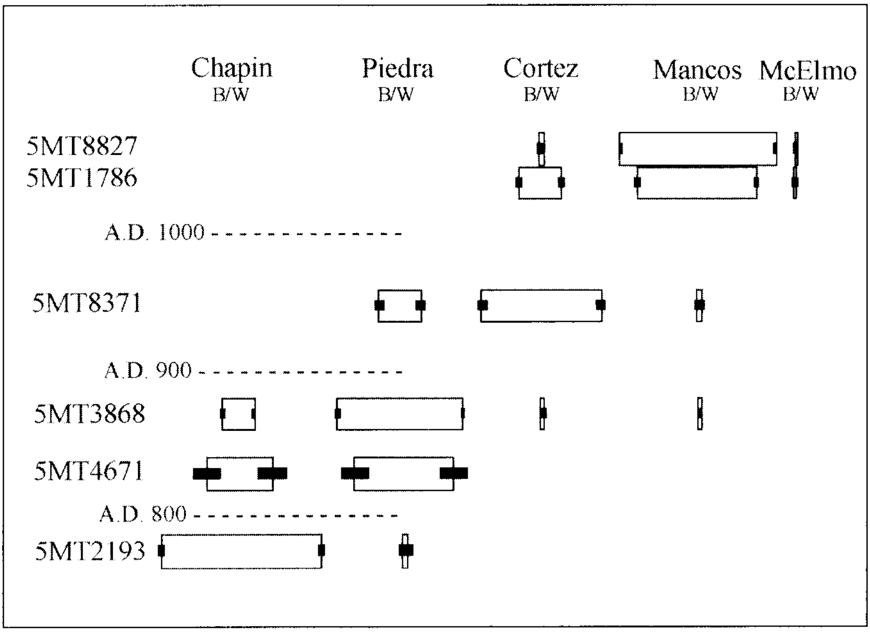

FIGURE 3. Seriation of painted pottery types recovered with the six utility-ware assemblages. Error bars = 90% confidence intervals.

same assemblages supports the temporal assignments of the assemblages based on absolute dates (Figure 3). Pierce (1999: 52–58) and the references given in Table 1 provide more information on these assemblages.

THE ATTRIBUTES MEASURED

The transition from scraped and smoothed plain to fully corrugated vessels involved several changes in how the pottery vessels were constructed prior to firing. Observations of ancient fragments from these different kinds of vessels can provide abundant evidence on the forming or construction techniques employed, and a wide range of techniques has been developed to extract this information (e.g., Feathers 1990; Rice 1987; Rye 1981; Shepard 1976). In these analyses, I relied on macroscopic and low power microscopic observations of surface features, core structure, and fracture patterns to document the techniques used to construct plain and corrugated gray ware vessels in the Mesa Verde region. Some of these attributes were measurable on all sherds, but others were applicable only to corrugated sherds with exposed coils.

For all sherds, I recorded five categorical attributes that provide data on the forming techniques employed: sherd fracture pattern, surface forming and finish-

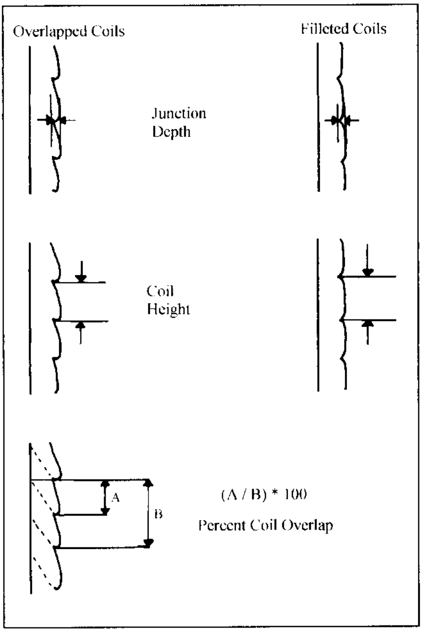

FIGURE 4. Diagram of metric attributes recorded on exposed coils.

ing traces, surface applications, and core structure. The fracture morphology of sherds was recorded as random, cubic, stepped, or indeterminate. Cubic and stepped fractures display parallel fracture edges in the horizontal plane of the vessel resulting from the fractures occurring along the joins between coils or other horizontally applied construction elements, and thus can be indicative of the use of coils in manufacture. Random fractures show no preferred edge orientation and result from either a lack of weaker coil junctions that produce preferred breakage planes, or the breakage of pots into pieces that are smaller than the coils used to construct the vessel. The states used to record surface forming and finishing traces include none, indented, incised, scraped, paddled, pinched, wiped, polished, smeared, combination, other, and indeterminate. Surface application states include none, slipped, painted, slipped and painted, other, and indeterminate. Each of the surface attributes was recorded for both interior and exterior surfaces. The texture and structure of the core exposed in a freshly broken edge of the sherd was recorded as homogeneous (very fine temper and pore size), blocky (angular structures present in the paste), laminar (temper and pores oriented in laminar planes), or irregular (large temper and pores with no preferred orientation). The quality and processing of the raw materials and the nature of pressures applied during manufacture contribute to the formation of different core structures. Finally, I also recorded the likely form, or shape of the vessel from which each sherd came. Vessel form categories include wide-mouth jar, narrow-mouth jar, seed jar, indeterminate jar, bowl, ladle, other, and indeterminate form.

For sherds with exposed or unobliterated coils on the exterior surface, I recorded five additional attributes indicative of the forming techniques employed. These attributes include coil application, coil junction depth, exposed coil height, coil surface indentation frequency, and the percent overlap between adjacent coils. Coil application technique was recorded as filleted (non-overlapping), overlapping, or indeterminate. For overlapped coils, coil junction depth refers to the distance in millimeters between the crest of a coil and the point at which it joins the coil below (Figure 4). I measured this attribute by resting the base of the arm of a dial caliper against the crest of a coil and opening the caliper until the projecting rod came in contact with the surface of the coil below. For filleted coils, this measurement is the depth of the incision or crease between exposed coils. In both cases, an average of several measurements was recorded. Exposed coil height is the average distance in millimeters between the crests or junctions of adjacent coils, whichever is most convenient to measure on a given piece (Figure 4). To obtain an average, I measured the distance across as many coil crests as were present on a given sherd and divided this distance by the number of coils over which the measurement was taken. Coil surface indentation frequency refers to the average distance in millimeters between adjacent indentations visible on the surface of exposed coils (Figure 4). This was determined by measuring the distance between the same location on the indentations (crest of ridge, bottom of indent, etc.) across as many indentations as possible and dividing this distance by the number of indentations across which the measurement was taken. Percent coil overlap is the percent of one coil that is overlapped or covered by the next coil applied above it (Figure 4). To measure this attribute, the boundaries between adjacent coils must be visible in an edge of the sherd. If coil boundaries were visible, I divided the distance from the coil junction at the inside surface of the vessel wall to the end of the overlapping coil by the distance from the same inside surface point to the end of the coil being overlapped.

RESULTS

To obtain a general overview of the change from plain to corrugated vessels, I track the occurrence of exposed coils in the six gray ware assemblages. Figure 5 shows the abundance, by weight, of sherds displaying exposed coils relative to the weight of plain sherds in each assemblage. Initially, in the late eighth and early ninth centuries A. D. , plain pottery dominated utility-ware assemblages. The relative abundance of pottery with exposed coils increased gradually, reaching just over 10 percent by the late ninth century, nearly 40 percent by the mid-tenth century, and then accounting for almost all gray ware pottery by the early to mid-eleventh century. This increase in the amount of pottery displaying exposed coils derives from both a change in the relative abundance of gray ware vessels with exposed coils and an increase in the amount of surface area per vessel covered with exposed coils. Table 2 indicates that exposed coils occur almost exclusively on wide-mouth jars, and the occurrence of exposed coils on wide-mouth jars increased rapidly during the ninth century. The proportion of wide-mouth jars in relation to other vessel forms in gray ware assemblages also increased during this time (see Pierce 1999: 100–104 for a more detailed discussion of changes in utility-ware vessel forms through time). Table 3 presents the relative frequency of exposed coils on different vessel parts, and shows a gradual extension of exposed coils down the vessel body through time.

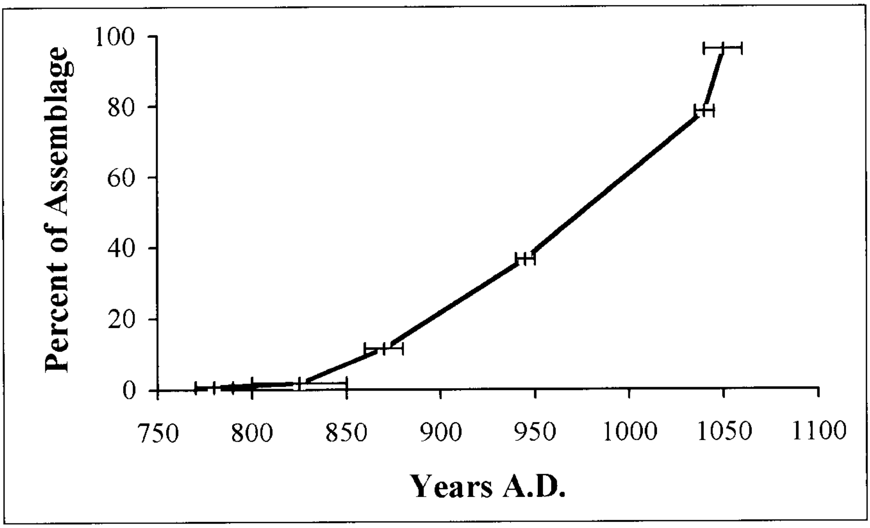

FIGURE 5. Relative abundance, by weight, of sherds with exposed coils in the six utility-ware assemblages.

TABLE 2. Relative abundance, by weight, of pottery with exposed coils on different vessel forms in the six utility-ware assemblages.

	Vessel Form Classes											
	Wide-Mouth Jar		Indeterm. Jar		Olla		Seed Jar		Bowl		Totals	
Assemblages	g[1]	%[2]	g	%	g	%	g	%	g	%	g	%
5MT2193	173	9.1	1963	0	34	0	0	0	100	0	2269	0.7
5MT4671	486	21.0	5217	0.1	66	0	0	0	213	0	5981	1.8
5MT3868	804	93.5	6065	1.6	325	0.6	6	0	86	0	7286	11.7
5MT8371	475	93.4	1087	12.1	6	0	0	0	0	0	1568	36.7
5MT1786	320	98.6	3013	76.5	0	0	0	0	0	0	3333	78.6
5MT8827	754	100	2729	95.3	0	0	0	0	0	0	3483	96.3

[1]Includes total grams of pottery identified to a particular vessel form in each assemblage.

[2]Exposed coil percentage calculations for vessel form classes are based on the total amount of pottery identified to each form class in each assemblage.

Total percentages are based on the total amount of pottery assigned to any vessel form class.

PLAIN SURFACE FORMING TECHNIQUES

Archaeologists commonly assume that plain-surfaced pottery in the Mesa Verde region was constructed from coils, which were then scraped and smoothed to form the vessel (Blinman and Wilson 1988; Breternitz et al. 1974). Very little empirical evidence has been brought to bear on the issue. Examination of bro-

TABLE 3. Relative abundance, by weight, of pottery with exposed coils on different vessel parts in the six utility-ware assemblages.

	Vessel Part													
							Upper		Lower		Indet.			
	Rim		Neck		Shoulder		Body		Body		Base		Body	
Assemblages	g[1]	%[2]	g	%	g	%	g	%	g	%	g	%	g	%
5MT2193	264	0.0	95	16.6	5	0.0	86	0.0	17	0.0	24	0.0	1806	0.0
5MT4671	626	12.6	213	11.3	122	0.0	388	0.0	434	0.0	558	0.0	3697	0.1
5MT3868	698	46.0	629	66.8	274	29.5	281	10.0	293	0.0	282	0.0	4906	0.0
5MT8371	63	86.1	383	100	59	93.2	121	21.0	69	0.0	167	0.0	705	8.1
5MT1786	354	94.5	175	92.0	0	0	545	67.2	202	98.5	26	100	2015	75.3
5MT8827	280	100	273	100	151	100	542	100	527	100	264	88.3	1446	93.3

[1]Includes total grams of pottery identified to this vessel part category in each assemblage
[2]Percentages based on weight of pottery with exposed coils calculated separately within each vessel part category for each assemblage.
Indet. = Indeterminate.

TABLE 4. Association between fracture pattern and sherd size for plain-surfaced pottery in the six utility-ware assemblages.

		Maximum Sherd Dimension					
Assemblage	Fracture Pattern	< 20mm	>20mm & ″40mm	>40mm	Total	Chi-Square	Sig. Level
5MT2193	Random	31	133	60	224		
	Nonrandom	4	31	34	69	13.1	.001
5MT4671	Random	38	324	196	558		
	Nonrandom	3	55	59	117	11.0	.004
5MT3868	Random	204	670	202	1076		
	Nonrandom	18	132	57	207	17.2	<.001
5MT8371	Random	7	86	19	112		
	Nonrandom	4	47	12	63	0.1	.940
5MT1786	Random	33	70	19	122		
	Nonrandom	14	30	8	52	0.0	.999
5MT8827	Random		7	6	13		
	Nonrandom		2	1	3	0.2	.687

Nonrandom fracture pattern includes cubic and stepped fractures.

N equals count of sherds.

ken vertical edges of plain surface pottery in the six gray ware assemblages revealed several cases in which the join between adjacent construction elements (coils or slabs) was clearly visible from the orientation of large particles and pores. For the earlier assemblages, in which plain surface pottery is much more common, all observed joins or junctions were filleted or stacked rather than

TABLE 5. Abundance of different surface forming marks on plain-surfaced utility-ware pottery in the six utility-ware assemblages.

		Assemblages											
Forming Marks	Surface	5MT2193 g	%	5MT4671 g	%	5MT3868 g	%	5MT8371 g	%	5MT1786 g	%	5MT8827 g	%
Scrape	Int.	2148	99.2	5610	99.5	5723	98.4	951	99.8	706	99.8	128	93.4
	Ext.	2248	99.2	5774	98.8	6065	96.1	926	97.7	695	99.3	99	75.0
Wipe	Int.	17	0.8	21	0.4	45	0.8	2	0.2				
	Ext.	17	0.8	44	0.7	86	1.4	11	1.1				
None	Int.			6	0.1	47	0.8			1	0.2		
	Ext.			15	0.3	135	2.1	6	0.6	5	0.7	22	16.3
Pinch	Int.											9	6.6
	Ext.					15	0.2	2	0.2			12	8.7
Other	Int.												
	Ext.	2	0.1	11	0.2	13	0.2	3	0.3				

Percentages calculated separately for each surface. Int. = Interior Ext. = Exterior

overlapping. In none of these cases, however, was both lower and upper edges of a construction element visible in a single sherd. At least one sherd from 5MT4671 (Periman Hamlet) preserves slightly over 2 cm of vessel wall above a coil/slab junction. This suggests that, at least in the earlier pottery, construction elements were relatively large, and either pinched up or applied as broad, flattened segments.

Fracture pattern data also suggest that construction elements, whether considered slabs or coils, were relatively wide during the eighth and ninth centuries A. D. , and became smaller after that time. Table 4 shows the frequencies of random and non-random (cubic and stepped) fractures and the association between sherd size (as measured by maximum sherd length) and fracture pattern in the six gray ware assemblages. The high proportion of random fractures and significant association between fracture pattern and sherd size in the earliest three assemblages (5MT2193, 5MT4671, and 5MT8368) suggest that most of the sherds in these assemblages are smaller than the size of the coil or slab from which the vessel wall was constructed. The increase in non-random fractures and breakdown in the association between sherd size and fracture pattern in the tenth and eleventh centuries without a significant increase in sherd size indicates a smaller diameter of the coil from which the vessel was constructed.

Surface features and core structure can provide information on how the vessel wall was manipulated after primary construction elements were applied. Tables 5 and 6 show the frequencies of surface features and core structure respectively for the six gray ware assemblages. Sherds displaying scrape marks on both surfaces dominate plain-surfaced pottery in all assemblages. Irregular core structures dominate all assemblages except Gnatsville (5MT1786), but laminated

TABLE 6. Abundance of different core structures in plain-surfaced pottery in the six utility-ware assemblages.

	Core Structures								
	Irregular		Laminar		Blocky		Homogeneous		Totals
Assemblages	g	%	g	%	g	%	g	%	g
5MT2193	2093	91.7	138	6.0	38	1.6	15	0.7	2289
5MT4671	4316	72.7	1030	17.3	513	8.6	81	1.4	5940
5MT3868	5919	90.6	324	5.0	169	2.6	120	1.8	6532
5MT8371	740	74.5	156	15.7	74	7.4	23	2.3	993
5MT1786	199	27.5	102	14.1	273	37.7	149	20.6	722
5MT8827	125	91.2	10	7.1			2	1.7	137
Totals	13397	80.6	1761	10.6	1066	6.4	390	2.3	16614

structures, which might result from forming with a paddle, are rare in all assemblages. The variation that does exist in core structure among assemblages shows no clear temporal trend that might be related to the development of corrugation. My experience in pottery replication suggests that the greater occurrence of blocky and homogeneous core structures in the Gnatsville assemblage may be due to differences in composition or preparation of the clay. It will require more focused and controlled experiments to further clarify the causes of these differences in core structure.

TECHNIQUES OF NECK-BANDING AND CORRUGATION

The manufacture techniques used for vessels or portions of vessels with exposed coils vary in the way coils were applied, the height of the exposed coil, the depth of the exposed junction between coils, and the manipulation of the exposed coil surface during and after coil application. In the analysis of the six gray ware assemblages, I measured several attributes designed to document variation and change in these four aspects of exposed coils.

Exposed coils were applied by either filleting or overlapping. In filleting, coils are stacked on top of one-another with no significant overlap between adjacent coils. In overlapping, coils are applied at an angle so that the upper coil covers or overlaps some of the surface of the coil below. These coils, whether filleted or overlapped, can be applied either in concentric rings or in a spiral fashion simulating a single continuous coil to build the vessel wall. Previous studies of complete vessels have shown that early exposed coils were applied using the concentric ring technique while later corrugated vessels were built with the spiral technique (Breternitz et al. 1974; Kidder and Shepard 1936; Morris 1939:186). The nature of the transition between these two techniques has never been adequately documented. Because it is extremely difficult to discern concentric and

TABLE 7. Relative abundance of filleted and overlapped exposed coils in the six utility-ware assemblages.

	Coil Application					
	Filleted		Overlapped		Totals	
Assemblage	g	%	g	%	g	%
5MT2193	16	100			16	100
5MT4671	77	71.2	31	28.8	108	100
5MT3868	607	74.4	208	25.6	815	100
5MT8371	138	26.0	393	74.0	531	100
5MT1786	3	0.1	2482	99.9	2485	100
5MT8827			3286	100	3286	100
Totals	840	11.6	6401	88.4	7241	100

spiral applications from vessel fragments, I was not able to document it in my analyses and do not discuss it further here.

Table 7 shows the abundance of filleted and overlapped coils in the six assemblages. The few fragments with exposed coils in the earliest assemblage are all filleted. Overlapped coils make up slightly less than 30 percent of assemblages dating to the ninth century. Overlapped exposed coils increased to almost 75 percent in the tenth century, and reached 100 percent in the eleventh century. Among overlapped coils, the amount of overlap between adjacent coils also increased through time. In the ninth century, most coils had less than 50 percent overlap while in the eleventh century, most coils overlapped more than 50 percent (Figure 6). Not only did overlapping replace filleting as a coil application technique, but the degree of overlapping itself became more pronounced through time.

Variation and change in the visible height of exposed coils follow a similar temporal pattern to coil application (Figure 7). During the eighth and ninth centuries, exposed coils were usually more than 10 mm high, although displaying considerable variation. In the tenth century, coil height decreased abruptly with most coils substantially less than 10 mm in height. This pattern of narrow exposed coils persisted into the eleventh century as the median and variation in coil height continued to decrease, although more gradually. A trend toward decreased exposed coil height has also been well documented for neck-banded pottery analyzed as part of the Dolores Archaeological Program (Blinman 1984). The decrease in coil height during the tenth century occurred in two ways. Increased use and degree of overlapped coil application resulted in less of each coil remaining exposed on the surface, and some filleted pottery was made with smaller coils than were used earlier. These small, filleted coils disappear in the eleventh century, and increased overlapping accounts for the continued decrease in coil height during that time.

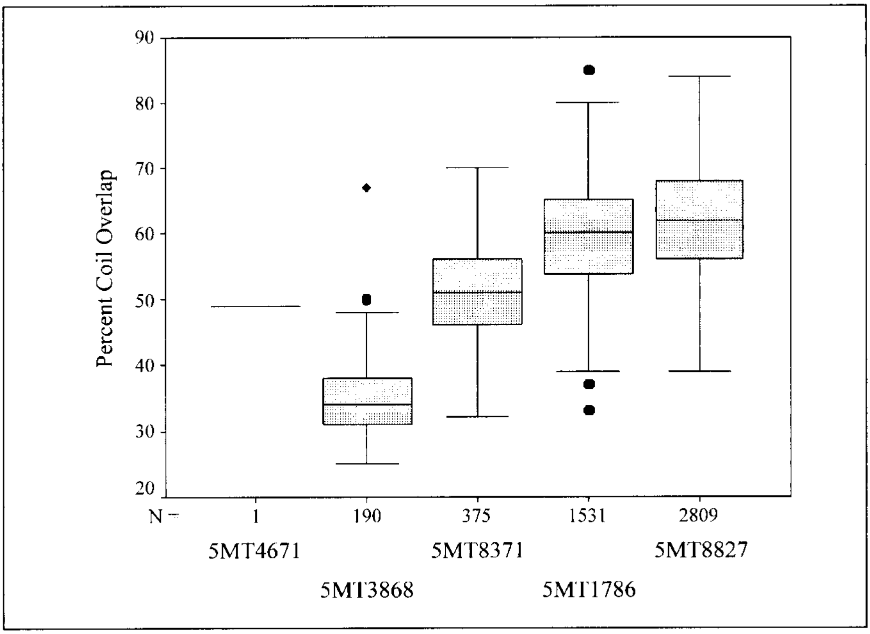

FIGURE 6. Box plot of the percentage of overlap between adjacent exposed coils in the six utility-ware assemblages (N = grams of pottery).

The junction depth measurement was used to record two different attributes. For filleted coil pottery, junction depth refers to the depth of the depressed line or zone marking the join between two coils below the maximum height of the adjacent coils. For overlapped coil pottery, junction depth measures the degree of clapboarding, or the distance between the highest point on the ridge of a coil and the surface of the coil that it overlaps. Figure 8 shows the median and variation in junction depth for filleted and overlapped coils in the six assemblages. Both the filleted junction depth and degree of clapboarding increased through time. Although the median degree of clapboarding in the Gnatsville (5MT1786) assemblage is less than that in some of the earlier assemblages, it is difficult to determine if this represents a general trend in early eleventh century pottery, or is a consequence of sampling error. For filleted coils, the increase in junction depth probably came mainly from the greater use through time of narrow, rounded coils in place of broad, flattened coils, and thus, creating a deeper depression between adjacent coils. The more pronounced clapboarding through time, particularly in the latest assemblage, probably reflects the use of deeper indentations which would push up the surrounding clay and result in a greater distance between the ridge peak and the coil below.

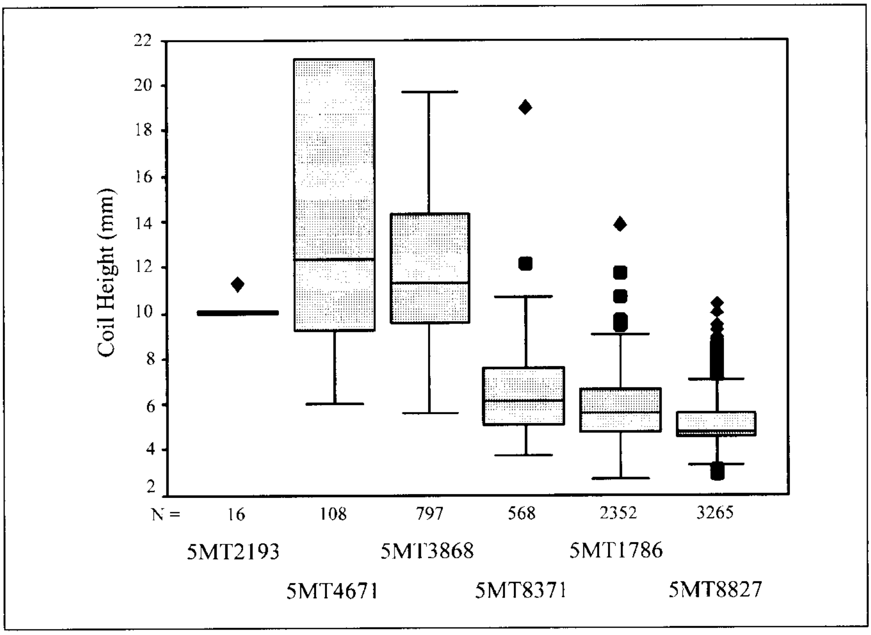

FIGURE 7. Box plot of the height of exposed coils in the six utility-ware assemblages (N = grams of pottery).

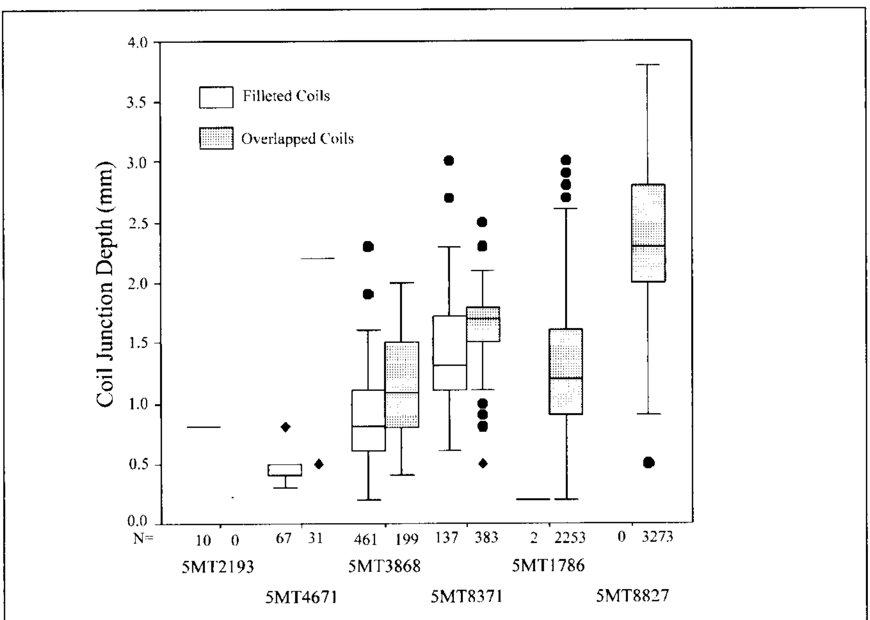

FIGURE 8. Box plot of coil junction depth for filleted and overlapped exposed coils in the six utility-ware assemblages.

TABLE 8. Abundance of different manipulations of exposed coil surfaces in the six utility-ware assemblages.

	Coil Manipulation												
	Indented		Pinched		Scraped		Wiped		Incised		None		Totals
Assemblages	g	%	g	%	g	%	g	%	g	%	g	%	g
5MT2193			10	65.8			5	34.2					16
5MT4671			62	57.7	30	27.5	7	6.2			9	8.6	108
5MT3868			34	4.0	204	24.2	311	36.9	49	5.9	244	29.0	843
5MT8371	66	11.4	19	3.3	14	2.4	2	0.3	135	23.5	340	59.1	575
5MT1786	2406	91.9	32	1.2	17	0.7	16	0.6	5	0.2	141	5.4	2617
5MT8827	2944	87.8	140	4.2	137	4.1	11	0.3			122	3.6	3354

Rounding error has produced small discrepancies in the totals.

Table 8 presents the data on the different ways in which the surface of exposed coils were manipulated in the six assemblages. In the assemblages dating to the eighth and ninth centuries, most of the coil surfaces were pinched, scraped, or wiped—probably during application. In the late ninth century, tool incising between exposed coils (along the join line) appeared for the first time, and, in the tenth century, finger and tool indenting of coil surfaces began. In both cases, these forms of coil manipulation occurred first on relatively few pieces. Most exposed coils were left unmanipulated through the middle of the tenth century. By the early eleventh century, indentations occurred on almost 90 percent of exposed coils. Figure 9 shows that the spacing between indents was erratic and relatively wide during the tenth century, but became more closely and consistently spaced in the eleventh century. In addition, indentations occur mostly just below the rim on the last three or four coils applied to the vessel during the tenth century, and thus, probably began as a decorative elaboration.

To examine the relationships among the different exposed coil dimensions, I created a paradigmatic or dimensional classification (Banning 2000; Dunnell 1971) using selected attributes of three of the dimensions—coil application (filleted, overlapped <50 percent, or overlapped >50 percent), coil height (<10mm or >10mm), and indentation (present or absent). Of the 12 possible classes defined by this paradigm, only nine classes have members identified among the sherds in the six gray ware assemblages. Figure 10 shows the changes through time in the relative abundance (quantified by weight) of pottery in the nine different exposed coil classes.

A majority of the exposed coils manufactured during the eighth and ninth centuries consisted of wide filleted coils without indentations. During the ninth century, however, narrower filleted coils and wide coils with slight overlap began to be manufactured in small to moderate amounts. In the tenth century, variation in the construction of exposed coils reached its zenith, and the most abundant class shifted to narrow, substantially overlapped coils without indentations.

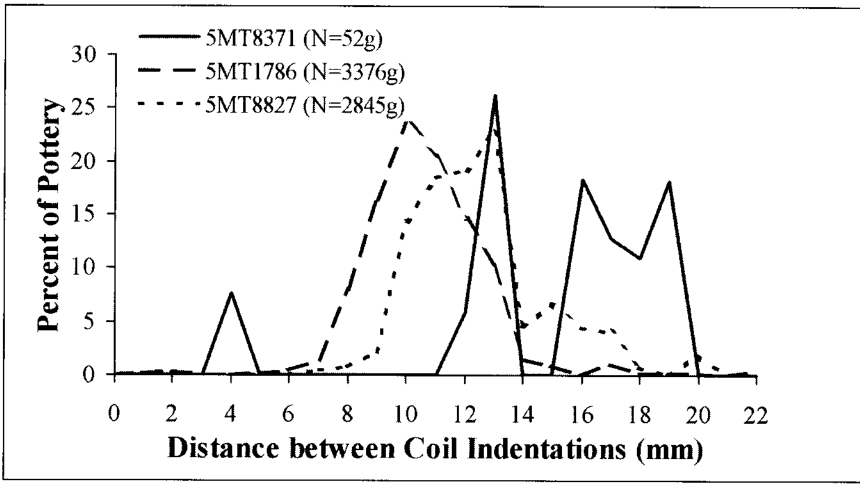

FIGURE 9. Variation in the spacing of indentations on exposed coils in the latest three utility-ware assemblages.

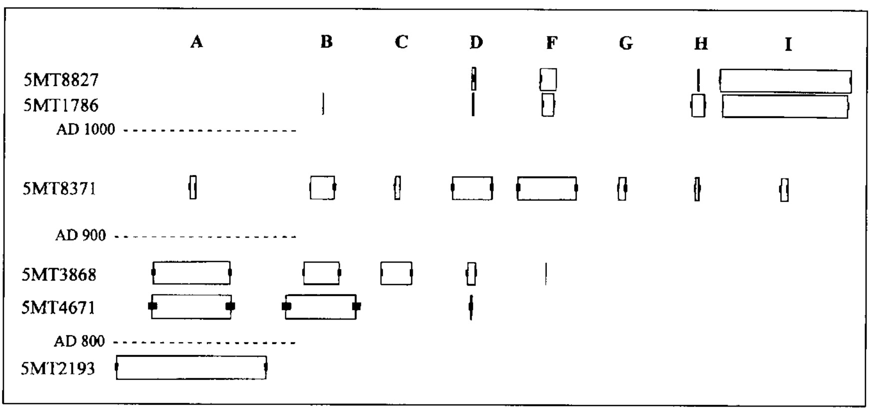

FIGURE 10. The relative abundance, by weight, of pottery assigned to different classes of exposed coils in the six utility-ware assemblages based on the paradigmatic combination of presence or absence of indenting, degree of coil overlap, and exposed coil height. Class E is represented by only 6 g (0.8% of the assemblage) of pottery from 5MT3868. Error bars = 90% confidence intervals. Class A = no indent, no overlap, >10mm height. Class B = no indent, no overlap, <10mm height. Class C = no indent, <50% overlap, >10mm height. Class D = no indent, <50% overlap, <10mm height. Class E = no indent, >50% overlap, >10mm height. Class F = no indent, >50% overlap, <10mm height. Class G = indented, no overlap, <10mm height. Class H = indented, <50% overlap, <10mm height. Class I = indented, >50% overlap, <10mm height.

Although no single variant accounts for more than 40 percent of the assemblage from the tenth century, three different varieties of narrow, unindented coils make up more than 80 percent of exposed coils. By at least the early eleventh century, one of the variants, narrow, substantially overlapped, and indented coils, which appeared in low frequencies for the first time in the tenth century, almost completely replaced all others. The abrupt increase in this class of exposed coils marks the full adoption of indented corrugation. This also coincides with the spread of exposed coils over the entire exterior surface of most gray ware vessels.

CONCLUSIONS

These results show that, in the Mesa Verde region at least, there was historical continuity in the development of corrugation from vessels with entirely plain exterior surfaces, through various forms of neck-banding, to full-body indented corrugation. In addition, the data document an initial, gradual accumulation of innovations in the manufacture of exposed coils culminating with a flourish of elaboration during the tenth century. This was followed by the nearly complete adoption of one combination of these innovations, indented corrugation, by the early eleventh century. Published data on pottery types suggest that the development of corrugated pottery followed a similar path in many, though not all, regions of the Southwest where corrugated pottery was made with the timing of changes varying, sometimes substantially, from one region to another (Pierce 1999).

Experimental studies with smoothed and textured ceramic cooking pots demonstrate that a textured exterior surface on cooking pots, such as that produced by neckbanding and corrugation, can yield several benefits not found in plain cooking pots (Pierce 1999, 2005; Schiffer 1990; Schiffer et al. 1994; Young and Stone 1990). These potential benefits include greater vessel durability, superior cooking control, reduced production failures, and possibly improved ease of handling. In addition, each step in the development of corrugation brought with it some benefit that may have played a causal role in the success of that set of innovations (Pierce 2005).

Given these experimental results, it may be tempting to view the development of corrugated pottery as an example progressive technological change with one step leading logically and inexorably to the next. Such an assessment would be premature. Rather than conceiving of the development of corrugation as a single problem, it may be helpful to break the issue down into three separate queries about critical junctures in the history of corrugated pottery: 1) Why was early neckbanding successful? 2) Why was neckbanding the subject of such intense experimentation and elaboration? 3) Why was full-body, indented corrugation adopted so rapidly, and to the almost complete exclusion of other forms of corrugation and neckbanding?

The success of neckbanding set the stage for the development of corrugation. Leaving construction coils unobliterated is only one way to create a textured surface on a ceramic vessel. Other techniques one could use to produce a similar effect include incising, appliqué, and stamping. Had another technique been used, the path to corrugation may have been disrupted. Was early neckbanding successful because of historical accident (it was adopted before other techniques appeared), or did neckbanding offer some benefit that other techniques did not?

Once neckbanding became established, considerable experimentation with neckbanding techniques produced several variations on the neckbanding theme as well as an increase in the amount of vessel surface displaying exposed coils. Was this experimentation a stochastic, more-or-less cost-free exploration of the new design space created by leaving coils exposed, or was it a costly enterprise directed toward solving some design problem(s)? Were there economic, social, or ideological conditions that drove the increase in innovation rate during the tenth century?

The variation in neckbanding produced by this experimentation soon disappeared as potters fixed on a single variant (relatively narrow, highly overlapped, and indented coils). This was followed in rapid succession by the use of corrugation over the entire exterior surface of utility ware jars. Published data suggest that full-body corrugated utility wares replaced neck-banded vessels at nearly the same time across large part of the northern Southwest including the San Juan basin, Mesa Verde, Kayenta, Sinagua, and Virgin Branch regions (Pierce 1999). Was this rapid adoption driven by some higher level cultural or political replacement, or an indication that full-body, indented corrugated pottery solved a pressing technological problem faced by separate people over wide area? Why did corrugated pottery apparently not spread more rapidly or completely into adjacent areas occupied by similar populations such as the Rio Grande valley and south of the Mogollon Rim?

To address these issues, we must perform attribute analyses of utility ware pottery from other regions creating a more detailed, multi-regional history of corrugated pottery. By merging these data on technological history with functional insights from experiments and other contextual information, we can begin to formulate testable hypotheses to account for the unique and complex history of corrugated pottery in the Southwest.

ACKNOWLEDGMENTS

I conducted this research as part of my Ph.D. dissertation while on the staff of Crow Canyon Archaeological Center, Cortez, Colorado. The analyses were supported in part by a grants from the Colorado Historical Society and the Standard Products Foundation. This article benefited from comments by Michael Schiffer and Ron Towner.

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