Excavations along NM 22:
Agricultural Adaptation from AD 500 to 1900 in the Northern Santo Domingo Basin, Sandoval County, New Mexico

compiled by Stephen S. Post and Richard C. Chapman

Volume 4
Analytical Studies: Chronology, Ceramics, Stone Tools

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Chronometric Dating of the Peña Blanca Sites

Stephen S. Post

One of the primary goals for the NM 22 project was to accurately date the many cultural-temporal components identified at the seven sites. LA 115863 consisted of an unknown cultural-temporal component. LA 265 and LA 115862 had one major cultural-temporal component (Early Developmental). LA 249 (Early Developmental and Classic), LA 6170 (Early and Late Developmental) and LA 6171 (Early Developmental and Coalition) had two main cultural-temporal components. LA 6169 had three major cultural-temporal components (Early and Late Developmental and Coalition). LA 265, LA 6169, LA 6170, and LA 6171 potentially had non-continuous, multiple occupations during the Early Developmental period that might have been spaced enough apart to allow for chronometric distinction. For the sites with multiple Early Developmental components, accurate dating was critical to determining if these were the same household sequentially building, occupying, and abandoning pit structures, contemporaneous structures occupied by two or more households or intermittent occupation by unrelated or related households spanning 100 to 150 years. Each occupation sequence scenario has important consequences for examining social and economic organization at local and regional scales.

At a minimum, the earliest and Early Developmental components are the earliest and northernmost Pueblo-like occupations predating AD 800 along the Middle Rio Grande Valley. Therefore, dating these components is important to understanding the pace at which settlements moved into more northern settings and the success of these settlements as gauged by longevity, intensity, and eventual expansion to the north.

Given the highly dynamic and changeable nature of local and regional social and economic frameworks from AD 1100 to 1350, tighter dating of Peña Blanca components is desirable. With chronometric dates, these data from Developmental and Coalition components can be integrated into existing frameworks and can be used to evaluate hypotheses regarding population movement and affiliation. Accurate dating also allows Peña Blanca components to be compared and synthesized with the excavation data from the Bandelier and Cochiti Dam and Reservoir projects.

Excavation of structures, features, and deposits at the eight NM 22 sites resulted in the collection or recovery of radiocarbon, dendrochronological, and archaeomagnetic samples from a wide range of contexts that provide variable accuracy and precision. Pottery and projectile points were recovered from all sites. Existing relative dating schemes are useful for cross-checking the chronometric dating and for comparison with contemporaneous components and sites excavated in the Bandelier and Cochiti areas, for which there are few absolute dates.

Chronometric Dating Methods and Limitations

Dendrochronological, archaeomagnetic, and radiocarbon samples were collected from architectural, feature, and stratigraphic contexts. Dates from these samples represent different events or episodes in each site occupation history. They also represent events within the life of the material used for dating, as well as the material's place on the natural landscape. A brief discussion of the dating methods and limitations is presented, followed by the enumeration of the chronometric dates assigned to the sites and components.

Dendrochronology

Dendrochronology produces extremely precise and accurate dates when appropriate samples are available. Ideal samples should have 15 to

20 years of growth rings, a sensitivity to climate variation that allows the sample to be matched with the regional chronology of climatic variation, qualities of outer surface that allow the outer ring to be interpreted as the death year of the tree, and an archaeological context that supports a linkage between tree death and the cultural behavior that is the target event of the dating effort. Tree-ring dating is most reliable when multiple samples are collected from structural remains where timbers were cut to length. Although construction timber reuse and stockpiling can cause inaccuracies (Graves 1983; Crown 1991), patterns of dates from multiple samples usually reveal the presence of remodeling or reuse of wood (Ahlstrom 1985). Although wood samples from nonarchitectural contexts can be dated, samples from fuel wood in hearth contexts risk the same "old wood" problem that affects radiocarbon samples (Schiffer 1987:309–312; Smiley 1985). A final limitation on dendrochronological dating is wood species. Piñon and ponderosa pine and Douglas fir have tree-ring growth patterns that are conducive to tree-ring dating. Juniper is a slow growth tree with narrow rings and poor indicators of age. Cottonwood, which grows in well-watered settings, is not suited to tree-ring dating.

A mix of wood species was recovered from architectural contexts. Piñon, juniper, and cottonwood were recovered from architectural contexts. Samples sent to the University of Arizona Tree-Ring Laboratory included piñon, juniper, and inadvertently, cottonwood. None of the nineteen samples (eight from LA 6169, eight from LA 7170, and three from LA 6171) were datable. Samples were classified as complacent or erratic and no dendrochronological dates were derived from the Peña Blanca samples. This is an interesting contrast to the Cochiti Dam and Reservoir sites, which yielded an abundant, if temporally and contextually restricted, array of dendrochronological dates from Late Developmental, Coalition, and Classic period contexts (Lange 1968; Hubbell and Traylor 1982; Snow 1976).

Archaeomagnetism

Archaeomagnetism does not have either the potential precision or accuracy of tree-ring dating, but it does have other advantages. Heating allows the field orientations of magnetic particles in earth or rock to become reoriented to the prevailing geomagnetic field when the particles cool (Sternberg 1990; Wolfman 1990). Since the geomagnetic field is constantly changing, features that are burned and cool will retain a distinctive magnetic orientation that is determined by the date of the cooling. Whereas tree-ring dating works best at recording the dates of construction events, archaeomagnetic dates apply to the final use of burned features and are one of the only dating techniques that can inform about abandonment events.

Archaeomagnetic samples are collected from burned cultural features or contexts, the orientation of the sample is measured in the laboratory, and the geomagnetic pole recorded by the feature is compared with the regional pattern of polar movement through time. Problems with archaeomagnetism stem from both measurement factors and interpretation factors, both of which can affect the precision and exclusivity of date interpretations. The precision of a given result is determined by the coherence of the orientations of the individual specimens (usually eight) that make up the sample. Variables affecting coherence include the type, size, and density of magnetic minerals in the earth, the temperature of the burn, and any sources of post-burning disturbance of the feature. Even a very coherent result may have imprecise or multiple date interpretations based on the intersection of the result's oval of confidence with the polar curve for the region. A time of particularly slow polar movement can result in a broad date range, or a region of the pole that is transected by several segments of the polar curve will result in multiple possible date ranges. When an archaeomagnetic sample results in multiple date ranges, independent dating evidence will be required to determine which of the possible date ranges is correct. The greatest advantage of this technique is that the sampled material is usually unambiguously related to the component being dated, but potential ambiguity of the technique requires that it be used in conjunction with other sources of chronology.

Twenty-nine archaeomagnetic samples were collected from five sites: LA 265, LA 6169, 6170, 6171, and LA 115862. The dates can be assigned to the earliest Developmental, Early Developmental, Late Developmental, and Coalition periods. Most were collected from thermal features from within structures.

Radiocarbon Dating

Radiocarbon dating has similar limitations to the first two methods, but it has the advantage that carbon is one of the most abundant sample materials in archaeological contexts (Taylor 2000). Plants incorporate carbon into their tissues through photosynthesis, drawing on the pool of carbon in the atmosphere. Radioactive isotopes of carbon are produced from cosmic radiation in the upper atmosphere, resulting in a relatively constant proportion of carbon-14 in the atmospheric pool. When plant tissue is no longer actively incorporating carbon, the amount of radioactive carbon declines at a rate consistent with the relatively short half-life of the isotope. The measured amount of radioactive carbon in a sample, the expected amount given the assumed atmospheric pool concentration, and the half-life value for the isotope can be used to calculate a radiocarbon age for the sample. Precision of radiocarbon age estimates is determined by the measurement error associated with determining the radioactive isotope contents. However, the assumption of a constant value for carbon-14 pool concentration has been shown to be inaccurate, and the radiocarbon age of a sample can only be translated into a calendric age estimate by comparison with carefully derived calibration curves (Stuiver and Reimer 1993). These curves reflect fluctuating pool values, increasing dating accuracy but affecting both precision and exclusivity of radiocarbon date interpretations. A single precise date expressed in radiocarbon years can yield an imprecise calendar date or multiple possible calendar date ranges.

Independent of the technical aspects of dating, radiocarbon samples are not unambiguously associated with cultural contexts. Although unburned organic materials deteriorate in most archaeological sites, charcoal is inert, and once it is produced, it is only subject to physical damage. Most charcoal results from heating and cooking fuel, but it can also result from the burning of structures and artifacts. Individual pieces of charcoal rarely carry any qualities that can be unambiguously related to a particular cultural event, therefore, the integrity of potential samples is dependent on feature contexts. If samples are collected from potentially disturbed contexts, then the resulting dates can only be interpreted in relation to other independent dates. Other problems with radiocarbon dating are the "old wood" issue previously mentioned for dendrochronology and cross-section effects. Long-dead (dry) wood tends to be harvested for fuel, and on Southwestern landscapes, standing dead trees may be sources of fuel for centuries after their death (Smiley 1985). In addition, slow-growing species such as piñon and juniper can incorporate centuries of growth into small branches (cross-section effect). These qualities can result in erroneously early radiocarbon dates, even though the sampled material is unambiguously associated with a particular cultural feature and behavior. To lessen the potential risks of these problem, the charcoal selected for dating can be sorted by species and plant part. Small twigs or branches contribute less to cross-section effects because they incorporate fewer years of growth and they persist for shorter periods on standing dead trees. Annual plants and perennial shrubs are better material for radiocarbon dating because they incorporate carbon over smaller numbers of years and are not likely to survive on the landscape a long time after dying. Care in collecting, selecting, and characterizing radiocarbon samples will increase their relevance to particular cultural contexts, but the other limitations of the technique and date interpretation will constrain use and interpretation in some contexts.

Seventeen radiocarbon samples from four sites were submitted to BetaAnalytic, Inc. for processing and analysis. Samples were charred plant parts, such as corn, horsetail, or saltbush and wood (juniper and cottonwood/willow). In most cases, calibrated two-sigma dates provided limited precision, but do corroborate archaeomagnetic and artifact dating. A large quantity of samples were not submitted because they were expected to have limited utility with their relatively large two-sigma errors.

Projectile Point Dating

Some chipped stone artifacts also have the potential to provide relative dates. Projectile points, in particular, are often used for this type of dating (see, for instance, Thoms 1977; Turnbow 1997). Unfortunately, dates for specific projectile point styles are usually not well anchored. In most cases they can only be assigned to time spans measured in centuries or millennia rather than years or decades. Some styles were used for long periods of time, often overlapping a wide range of ceramic types and styles. In addition, projectile points were frequently collected from earlier sites and reused, "contaminating" later sites with earlier styles. Thus, this artifact category can only be used to provide very gross dates.

Ceramic Dating

Ceramic dating is discussed in the Peña Blanca ceramics chapter by C. Dean Wilson in this report. Prehistoric pottery within the Middle Rio Grande and Northern Rio Grande traditions tend to have fairly long manufacturing date ranges. Therefore, more refined dating was expected to stem from datable intrusive ceramics, such as polychrome and black-on-red pottery from the south and west. Unfortunately, small quantities of intrusive ceramics were recovered from most contexts. The most productive context was the Late Developmental Structure 76 deposits from LA 6169. Ceramic dating provides general component dates and provides broad temporal context for site occupation histories.

Dating the Peña Blanca Occupations

Dating of the Peña Blanca occupations at LA 249, LA 265, LA 6169, LA 6170, LA 6171, LA 115862, and LA 115863 is an interesting contrast to previous excavations conducted for the Cochiti Dam and Reservoir projects. The major Cochiti Dam and Reservoir project reported in Biella and Chapman (1979) yielded no chronometric dates from the limited activity and architectural sites dating from Late Archaic to historic periods. The Cochiti Dam Archaeological Salvage Project reported by Lange (1968) yielded 77 dendrochronological dates from Late Developmental, Coalition, and Classic period contexts with the majority recovered from a kiva and room within the Classic period western component of the Alfred Herrera site (LA 6455). The abundance of datable conifer wood in the Coalition and Classic periods is a strong contrast to the stark absence of dendrochronological dates from later Cochiti efforts and the Peña Blanca project. Intermediate to the Cochiti Dam and Reservoir is the Cochiti Floodpool excavations conducted by the National Park Service (Hubbell and Traylor 1982). Fifteen archaeomagnetic samples and seventeen tree-ring dates were collected from Late Developmental and Classic period components from LA 12119 and LA 12121 (Traylor 1982:448–451). The twenty-nine archaeomagnetic and seventeen radiocarbon samples reported from the Peña Blanca project provide a much needed dating sequence for Early Developmental occupations and a substantial contribution to the existing Late Developmental and Coalition chronometric dates.

Site Chronometrics

Tables 15.1 and 15.2 provide summarized chronometric dating information for all sites. Table 15.1 presents the data in site order and Table 15.2 presents the data in chronological order. The data in these tables are briefly summarized below.

LA 249 had one radiocarbon sample sub-

Table 15.1. Chronometric Dates by Site

LA	Sample No. and Context	Archaeomagnetic Date (AD)	Radiocarbon Date, Intercept and Range (Cal AD, 2 sigma)	Sample	Comments
249	Beta-149011, FS282,		970-1260		
265	Beta-149017, Structure 1, upper fill		660, 530-890	Corn	
265	Beta-149018, Structure 13, middle fill		670, 640-770	Corn	
265	Beta-149015, Feature 59 in Structure 33		680, 650-780	Corn	
265	PB1145, SU 13, Feature 128, Hearth (shallow structure)	740			Weak samples
265	PB1148, Feature 27, shallow structure	750			Weak samples
265	Beta-149014, SU 2, F. 47, bell-shaped storage pit in F.27 floor (keyhole structure)		720, 740, 760, 670-870	Corn	
265	Beta-149012, SU 13, F.128, central hearth		770, 650-880		
265	PB1140, Feature 72, central hearth within Structure 4	805			
265	PB1149, Feature 33, wall niche, Structure 1	835			
265	PB1143, Feature 101, central hearth, Structure 1	850			
265	Beta-149016, SU 1, F. 106, central hearth		990, 680-1240	Corn	
6169	PB1155, Feature 4, ashpit	790			Weak
6169	PB1154, Feature 4, Feature 35 hearth	790			Weak
6169	PB1161, Feature 47, hearth coping	820			Weak sample
6169	Beta-149025, Feature 47, Feature 121 storage pit		770, 660-900	Cottonwood/ willow	
6169	PB1160, Feature 76, central hearth	1205			
6169	Beta-149022, Feature 76,		900, 670-1040	Juniper	
6169	PB1159, Feature 16, Feature 130 auxiliary hearth	1225			
6169	PB1156, Feature 15, central hearth	1235			
6169	PB1158, Feature 16, Feature 105 warming pit	1245			
6169	Beta-149019, Feature 16, Feature 105 warming pit		1030, 960-1210	Saltbush	
6169	Beta-149021, Feature 70, Feature 98 central hearth		1030, 960-1250	Juniper	
6169	Beta-149023, Feature 14, thermal feature intrusive to Feature 15		1230, 1040-1290	Saltbush	
6170	PB1144, Feature 61, burned pit in sheet midden area	710-775			
6170	PB1106, Structure 5, Feature 12, floor pit	720-785			
6170	Beta-149027. Structure 5		660, 610-760	Reeds	
6170	PB1125, Structure 50, Feature 152, upper hearth collar	755-830(?)			

Table 15.1. Continued.

LA	Sample No. and Context	Archaeomagnetic Date (AD)	Radiocarbon Date, Intercept and Range (Cal AD, 2 sigma)	Sample	Comments
6170	Beta-149028, Structure 50		880, 700-1000	Reeds	
6170	PB1102, Structure 2, burned floor	815-845			
6170	Beta-149026, Structure 2		910, 920, 960, 790-1010	Cottonwood/ willow	
6170	PB1152, Structure 5, Feature 38, wall niche	825-875			
6170	PB1151, Structure 50, SSW wall burn	900-950			
6170	PB1103, Structure 5A, mealing room, Feature 8 corner hearth	1035-1080			
6171	PB1147, Feature 91 w/in Feature 90	435-525			
6171	PB1109, Feature 43, bell-shaped roasting pit	500-650			
6171	PB1104, Feature 38, hearth in complex activity area	510-650			
6171	PB1108, Feature 54, bell-shaped roasting pit	515-655	560, 440-660	Corn	
6171	PB1146, Feature 88, thermal pit	610-630			
6171	PB1110, Feature 93, hearth in bell-shaped pit	605-665			
6171	PB1141, Structure 50, Feature 77, hearth	740-835			
6171	PB1107, Structure 9, Feature 10, shallow pit	775-825			
6171	Beta-149030, Structure 9		790, 670-970	Wood charcoal	
6171	Beta-14029, Structure 26		900, 770-1020	Charred annuals	
115862	PB1150, central hearth	775-815			

mitted from a context within the pit structure. Consisting of charred material (actual material was not recorded), the two-sigma calibrated date range is AD 970–1260 with an intercept date of AD 1040. The INTCAL98 radiocarbon calibration curve for this range undulates and has a gradual slope resulting in the almost 300-year range. The intercept date of AD 1040 is a little early for the associated ceramic types. The span from AD 1100–1140 also has a high probability within the curve and it fits with the majority of the pit structure floor and floor fill ceramics better than the AD 1040 date. Ceramics from this period are dominated by Kwahe'e Black-on-white and granite-tempered utility wares with half of the utility wares exhibiting exterior corrugation (see Wilson, Chapter 16).

LA 265 had five archaeomagnetic and six radiocarbon samples that yielded centroid dates or intercept dates and date ranges. All samples were recovered from architectural features. Structures 1, 4, and 13 were deep pit structures, while Structures 27 and 33 were shallow keyhole structures. Radiocarbon samples from the upper fill of Structure 1 yielded intercept and two-sigma date ranges that are earlier than the mid-800s archaeomagnetic centroid dates from the central hearth (Feature 101) and a burned wall niche (Feature 33). The radiocarbon sample from the central hearth yielded an intercept date of AD 990 and an AD 680 to 1240 two-sigma date range. The one-sigma calibrated date range of AD 810 to 840 is

Table 15.2. Chronometric Dates Ordered from Early to Late

LA	Sample No. and Context	Archaeomagnetic Date (AD)	Radiocarbon Date, intercept and range (Cal AD 2-sigma)	Sample	Comments
6171	PB1147, Feature 91 w/in Feature 90	435-525			
6171	PB1109, Feature 43, bell-shaped roasting pit	500-650			
6171	PB1104, Feature 38, hearth in complex activity area	510-650			
6171	PB1108, Feature 54, bell-shaped roasting pit	515-655	560, 440-660	Corn	
6171	PB1146, Feature 88, thermal pit	610-630			
6171	PB1110, Feature 93, hearth in bell-shaped pit	605-665			
265	Beta-149017, Structure 1, upper fill		660, 530-890	Corn	
265	Beta-149018, Structure 13, middle fill		670, 640-770	Corn	
265	Beta-149015, Feature 59 in Structure 33		680, 650-780	Corn	
6170	PB1144, Feature 61, burned pit in sheet midden area	710-775			
6170	PB1106, Structure 5, Feature 12, floor pit	720-785			
6170	Beta-149027, Structure 5		660, 610-760	Reeds	
265	PB1145, SU 13, Feature 128, Hearth (shallow structure)	740			Weak samples
265	PB1148, Feature 27, shallow structure	750			Weak samples
265	Beta-149014, SU 2, F. 47, bell-shaped storage pit in F.27 floor (keyhole structure)		720, 740, 760, 670-870	Corn	
265	Beta-149012, SU 13, F.128, central hearth		770, 650-880		
6169	PB1155, Feature 4, ashpit	790			Weak
6169	PB1154, Feature 4, Feature 35 hearth	790			Weak
6171	PB1141, Structure 50, Feature 77, hearth	740-835			
6170	PB1125, Structure 50, Feature 152, upper hearth collar	755-830(?)			
115862	PB1150, central hearth	775-815			
6171	PB1107, Structure 9, Feature 10, shallow pit	775-825			
6171	Beta-149030, Structure 9		790, 670-970	Wood charcoal	
265	PB1140, Feature 72, central hearth within Structure 4	805			
6170	PB1153, Structure 50, Feature 152, hearth under collar	815-845			
6170	Beta-149028, Structure 50		880, 700-1000	Reeds	
6170	PB1102, Structure 2, burned floor	815-845			
6170	Beta-149026, Structure 2		910, 920, 960, 790-1010	Cottonwood/ willow	
6169	PB1161, Feature 47, hearth coping	820			Weak sample
6169	Beta-149025, Feature 47, Feature 121 storage pit		770, 660-900	Cottonwood/ willow	
265	PB1149, Feature 33, wall niche, Structure 1	835			
6170	PB1152, Structure 5, Feature 38, wall niche	825-875			
265	PB1143, Feature 101, central hearth, Structure 1	850			
6170	PB1151, Structure 50, SSW wall burn	900-950			
265	Beta-149016, SU 1, F. 106, central hearth		990, 680-1240	Corn	
6171	Beta-14029, Structure 26		900, 770-1020	Charred annual	
249	Beta-149011, FS282		970-1260		
6170	PB1103, Structure 5A, mealing room, Feature 8 corner hearth	1035-1080			
6169	PB1160, Feature 76, central hearth	1205			
6169	Beta-149022, Feature 76,		900, 670-1040	Juniper	
6169	PB1159, Feature 16, Feature 130 auxiliary hearth	1225			
6169	PB1156, Feature 15, central hearth	1235			
6169	PB1158, Feature 16, Feature 105 warming pit	1245			
6169	Beta-149019, Feature 16, Feature 105 warming pit		1030, 960-1210	Saltbush	
6169	Beta-149021, Feature 70, Feature 98 central hearth		1030, 960-1250	Juniper	
6169	Beta-149023, Feature 14, thermal feature intrusive to Feature 15		1230, 1040-1290	Saltbush	

more consistent with the archaeomagnetic dates. Early Developmental period ceramic dating does not provide additional resolution. Wilson (Chapter 16) indicates that a middle ninth-century occupation of Structure 1 is supported by the ceramics, although the chronometric dates are more reliable. Structure 13 yielded a radiocarbon intercept date of AD 770 and a two-sigma date range of AD 650–880, which is slightly later than the upper fill sample date range. Structure 13's central hearth also yielded an AD 740 archaeomagnetic centroid date. This date and the radiocarbon date suggest that Structure 13 may be the earliest deep pit structure excavated at LA 265. A third deep pit structure (Structure 4) yielded an AD 805 archaeomagnetic centroid date from its central hearth (Feature 72). It would be temporally intermediate to Structures 13 and 1, suggesting that LA 265 structures were occupied sequentially and that the site features reflect accretion over time rather than intense accumulation over a short period. The two shallow keyhole structures, Structure 27 and 33, were assigned dates that were slightly earlier or contemporary with Structure 13. Structure 27 had an archaeomagnetic centroid date of AD 750 and three radiocarbon intercept dates of AD 720, 740, and 760. Combined, these dates strongly suggest occupation in the middle eighth century. Structure 33 yielded one radiocarbon date from charred corn with an intercept date of AD 680 and a two-sigma date range of AD 650 to 780. This date range indicates that Structure 33 may be the earliest excavated structure on the site. Thus, there may be an occupation and construction sequence of shallow structures early followed by larger, deeper structures in the ninth century.

LA 6169 yielded dates from three Early Developmental, one Late Developmental, and three Coalition archaeomagnetic samples. All samples were collected from thermal features within pit structures or pit rooms. An Early Developmental, one Late Developmental, and three Coalition period radiocarbon samples were submitted. The only nonarchitectural sample came from a thermal feature in the upper fill of Structure 15. Structures 4 and 47 archaeomagnetic dates had centroid dates of AD 790 and 820, respectively. These weak-signal samples suggest sequential occupation. The radiocarbon samples from Feature 121 within Structure 47 have an intercept date of AD 770 and a two-sigma date range of AD 660 to 900. It does not substantiate the archaeomagnetic date and the potential for "old wood effect" may partly explain the early intercept date and higher probability that the wood dated as early as AD 700. Basically, the two structures were probably occupied during the late eighth or early ninth century.

Structure 76, the Late Developmental pit structure, yielded two dates. The archaeomagnetic sample from the central hearth yielded an AD 1205 centroid date placing the occupation at the end of the Late Developmental period. The radiocarbon sample yielded an intercept date of AD 900 and a date range from AD 670 to 1040. Since the charred wood was juniper, it is likely that this sample suffers from "old wood effect." Adding 200 or 300 years to the intercept would make the radiocarbon date contemporaneous with the archaeomagnetic sample.

The small number of Coalition period samples provide intriguing, but inconclusive, temporal patterning. Structure 16, a pit room, yielded one radiocarbon and two archaeomagnetic dates. The Feature 130 archaeomagnetic centroid date of AD 1225 and the Feature 105 archaeomagnetic centroid date of AD 1245 coincide with the architectural evidence for two occupations. The radiocarbon date from saltbush recovered from Feature 105 had an intercept date of AD 1030 and a two-sigma date range of AD 960 to 1210. This date does not match up with the archaeomagnetic date and there is limited potential for "old wood effect," although some effect is probable. Intermediate to the Structure 16 archaeomagnetic dates is the AD 1235 centroid date from the hearth (Feature 72) in Structure 15. This sequence suggests that Structure 16 was built, perhaps fell into disuse, Structure 15 was built, and then Structure 16 was remodeled and occupied, soon after

Structure 15 was left unoccupied. Structure 70 was the third pit room in a cluster around Structure 4. A radiocarbon sample from the hearth (Feature 98) within Structure 70 yielded an intercept date of AD 1030 and a two-sigma date range of AD 960 to 1250. The sample was charred juniper and may suffer from "old wood effect." Adding 200 to 300 years to the intercept date would place Structure 70 occupation in the middle AD 1200s, which matches well with the ceramic dating. Further, Structure 70 had the most abundant refuse deposit in the upper structure fill suggesting that it was abandoned early in the Coalition period. Ceramic and chronometric dating place the three pit room occupations within a 20- to 30-year period suggesting consistent seasonal use of LA 6169 during the early to middle AD 1200s. A radiocarbon sample of charred saltbush from Feature 14, an upper fill intrusive thermal feature in Feature 15, yielded an intercept date of AD 1230 and a two-sigma date range of AD 1040 to 1290. The rapid filling of Feature 15 combined with reuse of the depression for heating or cooking confirms that Coalition period populations maintained a fluid land-use pattern along the river terraces.

LA 6170 yielded eight archaeomagnetic samples and three radiocarbon samples were submitted for analysis. Seven archaeomagnetic samples were collected from Early Developmental contexts including hearth collars, floor pit, wall niche, burned patches of pit structure floors and walls, and a burned pit within a sheet trash deposit. The assayed radiocarbon samples were from Early Developmental structure roof fall (charred reeds from Structures 5 and 50 and charred cottonwood/willow from Structure 2). One archaeomagnetic sample was collected from a corner hearth within a mealing room (Structure 5A) that was suspected to date to the Late Developmental period based on the associated pottery types.

The date ranges from the archaeomagnetic samples provide the best opportunity to examine construction sequence, but at the same time yielded some conflicting results. Radiocarbon assays are used to evaluate the reliability of the archaeomagnetic date ranges. Feature 61, a burned pit within a sheet midden yielded a date range from AD 710 to 775. This date range is contemporaneous with the 720–785 date range from Feature 12 within Structure 5. The Structure 5 date is the most reliable suggesting a mid to late eighth-century occupation. The radiocarbon assay from Structure 5 (Beta-149027) was derived from charred reeds and it yielded an intercept date of 660. This date is earlier than the archaeomagnetic date range, but the two-sigma date range of 610 to 760 suggests that a middle eight-century occupation is likely. Nancy Akins, in the LA 6170 site report, suggests that Structure 50, Floor 1 component is the earliest based on stratigraphic and remodeling evidence, but there is no independent dating in support of the observation. The upper hearth collar in Structure 50 yielded an archaeomagnetic date range of 755 to 830 suggesting that the second occupation may be contemporaneous with Structure 5, which could make the Floor 1 component earlier than Structure 5. Unfortunately, the Floor 1 hearth yielded an archaeomagnetic date range of 815 to 845, which is later than the date range from the stratigraphically later component. Thus, the hearth collar date range is probably unreliable. Interestingly, the charred reeds from the Structure 50 roof yielded a radiocarbon intercept date of 880 and a two-sigma date range of 700 to 1000. The intercept date suggests that the Structure 50 roof was built or remodeled late in the occupation sequence and that Structure 50 could have been occupied into the middle ninth century. Structure 2 had a burned floor patch that yielded an archaeomagnetic date range of 815 to 845. A radiocarbon assay of cottonwood/willow yielded three intercept dates of 910, 920, and 960. While substantially later than the archaeomagnetic date range, the radiocarbon date provides additional support that Structure 2 was used late in the LA 6170 occupation sequence. Based on this date, Structure 2 may have been the last pit structure built and temporarily occupied. An absence of intramural features, led the site author (Akins, Chapter 13) to surmise that Structure 2 was occupied for a short time. The short-lived occupation and middle eighth- to middle ninth-century dates for Structure 2 may inform on two other archaeomagnetic dates from non-floor contexts within Structures 5 and 50. A wall niche (Feature 38) in Structure 5 yielded an archaeomagnetic date range of 825–875 and a wall burn in Structure 50 yielded a date range of 900 to 950. These are later non-floor feature dates that may suggest that the pit structures continued in use as temporary shelters or transient stops after their more permanent residential use was discontinued. Rather than contradicting other structure dates, it is possible that these later dates reflect a longer and more complex structure or place life than is explained by domestic occupation.

Only one Late Developmental date range was obtained from the mealing room, Structure 5A. The 1035 to 1080 archaeomagnetic date range may be slightly early. Current understanding of the Late Developmental period suggest that a post-1100 date would be more accurate for the structure. The AD 1100 beginning date is derived from manufacture dates for Kwahe'e Black-on-white, which are admittedly not well supported by independent chronometric dating methods.

LA 6171 yielded eight archaeomagnetic samples and three radiocarbon samples were submitted for analysis. Six archaeomagnetic samples were collected from earliest Developmental pit features that represent the earliest evidence at the Peña Blanca sites of growing and storing maize as part of an early ancestral Puebloan subsistence strategy. Two archaeomagnetic samples were collected from pit structure intramural floor pits. One radiocarbon assay was analyzed from an earliest Developmental period pit feature and two were submitted from Early Developmental pit structures.

The earliest Developmental period archaeomagnetic date ranges span from AD 435 to AD 665. The pre-600 dates do not coincide with the occurrence of structures on any Peña Blanca sites. Four of the six dates cluster between 500 and 650 indicating intensive use of the Peña Blanca terraces in support of agriculture. The two date ranges that bracket the date range cluster indicate at least periodic use of the terraces as early as the middle to early 500s and as late as the middle 600s. These early dates reflect a pulsing into or, perhaps, testing of the Peña Blanca area for floodwater or dry-farming.

The archaeomagnetic date ranges from pit structure intramural floor pits came from Structure 50, hearth (Feature 77), and Structure 9, burned pit (Feature 10). The date ranges are roughly contemporaneous ranging from 740 to 835 and 775 to 825, respectively. These date ranges are contemporaneous with LA 265, LA 6169, LA 6170, and LA 115862 components. Radiocarbon assays yielded intercept dates of 790 (Structure 9; Beta-149030) and 900 (Structure 26; Beta-149029) with two-sigma date ranges of 670 to 970 and 770–1020. These dates do not provide better temporal resolution, but do indicate ninth-century occupations.

LA 115862 yielded one archaeomagnetic date range. The sample was collected from the central hearth within a pit structure. The sample yielded a date range of AD 775 to 815. The pit structure was occupied for a short time and may have been left unoccupied in conjunction with the death of two women, one of whom may have died in childbirth.

Summary and Occupation Sequence

From all Peña Blanca sites, five major temporal components were identified by the initial field inventory and the excavation. These components were Early and Late Developmental, Coalition, Classic, and historic period. Chronometric dating identified a sixth temporal component, which has been provisionally called the earliest Developmental. Including the earliest Developmental component, five temporal components were represented by absolute dates, with only the historic period components from LA 6169, LA 6170, and LA 115862 not tied to absolute dates. Basic date ranges can be suggested for all Peña Blanca sites from the total chronometric data array.

The earliest Developmental period was represented by components from LA 6171 that maximally date from AD 435 to 630. This date range corresponds to the time preceding the construction of pit structures at the Peña Blanca sites. Large pits were excavated into the deep eolian terrace soils. Some of the pits exhibited burned interior walls and floors or burned intramural floor pits that yielded archaeomagnetic samples and date ranges. The absence of associated structures may be reflect sampling error, since site area outside the right-of-way was not excavated and previous road construction removed an unknown amount of the west site limit. Roughly contemporaneous dates were obtained from radiocarbon assays from sites in the upper Tano Divide (Kennedy 1998) in Santa Fe and from excavations along the upper Nambé River (Skinner et al. 1980). The dates from the Tano Divide are slightly earlier, ranging from AD 200 to 400. The dates were recovered from sites containing fire-cracked rock-filled thermal features and shallow oval to irregularly shaped house pit foundations (Kennedy 1998:68). The low frequency of artifacts and limited number of intramural and extramural features suggested short-lived and seasonal occupations. No maize was recovered from the excavations emphasizing the hunting and gathering focus of the subsistence pattern. Nambé excavations encountered a single pit structure with a multitude of intramural pits that were dated between AD 400 and 610. No pottery was recovered, but the most abundant macrobotanical remain was maize. Maize was relatively abundant and ubiquitous (Skinner et al. 1980:59). The Nambé site structure pattern is consistent with Basketmaker II architecture and pit features, except that there were no large pits similar to the LA 6171 pits. The rough contemporaneity of the Nambé, Tano Divide, and LA 6171 sites suggest that there were multiple pathways by which maize and agriculture entered the Northern Rio Grande, while a predominantly hunting and gathering adaptation was maintained.

The Early Developmental components are the most widely distributed with every site, except LA 249 and LA 115863, having at least one pit structure and associated extramural pit features. The Early Developmental components were all residential and all but LA 6170 have human interments within structures, storage pits, or extramural activity areas. While the proportion of each site space that was sampled varied widely, the number and distribution of residential structures and pit features do provide some measure of intensity or duration of the occupations.

The first Early Developmental occupations may have included a transition from activities focused primarily on growing, harvesting, and storing maize to a more residential focus and are indicated by the archaeomagnetic date range from LA 6171, Feature 93, and a radiocarbon assay (Beta-149015) from a small pit structure (Structure 33) at LA 265. The date ranges overlap, primarily with one another and less with later or earlier date ranges from other contexts. They suggest that change in economic strategy and occupation pattern occurred late in the seventh century or early in the eighth century. This change in economic strategy and occupation pattern occurs later in the Peña Blanca area than for sites in the Albuquerque, Bernalillo, and Zia areas to the south, where a semipermanent residential pattern was well-established by the AD 600s, if not earlier (Schmader 1994; VanPool et al. 2003; Gerow 1999). A pulsing settlement pattern with ancestral Puebloan or Early Developmental period residences established in successively more northern locations along the Rio Grande is apparent from the regional site data (Lakatos 2003). The Peña Blanca sites represent the latest and northernmost expression of this dynamic and expanding settlement pattern.

From a site structure pattern dominated by large pits and a shallow pit structure, the Peña Blanca sites expand into full-time residential sites during the middle 700s with the residential pattern continuing until the middle 900s. Each of the Peña Blanca sites with Early Developmental period components, LA 265, LA 6169, LA 6170, LA 6171, and LA 115862, were occupied for some portion of this 100- to 125-year period that spanned three to four generations as derived from the chronometric dates and from the age distribution of the burial population. LA 115862 was occupied for the shortest time as indicated by the single pit structure during the late 700s or early 800s. LA 265 and LA 6170 were occupied for the longest span from the early to middle 700s to the early to middle 800s or approximately 100 years. At LA 265 this occupation duration is evidenced in multiple pit structures with an abundant and diverse array of extramural features and human interments in intramural and extramural contexts. At LA 6170 occupation duration is suggested by multiple pit structures, radical intramural remodeling episodes, and the deposition of layers of refuse in one of the pit structure's fill after its roof was removed. LA 6171 had several smaller pit structures and an array of extramural features comparable in variety, but on a smaller scale than LA 265. Date ranges indicate that LA 6171 was occupied for 75 to 100 years with the lesser span more likely. LA 6169 yielded the fewest archaeomagnetic date ranges and they had relatively weak signals. Consequently, the date ranges are broad and can only be used to suggest that the two pit structures may have been occupied sequentially during the middle 700s or early 800s and that they are roughly contemporaneous with the later end of the occupations at the other sites. For all sites, by AD 825 to 850 there was a definite decrease in occupation intensity with residential activities mostly curtailed by AD 850. An AD 900 to 950 wall burn within LA 6170, Structure 50, may represent continued use of the structure pits or footprints in support of seasonal or transient activities before it was completely filled. By AD 900, all residential activity represented in the excavation sample had ceased.

The next reliable dated context was the Structure 5A mealing room at LA 6170. The archaeomagnetic date range of AD 1035 to 1080, while earlier than is suggested by associated ceramic manufacture dates does suggest an end to an almost 200-year residential occupation hiatus of the Peña Blanca area. At about this same time, the LA 249 pit structure was probably built and occupied. These relatively early developments during the Late Developmental period were followed by more substantial pit structure occupations at the Red Snake Hill (LA 6461) and the North Bank site (LA 6462) (Bussey 1968) in the AD 1100s. Late Developmental period settlements signify the return of more permanent residential use of the Peña Blanca and Santo Domingo Basin. While on a slightly smaller scale than the Early Developmental period settlement, the sites represent an investment in occupying and, perhaps, claiming floodwater and dry farming lands. The Late Developmental period occupation at LA 6169 was dated between AD 1165 and 1220 or at the end of the period as defined by Wendorf and Reed (1955) and at the beginning of the Coalition period. The pit structure was part of the small scale and dispersed settlement pattern that may have allowed for the establishment of claims to prime agricultural land and water resources at a time when population distribution was radically shifting in the northern North American Southwest.

Only LA 6169 yielded chronometric dates from Coalition period contexts. Three archaeomagnetic dates from two pit rooms clustered in the early to middle 1200s. They precede the dendrochronological dates derived from the North Bank site by 25 to 50 years. The Peña Blanca dates suggest that the settlement pattern of dispersed interhousehold level room blocks that typifies the re-peopling of the Pajarito Plateau may have had a varied architectural repertoire that allowed for distant fields to be monitored and tended while village sites were established.

Finally, the latest chronometric date was derived from a radiocarbon assay of saltbush from a large thermal feature placed in the upper fill of Structure 15 at LA 6169. Dating from AD 1040 to 1290, it suggests that the local population continued to use the terraces for seasonal hunting and gathering as the village settlement pattern became more static and may have become Pajarito Plateau-centric.

Chapter 16
Peña Blanca Ceramics

C. Dean Wilson

Background

Investigations of the Peña Blanca Project conducted by the Office of Archaeological Studies near Cochiti Pueblo in the Northern Santo Domingo Basin resulted in a detailed analysis of 21,709 sherds from seven sites (Table 16.1). This analysis was conducted on 2,740 sherds from LA 249, 5,484 sherds from LA 265, 7,415 sherds from LA 6169, 3,352 sherds from LA 6170, 2,259 sherds from LA 6170, 389 sherds from LA 115862, and 70 sherds from LA 115863. A less detailed analysis was conducted on 2,607 sherds including 708 sherds from LA 6169 and 2,373 from LA 6171 (Table 16.2). Sherds analyzed as part of the present study were selected by the site report writers and include most but not all of the pottery recovered during Peña Blanca investigations.

All analysis was conducted under the supervision of this author. Office of Archaeological Studies' staff involved in this ceramic analysis included Rick Montoya, Christy Davis, Brenda Baletti, and Laura Rick. In addition, three volunteers (Bob Greene, Carol Price, and George Price) participated in this analysis.

The pottery analysis was conducted in a manner that allowed for a detailed characterization of pottery recovered from Peña Blanca contexts. These data form the basis for comparisons described in other studies. Most of what is known about the pottery sequences in the general area is based on ceramic studies conducted as part of the Cochiti Dam Project during the 1960s and 1970s (Honea 1968; Sudar- Murphy et al. 1977; Traylor and Scaife 1982; Warren 1976, 1977a, 1977b, 1979b, 1979c; Warren and Snow 1976). While studies by the Cochiti Dam Project have certainly contributed to an understanding of the sequence and nature of the prehistoric and historic occupations of the Santo Domingo Basin, large gaps in our knowledge about pottery distributions from this area as well as surrounding areas of the Middle Rio Grande still exist. Thus, data accumulated during this project will contribute to a better understanding of the nature of the long sequence of occupation of the northern Santo Domingo Basin by pottery-producing groups.

Initial discussions of pottery recovered during Peña Blanca investigations present definitions and descriptions of analytical categories employed during this project. In order to compare Peña Blanca ceramic data from this project with that from other studies, ceramic descriptive attributes and type categories, similar to those used during other projects where similar pottery was recovered, were employed (Honea 1968; Hurst 1991; Lang 1982; Sudar-Murphy et al. 1977; Traylor and Scaife 1982; Warren 1976). The Peña Blanca pottery variability is illustrated in the recording of a large number of types assigned to several distinct pottery traditions. Detailed descriptions and discussions will be presented by associated regional tradition.

Distributions of attribute and type categories are used to examine various trends and issues relating to the occupation of Peña Blanca sites. Examination of various trends required a fairly precise ceramic chronology. Therefore, initial discussions of ceramic distributions focus on the assignment of ceramic-based dates to various sites and proveniences. Peña Blanca assemblages indicate a long occupation with some probable gaps, beginning at about AD 600 and continuing to the early part of the Classic period (AD 1400). Ceramic dating groups were defined based on a review of data accumulated during previous studies in this area. Information concerning the dating of Peña Blanca contexts and associated trends are presented for each occupational period in chronological order.

Descriptions and interpretations of Peña Blanca Project assemblages contribute to our understand-

Table 16.1. Distribution of Pottery Type by Site for Sherds Subjected to Intensive Analysis by Site

	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
Indeterminate Utility Ware	-	2	3	-	9	-	2	16
	-	0.0%	0.0%	-	0.4%	-	2.9%	0.1%
Unpainted (Undifferentiated	2	-	8	-	-	-	-	10
White)	0.1%	-	0.1%	-	-	-	-	0.0%
Indeterminate Mineral Paint	3	-	3	-	-	-	-	6
Undifferentiated	0.1%	-	0.0%	-	-	-	-	0.0%
Unpainted Undifferentiated	111	2	354	27	75	-	-	569
	4.1%	0.0%	4.8%	0.8%	3.3%	-	-	2.6%
NRG Mineral Paint	15	-	35	6	-	-	-	56
(Undifferentiated)	0.5%	-	0.5%	0.2%	-	-	-	0.3%
NRG Pueblo II (Indeterminate	8	-	-	-	-	-	-	8
Mineral)	0.3%	-	-	-	-	-	-	0.0%
Kwahe'e B/w (Solid Designs)	19	-	60	3	-	-	3	85
	0.7%	-	0.8%	0.1%	-	-	4.3%	0.4%
Kwahe'e B/w (Thin Parallel	7	-	43	-	1	-	1	52
Line)	0.3%	-	0.6%	-	0.0%	-	1.4%	0.2%
Kwahe'e B/W (Thick Parallel	12	-	4	-	-	-	-	16
Lines)	0.4%	-	0.1%	-	-	-	-	0.1%
Kwahe'e B/w (Hatchured	16	-	12	-	-	-	-	28
Designs)	0.6%	-	0.2%	-	-	-	-	0.1%
Kwahe'e B/w (Solid and	2	-	1	1	-	-	-	4
Hatchure)	0.1%	-	0.0%	0.0%	-	-	-	0.0%
Kwahe'e B/w (Checkerboard)	-	-	4	-	-	-	-	4
	-	-	0.1%	-	-	-	-	0.0%
Kwahe'e B/w	6	-	7	-	-	-	-	13
	0.2%	-	0.1%	-	-	-	-	0.1%
NRG Indeterminate Organic	6	1	2	-	2	-	-	11
Paint	0.2%	0.0%	0.0%	-	0.1%	-	-	0.1%
NRG Indeterminate Organic	-	-	1	-	2	-	-	3
(Coalition phase)	-	-	0.0%	-	0.1%	-	-	0.0%
Santa Fe B/w	1	-	453	3	132	-	-	589
	0.0%	-	6.1%	0.1%	5.8%	-	-	2.7%
Wiyo B/w	-	1	-	-	3	-	-	4
	-	0.0%	-	-	0.1%	-	-	0.0%
Biscuit Ware Unpainted	8	-	-	-	7	-	-	15
	0.3%	-	-	-	0.3%	-	-	0.1%
Biscuit Ware Painted	1	-	-	-	3	-	-	4
Unspecified	0.0%	-	-	-	0.1%	-	-	0.0%
Biscuit A (Abiquiu B/G)	10	-	-	-	14	-	-	24
	0.4%	-	-	-	0.6%	-	-	0.1%
Biscuit B (Bandelier B/G)	3	-	-	-	8	-	-	11
	0.1%	-	-	-	0.4%	-	-	0.1%
Unpainted (Santa Fe Paste)	-	-	-	-	7	-	-	7
	-	-	-	-	0.3%	-	-	0.0%
Galisteo B/w	-	-	53	-	-	-	-	53
	-	-	0.7%	-	-	-	-	0.2%
Unpainted (Galisteo Paste)	-	-	4	-	-	-	-	4
	-	-	0.1%	-	-	-	-	0.0%
Jemez B/w	8	-	-	-	-	-	-	8
	0.3%	-	-	-	-	-	-	0.0%
NRG Plain Rim	22	-	41	7	1	-	-	71
	0.8%	-	0.6%	0.2%	0.0%	-	-	0.3%
NRG Unknown Rim	12	-	2	-	-	-	-	14
	0.4%	-	0.0%	-	-	-	-	0.1%
NRG Plain Body	728	4	848	177	25	-	-	1782
	26.6%	0.1%	11.4%	5.3%	1.1%	-	-	8.2%
NRG Wide Neckbanded	1	-	1	-	-	-	-	2
	0.0%	-	0.0%	-	-	-	-	0.0%

Table 16.1. Continued.

	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
NRG Wide Neckbanded	-	-	1	-	-	-	-	1
(Wiped or Undulated)	-	-	0.0%	-	-	-	-	0.0%
NRG Coiled Necked	1	-	-	-	-	-	-	1
	0.0%	-	-	-	-	-	-	0.0%
NRG Clapboard Neck	2	-	-	-	-	-	-	2
	0.1%	-	-	-	-	-	-	0.0%
NRG Indented Corrugated	532	-	438	50	2	-	-	1022
	19.4%	-	5.9%	1.5%	0.1%	-	-	4.7%
NRG Incised Corrugated	1	-	-	1	-	-	-	2
	0.0%	-	-	0.0%	-	-	-	0.0%
NRG Plain Corrugated	48	-	312	59	2	-	-	421
	1.8%	-	4.2%	1.8%	0.1%	-	-	1.9%
Corrugated	3.4%	-	3.9%	0.9%	0.1%	-	-	1.9%
NRG Smeared Indented	53	-	54	8	2	-	-	117
Corrugated	1.9%	-	0.7%	0.2%	0.1%	-	-	0.5%
NRG Neck Corrugated	-	-	-	2	-	-	-	2
	-	-	-	0.1%	-	-	-	0.0%
Sapawi Micaceous	1	-	-	-	-	-	-	1
	0.0%	-	-	-	-	-	-	0.0%
NRG Mudware	2	39	29	19	-	-	-	89
	0.1%	0.7%	0.4%	0.6%	-	-	-	0.4%
Tewa Buff undifferentiated	-	-	-	-	1	-	-	1
	-	-	-	-	0.0%	-	-	0.0%
Kapo Gray	-	-	-	1	-	-	-	1
	-	-	-	0.0%	-	-	-	0.0%
Smudged Interior Buff Exterior	1	-	-	-	-	-	-	1
	0.0%	-	-	-	-	-	-	0.0%
Smudged Interior Buff	-	-	-	-	1	-	-	1
exterior	-	-	-	-	0.0%	-	-	100.0%
NRG Local Brown Ware	-	-	-	2	-	-	-	2
	-	-	-	0.1%	-	-	-	0.0%
MRG Plain Rim	5	121	72	58	45	16	-	317
	0.2%	2.2%	1.0%	1.7%	2.0%	4.1%	-	1.5%
MRG Unknown Rim	-	-	10	2	2	-	-	14
	-	-	0.1%	0.1%	0.1%	-	-	0.1%
MRG Middle Rio Grande	121	4796	2539	2648	1348	259	58	11769
	4.4%	87.5%	34.2%	79.0%	59.7%	66.6%	82.9%	54.2%
MRG Wide Neckbanded	-	2	30	1	-	-	-	33
	-	0.0%	0.4%	0.0%	-	-	-	0.2%
Wide Neckbanded (Wiped)	-	1	10	-	4	-	-	15
	-	0.0%	0.1%	-	0.2%	-	-	0.1%
MRG Indented Corrugated	5	-	118	2	40	-	-	165
MRG Plain Corrugated	10	1	254	3	11	-	-	279
	0.4%	0.0%	3.4%	0.1%	0.5%	-	-	1.3%
MRG Smeared Plain	5	-	710	4	251	-	-	970
Corrugated	0.2%	-	9.6%	0.1%	11.1%	-	-	4.5%
MRG Smeared Indented	5	-	98	-	134	-	-	237
Corrugated	0.2%	-	1.3%	-	5.9%	-	-	1.1%
MRG Polished Gray	-	-	21	1	-	-	-	22
	-	-	0.3%	0.0%	-	-	-	0.1%
MRG Low Relief Corrugated	-	-	2	-	-	-	-	2
	-	-	0.0%	-	-	-	-	0.0%
MRG Plain Incised	-	-	2	-	-	-	-	2
	-	-	0.0%	-	-	-	-	0.0%
MRG Unfired Plain Gray Ware	-	36	-	-	-	-	-	36
	-	0.7%	-	-	-	-	-	0.2%
MRG Low Relief Corrugated	-	-	2	-	-	-	-	2
	-	-	0.0%	-	-	-	-	0.0%
MRG Unpainted	9	77	134	54	27	15	-	316
Undifferentiated	0.3%	1.4%	1.8%	1.6%	1.2%	3.9%	-	1.5%

Table 16.1. Continued.

	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
MRG Mineral Paint (Undiff)	1	29	79	42	14	2	4	171
	0.0%	0.5%	1.1%	1.3%	0.6%	0.5%	5.7%	0.8%
Pueblo II (Indeterminate	-	-	1	-	-	-	-	1
Mineral)	-	-	0.0%	-	-	-	-	0.0%
Red Mesa B/w	-	-	1	-	-	-	-	1
	-	-	0.0%	-	-	-	-	0.0%
Escavada Solid Designs	3	-	12	-	-	-	-	15
	0.1%	-	0.2%	-	-	-	-	0.1%
Gallup B/w	-	-	2	1	-	-	-	3
	-	-	0.0%	0.0%	-	-	-	0.0%
San Marcial B/w	2	44	91	31	18	74	-	260
	0.1%	0.8%	1.2%	0.9%	0.8%	19.0%	-	1.2%
Local Red Slipped Red-on-buff	-	-	1	-	-	-	-	1
	-	-	0.0%	-	-	-	-	0.0%
Local Red Slipped Red-on-buff	-	1	-	-	-	-	-	1
	-	0.0%	-	-	-	-	-	0.0%
White Mountain Red	-	-	2	2	6	-	-	10
(Undifferentiated)	-	-	0.0%	0.1%	0.3%	-	-	0.0%
Wingate B/r	-	-	5	-	-	-	-	5
	-	-	0.1%	-	-	-	-	0.0%
Puerco B/r	1	-	3	-	-	-	-	4
	0.0%	-	0.0%	-	-	-	-	0.0%
Slipped Red over white	-	149	59	47	25	2	-	282
paste (Tallahogan-like)	-	2.7%	0.8%	1.4%	1.1%	0.5%	-	1.3%
Slipped over red paste	-	11	15	1	2	-	-	29
	-	0.2%	0.2%	0.0%	0.1%	-	-	0.1%
MRG Local Brown Ware	-	2	-	2	-	-	-	4
	-	0.0%	-	0.1%	-	-	-	0.0%
Local R/b	-	-	-	-	3	10	-	13
	-	-	-	-	0.1%	2.6%	-	0.1%
Keres Utility Ware	75	-	-	1	3	-	-	79
	2.7%	-	-	0.0%	0.1%	-	-	0.4%
Glazed red (Unpainted)	344	-	-	-	3	-	-	347
	12.6%	-	-	-	0.1%	-	-	1.6%
Glaze White/Light Gray	6	-	-	-	-	-	-	6
(Unpainted)	0.2%	-	-	-	-	-	-	0.0%
Glaze Yellow/Cream Slipped	64	-	-	-	1	-	-	65
(Unpainted)	2.3%	-	-	-	0.0%	-	-	0.3%
Glaze Brown/tan (Unpainted)	17	-	-	-	2	-	-	19
	0.6%	-	-	-	0.1%	-	-	0.1%
Glaze-on-red (Undiff)	215	-	-	1	1	-	-	217
	7.8%	-	-	0.0%	0.0%	-	-	1.0%
Glaze-on-white Slipped	2	-	-	-	-	-	-	2
(Undifferentiated)	0.10%	-	-	-	-	-	-	0.00%
Glaze-on-yellow Cream	47	-	-	-	-	-	-	47
	1.7%	-	-	-	-	-	-	0.2%
Glazed-on-brown/tan	19	-	-	-	-	-	-	19
	0.7%	-	-	-	-	-	-	0.1%
Glaze White and Red Matte	1	-	-	-	-	-	-	1
(Undiff)	0.0%	-	-	-	-	-	-	0.0%
Unpainted Glaze A Yellow	3	-	-	-	-	-	-	3
	0.1%	-	-	-	-	-	-	0.0%
Unpainted Red Rim	6	-	-	-	-	-	-	6
	0.2%	-	-	-	-	-	-	0.0%
Agua Fria Glaze A	30	-	-	-	1	-	-	31
	1.1%	-	-	-	0.0%	-	-	0.1%
Cieneguilla Glaze-on-yellow	3	-	-	-	-	-	-	3
	0.1%	-	-	-	-	-	-	0.0%
Cieneguilla Glaze Polychrome	3	-	-	-	-	-	-	3
	0.1%	-	-	-	-	-	-	0.0%
Largo Glaze-on-yellow	2	-	-	-	-	-	-	2
	0.1%	-	-	-	-	-	-	0.0%

Table 16.1. Continued.

	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
Unpainted Slipped	-	-	-	1	-	-	-	1
	-	-	-	0.0%	-	-	-	0.0%
Kana'a B/w	-	2	-	-	-	-	-	2
	-	0.0%	-	-	-	-	-	0.0%
El Paso Brown Body	-	-	1	-	-	-	-	1
	-	-	0.0%	-	-	-	-	0.0%
Unpainted with Chupadero	-	-	2	-	-	-	-	2
Paste	-	-	0.0%	-	-	-	-	0.0%
Chupadero B/w (Solid Design)	-	-	1	-	-	-	-	1
	-	-	0.0%	-	-	-	-	0.0%
Chupadero B/w (Hatchured	-	-	1	-	-	-	-	1
Design)	-	-	0.0%	-	-	-	-	0.0%
Chupadero B/w (Hatchured	-	-	4	-	-	-	-	4
and Solid Design)	-	-	0.1%	-	-	-	-	0.0%
Jornada Brown rim	-	-	1	-	-	-	-	1
	-	-	0.0%	-	-	-	-	0.0%
Jornada Brown Body	-	30	8	28	9	8	1	84
	-	0.5%	0.1%	0.8%	0.4%	2.1%	1.4%	0.4%
Unpainted Socorro Paste	-	-	3	-	-	-	-	3
	-	-	0.0%	-	-	-	-	0.0%
Socorro B/w	2	-	10	1	2	-	-	15
	0.1%	-	0.1%	0.0%	0.1%	-	-	0.1%
Socorro B/w (Solid Designs)	-	-	18	2	-	-	-	20
	-	-	0.2%	0.1%	-	-	-	0.1%
Socorro B/w (Hatchured	-	-	14	-	-	-	-	14
Designs)	-	-	0.2%	-	-	-	-	0.1%
Socorro B/w (Hatchured and	-	-	10	1	1	-	-	12
Solid Designs)	-	-	0.1%	0.0%	0.0%	-	-	0.1%
Mogollon R/b	-	7	-	7	1	-	-	15
	-	0.1%	-	0.2%	0.0%	-	-	0.1%
Mimbres White Ware	-	-	-	-	-	1	-	1
(Unpainted)	-	-	-	-	-	0.3%	-	0.0%
Indeterminate Painted Brown	-	2	-	-	-	-	-	2
Ware	-	0.0%	-	-	-	-	-	0.0%
San Francisco Red	-	33	-	7	3	-	1	44
	-	0.6%	-	0.2%	0.1%	-	1.4%	0.2%
Alma Plain Rim	-	1	1	2		1	-	5
	-	0.0%	0.0%	0.1%		0.3%	-	0.0%
Alma Plain Body	-	71	6	4	1	1	-	83
	-	1.3%	0.1%	0.1%	0.0%	0.3%	-	0.4%
Alma Scored	-	15	-	-	-	-	-	15
	-	0.3%	-	-	-	-	-	0.1%
Reserve Plain Corrugated	-	-	1	-	-	-	-	1
Smudged	-	-	0.0%	-	-	-	-	0.0%
Reserve Smudged	-	4	2	1	1	-	-	8
	-	0.1%	0.0%	0.0%	0.0%	-	-	0.0%
Total	2740	5484	7415	3352	2259	389	70	21709
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

NRG = Northern Rio Grande; MRG = Middle Rio Grande

ing of the prehistory of the northern Santo Domingo Basin in two very different ways. The first contribution is the unique opportunity for a detailed characterization of Early Developmental pottery assemblages. These Early Developmental assemblages are among the northernmost examples of settlements so far documented for this period of the Rio Grande sequence. Given the rarity and unique characteristics of Early Developmental components, as compared with other Rio Grande occupations, Peña Blanca data provides an unmatched opportunity to characterize Early Developmental communities.

The majority of the Peña Blanca sites and components date to the Early Developmental period, and are the primary focus of much of the present investigations. These include comparison of data accumulated during earlier projects including those conducted in the Albuquerque area (Condie 1983; Frisbie 1967; Schmader 1994; Vivian and Clendenen 1965). Ceramic distributions from dated Peña Blanca contexts also provide critical informa-

Table 16.2. Distribution of Type by Site for Streamlined Analysis Sample

	LA 6169	LA 6170	Total
Plain Rim	13	40	53
	1.8%	1.7%	1.7%
Plain Body	363	2230	2593
	51.3%	94.0%	84.2%
Basket Impressed	1	-	1
	0.1%	-	0.0%
Indented Corrugated	50	-	50
	7.1%	-	1.6%
Plain Corrugated	47	5	52
	6.6%	0.2%	1.7%
Smeared Plain Corrugated	32	-	32
	4.5%	-	1.0%
Smeared Indented Corrugated	22	1	23
	3.1%	0.0%	0.7%
Unpainted (Undifferentiated	1	-	1
White)	0.1%	-	0.0%
Unpainted Undifferentiated	42	-	42
	5.9%	-	1.4%
Mineral Paint (Undifferentiated)	16	-	16
	2.3%	-	0.5%
Santa Fe B/w	76	-	76
	10.7%	-	2.5%
Historic organic paint	-	1	1
(Undifferentiated)	-	0.0%	0.0%
Unpainted Undifferentiated	8	6	14
	1.1%	0.3%	0.5%
Mineral Paint Undifferentiated	11	18	29
	1.6%	0.8%	0.9%
San Marcial B/w	8	29	37
	1.1%	1.2%	1.2%
Slipped red over white paste	6	32	38
(Tallahogan-like)	0.8%	1.3%	1.2%
Jornada Brown Rim	-	1	1
	-	0.0%	0.0%
Jornada Brown Body	-	7	7
	-	0.3%	0.2%
Socorro B/w (Solid Designs)	4	-	4
	0.6%	-	0.1%
Socorro B/w (Hatchured and	1	-	1
Solid Designs)	0.1%	-	0.0%
Mogollon R/b	-	1	1
	-	0.0%	0.0%
San Francisco Red	7	1	8
	1.0%	0.0%	0.3%
Alma Plain Body	-	1	1
	-	0.0%	0.0%
Total	708	2373	3081
	100.0%	100.0%	100.0%

tion relating to the timing of occupation for the still poorly dated Early Developmental period. Pottery trends from Early Developmental period occupations observed during the present study can also be compared with those from better-known contemporary periods such as the Basketmaker III and Pueblo I period of the Four Corners Anasazi and the Early Pithouse periods of the Mogollon Highlands. Such comparisons may provide clues concerning the origin of these groups as well as their participation in regional exchange networks. Characteristics of pottery distributions associated with these Early Developmental period components may also provide clues concerning the nature of overall economic patterns and the influences of resources and mobility on the overall technology. Such characterizations are extremely important as data and insights about Peña Blanca Early Developmental period components will provide a foundation for a characterization and interpretation of Early Developmental occupations in the Middle Rio Grande area for many years to come.

The other major set of contributions resulting from Peña Blanca ceramic studies involves the syntheses of data from the smaller number of later components including those associated with the Late Developmental, Coalition, and Classic periods. In contrast to the general absence of sites and components dating to the Early Developmental period encountered during the Cochiti Dam Project, sites and components dating to later periods were well represented. These include several large villages dating to the Coalition and Classic periods, from which pottery from large assemblages were described. Although these data present many interesting and useful observations, it often yields little relating to the overall temporal and technological trends. More is known about Cochiti Dam occupations dating to the Coalition and Classic periods (Honea 1968; Snow 1971, 1974; Traylor and Scaife 1982; Warren 1976). This is also the case for major investigations conducted at Arroyo Hondo (Habicht-Mauche 1993, 1995) and Bandelier National Park (Kohler 1989; Orcutt 1999; Vint 1999). Individually and as a whole, these projects have resulted in extensive research in the nature of change and transitions from the Coalition through the Classic period.

Thus, in contrast to trends noted for Early Developmental Peña Blanca components, data relating to the Late Developmental, Coalition, and Classic components documented during this project will supplement and expand on larger databases already accumulated for occupations dating to these periods. Still, ceramic data accumulated during this project provide unique opportunities to expand our knowledge and understanding about the very long and continuous prehistoric occupation of this area. Data from these components provide an opportunity to compare components from three distinct periods representing a steady continuum of occupation and growth in the Santo Domingo Basin. Of particular importance is the evidence of occupations that appear to bridge the Late Developmental and Coalition periods as normally described. Furthermore, the results of this study can be compared with data from Late Developmental sites in the Tewa Basin to the north. Thus, data accumulated during the present project can be incorporated with data and interpretive frameworks from earlier investigations of surrounding areas of the Middle and Northern Rio Grande.

The examination of questions and issues related to all Peña Blanca components require the accumulation of standardized data allowing for the comparison of ceramic assemblages from different contexts as well as the development and use of models and approaches allowing the interpretation of observed differences or similarities. While recent studies have developed fairly detailed models to document and explain trends reflected in prehistoric Rio Grande pottery, these are mainly limited to specific time periods such as the model of tribalization used to explain change from the Coalition to Classic period (Habicht-Mauche 1993). The few syntheses of ceramic period sequences in the Rio Grande region are largely limited to very basic characterizations mainly concerned with definition and recognition of various occupation periods and characterization of very broad changes in material culture, settlement patterns, and population growth (Cordell 1979; Riley 1995; Wendorf 1954;

Wendorf and Reed 1955).

Thus, examinations of ceramic data from the Peña Blanca sites will borrow from and rely on a patchwork of models and approaches presented in earlier studies. These will include both approaches developed specifically for the Middle and Northern Rio Grande, such as the tribalization model (Habicht-Mauche 1993; Vint 1999), as well as more general theoretical frameworks. Many of these approaches will be presented in more detail as part of discussions organized by occupation period. The overall strategy used here will begin by examining ceramic traditions defined for regional culture-history frameworks.

A wide range of frameworks and terminology have been developed to document and explain pottery trends at prehistoric sites in the American Southwest. Approaches used here focus on the documentation and interpretation of phenomena reflecting both the flow and alteration of conventions and decisions associated with the manufacture, transfer, and use of pottery vessels. Studies focusing on the source and movement of various pottery technological or decorative conventions are sometimes described in terms of a historical approach (Neff 1992, 1993). Those focusing on factors that may have ultimately influenced the acceptance, rejection, or alteration of these conventions are sometimes described in processual or evolutionary terms (Neff 1992, 1993).

More important than the use of any particular label is the implementation of research strategies that allow for the examination and interpretation of phenomena that may have influenced the spread and modification of ceramic complexes through time and across space. Observations about the distribution of pottery traits may be used to examine both the nature of historic connections reflected by different archaeological manifestations as well as "selective" influences that may have resulted in the adoption and rejection of certain pottery traits or forms (Neff 1992, 1993). Thus, the present study will attempt to document a wide range of trends and influences associated with the production, decoration, movement, and use of pottery vessels in the Peña Blanca area.

Analytical Approach

It is necessary to employ pottery analysis systems and approaches that document and address a wide range of ceramic traits and influences. Analysis of Peña Blanca pottery involved separating sherds from each provenience at a site that exhibited unique combination of traits into distinct piles (or lots). Information about each of these sherd lots was recorded on a distinct data line. Each data line from a particular provenience was assigned a consecutive lot number beginning with one. Sherds assigned to each lot were placed into a separate bag along with a small slip of paper recording the site, field specimen (fs), and lot number. Information recorded during ceramic analysis included associated provenience (or fs) and lot numbers, typological assignments, descriptive attribute codes, quantity of sherds, and total weight. These procedures allow for the matching of sherds with data lines recorded during ceramic analysis, which was necessary for locating items during data editing and for more detailed analyses.

Attribute Descriptions

The recording of ceramic descriptive attributes allows for basic examination of distributions of various types of traits that may be represented in ceramic assemblage. Descriptive attribute classes recorded for all Peña Blanca sherds analyzed include temper, interior pigment, exterior pigment, interior manipulation, exterior manipulation, interior slip, exterior slip, vessel form, vessel appendage, modification, rim radius, and rim arc. A small subsample of sherds was refired and even smaller samples were subjected to petrographic analysis. Attribute classes and categories are defined in the following section.

Temper

Temper refers to aplastic particles added to or naturally occurring in the clay. Temper analysis involved examining freshly broken sherd edges through a binocular microscope. Such characterizations are limited, but broad temper categories are defined based on combinations of color, shape, fracture, and sheen of tempering particles. Temper categories may reflect material sources that were used by prehistoric potters in various regions of the Southwest and may allow for the distinction of pottery from different Southwestern regions such as the Rio Grande Valley, Colorado Plateau, and Mogollon Highlands. Geological differences in these different regions resulted in the availability and use of distinct tempering materials. Temper categories recognized during the present analysis include the following.

Indeterminate temper refers to cases where temper was examined but the material could not be identified. Sherds with pastes too vitrified to identify the associated temper were classified as *Vitrified. Self-tempered* refers to cases in which distinct added aplastic inclusions were not present in the clay paste, and inclusions are limited to tiny naturally occurring silt grains. Some examples with similar fine inclusions were assigned to a *Very fine sand (silt)* category.

Micaceous granite refers to the dominant temper type occurring in many areas of the Northern Rio Grande region. This category reflects the use of combinations of local alluvial clays and crushed igneous river cobbles. Even without microscopic examination, sherds with this temper are often easy to recognized by the presence of numerous mica fragments visible on the vessel surface. Fragments are relatively large and subangular to subrounded grains of quartz and feldspar. These particles are usually white but occasionally are clear, light gray, or pink. Rock fragments may also contain mica or black inclusions.

Fine tuff or ash refers to fine volcanic fragments presumably derived from local pumice, ash, or tuff deposits. Particles are small, clear to light, or dark vitreous, angular to rod-shaped with light colored dull pumice. Tuff or ash may reflect the use of self-tempered ash-derived clays or the intentional addition of crushed or weathered tuff or ash to the clay. Petrographic analysis of Peña Blanca sherds indicates the use of self-tempered clays. Similar fragments often occurred with fine sand particles apparently weathered from volcanic-clastic sandstones and assigned to a *Fine tuff and sand* category. Some sherds exhibiting this temper along with numerous small mica particles were assigned to a *Mica and tuff* category. Another combination of these particles is reflected in a *Mica, tuff, and sand* category.

Gray crystalline basalt refers to the presence of homogeneous greenish, gray, or black colored angular crushed rock fragments. Some of the basalt assigned to this category also exhibited red colors and is similar to material previously classified as scoria. Similar temper with sand inclusions was classified as *Basalt and sand.*

Sand refers to rounded or subrounded, well-sorted sand grains. These grains are translucent, or white to gray in color and may be frosted. This category is distinguished from sandstone temper by the presence of large, even-sized quartz grains, and the absence of matrix. *Fine sandstone* exhibits rounded sand grains along with angular matrix fragments. Grains derived from sandstone are usually smaller than those found in sand temper. Sand grains which were dark gray to black in color, with characteristics indicating they were rolled basalt grains, were assigned to a *Dark sand* category.

Temper consisting of sand along with rounded white to dull gray fragments, assumed to represent natural inclusions in the clay, was assigned to an *Oblate shale and sand* category. Similar fragments without sand were much rarer and assigned to a *Shale* category. *Shale, sand, and sherd* refers to this combination of materials. Sherds with temper consisting of poorly sorted sand of varying size and color were assigned to a *Multi-lithic sand* category.

Another distinctive temper category recognized is referred to here as *Anthill sand*. These grains are often transparent or crystalline in structure, and generally occur in a non-micaceous paste. This temper appears to be common in utility wares found in some areas of the Pajarito Plateau, and represent quartz phenocrysts occurring in tuff particles sorted and carried by ants. Such sources are readily available from anthills on the mesa tops on the Pajarito Plateau (Vint 1999).

Andesite/Diorite refers to fragments from either crushed andesites or diorites along with sand grains. This category represents a temper used by Anasazi potters in most of the Northern San Juan or Mesa Verde region (Wilson and Blinman 1995). It is possible, however, that some of the sherds assigned to this category represent variations of volcanic material found in the Rio Grande region. This category is characterized primarily by angular to subangular lithic particles that are clear to milky white and sometimes reddish in color. Small, black, rod-shaped crystals are present, and may occur individually or within the larger particles. *Leucocratic Igneous* refers to a similar igneous rock without distinct crystalline structure.

Sherd refers to the use of crushed potsherds as temper. Crushed sherd fragments appear white, buff, gray, or orange in color. These fragments are often distinguished from crushed rock tempers by their dull nonreflective appearance. Fragments of tuff, however, may be similar in appearance. Small reflective rock particles may be included inside or outside the sherd fragments. In some cases, the presence of fairly large particles along with crushed sherd may indicate the addition of both crushed rock and sherd. In cases where both sherd and distinctive rock fragments occur together, the combination of the two materials was noted. Presence of such combinations noted during the present study include *Sherd and sand.*

Mogollon volcanics refers to the presence of natural inclusions common in Mogollon Highland clay sources in Southwest New Mexico. Previous studies of Mogollon ceramics indicate these reflect the use of pedogenic sources ultimately derived from local volcanic outcrops and volcanic-clastic sandstone in the Mogollon Highlands (Wilson 2000). These clay sources usually contain numerous natural igneous and sandstone inclusions, and in most cases the addition of separate tempering material would have been unnecessary. The inclusions commonly occurring in brown ware types produced in the Mogollon Highlands tend to vary in size and are often more numerous and smaller than crushed temper particles added in pottery produced in other areas of the Southwest. Volcanic inclusions found in the local clay and other deposits consist of angular basalt, rhyolite, and sand particles. Similar fragments with sand were placed into a *Sand and Mogollon volcanics* category.

Sherds were assigned to a J*ornada leucocratic igneous* category based on the presence of light feldspar and quartz fragments that may represent the use of crushed granites or monzonites. This group is dominated by white or gray grains probably representing feldspar along with some quartz. In addition, large rounded quartz fragments are often present. Dark fragments representing hornblende may be present in extremely low amounts. Fragment size appears to be relatively small as compared to other tempering material occurring in Jornada region pottery. Such fragments are commonly visible on the sherd surface. This temper is particularly common in brown wares produced in the El Paso area, where it appears to reflect the utilization of crushed granites from mountains in the southern Jornada region. It is also likely, however, that some of the examples assigned to this temper represent the utilization of crushed igneous rock sources occurring in the Sierra Blanca region.

Fine Jornada is similar but characterized by quartz grains that are usually crystalline in structure. These fragments appear to be crystalline or sugary in appearance. This group may represent the use of Capitan aplites. Petrographic analysis of sherds with similar tempering material indicates a granite aplite.

Another category previously noted in pottery for the Jornada Mogollon country was *Dark igneous and sherd.* Both sherd and rock particles tend to be small and dark, and can be difficult to distinguish. The sherd fragments are recognized by their dull appearance and range from dark gray to brown. Rock particles are very fine and consist of isolated fine mineral grains mainly of quartz and weathered feldspar. Similar dark small igneous fragments without crushed sherd were assigned to a *Dark igneous* category. This temper often occurs along with crushed sherd and is classified as Dark igneous and sherd. Similar particles with sand were classified and *Dark igneous and sand.*

Pigment Type

Pigment categories refer to the presence, surface characteristics, and color of painted decorations. Most pigments were divided into organic (or carbon) and mineral pigment groups based on previously described characteristics (Shepard 1963). A number of distinct paint categories associated with prehistoric and historic Southwest decorative pottery traditions were noted. Sherds without evidence of painted decorations were simply placed into a *None* category. Those for which the type of pigment could not be determined were placed into an *Indeterminate* category.

Matte mineral paint refers to the use of ground minerals such as iron oxides as pigment. These powdered compounds are usually mixed with an organic binder. Mineral pigment represents a distinct physical layer, and rests on the vessel surface. Such pigments are usually thick enough to exhibit visible relief. Mineral pigments usually obscure surface polish and irregularities. The firing atmospheres to which mineral pigments were exposed affect color. Mineral pigment categories identified during the present study include *Mineral black, Mineral red,* and *Mineral brown.*

Organic paint refers to the use of vegetal pigment only. Organic paint is soaked into rather than deposited on a vessel surface. Thus, streaks and polish are often visible through the paint. The painted surface is generally lustrous, depending on the degree of surface polishing. The pigment may be gray, black, bluish, and occasionally orange in color. The edges of the painted designs are often fuzzy. Sherds exhibiting decorations in extremely thin grayish organic paint were assigned to an *Organic diffuse* category.

Glaze paint refers to the use of a lead as a fluxing agent to produce vitreous decorations. Glaze pigments are often very thick and runny, and bubbles may protrude through the surface. The glaze may weather off, leaving a thin organic layer. Pigment color ranges from brown, black, orange, to green. Sherds exhibiting a glaze effect achieved by the vitrification of iron-based mineral paint were assigned to a *Sub-glaze* category.

Surface Manipulation

Attributes relating to surface manipulations reflect the presence and type of surface texture, polish, and slip treatments. Surface manipulation categories were recorded for both interior and exterior vessel surfaces.

Surfaces that have been too heavily worn to determine the original surface treatments were classified as *Surface missing. Indeterminate* refers to surfaces that are present, but the type of treatment cannot be determined. *Plain unpolished* refers to surfaces where coil junctures have been completely smoothed, but surfaces were not polished.

Some sherds were assigned to categories based on the presence and type of surface texture. *Plain striated* denotes the presence of a series of long, shallow, parallel grooves resulting from brushing with a fibrous tool on an unpolished surface. *Basket impressed* refers to impressions resulting from a vessel being made or pressed against a basket while it was still wet.

Surfaces with wide unobliterated coils or fillets were classified as *Wide coils*. *Wide neckbanded smeared* are similar to *Wide Neckbanded,* but the junctures between the coils have been partially obliterated. *Narrow coil* includes neckbanded forms with narrow, rounded coils.

Polished surfaces are those which have been intentionally polished after smoothing. Polishing implies intentional smoothing with a polishing stone to produce a compact and lustrous surface. Surfaces exhibiting polished treatments were assigned to a *Plain polished* category.

A few sherds also exhibited distinct slipped surfaces that had been polished over. *Slips* represent intentional applications of distinct clay, pigment, or organic deposits over an entire vessel surface. Such applications are used to achieve black, white, or red surface colors, not obtainable using paste clays or firing methods normally employed. Surfaces over which high iron slip clay was applied to create a red ware were assigned to a *Polished red slipped* or *Unpolished red slip* category. Those to which a low iron slip was applied, as represented in some white wares, were classified as *Polished white slipped, Polished thin white slip, Light polished white slip, Unpolished white slip,* or *Polished cream slip.* Surfaces coated with a black layer of soot during the later stages of firing were assigned to a *Polished smudged* category. *Micaceous slip* refers to a glittery surface produced by the application of a layer of finely ground mica. *Fugitive red* refers to the presence of a hematite coating applied after the vessel was fired.

Other categories reflect variations of corrugated textures. *Indented corrugated* refers to the presence of fine exterior coils with regular indentations on the exterior surface. *Plain corrugated* refers to gray wares with similar coil treatments and relief described for Indented Corrugated but without regularly spaced indentations. This category differs from similar neckbanded groups by thinner coils and coiled manipulations along the vessel body. *Smeared indented corrugated* and *Smeared plain corrugated* refer to similar treatments but with low relief and without visible indentations.

A few sherds exhibiting corrugated textures intermediate between those previously described were assigned to a *Low relief corrugated* category. Other texture categories include *Vegetal impressed, Indeterminate incised,* and *Plain incised herringbone.*

Vessel Form

Observations of sherd shape and surface manipulation provide clues concerning the form and use of associated vessels. Vessel form classification is usually dependant on sherd size, manipulation, and vessel portion. The consistent placement of sherds into form categories provides for functional comparisons of different sherd assemblages. It is usually possible to assign rim sherds to more specific categories than body sherds.

Indeterminate refers to cases where vessel form is unknown. *Bowl rim* refers to sherds exhibiting inward curvature from the rim indicating they derived from bowls. *Bowl body* refers to body sherds with interior polishing or painted decoration indicating they came from bowls.

Most of the sherds identified during the present study are unpolished body sherds for which the precise vessel form could not be determined. Most unpolished gray body sherds were assigned to a Jar body category, although some of these could have derived from bowls. Body sherds were assigned to this category only if they exhibited evidence of painting or polishing on the exterior surface. *Jar neck* includes body jar sherds with curvature indicating they were derived from necked jars. *Jar rims* refers to rim sherds derived from jars with relatively wide rim diameters. Such rims are often associated with vessels used for cooking or storage. This form is distinguished from other jar rim forms by a wide orifice relative to vessel size.

Several other jar forms were also identified based on rim shape. *Olla rim* refers to necked jar sherds with relatively narrow rim diameters. Such forms are assumed to have been used for the storage of water. *Seed jar rim* refers to spherical shaped vessels with openings near the top. Rim sherds with an outward slope from the rim were classified as seed jars. The rims are characterized by constriction but do not exhibit curvature indicative of a distinct neck. *Canteen rim* refers to small spherical shaped vessels, with lug handles near the top and very narrow necks.

Miniature pinch pot, body, and jar rim refer to jar sherds from vessels too small to have been used for activities normally associated with this form. Miniature forms probably served in ritual contexts or as toys. A few sherds represent very small miniature forms produced through hand molding or pinching.

Some sherds were derived from forms where vessel shape could not be determined based on manipulations noted on body sherds. Such sherds were assigned to descriptive categories based on combinations of manipulations noted. Body sherds not exhibiting polished treatments on either surface were classified as *Unpolished body.* Body sherds exhibiting roughly equal amounts of polishing on both sides were simply assigned to a *Polished body* category. Other body sherds were assigned to a category based on the presence of a distinct polish on one surface and include E*xterior polished body* and *Interior polished body.*

Sherds consisting of handles that may or may not have been attached were assigned to a series of categories describing the handle and associated attachment. Handle categories identified during Peña Blanca ceramic analysis include *Jar body with strap or coil handle, Jar body with lug handle, Indeterminate coil-strap handle, and Jar rim with lug handle.* Other forms identified include *Shaped spindle whorl, Dipper rim,* *Applique,* and *Cloud blower.* Cloud blower refers to sherds derived from conical shaped pipes.

Modification

Modification refers to evidence of post-firing alteration including abrasion, drilling, chipping, or spalling. Data concerning such treatments provide information about use, repair, and shaping of sherds and vessels. Modification categories combine information concerning the size, shape, and associated wear patterns of a modified sherd.

Most sherds analyzed did not exhibit post-firing modifications and were coded as *None. Drill hole (complete)* refers to the presence of drilled holes used to mend vessels by tying vessel fragments together. Repair holes are usually located within 2 cm of an old break. *Drill hole incomplete* reflect cases where the drill hole does not go completely through both surfaces. *Beveled edge* refers to the presence of one or more abraded edges resulting from the intentional shaping of a sherd. Sherds with evidence of abrasion from use were assigned to a rim wear category. *Ceramic scraper* refers to shaped sherds with wear indicative of use as a scraper. *Interior worn from cooking* refers to a series of marks on surface resulting from repeated heating cycles. Evidence of spalling resulting from repeated cooking cycles was recorded as *Exterior firing spall, Interior spall, Interior surface partially worn, Abraded surface (exterior),* and *Interior/exterior erosion. Abraded surface (interior)* reflects worn surfaces on the interior through continual use of a vessel. Evidence of sooting presumably from repeated use in cooking was sometimes but not always recorded in a series of categories including *Sooted interior-exterior wear, Sooted interior,* and *Sooted exterior. Spindle whorl* includes sherds shaped into rounded items with a drilled hole in the center, presumably used as balances. *Indeterminate shaped form with drill hole* indicate similar items, but do not appear to have functioned as either balances or ornaments.

Refiring Analysis

A technique used on small samples of sherds is refiring analysis, which allows for basic comparisons based on mineral impurities in clay and ceramic pastes. This technique involves firing samples in oxidizing conditions to temperatures of 950 degrees Centigrade. Such firings standardize the oxidation of iron compounds in clays, and fired out organic material, allowing for the comparison of color between samples, which reflects types and amounts of mineral impurities (particularly iron). Sample color is recorded using Munsell color categories. While refiring analysis does not provide information about specific clay composition, a comparison of colors recorded for raw clays and ceramic pastes may allow for the identification of clay sources that could have been exploited. Interpretation of data from refiring studies relies on the assumption that clays from the same source area should contain similar mineral impurities, and thus they should fire to the same color ranges. Such interpretations are limited by a number of factors. One problem is that a number of sources exhibiting different characteristics may occur within the catchment area of a potter at a given site. Also, clays from distinctive sources may sometimes fire to similar colors, or specific deposits firing to a particular color may occur over a wide area. Despite these potential problems, differences in clay availability and selection may be observed. These include strong correlations between paste color and temper or other attributes of pottery produced by potters at a particular site, indicating potters in specific areas often did consistently select distinct clay and temper resources. Some problems may be controlled by accumulating data relating to the range of variation present in sources available to potters within an area, raw clay recovered from a particular source, and paste clay dominating the local ceramic assemblages.

Whole Vessel Analysis

Each sherd derived from a complete or partial vessel was analyzed and counted. Then, a separate analysis was conducted on the complete or partial vessels identified. Information recorded for each vessel included all basic information recorded during sherd analysis, as well as completeness, overall wear patterns, sooting patterns, rim diameter, and height. Each vessel was photographed and profiles were sketched.

Ceramic Type Descriptions

All pottery analyzed was assigned to typological categories based on combinations of traits with spatial, functional, and temporal connotations. Items were assigned to various ceramic type categories based on the assignment of pottery first to recognized ceramic tradition, then ware, and finally to defined types. The recognition of associated ceramic tradition involved the separation of ceramics into broad groups indicative of postulated area of origin or culture area. Sherds were placed into ceramic traditions previously defined for sites in the Middle Rio Grande and surrounding regions based on temper, paste, and paint characteristics. Next, sherds were divided into broad ware groups based on technological attributes and surface manipulation. Finally, they were assigned to ceramic types or groupings based on temporally sensitive painted decorations or textured treatments.

The combination of pottery traditions identified during the present study reflects the unique sequence of influences and interactions between the Northern Santo Domingo Basin and the surrounding culture area. Numerous pottery traditions including those for regions of the Rio Grande Valley, Mogollon Highlands, and Colorado Plateau were identified as part of the present analysis. In contrast to many other Southwest areas, the dominant pottery tradition changes significantly through time in assemblages from the Northern Santo Domingo Basin and other areas of the Middle Rio Grande. Such changes are primarily reflected in shifts in paste, technology, and surface treatments associated with pottery dominating assemblages associated with various temporal components. For example, assemblages at Early Developmental sites are dominated by utility wares with sand temper and light colored pastes similar to pottery found in other areas of the Middle Rio Grande and Cibola region of the Colorado Plateau. Later assemblages contain large frequencies of pottery with volcanic rock tempers and styles associated with the Northern Rio Grande and other regional traditions. These changes in frequencies of associated traditions may ultimately reflect pan-regional patterns of shifting pottery technologies, ethnic identity, alliances, and exchange ties. Discussions and descriptions of pottery types identified during the present study are presented first by tradition and then ware group.

Indeterminate Tradition Types

Types assigned to an Indeterminate tradition refer to pottery that could not be assigned to types belonging to previously defined traditions. The indeterminate tradition category was seldom used and was limited to rare situations where sherds are tempered with material or inclusions or exhibit manipulations not attributed to specific traditions. Indeterminate utility ware refers to gray ware sherds for which the tradition could not be determined. Indeterminate unpainted undifferentiated white ware refers to unpainted white ware sherds for which tradition and manufacture range could not be determined. Indeterminate mineral painted white refers to white wares with decorations in mineral pigment for which the basic tradition cannot be determined. Temper types represented in sherds assigned to this tradition include indeterminate, gray basalt, sand, fine tuff and ash, basalt and sand, self-tempered, and vitrified.

Middle Rio Grande (or Cibola) Tradition Types

The criteria used to assign pottery to the Middle Rio Grande is different than that used in more recent projects conducted by the Office of Archaeological Studies. A high frequency of the pottery from Peña Blanca sites (particularly those from Early Developmental period components) exhibited distinct temper and pastes common to the Middle Rio Grande, and most of that from the Cibola region of the Four Corners Anasazi. Gray ware forms placed into this tradition often contain sand or sandstone temper. The white ware types are characterized by low iron clays or white slipped surfaces and sand temper.

Sherds assigned to types of the Middle Rio Grande tradition during the present study typically date to the Early Developmental period. Pastes and temper associated with these sherds tend to be fairly homogeneous. Although locally distinct, this pottery exhibits characteristics comparable to those used to define traditions of several different regions. Middle Rio Grande pottery has paste and temper combinations similar to those noted in Cibola tradition pottery types described for areas in of the Colorado Plateau to the west including much of west-central and northwestern New Mexico (Colton 1965; Gladwin 1945; Roberts 1940; Windes 1977). During the present study, pottery exhibiting sand temper and light pastes were assigned to types belonging to a Middle Rio Grande tradition, although it is recognized that some of the pottery assigned to types of this tradition could represent trade wares from the Cibola region of the Colorado Plateau. As a result of this classification continuum, at least some of the interaction that took place between these two regions may be underrepresented or masked.

Middle Rio Grande Utility Wares

Pottery exhibiting some form of sand temper and light-colored, low-iron paste assigned here to the Middle Rio Grande tradition pottery was probably locally produced in the Santo Domingo Basin. Given the dominance of gray ware forms with sand temper at early Peña Blanca sites, it is very likely that most of the pottery vessels exhibiting this paste combination were locally produced. It is also likely that some of the pottery displaying this temper and paste combination were produced at distant areas of the Rio Grande and Colorado Plateau.

Temper categories documented for Peña Blanca gray ware pottery assigned to this tradition include sand (86.8 percent of the pottery assigned to this tradition), oblate shale and sand (3.1 percent), fine sandstone (0.1 percent), self-tempered (0.1 percent), and anthill sand (9.9 percent). The variation in temper characteristics indicate production in at least a few distinct areas. An example is the dominance of sand in assemblages dating to the Early Developmental period versus the dominance of anthill sand in Coalition period assemblages. Temper classified here as anthill sand probably reflects material derived from areas of the Pajarito Plateau. In analyses conducted during later projects, pottery exhibiting ant hill sand temper has been classified as a variant of the Northern Rio Grande tradition. Petrographic analysis indicate that tempers assigned to these two categories represent very different materials. Thus, despite the fact that pottery exhibiting these two tempers was assigned to types defined for the Middle Rio Grande tradition, very different types of sources and areas of association, which changed through time, may be indicated.

Issues relating to the classification of gray ware pottery from sites in Rio Grande region have so far received very little attention, as most detailed analysis of Rio Grande pottery has focused on decorated white or glaze ware forms (Habicht-Mauche 1993; Lang 1982; Shepard 1942; Warren 1969). Despite the wide range of pastes and texture treatments noted in utility wares from sites in various areas of the Rio Grande region, very few types have been formally described. This has often resulted in the documentation of most of the range of variation in texture through the use of two or three types. One of the most detailed studies of Rio Grande Utility Ware was Kidder's study of gray ware pottery from Pecos Pueblo (Kidder and Shepard 1936). Utility ware recovered during the excavation of Pecos Pueblo was assigned to descriptive types based on surface texture. This approach avoids problems associated with other Rio Grande type definitions which assume relationships between paste and surface characteristics (Mera 1935) that are difficult to confirm.

Thus, the present study follows Kidder's basic strategy where pottery is assigned to a particular Rio Grande tradition type category based on variation in surface texture, although a wider range of categories is employed here. These categories reflect various plain, neckbanded, and corrugated treatments utilized during the Developmental, Coalition, Classic, and historic periods. Surface treatments include plain, neckbanded, corrugated, ridged exterior textures, and smudged-polished surfaces. Gray ware sherds assigned to Middle Rio Grande types are limited to those exhibiting some form of sand temper. Those exhibiting similar textures, but pastes and temper indicative of other traditions, were assigned to parallel categories.

Plain gray ware vessels with completely smoothed surfaces are common at Rio Grande sites dating to all phases, although in the Northern Santo Domingo Basin gray wares with sand temper and low-iron pastes are most common in Early Developmental period assemblages. Plain gray body sherds may be derived from plain surface vessels, or from the lower portion of neckbanded or corrugated vessels. Rim sherds that probably derive from completely smoothed vessels were classified as Middle Rio Grande (MRG) Plain Gray Rim. Examples of plain utility ware vessels associated with this tradition are presented in Figures 16.1–16.2. Rim sherds that were too small to indicate the vessel surface texture were classified as MRG Unknown Gray Rim. Smoothed body sherds that could have originated from plain vessels or smoothed portions of neckbanded or corrugated vessels, were classified as MRG Plain Gray Body. Unfired sherds with plain surfaces were assigned to a MRG Unfired Plain category. Sherds with plain surfaces are common at sites dating to most Rio Grande occupational periods. Their relative frequency, however, appears to have changed significantly through time. Other plain forms recognized include MRG Plain Polished Gray and MRG Plain Incised Gray.

Other gray ware sherds display textures created by incompletely obliterated coil junctures along the exterior of the necks of vessels. Neckbanded sherds found at early sites in this region may represent a local form of Kana'a Gray, a type commonly occurring on the Colorado Plateau at Pueblo I and early Pueblo II sites (Gladwin 1945). In the Rio Grande, such treatments are common at sites dating to the Red Mesa phase, which dates to the first half of the Late Developmental period. Neckbanded sherds were divided into a series of types based on thickness and treatment of the unobliterated neck coils. MRG Wide Neckbanded Gray refers to sherds with wide coils or fillets. These coils are clearly separated by distinct junctures, that rest vertically on each other, and usually do not overlap. MRG Wide Neckbanded (Smeared or Wiped) refers to sherds that are similar to Wide Neckbanded, but the junctures between the coils have been partially obliterated (see Fig. 16.10c). The area originally separated by these coils is still visible, and is reflected by undulating or ribbed surfaces. This effect is similar to that noted for Sapawe Micaceous Washboard sherds—a Northern Rio Grande type common at Classic phase components.

Other gray ware types are distinguished by corrugated exterior surfaces. Corrugated gray ware vessels have thin overlapping coils which often have regularly spaced indentations. These coils usually cover the entire exterior surface, although corrugated treatments are sometimes limited to the vessel neck. In some cases, corrugated types were further distinguished by other temporally sensitive attributes such as the type and pronouncement of coiled treatment and rim eversion.

MRG Indented Corrugated includes sherds with narrow coils, regularly spaced indentations, and moderate to high contrast between coils. For the Northern Santo Domingo Basin, indented corrugated pottery tends to be most common at Developmental phase and Early Coalition phase sites. MRG Plain Corrugated refers to gray wares with similar coil treatment and relief described for indented corrugated but without regularly spaced indentations.

MRG Smeared Indented Corrugated and MRG Smeared Plain Corrugated refer to sherds with indented corrugations (or without indentations, as in the case of MRG Smeared Plain) that have subsequently been smeared, resulting in the partial obliteration of indentations and coil junctures. Rio Grande Gray ware types exhibiting these treatments have been previously classified as Tesuque Smeared (Mera 1935). In the Rio Grande region, smeared indented represents the most recent form of corrugated treatment, and it dominates site assemblages dating to the Late Coalition and early Classic periods (Fig. 16.3). Some gray ware sherds exhibited slightly smeared corru-

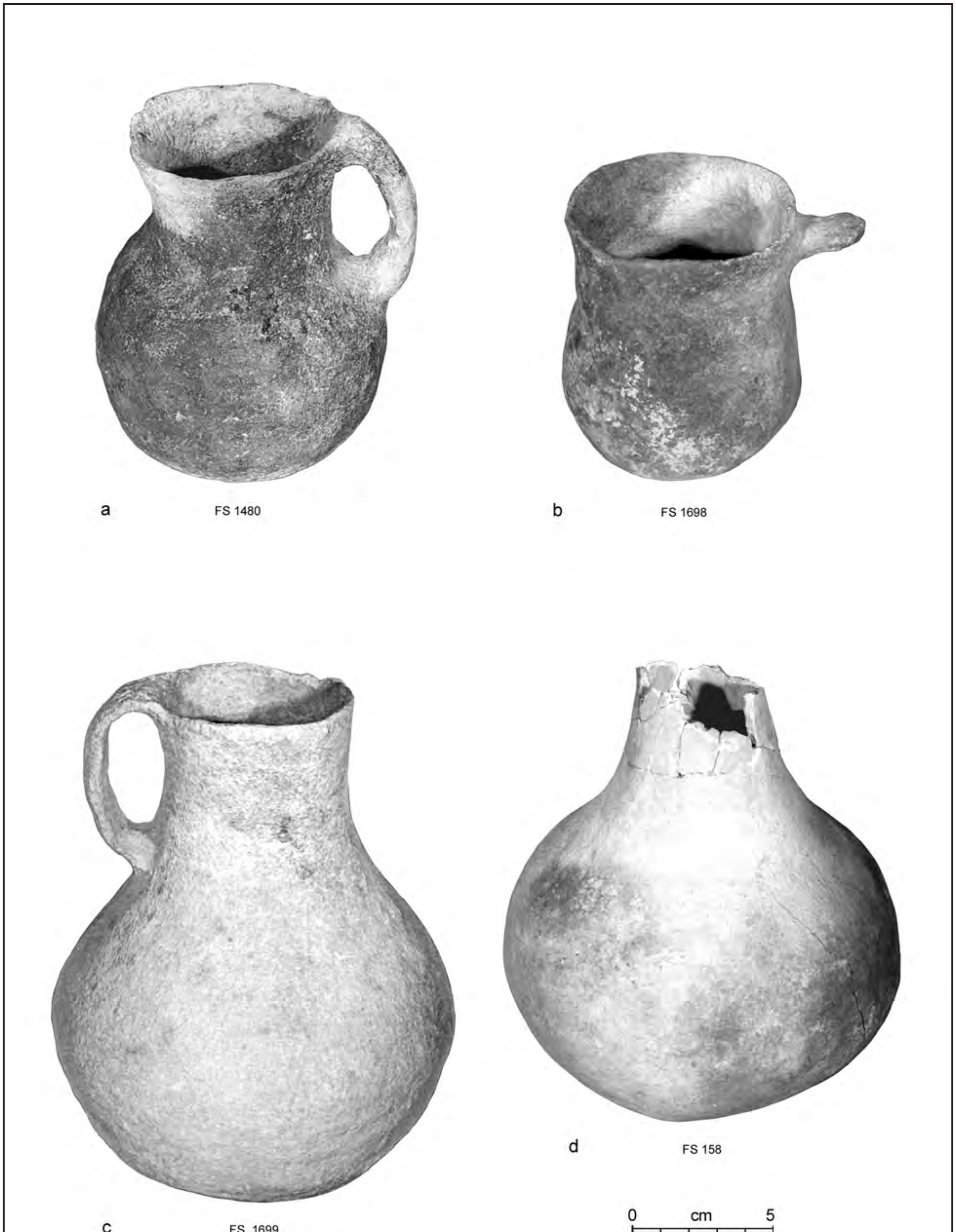

Figure 16.1. Reconstructible Middle Rio Grande Plain Gray Ware vessels: (a) Vessel 1 pitcher, LA265 (FS 1480); (b) Vessel 2 beaker, LA265 (FS 1698); (c) Vessel 3 pitcher, LA 265 (FS 1699); (d) Vessel 1 gourd jar, LA 115862 (FS 158).

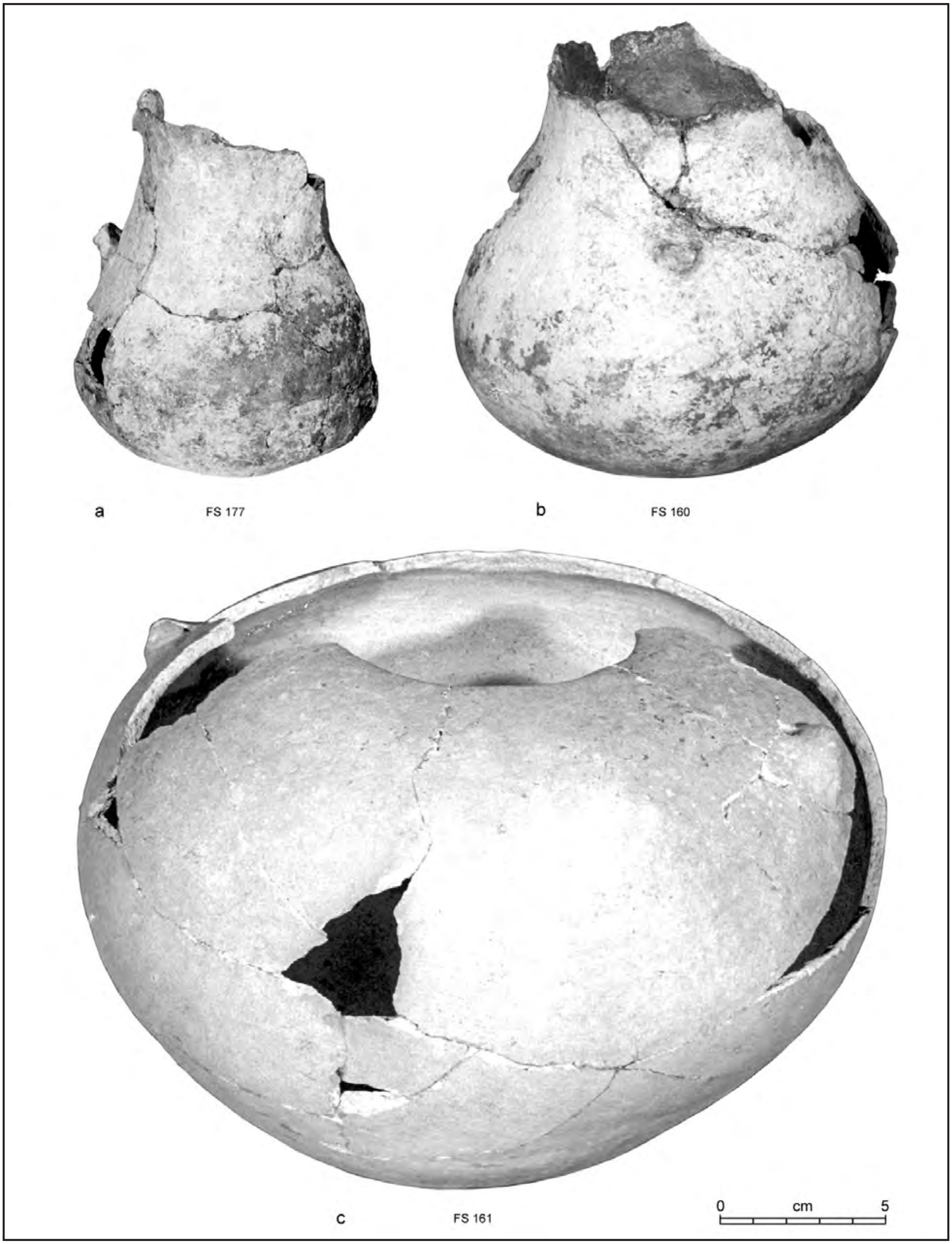

Figure 16.2. Reconstructible Middle Rio Grande Plain Gray Ware Vessels: (a) Vessel 6 pitcher, LA 115862 (FS 177); (b) Vessel 9 cooking/storage jar, LA115862 (FS 160); (c) Vessel 10 seed jar, LA115862 (FS 161).

gations with clear coil junctures, and reflected treatments intermediate between indented corrugated and Smeared Indented Corrugated. These sherds were assigned to a MRG Low Relief Corrugated category. Sherds with corrugations limited to the neck area were assigned to a Neck Corrugated category.

Middle Rio Grande (Cibola) White Wares

For components from sites in the Northern Santo Domingo Basin and elsewhere in the Middle Rio Grande region, the assignment of white wares with sand and/or sherd temper to a particular tradition presents several classification dilemmas. Problems relating to the assignment of regional traditions and types are confounded by the fact that characteristics noted for local white ware types such as San Marcial Black-on-white occurring in the earliest (Early Developmental) ceramic components exhibit pastes similar to those noted in other areas of the Middle Rio Grande as well as the Cibola region of the Colorado Plateau (Mera 1935). In contrast, at Late Developmental sites in various areas of the Rio Grande, sand-tempered pottery is commonly assigned to Cibola pottery types. The occurrence of these types is commonly interpreted as reflecting pottery originating in the Colorado Plateau. It is likely that pottery from Peña Blanca sites with this paste-temper combination represent a mixture of locally produced types as well as some trade wares from regions on the Colorado Plateau. A higher proportion of pottery from Early Developmental components were probably derived from locally produced vessels, while most of those from later components may reflect trade wares from the Colorado Plateau. Thus, pottery exhibiting this paste combination was assigned here to types belonging to a Middle Rio Grande tradition, but can include trade wares from the Cibola region of the Anasazi and other areas where pottery was tempered with sand and or sherd.

As is the case for Middle Rio Grande gray wares, the majority (51.5 percent) of the Middle Rio Grande white wares are dominated by similar sand tempers in Early Developmental assemblages. Still, the overall range and frequency of Middle Rio Grande white wares is very different than that documented for gray wares assigned to this tradition. Other tempers noted for white wares assigned to the Middle Rio Grande tradition include sherd (3 percent of the Middle Rio Grande white wares), sherd and sand (3.7 percent), fine sandstone (0.7 percent), oblate shale and sand (39.4 percent), dark sand (0.4 percent), shale (0.2 percent), very fine sand (0.2 percent), and multilithic sand (0.1 percent). Because temper used in white wares changed through time, distributions of tempers will be discussed later for San Marcial Black-on-white associated with the Early Developmental occupation and the various Pueblo II types assigned to this tradition.

Almost all Peña Blanca decorated pottery assigned to this tradition display decorations in mineral paint. Pottery belonging to this tradition was assigned to types based on temporally distinct design styles. White ware sherds not exhibiting painted decorations were assigned to an Unpainted Undifferentiated category. A similar sherd with a highly sooted interior was assigned to a Smudged White Paste category. Those for which the paint type could not be determined were classified as Indeterminate Paint. Those containing mineral paint for which temporal styles or surface treatment could not be determined were classified as Mineral Paint Undifferentiated.

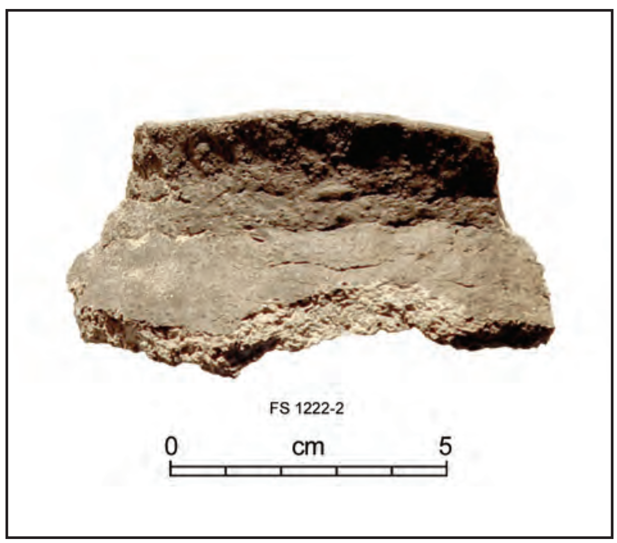

Figure 16.3. Middle Rio Grande Corrugated Ware Smeared Corrugated (FS 1222-2).

The earliest Peña Blanca black-on-white pottery is identified by a combination of pastes and styles indicative of the earliest decorated pottery produced in the Middle Rio Grande region. This pottery displays the range of characteristics long used to define San Marcial Black-on-white (Ferg 1983; Marshall 1980; Mera 1935). Although defined as reflecting the earliest white ware pottery produced in the Middle Rio Grande, San Marcial has been more broadly described as a type produced over much of the Anasazi country from AD 520 to 620 (Warren 1985; J. Wilson 1995).

Examples of sherds and vessels assigned to San Marcial Black-on-white are illustrated in Figures 16.4–16.6. Although some of the characteristics described for San Marcial Black-on-white may be unique to pottery produced in areas of the Middle Rio Grande, pottery assigned to this type does certainly resemble other early Cibola tradition types, such as White Mound Black-on-white produced in the Cibola region. San Marcial Black-on-white as used here appears to represent an eastern variant of White Mound Black-on-white (Ferg 1983). A closer examination, however, indicates that the earliest painted white wares from the Middle Rio Grande exhibit a distinct range of pastes and stylistic traits, and warrant the assignment of this pottery into San Marcial Black-on-white rather than White Mound Black-on-white. San Marcial Black-on-white as defined here, however, may include some sherds that other analysts might assign to White Mound Black-on-white.

Paste color ranges from light gray to white. Pastes consistently fire to a buff or white color in an oxidizing atmosphere, reflecting the use of a clay with an extremely low iron content. Most, but not all, of the San Marcial Black-on-white sherds exhibit a gray core; although some are white throughout. Paste is blocky with protruding temper fragments. Temper was very similar in most San Marcial Black-on-white sherds identified during the present study, consisting of rounded quartz sand sometimes with rounded gray-white to buff shale fragments. These shale pellets exhibited a silty texture and opaque surface, and were white to gray in color. Similar pellets were noted in pottery from the Rio Salado drainage (Marshall 1980) assigned to La Plata Black-on-white and White Mound Black-on-white. Observations concerning the distinct range of styles and pastes in early mineral-painted types resulted in the placement of most of the early painted white wares exhibiting shale temper and distinct early designs executed in mineral paint into San Marcial Black-on-white.

Surfaces tend to be light gray to white, although some examples are light gray in color. Jars and bowls are both relatively common. Jars are represented by a wide variety of forms including bowls, necked jars, and seed jars. Bowls tend to be painted on the interior surface only and jars are only painted on the exteriors. Unpainted surfaces are unpolished to lightly polished. Painted surfaces tend to be slightly to moderately polished. Some painted surfaces exhibit a distinct white slip.

Rims are tapered, and either undecorated or painted with a single solid painted line. Decorations exhibit use of a thick mineral pigment that ranges from red, brown to black in color, but are commonly brown. Some examples of this type exhibit designs that are well organized and precisely executed, while other designs are less well executed. While the basic design motifs are somewhat similar to those noted on White Mound and other contemporaneous Anasazi types, overall styles are distinct. The range of decoration has been characterized by Marshall (1980) as the San Marcial style. The styles differ from those noted in contemporary Cibola types such as La Plata and White Mound Black-on-white. This style is bold, and often consists of wide parallel lines, solid triangles, and serrated solids. Elements are often oriented in intersecting, chevron, rectilinear, or curvilinear patterns covering much of the vessel surface. The overall orientation pattern and effect of these designs more closely resemble those noted on Mogollon types such as Mogollon Red-on-brown or Three Circle Red-on-white (Haury 1936; Wasley 1969). It is possible that San Marcial Black-on-white may represent a decorative tradition that developed out of the Mogollon tradition but utilized white firing clays similar to those uti-

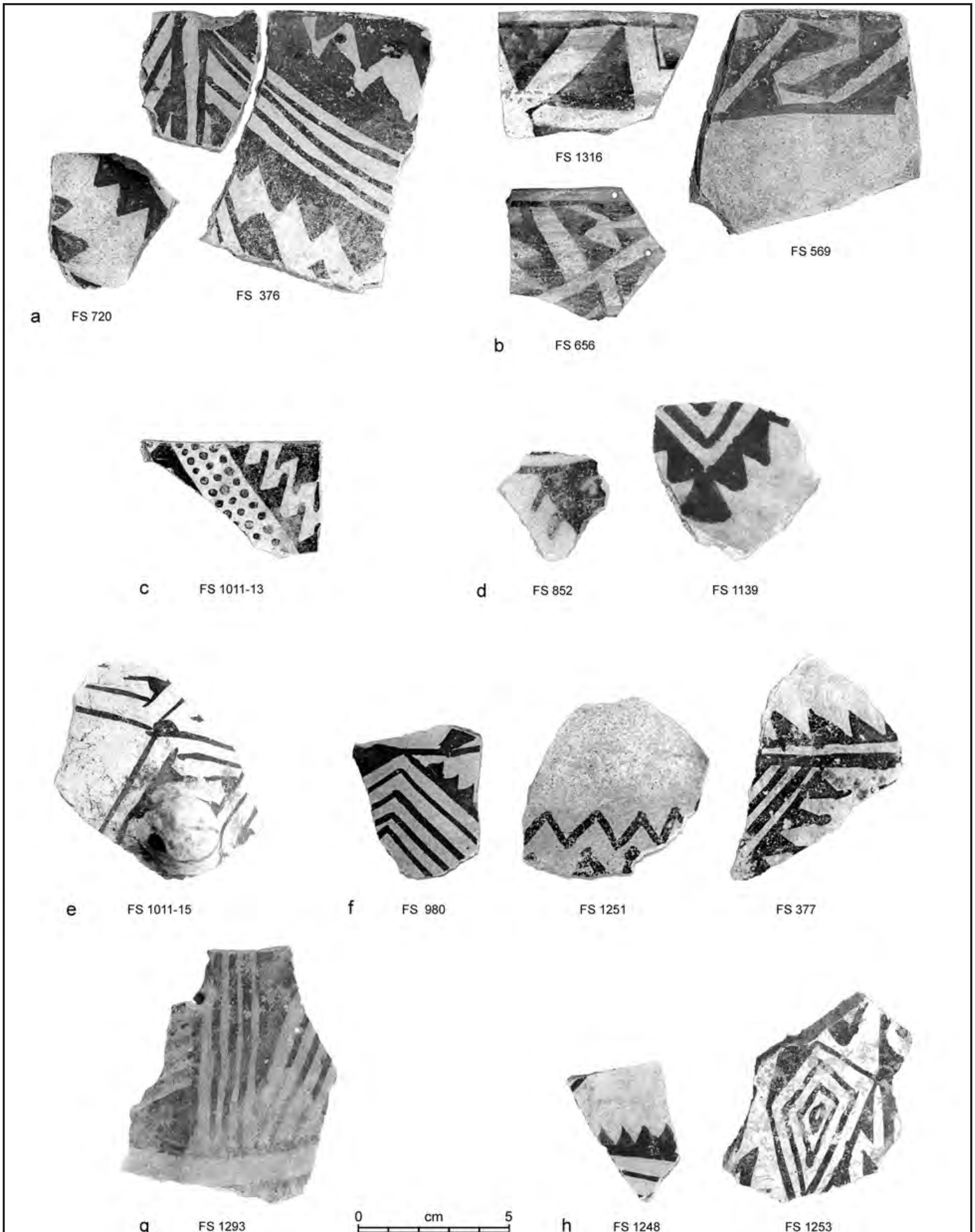

Figure 16.4. San Marcial Black-on-white sherds: (a) bowl rim, LA6169 (FS 376), LA 6171 (FS 720); (b) bowl rim, LA 6169 (FS 656, 569, 1316), (c) bowl rim, LA 265 (FS 1011 lot 13); (d) bowl body, LA 6171 (FS 852), LA 265 (FS 1139); (e) jar handle, LA265 (FS 1011 lot15); (f) jar body, LA 6171 (FS 980), LA 6170 (FS 1251), LA 6169 (FS 377); (g) jar body, LA 6169 (FS 1293 lot 35); (h) jar neck, LA 6169 (FS 1248), LA 6170 (FS 1253).

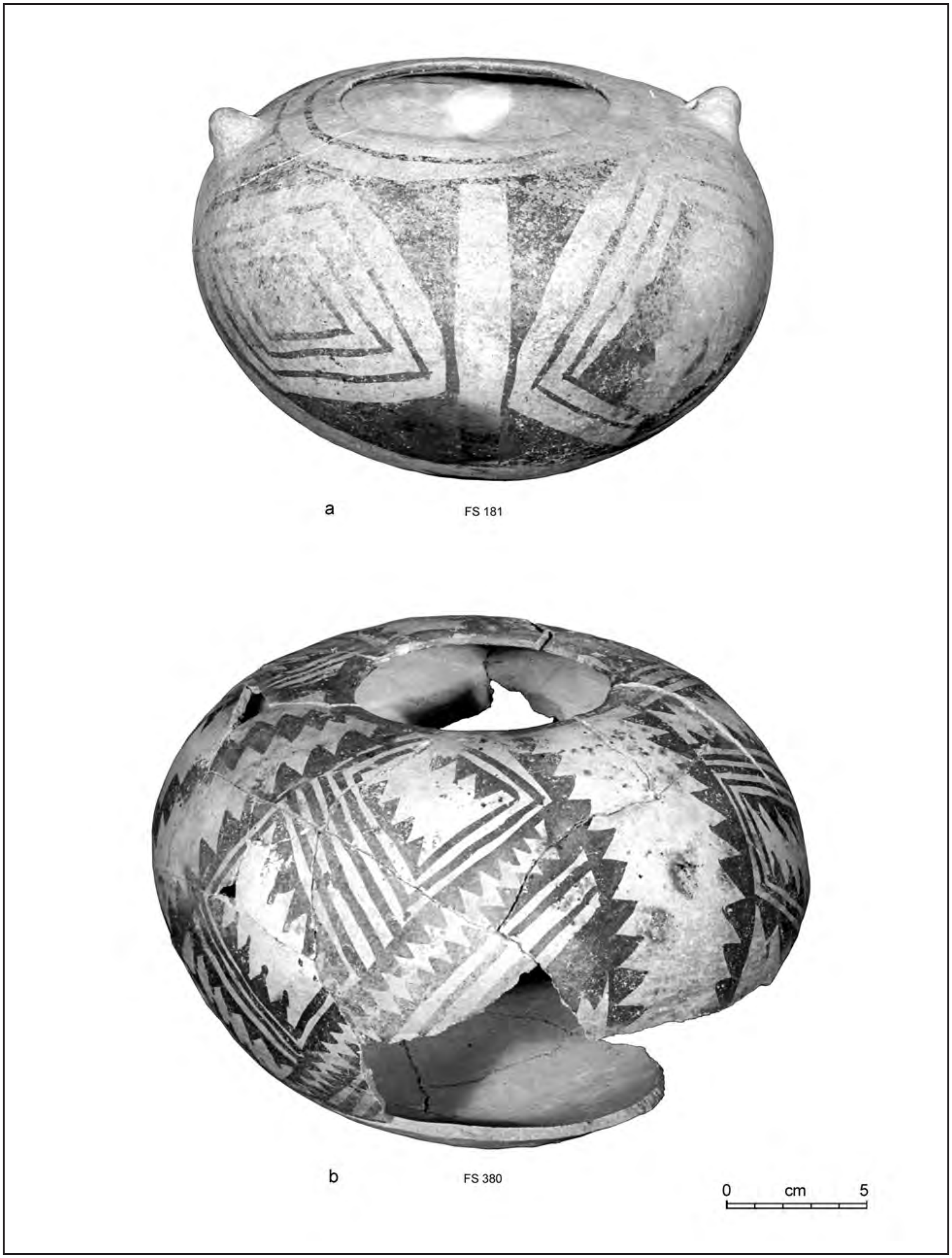

Figure 16.5. San Marcial Black-on-white reconstructible vessels: (a) Vessel 5 seed jar, LA 6169 (FS 380); (b) Vessel 8 seed jar, LA 115862 (FS 181).

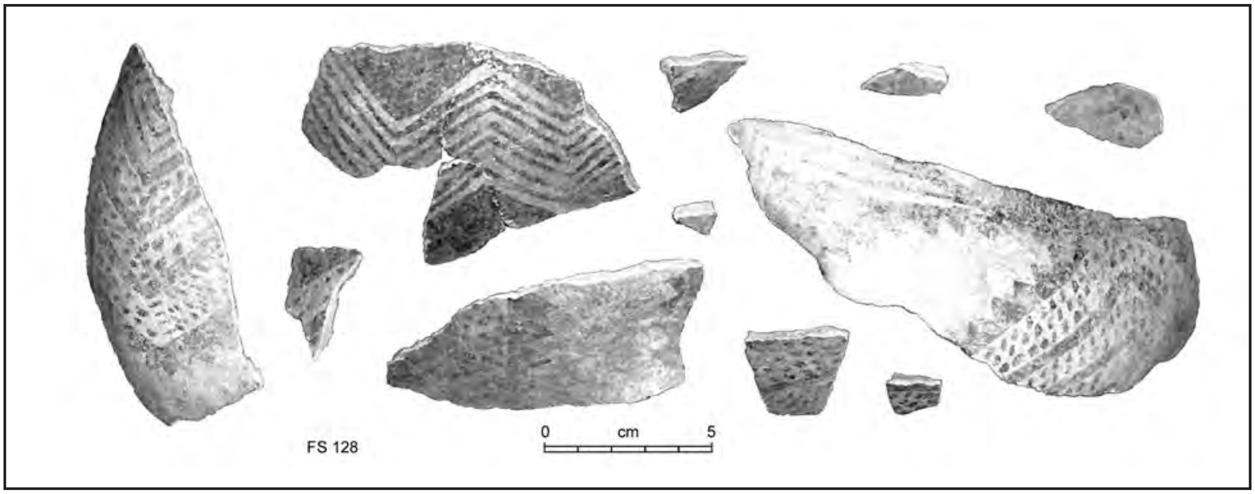

Figure 16.6. San Marcial Black-on-white reconstructible vessels: Vessel 2 jar body, LA 115862 (FS 174).

lized by Anasazi potters of the Colorado Plateau.

The overall designs of San Marcial Black-on-white may indicate it was produced by groups who had earlier made Mogollon Red-on-brown. The production of white wares may have co-occurred with movement by these groups into a new area where extremely low-iron and high-quality clays were available. Given the similarities of San Marcial Black-on-white found in various areas, it is likely that pottery assigned to this type was produced within a very limited area and may reflect early regional specialization.

Descriptive attributes for San Marcial Black-on-white sherds reinforce the preceding characterizations. Almost all the pottery assigned to this type exhibit low-iron pastes and are tempered with some variety of sand. Temper categories identified are evenly divided between sand (49.8 percent) and oblate shale with sand (49.8 percentage), with the remaining (0.3 percent) tempered with multilithic sand. A very wide range of vessel form categories were noted for Peña Blanca pottery assigned to this type. These included bowl rim (10.1 percent of the San Marcial Black-on-white sherds), bowl body (35.4 percent), seed jar (0.7 percent), olla rim (11.8 percent), jar neck (1.7 percent), jar rim (0.3 percent), jar body (38.0 percent), jar body with lug handle (0.7 percent), canteen rim (0.3 percent), and seed jar rim (0.7 percent). For sherds derived from bowls, interior surface manipulations recorded included plain unpolished (9.6 percent), plain polished (81.5 percent), polished with white slip (8.1 percent) and polished with thin white slip (0.7 percent). Bowl exterior manipulations documented include plain unpolished (57.0 percent), plain polished (36.3 percent), polished white slip (5.2 percent) and surface missing (1.5 percent). For sherds derived from jars, exterior manipulations include plain unpolished (10.6 percent), plain polished (70.2 percent), polished white slip (18.6 percent), and polished thin white slip (0.5 percent). Jar interior manipulations noted include plain unpolished (96.3 percent), plain polished (1.2 percent), polished white slip (1.9 percent), and surface missing (0.6 percent).

Other mineral painted types assigned to the sand-tempered Cibola tradition are similar to those noted at sites on the Colorado Plateau dating to the Pueblo II period. Sherds exhibiting combinations of styles and pastes similar to those noted on Pueblo II pottery forms were assigned to types previously defined for the Cibola pottery tradition. Such assignments, however, do not necessarily indicate that all the pottery placed into Pueblo II types defined for this tradition originated on the Colorado Plateau, although it is likely some of this pottery did. Mineral painted types with manipulations indicative of occupations within this span (AD 900 to 1200) but without styles characteristic of a specific type were classified as Pueblo II (Indeterminate Mineral).

Red Mesa Black-on-white refers to pottery exhibiting styles found throughout the Colorado Plateau and elsewhere in the Southwest during the early Pueblo II or early part of the Late Developmental period. Temper may include sand and/or sherd. Surfaces are often well polished, lightly slipped, and crackled. Designs consist of multiple parallel lines sometimes embellished with triangles or ticked lines, ribbons with squiggle hatchure, and scrolls. Painted designs are often well executed, and a number of elements often occur together in fairly complex patterns. Few sherds of Red Mesa Black-on-white were recovered during the present project, perhaps indicating an occupation hiatus during the tenth and early eleventh centuries.

Escavada (solid designs) Black-on-white was assigned to sherds exhibiting the range of painted styles indicative of material previously classified as Puerco Black-on-white or Escavada Black-on-white. Definitions of and distinctions between Puerco Black-on-white and Escavada Black-on-white are somewhat confusing and vague. As used here, these categories include the use of a range of solid design styles employed during the later part of the Pueblo II and early Pueblo III periods. Design styles often include triangles, parallel lines and chevrons. Gallup Black-on-white refers to sherds exhibiting Pueblo II surface manipulation and hatchured designs. Lines are usually thin and closely spaced.

Paste and surface attributes noted for all the Pueblo II white ware types assigned to this tradition during the Peña Blanca Project are discussed together. This pottery does appear similar to Cibola White Ware from various areas of the Colorado Plateau. Almost all the pottery assigned to these types exhibit low-iron pastes and are tempered with some variety of sand and/or sherd. Temper categories identified include sand (35.3 percent), sherd and sand (41.2 percent), and fine sandstone (23.5 percent). Vessel form categories identified include bowl rim (23.5 percent), bowl body (23.5 percent), and jar body (52.9 percent). For sherds derived from bowls, interior manipulations include plain polished (12.5 percent), polished white slip (75 percent), and unpolished white slip (12.5 percent). All bowl exteriors were unpolished. For sherds derived from jars, exterior manipulations include plain unpolished (11.1 percent), plain polished (44.4 percent), and polished white slip (44.4 percent). All jar interiors were unpolished.

Middle Rio Grande (or Cibola) Red Wares

Middle Rio Grande red wares as described here denote red ware pottery forms exhibiting similar pastes and temper combinations previously described for Middle Rio Grande gray wares or early white wares. Types within this grouping were distinguished based on paste characteristics.

Pottery with white pastes and sand temper identical to that noted in many of the gray wares covered with a distinct red slip were assigned to a Red Slip Over White Paste or Tallahogan Red-like (see Fig. 16.7) category. Pastes are made up of low-iron clays with sand temper. Red slip over white pastes refers to pottery with at least one surface with a distinct red slip. None of the sherds exhibiting this combination of paste and slip had painted decorations. This slip tends to be fairly thick and is bright to deep red in color. Slipped surfaces are almost always highly polished. While some examples were slipped on both surfaces, bowls assigned to this type were always slipped on at least the interior surface and jars were slipped on the exterior surface. Common forms noted for this type include seed jars and bowls. Pottery assigned to this type is similar to pottery from Basketmaker III and Early Pueblo I sites in the Four Corners country classified as Tallahogan Red (Daifuku 1961; Reed et al. 1998).

Pottery exhibiting similar temper and slip, but with a brownish to reddish paste was assigned to a Red Slip Over Reddish Paste category. The slip is bright to deep red. This pottery is similar to San Francisco Red from the Mogollon Highlands (Haury 1936), except the temper consists of sand similar to that noted in "local" gray and white wares. Similar pottery from early Basketmaker III sites in the Chuska region has recently been assigned to Tohatchi Red (Reed et al. 1998). Vessel forms are mainly represented by bowls. Forms noted in early

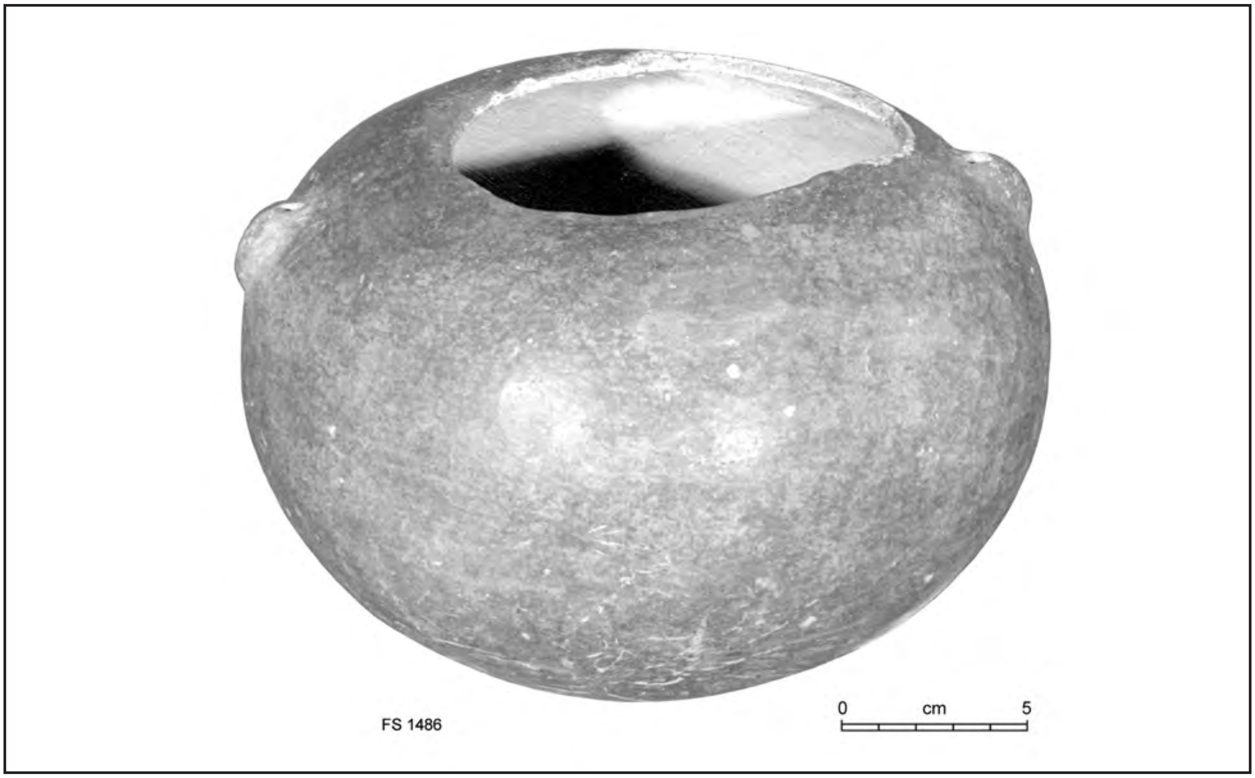

Figure 16.7. Early (Tallahogan) Slipped Red Wares: Vessel 4 seed jar, LA 265 (FS 1486).

unpainted red wares from Peña Blanca sites include indeterminate (1.0 percent), bowl rim (0.3 percent), bowl body (4.8 percent), jar neck (3.2 percent), jar rim (0.3 percent), jar body (78.5 percent), jar with lug handle (0.3 percent), seed jar rim (0.3 percent), and indeterminate rim (1.0 percent). The very high frequency of early unpainted red wares derived from jar forms is fairly unusual, particularly as compared to distributions noted for other Southwestern red ware traditions. A total of 56.3 percent of these red ware bowls were slipped on both sides, while only 2.4 percent of the red ware jars were slipped on both sides.

Other categories describe pottery displaying design styles and surface manipulation similar to Mogollon Red-on-buff but with local pastes. Styles and manipulations indicative of Mogollon Red-on-brown are presented in later discussions of Mogollon types. Type categories reflecting this combination of Mogollon Red-on-brown technology and local resources include Local Red-on-brown and Local Red Slipped Red-on-buff. While local red-on-brown sherds are extremely rare, a single local red-on-brown vessel was recovered from LA 115862 (see Fig. 16.8). This vessel copies Mogollon Red-on-brown in terms of both style and manipulations.

Local brown ware refers to pottery with reddish to brownish pastes and sand temper. Surfaces are plain, and at least one is usually polished. Pottery assigned to this category is similar to Alma Plain from the Mogollon Highlands (Haury 1936) with the exception of local sand temper.

White Mountain Redware

White Mountain Redware reflects a specialized technology that developed in areas of the southern Anasazi (Carlson 1970). White Mountain Redwares were produced within a fairly limited area in west-central New Mexico and east-central Arizona, but were widely traded throughout much of the Southwest. Pottery assigned to this tradition is characterized by a white, gray to orange paste, sherd temper, and a dark red slip. Surfaces are well polished, and painted decorations are usually executed in a black mineral or organic paint. A polychrome effect is sometimes achieved through the additional use of a white clay paint.

Undifferentiated White Mountain Redware refers to White Mountain Redware pottery not displaying painted decorations. Wingate Black-on-red contains dark red to bright red slips. Designs consist primarily of hatchured elements sometimes with opposed solid elements. Puerco Black-on-red is similar except decorations are limited to solid motifs.

Glaze Ware Types

Glaze ware types reflect a distinct pottery class produced in areas of the Middle and Southern Rio Grande region. Glaze ware refers to pottery either exhibiting painted decorations with glaze or to unpainted sherds assumed to have been derived from vessels decorated with glaze paint. This ware is defined by the use of lead glaze paint or a distinctive paste reflecting pottery produced in the Middle Rio Grande from about AD 1325 to the early 1700s (Franklin 1997; Kidder and Shepard 1936; Mera 1933). Glaze ware forms appear to have been produced in the Northern Santo Domingo Basin and surrounding areas of the Middle Rio Grande during most of this span (Warren 1979b). Examples of glaze ware sherds are illustrated in Figure 16.9.

The basic system of classification of glaze sherds developed by Mera (1933) was utilized in part during the present study. This classification system, however, is only applicable to rim sherds. Thus, during the present study, body sherds that could not be assigned to a specific type were assigned to types based on surface treatments using similar conventions as used in other recent studies in the Middle Rio Grande (Franklin 1997). Unpainted body sherds thought to have derived from glaze paint pottery were assigned to some descriptive type categories based on the presence or type of slip, and include Glaze Red (Unpainted), Glaze Yellow (Unpainted), Glaze Brown/Tan (Unpainted), Glaze-on-red (undifferentiated), Glaze-on-yellow slipped (undifferentiated), and Glaze-on-brown/tan.

Most of the glaze rim sherds exhibited straight, even walls, characteristics of Glaze A (Mera 1933). Unpainted bowl rims with

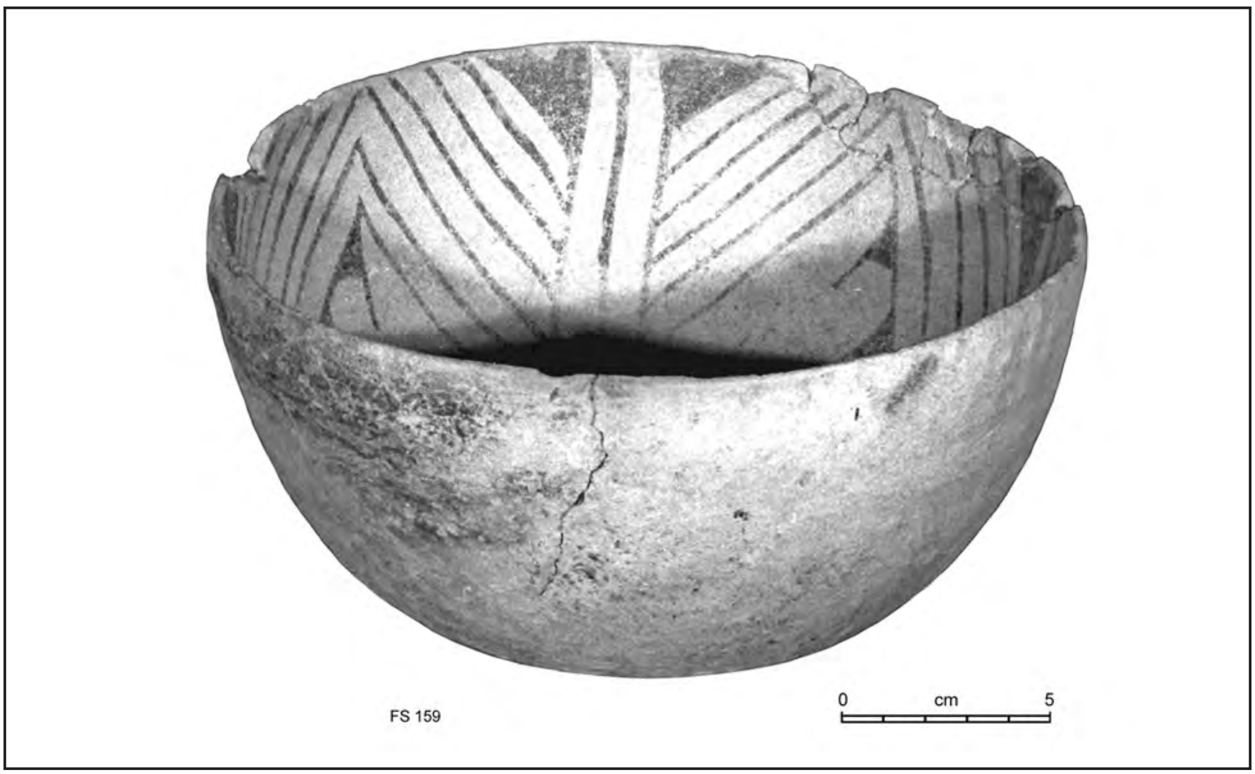

Figure 16.8. Local Red-on-brown: Vessel 7 Bowl, LA115862 (FS 159).

straight even walls were assigned to either an Unpainted Glaze A Yellow or Unpainted Glaze A Red category.

Sherds with straight rims exhibiting decorations in glaze paint on a red slipped surface were assigned to Agua Fria Glaze-on-red (Fig. 16.9c). Pottery exhibiting characteristics of these types appears to be similar to early glaze ware pottery recovered over a wide area (Franklin 1997; Habicht-Mauche 1993; Kidder and Shepard 1936; Lambert 1954). Pastes are usually oxidized and surfaces and cross sections are usually orange or red in color. Bowl interiors are usually covered with a deep red, well-polished slip.

The paint of Agua Fria Glaze-on-red is usually black, ranging from a thin matte-looking paint with limited evidence of vitrification to a distinct glaze. Application of the paint pigment tends to be well executed as compared to later glaze forms, and on initial perusal, often resembles earlier matte pigment. In addition, designs are usually even and well executed, and dripping and other defects common in later glazed types tend to be absent.

The design in Agua Fria most typically consists of a narrow band below the rim. This is composed of a series of solid triangles and rectangles, with some squiggle hatchures. A common element is a long triangle, which may extend from 1/5 to 1/3 of the circumference of a bowl, that merges with a single line to complete the circle.

Sherds exhibiting rim shapes similar to those described for Agua Fria Red-on-glaze but with a low-iron slip clay ranging from white, buff, to yellow in color were assigned to Cieneguilla Glaze-on-yellow (Fig. 16.9d). The increased production of Glaze A Yellow types at the end of the Glaze A Red period represents the onset of a new ceramic technology in the Northern and Middle Rio Grande regions. This change corresponds with a shift from the dispersed production of Glaze A Red to the more centralized production (centered in the Galisteo Basin) of Glaze B pottery forms.

Cieneguilla Glaze-on-yellow is similar to Agua Fria Glaze-on-red in form and style, but exhibits a light-slipped background. Cieneguilla Glaze polychrome is also the first Rio Grande glaze ware to

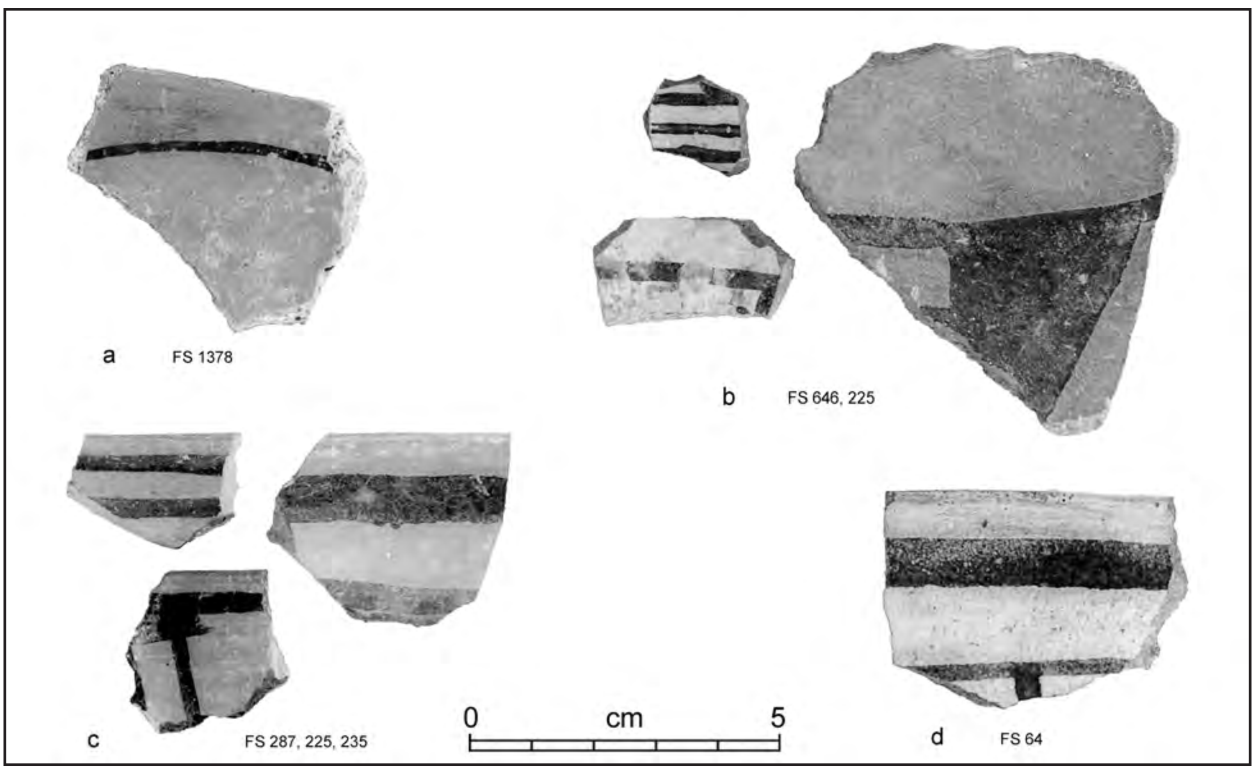

Figure 16.9. Glaze Ware types: (a) Glaze-on-red bowl body, LA6169 (FS 1378); (b) Glaze-on-yellow bowl body, LA 6171 (FS 646), LA249 (FS 225; (c) Agua Fria Glaze-on-red bowl rims, LA249 (FS 287, 225, 235); Cieniguilla Glaze-on-yellow bowl rim, LA249 (FS 64).

incorporate red matte paint into the design field.

Largo Glaze-on-yellow is differentiated from Cieneguilla Glaze-on-yellow by thickened rim forms that developed out of the straight Glaze A rim forms. Largo glaze ware is estimated to have been produced from AD 1400 to 1450 (Warren 1979b) and appears to represent a short-lived form transitional between Glaze A Yellow and Glaze C, Espinosa Glaze polychrome. Rim forms vary slightly with some rims showing a prominent change in thickness, while others have a more gradual thickening.

The quality of glaze paint of Largo glaze sherds ranges from a lustrous brown to an uneven, greenish brown. Some sherds have solid glaze painted lines around the rim. Interior bowl designs are predominantly linear, probably framing lines within banded designs. Triangular solid-filled motifs are common. In the polychrome style, red fill is incorporated into rectilinear ribbons on bowl exteriors, which begin slightly below the rim.

Tempers recorded for glaze ware types recovered during the present study include gray crystalline basalt (66.7 percent), latite (28.6 percent), basalt and sand (0.8 percent), fine tuff or ash (2.9 percent), fine tuff and sand (0.9 percent), sherd (0.3 percent), and vitrified (0.3 percent). Temper is dominated by types of basalt noted in glaze ware types from other sites although some examples were tempered by latite. Vessel forms are represented by indeterminate (2.4 percent), bowl rim (5.1 percent), bowl body (28.1 percent), jar neck (1.8 percent), jar body (15.5 percent), body sherd polished both sides (31 percent), body sherd unpolished (1.2 percent), body sherd polished exterior (11.0 percent), body sherd polished interior (3.3 percent), and indeterminate rim (0.6 percent). The assignment of glaze ware body sherds to categories simply describing combinations of polishing on different surfaces reflects difficulties in using locations of polished surfaces to define vessel form within this ware.

A few sherds exhibited combinations of temper and paste common in utility ware associated with glaze wares and were coded as Keres area gray. This category, as used here, refers to utility ware forms, displaying temper and pastes common in glaze ware types known to have been produced in surrounding areas of the Middle Rio Grande. Pastes tend to be dark to red in color, and appear to reflect the use of silty high-iron clays. Tempers noted in pottery from Peña Blanca sites include basalt (70.1 percent), basalt and sand (17.9 percent), and latite (11.0 percent). Vessel form categories recorded include bowl body (1.5 percent), jar neck (1.5 percent), jar rim (3 percent), jar body (85.1 percent), canteen rim (1.5 percent), body sherd unpolished (6 percent), and body sherd polished both sides (1.5 percent). Exterior manipulations noted include plain unpolished (83.6 percent), plain polished (1.5 percent), smeared indented corrugated (3 percent), and smeared plain corrugated (11.9 percent). Interior manipulations recorded include plain unpolished (97 percent), and plain polished (3 percent).

Pottery assigned to this category is more often associated with Classic period assemblages that tend to be dominated by glaze ware types. This association along with similarities of tempers noted in this pottery with that from Classic glaze period pottery indicate forms that may have been produced at the same Classic period villages that produced most of the glaze wares. While other utility ware associated with the Classic period was tempered with micaceous granite, this pottery is difficult to distinguish from similar gray wares produced during other periods. Given the high degree of mixing associated with almost all Peña Blanca components yielding Classic period pottery, the gray wares assigned to this category represent one of the few opportunities to identify and characterize utility ware pottery definitely associated with Classic components.

Northern Rio Grande Pottery Tradition

In the Northern Santo Domingo Basin, some assemblages yielded high frequencies of pottery exhibiting characteristics typical for types described for various areas of the Northern Rio Grande region. Pottery types from the Northern Santo Domingo Basin assigned to this tradition may include both pottery forms that could have been produced locally using temper, pastes, and technologies similar to those long employed in areas along the Northern Rio Grande Valley to the north. Thus, similar problems in assignments encountered in the utilization of Middle Rio Grande tradition types were also noted for Northern Rio Grande types, although there is no question that the common occurrence of Northern Rio Grande pottery at many sites in the Santo Domingo Basin reflects interaction and influences from the north. Conventions and categories used to define Rio Grande types stem from research by Kidder and Mera in the early part of this century (Kidder 1915; Kidder and Amsden 1931; Kidder and Shepard 1936; Mera 1939). These investigations resulted in the description and classification of the range of utility and decorated wares dominating assemblages at sites in the Northern Rio Grande region. These descriptions included observations relating to paste and temper and stylistic criteria used to define basic pottery groups. During the present study, pottery was assigned to a Northern Rio Grande tradition based on combinations of pastes and temper indicative of pottery sources used in the Northern Rio Grande region. This pottery sequence reflects the long-term utilization of alluvial and volcanic sources by potters residing along the Rio Grande and adjacent drainages. Changes in exploitation patterns of pottery resources in some areas resulted in dramatic shifts in the geographic distribution of types assigned to the Northern Rio Grande pottery tradition.

Northern Rio Grande Gray Utility Ware

Northern Rio Grande utility ware as defined here refers to the dominant gray ware found over wide areas of the Rio Grande region (Habicht-Mauche 1993; Wendorf 1953). Gray utility ware sherds dominate most sites in the Northern Rio Grande, but are not very well defined. Detailed descriptions, particularly those including paste descriptions, are very rare. Rio Grande utility wares were assigned to pottery exhibiting granite temper with mica fragments common in the Northern Rio Grande region. Warren (1979b) discusses the "micaceous" utility ware of the Northern Rio Grande region. It is unclear whether Warren would include some of the earlier gray wares containing mica into this group, as she gives a beginning date at about AD 1300 for micaceous utility ware. Her definition of micaceous pottery, however, encompasses traits noted in micaceous gray wares common in Northern Rio Grande sites as early as the tenth century and extending into historic times.

The earliest "micaceous" types are characterized as reflecting the use of crushed local mica-bearing cobbles as temper (Warren 1979a). Examination of pottery from Developmental and Early Coalition period sites indicate the use of similar temper beginning during the early tenth century (McNutt 1969; Mera 1935; Wiseman 1989). The geographic area dominated by micaceous gray wares expanded, and by the Classic period included much of the Rio Grande region (Mera 1935). While the temper particles in Classic period gray wares are similar to those found in earlier gray wares, there appears to have been an increase in the total frequency of mica particles during the Classic period. This may reflect a shift to clay sources with higher amounts of mica inclusions, or the addition of crushed mica, sometimes as a slip, to local utility wares. The Northern Rio Grande gray ware tradition as used here includes the earlier mica-containing gray wares produced in the Tewa Basin as well as the later "micaceous" and mica-slipped gray ware sherds found throughout the Northern Rio Grande region. Because paste composition was fairly consistent, gray ware pottery produced during different periods is often defined by variation of surface texture and manipulation. Since a wide variety of treatments were employed during various periods, many of these types may occur in components associated with several temporal periods.

In general, mica inclusions in Rio Grande gray ware sherds reflect the use of crushed granite and micaceous clays, as was the case in 96.9 percent of the Rio Grande gray wares. Mica grains are commonly visible on the surface, and the large temper particles consist of white, gray, or pink fragments. Paste colors in the cross sections of most of the gray wares are dark gray to black. Very low frequencies of sherds vary from this trend. Surface colors range from black, gray, brown, or red. Pastes consistently fire to red or yellow-red colors when exposed to oxidation conditions. Paste textures tend to be relatively soft, porous, and silty. Sherds break and crumble easily with an uneven and blocky texture.

A similar criterion was used to assign Northern Rio Grande gray wares (NRG) to types based on surface categories, as already discussed for gray ware sherds assigned to the Middle Rio Grande tradition. Gray ware categories assigned to this tradition include NRG Plain Gray Rim, NRG Unknown Rim, NRG Plain Gray Body, NRG Mud Ware, NRG Wide Neckbanded, NRG Wide Smeared Neckbanded, NRG Clapboard Neck, NRG Neck Corrugated, NRG Indented Corrugated (Fig. 16.10a-b), NRG Plain Corrugated (Fig. 16.10c) , NRG Smeared Plain Corrugated, NRG Smeared Indented Corrugated (Fig. 16.10d), and NRG Incised Corrugated.

Sherds exhibiting polished surfaces and brown pastes characteristic of brown ware types, but with pastes indicative of production with the Northern Rio Grande were assigned to a Rio Grande Brown ware category.

Because of the emphasis on granite and mica temper in the assignment of sherds to a Rio Grande tradition, this tradition may exclude at least some pottery exhibiting sand or anthill sand temper that may have been manufactured in areas of the Northern Rio Grande. This pottery was included in the sand-tempered gray ware, although most of it may have been produced in areas such as the Pajarito Plateau and Chama Valley that have been placed into the Northern Rio Grande tradition. More recent descriptions by OAS have included gray wares with this temper into the Northern Rio Grande tradition.

A few sherds examined during the present study exhibited characteristics of historic Pueblo plain wares. Most of the basic Tewa Plain forms did not appear until after the arrival of the Spanish (Hurt and Dick 1946). Most historic plain ware types are polished, and textured treatments are usually absent. Most sherds were assigned to types defined for this group based on the presence and type of slip treatment. Historic plain ware types identified include Tewa Buff Undifferentiated, Tewa (Kapo) Gray, and Smudged Interior/Buff Exterior.

Northern Rio Grande White Wares

The dominant painted white ware from components dating to the Late Developmental period and Coalition periods documented at Peña Blanca sites and elsewhere in the Northern Santo Domingo Basin exhibit fine tuff or silt-sized sand particles characteristic of Rio Grande black-on-white forms produced over very long periods (Lang 1997). The sequence of types assigned here to the Northern Rio Grande tradition is similar to that attributed to the Tewa series as defined for areas of the Northern Rio Grande (Gauthier 1987; Harlow 1973; Wendorf 1953). Part of the sequence is also reflected in the Pajarito series as employed during the Arroyo Hondo Project (Habicht-Mauche 1993). This long tradition produced distinctive black-on-white vessels using distinct resources employed over wide areas of the Northern Rio Grande Valley. Use of similar resources began with initial production of mineral-painted pottery in areas of the Northern Rio Grande during the tenth century, and continued with a long sequence of gradual changes that still continues with production of pottery by modern Tewa Pueblo groups.

The production of Kwahe'e Black-on-white marks the beginning of a long sequence of production of types with pastes and styles unique to areas of the Northern Rio Grande region (Sundt 1987). Kwahe'e Black-on-white, the earliest pottery type placed into the Rio Grande White ware group exhibits mineral paint and decorative styles noted in Pueblo II Anasazi types (Figs. 16.11–16.12). It is the most common decorated type at many Late Developmental period sites. This type is distinguished from other Pueblo II Anasazi types by fine pastes and tuff or fine silt temper characteristic of production in the Rio Grande region.

An important change in the Northern Rio Grande white ware sequence is represented by the shift to decorations in organic paint marked by the

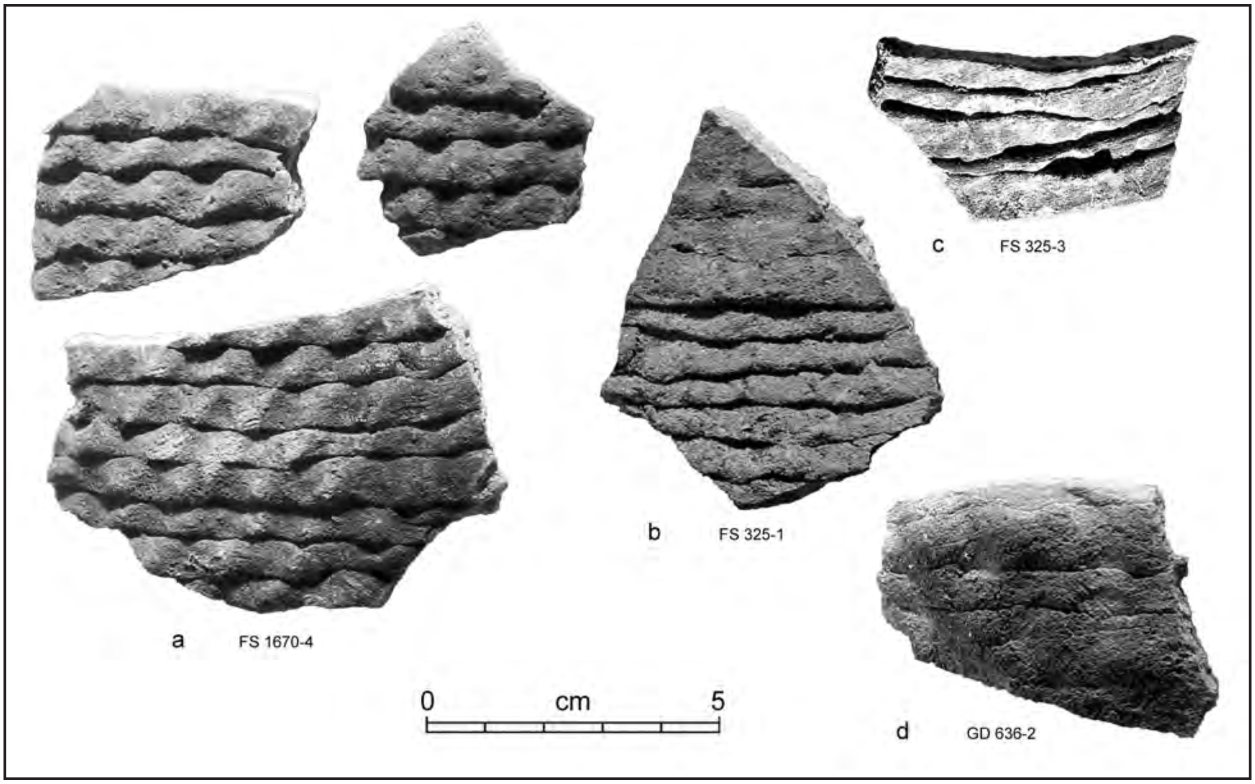

Figure 16.10. Northern Rio Grande Gray Wares: (a) Indented Corrugated jar rim, LA 6169 (FS 1670-4); (b) Plain Indented Corrugated jar rim, LA 249 (FS 325-1); (c) Plain Indented jar rim, LA 249 (FS 325-3); (d) Smeared Corrugated jar rim, LA 6169 (FS 636-2)

introduction of Santa Fe Black-on-white, whose presence marks the beginning of the Coalition period. The manufacture of organic painted white ware vessels continued into the Classic period with the production of distinct Biscuit ware types in areas north of Santa Fe. The introduction of red slips along with white slips marks the beginning of the production of Tewa Polychrome types sometime during the historic period.

The geographic distribution of types assigned here to the Northern Rio Grande white ware tradition changed through time. As previously indicated, while San Marcial Black-on-white appears to have been produced at least as far north as the Northern Santo Domingo Basin, associated technologies and styles reflect a development distinct from that noted for Rio Grande white ware types. Thus, it appears that pottery classified as San Marcial Black-on-white is not a part of the continuum of paste use and production represented by later Northern Rio Grande types. In contrast, later types belonging to the Northern Rio Grande sequence such as Kwahe'e Black-on-white and Santa Fe Black-on-white were produced over a very wide area of the Rio Grande region. They seem to be part of a sequence that may have developed out of Red Mesa, introduced into some areas of the Northern Rio Grande, and spread across this region. Thus, Northern Rio Grande pottery forms that were probably produced locally in the Santo Domingo Basin during the Late Developmental and Coalition periods were assigned to Northern Rio Grande types. During the Late Coalition and early Classic periods in much of the Southern and Middle Rio Grande region, organic-painted types coming out of this sequence were replaced by glaze-painted types as the locally produced decorated forms. The production of glaze wares reflects a technology that developed in areas to the west in the Zuni and Little Colorado regions. In areas of the Northern Rio Grande region such as the Tewa Basin, Pajarito Plateau, and Chama Valley, potters never adopted glaze-paint technology and continued to produce Biscuit ware forms during the Classic period and Tewa Polychrome types during the Historic period.

The range of technologies associated with Northern Rio Grande black-on-white resulted in the identification of a number of distinct pottery types belonging to this tradition. Unpainted white ware sherds with high iron pastes and fine silt or tuff/ash temper indicative of Rio Grande white wares were placed into a NRG Unpainted Undifferentiated White Ware category. In some cases, it may be possible to distinguish unpainted white ware sherds produced during different periods based on thickness, color, and texture. Such distinctions, however, are less reliable than those based on paint type and decoration.

By the eleventh century, potters in the Northern Rio Grande region appear to have begun exploiting the distinct resources characteristic of Rio Grande White Ware pottery along with technology and painted decorations characteristic of Pueblo II Cibola Anasazi White Ware types. The earliest Rio Grande or Tewa series white ware type is Kwahe'e Black-on-white. This type reflects the utilization of clays from volcanic ash or alluvial deposits common in areas of the Rio Grande Valley. These clays have high iron content and vitrify at relatively low temperatures. Temper fragments in Kwahe'e Black-on-white were originally described as finely ground sherd (Mera 1935), but more recent studies indicate the common use of fine volcanic rock such as tuff. Tewa Basin types also display fine volcanic rock such as tuff. The fineness of this temper contrasts with that noted for pottery from areas of the Colorado Plateau to the west.

Kwahe'e Black-on-white sherds examined during the present study display a wide range of surface characteristics. Some examples display surfaces that are not slipped, and range from green to gray in color. Others display thin streaky white to thick slips applied over a gray paste. Painted surfaces range from poorly to moderately polished, while well-polished examples are rare. Unpainted surfaces are almost always unpolished and light gray to gray.

Decorations are applied in iron oxide pigment. Pigments are usually black, although brown and red examples are common and may reflect poorly controlled firing atmospheres. Examples of this type are decorated with designs similar to those utilized in regions of the Colorado Plateau. Execution, however, tends to be poorer on Kwahe'e Black-on-white, although well-executed examples are occasionally encountered. Rims are usually tapered and may be either unpainted or painted with a solid line.

Honea (1968) assigned some of the pottery, placed here into Kwahe'e Black-on-white, into a series of geographically distinct types based on variation in temper and surface manipulation. These distinctions were reflected by the definition of Borrego Black-on-white, which was differentiated from Kwahe'e Black-on-white by a streaky polish, and Cholla Black-on-white differentiated by a gray-green to brown slip. While pottery encompassing the range of all these types was encountered during the present study, differences seem to represent commonly encountered variation in slip use or treatment rather than a regionally distinct technology. During the present study, pottery exhibiting characteristics of Borrego Black-on-white and Cholla Black-on-white as defined by Honea (1968) were assigned to Kwahe'e Black-on-white.

Early mineral-painted pottery forms with Rio Grande pastes and with styles found in Cibola types including Gallup Black-on-white and Escavada Black-on-white were assigned to Kwahe'e Black-on-white. Sherds were then placed into distinctive stylistic groups defined for Kwahe'e Black-on-white based on the presence of different design styles. Early painted sherds without distinct styles were assigned to a Mineral Paint Indeterminate category. Stylistic groups used to place Pueblo II white ware sherds into specific type categories recognized during the present analysis for Kwahe'e Black-on-white include: Indeterminate design, Solid design, Hatchured design, Thin parallel lines, Thick parallel lines, Solid and hatchured designs, and Checkerboard designs.

Descriptive attributes recorded for Kwahe'e Black-on-white sherds analyzed during the present study seem to conform to previous characterizations of this type. Almost all the pottery assigned to this type exhibit high-iron pastes and are tempered with some vari-

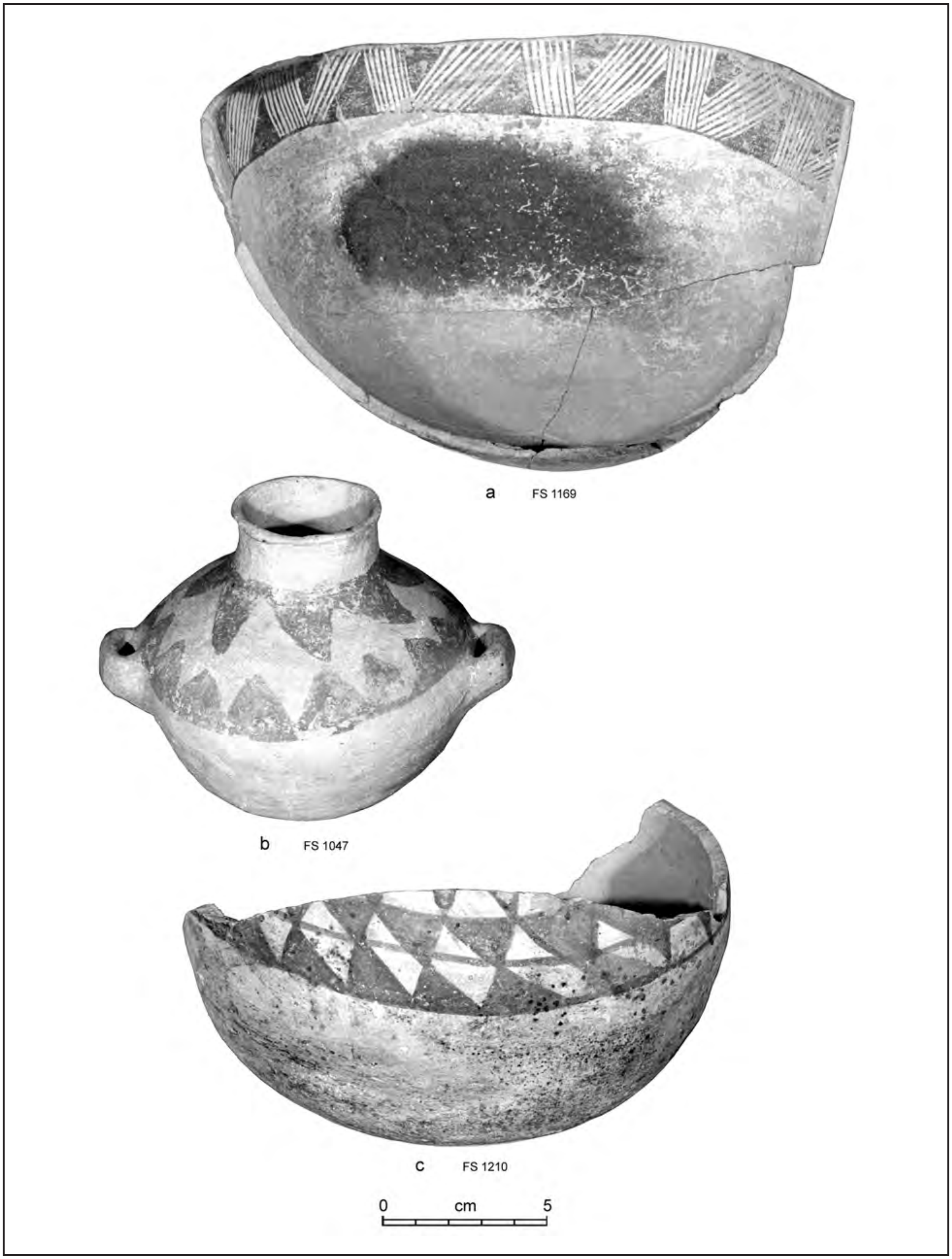

Figure 16.11. Kwahe'e Black-on-white reconstructible vessels; (a) Vessel 7 bowl, LA6169 (FS 1169); (b) Vessel 2 canteen, LA6169 (FS 1047); (c) Vessel 3 jar body, LA 6169 (FS 1210).

Figure 16.11. (d) Kwahe'e Black-on-white.

ety of fine sand or volcanic rock. Temper categories identified for this type include sand (3.4 percent), fine tuff or ash (30.8 percent), fine tuff and sand (65 percent), and mica tuff and sand (0.9 percent). Vessel form categories identified for Kwahe'e Black-on-white examined during the present study include indeterminate (1.7 percent), bowl rim (30.8 percent), bowl body (46.2 percent), jar neck (6.0 percent), jar body (14.5 percent), and canteen rim (0.9 percent). For sherds derived from bowls, interior surface manipulations recorded included plain unpolished (5.6 percent), plain polished (55.6 percent), polished with white slip (36.7 percent), polished with thin white slip (1 percent), and indeterminate incised (1.1 percent). Bowl exterior manipulations documented include plain unpolished (80.0 percent), plain polished (14.4 percent), polished white slip (4.4 percent), and surface missing (1.1 percent). Jar exterior manipulations include plain unpolished (20 percent), plain polished (44 percent), and white slip (36 percent). Jar interior manipulations recorded include plain unpolished (96 percent) and plain striated (4 percent).

Pottery produced during the Coalition period was very similar to Kwahe'e Black-on-white, but is generally distinguished from this type by decorations in organic rather than mineral paint. Most organic painted sherds without distinct styles or forms were assigned to an Indeterminate Organic Paint category and assumed to represent pottery produced during the Coalition period.

Santa Fe Black-on-white represents the earliest organic painted type of the Northern Rio Grande tradition and is the most commonly decorated white ware type at Peña Blanca Coalition phase components (Figs. 16.13). Santa Fe Black-on-white seems to be part of an extremely widespread shift to Pueblo III design styles decorated in organic paint (Lambert 1954;

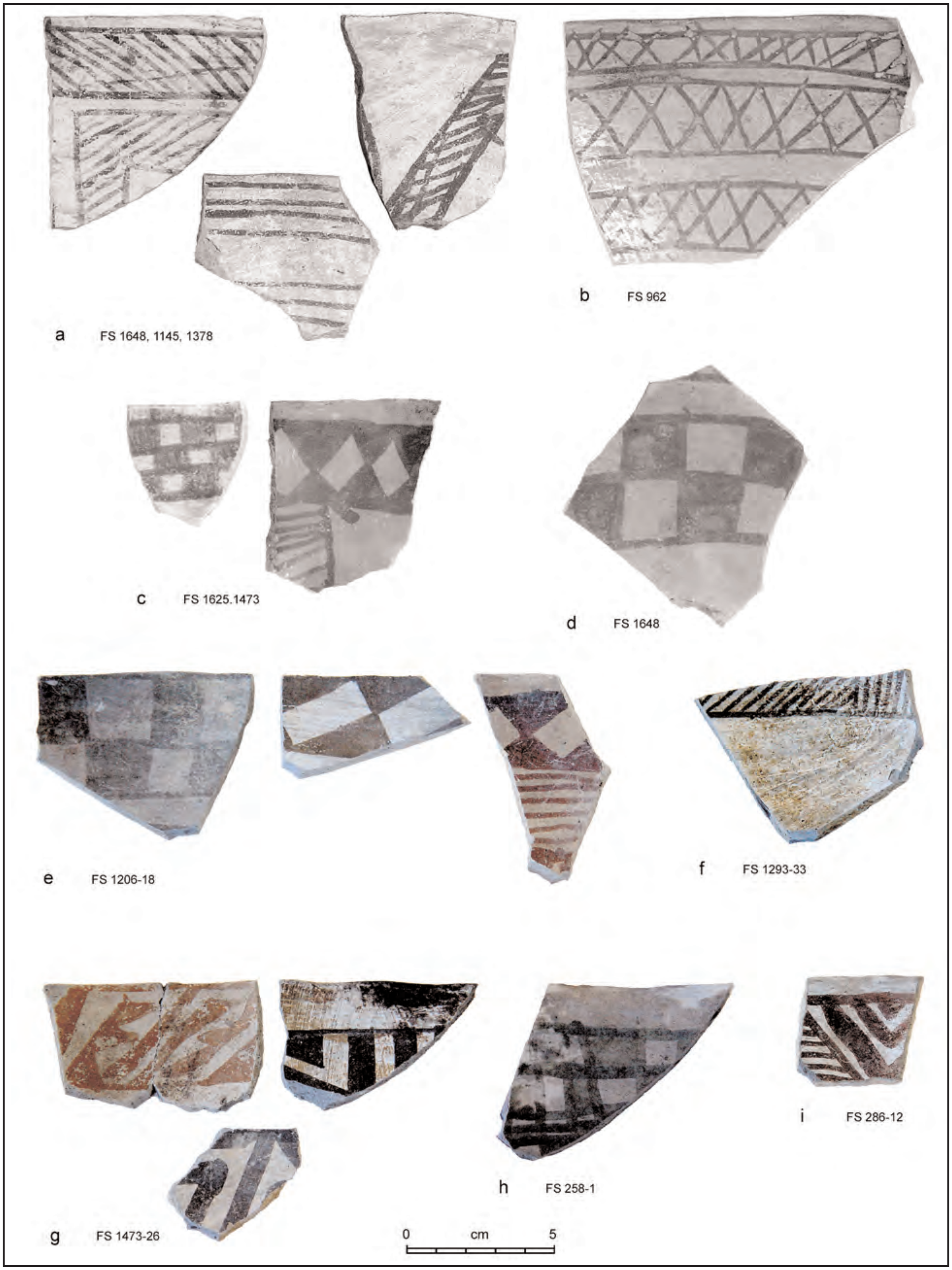

Figure 16.12. Kwahe'e Black-on-white sherds; (a) Bowl rim, LA 6169; (b) Bowl rim, LA 6169; (c) Bowl rim, LA 6169; (d) Bowl body, LA 6169; (e) Bowl sherd, LA 6169; (f) Bowl sherd, LA6169; (g) Bowl sherd, LA6169; (h) LA249; (i) LA249.

Lang 1982; Mera 1935; Stubbs and Stallings 1953; Sundt 1984), which occurred in many regions of the northern Southwest. The best-known expression of organic painted pottery with Pueblo III design styles is Mesa Verde Black-on-white produced in the San Juan region of the Four Corners Anasazi. While certain characteristics of Santa Fe Black-on-white do reflect pan-regional influences, other characteristics seem to reflect a local development out of Kwahe'e Black-on-white.

Vessel walls for Santa Fe Black-on-white are relatively thin and straight, and appear to be very similar in shape and thickness to Kwahe'e Black-on-white. Pastes are often homogeneous, dense, hard, and vitreous. Pastes are very fine and fracture along an even plane. Paste color ranges from light gray to blue-gray in color, but may be brown or reddish if misfired. Decorated surfaces are usually polished and often slipped. Surfaces are moderately to well polished and often slipped. Surfaces range from white, light gray, greenish, to tan. Bowls are the dominant vessel forms, although small canteens, seed jars, and ollas occur in very low frequencies. Undecorated surfaces are unslipped, unpolished to slightly polished, and may occasionally display unobliterated coils, striations, or basket impressions. Tempering materials include fine sand or finely crushed volcanic rock temper, and in some cases sherd (Habicht-Mauche 1993; Stubbs and Stallings 1953).

Painted decorations are executed in organic pigment that is sometimes faded and translucent. Paint color ranges from dark gray, blueish black to black. Rims are usually tapered and undecorated. Flat or ticked rims, similar to those noted in contemporaneous pottery from regions on the Colorado Plateau, may be present but are very rare. In bowls, decoration tends to be confined to a band on the interior, and exterior bowl decorations common in Mesa Verde Black-on-white are extremely rare. Decoration consists of banded panels on bowl interiors and the upper portions of jars. These banded panels are often framed by a single line near the rim that may be slightly above or incorporated into the panel. Occasionally these designs are framed by a series of similar-sized parallel lines or a combination of a single thick and several thin lines, a design style also common on contemporaneous pottery types from regions to the west. All over designs, also similar to those noted in Pueblo III types found to the west, are sometimes represented. Designs are composed of a variety of hatched and solid motifs including opposing triangles, stepped triangles, checkered squares, triangles, rectilinear lines, chevrons, and occasional anthropomorphic designs. Painted decorations cover much of the design field, and may result in negative designs in white. The Santa Fe Black-on-white examined during the present study tended to exhibit design styles without distinct framing lines and overall orientations more similar to that noted in Pueblo II and very early Pueblo III forms from the Four Corners area.

Santa Fe Black-on-white was produced throughout the Northern Rio Grande region, and may have the widest geographic distribution of any Tewa tradition white ware type (Habicht-Mauche 1993; Sundt 1972, 1984, 1987). Santa Fe Black-on-white is thought to have begun during the late 1100s and continued into the middle 1300s and possibly as late as the early 1400s (Habicht-Mauche 1993; Stubbs and Stalling 1953; Sundt 1987).

Descriptive attributes recorded for Santa Fe Black-on-white sherds analyzed during the present study seem to agree with many other characterizations of this type. Almost all the pottery assigned to this type exhibit high-iron pastes and are tempered with some variety of fine sand or volcanic rock. Temper categories identified for this type include fine tuff or ash (44 percent), fine tuff or sand (38.8 percent), indeterminant dark igneous (0.2 percent), mica and tuff (10.9 percent), and mica, tuff, and sand (5.8 percent). Vessel form categories identified for Santa Fe Black-on-white include indeterminate (0.3 percent), bowl rim (23.5 percent), bowl body (66.8 percent), jar neck (0.3 percent), jar body (7.7 percent), jar body with lug handle (0.2 percent), canteen rim (0.3 percent), and seed jar rim (0.3 percent). For sherds derived from bowl forms, interior surface manipulations recorded include plain unpolished (5.3

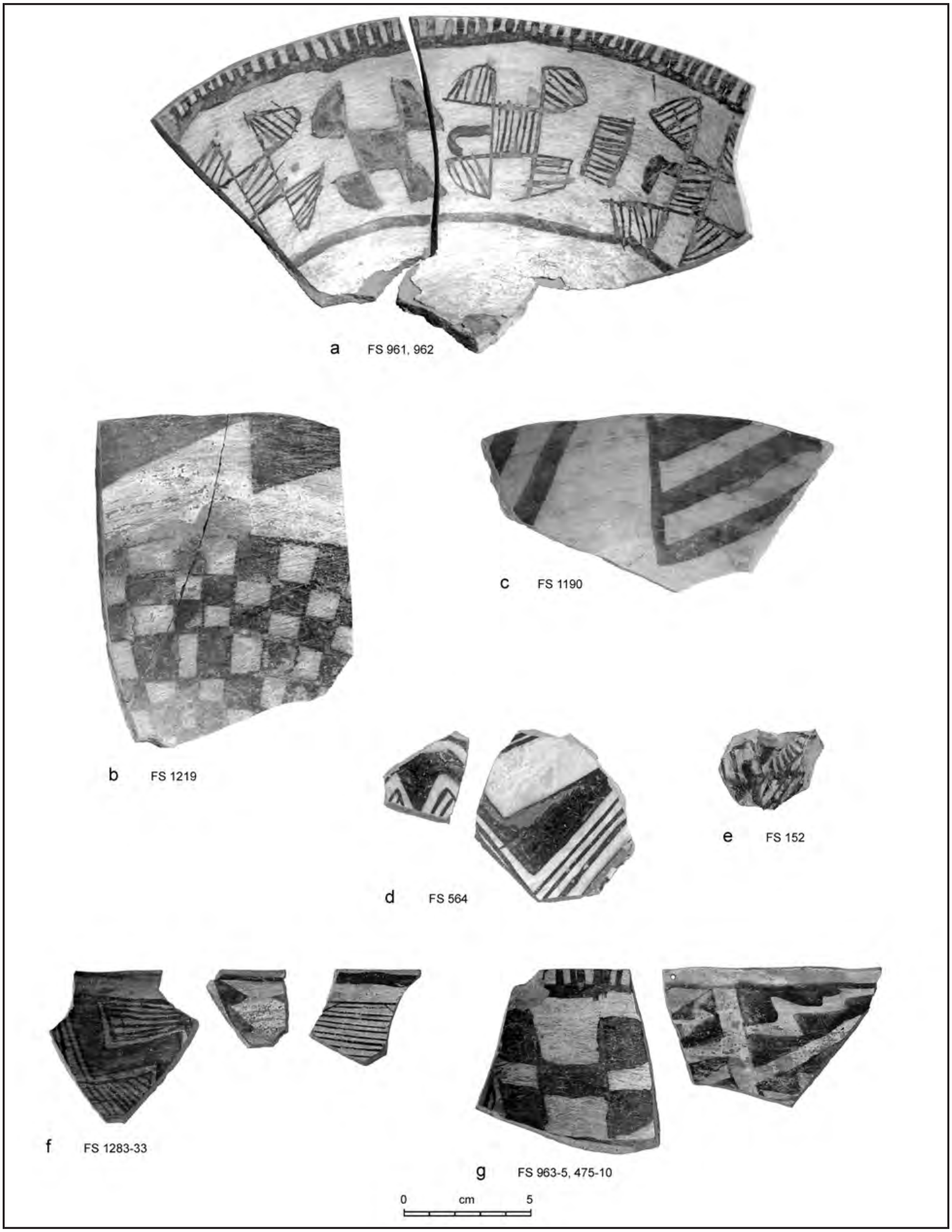

Figure 16.13. Santa Fe Black-on-white sherds: (a) Bowl rim, LA 6169 (FS 961, 962); (b) Bowl rim, LA 6169 (FS 1219); (c) Bowl rim, LA 6169 (FS 1190); (d) Bowl body, LA 6171 (FS 564); (e) Jar lug handle, LA 6169 (FS 152); (f) LA 6169, FS 1283-33; (g) LA 6169 (FS 963-5, 475-10).

percent), plain polished (47.3 percent), polished with white slip (47.3 percent), and unpolished with thin white slip (0.2. percent). Bowl exterior manipulations documented include plain unpolished (81.2 percent), plain polished (11.7 percent), polished white slip (3.87), surface missing (2.4 percent), smeared plain corrugated (0.2 percent), unpolished white slip (0.6 percent), and basket impressed (0.2 percent). Jar exterior manipulations include plain unpolished (20 percent), plain polished (44 percent), and white slip (36 percent). Jar interior manipulations recorded include plain unpolished (96 percent) and plain striated (4 percent).

Other types defined for the Coalition period of the Rio Grande region exhibit similar styles and treatments in organic paint, but are differentiated from Santa Fe Black-on-white mainly based on paste characteristics. Types defined for Northern Rio Grande sites in other studies but not distinguished from Santa Fe Black-on-white during the present study may include Poge Black-on-white, Pindi Black-on-white, and Rowe Black-on-white (Habicht-Mauche 1993). During initial investigations of the Cochiti Dam Project, Honea (1968) divided Santa Fe Black-on-white into Santa Fe, Peralta, and Pajarito varieties. Definitions of these varieties appear somewhat ambiguous, and they were not employed during the present study. Only two of the variations of organic painted types produced during the Coalition period were differentiated during the present study, these include Galisteo Black-on-white and Wiyo Black-on-white.

Pottery exhibiting designs executed in organic paint, characteristic of Rio Grande white wares, but with distinct pastes were assigned to Galisteo Black-on-white (Fig. 16.14). During the present study, Galisteo Black-on-white was differentiated from Santa Fe Black-on-white by the presence of a white, coarser paste with added sherd and/or sand temper (Lambert 1954; Stubbs and Stallings 1953). The classification of Galisteo Black-on-white using previously defined conventions and criteria presents some dilemmas. Galisteo Black-on-white has been previously defined as

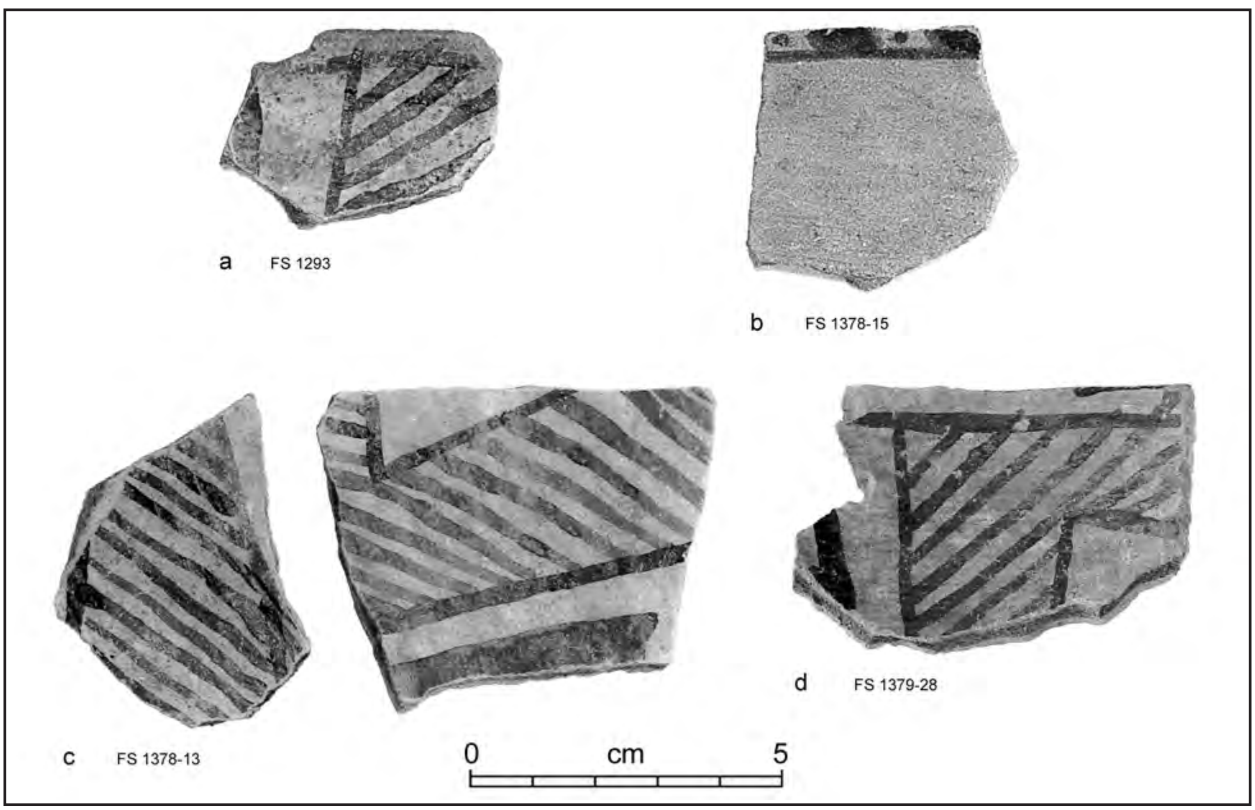

Figure 16.14. Galisteo Black-on-white sherds: (a) Bowl rim, LA 6169 (FS 1293); (c) Bowl body, LA 6169 (FS 13780 lot 15); (d) Bowl body, LA 6169 (FS 1378 lot 13); (e) LA 6169 (FS 1379-28).

a type reflecting a very distinct technology derived from Mesa Verde Black-on-white from the San Juan region (Stubbs and Stallings 1953) to an areal variation of Santa Fe Black-on-white produced in areas where low-iron geological clays were available (Wilson 2000).

Definitions of Galisteo Black-on-white employed in some studies imply strong technological and stylistic similarities between Galisteo Black-on-white and Mesa Verde Black-on-white from the San Juan region (Habicht-Mauche 1993; Stubbs and Stallings 1953). Proposed similarities include the use of sherd and volcanic rock temper, thick crazed slips, square rims, and similar designs (Abel 1955; Stubbs and Stallings 1953). The characterization of Galisteo Black-on-white as having appeared suddenly in the Rio Grande region just after AD 1300 has further been interpreted as reflecting influence by potters from the Mesa Verde region. Galisteo Black-on-white appears to have been the dominant decorated type on sites in the Galisteo Basin, south of Santa Fe, after AD 1300 and is postulated to have reached it widest distribution in the late fourteenth century (Habicht-Mauche 1993). The classic variety of Galisteo is characterized by white pastes that contrast markedly with the darker and finer Santa Fe pastes. Temper is generally described as crushed sherd that appears as coarse gray to black angular fragments, although a wide variety of lithic and mineral inclusions may be present (Habicht-Mauche 1993). Surfaces are covered by a well-polished slip that often has fine crackling. Organic-painted designs can appear on both interior and exterior surfaces.

Designs are usually organized in paneled bands of oblique and horizontal solids, oriented from multiple or single framing lines. Design elements are usually solid, as hatched elements are uncommon. In some assemblages squared rims may occur. Rims are sometimes ticked, but rounded and tapered rims also occur. Classic design styles on Galisteo Black-on-white are sometimes characterized as having derived from McElmo and Mesa Verde Black-on-white types (Lang 1982; Mera 1935), although there are definite differences in the range of styles and treatments occurring in these regional types.

My recent examinations of pottery assemblages from sites in the Galisteo Basin and surrounding areas have resulted in a different interpretation for Galisteo Black-on-white (Wilson 2008). Our experience has been with a black-on-white form that occurs along with Santa Fe Black-on-white, and is only distinguished from this type by the presence of white paste with varying combinations of sand, crushed rock, or shale temper. Other characteristics, such as design styles and surface manipulations, appear to be very similar to Santa Fe Black-on-white. Thus, this form of Galisteo Black-on-white reflects local Rio Grande styles along with the use of shale clays and added tempers. Thus, in some cases the resemblance between Mesa Verde Black-on-white and at least some forms of Galisteo Black-on-white may be more a reflection of similarities in pottery resources between separated areas rather than the transfer and continuation of pottery production from the San Juan region of the Colorado plateau.

A possible explanation for this dichotomy is that Galisteo Black-on-white as normally defined may represent at least two classes of pottery. The earliest form may simply reflect the utilization of low-iron clays and added temper by groups practicing a technology which derived out of Santa Fe Black-on-white. Another pottery form that may be characterized as Galisteo Black-on-white could consist of a later technology that may have been ultimately derived from or connected with Mesa Verde Black-on-white. Still another possibility is that the connection between all forms of Galisteo Black-on-white and Mesa Verde Black-on-white has been overstated. Many more analyses and descriptions of Galisteo Black-on-white are necessary before these various scenarios can be fully evaluated.

Traits recorded for Galisteo Black-on-white sherds from Peña Blanca sites seem to conform with previous characterizations of this type. Almost all the pottery assigned to this type exhibited low-iron pastes and are tempered with some variety of volcanic rock, sand, or sherd. Temper categories identified for this type include sherd (45.3 percent), sherd and sand (3.8 percent), fine tuff or ash (3.8 percent), oblate shale and sand (15.1 percent), and shale (32.1 percent). Vessel form categories identified for Galisteo Black-on-white examined during this project include bowl rim (5.9 percent), bowl body (66 percent), jar body (7.5 percent), and seed jar rim (5.7 percent). For sherds derived from bowl forms, interior surface manipulations recorded include plain unpolished (17.4 percent), plain polished (76.1 percent), and polished with white slip (4.3 percent). Bowl exterior manipulations documented include plain unpolished (28.3 percent), plain polished (67.4 percent), and polished white slip (4.3 percent). Jar exterior manipulations are all represented by plain unpolished and all interior forms were recorded as plain unpolished.

In some cases unpainted sherds thought to represent the unpainted portions of Galisteo Black-on-white vessels were classified as Unpainted Galisteo Paste. Given similarities between the paste of Galisteo and other pottery types, such a distinction may not be warranted. During the present study this category was rarely used.

Wiyo Black-on-white was originally referred to as "biscuitoid" to indicate pottery with pastes and treatments thought to be transitional between Santa Fe Black-on-white and the Biscuit ware types (Kidder and Amsden 1931; Mera 1935; Stubbs and Stallings 1953) This type exhibits organic-painted designs similar to Santa Fe Black-on white, but often has softer pastes that are tan, buff, orange, or greenish (Hibben 1937; Stubbs and Stallings 1953). Wiyo Black-on-white is consistently tempered with finely crushed volcanic rock. Forms are usually represented by bowls, although jars and dippers have been noted. Interior bowl surfaces are usually well polished and are evenly smoothed with thin slips that are often tan or brown. Bowl exteriors tend to be unslipped and unpolished and may exhibit a series of small striations. Vessel walls of Wiyo Black-on-white sherds tend to be slightly thicker and more porous than those noted in Santa Fe Black-on-white.

Pigments in Wiyo Black-on-white tend to be darker and denser than those noted in earlier organic painted types. Designs styles are very similar to those described for Santa Fe Black-on-white although they are sometimes described as heavier (Stubbs and Stallings 1953). Solid designs tend to be more common and lines are thicker. Panel designs are also common on Wiyo Black-on-white.

The temporal range of Wiyo Black-on-white definitely overlaps that for Santa Fe Black-on-white, and the two types occur together in some assemblages in the Northern Rio Grande. Wiyo Black-on-white may date from AD 1250 to 1400, but tends to be most common in assemblages dating between AD 1300 and 1350 (Breternitz 1966; Smiley et al. 1953; Sundt 1987), and is most common at about AD 1300 (Habicht-Mauche 1993). The relative frequency of Wiyo Black-on-white in Coalition phase assemblages decreases with distance from the Tewa Basin and Pajarito Plateau, and is very low at sites south of Santa Fe.

Only four Wiyo Black-on-white sherds were noted at the Peña Blanca sites. Forms recognized include bowl rim, bowl body (49 percent) and jar body (25 percent). Temper categories include fine tuff or ash (50 percent) and fine tuff and sand (50 percent). For sherds derived from bowl forms, interior surface manipulations recorded include plain polished (33 percent), and polished white slip (66 percent), while all exterior surfaces were recorded as plain polished. The single jar sherd assigned to this type was recorded as having a plain polished interior and plain unpolished exterior.

Biscuit ware forms represent the dominant decorated pottery at Classic period sites in the Tewa Basin, Chama Valley, and Pajarito Plateau. Biscuit ware refers to the distinctive white ware pottery technology produced in some regions of the Northern Rio Grande during the Classic period. Pastes of Biscuit ware types reflect the use of bentonite clays and vitric tuff temper (Kidder and Amsden 1931). Vessels have a soft gray to yellow paste, with finely crushed tuff or pumice. Biscuit ware forms are distinguished from other organic painted Rio Grande white ware types by their soft, light, and porous textures. Surfaces are often white, light gray, tan, or buff. Vessel walls tend to be very thick, particularly when compared to earlier Rio Grande white ware types. Vessels also tend to be extremely light in weight compared to their overall size, because of the porous paste texture. Bowl rims may often exhibit a distinct flare or eversion, and thickness may vary considerably from the rim.

Biscuit wares are decorated with sharp, clear, and black, organic paint. Plain bowl rims are generally ticked, and standing rims are embellished with repeating dashes or zigzag lines on the interior below the lip. Painted designs are often organized in banded patterns with panels of repeating hatched or solid geometrical elements. These include ticked edges, parallel or rectilinear lines, and stylized Awanyu motifs. While earlier studies have defined Biscuit ware types in term of black-on-gray (as in Bandelier Black-on-gray), this study employs a change in naming convention that would make the nomenclature of Biscuit ware types parallel to that employed for other types (Habicht-Mauche 1993; Lang 1997), so that Biscuit ware is assigned here to black-on-white type categories.

Biscuit A or Abiquiu Black-on-white is distinguished only for bowl forms and is defined by the presence of slipped or painted manipulations on interior surfaces only. Biscuit B, or Bandelier Black-on-white, is distinguished from Biscuit A by yellowish pastes (Kidder and Amsden 1931) with slipping and decoration on bowl exteriors as well as interiors.

While Biscuit ware is found over an area that includes the Tewa Basin, Pajarito Plateau, and Chama Valley (Mera 1934), this area is much smaller than that over which Santa Fe Black-on-white is the predominant decorated type. The temporal range for Biscuit A is estimated from about AD 1375 to 1450, while that for Biscuit B lasted from about AD 1400 to 1500 (Breternitz 1966; Gauthier 1987; Wendorf 1953).

In some cases, it was impossible to assign a specific type to pottery obviously exhibiting characteristics of Biscuit wares. Unpainted sherds clearly exhibiting pastes, shapes, and thickness indicative of Biscuit wares were assigned to an Unpainted Biscuit Ware category. Unspecified Painted Biscuit Ware was used for all jars, and for those bowls where it was not possible to determine the nature of decoration for both sides. Thus, specific types were only assigned to Biscuit ware bowls displaying diagnostic characteristics.

Temper of all sherds examined appeared to be very similar, and included the assignment of these sherds into either a fine tuff or ash (78.7 percent) of fine tuff and sand (21.3 percent) category. Vessel forms identified included indeterminate (8.5 percent), bowl rim (21.3 percent), bowl body (55.3 percent), jar neck (2.1 percent), jar rim (2.1 percent), jar body (8.5 percent), and indeterminate coil/strap handle (2.1 percent). Surface manipulation categories recorded for Biscuit ware bowl interiors include plain unpolished (2.8 percent), plain polished (28.7 percent), polished white slip (63.9 percent), and polished cream slip (5.6 percent). Those recorded for bowl exteriors include plain unpolished (69.4 percent), plain polished (5.6 percent), exterior white slip (25 percent). Surface manipulation categories recorded for Biscuit ware jar exteriors include plain polished (57.1 percent), plain polished white slip (28.6 percent), and unpolished white slip (14.3 percent). The relative high frequency of unslipped surfaces on bowl interiors and jar exteriors may reflect the effects of weathering on soft surfaces, and difficulties encountered by some in distinguishing Biscuit ware slips.

Southern Pottery Traditions

A very small amount of pottery identified during the present study was produced to the south, in the Mogollon Highlands or Jornada Mogollon regions. One distinct tradition that may indicate exchange with areas immediately to the south is indicated by pottery forms assigned to Socorro Black-on-white. The area of distribution for Socorro Black-on-white may cross cut several regions as normally divided but appears to be roughly bounded by the roads connecting Socorro, Albuquerque, Grants, and Quemado (Fig. 16.15). Socorro Black-on-white is distinguished from other white ware types by distinctive paste, surface characteristics, and painted designs (Mera 1935; Sundt 1979). Surfaces are unslipped and gray in color. Pastes are gray, hard, and often vitrified. Paint is usually black in color, and often dense and vitrified. This sub-glaze appearance may reflect high firing tempera-

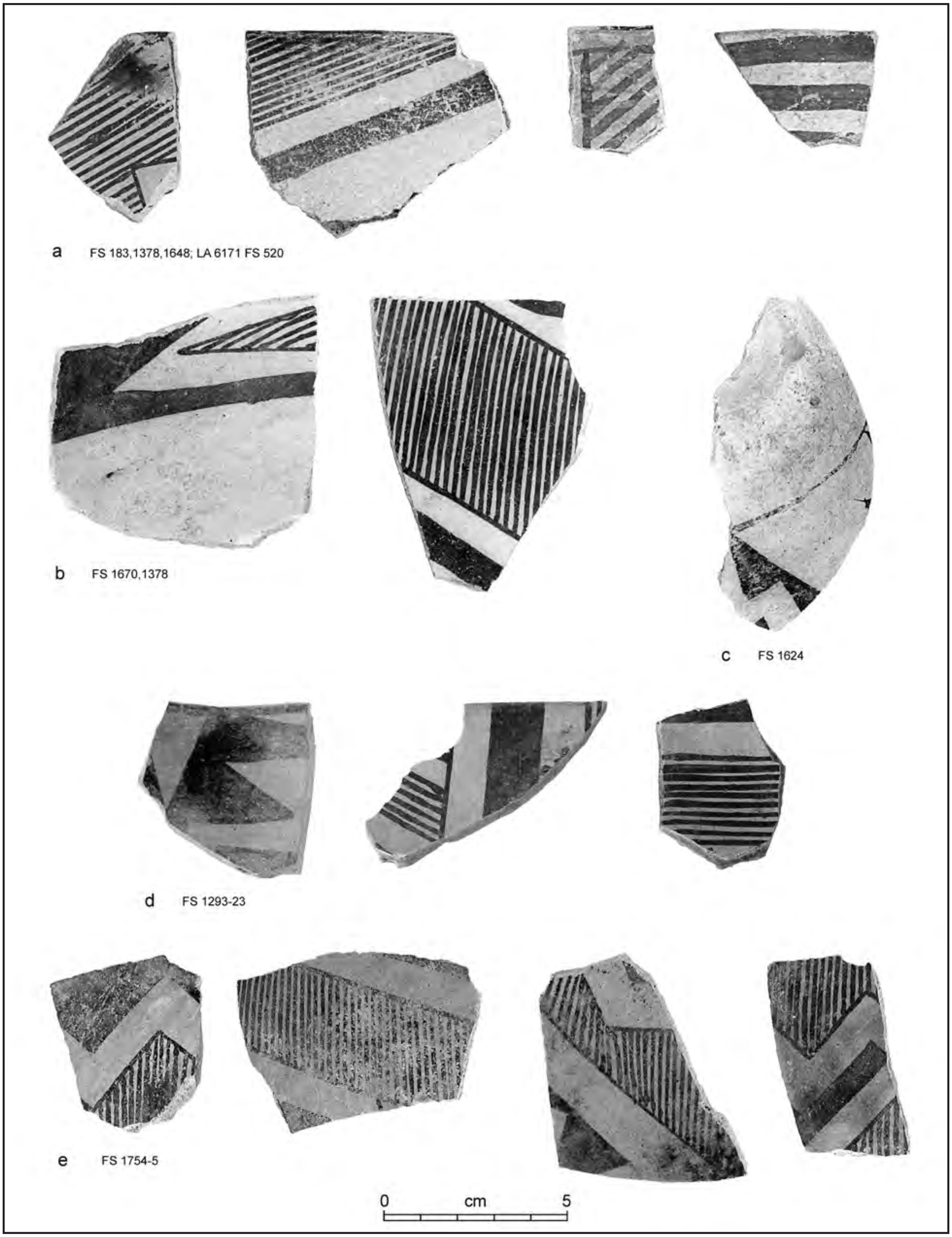

Figure 16.15. Soccoro Black-on-white sherds: (a) Bowl rim, LA 6169 (FS 183, 1378, 1648), LA 6171 (FS 520); (b) Bowl body, LA 6169 (FS 1670, 1378); (c) Bowl body, LA 6169 (FS 1624); (d) LA 6169 (FS 1293-23); (e) LA6169 (FS 1754-5F).

tures. Temper usually consists of a dark igneous rock that may occur along with crushed sherd. Petrographic analysis identifies these fragments as basalt and rhyolitic tuff.

Designs include fine lines, hatchure, dots, lines appended with dots, checkered squares with and without dots and triangles. Hatched lines are closely spaced. Motifs tend toward opposed solid and hatched combinations. Design layout consists of paneled bands for bowls, and wide bands or all-over patterns on jars. Sherds exhibiting pastes and other characteristics indicative of Socorro Black-on-white were assigned to a series of categories based on the presence and type of painted designs. Sherds were assigned to a series of categories based on the presence and type of painted designs including Socorro Black-on-white Indeterminate design, Solid designs, Hatchured designs, and Hatchured and solid designs. Unpainted sherds with Socorro pastes were assigned to an Unpainted Socorro Paste category. Sherds with Socorro pastes and surface manipulation but without distinct painted decoration were also classified as Unpainted Socorro Paste.

Traits noted for the Socorro Black-on-white sherds recorded during the present study conform to previous descriptions of this type. Temper types recorded include sherd (17.1 percent), sherd and sand (29.3 percent), dark igneous and sherd (43.0 percent), and dark igneous and sand (9.8 percent). Vessel forms recorded include bowl rim (17.1 percent), bowl body (43.9 percent), and jar body (39.0 percent). For bowl forms, interior manipulations recorded include plain unpolished (8 percent) and plain polished (92 percent). Exterior manipulations noted for bowl sherds include plain unpolished (76 percent) and plain polished (24 percent). For those derived from jars, exterior manipulations (87.5 percent) and plain jar (12.5 percent). Interior manipulations noted for these sherds include plain unpolished (87.5 percent) and plain striated (12.5 percent).

Mogollon Tradition

A small number of sherds displayed pastes, temper, and surface characteristics indicative of Mogollon Brown ware types produced in the Mogollon Highlands to the west and southwest. Temper consists of volcanic-clastic rock sometimes with sand and reflects the use of self-tempered clays weathered from surrounding volcanic rocks. Pastes tend to be dark gray, brown, or yellow-red. Sherds displaying Mogollon pastes also displayed a typical range of surface manipulations previously noted in Mogollon pottery, further supporting that these are trade wares from the Mogollon Highlands. All sherds displaying Mogollon pastes were assigned to previously defined Mogollon Brown Ware or Mogollon decorated types (Haury 1936; Wilson 2000). Sherds with Mogollon pastes and smoothed and polished surfaces were assigned to either Alma Plain Rim or Alma Plain Body. Alma Plain is the dominant pottery type at Mogollon sites, associated with almost the entire Mogollon occupational sequence (Wilson 2000). This represents almost the sole brown ware type associated with the earliest Mogollon occupations, and is associated with lower frequencies of neckbanded than corrugated types during later occupations. Alma Scored is similar but contains a small series of parallel striations reflecting wiping with tools such as cobs or bark during the final stages of vessel finishing. This type is primarily associated with earlier Mogollon occupational periods.

Sherds exhibiting pastes and manipulation similar to that noted for Alma Plain, with the addition of red slip over one surface were assigned to San Francisco Red. The temporal span for San Francisco Red is similar to that noted for Alma Plain.

Mogollon Brown Ware with smoothed plain polished exterior surfaces and highly polished and sooted interiors were classified as Reserve Smudged. This pottery type has a very long span but is most common at Pueblo period components. Reserve Plain Corrugated Smudged exhibits a similar interior smudged surface along with plain corrugated exterior treatments. These consist of a series of very thin overlapping coils often covering the entire vessel.

Most of the painted Mogollon pottery identified during the present study were classified as Mogollon Red-on-brown. Mogollon Red-on-brown represents the earliest painted type found in the Mogollon region (Colton and Hargrave 1937; Haury 1936). During the present study, no pottery was assigned to early Mogollon Brown Ware types such as San Lorenzo Red-on-brown or Dos Cabezas Red-on-brown (Haury 1936; Sayles 1945). Mogollon Red-on-brown is distinguished from earlier and contemporaneous Mogollon Brown Ware types by the addition of a red design executed in either high-iron slip or hematite pigments. Vessel surfaces are well smoothed and highly polished. It is likely that this type evolved out of San Francisco Red where similar red slips and pigments were applied over the entire vessel surface. In addition to the red designs, vessel surfaces may be unslipped or slipped with a soft light brown to light red clay.

The red pigment applied as decoration is often polished, creating a blurred effect. Rims are often solidly painted. Painted motifs usually consisted of relatively broad straight lines and single or connected triangles arranged together in simple patterns producing a sawtooth designs. Designs were often organized into four wedged-shaped sections. Each quarter was often organized around a single or group of solid triangles suspended by a single line and surrounded by a series of parallel curvilinear or chevron lines. These designs are simple and repetitive as compared to later painted decorations. Such designs often covered the entire interior of the vessel.

Mogollon Red-on-brown is primarily represented by bowls, although jars are present in very low frequencies. Forms identified for sherds assigned to this type include bowl body and jar. Mogollon Red-on-brown was probably first produced sometime just after AD 650 and may have been produced until AD 900.

Mimbres White Wares reflect white wares produced through the application of a white slip over white ware pastes. Mimbres wares identified during the present study were limited to a single undecorated sherd assigned to a Mimbres White Ware (Unpainted) category.

Jornada Brown Ware Types

Another tradition represented by very low frequencies of pottery is that represented by Jornada Mogollon pottery types known to have been produced in southeastern New Mexico. Plain brown ware types are the most common pottery at most sites in the Jornada Mogollon region. Plain brown wares are commonly divided into types sometimes attributed to various regions of the Jornada Mogollon region based on surface and paste characteristics (Wiseman 1996).

Jornada Brown is characterized by polished surfaces that obscure temper grains. Temper fragments are often very small, consisting of a profusion of equally sized grains. This type appears to have been produced in the highlands of the Sierra Blanca region. Low frequencies in the present study may reflect difficulties in distinguishing this type from Alma rather than the absence of brown wares derived from the Mogollon Highlands.

El Paso Brown is distinguished from Jornada Brown Ware types by the absence of distinct polished surfaces and the presence of large temper fragments which include rounded quartz fragments, often protruding through the surface. El Paso Brown sherds also tend to be soft and have less luster and more scraping marks on interior surfaces. Pastes tend to be dark or brown with a dark core, and surfaces are gray to chocolate brown. El Paso Brown appears to have been produced in the low-lands of the southern Jornada Mogollon region in south-central New Mexico and the most western parts of Texas.

The only decorated Jornada Mogollon type identified during the present study is Chupadero Black-on-white (Fig. 16.16). This type occurs at sites throughout the Jornada Mogollon (Farwell et al. 1992; Hayes et al. 1981; Kelley 1984; Mera 1931; Vivian 1964; Wiseman 1986). Chupadero Black-on-white was first manufactured sometime between AD 1050 and 1100 and continued to be produced until about AD 1550. Chupadero Black-on-white found over a wide area exhibit very similar characteristics. Chupadero Black-on-white sherds usually have dense light gray to white pastes reflecting the use of a low-iron clay firing to buff colors in a low-oxidizing or neutral atmosphere. The undecorated surfaces of Chupadero Black-on-white are often unpolished with striated or

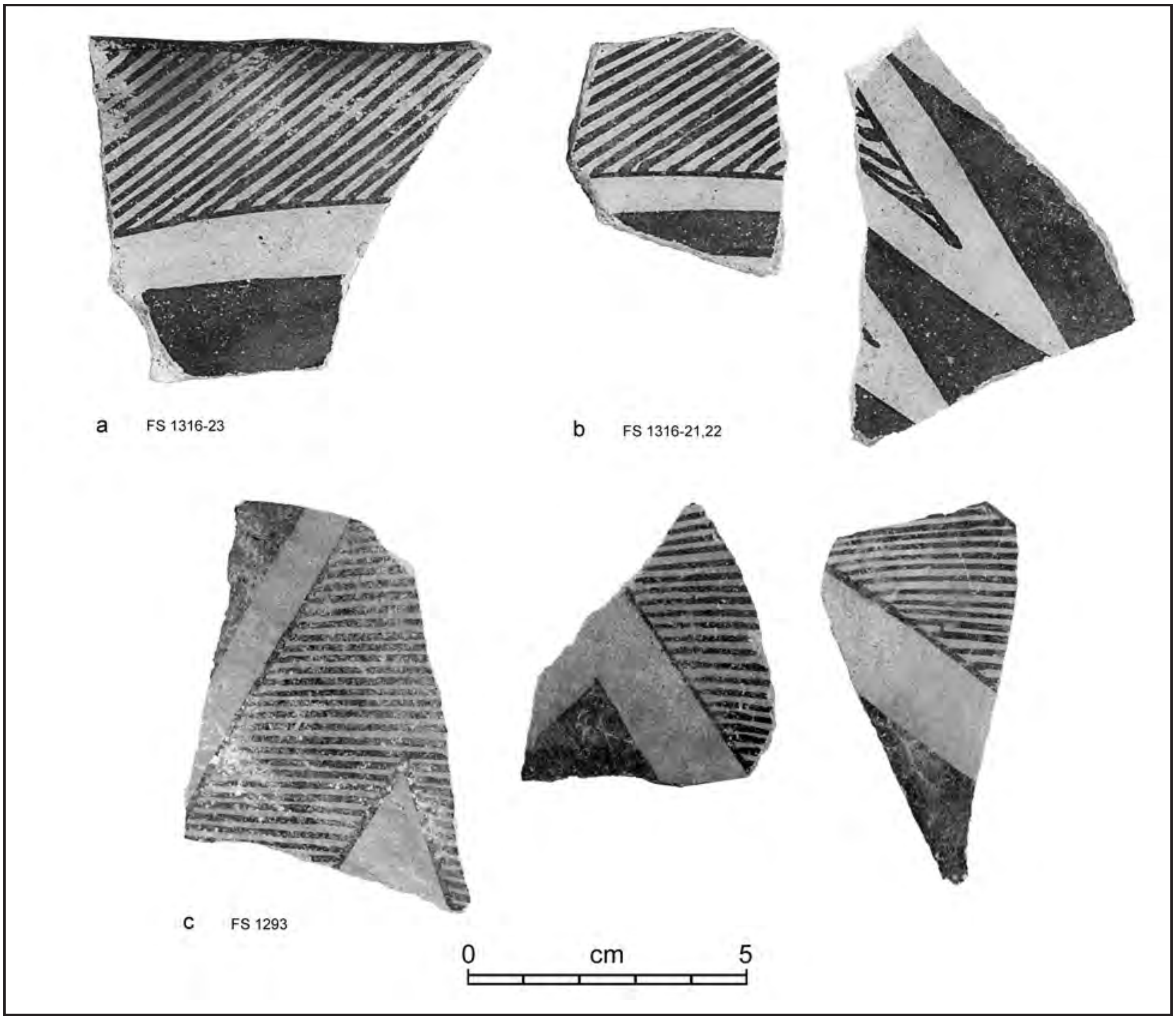

Figure 16.16. Chupadero Black-on-white sherds: (a) Bowl rim, LA 6169 (FS 1316 lot 23); (b) Bowl body, LA 6169 (FS 1316 lots 21, 22); (c) Jar body, LA 6169 (FS 1293).

scored treatments resulting from scraping. Chupadero Black-on-white sherds identified during the present study display a wide range of characteristics. Most Chupadero sherds are tempered with dark igneous rock and sherd, although a wide variety of tempers are represented, and may indicate Chupadero vessels were derived from a number of sources.

Painted designs of Chupadero Black-on-white vessels often consist of combinations of hatchured and solid motifs. Designs were executed in a series of panels where the basic design was repeated every one or two sections. At least four and as many as eight panels may be represented. During the present study sherds thought to have derived from Chupadero Black-on-white were assigned to a series of categories based on the presence of painted decoration or style. These stylistic categories do not appear to have any spatial or temporal significance, but simply reflect a range of styles associated with this type. Some of the sherds with previous described characteristics had no painted decoration and were classified as Unpainted Chupadero Black-on-white. Painted sherds were placed into a specific category by the type of design, and categories recognized include Chupadero Black-on white: Solid Design, Hatchured Design, and Solid and Hatchured Design.

Traits noted for the very small number of

Table 16.3. Distribution of Pottery from Dated Contexts at Different Sites

	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
None	-	-	-	-	12	-	-	12
	-	-	-	-	0.50%	-	-	0.10%
Early Developmental	-	5484	572	2629	95	389	-	9169
	-	100.0%	7.7%	78.4%	4.2%	100.0%	-	42.2%
Mainly Early Developmental	-	-	-	401	-	-	70	471
with Late Developmental	-	-	-	12.0%	-	-	100.0%	2.2%
Mainly Early Developmental	-	-	-	-	545	-	-	545
with Coalition	-	-	-	-	24.1%	-	-	2.5%
Late Developmental	-	-	305	207	-	-	-	512
	-	-	4.1%	6.2%	-	-	-	2.4%
Mainly Late Developmental	628	-	-	-	-	-	-	628
with Classic	22.9%	-	-	-	-	-	-	2.9%
Mainly Late Developmental	-	-	1078	-	-	-	-	1078
with some Early Developmental	-	-	14.5%	-	-	-	-	5.0%
Coalition	-	-	1650	-	215	-	-	1865
	-	-	22.3%	-	9.5%	-	-	8.6%
Mainly Coalition with Early	-	-	689	-	915	-	-	1604
Developmental	-	-	9.3%	-	40.5%	-	-	7.4%
Mainly Coalition with Early	-	-	2980	-	-	-	-	2980
Developmental and Late Developmental	-	-	40.2%	-	-	-	-	13.7%
Late Coalition	-	-	-	-	43	-	-	43
	-	-	-	-	1.9%	-	-	0.2%
Mainly Coalition with	-	-	-	-	272	-	-	272
Classic	-	-	-	-	12.0%	-	-	1.3%
Classic with Late	2074	-	-	-	-	-	-	2074
Developmental	75.7%	-	-	-	-	-	-	9.6%
Mainly Classic, Some	-	-	-	-	127	-	-	127
Coalition and Early	-	-	-	-	5.6%	-	-	0.6%
Developmental	-	-	-	-	-	-	-	
Late Developmental	-	-	43	99	-	-	-	142
Coalition Mix	-	-	0.6%	3.0%	-	-	-	0.7%
Indeterminate because of	38	-	98	16	35	-	-	187
small sample size	1.4%	-	1.3%	0.5%	1.5%	-	-	0.9%
	2740	5484	7415	3352	2259	389	70	21709
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

sherds assigned to Chupadero Black-on-white during this project are fairly distinct. Temper types noted include dark igneous and sherd (87.5 percent) and dark igneous and sand (12.5 percent). Vessel form categories noted include bowl body (12.5 percent), jar rim (12.5 percent), and jar body (25 percent). The single bowl sherd examined was polished on the interior and unpolished on the exterior. Jar sherds were polished on the exterior with plain striations on the exterior.

Temporal Trends

The first step in the examination of various issues and trends reflected by the long occupational span indicated by Peña Blanca assemblages involves the assignment of temporal dates to these assemblages. Such determinations initially focused on the definition, recognition, and assignment of assemblages from various components to pottery-based dating periods (Table 16.3). Because most of the sites examined during the present study have evidence of components dating to more than one period, some of the temporal categories employed note the presence of combinations of pottery types expected to be associated with more than one temporal component.

For many Southwest regions, the most basic dating assignments have long been based on the Pecos Classification. This scheme includes a series of periods spanning from the Basketmaker I through III and Pueblo I through IV periods (Kidder 1927). While this sequence was initially defined for the entire Southwest, various investigations have subsequently used differences noted in the southern regions of the Southwest to define culture areas or traditions (such as the Mogollon and Hohokam) with their own temporal sequences and phase names (Martin and Rinaldo 1951). Investigations have defined distinct temporal sequences within these various regions.

In the 1950s, differences noted in the prehistoric occupation sequence in the Northern Rio Grande region, as compared to that noted for Anasazi cultures in Colorado Plateau, resulted in the proposal of a distinct classification scheme for the Northern Rio Grande region (Wendorf 1954; Wendorf and Reed 1955). In their review of Rio Grande regional archaeology, Wendorf and Reed (1955) defined the Northern Rio Grande as extending from Isleta on the south, the Colorado border on the north, the Canadian River on the east, and the Puerco and Chama rivers on the west. Implicit in the utilization of a distinct classification for the Rio Grande region is a type and rate of material culture change distinct from that observed in Anasazi occupations on the Colorado Plateau (Boyer and Lakatos 2000). While many studies in the Northern Rio Grande have employed Wendorf and Reed's temporal classification system (Habicht-Mauche 1993; Lang 1997), others have continued to use the Pecos Classification system (Cordell 1979; Ellis 1975; Schmader 1994; Stuart and Gauthier 1981).

The periods and divisions proposed by Wendorf and Reed (1955) appear to be well suited for the examination of trends and patterns for the Rio Grande region. These periods coincide with dramatic changes in pottery technology and decoration as well as other aspects of material culture over much of the Rio Grande region. Ceramic-bearing sites in the Northern Rio Grande were placed into several occupational periods including the Developmental (AD 600 to 1200), Coalition (AD 1200 to 1325), Classic (AD 1325 to 1600), and historic (AD 1600 to present) periods (Wendorf 1954; Wendorf and Reed 1955).

Because of the very long time span assigned to most Rio Grande periods, it may be necessary to further divide spans within these periods into a series of shorter ceramic-based dating groups or phases. While ceramic distributions associated with some periods appear to occur over very wide areas, other sequences can be defined for various subregions of the Northern Rio Grande (Crown et al. 1996; Lang 1982; Sundt 1979). Assemblages are often given ceramic dates based on judgment-based assessments of combinations of pottery inferred to be associated with a previously defined period (Goetze and Mills 1993). Very distinct combinations of pottery tend to be associated with various periods, and confirmed by qualitative evaluations. The other aspect of such evaluations involves the identification of assemblages representing mixtures of pottery associated with different temporal components.

Discussions regarding the dating of Peña Blanca contexts will focus on the assignment of components from various Peña Blanca sites to specific dating periods based on comparison with pottery assemblages from dated contexts. Temporal assignments for various contexts will advance the determination of an occupation sequence for Peña Blanca sites, as well as provide information used to compare trends seen in Peña Blanca ceramics with those from other areas. The assignment of pottery assemblages from various contexts to temporal periods will provide the basis for the examination of issues related to ceramic change.

Developmental Period Occupations

Occupations dating prior to the formation of large villages over much of the Rio Grande region have often been subsumed under a very broadly defined Developmental period (Wendorf 1954; Wendorf and Reed 1955). This period as defined for the Rio Grande region refers to the long span during which pottery-using groups occupied small dispersed habitations beginning about AD 600 and ending about AD 1200 with the establishment of large Coalition phase pueblos. Various occupational spans assigned to the Developmental period of the Rio Grande are contemporaneous with the Basketmaker III, Pueblo I, Pueblo II, and early part of the Pueblo III periods as defined for Anasazi regions of the Colorado Plateau.

Significant changes took place at about AD 900. Developmental components can be divided into three distinct subperiods. These include an Early Developmental (AD 600 to 900), Middle Developmental (AD 900 to 1000), and a Late Developmental (AD 1000 to 1200) period. Components associated with the Early Developmental and Late Developmental periods are both well represented at Peña Blanca sites. Given the presence of an apparent gap in the occupational sequence represented for the sample of sites recovered during Peña Blanca investigations, and the very different nature of occupations associated with these two subperiods, discussions of trends associated with the Early Developmental and Late Developmental periods are presented separately.

Early Developmental Occupations

Most of the Peña Blanca sites exhibit combinations of pottery types indicative of occupations dating to the Early Developmental period (Table 16.4). Sites subjected to intensive analysis with pottery assemblages indicating largely unmixed Developmental components include LA 265 (5,484 sherds), LA 6169 (572 sherds), LA 6170 (2,629 sherds), LA 6171 (95 sherds), and LA 15862 (389 sherds). Distributions of types for assemblages assigned to Early Developmental components are illustrated in Table 16.4. A number of other Peña Blanca contexts have assemblages dominated by Early Developmental sherds along with low frequencies of types associated with later occupations. Sites with components assigned to a mainly Early Developmental with some Late Developmental include LA 6170 (401 sherds) and LA 115863 (70 sherds). Distributions of pottery types from these sites are illustrated in Table 16.5. Assemblages assigned to a mainly Early Developmental with Coalition period were noted at LA 6171 with 545 sherds (Table 16.6). In addition, a total of 1,899 sherds from LA 6170, recorded during streamlined analysis, are associated with Early Developmental assemblages (Table 16.2).

Information accumulated during the Peña Blanca project make up one of the largest ceramic data sets yet accumulated for the still poorly known Early Developmental period. Thus, the main focus of the Peña Blanca research design concerns issues relating to "culture history and change" for this period (Ware 1997). One aspect of the early ceramic period concerns the relationship of these occupations with better known Anasazi and Mogollon occupations. Previous syntheses have often interpreted these early occupations as related, but peripheral to, the better known Basketmaker and Pueblo I occupations of the Colorado Plateau (Ware 1997). According to this approach similarities and differences between groups in widely separated areas are interpreted as reflecting a Colorado Plateau Anasazi core from which traits and people spread to the surrounding peripheries. Differences in material culture between early occupations in the Rio Grande and contemporary occupations in the Anasazi core have been assumed to reflect a cultural lag associated with the Rio Grande periphery (Ware 1997). An alternative approach is to examine distinct local economic, settlement, and social patterns in the material culture of early Rio Grande populations.

Discussions presented for the other two problem domains presented in the Peña Blanca research design (Settlement and Subsistence Systems and Community Patterns and Social Organization) present various models, implications, and expected archaeological patterns relating to the overall subsistence and settlement patterns of Early Developmental groups at both a local and regional level.

The testing of such models based on pottery data will begin with detailed characterizations of ceramic distributions and assignments of dates to Early Developmental contexts. Distributions noted at these sites will be compared with those noted at contemporaneous sites in other areas of the Southwest. Attempts will be made to examine various causes of similarities and differences

Table 16.4. Distribution of Ceramic Types by Site for Early Developmental Components

	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	Total
Indeterminate utility ware	2	-	-	1	-	3
	0.00%	-	-	1.10%	-	0.00%
Unpainted (undifferentiated	-	1	-	-	-	1
white)	-	0.20%	-	-	-	0.00%
Unpainted undifferentiated	2	5	2	-	-	9
	0.00%	0.90%	0.10%	-	-	0.10%
NRG Indeterminate organic	1	-	-	-	-	1
paint	0.00%	-	-	-	-	0.00%
Santa Fe B/w	-	-	-	1	-	1
	-	-	-	1.10%	-	0.00%
Wiyo B/W	1	-	-	-	-	1
	0.00%	-	-	-	-	0.00%
NRG Plain rim	-	-	2	-	-	2
	-	-	0.10%	-	-	0.00%
NRG Unknown rim	-	1	-	-	-	1
	-	0.20%	-	-	-	0.00%
NRG Plain body	4	4	72	-	-	80
	0.10%	0.70%	2.70%	-	-	0.90%
NRG Indented Corrugated	-	2	-	-	-	2
	-	0.30%	-	-	-	0.00%
NRG Plain Corrugated	-	2	-	-	-	2
	-	0.30%	-	-	-	0.00%
NRG Mudware	39	2	19	-	-	60
	0.70%	0.30%	0.70%	-	-	0.70%
NRG Local Brown Ware	-	-	2	-	-	2
	-	-	0.10%	-	-	0.00%
MRG Plain rim	121	25	41	8	16	211
	2.20%	4.40%	1.60%	8.40%	4.10%	2.30%
MRG Unknown rim	-	-	2	-	-	2
	-	-	0.10%	-	-	0.00%
MRG Plain body	4796	457	2303	81	259	7896
	87.50%	79.90%	87.60%	85.30%	66.60%	86.10%
MRG Wide Neckbanded	2	-	-	-	-	2
	0.00%	-	-	-	-	0.00%
Wide Neckbanded (wiped)	1	6	-	1	-	8
	0.00%	1.00%	-	1.10%	-	0.10%
MRG Indented Corrugated	-	-	-	2	-	2
	-	-	-	2.10%	-	0.00%
MRG Plain Corrugated	1	2	-	-	-	3
	0.00%	0.30%	-	-	-	0.00%
MRG Smeared Plain	-	5	-	-	-	5
Corrugated	-	0.90%	-	-	-	0.10%
MRG Polished gray	-	5	-	-	-	5
	-	0.90%	-	-	-	0.10%
MRG Unfired Plain Grayware	36	-	-	-	-	36
	0.70%	-	-	-	-	0.40%
MRG Unpainted undifferentiated	77	12	34	-	15	138
	1.40%	2.10%	1.30%	-	3.90%	1.50%

Table 16.4. Continued.

	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	Total
MRG Mineral Paint (undiff)	29	5	35	-	2	71
	0.50%	0.90%	1.30%	-	0.50%	0.80%
Pueblo II (indeterminate	-	1	-	-	-	1
mineral)	-	0.20%	-	-	-	0.00%
San Marcial B/w	44	10	26	1	74	155
	0.80%	1.70%	1.00%	1.10%	19.00%	1.70%
Smudged White Paste	-	1	-	-	-	1
	-	0.20%	-	-	-	0.00%
Local Red Slipped Red on Buff	1	-	-	-	-	1
	0.00%	-	-	-	-	0.00%
MRG Slipped Red over white	149	13	40	-	2	204
paste (Tallahogan-like)	2.70%	2.30%	1.50%	-	0.50%	2.20%
MRG Slipped over red paste	11	5	1	-	-	17
	0.20%	0.90%	0.00%	-	-	0.20%
MRG Local Brown Ware	2	-	2	-	-	4
	0.00%	-	0.10%	-	-	0.00%
MRG Local R/b	-	-	-	-	10	10
	-	-	-	-	2.60%	0.10%
Glaze-on-red (undiff)	-	-	1	-	-	1
	-	-	0.00%	-	-	0.00%
Kana'a B/w	2	-	-	-	-	2
	0.00%	-	-	-	-	0.00%
Jornada Brown rim	-	1	-	-	-	1
	-	0.20%	-	-	-	0.00%
Jornada Brown body	30	1	28	-	8	67
	0.50%	0.20%	1.10%	-	2.10%	0.70%
Socorro B/w (solid designs)	-	-	1	-	-	1
	-	-	0.00%	-	-	0.00%
Mogollon R/b	7	-	7	-	-	14
	0.10%	-	0.30%	-	-	0.20%
Mimbres white ware (unpainted)	-	-	-	-	1	1
	-	-	-	-	0.30%	0.00%
Indeterminate Painted Brown	2	-	-	-	-	2
Ware	0.00%	-	-	-	-	0.00%
San Francisco Red	33	-	7	-	-	40
	0.60%	-	0.30%	-	-	0.40%
Alma Plain rim	1	-	1	-	1	3
	0.00%	-	0.00%	-	0.30%	0.00%
Alma Plain body	71	6	3	-	1	81
	1.30%	1.00%	0.10%	-	0.30%	0.90%
Alma Scored	15	-	-	-	-	15
	0.30%	-	-	-	-	0.20%
Reserve Smudged	4	-	-	-	-	4
	0.10%	-	-	-	-	0.00%
Total	5484	572	2629	95	389	9169
	100.00%	100%	100%	100%	100.00%	100%

Table 16.5. Distribution of Ceramic Type by Sites for Mainly Early Developmental with Some Late Developmental Components

	LA 6170	LA 115863	Total
Indeterminate Utility Ware	-	2	2
	-	2.9%	0.4%
Unpainted Undifferentiated	13	-	13
	3.2%	-	2.8%
NRG Mineral Paint (Undifferentiated)	3	-	3
	0.7%	-	0.6%
Kwahe'e B/w (Solid Designs)	-	3	3
	-	4.3%	0.6%
Kwahe'e B/w (Thin Parallel Line)	-	1	1
	-	1.4%	0.2%
Santa Fe B/w	1	-	1
	0.2%	-	0.2%
NRG Plain Rim	2	-	2
	0.5%	-	0.4%
NRG Plain Body	48	-	48
	12.0%	-	10.2%
NRG Indented Corrugated	19	-	19
	4.7%	-	4.0%
NRG Plain Corrugated	19	-	19
	4.7%	-	4.0%
NRG Smeared Plain Corrugated	8	-	8
	2.0%	-	1.7%
NRG Smeared Indented Corrugated	1	-	1
	0.2%	-	0.2%
NRG Neck Corrugated	1	-	1
	0.2%	-	0.2%
MRG Plain Rim	11	-	11
	2.7%	-	2.3%
MRG Plain Body	242	58	300
	60.3%	82.9%	63.7%
MRG Wide Neckbanded	1	-	1
	0.2%	-	0.2%
MRG Indented Corrugated	1	-	1
	0.2%	-	0.2%
MRG Plain Corrugated	3	-	3
	0.7%	-	0.6%
MRG Smeared Plain Corrugated	1	-	1
	0.2%	-	0.2%
MRG Polished Gray	1	-	1
	0.2%	-	0.2%
MRG Unpainted Uundifferentiated	10	-	10
	2.5%	-	2.1%
MRG Mineral Paint (undiff)	4	4	8
	1.0%	5.7%	1.7%
Gallup B/w	1	-	1
	0.2%	-	0.2%
San Marcial B/w	5	-	5
	1.2%	-	1.1%
White Mountain Red (Undifferentiated)	2	-	2
	0.5%	-	0.4%
Unpainted Slipped	1	-	1
	0.2%	-	0.2%
Jornada Brown Body	-	1	1
	-	1.4%	0.2%
Socorro B/w (hatchured and solid designs)	1	-	1
	0.2%	-	0.2%
San Francisco Red	-	1	1
	-	1.4%	0.2%
Alma Plain Rim	1	-	1
	0.2%	-	0.2%
Reserve Smudged	1	-	1
	0.2%	-	0.2%
Total	401	70	471
	100.0%	100.0%	100.0%

Table 16.6. Distribution of Ceramic Type by Site for Mainly Early Developmental with Coalition Components

	LA 6171
Indeterminate Utility Ware	1 0.2%
Unpainted Undifferentiated	9 1.7%
Santa Fe B/w	5 0.9%
NRG Plain Body	1 0.2%
NRG Smeared Indented Corrugated	1 0.2%
MRG Plain Rim	9 1.7%
MRG Plain Body	429 78.7%
Wide Neckbanded (Wiped)	1 0.2%
MRG Indented Corrugated	3 0.6%
MRG Smeared Plain Corrugated	51 9.4%
MRG Smeared Indented Corrugated	7 1.3%
MRG Unpainted undifferentiated	3 0.6%
MRG Mineral Paint (Undiff)	3 0.6%
San Marcial B/w	4 0.7%
White Mountain Red (Undifferentiated)	4 0.7%
Slipped Red over white paste (Tallahogan	8 1.5%
Glaze-on-red (Undiff)	1 0.2%
Jornada Brown body	4 0.7%
Reserve Smudged	1 0.2%
Total	545 100.0%

noted in the context of models presented in the Peña Blanca research design.

Assemblages associated with the Early Developmental period components share a number of characteristics (Tables 16.4, 16.5, 16.6). The great majority of the pottery from Early Developmental period components consists of plain unpolished gray wares, which in most assemblages accounts for more than 90 percent of all pottery. Neckbanded textures are sometimes represented but are extremely rare. The great majority of these gray wares are tempered with sand.

White ware accounts for 3 percent to 8 percent of the pottery in Early Developmental assemblages. One exception is the high frequency (26.2 percent) of white ware at LA 115862, which appears to reflect sherds from broken vessels in a small assemblage. Almost all white wares from Early Developmental period components with discernable decorations were classified as San Marcial Black-on-white. Most San Marcial Black-on-white sherds display very white pastes with similar sand and/or shale temper. Design styles reflect influences from Mogollon Brown Ware as well as Anasazi white ware types known to have been produced during this time.

Red wares are represented by sherds exhibiting pastes similar to those noted in gray or white ware forms but with a thin red slip. Red ware types comprise less than 5 percent of the pottery from Early Developmental period components. This pottery tends to have low-iron pastes and sand temper similar to that noted in gray and white ware types, but also has a red slip covering at least one surface. Mogollon Brown Wares were represented by both Alma Plain and Mogollon Red-on-brown and account for less than 3 percent of the pottery from these assemblages.

These Developmental assemblages display patterns associated with an early Pueblo occupation in the Santo Domingo Basin. The only data for similar occupations were collected during the Cochiti Dam Project. During the survey conducted as part of this project, ten sites were recorded as Basketmaker III occupations based on pithouse impressions (Biella and Chapman 1977a). Excavations during the Cochiti Dam Project resulted in only one site (LA 272) that appears to date to the end of the Early Developmental period (Honea 1971b; Snow 1971b). Examination of pottery from this site indicates it probably dates sometime between AD 950 and 1050 and thus may span the gap reflected in the Peña Blanca occupational sequence. A survey of the area spanning from Arroyo Hondo Canyon to the Rio Grande resulted in the identification of a very small number of sites that were all located along the floodplains of the Rio Grande and Santa Fe Rivers (Dickson 1979).

The great majority of the sites in the general area that were previously documented as dating to the Early Developmental period of the Rio Grande sequence are based on excavations conducted in the Rio Grande Valley just north of Albuquerque (Allen and McNutt 1955; Condie 1983; Ferg 1983; Frisbie 1967; Peckham 1976; Schmader 1994; Vivian and Clendenen 1965). Temporal subdivisions of Early Developmental period occupations in this area have been commonly defined in terms of Pecos Classification periods (Schmader 1994; Vivian and Clendenen 1965).

The earliest ceramic components of the Middle Rio Grande were assigned to the Basketmaker III period and postulated to date sometime between AD 400 and 650 (Vivian and Clendenen 1965; Schmader 1994). Assemblages assigned to this period are dominated by plain gray pottery similar to that found at early Anasazi sites and classified as Lino Plain. Other types documented during these investigations of Early Developmental sites include plain brown ware, gray ware with fugitive red, and slipped brown ware. The earliest occupations in areas of the Rio Grande north of Socorro are dominated by a sand-tempered plain gray ware, which has often been placed into a variety of Lino Gray (Frisbie 1967; Lang 1982; Sundt 1987). Similar pottery appears to have dominated Rio Grande assemblages at least into the tenth century (Sundt 1987). Also present at some sites assumed to date to the seventh and eighth century is pottery with similar pastes and temper noted in local gray wares but with a polished surface and red slipped surface, and similar to Tallahogan Red as defined for areas to the west.

The next period defined during these investigations of early sites in the Albuquerque area was referred to as the Basketmaker III/Pueblo I period (Schmader 1994; Vivian and Clendenen 1965). This span of occupation was defined by the appearance of the earliest white wares in this region which is primarily represented by San Marcial Black-on-white during the AD 700s. Another early local pottery form is represented by gray ware with similar pastes but with an obliterated rippled neckbanded treatment reminiscent of forms noted for Alma Neckbanded. Mogollon Brown Ware types noted in low frequencies included Alma Plain, San Francisco Red, and Mogollon Red-on-brown.

The period postulated to cover the late ninth and early tenth century was termed the Pueblo I-Pueblo II period. The most obvious change in pottery for this time is the introduction of Red Mesa Black-on-white. Some exuberant corrugated and Socorro Black-on-white may also be present at sites dating to the early tenth century. Other ceramic types noted include Pilares Banded, and Gallup Black-on-white. Other pottery included Lino Gray, Kana'a Neckbanded, and Jornada Brown.

Components with similar assemblages have been assigned to a San Marcial phase thought to be contemporaneous with Pueblo I sites in the Four Corners (Mera 1935). These assemblages are similar to those from Puerco Valley placed into the San Marcial period and defined as dating to the middle ninth century (Hurst 1991).

Excavations of three Early Developmental period sites near Zia Pueblo may also provide additional clues concerning the dating of the Early Developmental period in the Middle Rio Grande. The Sheep Chute and the Joe Matthew sites were dominated by plain gray and San Marcial Black-on-white along with Neckbanded gray and Mogollon Brown Wares and dated by archaeomagnetic samples to the early tenth century (Ferg 1983). Except for the occurrence of neckbanded pottery, these assemblages are very similar to Early Developmental sites in the Peña Blanca area. These similarities may indicate that the Late Developmental in the Peña Blanca sites date just prior to these occupations or in the ninth century.

Another interpretation relating to sites dominated by San Marcial is that they date significantly earlier than previously thought. John Wilson (1995) also proposes that San Marcial sites cover a much wider area than previously thought. He suggests that San Marcial Black-on-white and associated pottery is characteristic of occupations dating between AD 520 and 620 that can be attributed to a wide geographic area that includes most of the Middle Rio Grande and Colorado Plateau.

Such speculation seems to be partially supported by studies that indicate that Early Basketmaker III assemblages exhibit characteristics that are very similar to those assigned here to the San Marcial phase or Early Developmental period. Similarities include the dominance of plain gray wares, a distinct white ware with designs derived from early Mogollon decorated forms, unpainted slipped red wares, and Mogollon Brown Wares. An excellent example of Anasazi assemblages reflecting such characteristics is represented by pottery from Early Basketmaker III components in the Chuska region recently documented as part of the El Paso Pipeline Project (Kearns et al. 2000; Reed et al. 1998). Pottery from sites in the Tohatchi Flats areas assigned to the Muddy Wash phase (AD 500 to 600) occur as combinations of plain gray, painted white, red slipped, and Mogollon Brown Wares that are very similar to those noted at Early Developmental sites from the Peña Blanca Project (Kearns et al. 2000; Reed et al. 1998). Other investigations indicate similar assemblages in other Early Basketmaker sites in the Four Corners (Reed et al. 2000).

Similarities in the distribution and frequency of pottery from Early Developmental assemblages represented at various Peña Blanca sites appear to limit the degree of temporal resolution possible within this period. Archaeomagnetic dates seem to provide fairly good evidence for the assignment of Early Developmental components from the Peña Blanca area.

The only evidence of an occupation that could date to the very early part of the Basketmaker or earliest Developmental comes from LA 6171. Archaeomagnetic samples were taken from bell-shaped pit features, some of which could have be used as small pit structures (Blinman, pers. comm. 2004). Archaeomagnetic dates for these samples appear to fall between AD 450 and 700, although portions of the Late Archaic archaeomagnetic curve are in similar locations. Features from LA 6171 assigned to this span include Feature 91 (a pit inside Feature 90) dated between AD 435 and 525, Feature 43 (a bell-shaped roasting pit) dated between AD 500 and 650, Feature 38 (a hearth) dated between AD 510 and 650, Feature 54 (a bell-shaped roasting pit) dated between AD 515 and 655, Feature 88 (a thermal pit) dated between AD 610 and 630, and Feature 93 (a hearth in a bell-shaped pit) dated between AD 605 and 665.

Archaeomagnetic dates from two other features at LA 6171 as well as those from three other sites indicate later associations dating to the eighth and ninth centuries (Chapter 15). At LA 6171, dated features include those at Pit Structure 60, Feature 77, a hearth dating to AD 740–835; and that at Structure 9, Feature 10, a shallow pit dating to AD 775–825. Pottery assemblages associated with these features appear to derive from Early Developmental occupations with some pottery from a much later Coalition occupation mixed in. The Early Developmental pottery appears to be overwhelmingly dominated by plain gray ware types with extremely low frequencies of white wares.

LA 265 represents another site where pottery was recovered from several features dating to the Early Developmental period. Features at this site assigned archaeomagnetic dates include Pithouse 13, Feature 128, a hearth dated to AD 740; Feature 27 (a shallow pithouse with floor burn) dated to AD 750 or AD 840; Feature 72 (a central hearth) dated to AD 805; Feature 33 (a pit structure wall niche) dated to AD 835; and Feature 102 (a central hearth) dated to AD 850. These samples provide dates at a site where ceramic distributions and other evidence indicate an occupation solely during the Early Developmental period. Pottery from LA 265 is dominated by plain gray wares (91.2 percent), with low frequencies of white wares (3.0 percent) mainly derived from San Marcial Black-on-white, slipped red wares (2.3 percent), and Mogollon Brown Wares (2.2 percent).

Dates reflecting Early Developmental occupations at LA 6169 were documented at three contexts. These include Feature 4 (a pit structure with an ash pit) dating to AD 790, Feature 4 (a pit structure) dating to AD 790; and Feature 47 (coping and deflector near hearth) dating to AD 820. Assemblages associated with these components are dominated by plain gray ware sherds and San Marcial Black-on-white in frequencies similar to that noted for other

Early Developmental components.

Contexts from LA 6170 yielding archaeomagnetic dates include Structure 5, Feature 12 (a floor pit) dated to AD 720–785; Structure 50, Feature 152, a hearth dated to AD 755–830; Structure 50 (wall section) dated to AD 720–775 or AD 810–915; Structure 50, Feature 152, a hearth dated to AD 815–845; Structure 2, a burned floor, dated to AD 815–845; Feature 61, a burned pit, dating to 710–775 or AD 810–915, and Structure 5, Feature 38, a wall niche dating to AD 825–875. Sherds from proveniences associated with these dates are represented solely by types occurring at Early Developmental sites. The great majority of the sherds associated with these features represent plain gray ware types. White ware sherds were not represented while very low frequencies of red and brown wares were noted.

One archaeomagnetic sample was collected from LA 115862. This came from a hearth in the pit structure, and dated sometime between AD 775–815. All of the 389 sherds from LA 115862 reflect an Early Developmental period occupation. Distributions noted at this site are similar to those documented at other Early Developmental period sites although the total proportion of white wares (26.2 percent) is higher. The higher frequency of white wares is attributed to the influence of sherds from broken white ware vessels.

Together, the archaeomagnetic dates from contexts with Early Developmental pottery mainly indicate occupations during the eighth and ninth centuries, while the earlier dates from LA 6171 are more difficult to interpret. The six earliest dates from LA 6171 seem to conform to the very early date of the San Marcial phase as postulated by John Wilson (1995). It is quite possible, however, that these occupations may actually predate the introduction of pottery in this area, and that associated pottery represents contaminants from later components. This assertion is supported by both the low frequency and mixed nature of these assemblages, which consist primarily of Coalition period types along with lower frequencies of Early Developmental forms. One possibility explored was that a sample of the pottery from these early features could reflect early or transitional Basketmaker forms. Such pottery would conform to the earliest ceramic sites scattered throughout the Southwest which are characterized by self-tempered plain or brown ware vessels (Reed et al. 2000; Wilson et al. 1996). An examination of the few plain gray ware sherds directly associated with these early features indicate they are identical to gray wares from other Early Developmental components, casting further doubt on the validity of an early ceramic component associated with features yielding these early dates. While the possibility of a very early ceramic occupation dating to the sixth or early seventh century cannot be completely discounted, the direct association of pottery at these features cannot be confirmed. Given the nature of the archaeomagnetic dating curve in this area, it is also possible that these features date earlier, perhaps to the same time generally attributed to the Late Archaic period (Chapter 15).

Archaeomagnetic dates from five sites indicate that the majority of Early Developmental period components probably date to a fairly short period, most likely spanning from the late eighth to early ninth century. This date conforms to the likely span for the San Marcial phase as defined for the Middle Rio Grande region. It is probable that most if not all of the Early Developmental components recognized during investigations at Peña Blanca date to this span. Thus, components assigned to the San Marcial or Early Developmental period during the present study are largely contemporaneous with the Pueblo I period as defined in the Four Corners country.

Thus, while most of the Early Developmental components identified at Peña Blanca sites date to the late eighth or early ninth centuries, similarities with pottery assemblages from early Basketmaker III sites on the Colorado Plateau indicate a conservative technology. Such similarities also contrast with differences noted between San Marcial phase sites and contemporaneous Pueblo I sites on the Colorado Plateau. Differences include the presence of significant frequencies of neckbanded types, a higher frequency of decorated pottery, and the presence of San Juan Red Wares rather than early slipped red ware forms. As previously indicated, the apparent lack of change in ceramic technology and architectural traits, as compared to contemporary trends on the Colorado Plateau, has sometimes been interpreted as reflecting cultural lag. This interpretation assumes a gradual diffusion of pottery technology and other aspects of Anasazi material culture from a cultural core located on the Colorado Plateau to peripheral areas such as the Northern Rio Grande. Such areas are often interpreted as reflecting cultural backwaters where the rate of change or progress as compared to the Anasazi core was much slower. Such an approach, however, does not actually explain why certain changes may have occurred in one region but not the other. Another approach to this issue will involve the examination of environmental, population, and social factors that could have facilitated different types of changes in one area but not in others. Thus, the following discussion of ceramic trends associated with Early Developmental occupations will not only attempt to document and compare trends from different areas but will examine possible causes for differences noted. These include trends in subsistence, environment, climate, available pottery resources, population density, and settlement pattern.

Patterns of Regional Interaction and Exchange. Pottery from San Marcial phase components exhibit distinct combinations of elements associated with the early Anasazi and Mogollon culture areas. Basic technological traits normally defined as characteristic of the Anasazi occupation dominate pottery assemblages from all Early Developmental period components. The most notable example of such influence is the dominance of "Anasazi" gray ware sherds. Characteristics of this pottery appear to be identical to those noted in pottery dominating early Anasazi assemblages and classified as Lino Gray (Colton 1953, 1955; Gladwin 1945; Windes 1977). The overall characteristics of Basketmaker III assemblages from some areas of the Anasazi are also similar to those at Early Developmental components investigated during the Peña Blanca project, in terms of the presence of relatively low frequencies of mineral-painted white wares as well as slipped and unpainted red wares, and plain brown wares. Interestingly, the overall frequency of basic pottery forms at Early Basketmaker III sites in areas of the Four Corners (Reed et al. 2000) is very similar to that noted at the Early Developmental sites described during the present study.

Historic influences from ceramic traditions that developed earlier on the Colorado Plateau and in the Mogollon Highlands are certainly reflected by the earliest pottery in the Santo Domingo Basin and contemporaneous sites in the Rio Grande region. Unlike areas of the Colorado Plateau, where there is evidence of a series of gradual transitions from earlier brown ware to gray and white ware technologies (Reed et al. 2000), the initial gray and white ware technology documented in the Santo Domingo Basin appears to represent a fully developed gray and white ware tradition. Gray and brown wares from these Early Developmental sites are distinct, and there is no overlap in characteristics. Thus, a fully developed "Anasazi" gray and white ware technology appears to have been introduced to the Rio Grande region from areas of the Colorado Plateau where such technologies had earlier developed. The red slipped pottery in these Late Developmental components reflects a technology that seems to have gradually developed out of brown ware technology on the Colorado Plateau during the earliest ceramic periods (Reed et al. 2000). Thus, the great majority of the pottery from Early Developmental Peña Blanca components reflect a basic technology developed by Basketmaker III groups on the Colorado Plateau, and the basic technology appears to have altered very little over several centuries after its transfer into areas of the Rio Grande region.

Despite similarities between the gray, white, and red wares pottery in Early Developmental Peña Blanca sites to that from pottery in regions of the Colorado Plateau, it is likely that the great majority of this pottery was produced locally in the Northern Santo Domingo Basin. Examinations of pottery from Early Developmental period sites indicate a range of paste characteristics. Refiring analysis of sand-tempered plain gray sherds associated with Early Developmental occupations indicate a great deal of variability in paste color (Table 16.7). While sherds firing to pink (7.5YR in

Table 16.7. Refiring of Sherds from Early Developmental Components

Pottery Group	2.5YR	5YR	7.5YR	10YR	Total
MRG Gray	11	10	20	13	54
	20.3%	18.5%	37.0%	24.1%	
San Marcial	-	-	2	21	23
Black-on-white	-	-	8.7%	91.3%	
Total	11	10	22	34	77
	14.3%	13.0%	28.6%	44.2%	

Table 16.8. Distribution of Temper by Ware for Early Developmental Components for LA 265

	Gray	White	Red	Brown Plain	Total
Indeterminate	1	-	-	-	1
	0.0%	-	-	-	0.0%
Sand	4693	85	158	2	4938
	93.8%	51.2%	81.9%	1.6%	90.0%
Mica, quartz, and feldspar fragments	4	-	-	-	4
(schist granite)	0.1%	-	-	-	0.1%
Sherd and sand	-	1	-	-	1
	-	0.6%	-	-	0.0%
Fine tuff or ash	-	1	-	-	1
	-	0.6%	-	-	0.0%
Fine tuff and sand	-	3	-	-	3
	-	1.8%	-	-	0.1%
Fine sandstone	3	-	2	-	5
	0.1%	-	1.0%	-	0.1%
Fine Jornada temper	-	-	-	30	30
	-	-	-	24.4%	0.5%
Self tempered	57	-	-	-	57
	1.1%	-	-	-	1.0%
Mogollon volcanics	-	6	30	81	117
	-	3.6%	15.5%	65.9%	2.1%
Ant hill sand	6	-	-	-	6
	0.1%	-	-	-	0.1%
Sand and Mogollon volcanics	-	3	3	10	16
	-	1.8%	1.6%	8.1%	0.3%
Oblate shale and sand	238	67	-	-	305
	4.8%	40.4%	-	-	5.6%
	5002	166	193	123	5484
Total	100.0%	100.0%	100.0%	100.0%	100.0%

hue) colors occurred in slightly higher frequencies than any group, those firing to red, yellow-red, and buff color were also represented in significant frequencies. The color range of early plain wares from sites is quite variable, and a particular color does not dominate any particular site. This wide range of colors may reflect the use of clays derived from a number of different sources. Such variability in paste color is not represented in any other utility or decorated ware group from other components examined during the present study. A likely possibility is that early gray wares were produced by potters at various households spread throughout the Santo Domingo Basin and surrounding area where distinct clay sources firing to different colors were utilized. In contrast, the great

Table 16.9. Distribution of Temper by Ware for Early Developmental Components from LA 6169

Temper	Ware: Gray	White	Red	Brown Plain	Total
Sand	479	14	18	-	511
	93.7%	40.0%	100.0%	-	89.3%
Mica, quartz, and feldspar fragments (schist granite)	9	-	-	-	9
	1.8%	-	-	-	1.6%
Fine tuff and sand	-	5	-	-	5
	-	14.3%	-	-	0.9%
Fine Jornada temper	-	-	-	2	2
	-	-	-	25.0%	0.3%
Self tempered	2	-	-	-	2
	0.4%	-	-	-	0.3%
Mogollon volcanics	-	-	-	6	6
	-	-	-	75.0%	1.0%
Ant hill sand	16	-	-	-	16
	3.1%	-	-	-	2.8%
Oblate shale and sand	5	14	-	-	19
	1.0%	40.0%	-	-	3.3%
Vitrified	-	1	-	-	1
	-	2.9%	-	-	0.2%
Shale	-	1	-	-	1
	-	2.9%	-	-	0.2%
Total	511	35	18	8	572
	100.0%	100.0%	100.0%	100.0%	100.0%

majority of white wares fired to buff colors. Differences in the range of refired colors reflected in gray and white ware sherds may indicate that white wares were produced at fewer locations. This is particularly likely when considering that the buff and white firing clays had a very limited spatial distribution.

Distributions of temper types, as defined by visual criteria, are more homogeneous. Distributions of temper by ware are illustrated for Early Developmental components from LA 265 (Table 16.8) LA 6169 (Table 16.9), LA 6170 (Table 16.10), LA 6171 (Table 16.11), and LA 115862 (Table 16.12). Similar distributions are illustrated for components from assemblages reflecting pottery mainly from Early Developmental with some Late Developmental types from LA 6170 (Table 16.13) and LA 115863 (Table 16.14). These distributions are also illustrated for pottery associated with components mainly dating to the Early Developmental period with some pottery indicating mixture from the Coalition period at LA 6171 (Table 16.15).

Distribution of temper categories was fairly consistent among all sites. Gray wares are dominated by pottery assigned to a similar sand category. Over 90 percent of the gray wares from all Early Developmental components were tempered with sand. Other tempers represented in very low frequencies occurring in gray wares assigned to the local tradition include sandstone, self-tempered, oblate shale, basalt and sand, anthill sand, and granite and mica. In contrast, similar frequencies of sand, and sand and shale, were recorded for the white wares. The great majority of red wares are tempered with sand similar to that noted for the gray wares. Similarities in the types of resources used by Early Developmental potters in the Santo Domingo Valley and contemporaneous settlements to the south may have also been influenced by settlement patterns. Almost all Early Developmental sites documented are located along and above the Rio Grande floodplain on eroded surfaces (Cordell 1979), where similar sand and clay formations would have been common.

Data resulting from petrographic analysis of 51 sherds from Early Developmental components indicate that potters at various sites used local sand in the production of both utility and decorated vessels (Carpenter and Reed, Appendix 1). A

Table 16.10. Distribution of Temper by Ware for Early Developmental Components from LA 6170

Temper	Ware: Gray	White	Red	Brown Plain	Glaze	Historic Plain	Total
Sand	2249	27	41	4	-	-	2321
	92.2%	26.0%	85.4%	11.4%	-	-	88.3%
Mica, quartz, and feldspar fragments (schist granite)	74	-	-	-	-	-	74
	3.0%	-	-	-	-	-	2.8%
Fine tuff and sand	-	2	-	-	-	1	3
	-	1.9%	-	-	-	100.0%	0.1%
Fine Jornada temper	-	-	-	28	-	-	28
	-	-	-	80.0%	-	-	1.1%
Self tempered	19	-	-	-	-	-	19
	0.8%	-	-	-	-	-	0.7%
Dark igneous and sand	-	1	-	-	-	-	1
	-	1.0%	-	-	-	-	0.0%
Mogollon volcanics	-	4	7	2	-	-	13
	-	3.8%	14.6%	5.7%	-	-	0.5%
Ant hill sand	4	-	-	-	-	-	4
	0.2%	-	-	-	-	-	0.2%
Sand and Mogollon volcanics	-	3	-	1	-	-	4
	-	2.9%	-	2.9%	-	-	0.2%
Basalt and sand	-	-	-	-	1	-	1
	-	-	-	-	50.0%	-	0.0%
Oblate shale and sand	92	67	-	-	-	-	159
	3.8%	64.4%	-	-	-	-	6.0%
Vitrified	-	-	-	-	1	-	1
	-	-	-	-	50.0%	-	0.0%
Quartzite (Leucocratic Igneous)	1	-	-	-	-	-	1
	0.0%	-	-	-	-	-	0.0%
Total	2439	104	48	35	2	1	2629
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.11. Distribution of Temper by Ware for Early Developmental Components from LA 6171

Temper	Ware: Gray	White	Total
Sand	87	-	87
	93.5%	-	91.6%
Fine tuff or ash	-	1	1
	-	50.0%	1.1%
Ant hill sand	3	-	3
	3.2%	-	3.2%
Basalt and sand	1	-	1
	1.1%	-	1.1%
Oblate shale and sand	2	1	3
	2.2%	50.0%	3.2%
Total	93	2	95
	100.0%	100.0%	100.0%

Table 16.12. Distribution of Temper by Ware for Early Developmental Components from LA115862

Temper	Ware				Total
	Gray	White	Red	Brown Plain	
Sand	256	56	2	-	314
	93.1%	54.9%	100.0%	-	80.7%
Fine Jornada temper	-	-	-	8	8
	-	-	-	80.0%	2.1%
Mogollon volcanics	-	1	-	2	3
	-	1.0%	-	20.0%	0.8%
Oblate shale and sand	19	45	-	-	64
	6.9%	44.1%	-	-	16.5%
Total	275	102	2	10	389
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.13.Distribution of Temper by Ware for Mainly Early Developmental with Late Developmental Components from LA 6170

Temper	Ware					Total
	Gray	White	Red	Brown Plain	Historic Plain	
Sand	242	8	2	-	-	252
	68.6%	21.1%	66.7%	-	-	62.8%
Mica, quartz, and feldspar fragments	98	-	-	-	-	98
(schist granite)	27.8%	-	-	-	-	24.4%
Sherd	-	1	-	-	-	1
	-	2.6%	-	-	-	0.2%
Sherd and sand	-	2	-	-	-	2
	-	5.3%	-	-	-	0.5%
Fine tuff or ash	-	2	-	-	-	2
	-	5.3%	-	-	-	0.5%
Fine tuff and sand	-	13	-	-	6	19
	-	34.2%	-	-	100.0%	4.7%
Crushed Andesite or Diorite	-	-	1	-	-	1
	-	-	33.3%	-	-	0.2%
Ant hill sand	3	-	-	-	-	3
	0.8%	-	-	-	-	0.7%
Sand and Mogollon volcanics	-	-	-	1	-	1
	-	-	-	100.0%	-	0.2%
Oblate shale and sand	10	10	-	-	-	20
	2.8%	26.3%	-	-	-	5.0%
Mica and tuff	-	1	-	-	-	1
	-	2.6%	-	-	-	0.2%
Mica, tuff, and sand	-	1	-	-	-	1
	-	2.6%	-	-	-	0.2%
Total	353	38	3	1	6	401
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.14. Distribution of Temper by Ware for Mainly Early Developmental with Late Developmental Components from LA 115863

Temper	Ware: Gray	White	Red	Brown Plain	Total
Indeterminate	1	-	-	-	1
	1.7%	-	-	-	1.4%
Sand	56	3	-	-	59
	93.3%	37.5%	-	-	84.3%
Fine tuff or ash	-	3	-	-	3
	-	37.5%	-	-	4.3%
Fine tuff and sand	-	1	-	-	1
	-	12.5%	-	-	1.4%
Fine Jornada temper	-	-	-	1	1
	-	-	-	100.0%	1.4%
Mogollon volcanics	-	-	1	-	1
	-	-	100.0%	-	1.4%
Basalt and sand	1	-	-	-	1
	1.7%	-	-	-	1.4%
Oblate shale and sand	2	1	-	-	3
	3.3%	12.5%	-	-	4.3%
Total	60	8	1	1	70
	100.0%	100.0%	100.0%	100.0%	100.0%

series of temper groups were defined during petrographic analysis based on observation of associated volcanic inclusions.

Temper type I was defined based on a lack of volcanic-derived inclusions associated with the granitic sand. Sources for type I sand in this area include alluvium deposited by tributaries to the Rio Grande piedmont sand, undifferentiated (Appendix 1).

Temper type II was defined by the presence of sand grains with volcanic material. Previously mapped gravel and sand deposits representing potential sources for this temper include terrace gravel and gravel deposited by the ancestral Rio Grande (Appendix 1).

Most of the gray wares from LA 265 were assigned to Temper type I, while those from other sites were dominated by Temper type II. Thus, this analysis indicates differences in materials used in pottery production between different Peña Blanca sites that were not noted during earlier visual-based analysis using a binocular microscope (Appendix 1). Based on this data, it is possible that at least two distinct production areas are represented for Early Developmental gray ware vessels. One is at LA 265 and the other includes the LA 6169/6170/6171 complex. The San Marcial Black-on-white sherds from each site tend to be dominated by their own distinct combination of temper groups, and may indicate that potters at each of these sites produced their own white wares.

In order to determine if sand categories defined during petrographic analysis could be visually identified, all Early Developmental sherds submitted for petrographic analysis were reexamined. This examination involved descriptions and characterization of the sand temper, and comparisons of these characterizations to categories defined during petrographic analysis. Unfortunately, the relationship between categories defined during these visual characterizations and those defined during petrographic analysis was quite weak. For example, visual inspections of 13 samples assigned to the Temper type II (defined for sand with tuff fragments), resulted in the recognition of clear tuff fragments in only four of these sherds. Thus, while these categories defined through petrographic analysis may be valid, such distinctions do not appear to be evident without the use of petrographic analysis.

Table 16.15. Distribution of Temper by Ware for Mainly Early Developmental with Coalition Components from LA 6171

	Ware					
Temper	Gray	White	Red	Brown Plain	Glaze	Total
Sand	461	4	8	-	-	473
	91.7%	16.7%	66.7%	-	-	86.8%
Mica, quartz, and feldspar	2	-	-	-	-	2
fragments (schist granite)	0.4%	-	-	-	-	0.4%
Sherd	-	-	4	-	-	4
	-	-	33.3%	-	-	0.7%
Sherd and sand	-	1	-	-	-	1
	-	4.2%	-	-	-	0.2%
Fine tuff or ash	-	7	-	-	-	7
	-	29.2%	-	-	-	1.3%
Fine tuff and sand	-	4	-	-	-	4
	-	16.7%	-	-	-	0.7%
Fine Jornada temper	-	-	-	4	-	4
	-	-	-	80.0%	-	0.7%
Gray crystalline basalt	1	-	-	-	-	1
	0.2%	-	-	-	-	0.2%
Latite (Keres area)	-	-	-	-	1	1
	-	-	-	-	100.0%	0.2%
Ant hill sand	38	-	-	-	-	38
	7.6%	-	-	-	-	7.0%
Sand and Mogollon	-	-	-	1	-	1
volcanics	-	-	-	20.0%	-	0.2%
Oblate shale and sand	1	5	-	-	-	6
	0.2%	20.8%	-	-	-	1.1%
Mica, tuff, and sand	-	3	-	-	-	3
	-	12.5%	-	-	-	0.6%
Total	503	24	12	5	1	545
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Therefore, interpretations based on categories identified during petrographic analysis, are limited to the sherds submitted to this analysis.

Petrographic analysis also indicates the use of different types of materials in the production of different ware groups. Differences are also represented between wares (Appendix 1). A clay with low silt content was used in the production of San Marcial Black-on-white, as 92 percent of the sherds examined reflect the use of such clays. Natural inclusions of shale were found in 88 percent of the San Marcial Black-on-white from LA 6169, LA 6170, and LA 6171, and only 20 percent of the San Marcial Black-on-white from LA 265. The two Mogollon Brown Wares were tempered with a devitrified tuff, distinct from volcanic material noted in Rio Grande forms. This temper is similar to that noted in brown wares from the Mogollon Highlands (Wilson 2000), and supports the assignment of these and similar brown ware sherds to Mogollon tradition types. Some ceramic traits may reflect influences from or ties with Mogollon groups to the south. Despite the similarity in paints and pastes of San Marcial Black-on-white from Peña Blanca sites to those in white wares from sites on the Colorado Plateau, many of the designs exhibit motifs and bold layouts, similar to those noted in Mogollon decorated types such as Mogollon Red-on-brown and Three Circles Red-on-white (Haury 1936). A few examples of pottery that may represent local copies of Mogollon Red-on-brown were identified, and include a single reconstructible vessel from LA 115862. Another characteristic reflecting influence from the Mogollon Highlands is the presence of red slip over a local paste. This use of slip may reflect the production of local copies of the Mogollon tradition type San Francisco Red.

Exchange with groups in other regions is indicated by pottery assigned to various traditions. Distributions of pottery traditions associated with various wares are illustrated for Early Developmental components from LA 265 (Table 16.16), LA 6169 (Table 16.17), LA 6170 (Table 16.18), LA 6171 (Table 16.19), and LA 115862 (Table 16.20). Similar distributions are illustrated for assemblages from components mainly associated with the Early Developmental with some Late Developmental types from LA 6170 (Table 16.21), and LA 115863 (Table 16.22). These distributions are also illustrated for pottery from Early Developmental components with some pottery indicating mixture from Coalition components at LA 6171 (Table 16.23).

The overwhelming majority (more than 98 percent from most sites) of gray wares were assigned to Middle Rio Grande types based on temper. The remaining gray wares represent plain gray wares assigned to the Northern Rio Grande tradition. About 90 percent of the gray wares were assigned to Middle Rio Grande, with the remaining pottery representing types from other areas of the Anasazi region. While some of the white ware sherds assigned to Middle Rio Grande types may have been from the Cibola region, clearly intrusive white wares were limited to two sherds of Tusayan White Ware. Most red wares (about 80 percent) represent Middle Rio Grande Tallahogan-like red reflecting the use of red slip of a white or gray paste. The remaining pottery represents red-slipped San Francisco Red from the Mogollon Highlands. Other intrusive pottery includes plain brown ware types from the Mogollon Highlands or Jornada Mogollon country. Mogollon types identified include Mogollon Brown, San Francisco Red, and Mogollon Red-on-brown. Jornada Mogollon Brown Wares include Jornada Brown and El Paso Brown. Together these brown wares make from just over 1 percent to about 3 percent of the pottery from most Early Developmental components.

The mixture of Anasazi and Mogollon ceramic types and traits from other Early Developmental sites in the Middle Rio Grande is quite variable even for sites located fairly

Table 16.16. Distribution of Tradition by Ware for Early Developmental Components from LA 265

	Ware				
Temper	Gray	White	Red	Brown Plain	Total
Indeterminate	2	-	-	-	2
	0.0%	-	-	-	0.0%
NRG	43	4	-	-	47
	0.9%	2.4%	-	-	0.9%
MRG	4957	151	160	2	5270
	99.1%	91.0%	82.9%	1.6%	96.1%
Tusayan	-	2	-	-	2
	-	1.2%	-	-	0.0%
Northern Jornada Mogolon (Jornada)	-	-	-	30	30
	-	-	-	24.4%	0.5%
Mogollon Highlands	-	9	33	91	133
	-	5.4%	17.1%	74.0%	2.4%
Total	5002	166	193	123	5484
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.17. Distribution of Tradition by Ware for Early Developmental Components from LA 6169

	Gray	White	Red	Brown	Total
Indeterminate	-	1	-	-	1
	-	2.9%	-	-	0.2%
NRG	11	5	-	-	16
	2.2%	14.3%	-	-	2.8%
MRG	496	29	18	-	5437
	97.8%	82.9%	100.0%	-	95.6%
Northern Jornada Mogollon (Jornada)	-	-	-	2	2
	-	-	-	25.0%	0.3%
Mogollon Highlands	-	-	-	6	6
	-	-	-	75.0%	1.0%
Total	507	35	18	8	568
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.18. Distribution of Tradition by Ware for Early Developmental Components from LA 6170

	White	Red	Brown Plain	Glaze	Historic Plain	Total
NRG	2	-	2	-	-	97
	1.9%	-	5.7%	-	-	3.7%
Rio Grande (Historic Tewa)	-	-	-	-	1	1
	-	-	-	-	100.0%	0.0%
Rio Grande (Historic Keres)	-	-	-	2	-	2
	-	-	-	100.0%	-	0.1%
MRG	95	41	2	-	-	2484
	91.3%	85.4%	5.7%	-	-	94.5%
Northern Jornada Mogollon	-	-	28	-	-	28
	-	-	80.0%	-	-	1.1%
Mogollon Highlands	7	7	3	-	-	17
	6.7%	14.6%	8.6%	-	-	0.6%
Total	104	48	35	2	1	2629
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.19. Distribution of Tradition by Ware for Early Developmental Components from LA 6171

	Gray	White	Total
Indeterminate	1	-	1
	1.1%	-	1.1%
NRG	-	1	1
	-	50.0%	1.1%
MRG	92	1	93
	98.9%	50.0%	97.9%
Total	93	2	95
	100.0%	100.0%	100.0%

Table 16.20. Distribution of Tradition by Ware for Early Developmental Components from LA 115862

	Gray	White	Red	Brown Plain	Total
MRG	275	101	2	-	378
	100.0%	99.0%	100.0%	-	97.2%
Northern Jornada Mogollon	-	-	-	8	8
	-	-	-	80.0%	2.1%
Mogollon Highlands	-	1	-	2	3
	-	1.0%	-	20.0%	0.8%
Total	275	102	2	10	389
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.21. Distribution of Tradition by Ware for Mainly Early Developmental with Late Developmental Components from LA 6170

	Gray	White	Red	Brown Plain	Historic Plain	Total
NRG	98	17	-	-	-	115
	27.8%	44.7%	-	-	-	28.7%
Rio Grande (Historic Tewa)	-	-	-	-	6	6
	-	-	-	-	100.0%	1.5%
MRG	255	20	2	-	-	277
	72.2%	52.6%	66.7%	-	-	69.1%
Upper San Juan	-	-	1	-	-	1
	-	-	33.3%	-	-	0.2%
Eastern Mogollon	-	1	-	-	-	1
	-	2.6%	-	-	-	0.2%
Mogollon Highlands	-	-	-	1	-	1
	-	-	-	100.0%	-	0.2%
Total	353	38	3	1	6	401
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.22. Distribution of Tradition by Ware for Mainly Early Developmental with Late Developmental Components from LA 115863

	Gray	White	Red	Brown	Total
Indeterminate	2	-	-	-	2
	3.3%	-	-	-	2.9%
NRG	-	4	-	-	4
	-	50.0%	-	-	5.7%
MRG	58	4	-	-	62
	96.7%	50.0%	-	-	88.6%
Northern Jornada Mogollon	-	-	-	1	1
	-	-	-	100.0%	1.4%
Mogollon Highlands	-	-	1	-	1
	-	-	100.0%	-	1.4%
Total	60	8	1	1	70
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.23. Distribution of Tradition by Ware for Mainly Early Developmental with Coalition Components from LA 6171

	Gray	White	Red	Brown Plain	Glaze	Total
Indeterminate	1	-	-	-	-	1
	0.2%	-	-	-	-	0.2%
NRG	2	14	-	-	-	16
	0.4%	58.3%	-	-	-	2.9%
Rio Grande (Historic Keres)	-	-	-	-	1	1
	-	-	-	-	100.0%	0.2%
MRG	500	10	12	-	-	522
	99.4%	41.7%	100.0%	-	-	95.8%
Northern Jornada Mogollon	-	-	-	4	-	4
	-	-	-	80.0%	-	0.7%
Mogollon Highlands	-	-	-	1	-	1
	-	-	-	20.0%	-	0.2%
Total	503	24	12	5	1	545
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

close together (Tainter and Plog 1994). The nature of such variability in the frequency of Anasazi and Mogollon pottery and architecture has been interpreted by Tainter and Plog (1994) as reflecting the participation of Basketmaker and Pueblo period groups of the Albuquerque area in two interaction networks. The Anasazi influence is sometimes characterized as reflecting technological influences introduced by groups in the San Juan Basin who may have been predecessors of the Chaco system (Tainter and Plog 1994). Other traits are assumed to represent influences from a southern (Mogollon) "riverine" oriented system. This influence is not surprising when one considers that most of the sites, which originally used Mera (1935) to define San Marcial phase, are dominated by Mogollon Brown Ware and located south of Socorro, New Mexico. This includes sites in the Rio Abajo region discussed by Marshall and Walt (1984). This mixture of pottery is assumed to reflect a distinct geographic setting resulting in occasional rather than sustained interaction with groups to both the south and west. Ties with groups in various directions would have changed as local conditions would have made contact with one area or the other more advantageous (Tainter and Plog 1994). This is what Tainter and Plog (1994) call "weak" archaeological patterning resulting in combinations of material culture traits that are neither completely Anasazi or Mogollon as normally defined, but exhibit traits associated with both culture areas. The unique nature of combinations of traits may indicate a distinct Rio Grande material culture that could be associated with early Tanoan-speaking groups that are ancestral to modern Northern Rio Grande populations. The high degree of spatial variability in frequencies of Mogollon versus Anasazi pottery forms may indicate the informal nature of interaction between these groups and those residing in other areas of the Southwest.

Pottery Forms and Use. Similarities in the characteristics of pottery from Early Developmental components investigated during the Peña Blanca Project and those noted at early Basketmaker III sites in Colorado seem to be represented by distributions of wares and vessels forms. Such similarities ultimately reflect specific ranges of activities for which these forms were used. Two categories that appear to be useful in making functional-based comparison for early components are ware and form. Table 16.24 illustrates the frequencies of wares for Early Developmental assemblages from various sites. Distributions of vessel form for various ware groups are also illustrated for Early Developmental components from LA 265 (Table 16.25), LA 6169 (Table 16.26), LA 6170 (Table 16.27), LA 6171 (Table 16.28), and LA 115862 (Table 16.29).

These distributions are also illustrated for Early Developmental with Late Developmental components from LA 6170 (Table 16.30) and LA 115862 (Table 16.31), while those reflecting mixtures of mainly Late Developmental with Coalition were illustrated for LA 6171 (Table 16.32).

The great majority of pottery at Develop-mental period sites are gray ware jars (Table 16.24). Rim diameters indicate that most of these are from wide-mouth jars although some are from olla and seed jars. White ware sherds from Early Developmental components reflect a mixture of jars and bowls. Most of the red and brown ware sherds are derived from jar forms, although bowls are consistently present in lower frequencies.

Similarities in trends noted in pottery wares and forms from early Basketmaker III sites on the Colorado Plateau as well as Early Developmental components from sites in the Middle Rio Grande may reflect the role of pottery containers in similar types of overall subsistence patterns (Hays-Gilpin 1993; Mills 1989). It has been suggested that increased sedentism and reliance on agriculture accounts for shifts in various areas of the Southwest from a technology suited to the needs of mobile horticulturalists to more specialized manufacture of diverse and durable forms. Such changes have been described in terms of a shift from maintainable to reliable ceramic technologies. Mills (1989) argues that traits noted in pottery from Basketmaker III and Pueblo I ceramic components fit a model of maintainable technology that reflect ease of manufacture and repair, less lag between manufacture and use, portability, and a lack of backup systems.

The most striking example of a maintainable technology for the earliest ceramic stage in most Southwestern regions is the exclusive production of plain brown ware vessels (Reed et al. 2000). These vessels were produced using easily obtainable self-tempered clays not requiring much preparation, and fired in an uncontrolled atmosphere at a fairly low temperature. Vessels were often polished, but never textured or painted. Vessel forms were limited to a few primary shapes such as seed jars, wide-mouth jars, and bowls.

While the early brown technology is not represented at any of the Peña Blanca sites, the earliest assemblages identified are dominated by plain gray ware pottery with similar ranges of forms. Subsistence patterns associated with dispersed settlements represented by early occupations may have resulted in an emphasis on plain utility vessels for most activities (Mills 1989). The earliest production of plain gray wares reflect a basic technology that appears to have developed out of brown wares and appeared on the Colorado Plateau during the sixth century or the early Basketmaker III period (Reed et al. 2000). The common production of gray ware vessels reflects a technology more suited to the shale

Table 16.24. Distribution of Ware by Site for Early Developmental Components

	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	Total
Gray	5002	511	2439	93	275	8320
	91.2%	89.3%	92.8%	97.9%	70.7%	90.7%
White	166	35	104	2	102	409
	3.0%	6.1%	4.0%	2.1%	26.2%	4.5%
Red	193	18	48	-	2	261
	3.5%	3.1%	1.8%	-	0.5%	2.8%
Brown	123	8	35	-	10	176
	2.2%	1.4%	1.3%	-	2.6%	1.9%
Glaze	-	-	2	-	-	2
	-	-	0.1%	-	-	0.0%
Historic Plain	-	-	1	-	-	1
	-	-	0.0%	-	-	0.0%
Total	5484	572	2629	95	389	9169
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.25. Distribution of Vessel Form by Ware for Early Developmental Components from LA 265

	Gray	White	Red	Brown	Total
Indeterminate	94	2	-	-	96
	1.9%	1.2%	-	-	1.8%
Bowl rim	5	16	4	-	25
	0.1%	9.6%	2.1%	-	0.5%
Bowl body	1	66	13	5	85
	0.0%	39.8%	6.7%	4.1%	1.5%
Olla rim	3	-	1	-	4
	0.1%	-	0.5%	-	0.1%
Jar neck	626	10	26	16	678
	12.5%	6.0%	13.5%	13.0%	12.4%
Jar rim	102	-	1	7	110
	2.0%	-	0.5%	5.7%	2.0%
Jar body	4115	68	143	94	4420
	82.3%	41.0%	74.1%	76.4%	80.6%
Jar body with strap or coil handle	3	-	-	-	3
	0.1%	-	-	-	0.1%
Jar body with lug handle	8	1	2	-	11
	0.2%	0.6%	1.0%	-	0.2%
Indeterminate coil/strap handle	9	-	-	-	9
	0.2%	-	-	-	0.2%
Canteen rim	1	-	-	-	1
	0.0%	-	-	-	0.0%
Miniature pinch pot rim	1	-	-	-	1
	0.0%	-	-	-	0.0%
Miniature pinch pot body	4	-	-	-	4
	0.1%	-	-	-	0.1%
Cloud blower	7	-	-	-	7
	0.1%	-	-	-	0.1%
Jar rim w/ lug handle	2	-	-	-	2
	0.0%	-	-	-	0.0%
Seed jar rim	-	2	1	-	3
	-	1.2%	0.5%	-	0.1%
Indeterminate rim	17	1	2	1	21
	0.3%	0.6%	1.0%	0.8%	0.4%
Pitcher rim	2	-	-	-	2
	0.0%	-	-	-	0.0%
Spindle Whorl	1	-	-	-	1
	0.0%	-	-	-	0.0%
Figurine	1	-	-	-	1
	0.0%	-	-	-	0.0%
Total	5002	166	193	123	5484
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.26. Distribution of Vessel Form by Ware for Early Developmental Components from LA 6169

	Gray	White	Red	Brown	Total
Indeterminate	5	-	-	-	5
	1.0%	-	-	-	0.9%
Bowl rim	-	4	-	-	4
	-	11.4%	-	-	0.7%
Bowl body	-	8	4	-	12
	-	22.9%	22.2%	-	2.1%
Jar neck	72	3	2	1	78
	14.2%	8.6%	11.1%	12.5%	13.7%
Jar rim	20	2	-	1	23
	3.9%	5.7%	-	12.5%	4.0%
Jar body	402	17	12	6	437
	79.3%	48.6%	66.7%	75.0%	76.9%
Jar body with strap or coil handle	2	-	-	-	2
	0.4%	-	-	-	0.4%
Jar body with lug handle	1	1	-	-	2
	0.2%	2.9%	-	-	0.4%
Miniature pinch pot body	2	-	-	-	2
	0.4%	-	-	-	0.4%
Jar rim w/ lug handle	1	-	-	-	1
	0.2%	-	-	-	0.2%
Indeterminate rim	2	-	-	-	2
	0.4%	-	-	-	0.4%
Total	507	35	18	8	568
	100.0%	100.0%	100.0%	100.0%	100.0%

clays common on the Colorado Plateau (Wilson et al. 1996). The addition of added temper in such clays resulted in vessels that were stronger and better suited to repeated use in cooking. Thus, the shift toward gray wares represents a small but significant step toward more reliable technologies. It is possible that this shift may also have occurred as population moved north from the Rio Abajo where assemblages are dominated by brown wares. Many of the similarities in pottery assemblages associated with the San Marcial phase of the Middle Rio Grande and the early Basketmaker III period of the Colorado Plateau Anasazi, particularly the dominance of plain gray wares, may reflect similarities associated with similar patterns of mobility and vessel use. The production of very low frequencies of white and red ware vessels, which were essentially painted or slipped gray wares, represent the first steps toward ware specialization. Overall distribution of vessel forms including seed jars, necked jars, and bowls is still similar to those noted during the earlier brown ware period, and indicates the use of pottery vessels in similar activities.

In addition to the sherd data, data from 18 whole or partial vessels from Early Developmental contexts at three sites provide additional information concerning vessel form and use. Information concerning the forms, characteristics, and sizes of these vessels is presented in Table 16.33. Most of the vessels evidence minimum to moderate use (Table 16.33).

At LA 265, five vessels were recovered from three burials. Burial 3 contained one plain gray pitcher and one plain gray beaker with a handle. Vessels recovered from Burial 4 included a slipped (Tallahogan) red seed jar and a plain gray cooking storage jar. A single plain gray pitcher was associated with Burial 6.

A total of four vessels were recovered from Early Developmental components at LA 6169. These included a San Marcial Black-on-white seed

Table 16.27. Distribution of Vessel Form by Ware for Early Developmental Components from LA 6170

	Gray	White	Red	Brown	Glaze	Historic Plain	Total
Indeterminate	26	1	1	-	-	-	28
	1.1%	1.0%	2.1%	-	-	-	1.1%
Bowl rim	4	3	-	-	-	-	7
	0.2%	2.9%	-	-	-	-	0.3%
Bowl body	-	28	6	4	1	-	39
	-	26.9%	12.5%	11.4%	50.0%	-	1.5%
Jar neck	260	4	4	-		-	268
	10.7%	3.8%	8.3%	-		-	10.2%
Jar rim	35	-	-	2		-	37
	1.4%	-	-	5.7%		-	1.4%
Jar body	2097	68	36	28	1	-	2230
	85.0%	65.4%	75.0%	80.0%	50.0%	-	84.8%
Jar body with lug handle	2	-	-	-	-	-	2
	0.1%	-	-	-	-	-	0.1%
Indeterminate coil/strap handle	4	-	-	-	-	-	4
	0.2%	-	-	-	-	-	0.2%
Miniature pinch pot body	1	-	-	-	-	-	1
	0.0%	-	-	-	-	-	0.0%
Cloud blower	1	-	-	-	-	-	1
	0.0%	-	-	-	-	-	0.0%
Jar rim w/ lug handle	1	-	-	-	-	-	1
	0.0%	-	-	-	-	-	0.0%
Body sherd polished interior/ext	-	-	-	1	-	1	2
	-	-	-	2.9%	-	100.0%	0.1%
Indeterminate rim	8	-	1	-	-	-	9
	0.3%	-	2.1%	-	-	-	0.3%
Total	2439	104	48	35	2	1	2629
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.28. Distribution of Vessel Form by Ware for Early Developmental Components from LA 6171

	Gray	White	Total
Bowl body	1	1	2
	1.1%	50.0%	2.1%
Jar neck	11	1	12
	11.8%	50.0%	12.6%
Jar rim	5	-	5
	5.4%	-	5.3%
Jar body	75	-	75
	80.6%	-	78.9%
Jar rim w/ lug handle	1	-	1
	1.1%	-	1.1%
Total	93	2	95
	100.0%	100.0%	100.0%

Table 16.29. Distribution of Vessel Form by Ware for Early Developmental Components from LA 115862

	Gray	White	Red	Brown Plain	Total
Bowl rim	-	19	-	-	19
	-	18.6%	-	-	4.9%
Bowl body	-	55	-	-	55
	-	53.9%	-	-	14.1%
Jar neck	38	1	-	-	39
	13.8%	1.0%	-	-	10.0%
Jar rim	15	-	-	-	15
	5.5%	-	-	-	3.9%
Jar body	213	27	2	10	252
	77.5%	26.5%	100.0%	100.0%	64.8%
Indeterminate coil/strap handle	1	-	-	-	1
	0.4%	-	-	-	0.3%
Jar rim w/ strap handle	1	-	-	-	1
	0.4%	-	-	-	0.3%
Indeterminate rim	1	-	-	-	1
	0.4%	-	-	-	0.3%
Pitcher rim	1	-	-	-	1
	0.4%	-	-	-	0.3%
Form 47	5	-	-	-	5
	1.8%	-	-	-	1.3%
Total	275	102	2	10	389
	100.0%	100.0%	100.0%	100.0%	100.0%

jar, a San Marcial Black-on-white bowl, and a plain gray olla from Burial 2. In addition, portions of a polished white jar were recovered from Burial 3.

Nine vessels were recovered from two burials at LA 115962. Vessels from Burial 1 included one plain gray pitcher, one San Marcial Black-on-white seed jar, and one San Marcial Black-on-white bowl body. Body sherds from a San Marcial Jar were recovered from Burial 2. Vessels from Burial 3 include one plain gray gourd dipper, one local Mogollon Red-on-brown bowl, one plain gray cooking storage jar with lug, and one San Marcial seed jar. Examples from other proveniences include jar body sherds from plain gray vessels and portions of a San Marcial Black-on-white bowl.

Late Developmental Period

The next distinct archaeological manifestations in the Peña Blanca occupational sequence are the Late Developmental components. Components exclusively assigned to the Late Developmental period are limited to a small sample from LA 6169 and LA 6170 (Table 16.34). A much larger number of sherds from LA 6169 reflect pottery dating to the Late Developmental period, but these assemblages are mixed with pottery associated with Early Developmental components (Table 16.35). Pottery distributions from LA 249 indicate mixtures of pottery reflecting Late Developmental and Classic period occupations. Assemblages dominated by Late Developmental pottery types with some Classic period pottery were noted in Structure 6 at LA 249 (Table 16.36).

The clearest indicator of assemblages dating to the Late Developmental period is the predominance of Kwahe'e Black-on-white. Kwahe'e Black-on-white marks the beginning of a long technological and stylistic tradition of pottery making involving the utilization of distinct clays common along much of the Rio Grande and associated outcrops. This technology seems to reflect the utilization of very widespread volcanic clays and igneous temper that would be available to groups throughout the Rio Grande

Table 16.30. Distribution of Vessel Form by Ware for Mainly Early Developmental with Late Developmental Components from LA 6170

	Gray	White	Red	Brown Plain	Historic Plain	Total
Indeterminate	2	-	-	-	-	2
	0.6%	-	-	-	-	0.5%
Bowl rim	-	1	-	-	-	1
	-	2.6%	-	-	-	0.2%
Bowl body	1	14	1	1	1	18
	0.3%	36.8%	33.3%	100.0%	16.7%	4.5%
Jar neck	20	-	-	-	-	20
	5.7%	-	-	-	-	5.0%
Jar rim	13	-	-	-	-	13
	3.7%	-	-	-	-	3.2%
Jar body	313	21	2	-	-	336
	88.7%	55.3%	66.7%	-	-	83.8%
Jar body with strap or coil handle	1	-	-	-	-	1
	0.3%	-	-	-	-	0.2%
Cloud blower	1	2	-	-	-	3
	0.3%	5.3%	-	-	-	0.7%
Seed jar rim	1	-	-	-	-	1
	0.3%	-	-	-	-	0.2%
Body sherd polished inter/unpolished ext.	-	-	-	-	5	5
	-	-	-	-	83.3%	1.2%
Indeterminate rim	1	-	-	-	-	1
	0.3%	-	-	-	-	0.2%
Total	353	38	3	1	6	401
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.31. Distribution of Vessel Form by Ware for Mainly Early Developmental with Late Developmental Components from LA 115862

	Gray	White	Red	Brown Plain	Total
Bowl body	1	5	1	-	7
	1.7%	62.5%	100.0%	-	10.0%
Jar neck	11	-	-	1	12
	18.3%	-	-	100.0%	17.1%
Jar body	48	3	-	-	51
	80.0%	37.5%	-	-	72.9%
Total	60	8	1	1	70
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.32. Distributions of Vessel Form by Ware Mainly Developmental with Coalition Components from LA 6171

	Gray	White	Red	Plain	Glaze	Total
Indeterminate	-	-	1	1	-	2
	-	-	8.3%	20.0%	-	0.4%
Bowl rim	-	2	-	-	-	2
	-	8.3%	-	-	-	0.4%
Bowl body	-	8	3	1	1	13
	-	33.3%	25.0%	20.0%	100.0%	2.4%
Jar neck	40	-	1	1	-	42
	8.0%	-	8.3%	20.0%	-	7.7%
Jar rim	10	-	-	-	-	10
	2.0%	-	-	-	-	1.8%
Jar body	451	14	7	2	-	474
	89.7%	58.3%	58.3%	40.0%	-	87.0%
Jar body with strap or coil handle	1	-	-	-	-	1
	0.2%	-	-	-	-	0.2%
Indeterminate coil/strap handle	1	-	-	-	-	1
	0.2%	-	-	-	-	0.2%
Total	503	24	12	5	1	545
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.33. Vessels from Early Developmental Sites

Site/ Provenience	Vessel No.	Type	Temper	Vessel Form	Condition	Paint	Slip	Wear and Sooting	Rim Dia.	Height
LA 265, Burial 6	1	Plain gray (Lino)	Sand	Pitcher	100%	None	None	Wear on both, rim partially chipped	7	14
LA 265, Burial 3	2	Plain gray (Lino)	Sand	Beaker jar with handle	100%	None	None	Light sooting	7.5	10
LA 265, Burial 3	3	Plain gray (Lino)	Sand	Pitcher	100%	None	None	Light sooting	6.5	17.5
LA 265, Burial 4	4	Slipped (Tallahogan) red	Sand	Seed jar	100%	None	Red	Slight basal erosion	9	14
LA 265, Burial 4	5	Plain gray (Lino)	Sand	Indeterminate jar	40%	None	None	None	?	?
LA 6169, Burial 2	4	San Marcial B/w	Sand	Bowl	30%	None	None	None	19	?
LA 6169, Burial 2	5	San Marcial B/w	Sand	Seed jar	70%	Mineral	None	None	9	19
LA 6169, Burial 2	6	Plain gray (Lino)	Sand	Olla	10%	None	None	None	12	
LA 6169, Burial 3	7	Polished White	Sand	Polished white	?	None	None	?	?	?
LA 115862, Burial 3	1	Plain gray (Lino)	Sand	Gourd dipper	90%	None	None	Fire cloud	4	18
LA 115862, Burial 2	2	San Marcial	Sand	Jar body	10%	Mineral	None	?	?	?
LA 115862, Feature 6	3	San Marcial B/w	Sand	Bowl body	10%	Mineral	None	?	?	
LA 115862, Feature	4	Gray body	Sand	Jar						
LA 115862, Burial 1	5	San Marcial B/w	Sand	Bowl	5%	Mineral	None	?	?	?
LA 115862, Burial 1	6	Plain gray (Lino)	Sand	Pitcher	90%	None	None	None	5.5	11
LA 115862, Burial 3	7	Local red-on-brown	Sand	Bowl	100%	Mineral	None	None	22	12.5
LA 115862, Burial 1	8	San Marcial B/w	Sand	Seed jar	100%	Mineral	None	None	10.5	14.5
LA 115862, Burial 3	9	Plain gray (Lino)	Sand	Jar w/ lug	70%	None	None	None	9.5	13
LA 115862, Burial 3	10	San Marcial B/w	Sand	Seed jar	100%	None	None	None	9.5	19*

Table 16.34. Distribution of Ceramic Types by Site for Late Developmental Components

	LA 6169	LA 6170	Total
Unpainted undifferentiated	8	10	18
	2.6%	4.8%	3.5%
NRG Mineral paint (undifferentiated)	1	3	4
	0.3%	1.4%	0.8%
Kwahe'e B/w (solid designs)	22	3	25
	7.2%	1.4%	4.9%
Kwahe'e B/w (thin parallel line)	2	-	2
	0.7%	-	0.4%
Kwahe'e B/w (hatchured designs)	2	-	2
	0.7%	-	0.4%
Kwahe'e B/w (solid and hatchure)	1	-	1
	0.3%	-	0.2%
Kwahe'e B/w (checkerboard)	2	-	2
	0.7%	-	0.4%
Kwahe'e B/w	1	-	1
	0.3%	-	0.2%
Santa Fe B/w	3	-	3
	1.0%	-	0.6%
Galisteo B/w	2	-	2
	0.7%	-	0.4%
NRG Plain rim	3	1	4
	1.0%	0.5%	0.8%
NRG Plain body	56	35	91
	18.4%	16.9%	17.8%
NRG Indented Corrugated	16	20	36
	5.2%	9.7%	7.0%
NRG Incised Corrugated	-	1	1
	-	0.5%	0.2%
NRG Plain Corrugated	30	36	66
	9.8%	17.4%	12.9%
NRG Smeared Plain Corrugated	28	15	43
	9.2%	7.2%	8.4%
NRG Smeared Indented Corrugated	-	3	3
	-	1.4%	0.6%
NRG Neck Corrugated	-	1	1
	-	0.5%	0.2%
Kapo Gray	-	1	1
	-	0.5%	0.2%
MRG Plain rim	1	4	5
	0.3%	1.9%	1.0%
MRG Plain body	88	60	148
	28.9%	29.0%	28.9%
MRG Wide Neckbanded	1	-	1
	0.3%	-	0.2%
Wide Neckbanded (wiped)	1	-	1
	0.3%	-	0.2%
MRG Indented Corrugated	2	1	3
	0.7%	0.5%	0.6%
MRG Smeared Plain Corrugated	2	1	3
	0.7%	0.5%	0.6%
MRG Polished gray	1	-	1
	0.3%	-	0.2%
MRG Unpainted undifferentiated	3	6	9
	1.0%	2.9%	1.8%
MRG Mineral Paint (undiff)	5	3	8
	1.6%	1.4%	1.6%
Escavada solid designs	4	-	4
	1.3%	-	0.8%

Table 16.34. Continued.

	LA 6169	LA 6170	Total
Gallup B/w	1	-	1
	0.3%	-	0.2%
San Marcial B/w	3	-	3
	1.0%	-	0.6%
Puerco B/r	2	-	2
	0.7%	-	0.4%
MRG Slipped Red over white paste	-	1	1
(Tallahogan-like)	-	0.5%	0.2%
Keres Utility Ware	-	1	1
	-	0.5%	0.2%
Jornada Brown body	2	-	2
	0.7%	-	0.4%
Unpainted Socorro paste	1	-	1
	0.3%	-	0.2%
Socorro B/w (solid designs)	8	-	8
	2.6%	-	1.6%
Socorro B/w (hatchured designs)	2	-	2
	0.7%	-	0.4%
Socorro B/w (hatchured and solid design	1	-	1
	0.3%	-	0.2%
Alma Plain body	-	1	1
			0.5%
Total	305	207	512
	100.0%	100.0%	100.0%

Valley. This tradition began during the Late Developmental period and continues with pottery produced by modern Pueblos in this area. Kwahe'e Black-on-white is distinguished from later Rio Grande types such as Santa Fe Black-on-white by decorations executed in mineral paint. Other decorated types associated with Kwahe'e phase components include Cibola tradition types such as Red Mesa, Gallup, and Escavada Black-on-white, as well as Socorro Black-on-white, Chupadero Black-on-white, and White Mountain Red types. A few Santa Fe Black-on-white and Galisteo Black-on-white sherds associated with components assigned to the Late Developmental period could represent contaminants from the Coalition component, or organic-painted pottery associated with the very end of this period, or a transition into the Early Coalition period.

Other technological changes are reflected in the associated gray ware pottery. An important shift which occurred during the Late Developmental period is the occurrence of significant and sometimes dominant frequencies

Table 16.35. Distribution of Ceramic Type by Site for Mainly Late Developmental with Early Developmental Components

	LA 6169
Unpainted (undifferentiated white)	6 0.6%
Indeterminate Mineral paint undifferentiated	1 0.1%
Unpainted undifferentiated	36 3.3%
NRG Mineral paint (undifferentiated)	1 0.1%
Kwahe'e B/w (solid designs)	11 1.0%
Kwahe'e B/W (thin parellel designs)	38 3.5%
Kwahe'e B/W (thick parallel lines)	1 0.1%
Kwahe'e B/w (hatchured designs)	6 0.6%
Kwahe'e B/w (checkerboard)	1 0.1%
Santa Fe B/w	10 0.9%
Galisteo B/w	20 1.9%
NRG Plain rim	6 0.6%
NRG Plain body	313 29.0%
NRG Wide Neckbanded	1 0.1%
NRG Wide Neckbanded (wiped or undulated)	1 0.1%
NRG Indented Corrugated	16 1.5%
NRG Plain Corrugated	53 4.9%
NRG Smeared Plain Corrugated	144 13.4%
NRG Smeared Indented Corrugated	5 0.5%
NRG Mudware	1 0.1%
MRG Plain rim	7 0.6%
MRG Plain body	255 23.7%
Wide Neckbanded (wiped)	1 0.1%

Table 16.35. Continued.

	LA 6169
MRG Indented Corrugated	2 0.2%
MRG Plain Corrugated	1 0.1%
MRG Smeared Plain Corrugated	1 0.1%
MRG Low Relief Corrugated	2 0.2%
MRG Unpainted undifferentiated	62 5.8%
MRG Mineral Paint (undiff)	17 1.6%
Red Mesa B/w	1 0.1%
Escavada solid designs	5 0.5%
Gallup B/w	1 0.1%
San Marcial B/w	5 0.5%
White Mountain Red (undifferentiated)	2 0.2%
Wingate B/r	4 0.4%
WMR Slipped Red over white paste (Tallahogan-like)	6 0.6%
Unpainted with Chupadero paste	1 0.1%
Chupadero B/w (solid design)	1 0.1%
Chupadero B/w (hatchured design)	1 0.1%
Chupadero B/w (hatchured and solid design)	3 0.3%
Jornada Brown body	2 0.2%
Socorro B/w	2 0.2%
Socorro B/w (solid designs)	10 0.9%
Socorro B/w (hatchured designs)	9 0.8%
Socorro B/w (hatchured and solid designs)	6 0.6%
Total	1078 100.0%

Table 16.36. Distribution of Ceramic Types by for Mainly Late Developmental with Classic Components

	LA 249
Indeterminate Mineral paint undifferentiated	1
	0.2%
Unpainted undifferentiated	41
	6.5%
NRG Mineral paint (undifferentiated)	9
	1.4%
NRG Pueblo II (indeterminate mineral)	3
	0.5%
Kwahe'e B/w (solid designs)	14
	2.2%
Kwahe'e B/w (thin parallel line)	5
	0.8%
Kwahe'e B/W (thick parallel lines)	6
	1.0%
Kwahe'e B/w (hatchured designs)	10
	1.6%
Kwahe'e B/w (solid and hatchure)	2
	0.3%
Kwahe'e B/w	5
	0.8%
Santa Fe B/w	1
	0.2%
Biscuit Ware Unpainted	2
	0.3%
Jemez B/w	8
	1.3%
NRG Plain rim	9
	1.4%
NRG Unknown rim	6
	1.0%
NRG Plain body	176
	28.0%
NRG Indented Corrugated	147
	23.4%
NRG Plain Corrugated	27
	4.3%
NRG Smeared Plain Corrugated	52
	8.3%
NRG Smeared Indented Corrugated	20
	3.2%
NRG Mudware	1
	0.2%
MRG Plain rim	3
	0.5%
4103 MRG Plain body	17
	2.7%
MRG Unpainted undifferentiated	2
	0.3%
MRG Mineral Paint (undiff)	1
	0.2%
Escavada solid designs	3
	0.5%
Puerco B/r	1
	0.2%
Keres Utility Ware	4
	0.6%
Glazed red (unpainted)	21
	3.3%
Glaze yellow/cream slipped (unpainted)	1
	0.2%
Glaze brown/tan (unpainted)	5
	0.8%
Glaze-on-red (undiff)	16
	2.5%
Glaze-on-yellow cream	4
	0.6%
Glazed-on-brown/tan	3
	0.5%
5450 Aqua Fria Glaze A	2
	0.3%
Total	628
	100.0%

of sherds with micaceous paste and granite temper. This paste has been noted in gray ware assemblages spanning long periods and scattered through much of the Northern Rio Grande region. These gray ware types commonly display plain and corrugated exteriors. Unfortunately, it is often difficult to distinguish between plain wares from Late Developmental sites and those deriving from Early Developmental period components or the associated corrugated form derived from Coalition period sites. For either type of texture, a high frequency of forms tempered with micaceous granite appears to be a good indicator of association with Late Developmental components. The dominance of similar micaceous temper was noted for utility wares from Late Developmental assemblages recovered during excavations of the Cochiti Dam Project (Honea 1971b).

The Late Developmental period, as commonly applied to the Rio Grande region, refers to occupations dating sometime between AD 900 and 1200. All Late Developmental occupations identified at Peña Blanca sites seem to date to the later part of this phase. The Late Developmental period as normally defined for the Rio Grande region encompasses widespread archaeological manifestations that can be easily divided into two distinct phases including the Red Mesa and Kwahe'e phases.

The Red Mesa phase as defined for the Rio Grande region dates from about AD 900 to 1050 and is recognized by the occurrence of Red Mesa Black-on-white as the dominant white ware type. The vast majority of the Red Mesa Black-on-white from sites in the Rio Grande region exhibit characteristics similar to that noted for Red Mesa Black-on-white common in Anasazi sites on the Colorado Plateau as well as other regions of the Southwest (McNutt 1969). It is likely that much of the Red Mesa Black-on-white pottery from Rio Grande sites originated on the Colorado Plateau.

Characteristics of ceramic assemblages from Red Mesa phase sites found throughout the Rio Grande region tend to be very similar. Utility wares at Red Mesa phase sites are still dominated by plain utility wares, although neck and rim forms usually display wide coil, smeared coil, narrow coil, and clapboard coil treatments. Corrugated pottery, if present at all, tends to be extremely rare.

The Kwahe'e phase represents the next phase in the Late Developmental sequence and appears to date from about AD 1050 to about AD 1200. Sites assigned to the Kwahe'e phase have been documented over much of the Rio Grande region, but are best known from assemblages north of Santa Fe such as the Tewa Basin (Ellis 1975; McNutt 1969; Mera 1935; Stubbs 1954; Wiseman 1989, 1995). White ware forms exhibit similar decorative styles to those noted in contemporaneous Anasazi types from the Colorado Plateau. Pottery produced locally in the Rio Grande Valley is represented by Kwahe'e Black-on-white. Intrusive pottery types include Gallup Black-on-white, Escavada Black-on-white, Socorro Black-on-white, and Chupadero Black-on-white. While forms exhibiting corrugated exteriors are present, they tend to occur in lower frequencies than noted at contemporaneous sites on the Colorado Plateau. Utility wares exhibit plain, neckbanded, and corrugated exterior textures. Thus, many assemblages associated with this phase are characterized by a very wide range of gray ware forms. The great majority of utility wares from areas of the Northern Rio Grande that were most heavily occupied during the Kwahe'e period exhibit high-iron micaceous paste and crushed granite temper.

Types occurring at contemporary sites in the Albuquerque area to the south also display influences from the northeastern Mogollon Highlands (Lang 1982; Mera 1935). White wares are mainly represented by Socorro Black-on-white, which appears to have evolved out of Reserve Black-on-white. Utility wares include those of Mogollon derivation.

All of the Peña Blanca ceramic assemblages assigned to Late Developmental period components appear to date sometime during the Kwahe'e phase as normally defined. While an occupational gap seems to be represented by the absence of Peña Blanca sites dating to the Red Mesa phase in the tenth or early eleventh century, LA 272 (the Dead Horse site) investigated during the Cochiti Dam Project (Snow 1971b) reflects an occupation that dates sometime between the Early Developmental and Late Developmental phase components as recognized during the Peña Blanca Project. This site consists of a pithouse settlement located on top of a narrow mesa near the confluence of the Rio Grande and the Santa Fe River. As part of the Peña Blanca investigations, a sample of sherds from LA 272 was examined. Observations from these examinations as well as data presented in the site report for LA 272 indicate a combination of pottery very distinct from that of any Peña Blanca component. The great majority of white ware sherds appear to be derived from Red Mesa Black-on-white vessels tempered with sand and sometimes with sherd. A much lower proportion of pottery exhibiting pastes and styles similar to those previously described in this report as San Marcial was also noted. This pottery appears to have been assigned to Piedra Black-on-white during the Cochiti Dam Project (Snow 1971b). Gray ware pottery includes both sand-tempered forms classified as Lino Gray during Cochiti Dam studies and mica- and granite-tempered forms originally classified as Peña Blanca Gray (Honea 1971b). Most textured forms exhibited obliterated neckbanded treatments similar to forms previous assigned to Peña Blanca Gray (Honea 1971b). While LA 272 did not yield independent dates, based on distributions of recognized pottery types, this site was assigned to a date sometime between AD 850 and 950. Given the styles associated with the apparently intrusive Red Mesa Black-on-white, this site may likely date some time from the late ninth to the beginning of the eleventh century. Thus, LA 272 seems to span the period between components from Peña Blanca sites assigned to the Early Developmental and Late Developmental period.

Almost all the other ceramic period components identified during the Cochiti Dam project that date prior to the Coalition period were assigned to the Kwahe'e phase (Biella and Chapman 1977b; Bussey 1968a, 1968b; Honea 1968). Most of the information concerning Late Developmental occupations in this area is based on two sites (LA 6461 and LA 6462) reflecting relatively long and substantial occupations during the Kwahe'e phase. The earliest components at LA 6462 (North Bank site) date to the Late Developmental period. Tree-ring dates seem to indicate an occupation in the first half of the twelfth century. White wares from this site are dominated by Kwahe'e Black-on-white and several related mineral-painted pottery types, which would be defined here as Kwahe'e Black-on-white. Over 80 percent of the utility wares are tempered with a micaceous granite. These utility wares appear to exhibit a wide range of surface textures.

Contexts from two Peña Blanca assemblages assigned to Late Developmental components during the present study yielded archaeomagnetic dates. The curve associated with samples recovered from Structure 5A (a mealing room) at LA 6170 suggests two distinct spans. The earliest of these dated sometime between AD 1035 and 1080, while the later was between AD 1190 and 1240. The small number of sherds from this feature include a single Kwahe'e Black-on-white sherd. Thus, this assemblage appears to date sometime during the Kwahe'e period. The earlier date span is well within the range defined for the Kwahe'e phase, although it may reflect occupation during the earlier range of this phase. The occurrence of Kwahe'e Black-on-white and Cibola types as the dominant decorated types and roughly equal proportions of gray wares with plain exterior textures (see Table 16.34) and the presence of gray wares primarily tempered with micaceous granite with a wide range of textures also appear to support an eleventh-century occupation.

Late Developmental components from LA 249 did not yield independent dates. Contexts from the pithouse excavated along the right-of-way yielded assemblages dominated by Late Developmental pottery with a mix of Classic period types indicating contemporaneity with the Late Developmental component at LA 6170 (Table 16.36). Similarities between the two assemblages include the occurrence of Kwahe'e Black-on-white as the dominant white ware type and the dominance of utility wares often tempered with crushed granite, but exhibiting a wide range of tempers. Just under half the gray ware pottery exhibit corrugated exteriors. This combination of traits supports an interpretation of contemporaneity for the Late Developmental components at LA 249 and LA 6170.

The other component with an archaeomagnetic date from a context assigned to the Late Developmental period based on pottery distributions was from Structure 76 at LA 6169. Interestingly, this feature dated AD 1205 or just into the Coalition period as normally defined. Components from Structure 76 were placed into the Kwahe'e phase based on the presence of significantly more Kwahe'e Black-on-white than Santa Fe Black-on-white. Pottery assemblages associated with Structure 76, however, exhibit a very different range of pottery than for those from the other Peña Blanca assemblages and the Cochiti Dam Project assigned to the Kwahe'e phase.

Possible variation in the distribution of pottery types associated with Late Developmental assemblages from different sites and components may indicate temporal differences. Such a possibility is reflected by the occurrence of Galisteo Black-on-white, a range of Cibola White Ware types, Chupadero Black-on-white, and Socorro Black-on-white in Structure 76. The majority of gray wares are tempered with micaceous granite. The frequency of gray wares exhibiting corrugated exteriors from Structure 76 is slightly lower than that noted at early Late Developmental components.

The wide range of non-local types associated with Kwahe'e Black-on-white in Structure 76 from LA 6169 is unique and important. The occurrence of Socorro Black-on-white, along with mica-tempered utility wares, Mogollon Brown Wares, Kwahe'e Black-on-white, and very low frequencies of Santa Fe Black-on-white also resembles distributions noted at Socorro phase sites in the Albuquerque area (Hill 1995; Post 1994). While Socorro Black-on-white continues to have been produced during the Coalition period at most sites in the Albuquerque area, local organic-painted varieties of Santa Fe Black-on-white are common at sites dating after AD 1200 (Hammack 1966). Sites in the Albuquerque area assigned to the Socorro phase are postulated to date sometime between AD 1150 and 1200. The occurrence of low frequencies of Santa Fe Black-on-white and Galisteo Black-on-white in assemblages dominated by Socorro Black-on-white may be seen as evidence of an occupation dating sometime during the turn of the thirteenth century.

A similar combination of pottery was also noted at dated contexts from LA 12121 excavated in the Cochiti Dam flood pool (Traylor and Scaife 1983). Assemblages containing a combination of Kwahe'e Black-on-white, Socorro Black-on-white, Mancos Black-on-white, and Puerco or Wingate Black-on-red were recovered from contexts yielding mid to late AD 1100s tree-ring dates. Archaeomagnetic dates from this site seem to suggest an abandonment just before AD 1200.

Given the AD 1205 date and pottery distributions associated with contexts from Structure 76, a case could have also been made to assign this assemblage to the earliest span of the Early Coalition period. While the predominance of Kwahe'e Black-on-white over Santa Fe Black-on-white and utility wares tempered with crushed granite over anthill sand formed the basis for the assignment to the Late Developmental period, these assemblages were clearly transitional between the two periods as normally defined. This distinct transitional phase is recognized by combinations of pottery described in other studies for the Kwahe'e, Santa Fe, and Socorro phases. The recognition of a distinct transitional period between the Late Developmental and Coalition periods in the Santo Domingo Valley has important ramifications concerning the timing and nature of the transition from the Late Developmental to Early Coalition period. The documentation of this period represents one of two unique contributions, along with the detailed descriptions of the Early Developmental components, relating to the culture history of this area of the Rio Grande region resulting from investigations of the Peña Blanca project. Discussions of Late Developmental trends will be based on comparisons of these two temporally distinct components.

Patterns of Production: Regional Interaction and Exchange. Several lines of evidence suggest influences or movements of populations into the Northern Santo Domingo Basin from areas of the Rio Grande region to the north sometime during the Late Developmental period. One indicator of such influences is evidence of similarities in ceramic traits associated with Kwahe'e phase occupations in the Santo Domingo Basin and contemporaneous pottery from areas to the northeast such as the Tewa Basin and Santa Fe Valley. By AD 900, most of the Early Developmental sites in the Northern Santo Domingo Basin area and other localities of the Middle Rio Grande appear to have been abandoned. At about the same time, areas north of La Bajada appear to have been first occupied by ceramic-producing groups characteristic of the Red Mesa phase. While Late Developmental occupations in the Northern Rio Grande region reflect some ceramic traits that appear to have derived from the Colorado Plateau to the west, they exhibit even more characteristics distinct to the Rio Grande region. Many of the characteristics of Late Developmental period pottery from the Cochiti area are remarkably similar to those noted at contemporary sites in areas of the Northern Rio Grande such as the Tewa Basin and the Santa Fe Valley. This suggests that many of the manufacturing and decorative technologies that appeared over large areas of the Rio Grande including the Santa Domingo Basin during the Kwahe'e phase could have been derived from areas to the north, such as the Tewa Basin.

Even with a definite gap in occupation covering the late ninth to early eleventh centuries represented in the Peña Blanca components, information from LA 272 investigated during the Cochiti Dam Project provides some clues about the nature of the transition in regional connections and interaction during this span. Many of the utility ware sherds from LA 272 display micaceous granite temper and high iron pastes similar to those dominating Late Developmental sites in the Tewa Basin as well as Kwahe'e period sites in the Santo Domingo Basin. About one-fourth of the utility wares from this site display combinations of sand temper and low iron pastes similar to that dominating the great majority of utility ware sherds documented for Early Developmental components from Peña Blanca sites. Thus, pottery from LA 272 may reflect the beginning of a shift to increased interaction and influence from grouy Developmental components from Peña Blanca sites. Thus, pottery from LA 272 may reflect the beginning of a shift to increased interaction and influence with groups from areas of the Rio Grande region to the north.

Distributions of pastes and temper noted at Kwahe'e period components from Peña Blanca sites indicate the continuation of similar trends and regional connections. Pastes of both gray ware and white ware types tend to fire to red or yellow-red in color (Table 16.37). Color differences as well as other characteristics of this clay, such as paste texture, indicate the local utilization of very distinct clay sources. Also of significance are changes in temper present in both gray and white ware pottery. Distributions of temper by ware from Late Developmental components are illustrated for sites LA 6169 (Table 16.38), LA 6170 (Table 16.39), and LA 249 (Table 16.40). Similar distributions were noted for components dominated by Late Developmental pottery with the addition of Classic period pottery at LA 249 (Table 16.40), and in Late Developmental components with the addition of Early Developmental and Coalition period pottery at LA 6169 (Table 16.41). The majority of the utility wares were assigned to a crushed granite and mica category, while a lower but significant frequency were tempered with sand.

Similar temper distributions were noted in Developmental period gray wares examined during the Cochiti Dam Project (Honea 1968). These differences are also reflected in typological-based assignments of sherds with granite and mica temper to the Northern Rio Grande tradition and those tempered with sand to the Middle Rio Grande tradition. Petrographic studies indicated that the dominant temper for Late Developmental gray wares is a self-tempered clay with granitic fragments derived from a muscovite-bearing granite/gneiss (Appendix 1). Similar tempers were noted in gray ware types from Late Developmental sites excavated during the Cochiti Dam Project, where 80 percent of the utility ware was characterized as being tempered with weathered rock and sand and 20 percent with sand or weathered rock (Honea 1968). A brief examination of samples of gray ware sherds from Late Developmental components at Red Snake Hill investigated during the Cochiti Dam Project indicate that the dominant temper is identical to that recorded as granite and mica during the Peña Blanca Project. This temper also appears identical to that dominating utility wares from Developmental period sites in the Tewa Basin (Wilson 2000) as well as later sites at Arroyo Hondo (Habicht-Mauche 1993). Thus, micaceous pastes common in utility wares at

Table 16.37. Refiring of Sherds from Late Developmental Components

	2.5YR	5YR	7.5YR	10YR	Total
MRG Corrugated	7	32	2	-	41
	17.1%	78.0%	4.8%	-	
NRG Plain Body	-	11	-	-	11
	-	100.0%	-	-	
NRG Corrugated	3	18	-	-	21
	14.3%	85.7%	-	-	
Kwahee B/w	1	9	-	2	12
	8.3%	75.0%	-	16.7%	
Total	11	70	2	2	85
	12.4%	82.4%	2.4%	2.4%	

Table 16.38. Distribution of Temper by Ware for Late Developmental Components from LA 6169

	Gray	White	Red	Brown	Total
Sand	89	8	-	-	97
	38.9%	11.1%	-	-	31.8%
Mica, quartz, and feldspar	133	-	-	-	133
fragments (schist granite)	58.1%	-	-	-	43.6%
Sherd	-	3	2	-	5
	-	4.2%	100.0%	-	1.6%
Sherd and sand	-	16	-	-	16
	-	22.2%	-	-	5.2%
Fine tuff or ash	-	5	-	-	5
	-	6.9%	-	-	1.6%
Fine tuff and sand	-	36	-	-	36
	-	50.0%	-	-	11.8%
Fine sandstone	1	-	-	-	1
	0.4%	-	-	-	0.3%
Fine Jornada temper	-	-	-	2	2
	-	-	-	100.0%	0.7%
Dark igneous and sherd	-	1	-	-	1
	-	1.4%	-	-	0.3%
Anthill sand	6	-	-	-	6
	2.6%	-	-	-	2.0%
Oblate shale and sand	-	1	-	-	1
	-	1.4%	-	-	0.3%
Mica and tuff	-	1	-	-	1
	-	1.4%	-	-	0.3%
Multi-lithic Sand	-	1	-	-	1
	-	1.4%	-	-	0.3%
Total	229	72	2	2	305
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.39. Distribution of Ware by Temper for Late Developmental Components from LA 6170

	Gray	White	Red	Historic Plain	Total
Sand	61	7	1	-	69
	34.3%	28.0%	100.0%	-	33.3%
Mica, quartz, and feldspar fragments	112	-	-	-	112
(schist granite)	62.9%	-	-	-	54.1%
Sherd and sand	-	1	-	-	1
	-	4.0%	-	-	0.5%
Fine tuff or ash	-	1	-	-	1
	-	4.0%	-	-	0.5%
Fine tuff and sand	-	13	-	2	15
	-	52.0%	-	66.7%	7.2%
Gray crystalline basalt	-	-	-	1	1
	-	-	-	33.3%	0.5%
Oblate shale and sand	5	1	-	-	6
	2.8%	4.0%	-	-	2.9%
Mica, tuff, and sand	-	2	-	-	2
	-	8.0%	-	-	1.0%
Total	178	25	1	3	207
	100.0%	100.0%	100.0%	100.0%	100.0%

Kwahe'e phase sites in the Northern Santo Domingo Basin are very similar to those noted in Northern Rio Grande gray wares produced over a much longer span (Warren 1979a). Pottery vessels containing this temper were assumed to have been traded from sites located at the western and southern edge of the Sangre de Cristo Mountains, or river cobbles from the Santa Fe River or Rio Grande that were ultimately derived from these mountains could have been used (Warren 1979a). Whatever the source of pottery from Northern Santo Domingo Basin sites containing this temper, its occurrence reflects a technology that was derived from or was closely connected to other areas along the Rio Grande.

Local white ware types from Late Developmental period occupations are dominated by fine tempers such as ash, tuff, and fine natural silt inclusions. Petrographic analysis indicates that the clay used in these types consists of a silty clay, which is distinct from that used in the production of San Marcial Black-on-white (Carpenter and Reed, Appendix 1). The presence of ash flow tuff grains and the high density of ferromagnesium minerals in the paste suggest that the clay is volcanic in origin. Tuff tempers, which appear to be similar, were also noted in Kwahe'e Black-on-white from Peña Blanca and Cochiti Dam sites (Honea 1968). Similar pastes from Arroyo Hondo were attributed to production in the Tewa Basin north of Santa Fe (Habicht-Mauche 1993). A variety of other tempers noted in white wares from Early Developmental sites suggest pottery originating in several distinct regions.

The presence of various combinations of temper types, surface manipulations, and design styles resulted in the placement of pottery from Developmental sites into a number of distinct traditions. Distributions of pottery traditions by ware are illustrated for components either dominated or mainly represented by Late Developmental pottery in Tables 16.42 through 16.45. As previously noted, temper and paste distributions associated with the majority of both the gray and white wares resulted in their assignment to Northern Rio Grande types. An important and currently unresolved issue concerns whether the majority of this pottery was traded from areas to the north where similar pottery was produced over long periods, or if the dominance of Rio Grande gray wares at Late Developmental components in the Northern Santo Domingo Basin represents the extension of Northern Rio Grande pottery technologies into a new area.

Whatever the actual nature of this influ-

Table 16.40. Distribution of Ware by Temper for Mainly Late Developmental with Classic Components from LA 249

	Gray	White	Red	Glaze	Historic Plain	Historic Decorated	Total
Indeterminate	-	1	-	-	-	-	1
	-	1.0%	-	-	-	-	0.2%
Sand	21	4	-	-	-	-	25
	4.6%	3.8%	-	-	-	-	4.0%
Mica, quartz, and	398	1	-	1	-	-	400
feldspar fragments (schist granite)	86.9%	1.0%	-	1.9%	-	-	63.7%
Similar to (3), but	14	-	-	-	-	-	14
without mica	3.1%	-	-	-	-	-	2.2%
Sherd and sand	-	-	1	-	-	-	1
	-	-	100.0%	-	-	-	0.2%
Fine tuff or ash	6	48	-	1	-	8	63
	1.3%	45.7%	-	1.9%	-	100.0%	10.0%
Fine tuff and sand	5	40	-	1	-	-	46
	1.1%	38.1%	-	1.9%	-	-	7.3%
Fine sandstone	-	4	-	-	-	-	4
	-	3.8%	-	-	-	-	0.6%
Gray crystalline	-	-	-	36	4	-	40
basalt	-	-	-	69.2%	100.0%	-	6.4%
Self tempered	1	-	-	-	-	-	1
	0.2%	-	-	-	-	-	0.2%
Latite (Keres area)	-	-	-	7	-	-	7
	-	-	-	13.5%	-	-	1.1%
Basalt and sand	-	-	-	6	-	-	6
	-	-	-	11.5%	-	-	1.0%
Mica and tuff	1	2	-	-	-	-	3
	0.2%	1.9%	-	-	-	-	0.5%
Mica, tuff, and sand	12	5	-	-	-	-	17
	2.6%	4.8%	-	-	-	-	2.7%
Total	458	105	1	52	4	8	628
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

ence may have been, it is likely that the pottery technology characteristic of the Kwahe'e phase occupation in the Northern Santo Domingo Basin did not develop locally out of technologies associated with Early Developmental occupations. Instead, their appearance reflects the movement of technologies or populations from areas of the Rio Grande to the north and in some cases to the south. Other evidence indicates that the appearance of Kwhae'e phase occupations in the Northern Santo Domingo Basin reflect a much larger trend of expansion of similar pottery technologies over wide areas of the Middle and Northern Rio Grande (Cordell 1979; Lang 1982; Sundt 1979).

Other areas may have experienced a similar trend. An example is the Kwahe'e period of the Puerco Valley, documented during the Puerco Project in the Middle Puerco Valley based on the occurrence Kwahe'e Black-on-white (Hurst 1991). In the Puerco Valley, the Kwahe'e period follows a long series of occupational periods dominated by pottery types of the Cibola Anasazi tradition. Pottery associated with the Kwahe'e phase in the Puerco Valley is also represented by a major increase

Table 16.41. Distribution of Ware by Temper for Mainly Late Developmental with Early Developmental and Coalition Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	-	7	-	-	7
	-	2.7%	-	-	0.6%
Sand	264	84	6	-	354
	32.6%	32.9%	50.0%	-	32.8%
Mica, quartz, and feldspar fragments	539	-	-	-	539
(schist granite)	66.6%	-	-	-	50.0%
Sherd	-	49	6	-	55
	-	19.2%	50.0%	-	5.1%
Sherd and sand	-	13	-	-	13
	-	5.1%	-	-	1.2%
Fine tuff or ash	-	21	-	-	21
	-	8.2%	-	-	1.9%
Fine tuff and sand	-	44	-	-	44
	-	17.3%	-	-	4.1%
Fine sandstone	-	5	-	-	5
	-	2.0%	-	-	0.5%
Fine Jornada temper	-	-	-	2	2
	-	-	-	100.0%	0.2%
Self tempered	1	-	-	-	1
	0.1%	-	-	-	0.1%
Dark igneous and sherd (Chupadero)	-	19	-	-	19
	-	7.5%	-	-	1.8%
Dark igneous and sand	-	2	-	-	2
	-	0.8%	-	-	0.2%
Anthill sand	5	-	-	-	5
	0.6%	-	-	-	0.5%
Oblate shale and sand	-	7	-	-	7
	-	2.7%	-	-	0.6%
Mica and tuff	-	1	-	-	1
	-	0.4%	-	-	0.1%
Dark sand	-	1	-	-	1
	-	0.4%	-	-	0.1%
Very Fine Sand (silt)	-	2	-	-	2
	-	0.8%	-	-	0.2%
Total	809	255	12	2	1078
	100.0%	100.0%	100.0%	100.0%	100.0%

in recognizable intrusive types.

Thus, traits noted in Late Developmental assemblages in the Northern Santo Domingo Basin, as well as surrounding locations, reflect influences, if not the actual movement of populations, from localities in the Northern Rio Grande. The wide variation noted in Kwahe'e Black-on-white from Peña Blanca sites may reflect a combination of locally produced pottery as well as forms that may have originated at sites to the north. During the Cochiti Dam Project such variation was dealt with by assigning pottery that would be described here as Kwahe'e Black-on-white to types defined during this project, such as Borrego Black-on-white and Cholla Black-on-white, based on slight differences in surface treatments and pastes (Honea 1968). During investigations by the Cochiti Dam Project, pottery assigned to Kwahe'e Black-on-white was limited to forms

Table 16.42. Distribution of Ware by Tradition for Late Developmental Components from LA 6169

	Gray	White	Red	Brown Plain	Total
NRG	133	44	-	-	177
	58.1%	61.1%	-	-	58.0%
MRG	96	16	2	-	114
	41.9%	22.2%	100.0%	-	37.4%
Northern Jornada Mogollon	-	-	-	2	2
	-	-	-	100.0%	0.7%
Eastern Mogollon	-	12	-	-	12
	-	16.7%	-	-	3.9%
Total	229	72	2	2	305
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.43. Distribution of Ware by Tradition for Late Developmental Components from LA 6170

	Gray	White	Red	Historic Plain	Total
NRG	112	16	-	-	128
	62.9%	64.0%	-	-	61.8%
Rio Grande (Historic Tewa)	-	-	-	2	2
	-	-	-	66.7%	1.0%
Rio Grande (Historic Keres)	-	-	-	1	1
	-	-	-	33.3%	0.5%
MRG	66	9	1	-	76
	37.1%	36.0%	100.0%	-	36.7%
Total	178	25	1	3	207
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.44. Distribution of Ware by Tradition for Mainly Late Developmental with Classic

	Gray	White	Red	Glaze	Historic Plain	Historic Decorated	Total
Indeterminate	-	1	-	-	-	-	1
	-	1.0%	-	-	-	-	0.2%
Rio Grande (Prehistoric)	438	98	-	-	-	-	536
	95.6%	93.3%	-	-	-	-	85.4%
Rio Grande (Historic Tewa)	-	-	-	-	-	8	8
	-	-	-	-	-	100.0%	1.3%
Rio Grande (Historic Keres	-	-	52	4	-	56	-
	-	-	-	100.0%	100.0%	-	8.9%
Cibola Middle Rio Grande	20	6	1	-	-	-	27
	4.4%	5.7%	100.0%	-	-	-	4.3%
Total	458	105	1	52	4	8	628
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.45. Distribution of Ware by Tradition for Mainly Late Developmental with Early Developmental and Coalition Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	-	7	-	-	7
	-	2.7%	-	-	0.6%
NRG	540	122	-	-	626
	66.7%	47.8%	-	-	58.1%
MRG	269	93	12	-	410
	33.3%	36.5%	100.0%	-	38.0%
Northern Jornada Mogollon	-	6	-	2	8
	-	2.4%	-	100.0%	0.7%
Eastern Mogollon	-	27	-	-	27
	-	10.6%	-	-	2.5%
Total	809	255	12	2	1078
	100.0%	100.0%	100.0%	100.0%	100.0%

thought to have been produced in the Tewa Basin. While subsequent investigations in the area indicate that it is probably not possible on a sherd-by-sherd basis to distinguish pottery produced in the Middle Rio Grande from that produced in areas of the Northern Rio Grande such as the Tewa Basin, the wide variation of "Kwahe'e Black-on-white" from the Northern Santo Domingo Basin may reflect material originating from several areas of the Rio Grande region.

Traits noted in pottery assigned to other decorated traditions reflect small but significant frequencies from areas of the Anasazi region to the west, and the Mogollon region to the south. While Cibola White Ware types such as Escavada, Gallup, and Red Mesa Black-on-white were noted in Peña Blanca assemblages, the total frequency of non-local types tended to be significantly lower than noted in assemblages from the Tewa Basin. White Mountain Redware types appear to be represented in the same very low frequencies as noted for Tewa Basin sites. In contrast, the frequency of pottery such as Socorro Black-on-white and Chupadero Black-on-white known to have been produced in regions to the south, is particularly high in Structure 76 of LA 6169, and indicates increased interaction with areas to the south during the transition from the Late Developmental to Coalition phase. The continuation of such connections may be reflected by the presence of lower but still significant frequencies of Socorro Black-on-white at early Coalition period sites in the Santo Domingo Basin and Galisteo Basin.

It appears that distributions of pottery traditions and types from Late Developmental components in the Northern Santo Domingo Basin not only reflect shifting interaction and influence with the Northern Rio Grande area but also with areas to the south and west where distinct pottery forms were produced. Traits reflecting influences or contacts with areas to the west have sometimes been attributed to the location of Santo Domingo Basin on the very eastern edge of the vast Chacoan system (Mera 1935; Riley 1995). Contemporary developments in the Four Corners areas, however, are probably best viewed as a distinct regional development that represents responses to pan-regional pressures occurring during the eleventh and twelfth century. The movement of groups into the Northern Rio Grande is followed by the local development of a material culture and interaction system that represented a distinct regional system in its own right. This network is referred to here as the Kwahe'e system and is defined by the development and spread of similar pottery technologies and decorative conventions unique to the Rio Grande region. This system is associated with loosely scattered settlements that covered much of the Rio Grande Valley and associated drainages as well as areas to the west in the eastern San Juan Basin along the Puerco Valley and areas as far east as the modern town of Las Vegas, New Mexico. Most of the population lived in areas near the Rio Grande Valley, in many areas still occupied by Puebloan groups. Connections seemed to have been the strongest between areas in the Rio Grande Valley, such as the Taos Valley, Tewa Basin, and Santo Domingo Basin. In many ways the loose nature of the Kwahe'e exchange system is more similar to the network that may have linked the Northern Mogollon and Southern Anasazi groups during the Reserve and Tularosa phases (Wilson 1999), than the "Chacoan" network commonly described for the San Juan Basin and adjacent areas of the Four Corners country. The boundaries of the Kwahe'e system may reflect both ethnic ties (groups sharing a common history and Tanoan language), as well as a regional economic network. The acquisition of desired pottery forms from other regions may have been an important factor facilitating the long-distance movement of pots and reinforcing relationships between these separated groups. In addition, as was the case for contemporaneous regional networks documented in the upland Southwest, long-term social and economic ties between separated areas would have provided for the movement of food or other necessary resources between communities in various areas during times of shortages (Wilson 2000).

While similarities in many of the pottery traits at earlier Late Developmental sites and the late components at Structure 76 at LA 6169 indicate the continuation of some ties and relationships, other traits reflect increased interaction with groups to the south during the transition from the Late Developmental to the Coalition period. This is reflected by the occurrence of significant frequencies of Socorro Black-on-white and Chupadero Black-on-white. Both of these types are distinguished from Kwahe'e Black-on-white by distinct combinations of various rock tempers and crushed sherd.

Another interesting aspect of pottery from these assemblages concerns the very low frequency of organic-painted pottery. Almost twice as many of the organic-painted sherds from Structure 76 were assigned to Galisteo Black-on-white than assigned to Santa Fe Black-on-white. The assignment to Galisteo Black-on-white was based on the presence of lighter pastes with sand temper. It is possible this pottery reflects a sherd-tempered variety of Santa Fe Black-on-white defined for the Albuquerque area. This combination of pastes and temper appears to have been identical to that noted in Socorro Black-on-white from these assemblages. Organic-painted pottery exhibiting similar characteristics was noted at contemporaneous sites in the Albuquerque area by Hill (1995), but were classified as Santa Fe Black-on-white. These trends are in dramatic contrast to later Coalition period assemblages where almost all organic-painted sherds exhibited characteristics resulting in their assignment of Santa Fe Black-on-white. While the appearance of Galisteo Black-on-white in areas of the Middle Rio Grande has often been assumed to reflect influence from or migration of groups producing Mesa Verde Black-on-white in the Mesa Verde region, some occurrences may reflect a derivation out of Socorro Black-on-white. Thus, the spread of Galisteo Black-on-white in areas of the Middle Rio Grande may have resulted from influences from areas to the south.

While it is tempting to assume that the continual dominance of mica and igneous rock temper in utility wares may reflect continual interaction with areas to the north, it should be noted that mica-schist temper dominated gray wares at Socorro phase sites in the Albuquerque area. Still, the characteristics of micaceous granite temper from Late Developmental sites in the Peña Blanca area appear to be distinct from these schist-tempered forms, and trade pottery and influences appear to reflect northern connections. Therefore, a case for less southern influence on utility ware can be made. The only difference noted in mica-tempered utility wares from other Late Developmental phase components and those at Structure 76 was a decline in sherds with corrugated exteriors. Interestingly, the mica-tempered Tijeras Gray wares associated with the Socorro phase in the Albuquerque area are described as dominated by forms with plain exteriors (Hill 1995).

Pottery Forms and Use. Distributions of ware groups and vessel forms at Late Developmental components provide clues concerning the use of ceramic vessels in various activities during the Late Developmental period. Distributions of wares at Late Developmental assemblages are illustrated in Table 16.46, while comparisons of wares by vessel form for Late Developmental or mainly Late Developmental components are illustrated in Tables 16.47 through 16.50. The total frequency of gray ware declines from the Early to Late Developmental period and drops again during the Late Developmental/Coalition transition period (see Table 16.88). The frequency of gray ware forms, while lower than that documented at Early Developmental sites examined during the Peña Blanca Project, is still higher than that noted for contemporaneous sites in the Four Corners area.

Gray wares are characterized by a wide variety of surface textures. In many of these assemblages, there is a mixture of gray ware types dominated by plain and corrugated exteriors. About a 10 percent decline in frequency of corrugated utility wares is represented during the two Late Developmental components.

In contrast to Early Developmental sites, almost all gray ware sherds appear to be derived from wide necked cooking/storage vessels. A wider range of forms is represented in the white wares, which include bowl and jar forms.

Changes in pottery forms appear to reflect a shift toward a more maintainable technology as discussed earlier (Mills 1989). Such changes are reflected by a decrease in utility ware forms and increase in decorated types. Another aspect of this shift is reflected by increased distinctions between gray and white ware forms similar to that noted in the Four Corners area. Thus, gray utility wares are reflected by combinations of shapes, pastes, and surface treatments that reflect specialized cooking forms well suited for numerous heating cycles. In contrast, decorated forms have fine pastes, slipped and polished surfaces, and shapes suited for a wide variety of serving- and storage-related activities. Interestingly, certain trends including total frequency of white wares and corrugated textures for Late Developmental sites from the Peña Blanca area fall between those noted in Late Developmental sites in the Tewa Basin and Pueblo II sites in the Little Colorado Plateau region. This suggests a pottery technology somewhere between that described for contemporaneous occupation in these two other cases. In addition, differences noted between sites apparently dating to different spans of the Late Developmental period indicate a gradual trend to a more maintainable technology in the Northern Santo Domingo Basin.

Table 16.46. Distribution of Ware by Site for Late Developmental Components

	LA 6169	LA 6170	Total
Gray	229	178	407
	75.1%	86.0%	79.5%
White	72	25	97
	23.6%	12.1%	18.9%
Red	2	1	3
	0.7%	0.5%	0.6%
Brown plain	2	-	2
	0.7%	-	0.4%
Historic plain	-	3	3
	-	1.4%	0.6%
Total	305	207	512
	100.0%	100.0%	100.0%

Five reconstructible vessels are associated with the Late Developmental or transitional components at LA 6169 (see Table 16.51). One Kwahe'e Black-on-white bowl was associated with Burial 1, one Kwahe'e Black-on-white canteen was recovered from Burial 7, and portions of a Kwahe'e Black-on-white jar were identified at Burial 9. Two vessels were recovered from Structure 76 and include a Micaceous Plain pitcher and a Kwahe'e Black-on-white jar.

Coalition Period (AD 1200 to 1350)

The Coalition period is assumed to date sometime from AD 1200 to 1350. Coalition phase components are represented by assemblages from both LA 6169 and LA 6171 (Table 16.52). A very small number of sherds from LA 6171 may reflect an occupation dating to the Late Coalition period (Table 16.53). Components from both of these sites include some relatively unmixed Coalition period assemblages as well as those displaying Coalition period ceramics along with mixtures from other temporal periods.

Table 16.47 Distribution of Ware by Vessel Form by Late Developmental Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	1	1	-	-	2
	0.4%	1.4%	-	-	0.7%
Bowl rim	-	22	-	-	22
	-	30.6%	-	-	7.2%
Bowl body	-	31	2	-	33
	-	43.1%	100.0%	-	10.8%
Jar neck	14	4	-	-	18
	6.1%	5.6%	-	-	5.9%
Jar rim	5	1	-	-	6
	2.2%	1.4%	-	-	2.0%
Jar body	208	13	-	2	223
	90.8%	18.1%	-	100.0%	73.1%
Indeterminate coil/strap handle	1	-	-	-	1
	0.4%	-	-	-	0.3%
Total	229	72	2	2	305
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.48. Distribution of Ware by Vessel Form for Late Developmental (8) Components for LA 6170

	Gray	White	Red	Historic Plain	Total
Indeterminate	1	-	-	-	1
	0.6%	-	-	-	0.5%
Bowl rim	1	-	-	-	1
	0.6%	-	-	-	0.5%
Bowl body	-	16	-	-	16
	-	64.0%	-	-	7.7%
Jar neck	18	4	1	-	23
	10.1%	16.0%	100.0%	-	11.1%
Jar rim	5	-	-	-	5
	2.8%	-	-	-	2.4%
Jar body	151	5	-	3	159
	84.8%	20.0%	-	100.0%	76.8%
Indeterminate rim	2	-	-	-	2
	1.1%	-	-	-	1.0%
Total	178	25	1	3	207
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.49. Distribution of Ware by Vessel Form for Mainly Late Developmental with Classic Components from LA 249

	Gray	White	Red	Glaze	Historic Plain	Historic Decorated	Total
Indeterminate	-	-	-	-	-	8	8
	-	-	-	-	-	100.0%	1.3%
Bowl rim	1	15	-	3	-	-	19
	0.2%	14.3%	-	5.8%	-	-	3.0%
Bowl body	1	48	1	17	-	-	67
	0.2%	45.7%	100.0%	32.7%	-	-	10.7%
Jar neck	41	3	-	-	-	-	44
	9.0%	2.9%	-	-	-	-	7.0%
Jar rim	26	4	-	1	-	-	31
	5.7%	3.8%	-	1.9%	-	-	4.9%
Jar body	385	34	-	9	3	-	431
	84.1%	32.4%	-	17.3%	75.0%	-	68.6%
Jar body with strap or coil	-	1	-	-	-	-	1
handle	-	1.0%	-	-	-	-	0.2%
Indeterminate coil/strap	1	-	-	-	-	-	1
handle	0.2%	-	-	-	-	-	0.2%
Miniature pinch pot body	1	-	-	-	-	-	1
	0.2%	-	-	-	-	-	0.2%
Body sherd polished	-	-	-	16	-	-	16
int/ext	-	-	-	30.8%	-	-	2.5%
Body sherd unpolished	-	-	-	-	1	-	1
	-	-	-	-	25.0%	-	0.2%
Body sherd unpolished	-	-	-	5	-	-	5
int/polished ext	-	-	-	9.6%	-	-	0.8%
Body sherd polished	-	-	-	1	-	-	1
int/unpolished ext	-	-	-	1.9%	-	-	0.2%
Indeterminate rim	1	-	-	-	-	-	1
	0.2%	-	-	-	-	-	0.2%
Jar rim w/coil handle	1	-	-	-	-	-	1
	0.2%	-	-	-	-	-	0.2%
Total	458	105	1	52	4	8	628
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Assemblages dating to the Coalition period but also containing low frequencies of pottery associated with Early Developmental (Table 16.54), Early Developmental and Late Developmental (Table 16.55), and Classic (Table 16.56) periods were also noted.

Pottery assemblages associated with Coalition period occupations are easily distinguished from earlier assemblages by the dominance of organic-painted Santa Fe Black-on-white. Other Rio Grande White ware Coalition period assemblages have low frequencies of Kwahe'e Black-on-white, Wiyo Black-on-white, and Galisteo Black-on-white. Decorated pottery types noted from other regions include very low frequencies of White Mountain Redwares and Socorro Black-on-white.

Most of the gray ware sherds from Coalition components exhibit corrugated exteriors including a mixture of plain, corrugated, and smeared corrugated types. A slight majority of gray ware was tempered with anthill sand, with a lesser amount tempered with sand.

The Coalition period is one of the best-known occupations described for the Northern and Middle Rio Grande regions, and is the ear-

Table 16.50. Distribution of Ware by Vessel Form for Mainly Late Developmental with Early Developmental and Coalition Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	7	-	-	-	7
	0.9%	-	-	-	0.6%
Bowl rim	-	27	3	-	30
	-	10.6%	25.0%	-	2.8%
Bowl body	-	96	3	-	99
	-	37.6%	25.0%	-	9.2%
Jar neck	61	19	-	-	80
	7.5%	7.5%	-	-	7.4%
Jar rim	15	3	-	-	18
	1.9%	1.2%	-	-	1.7%
Jar body	712	107	6	2	827
	88.0%	42.0%	50.0%	100.0%	76.7%
Jar body with strap or coil handle	10	-	-	-	10
	1.2%	-	-	-	0.9%
Indeterminate coil/strap handle	2	-	-	-	2
	0.2%	-	-	-	0.2%
Canteen rim	1	1	-	-	2
	0.1%	0.4%	-	-	0.2%
Miniature pinch pot body	1	-	-	-	1
	0.1%	-	-	-	0.1%
Seed jar rim	-	2	-	-	2
	-	0.8%	-	-	0.2%
Total	809	255	12	2	1078
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.51. Reconstructible Vessels from Late Developmental or Coalition Period Components

Site Provenience	Vessel No.	Type	Temper	Vessel Form	Completeness	Paint	Slip	Wear and Sooting	Rim Dia.	Height
LA 6169, Burial 1	1	Kwahe'e B/w	Tuff	Bowl	50%	Mineral	White	Exterior base eroded	21.5	11
LA 6169, Burial 7	2	Kwahe'e B/w	Tuff	Canteen	100%	Mineral	No	None	4.5	10.5
LA 6169, Burial 9	3	Kwahe'e B/w	Tuff	Jar body	50%	Mineral	None	None	?	?
LA 6169, Feature 76	8	RG Plain	Micaceous igneous	Pitcher			None	None		
LA 6169, Feature 76	9	Kwahe'e B/w	Sand and tuff	Jar		Red Mineral	None			
LA 6169	10	Santa Fe B/w	Tuff	Bowl		Organic	White			

liest ceramic period in many areas of the Rio Grande region. Characterizations of pottery from Coalition period occupations are based on investigations of sites scattered throughout the Rio Grande region (Cordell 1979; Crown et al. 1996; Habicht-Mauche 1993; Kidder and Amsden 1931; Lambert 1954; Stubbs and Stallings 1953; Vint 1999; Wendorf 1954). The beginning of the Coalition period is characterized as a time of major population growth and shifts as reflected by both total number of sites and site size (Cordell 1989; Crown et al. 1996; Stuart and Gauthier 1981). Widespread trends documented for this period include population aggregation, construction of massive and formally arranged room blocks, and agricultural

Table 16.52. Distribution of Ceramic Type by Sites for Coalition Components

	LA 6169	LA 6171	Total
Indeterminate Mineral paint undifferentiated	1	-	1
	0.1%	-	0.1%
Unpainted undifferentiated	97	18	115
	5.9%	8.4%	6.2%
NRG Mineral paint (undifferentiated)	1	-	1
	0.1%	-	0.1%
Kwahe’e B/w (solid designs)	1	-	1
	0.1%	-	0.1%
Kwahe'e B/w (thin parallel line)	1	-	1
	0.1%	-	0.1%
Kwahe'e B/w (thick parallel lines)	1	-	1
	0.1%	-	0.1%
Kwahe'e B/w (hatchured designs)	1	-	1
	0.1%	-	0.1%
Santa Fe B/w	285	38	323
	17.3%	17.7%	17.3%
Wiyo B/W	-	3	3
	-	1.4%	0.2%
Biscuit A (Abiquiu B/G)	-	1	1
	-	0.5%	0.1%
Unpainted (Santa Fe paste)	-	1	1
	-	0.5%	0.1%
Galisteo B/w	17	-	17
	1.0%	-	0.9%
NRG Plain rim	2	1	3
	0.1%	0.5%	0.2%
NRG Plain body	29	5	34
	1.8%	2.3%	1.8%
NRG Indented Corrugated	1	-	1
	0.1%	-	0.1%
NRG Plain Corrugated	18	-	18
	1.1%	-	1.0%
NRG Smeared Plain Corrugated	20	2	22
	1.2%	0.9%	1.2%
NRG Smeared Indented Corrugated	2	-	2
	0.1%	-	0.1%
NRG Mudware	25	-	25
	1.5%	-	1.3%
Tewa Buff undifferentiated	-	1	1
	-	0.5%	0.1%
MRG Plain rim	9	1	10
	0.5%	0.5%	0.5%
MRG Unknown rim	2	-	2
	0.1%	-	0.1%
MRG Plain body	329	66	395
	19.9%	30.7%	21.2%
Wide Neckbanded (wiped)	1	-	1
	0.1%	-	0.1%
MRG Indented Corrugated	40	7	47
	2.4%	3.3%	2.5%
MRG Plain Corrugated	125	2	127
	7.6%	0.9%	6.8%
MRG Smeared Plain Corrugated	564	33	597
	34.2%	15.3%	32.0%

Table 16.52. Continued.

	LA 6169	LA 6171	Total
MRG Smeared Indented Corrugated	31	29	60
	1.9%	13.5%	3.2%
MRG Polished gray	10	-	10
	0.6%	-	0.5%
MRG Low relief corrugated	2	-	2
	0.1%	-	0.1%
MRG Unpainted undifferentiated	12	2	14
	0.7%	0.9%	0.8%
MRG Mineral Paint (undiff)	8	2	10
	0.5%	0.9%	0.5%
San Marcial B/w	4	-	4
	0.2%	-	0.2%
White Mountain Red (undifferentiated)	-	1	1
	-	0.5%	0.1%
WMR Slipped Red over white paste	8	1	9
(Tallahogan-like)	0.5%	0.5%	0.5%
Slipped over red paste	3	-	3
	0.2%	-	0.2%
Socorro B/w	-	1	1
	-	0.5%	0.1%
Totals	1650	215	1865
	100.0%	100.0%	100.0%

Table 16.53. Distribution of Ceramic Type by Site for Late Coalition Components

	LA 6171
Unpainted undifferentiated	3
	7.0%
NRG Indeterminate organic paint	1
	2.30%
Santa Fe B/w	1
	2.3%
NRG Plain body	2
	4.7%
NRG Smeared Plain Corrugated	1
	2.3%
MRG Plain body	16
	37.2%
MRG Indented Corrugated	4
	9.3%

Table 16.53.Continued.

	LA 6171
MRG Smeared Plain Corrugated	3
	7.0%
MRG Smeared Indented Corrugated	5
	11.6%
Keres Utility Ware	3
	7.0%
Glazed red (unpainted)	1
	2.3%
Glaze brown/tan (unpainted)	2
	4.7%
Aqua Fria Glaze A	1
	2.3%
Totals	43
	100.0%

intensification (Crown et al. 1996). Such trends are certainly reflected at sites in the Santo Domingo Basin, as investigations conducted as part of the Cochiti Reservoir Project indicate an increase in Coalition period sites (Biella and Chapman 1979). Documented Coalition phase site sizes vary considerably, and include villages with over 200 rooms (Snow 1971a).

Ceramic Dating. Earlier investigations by the Cochiti Dam Project attempted to divide Coalition period assemblages into two periods based on frequencies of Santa Fe Black-on-white versus Wiyo Black-on-white (Warren 1977b). A similar strategy was employed more recently at Arroyo Hondo, which involved the definition of Early Coalition (AD 1200–1250) and Late Coalition (AD 1250–1350) periods. During the first half of the thirteenth century, Santa Fe Black-on-white with similar characteristics appears to have been the

Table 16.54. Distribution of Ceramic Type by Sites for Mainly Coalition with Early Developmental Components

	LA 6169	LA 6171	Total
Indeterminate utility ware	-	2	2
	-	0.2%	0.1%
Unpainted undifferentiated	38	37	75
	5.5%	4.0%	4.7%
Kwahe'e B/w (thin parallel line)	-	1	1
	-	0.1%	0.1%
NRG Indeterminate organic paint	-	1	1
	-	0.1%	0.1%
Santa Fe B/w	57	70	127
	8.3%	7.7%	7.9%
Biscuit Ware Unpainted	-	3	3
	-	0.3%	0.2%
Biscuit Ware Painted Unspecified	-	1	1
	-	0.1%	0.1%
Biscuit A (Abiquiu B/G)	-	6	6
	-	0.7%	0.4%
Unpainted (Santa Fe paste)	-	3	3
	-	0.3%	0.2%
Galisteo B/w	6		6
	0.9%	-	0.4%
Unpainted (Galisteo paste)	2	-	2
	0.3%	-	0.1%
NRG Plain body	7	9	16
	1.0%	1.0%	1.0%
NRG Indented Corrugated	1	-	1
	0.1%	-	0.1%
NRG Plain Corrugated	2	1	3
	0.3%	0.1%	0.2%
NRG Smeared Indented Corrugated	-	1	1
	-	0.1%	0.1%
MRG Plain rim	8	24	32
	1.2%	2.6%	2.0%
MRG Unknown rim	5	-	5
	0.7%	-	0.3%
MRG Plain body	338	481	819
	49.1%	52.6%	51.1%
Wide Neckbanded (wiped)	1	1	2
	0.1%	0.1%	0.1%
MRG Indented Corrugated	21	13	34
	3.0%	1.4%	2.1%
MRG Plain Corrugated	79	6	85
	11.5%	0.7%	5.3%
MRG Smeared Plain Corrugated	66	143	209
	9.6%	15.6%	13.0%
MRG Smeared Indented Corrugated	17	53	70
	2.5%	5.8%	4.4%

Table 16.54. Continued.

	LA 6169	LA 6171	Total
MRG Polished gray	2	-	2
	0.3%	-	0.1%
MRG Unpainted undifferentiated	12	15	27
	1.7%	1.6%	1.7%
MRG Mineral Paint (undiff)	6	6	12
	0.9%	0.7%	0.7%
San Marcial B/w	7	11	18
	1.0%	1.2%	1.1%
White Mountain Red (undifferentiated)	-	1	1
	-	0.1%	0.1%
WMR Slipped Red over white paste	12	10	22
(Tallahogan - like)	1.7%	1.1%	1.4%
Slipped over red paste	1	-	1
	0.1%	-	0.1%
Local R/b	-	3	3
	-	0.3%	0.2%
Glazed red (unpainted)	-	1	1
	-	0.1%	0.1%
Jornada Brown body	-	5	5
	-	0.5%	0.3%
Socorro B/w	-	1	1
	-	0.1%	0.1%
Socorro B/w (hatchured and solid	-	1	1
designs)	-	0.1%	0.1%
Mogollon R/b	-	1	1
	-	0.1%	0.1%
San Francisco Red	-	3	3
	-	0.3%	0.2%
Alma Plain rim	-	-	1
	0.1%	-	0.1%
Alma Plain body	-	1	1
	-	0.1%	0.1%
Totals	689	915	1604
	100.0%	100.0%	100.0%

dominant type over an extremely wide area of the Rio Grande region (Habicht-Mauche 1993). The later span is characterized by greater variability in white ware pottery across space, with the replacement of Santa Fe Black-on-white by other decorated forms. The Santo Domingo Basin is located near the manufacturing locations of Wiyo Black-on-white, Galisteo Black-on-white, and early glaze ware in the Late Coalition period.

Studies by Orcutt (1999) as part of the Bandelier survey divided the Coalition period into six distinct ceramic-based dating periods for an area defined by Santa Clara Canyon on the north, Cochiti Pueblo on the south, the Rio Grande on the east, and the Jemez Mountains on the west, and included sites investigated during the Cochiti Dam Project as well as those derived from other excavations of Coalition period sites (Kohler 1989; Kohler and Root 1992). The earliest occupations are reflected by components dominated by Santa Fe Black-on-white and containing small but significant amounts of Kwahe'e Black-on-white. The earliest forms of Santa Fe Black-on-white exhibit traits that are similar to those noted for Kwahe'e Black-on-white and appear to have developed out of this type. The additional occurrence of Wiyo Black-on-white or Galisteo Black-on-white was interpreted as indicating components dating to the later part of the Coalition period. Percentages of reported decorated types associated with different temporal ranges were used to assign a ceramic date to sites recorded during the Bandelier survey.

A large number of sites with Coalition phase components were identified during the Cochiti Dam Project (Bussey 1968a; Honea 1968; Traylor and Scaife 1982). These included components assigned to both the early Santa Fe and late Santa Fe phases. One site investigated

Table 16.55. Distribution of Ceramic Type by Site for Coalition with Early and Late Developmental Components

	LA 6169
Indeterminate utility ware	3 0.1%
Unpainted (undifferentiated white)	1 0.0%
Indeterminate Mineral paint undifferentiated	1 0.0%
Unpainted undifferentiated	163 5.5%
NRG Mineral paint (undifferentiated)	32 1.1%
Kwahe'e B/w (solid designs)	26 0.9%
Kwahe'e B/w (thin parallel line)	2 0.1%
Kwahe'e B/W (thick parallel lines)	2 0.1%
Kwahe'e B/w (hatchured designs)	2 0.1%
Kwahe'e B/w (checkerboard)	1 0.0%
Kwahe'e B/w	6 0.2%
NRG Indeterminate organic paint	2 0.1%
NRG Indeterminate organic (Coalition phase)	1 0.0%
Santa Fe B/w	96 3.2%
Galisteo B/w	6 0.2%
Unpainted (Galisteo paste)	2 0.1%
NRG Plain rim	30 1.0%
NRG Unknown rim	1 0.0%
NRG Plain body	427 14.3%
NRG Indented Corrugated	399 13.4%
NRG Plain Corrugated	203 6.8%
NRG Smeared Plain Corrugated	84 2.8%
NRG Smeared Indented Corrugated	47 1.6%
NRG Mudware	1 0.0%

Table 16.55. Continued.

	LA 6169
MRG Plain rim	21 0.7%
MRG Unknown rim	3 0.1%
MRG Plain body	990 33.2%
MRG Wide Neckbanded	29 1.0%
MRG Indented Corrugated	53 1.8%
MRG Plain Corrugated	46 1.5%
MRG Smeared Plain Corrugated	71 2.4%
MRG Smeared Indented Corrugated	46 1.5%
MRG Polished gray	3 0.1%
MRG Plain Incised	2 0.1%
MRG Unpainted undifferentiated	31 1.0%
MRG Mineral Paint (undiff)	37 1.2%
Escavada solid designs	3 0.1%
San Marcial B/w	62 2.1%
Wingate B/r	1 0.0%
WMR Slipped Red over white paste (Tallahogan-like)	18 0.6%
Slipped over red paste	5 0.2%
El Paso Brown body	1 0.0%
Unpainted with Chupadero paste	1 0.0%
Jornada Brown body	1 0.0%
Unpainted Socorro paste	2 0.1%
Socorro B/w	8 0.3%
Socorro B/w (hatchured designs)	2 0.1%
Socorro B/w (hatchured and solid designs)	3 0.1%
Reserve Plain Corrugated Smudged	1 0.0%
Reserve Smudged	2 0.1%
Totals	2980 100.0%

Table 16.56. Distribution of Ceramic Type by Site for Mainly Coalition with Classic Components

	LA 6171
Indeterminate utility ware	3 1.1%
Unpainted undifferentiated	6 2.2%
NRG Indeterminate organic (Coalition phase)	2 0.7%
Santa Fe B/w	14 5.1%
Biscuit Ware Unpainted	1 0.4%
Biscuit Ware Painted Unspecified	2 0.7%
Biscuit A (Abiquiu B/G)	6 2.2%
Unpainted (Santa Fe paste)	3 1.1%
NRG Plain body	2 0.7%
NRG Indented Corrugated	2 0.7%
MRG Plain rim	2 0.7%
MRG Plain body	178 65.4%
MRG Indented Corrugated	10 3.7%
MRG Plain Corrugated	1 0.4%
MRG Smeared Plain Corrugated	12 4.4%
MRG Smeared Indented Corrugated	18 6.6%
MRG Unpainted undifferentiated	4 1.5%
San Marcial B/w	1 0.4%
WMR Slipped Red over white paste (Tallahogan-like)	5 1.8%
Totals	272 100.0%

during the Cochiti Dam Project included a component that was dominated by Santa Fe Black-on-white and yielded dates indicating occupations as early as AD 1150 (Traylor and Scaife 1982). Several other components including those from the North Bank site and Pueblo del Encierro yielded dates in the late thirteenth and early fourteenth century (Honea 1968; Traylor et al. 1977; Snow 1974; Warren 1976).

Archaeomagnetic samples were recovered from three contexts with assemblages indicative of Coalition period components at LA 6169. These include Feature 130 (a hearth) dated AD 1225, Pit Structure 15 (a hearth) dated AD 1235, and Feature 105 (a warming pit) dated AD 1245. Examination of pottery distributions associated with these features indicate that pottery assemblages from these different contexts are extremely similar. The painted pottery is almost exclusively represented by Santa Fe Black-on-white. The majority of utility wares exhibited smeared corrugated exteriors, and were tempered with anthill sand. Distribution of pottery types and other attributes noted for these dated contexts are very similar to those represented by other assemblages assigned to the Coalition period. Thus, it is likely that most of the Peña Blanca components assigned to the Coalition period based on ceramic assemblages date to the early part of the Coalition period, and reflect occupations spanning the first half of the thirteenth century.

Peña Blanca pottery distributions from Coalition period sites are similar to those noted in other areas of the Northern Rio Grande. The general lack of Kwahe'e at the Coalition phase components from LA 6171 and its low frequency at Coalition period components at LA 6169, despite the presence of a Late Developmental period component from this site, seem to indicate that Coalition period components date after AD 1200. The presence of the previously discussed Late Developmental period component from Feature 72 at LA 6169 suggests an even later beginning date. The absence of Wiyo Black-on-white at LA 6169 and its low frequency at LA 6171 are also consistent with components dating to the thirteenth century. While the presence of Galisteo Black-on-white at Coalition period components could be interpreted as indicating a date in the later part of the Coalition, characteristics of sherds assigned to this type may reflect an earlier form contemporary with the earliest Santa Fe Black-on-white. This may be supported by the existence of a form of Galisteo Black-on-white with styles more characteristic of Santa Fe Black-on-white, which may reflect earlier forms of this type. Most of the sherds assigned to this type exhibit design layouts consisting of incorporated framing lines or thin framing lines more indicative of earlier forms. Layouts and motifs noted for many of the designs are very similar to those noted in Kwahe'e Black-on-white.

The only context exhibiting combinations of types that could possibly indicate an occupation in the later part of the Coalition period is represented by an assemblage consisting of 53 sherds from LA 6171 (Table 16.54). This assemblage includes Santa Fe Black-on-white and Agua Fria Glaze-on-red. Utility wares include both plain gray and smeared corrugated forms. Combinations of Santa Fe Black-on-white and early glaze wares noted at sites investigated during the Cochiti Dam Project dated to the first half of the fourteenth century (Warren 1976). It is possible that this assemblage represents activities associated with the very limited use of this site in the Late Coalition period sometime during the first half of the fourteenth century. It is also possible that it may represent a mixture of pottery from the Coalition period and the Classic period in a way that resembles a Late Coalition assemblage.

Patterns of Regional Interaction and Exchange. Information relating to characteristics of paste, surface manipulation, and styles of pottery from Coalition period components provide clues concerning the nature of interaction and influence between the Cochiti area and elsewhere in the northern Southwest. One commonly invoked model for the spread of ceramic-producing groups over much of the Rio Grande region involves the migration of populations from the Northern San Juan region of the Four Corners sometimes during the thirteenth century (Cameron 1995; Cordell 1979; Davis 1965; Habicht-Mauche 1993; Lipe 1995). These migration scenarios have largely been inspired by two observations. One of these is based on parallels in the timing of the abandonment of Pueblo III villages in the Four Corners, and the establishment of the many villages that occur throughout much of the Rio Grande region. The other observation concerns the shift to white wares with Pueblo III styles in organic paint, such as represented in Santa Fe Black-on-white, and has been interpreted as reflecting influences from the Four Corners or San Juan region (Wendorf and Reed 1955).

Such models are largely based on a general absence of evidence of earlier occupations in many of the areas where major Coalition period occupations have been examined including the Chama Valley, Galisteo Basin, Pajarito Plateau, Galisteo Basin, and Upper Pecos Valley. Investigations in other areas, however, seem to indicate that the basic forms and technologies associated with Coalition period occupations were derived from earlier Late Developmental occupations. Two of the best examples of areas of the Rio Grande where continuity of occupation has been documented from at least the Late Developmental to Coalition period are the Santa Domingo Basin and the Tewa Basin. For Peña Blanca sites, evidence of local continuity of Late Developmental and Coalition period occupations is reflected by assemblages from Structure 76 at LA 6169, and similarities in the pottery between Late Developmental and Early Developmental assemblages.

As is the case for other areas of the Rio Grande, the great majority of the Santa Fe Black-on-white from Peña Blanca components exhibits relatively thin walls and solidly tapered rims not characteristic of assemblages in contemporaneous sites of the Four Corners country. Designs layouts common in the Four Corners country such as multiple thick-thin, and single thick framing lines tend to be very rare in Santa Fe Black-on-white assemblages. The range of characteristics associated with the earliest organic painted (Santa Fe Black-on-white) pottery then, does not seem to reflect a technology introduced from the Northern San Juan. Instead, Santa Fe Black-on-white reflects the continuation of decorative practices and styles associated with earlier Kwahe'e Black-on-white. In fact, the earlier forms of Santa Fe Black-on-white appear to be solely distinguished from Kwahe'e Black-on-white by the use of organic pigment. A comparison of styles noted in Peña Blanca pottery assigned to

Kwahe'e Black-on-white and Santa Fe Black-on-white indicate strong similarities. While influence from the San Juan country could have ultimately influenced the shift to organic paint, another possibility is noted by Mera (1935) who attributed the origin of Santa Fe Black-on-white to a combination of influences from Kwahe'e Black-on-white and organic-painted Gallina Black-on-white. Thus, it appears very likely that Santa Fe Black-on-white developed directly out of Kwahe'e Black-on-white produced along the Rio Grande. If this is the case, the appearance of Santa Fe Black-on-white in many areas not previously occupied by ceramic-producing groups may reflect the spread of groups along widely spread areas of the Rio Grande and associated drainages to the surrounding uplands.

Recent characterizations of interaction between groups in different areas of the Rio Grande have focused on sites or areas occupied during both the Coalition and Classic periods (Habicht-Mauche 1993; Vint 1999). These studies have attempted to characterize and contrast patterns of pottery production and exchange during these two occupational periods by focusing on a model of tribalization (Habicht-Mauche 1993; Vint 1999). Communities representing these periods are assumed to have been integrated through a complex of social and economic networks, which create ties through various means (Habicht-Mauche 1993; Vint 1999). Sharing of information by separate groups is reflected in regional distributions of styles noted in pottery assumed to be locally produced. Exchange networks are reflected by the presence of pottery pastes or other characteristics indicating non-local production.

In the tribalization model, increased specialization in ceramic production and increased economic competition is assumed to reflect a response to reduced agricultural yield. Such changes may be reflected by an overall increase in the diversity of types as potters began to use increased specialization in pottery production as an alternative strategy to procure needed goods including food.

Previous investigations indicate that pottery assemblages from Early Coalition sites throughout the Rio Grande region tend to be dominated by decorated pottery with local pastes and similar decorations and technological characteristics resulting in their assignment to Santa Fe Black-on-white (Habicht-Mauche 1993; Vint 1999). The widespread homogeneity of pottery at Early Coalition sites spread throughout much of the Rio Grande region has been interpreted as reflecting a broad, open economic and social network (Habicht-Mauche 1993). This homogeneity is reflected by the narrow range of stylistic and technological characteristics represented in both the Santa Fe Black-on-white and Smeared Corrugated gray that dominate assemblages spread throughout much of the Rio Grande region.

Similar patterns are represented in distributions of pottery pastes and temper traits noted at Peña Blanca sites assigned to the Early Coalition period. Distribution of refired paste color from Coalition sites is illustrated in Table 16.57. Distribution of temper group by ware is also illustrated for Coalition period components from LA 6169 (Table 16.58) and LA 6171 (Table 16.59) and Late Coalition components from LA 6171 (Table 16.60). Similar distributions are also illustrated for components dominated by Coalition pottery but with some mixing from that associated with the Early Developmental period at LA 6169 (Table 16.61) and LA 6171 (Table 16.62), Early and Late Developmental from LA 6169 (Table 16.63), and Classic from LA 6171 (Table 16.64).

Santa Fe Black-on-white pottery from Peña Blanca Coalition period sites display combinations of temper and paste very similar to that described for other sites in the Rio Grande region. Almost all the pastes are silty and fire to yellow-red and red colors in an oxidation atmosphere. Most Santa Fe Black-on-white examined appear to be tempered with fine tuff or ash similar to that used in other areas of the Rio Grande. These characterizations were supported by petrographic analysis, which indicate that most of the Santa Fe Black-on-white was tempered with vitric tuff (Carpenter, Appendix 1). This analysis indicated that other Santa Fe Black-on-white sherds were tempered

Table 16.57a. Refiring of Sherds from Coalition Components

Type	2.5YR	5YR	7.5YR	10YR	Total
NRG Corrugated	3	18	-	-	21
	14.3%	85.7%	-	-	
Santa Fe B/w	7	30	3	-	40
	17.5%	75.0%	7.5%	-	
Total	10	48	3	-	61
	16.4%	78.7%	4.9%	-	

Table 16.57b. Refiring of Sherds from Classic Components

Type	2.5YR	5YR	7.5YR	10YR	Total
Bisquit Ware	1	5	-	-	6
	16.7%	83.3%	-	-	
Glaze Ware	7	2	-	-	9
	77.8%	22.2%	-	-	

Table 16.58. Distribution of Temper by Ware for Coalition Components from LA 6169

	Gray	White	Red	Total
Sand	470	8	11	489
	38.8%	1.9%	100.0%	29.6%
Mica, quartz, and feldspar fragments (schist granite)	72	-	-	72
	6.0%			4.4%
Sherd	-	2	-	2
		0.5%		0.1%
Sherd and sand	-	2	-	2
		0.5%		0.1%
Fine tuff or ash	-	92	-	92
		21.4%		5.6%
Fine tuff and sand	-	182	-	182
		42.4%		11.0%
Indeterminate dark igneous	-	1	-	1
		0.2%		0.1%
Self tempered	25	-	-	25
	2.1%			1.5%
Ant hill sand	642	-	-	642
	53.1%			38.9%
Oblate shale and sand	1	18	-	19
	0.1%	4.2%		1.2%
Mica and tuff	-	76	-	76
		17.7%		4.6%
Mica, tuff, and sand	-	38	-	38
		8.9%		2.3%
Shale	-	10	-	10
		2.3%		0.6%
Total	1210	429	11	1650
	100.0%	100.0%	100.0%	100.0%

Table 16.59. Distribution of Temper by Ware for Coalition Components from LA 6171

	Gray	White	Red	Historic Plain	Total
Sand	79	2	1	-	82
	54.1%	3.0%	50.0%	-	38.1%
Mica, quartz, and feldspar fragments	8	-	-	-	8
(schist granite)	5.5%	-	-	-	3.7%
Sherd	-	-	1	-	1
	-	-	50.0%	-	0.5%
Fine tuff or ash	-	52	-	-	52
	-	78.8%	-	-	24.2%
Fine tuff and sand	-	9	-	-	9
	-	13.6%	-	-	4.2%
Gray crystalline basalt	-	-	-	1	1
	-	-	-	100.0%	0.5%
Dark igneous and sand	-	1	-	-	1
	-	1.5%	-	-	0.5%
Ant hill sand	53	-	-	-	53
	36.3%	-	-	-	24.7%
Oblate shale and sand	6	2	-	-	8
	4.1%	3.0%	-	-	3.7%
Total	146	66	2	1	215
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.60. Distribution of Temper by Ware for Late Coalition Components from LA 6171

	Gray	White	Glaze	Historic Plain	Total
Sand	15	-	-	-	15
	48.4%	-	-	-	34.9%
Mica, quartz, and feldspar	3	-	-	-	3
fragments (schist granite)	9.7%	-	-	-	7.0%
Fine tuff or ash	-	3	-	-	3
	-	60.0%	-	-	7.0%
Fine tuff and sand	-	1	-	-	1
	-	20.0%	-	-	2.3%
Gray crystalline basalt	-	-	4	3	7
	-	-	100.0%	100.0%	16.3%
Ant hill sand	12	-	-	-	12
	38.7%	-	-	-	27.9%
Oblate shale and sand	1	-	-	-	1
	3.2%	-	-	-	2.3%
Mica and tuff	-	1	-	-	1
	-	20.0%	-	-	2.3%
Total	31	5	4	3	43
	100.0%	100.0%	100.0%	100.0%	100.0%

Table16.61. Distribution of Temper by Ware for Coalition with Early Developmental Components from LA 6169

	Gray	White	Red	Glaze	Total
Sand	338	14	13	-	365
	61.8%	10.9%	100.0%		53.0%
Mica, quartz, and feldspar fragments (schist granite)	10	-	-	-	10
	1.8%				1.5%
Sherd and sand	-	1	-	-	1
		0.8%			0.1%
Fine tuff or ash	-	54	-	-	54
		42.2%			7.8%
Fine tuff and sand	-	35	-	-	35
		27.3%			5.1%
Dark igneous and sherd (Chupadero)	-	1	-	-	1
		0.8%			0.1%
Latite (Keres area)	-	-	-	1	1
				100.0%	0.1%
Ant hill sand	197	-	-	-	197
	36.0%				28.6%
Oblate shale and sand	2	7	-	-	9
	0.4%	5.5%			1.3%
Mica and tuff	-	6	-	-	6
		4.7%			0.9%
Dark sand	-	2	-	-	2
		1.6%			0.3%
Shale	-	8	-	-	8
		6.3%			1.2%
Total	547	128	13	1	689
	100.0%	100.0%	100.0%	100.0%	100.0%

with rhyolitic tuff or type I sand. The clays used in the production of Santa Fe Black-on-white are similar in origin to those noted for Kwahe'e Black-on-white. Similar combinations of fine tuff temper and gray clays were noted in the great majority of Santa Fe Black-on-white from Coalition period sites excavated during the Cochiti Dam Project (Honea 1968).

The range of vessel form, rim, and design variation noted in Santa Fe Black-on-white from Peña Blanca sites is very similar to that described for sites in the Tewa Basin and Pajarito Plateau to the north. While during the Cochiti Dam Project, variation noted in pottery that would be defined here as Santa Fe Black-on-white, was used to define other varieties of Santa Fe Black-on-white (Honea 1968), observations made during the Peña Blanca analysis indicate very little variability in Santa Fe Black-on-white. This seems to indicate most Santa Fe period assemblages from Peña Blanca sites reflect occupations during the earlier part of the Coalition at a time when similar technological and decorative conventions were employed in the production of black-on-white pottery over an extremely wide area. Characteristics associated with the utility ware may provide additional clues concerning the nature of connections with other areas. Utility wares from these assemblages appear to display a combination of pottery assigned to plain gray, corrugated, and smeared corrugated types, which may reflect variation around similar smeared corrugated forms. This variation in textures appears to be similar to ranges of variation noted for the Coalition period in various areas to the north (Habicht-Mauche 1993; Stubbs and Stallings 1953). In contrast to Late Developmental period assemblages, the majority of gray wares from these assemblages are tempered with a material classified during the present study as anthill sand. Pottery assigned to this category shows

Table 16.62. Distribution of Temper by Ware for Coalition with Early Developmental Components from LA 6171

	Gray	White	Red	Brown Plain	Glaze	Total
Sand	553	16	10	3	-	582
	75.3%	10.2%	71.4%	33.3%		63.6%
Mica, quartz, and feldspar fragments (schist granite)	11	-	-	-	-	11
	1.5%					1.2%
Sherd	-	-	1	-	-	1
			7.1%			0.1%
Sherd and sand	-	3	-	-	-	3
		1.9%				0.3%
Fine tuff or ash	-	95	-	-	-	95
		60.5%				10.4%
Fine tuff and sand	-	27	-	-	1	28
		17.2%			100.0%	3.1%
Fine Jornada temper	-	-	-	5	-	5
				55.6%		0.5%
Gray crystalline basalt	1	-	-	-	-	1
	0.1%					0.1%
Mogollon volcanics	-	1	2	1	-	4
		0.6%	14.3%	11.1%		0.4%
Anthill sand	156	-	-	-	-	156
	21.3%					17.0%
Sand and Mogollon volcanics	-	-	1	-	-	1
			7.1%			0.1%
Basalt and sand	1	-	-	-	-	1
	0.1%					0.1%
Oblate shale and sand	12	14	-	-	-	26
	1.6%	8.9%				2.8%
Mica, tuff, and sand	-	1	-	-	-	1
		0.6%				0.1%
Total	734	157	14	9	1	915
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

the use of pumice or tuff-derived sand with some related basalt (Carpenter, Appendix 1). This combination of temper is distinct from that noted in Developmental period sites in the Tewa Basin but similar to those in areas of Pajarito Plateau. The increased dominance of this temper seems to indicate a shift in interaction from areas where micaceous granite temper was employed in the production of utility wares in areas to the north such as the Pajarito Plateau where "ant hill sand" was used in the production of local gray wares. Such a shift may represent a response to developing ties with growing settlements in the Pajarito Plateau. Based on pottery similarities it is more likely that populations were most closely connected to groups in the Tewa Basin and Pajarito Plateau to the north. Thus, economic ties may have developed between groups in the Santo Domingo Basin and Pajarito Plateau.

The widespread homogeneity of decorated pottery and other traits characteristic of the early part of the Coalition period appears to reflect broad open economic and social networks. Such connections seem to be reflected by both widespread similarities in Santa Fe Black-on-white produced in separate areas of the Rio Grande region as well as further differentiation of pottery produced in areas of the Northern Rio Grande from those produced in other regions. The areal extent in which similar Santa Fe Black-on-white and gray wares occur

Table 16.63. Distribution of Temper by Ware for Mainly Coalition with Early and Late Developmental Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	3	2	-	-	5
	0.1%	0.4%			0.2%
Sand	1079	80	23	-	1182
	43.9%	16.3%	95.8%		39.7%
Mica, quartz, and feldspar fragments	1191	-	-	-	1191
(schist granite)	48.4%				40.0%
Sherd	-	3	1	-	4
		0.6%	4.2%		0.1%
Sherd and sand	-	10	-	-	10
		2.0%			0.3%
Fine tuff or ash	-	159	-	-	159
		32.3%			5.3%
Fine tuff and sand	-	146	-	-	146
		29.7%			4.9%
Leucocratic igneous (El Paso area)	-	-	-	1	1
				20.0%	0.0%
Fine sandstone	-	1	-	-	1
		0.2%			0.0%
Fine Jornada temper	-	-	-	1	1
				20.0%	0.0%
Self tempered	1	-	-	-	1
	0.0%				0.0%
Dark igneous and sherd (Chupadero)	-	13	-	-	13
		2.6%			0.4%
Dark igneous and sand	-	1	-	-	1
		0.2%			0.0%
Mogollon volcanics	-	-	-	2	2
				40.0%	0.1%
Anthill sand	150	-	-	-	150
	6.1%				5.0%
Sand and Mogollon volcanics	-	-	-	1	1
				20.0%	0.0%
Oblate shale and sand	35	51	-	-	86
	1.4%	10.4%			2.9%
Mica and tuff	-	12	-	-	12
		2.4%			0.4%
Mica, tuff, and sand	-	11	-	-	11
		2.2%			0.4%
Shale	-	3	-	-	3
		0.6%			0.1%
Total	2459	492	24	5	2980
	100.0%	100.0%	100.0%	100.0%	100.0%

appears to reflect the intensification of a Rio Grande-oriented network that originated during the Late Developmental period. Such distributions reflect both the continuation of many regional patterns established during the Late Developmental period and some new developments. These changes included increased geographic area of the regional network and standardization of certain pottery forms. Thus, the "Santa Fe" regional network commonly pro-

Table 16.64. Distribution of Temper by Ware for Mainly Coalition with Classic Components from LA 6171

	Gray	White	Red	Total
Indeterminate	1	-	-	1
	0.4%			0.4%
Sand	184	-	5	189
	80.7%		100.0%	69.5%
Mica, quartz, and feldspar fragments	4	-	-	4
(schist granite)	1.8%			1.5%
Sherd and sand	-	1	-	1
		2.6%		0.4%
Fine tuff or ash	-	12	-	12
		30.8%		4.4%
Fine tuff and sand	-	22	-	22
		56.4%		8.1%
Gray crystalline basalt	2	-	-	2
	0.9%			0.7%
Anthill sand	37	-	-	37
	16.2%			13.6%
Oblate shale and sand	-	4	-	4
		10.3%		1.5%
Total	228	39	5	272
	100.0%	100.0%	100.0%	100.0%

Table 16.65. Distribution of Tradition by Ware for Coalition Components from LA 6169

	Gray	White	Red	Total
Indeterminate	-	1	-	1
		0.2%		0.1%
NRG	97	404	-	501
	8.0%	94.2%		30.4%
MRG	1113	24	11	1148
	92.0%	5.6%	100.0%	69.6%
Total	1210	429	11	1650
	100.0%	100.0%	100.0%	100.0%

Table 16.66. Distribution of Tradition by Ware for Coalition Components

	Gray	White	Red	Historic Plain	Total
NRG	8	61	-	-	69
	5.5%	92.4%			32.1%
Rio Grande (Historic Tewa)	-		-	1	1
				100.0%	0.5%
MRG	138	4	2	-	144
	94.5%	6.1%	100.0%		67.0%
Eastern Mogollon	-	1	-	-	1
		1.5%			0.5%
Total	146	66	2	1	215
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.67. Distribution of Tradition by Ware for Mainly Coalition with Early Developmental Components from LA 6171

	Gray	White	Red	Brown Plain	Glaze	Total
Indeterminate	2	-	-	-	-	2
	0.3%					0.2%
NRG	11	122	-	-	-	133
	1.5%	77.7%				14.5%
Rio Grande (Historic Keres)	-	-	-	-	1	1
					100.0%	0.1%
MRG	721	32	11	3	-	767
	98.2%	20.4%	78.6%	33.3%		83.8%
Northern Jornada Mogollon	-	-	-	5	-	5
				55.6%		0.5%
Eastern Mogollon	-	2	-	-	-	2
		1.3%				0.2%
Mogollon Highlands	-	1	3	1	-	5
		0.6%	21.4%	11.1%		0.5%
Total	734	157	14	9	1	915
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.68. Distribution of Tradition by Ware for Mainly Coalition with Early and Late Developmental Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	3	2	-	-	5
	0.1%	0.4%			0.2%
NRG	1192	341	-	-	1533
	48.5%	69.3%			51.4%
MRG	1264	133	24	-	1421
	51.4%	27.0%	100.0%		47.7%
Southern Jornada Mogollon (El Paso)	-	-	-	1	1
				20.0%	0.0%
Northern Jornada Mogolon (Jornada)	-	1	-	1	2
		0.2%		20.0%	0.1%
Eastern Mogollon	-	15	-	-	15
		3.0%			0.5%
Mogollon Highlands	-	-	-	3	3
				60.0%	0.1%
Total	2459	492	24	5	2980
	100.0%	100.0%	100.0%	100.0%	100.0%

posed for the Early Coalition period, as characterized by the widespread sharing of social and economic ties, reflects an elaboration and extension of the earlier "Kwahe'e" network.

While most of interaction appears to have been limited to the Rio Grande, evidence of interaction and exchange with other areas is indicated by the distribution of types assigned to various regional traditions (Tables 16.65–16.70). Extremely limited exchange with areas to the south is reflected by very low frequencies of Socorro Black-on-white, Chupadero Black-on-white, Jornada Brown Ware, and Mogollon Brown indicating a decline in ties established during the previous "transitional" occupation, and a return to homogeneity among white ware forms. While similar types are also present at components dating to latest span of the Late

Table 16.69. Distribution of Tradition by Ware for Late Coalition Components from LA 6171

	Gray	White	Glaze	Historic Plain	Total
Rio Grande (Prehistoric	3	5	-	-	8
Tewa/Keres)	9.7%	100.0%			18.6%
Rio Grande (Historic Keres)	-	-	4	3	7
			100.0%	100.0%	16.3%
Cibola	28	-	-	-	28
	90.3%				65.1%
Total	31	5	4	3	43
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.70. Distribution of Tradition by Ware for Mainly Coalition with Classic Components from LA 6171

	Gray	White	Red	Total
Indeterminate	3	-	-	3
	1.3%			1.1%
Rio Grande (Prehistoric Tewa/Keres)	4	34	-	38
	1.8%	87.2%		14.0%
Cibola	221	5	5	231
	96.9%	12.8%	100.0%	84.9%
Total	228	39	5	272
	100.0%	100.0%	100.0%	100.0%

Table 16.71. Distribution of Ware for Coalition Period Components

	LA 6169	LA 6171	Total
Gray	1210	146	1356
	73.3%	67.9%	72.7%
White	429	66	495
	26.0%	30.7%	26.5%
Red	11	2	13
	0.7%	0.9%	0.7%
Historic plain	-	1	1
		0.5%	0.1%
Total	1650	215	1865
	100.0%	100.0%	100.0%

Developmental period, the frequencies of these types are lower in the Coalition period assemblages. The decline in exchange with groups to the south may simply reflect a northern shift to ties with the populations in the Pajarito Plateau and elsewhere in the Rio Grande.

Pottery Forms and Use. Distributions of ware groups and vessel forms from Coalition period assemblages are fairly similar to those noted for the previous period (Tables 16.71 through 16.78). Gray wares comprise about 70 percent of the pottery, while most of the decorated ceramics are represented by white wares. The majority of gray wares are represented by wide-mouth jars. About two-thirds of the utility wares from this site exhibit corrugated exteriors. While a range of corrugated surfaces are represented, most of these are smeared forms.

Most of the white wares are represented by sherds derived from bowls, although about a quarter are derived from jar forms. The shift away from gray wares with mica in the temper during the Coalition period may have functional significance. A fairly wide range of textured types are represented, although the majority consist of smeared corrugated forms. Forms appear to represent the continuation of trends that began during the Late Developmental period, and again fit well with the model of a gradual shift toward an increasingly reliable technology as describe by Mills (1989). Similar distributions of ware and vessel forms were noted at other Coalition period sites (Habicht-Mauche

Table 16.72. Vessel Form by Ware for Coalition Components

	Gray	White	Red	Total
Indeterminate	18	10	-	28
	1.5%	2.3%		1.7%
Bowl rim	2	83	-	85
	0.2%	19.3%		5.2%
Bowl body	9	269	1	279
	0.7%	62.7%	9.1%	16.9%
Jar neck	63	3	2	68
	5.2%	0.7%	18.2%	4.1%
Jar rim	60	-	-	60
	5.0%			3.6%
Jar body	1045	60	8	1113
	86.4%	14.0%	72.7%	67.5%
Jar body with lug handle	1	-	-	1
	0.1%			0.1%
Indeterminate coil/strap handle	-	1	-	1
		0.2%		0.1%
Canteen rim	1	1	-	2
	0.1%	0.2%		0.1%
Miniature pinch pot body	9	-	-	9
	0.7%			0.5%
Applique	1	-	-	1
	0.1%			0.1%
Seed jar rim	-	1	-	1
		0.2%		0.1%
Indeterminate rim	1	1	-	2
	0.1%	0.2%		0.1%
Total	1210	429	11	1650
	100.0%	100.0%	100.0%	100.0%

Table 16.73. Distribution of Vessel Form by Ware for Coalition Components

	Gray	White	Red	Historic Plain	Total
Indeterminate	1	1	1	-	3
	0.7%	1.5%	50.0%		1.4%
Bowl rim	-	5	-	-	5
		7.6%			2.3%
Bowl body	1	44	1	-	46
	0.7%	66.7%	50.0%		21.4%
Jar neck	8	1	-	-	9
	5.5%	1.5%			4.2%
Jar rim	2	2	-	-	4
	1.4%	3.0%			1.9%
Jar body	133	13	-	-	146
	91.1%	19.7%			67.9%
Indeterminate coil/strap handle	1	-	-	-	1
	0.7%				0.5%
Body sherd polished int/unpolished ext	-	-	-	1	1
				100.0%	0.5%
Total	146	66	2	1	215
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.74. Distribution of Vessel Form by Ware for Coalition with Early Developmental Components from LA 6169

	Gray	White	Red	Glaze	Total
Indeterminate	-	5	-	-	5
		3.9%			0.7%
Bowl rim	-	17	-	-	17
		13.3%			2.5%
Bowl body	1	81	2	1	85
	0.2%	63.3%	15.4%	100.0%	12.3%
Jar neck	59	-	-	-	59
	10.8%				8.6%
Jar rim	13	-	-	-	13
	2.4%				1.9%
Jar body	467	24	11	-	502
	85.4%	18.8%	84.6%		72.9%
Jar body with strap or coil handle	2	-	-	-	2
	0.4%				0.3%
Jar body with lug handle	1	-	-	-	1
	0.2%				0.1%
Canteen rim	1	1	-	-	2
	0.2%	0.8%			0.3%
Indeterminate rim	3	-	-	-	3
	0.5%				0.4%
Total	547	128	13	1	689
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.75. Distribution of Vessel Form by Ware for Coalition with Early Developmental Components

	Gray	White	Red	Brown	Glaze	Total
Indeterminate	17	5	-	-	-	22
	2.3%	3.2%				2.4%
Bowl rim	-	26	-	-	1	27
		16.6%			100.0%	3.0%
Bowl body	-	82	1	2	-	85
		52.2%	7.1%	22.2%		9.3%
Jar neck	76	2	4	2	-	84
	10.4%	1.3%	28.6%	22.2%		9.2%
Jar rim	27	2	-	1	-	30
	3.7%	1.3%		11.1%		3.3%
Jar body	611	38	9	4	-	662
	83.2%	24.2%	64.3%	44.4%		72.3%
Jar body with strap or coil handle	1	-	-	-	-	1
	0.1%					0.1%
Indeterminate coil/strap handle	-	1	-	-	-	1
		0.6%				0.1%
Canteen rim	-	1	-	-	-	1
		0.6%				0.1%
Jar rim w/ lug handle	1	-	-	-	-	1
	0.1%					0.1%
Body sherd polished int/unpolished ext	1	-	-	-	-	1
	0.1%					0.1%
Total	734	157	14	9	1	915
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.76. Distribution of Vessel Form by Ware for Mainly Coalition with Early and Late Developmental Components from LA 6169

	Gray	White	Red	Brown Plain	Total
Indeterminate	27	30	-	-	57
	1.1%	6.1%			1.9%
Bowl rim	11	55	1	-	67
	0.4%	11.2%	4.2%		2.2%
Bowl body	2	195	2	2	201
	0.1%	39.6%	8.3%	40.0%	6.7%
Seed jar	-	2	-	-	2
		0.4%			0.1%
Olla rim	-	35	-	-	35
		7.1%			1.2%
Jar neck	139	6	1	-	146
	5.7%	1.2%	4.2%		4.9%
Jar rim	55	3	-	-	58
	2.2%	0.6%			1.9%
Jar body	2212	158	20	3	2393
	90.0%	32.1%	83.3%	60.0%	80.3%
Jar body with strap or coil handle	1	-	-	-	1
	0.0%				0.0%
Jar body with lug handle	2	1	-	-	3
	0.1%	0.2%			0.1%
Indeterminate coil/strap handle	1	1	-	-	2
	0.0%	0.2%			0.1%
Canteen rim	-	1	-	-	1
		0.2%			0.0%
Miniature pinch pot rim	1	-	-	-	1
	0.0%				0.0%
Jar rim w/ lug handle	2	-	-	-	2
	0.1%				0.1%
Seed jar rim	-	3	-	-	3
		0.6%			0.1%
Body sherd polished int/ext	-	1	-	-	1
		0.2%			0.0%
Indeterminate rim	6	1	-	-	7
	0.2%	0.2%			0.2%
Total	2459	492	24	5	2980
	100.0%	100.0%	100.0%	100.0%	100.0%

1993; Honea 1968; Lambert 1954; Stubbs and Stallings 1953).

A single Santa Fe Black-on-white vessel was recovered from Feature 15 at LA 6169 (Table 16.51).

Classic Period (AD 1350 to 1600)

Very little evidence of occupations dating after AD 1350 were noted during Peña Blanca excavations. This contrasts with excavations by the Cochiti Dam Project during which large numbers of pottery were recovered from components dating to the Classic and historic periods (Honea 1968; Snow 1971b; Warren 1976, 1979a, 1979b, 1979c). The recovery of tree-ring dates from many assemblages during the Cochiti project provided for the division of the Classic period into a number of distinct periods. Thus, while investigations conducted during the

Table 16.77. Distribution of Vessel Form by Ware for Late Coalition Components

	Gray	White	Glaze	Historic Plain	Total
Indeterminate	8	-	-	-	8
	25.8%				18.6%
Bowl body	-	3	1	-	4
		60.0%	25.0%		9.3%
Jar body	23	2	-	3	28
	74.2%	40.0%		100.0%	65.1%
Body sherd unpolished int/polished ext	-	-	1	-	1
			25.0%		2.3%
Body sherd polished int/unpolished ext	-	-	2	-	2
			50.0%		4.7%
Total	31	5	4	3	43
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.78. Distribution of Vessel Form by Ware for Mainly Coalition with Classic Components from LA 6171

	Gray	White	Red	Total
Indeterminate	1	4	-	5
	0.4%	10.3%		1.8%
Bowl rim	-	5	-	5
		12.8%		1.8%
Bowl body	-	13	-	13
		33.3%		4.8%
Jar rim	2	2	-	4
	0.9%	5.1%		1.5%
Jar body	225	15	5	245
	98.7%	38.5%	100.0%	90.1%
Total	228	39	5	272
	100.0%	100.0%	100.0%	100.0%

Cochiti Dam project provided a strong foundation for understanding ceramic change from AD 1350 to today, given the extremely small assemblages of late pottery encountered during the Peña Blanca Project, patterns associated with most of the later periods are largely beyond the scope of the present study.

Examples of components dating after the middle fourteenth century are limited to small assemblages from two Peña Blanca sites. The majority of the sherds from the upper deposits at LA 249 reflect material associated with a Classic mixed with Late Developmental period components. Table 16.79 illustrates pottery distributions from contexts dominated by Classic period pottery. A much smaller number of sherds reflects a Classic period component at LA 6171 with a mixture of pottery from Coalition and Early Developmental period components (Table 16.80).

The most obvious evidence of Classic period occupation is reflected by the occurrence of Biscuit ware and glaze ware, which do not appear to have been produced in this region until the fourteenth century. Utility ware types associated with Classic period occupations are dominated by micaceous pastes, some of which are distinct from those associated with earlier occupations due to increased mica in the temper or the application of a mica slip. In many areas of the Northern and Middle Rio Grande, the transition to the Classic period is characterized by a dramatic rise in population size, and the aggregation of settlements into a few clusters of large

Table 16.79. Distribution of Ceramic type by Site for Classic with Late Developmental Components

	LA 249	Total
Unpainted (Undifferentiated White)	2	2
	0.1%	0.1%
Indeterminate Mineral paint Undifferentiated	2	2
	0.1%	0.1%
Unpainted Undifferentiated	66	66
	3.2%	3.2%
NRG Mineral Paint (Undifferentiated)	6	6
	0.3%	0.3%
NRG Pueblo II (Indeterminate Mineral)	5	5
	0.2%	0.2%
Kwahe'e B/w (Solid Designs)	5	5
	0.2%	0.2%
Kwahe'e B/w (Thin Parallel Line)	2	2
	0.1%	0.1%
Kwahe'e B/W (Thick Parallel Lines)	6	6
	0.3%	0.3%
Kwahe'e B/w (Hatchured Designs)	6	6
	0.3%	0.3%
Kwahe'e B/w	1	1
	0.0%	0.0%
NRG Indeterminate Organic Paint	6	6
	0.3%	0.3%
Biscuit Ware Unpainted	6	6
	0.3%	0.3%
Biscuit Ware Painted Unspecified	1	1
	0.0%	0.0%
Biscuit A (Abiquiu B/G)	10	10
	0.5%	0.5%
Biscuit B (Bandelier B/G)	3	3
	0.1%	0.1%
NRG Plain Rim	12	12
	0.6%	0.6%
NRG Unknown Rim	6	6
	0.3%	0.3%
NRG Plain Body	531	531
	25.6%	25.6%
NRG Wide Neckbanded	1	1
	0.0%	0.0%
NRG Coiled Necked	1	1
	0.0%	0.0%
NRG Clapboard Neck	1	1
	0.0%	0.0%
NRG Indented Corrugated	380	380
	18.3%	18.3%
NRG Incised Corrugated	1	1
	0.0%	0.0%
NRG Plain Corrugated	21	21
	1.0%	1.0%
NRG Smeared Plain Corrugated	37	37
	1.8%	1.8%
NRG Smeared Indented Corrugated	31	31
	1.5%	1.5%

Table 16.79. Continued.

	LA 249	Total
Sapawi Micaceous	1	1
	0.0%	0.0%
Highly Micaceous	1	1
	0.0%	0.0%
MRG Plain Rim	2	2
	0.1%	0.1%
MRG Plain Body	104	104
	5.0%	5.0%
MRG Indented Corrugated	5	5
	0.2%	0.2%
MRG Plain Corrugated	10	10
	0.5%	0.5%
MRG Smeared Plain Corrugated	5	5
	0.2%	0.2%
MRG Smeared Indented Corrugated	5	5
	0.2%	0.2%
MRG Unpainted undifferentiated	7	7
	0.3%	0.3%
San Marcial B/w	2	2
	0.1%	0.1%
Keres Utility Ware	71	71
	3.4%	3.4%
Glazed Red (Unpainted)	323	323
	15.6%	15.6%
Glaze White/light gray (Unpainted)	6	6
	0.3%	0.3%
Glaze yellow/cream Slipped (Unpainted)	63	63
	3.0%	3.0%
Glaze Brown/tan (Unpainted)	12	12
	0.6%	0.6%
Glaze-on-red (Undiff)	199	199
	9.6%	9.6%
Glaze-on-white Slipped (Undiff)	2	2
	0.1%	0.1%
Glaze-on-yellow Cream	43	43
	2.1%	2.1%
Glazed-on-brown/tan	16	16
	0.8%	0.8%
Glaze White and red matte (undiff)	1	1
	0.0%	0.0%
Unpainted Glaze A Yellow	3	3
	0.1%	0.1%
Unpainted Red Rim	6	6
	0.3%	0.3%
Aqua Fria Glaze A	28	28
	1.4%	1.4%
Cienequilla Glaze-on-yellow	3	3
	0.1%	0.1%
Cienequilla Glaze Polychrome	3	3
	0.1%	0.1%
Largo Glaze-on-yellow	2	2
	0.1%	0.1%
Socorro B/w	2	2
	0.1%	0.1%
Total	2074	2074
	100.0%	100.0%

Table 16.80. Distribution of Ceramic Type by Site for Mainly Classic, Some Coalition and Early Developmental Components

	LA 6171
Indeterminate utility ware	2
	1.6%
Santa Fe B/w	3
	2.4%
Biscuit Ware Unpainted	3
	2.4%
Biscuit A (Abiquiu B/G)	1
	0.8%
Biscuit B (Bandelier B/G)	8
	6.3%
NRG Plain body	5
	3.9%
NRG Plain Corrugated	1
	0.8%
Smudged interior/buff exterior	1
	0.8%
MRG Unknown rim	1
	0.8%
MRG Plain body	69
	54.3%
MRG Indented Corrugated	1
	0.8%
MRG Plain Corrugated	1
	0.8%
MRG Smeared Plain Corrugated	5
	3.9%
MRG Smeared Indented Corrugated	21
	16.5%
MRG Unpainted undifferentiated	1
	0.8%
MRG Mineral Paint (undiff)	1
	0.8%
San Marcial B/w	1
	0.8%
Glazed red (unpainted)	1
	0.8%
Glaze yellow/cream slipped (unpainted)	1
	0.8%
Totals	127
	100.0%

villages (Habicht-Mauche 1993).

Investigations from the Cochiti Reservoir Project resulted in the documentation of a large number of sites including very large sites such as Pueblo del Encierro, the Alfred Herrera site, and the small sites within the reservoir flood pool (Cordell 1979; Honea 1968; Snow 1974). These investigations recognized several distinct ceramic-based dating periods defined by combinations of various glaze ware forms and types (Warren 1976). The Glaze-on-red period (AD 1315–1425, Group A) was defined by the presence of pottery types associated with this period. This period is defined by assemblages displaying Glaze A rim forms including Agua Fria Glaze-on-red, San Clemente Glaze Polychrome, Arenal Glaze Polychrome, Cieneguilla Glaze-on-yellow, and Cieneguilla Glaze Polychrome. Many of the small sites located in the Cochiti Reservoir study area dated to this period.

Next in this sequence is the Glaze-on-yellow period (AD 1425 to 1550). Before the end of the fourteenth century, glaze-painted vessels with white, cream, yellow, or pink slips were being made at sites within the Cochiti study area, including Cieneguilla Glaze-on-yellow, Cieneguilla Glaze Polychrome, and Largo Glaze-on-yellow. In addition, glaze-on-red forms continued to be produced and were represented by Largo Glaze-on-red. Tree-ring dates from Pueblo del Encierro (LA 70) investigated during the Cochiti Dam Project suggest that glaze-on-yellow ware tradition may have appeared as late as the AD 1420s.

The Intermediate Glaze period (AD 1450 to 1600) is characterized by the presence of Glaze C, D, and early E forms. Biscuit ware that was produced in the Tewa villages on the northern Pajarito Plateau appear as trade at Intermediate Glaze period sites in the Cochiti area. The Kotyiti period (AD 1600–1750) is characterized by the dominance of Glaze E and F forms.

Changes noted in Biscuit ware types produced in areas to the north may also be used to define specific spans within the Classic period. Biscuit A or Abiquiu Black-on-white may have appeared as early as AD 1350 and may have been common by AD 1350 to 1360 (Lang 1997). The end date for this type appears to be sometime between AD 1450 and 1500. Biscuit B or Bandelier Black-on-white may have first appeared at about AD 1400 and lasted up to AD 1550 (Lang 1997). This type appears to have been most abundant at sites dating between AD 1500 and 1550.

Interestingly, the two Classic period Peña Blanca pottery assemblages recovered are dominated by different frequencies of decorated ware groups. Decorated types associated with the small Classic period assemblage at LA 6171 are dominated by Biscuit ware types. For the sherds from the small assemblages assigned to the Classic period, Biscuit wares outnumber Glaze wares 12 to 2. For sherds from components assigned to all ceramic dating periods, Biscuit wares outnumber glaze wares 32 to 8. Biscuit wares include sherds assigned to both Biscuit A and Biscuit B. Glaze wares include glaze-on-red, glaze-on-yellow, and unpainted glaze ware forms. The only glaze ware that could be assigned to a specific type was represented by a single Agua Fria Glaze-on-red sherd. Utility wares apparently associated with this component include plain gray and smeared corrugated forms as well as a single smudged buff utility ware. Most of the utility wares associated with this component exhibit mica and granite temper.

The other site with components assigned to the Classic period was LA 249. This site was originally mapped and recorded by H. P. Mera (1940) and has also been referred to as Tashkatze Pueblo (Marshall 1997). This site consists of two large overlapping rectangular room blocks, each enclosing a plaza. This site includes at least two associated kivas, and two smaller, superimposed room blocks (Marshall 1997). Mera (1940) presented a very brief description and a map location of LA 249 along with similar data for various sites he placed into the Keres division. Based on distributions of pottery types noted by Mera, this site was assumed to date from the Glaze A to D periods.

As part of the Peña Blanca investigations only portions of the extreme edge of LA 249, as defined by the extent of the ceramic scatter, were excavated. Upper components investigated appear to reflect pottery transported downslope from the main Classic period component and are mixed with lower frequencies of Late Developmental pottery that appear to be associated with an excavated pit structure.

In contrast to distributions from Classic period components at LA 6171, decorated pottery associated with the Classic period occupation at LA 249 is dominated by glaze wares, which outnumber Biscuit wares 351 to 15. The dominance of glaze pottery at this site is similar to that noted at Early Coalition period contexts examined during the Cochiti Dam Project (Honea 1968; Warren 1979b). Most of the Biscuit wares are represented by sherds assigned to Biscuit A. Glaze-on-red sherds outnumber glaze-on-yellow sherds 282 to 34. Glaze rim sherds are dominated by Glaze A forms including Agua Fria Glaze-on-red (24 sherds) and Cieneguilla Glaze-on-yellow sherds. Other glaze rim sherds include three Largo Glaze-on-yellow sherds. Utility ware sherds include plain and smeared corrugated forms. Almost all of the utility ware sherds from this site including those associated with the Classic period component are tempered with mica and granite.

Dating of Classic period components identified during Peña Blanca investigations is solely based on associated pottery types. The assignment of dates to Classic period assemblages is largely based on the frequency of Biscuit A to Biscuit B and glaze rim forms. The dominance of Biscuit A and glaze forms at LA 249 indicate an occupation dating to the Early Classic period probably spanning between AD 1350 and 1450, although some of the glaze-on-yellow forms could reflect pottery associated with slightly later occupations. The higher frequency of Biscuit B over Biscuit A associated with Classic period assemblages at LA 6171 indicates that the small Classic period component at this site may date later than the one at LA 249, although the general lack of diagnostic Glaze ware rims make this determination difficult.

Exchange and Interaction. If the two Classic period Peña Blanca components are roughly contemporaneous, differences in the frequencies of Glaze ware versus Biscuit ware types may reflect the influence of social or ethnic boundaries on ceramic production and exchange (Habicht-Mauche 1993; Vint 1999). By the Early Classic period, spatial patterns noted for various pottery forms have been interpreted as indicating the emergence, consolidation, and competition of a distinct regional alliance (Habicht-Mauche 1993). Such changes have been previously described in terms of tribalization, and are thought to reflect alliances supported by formalized reciprocal transactions (Habicht-Mauche 1993).

These patterns of economic specialization and regional integration appear to be reflected in the increased differentiation of pottery produced in different areas of the Rio Grande. In the northernmost areas of the Rio Grande including much of the Pajarito Plateau, Chama Valley, and Tewa Basin, the tradition of organic-painted white wares reflected earlier in Santa Fe Black-on-white continued with the production of Biscuit ware types throughout the Classic period. A distinct glaze ware technology was introduced into large areas south of where organic-painted Biscuit wares were produced. The technology associated with the production of Glaze ware pottery did not develop locally in the Rio Grande area region but was introduced by Keresan-speaking groups from the Zuni and Little Colorado areas where it had developed out of the White Mountain Redware tradition. This new Glaze ware technology was characterized by a range of styles and techniques characteristic of experimentation with new technology (Snow 1982). By the middle of the fourteenth century, glaze pottery had become quite standardized. The production of Glaze ware appears to reflect a level of craftsmanship that surpassed any of the preceding white ware forms produced in the Rio Grande region (Habicht-Mauche 1993). Many of the glaze vessels from sites throughout the Rio Grande region may have been manufactured at a few production centers, and then exchanged over wide areas.

Cochiti Pueblo represents one of the northernmost Keres pueblos, and is located in the northern portion of the area where Glaze ware pottery was prevalent. For example, surveys of Bandelier National Monument indicate that Glaze wares dominated Classic period sites in the southern part of Bandelier National Monument, while Biscuit wares dominated the Tsankawi area (Vint 1999).

Distributions of Glaze versus Biscuit ware types at sites in the Northern Santo Domingo Basin, which is located fairly close to the boundary between the two traditions, may provide important clues concerning the nature of regional exchange networks during the Classic period. The north-south distributions of Biscuit wares versus Glaze wares appears to partly correspond with historical boundaries of Tewa and Keresan-speaking groups (Vint 1999). Both Keres and Tewa Pueblo groups claim the area between Frijoles and Anchos canyons, north of Cochiti, as the spatial dividing line between these groups (Mera 1935). Early archaeological investigations attempted to extend this boundary into prehistory based on the distribution of Glaze wares versus organic-paint Biscuit wares (Kidder 1915; Mera 1935, 1940).

Another factor that may have contributed to the observed distributions of various Glaze and Biscuit ware types are the geological distributions of clays used in the production of these different ware groups. It is also possible that many Classic period villages may not have produced decorated pottery, but instead relied on villages that had already begun to specialize in the production of certain decorated pottery forms. Technological expertise and resource distributions associated with Classic period Glaze ware and Biscuit ware forms might have also limited the areas in which they were produced. Even if the specific ethnic affiliation of a particular site or locality cannot be determined, differences in wares may reflect the nature and direction of economic or social ties between groups in Santo Domingo Basin and other areas of the Rio Grande region. The spatial distribution of similar ceramic forms between separated areas may reflect communities composed of multiple pueblos linked together into distinct "tribal" networks (Habicht-Mauche 1993; Vint 1999).

While the predominance of Glaze ware types at sites south of Frijoles Canyon and Biscuit ware types to the north is indicated by data from the Bandelier Survey Project, the nature and timing of potential shifts in boundaries between these ware groups is unclear (Vint 1999). Data from the two Classic period Peña Blanca components may indicate differences in the distributions of decorated forms at communities located surprisingly close to each other. Such observations may provide important clues about the nature of exchange ties and networks that linked groups in the Northern Santo Domingo Basin to groups with very different ceramic traditions.

Pastes and tempers associated with pottery technologies common in the two Classic period components identified during Peña Blanca investigations are similar to those noted at Classic period sites in other areas of the Rio Grande region (Tables 16.81 and 16.82). The majority of glaze-painted sherds from LA 249 are tempered with crushed crystalline basalt, although a significant number of sherds were tempered with crushed rock probably representing latite or andesite. Detailed analysis by Shepard (1942) of Glaze A types from sites throughout the Rio Grande region indicated that pottery produced in the Rio Grande was dominated by sherd, basalt, and indeterminate temper. Sherd temper dominated Glaze wares in the Albuquerque area. Indeterminate volcanic rock dominated Glaze wares in the Galisteo Basin. Shepard (1942) also recognized a variety of basalt tempers including vitric and crystalline forms.

Examinations of Glaze ware pottery from Early Classic period Cochiti Dam sites indicate a range of temper materials including fine-grained basalt, red basalt scoria, and andesite (Warren 1976, 1979b). These tempers reflect the use of volcanic rocks available in the general area. Petrographic analyses of Cochiti Dam pottery indicate the potential use of a wide range of basaltic rocks that can be traced to different sources (Warren 1969, 1976, 1979b). A range of basalt tempers were common in Glaze A forms from the Valencia site south of Albuquerque (Franklin 1997). Thus, the distribution of basalt noted for Glaze wares from LA 249 as well as other sites in the Cochiti area may reflect exchange ties with areas to the south. The presence of latite temper may reflect interaction with groups in the Galisteo Basin to the west. The low frequency of Biscuit ware at this site may also reflect limited exchange with groups on the Pajarito Plateau and other areas to the north.

Biscuit ware pottery from both Peña Blanca sites with Classic period assemblages were tempered with a fine tuff identical to that dominating contemporaneous assemblages in areas to the north. It is likely that most Biscuit ware pottery recovered from Peña Blanca sites was produced in areas to the north such as the Pajarito Plateau, Tewa Basin, Santa Fe Valley, and Chama Valley (Mera 1934). The occurrence of Biscuit wares as the dominant decorated form at LA 6171 may indicate that groups at this site were integrated into a network centered on the Pajarito Plateau to the north. Similar connections may also be reflected by the dominance of gray wares tempered with anthill sand, which appears to represent a material common in utility wares from the Pajarito Plateau. The presence of significant numbers of pottery tempered with micaceous granite may also reflect pottery associated with other areas to the north where this resource was utilized.

Thus, pottery and temper distributions from the two Classic period components recognized during Peña Blanca analysis indicate that groups at two sites located very close to each other may have participated in two distinct networks (Tables 16.83 and 16.84). Groups at LA 249 seem to have participated in alliances with Glaze-ware producing groups mainly located in areas to the south. During the Classic period, groups at LA 6171 appear to have participated in a network aligned with groups to the north who produced Biscuit wares.

Pottery Forms and Use. Examinations of distributions of ware groups indicate a much higher frequency of decorated ware when compared to assemblages associated with earlier occupational periods (Table 16.85). For example, half the total pottery from LA 249 components dominated by Classic types represent utility ware types. Most of the decorated wares consist of Glaze ware types.

Almost all the utility wares sherds from Classic period components appear to be derived from wide-mouth jars (see Tables 16.86 and 16.87). Decorated white and glaze ware types are represented by a fairly even mixture of sherds derived from jars and bowls. The continual distinction of gray and utility ware types as well as the increase of decorated pottery seem to reflect a continuation of trends associated with a more reliable technology. This technology is associated with an increased

Table 16.81. Distribution of Temper by Ware for Classic with Late Developmental Components

	Gray	White	Glaze	Micaceous	Historic Plain	Total
Sand	124	6	-	-	-	130
	10.8%	4.3%				6.3%
Mica, quartz, and feldspar	986	3	2	-	-	991
fragments (schist granite)	85.5%	2.2%	0.3%			47.8%
Similar to (3), but without	2	-	1	-	-	3
mica	0.2%		0.1%			0.1%
Highly micaceous paste	14	-	-	1	1	16
	1.2%			100.0%	1.4%	0.8%
Sherd	-	-	1	-	-	1
			0.1%			0.0%
Fine tuff or ash	1	99	20	-	-	120
	0.1%	71.7%	2.8%			5.8%
Fine tuff and sand	1	19	5	-	-	25
	0.1%	13.8%	0.7%			1.2%
Fine sandstone	4	-	-	-	-	4
	0.3%					0.2%
Gray crystalline basalt	12	1	560	-	50	623
	1.0%	0.7%	78.9%		69.4%	30.0%
San Marcos latite	-	-	16	-	1	17
			2.3%		1.4%	0.8%
Dark igneous and sherd	-	2	-	-	-	2
(Chupadero)		1.4%				0.1%
Latite (Keres area)	-	-	95	-	8	103
			13.4%		11.1%	5.0%
Anthill sand	3	-	-	-	-	3
	0.3%					0.1%
Basalt and sand	-	-	10	-	12	22
			1.4%		16.7%	1.1%
Oblate shale and sand	1	3	-	-	-	4
	0.1%	2.2%				0.2%
Mica and tuff	1	-	-	-	-	1
	0.1%					0.0%
Vitrified	-	4	-	-	-	4
		2.9%				0.2%
Mica, tuff, and sand	4	1	-	-	-	5
	0.3%	0.7%				0.2%
Total	1153	138	710	1	72	2074
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

distinction and importance of decorated vessels. No complete vessels were recovered from Classic period components.

Historic Period (AD 1600 to present)

While investigations of the Cochiti Dam Project resulted in the recovery and description of large amounts of "native" pottery types from historic sites dating to the seventeenth, eighteenth, and nineteenth centuries (Warren 1979c), few historic sherds were recovered during Peña Blanca investigations. Although an historic structure was excavated at LA 6170, no historic pottery was directly associated with these contexts.

A few sherds grouped into the historic plain ware category actually represent types associated with Classic period components. Pottery

Table 16.82. Distribution of Temper by Ware for Mainly Classic with Coalition Components from LA 6171

	Gray	White	Glaze	Historic Plain	Total
Sand	74	1	-	-	75
	69.8%	5.6%			59.1%
Mica, quartz, and feldspar fragments	6	-	-	-	6
(schist granite)	5.7%				4.7%
Fine tuff or ash	-	15	-	1	16
		83.3%		100.0%	12.6%
Gray crystalline basalt	2	-	1	-	3
	1.9%		50.0%		2.4%
Latite (Keres area)	-	-	1	-	1
			50.0%		0.8%
Anthill sand	24	-	-	-	24
	22.6%				18.9%
Oblate shale and sand	-	2	-	-	2
		11.1%			1.6%
Total	106	18	2	1	127
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.83. Distribution of Tradition by Ware for Classic with Late Developmental Components

	Gray	White	Red	Brown	Glaze	Micaceous	Historic Plain	Historic Decorated	Total
Intermediate	16	16	-	-	-	-	-	-	32
	0.1%	0.7%							0.1%
Rio Grande (Prehistoric)	3938	1560	-	2	-	1	-	-	5501
	22.1%	63.8%		1.0%		100.0%			25.3%
Rio Grande (Historic Tewa)	-	-	-	-	-	-	4	8	12
							4.8%	100.0%	0.1%
Rio Grande (Historic Keres)	-	-	-	-	771	-	79	-	850
					100.0%		95.2%		3.9%
Middle Rio Grande (Cibola)	13863	779	330	7	-	-	-	-	14979
	77.8%	31.8%	88.0%	3.4%					69.0%
Upper San Juan	-	-	1	-	-	-	-	-	1
			0.3%						0.0%
Tusayan	-	2	-	-	-	-	-	-	2
		0.1%							0.0%
Southern Jornada Mogollon	-	-	-	1	-	-	-	-	1
(El Paso)				0.5%					0.0%
Northern Jornada Mogollon	-	8	-	85	-	-	-	-	93
		0.3%		41.1%					0.4%
Eastern Mogollon	-	64	-	-	-	-	-	-	64
		2.6%							0.3%
Mogollon Highlands	-	18	44	112	-	-	-	-	174
		0.7%	11.7%	54.1%					0.8%
Total	17817	2447	375	207	771	1	83	8	21709
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.84. Distribution of Tradition by Ware for Mainly Classic with Coalition Components

	Gray	White	Glaze	Historic Plain	Total
Indeterminate	2	-	-	-	2
	1.9%				1.6%
Rio Grande (Prehistoric Tewa/Keres)	6	15	-	-	21
	5.7%	83.3%			16.5%
Rio Grande (Historic Tewa)	-	-	-	1	1
				100.0%	0.8%
Rio Grande (Historic Keres)	-	-	2	-	2
			100.0%		1.6%
Middle Rio Grande (Cibola)	98	3	-	-	101
	92.5%	16.7%			79.5%
Total	106	18	2	1	127
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.85. Distribution of Ware at Components Dominated by Classic Period

	LA 249	LA 6171	Total
Gray	1153	106	1259
	55.6%	83.5%	57.2%
White	138	18	156
	6.7%	14.2%	7.1%
Glaze	710	2	712
	34.2%	1.6%	32.3%
Micaceous	1	-	1
	0.0%		0.0%
Historic plain	72	1	73
	3.5%	0.8%	3.3%
Total	2074	127	2201
	100.0%	100.0%	100.0%

clearly representing types associated with historic period components identified during analysis of Peña Blanca ceramics are limited to one Kapo Gray sherd from LA 6170, and a Tewa Buff undifferentiated and one buff with smudged interior sherds from LA 6171. These three utility wares appear to reflect material somehow derived from components dating to either the eighteenth or nineteenth century.

Summary of Peña Blanca Pottery Trends

Distributions documented during Peña Blanca ceramic studies provided unique opportunities to document and examine trends spanning most of the Rio Grande occupational sequence. Much of the preceding discussions focused on Early Developmental components. These examinations provided data relating to patterns associated with largely undocumented Early Developmental occupations in the Northern Santo Domingo Basin (Post 2000). Information from the later occupations was used to supplement and evaluate data accumulated during Cochiti Dam investigations (Biella and Chapman 1977a, 1979; Honea 1968; Snow 1971; Warren 1976). These components were largely represented by smaller pottery assemblages dating to the Late Developmental, Coalition, and Classic periods. Another important contribution of Peña Blanca ceramic studies was the documentation of components that were unique and clearly transitional between the Late Developmental and Coalition periods.

Peña Blanca Pottery Sequence

Pottery distributions noted at most sites investigated during the Peña Blanca Project indicate a long sequence of occupation and reoccupation of similar locations on gravel terraces (Table 16.3). In fact, pottery distributions from only two sites yielded components limited to a single (Early Developmental) period. These are represented by a large number of sherds recovered from several proveniences at LA 265 and an extremely small assemblage from LA 115862. Pottery assemblages from LA 249 display various mixtures of pottery derived from a large

Table 16.86. Distribution of Vessel Form by Ware for Classic and Late Developmental Components from LA 249

	Gray	White	Glaze	Micaceous	Historic	Total
Indeterminate	23	5	10	-	-	38
	2.0%	3.6%	1.4%			1.8%
Bowl rim	1	9	35	-	-	45
	0.1%	6.5%	4.9%			2.2%
Bowl body	2	79	231	-	1	313
	0.2%	57.2%	32.5%		1.4%	15.1%
Seed jar	-	-	5	-	-	5
			0.7%			0.2%
Jar neck	139	6	11	-	1	157
	12.1%	4.3%	1.5%		1.4%	7.6%
Jar rim	28	1	1	-	2	32
	2.4%	0.7%	0.1%		2.8%	1.5%
Jar body	955	35	161	1	63	1215
	82.8%	25.4%	22.7%	100.0%	87.5%	58.6%
Jar body with strap or coil handle	3	-	-	-	-	3
	0.3%					0.1%
Jar body with lug handle	-	1	-	-	-	1
		0.7%				0.0%
Indeterminate coil/strap handle	2	-	-	-	-	2
	0.2%					0.1%
Canteen rim	-	-	-	-	1	1
					1.4%	0.0%
Body sherd polished int/ext	-	2	202	-	-	204
		1.4%	28.5%			9.8%
Body sherd unpolished	-	-	4	-	3	7
			0.6%		4.2%	0.3%
Body sherd unpolished int/polished ext	-	-	37	-	-	37
			5.2%			1.8%
Body sherd polished int/unpolished ext	-	-	11	-	1	12
			1.5%		1.4%	0.6%
Indeterminate rim	-	-	2	-	-	2
			0.3%			0.1%
Total	1153	138	710	1	72	2074
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Classic period village located up-slope and Late Developmental pottery from a pithouse identified during excavation inside the right-of-way. Pottery from LA 6169 reflects the presence of distinct components dating to the Early Developmental, Late Developmental (or transitional Late Developmental-Coalition), and Coalition periods. Pottery from the majority of components at LA 6170 indicate an Early Developmental period occupation, although pottery associated with a few contexts also indicate more limited occupation during the Late Developmental period. Those from LA 6171 reflect occupations during the Early Developmental, Coalition, and Classic periods. The very small ceramic assemblage recovered from LA 115862 reflects a mixture of Early Developmental and Late Developmental pottery.

Interpretation of Peña Blanca Pottery Data

Assigning assemblages from various contexts to different dating periods provided a framework for examining a variety of trends. Many of these trends were examined through comparison of several attributes within and between different ware groups (Tables 16.88 through 16.97).

Comparisons with data from previous studies

Table 16.87. Distribution of Vessel Form by Ware for Mainly Classic with Coalition Components from LA 6171

	Gray	White	Glaze	Historic Plain	Total
Indeterminate	-	3	-	-	3
		16.7%			2.4%
Bowl rim	-	8	-	-	8
		44.4%			6.3%
Bowl body	3	6	2	-	11
	2.8%	33.3%	100.0%		8.7%
Jar neck	3	-	-	-	3
	2.8%				2.4%
Jar body	99	1	-	1	101
	93.4%	5.6%		100.0%	79.5%
Body sherd polished	1	-	-	-	1
int/unpolished ext	0.9%				0.8%
Total	106	18	2	1	127
	100.0%	100.0%	100.0%	100.0%	100.0%

in this area are limited by the rarity of components encompassing the entire temporal span as represented by Peña Blanca sites. Recent pottery-based syntheses do provide a good framework for interpreting trends observed in Coalition to Classic period assemblages (Habicht-Mauche 1993; Vint 1999), however these studies were not concerned with occupations dating to earlier components. Thus, data accumulated during the Peña Blanca pottery studies are interpreted using a patchwork of approaches and models including those presented in the Peña Blanca research design (Post and Blinman 2001; Ware 1997) and other studies in the region (Habicht-Mauche 1993; Vint 1999). Examination of ceramic patterns for different occupational periods have focused on the nature of and the potential causes of various trends including cultural affiliation, production technology, interaction between different groups, and influences of economic and substance patterns of vessel use.

Local and Regional Occupational History and Connections

Pottery data accumulated during Peña Blanca studies provide important insights about the sequence and nature of ceramic-bearing occupations in the Santo Domingo Basin and surrounding areas. Peña Blanca pottery data extend the occupation of the Santo Domingo Basin by ceramic-producing groups to the Early Developmental period beginning by the eighth century. Combinations of data from this project and Cochiti Dam investigations indicate a very long history of occupation of the Santo Domingo area beginning with establishment of San Marcial phase villages by at least the eighth century and continuing with occupations during all Rio Grande occupation periods to the modern occupation of Cochiti Pueblo.

Peña Blanca pottery data indicate that the earlier occupations (AD 700 to 1350) in the Middle and Northern Rio Grande region may reflect material culture similar to that noted for groups to the north, thought to be ancestral to the modern Tewa Pueblos (Ford et al. 1972). Later occupations may reflect Keres immigrants, producing glaze ware pottery, from areas to the west (Ford et al. 1972). This view contrasts with many other models, which propose that Tanoan groups migrated from the Chaco or Mesa Verde areas to areas of the Northern Rio Grande (Reed 1949; Wendorf 1954), but may better explain the continuity in painted white ware forms at sites in the Northern Rio Grande.

Pottery trends noted at sites in the Northern Santo Domingo Basin indicate a long and continuous occupation as well as shifting ties and interactions with groups in different areas of the Rio Grande region, which are reflected by changes in the distributions of traditions and tempers within various ware groups through time in both gray

Table 16.88. Distribution of Ware by Dating Period

	Early Develop.	Late Develop.	Transitional Late Develop., Some Early Devel.	Coalition	Classic w/ Late Develop.
Gray	8320	407	809	1356	1153
	90.7%	79.5%	75.0%	72.7%	55.6%
White	410	97	255	495	138
	4.5%	18.9%	23.7%	26.5%	6.7%
Red	261	3	12	13	-
	2.8%	0.6%	1.1%	0.7%	
Brown	177	3	2	-	-
	1.9%	0.6%	0.2%		
Glaze	1	-	-	-	710
	0.0%				34.2%
Micaceous	-	-	-	-	1
					0.0%
Historic plain	-	2	-	1	72
		0.4%		0.1%	3.5%
Total	9169	512	1078	1865	2074
	100.0%	100.0%	100.0%	100.0%	100.0%

utility and white ware types (Tables 16.91–16.96). For the utility ware, this sequence begins with the dominance of sand or sandstone temper during the Early Developmental period, to micaceous igneous rock during components assigned to the Late Developmental period, to anthill sand during the Coalition period, and back to micaceous igneous rock during the Classic period. The majority of decorated wares from Early Developmental components exhibit combinations of pastes and treatments resulting in their assignment to Middle Rio Grande White ware types, but resemble those in the Anasazi region to the west during the Early Developmental period and the Pajarito Plateau during the Coalition period, while most of those from Late Developmental to Coalition phase sites were assigned to Northern Rio Grande types, and decorated wares from Classic phase sites were assigned to a mixture of Rio Grande Glaze ware and Northern Rio Grande White ware types. Information relating to changes within the frequencies of various traditions form the basis for characterizations of the regional systems in which Santo Domingo Basin groups participated during various periods.

Early Developmental Components

Early Developmental components documented during Peña Blanca investigations are represented at six of the seven sites investigated. With the exception of a possible archaeomagnetic date of AD 450 to 700 for the earliest components at LA 6171, Early Developmental components dated to the eighth and ninth century. Early Developmental components documented during the Peña Blanca Project appear to reflect the northernmost extension of a ceramic complex that included areas along the Rio Grande in the vicinity of Albuquerque to the south as well as areas along the Rio Puerco Valley to the west (Frisbie 1967; Schmader 1994; Vivian and Clendenen 1965) and in areas of the Rio Abajo region as far south as the town of T or C (Mera 1934; Marshall and Walt 1984). Examinations of pottery from Early Developmental components documented during Peña Blanca investigations indicate that pottery from assemblages assigned to this period share a number of traits (such as the dominance of gray and white wares) with contemporary sites on the Colorado Plateau as well as some traits (such as decorative styles) with the Mogollon Highlands.

Table 16.89. Distribution of Gray Ware Exterior Manipulation by Dating Period

	Early Develop.	Late Develop.	Transitional Late Develop., Some Early Develop.	Coalition	Classic w/ Late Develop.
Plain unpolished	8037	236	559	457	653
	96.6%	58.0%	69.1%	33.7%	56.6%
Plain polished	11	3	-	12	-
	0.1%	0.7%		0.9%	
Plain striated	1	7	19	-	-
	0.0%	1.7%	2.3%		
Surface missing	123	-	4	1	4
	1.5%		0.5%	0.1%	0.3%
Wide Coils (fillets)	2	-	1	-	-
	0.0%		0.1%		
Narrow Coil	-	-	-	-	2
					0.2%
Clapboard	-	-	-	-	9
					0.8%
Indented Corrugated	4	39	18	49	373
	0.0%	9.6%	2.2%	3.6%	32.4%
Plain Corrugated	5	67	54	146	31
	0.1%	16.5%	6.7%	10.8%	2.7%
Smeared Indented	-	3	5	62	48
Corrugated		0.7%	0.6%	4.6%	4.2%
Smeared Plain Corrugated	5	46	145	619	29
	0.1%	11.3%	17.9%	45.6%	2.5%
Wide Neck Banded Wiped	9	2	2	1	1
Undulated	0.1%	0.5%	0.2%	0.1%	0.1%
Indented Corrugated Incised	-	-	-	-	1
					0.1%
Plain Incised Herringbone	2	-	-	-	-
	0.0%				
Basket impressed	1	-	-	-	-
	0.0%				
Low relief corrugated	-	-	2	-	-
			0.2%		
Fugitive Red	120	1	-	2	-
	1.4%	0.2%		0.1%	
Red Slipped Unpolished	-	1	-	3	-
		0.2%		0.2%	
Indeterminate Incised	-	1	-	-	-
		0.2%			
Smeared Indeterminate	-	-	-	-	1
					0.1%
Punctate	-	-	-	-	1
					0.1%
Indeterminate	-	1	-	4	-
		0.2%		0.3%	
Total	8320	407	809	1356	1153
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.90. Distribution of White Ware Pigment by Dating Period

	Early Develop.	Late Develop.	Transitional, Late Develop., Some Early Develop.	Coalition	Classic w/ Late Develop.
None	152	28	105	131	80
	37.1%	28.9%	41.2%	26.5%	58.0%
Indeterminate	-	-	1	2	2
			0.4%	0.4%	1.4%
Mineral black	202	46	107	13	24
	49.3%	47.4%	42.0%	2.6%	17.4%
Mineral brown	24	8	8	3	8
	5.9%	8.2%	3.1%	0.6%	5.8%
Mineral red	26	10	-	2	2
	6.3%	10.3%		0.4%	1.4%
Organic	5	5	29	343	19
	1.2%	5.2%	11.4%	69.3%	13.8%
Organic diffuse	-	-	1	-	-
			0.4%		
Glaze paint	1	-	-	-	3
	0.2%				2.2%
Sub-glaze	-	-	4	1	-
			1.6%	0.2%	
Total	410	97	255	495	138
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.91. Distribution of Gray Ware Tradition by Dating Period

	Early Develop.	Late Develop.	Transitional Late Develop., w/ Some Early Develop.	Coalition	Classic w/ Late Develop.
Indeterminate	3	-	-	-	-
	0.0%				
Rio Grande (Prehistoric)	147	245	540	105	1022
	1.8%	60.2%	66.7%	7.7%	88.6%
Cibola	8170	162	269	1251	131
	98.2%	39.8%	33.3%	92.3%	11.4%
Total	8320	407	809	1356	1153
	100.0%	100.0%	100.0%	100.0%	100.0%

Combinations of traits appear to reflect derivation out of and interaction with groups on the Colorado Plateau. Early Developmental ceramic assemblages are characterized by "locally" produced pottery with white pastes and sand temper, as well as construction and firing technology similar to that noted in pottery from the Colorado Plateau. These traits may reflect a development out of the earliest Anasazi pottery traditions, which appeared earlier in areas of the Colorado Plateau. Low frequencies of pottery exhibiting characteristics of or reflecting types from the Mogollon Highlands also reflect a significant amount of influence and interactions with groups to the south. The combination of characteristics in these assemblages are distinct from those in other regions of the Southwest, and reflect the development of a distinct areal pottery tradition during the eighth or ninth century. The unique combination of traits associated with the

Table 16.92. Distribution of Decorated Pottey Tradition by Dating Period

	Early Develop.	Late Develop.	Late Develop. w/ Some Early Develop.	Coalition	Classic w/ Late Develop.
Indeterminate	1	-	7	1	4
	0.2%		2.7%	0.2%	0.5%
Northern Rio Grande	12	60	124	465	123
	2.9%	61.9%	48.6%	93.9%	14.5%
(Rio Grande Glaze)	1	-	-	-	710
	0.2%				83.7%
MRG Cibola	377	25	91	28	9
	91.7%	25.8%	35.7%	5.7%	1.1%
Tusayan	2	-	-	-	-
	0.5%				
Northern Jornada Mogollon	-	-	6	-	-
			2.4%		
Eastern Mogollon	1	12	27	1	2
	0.2%	12.4%	10.6%	0.2%	0.2%
Mogollon Highlands	17	-	-	-	-
	4.1%				
Total	411	97	255	495	848
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.93. Distribution of Gray Ware Temper by Dating Period

	Early Develop.	Late Develop.	Late-Late Develop. or Transitional	Coalition	Classic w/ Late Develop.
Indeterminate	1	-	-	-	-
	0.0%				
Sand	7764	61	353	549	116
	93.3%	34.3%	34.0%	40.5%	28.9%
Mica, quartz, and feldspar	87	112	672	80	277
fragments (schist granite)	1.0%	69.2%	64.7%	5.9%	69.1%
Fine sandstone	3	-	1	-	4
	0.0%		0.1%		1.0%
Self tempered	78	-	1	25	-
	0.9%		0.1%	1.8%	
Ant hill sand	29	-	11	695	3
	0.3%		1.1%	51.3%	0.7%
Basalt and sand	1	-	-	-	-
	0.0%				
Oblate shale and sand	356	5	-	7	1
	4.3%	2.8%		0.5%	0.2%
Quartzite (Leucocratic Igneous)	1	-	-	-	-
	0.0%				
Total	8320	178	1038	1356	401
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.94. Distribution of White Ware Temper by Dating Period

	Early Develop.	Late Develop.	Transitional Late Develop. w/ Some Early Develop.	Coalition	Classic w/ Late Develop.
Indeterminate	-	-	7 2.7%	-	-
Sand	182 44.4%	15 15.5%	84 32.9%	10 2.0%	6 4.3%
Mica, quartz, and feldspar fragments (schist granite)	-	-	-	-	3 2.2%
Sherd	-	3 3.1%	49 19.2%	2 0.4%	-
Sherd and sand	1 0.2%	17 17.5%	13 5.1%	2 0.4%	-
Fine tuff or ash	2 0.5%	6 6.2%	21 8.2%	144 29.1%	99 71.7%
Fine tuff and sand	10 2.4%	49 50.5%	44 17.3%	191 38.6%	19 13.8%
Fine sandstone	-	-	5 2.0%	-	-
Gray crystalline basalt	-	-	-	-	1 0.7%
Indeterminate dark igneous	-	-	-	1 0.2%	-
Dark igneous and sherd (Chupadero)	-	1 1.0%	19 7.5%	-	2 1.4%
Dark igneous and sand	1 0.2%	-	2 0.8%	1 0.2%	-
Mogollon volcanics	11 2.7%	-	-	-	-
Sand and Mogollon volcanics	6 1.5%	-	-	-	-
Oblate shale and sand	194 47.3%	2 2.1%	7 2.7%	20 4.0%	3 2.2%
Mica and tuff	-	1 1.0%	1 0.4%	76 15.4%	-
Vitrified	2 0.5%	-	-	-	4 2.9%
Mica, tuff, and sand	-	2 2.1%	-	38 7.7%	1 0.7%
Dark sand	-	-	1 0.4%	-	-
Shale	1 0.2%	-	-	10 2.0%	-
Very Fine Sand (silt)	-	-	2 0.8%	-	-
Multi-lithic Sand	-	1 1.0%	-	-	-
Total	410 100.0%	97 100.0%	255 100.0%	495 100.0%	138 100.0%

Table 16.95. Distribution of Glaze Ware Temper at LA 249

	Frequency	Percent
Mica, quartz, and feldspar fragments (schist granite)	2	0.3
Similar to (3), but without mica	1	0.1
Sherd	1	0.1
Fine tuff or ash	20	2.8
Fine tuff and sand	5	0.7
Gray crystalline basalt	560	78.9
San Marcos latite	16	2.3
Latite (Keres area)	95	13.4
Basalt and sand	10	1.4
Total	710	100

Early Developmental period or San Marcial phase may represent groups that were distinct from those residing in either the Mogollon Highlands or Colorado Plateau. As previously indicated, these Early Developmental components may represent early Tanoan-speaking groups who later expanded into areas of the Rio Grande region to the north.

Peña Blanca Early Occupational Gap

The lack of evidence of occupation at Peña Blanca sites from the late part of the Early Developmental period beginning during the early tenth century to the early part of the Late Developmental period sometime during the middle eleventh century is in itself noteworthy. This gap does not necessarily represent a hiatus in the occupation of the Northern Santo Domingo Basin. Evidence of occupation dating immediately after the Early Developmental period at Peña Blanca sites is present at LA 272 (Dead Horse site) investigated during the Cochiti Dam Project (Snow 1971a). Pottery from this site exhibits a combination of traits that are intermediate to those noted at Early Developmental sites documented during the present study and Red Mesa phase sites appearing in various areas of the Rio Grande, and appears to date sometime between AD 850 and 950.

By the early tenth century, there appears to have been a movement of populations into areas of the Rio Grande Valley north of La Bajada, areas with a large number of Red Mesa and Kwahe'e phase sites such as the Santa Fe Valley and Tewa Basin (Dickson 1979; Ellis 1975; McNutt 1969; Mera 1935; Wendorf 1954). Populations may have also begun to increase in the Santo Domingo Basin after a dramatic decline beginning in the middle tenth century. Similarities in pottery assemblages from LA 272 and Red Mesa phase sites in the Tewa Basin may indicate population movements from the Albuquerque area and Santo Domingo Basin into areas of Rio Grande Valley to the north. Red Mesa phase components scattered throughout the Northern Rio Grande Valley appear to reflect the northern movement of distinct Tanoan groups who long lived in areas of the Rio Grande to the south. Pottery distributions at these Red Mesa sites indicate both a continuation of a distinctly Rio Grande ceramic technology (as reflected by the distinctive mica and granite temper utility wares) as well as interaction and exchange with groups on the Colorado Plateau (as indicated by the dominance of Red Mesa Black-on-white similar to that produced in regions to the west).

Late Developmental and Transitional Components

Contexts from three Peña Blanca sites were assigned to Late Developmental components based on the occurrence of Kwahe'e Black-on-white and the dominance of micaceous utility ware that is extremely similar to those produced in areas of the Rio Grande to the north. While these components were all initially subsumed under the Late Developmental period,

Table 16.96. Distribution of Gray Ware Form by Dating Period

	Early Develop.	Late Develop.	Transitional Late Develop. w/ Some Early Develop.	Coalition	Classic w/ Late Develop.
Indeterminate	126	2	7	19	23
	1.5%	0.5%	0.9%	1.4%	2.0%
Bowl rim	9	1	-	2	1
	0.1%	0.2%		0.1%	0.1%
Bowl body	2	-	-	10	2
	0.0%			0.7%	0.2%
Olla rim	3	-	-	-	-
	0.0%				
Jar neck	1008	32	61	71	139
	12.1%	7.9%	7.5%	5.2%	12.1%
Jar rim	177	10	15	62	28
	2.1%	2.5%	1.9%	4.6%	2.4%
Jar body	6904	359	712	1178	955
	83.0%	88.2%	88.0%	86.9%	82.8%
Jar body with strap or coil handle	5	-	10	-	3
	0.1%		1.2%		0.3%
Jar body with lug handle	11	-	-	1	-
	0.1%			0.1%	
Indeterminate coil/strap handle	14	1	2	1	2
	0.2%	0.2%	0.2%	0.1%	0.2%
Canteen rim	1	-	1	1	-
	0.0%		0.1%	0.1%	
Miniature pinch pot rim	1	-	-	-	-
	0.0%				
Miniature pinch pot body	7	-	1	9	-
	0.1%		0.1%	0.7%	
Jar rim w/ strap handle	1	-	-	-	-
	0.0%				
Cloud blower	8	-	-	-	-
	0.1%				
Applique	-	-	-	1	-
				0.1%	
Jar rim w/ lug handle	5	-	-	-	-
	0.1%				
Indeterminate rim	28	2	-	1	-
	0.3%	0.5%		0.1%	
Pitcher rim	3	-	-	-	-
	0.0%				
Spindle Whorl	1	-	-	-	-
	0.0%				
Figurine	1	-	-	-	-
	0.0%				
Jar lid	5	-	-	-	-
	0.1%				
Total	8320	407	809	1356	1153
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16.97. Distribution of White Ware Form by Dating Period

	Early Develop.	Late Develop.	Transitional Late Develop. w/ Some Early Develop.	Coalition	Classic w/ Late Developmental
Indeterminate	3	1	-	11	5
	0.70%	1.00%		2.20%	3.60%
Bowl rim	42	22	27	88	9
	10.20%	22.70%	10.60%	17.80%	6.50%
Bowl body	159	47	96	313	79
	38.80%	48.50%	37.60%	63.20%	57.20%
Jar neck	19	8	19	4	6
	4.60%	8.20%	7.50%	0.80%	4.30%
Jar rim	2	1	3	2	1
	0.50%	1.00%	1.20%	0.40%	0.70%
Jar body	180	18	107	73	35
	43.90%	18.60%	42.00%	14.70%	25.40%
Jar body with lug handle	2	-	-	-	1
	0.50%				0.70%
Indeterminate coil/strap handle	-	-	-	1	-
				0.20%	
Canteen rim	-	-	1	1	-
			0.40%	0.20%	
Seed jar rim	2	-	2	1	-
	0.50%		0.80%	0.20%	
Body sherd polished int/ext	-	-	-	-	2
					1.40%
Indeterminate rim	1	-	-	1	-
	0.20%			0.20%	
Total	410	97	255	495	138
	100.00%	100.00%	100.00%	100.00%	100.00%

differences in associated pottery and associated dates resulted in the recognition of two distinct temporal spans. The earliest of these is reflected by assemblages from LA 249 and LA 6170 and consists of decorated assemblages overwhelmingly dominated by Kwahe'e Black-on-white. It is likely that these assemblages reflect an occupation dating sometime from the middle eleventh to middle twelfth centuries. Assemblages from LA 6169 exhibit similar Kwahe'e Black-on-white and micaceous utility wares as well as the additional presence of Socorro Black-on-white, Chupadero Black-on-white, Cibola Wares, Santa Fe Black-on-white, and Galisteo Black-on-white. This combination of pottery and a single archaeomagnetic date indicate an occupation spanning the very late twelfth and early thirteenth centuries.

The initial production of Kwahe'e Black-on-white similar to that produced in other areas along the Rio Grande represents the beginning of a distinct Rio Grande pottery technology that characterizes subsequent occupational periods. The widespread occurrence of similar pottery on sites along the Rio Grande Valley may reflect the development and spread of an expanding social-economic network that may be associated with the growth and dispersal of Tanoan populations. Initial production of Kwahe'e Black-on-white and micaceous utility wares may have developed in areas along the Rio Grande Valley to the north and spread throughout this region. Similarities noted in pastes and styles indicate that most of the ties were between groups living in the Rio Grande region, reflecting a distinct and relatively confined regional sphere or network characterized earlier in this study as the Kwahe'e system. The occurrence of similar ceramics along with significant frequencies of types, such Socorro Black-on-white and Chupadero Black-on-white, may reflect increased ties with groups to the south during the late eleventh and early twelfth centuries.

Coalition Period Components

Components dating to the Coalition period were identified at two sites (LA 6169 and LA 6171). Most of these components appear to date to the early part of this phase or the first half of the thirteenth century. Distributions of pottery traits noted at Coalition period components reflect both the continuation of patterns established during the Late Developmental period as well as some important changes. Pottery associated with Early Coalition period assemblages recovered during Peña Blanca investigations indicate the continuation of a technology that appears to have developed in this area. Such connections are reflected by characteristics of Santa Fe Black-on-white that appear to only differ from Kwahe'e by decorations in organic rather than mineral pigments. This decorated pottery was produced with high iron pastes and fine tuff or ash temper, design styles executed in organic paint, and manipulations similar to Santa Fe Black-on-white produced throughout the Northern Rio Grande. Pottery traits also demonstrate strong connections with other areas of the Rio Grande region indicated by both the presence of Santa Fe Black-on-white with styles and treatments typical of most of the Rio Grande region and corrugated pottery exhibiting a temper referred to here as anthill sand. The widespread distribution and homogeneity of decorated pottery and other traits characteristic of the early part of the Coalition period have been interpreted as reflecting broad, open economic and social networks associated with increasing populations (Orcutt 1999).

Classic Period Components

The small size and mixed nature of assemblages with Classic period pottery examined during the Peña Blanca analysis limit examinations of trends associated with this component. The majority of gray wares associated with this period are tempered with a granite and mica similar to that dominating pottery from early Pueblo II components. Distributions noted in decorated pottery may indicate considerable variation in pottery production and exchange.

This variation is reflected by the dominance of glaze ware types, mainly tempered with basalt or latite, for one Classic period component and Biscuit wares for the other. Such variations in pottery distributions at sites located in close proximity may reflect the complex nature of social and economic ties during this period (Habicht-Mauche 1993; Vint 1999). The occurrence of glaze ware as the dominant decorated form may reflect ties with Keres groups who appear to have moved into the Santo Domingo Basin and surrounding areas during the early part of the Classic period. The dominance of Biscuit wares at the other site may reflect stronger ties with groups on the Pajarito Plateau and other areas to the north who continued a tradition of pottery tempered with fine tuff and ash and decorated with organic pigment. Distributions from the two Classic period Peña Blanca sites may indicate that communities located close to each other may have participated in very different networks. This observation appears to support previous proposed models of increased economic specialization and regional integration during the Classic period.

The seemingly abrupt changes in ceramic pastes, technologies, and decoration documented for Peña Blanca ceramic assemblages and other Cochiti area projects assigned to various periods contrasts dramatically with ceramic trends noted for sites in the Northern Pajarito Plateau and Tewa Basin to the north (Wilson 2008). In these areas, the type of tempering material noted in different locally produced wares was distinct and fairly consistent through time. In addition, changes in technology and conventions and styles used to decorate pottery appear to have gradually changed through time. Thus, almost all locally produced ceramics spanning the entire Pueblo occupation in these areas can be placed into types associated with a single tradition that reflects a very long occupation of these areas by Northern Tewa Pueblo groups.

In contrast, the very long ceramic sequence noted for the Cochiti area is reflected by a series of abrupt shifts in the use of tempering material sources and decorative conventions. Many of these changes appear to reflect shifting waves of influence from and ties between surrounding villages. Thus, unlike areas to the north, it is not possible to trace a continual ceramic tradition through time for ceramics from sites in the Cochiti area. Instead, ceramic change is best described in terms of dramatic shifts in associated traditions and ties with surrounding groups. The occurrence of such shifts presented distinct challenges regarding the classification and characterization of this pottery. The many difficulties encountered during the classification of this pottery, however, are in themselves very instructive. The problems in classification encountered may indicate that at varous times Pueblo groups residing in the Cochiti area were affiliated with groups belonging to various cultural traditions, although it may not be possible to determine whether such changes reflect shifts in cultural or ethnic affinity or changes in participation with various regional netweorks than may have extended into this area at one time or another. The nature of ceramic change in the Cochiti area may reflect its location near the edge of a number of distinct geographic provinces that may have been inhabited by distinct ethnic groups. In addition, the location of this area near the confluence of different river valleys and its transitional location between different geographic zones may have contributed to its role as an important pathway through which people and ideas continually moved from various provinces.

Trends in Vessel Form and Use

Patterns involving various functionally related changes in pottery forms are reflected by changes in frequencies of ware groups and vessel form (Tables 16.88, 16.96, 16.97). Previous discussions have noted that these changes may reflect influences from a changing subsistence strategy ultimately involving a shift from a maintainable to reliable technology (Mills 1989). The Peña Blanca pottery data provided an excellent opportunity to examine functional trends over a very long span for this area of the Rio Grande region. Thus, the nature and implications of such functional trends are discussed here separately from other trends.

Early Developmental components are overwhelmingly dominated by plain gray ware jars that represent over 90 percent of the pottery from almost all assemblages. White wares consist of an even mixture of jars and bowls. About 80 percent of the pottery from Late Developmental components represent gray ware types. These include varying mixtures of forms exhibiting plain and corrugated exteriors. About 70 percent of the white wares from most sites represent bowls, with the remaining representing jars. A slight drop in the frequency of gray wares (70 percent) is reflected in Coalition period occupations. The majority of these gray wares exhibit corrugated exteriors. Another dramatic change in gray ware frequencies is reflected in Classic period components where they make up about half of all pottery. Most of the decorated pottery is represented by glaze wares, which include a mixture of jar and bowl forms.

The overall trends in wares and forms lend considerable support to the previously discussed model involving a shift from a maintainable to reliable technology. These trends are reflected by both the decrease in gray utility and increase in decorated white or glaze wares though time, and the continual distinction and elaboration of the technologies associated with different ware groups.

The basic type shifts in functionally related traits involve a shift from assemblages dominated by plain gray wares to those containing increasing frequencies of white wares and utility wares dominated by forms with exterior manipulations. The basic types of trends are similar to those for other areas of the Southwest, although important differences in nature of changes and timing of functionally related changes from regions are represented. These differences appear to reflect differences in the overall nature and timing of settlement and economic patterns in different regions.

Chapter 17

Stone Tool Assemblages from the NM 22 Project: A Comparison of Early Developmental, Late Developmental, Coalition, and Classic Assemblages

Jeanne A. Schutt

A number of analytical approaches were implemented to examine chipped and ground stone artifacts recovered from sites excavated during the New Mexico Highway 22 mitigation project. Due to the sheer magnitude of lithic materials, a sampling procedure was adopted to select proveniences with good integrity that would provide a basis to compare assemblages from different temporal periods as well as to distinguish assemblages associated with primary occupation from secondary trash deposits. As a rule, surface artifacts were not sampled because the ground surface on all sites was disturbed by previous highway construction. The detailed lithic analysis of chipped and ground stone recorded 21,124 artifacts. This sample recorded 2,130 artifacts (70 percent) from LA 249, 6,395 artifacts (29 percent) from LA 265, 5,588 artifacts (29 percent) from LA 6169, 4,663 artifacts (32 percent) from LA 6170, 1,741 artifacts (29 percent) from LA 6171, 564 artifacts (85 percent) from LA 115682, and 43 artifacts (13 percent) from 115683. Proveniences that were not sampled underwent a rough sort to recover all formal tools from each site. These additional artifacts (n = 150) are not included in the artifact counts for each site above and they are not included in site component tables presented in each site report. Artifacts recovered from the rough sort as well as the detailed analysis are, however, both included in the discard pattern study described below and the projectile point study (Van Pool, Chapter 18).

Research Objectives

Analytical procedures were designed to address a complement of research issues defined in the research design. The primary objectives of this analysis were to identify formal tool discard patterns and use these data to address a series of research issues: (1) to identify the range of subsistence activities that characterize each temporal period, (2) to determine the organization of lithic technology, (3) identify lithic source areas, (4) gain insight into patterns of settlement, and (5) define occupation histories for the sites. The analytical procedures selected to address these issues include: a detailed lithic analysis of a sample of lithics from each site, an analysis of all formal tools, including formal tools from proveniences not selected for the detailed analysis, an obsidian source study, and a tool discard pattern study. These analyses will target artifacts from selected proveniences.

The detailed analysis of chipped stone is presented in the individual site reports to describe types of reduction and manufacturing trajectories. The formal tool analysis includes formal tools from the detailed analysis sample and the rough sort of all proveniences not included in the original analysis. The obsidian source study was implemented to provide more detailed information about obsidian sources in the Jemez Mountains as well as potential non-local sources (Shackley, Appendix 2). Warren's (1979d:46) study of raw material sources in the ancestral Rio Grande gravels in the Cochiti area were also used for comparison. The tool discard study was developed to identify both formal tool discard patterns and consequently provide a more detailed assessment of activities performed on each site, and consider the implications brought to light when certain tool discard patterns are represented in a given assemblage. These data then provide a basis to address the broad settlement and subsistence issues defined above.

The variables selected for these analyses provide a means to define the activities that occur at each site and facilitate comparative analyses, which can be used to evaluate occupation history. What kinds of reduction technologies are represented on sites in the study area? Does reduction indicate limited trajectories more typical of repeated short-term site use or more diverse trajectories typical of prolonged occupation? Are lithic assemblages characteristic of continuous occupation or a discontinuous history of occupation, abandonment, and reoccupation? Does the lithic assemblage reflect a single-event occupation or repeated, possibly seasonal use of the site? The distribution of different types of lithic artifacts within each site can be used to determine if discrete locales within the site represent similar activities that might represent repeated single events or a combination of activities that reflect a variety of subsistence activities more typical of year-round use of the site. Flenniken (1991:185), for example, argues that complete points and bases indicate rejuvenation and weapon repair while tips and midsections are left in the field at kill sites or at butchering camps when removed from the dead animal.

The distribution of certain types of artifacts will provide an avenue to address these issues. What is the difference between Early and Late Developmental subsistence activities? Why does White Rock Canyon to the north lack a significant Early Developmental occupation while the NM 22 sites located below Cochiti Dam exhibit an emphasis on Early Developmental use?

Methodology and Summarized Results of the Lithic Analysis

Debitage

Debitage is the artifact class that refers to fragments of lithic material that have been detached by human force from a modified source of raw material. Force, direction of force, hammer mass, hammer mass velocity, and raw material quality are critical in determining the physical attributes of the resulting debitage. Three techniques of imparting force on lithic material sufficient for flake detachment are variously employed to reduce the raw material to its functional form. These techniques are referred to as freehand flaking, bipolar flaking, and pressure flaking.

Five categories of debitage result from these flaking processes: cores, core flakes, biface thinning flakes, sharpening (pressure) flakes, and angular debris. Debitage recovered from sites within the NM 22 project area was analyzed chronologically by site on material type, cortical content, platform configuration, condition, heat treatment, and dimensions. This type of quantitative attribute analysis is utilized to develop inferences relating to technological, subsistence, and procurement strategies associated with former inhabitants of the project area. Table 17.1 provides debitage class frequencies by time period by site.

Debitage resulting from the freehand flaking technique is fragmented lithic material that has been detached from a core by the unidirectional force created from a hand-held hammer. Typically, the core is held in one hand and struck by the hammer held in the other hand. In most cases this percussion produces a flake with a definite dorsal (outside) surface and a ventral (inside) surface with a positive bulb of percussion.

The bipolar flaking technique utilizes an anvil or rigid surface on which the core is placed and then struck with a hammer from

Table 17.1. Debitage and Cores by Period and Site

Period	Artifact Type	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
Earliest Developmental	Angular debris	-	-	-	-	18	-	-	18
	Flake	-	-	-	-	57	-	-	57
	Flake, bifacial thinning	-	-	-	-	2	-	-	2
	Tested rock	-	-	-	-	1	-	-	1
	Core, multiplatform	-	-	-	-	1	-	-	1
	Total	-	-	-	-	79	-	-	79
Early Developmental	Angular debris	-	566	165	433	134	60	-	1358
	Flake	-	5212	797	3078	682	359	-	10128
	Flake, bifacial thinning	-	139	6	287	14	1	-	447
	Flake, sharpening	-	4	14	1	-	20	-	39
	Flake from ground stone	-	2	-	1	-	-	-	3
	Flake from hammerstone	-	1	-	-	2	-	-	3
	Flake, bipolar	-	1	-	-	-	-	-	1
	Flake, uniface resharpening	-	-	-	-	1	13	-	14
	Tested rock	-	20	3	12	1	3	-	39
	Core, multiplatform	-	132	13	47	12	8	-	212
	Core, bifacial	-	-	1	-	-	1	-	2
	Core, single platform	-	6	1	9	-	-	-	16
	Total	-	6083	1000	3868	846	465	-	12262
Late Developmental	Angular debris	100	2	257	50	-	-	-	409
	Flake	789	16	968	258	-	-	-	2031
	Flake, bifacial thinning	1	-	4	3	-	-	-	8
	Flake, sharpening	-	-	2	-	-	-	-	2
	Flake from ground stone	-	-	-	1	-	-	-	1
	Flake from hammerstone	-	-	2	-	-	-	-	2
	Flake, uniface resharpening	-	-	1	1	-	-	-	2
	Tested rock	-	-	8	1	-	-	-	9
	Core, multiplatform	30	1	23	10	-	-	-	64
	Core, bifacial	1	-	-	-	-	-	-	1
	Core, single platform	-	-	1	1	-	-	-	2
	Total	921	19	1266	325	-	-	-	2531
Coalition	Angular debris	-	-	613	-	109	-	-	722
	Flake	-	-	1647	-	376	-	-	2023
	Flake, bifacial thinning	-	-	6	-	2	-	-	8
	Flake, sharpening	-	-	6	-	-	-	-	6
	Flake from hammerstone	-	-	2	-	-	-	-	2
	Flake, uniface resharpening	-	-	1	-	-	-	-	1
	Tested rock	-	-	11	-	-	-	-	11
	Core, multiplatform	-	-	42	-	9	-	-	51
	Core, bifacial	-	-	1	-	-	-	-	1
	Core, single platform	-	-	5	-	2	-	-	7
	Total	-	-	2334	-	498	-	-	2832
Classic	Angular debris	111	-	-	-	8	-	-	119
	Flake	946	-	-	-	36	5	-	987
	Flake, bifacial thinning	3	-	-	-	-	-	-	3
	Tested rock	14	-	-	-	-	-	-	14
	Core, multiplatform	34	-	-	-	1	-	-	35
	Core, bifacial	1	-	-	-	-	-	-	1
	Core, single platform	2	-	-	-	-	-	-	2
	Total	1111	-	-	-	45	5	-	1161
Mixed/unknown	Angular debris	1	2	204	26	39	11	7	290
	Flake	26	27	458	159	125	59	34	888
	Flake, bifacial thinning	1	-	2	2	-	-	-	5
	Flake, sharpening	-	-	2	1	-	-	-	3
	Flake from ground stone	-	-	1	-	1	-	-	2
	Flake from hammerstone	-	-	2	-	-	-	-	2
	Tested rock	1	-	1	-	-	2	-	4
	Core, multiplatform	1	1	4	1	4	-	1	12
	Core, bifacial	-	-	1	-	-	-	-	1
	Core, single platform	-	-	2	-	-	-	-	2
	Total	30	30	677	189	169	72	42	1209

above. This technique has the effect of producing force vectors originating from two opposing surfaces of a core. Although debitage produced by this technique is often indistinguishable from debitage produced by the freehand technique, unique attributes include the presence of a negative bulb of percussion on one or both surfaces, two positive bulbs of percussion on opposite surfaces, or two bulbs of percussion at opposite ends of the same surface. Additionally, crushing on distal and/or proximal ends of lithic material is often the result of the bipolar flaking technique.

Pressure flaking is the process of manually applying a prolonged, constant, pushing force to the edge of a tool held in one hand, using an implement such as an elk antler tine held in the other hand, to detach small pressure flakes in order to sharpen, finish, or resharpen the tool edge. Pressure flaking is employed during the late stages of stone tool manufacture, and during the resharpening of dull tools.

Flakes and angular debris, which are primarily left over from freehand or pressure flaking of lithic raw materials, dominate the chipped stone assemblages from all periods and sites. Typically, freehand reduction debris accounts for 90 to 96 percent of the debitage assemblages. High proportions of freehand flaking debris may be a normal result of longer occupation with access to raw materials spurring accumulations of new debitage as raw material stores are replenished. Shorter occupations may have used available raw material more intensively with fewer trips from the residence to neighboring residences, fields, or resource areas affording less opportunity to replenish lithic raw materials. The assemblage from the shorter occupation of LA 115862 has a higher percentage of biface thinning and uniface resharpening flakes, which remain from formal tool production and maintenance. All site assemblages have limited evidence of tool production and maintenance, but its presence is masked by the abundant freehand flaking debris.

Biface thinning flakes are removed from a lithic artifact during biface manufacture or resharpening. Characteristic attributes include retouched platforms, parallel dorsal scars, lipped platforms, concave curvature, maximum thickness of less than 5 mm, even edge outlines, and weak bulb of percussion (Acklen et al. 1984). While biface thinning flakes comprise just over 2 percent of the debitage assemblage, a suggestive presence of them in the Early Developmental period is compelling.

Sharpening flakes, referred to elsewhere as pressure flakes, are the result of refurbishing or resharpening formal tools. Flakes of this type are typically small and exhibit retouched platforms with evidence of use-wear on the platform edge. It is important to distinguish platform preparation by grinding, which results in a flatter edge surface, from the lustrous platform rounding that results from utilization. Sharpening flakes comprise less than 1 percent of the debitage assemblage.

Angular debris, or lithic shatter, is debitage that lacks an obvious ventral surface. It is amorphous and angular, and detached as a secondary bi-product of lithic reduction. Unutilized angular debris is not analyzed in this report. Utilized angular debris is quantified in the expedient tool section of this analysis.

Flakes from ground stone, hammerstones, and bipolar flakes are not significantly represented within the project area and are not analyzed in this report. Unifacial resharpened flakes are expedient tools and are discussed in that section of this analysis.

Dorsal cortex percentage and flake thickness are two attributes recorded for debitage that can be used to examine general characteristics of reduction patterns. These two attributes were consistently reported for each site assemblage and are compared between sites and time periods. Other debitage attributes such as platform type and condition were found to exhibit systematic errors in recording that reflect different application of attribute definitions by individual laboratory technicians. These attributes are not summarized or compared because of the analytical inconsistencies.

Dorsal cortex percentage has a long history of use as an indicator of reduction sequence and intensity (see Chapman 1977; Gossett and Chapman 1981, as examples). Flake cortex was summarized into three groups: no cortex, 10 to 50 percent, and 60 to 100 percent. These ranges are used to approximate the reductive trajectory of chipped stone tool manufacture and use.

Early Developmental period whole flake dorsal cortex distribution shows a high proportion of non-cortical to cortical artifacts for all sites (Table 17.2). The lowest proportion of cortical to non-cortical flakes is evident from LA 115862, which is interpreted as having the shortest occupation span of one to five years. Sites with longer or more intense occupations (as measured by the frequency of structures and extramural features) have much higher non-cortical to cortical flake proportions. These high proportions suggest that raw material use focused on exhausting available materials rather than replenishing raw material supplies after low levels of use. High proportions also suggest that some raw material was obtained on or near the site, but that the majority of the raw material came from a local, but not immediately proximate source.

Late Developmental and Coalition period components show similar patterning. Components with the more permanent or intensive occupation evidence have high proportions of non-cortical to cortical whole flakes. The LA 6170 component was a mealing bin or processing feature that had an overall lower frequency of whole flakes with approximately 30 percent exhibiting dorsal cortex (Table 17.2). The Coalition period components appear to reflect residential occupations with very high frequencies of non-cortical flakes. The LA 6169 component consisted of four small pit rooms that were probably seasonally occupied. However, the artifacts recovered from the fill of these features may have derived from residential occupation suggested by Structure 12, a surface room block remnant. It is likely that the LA 6169 assemblage is a mix of seasonal and permanent refuse with more expedient and less intensive use of raw material masked by the more intensive residential use.

Flake thickness is also a proxy measure for chipped stone reduction intensity. Empirically, core reduction and tool production and maintenance are reductive processes. Therefore, the resultant debris from core reduction and tool production and maintenance should decrease in size, specifically thickness as later stages of each process is reached. That is not to say that all flakes from early stages are thicker, but that the majority should be thinner because tools are more complete or core platforms decrease in size. It is further expected that residential occupations with a wider range of activities and longer occupation present more opportunity for intensive reduction of raw material, a production of a wider range of tools, and more maintenance of tools. This should result in higher proportions of thin flakes relative to short or seasonal occupations that may have supported a decreased range of activities. Obviously, task-specific sites, such as animal hunting camps, may have inordinately high proportions of thin flakes, since the majority of the chipped stone reduction focused on formal tool production or maintenance. The whole flake thickness was divided into three ranges: 1–5 mm, 5–10 mm, and 10 + mm.

Early Developmental period components typically had higher frequencies of less than 5-mm-thick flakes, although a full range of flake thicknesses is represented (Table 17.3). The consistent and 35 to 40 percent occurrence of flakes with thicknesses of 5 mm or greater reflect that full range of activities supported by permanent residential occupations. The similar proportions demonstrate a consistent pattern, as would be expected for the Early Developmental period components. The differences are primarily of magnitude (assemblage count) rather than proportion.

Interestingly, Late Developmental period components exhibit higher proportions of thicker flakes. This would seem to reflect the seasonal aspect of the Late Developmental components, somewhat contradicting the flake dorsal cortex evidence just presented. Thicker flakes may reflect less emphasis on formal tool production or maintenance, although these activities remained an important part of the chipped stone manufacturing repertoire. A

Table 17.2. Dorsal Cortex Coverage by Period and Site

Count Row %	Site	No Cortex	10-50% Dorsal Cortex	60-100% Dorsal Cortex	Total
Earliest Developmental	LA 6171	53	3	1	57
		93.0%	5.3%	1.8%	100.0%
Early Developmental	LA 265	4354	470	388	5212
		83.5%	9.0%	7.4%	100.0%
	LA 6169	729	26	42	797
		91.5%	3.3%	5.3%	100.0%
	LA 6170	2460	362	256	3078
		79.9%	11.8%	8.3%	100.0%
	LA 6171	610	45	27	682
		89.4%	6.6%	4.0%	100.0%
	LA 115862	240	86	33	359
		66.9%	24.0%	9.2%	100.0%
	Total	8446	992	747	10185
		82.9%	9.7%	7.3%	100.0%
Late Developmental	LA 249	645	93	51	789
		81.7%	11.8%	6.5%	100.0%
	LA 265	14	1	1	16
		87.5%	6.3%	6.3%	100.0%
	LA 6169	855	59	54	968
		88.3%	6.1%	5.6%	100.0%
	LA 6170	198	35	25	258
		76.7%	13.6%	9.7%	100.0%
	Total	1712	188	131	2031
		84.3%	9.3%	6.5%	100.0%
Coalition	LA 6169	1438	89	120	1647
		87.3%	5.4%	7.3%	100.0%
	LA 6171	324	31	21	376
		86.2%	8.2%	5.6%	100.0%
	Total	1762	120	141	2023
		87.1%	5.9%	7.0%	100.0%
Classic	LA 249	770	114	62	946
		81.4%	12.1%	6.6%	100.0%
	LA 6171	32	1	3	36
		88.9%	2.8%	8.3%	100.0%
	LA 115862	2	2	1	5
		40.0%	40.0%	20.0%	100.0%
	Total	804	117	66	987
		81.5%	11.9%	6.7%	100.0%
Mixed/unknown	LA 249	18	5	3	26
		69.2%	19.2%	11.5%	100.0%
	LA 265	23	-	4	27
		85.2%	-	14.8%	100.0%
	LA 6169	393	20	45	458
		85.8%	4.4%	9.8%	100.0%
	LA 6170	124	19	16	159
		78.0%	11.9%	10.1%	100.0%
	LA 6171	104	11	10	125
		83.2%	8.8%	8.0%	100.0%
	LA 115862	35	14	10	59
		59.3%	23.7%	16.9%	100.0%
	LA 115863	27	4	3	34
		79.4%	11.8%	8.8%	100.0%
	Total	724	73	91	888
		81.5%	8.2%	10.2%	100.0%

Table 17.3. Core Flake Thickness by Period and Site

Count Row %	Site	1 to 5 mm	5 to 10 mm	Greater than 10 mm	Total
Earliest Developmental	LA 6171	41	14	2	57
		71.9%	24.6%	3.5%	100.0%
Early Developmental	LA 265	3169	1601	442	5212
		60.8%	30.7%	8.5%	100.0%
	LA 6169	481	226	90	797
		60.4%	28.4%	11.3%	100.0%
	LA 6170	1412	1273	393	3078
		45.9%	41.4%	12.8%	100.0%
	LA 6171	493	155	34	682
		72.3%	22.7%	5.0%	100.0%
	LA 115862	220	114	25	359
		61.3%	31.8%	7.0%	100.0%
	Total	5775	3383	986	10144
		56.9%	33.3%	9.7%	100.0%
Late Developmental	LA 249	426	278	85	789
		54.0%	35.2%	10.8%	100.0%
	LA 265	9	6	1	16
		56.3%	37.5%	6.3%	100.0%
	LA 6169	388	409	171	968
		40.1%	42.3%	17.7%	100.0%
	LA 6170	110	110	38	258
		42.6%	42.6%	14.7%	100.0%
	Total	933	803	295	2031
		45.9%	39.5%	14.5%	100.0%
Coalition	LA 6169	861	586	200	1647
		52.3%	35.6%	12.1%	100.0%
	LA 6171	222	123	31	376
		59.0%	32.7%	8.2%	100.0%
	Total	1083	709	231	2023
		53.5%	35.0%	11.4%	100.0%
Classic	LA 249	514	338	94	946
		54.3%	35.7%	9.9%	100.0%
	LA 6171	24	10	2	36
		66.7%	27.8%	5.6%	100.0%
	LA 115862	2	2	1	5
		40.0%	40.0%	20.0%	100.0%
	Total	540	350	97	987
		54.7%	35.5%	9.8%	100.0%
Mixed/unknown	LA 249	14	9	3	26
		53.8%	34.6%	11.5%	100.0%
	LA 265	18	8	1	27
		66.7%	29.6%	3.7%	100.0%
	LA 6169	249	174	35	458
		54.4%	38.0%	7.6%	100.0%
	LA 6170	71	62	26	159
		44.7%	39.0%	16.4%	100.0%
	LA 6171	70	49	6	125
		56.0%	39.2%	4.8%	100.0%
	LA 115862	32	23	4	59
		54.2%	39.0%	6.8%	100.0%
	LA 115863	17	7	10	34
		50.0%	20.6%	29.4%	100.0%
	Total	471	332	85	888
		53.0%	37.4%	9.6%	100.0%

similar pattern is observed for the Coalition period components, where roughly equal proportions of thin and thicker flakes were recovered. Minimally, the difference between Early Developmental and Late Developmental and Coalition period assemblages may reflect different occupation length and focus. However, the difference also may reflect a fundamental change in the organization of subsistence activities with later occupations relying on more long-distance procurement of large game resulting in the locus or productive and maintenance activities shifting away from residences to camps.

Cores are classified as debitage in this study. Cores are the pieces of lithic raw material from which flakes longer than 2 cm have been detached from one or more platform. They are the nuclei from which flakes are struck, often preformed by the knapper to a desired shape from which specific flake types may be removed. While cores (n = 488) represent 2 percent of the total debitage assemblage, their presence indicates lithic manufacturing activities that may be further analyzed for technology-based subsistence activities by quantifying core morphological attributes. For example, a core with few large flake scars may be associated with early stage core preparation and reduction, while a core with many small flake scars may indicate late stage reduction such as biface or projectile point manufacture. All of the core technologies show evidence of organized flake removal, unlike similar raw materials from which flakes have been detached randomly by natural erosive forces, such as freeze-thaw, tectonic grinding, or trampling. Core frequencies are presented in Table 17.1.

Four categories of cores have been identified in this analysis: multiplatform cores, bifacial cores, single platform cores, and tested rocks or cobbles. These are examined chronologically for all sites within the project area and distribution by time is shown in Table 17.1. Multiplatform cores exhibit multiple platforms from which multiple flakes of variable length have been removed. They are the most frequent (n = 375) category of core artifacts recovered within the project area, representing 77 percent of the core assemblage. The predominance of multiplatform cores indicates that the majority of the chipped stone manufacture during all periods focused on flake production. Flake production supported expedient tool use and resulted in relatively unpatterned flake and core morphology. The apparent ready availability of obsidian and other fine-grained materials rendered more sophisticated or specialized reduction strategies of limited necessity. Multiplatform cores and the flakes removed from them were the multipurpose source for tools that supported everyday activities at the Early Developmental period residences and the Late Developmental and Coalition period residences.

Bifacial cores (n = 6) is the smallest category of cores recovered from the project area, representing just over 1 percent of the core assemblage. Bifacial cores are formed as flakes are removed from either surface of an edge perimeter while striking platforms on the opposing surface. Bifacial cores are similar to bifaces but lack bifacial thinning flake scars, which may indicate later stages of biface reduction. Steep edge angles, high centers, and flake scars longer than 2 cm are typical of bifacial cores. Flakes detached from bifacial cores (core flakes) may be manufactured into formal tools or utilized as expedient tools. The depleted bifacial core itself may also be manufactured into a variety of tools. Low frequency of bifacial cores for all periods suggest that cores were not systematically reduced for specialized flake forms or sizes. It is also suggests that bifacial cores were not produced in preparation for long-distance logistical resource gathering or hunting forays.

Single-platform cores (n = 29) represent 6 percent of all cores recovered from the project area. Single-platform cores have one or more striking platforms located on a single surface. Flake removal from the perimeter of one surface often produces cores that are conical in shape, and flakes that are similar in length, with little variation, suggesting a systematic technique of core reduction employed to produce tools dedicated to limited tasks.

Tested rocks (n = 78) represent 16 percent of all cores recovered from the project area. Tested rocks are typically cobbles or pebbles from which only one or two flakes have been removed in order to examine the quality of raw material. Tested rocks often indicate raw material source areas for quarrying activities, but are also utilized expediently away from quarrying areas. Field identification of tested cobbles is sometimes obscured by naturally eroded, fractured, or battered material. Since tested rocks may be utilized as expedient cores, they are expected to increase in predominance of all core usage with increased sedentism (Yerkes 1989). Table 17.2 indicates that 27 percent of all cores recovered from Classic period contexts were tested rocks, while only 15 percent of all cores recovered from Early and Earliest Developmental contexts were tested rocks.

Formal Tools

Formal tools are artifacts that exhibit retouch scars extending over one-third or more of both surfaces for bifacial tools, or over one-third of one surface for unifacial tools. Flake scars extending over one-third of the edge perimeter are examples of facial retouch and are characteristic of formal tools. Examples of bifacial tools include projectile points, bifaces, unifaces, hammerstones, pecking stones, choppers, axes, anvils, and drills. In general, unifacial tools are used in scraping activities resulting in unidirectional use-wear patterns. Unifacial formal tools usually refer to unifaces, scrapers, and choppers, characterized by the presence of flake scars on a single surface only, which creates a steep working edge. Unidirectional wear patterns generally occur on the trailing side of the working edge in proportions greater than or equal to 3.5:1. Formal tools are statistically analyzed for "goodness of fit" within and across ceramic period by site context, material type, condition, and breakage pattern. The assemblage of formal tools recovered from the project is represented by period in Table 17.4.

Projectile points and bifaces represent 61 percent of the formal flaked tool assemblage for all time periods. Projectile points have a pointed tip to facilitate piercing, angled margins, and a base flaked or ground to facilitate hafting to an arrow or spear shaft. Typically, projectile points are the result of bifacial flaking, although they may be manufactured by grinding. Projectile points and bifaces predominate by proportion the formal tool assemblage in the Earliest Developmental context where they account for 66 percent of the formal lithic flaked tool assemblage. By the Classic period, frequencies of projectile points and bifaces are diminished twentyfold. Projectile point and formal tool production and use are addressed by Schutt and VanPool (Chapters 17 and 18).

Hammerstones are generally cobbles with a smooth, cortical surface that exhibits battering on a localized area. Since hammerstones are repeatedly used for striking platforms with sufficient force to detach flakes, they must be made of materials harder than the material being struck. Quartzite cobbles are often used as hammerstones. A hammerstone of optimum size, shape, and material may be curated; however, hammerstones are also selected and used expediently. The presence of significant frequencies of hammerstones indicates a lithic reduction provenience. Analysis of raw materials, use-wear patterns, flake size and shape, and platform morphology may indicate a finer-grained perspective of such a provenience. Hammerstones comprise 17 percent of the formal flaked tool assemblage in the project area, and are especially conspicuous in the Developmental periods.

Pecking stones are angular pieces of raw material that exhibit battering of a less localized nature than the battering found on hammerstones. Cores and angular materials like silicified wood are commonly used as pecking stones. Pecking stones have a demonstrated association with the roughening of grinding surfaces on ground stone metates. Data from Chaco Canyon also suggest they may have been used to shape tabular building slabs

Table 17.4. Chipped Stone Tools by Period and Site

Period	Type of Tool	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	LA 115863	Total
Earliest Developmental	Flake, marginal retouch	-	-	-	-	1	-	-	1
	Projectile point	-	-	-	-	1	-	-	1
	Biface	-	-	-	-	2	-	-	2
	Total	-	-	-	-	4	-	-	4
Early Developmental	Hammerstone	-	18	7	24	1	-	-	50
	Pecking stone	-	1	-	2	-	1	-	4
	Chopper, unifacial	-	3	-	-	1	2	-	6
	Chopper, bifacial	-	4	-	5	-	-	-	9
	Utilized core fragment	-	-	2	1	-	-	-	3
	Angular debris, utilized	-	3	2	3	-	-	-	8
	Angular debris, marginal retouch	-	3	-	3	1	3	-	10
	Flake, utilized	1	38	10	44	9	14	-	116
	Flake, marginal retouch	-	50	17	42	3	3	-	115
	Projectile point	-	45	12	15	4	4	-	80
	Biface	-	48	12	24	10	-	-	94
	Uniface	-	2	4	5	3	-	-	14
	Drill	-	-	-	2	-	1	-	3
	Total	1	215	66	170	32	28	0	512
Late Developmental	Hammerstone	-	-	3	10	-	-	-	13
	Pecking stone	-	-	3	-	-	-	-	3
	Chopper, bifacial	1	-	-	1	-	-	-	2
	Flake, utilized	3	-	41	7	-	-	-	51
	Flake, marginal retouch	9	-	13	2	-	-	-	24
	Projectile point	2	-	4	2	-	-	-	8
	Biface	6	-	18	3	-	-	-	27
	Uniface	-	-	5	-	-	-	-	5
	Scraper, hide	-	-	1	-	-	-	-	1
	Pick	-	-	1	-	-	-	-	1
	Total	21	0	89	25	0	0	0	135
Coalition	Hammerstone	-	-	2	-	1	-	-	3
	Chopper, unifacial	-	-	3	-	2	-	-	5
	Anvil	-	-	1	-	-	-	-	1
	Utilized core fragment	-	-	3	-	-	-	-	3
	Angular debris, utilized	-	-	11	-	-	-	-	11
	Angular debris, marginal retouch	-	-	5	-	-	-	-	5
	Flake, utilized	-	-	48	-	2	-	-	50
	Flake, marginal retouch	-	-	17	-	16	-	-	33
	Projectile point	-	-	2	-	3	-	-	5
	Biface	-	-	11	-	6	-	-	17
	Uniface	-	-	10	-	2	-	-	12
	Scraper, hide	-	-	1	-	-	-	-	1
	Drill	-	-	5	-	-	-	-	5
	Graver	-	-	1	-	-	-	-	1
	Total	-	-	120	-	32	-	-	152
Classic	Chopper, unifacial	1	-	-	-	3	-	-	4
	Angular debris, marginal retouch	1	-	-	-	-	-	-	1
	Flake, utilized	11	-	-	-	-	-	-	11
	Flake, marginal retouch	13	-	-	-	-	-	-	13
	Projectile point	2	-	-	-	-	-	-	2
	Biface	12	-	-	-	-	-	-	12
	Uniface	5	-	-	-	-	-	-	5
	Total	45	-	-	-	3	-	-	48
Mixed/Unknown	Hammerstone	2	-	1	1	-	-	-	4
	Pecking stone	-	-	1	-	-	-	-	1
	Chopper, unifacial	-	-	-	2	-	-	-	2
	Utilized core fragment	-	-	-	-	-	-	1	1
	Angular debris, marginal retouch	-	-	-	-	1	-	-	1
	Flake, utilized	-	-	2	4	-	-	-	6
	Flake, marginal retouch	2	-	6	1	1	-	-	10
	Projectile point	-	-	-	2	1	-	-	3
	Biface	-	-	2	3	3	-	-	8
	Uniface	-	-	-	-	1	-	-	1
	Total	4	0	12	13	7	0	1	37

(Schutt and Fisher 1984). Pecking stones comprise 2 percent of the formal tool assemblage recovered from the project area.

Choppers are characterized by bidirectional or unidirectional flake scars along one or more edges, and use-wear in the form of battering. Use-wear analysis of choppers can indicate site (or area) use. For example, use-wear created by wood chopping activities can be distinguished from the wear patterns and polish created by culinary activities. Choppers account for 7 percent of the formal tool assemblage, and are categorized as either bifacial (2.7 percent) or unifacial (4.2 percent) depending on flake scar length and location.

Anvils are utilized during bipolar reduction, providing a hard and resistant surface on which the raw material is placed prior to flake detachment. Anvils also provide a stable surface on which vegetal material may be processed or pigment crushed and ground. The resulting percussion indentations on the surface of anvils provides a readily identifiable attribute. A single anvil was found within the project area (LA 6169) in a mixed Early Developmental-Coalition period context.

Drills are produced by bifacial thinning and exhibit extensive marginal retouch or sharpening. They are recognizable by a projecting tip and an elongated, slender shaft or handle. Drills are utilized in a rotary motion and commonly exhibit wear patterns in the form of scarring or edge abrasion on the shaft. The tip of a utilized drill may exhibit crushing or rounding. While drills comprise only 2 percent of the formal flaked lithic tool assemblage, their conspicuous presence in Coalition period temporal contexts is noteworthy, and they are statistically analyzed for significance later in this analysis.

Expedient Tools

Expedient tools are flakes that require either no modification to perform a useful task or are marginally retouched to alter the shape of the functional edge. Marginal retouch is observed as a series of small negative scars, which extend from the functional edge perimeter over less than one-third of either surface of the artifact. Marginal retouch is an expedient and quick way to change the shape of an edge to meet the necessary criteria for the task intended for the tool. Flake scars extending over more than one-third of the edge perimeter are termed facial retouch and are characteristic of formal tool manufacture. Gravers, like drills, have a projecting tip with a blunt edge for scraping; unlike drills, gravers do not necessarily have a shaft-like handle. They are generally marginally retouched tools that are used in a scraping motion. Spokeshaves are often marginally retouched and exhibit a distinctive "U" shaped notch on the edge of a flake. The notch is used to smooth a length of rounded material like an arrow shaft. Use-wear is evident only within the notched area.

Utilization

Evidence of use-wear can also be used to determine certain discard patterns. The degree to which tool function can be identified is in part dependent on technology. At present the binocular microscope with a magnification of 10x to 80x is the most commonly used instrument to examine tool use edges—sometimes magnifications of 160x may also be used. Proponents of this technique argue that low power magnification is the only method that can be carried out routinely and affordably (Odell 1979, 1980; Ahler 1970; Chapman 1977; Chapman and Schutt 1977; Schutt 1979, 1980). Unfortunately, the magnification of the binocular scope is limited to identifying use on hard media like bone and wood or highly repetitive hide scraping activities (Schutt 1980, 1982). It does not allow for the identification of wear resulting from use on soft materials like plants. Therefore, one cannot assume that tools lacking visible wear patterns were not used. Keeley (1974, 1976, 1980) and others (Rosenfeld 1971; Keeley and Newcomber 1977; Newcomer and Keeley 1979; Akoshima 1979) have had success using the electron microscope, with a power of 200x to 400x, to identify these less obvious wear patterns. Unfortunately, identifying these subtle wear patterns is both expensive and time consuming.

Utilization of an artifact may be viewed as edge damage that can be specifically attributed to human usage. Different kinds of tool uses result in a suite of wear patterns (Odell 1979, 1980; Kelley 1979,1980; Chapman 1982; Schutt 1980, 1982, 1988; Lang 1992). Utilization can be undertaken at any stage of the reduction process. A number of attributes were recorded to determine the function of tools. For artifacts that exhibited use-wear, four directional categories were established: N/A, unidirectional, bidirectional, and unknown. Unidirectional wear and bidirectional wear are distinguished by the number of scars on either side of a particular edge (Schutt 1982:97–99). An edge with more than three and a half scars on one side of an edge to each scar on its opposite side is categorized as unidirectional wear. An edge with scars more evenly distributed on each side (fewer than 3.5 to 1) is categorized as bidirectional wear. Experiments have shown that unidirectional wear results from scraping activities, while bidirectional wear results from cutting activities and that cutting tools exhibit edge angles that are statistically (.001) more acute than scraping edges (Schutt 1982:97–99). In the detailed analysis, a functionally complete edge is an edge that exhibits uniformity and wear patterns that are either completely intact or truncated from breakage, i.e., a fragment of a larger utilized edge. Three descriptions were used: N/A, yes, and no. Edge shape was recorded for both utilized edges and retouched edges lacking evidence of use. Nine categories were used in this analysis: straight, concave, convex, wavy, denticulate, beak, tip (sharp), concave denticulate, and convex denticulate. When applicable, these were augmented by information relating to degree of polish, presence of scars, and presence of striations. Multiple use observations could be recorded for a single tool and multiple observations could be recorded about a specific edge on that tool. A comment category was used to describe additional information that may not be evident from the attribute analysis.

Stage of Formal Tool Manufacture and Tool Discard Patterns

Lithic debris is a highly durable byproduct of human behavior that can be used to address a number of important issues about settlement and subsistence. Lithic artifacts recovered from the archaeological record represent items that were discarded or left for a wide variety of reasons. By examining a combination of morphological and spatial variables it is often possible to reconstruct how a particular artifact or group of artifacts entered the archaeological record. These "discard patterns" can then provide clues to the activities that occurred at a site. The importance of identifying "discard patterns" is tantamount to addressing behavioral issues concerning the use of the landscape within and between sites, the purpose, duration and intensity of this use, and the implications these issues have on settlement and subsistence through time.

Formal tools or tool fragments are many times incorrectly interpreted to reflect tools used and discarded at the site often resulting in an inaccurate interpretation of site function. More often than not these tools are "manufacturing failures" that were never finished because during the manufacturing process a material flaw or a manufacturing mistake prevented the knapper from completing the tool's manufacture. Were they finished tools used at the site and discarded when no longer functional or do they represent unfinished manufacturing failures? While the former implies that specific use activities were carried out at the site, the latter suggests that the site served as a manufacturing location.

Studies have shown that it is possible to distinguish between "manufacturing successes" and "manufacturing failures" using both empirical and objective methods (Schutt and Vierra 1980; Schutt 1983a, 1983b, 1988). The following analysis is based on empirical attributes previously developed to evaluate tool discard patterns (Schutt 1983b).

The following attributes were used to classify formal tools into various "discard pattern" categories—artifact type and stage of manufacture, condition, finished functional edges, and evidence of use. The artifact type in conjunction with the stage of manufacture are two variables that aid in identifying finished (manufacture successes) and unfinished (manufacturing failures) tools. The formal tool types are projectile points, bifaces, unifaces, and drills. All tool types require overall symmetry, which include edge uniformity, bifacial thinning or uniform unifacial retouch, pressure retouch, and overall workmanship. Each of these individual artifact types require specific criteria to function properly for their prescribed use. A projectile point is typically bifacially thinned, must have two uniform lateral and transverse edges produced by pressure flaking, and have a sharp tip for piercing. It must also exhibit a base that will facilitate hafting. A finished biface must also be bifacially thinned and again have transverse and laterally uniform edges that will facilitate cutting.

Bifacially manufactured artifacts can first be classified into five stages of manufacture: blanks, early preforms, late preforms, final preforms, and bifacial tools (Schutt 1983a:80–81). By definition, blanks, early preforms, late preforms, and final preforms are manufacturing failures that were not finished. A blank generally exhibits minimal cortex and a few large, direct percussion negative flake scars. Early preforms exhibit bifacial retouching and initial stages of bifacial thinning while late preforms exhibit symmetrical, bifacially thinned edges but lack the refined flaking necessary to produce a uniform, functionally complete tool. These artifacts are generally discarded due to manufacturing error or flaws in the raw material. Final preforms are very close to completion—they are bifacially thin and exhibit uniform edges sharpened by pressure flaking. These artifacts most likely broke due to a manufacturing error during the last stage of manufacture—perhaps notching a tool. Bifacial tools exhibit the refined workmanship resulting from pressure flaking—these tools have uniform, functionally complete edges, and meet criteria for a finished tool or manufacturing success. Bifacial tools appear functionally finished but have been broken or no longer functioned for their prescribed use. Successful whole tools, on the other hand, are empirically perfect, complete, finished artifacts. It is problematic why these artifacts have been discarded. An attempt will be made, once the proveniences containing these tools are identified, to postulate why they were discarded. The condition of the artifact refers to breakage. Bifaces, unifaces, and drills were recorded as complete, proximal, distal, lateral, medial, or unknown. Breakage patterns on projectile points are considerably more complex and difficult to categorize as manufacturing or use breakage.

All formal tools were examined to determine if functional edges were finished or not. Again, attributes of both lateral and transverse uniformity and symmetry were used to make this determination. In some cases it was impossible to make this distinction, so an "unknown" category was used.

Statistics Selected to Quantify Data

The statistical tests selected for this analysis were both the chi-square and adjusted residuals tests. Although there are often problems applying statistics to archaeological data, there a number of statisticians that feel that the chi-square test combined with adjusted residuals are reliable methods to test anthropological and archaeological data (Blalock 1976; Everitt 1995; Kimble 1978; Thomas 1986). The chi-square test is significant in a complex rows-by-columns table while the adjusted residuals test for each cell serves to identify the portions of a table that have contributed most to the total chi-square value (Blalock 1976:297). Adjusted residuals also provide a more robust statistic when some cells have counts of less than five. Everitt (1995:39) notes "When the variables forming the contingency table are independent, the adjusted residuals are approximately normally distributed with mean zero and standard deviation." For the purpose of this analysis, the level of rejection (alpha) is set at 0.05. An adjusted residual greater than 1.96 or less than –1.96 indicates a significant difference at the 0.05 level.

The first level of analysis examined formal tool assemblage variability within selected contexts—floors, roof fall, upper fill, middens, and large pits—for each time period represented on sites in the NM 22 project area. Statistics were used to compare each context by temporal period. These comparisons were made for all dated assemblages (single and multicomponent proveniences).

Discard Pattern

The objective of this study is to determine why certain artifacts entered the archaeological record.

The "discard pattern study" relies on a series of complementary variables, which, when combined, can, in some cases, be used to classify formal tools as either "manufacturing successes" or "manufacturing failures." In the "manufacturing success" category "functionally complete tools" were recorded as either "finished, used, and discarded," "finished, used, broken, and discarded," or "successful whole tools." Again, as described above, manufacturing successes must exhibit overall symmetry, consistency of retouch, both lateral and transverse functional edges, and bifacial thinning. The first two categories are self-explanatory. If a tool is "finished, used, and discarded" the tool will be discarded at the use location—these tools no longer function for the task prescribed resulting in their discard. In the second case where the tool is classified as "finished, used, broken, and discarded," again the tool will be discarded at the location where breakage occurred. The third category "successful whole tools" is more problematic—these are complete projectile points that appear to be in perfect condition—why were these tools discarded? One might argue that occasionally tools may have been lost, but one would not expect large numbers.

Bifaces, unifaces, and drill stage of discard is much easier to determine than projectile points. These formal tools were classified as finished tools or unfinished tools. Finished tools were placed into two categories: complete tools or complete used and broken tools. Unfinished tools were classified as manufacturing failure. Two categories of manufacturing failures were recorded. Artifacts were classified as unfinished or unfinished with secondary use. Both categories indicate that for some reason it was impossible to complete the tool. This may result from flaws in the material or knapping errors that prevent further reduction of the tool. Breakage resulting from these inconsistencies can be readily identified by someone with minimal knapping experience. Some of the artifacts that are manufacturing failures are blanks, early preforms, late preforms, and final preforms. The classification of "unfinished with secondary use" indicates the tool was used but not for its primary function.

As with most research endeavors there are always examples that for a variety of reasons cannot reliably be placed within a classification. These artifacts were recorded in two ways: (1) artifacts exhibiting morphology that does not allow distinguishing whether they were broken during manufacture or if they were broken during use, and (2) artifacts lacking adequate data to place them in the categories defined. These artifacts were recorded as "not applicable" (N/A). Projectile points often fall into the category of tools exhibiting breakage that does not allow distinguishing whether they were broken during manufacture or use because similar breakage can result from both manufacturing and use. The problems with projectile point classification will be discussed below.

There is a wealth of experimental research that is specifically directed to address issues concerning projectile breakage from use and manufacture. Studies include the work of Swanson (1975), Purdy (1975), Titmus and Woods (1986:37–49), Odell and Cowan (1986:199–212), Flenniken (1991:180–193), Dockall (1997:321–331), Preston (1926:250), and Ozbun (pers. comm. 2002), among others.

Titmus and Woods (1986:37) note "…that manufacturing breakage would occur most frequently during the notching sequence…."

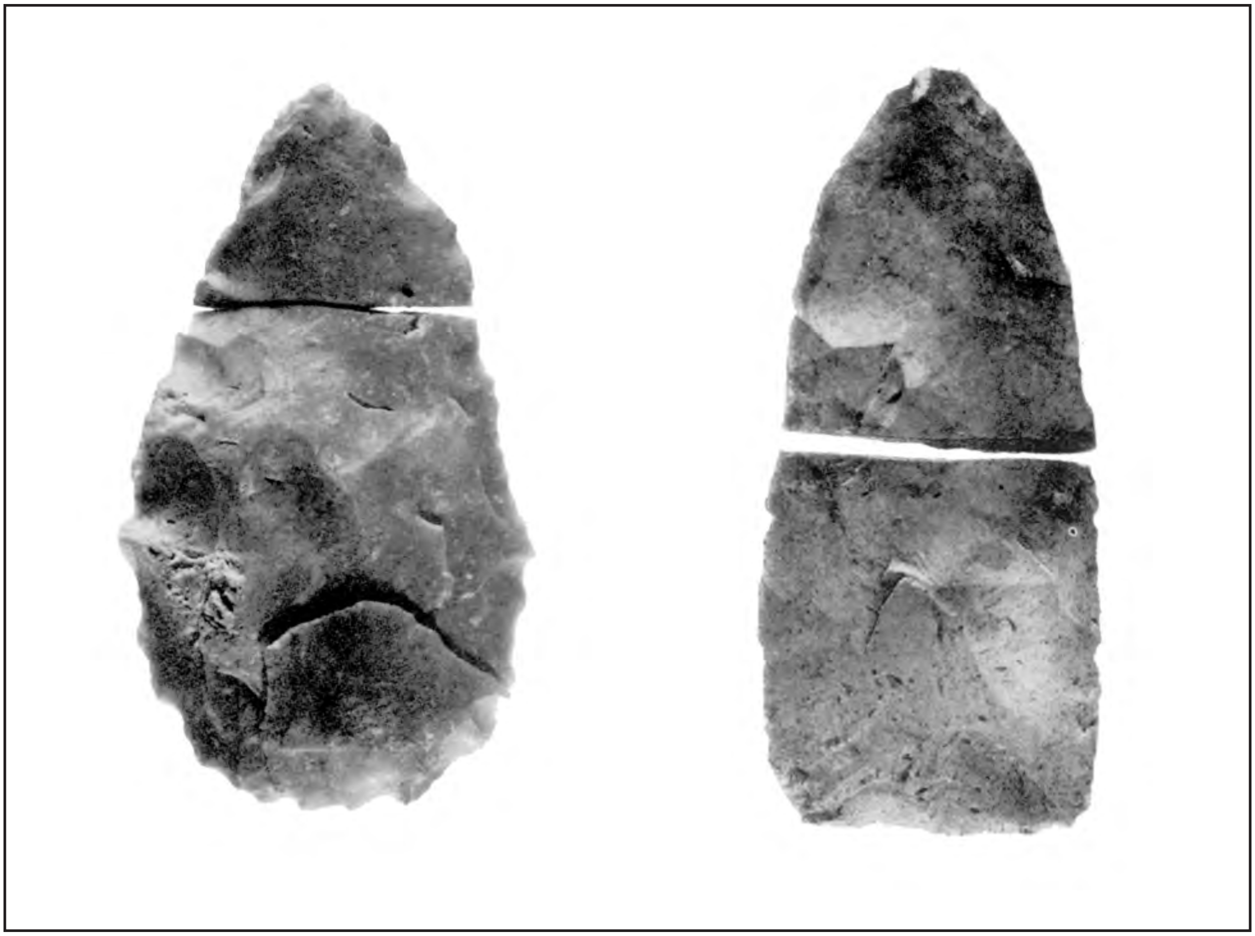

Figure 17.1. Lateral manufacturing break resulting from end shock (taken from Purdy 1975:134).

Thus, he replicated Elko corner-notched points because they have relatively narrow notch widths. These projectiles exhibited higher rates of manufacturing breakage as a result of limited space between the notching tool and the sides of the notch. The 39 points were manufactured from obsidian. The completed projectiles were thrown at a variety of materials including sand, gravel, cinders, loose bark, dirt, sod, and wood. Nine points (23 percent) broke during manufacture and 30 points (77 percent) were hafted and used in the use-breakage portion of the study. Titmus and Woods (1986:47) conclude from their replicative experiments that while use-breakage can occur on any portion of the tool, most use damage was a combination of proximal and distal end damage. They also found that manufacturing damage will not result in tip damage but rather types of basal breaks.

Other breakage that can result from manufacturing is a lateral snap that results from end shock (Fig. 17.1) and perverse fractures (Fig. 17.2) that originate at the biface edge when force is overshot resulting in "outré passe" flakes or scars (Ozbun, pers. comm. 2002). In Swanson's (1975) *Lithic Technology Making and Using Tools,* Purdy (1975:135) discusses the frequent cause of a lateral snap as described by Preston (1926:250) "…the area of impact is usually a region of compression, whilst the explosion center will be in the region of maximum tension." Under suitable conditions, a blow delivered at one point will create great tension in some other region." Because the lateral snap, due to end shock, does not occur at the point of impact, no bulb of force is present on the face of the fracture (Purdy 1975:134).

Odell and Cowan (1986:195–212) conducted a series of experiments that also addressed

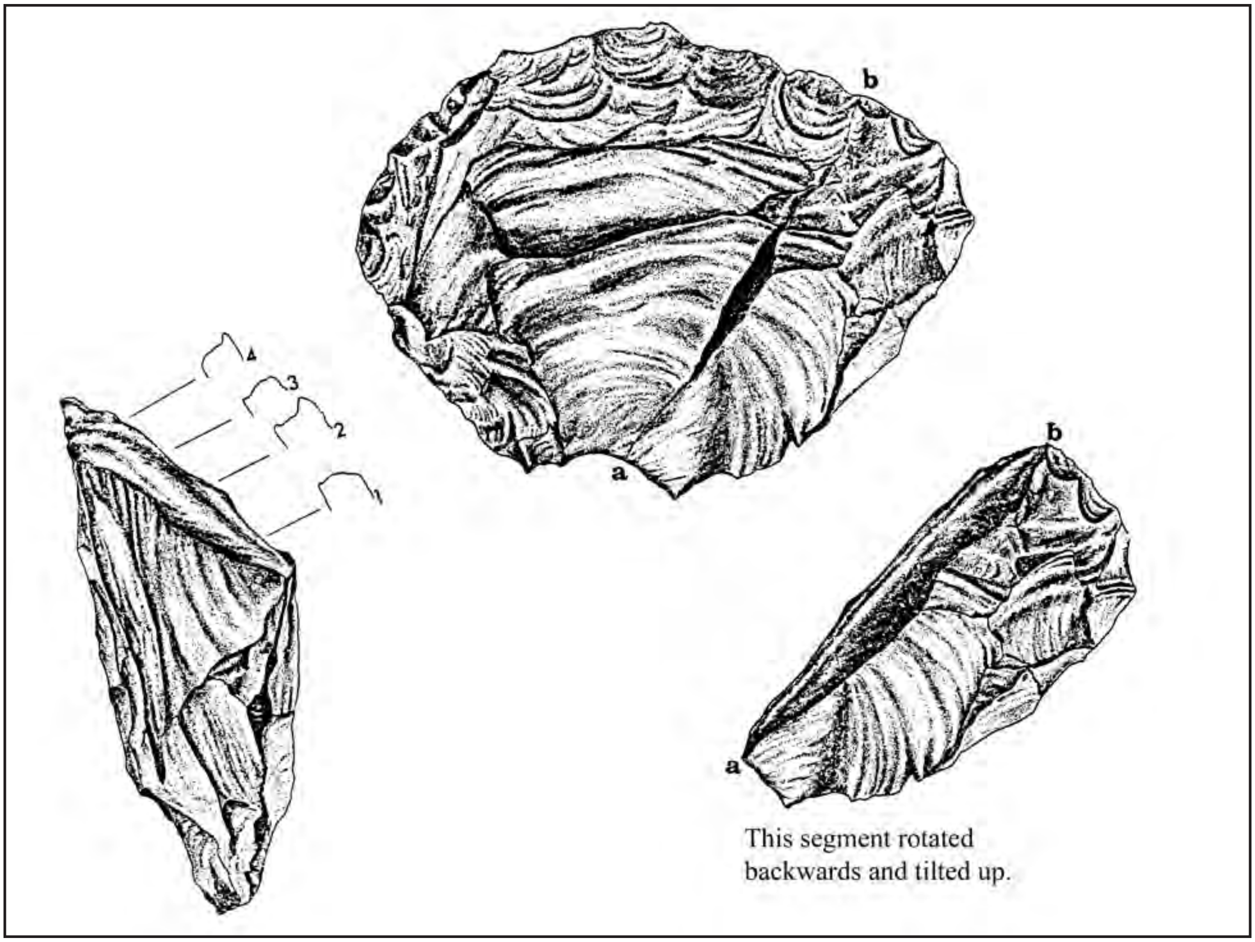

Figure 17.2. Perverse manufacturing fracture caused by overshot force (taken from Crabtree 1972:83).

issues of breakage from missile impact. The manufacturing failures were not reported. Unlike Titmus and Woods (1986), who manufactured their experimental points from obsidian recovered from three sources in the western United States, Odell and Cowan (1986:202) used, for the most part, heat-treated Burlington chert. They used 40 bifacially retouched points and 40 unmodified points. Each category had half spear points and half arrow points. For the purpose of this analysis only bifacially retouched experimental tools are compared. Their spearheads and arrowheads were propelled into dead animals. In almost all cases damage was the result of contact with a bone, although in some cases points that missed the target exhibited damage from striking a stone or other inclusion in the soil (Odell and Cowan 1986:204).

Interestingly, they found that every piece exhibited tip damage upon retirement of the tool, while basal damage was not observed on a majority of points. Figure 17.3 illustrates the breakage patterns that resulted from use. Common breaks include the "broken base" (Fig. 17.3a), the "shallow step/hinge"(Fig. 17.3b), "crushing" (Fig. 17.3c and 17.3f), "snapped and step" (Fig. 17.3d), the "basal shear" (Fig. 17.3e), and the "snap" (Fig. 17.3g). The "shallow step/hinge" is similar to a "burin" break.

Odell and Cowan (1986:204) also examined their assemblage to determine if the category of large versus small projectile points exhibit more readily diagnostic tip damage. As the result of four chi-square tests they found that in no case are large and small points different at the .05 level of confidence. Although large points do exhibit diagnostic tip damage more often than small points, four chi-square tests indicate that there are no significant differences in the type of breakage.

Towner and Warburton (1990:311–320) also carried out replication experiments. While they

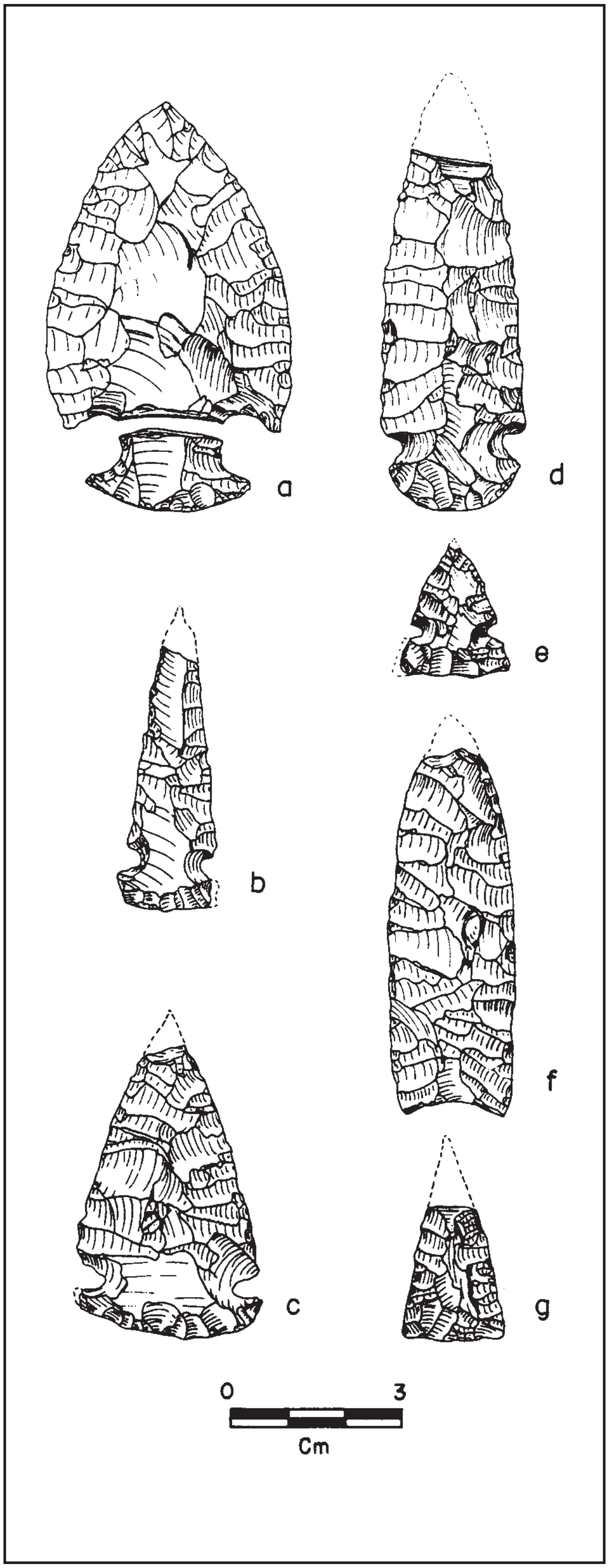

Figure 17.3. Experimental projectile point breakage resulting from use; (a) broken base, (b) shallow step/hinge, (c) crushing, (d) snapped and step, (e) basal shear, (f) crushing, (g) snap.

recorded breakage damage on 30 Elko corner-notched projectile points, their primary objective was to evaluate the number of projectile points that could be reworked and still used as projectile points and determine if debitage resulting from rejuvenation produces a "signature" assemblage. All projectile points were manufactured from Oregon obsidian. Only one manufacturing failure could not be used as a projectile point. The target was a dead ponderosa pine tree. Twenty-six of the points exhibited breakage from use that could be corrected by rejuvenation producing functional projectile points.

The breakage patterns resulting from use were compared to other studies to determine if use breakage can be distinguished from manufacturing breakage. Four general categories of breakage were defined from the Towner and Warburton (1990) study (Fig. 17.4). Sixty-two percent of the projectile points (16 items) exhibited broken tips. Of these, 38 percent (6 items) exhibited only tip breakage and 67 percent (10 items) exhibited both tip and basal breakage. This would indicate that if we assume that tip damage on projectile points definitely reflects breakage during use of the tool as a projectile or thrusting implement then breakage on 16 of 26 point (62 percent) fragments can be reliably attributed to use. It is, however, impossible at this time to determine if the breakage on the 10 remaining points was the result of manufacturing error or use.

Ozbun (pers. comm. 2002) agrees that the best or most diagnostic breaks on manufacturing failures are perverse fractures that originate from the biface edge where force was applied and overshot resulting in "outré passe" flakes or scars. He also found that the most diagnostic fracture resulting from use, on the other hand, is a burination from the tip or base and down a lateral margin and from the tip and down one or both faces like a channel scar. He does maintain however, that there is considerable overlap between breaks caused by manufacture and those caused by use.

The overall results of these tests provide considerable information about the numerous breakage patterns that result from projectile use.

However, there is still minimal information about projectile manufacturing failures. Purdy (1975:135) notes that "Many nearly complete, potentially beautiful projectile points result in failure because of end shock" during manufacture. The studies discussed above indicate that tip damage is the result of use while base damage may result from manufacture or use. Unlike Titmus and Woods (1986), Odell and Cowan (1986) found that every point exhibited tip damage while basal damage did not occur on the majority of points. None of the manufacturing failures described by Titmus and Woods (1986:42) exhibited tip damage (Fig. 17.5). The nine projectile points that were manufacturing failures in the Titmus and Woods experiments all exhibited basal breakage associated with notching the tools (Fig. 17.5). Basal breaks similar to those produced on manufacturing failures in the Titmus and Woods (1986) experiments were also produced as the result of use (Fig. 17.6). Ten points had basal breakage: five were snapped at the base and five had basal/ear breaks.

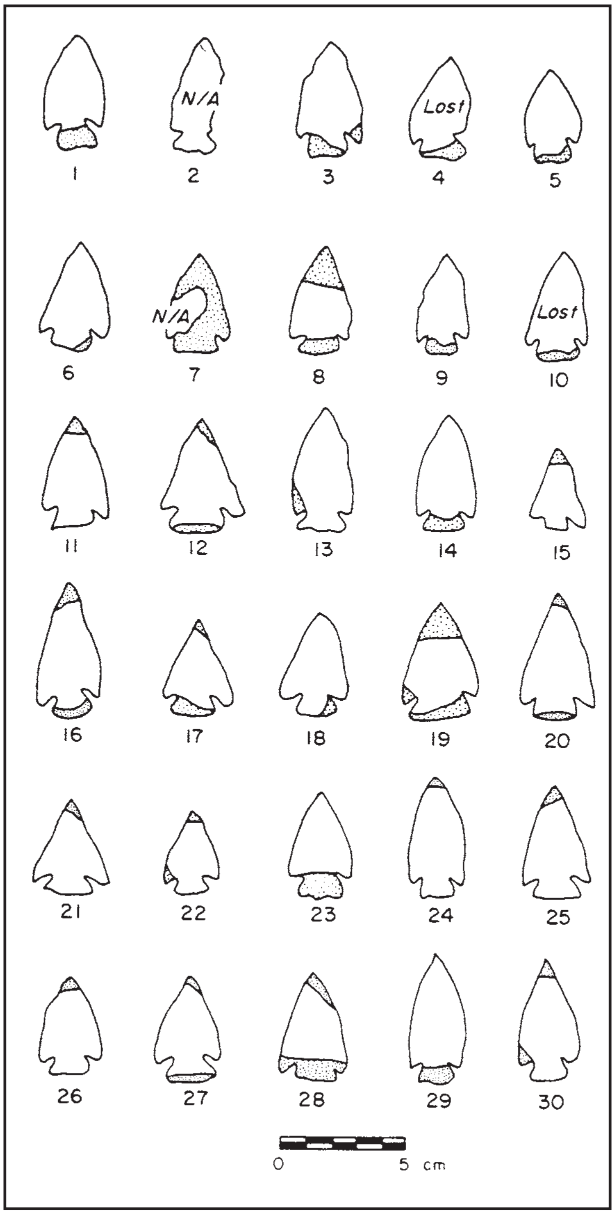

Figure 17.4. Projectile point breakage location (taken from Towner and Warburton 1990:313).

Based on the above experimental data, projectile tip breakage is the most reliable indicator of breakage resulting from use. In fact, tip breakage combined with any other breakage pattern can be attributed to use. It would still appear that the end shock lateral snaps, as defined by Purdy (1975), and the perverse fractures resulting from an overshot, "outré passe" flake or scar (Ozbun, pers. comm. 2002), are the most reliable evidence of manufacturing failures.

Analytical Results

The following discussions will rely on data from the initial detailed lithic analysis, and will incorporate data from the tool discard pattern study and the stage of reduction study to address a number of research issues presented in the research design. For the purpose of this study, only select components will be compared. These components meet certain important criteria that will facilitate consistent comparisons of formal tool technology through time. First, an attempt was made to select datable components with good integrity that could be compared within each site and later be used to evaluate assemblage variability through time. The initial selection included floor contact, roof fall, and upper fill assemblages. Additional proveniences included formal midden deposits and trash-filled pits. An attempt was made to identify pit structures containing refuse from later occupations also.

Material Selection Through Time

The identification of raw material types selected by prehistoric groups can be used to

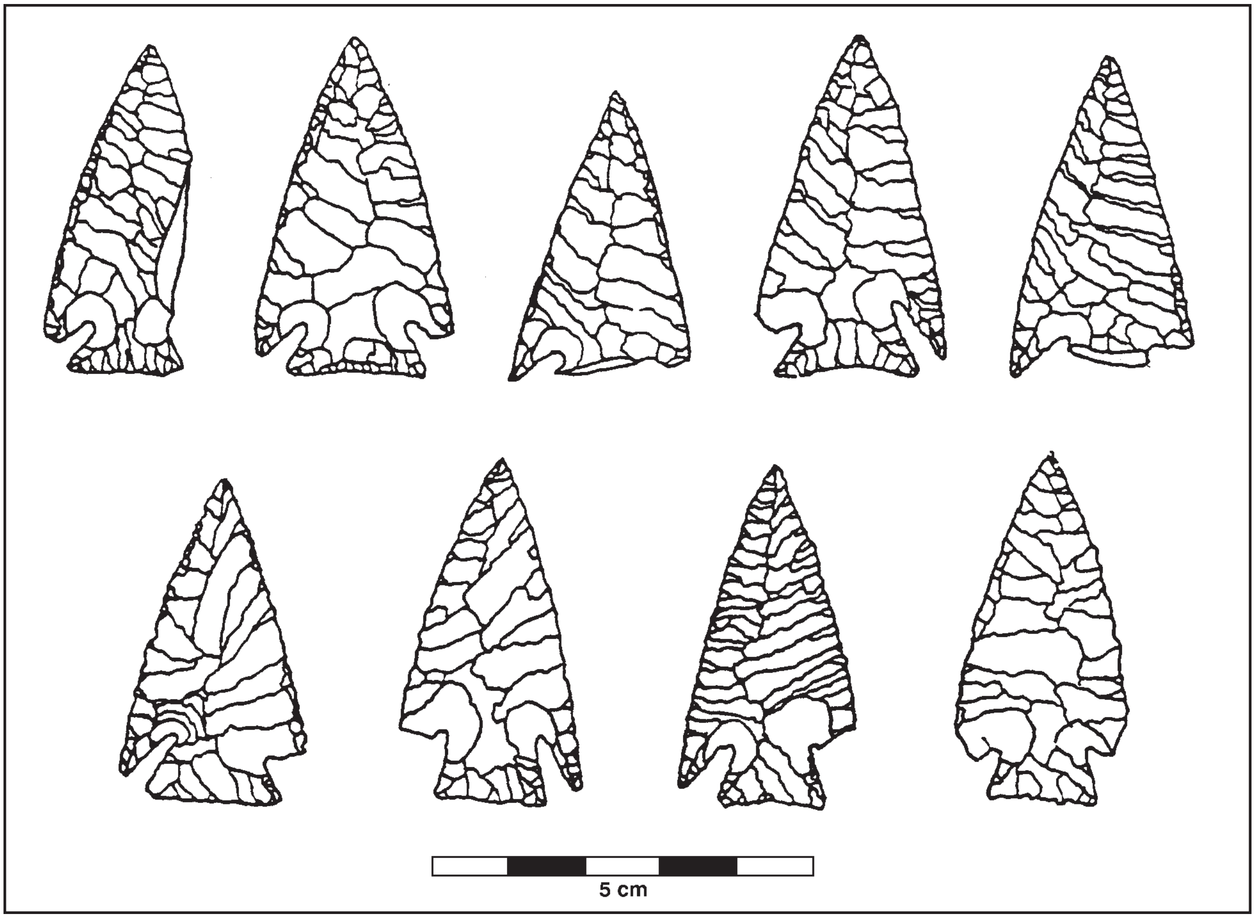

Figure 17.5. Projectile point breakage resulting from manufacture (taken from Titmus and Woods 1986:42).

address questions of prehistoric technology and subsistence, as well as material selection and acquisition. Raw material type is a variable that can be used in conjunction with technological and spatial attributes to identify subsistence patterns, site function, length and duration of occupation, and distinguish between special activity locations and residential sites.

A considerable variety of fine quality lithic raw materials occur in the immediate vicinity of the sites in the study area. Shackley (Appendix 2) matched obsidian from the NM 22 project to four individual source areas within the Jemez Mountains. He also points out that these obsidians occur in the Rio Grande gravels, which also contain a wide variety of fine quality cherts, chalcedony, and additional igneous materials. Limited numbers of lithic material do not appear local. Shackley was unable to match one obsidian artifact to any known obsidian source. The only other nonlocal material was dendritic jasper.

Four obsidian sources were identified for obsidian recovered from the NM 22 sites (see Appendix 2, Fig. 1). The majority of the obsidian examined during Shackley's XRF analyses match the signature of obsidian from the Cerro Toledo rhyolite (70.8 percent, n = 46) of the Jemez Mountains. Other Jemez obsidian sources were represented by low frequencies and include Valle Grande obsidian (15.4 percent, n = 10), Bland Canyon obsidian (9.2 percent, n = 6), and El Rechuelos obsidian (3.1 percent, n = 2). Shackley (Appendix 2) considers the Cerro Toledo and the Valle Grande Member obsidians "…the best natural glass media in the Jemez Mountains." Obsidian from these sources generally occurs in large nodules and exhibit minimal devitrification and hydration.

The identification of both local and nonlocal material is derived originally from a four-digit classification system developed by geoar-

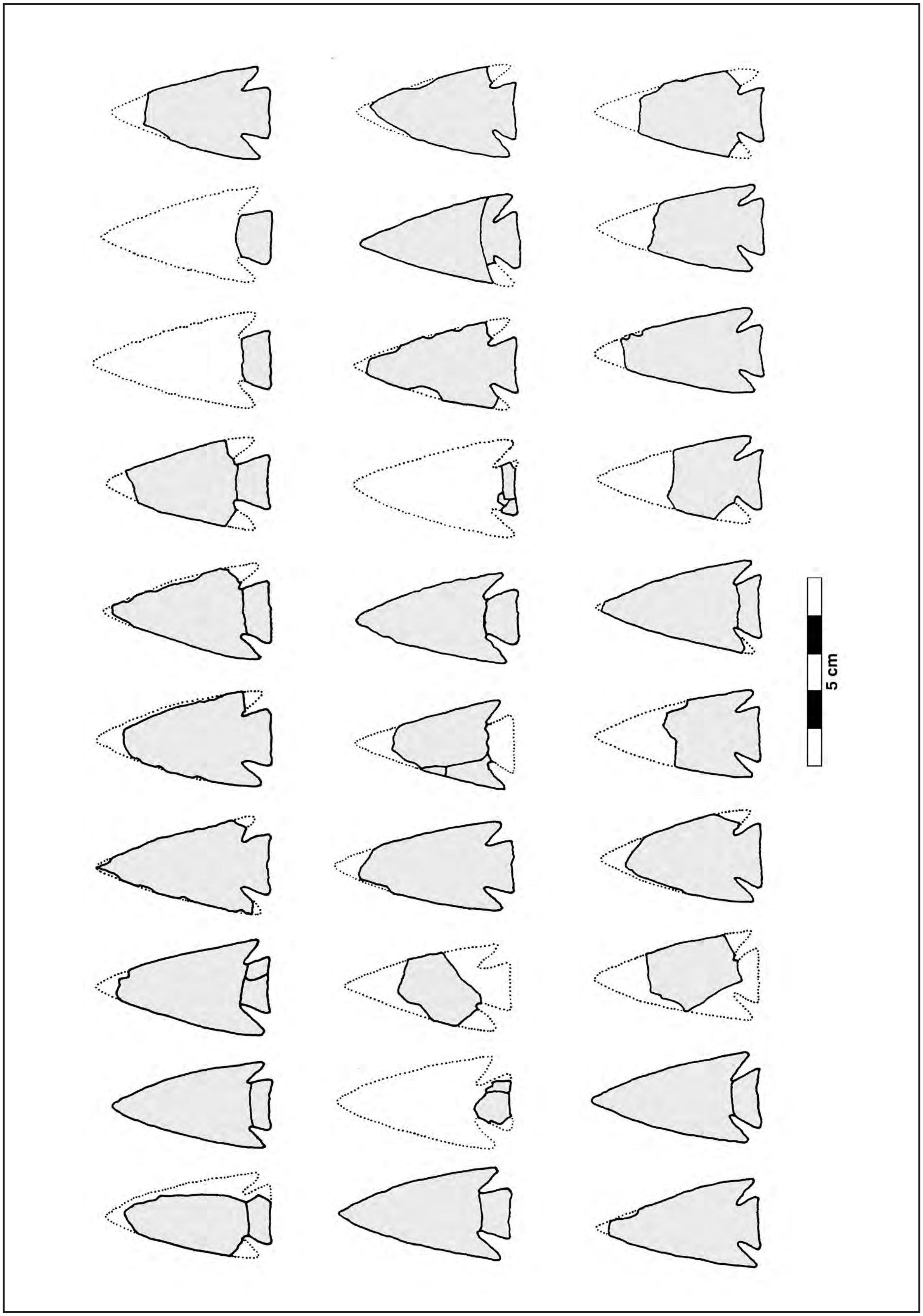

Figure 17.6. Projectile point breakage resulting from use (taken from Titmus and Woods 1986:44).

chaeologist A. H. Warren who studied raw material sources throughout the Southwest. Her code sheets are on file in the H. P. Mera Room, Laboratory of Anthropology, Museum of New Mexico, Santa Fe. Although Warren's four-digit number designations are not used here, material groups are based on a modification of Warren's identification of material type variation within the Rio Grande gravels near the study area.

Warren (1977c:24) notes that diverse raw materials can be acquired in White Rock Canyon from outcrops of ancient axial gravels of the Rio Grande (Fig. 17.7). These gravels are exposed on high surfaces on both sides of White Rock Canyon from both tributary and river gravels or from both landslide and talus debris (Warren 1979d:47–58). These gravels occur in the Totavi Lentil that was deposited by a large ancestral river to the Rio Grande. Materials found in this stratum include cobbles of granite, chert, schist, meta-rhyolite, quartzite, and volcanic rocks. Both yellow and dark silicified wood can also be found in the Totavi Lentil, although it is sparse in the axial gravels of the Rio Grande. Silicified wood is more common in the gravels in the Jemez and Galisteo River valleys. Chert cobbles include Pedernal-like chalcedony and chert, olive-brown chert, cream-colored chert, fossiliferous chert, and cherty meta-rhyolite. Virtually all colors of chert and chalcedony can be found in these gravels (Warren 1977c:25–27). Most of the chert resembles chert from Cerro Pedernal. This chert is white to clear and may exhibit dendritic inclusions ranging in color, including black, red, and yellow. For the purpose of this analysis the cherts and chalcedonies are referred to as Rio Grande chert and chalcedonies. Obsidian, glassy basalt, and Rio Grande chert all occur in these axial gravels and are the most abundant materials used by prehistoric inhabitants of the area.

The Peña Blanca Study Area

A series of cross-tabulations were used to determine if material selection changed through time. Initially each context within a temporal period was statistically compared using the Pearson's chi-square and adjusted residual tests to determine if assemblages exhibit significant differences at the .05 level of confidence. Adjusted residuals determine the contribution of each cell to the chi-square sum. For example, each floor assemblage (context) dating to the Early Developmental period were statistically compared to each other, then each floor assemblage dating from the Late Developmental, Coalition, etc., were compared in similar fashion. The Pearson's chi-square test indicates, with one exception, that within each temporal and contextual category there are significant differences (at the .05 level of confidence) in the proportions of material types represented. The only context that was not significantly different was the undated middens.

Each context dating to select temporal periods was compared to one another. Then all floors dating to specific temporal periods were compared. This was done for each context (roof fall, upper fill, etc.) and compared by temporal period—again using adjusted residuals and the chi-square tests (Tables 17.5, 17.6). The adjusted residuals and chi-square test again indicate that there are significant differences in raw material selection between temporal periods. Proportions of quartzite were most similar across contextual and temporal periods. Finally assemblages that were not temporally mixed, single component assemblages, were compared to each other. Again, the result was significant differences in material selection through time.

It appears that earliest Developmental and Early Developmental assemblages exhibit significantly more obsidian than later periods (Table 17.7). The significant amount of obsidian in the Early Developmental assemblage is likely the result of significantly greater numbers of projectile points (Table 17.8). The Classic period assemblages contain significantly less obsidian than all earlier periods. The Early Developmental period assemblages exhibit significantly more chert and quartzite, but signifi-

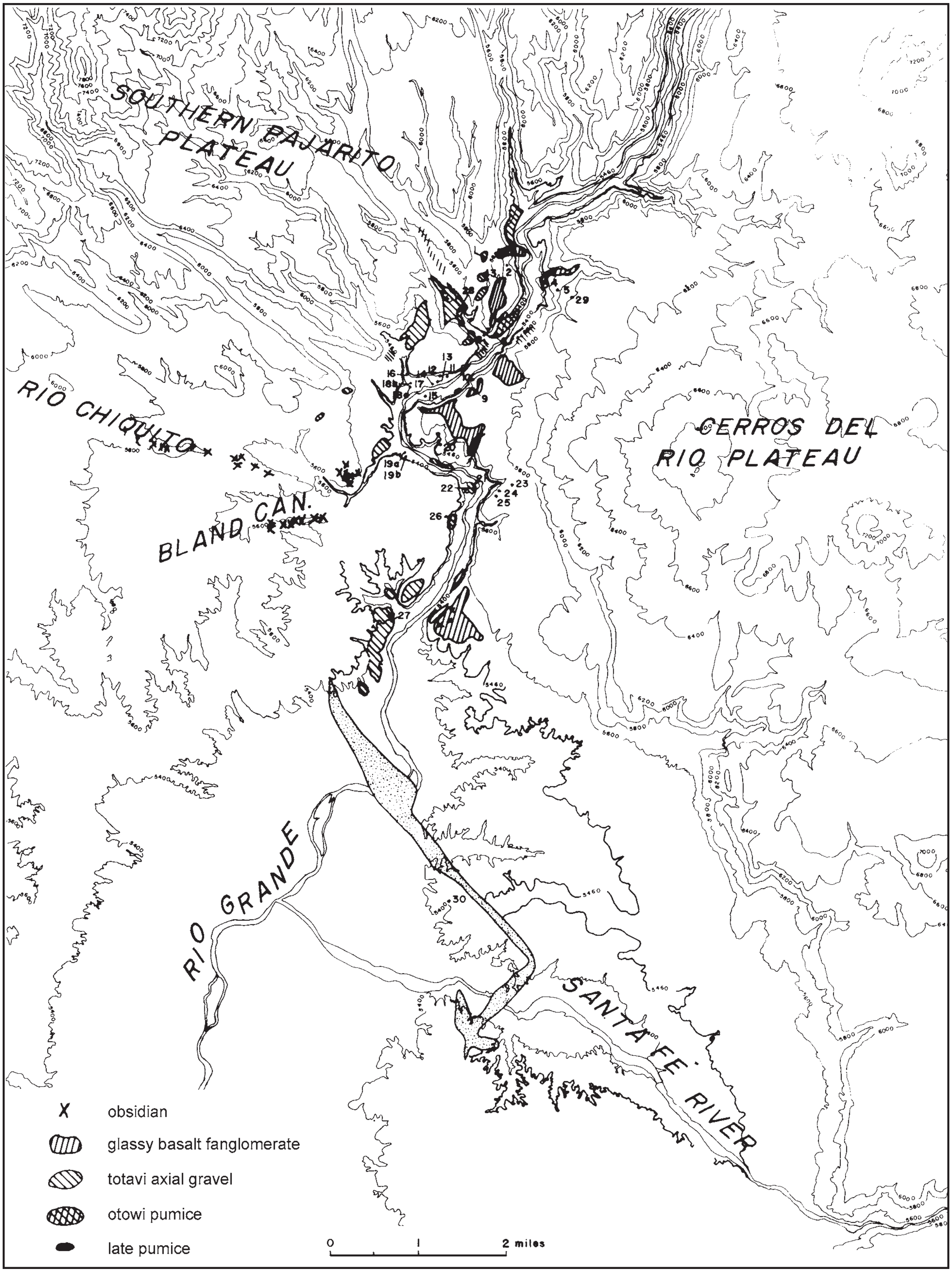

Figure 17.7. White Rock Canyon raw material sources. The numbers reflect 31 geologic stations sampled by Warren (1979:46).

Table 17.5. Chi-square Evaluation of Material Selection and Selected Contexts

Pearson Chi-Square Likelihood Ratio Linear-by-Linear Association N of Valid Cases	Value	*df*	Asymptotic Significance (2-sided)
Floor: Early Developmental	781.311[a]	48	.000
	831.020	48	.000
	11.012	1	.001
	2795		
Floor: Late Developmental	15.855[b]	4	.003
	14.243	4	.007
	3.127	1	.077
	365		
Floor: Coalition	64.038[c]	12	.000
	56.248	12	.000
	5.935	1	.015
	311		
Floor: Early Developmental with Coalition	53.106[d]	20	.000
	53.230	20	.000
	1.439	1	.230
	644		
Roof fall: Early Developmental	122.356[e]	16	.000
	116.810	16	.000
	31.673	1	.000
	1168		
Upper fill: Early Developmental	35.594[f]	16	.003
	37.775	16	.002
	1.438	1	.231
	830		
Upper fill: Coalition	258.770[g]	12	.000
	280.327	12	.000
	21.266	1	.000
	851		
Upper fill: Coalition with Developmental	97.800[h]	12	.000
	95.258	12	.000
	0.524	1	.469
	648		
Midden: Early Developmental	55.508[i]	8	.000
	50.029	8	.000
	4.602	1	.032
	753		
Midden: No date	7.509[j]	4	.111
	8.097	4	.088
	2.830	1	.930
	215		

[a] 17 cells (26.2%) have expected count less than 5. The minimum expected count is .14.
[b] 5 cells (50.0%) have expected count less than 5. The minimum expected count is .17.
[c] 8 cells (40.0%) have expected count less than 5. The minimum expected count is 1.54.
[d] 9 cells (30.0%) have expected count less than 5. The minimum expected count is .32.
[e] 4 cells (16.0%) have expected count less than 5. The minimum expected count is 1.29.
[f] 4 cells (16.0%) have expected count less than 5. The minimum expected count is 1.71.
[g] 4 cells (20.0%) have expected count less than 5. The minimum expected count is 1.16.
[h] 4 cells (20.0%) have expected count less than 5. The minimum expected count is 1.70.
[i] 6 cells (40.0%) have expected count less than 5. The minimum expected count is .16.
[j] 2 cells (20.0%) have expected count less than 5. The minimum expected count is .48.
[k] 5 cells (20.0%) have expected count less than 5. The minimum expected count is 1.84.

Table 17.6. Adjusted Residuals Comparing Temporal Periods by Context

Count Row % Residual Adjusted Residual	Ceramic Date	Chalcedony	Chert	Quartzite	Jemez Obsidian	Igneous	Total
Floor	Early Developmental	952	370	64	511	898	2795
		34.1%	13.2%	2.3%	18.3%	32.1%	100.0%
		-101.5	33.1	-4.6	49.8	23.2	
		-7	**3.4**	-1.0	**4.5**	1.7	
	Mainly early Developmental	284	82	16	125	137	644
	with Coalition	44.1%	12.7%	2.5%	19.4%	21.3%	100.0%
		41.3	4.4	.2	18.7	-64.6	
		3.7	.6	.1	**2.2**	**-6**	
	Late Developmental	176	16	9	27	137	365
		48.2%	4.4%	2.5%	7.4%	37.5%	100.0%
		38.4	-28	.0	-33.2	22.8	
		4.3	**-4.7**	.0	**-4.9**	**2.7**	
	Coalition	139	28	12	16	116	311
		44.7%	9.0%	3.9%	5.1%	37.3%	100.0%
		21.8	-9.5	4.4	-35.3	18.7	
		2.7	-1.7	1.7	**-5.6**	**2.4**	
	Total floor	1551	496	101	679	1288	4115
		37.7%	12.1%	2.5%	16.5%	31.3%	100.0%
Roof fall	Early Developmental	314	302	29	58	465	1168
		26.9%	25.9%	2.5%	5.0%	39.8%	100.0%
		.0	.0	.0	.0	.0	
		-	-	-	-	-	
	Total roof fall	314	302	29	58	465	1168
		26.9%	25.9%	2.5%	5.0%	39.8%	100.0%
Upper fill	Early Developmental	386	93	18	58	275	830
		46.5%	11.2%	2.2%	7.0%	33.1%	100.0%
		69.2	-50.6	-.2	1.0	-19.4	
		6.2	**-5.8**	-.1	.2	-1.8	
	Coalition	364	114	11	50	312	851
		42.8%	13.4%	1.3%	5.9%	36.7%	100.0%
		39.2	-33.3	-7.6	-8.5	10.2	
		3.5	**-3.8**	**-2.2**	-1.4	.9	
	Mainly Coalition	139	196	22	52	239	648
	with Early Developmental	21.5%	30.2%	3.4%	8.0%	36.9%	100.0%
		-108.3	83.9	7.8	7.5	9.2	
		-10.3	**10.3**	**2.5**	1.4	.9	
	Total upper fill	889	403	51	160	826	2329
		38.2%	17.3%	2.2%	6.9%	35.5%	100.0%
Midden	Early Developmental	321	230	12	42	148	753
		42.6%	30.5%	1.6%	5.6%	19.7%	100.0%
		.0	.0	.0	.0	.0	
		-	-	-	-	-	
	Total midden	321	230	12	42	148	753
		42.6%	30.5%	1.6%	5.6%	19.7%	100.0%
Large pits	Early Developmental	557	173	47	84	490	1351
		41.2%	12.8%	3.5%	6.2%	36.3%	100.0%
		.0	.0	.0	.0	.0	
		-	-	-	-	-	
	Total large pits	557	173	47	84	490	1351
		41.2%	12.8%	3.5%	6.2%	36.3%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

Table 17.6 (continued). Chi-square Tests

Context		Value	*df*	Asymptotic Significance (2-sided)
Floor	Pearson chi-square	138.820[a]	12	0
	Likelihood ratio	158.875	12	0
	Linear-by-linear association	6.073	1	0.014
	N of valid cases	4115		
Roof Fall	Pearson chi-square	-[b]		
	N of valid cases	1168		
Upper Fill	Pearson chi-square	167.291[c]	8	0
	Likelihood ratio	166.724	8	0
	Linear-by-linear association	8.43	1	0.004
	N of valid cases	2329		
Midden	Pearson chi-square	-[b]		
	N of valid cases	753		
Large Pits	Pearson chi-square	-[b]		
	N of valid cases	1351		

[a] 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 7.63.
[b] No statistics are computed because ceramic date is a constant.
[c] 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 14.19.

Table 17.7. Adjusted Residuals and Chi-square Evaluation of Material Selection Comparing Single-Component Proveniences by Ceramic Date

Count % within Ceramic Date Residual Adjusted Residual	Chalcedony	Chert	Quartzite	Jemez Obsidian	Igneous	Total
Earliest Developmental	26	6	2	18	30	82
	31.7%	7.3%	2.4%	22.0%	36.6%	100.0%
	-6.7	-6.6	.1	9.6	3.5	
	-1.5	**-2**	.1	**3.5**	.8	
Early Developmental	2809	1248	190	868	2459	7574
	37.1%	16.5%	2.5%	11.5%	32.5%	100.0%
	-207.2	87.9	13.6	95.3	10.3	
	-9.5	**5.5**	**2**	**7.1**	.5	
Late Developmental	287	69	19	61	264	700
	41.0%	9.9%	2.7%	8.7%	37.7%	100.0%
	8.2	-38.2	2.7	-10.4	37.7	
	.7	**-4.2**	.7	-1.3	**3.2**	
Coalition	529	188	25	75	493	1310
	40.4%	14.4%	1.9%	5.7%	37.6%	100.0%
	7.3	-12.7	-5.5	-58.6	69.5	
	.4	-1	-1.1	-0.57	**4.4**	
Classic	436	61	3	25	72	597
	73.0%	10.2%	0.5%	4.2%	12.1%	100.0%
	198.3	-30.4	-10.9	-35.9	-121	
	17.1	**-3.6**	**-3**	**-5**	**-10.9**	
Total	4087	1572	239	1047	3318	10263
% of total	39.8%	15.3%	2.3%	10.2%	32.3%	100.0%

Bold adjusted residual values are significantly greater or less than expected at a .05 level of confidence.

Table 17.8. Adjusted Residuals and Chi-square Evaluation Comparing Materials Selected for Projectile Points and Bifaces

Count % within Ceramic Date Residual Adjusted Residual	Ceramic Date	Projectile Point	Biface	Total
Chalcedony	Early Developmental	3	2	5
		60.0%	40.0%	100.0%
		.2	-.2	
		.3	-.3	
	Late Developmental	2	1	3
		66.7%	33.3%	100.0%
		.3	-.3	
		0.5	-0.5	
	Coalition	-	1	1
		-	100.0%	100.0%
		-.6	.6	
		-1.2	1.2	
Total chalcedony		5	4	9
		55.6%	44.4%	100.0%
Chert	Early Developmental	-	4	4
		-	100.0%	100.0%
		-.8	.8	
		-2.2	**2.2**	
	Late Developmental	1	-	1
		100.0%	-	100.0%
		.8	-.8	
		2.2	**-2.2**	
Total chert		1	4	5
		20.0%	80.0%	100.0%
Jemez obsidian	Earliest Developmental	1	1	2
		50.0%	50.0%	100.0%
		.0	.0	
		.0	.0	
	Early Developmental	32	27	59
		54.2%	45.8%	100.0%
		3.3	-3.3	
		2	**-2**	
	Late Developmental	1	5	6
		16.7%	83.3%	100.0%
		-1.9	1.9	
		-1.6	1.6	
	Coalition	-	3	3
		-	100.0%	100.0%
		-1.5	1.5	
		-1.7	1.7	
	Classic	1	1	2
		50.0%	50.0%	100.0%
		.0	.0	
		.0	.0	
Total Jemez obsidian		35	37	72
		48.6%	51.4%	100.0%
Igneous	Early Developmental	-	5	5
		-	100.0%	100.0%
		-	.0	
		-	-	
	Classic	-	1	1
		-	100.0%	100.0%
		-	.0	
		-	-	
Total igneous		-	6	6
		-	100.0%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

Table 17.8 (continued). Chi-square Tests

Grouped Material		Value	*Df*	Asymptotic Significance (2-sided)	Exact Significance (2-sided)	Exact Significance (1-sided)
Chalcedony	Pearson chi-square	1.440[b]	2	.487		
	Likelihood ratio	1.816	2	.403		
	Linear-by-linear association	0.568	1	.451		
	N of valid cases	9				
Chert	Pearson chi-square	5.000[c]	1	.025		
	Continuity correction[a]	0.703	1	.402		
	Likelihood ratio	5.004	1	.025		
	Linear-by-linear association	4000	1	.046	.200	.200
	N of valid cases	5				
Jemez obsidian	Pearson chi-square	6.040[d]	4	.196		
	Likelihood ratio	7.439	4	.114		
	Linear-by-linear association	2.525	1	.112		
	N of valid cases	72				
Igneous	Pearson chi-square	-[e]				
	N of valid cases	6				

a Computed only for a 2 by 2 table.
b 6 cells (100.0%) have expected count less than 5. The minimum expected count is .44.
c 4 cells (100.0%) have expected count less than 5. The minimum expected count is .20.
d 8 cells (80.0%) have expected count less than 5. The minimum expected count is .97.
e No statistics are computed because lithic type is a constant.

cantly less chalcedony. Late Developmental and Coalition assemblages exhibit significantly more non-obsidian igneous materials. And finally, the Classic period assemblage has significantly more Rio Grande chalcedony. All other material categories dating to the Classic period have significantly less chert, quartzite, Jemez obsidian, and other igneous materials. The Early Developmental period assemblage is the only period containing significantly more quartzite. This is probably the result of variation in activities through time.

Although proportions of raw materials are significantly different through time on the NM 22 sites, it is interesting to note that, generally, materials selected for biface and projectile point manufacture are not statistically different across temporal periods (Table 17.8). The proportion of chalcedony point and bifaces are similar for the Early, Late Developmental, and Coalition periods. The Early Developmental and Late Developmental chert assemblages are significantly different in proportions of points to bifaces—the Early Developmental period has significantly fewer chert points, while the Late Developmental assemblage exhibits significantly more chert projectile points. As previously noted, there are significantly more Early Developmental obsidian projectile points and fewer bifaces than all other temporal periods.

Jemez Valley

The MAPCO project excavated six Middle Rio Grande sites in the Jemez Valley that are contemporary with the NM 22 sites. Lithic materials on these six sites were compared by temporal periods to the NM 22 data to determine if there were significant differences in raw material selection through time. Table 17.9 lists the Jemez Valley MAPCO sites that could be compared to the NM 22 data. The MAPCO material categories were similar to the lumped material classes defined for NM 22 with the exception of silicified wood. This difference is due to the fact that Rio Grande gravels in the vicinity of the Peña Blanca sites exhibit low percentages of silicified wood while silicified wood is much more abundant in sources near the Jemez River Valley (Warren 1979d:47–54). Among MAPCO sites,

Table 17.9. Adjusted Residuals for Material Types at Six Sites in the Jemez Valley (after Elyea 1994:38)

Site	Temporal Affiliation MAPCO	Temporal Affiliation NM 22	Chalcedony	Silicified Wood	Quartzite	Obsidian	Volcanic Other	Other	Chert
LA 25856	Basketmaker III-Pueblo I	Early Developmental	-0.09	0.77	0.58	-1.44	0.21	**3.18**	-0.83
LA 25862	Pueblo I-II	Late Developmental	-0.22	**-4.27**	-1.38	**-7.37**	**15**	**20.68**	-2.02
LA 27632	Archaic?/ Formative	Archaic?/ Formative	**3.64**	-1.81	-1.07	**-2.15**	-0.72	-0.58	-1.06
LA 109129	Basketmaker III-Pueblo I	Early Developmental	**-57.86**	**-28.04**	**53.49**	**56.96**	**37.41**	-0.08	-1.95
LA 110949	Formative	Formative	1.38	-1.19	1.2	-1.18	-0.75	-0.24	-0.68
LA 110953	Pueblo III-IV	Classic	**-7.24**	0.52	**4.56**	-1.83	**13.46**	**7.19**	-1.39

Bold adjusted residual values are significantly greater or less than expected at a .05 level of confidence.

one Early Developmental site (LA 25856) and a Formative site (LA 110949) do not exhibit significant differences in the proportion of most lithic material types. A second Early Developmental period site (LA 109129) exhibits significant differences in all material categories except chert and "other" material. LA 109129 is consistent with the NM 22 Early Developmental proveniences exhibiting significantly more obsidian than sites dating to later periods. When Classic assemblages are compared, the NM 22 assemblages exhibit significantly more chalcedony than the MAPCO Classic site (LA 110953).

Unlike the results described by Elyea (1994:38) on MAPCO sites in the Jemez Valley, the NM22 data indicate significantly different raw material composition through time. She found that assemblages on Formative sites located several miles apart (LA 27632, LA 110949, and LA 25856) contain similar proportions of lithic raw materials.

Discard Pattern Results

As discussed in the research design, the locations where certain types of artifacts are thrown away provide clues about the activities that occur at a given location. Are tools being manufactured at residential sites, hunting camps, special use locations, etc.? Where are these tools being refurbished and where are they discarded when they are no longer useful? These data can be used to identify patterns of settlement and subsistence, providing a basis to evaluate individual site types and provide a basis to compare settlement and subsistence issues through time. The type and number of artifacts and stage of manufacture can also be used to evaluate various strata across the site. For example, one would not expect to find large numbers of lithics and ceramics on the floor. Large assemblages in floor contexts are probably trash deposits where one would expect manufacturing failures and broken or used up tools.

I must caution the reader that the discussions that follow deal with assemblages of various sizes. In some cases artifacts lacking certain attributes were removed from the target assemblage. For example, artifacts in proveniences lacking an assigned date from ceramic analysis are not included in studies that evaluate changes through time. In other cases artifacts lacking data necessary to place them in a category of manufacturing failures or successes are also eliminated. Also an attempt was made to compare single component assemblages. Because there were many multicomponent sites, the following study deals with temporal periods not individual sites. An attempt was also made to select specific contexts across sites. These include dated floor, roof fall, upper fill, and midden strata.

Three hundred and eighty-eight formal tools were included in the discard pattern study (Table 17.10). Although artifacts with breakage which could not be classified as manufacturing failures or successes made up 37 percent (n = 143) of the formal tool assemblage, 63 percent (n = 245) were successfully placed in categories of manufacturing failures, manufacturing successes, and successful whole tools. As will be discussed later, projectile points are the most difficult artifact type to distinguish manufacturing successes from manufacturing failures. The distinction between manufacturing successes and manufacturing failures could not be made on 143 tools. These include 110 (77 percent) projectile points, 27 (19 percent) bifaces, 3 (2 percent) unifaces, and 3 (2 percent) drills.

Two hundred and forty-five formal tools remain in the target population once unclassifiable artifacts are removed from the sample. Manufacturing failures made up 49 percent (n = 121) of the classified tools and manufacturing successes totaled 51 percent (n = 124) of the assemblage. The category of manufacturing successes include bifacial tool fragments or used up tools and successful whole tools. This distinction was made to separate finished tool fragments or used-up tools from whole tools that appear perfectly functional. It is clear why bifacial tool fragments and used-up tools enter the archaeological record but unclear why tools which appear perfectly usable have been

Table 17.10. Technology Summary of Stages of Discard for All Formal Tools

Count % within Technology Residual Adjusted Residual	Projectile Point	Biface	Uniface	Drill	Total	Column %
Manufacturing failure	49 40.5% -33.0 **-7.7**	66 54.5% 34.2 **8.5**	6 5.0% 2.3 1.4	0 0.0% -3.4 **-2.3**	121 100.0%	31.2%
Successful tool fragment	79 82.3% 13.9 **3.5**	6 6.3% -19.2 **-5.1**	3 3.1% .0 .0	8 8.3% 5.3 **3.7**	96 100.0%	24.7%
Successful whole tool	25 89.3% 6 **2.5**	3 10.7% -4.4 -1.9	0 0.0% -.9 -1.0	0 0.0% -.8 -.9	28 100.0%	7.2%
Unknown	110 76.9% 13.1 **2.9**	27 18.9% -10.6 **-2.5**	3 2.1% -1.4 -.9	3 2.1% -1.1 -.7	143 100.0%	36.9%
Total % of total	263 67.8%	102 26.3%	12 3.1%	11 2.8%	388 100.0%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

discarded. Twenty-five (89 percent) of the 28 successful whole tools were projectile points while conversely, only three bifaces (11 percent) were successful whole tools. The adjusted residuals clearly indicate that significantly (.05 level of confidence) more bifaces are manufacturing failures and significantly fewer projectile points are manufacturing failures.

Manufacturing failures were further examined to determine the stage they were discarded. This involved classifying tools as preforms, early bifaces, late bifaces, and final preforms. Statistical comparisons were made for the following contexts—floors, roof fall, upper fill, and middens. Adjusted residuals were calculated to deal with the low chi-square cell counts and determine the attributes contributing to the chi-square values.

Initially the discard status was compared by context within temporal periods. For example, all Early Developmental floors were compared, then Early developmental roof fall assemblages, upper fill assemblage, and then middens. Once clear that the assemblages were not statistically different at the .05 level of confidence, each context, floor, roof fall, upper fill, and middens was compared by temporal period. Then, lumped assemblages from combined contexts were compared by temporal period. Finally, single component assemblages were compared to determine if significant discard patterns occurred through time.

Initially floors within each temporal period were compared. At this basic level, statistical comparisons were limited when each temporal period had only one assemblage. Eleven floor assemblages dating to the Early Developmental period were statistically compared. The chi-square value for most Early Developmental floors indicate that the assemblages are not significantly different at a .05 level of confidence. To deal with the low cell counts, adjusted residuals were calculated. With the exception of three floor assemblages Early Developmental floors are not significantly different from one another. The floor assemblage in Feature 47 (comp. 102), and Structure 9 (comp. 332) exhibited significantly more late preforms while significantly more early preforms were found in the floor assemblage in Structure 5 (comp. 236).

Five floors dated to the Early Developmental with Coalition periods. The Structure 26 (comp. 310) floor assemblage contained significantly more early preforms while the Structure 18 (comp. 331) floor assemblage contained significantly more late preforms. Feature 47 also contained significantly more successful whole tools. The other dated floors contained only one floor within each period, consequently no statistics were applied.

When roof fall assemblages are compared within dated temporal periods only the Early Developmental period exhibits more than one roof fall assemblage. Study Unit 4 (comp. 509) exhibited significantly more final preforms.

No upper fill assemblages exhibited significant differences in artifact stage of discard. Two Early Developmental midden assemblages were compared and Study Unit 14 (comp. 280) had significantly more blanks while Study Unit 15 (comp. 285) contained significantly fewer blanks.

Next, the lumped contexts were compared by temporal period (Table 17.11). The figures below do not include artifacts that could not be classified by stage of manufacture or artifacts from undated temporal periods. One hundred and nine of the formal tools could be placed in the four stages of manufacturing failures. It appears that manufacturing failures most often occur at the late preform stage (n = 64, 59 percent). The remaining manufacturing failures were blanks (n = 7, 6 percent), early preforms (n = 19, 18 percent), and final preforms (n = 19, 18 percent). Studies conducted by the author indicate that early preforms and blanks often become manufacturing failures as the result of flaws in the material or blows ending in large step terminations preventing further bifacial thinning. Final preform manufacturing failures most frequently occur during the notching sequence (Titmus and Woods 1986:37) or as the result of end shock (Purdy 1975:134).

The manufacturing successes total 229. Two hundred and fourteen were successful bifacial tools that were either broken or used up and consequently discarded. These made up 93 percent of the manufacturing success. Fifteen successful whole tools (7 percent) were manufacturing successes. As previously mentioned, it is unclear why these tools were discarded.

The chi-square values for floors, roof fall, upper fill, and middens are significantly different at less than a .05 confidence level, but many cells have expected counts with less than five. The adjusted residuals, however, clearly indicate that assemblages within each context are not significantly different. Floor assemblages dating between the Early Developmental and Classic periods were compared within each context (floors, roof fall, upper fill, and middens). The general trends within these four contexts indicate that during later periods there are significantly more blanks and early preforms than in earlier periods and that proportions of used up or fragmentary bifaces and successful whole tools are not significantly different through time. The Early Developmental period exhibits fewer early preforms while the mixed Late Developmental and Classic floor assemblages, as well as the Coalition period floors have significantly more early preforms and blanks respectively. The remaining periods do not exhibit significantly different numbers of blanks, early preforms, late preforms, and final preforms.

All stages of tool manufacture and use are represented on the Early Developmental floors (10 manufacturing failures and 24 manufacturing successes). This would indicate that tools were both manufactured and used in these early structures. Two successful whole projectile points were also recovered from the floor assemblages.

Early Developmental roof fall and upper fill assemblages exhibit a similar trend. There are significantly fewer blanks and early preforms in Early Developmental roof fall, while the mixed Early Developmental with Late Developmental roof fall has significantly more early preforms. The upper fill also has significantly more blanks and early preforms in the Classic and Coalition periods. Unlike other temporal periods, the Coalition period exhibits significantly more final preforms and fewer used up and fragmentary bifaces. This assemblage consists of manufacturing failures and a used-up or broken tool.

Table 17.11. Stage of Tool Manufacture by Ceramic Date

Count % within Ceramic Date Residual Adjusted Residual	Blank	Early Preform	Late Preform	Final Preform	Biface Fragment	Successful Whole Tool	Total
Earliest Developmental	-	-	1	-	1	-	2
	-	-	50.0%	-	50.0%	-	100.0%
	.0	-.1	.6	.1	-.3	-.1	
	-.2	-.3	1.1	-.3	-.4	-.3	
Early Developmental	2	7	44	14	160	11	238
	0.8%	2.9%	18.5%	5.9%	67.2%	4.6%	100.0%
	-2.9	-6.4	-1.1	.6	9.3	.4	
	-2.5	**-3.3**	-.3	.3	**2.3**	.3	
Mainly Early Developmental	1	2	-	1	-	1	5
with Late Developmental	20.0%	40.0%	-	20.0%	-	20.0%	100.0%
	.9	1.7	-.9	.7	-3.2	.8	
	2.8	**3.4**	-1.1	1.4	**-3**	1.7	
Mainly Early Developmental	-	2	1	1	7	-	11
with Coalition	-	18.2%	9.1%	9.1%	63.6%	-	100.0%
	-.2	1.4	-1.1	.4	0	-.5	
	-.5	1.8	-.8	.5	0	-.7	
Late Developmental	1	1	1	-	5	-	8
	12.5%	12.5%	12.5%	-	62.5%	-	100.0%
	.8	.6	-.5	-.4	-.1	-.4	
	2.1	.9	-.5	-.7	0	-.6	
Late Developmental and Classic	-	1	-	-	1	-	2
	-	50.0%	-	-	50.0%	-	100.0%
	.0	.9	-.4	-.1	-.3	-.1	
	-.2	**2.7**	-.7	-.3	-.4	-.3	
Mainly Late Developmental	-	3	4	-	7	1	15
with some Early Developmental	-	20.0%	26.7%	-	46.7%	6.7%	100.0%
	-.3	2.2	1.2	-.8	-2.5	.3	
	-.6	**2.5**	.8	-1	-1.4	.4	
Coalition	1	1	2	2	5	-	11
	9.1%	9.1%	18.2%	18.2%	45.5%	-	100.0%
	.8	.4	-.1	1.4	-2	-.5	
	1.7	.5	-.1	1.8	-1.2	-.7	
Mainly Coalition with	-	-	-	1	10	1	12
Early Developmental	-	-	-	8.3%	83.3%	8.3%	100.0%
	-.2	-.7	-2.3	.3	2.4	.5	
	-.5	-.9	-1.7	.4	1.5	.7	
Mainly Coalition with Early	-	1	7	-	9	-	17
Developmental and	-	5.9%	41.2%	-	52.9%	-	100.0%
Late Developmental	-.4	0	3.8	-1	-1.8	0.8	
	-.6	0	**2.4**	-1	-.9	-.9	
Coalition with Classic and	-	-	1	-	7	-	8
Early Developmental mix	-	-	12.5%	-	87.5%	-	100.0%
	-.2	-.4	-.5	-.4	1.9	-.4	
	-.4	-.7	-.5	-.7	1.4	-.6	
Classic	1	1	-	-	1	-	3
	33.3%	33.3%	-	-	33.3%	-	100.0%
	.9	.8	-.6	-.2	-.9	-.1	
	3.8	**2.1**	-.8	-.4	-1.1	-.4	
Mainly Classic, some Coalition	-	-	-	-	-	1	1
and Early Developmental	-	-	-	-	-	100.0%	100.0%
	0	-.1	-.2	-.1	-.6	1	
	-.1	-.2	-.5	-.2	-1.3	4.6	
Late Developmental	1	-	3	-	1	-	5
Coalition Mix	20.0%	-	60.0%	-	20.0%	-	100.0%
	.9	-.3	2.1	-.3	-2.2	-.2	
	2.8	-.5	**2.4**	-.5	**-2**	-.5	
Total	7	19	64	19	214	15	338
% of total	2.1%	5.6%	18.9%	5.6%	63.3%	4.4%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

Table 17.11 (continued). Chi-square Tests

	Value	*df*	Asymptotic Significance (2-sided)
Pearson chi-square	136.124[a]	65	0
Likelihood ratio	92.611	65	0.014
Linear-by-linear association	8.567	1	0.003
N of valid cases	338		

[a] 72 cells (85.7%) have expected count less than 5. The minimum expected count is .02.

Assemblages of formal tools from each temporal period were compared next. Again, the pattern that the Early Developmental period assemblages have significantly fewer blanks and early preforms than later periods is supported by the adjusted residuals. When significant differences appeared in assemblages dated after the Early Developmental, there are significantly greater numbers of blanks and early preforms through time. The Early Developmental assemblages also contain significantly more biface fragments and used-up tools.

Assemblages dating to single-component temporal periods were then compared to evaluate formal tool manufacture through time. Although this reduces the number of tools in the target sample by 76 tools it does eliminate noise resulting from multicomponent assemblages. Table 17.12 presents the adjusted residuals and chi-square values. Although the chi-square test indicates significant differences in stage of manufacture (.003) between the five temporal periods, a large number of the cells have expected counts of less than five. The adjusted residuals were again calculated to determine the factors contributing to the chi-square results. Once again the adjusted residuals support patterns seen before which indicate that the Early Developmental period exhibits significantly fewer blanks and early preforms than later periods. The Late Developmental and Classic periods exhibit significantly more blanks and/or early preforms. Again, the Coalition period assemblages exhibit significantly fewer biface fragments and exhausted tools.

Classifying bifaces, unifaces, and drills as manufacturing failures or successes is much easier than making this distinction with projectile points. The types of breakage that occur on bifaces during manufacture are not as complex as the breakage on projectile points. Projectile point breakage resulting from use and manufacture are often indistinguishable.

Discard Pattern Analysis

The formal tool assemblage consisted of 388 artifacts—263 projectile points, 102 bifaces, 12 unifaces, and 11 drills. These tools were examined for breakage to determine their status when they entered the archeological record, or were discarded. The status at discard can be used to determine the activities that occurred at a specific location. Numbers of manufacturing failures indicate that formal tool manufacture occurred at the site, while successful tool fragments and used up tools indicate that tool utilization occurred at that location. These data can then provide information on site function, specialized manufacturing locations

Projectile Point Breakage

The 263 projectile points recovered from the NM 22 project were placed into 17 breakage categories to determine if they were broken during manufacture or as the result of use. Projectile points that fell into the four categories of manufacturing failures (blank, early preform, late preform, and final preforms) were also classified as manufacturing failures.

Table 17.12. Stage of Manufacture When Discarded by Ceramic Date

Count % within Ceramic Date Residual Adjusted Residual	Blank	Early Preform	Late Preform	Final Preform	Biface Fragment	Stage of Successful Whole Tool	Total
Earliest Developmental	-	-	1	-	1	-	2
	-	-	50.0%	-	50.0%	-	100.0%
	.0	-.1	0.6	-.1	-.3	-.1	
	-.2	-.3	1.2	-.4	-.5	-.3	
Early Developmental	2	7	44	14	160	11	238
	0.8%	2.9%	18.5%	5.9%	67.2%	4.6%	100.0%
	-2.5	-2.1	.4	-.5	3.8	1	
	-4	**-2.3**	.2	-.5	1.7	1.1	
Late Developmental	1	1	1	-	5	-	8
	12.5%	12.5%	12.5%	-	62.5%	-	100.0%
	.8	.7	-.5	-.5	-.3	-.3	
	2.2	1.3	-.4	-.7	-.2	-.6	
Coalition	1	1	2	2	5	-	11
	9.1%	9.1%	18.2%	18.2%	45.5%	-	100.0%
	.8	0.6	.0	1.3	**-2.2**	-.5	
	1.8	0.9	.0	1.7	-1.4	-.7	
Classic	1	1	-	-	1	-	3
	33.3%	33.3%	-	-	33.3%	-	100.0%
	.9	.9	-.5	-.2	-1	-.1	
	4	**2.7**	-.8	-.4	-1.2	-.4	
Total	5	10	48	16	172	11	262
% of total	1.9%	3.8%	18.3%	6.1%	65.6%	4.2%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

Table 17.12 (continued). Chi-square Tests

	Value	*Df*	Asymptotic Significance (2-sided)
Pearson chi-square	42.129	20	0.003
Likelihood ratio	23.088	20	0.285
Linear-by-linear association	9.083	1	0.003
N of valid cases	262		

Projectile points that could not be classified were simply classified as unknown. These categories were developed to represent all the breakage variation in the NM 22 assemblage (Fig. 17.8) and compare breakage to experimental projectile point studies designed to identify breakage patterns resulting from manufacture and use. As previously discussed, it is often difficult to make this distinction because some breaks can result from both manufacturing and use.

Table 17.13 provides a technological summary of projectile point breakage. Points were classified by breakage pattern as manufacturing failures, successful tool fragments or used up tools, successful whole tools, and unknown. The "unknown" category includes point breakage that could result from either use or manufacture.

If a category of breakage is primarily a consequence of use, the breakage will be defined as resulting from use. There are, however, a few cases (n = 16) where the breakage signature represents a successful tool fragment or used up tool but exhibits other empirical criteria resulting from manufacturing error. An example

Table 17.13. Breakage Patterns and Discard Status of Projectile Points

Count % within Breakage Pattern Residual Adjusted Residual	Manufacturing Failure	Successful Tool Fragment	Successful Whole Tool	Unknown	Total
Tip + base missing (use)	2	19	-	-	21
	9.5%	90.5%	-	-	100.0%
	-1.9	12.7	-2	-8.8	
	-1.1	**6.3**	-1.5	**-4.1**	
Tip missing (use)	2	5	-	-	7
	28.6%	71.4%	-	-	100.0%
	.7	2.9	-.7	-2.9	
	.7	**2.4**	-.9	**-2.3**	
Tip + ear(s) missing (use)	-	16	-	-	16
	-	100.0%	-	-	100.0%
	-3	11.2	-1.5	-6.7	
	-2	**6.3**	-1.3	**-3.5**	
Tip + base + ear(s) missing (use)	-	25	-	1	26
	-	96.2%	-	3.8%	100.0%
	-4.8	17.2	**-2.5**	**-9.9**	
	-2.6	**7.7**	-1.7	-4.1	
Tip + lateral base missing (use)	-	2	-	-	2
	-	100.0%	-	-	100.0%
	-.4	1.4	-.2	-.8	
	-.7	**2.2**	-.5	-1.2	
Burin (use)	1	9	-	-	10
	10.0%	90.0%	-	-	100.0%
	-.9	6	-1	-4.2	
	-.7	**4.2**	-1	-2.7	
Manufacturing failures	33	-	-	-	33
	100.0%	-	-	-	100.0%
	26.9	-9.9	-3.1	-13.8	
	12.8	**-4**	**-2**	**-5.2**	
Base missing (unknown)	-	2	-	7	9
	-	22.2%	-	77.8%	100.0%
	-1.7	-.7	-.9	3.2	
	-1.5	-.5	-1	**2.2**	
Tip present with basal snap (unknown)	3	-	-	28	31
	9.7%	-	-	90.3%	100.0%
	-2.8	-9.3	-2.9	15	
	-1.4	**-3.9**	-1.9	**5.8**	
Base + ear missing (unknown)	2	-	-	29	31
	6.5%	-	-	93.5%	100.0%
	-3.8	-9.3	-2.9	16	
	-1.9	**-3.9**	-1.9	**6.2**	
Ear(s) missing (unknown)	1	-	-	10	11
	9.1%	-	-	90.9%	100.0%
	-1	-3.3	-1	5.4	
	-.8	**-2.2**	-1.1	**3.4**	
Medial double snap fragment (unknown)	1	-	-	7	8
	12.5%	-	-	87.5%	100.0%
	-.5	-2.4	-.8	3.7	
	-.5	-1.9	-.9	**2.7**	
Base with distal snap (unknown)	3	1	-	16	20
	15.0%	5.0%	-	80.0%	100.0%
	-.7	-5	-1.9	7.6	
	-.4	**-2.5**	-1.5	**3.6**	

Table 17.13. Continued.

Count % within Breakage Pattern Residual Adjusted Residual	Manufacturing Failure	Successful Tool Fragment	Successful Whole Tool	Unknown	Total
Base with lateral snap	-	-	-	5	5
(unknown)	-	-	-	100.0%	100.0%
	-.9	-1.5	-.5	2.9	
	-1.1	-1.5	-.7	**2.7**	
Base + ear + distal snap	-	-	-	4	4
(unknown)	-	-	-	100.0%	100.0%
	-.7	-1.2	-.4	2.3	
	-1	-1.3	-.7	**2.4**	
Successful whole	-	-	20	-	20
complete tool	-	-	100.0%	-	100.0%
	-3.7	-6	18.1	-8.4	
	-2.2	**-3**	**14.4**	**-3.9**	
Single notch	1	-	5	-	6
(successful whole tool)	16.7%	-	83.3%	-	100.0%
	-.1	-1.8	4.4	-2.5	
	-.1	-1.6	**6.2**	-2.1	
N/A	-	-	-	3	3
	-	-	-	100.0%	100.0%
	-.6	-.9	-.3	1.7	
	-.8	-1.1	-.6	**2.1**	
Total	49	79	25	110	263
% of total	18.6%	30.0%	9.5%	41.8%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

Table 17.13 (continued). Chi-square Tests

Pearson Chi-square Likelihood Ratio Linear-by-Linear Association N of Valid Cases	Value	*Df*	Asymptotic Significance (2-sided)
Projectile point	651.496[a]	51	0
	540.839	51	0
	55.478	1	0
	263		
Biface	200.212[b]	12	0
	144.545	12	0
	3.28	1	0.07
	102		
Uniface	12.000[c]	2	0.002
	16.636	2	0
	7.333	1	0.007
	12		
Drill	-[d]		
	11		

[a] 54 cells (75.0%) have expected count less than 5. The minimum expected count is .19.

[b] 16 cells (80.0%) have expected count less than 5. The minimum expected count is .03.

[c] 6 cells (100.0%) have expected count less than 5. The minimum expected count is 1.50.

[d] No statistics are computed.

might be the "end shock" flake removal, which occurs during the later stages of manufacture causing a lateral snap (Purdy 1975:134) or the perverse fracture that originates from a biface edge when force is overshot creating a "outré passe" flake or scar (Preston 1926:250). Another common manufacturing error occurs in final stages of manufacture when notching occurs (Purdy 1975:135; Titmus and Woods 1986:37). These tools exhibit certain characteristics that place them in another category. With the exception of one tool, these points were classified as manufacturing failures.

A brief summary of the results from the experiments previously described is warranted to provide the information used to assign projectile points to each breakage pattern and consequently determine the cause of discard. The experiments conducted by Titmus and Woods found that manufacturing failures do not exhibit tip damage but do have basal damage generally resulting from notching (Fig. 17.5). Titmus and Woods (1986:37) found that manufacturing errors comprised 23 percent (n = 9) of the experimental assemblage while breakage from use was 77 percent (n = 30) of the projectile point assemblage. They further found that although breakage can occur on any portion of the tool, most use damage was a combination of distal and basal breakage. The results of Odell and Cowan's (1986) work indicate that every piece exhibited tip damage upon retirement, while basal damage did not occur on the majority of points (Fig. 17.3). In contrast to Odell and Cowan's (1986) study, experiments conducted by Towner and Warburton (1990) found that 62 percent of the projectile point exhibit broken tips. Of these, 38 percent exhibit only tip damage and 67 percent both tip and basal breakage. Ozbun (pers. comm. 2002) feels that the most common breakage from use is a burination from the tip or base and down the lateral side.

Based on these experimental results, the NM 22 projectile points (n = 263) were classified into four discard status categories—breakage from use, breakage during manufacture, unknown breakage, and successful whole tools (Table 17.13, Fig. 17.8). With the exception of the 16 projectile points discussed above, projectile points with tip damage, in combination with any other damage, were considered broken from use. Because basal and ear damage can result from both manufacturing and use, these projectile points were classified as "unknown."

The entire projectile assemblage consisted of 82 (31 percent) tools broken from use, 33 (13 percent) manufacturing failures, and 26 (10 percent) whole tools with no breakage and no evidence of use. Projectile points which exhibited breakage that could result from both use and manufacture made up the largest portion of the assemblage (n = 119, 45 percent). The breakage pattern on three projectile points could not be identified.

Breakage patterns within all temporal periods, including multicomponent assemblages, were compared with the chi-square and adjusted residual calculations to determine if significant differences in discard patterns occurred through time. Two hundred and forty projectile points were recovered from dated components. The chi-square results identified no significant differences between temporal periods, however, 48 cells had expected counts of less than five. Consequently, adjusted residuals were calculated to accommodate low cell counts. The adjusted residuals support the chi-square results indicating that there are no significant differences in the proportion of manufacturing failures and successfully manufactured projectile points.

Similar results were identified when only single component assemblages were compared. Projectile points were recovered from the Early (n = 180) and Late Developmental (n = 4) periods, the Coalition (n = 7), and Classic (n = 1) periods. The small number of projectile points in later temporal assemblages prohibit further conclusions. One hundred and eighty projectile points were recovered from the Early Developmental period. Manufacturing failures made up 20 percent (n = 36) of the assemblage. Thirty-two percent (n = 58) of the projectile points were successful tool fragments broken

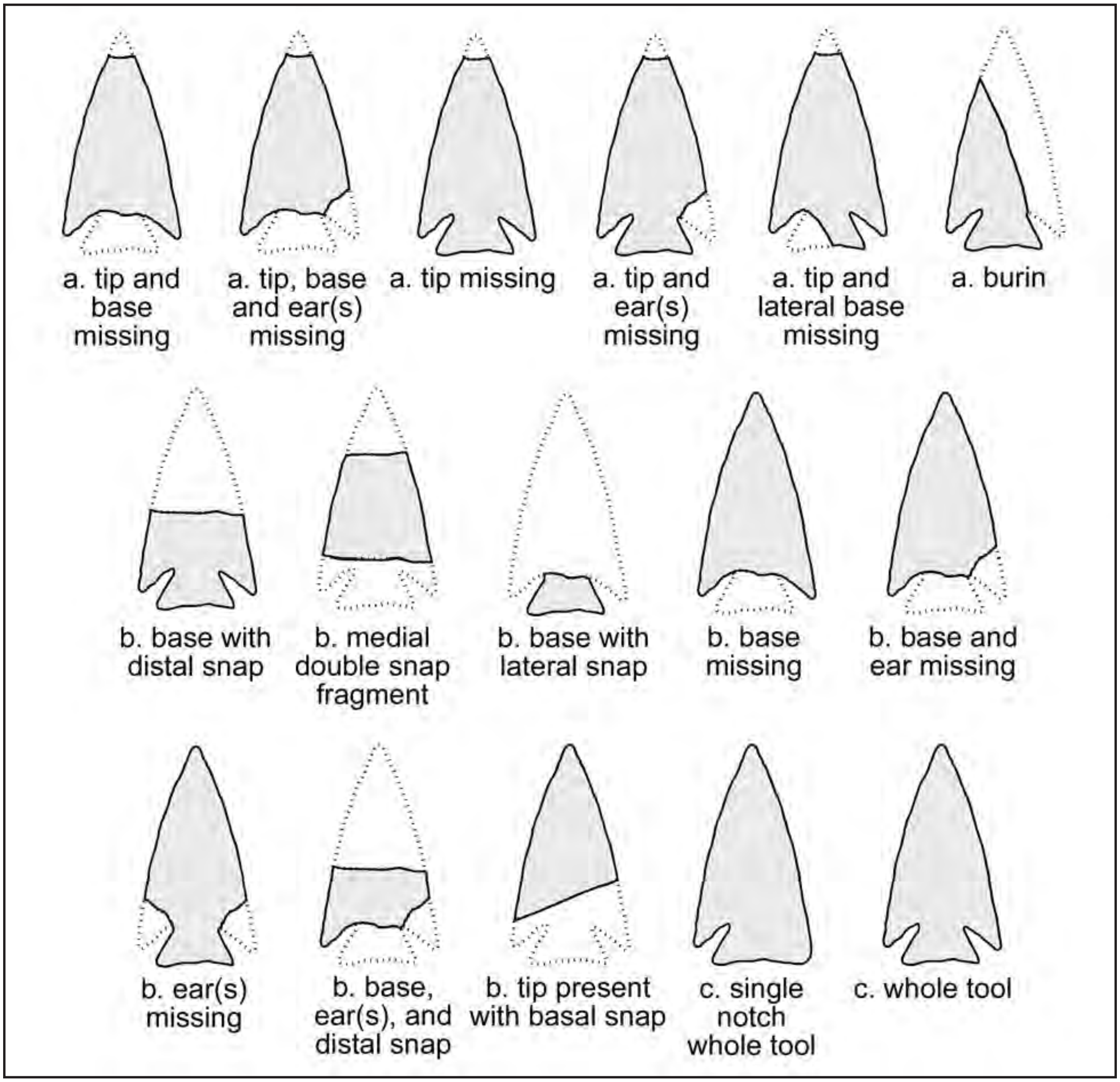

Figure 17.8. Projectile point breakage identified in the NM assemblage; (a) breakage resulting from use, (b) unknown if breakage results from use or manufacture, (c) successful whole tool.

from use and 9 percent (n = 16) were successful whole tools lacking evidence of breakage or use. Thirty-nine (n = 70) percent of the points exhibited breakage that could not be classified. Successful point fragments combined with whole points have a 2 to 1 ratio when compared to manufacturing failures.

Projectile point assemblages were then compared by context (floors, roof fall, upper fill, and middens) within each temporal period. Only two floor assemblages exhibited a significant difference in discard status. The Early Developmental Feature 47 floor (comp.102) assemblage on LA 6169 contained significantly more manufacturing failures (n = 4) and the Early Developmental/Coalition Structure 18 floor (comp. 308) assemblage on LA 6171 exhibited significantly more successful point fragments when all floor assemblages are compared. The Feature 47 floor assemblage contained 632 lithics and 153 ceramics. Lithic counts are taken from grouped material types and may not be consistent with counts from the entire assemblages. Typically, one would not expect this number of lithics on an active floor. Four projectile point manufacturing failures, a broken used projectile point, and a successful whole projectile point were also recovered from the Feature 47 floor. It is likely that this point was lost in the structure. The Structure 18 floor assemblage contained 50 lithics and 253 ceramics. This number of ceramics is not inconsistent with floor assemblages where pots were left behind and broke when the roof collapsed.

In general all other contexts exhibited similar assemblage variability. The Early Developmental roof fall in Study Unit 4 (comp.509) on LA 265 exhibited significantly more final preforms. The projectile point discard status in the upper fill, middens, and large pits in all dated structures was not significantly different.

Biface, Uniface, and Drill Breakage

One hundred and twenty-five non-projectile point bifacial tools were recovered on the project (Table 17.14). Thirty-three could not be classified as manufacturing failures or successes. Once the unclassified tools are removed from the assemblage, 75 bifaces, 9 unifaces, and 8 drills remain in the target assemblage.

With the exception of drills, the majority (78 percent, n = 72) of the tools were manufacturing failures. It is interesting to note that there were only six successful biface fragments or exhausted tools and three successful whole tools found on the NM 22 sites. The six unifacial artifacts were manufacturing failures and three were successful tool fragments or exhausted tools. Eight drill fragments were broken from use.

Table 17.14. Technology Summary, Nonprojectile Tools

Count % within Breakage Pattern Residual Adjusted Residual	Manufacturing Failure	Successful Tool Fragment	Successful Whole Tool	Unknown	Total
Biface	66	6	3	27	102
	64.7%	5.9%	2.9%	26.5%	100.0%
	7.2	-7.9	.6	.1	
	3.4	-5.3	0.8	.0	
Uniface	6	3	0	3	12
	50.0%	25.0%	0.0%	25.0%	100.0%
	-.9	1.4	-.3	-.2	
	-.6	1.2	-.6	-.1	
Drill	-	8	-	3	11
	-	72.7%	-	27.3%	100.0%
	-6.3	6.5	-.3	.1	
	-4	**6**	-.5	.1	
Total	72	17	3	33	125
% of total	57.6%	13.6%	2.4%	26.4%	100.0%

Bold adjusted residual values are either significantly greater or less than expected at a .05 level of confidence.

	Value	*Df*	Asymptotic Significance (2-sided)
Pearson chi-square	41.930[a]	6	0
Likelihood ratio	35.312	6	0
Linear-by-linear association	2.363	1	0.124
N of valid cases	125		

[a] 7 cells (58.3%) have expected count less than 5. The minimum expected count is .26.

The virtual lack of used and broken bifaces and unifaces, yet large number of manufacturing failures, indicates that manufacturing occurred on the sites, but tools were used and discarded at other locations. This would suggest that tool fragments and exhausted tools were discarded at special activity sites.

Conclusions

This formal tool analysis has used a variety of attributes to identify material selection and discard patterns through time. This discussion examined proveniences dating to different temporal periods across all sites and not on a site level. This was decided because most of the sites are multicomponent. The emphasis of this study was to identify when formal tools entered the archaeological record.

The primary objectives were to use the formal tool discard study to address a series of settlement and subsistence issues that include: (1) identifying the range of subsistence activities within temporal periods, (2) determining the organization of technology through time, (3) identifying lithic source areas and determining if material selection changed through time, (4) gain insight into patterns of settlement, and (5) define occupational history.

Seventeen projectile point breakage categories were defined to try to determine if the breakage was the result of use or manufacturing (Fig. 17.8). Eighty-two points (31 percent) exhibited breakage that resulted from use, 33 (13 percent) were manufacturing failures, and 26 (10 percent) were whole tools with no breakage or evidence of use. One hundred and sixteen could not be classified. As previously noted, projectile points with broken tips and any other combination of breakage were classified as broken from use. Within the category of used and broken projectile points (Table 17.13), however, the majority have tip, base, and ear breakage (n = 26, 32 percent) or tip and base missing (n = 21, 32 percent). One would expect that projectile points with this type of breakage would not occur on-site but rather in the field because they have no base remaining in the haft. Projectile points with just tip damage (n = 7, 9 percent), tip and ear damage (n = 16, 20 percent), tip and lateral base missing (n = 2, 2 percent), and burin breaks (n = 10, 12 percent) should occur on the site where the projectile point bases are removed from the haft. Forty-nine projectile points were manufacturing failures. Thirty-three of these points were classified as manufacturing failures because they were blanks, early preforms, late preforms, or final preforms and the remaining 16 exhibited breakage consistent with manufacturing. These incomplete points should occur on the site where they are manufactured. It is unclear, however, why whole projectile points with a single notch (n = 3, 12 percent) and projectiles with no evidence of breakage or use (n = 6, 77 percent) enter the archaeological record. Point breakage that could not be classified as resulting from use or manufacture (n = 116) have the tip intact with base and/or ear missing, medial or double medial snaps, base with distal snap, and a base with a lateral snap.

The context of projectile points was also examined. Early Developmental floor assemblages contained seven manufacturing failures, eight successful point fragments, and one successful whole tool. The successful whole projectile point was recovered from the floor in Feature 47 (LA 6169) floor along with four manufacturing failures, and a successful tool fragment. It is likely that this projectile point was lost.

A whole successful point was also recovered from the Late Developmental floor in Feature 76 (LA 6169). No other successful whole points were recovered from floor contexts.

Four successful whole points were also recovered from Early Developmental roof fall: two from Structure 50 in LA 265 and two from Study Unit 1 also from LA 265. Three additional whole successful points were also recovered from the upper fill in the Early Developmental Study Unit 1 on LA 265. The Structure 5 upper fill on LA 6170 contained one whole successful point and the upper fill in Structure 26 on LA 6171 also contained two whole points. Two additional whole points were found in the midden fill on LA 6170. Again the presence of these perfect, whole points in most of these contexts is problematic.

One hundred and twenty-five non-projectile point formal tools were recovered on the project

(Table 17.14). Thirty-three could not be classified as manufacturing failures or successes. Once the unclassified tools are removed from the assemblage, 75 bifaces, 9 unifaces, and 8 drills remain in the target assemblage. With the exception of drills, the majority (78 percent, n = 72) of the tools were manufacturing failures. It is interesting to note that there were only six successful biface fragments or exhausted tools and three successful whole tools found on the NM 22 sites. The six unifacial artifacts were manufacturing failures and three were successful tool fragments or exhausted up tools. Eight drill fragments were broken from use.

The virtual lack of used and broken bifaces and unifaces, yet large number of manufacturing failures indicates that manufacturing occurred on the sites. Clearly, tools were used and discarded at other locations. This would suggest that tool fragments and exhausted tools were discarded at special activity sites away from the NM 22 sites.

Anschuetz (1995:9) found that the Early Developmental period brought a move to sedentism resulting from a Scandic climate episode between AD 300 and AD 775–900. With this climatic change came increased moisture, long winters, and stream adaptations. The Early Developmental occupation of the Peña Blanca area probably occurred in response to these changing climatic conditions. He notes that most Early Developmental sites occur in the Albuquerque District, along the Rio Tesuque, Nambé, and in the Santa Cruz valleys of the Northern Española District as well as the Pecos District, all physiographic locations similar to the project area. In the Late Developmental period, there is a warming trend resulting in greater summer rains associated with monsoonal air masses (Anschuetz 1995:7).

In the Cochiti Reservoir area, north of the NM 22 project area, the first substantial appearance of ceramics occurs in the Early Developmental period (Basketmaker III/Pueblo I). There is not, however, a major occupation of the Pajarito Plateau until the Coalition or the Pueblo III period. It is apparent that the Early Developmental occupation of the residential sites in the Peña Blanca area used the Cochiti area, not only for its wealth of lithic raw materials, but also abundant food and medicinal plants, as well as faunal resources.

The wide range of different raw materials that occur in the Cochiti and Jemez area provide a source for the manufacture of a variety of stone tools. Different raw materials exhibit characteristics that are more suited for one function than another. For example, obsidian is relatively easy to work and exhibits very sharp edges compared to chert, quartzite, and non-obsidian igneous materials but it is very brittle, and consequently not as durable.

There is a significant difference in the proportion of raw material when the debitage is examined through time. When single component assemblages are compared, the earliest Developmental and Early Developmental periods exhibit significantly more obsidian than later periods. Both of these periods also exhibit an increased use of chert. The greatest differences in the proportion of material types occur when the Early Developmental and Classic periods are compared. While the Early Developmental assemblage exhibits significantly less chalcedony but significantly more chert, quartzite, and Jemez obsidian, the Classic assemblage is the opposite with significantly more chalcedony and significantly less chert, quartzite, obsidian, and non-obsidian igneous materials. The Early Developmental period assemblage exhibits a large assemblage of obsidian projectile points, consequently a significantly larger obsidian assemblage.

The Early Developmental period assemblages also exhibit significantly more chert tools but significantly fewer chalcedony tools. Late Developmental and Coalition assemblages exhibit significantly more non-obsidian igneous materials. And finally, the Classic period assemblage has significantly more Rio Grande chalcedony. All other material categories dating to the Classic period have significantly less chert, quartzite, Jemez obsidian, and other igneous materials. This is probably related to the activities performed at the Classic proveniences. Only three Classic formal tools occurred in the assemblage. This would suggest that this late component represents a special-use activity area.

Chapter 18
A Technological Analysis of the NM 22 Projectile Points

Todd L. VanPool

Technological analyses of artifacts such as projectile points rest on the premise that form follows function (Salmon 1982:39; Schiffer and Skibo 1997). Simply put, archaeologists argue that artifacts are tools that must possess attributes that allow them to be used for specific tasks. Schiffer and Skibo (1987:599) have coined the term "performance characteristics" to refer to those "behavioral capacities that an artifact *must* possess in order to fulfill its functions in a specific activity" (emphasis in original). The morphological and compositional attributes of an artifact must produce the appropriate performance characteristics if an object is going to be a useful tool.

Given that at least some of the attributes of artifacts necessarily impact their usefulness, the artifacts' performance characteristics must place limits upon their morphological and compositional variation. By considering the variation in the composition and the morphology of a group of artifacts, it should be possible to identify the attributes that were performance characteristics and, by extension, the tasks that the artifacts were designed to accomplish. In other words, archaeologists should be able to isolate the functionally prescribed characteristics of tools and reconstruct their use, thereby explaining why they were fabricated in the first place (Amick et al. 1989; Binford 1968; Schiffer and Skibo 1987, 1997; Toth 1991).

A useful structure for the technological analysis of any group of artifacts is therefore quantifying the variation within the attributes of an artifact assemblage to determine which of them are free to vary and which are constrained by the performance characteristics of the artifacts, using this information to specify the artifacts' use, and then using differences in the use of artifacts to explain the variation within an artifact assemblage across time and through space. The differences within the use of artifacts can be further explained by identifying the characteristics of the natural and cultural environments that led to the changes in the performance requirements of artifacts.

For example, screwdrivers are tools designed to allow torque to be applied to the head of a screw, thereby allowing the screw to be driven into or out of wood, metal, or some other medium. The contexts of use place specific morphological and compositional requirements on screwdrivers, thereby requiring definable performance characteristics. Such performance characteristics would include characteristics such as the size and shape of the screwdriver head (e.g., a large Phillips head screwdriver versus a small standard head screwdriver), the length of the screwdriver shaft, the diameter of the screwdriver's grip, and the strength of the material used to form the screwdriver. By considering the variation within an assemblage of screwdrivers, their general performance characteristics can be identified (e.g., the performance characteristics of a class of screwdrivers might be that they must be useful for working with large Phillips head screws). Differences in the frequencies of various classes of screwdrivers can then be explained by reference to changes in the environment of their use (e.g., standard-sized screwdrivers were replaced by metric-sized screwdrivers in automobile shops through time because of the increased frequency of metric-sized screws).

Applying the model proposed above requires four steps: (1) identifying performance characteristics of a series of artifacts, (2) separating the artifacts into distinct classes based on the similarity in their functionally prescribed attributes, (3) creating descriptions of changes in artifact morphology through time and across space, and (4) explaining the observed trends by identifying the variation in the natural and cultural environment that cause items with certain performance characteristics to be favored over other items. The following chapter will accomplish these five steps for the projectile point assemblage recovered during the survey and excavation of LA 249, LA 265, LA 6169, LA 6170, LA 6171, and LA 115862 along the NM 22 highway.

Step 1: Performance Characteristics of Projectile Points

Projectile points are a component of several weapon systems, which each place definite performance requirements on them. Four weapon systems that employ projectile points have been used in North America: the thrusting spear, the throwing spear, the atlatl (also called the spear thrower or the woomera), and the bow and arrow. However, by the time agriculture was adopted in the American Southwest, only two of these weapon systems were commonly used—the bow and arrow and the atlatl. Consequently, the following discussion will focus on these weapons.

Although the mechanics of atlatls and bows and arrows are quite different, they are both designed to transfer energy from a human into a shaft that propels a projectile point into a target, generally an animal. The movement of their projectiles can be conceived of as having three stages: launch, flight, and penetration (Hughes 1998:348).

The usefulness of each of the weapon systems can be evaluated using four performance characteristics: (1) the penetration of the projectile into the target, (2) the durability of various components of the weapon system, (3) the accuracy and range of the projectile, and (4) the versatility of the weapon system in different situations (Hayden et al. 1996:12–13; Hughes 1998:350–351). Each of these performance characteristics is the product of the attributes of a weapon, with a single attribute often affecting more than one performance characteristic. For example, increasing the efficiency of energy transfer from a human into a projectile's shaft will increase the energy of the projectile, which in turn increases both the projectile's penetration and maximum flight distance. Some attributes can also help enhance a performance characteristic(s) while negatively impacting other performance characteristics. For example, an obsidian projectile point may increase a projectile's penetration because it is sharp and smooth, but may also decrease the projectile's durability because obsidian breaks easily.

The mechanics of energy transfer from the human into the projectile is different for atlatl darts and bows and arrows, but is based on surprisingly similar principles. I will therefore briefly outline the general mechanical principles underlying projectile technology, thereby identifying performance characteristics that affect the design of points, and then discuss the unique characteristics of both weapon systems separately. The attributes that affect the general usefulness of the atlatl darts and bows and arrows are weapon efficiency, penetration, flight distance, accuracy, and balance.

Weapon Efficiency, Penetration, Flight Distance, and Velocity

The penetration, the maximum distance, and the velocity of a projectile are related performance characteristics in that they are all partly the product of the energy transferred from a human into a projectile. The energy transferred into a projectile in the form of kinetic energy can be calculated using the following formula, where m is the projectile mass and v is the projectile velocity:

Formula 1:

$$\text{Kinetic energy} = \tfrac{1}{2}\, m\, v^2$$

As is evident from this formula, increased mass with a constant velocity or increased velocity with a constant mass will increase the amount of kinetic energy stored in a projectile.

However, it is more likely that the kinetic energy that can be transferred into a projectile is relatively fixed by the general design of the weapon system and the strength of the user. Given that the amount of kinetic energy is generally fixed, as mass increases, the velocity at which the projectile can be propelled decreases, and as mass decreases, the velocity of the projectile will increase.

None of the four weapon systems are capable of transferring 100 percent of the energy generated by the human into the projectile. At least some of the energy will be lost as it is retained in the user's body or the bow. For example, some of the kinetic energy generated by a man throwing a dart using an atlatl will be retained by his body in the form of the forward movement of his arm and wrist (Cotterell and Kamminga 1992:164–165). Although the loss of kinetic energy is unavoidable, some weapons are more efficient than others, meaning that they are capable of transferring a greater proportion of the energy generated by humans into the projectile. I will discuss the specific factors affecting the efficiency of the various weapon systems in more detail later, but I observe that projectiles used with more efficient weapons will have greater kinetic energy than those cast using less efficient weapons, all other variables being equal (Cotterell and Kamminga 1992:164–165). Because weapon efficiency affects the kinetic energy of a projectile, it will also affect a projectile's velocity, maximum flight distance, and penetration, as outlined below.

Velocity is the speed at which a projectile travels, whether it is through the air or through the flesh of an animal. The maximum flight distance of a projectile is a direct product of velocity, and is a measure of the distance a projectile can travel (Hughes 1998:368–369). As Galileo observed in the seventeenth century, projectiles launched in a vacuum will travel in parabolic motion, initially having an upward movement and then being pulled down to the earth's surface (Cotterell and Kamminga 1992:160–161). Consequently, the maximum range (*R*max) of a projectile launched in a vacuum will be achieved when it is launched at a 45 degree angle and can be calculated using the following formula, where *v*o is the projectile's initial velocity and *g* is the gravitational acceleration, which is 9.8 m^2 per second (Cotterell and Kamminga 1992:162).

Formula 2:

$$R\text{max} = v\text{o}^2 / g$$

Outside of a vacuum, a projectile's maximum range is more difficult to calculate, because it will be reduced by drag, that is, because of the resistance created as a projectile travels through the air and other substances such as animal flesh (Cotterell and Kamminga 1992:162). Drag has the effect of reducing a projectile's velocity, meaning that the distance it travels in a given time period of flight continually decreases after the missile is launched. As a result, the maximum possible range of a projectile decreases as drag increases.

Drag itself is a product of the density of the medium(s) though which the projectile travels, and the projectile's surface area (Cotterell and Kamminga 1992:162). The amount of drag can be calculated as:

Formula 3:

$$D = \tfrac{1}{2}\, p\, v^2\, S\, CD$$

In this formula, *D* is drag, *p* is the density of the medium through which the projectile is traveling, *S* is the projectile's surface area, and *CD* is a coefficient whose value depends on the "Reynold's Number" in a particular circumstance. The density *(p)* of air, which is the most common medium that projectiles travel through before they hit their target, is 1.23 kg/m^3.

Reynold's Number is greatly affected by the viscosity *(μ)* of the medium through which a projectile travels. In contrast to projectiles such as catapult stones or boomerangs, the long, narrow shape of the arrows and spears tipped with projectile points causes only a thin layer of air, called the boundary layer, around the projectile to be disturbed by its passing (Cotterell and Kamminga 1992:162–163). Consequently, the only real cause of drag on a projectile is the friction caused by the movement of the boundary layer, allowing the Reynold's Number of a projectile to be calculated fairly easily using the following simplified formula (Cotterell and Kamminga 1992:163).

Formula 4:

$$Re = p\ v\ l\ /\ \mu$$

Re is Reynold's Number, *p* is the density of a medium, *v* and *l* are the velocity and the length of a projectile, respectively, and *μ* is the viscosity of a medium. The viscosity of air is 1.79×10^{-8} Pas, about 1/5th the viscosity of water (Cotterell and Kamminga 1992:163). In general, the Reynold's Number for most cast projectiles tipped with projectile points is between 5×10^5 and 5×10^7.

Because the drag of a thin projectile, such as a throwing spear or an arrow, is almost completely the product of skin friction, the coefficent *CD* from Formula 3 is effectively equal to the coefficient *CF,* which is an easily computed coefficient measuring the effect of skin friction (Cotterell and Kamminga 1992:163). *CF* can be calculated using Reynold's Number in the following formula:

Formula 5:

$$CF = 0.074\ Re^{-0.2}$$

Although air has a relatively low density and viscosity when compared to blood and animal flesh, it still has a significant impact on a projectile's velocity and hence the maximum range of a projectile. As a result, the practical maximum range of projectiles such as arrows traveling through air is only 60 percent to 90 percent of their theoretical maximum range in a vacuum, depending on the size of their surface areas (Cotterell and Kamminga 1992:162).

As velocity increases and mass decreases, the possible flight distance of a projectile increases. Likewise, if velocity decreases or the mass of a projectile increases, the maximum flight distance decreases, assuming all other variables remain the same. In practice, light shafts increase velocity and thereby increase flight distance but, for reasons outlined below, their decreased mass often causes them to have less kinetic energy and consequently less penetration. Heavier objects often have more kinetic energy but less velocity, and therefore a comparatively shorter maximum flight distance (Cotterell and Kamminga 1992:164).

Penetration, defined as the distance that a projectile will travel once it encounters the target, is similar to maximum flight distance in that they are both related to the velocity of a projectile and are a measure of the distance that the projectile will travel. Given that drag caused by the projectile traveling through air decreases velocity and therefore decreases a missile's kinetic energy (as specified in Formula 1), the projectile's penetration will decrease the farther it travels before striking its target. Penetration is important because prehistoric weapon systems are designed to kill animals, possibly including humans, by cutting the target animal and causing it to bleed. The greater the penetration, the greater the amount of internal bleeding caused by a projectile after it strikes its target, as well as the greater the probability that it will damage a major organ.

Although it is possible that an animal, particularly a smaller animal, will die simply from blood loss after being struck with a projectile, death will come much more quickly for a large animal if an internal organ is damaged, causing the animal's metabolic system to stop. At least 20 cm of penetration is necessary to reach the internal organs of many large animals and to quickly cause fatal bleeding, although much less penetration is necessary for smaller animals (Hughes 1998:351). Consequently, penetration is a performance characteristic that is clearly more important when using projectile weapons to kill large animals than when hunting smaller animals.

The major factors affecting penetration are the kinetic energy of the projectile at the time it hits the target animal, the shape of the projectile's tip (the projectile point and associated portion of the shaft), and the resistance caused by the projectile point and the shaft as they travel through the animal's flesh, also called drag. These factors can be quantified using Formula 6, where m is the projectile mass, vo is the velocity when the projectile begins penetrating the target, C is a constant based on Reynold's Number that refers to the drag caused by the shape of the projectile, and A is the cross-sectional area of the projectile (Hughes 1998:349–350).

Formula 6:

$$\text{Penetration} = m\,vo \,/\, C\,A$$

As is obvious from this formula, penetration increases with increased mass, increased velocity, and tips that have decreased cross-sectional areas and characteristics such as smooth surfaces that cause them to encounter less resistance when traveling though a semiviscous membrane including animal flesh (see Pope 1923:40–44, 50–61). The increased density and viscosity of animal flesh, which is about 100 times more dense than air, necessitates that C, the coefficient reflecting the impact of drag, will be much more significant than was the case for projectiles traveling through air (Hughes 1998:349). Although C is too complex of a coefficient to quantify as easily as CF from Formula 5, it is primarily the product of the surface roughness and shape of a projectile. Projectile points greatly affect penetration, because they impact both a projectile's cross-sectional area (A) and its surface roughness (reflected in C). For example, as a projectile travels through a dense medium such as animal flesh and blood, surface and edge irregularities such as serrations and barbs on the projectile's tip can greatly increase drag, and thereby reduce penetration. By the same token, projectile points with smooth surfaces and edged can greatly reduce drag and increase penetration relative to other point designs (Hughes 1998:357; Pope 1923:50–61).

The drag caused by the shape of projectile points is particularly significant in allowing the initial penetration through the animal's skin. Skin is a highly viscous and flexible membrane that requires considerable energy to penetrate (Berlin et al. 1979; Mattoo et al. 1974). A bifacially flaked, sharp edged, pointed projectile point is crucial to successfully breach skin, especially if the projectile is to have enough kinetic energy remaining to reach vital organs in large- and medium-sized animals.

In an experiment to determine the characteristics that affect the usefulness of points, Odell and Cowan (1986) constructed 40 bifacially flaked chert points of various morphologies and sizes, and 40 unretouched or minimally retouched chert flakes that could be hafted on arrows and atlatl dart shafts, which they then used to pierce the flesh of stray or vicious dogs recently killed by a city veterinarian. During their experiments, they found that it was not uncommon for projectiles to bounce off of the target without penetrating the skin (Odell and Cowan 1986:202). This was especially true for arrows and atlatl darts tipped with unretouched flakes and atlatl darts tipped with bifacially flaked projectile points, all of which failed to penetrate the skin between 37 percent and 44 percent of the time. In contrast, arrows tipped with bifacially flaked projectile points bounced off the target animal only 12 percent of the time (Odell and Cowan 1986:202).

Although the comparatively high velocity of arrows when compared to the atlatl darts probably accounts for some of the differential success in breaching the skin (Odell and Cowan 1986:202), it does not explain why arrows tipped with unretouched flakes failed to penetrate the target 44 percent of the time whereas points with bifacially flaked tips penetrated far more frequently (88 percent of the time). Nor does it explain why large bifacially flaked points tended to be less successful in penetrating the skin when compared to small points, even when they were mounted on arrows. Instead, the reason for the difference in penetration is attributable to: (1) the sharp edges of the bifacially flaked points, which helped initiate a break in the skin, and (2) the decreased cross section of the smaller points compared to the larger points/unretouched flakes, which decreased the drag coefficient.

A projectile point's raw material will also greatly impact the projectile's initial penetration and the subsequent drag. The friction caused by coarse raw material types such as basalt will increase drag, causing velocity to decrease quickly, and thereby decrease penetration. In contrast, raw materials like obsidian and cryptocrystalline silicates (e.g., chert) are smooth and will therefore produce less drag. Cryptocrystalline silicates and obsidian will also produce sharper edges that are more likely to penetrate an animal's skin when compared to more crystalline raw materials such as basalt. Consequently, projectile points made of obsidian and cryptocrystalline raw materials will tend to have greater penetration than morphologically similar points made of coarser materials. In fact, Pope (1923:56) reports that in experiments using American Indian bows, the smooth surfaces and sharp edges of obsidian points allowed 25 percent better penetration than steel points of the same size.

The transition from the projectile's point to its shaft also impacts penetration. A gradual expansion of the point base will help penetration by gradually enlarging the wound so that the shaft can enter without needing to further tear the animal's flesh (Hughes 1998:356). A smooth profile in which the hafting element expands gradually from the point to the body of the shaft will also help maximize penetration.

The smoothness of the transition of the point to the shaft can be quantified using a maximum width to maximum length ratio and a blade width to base width ratio (Hughes 1998:357–358). Blade width to base width ratios slightly more than one appear to be best for maximum penetration, because the base constricts to allow smooth transition for the shaft. Thinner, wide tips tend to be better than thicker, narrow tips because they create large wounds but have lower cross-sectional area, and as a result, less drag when breaking the skin and traveling through the body. Albertson et al. (1960) in fact report that "elliptical cylinders" similar in shape to lanceolate tips have the best penetration in most instances because of their limited drag.

The effect of drag on a projectile's flight distance and penetration can be mitigated somewhat by changing various aspects of the weapon system, thereby allowing for increased penetration. Increases in mass or velocity can be used to offset increased surface roughness, if the weapon system allows it (e.g., the use of a bow with a heavier draw can compensate for an arrow tipped with a serrated point). The affects of drag can be countered by increasing the "lift" of the projectile, generally caused by adding fletching such as feathers or other lightweight materials to increase the surface area of the back portion of arrows. Lift is caused by the uneven flow of air over a projectile, increasing the distance a projectile can travel and, by counteracting drag, increasing penetration (Hughes 1998:350, 366–367).

Great penetration is not always desirable, though. A point that allows for the greatest penetration can also come out of a wound easily, which may not be desirable if a weapon's user wants to cause extensive internal bleeding. Barbs on the hafting elements of points and serrations on the edges of points will decrease penetration but will also hold a point in a wound, causing more cutting as the animal moves, and thereby increasing tissue damage. Likewise, projectiles used on small animals may not need to maximize penetration; arrows and other light, fast-moving projectiles may travel completely through small targets, even with points that are not designed to maximize penetration.

Balance and Accuracy

Additional attributes that affect the usefulness of projectile weapons are accuracy and balance. These two characteristics are closely related in that the balance of a projectile greatly affects its accuracy (Hughes 1998:349).

Balance. Balance is the product of a projectile's center of gravity and its center of pressure. The center of gravity is the midpoint that evenly divides a projectile's mass. The center of pressure is the result of the aerodynamic forces affecting a projectile's flight. It is the product of three primary factors: (1) drag from the skin friction affects how a projectile travels through the air, (2) lift forces caused by the uneven airflow over a projectile, and (3) forces perpendicular to the path of travel (Cotterell and Kamminga 1992:171). The "line of action" of these three forces is the center of pressure.

If the center of gravity is behind the center of pressure, then the projectile will rotate upwards, and will become perpendicular to the projectile's flight path, that is, the direction the projectile is traveling (Cotterell and Kamminga 1992:171). If a projectile's center of gravity is ahead of the center of pressure, then the projectile will be aligned with its flight path. This will generally result in stable, balanced flight. However, if the center of gravity is too far forward, the projectile will pass its flight path, and flight will again become unstable. Stable flight is impossible if the center of gravity is behind a projectile's midpoint, because the projectile will literally “flip over” so that its attitude (the direction the projectile is pointing) is opposite of the direction the projectile is flying.

However, the center of pressure is not at a fixed point as is the center of gravity, because the aerodynamic forces acting on a projectile change with its changing attitude (Cotterell and Kamminga 1992:171). This relationship is perhaps best conceptualized using the angle of incidence, which is the degree difference between a projectile's attitude and its flight path. As the angle of incidence increases, the center of pressure will move towards the projectile's base. The angle of incidence will change during a projectile's flight until the center of pressure is at the same point as the center of gravity, thereby reaching equilibrium. At that point, the angle of incidence will no longer change, and the center of pressure becomes fixed, assuming flight is not interrupted (Cotterell and Kamminga 1992:172).

Balance is critical for allowing predictable, and hence accurate flight, and for good penetration. A poorly balanced projectile will not be aerodynamically stable and will therefore not fly true (Hughes 1998:365–366). More significantly, a projectile that does not have an angle of incidence of 5 degrees or less will likely not have any penetration *at all,* because the projectile's tip will be deflected from the target (Cotterell and Kamminga 1992:172). A projectile with its center of pressure behind its center of gravity will tend to align along its flight path, and will therefore have stable flight with a relatively small angle of incidence. In contrast, a projectile with its center of gravity behind its center of pressure will tend to point upwards, leading to unstable flight with a high angle of incidence (Cotterell and Kamminga 1992:171; Cundy 1989; Evans 1957; Hughes 1998:365–366). Consequently, the unbalanced projectile would tend to have little to no penetration, even if it did happen to hit its target.

An unstable projectile can be used over short distances, though, so long as the angle of incidence doesn't have enough time to become more than 5 degrees. Cotterell and Kamminga (1992:173–174) report that an unbalanced Tasmanian throwing spear with its center of gravity right at 50 percent of the spear's length can still be used effectively up to a range of about 20 m, so long as it is initially cast so that it has a small angle of incidence. Beyond that range, the spear's angle of incidence will increase beyond 5 degrees, and the spear will not be effective. Likewise, a well-balanced projectile can be cast with an initially poor angle of incidence, but will align itself with its flight path, given that it has enough time to change its attitude so that it reaches its equilibrium. This becomes critical for projectiles such as atlatl darts cast, which tend to allow little control over the initial angle of incidence. I will return to this point presently.

Two strategies can be employed to help bring the center of force behind the center of gravity and can thereby produce more balanced flight: (1) increased mass on the front of a projectile will move the center of gravity forward, which has the added advantage of causing the projectile to reach equilibrium more quickly, and (2) increased surface area in back of the projectile formed using lightweight materials will move the center of force back. Obviously, large, heavy projectile points can be used to increase forward mass. Fletching is an excellent means of increasing the surface area of the rear of the projectile.

Balance is measured as the proportion of the shaft between the projectile tip and the center of gravity (Hughes 1998:365–366). For example, a projectile that has 40 percent of its length between its tip and its center of gravity has a balance of 0.4*L*, where *L* stands for the total length of the projectile. Heavy shafts such as those of the pilum, a heavy throwing spear used by the early Roman infantry (Hall 1956:704–705) that weighed about 2 kg, are naturally more balanced around 0.5*L* than lighter shafts such as those used for arrows, because fletching and projectile points with similar masses will have comparatively less effect on the center of gravity (Hughes 1998:366). As a result, points used with heavy weapons will tend to be heavier in order to move the center of gravity forward for larger projectiles. There is a limit on the size of projectile points, though, because points that are too heavy will lead to a projectile with too small of a balance, causing it to point downward at too low of an angle to be useful. Ethnographically observed projectiles tend to range between 0.53*L* and 0.19*L* (Table 18.1), and it is doubtful that useable projectiles could have balances significantly smaller than 0.19*L* (Cotterell and Kamminga 1992:175; Palter 1977:167–170).

Hughes (1998:368) uses shaft size and balance requirements to estimate the practical limits on point size for various weapon systems. She argues that the minimum weight for fletched dart points required to create a balanced projectile is 3 g, but that projectile points that weigh less than 3 g are likely ideal for the comparatively light shafts of arrows. However, she notes that arrowheads heavier than 3 g are possible, indicating that there is likely some overlap in the weight of atlatl dart points and arrowheads.

Accuracy. A useful projectile must be cast with enough accuracy to hit the intended target. A well-balanced projectile will fly predictably, and therefore can be aimed accurately. All other variables being equal, the more balanced a projectile, the more accurately it can be aimed.

Several factors other than balance also affect accuracy. Increased projectile velocity has a significant impact on accuracy, because of the parabolic nature of projectile motion. The farther away a target is, the greater the adjustment required in the point-of-aim. However, increased velocity allows a much lower trajectory of flight, thereby decreasing the point of aim relative to slower moving projectiles (Cotterell and Kamminga 1992:168). Increased velocity also requires lighter shafts, which frequently have less kinetic energy because of their decreased mass and a decrease in the efficiency of the weapon system (a point that will be further developed in the discussion of the individual weapon systems). As a result, there is somewhat of a trade-off between the

Table 18.1. Balance of Ethnographically Studied Atlatl Darts and Arrows

Weapon	Average Projectile Length (cm)	Balance
Tasmanian Unfletched Spears (Cundy 1989)	400	0.33-0.36L
Australian Unfletched Throwing Spears (Palter 1977)	267	0.41-0.53L
Australian Unfletched Darts (Palter 1977)	250	0.30-0.48L
Central Australian Unfletched Sarts (Cundy 1989)	Unknown	0.40-0.47L
Northwestern Australian Unfletched Darts (Cundy 1989)	Unknown	0.32-0.40L
North American Indian Fletched Arrows from Various Groups (Van Buren 1974)	72	0.19-0.54L

accuracy and the kinetic energy of a projectile; as projectile mass decreases, accuracy tends to improve but the projectile's energy tends to decline (Cotterell and Kamminga 1992:168). Given that a projectile must both strike the target and penetrate deeply enough to kill it, the trade-off between velocity and penetration is a significant consideration.

Accuracy also increases as the distance to the target decreases, because (1) there is less chance that a projectile will be deflected by wind or vegetation, and (2) close targets require less of a point-of-aim adjustment compared to more distant targets. Hughes (1998:369) recommends the use of the concept of effective distance, the range at which a hunter has enough accuracy to fell game, instead of the maximum possible flight distance for evaluating weapon systems. The maximum effective range for well-balanced Australian throwing spears is between 12 and 18 m, for Australian atlatl darts is 18 m, and for most traditional bows and arrows is between 25 and 30 m (Hughes 1998:368). The effective range of a thrusting spear is obviously the spear's length.

An additional factor that affects accuracy is spine. Spine is defined as the ability of the projectile's shaft to absorb and release energy (Cotterell and Kamminga 1992:187). Although spine is not a factor for thrusting spears, because they have no flight phase, and only of limited importance with throwing spears, because the build-up of the energy in the shaft during launch is gradual, it is a significant issue for atlatl darts and arrows (Cotterell and Kamminga 1992:187; Cundy 1989; Hughes 1998:360–361; Perkins 1992). When a bow's drawstring or an atlatl dart is released, a large compressive load is suddenly released into the projectile. This causes the projectile, whether it is an arrow or an atlatl dart, to buckle slightly as it begins to accelerate. An elastic shaft will then vibrate laterally during flying in a manner similar to the vibrations of a taut string, with the amplitude and frequency of the vibration being dependent on the amount of force applied to the projectile, the type of wood and design of the shaft, and the projectile's mass, diameter, and length (Cotterell and Kamminga 1992:187–188). Thus, arrows and atlatl darts move both laterally and horizontally as they fly. This phenomenon, commonly called the Archer's paradox when dealing with archery, causes projectiles that are not properly configured to fly erratically and potentially to even break during flight (Cundy 1989); projectiles that are too rigid will not buckle with the influx of compressive force, but will instead be thrown off course (Cotterell and Kamminga 1992:187). In contrast, projectiles with too much spine, i.e., that are too flexible, will buckle too much, causing the shaft to overcorrect as it becomes straight again thereby altering its course and perhaps even causing the shaft to snap, if the force caused by the buckling exceeds the projectile's tensile strength. Fadala (1999:91) reports that too little spine, i.e., too rigid of a shaft, will frequently cause arrows shot by right-handed individuals to veer to the left whereas too much spine will cause arrows to veer to the right. Because the spine required for a projectile to fly true is a product of the amount of energy a human transfers into the projectile, and the projectile's length, diameter, and raw material, creating proper spine, and thus have accurate atlatl darts and arrows, requires that the components of the weapon be properly "matched," as outlined below (Cotterell and Kamminga 1992:188).

A projectile's mass affects the frequency and the amplitude of the projectile's vibration, and therefore affects its spine (Cotterell and Kamminga 1992:170,188). Proper spine requires having a projectile that is heavy enough that it doesn't bend too much, thereby allowing predictable forward movement, but not so heavy that the projectile is unbalanced and rigid. The mass of projectile points is a significant component of a projectile's total mass, especially in the case of light projectiles such as arrows. Consequently, using projectile points with differing masses is an effective means of increasing or decreasing a projectile's spine.

For example, the spine needed for an accurate arrow is determined by the "pull" of the bow, that is, the amount of force that the bow generally stores, the efficiency of the bow, the type of wood of which the arrow is made, and the length, the mass, and the diameter of the arrow (Cotterell and Kamminga 1992:188). Because simply adding a projectile point can easily change the mass of an arrow, an arrow's mass is the most easily altered of these variables. As a result, archers frequently select their arrowheads after the other aspects of the weapon system are determined to help ensure proper spine. Modern archers have in fact created tables listing the weight of projectile points required to ensure proper spine based on the pull of the bow and the size and type of arrow being used. Additionally, many modern archers using traditional-style bows will experiment with arrows using points of different weights before they add fletching to ensure that the arrows' spines are correct (Fadala 1999:89).

Durability

Durability is defined as the probability that a given component of a weapon system will not break during its usage. Weapon systems differ considerably in their durability, and the durability of any given component of a weapon system is likely to be a trade-off with the durability of other components; some structural changes may make one type of break less likely while increasing the probability of other types of damage.

Most pre-industrial projectiles from North America, and from around the world for that matter, are tipped with stone tips or, less frequently, bone tips that are attached to wood foreshafts using sinew. As the projectile strikes a surface, whether it is the intended target or something else such as a rock, the ground, or a tree, projectile points are exposed to both compression and tensional stress. Compression stress, that is, stress oriented parallel with the long axis of the point, is particularly significant on impact as the point tip encounters resistance and becomes the focus of the energy stored in the projectile. Tensional stress, that is, "sideways" stress perpendicular to the projectile point's long axis, is the result of the vibration initiated as the energy is transmitted into the projectile at the start of flight (as discussed during the preceding discussion of spine), and the more violent vibration during impact as the energy is transmitted to the target.

A durable point should be able to withstand both the compressive and tensional stress sustained during flight and on impact, remaining in the animal to cause cutting and bleeding. Three primary factors determine the durability of a projectile point: the point's raw material, morphology, and hafting. The effects of raw material on point durability can be measured using two variables: strength and elasticity (Hughes 1998:371). Strength refers to how much force must be applied to produce a fracture. Elasticity refers to how capable a material is of deforming without breaking (Hughes 1998:371). Most stone used for points has high compression strength. Its elastic strength is generally much lower. Although there is variation in the strength of different types of stone, stone projectile points tend to be quite strong when undergoing compressive force, but to "snap" quite easily when exposed to tensional stress. Table 18.2 presents data reported by Hughes (1998:372) on the tensile strength and compressive strength of various raw materials, demonstrating significant variation between them. For example, the noncrystalline, glassy structure of obsidian makes it extremely susceptible to breakage from compressive forces when compared with quartzite, which has a well-developed crystalline structure.

The morphology of points greatly affects their durability, because it affects both the structural ability of points to withstand force (thicker points are stronger than thinner points) and the distribution of force through the point after it makes contact with the target. The most durable points are conical with a roughly equal length and width, because they distribute stress equally throughout the entire point while having no "weak" spot that is particularly or consistently susceptible to breakage (Hughes 1998:373). The tips of modern tar-

Table 18.2. The Strength of Various Raw Materials Used for Projectile Points (adapted from Hughes 1998:372)

Stone	Tensile Strength (MPa)	Compression Strength (MPa)
Basalt	10-29	279
Chalcedony	360	?
Chert	6	329
High Springs Chert	18	173
Obsidian	215-346	0.15
Quartz	167-329	?
Quartzite	10-29	302

get arrows best typify such points.

Given that larger, "circular" points with large cross-sectional areas made of coarse-grained silicates such as quartzite or basalt tend to be more durable than smaller, thinner points with smaller cross sections made of obsidian or a cryptocrystalline silicate, more durable points tend to have large drag coefficients and consequently to decrease penetration (see Formula 6). There is therefore a trade-off between the performance characteristics of durability and penetration. More durable point designs will result in less penetration, whereas points that maximize penetration are likely to be quite fragile. For example, a thin, lanceolet obsidian point will help maximize penetration because its smooth surface and small cross section will decrease drag, and its extremely sharp edges will help puncture the skin while also opening a wound large enough for the shaft to enter, but it will not be very durable because its thin cross section and poor strength causes it to be susceptible to snaps caused by tensional and compressive stress. In contrast, a thick, conical chert point may be very durable because of the general strength of chert and its size, but it will have poor penetration (see Odell and Cowan 1986).

A projectile's hafting technique has a significant affect on the durability of points. Wood, of which most foreshafts are constructed, has good compressive strength, although frequently not as great as stone, and is generally quite elastic. Sinew, the leg tendon of animals that is frequently used to attach a projectile point on the foreshaft, has excellent tensile strength. As a result, wood and sinew can deform during stress and then return to their original shape, making them quite durable. The portion of the projectile point braced by the wood and sinew will therefore be exposed to less stress, because the foreshaft will absorb much if not most of the stress. The portion of the point protruding from the foreshaft will consequently be much more susceptible to snapping in a relative sense, with the greatest tensional stress being focused where the hafting ends and the shaft and sinew no longer support the point. This is because the hafting materials will no longer help absorb the stress but will also prevent the elastic deformation that a point would otherwise be capable of (Hughes 1998:371). As a result, the method of attaching the projectile point onto the foreshaft significantly impacts the point's durability and the types of breaks a point is likely to sustain.

The significance of hafting techniques has been demonstrated experimentally. In Odell and Cowan's (1986) previously discussed experiment in which they used chert points hafted onto throwing spears and arrows to penetrate dogs' hides, they also recorded the frequency of point breakage. They found that their bifacially flaked points tended to last for two uses before sustaining enough damage that they needed to be repaired or discarded (Odell and Cowan 1986:204). With resharpening and repair, the chert points averaged 3.65 hits before they were damaged too significantly to repair. In contrast, Clovis points used by Frison (1989) to penetrate an elephant's hide lasted for up to twelve uses without sustaining damage that could not be repaired.

A significant reason for the difference in the durability of Odell and Cowan's (1986) and Frison's (1989) points is the difference in hafting. The flute of Frison's Clovis points allowed them to be hafted so that much more of the body of the point was protected by the foreshaft when compared to the points used by Odell and Cowan, which were hafted only at the base. Consequently, Odell and Cowan's (1986) points had much more exposed area than was the case for Frison's (1989) Clovis points, and were therefore less durable.

Versatility of the Weapon Systems

A final consideration is the versatility of each weapon system, that is, the range of conditions under which the weapon system can be used. Hughes (1998:393–394) provides an excellent discussion of the versatility of each weapon system, based on the maximum effective distance, the environments in which the weapon can be used effectively, that rapidness of casting the projectile, the ease of transportation of the complete weapon system, the quietness of the weapon system, and the variety of positions that the weapon can be used from.

Atlatls and their darts are generally lightweight, and therefore easy to carry when compared to throwing and thrusting spears. They also have an increased effective distance and greater accuracy when compared to hand-thrown spears. Finally, the atlatl itself can be used as a multipurpose tool, such as the woomera of the Central Aborigines from Australia, which is used as a ceremonial tool for holding blood and pigments, a handle for a stone chisel blade, a shovel, a musical instrument, and even a spear deflector (Cotterell and Kamminga 1992:168). Atlatls are not versatile in terms of the rapidity of their use or the number of positions from which they can be used; they require their user to be standing, preferably with enough room to take one step forward. They also require considerable movement with a reasonably massive dart, making it likely that prey will be spooked when the user casts a dart at them.

The bow and arrow is without a doubt a more versatile weapon system when compared to the atlatl. It can be used in virtually any environment, and from a standing, kneeling, and possibly even prone position (Fadala 1999:69). The fast movement and light mass of the arrow give it a great effective range. Also, the limited movement required to fire an arrow and the arrow's light mass allow arrows to be fired quickly and quietly. Hunters using the bow and arrow can frequently take several shots at the same prey without spooking it (Fadala 1999:24).

Although the bow and arrow is more versatile when compared to the other weapon systems, groups that have bow technology still frequently use the atlatl. For example, the Inuit use atlatls in situations when they can only use only one hand (Fadala 1999:8) and the Aztec used atlatl darts during warfare **(XX)**. Evidence of "atlatl warriors" in Basketmaker and Puebloan rock art suggests that the atlatl may have been used for warfare in the American Southwest (Farmer 1997: 406–407, 414). As a result, it is entirely possible and even probable that groups in the Southwest used atlatl technology even after the bow and arrow was widely adopted.

Mechanical Variation between the Weapon Systems

Although the weapon systems possess similar performance characteristics and the preceding discussion is applicable to both atlatl darts and arrows, the differences in the design of the weapon systems does produce significant differences in their performance characteristics and the factors that affect them. In a general sense, the weapon systems represent two different types of technologies based on the nature of their flight and the means by which humans transfer energy into the projectiles.

Hand-Thrown Spears and Atlatl Darts

Atlatl darts are cast, receiving their energy directly from humans. The atlatl dart receives its kinetic energy directly from the arm of the thrower (Cotterell and Kamminga 1992:164). As a general rule, heavier spears will be more mechanically efficient in terms of allowing the energy from the human to be transmitted into the projectile. The reason for this can be best understood using the concept of "virtual mass," which is a measure of the amount of energy retained by the thrower's body (Cotterell and Kamminga 1992:164–165; Klopsteg 1943:180–181). Virtual mass is defined as "the hypothetical mass that would move at the same speed as the thrown spear that would correlate with the amount of energy retained by the thrower" (see Cotterell and Kamminga 1992:164). Stated more simply, virtual mass is the mass calculated that would be required to account for all of the energy lost (in the sense that it wasn't transmitted to the atlatl dart) during the transfer of energy, assuming the mass was moving at the same velocity as the thrown spear. The efficiency of a hand-thrown spear can be calculated using Formula 7, where N is the weapon's efficiency, m is the mass of the spear, and mv is the virtual mass corresponding to the energy retained by the thrower's body (Cotterell and Kamminga 1992:164).

Formula 7:

$$N = m / (m + mv)$$

As the mass of the dart increases, the ratio (weapon efficiency) increases, reflecting the increased transfer of kinetic energy into the dart.

Atlatls allow for much more efficient energy transfer when compared to technology such as hand-thrown spears (Cotterell and Kamminga 1992:164). The reason for the increased efficiency of atlatls is the decreased physical movement of the human body and the concentration of movement into a relatively light spearthrower. The atlatl is generally a wooden stick about a meter long with a handle on one end and a hook that fits into a concave depression on the butt of the projectile on the other end. Its use reduces the angular velocity of the human wrist to about 1/5th that required to cast a throwing spear (Cundy 1980:63–71). Because the velocity of the relatively heavy human body is reduced and instead concentrated in a comparatively light wooden shaft, the virtual mass of the atlatl is less than a hand-thrown spear; Cotterell and Kamminga (1992:167) report that the typical virtual mass of an atlatl is only 0.13 kg, or about one-third the virtual mass of 0.4 kg associated with hand-thrown spears. As a result, atlatls are a much more efficient weapon system. Because the kinetic energy of the light atlatl dart is comparable to and often greater than hand-thrown spears with greater mass, the atlatl dart's velocity is comparatively greater and its flight trajectory is comparatively lower, all of which leads to increased accuracy without a significant loss of kinetic energy when compared to hand-thrown spears (Cotterell and Kamminga 1992:166–168; Hughes 1998:351).

For example, the Australian spearthrower, called a woomera, can cast a dart weighing 0.25 kg with an efficiency of 70 percent, whereas the heavy Australian throwing-spear weighing 0.6 kg can only be cast with 60 percent efficiency (Cotterell and Kamminga 1992:168). Given that the woomera generates a comparable amount of total kinetic energy as is possible throwing a spear by hand (Hughes 1998:351), the kinetic energy of the lighter projectile will actually be greater than the much heavier hand-thrown spear. It will consequently move much faster and have a much longer effective range—90 to 125 m for the woomera compared to 36 to 60 m for the hand-thrown spear (Cotterell and Kamminga 1992:168). This is particularly significant when one considers that a decrease in mass leads to an exponential increase in velocity (see Formula 1), and that an increase in velocity improves penetration (see Formula 6). For example, decreasing a projectile's mass by 50 percent leads to a 400 percent increase in velocity, which corresponds with a 200 percent increase in penetration, assuming that all other variables remain constant. Consequently, as mass decreases and velocity increases exponentially, the penetration of a projectile will also increase, assuming that the amount of energy transmitted into the projectile remains constant. A fast-moving, light dart can therefore have as much or even more penetration as a slow moving, heavy spear, assuming that the two projectiles have similar amounts of kinetic energy.

The increased efficiency, accuracy, and ease of use of atlatls have led to their virtual replacement of hand-thrown spears in most groups. The only exception to this, according to Cotterell and Kamminga (1992:164), are the aboriginal Tasmanians, who were cut off from Australia by the end of the Pleistocene and who did not develop the atlatl at all. Heavy throwing spears also continued to be used in other groups including the Greeks and the Romans after the development of atlatls under certain circumstances, generally either warfare or hunting large game (Cotterell and Kamminga 1992:164).

Although the atlatl has significant performance advantages over hand-thrown spears, it does present new performance requirements for the projectile. The most significant of these is spine. When cast, the release of energy into the atlatl dart will cause its butt to be deflected sideways (Cotterell and Kamminga 1992:170). As with arrows, atlatl darts must be flexible enough to bend, so that the initial sideways deflection will be absorbed by the rest of the shaft as lateral vibrations, allowing the dart to fly true. If the spine is not adequate, i.e., the shaft is too rigid, then the dart will "tumble" in flight (Cotterell and Kamminga 1992:170). The spine of atlatl darts is determined by the length of the shaft and the spear thrower, the type of wood that the dart is made of, and the dart shaft's length, diameter, and mass (Cotterell and Kamminga 1992:170; Perkins 1992).

As with archery, the relatively light shafts of atlatl darts make the projectile point an effective means of modifying spine by modifying mass. Unlike archery, though, the exact requirements of atlatls with different length and shafts made of various woods and designs has not been quantified, but it is clear that the point must be heavy enough that its inertia resists motion long enough to initiate oscillations in the shaft (Perkins 1992). Perkins (1992) reported that experimental analysis indicates that atlatl dart points must weigh at least 3 g to allow adequate spine, a finding that agrees with Thomas's (1978), Shott's (1997), and Patterson's (1985) conclusions that atlatl dart points tend to weigh more than 3 g (see also Hughes 1998:368).

The weight of the projectile point and the general design of the atlatl dart are also important for insuring the correct balance of a dart. Atlatls allow less control over the initial angle of incidence (the difference between the dart's attitude and its path of flight) when compared with hand-thrown spears (Cotterell and Kamminga 1992:175). Consequently, the projectile must be well balanced to ensure that the angle of incidence falls within the 5-degree range necessary to successfully penetrate a target. However, the high velocity of atlatl darts causes their attitude to change quickly (Cotterell and Kamminga 1992:173–175). Atlatl darts consequently do not need to be particularly stable; a center of gravity greater than 50 percent of the length of the projectile from its tip would render a projectile useless, but according to Cotterell and Kamminga (1992:175), any center of gravity between 45 percent and 19 percent of the length would probably be acceptable. Their argument is supported by ethnographic evidence that woomera darts used by Australian aborigines have their centers of gravity between 26 percent and 48 percent of the length of the shaft from the projectiles' tips (Palter 1977:168).

There is also considerable variation in the design of spear throwers from around the world. Cotterell and Kamminga (1992:168) argue that light spear throwers with a circular cross section are generally better than heavier spear throwers because they have less virtual mass and are therefore more efficient. Using ethnographic data, Cundy (1989) suggests that short, thick spear throwers are better for casting heavier darts. Atlatls used by the American

Indians also occasionally had bannerstones, weights that were added to the upper tip of atlatls (Webb 1944:199). The purpose of bannerstones is uncertain, but they would have made the atlatl less efficient according to Cotterell and Kamminga (1992:168–169; contra Webb 1944:199).

Bow and Arrows

The bow and arrow is a very different technology when compared to throwing spears and atlatl darts. Bows are tools used to store force generated by humans, which is then released into the arrow, as well as the rebounding limbs of the bow and the bowstring (Fadala 1999:8, 14). The amount of energy stored by a bow is generally less than that generated using hand-thrown spears and spear-throwers (Cotterell and Kamminga 1992:180), but it is transferred to an arrow, which is light compared to spears and darts. The comparatively small mass of the arrow, therefore, allows it to have a high velocity, which in turn results in a flatter trajectory and a longer maximum range. These attributes in turn lead to greater accuracy and a greater effective range.

The mechanics of bows and arrows are extremely complicated and interdependent (Klopsteg 1943). The morphology and raw material of the bow, the morphology and raw material of the arrow, and the raw material of the bowstring all have profound effects on the usefulness and performance potentials of the weapon system; there is no single list of "good traits" that a "good" bow has because each bow and each person are different, and will consequently work well with different things. In fact, the process of manufacturing effective bows is so complex that particularly skillful bowyers produced them as part-time specialists among many ethnographically recorded American Indian groups that otherwise did not have craft specialization (Laubin and Laubin 1980:24).

A bowyer making a bow had two fundamental considerations: matching the bow to the body and physical characteristics of the archer, and making the transfer of energy from the bow to the arrow as efficient as possible (Blyth 1992:222). Mechanical aspects of bows and arrows therefore cannot be as easily modeled as is possible with atlatl darts. However, many of the same fundamental principles outlined previously do apply.

When a bow is bent, it forms a spring whose resistance builds from 0 to its maximum draw. The force required to draw the bow, which is generally called the bow's "weight," is a direct product of the bow's design and raw material, and corresponds perfectly with the amount of energy the bow can store. The farther back the bow is drawn, the more energy the bow stores, up to the point that the stored energy exceeds the tensile strength of either the bow or the string, at which time the bow or string will snap. However, the actual maximum amount of energy that can be stored in a bow is limited by the archer's strength and arm length, which corresponds with his or her maximum draw length (Cotterell and Kamminga 1992:181).

Obviously, there is a direct relationship between the upper body strength of the archer and the range of bow weights that he or she will find useful. A bow that is not suited for an individual will either have too light of a draw, thereby not maximizing the amount of energy its user could ideally generate, or will have too heavy of a draw, thereby preventing the user from effectively storing his or her energy in the bow.

The energy that a bow stores, and therefore the maximum energy that could be transferred to an arrow, builds as the bow bends. Figure 18.1 illustrates this relationship; the area under the curve represents the amount of energy stored by the bow as it is drawn. The shape of the curve representing the stored energy is very different depending on the raw material of the bows, ranging from an almost linear increase for many hard woods to an exponential growth in the energy required to draw materials such as horn and sinew. Not all of the energy will be discharged when the bowstring is released, however. Some will go into the bow's limbs and string. More significantly, the

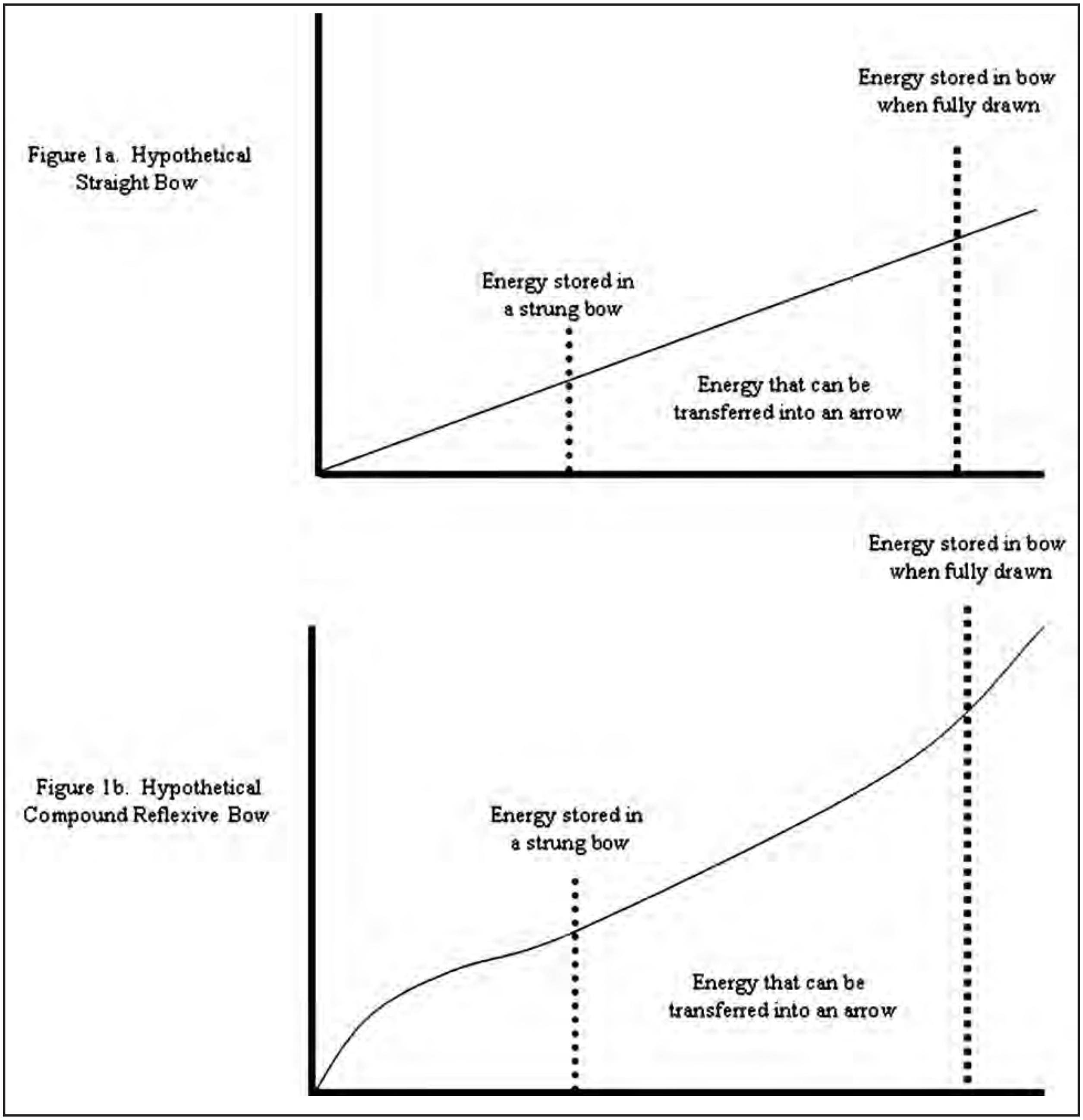

Figure 18.1. Energy stored by a bow; (a) hypothetical straight bow, (b) hypothetical compound reflexive bow.

bow is bent some when it is strung, meaning that it is "braced" so that the bowstring will not allow the arms of the bow to spread to their at-rest position, and thereby release all of the stored energy (Blyth 1992:222). As a result, the energy of the entire draw cannot be released when the string is released, despite the fact that the user had to invest the entire amount of energy under the curve; the user receives no break in the energy required to draw a bow because the bow is initially bent. Bending the bow even a bit more than the amount that it is bent when braced by the string still requires that the human invest enough effort to store the entire amount of energy under the curve.

The efficiency of the bow is therefore a significant factor in its usefulness, especially given the small mass and high velocity of arrows; an efficient 55-pound bow can easily outshoot an inefficient 65-pound bow (Fadala

1999:41). The efficiency of the weapon system can be quantified using the concept of virtual mass, again defined as the hypothetical weight that would be required to travel at the same velocity as the projectile to account for the kinetic energy left in the weapon system (Klopsteg 1943:180–181; see Formula 7). A bow's mass and raw material(s), the arrow's mass, and the raw material of the arrow's shaft all affect a bow and arrow's efficiency. As is true with both atlatls and hand-thrown spears, heavier projectiles tend to be more efficient, causing heavier arrows to have more energy and penetration, but to be slower and less accurate than lighter arrows (see Pope 1923:43–44). The portion of a bow's energy that cannot be discharged because the bow is braced by the string also adds to the virtual mass, in that this energy is mechanically forced to remain in the bow (Blyth 1992:223). This is also illustrated in Figure 18.1, in which the shaded area of the curve represents the amount of energy that cannot be released because of the bow's bracing. As a result, bows and arrows are quite inefficient weapon systems.

Bows from around the world and from different times vary greatly in their design, and therefore vary greatly in their efficiency (Blyth 1992:223). Long, straight bows such as the English longbow will be the least deflected when strung, and will therefore have the least amount of energy mechanically trapped within the bow. In contrast, short bows that are highly reflexive, that is, bows such as the Turkish short bow and many of those used by the American Indians of North America that are designed so that the bow bends away from the archer when unstrung (see Cotterell and Kamminga 1992:185-186), have an extremely large amount of mechanically unavailable energy, and would therefore appear to be very inefficient (Blyth 1992:223). This is true to a degree, but the inefficiency of the reflexive bow can be compensated for through their greater energy storage potential. A heuristic example will help illustrate this point.

In cases such as that illustrated in Figure 18.1a where the energy stored in a bow increases in a near-linear manner as the bow is drawn, the inefficiency caused by a reflexive bow design will generally make reflexive bows inferior to their non-reflexive counterparts (Blyth 1992:223). However, the energy stored in composite bows, that is, bows made of two or more materials, frequently increases at an exponential rate, especially if the bow is backed with sinew as they commonly are in pre-industrial societies (Blyth 1992:222–233). The energy stored in these bows therefore starts slowly and increases dramatically as the bow is bent further (Fig. 18.1b). The amount of energy stored in these reflexive bows is therefore greater, perhaps by as much as 50 percent, than is possible for non-reflexive bows with the same draw weights (Cotterell and Kamminga 1992:185). The energy that is mechanically bound in the strung bow consequently represents less of the area under the curve, and the efficiency of the bow is in fact increased by its increased reflexivity, compared to a straight long bow of the same materials.

Even with efficient bows, though, arrows frequently have less kinetic energy than hand-thrown spears and atlatl darts (Cotterell and Kamminga 1992:180). Klopsteg (1943:190; see also Hughes 1998:352) reports that the kinetic energy of a hunting arrow is generally no more than about 60 J, which is less than the maximum kinetic energy of hand-thrown spears and atlatl darts (see Cotterell and Kamminga 1992:180; Hughes 1998:352). However, arrows have excellent penetration because of their high velocity and narrow shaft, which decreases drag (Cotterell and Kamminga 1992:180). In fact, the penetration of arrows is so great that arrows fired from English longbows could easily puncture full plate mail, and arrows fired from the comparatively light bows of the American Indians could puncture two coats of Spanish chain mail (Pope 1923:40–41). In hunting, the small shaft of the arrow and its subsequent limited drag (assuming it has a sharp point for breaking the skin) allow for excellent penetration, making the impact energy of an arrow less critical than is the case when trying to pierce metal armor. As a result, heavy arrows that increase efficiency were frequently used in warfare around the world, but lighter arrows that allowed greater velocities, longer effective distances, and more accuracy were preferred for hunting most animals (Cotterell and Kamminga 1992:181).

The length and weight of arrows affect more than just an arrow's effective range and velocity. They also affect an arrow's spine, which is especially important in archery (Cotterell and Kamminga 1992:187–188). The rapid transfer of the energy stored in the bow into the arrow causes the arrow to be deflected from its line of sight, and therefore from its intended flight path. In order to correct its course and fly accurately, the arrow must be sufficiently flexible to bend, and begin vibrating. It cannot be too flexible, though, or it will vibrate too rapidly, and the arrow will strike the bow's grip, causing it to be deflected from its intended flight path. The phenomenon, which is called "the Archer's Paradox" and is illustrated in Figure 18.2 (adapted from Cotterell and Kamminga 1992:187), requires that the flexibility of the arrow match the force that is applied, and the length and mass of the shaft.

The significance of spine is illustrated by the creation of the previously mentioned spine charts, which match arrow material type, length, diameter, and projectile point weight with bows of specific weights. Still, the complexity of the mechanics of archery causes these tables to be no more than starting points. Bows with the same draw weight may shoot different spines because of vagaries of the bow itself. A 55-pound bow could require a 70-pound spine or a 55-pound spine, depending on the specific attributes of the bow and its user (Fadala 1999:46).

A great deal of variation resulting from differences in raw material availability, differences in the skill of the bowyer and the user, and personal preferences typifies American Indian archery (Laubin and Laubin 1980:111).

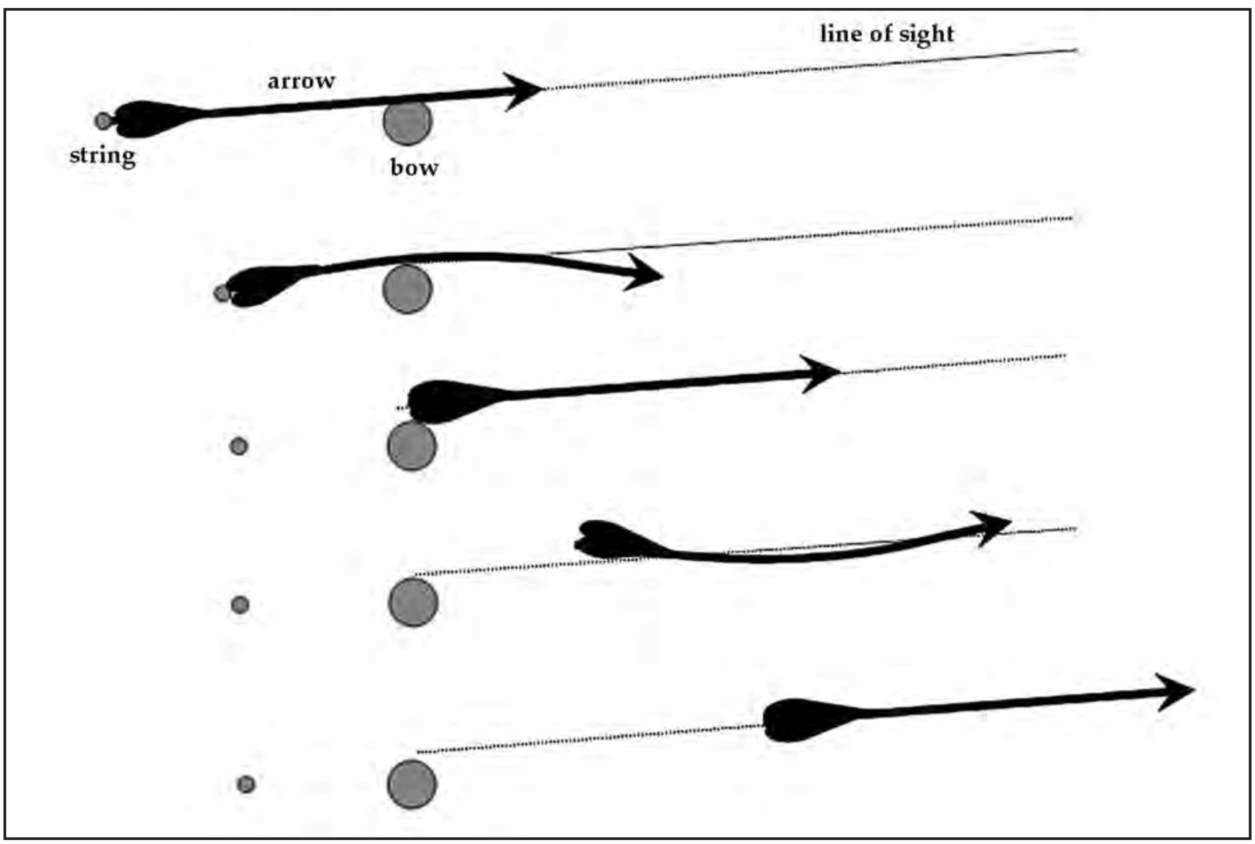

Figure 18.2. Illustration of the Archer's Paradox.

For example, Native Americans from New England made bows using hickory, white ash, ironwood, and red cedar (Laubin and Laubin 1980:20–21), the Navajo used mesquite wood backed with sinew (Pope 1923:12), the Inuit (Eskimo) used Douglas fir (Pope 1923:13), and the Cheyenne used ash (Pope 1923:15). Many groups in arid areas including the American Southwest used willow and cottonwood (Laubin and Laubin 1980:30), and some groups even made bows of elk antler, mountain sheep horn, and buffalo horn, particularly after the introduction of the horse (Laubin and Laubin 1980:88).

In general, most North American Indian bows are short, especially when compared to other traditional bows like the English longbow, with many ethnographically observed groups using bows between 40 and 48 inches in length (Pope 1923:10–19). In such groups, the length of a bow was often determined by having the intended user hold his left arm out to his side so that it formed a 90 degree angle with his body, and then measuring the distance between the intended user's middle finger and his right hip. Some Plains groups used bows measuring only 40–43 inches (Laubin and Laubin 1980:5). Yahi and Woodland Indians frequently used slightly longer bows, measuring 50 inches and perhaps as long as 60 inches respectively (Allely and Hamm 1999; Laubin and Laubin 1980:32; Pope 1923:14), and a bow measuring 55 inches was recovered from Arizona, suggesting that the prehistoric occupants of Arizona and perhaps the rest of the American Southwest used comparatively longer bows (Pope 1923:33–34, plate 8). In contrast, English longbows were frequently as long as 72 inches. The small size of Native American bows resulted in relatively short draw lengths and arrow shafts. For example, the average Sioux bow only pulled about 23 inches in comparison to the English longbow, which frequently pulled 45 inches.

Two general types of traditional bows were used in the Americas: self-bows and composite bows (Fadala 1999:2–3). Self-bows are made of a single material, whereas composite bows are constructed using two or more materials. Examples of self-bows include those made of Osage orange and other woods from the eastern and southeastern United States (e.g., Pope 1923:18; see also Laubin and Laubin 1980:76). An example of a composite bow is the Inuit (Eskimo) bow that Pope (1923:13–14) describes as made of Douglas fir backed with a strip of bone 22 inches long. The backing was held in place using sinew. Sinew is very commonly added to the back of American Indian bows, and has the effect of making them more durable, causing them to shoot more smoothly, and causing them to have greater draw weights than they would otherwise (Laubin and Laubin 1980:28; Pope 1923:10–19). As a general rule, composite bows are more durable and powerful, i.e., more efficient for the given weight, than self-bows, although they are considerably more difficult to make.

A Summary of the Performance Characteristics of Projectile Points

As outlined above, a projectile point's morphology, raw material, and mass affect many aspects of the performance of atlatl darts and arrows. Primary among these is the balance, accuracy, penetration, drag, mass, velocity, spine, durability, and efficiency of the projectiles, emphasizing again that these performance attributes are closely tied to each other. The characteristics of their projectile points are therefore important considerations to the hunter or warrior using one of the weapon systems.

The mass of a projectile point is frequently a significant determinant of the mass of a projectile, especially light atlatl darts and arrows. As a result, it has a significant impact on both the velocity and the balance of such projectiles, and consequently on their accuracy. It also affects the efficiency of a weapon, given that heavier projectiles tend to be more efficient. In addition, heavy points tend to be larger, which necessitates that they have a larger drag coefficient and less penetrations when compared to points with less mass. Finally, the mass of points affects the spine of an arrow by impacting the mass of the entire projectile and therefore its flexibility.

Atlatl darts require heavier points to help them be balanced. Hughes (1998:368) in fact reports that atlatl darts must have points with a mass of at least 3 g or more, whereas arrows tend to have lighter points, although they can be over 3 g on occasion (see also Patterson 1985; Shott 1997; Thomas 1978). (A well-balanced, efficient throwing spear with a heavy shaft would need an even larger projectile point, although poorly balanced spears can be used for short distances.) In contrast, the smaller mass of arrow shafts and the need to maintain proper spine require points that weigh less than 3 g.

The raw material of a projectile point affects the sharpness of the point's edges and its coarseness, both of which affect the projectile's drag. In general, cryptocrystalline and glassy materials, especially obsidian, have very thin, sharp edges and smooth surfaces, allowing for excellent penetration. As previously mentioned, Pope (1923:56) reports that experiments using American Indian bows indicate that obsidian points allowed 25 percent better penetration than steel points of the same size. In contrast to materials such as obsidian, more crystalline materials such as basalt will have thicker edges, causing them to be dull and to have rougher surfaces.

A point's raw material also has a profound impact on the durability of a point. Cryptocrystalline and glassy materials tend to have very poor tensile strength when compared to more crystalline materials such as basalt and quartzite, because of the difference in grain size and the subsequent strength of the materials. As a result, durable points frequently result in less penetration than is possible using other raw materials. Of course, durability may be a more significant consideration for atlatl darts than for arrows, which will frequently be lost or broken because of their velocity and the ranges at which they are used.

Point morphology affects the durability and penetration of a point. The hafting of a point greatly affects its durability. Points such as Clovis and Folsom that allow the shaft to provide structural support over much of the point's surface provide very good durability, whereas points with small hafting elements tend to be comparatively fragile. Conical points with large cross sections are very durable, but have poor penetration. Penetration can further be reduced by serrations on the blade, barbs, and abrupt transitions from the point's blade to the hafting element. In contrast, points with thin cross sections that create large wounds and gradual transitions to the hafted element allow excellent penetration.

Projectile point morphology is not just a result of initial point design, though. A point's morphology can change during the course of its use-life, and a number of factors can exert a profound impact on the form of any given point. Primary among these is point breakage and subsequent repair.

Projectile Point Breakage and Repair

The fact that prehistoric artisans repaired and reworked projectile points has long been established (e.g., Fenenga 1953; Flenniken and Wilke 1989; Frison 1993:244; Hoffman 1985; Towner and Warburton 1990; Knecht 1997:204–205). The effects of reworking and repair on point morphology have been debated, however (Bettinger et al. 1991; Flenniken and Raymond 1986; Flenniken and Wilke 1989, 1991). Perhaps the most readily apparent characteristic of flaked stone technology is that it is reductive, meaning that it is based on making "big rocks into smaller rocks." Archaeologists have long recognized that the reductive nature of flaked stone, and ground stone for that matter, greatly affects the technology and the behavior associated with lithic tools, especially when compared to additive technologies such as ceramics, where materials are mixed and then formed into larger shapes. Because flaked stone technology is reductive, additional material must be removed during the repair of a point, necessitating that the repaired point will be smaller and differently shaped than its original form.

Several authors such as Hoffman (1985) and Flenniken (1985; Flenniken and Raymond 1986; Flenniken and Wilke 1989, 1991) argue that the morphology of projectile points can change drastically over the course of their use-life. According to these authors, points of one archaeologically defined type can be modified as necessary to repair damage and may ultimately take the form of points from other types. They suggest that until such factors are accounted for, chronologies and behavioral inferences based on projectile points are suspect at best, and down-right misleading at worst (Hoffman 1985; Flenniken and Wilke 1989:153).

Taken to an extreme, arguments such as those presented by Flenniken (1985; Flenniken and Raymond 1986) could undermine the present study. After all, how can explanations for changes in point morphology such as those that I propose to develop be valid if the shape of any point is a historical accident resulting from the breakage and reworking of each individual point? Fortunately, as Thomas (1986:621) points out, such extreme reworking is unlikely. Thomas challenges the most extreme expression of Flenniken's argument on empirical grounds, i.e., by observing that a burial containing a quiver of arrows contained projectile points of a single type, but it can also be critiqued on theoretical grounds.

An argument contending that a point's morphology is simply a reflection of historical accident begins from the assumption that there are no real performance differences between points of various morphologies and consequently that a broken point will always be repaired when possible as long as it can be rehafted. Expressed another way, the argument denies that projectile points have performance characteristics other than that they have a sharp tip and can be hafted on the end of an arrow or dart. This premise is at odds with our knowledge of projectile point performance characteristics outlined by authors such as Christenson (1986), Hughes (1998), Odell and Cowan (1986), and Shott (1997) and in this chapter. Quite simply, not all projectile points are created equal given the weapon system's characteristics, just as not all bullets are equally usable with a specific type of firearm used in a specific context.

Projectile points that differ in their basic morphology also differ in their performance. Factors such as mass and cross-sectional shape do affect the usefulness of points. The characteristics of projectile points must be tailor-fit to provide the points with the characteristics necessary for the specific circumstances of use.

As a result, the morphology of projectile points, even those that have been repaired, reflects the performance characteristics required from them. Factors favoring the production and use of projectile points or other artifacts that possess certain performance characteristics create performance constraints. Such performance constraints limit the range within which an artifact's morphology can vary in order that it possesses the performance characteristics necessary for its use. Given the concept of performance constraints, two expectations concerning morphological variation in projectile points resulting from point repair and reworking are possible: (1) projectile points will generally be repaired when necessary as long as the repaired points still possess the required performance characteristics, and (2) a point will cease to be used as a point when it cannot be repaired so that it continues to possess the required performance characteristics.

Performance constraints can affect either quantitative or qualitative attributes. In general, constraints on quantitative attributes binds them between being too small and being too large. For example, the eye of a needle used with a needle point canvas cannot be too small, because it will be impossible to thread, or too large, because it would then not be able to go through the canvas. Likewise, the base of a projectile point cannot be too wide or too narrow, because it cannot be securely hafted in either case. Constraints on qualitative attributes are created when only a limited number of attribute states provide the requisite performance characteristics (e.g., firing ceramics at a certain temperature may require the use of a particular type of fuel). Hypothetical examples using projectile points are constraints on the raw material or notch location. Of course some attributes, i.e., stylistic attributes sensu Dunnell (1978; see also O'Brien and Holland 1990), may not have performance constraints, although their absolute variation may be limited by the physical size or other morphological attributes created by performance constraints. Qualitative and quantitative attributes will each be impacted differently by retouch and repair.

Quantitative Attributes. Because the reuse and resharpening of projectile points is desirable as evidenced by the very frequent evidence of repair-reworking of points in the archaeological record, and because lithic technology is reductive, important metric characteristics of new "unused" points should ideally cluster towards the upper limit of the range created by the performance constraints (Fig. 18.3). The upper limit will likely be fuzzy for many, if not most, functional (sensu Dunnell 1978) attributes, because there is likely no absolute maximum at which an artifact will cease to be usable in most cases. For example, the cross section of an arrowhead does not have an absolute size after which the arrowhead is "too big to be used." Instead, there is a zone of projectile point cross sections that will correspond with arrowheads that have excellent penetration. Arrowheads with cross sections that are larger than this ideal zone will likely have decreased penetration and therefore decreased performance, but they will not be "useless." Therefore, slightly larger members outside of the "ideal zone" can be present, but the distributions should be concentrated around the upper limit of the functionally acceptable zone. In contrast, no repaired points should be below the lower boundary for functional attributes because the impact of the performance of the points is more likely to be great. This is because of the probability that once replicatively important attributes become too small, the artifact likely cannot be used at all. For example, if the basal width of a point becomes too small for the point to be hafted using the hafting strategy that is favored in a particular environment, the point simply is not usable as a projectile point. Therefore, the lower boundary should be fairly well defined, when compared to the upper boundary.

In contrast, the distribution of stylistic metric attributes is not bounded by performance constraints and can take any form, including that illustrated in Figure 18.3. I suspect, however, that such attributes will be normally distributed, because the distribution will be the product of random variation around a "standard" value created by the interplay of the performance constraints of the projectile points. Regardless of the shape of the distribution though, characteristics that affect a point's usefulness less or not at all should vary within a much larger range relative to other functional traits that greatly affect the usefulness of the points.

Several metric and qualitative attributes of points may also "hitchhike" with functional attributes because of mechanical relationships between the attributes (Hurt et al. 2001; VanPool 2001). For example, the size of the base of the projectile point may dictate, at least in a general sense, the size of the notches in side-notched points. Large notches are not possible for small bases but are possible on larger bases. Therefore, small notches may co-occur with small bases.

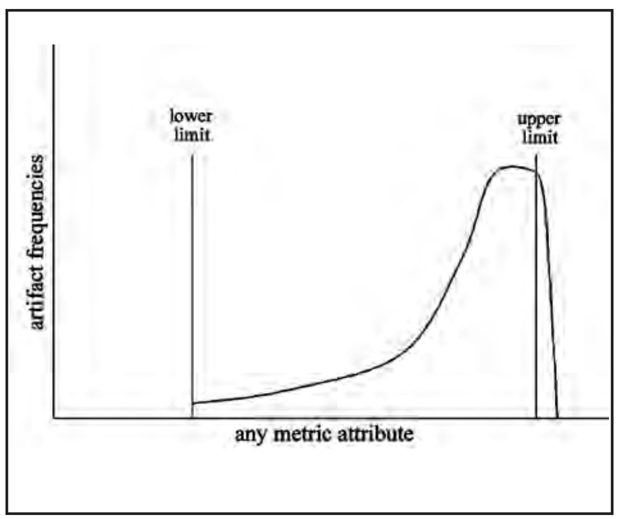

Figure 18.3. The expected distribution for functional attributes of unused points.

If point base size affects a performance characteristic in a particular situation and small bases are selected for, then notch size may have a bounded range of variation, even though it may not be replicatively important itself. In such a case, notch depth would be hitchhiking on basal width. It could potentially be difficult to distinguish hitchhiking stylistic traits. The distribution of hitchhiking metric variables should roughly mirror the distribution of the associated replicatively important traits, but they should be randomly distributed when grouped by the size of the replicatively important trait, however. In other words, if notch depth is a hitchhiking trait, it should be randomly distributed for points with the same basal width.

Broken and worn points will generally be repaired until the boundaries of one or more performance constraint is exceeded. As a result, a projectile point that has been used, reworked, and repaired until it is no longer usable will have the size of one or more of its replicatively important attributes reduced from the upper end to the lower end of the acceptable range during reworking/repair. Once a performance constraint is exceeded, the point is no longer serviceable (e.g., the point base is too narrow for it to be hafted), and won't be used as a projectile point. For an assemblage of heavily used points, the distribution of important quantitative performance characteristics will therefore be skewed to the right (Fig. 18.4). As before, the distribution of metric traits that are not replicatively important will be more variable relative to replicatively important attributes and will likely remain roughly normally distributed, because they are likely to be the result of the random interplay of the modification of the point's attributes during the repair process.

Projectile points that have been used, reworked, and repaired until they are no longer usable should be greatly modified when compared to their original shapes. Because lithic technology is reductive in nature, repaired projectile points must be smaller than they were initially. Functional attributes will be most directly affected by sharpening or reworking activity, because they should be the focus of such activity; points will be modified to specifically affect those attributes that impact their usefulness. Stylistic attributes do not significantly impact the usefulness of the points, by definition, and will therefore not need to be repaired or fixed, except as required by the modification of replicatively important attributes traits.

It is difficult to consistently distinguish between new and used projectile points. Fortunately, this should not be a serious problem; used and broken projectile points are more common than new points in the archaeological record, especially in the context of sites excavated along NM 22. Most of the points show some evidence of breakage or use, and new points will only be represented by specimens that were lost or cached, or by production failures that were discarded before they were completed because they were not usable. Otherwise, points will generally be used and reworked until they are no longer useful. As a result, the variation in functional attributes should be heavily slanted toward the lower boundaries of the performance constraints with perhaps slightly bimodal distribution with a small peak on the right hand side when compared to the expected distributions in Figures 18.3 and 18.4. Even in an assemblage that includes both new and used points, replicatively important traits should be more tightly bounded than other traits.

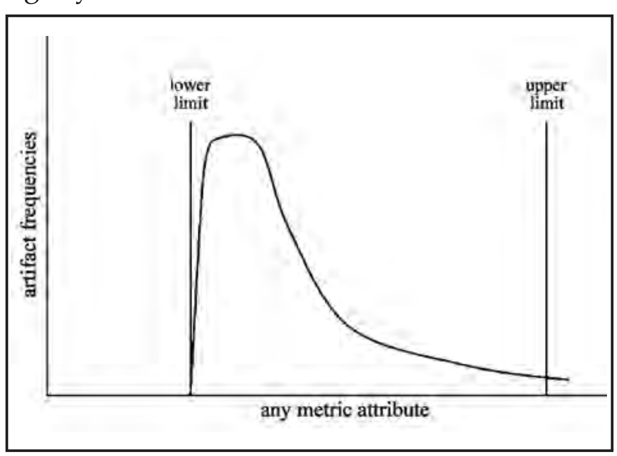

Figure 18.4. The expected distribution for functional attributes of used and repaired points.

Qualitative Attributes. Functional qualitative attributes can take either the form of a single variant (e.g., corner notching) or a limited number of functionally equivalent variants (e.g., corner notches or side notches) out of a range of possible alternatives. During rework and repair, functional qualitative attributes should either remain unchanged or be limited to design variants that are equivalently useful on points that have been reworked/repaired, unless the point is formed into a different tool with different performance requirements (e.g., a point modified to be a drill). For example, if a qualitative attribute such as notching method is functional within an environment, then the notching method should not change during the use-life of a point, assuming there is no change in the performance constraints.

Breaks. Breaks represent a failure in the point's morphology during bending, twisting, or impact, and reflect the location and type of stresses (compressive or tensile) to which a point was subjected. Two types of breaks can be distinguished. Catastrophic breaks are defined as damage to the projectile point reducing one or more attribute below the range established by its performance constraints (Fig. 18.4). Catastrophic breaks are somewhat like a frozen moment in the continuum of repair and reworking illustrated in Figures 18.3 and 18.4. They reflect when a usable projectile point became useless and was discarded without any attempted repair.

Repairable breaks are defined as damage that does not reduce an attribute below the performance boundaries and that can therefore be fixed. Unlike catastrophic breaks, repairable breaks can be repaired while keeping all of a point's functional attributes within the acceptable range. Because repairable breaks can be repaired, their presence may not be apparent on repaired points.

Given the implications of the difference between what constitutes catastrophic and repairable breaks for a projectile point within a specific environmental context, it would be ideal if an analyst could always recognize where breaks occurred and how the breaks were dealt with by prehistoric artisans. In the case of catastrophic breaks, this is no problem. The point's remnants will probably be discarded by the point's user(s), and can therefore at least possibly be recovered by archaeologists. However, repairable breaks that are repaired will effectively "disappear" from the projectile point. Only the broken projectile point fragments will remain. Unfortunately, these fragments are easily overlooked, and may not be recognized as part of a projectile point even when they are recovered.

The Probabilistic Nature of the Model

A note regarding the probabilistic nature of models is warranted before the model is applied. The argument presented above should not be overstated. It is of course always possible that situational necessities will force an individual to modify and use a broken point that would otherwise be discarded. For example, a hunter may modify and use a point he would otherwise discard, if it is the individual's only point. The model does suggest that the broken point would be discarded and replaced by the individual as quickly as possible, however. In this way, the model is probabilistic in that it is intended to apply to most, but not all, situations, and is designed to identify trends in behavior but not necessary to predict the behavior of an individual acting in a specific social and natural environment.

Variation Attributable to the Artisan and Material

The size and flaking characteristics of the raw material and the skill and the manufacturing technique of the artisans may also contribute to morphological variation in projectile point morphology, even when a uniform technological system is present. Each of these factors undoubtedly contributes to the variation in morphology of the NM 22 projectile points. Additionally, these factors may be interdependent; the manifestation of one factor can dictate a corresponding manifestation in another trait (e.g., poor raw material quality may limit manufacturing technique). Such variation will undoubtedly add noise to the ideal distributions described above. However, such noise should not present a serious problem for the application of this model, because the boundaries of functional variables should remain consistent regardless of these factors.

For example, a poorly made point that does not possess the appropriate performance characteristics will probably be discarded, just as a cooking pot made by an inexperienced potter that is too porous will probably be discarded. An unskilled flint knapper also may not be able to successfully repair a point as many times as a skilled knapper, but the point will still be unusable as a projectile point when the performance boundaries are exceeded. Likewise, factors such as variation in the size of raw material, which constrains the absolute size of the subsequent points, will not add too much to the morphological variation in a point assemblage. Although large projectile points cannot be made from small nodules of raw material, the small points can still not be smaller than the lower performance constraints of projectile points under the current selective environment. In other words, the idiosyncratic and context-specific factors that affect the morphological variation of projectile points still do not affect the performance requirements of the projectile points, and therefore will not greatly affect resulting variation.

Step 2: Creation of a Paradigmatic Classification

Perhaps the most critical factor facing an analyst is systematics, that is, the formation of analytic units (Dunnell 1971). The creation of analytic units is a direct product of the analyst, yet it forms the basis of the analysis and structures the variation and similarities the analyst seeks to explain. Consequently, poorly conceived units can either obscure variation that is meaningful to an analysis or mischaracterize the variation so that it is not properly quantified. Either result can lead to spurious conclusions and error. Misunderstanding the nature of the variation within units has created serious misinterpretations in lithic studies in particular. As Collins (199?:87) states, "much effort has been wasted, for example, in trying to understand variation in lithic tool forms as stylistic when, in fact, it probably results from progressive resharpening, or, as another example, in creating endless stylistic “types” among what are actually unfinished bifaces."

O'Brien and Holland (1990), Ford (1954), and others (e.g., Read 1982) have observed that the archaeological record contains artifacts and features that vary in their morphology and characteristics without clear boundaries between "natural kinds," that is, without clear distinction between bounded groups with non-overlapping members that differ in a transformational way. Archaeologists must instead divide the wide range of variation into meaningful units that properly characterize the variation that is significant to the archaeologist's research (Ford 1954). There is no "right" classification that will be applicable in all circumstances. Instead, classes, groups, and types change as new variables are considered, and the appropriateness of a particular systematic system changes as both the collection of artifacts under analysis changes and the research question of the analyst changes.

Because the amount of variation within a class of artifacts will change as the constitution of analytic classes change, it is important to develop a classification system to allow analytically comparable groups to be formed (Read 1982:57–60, 86–88). Archaeologists have long used cultural-historical types for their primary units, even when conducting technological analyses. Such classifications are particularly useful because they are widely known, have generally been evaluated over time, and have been illustrated to reflect temporal relationships. Furthermore, the fact that they frequently reflect morphological and technological change through time and space would superficially seem to indicate that they would be ideal. Unfortunately, cultural-historical types for projectile points and other artifacts are generally inappropriate units of technological study for three reasons.

First, many cultural-historical types are poorly and inconsistently defined. For example, numerous authors have commented on the difficulty in identifying various projectile point types correctly (e.g., Chapman 1980:19–22; Hogan 1996; Moore 1994; Phagan 1988a, 1988b; see also Whittaker et al. 1998), but the severity of the problem can be illustrated by a roundtable discussion on projectile point typology held during the Conference on the Archaic Prehistory of the North American Southwest at the University of New Mexico in 1996. The participants of the roundtable discussion were all experienced flaked stone analysts who were presented with five projectile points that they were asked to type using standard Southwestern point types (B. Huckell, pers. comm. 1996). No more than three of the five experts agreed on the type designation of any point, and one point was assigned to cultural-historical types ranging from late Paleoindian/Early Archaic (~10,000 BP) to the Basketmaker III (~1,100 BP) time period. The disagreement of the type designations of each of the points is symptomatic of a larger problem with cultural-historical types, including those used for ceramics, rock art, and architecture (Whittaker et al. 1998). Many cultural-historical types lack the replicability necessary for use in this or other technological analyses.

Second, cultural-historical types are based on a variety of qualitative and metric characteristics that are not consistent across types (Read 1982:58). Changing demarcation criteria may be appropriate for the construction of chronological types, but it is certain to obfuscate meaningful functional changes within a classification. In other words, the cultural-historical types are defined on changing criteria based on variation that is temporally sensitive. Some cultural-historical types will therefore include a great deal of variation whereas others may be very limited. For example, "Pinto" points include a tremendous amount of morphological variation and can include almost any small side-notched or corner-notched arrowhead. In contrast, Clovis or Folsom points have very unique morphologies consisting of lanceolet blades with diagnostic flutes. As a result, cultural-historical types are not comparable analytic units as required by a technological study.

Third, and most important, cultural-historical types are almost certainly based on both functional and stylistic attributes. They therefore artificially conflate variation into groups that do not provide useful units for explaining the technological significant morphological variation. For instance, functionally similar pots may be separated into two different cultural-historical groups based on differences in stylistic attributes and a single cultural-historical type may include functionally distinct artifacts such as cooking pots and storage pots. Ultimately, an archaeologist using cultural-historical types to study ceramics would not be able to adequately identify changes in functional attributes. The same is likely true for those studying projectile points.

The three observations presented above are not meant to imply that cultural-historical types are without merit. Quite to the contrary, they do have merit when dealing with the particular issues that led to their development, i.e., identifying the temporal period to which archaeological materials date (O'Brien and Lyman 1999). In fact, cultural historians may very well have keyed in on technologically important variation. However, the underlying structure of the units does not consistently allow technologically meaningful units to be derived.

Because the units of study in most archaeological contexts are qualitative and quantitative morphological characteristics of artifacts (e.g., projectile point length, notch type), a useful means of grouping artifacts is a paradigmatic classification system (Allen 1996:10; Dunnell 1971; O'Brien and Holland 1990; Read 1982:86–89). Paradigmatic classifications are created when the entire range of co-occurrences of a number of traits is subdivided into separate classes. Each cell represents the co-occurrence of the traits listed on the corresponding column and row.

Paradigmatic classes have a number of advantages that make them useful (Dunnell 1995; O'Brien and Holland 1990; Read 1982:86–89). First, unlike cultural-historical or hierarchical typologies, all traits are treated equally during the classification process; the presence or manifestation of one trait does not influence the consideration of additional traits. As a result, classes within a paradigmatic classification can be compared in a quantitatively meaningful manner because they are based on the same criteria, and the distinction between classes is a result of their morphology, not a product of which attributes are considered for each individual class as is the case in many hierarchically organized cultural-historical typologies.

Second, differences between classes are explicitly specified and reflect differences in functional attributes, assuming the paradigmatic classification is properly constructed to reflect such differences. As a result, the classification should reflect the functionally distinct classes. Also, paradigmatic classes are often more replicable than other types of classifications because the differences between classes is clearly specified; subtle differences between artifacts do not cause them to be classified using completely separate classificatory branches as is common in hierarchical typologies such as those used in cultural-historical types.

Finally, a paradigmatic classification provides a measurement of both the variation that is and is not present. This can provide insight into the performance characteristics that are required for an artifact class, and can potentially illustrate general constraints of a technological system created by the lack of variation that was physically impossible or simply never present.

Given the advantages of a paradigmatic classification, I will employ one during this analysis. The goal of the current analysis is to explain changes in projectile point technology, so the paradigmatic classification should be based on traits that affect the usefulness of points. Ideally, the paradigmatic classification should produce classes whose members share the same manifestation of functional traits so as to create functionally homogeneous groups. After all, just as it is necessary to differentiate between cats and dogs when trying to explain the development and current morphology of these mammals, it is necessary to differentiate between functionally distinct projectile points when trying to explain their development and morphology. The dimensions of the paradigmatic classification should therefore correspond to attributes that relate to the general performance characteristics of projectile points; these attributes are the ones that will reflect functional changes.

The paradigmatic classification I use is based on two variables, which are referred to more properly as dimensions (Dunnell 1971). First, the points are divided by weight, with those weighing 3 g or more separated from those weighing less than 3 g. This division is based on the differences in performance requirements of atlatl darts and arrows. As previously outlined and discussed by Hughes (1998:368), atlatl darts will almost certainly require points weighing more than 3 g to pull the projectile's center of gravity forward, allowing well-balanced flight. Although arrows can be used with projectile points weighing more than 3 g, arrow points generally weigh less than 3 g because of the small mass of the arrow shafts, which generally require light points to have proper spine (Hughes 1998:368).

The second dimension used in the paradigmatic classification is the morphology of the hafting element. The shape of the hafting element affects several performance characteristics including durability (especially the frequency and nature of projectile point breakage) and penetration (Christenson 1986; Corliss 1972; Fawcett and Kornfeld 1980). For this analysis, seven hafting element morphologies are defined: corner notch, concave base, convex base, stem, pointed stem, side notch, and triangular. In a general sense, any two of these hafting elements can co-occur (e.g., a point can be side notched and have a concave base). As a result, twenty-one possibilities defined by the occurrence and co-occurrence of the seven hafting morphology characteristics comprise the second dimension of the paradigmatic classification. The intersection of the two dimensions produced 42 classes.

Most of the NM 22 assemblage (75.5 percent) demonstrates some evidence of unrepaired breaks. Attributes of the points that are not affected by the breaks can still be measured and included in the analysis. For example, attributes of the point's haft can be accurately measured, if the breaks are limited to the point blade. However, there are of course several difficulties inherent with analyzing broken points, not the least of which is that it may be difficult or impossible to classify some broken points using the paradigmatic classification employed here.

Point fragments that lack hafting elements cannot be classified, because the paradigmatic classification is based in part on hafting element morphology. The classification of point fragments that do have hafting elements but that weigh less than 3 g is also uncertain, because the original weight of the points is unknown. For example, an atlatl dart point weighing 4 g can break into two pieces that each weighs 2 g. It would be incorrect to assume that the two pieces of the point originally were arrow points, because they now weigh less than 3 g. Consequently, the classification of these fragments requires careful consideration of each of them individually.

Despite this difficulty, the current weight and the nature of the breakage will allow the estimation of the original weight of a point, at least at a resolution sufficient to determine if it weighed more or less than 3 g in many cases. It is certain that broken points that currently weigh more than 3 g originally weighed more than 3 g, because flaked stone is a reductive technology; points cannot get bigger, only smaller. Likewise, a point that currently weighs 0.6 g and that has only a small portion of the blade's tip missing certainly weighed less than 3.0 g originally, and can therefore be classified as an arrow point. Assuming these points have their hafting elements, they can be unambiguously classified.

However, some fragments will either not provide enough information about the original points' weight (e.g., it may be impossible to determine the original mass of a point from a basal fragment), or the range of possible original weights may be too close to the 3.0 g cut-off to allow them to be securely classified (e.g., a fragment that appears to be missing about a third of its original length and that weighs 2.1 g doesn't provide enough information to determine if it originally weighed more or less than 3 g). Such point fragments are unclassifiable.

Of the 42 possible classes, 14 actually have members (Table 18.3). The frequencies of the classes for each site are listed on Table 18.4. As is obvious from this table, arrow points dominate all of the site assemblages; 247 of the 256 points recovered from the six sites along NM 22 are arrowheads. Six of the points are probably atlatl dart points, and three of the points can not be securely associated with either weapon system, i.e., it is unclear whether the original point weighed more or less than 3 g.

Across the sites, the most common point class is corner-notched arrowheads (39 percent of the total assemblage), with side-notched, stemmed, and triangular-shaped arrowheads also being somewhat common (8 percent, 7 percent, and 12 percent of the total assemblage, respectively). The remaining classes comprises 1 percent or less of the total assemblage. In addition, 71 arrowheads (28 percent of the total assemblage) lacked enough of their hafting element to allow them to be classified, and two points (less than 1 percent of the total assemblage) are unclassifiable atlatl dart points.

Obviously, some of the classes—corner-notched arrowheads, side notched arrowheads, stemmed arrowheads, and triangular arrowheads—represent point morphologies that had considerably better replicative success (Leonard and Jones 1987) than other classes. The explanation of this difference in replicative success is the goal of the remainder of this analysis. Jones et al. (1995) outline the framework necessary for such explanations. First, they observe that explanations must be created within a historical framework in which the dif-

Table 18.3. Classes Represented by Projectile Points

Weapon System	Hafting Type (CN)
Arrow	Corner Notched
Arrow	Corner Notched with Concave Base (CN/CONCAVE)
Arrow	Corner Notched with Stemmed Base (CN/STEM)
Arrow	Side Notched with Concave Base (CONCAVE/SN)
Arrow	Convex Based (CONVEX)
Arrow	Side Notched with Convex Base (CONVEX/SN)
Arrow	Side Notched (SN)
Arrow	Stemmed Base (STEM)
Arrow	Triangular Base (TRI)
Atlatl Dart	Corner Notched (CN)
Atlatl Dart	Stemmed with Convex Base (CONVEX/STEM)
Atlatl Dart	Side Notched (SN)
Atlatl Dart	Stemmed Base (STEM)

Table 18.4. Frequencies of the Projectile Point Classes

Weapon	Haft Morphology	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	Total
Arrow	CN	-	48	16	21	10	3	98
	CN/CONCAVE	-	1	-	-	-	-	1
	CN/CONVEX	-	1	-	-	-	-	1
	CN/STEM	-	-	-	1	-	-	1
	CONCAVE/SN	-	-	-	-	1	-	1
	CONVEX	-	-	1	-	-	-	1
	CONVEX/SN	2	-	-	-	-	-	2
	CONVEX/STEM	-	-	1	-	-	-	1
	SN	-	2	7	11	1	-	21
	STEM	-	11	1	5	-	-	17
	TRI	-	10	5	12	3	-	30
	UNKNOWN	-	27	13	19	12	-	70
Atlatl Dart	CN	-	-	-	1	-	-	1
	CONVEX/SN	-	-	-	-	1	-	1
	SN	-	1	-	-	-	-	1
	STEM	-	1	-	-	-	-	1
	Unknown	1	-	-	-	1	-	2
Indeterminate	Unknown	2	-	1	-	-	-	3
Total		5	102	45	70	29	3	254

ferential replicative success of artifacts is tied to specific environmental and behavioral contexts. Second, the explanation must be divided into two parts: a historical description and the actual explanation. The historical description is created by identifying the variation within the artifacts under analysis through time and across space. The explanation itself is then created by identifying the specific aspects of the natural and cultural environments that led to the selection for the attributes that the replicatively successful artifact classes possess.

Step 3. Historical Description of the Point Assemblage

The sites from which the projectile points were recovered dated from the BM III (Early Formative) to the Pueblo IV (Classic) periods. To create the historical description of the NM 22 projectile points, each projectile point was dated using associated ceramic or radiocarbon dates to the Early Developmental, Late Developmental, Coalition, or Classic periods. In cases where there were conflicting dates (e.g., points found in midden deposits that contained materials from both the Classic and the Early Developmental periods) or where there were no associated datable materials, the temporal association of the projectile point was considered indeterminate.

Although it is certainly possible that some points were collected from earlier sites and then re-used, I assume that most of them are associated with materials from the same time period that the points were manufactured, used, and discarded. Even if some of the points are recycled from earlier sites, they still must have the attributes necessary for the performance characteristics associated with the weapon system. Consequently, they will still accurately reflect the performance requirements of the weapon technology for each time period.

The frequencies of points from each time period are reported on Table 18.5. A majority of the total point assemblage (69 percent of all of the points) date to the Early Developmental period. These points are primarily corner-notched arrowheads, although there are a significant number of side-notched, stemmed, and triangular points (Table 18.6). Two atlatl dart points are also present.

The assemblages from the remaining time periods are much smaller. The few points associated with Late Developmental remains (n = 15; Table 18.7) are about equally split between side notched and corner notched arrowheads, with no atlatl dart points. Corner-notched arrowheads are the most common point class among the Coalition period points (Table 18.8), which number 32, but the Classic period sites produced too few points (n = 3) to allow any conclusions concerning the replicative success of the different point classes (Table 18.9). Finally, only a small portion of the assemblage (17 percent) could not be reliably assigned to one of the time periods. About half of the 29 points that could not be assigned are corner-notched (Table 18.10).

Based on the relative proportions of the

Table 18.5. Frequency of Projectile Points Found in Association with Remains from the Various Temporal Periods at Each Site

Date	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	Total
Early Developmental	-	89	11	64	8	3	175
Late Developments	-	-	11	4	-	-	15
Coalition	-	-	15	-	17	-	32
Classic	2	-	-	-	1	-	3
Indeterminate	3	13	8	2	3	-	29
Total	5	102	45	70	29	3	254

Table 18.6. Frequencies of the Point Classes among Points Dated to the Early Developmental Period

Weapon	Haft Morphology	LA 265	LA 6169	LA 6170	LA 6171	LA 115862	Total
Arrow	CN	41	6	19	1	3	70
	CN/CONCAVE	1	-	-	-	-	1
	CN/CONVEX	1	-	-	-	-	1
	CN/STEM	-	-	1	-	-	1
	SN	2	2	9	-	-	13
	STEM	9	-	5	-	-	14
	TRI	9	-	12	2	-	23
	Unknown	25	3	17	4	-	49
Atlatl	CN	-	-	1	-	-	1
	STEM	1	-	-	-	-	1
	Unknown	-	-	-	1	-	1
Total		89	11	64	8	3	175

Table 18.7. Frequencies of the Point Classes among Points Dated to the Late Developmental Period

Weapon	Haft Morphology	LA 6169	LA 6170	Total
Arrow	CN	3	1	4
	Convex	1	-	1
	Convex/SN	1	-	1
	SN	1	2	3
	Unknown	5	1	6
Total		11	4	15

Table 18.8. Frequencies of the Point Classes among Points Dated to the Coalition Period

Weapon	Haft Morphology	LA 6169	LA 6171	Total
Arrow	CN	5	6	11
	SN	3	1	4
	STEM	1	-	1
	TRI	3	1	4
	Unknown	2	8	10
Atlatl	Convex/SN	-	1	1
Indeterminate	Unknown	1	-	1
Total		15	17	32

Table 18.9. Frequencies of the Point Classes among Points Dated to the Classic Period

Weapon	Haft Morphology	LA 249	LA 6171	Total
Arrow	Concave/SN	-	1	1
	Convex/SN	1	-	1
Indeterminate	Unknown	1	-	1
Total		2	1	3

Table 18.10. Frequencies of the Point Classes among Points that Cannot be Dated

Weapon	Haft Morphology	LA 249	LA 265	LA 6169	LA 6170	LA 6171	Total
Arrow	CN	-	7	2	1	3	13
	Convex/SN	1	-	-	-	-	1
	SN	-	-	1	-	-	1
	STEM	-	2	-	-	-	2
	TRI	-	1	2	-	-	3
	Unknown	-	2	3	1	-	6
Atlatl	SN	-	1	-	-	-	1
	Unknown	1	-	-	-	-	1
Indeterminate	Unknown	1	-	-	-	-	1
Total		3	13	8	2	3	29

various point classes, intuitively there does not seem to be differences in the replicative success of the alternate point classes through time. Corner-notched arrowheads are the most replicatively successful class for all time periods, with the exception of the Classic period, which is represented by an excessively small sample (n = 3). The similarities in the frequencies are even more strongly supported in the samples dating to the Early Developmental and the Coalition periods, samples that are larger than 20, and that would therefore be more likely to be large enough to allow differences in class frequencies to be detected. Among these samples, the proportional frequencies of triangular, side-notched, and stemmed points are about equal.

The hypothesis that the proportional frequencies of the point classes are similar between the periods can be evaluated using a Fisher's Exact Probability Test. The null hypothesis for the test is that each of the replicatively successful classes occurs in the same proportional frequencies in each time period. If the null hypothesis is rejected, then the frequencies of each point class changed over time (e.g., corner-notched points had greater replicative success through time). If the null hypothesis cannot be rejected, then the available evidence indicates that the assemblages from the different time periods are effectively identical. Given that samples as small as three points cannot accurately reflect the underlying distributions, the Classic period assemblages must be excluded from the analysis.

The level of rejection (alpha) for the Fisher's Exact Probability test is set at 0.05, and the resulting p-value is 0.20, which is greater than the level of rejection. As a result, I cannot reject the null hypothesis and I conclude that the proportional frequencies of the various point classes are similar through time; the corner-notched points, and, to a more limited extent, the stemmed, the triangular, and the side-notched points, had consistent replicative success through time, which was greater than the members of the other point classes.

In keeping with Jones and others' (1995) observation, the task now becomes explaining why these point classes had good replicative success, which requires a consideration of the variation in point morphology and its affect on their usefulness. Read (1982:73–74) observes that the only way to ensure that the entire range of potential functional attributes are represented in an analysis is to take measurements that "completely characterize the artifact," that is, that allow the general morphology of each point to be accurately drawn from the resulting data. Measurements that allow the reconstruction of the general artifact morphology allow, by extension, the quantification and comparison of virtually any aspect of an artifact's general morphology, which will, by extension reflect the point's performance requirements.

In accordance with Read's (1982) suggestion, 19 variables were recorded for each point in addition to weight and hafting element morphology, which allow each point's general morphology to be reconstructed from the resulting data. These variables are listed on Table 18.11. They can be divided into three categories: measurements of the entire point, measurements of the point's blade, and measurements of the point's base. Measurements applicable to the entire point were raw material, total length, maximum width, and location of breaks, if present. The measurements of the point blade were maximum blade length, maximum blade width, maximum blade thickness, and the average number of serrations per centimeter, when present. The measurements of the point base were maximum basal length, maximum basal width, minimum basal width, maximum basal thickness, notch widths, notch depths, depth of the basal indention, and depths of the stem in comparison to the blade (Fig. 18.5). Depending on the nature of the point morphology and point breakage, not all of these measurements could be recorded for each point. For example, recording notch depths is not possible for points that are not notched or that are missing their basal elements.

The variation in each attribute can be quan-

Table 18.11. Attributes Recorded for Each Point as Possible

Measurements of the Entire Point	Raw Material
	Weight
	Total Point Length
	Total Point Width
	Location of Breaks
Measurements of the Point Blade	Maximum Blade Length
	Maximum Blade Width
	Maximum Blade Thickness
	Average Number of Serrations per Centimeter
Measurements of Point Base	Maximum Basal Length
	Maximum Basal Width
	Minimum Basal Width
	Maximum Basal Thickness
	Width of Notches
	Depth of Notched
	Depth of Basal Indentation
	Stem Depths

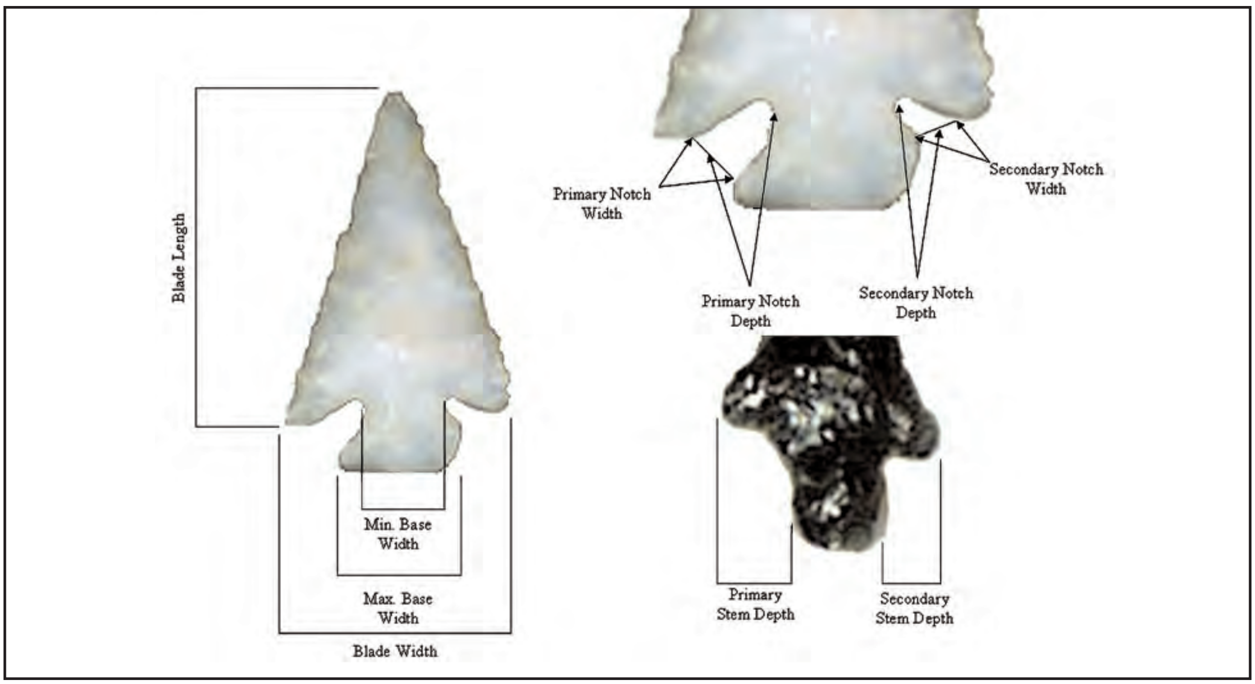

Figure 18.5. Illustrations of measurements taken for each projectile point.

tified and compared for the various artifact classes. Because all of the classes other than corner-notched, side-notched, stemmed, and triangular arrowheads had such poor replicative success, i.e., n < 5, as illustrated on Table 18.4, it is impossible to accurately quantify the variation in their various attributes. As a result, they must be excluded from the following statistical analyses.

The recorded attributes can be divided into two groups, non-metric and metric. Non-metric variables are raw material and the location of the breaks. These are nominal scale data that can be quantified using counts and frequency analyses. All of the remaining attributes are metric variables. These are interval data, which can be analyzed using means, standard deviations, and other measures of dispersal and central tendencies.

Table 18.12 presents the frequency of the raw materials though time. Points made of obsidian from the Jemez Mountains are the most common in all of the assemblages. Furthermore, obsidian points comprise 70 percent or more of the points from each time period.

Because the obsidian is primarily from the Jemez region and most of the chert and chalcedony is from the Rio Grande gravels, the raw material categories listed on Table 18.12 can be collapsed into Jemez obsidian and Rio Grande chert. Although the differences in their sample sizes are quite large, each raw material type appears to occur in more or less the same frequencies within each time period. The accuracy of this conclusion can be evaluated with a Chi-Square test. The null hypothesis for the test is that the proportional frequencies of each raw material are equal during each time period. The level of rejection (alpha) is set at 0.05. In addition, only two basalt points are present, so they are excluded from the Chi-Square test; basalt is not a significant raw material for projectile points from any of the time periods.

The results of the analysis are reported on Table 18.13. The Chi-Square value is 2.68, which does not exceed the critical value of 5.99 for 2 degrees of freedom. As a result, I cannot reject the null hypothesis, and I conclude that points from each time period had the same proportional frequencies of chert and obsidian.

It is also possible that the performance characteristics of the various point classes required the use of different raw materials, i.e., the prehistoric inhabitants of the sites may have used chert to make certain types of points and used obsidian others. Table 18.14 presents the frequency of the raw materials divided by point class. Obsidian is the most frequent material type for all four point classes, and there is no obvious difference in the proportional frequencies of chert points among the classes. This hypothesis can be more fully evaluated again using a Chi-Square test.

The null hypothesis of the Chi-Square test is that each class of projectile points has the same proportional frequency of each raw material. The level of rejection (alpha) is again set at 0.05 and the raw material classes are again collapsed into the more general classes of obsidian and chert. The results of the Chi-Square test are presented on Table 18.15. The Chi-Square value is 1.78, which is less than the critical value of 7.81 for 3 degrees of freedom. I therefore cannot reject the null hypothesis, and I conclude that chert and obsidian points occur in the same proportional frequencies in all four of the point classes.

Based on the two Chi-Square tests presented in Tables 18.13 and 18.15, I argue that there is no difference in the proportional frequency of point raw materials through time or among the projectile point classes. Raw material is an important functional attribute, affecting both penetration through its impact on the surface friction of the points and the sharpness of the edge, and durability through its impact on the

Table 18.12. Frequencies of Raw Materials by Date

Raw Material	Early Developmental	Late Developmental	Coalition	Total
Basalt	2	-	-	3
Chert, White	-	-	1	2
Obsidian	1	-	-	1
Obsidian, Black Opaque	8	-	1	11
Obsidian, Jemez, Brown	4	-	-	4
Obsidian, Jemez	91	4	17	123
Obsidian, Polvadera	4	1	-	5
Rio Grande Chalcedony	10	2	-	12
Rio Grande Chert	1	-	1	3
Chert	-	-	-	1
Total	121	7	20	165

Table 18.13. Chi Square Test Comparing the Proportional Frequencies of Chert and Obsidian Points Through Time

Raw Material	Time Period	Observed	Expected	Chi Square
Chert	Early Developmental	11	12.23	0.12
	Late Developmental	2	0.72	2.28
	Coalition	2	2.05	0
Obsidian	Early Developmental	108	106.77	0.01
	Late Developmental	5	6.28	0.26
	Coalition	18	17.95	0
		Chi-Square Value = 2.68		
		Critical Value (0.05,2) = 5.99		

Table 18.14. The Frequency of Raw Materials Divided by Point Class

	Haft Morphology				
Raw Material	CN	SN	STEM	TRI	Total
Basalt	3	-	-	-	3
Chert, White	1	1	-	-	2
Obsidian	-	-	-	1	1
Obsidian, Black Opaque	7	-	1	3	11
Obsidian, Jemez, Brown	3	-	-	1	4
Obsidian, Jemez	69	17	14	23	123
Obsidian, Polvadera	3	1	-	1	5
Rio Grande Chalcedony	9	2	2	2	15
Rio Grande Chert	3	-	-	-	3
Chert	-	1	-	-	1
Total	98	22	17	31	168

Table 18.15. Chi Square Test Comparing the Proportional Frequencies of Raw Material Divided by Arrow Point Class

Raw Material	Haft Morphology	Observed	Expected	Chi Square
Chert	CN	13	12.09	0.07
	SN	4	2.8	0.51
	STEM	2	2.16	0.01
	TRI	2	3.95	0.96
Obsidian	CN	82	82.91	0.01
	SN	18	19.2	0.07
	STEM	15	14.84	0
	TRI	29	27.05	0.14
		Chi Square Value = 1.78		
		Critical Value (0.05,3) = 7.81		

compressive and tensile strength of the material. Obsidian, which provides great penetration but is also very fragile, is overwhelmingly favored over other raw material types, suggesting that the penetration was an important performance characteristic. Furthermore, the fact that raw material selection does not change through time or across the artifact classes indicates that this performance characteristic was present for all of the points.

Table 18.16 presents summary statistics for the four replicatively successful classes of arrowheads. The structure of the variation in the nineteen variables as reflected by their means and medians superficially appears quite similar within the classes in many if not all of the attributes. An Analysis of Variance test would be ideal to determine if this is in fact the case.

Table 18.16. Summary Statistics for the Replicatively Successful Arrowhead Classes

Attribute	Haft Morphology	N	Mean	Std. Deviation	Corrected CV	Median	Skewness	Std. Error of Skewness
Point Weight	CN	23	0.77	0.36	47.06	0.7	2.55	0.48
	SN	12	0.65	0.24	36.98	0.65	0.08	0.64
	STEM	15	0.63	0.25	41.35	0.6	0.1	0.58
	TRI	10	0.79	0.41	53.48	0.7	1.04	0.69
	Total	60	0.71	0.32	45.45	0.7	1.75	0.31
Point Length	CN	33	22.05	4.59	20.97	21.94	0.58	0.41
	SN	12	20.03	2.8	14.29	19.46	0.72	0.64
	STEM	16	19.98	2.79	14.17	19.41	0.55	0.56
	TRI	13	21.03	3.1	15.01	20.01	0.98	0.62
	Total	74	21.1	3.8	18.09	20.34	0.9	0.28
Point Width	CN	29	13.69	2.75	20.24	13.52	-0.1	0.43
	SN	14	12.63	2.79	22.51	12.5	0.26	0.6
	STEM	16	12.19	2.37	19.77	11.97	0.43	0.56
	TRI	23	13.51	2.79	20.86	13.38	0.06	0.48
	Total	82	13.16	2.72	20.7	12.59	0.12	0.27
Blade Length	CN	60	17.81	4.3	24.24	17.77	0.39	0.31
	SN	14	14.31	3.21	22.83	13.98	0.31	0.6
	STEM	16	16.5	2.29	14.11	16.47	-0.01	0.56
	TRI	14	20.75	3.16	15.51	19.9	0.97	0.6
	Total	104	17.53	4.12	23.54	17.59	0.4	0.24
Blade Width	CN	61	12.96	2.47	19.13	12.54	0.31	0.31
	SN	17	11.42	2.34	20.76	11.45	0.97	0.55
	STEM	17	12.3	2.35	19.4	12.25	0.29	0.55
	TRI	22	13.29	2.86	21.78	12.87	0.19	0.49
	Total	117	12.7	2.55	20.14	12.35	0.37	0.22
Blade Thickness	CN	85	2.92	0.64	21.94	2.78	0.64	0.26
	SN	20	3.47	1.58	46.15	3.21	3.51	0.51
	STEM	16	3.34	0.78	23.7	3.44	-0.28	0.56
	TRI	31	3.1	0.69	22.47	3.06	1.3	0.42
	Total	152	3.07	0.86	28.03	2.94	3.3	0.2
Ave. # of Serrations	CN	2	1.07					
Basal Length	CN	57	5.49	1.31	24.02	5.18	0.63	0.32
	SN	17	6.43	1.37	21.63	5.94	0.84	0.55
	STEM	17	4.19	1.09	26.31	4.38	0.35	0.55
	Total	92	5.39	1.47	27.32	5.21	0.48	0.25
Max. Basal Width	CN	53	8.87	2.55	28.92	8.5	0.39	0.33
	SN	15	12.12	2.85	23.9	11.73	0.46	0.58
	STEM	17	5.58	1.69	30.72	5.1	1.18	0.55
	Total	86	8.72	3.22	36.99	8.55	0.46	0.26
Min. Basal Width	CN	78	5.76	1.93	33.59	5.13	1.62	0.27
	SN	17	7.46	2.28	31.03	6.78	1.2	0.55
	STEM	17	5.15	1.75	34.51	4.86	1.3	0.55
	Total	112	5.92	2.06	34.86	5.29	1.42	0.23
Basal Thickness	CN	57	2.34	0.51	22.05	2.23	0.39	0.32
	SN	16	2.59	0.6	23.66	2.49	0.67	0.56
	STEM	17	2.32	0.7	30.56	2.26	0.36	0.55
	Total	91	2.37	0.59	24.84	2.26	0.31	0.25
Notch Width	CN	57	3.32	1.47	44.4	2.85	0.95	0.32
	SN	17	3.72	1.56	42.69	3.23	1	0.55
	Total	75	3.4	1.49	43.94	3.18	0.95	0.28
Sec. Notch Width	CN	25	2.88	0.96	33.79	2.62	0.99	0.46
	SN	11	2.62	1.22	47.81	2.27	0.62	0.66
	Total	36	2.8	1.04	37.37	2.59	0.7	0.39
Notch Depth	CN	57	2.87	0.96	33.63	2.76	0.98	0.32
	SN	17	2.43	0.94	39.51	2.19	0.3	0.55
	Total	75	2.75	0.98	35.74	2.62	0.77	0.28
Sec. Notch Depth	CN	25	2.78	0.95	34.66	2.67	-0.13	0.46
	SN	11	2.22	1.27	58.63	1.91	0.43	0.66
	Total	36	2.61	1.07	41.48	2.6	-0.08	0.39
Stem Depth	STEM	17	3.79	0.72	19.35	3.98	0.32	0.55
Sec. Stem Depth	STEM	16	2.92	1.27	44.12	3.25	-0.83	0.56

Note: Skewness is a measure of how closely a distribution approximates a normal distribution, with a value of 0 indicating a perfect approximation. A positive value indicates a distribution is skewed to the right, whereas a negative value indicates it is skewed to left. In general, any distribution whose skewness value is twice its standard error of skewness is considered to be asymmetrical.

The most commonly used Analysis of Variance test is the ANOVA Test, which compares the means of various classes to determine if they are statistically similar. However, an examination of the skewness of the distributions of the various attributes indicates that the assumptions for ANOVA analyses are not met (Table 18.16); ANOVA is robust to departures from normality, but it does require symmetric distributions, because it uses the mean as a measure of central tendency. The mean is a poor measure of central tendency in heavily skewed distributions because the outliers pull it in the direction of the skewness. The skewness values reported on Table 18.16 indicate that many of the distributions are heavily skewed, frequently to the right with the data clustered towards the lower limit of variation. The presence and direction of skewness is consistent with my expectations outlined previously that many of the variates will likely cluster towards the lower range of acceptable variation because of point reworking and repair, but it does necessitate the use of a different statistical approach than the standard ANOVA test.

One means of completing a nonparametric Analysis of Variance is to use the median values as measures of central tendency. Unlike means, which are heavily impacted by outliers, medians are robust measures of a distribution's central tendencies in skewed distributions, because they are impervious to the absolute size of outliers. Differences in medians can be detected by computing the group median value of all of the classes being compared, and then determining the number of members of each class that are greater than and less than the group median value. The total number of variates that are greater than the median will be equal to the number of variates that are less than the median across all of the classes, an obvious result of how the median is calculated, but some classes may have an inordinate number of variates either above or below the group median. Using a Chi-Square test, the presence of classes that tend to be statistically smaller or larger than the group median can be detected. Such an approach makes no assumptions concerning the shape of the distribution of the data.

The null hypotheses of the nonparametric Analysis of Variation tests are that the attribute median values are equal. The level of rejection (alpha) is set at 0.05 for all of the comparisons, and the results are reported on Table 18.17. These results confirm for the most part that there are not statistically significant differences between the four classes in most attributes. Statistically significant differences are present

Table 18.17. Results of Nonparametric Analysis of Variance Test Comparing the Median Values of the Replicatively Success NM 22 Arrow Point Classes

Attribute	N	Median	Chi-Square	df	p-value
Point Weight	60	0.7	0.24	3	0.97
Point Length	74	20.34	3.84	3	0.28
Point Width	82	12.59	2.19	3	0.53
Blade Length	104	17.59	12.78	3	0.01
Blade Width	117	12.35	1.6	3	0.66
Blade Thickness	152	2.94	7.23	3	0.06
Basal Length	91	5.21	20.78	2	0
Max. Basal Width	85	8.59	25.1	2	0
Min. Basal Width	112	5.29	12.28	2	0
Max. Basal Thickness	90	2.26	2.75	2	0.25
Notch Width	74	3.18	0.28	1	0.6
Sec. Notch Width	36	2.59	1.18	1	0.28
Notch Depth	74	2.64	0.69	1	0.41
Sec. Notch Depth	36	2.6	1.18	1	0.28

Note: Statistically significant differences are indicated by bolded p-values.

in blade length, basal length, maximum basal width, and minimum basal width.

In addition, several attributes were excluded from this analysis. First, the depth of stems could only be recorded for stemmed points, thereby preventing the comparison of stemmed depths with the other classes. Second, serrations on the edge of the points occur so infrequently in all of the classes that the entire attribute must be excluded from the analysis. Third, stemmed points were excluded from the comparisons of attributes related to notch size, because they do not have notches. Finally, triangular points were excluded from the consideration of all attributes related to basal morphology, because they lack definable bases.

The similarities in the attributes of point weight, point length, point width, blade width, blade thickness, maximum basal thickness, notch width, second notch width, notch depth, and the second notch depth suggest that the replicatively important point classes do not differ in performance characteristics effected by these attributes. Two possibilities could account for this. First, the attributes may be stylistic, and not affect any significant performance characteristics at all. Second, the attributes could be functional, but reflect performance characteristics that are required of arrowheads in general. Determining which of these possibilities is applicable in each case is possible using the performance characteristics of bows and arrows outlined previously.

When considering the variables that do not demonstrate a difference among the replicatively successful classes, it is clear that point weight, point length, point width, blade width, blade thickness, and maximum basal thickness are functional attributes. The importance of point weight has been directly established during the previous discussion of the need for balanced flight and the correct spine.

Furthermore, blade width, total point width, blade thickness, and base thickness affect durability and penetration, because they affect the point's cross section. As previously outlined, cylindrical points are very durable whereas thin, wide points break easily. Thicker points are more durable than thinner points, consequently, because they are more cylindrical in shape, they also have larger cross sections, which corresponds with decreased penetration. Likewise, narrow points, i.e., points with small point widths and blade widths, will be more cylindrical in shape than a wider point with a similar thickness. As a result, narrow points will tend to be more durable, but to have less penetration when compared to wider points.

The attributes of point width and blade width, as well as point length, also affect the angle of the point's tip, that is, its "pointedness," and thereby affect the performance characteristics of penetration and durability. The angle of the point's tip is created by the ratio between a point's width and its length. Penetration is affected because the tip angle helps determine the smoothness of initial penetration. For example, a point that has a small total length will have a wide tip angle when compared to an equally wide longer point. The wider tip angle will cause the shorter point to have less penetration than the longer point, because the longer point will allow its sharp edge to gradually break the skin and will thereby allow for a smoother transition into the target (see Pope 1923:50–61). An extreme example of this is a square point with a sharp but flat edge, like a razor blade. Despite the fact that the edge is sharp, the square point will not have the same penetration as a triangularly shaped point with a small tip angle even if the points have the same width and thickness (and therefore the same cross-sectional area), because the square point will require the abrupt penetration of the skin across the entire cutting edge. In contrast, the triangular point will initiate penetration in a very small area and then gradually increase the wound to accommodate the rest of the cutting edge. This requires less energy, especially during the initiation of penetration into a viscous membrane such as animal skin, and allows for greater penetration. Given that point length, point width, and blade width help determine the angle of a point's tip, they therefore affect the penetration of the projectile.

Durability is affected because the angle of the point's tip reflects the amount of the point extending beyond the hafting element. Hughes (1998:371) observes that this portion of the point is very susceptible to damage, because stone generally has poor elastic strength and the point blade is not generally protected by the projectile's haft. Points with longer blade lengths are more likely to break than points with shorter blade lengths, as a general rule, because the amount of surface exposed to stress is greater. There is consequently a trade-off between the performance characteristics of penetration and durability in regards to point length, point width, and blade width. Arrow points with short blade lengths are more durable, but points with longer blade lengths will tend to have greater penetration.

Based on the performance characteristics of arrows, I therefore conclude that point weight, point length, point width, blade width, blade thickness, and maximum basal thickness are functional characteristics that affect the general performance characteristics of arrows as a whole. The fact that the point classes do not differ in regards to these attributes indicates that the same performance constraints were affecting the variation in these attributes. Thus, the uniformity in the point morphology indicates the general requirements of arrow points within the environmental and social contexts of the NM 22 sites.

Durability and penetration create the performance constraints reflected by the limited variation, but they are inversely related. The impact of their interaction on point length, point width, and blade width can be quantified using a ratio between point length and point width. Remembering that more "pointed" points tend to have better penetration but also tend to be more fragile, high ratios indicate that good penetration was the dominant performance characteristic. Low ratios indicate that the performance characteristic of durability was more important.

Previous analysis indicates that points from Ventana Cave, Arizona, were designed to encourage penetration, even at the expense of durability (VanPool 2002). The average ratio between the length and width of the Ventana Cave arrowheads is 1.73, that is, the average arrowhead from Ventana Cave is a little over two-thirds again longer than it is wide. This ratio allowed for good penetration, and can consequently be used as a yardstick to judge the interplay between the performance characteristics of durability and penetration of the NM 22 assemblage. If the NM 22 assemblage has an average ratio that is equal to or larger than the Ventana Cave points, then they, too, are designed to ensure excellent penetration. If their average ratio is less than the Ventana Cave assemblage, they are likely designed to emphasize durability.

The average ratio between point length and point width for the NM 22 points is 1.36 with a standard deviation of 0.33. The mean of 1.36 intuitively appears to be significantly less than the average ratio of 1.73 for the Ventana Cave points. This hypothesis can be evaluated using a Student t-Test. The null hypothesis for the Student t-Test is that the average ratio of the NM 22 points is statistically equal to 1.75. The level of rejection (alpha) is set at 0.05, and the null hypothesis can be evaluated by calculating 95 percent confidence intervals around the mean using the standard error. In this case, the standard error of the distribution is 0.042, which corresponded with an upper confidence interval of 1.45 and a lower confidence interval of 1.28. The confidence intervals do not encompass 1.75, necessitating that the null hypothesis must be rejected. The average ratio between point length and point width for the NM 22 points is in fact less than the average ratio for the Ventana Cave points. Given that the Ventana Cave points are designed to ensure good penetration (VanPool 2002), the lower ratio of the NM 22 points suggests that they are designed to be more durable. This conclusion is consistent with the fact that the NM 22 points are made primarily of obsidian and cryptocrystalline stone such as chert, whose smooth surfaces and sharp edges would naturally encourage good penetration but tend to be very fragile, especially compared to the course and durable basalt used to make the Ventana Cave assemblage (Haury 1975; VanPool 2002).

I therefore argue that the uniformity in point length and point width between the replicatively successful arrowhead classes from the NM 22 assemblage is the result of the need to create durable points that could survive long enough to allow penetration into the target and perhaps even be recovered, repaired as needed, and re-used. This performance requirement further explains the similarity in blade width between the classes. In about 93 percent of the cases, the maximum blade width corresponds with the maximum point width. As a result, the performance constraints affect both maximum point width and maximum blade width, because they are effectively the same variable. The emphasis on durable points is also illustrated in the similar medians of maximum blade thickness and maximum base thickness between the classes.

The widths and depths of both notches are also likely to be functional attributes. Odell and Cowan's (1986:202) experiment using atlatl darts and arrows to penetrate the skin of dogs illustrates the importance of securely hafting a projectile point. In their analysis, they found that points that were not properly hafted often twisted in the shaft, thereby greatly reducing penetration, even to the point that the projectile failed to break the target's skin. Arrowheads without formal hafting element preparation such as notching failed to even penetrate their targets. In contrast, only 12 percent of the notched arrowheads failed to penetrate their target. Although not the only means of securing a point onto a shaft, notching has a significant impact on the performance characteristics of hafting when it is present, causing it to be functional. Consequently, the depth and width of the notches are also functional, because they directly affect the morphology of the hafting element and the ability of the user to securely haft the point.

The differences between the medians of blade lengths, basal lengths, maximum basal widths, and minimum basal widths of corner-notched, side-notched, stemmed, and triangular arrow points suggests that the different classes did have some differences in their performance characteristics. Blade length is a functional characteristic because it affects the performance characteristics of durability and penetration. It impacts durability because it directly controls the portion of the point extending beyond the hafting element. As previously mentioned, Hughes (1998:371) observes that the portion of the point not directly protected by the projectile's shaft is most likely to break. Longer blades are more likely to break than shorter blades. Blade length affects penetration because it directly impacts the angle of the point's tip. Tips with more acute angles will tend to have better penetration than tips with wider angles, as previously outlined.

Examining the median blade length values for the four classes reported on Table 18.16 indicates that side-notched points have considerably shorter blade lengths than corner notched, stemmed, and triangular points, which are all fairly similar. Much of the reason for the difference in blade length is attributable to the fact that the blade length of corner-notched points are constrained by the location of the notches. In contrast, the blade length of corner-notched and triangular points are effectively limited only by the total length of the point. For example, a side-notched point with notches at one-third of its length will have a shorter blade length than a corner-notched point that has the same overall length. The effects of this are that the side-notched point will tend to be more durable but have less penetration, because of the decreased blade length and wider tip angle. The fact that the point lengths of all of the classes are the same but that the blade lengths of the corner-notched points are shorter suggests that side-notched points from the NM 22 sites tend to be more durable than points from the other classes, but have less penetration. Furthermore, the small Corrected CVs of less than 25 percent indicate that the distributions around the medians were quite tight for all of the classes, but especially the stemmed and triangular points, which tend to have longer blades than the side-notched points. This limited range of variation supports the argument that blade length did affect performance characteristics for these points, and that the differences between the classes is in fact the result of differences in performance characteristics.

The conclusion that side-notched points are designed to be more durable but to have less penetration is supported by the trends evident in basal length, maximum basal width, and minimum basal width. The statistically significant differences in basal length is driven by the large values for side-notched points and the small value of stemmed points when compared to corner-notched points (Tables 18.16 and 18.17). The longer bases of the side-notched points allow them to be securely hafted while protecting much of the point base with the shaft. The comparatively long base, therefore, increases durability, given that all of the classes have statistically the same median point length; more of the side-notched point is protected by the arrow shaft and less is exposed to unprotected stress, i.e., the blade length is smaller. The short bases of the stemmed points allow them to have blade lengths, and therefore penetrations and durability, similar to the corner-notched points. However, the short bases may also make the points hard to securely haft, and therefore may also negatively impact penetration.

The maximum and minimum widths of side-notched points are also statistically larger than the other classes (Tables 18.16 and 18.17). The wide bases will help increase the durability of the point, and the user's ability to securely haft the point. The effect of minimum basal width is particularly significant; the notch creates a naturally weak spot where the point can break easily (Hughes 1998:372). The wider the minimum basal width, the less likely the point is to break across the notches, all other variables being equal. Wider maximum widths allow for deep notches that will allow the point to be securely hafted while also helping to preserve a large minimum basal width. Of course, a wide base will reduce penetration because it increases the cross section of the point.

The fact that side-notched points have shorter blade lengths, and larger basal lengths, maximum basal widths, and minimum basal widths indicates that these points tend to be more durable than the points of the other classes. Still, all of the point classes have somewhat short blade lengths and point length to width ratios when compared to assemblages such as the Ventana Cave assemblage, which is composed of points designed to ensure good penetration, suggesting that all of the points are designed to be somewhat durable. The reason for this emphasis is likely attributable to the use of obsidian as a raw material (see Table 18.14).

Obsidian naturally allows for excellent penetration because of its sharp edges and smooth surface, but it is very fragile. Because of the use of this raw material, designing arrow points that morphologically emphasized penetration was likely unnecessary, especially when hunting small game such as rabbits, the most common faunal remain found at the NM 22 sites. Instead, the fragility of obsidian likely required that the points be made so as to balance penetration with durability, especially if the points were to be used more than once. Considering the frequency and location of breaks on the point can help evaluate the effect of the morphological variation on point durability.

Five types of breaks were defined for this analysis. These are broken tips (breaks to one-third of the blade that includes the point's tip), broken medial sections (breaks to the lower two-thirds of the point's blade), broken edges (breaks to the blade that do not carry across the point), broken tangs (breaks to the area directly adjacent to a notching or stem element), and broken hafts (breaks that carry across the base of a point).

One hundred and nine of the points in the replicatively successful classes (66 percent of the assemblage) had some type of break. The frequency of breaks by raw material is presented on Table 18.18. Collapsing the data into the more general raw material categories and break types illustrates that a significant portion of the total assemblage of both obsidian and chert points is

Table 18.18. Summary of the Co-occurrence of Breaks by Raw Material Type

Break Location	Basalt	Chert, White	Obsidian	Obsidian, Black Opaque	Obsidian, Jemez, Brown	Obsidian, Jemez	Obsidian, Polvadera	Rio Grande Chalcedony	Rio Grande Chert	Chert	Total
Edge	-	-	-	-	-		1	2	-	-	3
Edge and Haft	-	-	-	-	-	1	-	-	-	-	1
Edge and Tip	-	-	-	-	-	6	-	-	-	-	6
Edge, Tip, and Tang	-	-	-	-	-	1	-	-	-	-	1
Edge and Tang	-	-	-	-	-	3	-	-	-	-	3
Haft	-	-	-	2	1	13	1	2	2	-	21
Haft and Tip	1	-	-	1	1	9	1	-	-	-	13
Haft, Tip, and Tang	-	-	-	2	-	3	-	-	-	-	5
Haft and Tang	-	-	-	1	-	5	-	-	-	1	7
Medial	-	-	-	-	-	2	-	-	-	-	2
Medial and Tip	-	-	-	-	-	1	-	-	-	-	1
Tip	1	1	1	1	-	19	-	2	1	-	26
Tip and Tang	1	-	-	-	-	8	-	2	-	-	11
Tang	-	-	-	-	1	7	-	1	-	-	9
Total	3	2	1	11	4	123	5	15	3	1	168

Table 18.19. Frequency and Percentage of the Points with Each Type of Break Divided by Raw Material Type

Location of Break	Chert Frequency	Chert % of Assemblage	Obsidian Frequency	Obsidian % of Assemblage
Edge	2	17	12	9
Haft	5	42	41	31
Medial	0	0	3	2
Tip	6	50	54	41
Tang	4	33	31	24

Note: the same point can be represented twice, if it is broken in two or more locations.

broken (Table 18.19). Broken tips and breaks across the haft are by far the most common breaks, occurring at naturally fragile areas of the point. The tip is fragile because it is not protected by the hafting element of the shaft and is subjected to great stress during the initial penetration of the target and when striking hard surfaces such as bone and the ground. The notches make the haft fragile, because they create a naturally thin section of the point that is also the focal point for stress created by the point attempting to twist against the haft during impact.

Tables 18.20 and 18.21 report the locations and frequencies of breaks for each point type. Given that triangular points lack definable basal elements and that stemmed points do not have truly definable tangs, broken hafts are not possible on triangular points and broken tangs are not possible on either triangular or notched points.

The previous analysis suggests that the side-notched points are designed to be comparatively durable. Side-notched points do in fact appear to have proportionally fewer breaks than their replicatively more successful corner-notched counterparts (Table 18.21). A Chi-Square test can be used to determine if this apparent difference is statistically significant. Given that some break types are not applicable to triangular points and stemmed points, these point classes will be temporarily excluded from this analysis. Additionally, this test uses the percentages reported in Table 18.21, because the issue of interest is the frequency of breaks within each class, not the proportional frequency of breaks compared to other breaks. The null hypothesis for the test is that the same proportion of the corner-notched points have breaks at each location as do side-notched points. The level of rejection (alpha) is set at 0.05, and the results of the Chi-Square test are reported on Table 18.22. The Chi Square value is 12.50, which exceeds the critical value of 9.49 for 4 degrees of freedom. As a result, I must reject the null hypothesis. The analysis of adjusted residuals indicates that side-notched points are less likely to have broken edges, broken tips, broken hafts, and broken tangs than are the corner-notched points. As a result, I conclude that the side-notched points are in fact more durable than the corner-notched points.

Side-notched points are also more durable than triangular points as reflected by their comparatively small percentage of broken edges and tips (Table 18.21). Interestingly, stemmed points have fewer breaks than any of the other point types. The lack of broken hafts is explained by the fact that stemmed bases are very durable because they lack areas of acute weakness when compared to notched points and their bases are completely or nearly completely protected by the arrows' shafts. However, the blades of the stemmed points are morphologically identical to the blades of the corner-notched points, which demonstrate a high incidence of breakage compared to the side-notched points, and they are made using comparable raw materials. As a result, the lack of broken tips and other breaks to the points' blades suggests that the stemmed points weren't used as intensively, perhaps because they were difficult to haft, and thus weren't broken as frequently.

Table 18.20. Frequencies of Broken Points Divided by Arrow Point Class

	Haft Morphology				
	CN	SN	STEM	TRI	Total
Edge	-	-	-	3	3
Edge and Haft	1	-	-	-	1
Edge and Tip	5	-	-	1	6
Edge, Tip, and Tang	1	-	-	-	1
Edge and Tang	3	-	-	-	3
Haft	20	1	-	-	21
Haft and Tip	10	3	-	-	13
Haft, Tip, and Tang	5	-	-	-	5
Haft and Tang	6	1	-	-	7
Medial	1	1	-	-	2
Medial and Tip	1	-	-	-	1
Tip	8	3	1	14	26
Tip and Tang	7	2	-	2	11
Tang	7	1	-	1	9
Total	98	22	17	31	168

Table 18.21. Frequency and Percentage of the Points with Each Type of Break Divided by Arrow Point Class

Location of	CN		SN		STEM		TRI	
Break	Observed	%	Observed	%	Observed	%	Observed	%
Edge	10	10	0	0	0	0	4	13
Haft	42	43	5	23	0	0	NA	NA
Median	2	2	1	5	0	0	0	0
Tip	37	38	8	36	1	6	17	57
Tang	29	30	4	18	NA	NA	NA	NA

Note: the same point can be represented more than once, if it is broken in two or more locations.

Table 18.22. Chi Square Test Comparing the Percent Frequencies of Breaks between Corner Notched and Side Notched Arrowheads

Point Class	Break Location	Observed	Expected	Chi Square
CN	Edge	10	6.12	2.73
	Haft	43	39.31	0.32
	Median	2	3.95	0.92
	Tip	38	44.43	1
	Tang	30	28.64	0.03
SN	Edge	0	4.09	4.09
	Haft	23	26.27	0.48
	Median	5	2.64	1.38
	Tip	36	29.69	1.5
	Tang	18	19.14	0.05
		Chi Square Value = 12.5		
		Critical Value (0.05,4) = 9.49		

Step 4: Explaining the Differential Replicative Success of the NM 22 Points

The previous analysis has provided the description necessary for the creation of explanations for the form of the point technology reflected in the points collected from LA 249, LA 265, LA 6169, LA 6170, and LA 6171. The variation in point morphology can now be tied to the specifics of the prehistoric occupation of these sites.

The bow and arrow was clearly the preferred weapon system during the entire occupation of the sites, although six atlatl dart points suggest that the atlatl was also used on occasion. The bones of large ungulates such as deer suggested that perhaps the atlatl darts were used for hunting large animals. Another possibility, although one that is not directly supported by evidence from the six sites, is that the atlatl darts were used during small-scale warfare or feuding.

Corner-notched arrow points were far and away the most replicatively successful of the point classes. These points were designed to allow good penetration as evidenced by the use of obsidian and cryptocrystalline materials such as chert, but to also be somewhat durable as illustrated by the small ratio between point length and width when compared with arrowheads from Ventana Cave, Arizona. The reasons for the excellent replicative success of corner-notched points probably relate to their excellent penetration created by long blade widths and the ability to haft them securely. Furthermore, the presence of backward-pointing barbs created by the point's tangs would not have allowed the point to easily slip from a wound. Thus, the point would have remained in the animal causing additional bleeding if the animal was not killed immediately and could potentially allow the arrow shaft to be easily recovered. Additionally, the notches would have allowed the point to be securely fastened onto the arrow shaft, and would thereby have helped penetration by preventing the point from twisting when it initially encountered the target. However, the notch created a weak section on the point haft, resulting in frequent breaks to the hafting element. These points would have been ideal for use in hunting the medium-sized game such as deer, as well as the smaller game such as rabbits.

The other replicatively successful arrow point classes are side-notched, stemmed, and triangular points. These classes are much less replicatively successful than the corner-notched points. However, their presence indicates that the inhabitants of the six sites used them consistently through time. I argue that the reason for their comparatively limited replicative success is related to the ability of the user to securely haft them. Triangular and stemmed points in particular can be difficult to haft. Triangular points are little more than sharp bifaces that can be mounted onto an arrow shaft. The lack of a formal base makes them more difficult to securely haft, however. Stemmed points do have a formal, but narrow, base. The lack of a wide base at the portion of the basal end of the point will allow them to twist in the shaft more easily than a corner-notched or side-notched point. This can greatly impact penetration, as Odell and Cowan's (1986) study has demonstrated. The lack of breakage to the blades of stemmed points further illustrates that the points were not heavily used, and were frequently discarded before the development of catastrophic breaks.

Corner-notched points are angled so that their blade reaches its widest point effectively at the point's maximum length. This allows for a gradual expanding of the wound to allow the smooth transition of the point and shaft into the wound, and a comparatively small angle from a point's tip to its end.

The notches of side-notched points did allow them to be securely hafted. However, these points would naturally have less penetration than their similarly sized corner-notched counterparts, because the cutting edges of the side-notched points are shorter and the angle of their tip is larger. Side-notched points concentrate the cutting edge of the point on only the portion of the point above the notch. This requires a more abrupt penetration of the target without a gradual enlargement of the wound, but would have made them more durable. Given the general availability of excellent raw material in the region and the ease with which new points could be manufactured, durability was likely not a tremendously significant performance characteristic, as is reflected by the only moderate reproductive success of the side-notched points.

Stemmed and triangular points would have limited penetration as well. Blade length of stemmed points would be contingent on the length of the stem (and vice-versa.) As a result, a stemmed point would either have a shorter blade length, and therefore less penetration, or a less well-defined base, and therefore be less securely hafted, when compared to a corner-notched point with the same total length and maximum width. The hafting of triangular points would have interfered with part of the cutting edge on the points, and therefore would have prevented the smooth transition from the point to the shaft that a corner-notched point would provide.

Ultimately, I argue that the corner-notched points were favored because they are more versatile. They allowed excellent penetration, while also preventing the point from falling out of a wound. This would have helped allow for the recovery of the point, and perhaps even more importantly, the arrow shaft. These points could be securely fastened into the shaft when compared to triangular and stemmed points, and would have been more durable than various alternatives that were possible. Their excellent penetration further allowed them to be used for both large game and small game. As a result, the performance characteristics of the corner-notched points made them generally more useful than their counterparts, and lead to their higher replicative success.

Chapter 19
Ground Stone Artifacts

Jesse Murrell

A technological approach, which incorporates an analysis of wear patterns, tool efficiency, and grinding intensity, is adopted for the analysis of ground stone tools (Adams 1993:331–332, 1996, 1999:476). An understanding of technological organization (Binford 1979:255; Kelly 1988:717; Nelson 1996:185) necessitates consideration of an artifact's entire historical continuum, from initial material selection to discard or abandonment in archaeological context. Intermediate points in this continuum may include manufacture, use, maintenance, and reuse. These may leave morphological or wear-pattern signatures on ground stone tools, such as the flaking of tool margins that reflects manufacture, striations across the tool's surface that reflect use, or pecking across the tool's use surface that reflects maintenance. The objective of technological studies is to clarify how technological changes reflect behavioral changes (Kelly 1988:717). Studies of chipped stone assemblages have explored the relationships between technological organization and mobility as well as land use (Bamforth 1991; Shott 1986). Here, an attempt will be made to measure diachronic variability in material selection, grinding efficiency, and grinding intensity, which may demonstrate technological change. For instance, in the case of food processing tools, such as manos and metates, shifts in grinding surface area through time reflect variation in tool efficiency, which may provide insights into subsistence strategies (Plog 1974:139–141; Lancaster 1983:2–3, 1984:256, 1986:188; Hard 1986: 9–10,103,105–108, 1990:136–138; Mauldin 1991:59, 61, 1993:318–322; Diehl 1996:105–106).

Material

An artifact's life history begins with material selection. Glassy and cryptocrystalline materials, such as obsidian and chert, are not well suited for most ground stone tool functions. These materials are better suited to cutting, scraping, and piercing functions. Fine to coarse-grained materials are better suited or more easily modified to accommodate ground stone tool functions. A fairly wide range of materials, including igneous, sedimentary, and metamorphic rocks, were utilized for ground stone tools (n = 311) at the investigated sites. The majority of these materials are igneous (67 percent), followed by sedimentary (21 percent) and metamorphic (12 percent).

Most of the igneous materials, with the possible exception of the igneous, unspecified type, are extrusive or volcanic rocks. The origin of these rocks is three episodes of Quaternary and Tertiary period volcanism in the Jemez Mountains. Important for this study is the Tertiary period Keres Group volcanism that occurred along the Cañada de Cochiti fault zone about 13 to 6 million years ago, making it the oldest of the Jemez Mountain volcanic groups. Formations in the Keres Group, such as the Bearhead Rhyolite, Peralta Tuff, and Intrusive and Volcanic Rocks of the Bland District, include andesite, basalt, rhyolite, and tuff . In secondary context, these materials are available from exposures of the Cochiti Formation (LeTourneau et al. 1997:4, 18–19). Warren (1977:24) notes that pumice originating in the Bandelier Tuff is common in secondary deposits in the vicinity of the project area, namely the Pajarito Plateau, Cerros del Rio, and White Rock Canyon. Vesicular basalt is commonly derived from surface flows of the Cerros del Rio basalts. Red scoria is also common on Cerros del Rio Mesa and outcrops on both sides of the Rio Grande at its confluence with Bland Canyon (Warren 1977c:24, 28).

Visually distinguishing between basalt and andesite is difficult. Both derive their dark color from a ferromagnesian mineral content. Andesite, which can contain excess silica, is more commonly aphanitic-porphyritic, while basalt is more commonly aphanitic. Rhyolite generally contains excess silica, is lighter in color, and is aphanitic-porphyritic. Surface flows of both rhyolite and basalt can have a vesicular structure (Chesterman 1995:684–690). They are differentiated on the basis of color, presence of phenocrysts, and siliceous appearance. Regarding this assemblage, vesicular rhyolite generally has a greater groundmass to vesicle ratio than vesicular basalt.

The metamorphic rocks, including metaquartzite, schist, and probably the metamorphic-unspecified, along with sedimentary rocks, including sandstone and orthoquartzite, are available in secondary contexts from the Totavi Lentil gravels of the ancestral Rio Grande. The Totavi Lentil also contains volcanic materials (Warren 1977c:17, 26).

A wide range of materials are available in the axial gravels of the Rio Grande. Many of the previously mentioned materials are available here in secondary context. It appears that all of the materials used for ground stone tools are locally available.

Manufacture and Maintenance

Some ground stone tools have a less complicated history than others. Expedient or informal tools are modified only through use, and therefore retain much of their natural form. They lack evidence of production input and maintenance. Conversely, formal tools may exhibit some degree of production input that includes the initial shaping of a raw material usually through pecking, flaking, or grinding. Formal tools may also exhibit evidence of maintenance in the form of pecking across a well-worn ground surface, which serves to sharpen it. This is usually accomplished with repeated strikes against the worn use surface of the tool with a hammerstone (Bartlett 1933:4; Lancaster 1983:62). Bartlett (1933:4) reports that the historic Hopi engaged in this type of maintenance as often as once every five days and that it, too, may lead to a significant amount of wear. Horsfall (1987:341), who studied the contemporary ground stone tools of San Mateo Ixtatan, Guatemala, reports that metates need sharpening about three times a year or more. Ground stone tools of vesicular igneous materials, which can include basalt, rhyolite, scoria, and tuff, are considered self-sharpening because they maintain a coarse grinding texture without the need for pecking. Tools of this material may be considered formal. The nature of vesicular material can obscure definitive evidence of production input, especially pecking.

Use

Several use-related variables were monitored during the course of this analysis. These include wear patterns, use surface cross-section form, presence of adhesions, and the number of use surfaces.

The examination of wear patterns gives the analyst clues on how the artifact was used. Indications of wear on the surfaces of ground stone included polish, striations, and grinding/faceting. Polish, a lustrous sheen, is usually formed by an abrasive or a depositional process (Zier 1981:14). Adams (1988:310) attributes the polish on hide processing stones to the deposition of tribochemical reaction products enhanced by the friction created by contacting surfaces. A striation is a linear scratch from which the surface material has been displaced or deformed (Zier 1981:14). The orientation and linearity of striations point to how the handstone or ground material was moved across the netherstone (Adams 1996:8). For instance, curvilinear striations reflect a rotary motion, while unidirectional linear striations reflect a consistently oriented reciprocal motion. Battering wear is a crushing of the grains of a material through impact with another hard and resistant material. Grinding/faceting wear is expressed by the faceting of a use surface or in some instances of the individual grains of a material. Striations or polish are not visible if grinding/faceting wear is recorded. An example is a well-worn cobble mano with a slightly convex faceted use surface, but lacking striations or polish.

The use-surface cross-section form variable was especially useful in classifying ground stone fragments. Generally, handstones have a convex or flat use-surface cross section, while netherstones have a concave or flat cross section. For fragments, the cross-section form was recorded for the artifact's long axis. Fragmentary formal tools with convex, concave, and flat cross-section forms were classified as fragmentary manos, fragmentary metates, and indeterminate ground stone fragments, respectively. Ground stone fragments lacking evidence of formal manufacture or maintenance regardless of cross-section form were classified as indeterminate ground stone fragments. For grinding slabs, expedient handstones, and manos, the longitudinal cross section was taken into account. For metates, the transverse cross section was recorded in anticipation of more variability than expressed in the longitudinal cross section, which was likely to be consistently concave. However, in this assemblage, even slab metates, which are generally thought to have flat transverse cross sections, all have slightly concave transverse cross sections.

Adhesions provide indications of how ground stone tools were used. In this assemblage, adhesions include hematite, limonite, red clay, and a resin. Pigment grinding is evidenced by adhering hematite and limonite. Warren (1977c:24, 29) notes the occurrence of hematitic sandstone underlying basalt flows in White Rock Canyon as well as clayey red and yellow pigments located on the east side of the Rio Grande across from the mouth of Bland Canyon. The sources are considered locally available. The red clay is reminiscent of the clayey pigments described by Warren (1977c:24, 29) and points to the processing of clay or pigments or both. The resin probably served as some type of mastic.

Multiple use refers to multiple wear patterns that occupy discrete areas of a single tool. These different patterns suggest that the tool served a multiplicity of functions. An example is a handstone that exhibits facial striations and a battered end, suggesting that it was employed in both grinding and hammering. A similar wear pattern evidenced on adjoining surfaces or two opposing use surfaces indicates the practice of a wear management technique (Mauldin 1993:322; Adams 1993:335–336, 1996:5–6) whereby rotating the proximal and distal ends of a mano or the opposing surfaces of a mano or metate prolongs the tool's use-life and reflects grinding intensity.

Reuse

On occasion, an artifact that has become inefficient or that can no longer function in its original capacity will neither be rejuvenated through maintenance nor discarded, but rather reused. Two types of reuse were recognized during this analysis.

As defined by Schiffer (1987:29), "recycling is the return of an artifact after some period of use to a manufacturing process." Regarding ground stone, recycling is identifiable from morphological and wear pattern evidence. From this assemblage, a prime example is a metate fragment that was reshaped through flaking and was then used as a chopper. If the artifact is entirely reshaped, evidence of its primary use may be lost, but, in this case, the metate's original edge provided a good backing for a new chopper edge flaked along its fractured margin. The artifact's primary wear pattern remained discernible, but the artifact could no longer function in this capacity.

Modification is unnecessary for an artifact's secondary use (Schiffer 1987:30). Secondary use occurs when an artifact is used in a different way without revisiting the manufacturing stage of its historical continuum. Secondary use can be identified through wear pattern or contextual evidence (Schiffer 1987:30). A mano reused in a rock-filled roasting pit and a mano reused as a grooved abrader are examples of secondary use. Regarding wear patterns, secondary use is identifiable when one wear pattern overlies another. If there is no superimposition, the tool may exemplify multiple use rather than secondary use.

Discard and Abandonment

An artifact enters archaeological context when it is discarded or abandoned. This refuse can take one of several forms. As defined by

Schiffer (1987:47, 58, 89–90) non-functioning artifacts are discarded as primary or secondary refuse depending on whether they are in their location of use or elsewhere, respectively, whereas functioning artifacts that are abandoned in their location of use are de facto refuse. In this analysis, de facto refuse must be whole or reconstructible. Caching, or storage in anticipation of future use or reuse, may be manifest in multiple functioning artifacts that are transported from their location of use to another more unobtrusive location or facility. An evaluation of archaeological context is key in determining where ground stone artifacts were actually used, simply discarded, or stored for reuse (Adams 1996:10).

Artifact Types

The following section presents a brief definition for each of the artifact types identified during this analysis.

Anvils are large informal netherstones that may exhibit facial battering, crushing, pecking, and/or occasional striations as if acted upon by a hammerstone.

Indeterminate Ground Stone Fragments may exhibit a variety of wear patterns including striations, polish, and/or faceting. These fragments are either formal tools with flat use surfaces that cannot be positively identified as mano or metate fragments or they are informal tools exhibiting a wide range of use surface cross-section forms.

Mano Fragments exhibit evidence of production input and/or maintenance. They exhibit a convex use surface cross-section form as well as a variety of wear patterns. Their fragmentary condition precludes classification as either one or two-hand manos. A ground, upturned end may indicate that the original mano was used in a trough metate.

One-hand Manos first appear in the Archaic period when the subsistence base is more diversified and there is little if any dependence on agriculture (Lancaster 1983:17). One-hand manos are a more general grinding tool serving multiple functions including processing agricultural and wild food resources, hides, pigments, and pottery clays (Lancaster 1983:34; Adams 1989:307; Mauldin 1993:321).

Two-hand Manos are primarily used for processing agricultural grains (Lancaster 1983:17; Mauldin 1993:321). One-hand manos are thought to have been utilized primarily with basin metates in a rotary fashion, while two-hand manos were utilized with trough or slab metates in a reciprocal fashion (Eddy 1964:3).

Different researchers have employed different criteria for defining mano types. Based on a cluster analysis of a scattergram plot of the lengths and widths of whole manos from the Mimbres Valley, Lancaster (1983:18–20) proposes that one-hand manos (Type I) are less than or equal to 13.2 cm in length and less than or equal to 11.5 cm in width, while two-hand manos (Type II) are greater than these measurements. Diehl (1996:109) observes a bimodal distribution in the grinding area measurements of 1,007 manos from the upland Mogollon Pithouse period. There is not a complete break but there is an overlap at 128 sq cm. He proposes that one-hand manos have a grinding area of less than 128 sq cm and that two-hand manos have a grinding area that is greater than this measurement. Mauldin (1991:63, 1993:323) observes a bimodal distribution in a histogram of use-surface area measurements for 1,300 manos from the upland Mogollon Pithouse and Pueblo periods. This pattern suggests a break at approximately 75 sq cm. This measurement became his separation point between the larger manos that were probably involved in food processing and those more likely involved in other activities.

In this analysis, one-hand manos are defined as having use-surface areas that measure 13,000 sq mm or under, while two-hand manos have use-surface areas that measure over this amount. These criteria are roughly comparable to that established by Diehl (1996:109). Both types are likely to manifest a convex use-surface cross section and an oval to subrectangular plan view outline. Two-hand manos are less likely to exhibit curvilinear or multidirectional linear striations, which indicate movement in a rotary or inconsistently oriented manner. These wear patterns are more likely to occur on one-hand manos used in a basin metate. If striations are present, two-hand manos generally exhibit unidirectional linear striations indicating movement in a consistently oriented reciprocal manner. One-hand manos may also display evidence of use in this manner. A lack of wear on the ends of a two-hand mano may suggest that it was used with a slab metate, whereas ground, upturned ends suggest use with a trough metate.

Metate Fragments exhibit evidence of production input and/or maintenance. They display a concave use-surface cross-section form as well as a variety of wear patterns. Lateral edge fragments of trough metates can be positively identified by their characteristic elevated edge with an abrupt, high-angled concavity. Slab or basin metate fragments may not be identifiable unless a large end fragment, which contains an end and lateral edges, is recovered.

Slab Metate does not refer to the flat/concave metates (Adams 1996:24, 1999:482) or the slab or flat netherstones (Haury 1950:305–308; Dick 1965:51–53; Sayles 1983:68–69) commonly associated with Archaic or early formative cultures. Slab metates are formal netherstones that were commonly used with a two-hand mano that was as long as the metate is wide giving the metate a flat or slightly concave transverse use-surface cross section. If the cross section is slightly concave, it measures under 1 cm in maximum depth. The longitudinal use surface cross section is usually concave. If striations are apparent on the use surface, they are generally linear, unidirectional, and parallel the metate's longitudinal axis indicating that the metate was used with a mano that was moved in a reciprocal manner paralleling the metate's longitudinal axis. Slab metates lack edges that can contain the ground product, so they are commonly set in mealing bins (Bartlett 1933:14–15, figs. 5, 7 for modern Hopi examples).

Basin Metates are formal netherstones that have an oval to elliptical use surface in plan view and a concave use surface in both longitudinal and transverse cross section. The basin is usually centrally located and encircled by the higher elevated edges. The basin can be shallow to deep with gently to steeply sloping walls, respectively. The basin metate's edges can contain the ground product. If striations are apparent on the use surface, they can be linear and unidirectional indicating reciprocal mano movement, they can be linear and multidirectional indicating either reciprocal mano movement that is not consistently oriented or rotary mano movement, and/or they can be curvilinear indicating rotary mano movement. Basin metates are generally used with one-hand manos that allow for the wear of the characteristic concave basin.

Trough Metates are formal netherstones that have oval to subrectangular use surfaces in plan view and have a concave use surface in both longitudinal and transverse cross section. In transverse cross section the concavity is high angled at the edges and rounds out to a slight concavity across the base. These steep edges act to contain the ground product. Trough metates have several end configurations including forms with both ends open, one end open, and both ends closed. Trough metates with both ends open are also known as through troughs (Lancaster 1983). If striations are apparent on the use surface, they are generally linear and unidirectional, indicating reciprocal mano movement. Trough metates are generally used with two-hand manos that are not long enough to span the entire width of the metate. This gives the metate its characteristic form.

Grinding Slabs are informal netherstones that exhibit a diversity of use-surface cross-section forms including flat, concave, convex, and irregular or sinuous. They also exhibit a relatively wide range of sizes and could be described as hand-held, lap-held, and self-supported. Wear can be minimal or patchy and can include a diversity of wear patterns, such as striations, polish, and faceting. Grinding slabs may be used with a handstone or by grinding a hand-held material directly on the use surface.

Expedient Handstones are informal tools that exhibit a flat or convex use-surface cross section. Wear can be minimal or patchy and can include a diversity of wear patterns, such as striations, polish, and faceting. Expedient handstones may be used with a netherstone or by direct application on the worked material without the use of a netherstone.

Mauls are formal tools. All specimens have a full groove shaped by pecking and/or grinding. The groove probably supported a haft. Maul ends display crushing, battering, and/or pecking wear from use as a hammer.

Axes are formal tools that show evidence of production input in the form of flaking, pecking, and/or grinding. This shaping is usually restricted to the manufacture of the bit through flaking and the hafting element, which is either notched through flaking or grooved through pecking and/or grinding. The wear pattern may include crushing and/or step fracturing along the bit edge as well as facial striations. Axes probably functioned in a variety of chopping and wedging tasks.

Hoes are formal tools that may display evidence of hafting as well as distal and lateral bimarginal flaking and step fracturing. This flaking and step fracturing may be overlain by rounding, polish, and/or striations. Facial striations may also be evident. Hoes are commonly associated with horticultural or agricultural field preparation and maintenance.

Mortars are formal netherstones of variable size that have use surfaces that are circular to oval in plan view and concave in cross section. Near the edges, the concavity can be relatively high angled. These edges contain the crushed and/or ground product. Wear patterns may include pecking and/or grinding.

Pestles are relatively cylindrical or oblong handstones that are used to crush and/or grind a resource. Pestles may be used with mortars. Wear patterns may include crushing and grinding wear as well as striations concentrated on the ends of the artifact. The wear pattern may extend a short distance up the lateral margins from the ends.

Polishing Stones are informal tools with a wear pattern consisting of a lustrous polish and overlying striations. They are usually small and finger-gripped. Polishing stones are commonly associated with ceramic production.

Shaped Slabs show no evidence of use. They are modified strictly through manufacture, which usually consists of flaking the margins. They are commonly used as architectural elements, such as bin walls, vent covers or dampers, entryway hatch covers, or as lids for ceramic containers.

Stone Balls are small spheres with relatively equal lengths, widths, and thicknesses and circular plan view outlines. In this assemblage, none display evidence of production input or use, with the exception of one with a possible impact fracture. This makes their designation as an artifact type separate from manuports tentative, but the possible impact fracture hints at their use as projectiles.

Unmodified Cobbles and Pebbles with Pigment have adhering pigment residue, but otherwise retain their natural form.

Picks are formal tools. Evidence of production input may take the form of flaking to notch a hafting element or minimal flaking of the bit. They are distinguished from axes by their elongated and more pointed bits that appear less suited to chopping. Facial striations as well as rounding and step fracturing of the bit may be included in wear patterns. Picks may have functioned in digging or tilling tasks.

Hide Processing Handstones may exhibit polish overlain by an occasional striation (Adams 1989:312). Evidence of production input may be minimal. Pumice is commonly included in the modern hide-workers toolkit and is applied to both the hair and flesh sides of a hide, although a finer pumice is better suited for the flesh side. Materials other than pumice may be used but must have a sufficiently gritty texture (Edholm and Wilder 1997:38, 39, 218, 227).

Grooved Abraders are usually handstones that exhibit a linear u- or v-shaped groove. Generally, they lack evidence of production input, however use-wear can obscure this evidence. A material with a coarse grinding texture may be more commonly employed.

MAGNIFICATION

All ground stone was inspected macroscopically and most was inspected microscopically with the aid of a binocular microscope set at 8 to 40 power. Large artifacts, namely the metates, were inspected with an 8 power hand lense rather than a binocular microscope. This low-power magnification was especially useful in making determinations of material texture, wear pattern, and the presence of adhesions.

MEASURING DIMENSIONS, CALCULATING USE-SURFACE AREA, AND PRESENTING DESCRIPTIVE STATISTICS

Maximum linear dimensions were measured using calipers with a 15 cm capacity. For larger artifacts, namely metates, a meter rule was used. Length, width, and thickness are perpendicular maximum linear dimensions. Lengths and widths of the use surfaces of whole artifacts were measured. For oval-shaped use surfaces, use-surface area was calculated using the following equation: use-surface area = (use-surface length)(use-surface width)(0.8). For subrectangular use surfaces, use-surface area was calculated using the following equation: use-surface area = (use-surface length)(use-surface width)(0.9). For circular use surfaces, use-surface area was calculated using the following equation: use-surface area = (pi)(use-surface radius)^2. The maximum depths of all whole metates and mortars were measured by placing a straight edge across the artifact's transverse cross section and recording the maximum linear measurement between this straight edge and the base of the artifact's use surface. Depth or curvature is not taken into account in calculating use-surface area, therefore all use-surface areas are approximations. In the site data presentation section which follows, a table that includes mean and standard deviation statistics as well as a minimum and maximum range for each measurement will be presented if the sample size is greater than or equal to five.

DESCRIPTION AND DATA PRESENTATION

LA 249

LA 249 yielded nine ground stone artifacts from eight separate analytic units (Table 19.1). A total of five different artifact types were identified. The most frequent artifact types are indeterminate ground stone fragments (33.4 percent) and expedient handstones (22.2 percent). The artifact type distribution suggests that the site's occupants were involved in a fairly limited range of grinding activities including agricultural produce processing as well as grinding tasks involving informal tools. The recovery of a fragmentary axe and a fragmentary axe or hoe suggests that the site's occupants were also involved in chopping tasks and possibly horticultural or agricultural field preparation and/or maintenance.

Indeterminate Ground Stone Fragments. Three indeterminate ground stone fragments were recovered from LA 249 (Table 19.2). FS 278, which is heat fractured, was secondarily used as a heat-retaining element in a cobble-filled thermal feature (Feature 7). FS 209 and FS 305 were recovered from secondary refuse deposits. All are of igneous material and all appear to represent informal tools. FS 305 has two opposing use surfaces, both exhibit a moderately lustrous polish and linear unidirectional striations paralleling the artifact's short axis. The striations indicate that the artifact was used in a consistently oriented reciprocal motion. The fragment's maximum linear dimensions range from 85 to 119 mm.

Mano Fragments. A single mano fragment (FS 307) was recovered from an extramural feature (Feature 8). It is an end fragment of a mano that was manufactured from a coarse-grained rhyolite by grinding. It exhibits linear unidirectional striations, a convex use-surface cross section, and lacks evidence of maintenance. The artifact has a maxi-

Table 19.1. Artifact Type by Analytic Unit, LA 249

N Row % Column %	Midden	Feature 7, Hearth	Structure 6 Fill, Stratum 29c	Structure 6 Fill, Stratum 50	Structure 6 Floor, Stratum 60	Feature 5	Test Grid, 142N 114E	Feature 8	Total
Indeterminate	1	1	-	-	-	-	1	-	3
ground stone fragment	33.3%	33.3%	-	-	-	-	33.3%	-	100.0%
	100.0%	100.0%	-	-	-	-	100.0%	-	33.3%
Mano fragment	-	-	-	-	-	-	-	1	1
	-	-	-	-	-	-	-	100.0%	100.0%
	-	-	-	-	-	-	-	100.0%	11.1%
Grinding slab	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	100.0%	-	-	100.0%
	-	-	-	-	-	100.0%	-	-	11.1%
Expedient handstone	-	-	-	1	1	-	-	-	2
	-	-	-	50.0%	50.0%	-	-	-	100.0%
	-	-	-	50.0%	100.0%	-	-	-	22.2%
Fragmentary axes	-	-	1	1	-	-	-	-	2
	-	-	50.0%	50.0%	-	-	-	-	100.0%
	-	-	100.0%	50.0%	-	-	-	-	22.2%
Total	1	1	1	2	1	1	1	1	9
	11.1%	11.1%	11.1%	22.2%	11.1%	11.1%	11.1%	11.1%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19.2. Indeterminate Ground Stone Fragments, LA 249

FS No.	Analytic Unit	Material	Condition	Cross Section	Wear Pattern	Maximum Dimension (mm)
209	Test grid, 142N, 114E	igneous, not specified further	edge fragment	concave	grinding/faceting	85
278	Feature 7, Hearth	coarse-grained rhyolite	medial fragment	convex	grinding/faceting	119
305	Midden, Feature 2	andesite	end fragment	convex	polish and linear unidirectional striations, parallel to short axis	99
309	Structure 6 fill, Stratum 29c	andesite	edge fragment	convex	linear multidirectional striations	68

mum linear dimension of 131 mm. Its ground end suggests that it was used with a trough metate.

Grinding Slab. One large grinding slab (FS 292) was recovered from Feature 5. It is basalt and displays an irregular plan view outline with a convex use-surface cross section. The use surface exhibits a moderately lustrous polish and linear unidirectional striations paralleling the artifact's longitudinal axis indicating a consistently oriented reciprocal grinding motion. The artifact measures 374 mm long by 301 mm wide by 135 mm thick. Its use surface measures 249 mm long by 154 mm wide giving it an area of 30,678 sq mm. This is the largest grinding slab area recorded from the project.

Expedient Handstones. Two expedient handstones (FS 326 and FS 329) were recovered. FS 326 is from Stratum 50 in Structure 6 fill and likely represents secondary refuse, while FS 329 is from the floor of Structure 60 and may represent de facto refuse. Both are flattened cobbles of fine-grained rhyolite that lack evidence of production input and maintenance. FS 326 is oval shaped in plan view and has a convex use surface cross section. Its use surface exhibits a moderately lustrous polish and linear unidirectional striations that are obliquely oriented to the artifact's short axis. The striations indicate a consistently oriented reciprocal grinding motion. The artifact measures 70 mm long by 60 mm wide by 28 mm thick. Its use surface measures 60 mm long by 44 mm wide, giving it an area of 2,112 sq mm. FS 329 displays two opposing use surfaces. It is circular in plan view and both use surfaces are sinuous in cross section. Both use surfaces display linear multidirectional striations indicating an inconsistently oriented or a rotary grinding motion. Multiple use is apparent along the edges in the form of battering and flake removal. This wear pattern is consistent with that of a hammerstone.

Fragmentary Axes. At least one fragmentary axe (FS 283) was recovered. It was recovered from Stratum 50 of Structure 6 fill and may represent secondary refuse. It is a bit end fragment of an axe that was manufactured from fine-grained rhyolite. The fragment displays two opposing lateral notches that were created by bifacial flake removal. The bit edge exhibits bimarginal flake removal and step fracturing as well as discontinuous edge rounding with a slight lustrous polish. The opposing faces of the artifact exhibit few linear multidirectional striations. The wear pattern appears to be consistent with a chopping and/or wedging function. The entire flaked edge, which extends laterally toward the notches, measures 165 mm. The bit edge has an angle of approximately 60 degrees. The maximum linear dimension of this fragmentary axe is 125 mm.

FS 309 appears to be a bit edge fragment of an axe or hoe manufactured from a fine-grained andesite. It was recovered from Stratum 29c of Structure 6 fill and represents secondary refuse. The incomplete edge displays bimarginal flake removal and step fracturing. The opposing faces exhibit linear multidirectional striations. The edge has an angle of approximately 55 degrees. The artifact has a maximum linear dimension of 68 mm.

LA 265

LA 265 yielded 74 ground stone artifacts from 26 separate analytic units (Table 19.3). Ground stone from the upper fill of SU 1, an Early Developmental period pit structure, has the highest relative frequency comprising 23 percent of the site assemblage, while ground stone from other analytical units comprises less than 7 percent each. A total of 15 different artifact types were identified. The most frequent artifact types are metate fragments (28.4 percent), indeterminate ground stone fragments (20.3 percent), and mano fragments (16.2 percent). The artifact type distribution suggests the site's occupants were involved in a fairly wide range of grinding and other activities including ground stone tool manufacture and maintenance, wild vegetal resource processing, agricultural produce processing, pigment processing, horticultural or agricultural field prepara-

Table 19.3. Ground Stone Artifact Type by Analytic Unit, LA 265

N	462N	SU 1	SU 1	SU 1	SU 4	SU 4	SU 4	SU 13	SU 13	SU 13	SU 13	SU 2	SU 2
Row % Column %	Backhoe Trench	Upper Fill	Roof Fall	Structure Floor Contact	Roof Fall	Structure Floor Contact	All Floor Features	Upper Fill	Roof Fall	Vent Shaft Fill	Human Burial Subfloor	Keyhole Structures and Internal Features	Large Bell-shaped Pits
Indeterminate ground	-	5	1	1	2	1	-	-	-	-	-	1	3
stone fragment	-	33.3%	6.7%	6.7%	13.3%	6.7%	-	-	-	-	-	6.7%	20.0%
	-	29.4%	20.0%	33.3%	100.0%	50.0%	-	-	-	-	-	50.0%	60.0%
Mano fragment	1	3	-	1	-	-	-	1	-	-	-	-	-
	8.3%	25.0%	-	8.3%	-	-	-	8.3%	-	-	-	-	-
	50.0%	17.6%	-	33.3%	-	-	-	100.0%	-	-	-	-	-
One-hand mano	-	-	1	-	-	-	-	-	-	-	-	-	-
	-	-	100.0%	-	-	-	-	-	-	-	-	-	-
	-	-	20.0%	-	-	-	-	-	-	-	-	-	-
Two-hand mano	-	1	-	-	-	1	-	-	-	-	-	-	-
	-	50.0%	-	-	-	50.0%	-	-	-	-	-	-	-
	-	5.9%	-	-	-	50.0%	-	-	-	-	-	-	-
Metate fragment	1	3	3	1	-	-	1	-	1	-	-	-	-
	4.8%	14.3%	14.3%	4.8%	-	-	4.8%	-	4.8%	-	-	-	-
	50.0%	17.6%	60.0%	33.3%	-	-	50.0%	-	50.00%	-	-	-	-
Basin metate	-	-	-	-	-	-	-	-	-	-	1	-	-
	-	-	-	-	-	-	-	-	-	-	100.0%	-	-
	-	-	-	-	-	-	-	-	-	-	100.0%	-	-
Grinding slab	-	-	-	-	-	-	-	-	-	-	-	1	2
	-	-	-	-	-	-	-	-	-	-	-	33.3%	66.7%
	-	-	-	-	-	-	-	-	-	-	-	50.0%	40.0%
Expedient handstone	-	1	-	-	-	-	-	-	-	-	-	-	-
	-	33.3%	-	-	-	-	-	-	-	-	-	-	-
	-	5.9%	-	-	-	-	-	-	-	-	-	-	-
Hoe	-	-	-	-	-	-	-	-	1	-	-	-	-
	-	-	-	-	-	-	-	-	100.0%	-	-	-	-
	-	-	-	-	-	-	-	-	50.00%	-	-	-	-
Mortar	-	-	-	-	-	-	1	-	-	-	-	-	-
	-	-	-	-	-	-	25.0%	-	-	-	-	-	-
	-	-	-	-	-	-	50.0%	-	-	-	-	-	-
Shaped slab	-	2	-	-	-	-	-	-	-	1	-	-	-
	-	50.0%	-	-	-	-	-	-	-	25.0%	-	-	-
	-	11.8%	-	-	-	-	-	-	-	50.0%	-	-	-
Stone ball	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble with pigment	-	-	-	-	-	-	-	-	-	1	-	-	-
residue, otherwise	-	-	-	-	-	-	-	-	-	50.0%	-	-	-
unmodified	-	-	-	-	-	-	-	-	-	50.0%	-	-	-
Hide-processing	-	1	-	-	-	-	-	-	-	-	-	-	-
handstone	-	100.0%	-	-	-	-	-	-	-	-	-	-	-
	-	5.9%	-	-	-	-	-	-	-	-	-	-	-
Grooved abrader	-	1	-	-	-	-	-	-	-	-	-	-	-
	-	100.0%	-	-	-	-	-	-	-	-	-	-	-
	-	5.9%	-	-	-	-	-	-	-	-	-	-	-
Total	2	17	5	3	2	2	2	1	2	2	1	2	5
	2.7%	23.0%	6.8%	4.1%	2.7%	2.7%	2.7%	1.4%	2.7%	2.7%	1.4%	2.7%	6.8%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.00%	100.0%	100.0%	100.0%	100.0%

Table 19.3. Continued.

N Row % Column %	SU 2 Buried Hearths	SU 3 Feature 7	SU 3 Feature 3 Upper Ash	SU 3 Feature 14 NW Large Pit	SU 3 Feature 34 SE Large Pit	SU 3 Small Pits on the Edge of Feature 14	SU 3 Hearths/ Roasting Pits	SU 3 All Other Features	SU 9 Vent Shafts and Tunnels to SU 4	SU 12 All Other Features	SU 14 Possible Structure with Interior Features	SU 14 Small Pits	Surface Collection	Total
Indeterminate ground	-	-	-	-	-	-	1	-	-	-	-	-	-	15
stone fragment	-	-	-	-	-	-	6.7%	-	-	-	-	-	-	20.3%
	-	-	-	-	-	-	33.3%	-	-	-	-	-	-	20.3%
Mano fragment	-	-	1	-	-	-	2	-	-	2	-	-	1	12
	-	-	8.3%	-	-	-	16.7%	-	-	16.7%	-	-	8.3%	16.2%
	-	-	25.0%	-	-	-	66.7%	-	-	100.0%	-	-	33.3%	16.2%
One-hand mano	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
Two-hand mano	-	-	-	-	-	-	-	-	-	-	-	-	-	2
	-	-	-	-	-	-	-	-	-	-	-	-	-	2.7%
	-	-	-	-	-	-	-	-	-	-	-	-	-	2.7%
Metate fragment	2	1	2	-	1	-	-	1	2	-	1	-	1	21
	9.5%	4.8%	9.5%	-	4.8%	-	-	4.8%	9.5%	-	4.8%	-	4.8%	28.4%
	100.0%	33.3%	50.0%	-	100.0%	-	-	100.0%	40.0%	-	100.0%	-	33.3%	28.4%
Basin metate	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
Grinding slab	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	-	-	-	-	-	-	-	-	-	-	-	-	-	4.1%
	-	-	-	-	-	-	-	-	-	-	-	-	-	4.1%
Expedient handstone	-	-	-	-	-	-	-	-	2	-	-	-	-	3
	-	-	-	-	-	-	-	-	66.7%	-	-	-	-	4.1%
	-	-	-	-	-	-	-	-	40.0%	-	-	-	-	4.1%
Hoe	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
Mortar	-	2	-	-	-	-	-	-	-	-	-	-	1	4
	-	50.0%	-	-	-	-	-	-	-	-	-	-	25.0%	5.4%
	-	66.7%	-	-	-	-	-	-	-	-	-	-	33.3%	5.4%
Shaped slab	-	-	-	-	-	-	-	-	-	-	-	1	-	4
	-	-	-	-	-	-	-	-	-	-	-	25.0%	-	5.4%
	-	-	-	-	-	-	-	-	-	-	-	100.0%	-	5.4%
Stone ball	-	-	1	1	-	1	-	-	-	-	-	-	-	3
	-	-	33.3%	33.3%	-	33.3%	-	-	-	-	-	-	-	4.1%
	-	-	25.0%	100.0%	-	100.0%	-	-	-	-	-	-	-	4.1%
Cobble with pigment	-	-	-	-	-	-	-	-	1	-	-	-	-	2
residue, otherwise	-	-	-	-	-	-	-	-	50.0%	-	-	-	-	2.7%
unmodified	-	-	-	-	-	-	-	-	20.0%	-	-	-	-	2.7%
Hide-processing	-	-	-	-	-	-	-	-	-	-	-	-	-	1
handstone	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
Grooved abrader	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4%
Total	2	3	4	1	1	1	3	1	5	2	1	1	3	74
	2.7%	4.1%	5.4%	1.4%	1.4%	1.4%	4.1%	1.4%	6.8%	2.7%	1.4%	1.4%	4.1%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

tion and maintenance, shaft abrasion, and hide processing.

Indeterminate Ground Stone Fragments. Fifteen indeterminate ground stone fragments were recovered from Area 1 at LA 265 (Table 19.4). Those recovered from the upper fill and the roof-fall layers of the SU 1 and SU 4 structures are considered secondary refuse. FS 876 was recovered from Feature 11, a thermal feature. The artifact is not heat-altered and appears to represent secondary refuse that was discarded into the feature after it burned. Prior to its discard, the artifact was recycled into a unidirectional core and it exhibits multiple complete flake scars. Two fragments (FS 1029 and FS 1265-2) were recovered from structure floors. It is unclear whether these artifacts represent primary or secondary refuse. Three fragments (FS 1071, FS 1121, and FS 1405) were recovered from the fill of large bell-shaped pits and appear to represent secondary refuse. FS 1228 was located in Feature 33 fill, which was not burned, along with abundant heat-fractured cobbles. The artifact is also heat-fractured, and it represents secondary refuse.

A variety of material types, conditions, and use surface cross-section forms are exhibited (Table 19.4). The majority (71 percent) of these fragments display striations. Both unidirectional and multidirectional linear striations as well as multidirectional curvilinear striations are evident. This suggests that a variety of grinding motions were employed in the use of these artifacts, including a consistently oriented reciprocal motion, an inconsistently oriented reciprocal motion, and a rotary motion. Three fragments (FS 699, FS 876, and FS 1121) exhibit two opposing use surfaces suggesting more intensive use. Two fragments (FS 996 and FS 1011-2) exhibit an adhering red pigment residue reflecting their use in pigment processing. Maximum linear dimensions of the fragments range from 46 to 369 mm. Three fragments (FS 737, FS 1121, and FS 1228) exhibit evidence of heat alteration in the form of sooting or crenated fracturing.

Mano Fragments. A total of 12 mano fragments, most of which appear to be secondary refuse, were recovered from LA 265 (Table 19.5). Four fragments (FS 659, FS 1011-4, FS 1036, and FS 1193) were recovered from upper structure fill, which includes SU 1 and SU 13 structures, both of which are Early Developmental period pit structures. A single mano fragment (FS 1238) was located on the floor of the SU 1 structure. This fragment is heat fractured and since the structure did not burn it is believed to be secondary refuse. FS 875 and FS 901 were located in Feature 11, a large thermal feature, where they may have been secondarily used as heat retaining elements. Similarly FS 1065, which is heat fractured, may have been secondarily used as a heat-retaining element in Feature 31. The cobble-filled upper portion of this feature displays evidence of burning. FS 1605 was contained within Feature 208 fill and appears to be secondary refuse. A single mano fragment (FS 602) was recovered from the present ground surface.

These end, edge, and medial fragments consist of a variety of materials. Self-sharpening vesicular igneous materials are frequent, accounting for 42 percent of the mano fragments. Half of the fragments display evidence of initial shaping in the form of pecking or flaking and grinding. All display convex use-surface cross sections. Half of the use surfaces display grinding/faceting wear, while the other half display polish and/or linear unidirectional striations. This type of striation is characteristic of manos that are moved in a consistently oriented reciprocal manner. Four metaquartzite and sandstone mano fragments exhibit pecking, presumably to sharpen the use surface. Five mano fragments (FS 901, FS 1011-4, FS 1036, FS 1065, and FS 1238) appear heat fractured. Two mano fragments (FS 640 and FS 1301-1) have ground ends that reflect use with a trough metate. Maximum linear dimensions range from 52 to 163 mm.

One-Hand Mano. A single, whole, one-hand mano (FS 1037-2) was recovered from the roof-fall layer of the SU 1 pit structure. It is unclear

Table 19.4. Indeterminate Ground Stone Fragments, LA 265

FS No.	Analytic Unit	Material	Condition	Cross Section	Wear Pattern	Maximum Dimension (mm)
309	SU 1, upper fill	basalt	medial	convex	linear unidirectional striations	139
658	SU 1, upper fill	medium-grained metaquartzite	end fragment	concave	grinding/facetting	135
699	SU 1, upper fill	fine-grained rhyolite	edge fragment	concave	linear unidirectional striations, linear multidirectional striations*	197
737	SU 1, roof fall	fine-grained rhyolite	edge fragment	sinuous or irregular	grinding/facetting	224
876	SU 3, hearths/roasting pits, Feature 11	fine-grained rhyolite	end fragment	convex	linear multidirectional striations	130
996	SU 4, roof fall	fine-grained rhyolite	corner fragment	sinuous or irregular	linear multidirectional striations	101
998	SU 4, roof fall	fine-grained sandstone	medial fargment	convex	grinding/facetting	61
1011-2	SU 1, upper fill	coarse-grained rhyolite	edge fragment	flat	linear unidirectional striations	76
1011-3	SU 1, upper fill	fine-grained rhyolite	edge fragment	flat	linear unidirectional striations	46
1029	SU, structure floor contact	basalt	end fragment	concave	grinding/facetting	369
1071	SU 2, large bell-shaped pits, Feature 23	andesite	end fragment	concave	linear unidirectional striations	120
1121	SU 2, large bell-shaped pits, Feature 26	fine-grained rhyolite	internal fragment	flat	linear multidirectional striations, curvilinear multidirectional striations*	89
1228	SU 2, keyhole structures and internal features, Feature 33	fine-grained metaquartzite	end fragment	convex	linear unidirectional striations, parallel to short axis	119
1265-2	SU 1, structure floor contact	fine-grained sandstone	edge fragment	flat	grinding/facetting	31
1405	SU 2, large bell-shaped pits, Feature 60	fine-grained rhyolite	end fragment	convex	linear unidirectional striations	120

* Artifact displays multiple use-surfaces with different values for the same variable.

Table 19.5. Mano Fragments, LA 265

FS No.	Analytic Unit	Material	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)
602	surface collection	fine-grained sandstone	end fragment	pecking	linear unidirectional striations	pecked to sharpen	104
640	SU 3, Feature 3, upper ash	medium-grained metaquartzite	end fragment	pecking	grinding/faceting	pecked to sharpen	83
659	SU 1, upper fill	medium-grained metaquartzite	medial fragment	pecking	linear unidirectional striations	no maintenance	110
875	SU 3, hearths/roasting pits, Feature 11	vesicular rhyolite	end fragment	no production input	linear unidirectional striations, parallel to short axis	no maintenance	163
901	SU 3, hearths/roasting pits, Feature 11	vesicular basalt	edge fragment	no production input	linear unidirectional striations	no maintenance	108
1011-4	SU 1, upper fill	vesicular rhyolite	edge fragment	no production input	polish and linear unidirectional striations	no maintenance	111
1036	SU 1, upper fill	vesicular rhyolite	edge fragment	no production input	polish and linear unidirectional striations	no maintenance	110
1065	SU 12, Feature 31	coarse-grained rhyolite	end fragment	pecking	grinding/faceting	no maintenance	124
1193	SU 13, upper fill	fine-grained rhyolite	edge fragment	flaking and grinding	polish and linear unidirectional striations	no maintenance	97
1238	SU 1, structure floor contact	medium-grained sandstone	edge fragment	no production input	grinding/faceting	pecked to sharpen	52
1301-1	462N, backhoe trench	fine-grained metaquartzite	end fragment	flaking and grinding	grinding/faceting	pecked to sharpen	99
1605	SU 12, Feature 208	vesicular basalt	end fragment	no production input	grinding/faceting	no maintenance	122

whether this artifact represents secondary refuse or if it was used or stored in or on the roof. This vesicular basalt mano is oval-shaped in plan view and has a convex use-surface cross section. It lacks evidence of production input and maintenance. Its use surface displays linear unidirectional striations that parallel the artifact's short axis. This type of striation indicates a consistently oriented reciprocal grinding motion. The artifact displays an adhering red clay substance, which may be a local clay pigment mentioned by Warren (1977c:29). The mano measures 120 mm long by 102 mm wide by 52 mm thick. The use surface measures 81 mm long by 80 mm wide giving it a use surface area of 5184 sq mm.

Two-Hand Manos. Two whole two-hand manos were recovered from Area 1 at LA 265. FS 799 was recovered from the upper fill of the SU 1 pit structure and likely represents secondary refuse. FS 1034 was located on the floor of the SU 4 pit structure. This artifact may represent de facto refuse.

FS 799 was manufactured by flaking and grinding a slab of fine-grained basalt. It exhibits a subrectangular plan view outline and a convex use-surface cross section. The use surface exhibits grinding/faceting wear and measures 233 mm long by 119 mm wide giving it a use surface area of 24,954 sq mm. The mano measures 245 mm long by 127 mm wide by 35 mm thick.

FS 1034 was manufactured by pecking a flattened cobble of coarse-grained rhyolite. It is oval-shaped in plan view outline and exhibits a convex use-surface cross section. The use surface displays grinding/faceting wear and measures 178 mm long by 106 mm wide giving it a use surface area of 15,094 sq mm. The artifact measures 186 mm long by 113 mm wide by 40 mm thick.

Metate Fragments. A total of 21 metate fragments were recovered from LA 265 (Table 19.6). Those recovered from the upper fill and roof-fall layers of the SU 1 and SU 13 structures represent secondary refuse. Four fragments (FS 870, FS 883, FS 1046, FS 1153) were recovered from the fill of features located in SU 3 and represent secondary refuse. A single metate fragment (FS 790) was recovered from Feature 7 (SU 3), a fire-cracked rock-filled pit, where it was likely secondarily used as a heat-retaining element. The fill of both ventilator shafts (Feature 32 and Feature 51) associated with the SU 4 Early Developmental period pit structure contain metate fragments (FS 1217 and FS 1286). These artifacts are considered secondary refuse on the basis of their context and condition. FS 1712-1 and FS 1712-2 are possibly from the same metate, but cannot be refitted. They were recovered from a fire-cracked rock-filled pit (Feature 126). The artifacts do not appear to be heat altered and likely represent secondary refuse. FS 1419 was contained in the fill of Feature 152 and appears to represent secondary refuse. A single metate fragment (FS 1265) was located on the floor of the SU 1 structure. This fragment is heat fractured and since the structure did not burn it is believed to be secondary refuse. FS 1292 was recovered from a post hole in the floor of the SU 4 pit structure. It is unclear whether this artifact was secondarily used in the feature to brace or otherwise support a post or simply deposited as secondary refuse. FS 1301-2 was recovered from the 462N exploratory backhoe trench in the SU 13 structure fill. The artifact most likely represents secondary refuse. A single metate fragment (FS 798) was recovered from the present ground surface.

The metate fragments consist of a variety of materials, with fine-grained sandstone being the most frequent (43 percent). The majority are edge fragments (43 percent), which exhibit grinding/faceting wear (86 percent), and/or lack evidence of initial shaping (62 percent) as well as sharpening (52 percent). Corner and internal fragments are also represented and if initial shaping is evident it takes the form of pecking or flaking. All metate fragments have concave use-surface cross sections. Three (FS 1011-5, FS 1236, and FS 1301-2) exhibit linear unidirectional striations indicating a consistently oriented reciprocal grinding motion.

Table 19.6. Metate Fragments, LA 265

FS No.	Analytic Unit	Material	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)	Metate Type
746	SU 1, roof fall	fine-grained sandstone	edge fragment	pecking	grinding/faceting	pecked to sharpen	114	trough
747	SU 1, roof fall	fine-grained sandstone	edge fragment	pecking	grinding/faceting	pecked to sharpen	83	trough
790	SU 3, Feature 7	coarse-grained rhyolite	edge fragment	no production input	grinding/faceting	no maintenance	234	trough
798	surface collection	vesicular rhyolite	internal fragment	no production input	grinding/faceting	no maintenance	111	indeterminate
870	SU 3, Feature 3, upper ash	vesicular rhyolite	edge fragment	no production input	grinding/faceting	no maintenance	179	trough
883	SU 3, Feature 3, upper ash	schist	edge fragment	no production input	grinding/faceting	pecked to sharpen	121	trough
1011-5	SU 1, upper fill	igneous*	internal fragment	no production input	polish and linear unidirectional striations	no maintenance	113	trough
1037	SU 1, roof fall	andesite	corner fragment	flaking	grinding/faceting	no maintenance	240	basin
1038-1	SU 1, upper fill	fine-grained sandstone	corner fragment	no production input	grinding/faceting	pecked to sharpen	515	trough
1038-2	SU 1, upper fill	vesicular basalt	corner fragment	no production input	grinding/faceting	no maintenance	312	trough
1046	SU 3, all other features	metamorphic*	edge fragment	no production input	grinding/faceting	pecked to sharpen	115	trough
1153	SU 3, Feature 34, SE large pit	fine-grained sandstone	edge fragment	no production input	grinding/faceting	pecked to sharpen	131	trough
1217	SU 9, vent shafts and tunnels to SU 4, Feature 32	fine-grained sandstone	corner fragment	pecking	grinding/faceting	pecked to sharpen	296	trough
1236	SU 13, roof fall	andesite	edge fragment	flaking	polish and linear unidirectional striations	no maintenance	173	trough
1265	SU 1, structure floor contact	orthoquartzite	internal fragment	no production input	grinding/faceting	pecked to sharpen	103	indeterminate
1286	SU 9, vent shafts and tunnels to SU 4, Feature 51	fine-grained sandstone	edge fragment	pecking	grinding/faceting	pecked to sharpen	213	trough
1292	SU 4, all floor features, Feature 70	vesicular rhyolite	corner fragment	no production input	grinding/faceting	no maintenance	143	basin
1301-2	462N, backhoe trench	fine-grained sandstone	internal fragment	flaking	linear unidirectional striations	no maintenance	167	indeterminate
1419	SU 14, possible structure with interior features, Feature 152	vesicular basalt	internal fragment	no production input	grinding/faceting	no maintenance	125	indeterminate
1712-1	SU 2, buried hearths, Feature 126	fine-grained sandstone	internal fragment	no production input	grinding/faceting	pecked to sharpen	156	indeterminate
1712-2	SU 2, buried hearths, Feature 126	fine-grained sandstone	corner fragment	flaking	grinding/faceting	no maintenance	359	indeterminate

* not further specified

Two fragments (FS 1011-5 and FS 1236) exhibit a moderately lustrous polish and four (FS 790, FS 798, FS 1038-1, and FS 1265) appear to be heat fractured. The majority of the fragments (62 percent) include edge configurations diagnostic of trough metates. FS 1046 was recycled into a chopper. It displays unidirectional flake removal and step fracturing consistent with a secondary shaping of the artifact as well as battering wear. This edge has an angle of 62 degrees. The maximum linear dimensions of these artifacts range from 83 to 359 mm.

Basin Metate. A single, whole, basin metate (FS 1606) was recovered from Area 2 at LA 265. It was located 4 to 8 cm above floor level over the southwest portion of Feature 131, a subfloor pit containing a human burial. The metate was 26 cm above the burial and beyond the vertical limits of the pit, therefore, it appears that it is not directly associated with the burial. The use surface was positioned toward the floor. Its context suggests that it is not de facto refuse. The metate is of an unspecified igneous material and displays an oval-shaped plan view outline as well as a concave use-surface cross section. It lacks evidence of production input and maintenance. The material is aphanitic-porphyritic and contains tiny vesicles, therefore, it is considered self sharpening. Its use surface exhibits grinding/faceting wear and measures 265 mm long by 168 mm wide giving it an area of 35,616 sq mm. The use surface has a maximum depth of 20 mm. The metate measures 402 mm long by 248 mm wide by 92 mm thick.

Grinding Slabs. Three grinding slabs were recovered from SU 2 at LA 265 (Table 19.7). Two (FS 1111 and FS 1259) were recovered from feature fill and considered secondary refuse. FS 1085 was ritually deposited to accompany the adult female buried in Feature 24.

All the slabs are igneous materials and have irregular plan view outlines. FS 1259 consists of four fragments that can be refitted into a larger fragment that lacks a portion of one edge. Whole measurements can be obtained from this artifact. FS 1085 displays two opposing use surfaces, both of which display linear unidirectional striations indicating a consistently oriented reciprocal grinding motion. One end of the artifact also displays flake removal, which is possibly related to reuse. FS 1111 displays linear multidirectional striations, indicating either an inconsistently oriented or a rotary grinding motion, while FS 1259 exhibits grinding/faceting wear as well as an adhering red pigment residue. None appear heat altered. Table 19.8 presents the metric attributes of these artifacts.

Expedient Handstones. Three expedient hand-

Table 19.7. Grinding Slabs, LA 265

FS No.	Analytic Unit	Material	Plan View	Cross Section	Wear Pattern
1085	SU 2, large bell-shaped pits, Feature 24	andesite	irregular	flat, concave*	linear unidirectional striations
1111	SU 2, large bell-shaped pits, Feature 26	coarse-grained rhyolite	irregular	sinuous or irregular	linear multidirectional striations
1259	SU 2, keyhole structures and internal features, Feature 27	fine-grained rhyolite	irregular	sinuous or irregular	grinding/faceting

Table 19.8. Dimensions of Grinding Slabs, LA 265

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
1085	351	222	84	201	122	19618
1085	351	222	84	199	131	20855
1111	135	103	55	58	51	2366
1259	301	289	22	175	160	22400

Table 19.9. Expedient Handstones, LA 265

FS No.	Analytic Unit	Material	Wear Pattern	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
727	SU 1, upper fill	fine-grained rhyolite	grinding/faceting	130	126	48	111	84	7459
1219	SU 9, vent shafts and tunnels to SU 4, Feature 32	fine-grained rhyolite	polish and linear multidirectional striations	128	86	57	91	77	5606
1241	SU 9, vent shafts and tunnels to SU 4, Feature 32	igneous, not further specified	linear multidirectional striations, parallel to long axis	222	135	43	169	88	11898

stones were recovered from Area 1 at LA 265 (Table 19.9). All appear to represent secondary refuse. FS 727 was recovered from the upper fill of the SU 1 pit structure, while FS 1219 and FS 1241 were recovered from the fill of the ventilator shafts of the SU 4 pit structure. All are whole and exhibit convex use-surface cross sections. None exhibit evidence of production input or maintenance. The use surfaces exhibit a variety of wear patterns (Table 19.9). A single expedient handstone (FS 1241) appears heat altered. The material is sooted and reddened. Table 19.9 also presents the metric attributes of these artifacts.

Hoe. A single complete hoe (FS 1212) was recovered from the roof-fall layer of the SU 13 pit structure. Unless it was stored in or on the roof, it most likely represents secondary refuse. The artifact is a fine-grained rhyolite and exhibits an elongate oval-shaped plan view outline. One end is more tapered than the other. The wider end appears to be the distal end. It displays bimarginal flaking and step fracturing as well as an overlying rounding, moderately lustrous polish, and striations that are oriented perpendicular to the edge. This convex edge, which extends up an estimated one-third of the lateral margins, measures approximately 216 mm long with an edge angle of approximately 45 degrees. Highly polished areas are along both lateral edges and the proximal end may represent hafting polish, other than this possibility the artifact lacks evidence of the method of hafting. Both faces exhibit linear multidirectional striations and a moderately lustrous polish. The hoe measures 216 mm long by 118 mm wide by 18 mm thick.

Mortars. A total of four mortar fragments were recovered from LA 265 (Table 19.10). FS 1295 was recovered from the fill of a post hole in the SU 4 pit structure. The use surface was positioned upward. It is unclear whether this artifact was secondarily used in the feature to brace or otherwise support a post or simply deposited as secondary refuse. Although they cannot be refitted, FS 1319-1 and FS 1319-2 are most likely from the same mortar. This statement is based on similarities in morphology, material type, and recovery location. Both were recovered from Feature 7, a fire-cracked rock-filled pit, where they were secondarily used as heat-retaining elements. Both appear sooted. FS 42 was recovered from the present ground surface.

All mortar fragments are vesicular igneous materials. None display evidence of initial shaping or maintenance and all display concave use-surface cross sections. The use surface of FS 1295 exhibits evidence of pecking. The maximum linear dimensions of these artifacts range from 96 to 134 mm.

Shaped Slabs. Four fragmentary shaped slabs were recovered from LA 265 (Table 19.11). All appear to represent secondary refuse. Two (FS 304 and FS 329) were recovered from the upper fill of the SU 1 pit structure. FS 1435 was recovered from the upper fill of Feature 62, a bell-shaped pit. FS 1659-1, a fragmentary shaped disk, was recovered from the fill of Feature 212, which is the ventilator shaft of the SU 13 pit structure.

Most slabs (75 percent) were manufactured from fine-grained rhyolite and most (75 percent) are edge fragments. All shaped slabs were manufactured by bimarginal flaking, with the possible exception of FS 1659-1. None

Table 19.10. Mortars, LA 265

FS No.	Analytic Unit	Material	Condition	Maximum Dimension (mm)
42	surface collection	scoria	end fragment	96
1295	SU 4, Feature 71	welded tuff	corner missing	271
1319	SU 3, Feature 7	tuff	edge fragment	138
1319-2	SU 3, Feature 7	tuff	internal fragment	134

Table 19.11. Shaped Slabs, LA 265

FS No.	Analytic Unit	Material	Condition	Maximum Dimension (mm)
304	SU 1, upper fill	fine-grained rhyolite	edge fragment	101
329	SU 1, upper fill	fine-grained rhyolite	edge fragment	75
1435	SU 14, small pits, Feature 62	fine-grained rhyolite	internal fragment	110
1659	SU 13, vent shaft fill, Feature 212	fine-grained sandstone	edge fragment	80

Table 19.12. Stone Balls, LA 265

FS No.	Analytic Unit	Material	Length (mm)	Width (mm)	Thickness (mm)
642	SU 3, Feature 3, upper ash	fine-grained rhyolite	27	26	23
1088	SU 3, Feature 14, NW large pit	fine-grained rhyolite	23	22	16
1232	SU 3, small pits on the edge of Feature 14, Feature 37	medium-grained metaquartzite	35	31	29

shows evidence of facial modification. FS 1659-1 displays a small shallow divot, like an incipient drill hole, which appears as if it was centrally located when the artifact was complete. Maximum linear dimensions of these artifacts range from 75 to 110 mm.

Stone Balls. Three stone balls were recovered from SU 3 at LA 265 (Table 19.12). All appear to represent secondary refuse. All are whole and display circular plan view outlines. FS 642 exhibits a moderately lustrous polish, while the others retain their natural form. None appear heat altered. Metric attributes are presented in Table 19.12.

Unmodified Cobble with Pigment Residue. A fragmentary pebble (FS 1659-2) and a cobble (FS 1315) that displays an adhering red pigment residue are otherwise unmodified. They were recovered from the fill of the ventilator system (Feature 212) of the SU 13 pit structure and the fill of the ventilator system (Feature 101) of the SU 4 pit structure. The artifacts likely represent secondary refuse. The pebble (FS 1659-2) is a fine-grained metaquartzite and measures 58 mm long by 42 mm wide by 14 mm thick. Pigment covers the intact surfaces and is also present in some areas along the fractured margins. The cobble (FS 1315) is a medium-grained metaquartzite and measures 113 mm long by 106 mm wide by 46 mm thick. The extent of pigment residue measures 52 mm long by 29 mm wide.

Hide-Processing Handstone. A single whole hide processing handstone (FS 614) was recovered from the upper fill of the SU 1 pit structure. The artifact may represent secondary refuse. It is a gray scoria and exhibits an oval-shaped plan view outline as well as a convex use-surface cross section. The handstone lacks evidence of production input and maintenance. The wear pattern on its faceted use surface consists of rounded and polished high points between vesicles. The coarse grinding texture provided by the highly vesicular material is well suited to the removal of unwanted hair or tissue from a hide. The use surface measures 71 mm long by 65 mm wide giving it a use surface area of 3,692 sq mm. The artifact measures 110 mm long by 91 mm wide by 71 mm thick. The artifact does not appear to be heat altered.

Grooved Abrader. A single, whole, grooved abrader (FS 1011-1) was recovered from the upper fill of the SU 1 pit structure. The artifact may represent secondary refuse. It is a vesicular rhyolite and exhibits an oval-shaped plan view outline, as well as a u-shaped groove cross section. The artifact lacks evidence of production input and maintenance. The groove, which exhibits grinding/faceting wear, measures 102 mm long by 31 mm wide by 11 mm deep. The artifact measures 215 mm long by 114 mm wide by 81 mm thick.

LA 6169

LA 6169 yielded 92 ground stone artifacts from 22 separate analytic units (Table 19.13). Ground stone from the upper fill of Feature 76, a Developmental period pit structure, has the highest relative frequency comprising 45.7 percent of the site assemblage, while ground stone from each of the other analytic units comprises less than 6 percent of the assemblage. A total of 16 different artifact types were identified. The most frequent artifact types are indeterminate ground stone fragments (30.4 percent), mano fragments (15.2 percent), and metate fragments (15.2 percent). The artifact type distribution suggests the site occupants were involved in a fairly wide range of grinding and other activities including tool manufacture and maintenance, and the processing of wild vegetal resources, agricultural produce, and pigments, as well as chopping and digging tasks.

Anvil. A single relatively large fine-grained metaquartzite cobble that was utilized as an anvil (FS 591) was recovered from the upper fill of Feature 10. This recovery location suggests deposition as secondary refuse. It is an informal tool that has an irregular plan view outline and a convex use-surface cross section. The artifact is whole and measures 130 mm long by 108 mm wide by 37 mm thick. One surface exhibits battering and pitting wear as if struck by a hammerstone. The extent of this wear measures 65 mm long by 40 mm wide.

Indeterminate Ground Stone Fragments. A total of 28 indeterminate ground stone fragments were recovered from LA 6169 (Table 19.14). Most appear to represent secondary refuse. The majority (68 percent) were recovered from the upper fill of Feature 76, a Late Developmental period pithouse. FS 490 was secondarily used as a construction element in a cobble pile (Feature 13), which is associated with the interment of two dogs, on the floor of Feature 4, an Early Developmental period pithouse. FS 1772 was also secondarily used. In this case, as a heat-retaining element in a cobble-filled roasting pit (Feature 134). Prior to this secondary use, the artifact was recycled as a core showing multiple complete negative flake scars. This extensively used artifact also exhibits two opposing use surfaces indicating the practice of a wear management technique (Mauldin 1993:322; Adams 1993:335–336, 1996:5–6), which suggests intensive use as well. FS 1236 was recovered from Feature 81 in Feature 76.

Neither FS 1199 nor FS 1244-3 shows evidence of production input or maintenance. These two artifacts exhibit flat use-surface cross sections, thus their classification as indeterminate ground stone fragments. FS 1199 was shaped by flaking and displays no evidence of maintenance, while FS 1244-3 was shaped by pecking and also displays evidence of sharpening. In addition to FS 1772, two fragments (FS 1571 and FS 1569) exhibit two opposing use surfaces. The majority of fragments are fine-grained rhyolite (68 percent), have flat use-surface cross sections (71 percent), and/or exhibit linear unidirectional striations (61 percent). A total of three fragments display adhesions. All of these exhibit linear multidirectional striations. FS 1561 displays an adhering resin, FS 1562 a red pigment, and FS 1571 a red pigment and resin. Four fragments (FS 1497, FS 1262, FS 1363, and FS 1540) are heat altered, resulting in sooting, reddening, and/or crenated fracturing. In addition to FS 1772, FS 1258 is an example of recycling. The artifact was reused as a chopper exhibiting bifacial flaking and battering along the edge. The maximum linear dimensions of all indeterminate fragments range from 43 to 291 mm.

Mano Fragments. A total of 14 mano end, corner, and medial fragments were recovered from LA 6169 (Table 19.15). Those recovered from upper feature fill and sheet trash areas

Table 19.13. Ground Stone Artifact Type by Analytic Unit, LA 6169

N Row % Column %	Unproven-ienced	Fea. 4, Floor Fill and Floor	Fea. 47, Floor Fill and Floor	Fea. 76, Floor Fill and Floor	Fea. 47, Upper Fill	Fea. 76, Upper Fill	Fea. 10, Upper Fill	Fea. 15, Floor Fill and Floor	Fea. 15, Upper Fill	Fea. 16, Upper Fill	Fea. 16, Floor Fill and Floor
Anvil	-	-	-	-	-	-	1	-	-	-	-
	-	-	-	-	-	-	100.0%	-	-	-	-
	-	-	-	-	-	-	50.0%	-	-	-	-
Indeterminate ground	-	1	-	-	2	19	-	-	-	-	-
stone fragment	-	3.6%	-	-	7.1%	67.9%	-	-	-	-	-
	-	20.0%	-	-	50.0%	45.2%	-	-	-	-	-
Mano fragment	-	1	-	-	-	8	1	-	-	1	1
	-	7.1%	-	-	-	57.1%	7.1%	-	-	7.1%	7.1%
	-	20.0%	-	-	-	19.0%	50.0%	-	-	33.3%	20.0%
One-hand mano	-	-	1	-	-	-	-	-	-	-	-
	-	-	100.0%	-	-	-	-	-	-	-	-
	-	-	20.0%	-	-	-	-	-	-	-	-
Two-hand mano	-	-	1	-	1	-	-	1	-	-	1
	-	-	16.7%	-	16.7%	-	-	16.7%	-	-	16.7%
	-	-	20.0%	-	25.0%	-	-	100.0%	-	-	20.0%
Metate fragment	1	1	-	-	1	7	-	-	1	-	-
	7.1%	7.1%	-	-	7.1%	50.0%	-	-	7.1%	-	-
	100.0%	20.0%	-	-	25.0%	16.7%	-	-	100.0%	-	-
Slab metate	-	-	-	-	-	1	-	-	-	-	-
	-	-	-	-	-	100.0%	-	-	-	-	-
	-	-	-	-	-	2.4%	-	-	-	-	-
Grinding slab	-	-	-	-	-	-	-	-	-	1	1
	-	-	-	-	-	-	-	-	-	16.7%	16.7%
	-	-	-	-	-	-	-	-	-	33.3%	20.0%
Expedient handstone	-	1	-	-	-	3	-	-	-	-	-
	-	25.0%	-	-	-	75.0%	-	-	-	-	-
	-	20.0%	-	-	-	7.1%	-	-	-	-	-
Maul	-	-	-	-	-	1	-	-	-	-	-
	-	-	-	-	-	100.0%	-	-	-	-	-
	-	-	-	-	-	2.4%	-	-	-	-	-
Axe	-	-	-	1	-	-	-	-	-	-	1
	-	-	-	50.0%	-	-	-	-	-	-	50.0%
	-	-	-	100.0%	-	-	-	-	-	-	20.0%
Mortar	-	1	-	-	-	1	-	-	-	-	-
	-	50.0%	-	-	-	50.0%	-	-	-	-	-
	-	20.0%	-	-	-	2.4%	-	-	-	-	-
Shaped slab	-	-	1	-	-	-	-	-	-	-	-
	-	-	33.3%	-	-	-	-	-	-	-	-
	-	-	20.0%	-	-	-	-	-	-	-	-
Stone ball	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Cobble with pigment	-	-	2	-	-	1	-	-	-	-	1
residue, otherwise	-	-	40.0%	-	-	20.0%	-	-	-	-	20.0%
unmodified	-	-	40.0%	-	-	2.4%	-	-	-	-	20.0%
Pick	-	-	1	-	-	-	-	-	-	-	-
	-	-	50.0%	-	-	-	-	-	-	-	-
	-	-	2.4%	-	-	-	-	-	-	-	-
Total	1	5	5	1	4	42	2	1	1	3	5
	1.1%	5.4%	5.4%	1.1%	4.3%	45.7%	2.2%	1.1%	1.1%	3.3%	5.4%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19.13. Continued.

N Row % Column %	Fea. 70, Upper Fill	Fea. 70, Floor Fill and Floor	Possible Surface Rooms and Extramural Area	Fea. 4, Upper Fill	SU 12, Extramural Area and Refuse	SU 13, Features and Sheet Trash	SU 1, Extramural Area and Sheet Trash	SU 6, 7, 8, Extramural Areas and Sheet Trash	SU 11, Extramural Area and Sheet Trash	Feas. 81and 82 in Fea. 76	SU 6, Extramural Area and Sheet Trash	Total
Anvil	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	1.1%
Indeterminate ground	1	-	1	1	-	1	-	-	-	1	1	28
stone fragment	3.6%	-	3.6%	3.6%	-	3.6%	-	-	-	3.6%	3.6%	100.0%
	33.3%	-	33.3%	33.3%	-	33.3%	-	-	-	33.3%	33.3%	30.4%
Mano fragment	-	-	-	-	-	-	-	2	-	-	-	14
	-	-	-	-	-	-	-	14.3%	-	-	-	100.0%
	-	-	-	-	-	-	-	40.0%	-	-	-	15.2%
One-hand mano	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	1.1%
Two-hand mano	-	1	-	1	-	-	-	-	-	-	-	6
	-	16.7%	-	16.7%	-	-	-	-	-	-	-	100.0%
	-	100.0%	-	20.0%	-	-	-	-	-	-	-	6.5%
Metate fragment	-	-	-	1	-	-	-	1	-	-	-	14
	-	-	-	7.1%	-	-	-	7.1%	-	-	-	100.0%
	-	-	-	20.0%	-	-	-	20.0%	-	-	-	15.2%
Slab metate	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	1.1%
-	1	-	-	-	-	-	-	2	1	-	-	6
	16.7%	-	-	-	-	-	-	33.3%	16.7%	-	-	100.0%
	33.3%	-	-	-	-	-	-	40.0%	100.0%	-	-	6.5%
Expedient handstone	-	-	-	-	-	-	-	-	-	-	-	4
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	4.3%
Maul	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	1.1%
Axe	-	-	-	-	-	-	-	-	-	-	-	2
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	2.2%
Mortar	-	-	-	-	-	-	-	-	-	-	-	2
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	2.2%
Shaped slab	1	-	-	1	-	-	-	-	-	-	-	3
	33.3%	-	-	33.3%	-	-	-	-	-	-	-	100.0%
	33.3%	-	-	20.0%	-	-	-	-	-	-	-	3.3%
Stone ball	-	-	-	-	2	-	-	-	-	-	-	2
	-	-	-	-	100.0%	-	-	-	-	-	-	100.0%
	-	-	-	-	100.0%	-	-	-	-	-	-	2.2%
Cobble with pigment	-	-	-	-	-	-	1	-	-	-	-	5
residue, otherwise	-	-	-	-	-	-	20.0%	-	-	-	-	100.0%
unmodified	-	-	-	-	-	-	100.0%	-	-	-	-	5.4%
Pick	-	-	-	1	-	-	-	-	-	-	-	2
	-	-	-	50.0%	-	-	-	-	-	-	-	100.0%
	-	-	-	20.0%	-	-	-	-	-	-	-	2.2%
Total	3	1	1	5	2	1	1	5	1	1	1	92
	3.3%	1.1%	1.1%	5.4%	2.2%	1.1%	1.1%	5.4%	1.1%	1.1%	1.1%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19.14. Indeterminate Ground Stone Fragments, LA 6169

FS No.	Analytic Unit	Material	Condition	Cross Section	Wear Pattern	Maximum Dimension (mm)
289	possible surface rooms and extramural area	fine-grained rhyolite	end fragment	flat	linear unidirectional striations	139
938	Feature 76, upper fill	fine-grained rhyolite	end fragment	flat	linear unidirectional striations	87
943	Feature 76, upper fill	fine-grained rhyolite	edge fragment	flat	linear unidirectional striations	159
1424	Feature 76, upper fill	andesite	end fragment	flat	linear unidirectional striations	229
1497	Feature 76, upper fill	fine-grained rhyolite	end fragment	flat	linear unidirectional striations, perpendicular to short axis	160
1519	Feature 76, upper fill	fine-grained rhyolite	end fragment	flat	linear unidirectional striations, perpendicular to short axis	171
1623	Feature 70, upper fill	fine-grained rhyolite	end fragment	sinuous or irregular	linear unidirectional striations, perpendicular to short axis	291
699	Feature 4, upper fill	fine-grained sandstone	internal fragment	flat	grinding/faceting	77
490	Feature 4, floor fill and floor, Feature 13	fine-grained sandstone	internal fragment	flat	grinding/faceting	97
1199	SU 13, features and sheet trash, Feature 63	fine-grained rhyolite	edge fragment	flat	linear unidirectional striations	75
1236	Feature 81 in Feature 76	coarse-grained sandstone	end fragment	flat	grinding/faceting	71
1244-2	Feature 47, upper fill	fine-grained rhyolite	end fragment	flat	linear unidirectional striations	82
1244-3	Feature 47, upper fill	coarse-grained rhyolite	edge fragment	flat	grinding/faceting	101
1258	Feature 76, upper fill	basalt	end fragment	convex	linear unidirectional striations	116
1262	Feature 76, upper fill	coarse-grained rhyolite	end fragment	flat	linear unidirectional striations	136
1259	Feature 76, upper fill	fine-grained rhyolite	corner fragment	convex	linear multidirectional striations	129
1309	Feature 76, upper fill	fine-grained rhyolite	corner fragment	concave	linear unidirectional striations	110
1339	Feature 76, upper fill	basalt	end fragment	convex	linear unidirectional striations	140
1363	Feature 76, upper fill	fine-grained rhyolite	internal fragment	concave	linear multidirectional striations	99
1430	Feature 76, upper fill	fine-grained rhyolite	end fragment	flat	linear unidirectional striations	128
1480	Feature 76, upper fill	fine-grained rhyolite	edge fragment	flat	linear unidirectional striations	62
1540	Feature 76, upper fill	orthoquartzite	edge fragment	convex	grinding/faceting	140
1546	Feature 76, upper fill	fine-grained rhyolite	edge fragment	flat	linear unidirectional striations	77
1561	Feature 76, upper fill	fine-grained rhyolite	internal fragment	flat	linear multidirectional striations	83
1562	Feature 76, upper fill	fine-grained rhyolite	corner fragment	flat	linear multidirectional striations	43
1571	Feature 76, upper fill	fine-grained rhyolite	corner fragment	convex	linear multidirectional striations	75
1569	Feature 76, upper fill	fine-grained rhyolite	edge fragment	flat	linear unidirectional striations	72
1772	SU 6, extramural area and sheet trash, Feature 134	fine-grained rhyolite	internal fragment	flat	linear unidirectional striations	112

appear to represent secondary refuse. FS 1599 was recovered from the floor of a Coalition period mealing room (Feature 16) suggesting that it is primary refuse. Its relatively large maximum dimension and the lack of wear on its end suggest that the fragment is from a two-hand mano that was used with a slab metate. FS 203 is considered de facto refuse. The mano fragment was recycled into a chopper. Battering is evident along one edge created by bifacial flaking. This edge is backed by an original mano edge that shows evidence of initial manufacture. This artifact may have functioned in its secondary capacity, in its recovery location, the floor of Feature 4. FS 1823 was secondarily used as a heat-retaining element in a cobble-filled roasting pit (Feature 147). This artifact displays one fractured edge that shows evidence of thermal alteration in the form of sooting, suggesting prior breakage rather than heat fracture.

These manos fragments were manufactured from a variety of materials, with vesicular igneous materials being the most common (57 percent). All mano fragments exhibit convex use-surface cross sections. Two fragments (FS 506 and FS 1342) exhibit linear unidirectional striations indicating movement in a consistently oriented reciprocal manner. The striations on the use surface of FS 1342 parallel the artifact's short axis. Four end and corner fragments (FS 1293, FS 1342, FS 1346, and FS 1433) have ground ends suggesting they were used with trough metates. A single fragment (FS 1316) is heat fractured. Maximum linear dimensions range from 96 to 157 mm.

One-Hand Mano. A single one-hand mano (FS 1978), manufactured from medium-grained metaquartzite, was recovered from the ventilator system of Feature 47. It is likely the artifact represents secondary refuse. It is whole and exhibits an oval-shaped plan view outline as well as a convex use-surface cross section. It displays evidence of initial shaping as well as sharpening in the form of pecking. The artifact displays an adhering red pigment residue. It measures 109 mm long by 102 mm wide by 40 mm thick. The use surface is circular with a diameter measuring 78 mm, and the use surface is 4,779 sq mm.

Two-Hand Manos. Six whole two-hand manos were recovered from LA 6169 (Table 19.16). Three (FS 1245, FS 416, and FS 1879) recovered from the upper feature fill appear to represent secondary refuse. FS 1879 was recovered from the upper fill of a wall bin associated with Feature 47. FS 1612 is considered de facto refuse. It was recovered from the floor of a mealing room (Feature 16). Two (FS 1004 and FS 1178) were recovered from floor contexts and are likely de facto refuse.

All are igneous materials and exhibit a convex use-surface cross section as well as grinding/faceting wear. The majority (83 percent) were initially manufactured by pecking, while only two (FS 1178 and FS 1612) show evidence of sharpening in the form of pecking across the use surface. Two (FS 1879 and FS 416) display ground upturned ends suggesting use in a trough metate. FS 1245 exhibits finger grooves, which is a comfort feature suggestive of intensive use (Adams 1996:36, 1999:492). Table 19.17 presents two-hand mano metric attributes and Table 19.18 presents the associated descriptive statistics.

Metate Fragments. Fourteen FS numbers were assigned to metate fragments representing twelve different metates (Table 19.19). Although FS 1151 and FS 1317 cannot be refitted, their similar recovery location and material type suggest they are from the same metate. FS 1263 and FS 1305 articulate into a larger fragment, representing a deep basin metate. All other fragments represent a single metate. Fragments from the upper feature fill likely represent secondary refuse. This constitutes the majority (79 percent) of the metate fragments. FS 883 lacks provenience information. FS 493 and FS 1941 were secondarily used as construction elements in a cobble pile associated with the interment of two dogs (Feature 13) and a cobble-filled roasting pit (Feature 149), respectively.

With the exception of FS 1341, all of the rep-

Table 19.15. Mano Fragments, LA 6169

FS No.	Analytic Unit	Material	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)
203	Feature 4, floor fill and floor	fine-grained sandstone	internal fragment	flaking	grinding/faceting	pecked to sharpen	97
945	SU 6, 7, and 8, extramural areas and sheet trash	vesicular basalt	corner fragment	no production input	grinding/faceting	no maintenance	127
1316	Feature 76, upper fill	vesicular rhyolite	end fragment	no production input	grinding/faceting	no maintenance	157
1142	Feature 76, upper fill	andesite	end fragment	pecking	grinding/faceting	no maintenance	122
1166	Feature 16, upper fill	coarse-grained rhyolite	end fragment	grinding	grinding/faceting	no maintenance	122
1293	Feature 76, upper fill	vesicular basalt	corner fragment	no production input	grinding/faceting	no maintenance	104
1342	Feature 76, upper fill	orthoquartzite	end fragment	pecking	linear unidirectional striations parallel to short axis	no maintenance	109
1346	Feature 76, upper fill	vesicular rhyolite	end fragment	no production input	grinding/faceting	no maintenance	121
1433	Feature 76, upper fill	fine-grained sandstone	end fragment	flaking and grinding	grinding/faceting	pecked to sharpen	130
1587	Feature 76, upper fill	vesicular rhyolite	end fragment	no production input	grinding/faceting	no maintenance	96
1599	Feature 16, floor fill and floor	vesicular rhyolite	end fragment	no production input	grinding/faceting	no maintenance	151
1631	Feature 76, upper fill	vesicular rhyolite	medial	no production input	grinding/faceting	no maintenance	129
1823	SU 6, 7, and 8, extramural areas and sheet trash, Feature 147	medium-grained metaquartzite	end fragment	grinding	grinding/faceting	no maintenance	110

Table 19.16. Two-hand Manos, LA 6169

FS No.	Analytic Unit	Material	Shaping	Plan View	Wear Pattern	Sharpening
1004	Feature 15, floor fill and floor	coarse-grained rhyolite	pecking	elongate oval/elliptical	grinding/faceting	no maintenance
1178	Feature 70, floor fill and floor	igneous, not further specified	pecking	elongate oval/elliptical	grinding/faceting	pecked to sharpen
1245	Feature 47, upper fill	vesicular basalt	pecking	subrectangular	grinding/faceting	no maintenance
1612	Feature 16, floor fill and floor	coarse-grained rhyolite	pecking	elongate oval/elliptical	grinding/faceting	pecked to sharpen
1879	Feature 47, floor fill and floor; Feature 121	vesicular rhyolite	pecking	oval	grinding/faceting	no maintenance
416	Feature 4, upper fill	vesicular rhyolite	no production input	oval	grinding/faceting	no maintenance

Table 19.17. Dimensions of Two-hand Manos, LA 6169

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
1004	221	109	47	213	97	16529
1178	269	124	58	257	112	23027
1245	257	143	47	251	138	31174
1612	255	142	71	239	128	24474
1879	208	127	58	195	116	18096
416	203	120	37	203	120	19488

Table 19.18. Two-hand Mano Statistics, LA 6169 (N = 6)

	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
Mean	235	128	53	226	119	22131
SD	28	13	12	26	14	5343
Minimum	203	109	37	195	97	16529
Maximum	269	143	71	257	138	31174

resented metates were manufactured from igneous materials. All fragments have concave use surface cross-sections and the majority (86 percent) exhibit grinding/faceting wear. Two large end fragments (FS 1175 and FS 1246) exhibit striations that indicate the grinding motion was reciprocal and consistently oriented to parallel the artifact's longitudinal axis. Five metate fragments (FS 846, FS 1151, FS 1175, FS 1246, and FS 1341) have edge configurations that are consistent with those of trough metates. Five fragments (FS 846, FS 1151, FS 1941, FS 419, and FS 1858) exhibit evidence of heat alteration, including sooting and crenated fracturing. The maximum linear dimensions of the metate fragments range from 135 to 364 mm.

Slab Metate. A single slab metate (FS 1138) was recovered from the upper fill of Feature 76 suggesting it was deposited as secondary refuse. The metate was manufactured from rhyolite and exhibits minimal marginal flaking. It is oval-shaped in plan view outline and slightly concave in cross section. The artifact measures 491 mm long by 343 mm wide by 203 mm thick. Its use surface, which displays pecking to sharpening, measures 435 mm long by 235 mm wide. The use-surface area is 81,780 sq mm. It has a maximum depth of 5 mm.

Grinding Slabs. A total of six grinding slabs were recovered from LA 6169 (Table 19.20). FS 1887 appears to be an example of de facto refuse. This artifact was recovered from the floor of a mealing room (Feature 16) and displays an adhering red pigment residue. FS 1937 was secondarily used as a construction element in a cobble-filled roasting pit. The artifact shows two areas of heat spalling or exfoliation of the cortex. The remaining grinding slabs were recovered from upper feature fill and sheet trash contexts suggesting that they represent secondary refuse.

With the exception of FS 312, all grinding slabs are igneous materials. A variety of plan view outlines and cross-section forms are apparent. The majority (83 percent) exhibit striations. Three (FS 312, FS 1147, and FS 1887) exhibit linear unidirectional striations indicating a consistently oriented reciprocal grinding motion, while two (FS 944 and FS 1190) exhibit linear multidirectional striations indicating either an inconsistently oriented reciprocal or a rotary grinding motion. FS 1887 also exhibits a moderately lustrous polish. None of the grinding slabs appears heat altered.

Table 19.21 presents the metric attributes for the grinding slabs. Table 19.22 presents the

Table 19.19. Metate Fragments, LA 6169

FS No.	Analytic Unit	Material	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)
493	Feature 4, floor fill and floor; Feature 13	vesicular rhyolite	corner fragment	pecking	grinding/faceting	no maintenance	279
846	Feature 15, upper fill	vesicular rhyolite	edge fragment	no production input	grinding/faceting	no maintenance	234
883	unprovenienced	vesicular basalt	internal fragment	no production input	grinding/faceting	no maintenance	207
1151	Feature 76, upper fill	igneous, not further specified	edge fragment	no production input	grinding/faceting	pecked to sharpen	364
1416	Feature 76, upper fill	vesicular basalt	internal fragment	no production input	grinding/faceting	no maintenance	312
1941	SU 6, 7, and 8, extramural areas and sheet trash	fine-grained rhyolite	edge fragment	flaking	grinding/faceting	no maintenance	180
1175	Feature 76, upper fill	fine-grained rhyolite	end fragment	pecking	linear unidirectional striations, perpendicular to short axis	no maintenance	275
1246	Feature 16, upper fill	vesicular rhyolite	end fragment	no production input	linear unidirectional striations, perpendicular to short axis	no maintenance	341
1263	Feature 76, upper fill	welded tuff	edge fragment	no production input	grinding/faceting	no maintenance	293
1305	Feature 76, upper fill	welded tuff	end fragment	no production input	grinding/faceting	no maintenance	354
419	Feature 4, upper fill	vesicular rhyolite	edge fragment	no production input	grinding/faceting	no maintenance	184
1317	Feature 76, upper fill	igneous, not further specified	edge fragment	no production input	grinding/faceting	pecked to sharpen	219
1341	Feature 76, upper fill	fine-grained sandstone	corner fragment	no production input	grinding/faceting	pecked to sharpen	135
1858	Feature 47, upper fill	vesicular rhyolite	corner fragment	no production input	grinding/faceting	no maintenance	224

descriptive statistics for these attributes.

Expedient Handstones. Four expedient handstones were recovered from LA 6169 (Table 19.23). Three (FS 1478, FS 1541, and FS 1649) were recovered from the upper fill of Feature 76 and likely represent secondary refuse. A single expedient handstone (FS 806) was recovered from the floor of Feature 4, probably representing de facto refuse. It is a multiple-use tool, displaying striations on one surface, pigment residue on another, and battering wear on one end. FS 1478 is also a multiple-use tool, which displays grinding/faceting wear on one surface and battering wear consistent with use as a hammerstone along one end. FS 1649 displays two opposing use surfaces and FS 1541 displays a single use surface. Both handstones display linear unidirectional striations that parallel the artifacts' short axis. These wear patterns suggest that the artifacts were moved in a reciprocal manner consistently oriented at a right angle to their longitudinal axis. All expedient handstones are whole, exhibit a slightly convex use-surface cross section, and lack evidence of production input as well as maintenance. FS 1478

Table 19.20. Grinding Slabs, LA 6169

FS No.	Analytic Unit	Material	Plan View	Cross Section	Wear Pattern
312	SU 11, extramural area and sheet trash	fine-grained metaquartzite	irregular	flat	linear unidirectional striations
944	SU 6, 7, and 8, extramural areas and sheet trash	fine-grained rhyolite	irregular	concave/convex*	linear multidirectional striations
1937	SU 6, 7, and 8, extramural areas and sheet trash; Feature 149	coarse-grained rhyolite	oval	concave	grinding, faceting
1147	Feature 16, upper fill	andesite	irregular	flat	linear unidirectional striations parallel to short axis
1190	Feature 70, upper fill	fine-grained rhyolite	subsquare	concave	linear multidirectional striations
1887	Feature 16, floor fill and floor	andesite	oval	convex	polish and linear unidirectional striations

Table 19.21. Dimensions of Grinding Slabs and Use-Surfaces, LA 6169

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
312	279	172	78	177	85	12036
944*	226	152	44	152	95	11552
944*	226	152	44	120	70	6720
1147	199	189	52	166	105	13944
1190	80	77	14	66	64	3802
1887	202	153	28	124	84	8333
1937	221	137	87	174	66	9187

* Artifact exhibits two use-surfaces with different values for the same variable.

Table 19.22. Grinding Slab and Use-Surface Statistics, LA 6169 (N = 7)

	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
Mean	205	147	50	140	81	9368
SD	61	35	26	40	15	3462
Minimum	80	77	14	66	64	3802
Maximum	279	189	87	177	105	13944

Table 19.23. Expedient Handstones, LA 6169

FS No.	Analytic Unit	Material	Plan View	Wear Pattern
806	Feature 4, floor fill and floor	fine-grained metaquartzite	irregular	polish and linear unidirectional striations, pigment, battering*
1478	Feature 76, upper fill	medium-grained metaquartzite	oval	grinding, faceting, battering*
1541	Feature 76, upper fill	coarse-grained rhyolite	elongate oval, elliptical	linear unidirectional striations parallel to short axis
1649	Feature 76, upper fill	fine-grained rhyolite	oval	linear unidirectional striations parallel to short axis

* Artifact exhibits multiple use-surfaces with different values for the same variable.

Table 19.24. Dimensions of Expedient Handstones and Use-Surfaces, LA 6169

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
806	174	119	30	95	60	4560
1478	113	103	33	85	72	4896
1541	118	50	19	92	38	2797
1649*	154	97	26	120	65	6240
1649*	154	97	26	90	64	4608

Table 19.25. Expedient Handstone and Use-Surface Statistics, LA 6169 (N = 5)

	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
Mean	143	93	27	96	60	4620
SD	26	26	5	14	13	1228
Minimum	113	50	19	85	38	2797
Maximum	174	119	33	120	72	6240

exhibits evidence of thermal alteration in the form of sooting. Table 19.24 presents the metric attributes of these artifacts and Table 19.25 presents the associated descriptive statistics.

Maul. A single fully grooved maul (FS 909) manufactured from vesicular basalt was recovered from the upper fill of Feature 76. The groove, which presumably supported a haft, lacks definitive evidence of the method of shaping. Vesicular materials tend to mask evidence of initial manufacture, especially pecking or flaking. Both ends are well battered. This fact coupled with its provenience, points to its deposition as secondary refuse. It measures 103 mm long by 85 mm wide by 62 mm thick.

Axes. A single whole axe (FS 1601) manufactured from a fine-grained basalt was recovered from Feature 16 (mealing room) floor fill. The artifact does not appear to be expended and may have been stored for future use, or it may represent de facto refuse. The blunt end of the axe is well suited for crushing and/or hammering tasks. The bit end was initially shaped through bimarginal flaking. The edge created by this flaking exhibits step fracturing consistent with battering or chopping wear. The bit edge measures 59 mm with an angle of approximately 65 degrees. The opposing faces of the artifact display a patchy, moderately lustrous polish that is restricted from the flake scars associated with the bit edge and is overlain by multidirectional linear and curvilinear striations. Speculatively, this wear pattern may be the result of wedging or splitting a material and then, if imbedded in the material, loosening it for a subsequent blow. The hafting element consists of opposing lateral notches created by flaking and pecking. The blunt end displays pecking, flaking, and step fracturing consistent with battering wear. The artifact measures 145 mm long by 102 mm wide by 54 mm thick.

A fragmentary axe or pick was recovered from Feature 76 floor fill and likely represents secondary refuse. The artifact was manufactured from a fine-grained rhyolite. It is a medial portion and displays two opposing lateral notches created by bifacial flaking. Both faces exhibit linear multidirectional striations. The artifact measures 100 mm long by 87 mm wide by 22 mm thick.

Mortars. Two whole mortars were recovered from LA 6169. FS 1266 was recovered from the upper fill of Feature 76 where it was likely deposited as secondary refuse. The artifact is of a vesicular tuff. The mortar basin, which appears to be pecked or gouged, is circular in plan view and has a maximum depth of 18 mm. The artifact measures 118 mm long by 112 mm wide by 88 mm thick. Its use surface measures 64 mm long by 63 mm thick by 18 mm deep. FS 2048 was recovered from a cobble pile (Feature 13) where it was secondarily used as a construction element. The mortar was manufactured from a small boulder of red scoria. The mortar basin is oval shaped in plan view and has a maximum depth of 54 mm. The artifact measures 515 mm long by 372 mm wide by 290 mm thick. Its use surface measures 274 mm long by 182 mm wide.

Shaped Slabs. Three fragmentary shaped slabs were recovered (Table 19.26). All were manufactured through bimarginal flaking of fine-grained rhyolite slabs. All represent secondary refuse. FS 1978, a relatively small fragment, was recovered from the fill of the ventilator system of Feature 47. FS 1624 displays red pigment residue, but no other surface modification. Maximum linear dimensions range from 102 mm to 327 mm.

Stone Balls. Two stone balls (FS 613-1 and FS 613-2) were recovered from Study Unit 12. If the balls were used in this activity area, which is unclear, then they represent de facto refuse. Both are of fine-grained rhyolite and lack evidence of initial shaping. FS 613-1 exhibits a possible impact fracture suggesting use as a projectile. FS 613-1 measures 33 mm long by 29 mm wide by 27 mm thick. FS 613-2 measures 32 mm long by 31 mm wide by 30 mm thick.

Unmodified Cobbles with Pigment. Five unmodified cobbles with adhering red pigment

Table 19.26. Shaped Slabs, LA 6169

FS No.	Analytic Unit	Material	Maximum Dimension (mm)
796	Feature 4, upper fill	fine-grained rhyolite	327
1624	Feature 70, upper fill	fine-grained rhyolite	256
1978	Feature 47, floor fill and floor, Feature 153	fine-grained rhyolite	102

Table 19.27. Cobbles with Pigment Residue, LA 6169

FS No.	Analytic Unit	Material	Condition	Plan View
652	SU 1, extramural area and sheet trash	igneous, not further specified	end fragment	N/A
1999	Feature 47, floor fill and floor; Feature 163	fine-grained rhyolite	whole	oval
1610	Feature 16, floor fill and floor	fine-grained metaquartzite	whole	oval
1559	Feature 76, upper fill	fine-grained metaquartzite	whole	oval
1949	Feature 47, floor fill and floor; Feature 153	fine-grained metaquartzite	whole	irregular

Table 19.28. Dimensions of Unmodified Cobbles with Pigment, LA 6169

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Extent of Pigment Length (mm)	Extent of Pigment Width (mm)	Extent of Pigment Area (sq mm)
652	208	186	47	125	81	-
1559	120	118	38	98	76	5958
1610	200	137	38	79	82	5182
1949	149	106	32	91	72	5242
1999	301	193	111	104	20	1664

Table 19.29. Statistics, Unmodified Cobbles with Pigment, LA 6169

	Length (mm)	Width (mm)	Thickness (mm)	Extent of Pigment Length (mm)	Extent of Pigment Width (mm)	Extent of Pigment Area (sq mm)
N	5	5	5	5	5	4
Mean	196	148	53	99	66	4512
SD	69	40	33	17	26	1931
Minimum	120	106	32	79	20	1664
Maximum	301	193	111	125	82	5958

residue were recovered from LA 6169 (Table 19.27). FS 1610, which was recovered from the floor of a mealing room (Feature 16), may represent de facto refuse. FS 1999, which was recovered from a wall niche in Feature 47, may have been stored for future use or may simply represent secondary refuse. FS 1949 was recovered from the fill of the ventilator system of Feature 47 and likely represents secondary refuse, as do the remaining artifacts from upper feature fill and sheet trash contexts. All lack evidence of wear. With the exception of the area displaying pigment on FS 1610, all areas displaying pigment have convex cross sections. All are whole, except FS 652. Because of FS 652's fragmentary nature, the extent of pigment measurements are not complete, and therefore the area was not calculated. Table 19.28 presents the metric attributes and Table 19.29 presents the corresponding descriptive statistics.

Picks. Two picks (FS 157 and FS 1323) were recovered from upper feature fill contexts suggesting discard as secondary refuse. Both were manufactured from flattened cobbles of fine-grained rhyolite that have elongate oval-shaped plan-view outlines with one end tapering nearly to a point. FS 157, which was recovered from the upper fill of Feature 4, displays very shallow opposing lateral notches created by minimal flaking and a moderate lustrous polish surrounding the notches. The polish may be the product of friction between the haft and the artifact. The bit displays bifacial flake removal, step fracturing, rounding, and a slightly lustrous polish. It measures 48 mm. The artifact measures 314 mm long by 143 mm wide by 50 mm thick. FS 1323, which was recovered from the upper fill Feature 76, displays opposing lateral notches created by bifacial flaking. Both faces exhibit linear multidirectional striations. The bit, which measures 34 mm, displays minimal bifacial flake removal and rounding. The flake removal at each artifact's bit appears to be the product of wear rather than initial shaping. FS 1323 measures 286 mm long by 151 mm wide by 38 mm thick.

LA 6170

LA 6170 yielded 101 ground stone artifacts from 24 separate analytic units (Table 19.30). Ground stone is consistently the most frequent artifact in the lower structure fill or in a roof-fall context. This includes Structure 2, Structure 5, and Structure 50, which are all

Table 19.30. Ground Stone Artifact Type by Analytic Unit, LA 6170

	Area 1	Stratum 1 Area	SU 3	Feature 2	Stratum 2, Wind/ Water Deposits	Stratum 2, Roof Fall/Redeposit	Stratum 2, Floor Fill and Contact	Stratum 5, Overburden	Feature 5	Stratum 5, Wind/ Water Deposits	Stratum 5a, Fill	Stratum 5, Roof and Closing
Indeterminate ground	-	-	1	-	-	5	1	-	1	1	1	3
stone fragment	-	-	4.2%	-	-	20.8%	4.2%	-	4.2%	4.2%	12.5%	12.5%
	-	-	100.0%	-	-	41.7%	50.0%	-	50.0%	50.0%	20.0%	20.0%
Mano fragment	-	-	-	1	-	-	-	-	-	-	1	1
	-	-	-	14.3%	-	-	-	-	-	-	14.3%	14.3%
	-	-	-	100.0%	-	-	-	-	-	-	50.0%	6.7%
One-hand mano	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Two-hand mano	-	-	-	-	-	-	-	-	5	-	-	-
	-	-	-	-	-	-	-	-	55.6%	-	-	-
	-	-	-	-	-	-	-	-	50.0%	-	-	-
Metate fragment	-	-	-	-	1	1	-	-	-	-	-	2
	-	-	-	-	7.7%	7.7%	-	-	-	-	-	15.4%
	-	-	-	-	50.0%	8.3%	-	-	-	-	-	13.3%
Slab metate	-	-	-	-	-	-	-	-	3	-	-	1
	-	-	-	-	-	-	-	-	75.0%	-	-	25.0%
	-	-	-	-	-	-	-	-	30.0%	-	-	6.7%
Basin metate	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Trough metate	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Grinding slab	1	1	-	-	1	2	-	-	-	1	-	3
	10.0%	10.0%	-	-	10.0%	20.0%	-	-	-	10.0%	-	30.0%
	50.0%	50.0%	-	-	50.0%	16.7%	-	-	-	50.0%	-	20.0%
Expedient handstone	1	-	-	-	-	-	-	1	-	-	-	1
	25.0%	-	-	-	-	-	-	25.0%	-	-	-	25.0%
	50.0%	-	-	-	-	-	-	100.0%	-	-	-	6.7%
Maul	-	-	-	-	-	-	-	-	1	-	-	-
	-	-	-	-	-	-	-	-	100.0%	-	-	-
	-	-	-	-	-	-	-	-	10.0%	-	-	-
Pestle	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	50.0%
	-	-	-	-	-	-	-	-	-	-	-	6.7%
Mortar	-	-	-	-	-	1	-	-	-	-	-	-
	-	-	-	-	-	50.0%	-	-	-	-	-	-
	-	-	-	-	-	8.3%	-	-	-	-	-	-
Polishing stone	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	6.7%
Shaped slab	-	-	-	-	-	3	1	-	-	-	-	1
	-	-	-	-	-	27.3%	9.1%	-	-	-	-	9.1%
	-	-	-	-	-	25.0%	50.0%	-	-	-	-	6.7%
Stone ball	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Cobble with pigment	-	-	-	-	-	-	-	-	-	-	-	1
residue, otherwise	-	-	-	-	-	-	-	-	-	-	-	25.0%
unmodified	-	-	-	-	-	-	-	-	-	-	-	6.7%
Total	2	1	1	1	2	12	2	1	10	2	2	15
	2.0%	1.0%	1.0%	1.0%	2.0%	11.9%	2.0%	1.0%	9.9%	2.0%	2.0%	14.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19.30. Continued.

	Stratum 5, Floor Fill and Closing	Stratum 5, Pits with Occupation Fill	Stratum 5, Vent Shaft	Area 2	Stratum 50, Overburden	Stratum 50, Wind/Water Deposits	Stratum 50, Roof and Closing	Stratum 50, Floor Fill and Contact	Stratum 50, Pits with Occupation Fill	Stratum 50 Vent Shaft	SU 15	SU 17	Total
Indeterminate ground	3	-	-	-	-	-	4	-	1	-	2	1	24
stone fragment	12.5%	-	-	-	-	-	16.7%	-	4.2%	-	8.3%	4.2%	100.0%
	37.5%	-	-	-	-	-	33.3%	-	12.5%	-	66.7%	50.0%	23.8%
Mano fragment	-	-	-	1	1	1	1	-	-	-	-	-	7
	-	-	-	14.3%	14.3%	14.3%	14.3%	-	-	-	-	-	100.0%
	-	-	-	50.0%	100.0%	33.3%	8.3%	-	-	-	-	-	6.9%
One-hand mano	-	-	-	-	-	-	-	1	-	-	-	-	1
	-	-	-	-	-	-	-	100.0%	-	-	-	-	100.0%
	-	-	-	-	-	-	-	14.3%	-	-	-	-	1.0%
Two-hand mano	1	-	-	-	-	-	1	1	1	-	-	-	9
	11.1%	-	-	-	-	-	11.1%	11.1%	11.1%	-	-	-	100.0%
	12.5%	-	-	-	-	-	8.3%	14.3%	12.5%	-	-	-	8.9%
Metate fragment	1	-	-	1	-	-	2	2	2	-	1	-	13
	7.7%	-	-	7.7%	-	-	15.4%	15.4%	15.4%	-	7.7%	-	100.0%
	12.5%	-	-	50.0%	-	-	16.7%	28.6%	25.0%	-	33.3%	-	12.9%
Slab metate	-	-	-	-	-	-	-	-	-	-	-	-	4
	-	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	-	4.0%
Basin metate	1	-	-	-	-	-	-	-	-	-	-	-	1
	100.0%	-	-	-	-	-	-	-	-	-	-	-	100.0%
	12.5%	-	-	-	-	-	-	-	-	-	-	-	1.0%
Trough metate	-	-	2	-	-	-	-	-	2	-	-	-	4
	-	-	50.0%	-	-	-	-	-	50.0%	-	-	-	100.0%
	-	-	100.0%	-	-	-	-	-	25.0%	-	-	-	4.0%
Grinding slab	-	-	-	-	-	-	-	1	-	-	-	-	10
	-	-	-	-	-	-	-	10.0%	-	-	-	-	100.0%
	-	-	-	-	-	-	-	14.3%	-	-	-	-	9.9%
Expedient handstone	-	-	-	-	-	-	-	-	-	-	-	1	4
	-	-	-	-	-	-	-	-	-	-	-	25.0%	100.0%
	-	-	-	-	-	-	-	-	-	-	-	50.0%	4.0%
Maul	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	-	1.0%
Pestle	-	-	-	-	-	-	-	-	1	-	-	-	2
	-	-	-	-	-	-	-	-	50.0%	-	-	-	100.0%
	-	-	-	-	-	-	-	-	12.5%	-	-	-	2.0%
Mortar	-	-	-	-	-	1	-	-	-	-	-	-	2
	-	-	-	-	-	50.0%	-	-	-	-	-	-	100.0%
	-	-	-	-	-	33.3%	-	-	-	-	-	-	2.0%
Polishing stone	-	-	-	-	-	-	-	-	-	-	-	-	1
	-	-	-	-	-	-	-	-	-	-	-	-	100.0%
	-	-	-	-	-	-	-	-	-	-	-	-	1.0%
Shaped slab	1	1	-	-	-	-	4	-	-	-	-	-	11
	9.1%	9.1%	-	-	-	-	36.4%	-	-	-	-	-	100.0%
	12.5%	100.0%	-	-	-	-	33.3%	-	-	-	-	-	10.9%
Stone ball	-	-	-	-	-	1	-	1	1	-	-	-	3
	-	-	-	-	-	33.3%	-	33.3%	33.3%	-	-	-	100.0%
	-	-	-	-	-	33.3%	-	14.3%	12.5%	-	-	-	3.0%
Cobble with pigment	1	-	-	-	-	-	-	1	-	1	-	-	4
residue, otherwise	25.0%	-	-	-	-	-	-	25.0%	-	25.0%	-	-	100.0%
unmodified	12.5%	-	-	-	-	-	-	14.3%	-	100.0%	-	-	4.0%
Total	8	1	2	2	1	3	12	7	8	1	3	2	101
	7.9%	1.0%	2.0%	2.0%	1.0%	3.0%	11.9%	6.9%	7.9%	1.0%	3.0%	2.0%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Early Developmental period pithouses. A total of 17 different artifact types were identified. The most frequent artifact types are indeterminate ground stone fragments (23.8 percent), metate fragments (13.9 percent), and fragmentary shaped slabs (10.9 percent). The artifact type distribution suggests that the site's occupants were involved in a fairly wide range of grinding and other activities including tool manufacture and maintenance, wild vegetal resource processing, agricultural produce processing, and pigment processing.

Indeterminate Ground Stone Fragments. A total of 24 indeterminate ground stone fragments, most of which appear to be secondary refuse, were recovered from LA 6170 (Table 19.31). Distinguishing between primary and secondary refuse on structure floors is difficult due to the amount of refuse deposition during and after structure closing and abandonment. It is possible that this deposition may mask some primary refuse.

Several fragments were recovered from features within analytical units. FS 1937 and FS 2349-2 were recovered from Structure 5 and Structure 50 ventilator tunnels, respectively. FS 1897 was recovered from a rodent-disturbed wall niche in Structure 5. FS 2195 appears to be an example of reuse. It was secondarily used as a heat-retaining element in an extramural cobble-filled roasting pit (Feature 52).

None of the fragments exhibits evidence of production input. However, six fragments (FS 1651, FS 1661, FS 1897, FS 2070, FS 2267, and FS 2081), which exhibit flat use-surface cross sections, display maintained use surfaces, and, therefore may be considered formal tool fragments. Four fragments (FS 1897, FS 1235, FS 1266, and FS 2195) exhibit two opposing use surfaces. If striations are apparent, all, except FS 1810, are linear and unidirectional indicating that the artifact itself was moved or that it was acted upon by another artifact that was moved in a consistently oriented reciprocal manner. FS 1810 displays multidirectional linear striations that indicate either an inconsistently oriented motion or a rotary motion. The fragments have maximum linear dimensions ranging from 63 to 319 mm.

Three fragments (FS 2029, FS 2073, FS 2081) show evidence of thermal alteration in the form of crenated fracturing and/or sooting, which is not surprising, since they were recovered from the burned roof fall layers of Structure 50.

Mano Fragments. A total of seven mano end and edge fragments were recovered, all of which appear to be secondary refuse (Table 19.32). The majority (57 percent) are fine-grained sandstone. If striations are apparent, they are linear and unidirectional, indicating the mano was moved in a consistently oriented reciprocal manner. With the exception FS 593 and FS 1475, which are of vesicular igneous materials and considered self-sharpening, all show pecking across the use surface. FS 1981 is an example of recycling. It displays numerous complete flake scars suggesting reuse as a unidirectional core. Two fragments (FS 1475 and FS 2051) exhibit ground ends that are consistent with use in a trough metate. A single fragment (FS 1012) appears heat fractured. The fragments have maximum linear dimensions ranging from 91 to 169 mm.

One-Hand Mano. A single quartzite one-hand mano (FS 2187) was recovered from the floor of Structure 50. It likely represents de facto refuse and may have been used in conjunction with FS 2348 and FS 2349, which are fragments of a nearly complete basin metate, recovered from the ventilator tunnel opening. The mano was initially shaped by pecking, but lacks evidence of maintenance. It is oval in plan view outline and measures 159 mm long by 116 mm wide by 84 mm thick. The use surface displays linear unidirectional striations that parallel the artifact's transverse axis, indicating that it was used in a reciprocal motion consistently oriented at a right angle to the artifact's longitudinal axis. This surface is convex in cross section and measures 102 mm long by 81 mm wide, giving it an area of 6,610 sq mm.

Two-Hand Manos. A total of nine two-hand

Table 19.31. Indeterminate Ground Stone Fragments, LA 6170

FS No.	Analytic Unit	Material	Condition	Cross Section	Wear Pattern	Sharpening	Maximum Dimension (mm)
1199	SU 3	basalt	end fragment	concave	linear unidirectional striations	no maintenance	138
1263	Structure 2 roof fall	fine-grained rhyolite	edge fragment	concave	linear unidirectional striations	no maintenance	108
1224	Structure 2 roof fall	fine-grained rhyolite	internal fragment	flat	linear unidirectional striations	no maintenance	120
1218	Structure 2 floor fill and contact	igneous, not further specified	end fragment	convex	polish and linear unidirectional striations	no maintenance	102
1651	Structure 5, roof and closing	fine-grained sandstone	corner fragment	flat	grinding, faceting	pecked to sharpen	90
1661	Structure 5, roof and closing	orthoquartzite	edge fragment	flat	grinding, faceting	1 pecked to sharpen, 2 no maintenance*	63
1897	Structure 5, Feature 22	fine-grained sandstone	internal fragment	flat	grinding, faceting	pecked to sharpen	69
2029	Structure 50, roof and closing	medium-grained sandstone	internal fragment	flat	grinding, faceting	no maintenance	85
2073	Structure 50, roof and closing	medium-grained sandstone	corner fragment	concave	grinding, faceting	no maintenance	139
2070	Structure 50, roof and closing	orthoquartzite	internal fragment	flat	grinding, faceting	pecked to sharpen	113
2267	SU 15	fine-grained sandstone	edge fragment	flat	linear unidirectional striations	pecked to sharpen	83
1127	Structure 2 roof fall	basalt	edge fragment	concave	linear unidirectional striations	no maintenance	150
1235	Structure 2 roof-fall	fine-grained rhyolite	edge fragment	1 concave, 2 convex*	linear unidirectional striations	no maintenance	135
1266	Structure 2 roof-fall	fine-grained rhyolite	edge fragment	convex	linear unidirectional striations	no maintenance	106
1458	Feature 5	andesite	end fragment	concave	linear unidirectional striations	no maintenance	287
1463	Structure 5a, fill	fine-grained rhyolite	end fragment	convex	linear unidirectional striations	no maintenance	93
1549	Structure 5, roof and closing	fine-grained rhyolite	corner fragment	concave	linear unidirectional striations, oblique to short axis	no maintenance	197 67
1789	Structure 5, floor fill and closing	fine-grained rhyolite	edge fragment	convex	linear unidirectional striations	no maintenance	95
1810	Structure 5, floor fill and closing	fine-grained metaquartzite	end fragment	sinuous or irregular	linear multidirectional striations	no maintenance	
1937	Structure 5, floor fill and closing/ Feature 24	fine-grained sandstone	end fragment	concave	linear unidirectional striations, perpendicular to short axis	no maintenance	127 117
2081	Structure 50, roof and closing	fine-grained sandstone	internal fragment	flat	grinding, faceting	pecked to sharpen	166
2195	SU 17 Feature 52	fine-grained rhyolite	end fragment	convex	linear unidirectional striations	no maintenance	
2330	SU 15	medium-grained metaquartzite	edge fragment	convex	grinding, faceting	no maintenance	96
2349-2	Structure 50, pits	fine-grained sandstone	corner fragment	concave	linear unidirectional striations	no maintenance	319

* Artifact exhibits two use-surfaces with different values for the same variable.

Table 19.32. Mano Fragments, LA 6170

FS No.	Analytic Unit	Material	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)
593	Area 2	vesicular rhyolite	end fragment	no production input	grinding, faceting	no maintenance	107
1475	Structure 5a, fill	vesicular basalt	end fragment	pecking	grinding, faceting	no maintenance	109
1981	Structure 50, wind/water deposits	fine-grained sandstone	edge fragment	no production input	grinding, faceting	pecked to sharpen	91
2038	Structure 50, roof and closing	fine-grained sandstone	end fragment	pecking and flaking	grinding, faceting	pecked to sharpen	132
1012	Feature 2	fine-grained sandstone	edge fragment	no production input	linear unidirectional striations	pecked to sharpen	108
1715	Structure 5, roof and closing	fine-grained sandstone	edge fragment	pecking	linear unidirectional striations	pecked to sharpen	104
2051	Structure 50, overburden	vesicular rhyolite	end fragment	pecking	linear unidirectional striations, parallel to short axis	pecked to sharpen	169

Table 19.33. Two-hand Manos, LA 6170

FS No.	Analytic Unit	Material	Shaping	Plan View	Wear Pattern	Sharpening
1311	Feature 5	vesicular rhyolite	no production input	oval	linear unidirectional striations, parallel to short axis	no maintenance
1312	Feature 5	medium-grained metaquartzite	pecking	oval	grinding, faceting	pecked to sharpen
1450	Feature 5	vesicular basalt	pecking	subrectangular	grinding, faceting	no maintenance
1452	Feature 5	fine-grained sandstone	pecking	subrectangular	linear unidirectional striations, parallel to short axis	pecked to sharpen
1453	Feature 5	medium-grained sandstone	pecking	subrectangular	linear unidirectional striations, parallel to short axis	pecked to sharpen
1937-2	Structure 5, Feature 24	coarse-grained sandstone	pecking	subrectangular	linear unidirectional striations, parallel to short axis	pecked to sharpen
1978	Structure 50, roof and closing	coarse-grained sandstone	pecking	subrectangular	grinding, faceting	pecked to sharpen
2112	Structure 50, floor fill and contact	vesicular basalt	pecking	subrectangular	grinding, faceting	no maintenance
2337	Structure 50, Feature 169	fine-grained sandstone	pecking	irregular	grinding, faceting	pecked to sharpen

Table 19.34. Dimensions of Two-hand Manos, LA 6170

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
1311	252	123	40	252	111	22378
1312	231	127	37	231	123	22730
1450	242	135	82	232	139	29023
1452	224	120	24	215	118	22833
1453	224	137	26	220	132	26136
1937-2	176	109	42	176	109	17266
1937-2	176	109	42	158	94	13367
1978	177	106	51	154	97	13444
2112	233	128	85	204	103	18911
2337	222	118	56	208	104	17306

Table 19.35. Two-hand Mano Statistics, LA 6170 (N = 10)

	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
Mean	216	121	49	205	113	20339
SD	29	11	21	33	15	5184
Minimum	176	106	24	154	94	13367
Maximum	252	137	85	252	137	29023

manos were recovered from five separate analytic units (Table 19.33). The items recovered from Feature 5 are part of a ground stone cache associated with a Late Developmental/Early Coalition period occupation. The cache reflects storage in anticipation of future use. FS 2112 is an example of de facto refuse. It was located on the floor of Structure 50 in close proximity to Feature 151, a trough metate resting on prop stones. FS 1937-2 and FS 2337 were located at the vent tunnel openings in Structure 5 and Structure 50, respectively, and may have been secondarily used to partially restrict airflow through the ventilator system. FS 2348, a large fragment of a basin metate, was similarly positioned at the vent tunnel opening in Structure 50. FS 1978 may be an example of secondary refuse, unless it was stored or used in or on the roof.

With the exception of FS 1450 with its flat use-surface cross section, all have slightly convex cross sections. If striations are apparent, they are linear, unidirectional, and parallel the manos' transverse axis indicating that the mano was moved in a reciprocal manner that was consistently oriented at a right angle to the mano's longitudinal axis.

The manos included in Feature 5 were associated with three slab metates. This fact and the lack of wear on their ends suggest that the five manos were used with slab metates. FS 1450 and FS 1453 have manufactured finger grooves, which are a comfort feature and suggest intensive grinding (Adams 1996:36, 1999:492). FS 1937-2 has two opposing use surfaces, which reflects the practice of a wear management technique (Adams 1993:336; Mauldin 1993:322). The two use surfaces have similar wear patterns, but one surface appears more well worn and has an upturned ground end, indicating it was used in a trough metate.

Table 19.34 presents the recorded and calculated metric attributes by mano use surface. Central tendency and dispersion statistics are tabulated in Table 19.35. Initial examination of Table 19.34 reveals that two-hand manos used in slab metates have consistently larger use-surface areas.

Metate Fragments. A total of 13 FS numbers were assigned to metate fragments representing nine separate metates (Table 19.36). FS 2039

Table 19.36. Metate Fragments, LA 6170

FS No.	Analytic Unit	Material	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)
1473	Structure 5, roof and closing	fine-grained sandstone	edge fragment	pecking, flaking, and grinding	grinding, faceting	pecked to sharpen	136
1840	Structure 5, floor fill and closing	fine-grained sandstone	edge fragment	flaking	grinding, faceting	pecked to sharpen	89
2441	Area 2	fine-grained sandstone	internal fragment	no production input	linear unidirectional striations	pecked to sharpen	62
1125	Structure 2, wind, water deposits	coarse-grained sandstone	internal fragment	no production input	grinding, faceting	pecked to sharpen	74
1170	Structure 2 roof fall	fine-grained sandstone	edge fragment	pecking	grinding, faceting	pecked to sharpen	161
1695	Structure 5, roof and closing	medium-grained metaquartzite	end fragment	flaking	linear unidirectional striations	no maintenance	205
2042	Structure 50, roof and closing	fine-grained rhyolite	end fragment	pecking	grinding, faceting	pecked to sharpen	204
2039	Structure 50, roof and closing	fine-grained rhyolite	19 fragments	pecking	grinding, faceting	pecked to sharpen	218
2156	Structure 50, floor fill and contact	fine-grained rhyolite	25 fragments	pecking	grinding, faceting	no maintenance	142
2185	Structure 50, floor fill and contact	fine-grained rhyolite	internal fragment	no production input	grinding, faceting	pecked to sharpen	204
2349	Structure 50, Feature 169	igneous, not further specified	6 fragments	flaking	grinding, faceting	no maintenance	149
2348	Structure 50, Feature 169	igneous, not further specified	end fragment	no production input	linear unidirectional striations, perpendicular to short axis	no maintenance	324
2216	SU 15	fine-grained sandstone	internal fragment	no production input	grinding, faceting	pecked to sharpen	126

Table 19.37. Slab Metates, LA 6170

FS No.	Analytic Unit	Material	Plan View	Cross Section	Wear Pattern	Sharpening
1451	Feature 5	fine-grained sandstone	subrectangular	concave	linear unidirectional striations, perpendicular to short axis	pecked to sharpen
1453-2	Feature 5	vesicular basalt	subrectangular	concave	grinding, faceting	no maintenance
1453-3	Feature 5	fine-grained rhyolite	subrectangular	concave	linear unidirectional striations, perpendicular to short axis	no maintenance
1527	Structure 5a, floor	vesicular basalt	oval	concave	grinding, faceting	no maintenance

and FS 2156 have 19 and 25 fragments, respectively, and FS 2042 and FS 2185 are from the same trough metate. Whole measurements cannot be obtained from the metate reconstruction, therefore, it is not considered whole. Most likely, part of the metate was heat shattered when the structure burned. Vertically, FS 2042 and FS 2039 were recovered from roof fall and closing layers in Structure 50, while FS 2156 and FS 2185 were recovered from floor fill and floor contact layers. Horizontally, FS 2185 was located approximately 3 m away from the main cluster. The vertical and horizontal distribution of these fragments point to their deposition as multiple fragments and secondary refuse. FS 2349 contains six fragments from one metate. Some of these fragments can be refitted with FS 2348. Reconstruction yields an almost complete basin metate. Its location at the vent tunnel opening points to a secondary use as a vent cover. Along with FS 2337, a two-hand mano that was similarly positioned, the artifact would have partially restricted airflow through the ventilator system.

If striations are apparent, they are linear and unidirectional indicating that the metate was used with a mano that was moved in a consistently oriented reciprocal manner. FS 2039 has a fragment with a flat use surface, otherwise all use surfaces are concave. Due to its edge configuration, FS 1170 appears to represent a trough metate. For all fragments, maximum linear dimensions range from 62 to 324 mm. In the case of FS numbers that contain multiple fragments, the maximum linear dimension of the largest fragment was recorded.

Slab Metates. A total of four slab metates were recovered from Area 1 at LA 6170 (Table 19.37). Three slabs (FS 1451, FS 1453-2, and FS 1453-3) were recovered from Feature 5. This cache also contained five two-hand manos and a fully grooved maul. The feature stratigraphically overlies Structure 5A, which produced an archaeomagnetic date of AD 1103. Interestingly, a Coalition period mealing room (Feature 16) at LA 6169 contained three mealing basins, but lacked metates. The cache reflects storage in anticipation of future use and possibly short-distance transport to the cache location. The use-surface textures of the cached metates grade from coarse (FS 1453-2) to medium (FS 1451) to fine (FS 1453-3). If these metates were used together, the progressively less coarse texture suggests the employment of a multiple-stage grinding technique (Lancaster 1983:60,70–71, 1986:188), in which corn is initially crushed and ground on a coarse-textured metate, usually manufactured from vesicular igneous material, then ground into a progressively finer flour using finer textured metates. This process is similar to that reported by Bartlett (1933:4) for the modern Hopi. The remaining slab metate, FS 1527, was recovered from approximately floor level in Structure 5A. It is an example of de facto refuse.

With the exception of FS 1527, all display evidence of initial manufacture through pecking. All use surfaces' transverse cross sections are slightly concave rather than flat with a maximum transverse cross-section depth of 9 mm. If striations are apparent, they are unidirectional, linear, and perpendicular to the transverse axis of the metate indicating that it was used with a mano that was moved in a reciprocal manner consistently paralleling the metate's longitudinal axis. FS 1453-3 has two opposing use surfaces that were used with two different manos. The use surface described here is consistent with that of a slab metate, while the opposing surface is that of a shallow basin metate. The wear on this opposing surface is linear and unidirectional, but does not encompass the entire width of the metate suggesting that it was used with a one-hand mano. FS 1453-3 is an example of a multiple use tool. Its shallow basin surface will be further described with the basin metates.

Table 19.38 presents the metric attributes for slab metates. It is noteworthy that the use surface areas of slab metates are consistently larger than those of the trough and basin metates. Metric attributes for FS 1453-3's shallow basin surface will be presented with the other basin metate.

Table 19.38. Dimensions of Slab Metates, LA 6170

FS No.	Length (mm)	Width (mm)	Length (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)	Maximum Depth (mm)
1451	464	312	134	439	244	96404	9
1453-2	512	303	94	484	275	119790	1
1453-3	480	301	69	449	257	103854	2
1527	527	271	227	474	226	85699	2

Basin Metates. As previously mentioned, FS 1453-3 is a metate that displays two opposing use surfaces. The shallow basin surface is concave in cross section, lacks evidence of maintenance, and measures 209 mm long by 170 mm wide, giving it an area of 28,424 sq mm. It has a maximum depth of 5 mm.

Another basin metate, FS 1800, was recovered from floor of Structure 5 and likely represents de facto refuse. It was positioned with the use surface facing the floor. It is a vesicular rhyolite that lacks evidence of production input and would not require sharpening. It is oval in plan view outline and measures 406 mm long by 228 mm wide by 99 mm thick . The use surface exhibits grinding/faceting wear, is concave in cross section, and measures 360 mm long by 154 mm wide, giving it an area of 44,352 sq mm. It has a maximum depth of 32 mm.

Trough Metates. A single whole trough metate (FS 1930) and two reconstructible trough metates (FS 2191, FS 2194, and FS 1953) were recovered from LA 6170 (Table 19.39). Multiple fragments of one reconstructible metate were assigned two FS numbers, FS 2191 and FS 2194. This artifact is an example of de facto refuse from the floor of Structure 50. The metate was discovered in its use location on prop stones that set the metate at an angle with its open end down. The metate was heat fractured, probably when the structure burned. FS 1930 and FS 1953 were recovered from the ventilator shaft of Structure 5. FS 1953 was located in the fill approximately 49 cm below FS 1930. FS 1953 is fragmentary, but all whole measurements can be obtained. Its fragmentary nature points to its deposition as secondary refuse. FS 1930 does not appear to be expended and may have been cached in the partially filled vent shaft. FS 1930 is an example of the through trough type (Lancaster 1986:183), while the others are examples of the one-end-open type.

Both of the one-end-open trough metates exhibit evidence of pecking during initial manufacture and maintenance. The through trough metate lacks evidence of initial shaping. All trough metates exhibit concave transverse cross sections. If striations are apparent, they are linear, unidirectional, and perpendicular to the metates' transverse axis indicating that they were used with a mano that was moved in a reciprocal manner that was consistently oriented to parallel the metates' longitudinal axis.

Table 19.40 presents the metric attributes of the trough metates. Interestingly, the use-surface areas of these trough metates are consistently smaller than the those of the slab metates, but larger than those of the basin metates.

Grinding Slabs. A total of 10 grinding slabs were recovered from LA 6170 (Table 19.41). Most appear to be deposited as secondary refuse. The grinding slabs recovered from roof-fall layers are somewhat problematic and could be considered de facto refuse if they were used at a roof-top activity area. FS 2189, which was in contact with the floor and heat altered during the burning of Structure 50, may be an example of de facto refuse.

Two grinding slabs, FS 1172 and FS 1335, exhibit adhering red and yellow pigment residues, respectively, indicating that these artifacts were involved in pigment processing. A variety of plan view and use-surface cross-section forms are apparent. If striations are apparent, the majority (50 percent) are linear,

Table 19.39. Trough Metates, LA 6170

FS No.	Analytic Unit	Material	Condition	Plan View	Wear Pattern
2191 and 2194	Structure 50, Feature 151	fine-grained metaquartzite	multiple fragments	oval	linear unidirectional striations, perpendicular to short axis
1930	Structure 5,vent shaft/ Feature 37	vesicular rhyolite	whole	irregular	grinding, faceting
1953	Structure 5,vent shaft/ Feature 37	fine-grained sandstone	multiple fragments	subrectangular	linear unidirectional striations, perpendicular to short axis

Table 19.40. Dimensions of Trough Metates, LA 6170

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (mm)	Maximum Depth (mm)
2191	580	376	119	410	247	81016	75
1930	461	422	143	415	218	72376	26
1953	456	374	72	294	228	53626	60

Table 19.41. Grinding Slabs, LA 6170

FS No.	Component	Material Type	Plan View	Cross Section	Wear Pattern
328	Structure 1 area	fine-grained rhyolite	subrectangular	flat	polish and linear multidirectional striations
1061	Structure 2 roof fall	fine-grained rhyolite	irregular	flat	linear unidirectional striations, perpendicular to short axis
1172	Structure 2 roof fall	fine-grained rhyolite	irregular	concave	polish and linear unidirectional striations
1335	Structure 5, wind, water deposits	fine-grained rhyolite	irregular	flat	linear unidirectional striations, perpendicular to short axis
1525	Structure 5, roof and closing	fine-grained rhyolite	oval	concave	linear unidirectional striations, perpendicular to short axis
1690	Structure 5, roof and closing	fine-grained rhyolite	irregular	flat	linear unidirectional striations
1718	Structure 5, roof and closing	fine-grained rhyolite	irregular	1 convex, 2 concave*	linear unidirectional striations, perpendicular to short axis
1963	Area 1/Feature 41	fine-grained rhyolite	oval	flat	linear unidirectional striations, perpendicular to short axis
2189	Structure 50, floor fill and contact	vesicular rhyolite	oval	flat	polish and linear unidirectional striations
1091	Structure 2, wind, water deposits	andesite	oval	convex	grinding, faceting

*Artifact exhibits two use-surfaces with different values for the same variable.

Table 19.42. Dimensions of Grinding Slabs, LA 6170

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
328	240	143	72	186	107	15922
1061	264	130	54	190	95	14440
1172	259	165	45	156	87	10858
1335	149	130	31	132	101	10666
1525	248	183	82	209	128	21402
1690	217	181	49	136	87	9466
1718	302	208	61	210	95	15960
1718	302	208	61	175	83	11620
1963	197	123	31	133	73	7767
2189	237	173	102	156	79	9859
1091	314	246	141	149	105	12516

unidirectional, and perpendicular to the artifact's transverse axis indicating that grinding consisted of a reciprocal motion consistently oriented to parallel the artifact's longitudinal axis. A single grinding slab (FS 328) displays linear multidirectional striations indicating that the grinding motion was either inconsistently oriented or rotary. Three grinding slabs (FS 328, FS 1172, and FS 2189) display a moderately lustrous polish. A single grinding slab (FS 1718) has two opposing use surfaces.

Table 19.42 presents grinding slab metric attributes. It is noteworthy that these grinding slabs consistently have the smallest use-surface areas of all netherstones from the site. Table 19.43 presents the central tendency and dispersion statistics for these measurements.

Expedient Handstones. Four expedient handstones were recovered from LA 6170 (Table 19.44). None displays evidence of manufacture or maintenance. All have slightly convex use-surface cross sections. If striations are apparent, they are linear and unidirectional indicating that the mano was moved in a consistently oriented reciprocal manner. The majority (75

Table 19.43. Grinding Slab Statistics, LA 6170 (N = 11)

	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
Mean	248	172	66	167	95	12770
SD	49	39	33	29	15	3890
Minimum	149	123	31	132	73	7767
Maximum	314	246	141	210	128	21402

Table 19.44. Expedient Handstones, LA 6170

FS No.	Analytic Unit	Material	Plan View	Wear Pattern
1397	Structure 5, overburden	basalt	irregular	linear unidirectional striations, parallel to short axis
1698	Structure 5, roof and closing	fine-grained metaquartzite	oval	linear unidirectional striations, perpendicular to short axis
1962	Area 1, Feature 41	fine-grained rhyolite	irregular	linear unidirectional striations, parallel to short axis
2195-2	SU 17, Feature 52	fine-grained rhyolite	subrectangular	polish and linear unidirectional striations

Table 19.45. Dimensions of Expedient Handstones, LA 6170

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
1397	100	75	36	16	12	154
1397	100	75	36	44	34	1197
1698	130	78	35	68	54	2938
1962	194	110	46	139	76	8451
2195-2	112	87	48	79	55	3911

Table 19.46. Expedient Handstone Statistics, LA 6170 (N = 5)

	Length (mm)	Width (mm)	Thickness (mm)	Use-Surface Length (mm)	Use-Surface Width (mm)	Use-Surface Area (sq mm)
Mean	127	85	40	69	46	3329
SD	39	15	6	46	24	3216
Minimum	100	75	35	16	12	154
Maximum	194	110	48	139	76	8451

percent) of these striations parallel the manos' transverse axis indicating that mano stroke was consistently oriented at a right angle to the manos' longitudinal axis. Most appear to be deposited as secondary refuse. FS 1698 may be considered de facto refuse if it was used in roof-top activity area. FS 2195-2 was secondarily used as a heat-retaining element in a cobble-filled roasting pit where it was recovered. Table 19.45 presents the metric attributes of the expedient handstones and Table 19.46 presents the associated descriptive statistics.

Maul. A single fully grooved maul (FS 1310) of vesicular basalt was recovered from Feature 5, a ground stone cache reflecting anticipation of future use. The full groove allowed for the hafting of the maul, which may have functioned in maintaining ground stone tools. It is directly associated with three slab metates and five two-hand manos. Striking a ground stone use surface with a maul of this material type may have left multiple small peck marks which effectively sharpened the use surface. The maul measures 144 mm long by 86 mm wide by 72 mm thick.

Mortars. Two whole mortars (FS 1161 and FS 2068) pecked out of red scoria were recovered. Both have oval-shaped use surfaces that are concave in cross section. One (FS 1161) was recovered from the roof fall layers of Structure 2. It probably represents secondary refuse, unless it was stored in or used on the roof. It measures 116 mm long by 93 mm wide by 48 mm thick and has a use surface measuring 74 mm long by 66 mm wide by 13 mm deep. The other mortar (FS 2068) was recovered from the wind and water deposits of Structure 50 and represents secondary refuse. It measures 156 mm long by 137 mm wide by 77 mm thick and has a use surface measuring 76 mm long by 62 mm wide by 44 mm deep.

Pestles. Two whole pestles were recovered from LA 6170. FS 2283 was recovered from the fill of Feature 168, a subfloor posthole in Structure 50. Most likely it is secondary refuse. The artifact lacks evidence of production input and maintenance. It is an elongate oval-shaped pebble of massive quartz. Both ends display crushing wear. From one end, wear extends a short distance up the lateral margins. This end also displays linear multidirectional striations. The artifact measures 49 mm long by 27 mm wide by 20 mm thick. FS 1591 was recovered from the roof and closing layers of Structure 5. Unless it was stored or used in or on the roof, which remains unclear, it represents secondary refuse. The artifact lacks evidence of production input and maintenance. It is an elongate oval-shaped cobble of fine-grained metaquartzite. The pestle displays minimal crushing wear that is restricted to both ends. It measures 219 mm long by 62 mm wide by 43 mm thick.

Polishing Stone. FS 1562 is pebble of an unspecified material that exhibits a moderately lustrous polish over its entire surface. Multidirectional striations lay over the polish at one end of the artifact. It is elliptical in plan view outline and roughly circular in transverse cross section. The artifact measures 58 mm long by 14 mm wide by 10 mm thick. It was recovered from the roof and closing layers of Structure 5 and likely reflects secondary refuse. It is unclear whether or not this artifact functioned in ceramic production.

Shaped Slabs. A total of 11 fragmentary shaped slabs were recovered form LA 6170 (Table 19.47). FS 1095 and FS 1165 can be refitted into one larger fragmentary artifact. Although FS 1167 and FS 1216 does not articulate with the larger fragments of FS 1095 and FS 1165, they appear to be from the same artifact. This observation is based on material type and slab thickness. FS 2047 and FS 2048 also refits into another larger fragmentary artifact. The shaped slab fragments recovered from roof-fall layers may include partial roof entryway hatch covers. These may be considered primary refuse. FS 1916 is another example of primary refuse. It could have served as a deflector positioned between the ash pit (Structure 5, Feature 19) and the vent tunnel opening, which later collapsed into the ash pit. FS 1853 originally appears to have had a circular plan view outline, and may have functioned as a pit or con-

Table 19.47. Shaped Slabs, LA 6170

FS No.	Analytic Unit/Feature	Material	Condition	Maximum Dimension (mm)
1095	Structure 2 roof fall	fine-grained rhyolite	edge fragment	197
1165	Structure 2 roof fall	fine-grained rhyolite	edge fragment	133
1167	Structure 2 roof fall	fine-grained rhyolite	edge fragment	231
1216	Structure 2 floor fill and contact	fine-grained rhyolite	edge fragment	133
1649	Structure 5, roof and closing	fine-grained rhyolite	corner fragment	254
1853	Structure 5, floor fill and closing	fine-grained rhyolite	edge fragment	245
1916	Structure 5, Feature 19	fine-grained sandstone	corner fragment	330
2044	Structure 50, roof and closing	fine-grained rhyolite	edge fragment	229
2047	Structure 50, roof and closing	fine-grained rhyolite	edge fragment	298
2048	Structure 50, roof and closing	fine-grained rhyolite	edge fragment	204
2100	Structure 50, roof and closing	fine-grained sandstone	internal fragment	209

Table 19.48. Stone Balls, LA 6170

FS No.	Analytic Unit	Material	Length (mm)	Width (mm)	Thickness (mm)
2273	Structure 50, Feature 153	fine-grained metaquartzite	32	29	29
2068-2	Structure 50, wind, water deposits	fine-grained metaquartzite	47	45	39
2140	Structure 50, floor fill and contact	fine-grained rhyolite	21	20	19

Table 19.49. Cobbles with Pigment Residue, LA 6170

FS No.	Analytic Unit	Material	Plan View	Cross Section
1589	Structure 5, roof and closing	fine-grained metaquartzite	irregular	flat
2458	Structure 50 vent shaft, Feature 150	fine-grained metaquartzite	oval	convex
1753	Structure 5, floor fill and closing	medium-grained metaquartzite	oval	concave
2114	Structure 50, floor fill and contact	fine-grained rhyolite	oval	convex

tainer cover and may represent primary refuse. The maximum linear dimensions of these artifacts range from 133 mm to 330 mm.

Stone Balls. All stone balls were recovered from Structure 50 (Table 19.48). It is unclear how these artifacts functioned, so the contextual designation is tentative. Based solely on recovery locations, FS 2068-2 most likely represents secondary refuse. FS 2273 came from an ash pit in Structure 50, suggesting deposition as primary refuse if it was used inside the structure. FS 2140 may represent de facto refuse if it was used inside of the structure. All stone balls retain their natural form.

Unmodified Cobbles with Pigment. Four unmodified cobbles with adhering red pigment residue were recovered from Structure 5 and Structure 50 (Table 19.49). All retain their natural forms and lack evidence of wear, such as grinding/faceting, striations, and polish. The cobbles recovered from Structure 5 may be considered secondary refuse unless used or stored in or on the roof. Due to its location in the ventilator shaft of Structure 50, FS 2458 is considered secondary refuse. FS 2114 is likely de facto refuse. It displays sooting, which testifies to its presence on the floor during the burning of the structure. Table 19.50 presents the metric attributes of these artifacts.

LA 6171

LA 6171 yielded 31 ground stone artifacts from 12 separate analytic units (Table 19.51). Ground stone was consistently the most frequent artifact found on structure floors. This includes Structure 9 (22.6 percent) and Structure 60 (16.1 percent), both of which are Early Developmental period pit structures. A total of 13 different artifact types were identified. The most frequent artifact types are indeterminate ground stone fragments (25.8 percent), metate fragments (19.4 percent), and fragmentary shaped slabs (12.9 percent). The artifact type distribution suggests the site's occupants were involved in a fairly wide range of grinding and other activities including tool manufacture and maintenance, wild vegetal resource processing, agricultural produce processing, pigment processing, and hide processing.

Indeterminate Ground Stone Fragments. A total of eight indeterminate ground stone artifacts were recovered from LA 6171 (Table 19.52). The majority of these fragments (50 percent) were recovered from structure fill and likely represent secondary refuse. FS 658 and FS 683, both display adhering red pigment residue and refit into a larger fragmentary artifact. These fragments were recovered from the floor of Structure 60 and may represent primary refuse. The contextual designations of FS 357-2 and FS 161, were recovered from SU 2 and SU 10, respectively, are problematic due to the incomplete excavation of these units.

None of the fragments display evidence of initial shaping. The majority have flat cross sections (63 percent) or display grinding/faceting wear (75 percent). FS 161 exhibits linear multidirectional striations indicating use in an inconsistently oriented or rotary motion and FS 520 exhibits linear unidirectional striations indicating use in a reciprocal motion. Two fragments (FS 357-2 and FS 507) exhibit pecking to sharpen, therefore, may be considered formal tools, but their flat use-surface cross sections preclude classification as either mano or metate fragments. Three (FS 507, FS 658, and FS 683) appear to be thermally altered. In the case of FS 507, this alteration appears as a reddening in color, while FS 658 and FS 683 display sooting and crenated fracturing. The fragments have maximum linear dimensions ranging from 64 to 269 mm.

Mano Fragments. A total of three mano fragments were recovered from LA 6171 (Table 19.53). All were recovered from the present ground surface. FS 123 was recovered from SU 10. Only FS 204 displays evidence of both initial shaping and maintenance. FS 35 was pecked to sharpen its use surface, while FS 123 was pecked during initial shaping. A single fragment (FS 123) displays linear unidirectional striations indicating that it was used in a reciprocal motion consistently oriented to parallel its short axis. FS 35 displays evidence of heat alteration in the form of reddening and crenated fracturing. Maximum linear dimensions range from 89 to 145 mm.

One-Hand Mano. A single one-hand mano (FS 849), manufactured by pecking and grinding a fine-grained metaquartzite cobble, was recovered from the floor of Structure 26. It likely rep-

Table 19.50. Dimensions of Cobbles with Pigment Residue, LA 6170

FS No.	Length (mm)	Width (mm)	Thickness (mm)	Extent of Pigment Residue Length (mm)	Extent of Pigment Residue Width (mm)	Extent of Pigment Residue Area (sq mm)
1589	136	78	25	80	34	2176
2458	201	137	69	109	80	6976
1753	112	90	36	45	18	648
2114	111	85	64	19	14	213

Table 19.51. Ground Stone Artifact Type by Analytic Unit, LA 6171

N Row % Column %	Surface	SU 1	SU 2	Stratum 9, Floor	Stratum 9, Fill	Stratum 18, Fill	Stratum 26, Floor	Stratum 26 Fill	SU 4, Extramural Features	SU 6, Extramural Features	Stratum 60, Floor	SU 10 Fill	Total
Indeterminate ground	-	-	1	-	2	-	-	1	1	-	2	1	8
stone fragment	-	-	4.2%	-	25.0%	-	-	12.5%	12.5%	-	25.0%	12.5%	100.0%
	-	-	33.3%	-	66.7%	-	-	33.3%	100.0%	-	40.0%	50.0%	25.8%
Mano fragment	2	-	-	-	-	-	-	-	-	-	-	1	3
	66.7%	-	-	-	-	-	-	-	-	-	-	33.3%	100.0%
	66.7%	-	-	-	-	-	-	-	-	-	-	50.0%	9.7%
One-hand mano	-	-	-	-	-	-	1	-	-	-	-	-	1
	-	-	-	-	-	-	100.0%	-	-	-	-	-	100.0%
	-	-	-	-	-	-	100.0%	-	-	-	-	-	3.2%
Two-hand mano	-	-	1	1	-	-	-	-	-	-	-	-	2
	-	-	50.0%	50.0%	-	-	-	-	-	-	-	-	100.0%
	-	-	33.3%	14.3%	-	-	-	-	-	-	-	-	6.5%
Metate fragment	-	1	1	2	-	-	-	1	-	-	1	-	6
	-	16.7%	16.7%	33.3%	-	-	-	16.7%	-	-	16.7%	-	100.0%
	-	100.0%	33.3%	28.6%	-	-	-	33.3%	-	-	20.0%	-	19.4%
Trough metate	-	-	-	-	1	-	-	-	-	-	-	-	1
	-	-	-	-	100.0%	-	-	-	-	-	-	-	100.0%
	-	-	-	-	33.3%	-	-	-	-	-	-	-	3.2%
Grinding slab	-	-	-	-	-	-	-	1	-	-	-	-	1
	-	-	-	-	-	-	-	100.0%	-	-	-	-	100.0%
	-	-	-	-	-	-	-	33.3%	-	-	-	-	3.2%
Expedient handstone	1	-	-	-	-	-	-	-	-	-	-	-	1
	100.0%	-	-	-	-	-	-	-	-	-	-	-	100.0%
	33.3%	-	-	-	-	-	-	-	-	-	-	-	3.2%
Maul	-	-	-	-	-	1	-	-	-	-	-	-	1
	-	-	-	-	-	100.0%	-	-	-	-	-	-	100.0%
	-	-	-	-	-	100.0%	-	-	-	-	-	-	3.2%
Mortar	-	-	-	-	-	-	-	-	-	-	1	-	1
	-	-	-	-	-	-	-	-	-	-	100.0%	-	100.0%
	-	-	-	-	-	-	-	-	-	-	20.0%	-	3.2%
Shaped slab	-	-	-	4	-	-	-	-	-	-	-	-	4
	-	-	-	100.0%	-	-	-	-	-	-	-	-	100.0%
	-	-	-	57.1%	-	-	-	-	-	-	-	-	12.9%
Cobble with pigment	-	-	-	-	-	-	-	-	-	-	1	-	1
residue, otherwise	-	-	-	-	-	-	-	-	-	-	100.0%	-	100.0%
unmodified	-	-	-	-	-	-	-	-	-	-	20.0%	-	3.2%
Hide-processing	-	-	-	-	-	-	-	-	-	1	-	-	1
handstone	-	-	-	-	-	-	-	-	-	100.0%	-	-	100.0%
	-	-	-	-	-	-	-	-	-	100.0%	-	-	3.2%
Total	3	1	3	7	3	1	1	3	1	1	5	2	31
	9.7%	3.2%	9.7%	22.6%	9.7%	3.2%	3.2%	9.7%	3.2%	3.2%	16.1%	6.5%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19.52. Indeterminate Ground Stone Fragments, LA 6171

FS No.	Analytic Unit	Material Type	Condition	Cross Section	Wear Pattern	Sharpening	Maximum Dimension (mm)
161	SU 10 fill	fine-grained rhyolite	internal fragment	flat	linear multidirectional striations	no maintenance	85
357-2	SU 2	fine-grained sandstone	internal fragment	flat	grinding, faceting	pecked to sharpen	37
507	Structure 9, fill	fine-grained sandstone	internal fragment	flat	grinding, faceting	pecked to sharpen	64
520	Structure 9, fill	fine-grained rhyolite	corner fragment	convex	linear unidirectional striations	no maintenance	123
658	Structure 60, floor	fine-grained sandstone	edge fragment	flat	grinding, faceting	no maintenance	116
683	Structure 60, floor	fine-grained sandstone	internal fragment	flat	grinding, faceting	no maintenance	269
806	SU 4, Structure 2 fill, Feature 104	vesicular basalt	end fragment	sinuous or irregular	grinding, faceting	no maintenance	166
857	Structure 26, fill	coarse-grained sandstone	internal fragment	concave	grinding, faceting	no maintenance	97

Table 19.53. Mano Fragments, LA 6171

FS No.	Analytic Unit	Material Type	Condition	Shaping	Wear Pattern	Sharpening
35	surface collection	fine-grained sandstone	edge fragment	no production input	grinding, faceting	pecked to sharpen
123	SU 10 fill	vesicular rhyolite	end fragment	pecking	linear unidirectional striations, parallel to short axis	no maintenance
204	surface collection	fine-grained sandstone	end fragment	pecking and flaking	grinding, faceting	pecked to sharpen

Table 19.54. Metate Fragments, LA 6171

FS No.	Analytic Unit	Material Type	Condition	Shaping	Wear Pattern	Sharpening	Maximum Dimension (mm)
320	SU 2	vesicular rhyolite	internal fragment	no production input	grinding, faceting	no maintenance	74
487	SU 1, Structure 1 fill	vesicular rhyolite	internal fragment	no production input	grinding, faceting	no maintenance	125
588	Structure 9, floor	fine-grained sandstone	edge fragment	no production input	grinding, faceting	pecked to sharpen	73
655	Structure 60, floor	fine-grained sandstone	edge fragment	pecking	grinding, faceting	pecked to sharpen	316
694	Structure 9, floor	fine-grained sandstone	edge fragment	pecking	linear unidirectional striations	pecked to sharpen	364
983-2	Structure 26, fill	welded tuff	edge fragment	no production input	grinding, faceting	no maintenance	302

resents de facto refuse. The mano is oval-shaped in plan view outline and biconvex in cross section. The artifact exhibits two opposing use surfaces. One of these use surfaces displays grinding/faceting wear as well as evidence of maintenance. The surface measures 106 mm long by 85 mm wide giving it an area of 7,208 sq mm. This surface also displays an adhering red pigment residue. The opposing use surface exhibits linear multidirectional striations indicating that the grinding motion was inconsistently oriented or rotary. This surface measures 101 mm long by 89 mm wide giving it an area of 7,191 sq mm. The whole artifact measures 130 mm long by 107 mm wide by 42 mm thick.

Two-Hand Manos. FS 357-1 and FS 551 are two-hand manos. Both are subrectangular in plan view and have slightly convex use-surface cross sections. FS 357-1 was recovered from SU 2. Its contextual designation is problematic because of the incomplete excavation of this unit. The mano was manufactured by pecking and grinding a fine-grained sandstone. Its use surface exhibits linear unidirectional striations that parallel the artifact's short axis indicating a consistently oriented reciprocal grinding motion. The use surface exhibits pecking, presumably to sharpen it. The artifact measures 201 mm long by 128 mm wide by 42 mm thick. Its use surface measures 185 mm long by 122 mm wide giving it an area of 20,313 sq mm. FS 551 was recovered from the floor of Structure 9 and likely represents de facto refuse. The mano was manufactured by pecking a flattened vesicular rhyolite cobble. Its use surface exhibits grinding/faceting wear with no evidence of maintenance. The artifact measures 185 mm long by 114 mm wide by 41 mm thick. Its use surface measures 184 mm long by 114 mm wide giving it an area of 18,878 sq mm. Its ground upturned ends suggest that it was used with a trough metate.

Metate Fragments. Six metate fragments were recovered from LA 6171 (Table 19.54). Three fragments (FS 588, FS 694, and FS 655) were in contact with structure floors and may represent primary refuse. Although FS 588 and FS 694, which were recovered from the floor of Structure 9, do not articulate, they may be from the same trough metate. This observation is based on similarities in material type and manufacturing technique, as well as the edge configuration with FS 694. FS 655 was recovered from the floor of Structure 60 and also has an edge configuration consistent with that of a trough metate. FS 487 and FS 983-2 were recovered from upper structure fill and likely represent secondary refuse. FS 983-2 is a nearly complete basin metate. The contextual designation of FS 320, which was recovered from SU 2, is problematic due to the incomplete excavation of this unit.

The edge and internal fragments are either vesicular igneous materials, including rhyolite and welded tuff, or a fine-grained sandstone. Three fragments (FS 588, FS 655, and FS 694) were manufactured by flaking and/or pecking. The sandstone metate fragments display evidence of maintenance, while the vesicular igneous fragments are considered self-sharpening. All display concave use-surface cross sections and most (86 percent) display only grinding/faceting wear. FS 694 exhibits linear unidirectional striations indicating use in a reciprocal motion. None appears heat altered. Maximum linear dimensions range from 73 to 364 mm.

FS 694 manifests evidence of multiple use and reuse. The surface opposing the trough metate surface displays a small circular mortar basin with a diameter of 34 mm pecked to a maximum depth of 4 mm. The fragment was recycled into a chopper. A fractured edge opposing the original trough metate edge was bimarginally flaked to create a convex chopper edge that displays step fracturing and crushing. The edge measures 181 mm with an angle of 65 degrees. The opposing original trough metate edge provides a backing. If utilized in its recycled capacity, at its recovery location this artifact is better viewed as de facto refuse.

Trough Metate. A single complete trough metate (FS 596) was recovered from the floor of Structure 9. It represents de facto refuse and may have been used with the whole two-hand mano (FS 551) recovered from the floor. The relevant metric attributes and the use-surface cross-section forms of the artifacts correspond well. The metate is a vesicular rhyolite that lacks evidence of initial shaping. Grinding/faceting wear is apparent. The artifact lacks evidence of maintenance, but is considered self-sharpening due to its material type. The metate measures 609 mm long by 350 mm wide by 153 mm thick. Its use surface measures 369 mm long by 225 mm wide giving it an area of 66,420 sq mm. The maximum depth of the use surface is 71 mm.

Grinding Slab. A single grinding slab (FS 983-1) was recovered from the present ground surface. It is an expediently used flattened cobble of schist. It is irregular in plan view outline and slightly concave in use surface cross-section form. Its use surface exhibits linear multidirectional striations indicating either an inconsistently oriented or a rotary grinding motion. The artifact displays an adhering red pigment residue, suggesting it functioned in the processing of such pigments. The slab measures 74 mm long by 55 mm wide by 17 mm thick and could be comfortably hand-held. Its use surface measures 64 mm long by 47 mm wide, giving it an area of 2,406 sq mm.

Expedient Handstone. A single expedient handstone (FS 111) was recovered from the present ground surface. It is a flattened cobble of fine-grained rhyolite with an irregular plan view outline and a flat use surface. Its use surface displays linear multidirectional striations indicating either an inconsistently oriented or a rotary grinding motion. The artifact measures 106 mm long by 93 mm wide by 26 mm thick. Its use surface measures 69 mm long by 61 mm wide, giving it an area of 3,367 sq mm.

Maul. A single fully grooved maul (FS 512) was recovered from the fill of Structure 18. Its recovery location suggests it is secondary refuse. The shallow medial groove parallels the artifact's short axis. It was manufactured by pecking an elongate ovoid cobble of medium-grained metaquartzite. Both ends show minimal battering wear. The artifact measures 245 mm long by 87 mm wide by 79 mm thick.

Mortar. A fragmentary mortar (FS 664) of welded tuff was recovered from the floor of Structure 60 and likely represents primary refuse. The mortar basin appears to be pecked. The use-surface cross section is concave. The artifact's maximum linear dimension is 223 mm. Its use surface has a maximum linear dimension of 140 mm and a maximum depth of 51 mm.

Shaped Slab. Four shaped slab fragments were recovered from the floor of Structure 9 (Table 19.55). These fragments may represent primary refuse. Three fragments (FS 624, FS 625, and FS 628) can be refitted into a single larger fragment, with a maximum linear dimension of 341 mm. Although FS 627 cannot be refitted with these fragments, it is most likely from the same shaped slab. This observation is made on the basis of similarities in slab thickness, material type, and manufacturing technique. Slab thickness has a fairly tight range of 18 to 25 mm. All slabs were manufactured through bi-marginal flaking and several display edge grinding, presumably to dull the sharp edges. The surfaces do not display wear.

Unmodified Cobble with Pigment. FS 673 is a small cobble of fine-grained metaquartzite that retains its natural form, but displays an adhering yellow pigment residue. The cobble was

Table 19.55. Shaped Slabs, LA 6171

FS No.	Analytic Unit	Material Type	Condition	Shaping	Maximum Dimension (mm)
624	Structure 9, floor	fine-grained rhyolite	edge fragment	flaking and grinding	191
625	Structure 9, floor	fine-grained rhyolite	edge fragment	flaking and grinding	190
627	Structure 9, floor	fine-grained rhyolite	edge fragment	flaking and grinding	151
628	Structure 9, floor	fine-grained rhyolite	edge fragment	flaking	133

recovered from the floor of Structure 60 and may represent de facto refuse. The cobble is oval shaped in plan view and measures 98 mm long by 86 mm wide by 49 mm thick. The extent of the pigment residue measures 70 mm long by 66 mm wide.

Hide Processing Handstone. FS 899 is a pumice handstone with a slightly convex faceted use surface. Other wear patterns are lacking. The nature of the material may not be conducive to the formation of wear patterns such as polish. It is oval-shaped in plan view and measures 136 mm long by 107 mm wide by 43 mm thick. Its use surface measures 134 mm long by 104 mm giving it an area of 11,149 sq mm, which is within the range of one-hand manos. The artifact was recovered from Feature 87, a thermal pit in an extramural activity area (SU 6), associated with Structure 60, an Early Developmental period pithouse. Edholm and Wilder (1997:38, 218, 247) state that pumice is well suited to hide-processing tasks.

LA 115862

LA 115862 yielded four ground stone artifacts including an indeterminate ground stone fragment, a mano fragment, a metate fragment, and a fragmentary shaped slab. The indeterminate ground stone fragment and the metate fragment suggest the site occupants were involved in the manufacture and maintenance of ground stone tools. The mano and metate fragments reflect the processing of agricultural produce. The shaped slab suggests that the site occupants were involved in the construction of architectural elements.

Indeterminate Ground Stone Fragment. FS 237 is a fine-grained sandstone recovered from the structure's floor and may represent primary refuse. It is an internal fragment that exhibits a sinuous use-surface cross section and grinding/faceting wear. The fragment represents a formal tool with a maintained use surface. Its maximum linear dimension is 126 mm.

Mano Fragment. A single, heat-fractured mano fragment (FS 197) was recovered from Feature 11, a cobble-filled roasting pit, where it was secondarily used as a heat-retaining element. The artifact is a flattened cobble of vesicular rhyolite, that lacks evidence of production input and maintenance. Due to its material type, the artifact is considered self-sharpening. The use surface is convex in cross section and exhibits grinding/faceting wear. This medial fragment has a maximum linear dimension of 124 mm. This measurement is the complete width of the artifact.

Metate Fragment. FS 205 is a large edge fragment of a vesicular basalt trough metate. Evidence of production input and maintenance is lacking, but due to its material type the use surface is considered self-sharpening. The use surface is concave in cross section and exhibits grinding/faceting wear. The artifact's maximum linear dimension is 414 mm. It was recovered from the fill of the structure's ventilator shaft and likely represents secondary refuse.

Shaped Slab. FS 189 is an edge fragment of a shaped slab that was recovered from structure fill and may represent secondary refuse. It was manufactured by the unimarginal flaking of a fine-grained rhyolite. The faces of the artifact lack wear patterns. The fragment's maximum linear dimension is 143 mm.

Shifts in Ground Stone Use Through Time

Ground stone artifacts were recovered and analyzed from all Peña Blanca sites, except LA 115863. A total of 192 artifacts were analyzed from Early Developmental contexts, 58 from Late Developmental contexts, 35 from Coalition contexts, 5 from Classic contexts, and 35 from mixed or unknown components. These disparate assemblage sizes reflect excavation sampling, occupation intensity and duration, and the range of activities carried out in support of the different occupations. This section seeks to examine changes in ground stone artifact manufacture, use, and discard within and across the different time periods. The avenues selected for examining general patterning are material selection, artifact production and maintenance, and artifact type variability and use. Studies of assemblages from sites in other regions indicate that these research avenues can be productively addressed with ground stone artifacts (Nelson and Lippmeier 1993; Schlanger 1991; Hard 1986, 1990).

Material Selection

Material selection of ground stone artifacts can reflect a wide range of choices and decisions made by prehistoric tool makers and users. Raw material characteristics such as texture, hardness, and porosity can affect tool design, longevity, and suitability for processing of different materials (Nelson and Lippmeier 1993; Bamforth 1991). As presented earlier, locally available raw materials are abundant and offer a wide selection for ground stone tool makers and users. In terms of functional variability, artifact longevity, and material suitability, raw materials can be segregated into igneous and sedimentary and metamorphic classes. Igneous materials include a range of basalt, andesite, rhyolite, and diorite. Sedimentary materials include sandstone, while metamorphic materials include metaquartzite and schist, for example. In terms of longevity and durability for the purpose of intensive or anticipated long-term plant or food processing needs, igneous materials would be the best suited. Sedimentary materials offer flexibility in terms of granularity and texture, ease of modification and resharpening, and may be suited to a wider range of expedient or daily tasks.

For the Peña Blanca sites, Early Developmental components, which have the best evidence for permanent residential occupation, use of a wide range of raw materials might be expected in support of a full set of subsistence and productive activities. With the potential for the widest range of activities, ground stone tools may be used in specific and informal ways that may be reflected in their raw material, but may also have nothing to do with raw material preferences as tools are recycled, scavenged, or otherwise adaptively reused. Late Developmental and Coalition components, which may have been less permanent, smaller-scale and in the case of Coalition period pit rooms more specialized, the range of ground stone materials would expect to be diminished or limited. This apparent restriction in material preference might be conditioned by the range of daily activities and access to raw material sources, as distance from residence to daily activity areas may have decreased limiting the frequency and breadth of encounters with more variable raw material sources.

Early Developmental period components show a relatively equal distribution of igneous and sedimentary and metamorphic materials. LA 265 and LA 6170, with the largest ground stone assemblages, most strongly reflect the pattern. They show that as occupation length increases and the range of activities diversifies, raw material needs are fairly broad. Looking at the artifact type distribution by material type, there is a weak pattern of sandstone use for trough metates, basalt for grinding slabs, and quartzite for manos. This pattern indicates raw material preferences, although not exclusive use, for specific tool types. These selective preferences cross-cut material diversity as a reflection of occupation duration and intensity and suggest that efficiency and suitability for specific tasks strongly conditioned material selection during the Early Developmental period. This is a strong pattern observed in ground stone assemblages from sites with mixed subsistence strategies represented.

For the Late Developmental and Coalition components, which are more seasonal with activities potentially more focused on farming and harvesting rather than consumption and processing, there is a strong preference for igneous materials. This change in material selection from more to less diverse may reflect changing occupation pattern and subsistence activities. There is only one trough metate from LA 6171 and an increased proportion of grinding slabs, which are less efficient (Lancaster 1983; Hard 1986), but require less labor input (Nelson and Lippmeier 1993). This change is interesting because less efficient grinding slabs become the prevalent netherstone found at and used by residents of Classic period villages along the Rio Grande (Fagan 1993; Honea 1968; Stubbs and Stallings 1953). A change in grinding mechanics combined with specialized grinding or mealing rooms may have offset a decrease in productive efficiency caused by the change in metate form from trough to slab. Slab metates are the metate of choice by the thirteenth century and at the Peña Blanca sites, and igneous materials were preferred. Igneous materials were the most durable and reliable, supporting the inference that they would be common on residential sites, as suggested by Nelson and Lippmeier (1993).

Ground Stone Production and Maintenance

The production and maintenance of ground stone implements should reflect different residential activities and occupation patterns. Ground stone tools can be thought of as a backbone or staple of maize-based subsistence that sustained all occupations after AD 700. All Peña Blanca occupations had residential components that varied in duration and intensity. Intermittent or seasonal occupation is evident for the earliest Developmental and Coalition periods, although the Coalition period occupations were supported by multiple pit rooms, some of which had relatively formal intramural features. This accumulation of Coalition period semipermanent structures indicates that biseasonal residence was an important aspect of the subsistence strategy, which relied on a land-extensive settlement pattern.

Given the likelihood that Peña Blanca occupations were permanent or seasonal for many years, the ground stone tools might be expected to reflect manufacture and maintenance tactics that increased grinding efficiency and tool longevity. Nelson and Lippmeier (1993: 296–297) propose that tools that were intended for reuse should have been made with longevity and efficiency in mind. Two aspects of ground stone manufacture that should reflect efficiency and longevity are production input (shaping) and maintenance (sharpening).

Production input can be examined for Peña Blanca assemblages through the tool shaping that occurred as part of manufacture. Evidence of tool shaping is pecking, flaking, grinding, or a combination of these attributes as applied to manos, metates, or grinding slabs and mortars. As might be expected, the Early Developmental components exhibit variability in the relative proportion of shaped and unshaped tools. For example, LA 265, the most intensively occupied component, had only 25 percent of the ground stone tools exhibiting production input shaping. LA 6169, which had fewer ground stone artifacts and may have been occupied for a shorter time by fewer people, had 73 percent of the ground stone tools exhibiting production input shaping. LA 6170 exhibits a similar high proportion of low production input to LA 265 and LA 6171 exhibits a similar high proportion of greater production input to LA 6169. In this case, occupation pattern may influence the relative proportion of production input on ground stone tools, as more intensively occupied components have greater frequencies of indeterminate ground stone, which has the least evidence of production input. Sites occupied less intensively or for shorter periods have fewer indeterminate ground stone fragments and higher proportions of recognizable tools. From these assemblages, it is difficult to ascertain if more efficient production behaviors predominated for sites that were residential and evidenced a relatively strong dependence on maize.

Ground stone tools do appear to have been more completely used at the more intensively and longer occupied sites. LA 265 and LA 6170 had higher proportions of resharpened or maintained tools than LA 6169 and LA 6171, although the difference is not great and assemblage frequencies between site components are disproportionate. The overall pattern is that ground stone tools were well used and maintained at all residential sites. This is consistent with the expectation that efficiency and reliability would coincide with maintenance and production, since ground stone tools were not typically used and discarded without some measure of production input or maintenance.

Table 19.56. Ground Stone Artifact Type by Period and Site

Period	Artifact Type	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862
Early Developmental	Indeterminate ground stone fragment	-	18	3	26	3	1
	Mano fragment	-	11	1	6	-	1
	One-hand mano	-	1	1	1	2	-
	Two-hand mano	-	2	2	5	1	-
	Metate fragment	-	19	2	14	3	1
	Basin metate	-	1	-	1	-	-
	Trough metate	-	-	-	1	-	-
	Grinding slab	-	4	-	11	-	-
	Expedient handstone	-	3	3	3	-	-
	Hoe	-	1	-	-	-	-
	Pestle	-	-	-	2	-	-
	Mortar	-	4	1	2	1	-
	Polishing stone	-	-	-	1	-	-
	Shaped slab	-	4	1	3	4	1
	Stone ball	-	2	-	3	-	-
	Cobble with pigment residue, otherwise unmodified	-	2	2	4	1	-
	Hide-processing handstone	-	1	-	-	-	-
	Abrader	-	1	-	-	-	-
	Total	-	74	16	83	15	4
Late Developmental	Indeterminate ground stone fragment	2	-	21	1	-	-
	Mano fragment	-	-	8	1	-	-
	Metate fragment	-	-	7	-	-	-
	Slab metate	-	-	1	1	-	-
	Expedient handstone	3	-	5	2	-	-
	Maul	-	-	1	-	-	-
	Axe	1	-	1	-	-	-
	Mortar	-	-	1	-	-	-
	Cobble with pigment residue, otherwise unmodified	-	-	1	-	-	-
	Pick	-	-	1	-	-	-
	Total	6	-	47	5	-	-
Coalition	Anvil	-	-	1	-	-	-
	Indeterminate ground stone fragment	-	-	3	-	3	-
	Mano fragment	-	-	5	-	-	-
	Two-hand mano	-	-	3	-	-	-
	Metate fragment	-	-	3	-	2	-
	Trough metate	-	-	-	-	1	-
	Grinding slab	-	-	7	-	1	-
	Maul	-	-	-	-	1	-
	Axe	-	-	1	-	-	-
	Shaped slab	-	-	1	-	-	-
	Cobble with pigment residue, otherwise unmodified	-	-	2	-	-	-
	Hide processing handstone	-	-	-	-	1	-
	Total	-	-	26	-	9	-
Classic	Indeterminate ground stone fragment	-	-	-	-	1	-
	Two-hand mano	-	-	-	-	1	-
	Metate fragment	-	-	-	-	1	-
	Stone ball	-	-	2	-	-	-
	Total	-	-	2	-	3	-

Table 19.56. Continued.

Period	Artifact Type	LA 249	LA 265	LA 6169	LA 6170	LA 6171	LA 115862
Historic	Indeterminate ground stone fragment	1	-	-	-	-	-
	Total	1	-	-	-	-	-
Mixed/unknown	Indeterminate ground stone fragment	1	-	4	1	1	-
	Mano fragment	1	1	-	-	3	-
	Two-hand mano	-	-	1	5	-	-
	Metate fragment	-	2	2	-	-	-
	Slab metate	-	-	-	3	-	-
	Basin metate	-	-	-	1	-	-
	Trough metate	-	-	-	2	-	-
	Grinding slab	1	-	-	-	-	-
	Expedient handstone	-	-	-	-	1	-
	Maul	-	-	-	1	-	-
	Axe	1	-	-	-	-	-
	Shaped slab	-	-	1	-	-	-
	Stone ball	-	1	-	-	-	-
	Pick	-	-	1	-	-	-
	Total	4	4	9	13	5	-

The Late Developmental and Coalition period components exhibit high proportions of ground stone tools showing no production input and maintenance. This seems to correspond with the proposition that less regular or more seasonal occupation may result in lower efficiency and, perhaps, maintenance requirements. Less permanent occupation may result in well-made ground stone tools lasting for a longer time because they are used less during each occupation episode. Planned use is seen in the caching of ground stone at LA 6170. This caching is combined with the earliest mealing room identified for the project area, suggesting that during the Late Developmental period the organization of maize processing was shifting from a residential activity to seasonally occupied locations.

Ground Stone Tool Variability and Use

Variability in tool types and their inferred uses is expected to vary in concert with the range of activities conducted at a site. As subsistence focus changed, the technological organization supporting activities should also change. Minor or brief shifts in subsistence activities, such as fluctuating reliance on cultivated or gathered foods might not be reflected in ground stone assemblages. Major shifts in the range of activities associated with permanent versus seasonal domestic occupations may result in lower frequency assemblages with less variability. Ground stone tool use as measured from wear pattern intensity and type may be more variable at permanently occupied domestic sites with less variability and use intensity expected for seasonal or fieldhouse sites.

Table 19.56 shows the distribution of artifact type period. Early Developmental component assemblages can be examined for tool type and use variability. Low frequencies from LA 6169, LA 6171, and LA 115862 may be less conclusive or indicative than the LA 265 and LA 6170 assemblages. In terms of tool type inventories, LA 265, LA 6169, and LA 6170 have a similar range of tools. Longer occupation of LA 265 and LA 6170 is reflected in the higher tool frequencies. The major tool type missing from LA 6169 was a formal or identifiable metate. LA 265 and LA 6170 had slab, trough, and basin examples. Their absence from the LA 6169 assemblage may reflect site processes relative to changing occupation patterns or variable abandonment behaviors. Certainly, the variability in mano and metate types at LA 265 and LA 6170 reflects acquisition and processing of a broad spectrum of plant resources. A similar spectrum is suggested by the LA 6169 assemblage, while the less occupied LA 6171 and LA 115862 indicate that grinding tools were part of the initial tool repertoire, but apparently length of occupation strongly influenced abundance and variability.

Late Developmental and Coalition period components exhibit similar ground stone tool types. LA 6169 Late Developmental and Coalition components were the most robust with formal architecture and evidence for repeated or longer-lasting seasonal occupations than LA 249 and LA 6170. Manos and metates are ubiquitous with specialized tools, such as grooved axes, grooved mauls, and stone balls, indicating more than maize processing sustained the occupations. The less substantial components at LA 249 and LA 6170 yielded higher proportions of expedient handstones and fewer manos and metates. This distribution is consistent with investment in tool assemblages increasing with longer, more permanent residential occupations. A similar ground stone tool kit was maintained by Early Developmental, Late Developmental, and Coalition residents when architecture was present and repeated occupations occurred.

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