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The Mossy Grove Model of Long-Term
Forager-Collector Adaptations in Inland Southeast Texas

by

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A Thesis Submitted
in Partial Fulfillment of the
Requirements for the Degree
Doctor of Philosophy

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Abstract

This dissertation examines the archeology of inland southeast Texas during the Ceramic and Historic periods (ca. A.D. 400 - A.D. 1850). Previous investigations, prehistory and ethnohistoric data regarding the region are reviewed. Archeological theory on hunter-gatherer groups in general and pertaining to the Study Area is synthesized. The Mossy Grove Model of long-term hunter-gatherer adaptation is generated to provide a framework for the analysis of archeological remains from the region. This model outlines the general nature of the operating settlement and subsistence system and the process of ethnic boundary formation in the region. The model specifies that sites of the region may productively be compared on the basis of geographical analytical units based on major and minor stream drainages in the region. It also establishes a trimodal classification of archeological sites and discusses the implications of archeological data for categorization of prehistoric groups on the forager-collector continuum.

The balance of the dissertation is given to establishing justifications for the analytical units employed, tests of the implications of the Mossy Grove Model through comparative studies and through the detailed examination of three exemplary sites within the Study Area.
Acknowledgments

I would first extend my thanks to my committee, Dr. Rod McIntosh, Dr. Susan McIntosh, and Dr. John Boles, for their cooperation and encouragement, without which the completion of this dissertation would not have been possible. Likewise I extend my thanks to the faculty and staff of the Department of Anthropology for their contributions to my graduate education.

It will be obvious to any reader of this dissertation that my work is dependent in large measure on the work of the staff and consultants of Moore Archeological Consulting over the years. I would like to single out Dr. Grant Hall and Joseph Sanchez for their fine direction of excavations at 41HR616 and 41FB200, Linda Wootan Ellis and G. Lian Ellis for their invaluable contributions to ceramic studies in southeast Texas, Blaine Ensor and Robert Booth for thoughtful work on lithic analysis, Dr. Saul Aronow for his geologic contributions over the years and for this volume, and Carmine Stahl for the preparation of a section on economic plants. There are of course countless other persons whose efforts on my crews and in the office have helped to gather the information presented herein, and I am grateful to them all.

Finally, and most importantly, I must express my deepest gratitude to my wife, Candice, and my daughters, Christine and Katherine. They made possible the completion of my dissertation by their encouragement and tolerance of my unceasing absences in recent months. They will be relieved that it is all over...
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1. Introduction

Southeast Texas is a region that has been undeservedly maligned in the anthropological literature. No less an authority than Swanton (1979: 820-821) has dismissed this region of hunter-gatherer groups as a "kind of ethnological 'sink.'" Newcomb (1961:315) acknowledges the kinship of the inhabitants of the region to the broader southeastern United States cultural pattern but dismisses them as 'peripheral,' 'marginal' and 'provincial' in his review of the Indians of Texas. It is true that the region lacks the hallmarks of the more complex, ranked societies that were its neighbors to the north and east. It is equally true that the archeological record seems to reflect fundamental conservatism and stability (and hence a degree of monotony) for the last 2000 years. Never-the-less, it seems to this investigator to be truly provincial to assume that nothing of anthropological import can be gained by a study of this patently successful long-term adaptation to the juncture of the eastern forest, the western prairie and the Gulf of Mexico.

As a matter of both circumstance and choice I seek to draw on diverse prior contract and avocational archeological studies that others and I have conducted within inland southeast Texas as the substantive core of my dissertation. In doing so, I am incidentally but inevitably faced with one of the frequent critiques of contract archeology: that it generates large volumes of localized empirical data that remain of limited utility due to the lack of a unifying theoretical perspective. The same might be said of the large body of avocationally-generated work in the area. Thus, in order to produce a thesis that does more than simply (and unsatisfactorily) recapitulate this empirical data I am forced first to attempt to define such a unifying theoretical perspective. This objective I attempt
through the application of the Mossy Grove Model of Long-Term Forager-Collector Adaptations.

The body of this dissertation will consist of explication, justification and application of the Mossy Grove Model in regard to the archeology of inland southeast Texas. The context for the exercise will be established through an appropriately, as the reader will see, watershed-based review of previous archeological investigations and through synthesis of the available prehistoric and ethnohistorical record for the region. I will review relevant hunter-gatherer theory and present the Mossy Grove model itself. I will then explore a fundamental justification for the model, one seeking to establish the validity of stream channels as the focus of prehistoric settlement.

Summaries of the results of excavations at three "exemplary sites" will be presented; these sites are both exemplary of the functional site classification component of the model and will provide the bulk of the detailed data permitting the application of aspects of the model's 'middle-range' theoretical perspective.

In conclusion, I will recapitulate any insights which have been gained regarding the social and technological organization of southeast Texas and I will make recommendations for future work. More importantly, I will suggest how adaptations of the model presented may benefit the general field of hunter-gatherer studies, especially those of 'stable' hunter-gatherer societies.

Detailed supporting data will follow in appendices.
Parameters of the Investigation

The archaeological Study Period for this investigation encompasses the Early and Late Ceramic periods (ca. A.D. 400-A.D. 1750), although I will additionally examine the period from A.D. 1750 to A.D. 1850 in order to deal with the ethnohistoric record. While I will deal with issues of broader geographic scope the formal Study Area for the dissertation is quite restricted which is appropriate for an investigation with a microtopographical focus. It extends west from the San Jacinto River to the Brazos River and south from the north side of Spring Creek to some distance south of Buffalo Bayou (Figure 1; see also Appendix III). Both the Study Period and the Study Area will be discussed at further length below. The Study Area is depicted in detail in Map A in the pocket at the rear of Volume I. Also included in this pocket is Map B, which locates sites discussed within the Study Area.
2. Environmental Background

Modern Climate

The modern climate of the Study Area can aptly be characterized as hot and wet for most of the year. The mean annual temperature for the Study Area region is about 20 degrees Centigrade, with mean rainfalls of 117 centimeters. Summer temperatures average about 34 degrees Centigrade with temperatures above 100 degrees common, during the months of July and August (Carr 1967; St. Clair et al. 1975). The average winter temperature is a mild 18 degrees Centigrade. Freezes are infrequent and of short duration, with an average of 271 frost-free days per year. Snow, sleet, and freezing rain are quite uncommon.

Rainfall varies from 7 centimeters in March to 11 centimeters in December, with July to December rainfalls often supplemented by tropical fronts and storms. The rainfall records are 45 centimeters in 1917 and 185 centimeters in 1917. Prevailing winds are usually from the southeast except during the winter months when ‘Northers’ sweep into the area.
Modern Flora and Fauna

Southeast Texas is within the Austroriparian biotic province as defined by Blair (1950:98-101), near its western boundary with the Texan province. This boundary is marked by the western edge of the pine-hardwood forests of the eastern Gulf coastal plain with this boundary set by available moisture levels. The southeast Texas Study Area is situated within the pine-oak forest subdivision of the Austroriparian province and includes within its western limits portions of the coastal prairie (Tharp 1939).

Grasses within the coastal prairies and marshes vegetational area are described from a range-management perspective in Hoffman et al. nd: 45. This 10,000,000 acre area is comprised of 9,500,000 acres of Gulf Prairies and 500,000 acres of Gulf Marshes situated along the Texas coast. The regional vegetation of the coastal prairies is characterized as follows:

The principal grasses of the prairies are tall bunchgrass, including big bluestem (Andropogon gerardi), little bluestem, seacoast bluestem (Schizachyrium scoparium, var. littorus), Indiangrass, eastern gamagrass (Tripsacum dactyloides), switchgrass, and gulf cordgrass. Seashore saltgrass is common on moist saline sites. Grazing pressures have changed the composition of the range vegetation so that the grasses now existing are broomsedge bluestem, smutgrass, threeawns, tumblegrass and
many other inferior grasses. The other plants that have invaded the productive grasslands are oak underbrush, mcartney rose, huisache, mesquite, pricklypear, ragweed, bitter sneezeweed, broomweed, and many other unpalatable annual weeds.

The dominant floral species of the pine-oak forest subdivision of the Austroriparian biotic province include loblolly pine (*Pinus taeda*), yellow pine (*Pinus echinata*), red oak (*Quercus rubra*), post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*). Hardwood forests are found on lowlands within the Austroriparian and are characterized by such trees as sweetgum (*Liquidambar styr municipa*), magnolia (*Magnolia grandiflora*), tupelo (*Nyssa sylvatica*), water oak (*Quercus nigra*) and other species of oaks, elms, and ashes, as well as the highly diagnostic Spanish moss (*Tillandsia usneoides*) and palmetto (*Sabal glabra*). Swamps are common in the region.

Blair (1950) and Gadus (Gadus and Howard 1990:12-15) define the following mammals as common within the Austroriparian province: white-tailed deer (*Odocoileus virginianus*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), opossum (*Didelphis virginiana*), *Scalopus aquaticus, Pipistrellus subflavus, Lasiurus borealis, Sciurus niger, Sciurus carolinensis, Glaucous volans*, *Geomys breviceps, Reithrodonomys fulvescens, Peromyscus leucopus, Oryzomys palustris, cotton rat* (*Sigmodon hispidus,*), packrat (*Neotoma floridana*), eastern cottontail (*Sylvilagus floridanus*), and swamp rabbit (*Sylvilagus aquaticus*). *Bison (Bison bison)*
may have been present on nearby grasslands at various times in the past (Gadus and Howard 1990:15).

Common land turtles include eastern box turtle (*Terrapene carolina*) and *Terrapene ornata*, while snapping turtle (*Chelydra serpentina*), mud turtle (*Kinosternon spp.*), river cooter (*Chrysemys concinna*) and diamondback terrapin (*Malaclemys terrapin*) comprise common water turtles. Common lizards include *Anolis carolinensis*, *Sceloporus undulatus*, *Leiopelma laterale*, *Eumeces laticeps*, *Cnemidophorus sexlineatus* and *Ophiouros venralis*. Snakes and amphibians are also present in considerable numbers and diversity.

The resources provided by river-influenced estuarine and marsh environments were undoubtedly of great importance to the littoral residents of southeast Texas. These resources are admirably summarized by Gadus (Gadus and Howard 1990: 12 - 15). Estuarine fish resources cited by Gadus include sand trout (*Cynoscion arenarius*), spotted sea trout (*Cynoscion nebulosus*), Atlantic croaker (*Micropogon undulatus*), striped mullet (*Mugil cephalus*), southern flounder (*Paralichthys lethostigma*), shorthose gar (*Lepisosteus platostomus*), channel catfish (*Ictalurus punctatus*), freshwater drum (*Aplodinotus grunniens*), red drum (*Sciaenops ocellata*), and bluegill (*Lepomis macrochirus*) and other sunfishes. Common shellfish include Rangia (*Rangia cuneata*), *Macoma* spp., dwarf surf clam (*Muliniia lateralis*), oyster (*Crassostrea*
virginica), *Vioscalba lousianae*, and olive nereite (*Neritina [Vitta] replita*). Arthropods such as shrimp and crab are also numerous and highly productive.

Area marshes replete with plants such as cordgrasses (*Spartina* spp.), reeds (*Phragmites* spp.) giant millet (*Setaria magna*) and bullrushes (*Scirpus* spp.) would have formed a highly attractive and bountiful magnet for waterfowl (Gadus and Howard 1990).

Detailed floristic studies of the Harris County Jesse Jones Park (then known as the Welker Unit of the Cypress Creek Park system) situated on Spring Creek in northern Harris County, provide a fine-grained portrait of riparian flora in southeast Texas. Sandra T. Brown, Forester, with the Houston office of the USDA Soil Conservation Service characterized the flora of the Welker unit as follows (Letter from S. Brown to Judy Overby, Office of the County Judge, Harris County, Dec. 5, 1978):

The vegetative overstory on this tract is composed of pines and hardwoods. Loblolly makes up the majority of the pine and there is some shortleaf. Hardwoods are primarily willow, water, and southern red oak along with green ash, sweetgum, hickories, and elms. The understory vegetation is primarily small overstory species, yaupon, parsley hawthorn, greenbriars, blackberry, farkleberry, and hornbeams in small areas which are poorly drained. Grasses are largely low *panicums* and *paspalums*,
carpetgrass, and woodsglass. There are a few small openings in
the canopy, perhaps 30 ft. in diameter which are richly covered
with carpetgrass and dewberries.

Carl Gilley, a biologist within Ms. Brown's office, compiled a floristic list of species
present on the tract in 1977. This floristic list, considered representative of southeast
Texas riparian flora, is presented as Appendix I. A compendium of economic plants in
the region and their uses was prepared expressly for this dissertation by Mr. Carmine
Stahl. Park Naturalist, Jesse Jones Park. This valuable interpretive summary appears as
Appendix II.

**Study Area Geology and Geomorphology**

The surface geology of the Study Area can broadly be divided by decreasing age into the
following components, which are defined in detail in Appendix III (see geologic map in
pocket at rear of Volume II):

1. A minor outcrop of the Catahoula formation in the northwestern
   portion of the Study Area;
2. Outcrop of the surface of the Willis formation in the northwestern
   portion of the Study Area;
3. Outcrop of the Lissie formation in a band running from northeast to southwest;

4. Outcrop of the Beaumont formation in the southeastern half of the Study Area;

5. Deweyville terraces along the San Jacinto River; and,

6. Modern alluvial floodplain deposits along current stream channels.

The geology, geomorphology, and soils of the study area are examined in detail by Saul Aronow, Ph.D., in Appendix III of this dissertation. Dr. Aronow is a leading authority on this region and has functioned as Consulting Geologist on many Moore Archeological Consulting investigations. Analyses of the topographic, geologic and soils context of known archeological sites in the region and predictive modeling based on these analyses follow in Chapters 8 and 13.

**Paleoenvironment and Bison Movements in the Study Area**

I will begin a discussion of paleoenvironmental reconstructions with a series of events of undoubted consequence for the prehistoric inhabitants of the Study Area: the periodic movements of bison into and out of the region since the terminal Pleistocene. The movement of bison on the Southern Plains has been reconstructed by Dillehay (1974) based on a synthesis of data from 160 archeological and paleontological sites in Texas, New Mexico and Oklahoma (including sites within the study area). Dillehay has utilized
data from these sites and made the assumption that the consistent absence of bison from archeological sites implies its physical absence from the region. Dillehay has thus inferred the following sequence of periods of bison presence and absence within the Southern Plains:

<table>
<thead>
<tr>
<th>Presence Period I:</th>
<th>10,000 to 6000-5000 B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence Period I:</td>
<td>6000-5000 B.C. to 2500 B.C.</td>
</tr>
<tr>
<td>Presence Period II:</td>
<td>2500 B.C. to A. D. 500</td>
</tr>
<tr>
<td>Absence Period II:</td>
<td>A. D. 500 to 1200-1300</td>
</tr>
<tr>
<td>Presence Period III:</td>
<td>A. D. 1200-1300 to 1550</td>
</tr>
</tbody>
</table>

Dillehay speculates that Absence Period I coincides with the 'dry and warm' interpretation of the controversial Altithermal Period (5500-2000 B.C.). As to Presence Period III, Dillehay states (1974:185) that "the climatic change on the plains in the 13th century has been well-documented by climatic, ecological and cultural evidence." It has been linked to significant subsistence and technological shifts throughout the Great Plains region.

Absence Period II and Presence Period III are obviously relevant to the Ceramic Period study period of this investigation. Bison have been found at numerous Late Ceramic sites in the study area region including the Doering and Kobs sites within the Addicks Reservoir (Wheat 1953) and 41HR541, a bison kill site on White Oak Bayou
(McReynolds, Korgel and Ensor 1988). Johnson (1994:Figure 2) links the return of the bison in Presence Period III to a temporary phase of more xeric conditions on the Edwards Plateau around A.D. 1200. He states further that they remained on the plateau after the end of this relatively brief dry period. (The presence of bison locally until historic times is supported by numerous early travelers accounts and by our recovery of bison remains in 1840-1860 contexts at site 41HR575 in downtown Houston.)

The reintroduction of the bison into central and southern Texas has been associated with the spread of the Toyah horizon artifact assemblage (Prewitt 1981, 1985; Ricklis 1992). This assemblage is comprised of

"Perdiz arrowpoints; an abundance of unifacial end scrapers; thin bifacial knives, often alternately beveled; flake drills or perforators; a blade-core lithic technology; and a simple ceramic technology represented mainly by bowls, jars and ollas of bone tempered plainware. Ongoing research has demonstrated that this Late Prehistoric assemblage is generally found in association with bison bone. Since the assemblage appears ca. A.D. 1300, a general consensus has emerged that it correlates with Dillehay's postulated southward expansion of bison herds into Texas during the Late Prehistoric, ca. A.D. 1200/1300. (Ricklis 1992:261)
Ricklis (1992) makes a strong case for the introduction of the bison hunting tool kit into the central coastal prairie through technological borrowing across a major prehistoric cultural boundary rather than via the mechanism of population movements.

The period which roughly includes the return of the bison and the spread of the Toyah Horizon emerges as one which is climatically anomalous for the globe, North America, the Great Plains, and probably even southeast Texas. I will explore in some detail the evidence that this was an unsettled period. Considerable evidence is available to indicate the commencement of a warm climatic episode in the Old World ca. A.D. 1000 (Lamb 1982); among the consequences of this warming was the historically documented florescence of agriculture in such normally inhospitable areas as Greenland and Iceland. Further, there is an accumulating body of data which indicates that that the climatic anomaly which maintained this warming trend was a world-wide phenomenon. While this warm period prompted the growth and expansion of European civilization (Street-Perrott 1994), there is mounting evidence that its consequence in many parts of the world was an interval of more or less severe drought. Stine (1994) has recently compared data regarding low water stands as witnessed by drowned tree stumps on lakes and rivers in the Sierra Nevada range in California and in the Patagonian portion of the Andes in South America. These stumps may be reliably considered to represent periods of low runoff as they are of trees which cannot tolerate inundation situated in hydrologically-stable locales. The subdivision of the stumps into two groups on the basis of elevation indicates that there were two different drought periods of different
intensities. Radiocarbon dating confirms that there were two separate periods, the ‘Group I’ drought dating from ca. A.D. 892 to ca. A.D. 1112 and the ‘Group II’ drought dating from ca. A.D. 1209 to ca. A.D. 1350. The periods were separated by one of extraordinarily high runoff.

Stine argues that contraction of the global polar vortex moved the Pacific storm tract north of California and intensified the Andean rainshadow, thus accounting for the data from both the northern and southern hemispheres. This explanation would further account for the global effects felt during the medieval period including the balmy weather in Europe and the North Atlantic. Further, Street-Perrott (1994:518) correlates Stine’s dry periods to the desiccation of eastern China ca. A.D. 950 to A.D. 1250. One must expect, then, that a phenomenon which produced unsettled weather on a global scale would have had effects even within southeast Texas. If we assume that the effects centered around the xeric-mesic axis, then it seems likely that they would have included an alteration of the forest-prairie boundary in the area but that assumption is a very big if. For the present the nature of these effects remains unknown due to the dearth of local paleoenvironmental data.

Other evidence of this unsettled climatic period centered around A.D. 1000 is provided by an analysis of channel cutting in north Texas and central Oklahoma (Hall 1990). Hall examined 15 well-documented alluvial sites in the southern Great Plains and found a
close correspondence between a channel trenching event ca. A.D. 1000. He summarizes his findings as follows (Hall 1990:344-345):

A period of moist climate at 1 to 2 ka resulted in permanent stream flow but slow fluvial sedimentation in many valleys, probably because of increased plant cover and decreased sheet erosion rates. Slow sedimentation promoted the formation of the sediment-rich Copan [paleo] Soil on floodplains throughout the region. At 1 ka the climate became drier; decreasing plant cover and increasing runoff and discharge from rainfall led directly to deepening and widening of stream channels in the Arkansas, Red, Brazos, Trinity and Colorado river basins. This episode of erosion was rapid, lasting less than 200 years, and was followed by a renewed alluviation during a period of dry climate. The climate-caused channel cutting at 1 ka in the southern Great Plains may not have parallels in other areas or during other periods in the Holocene because of unique combinations of regional geomorphic and climatic histories.

While the possible extension of this channel trenching and erosional activity at A.D. 1000 into the Study Area is an essentially unexamined question in the literature, I will note without attaching any significance to the association two items of interest: (1) the erosional interval is coeval with the abandonment of the Oyster Creek channel of the Brazos River, on which site 41FB200 discussed herein is situated; and, (2) Lain Ellis (in
Moore 1994b:153) hypothesized a vaguely contemporary brief period of erosion between Early and Late Ceramic components at site 41HR616 (also discussed at length herein) on the basis of his analysis of radiocarbon dates from the site viz. rates of deposition at the site.

Johnson and Holliday (in Johnson 1993:8) state that the Lubbock Lake area in west Texas exhibited relatively moist conditions up until A.D. 1000 when “a pattern of episodic drought began that continues today... Although these droughts appear not to have been severe enough to alter the modern Southern Plains faunal communities, they were severe enough to cause vegetation denuding and surface erosion leading to deposition and alteration of the landscape.” These droughts were accompanied by eolian activity in the region’s dune fields.

Bruseth, Rabb and McGregor (in Bruseth and Moir 1987) have reviewed paleoenvironmental data from southern Oklahoma and north Texas which they consider relevant to the Richland-Chambers Reservoir project on the Trinity River southeast of Dallas. They suggest (Bruseth and Moir 1987:47) that the period from A.D. 1200 to A.D. 1820 represents one of “major climatic deterioration” as a consequence of decreased rainfall. This decreased rainfall led to the establishment of the area’s current Tall Grass Prairie, with a decline in “many important food species such as nut-producing trees and deer. The floodplain would not have been seasonally inundated and a climax forest would have developed. This factor would have further decreased the abundance
of many exploitable resources. In particular, deer would have been less abundant since they prefer edge areas and a floodplain forest does not provide this situation. Although an edge condition would have existed at the interface between the floodplain forest and the upland grasslands, this would have been a narrow strip and not have been as extensive as before” (Bruseth and Moir 1987:47). I must note that I fail to see how an edge area, floodplain margin or not, can avoid being a narrow strip. However, the comments regarding declining deer populations would be of importance if they hold true for southeast Texas. I will point out (see Appendix II) that the floodplain forest of southeast Texas are not without their own exploitable resources. McGregor, in the same volume, notes that radiocarbon data from site 41FT193 indicates a substantial reduction in the rate of sedimentation and the consequent formation of the Navarro Paleosol after around A.D. 1200 and continuing until A.D.1820.

Madole (1994) has collected data from eastern Colorado, even further afield from the current Study Area, which indicates that eolian sand was massively mobilized after 1000 B.P. This mobilization is linked to the incidence of drought on a scale exceeding any known in the historic record. The data at which dune formation ceased is unknown but it is interesting to observe that there was a brief period of wetter conditions in the mist of the sand-mobilization period which resulted in the temporary vegetation of the dunes and the formation of mature soils. I will note in passing that Stine (1994) found evidence of a brief wet period between his Group I and Group II drought intervals in California.
Palynological data for Texas has traditionally been interpreted to represent a long-term trend to drier and warmer conditions since the end of the Pleistocene (Bryant and Holloway 1985). Ricklis (1993a:11), however, cites more recent data interpretations in an unpublished manuscript by Collins and Bousman which suggest a "broadly fluctuating pattern of climatic change during the Holocene, as opposed to a unidirectional trend to increasingly drier conditions." These interpretations are based upon high arboreal pollen counts between ca. 17,000 and 8000 B.P., a marked drop in these pollens between ca. 8000 and 5000-4000 B.P. and a significant increase again in the period after ca. 4000 B.P. Faunal findings from the Hall's Cave site in the southwestern Edwards Plateau indicate peaks of a desert species of shrew in the terminal Pleistocene (after 12,000 B.P.), in the mid- to late-Holocene (ca. 8000-3000/2500 B.P.) and in the last 1000 to 1500 years. Geologic data from the Pedernales River in central Texas also suggest a shift to drier conditions about 1000 B.P.

Ricklis (1993a:12) summarizes the following interpretations of data as they apply to the lower Texas coast:

...bits of information from disparate locations in the southern Texas coastal zone point to a general shift from erosional to depositional conditions by around ca. 5000 B.P. The sites discussed further in [Ricklis'] report show the same basic stratigraphic patterns, indicating
widespread regional change rather than only isolated instances of site-specific shifts in local conditions.

Beyond these indicators for a possible mid-Holocene period of relative aridity, little can be said of the long-term climatic history of the lower Texas coast. Pollen sequences are not available, nor have other kinds of paleoenvironmental studies been carried out. Tentatively applying the paleoenvironmental information of the interior to the coastal zone, it is likely that the terrestrial environment encountered by early European settlers had not significantly changed since ca. 1000 B.P. Prior to that, the climate may have been somewhat moister if changes were in fact parallel to those in the interior. In early historic times extensive grassland prairies and savannas characterized the area, and must have dominated the landscape in later prehistory as well. During mesic intervals there may have been expansion of arboreal plant communities. Conversely, cacti and xerophytic shrub vegetation communities may have expanded during the mid-Holocene, as they have been shown to do even during short-term modern drought intervals.

As stated by Ricklis (1993a) above, direct palynological data is sadly lacking for east and
southeast Texas. The limited available information has been summarized in a review of Texas pollen record by Bryant and Holloway (1985:54-55):

Thus far, east Texas sediments have not yielded a single lengthy pollen record. Over the past 20 years I (Bryant) have examined and sampled a significant number of east Texas archaeological sites and swamp locales in an effort to obtain a fossil pollen record from that region. To date none of the examined samples contained sufficient pollen to conduct statistically valid analyses of 200 or more pollen grains per sample.

The apparent absence of fossil pollen in most east Texas localities may result from a variety of factors. First, the soils in that region consist mainly of oxisols and alfisols which are characterized by high rates of oxidation and low percentages of organic matter, conditions under which pollen rarely preserves. Second, the high regional rainfall average repeatedly wets and dries the soils of east Texas. As Holloway has demonstrated under experimental laboratory conditions, cycles of wetting and drying cause structural weakness of the pollen exine and encourages mechanical breakdown of the pollen wall. Third, high rates of microbial activity in the leaf litter causes the loss of certain pollen types and damages others.
Pollen records from the nearby Tunica Hills region of Louisiana contain fossil pollen of *Picea, Pinus, Quercus* and other deciduous taxa suggesting that western Louisiana and perhaps east Texas, still was covered by a deciduous woodland during the late-glacial period. We suspect that the only major late-glacial changes were in the actual percentages of certain taxa and the absence of other genera. For example, we suspect that genera such as *Picea, Corylus and Alnus* either were already absent from those deciduous woodlands or were severely reduced in percentages. Although difficult to prove in the absence of fossil pollen evidence, we suspect that the proportions of certain taxa such as *Acer, Betula, Fagus* (beech) and *Carpinus* (hornbeam) may have been reduced while other taxa such as *Quercus, Liquidambar* (sweetgum) and *Pinus* increased.

Speaking in very general terms of the inland southeast Texas study area region, it may reasonably be assumed that climatic change between dry and moist conditions manifested themselves in shifts in the forest/prairie boundary. For the study period of this investigation (ca. A.D. 400 to 1850) it may be that the only significant shift in these boundaries took place with a shift to a drier environment ca. 1000-1200 B.P. and the subsequent return to moister conditions. It would be reasonable to expect that the riparian forests became more attenuated and retreated eastward with increasingly dry conditions.
There is unfortunately essentially no data upon which to reconstruct these changes even upon a broad-brush basis. Purely hypothetical maps depicting the forest/prairie boundary in A.D. 1000-1200 and A.D. 1750 appear as Figures 2 and 3.

While we have been looking at evidence of large-scale, long-period drought events I would like to emphasize (with thanks to Lain Ellis) that hunter-gatherer peoples also have to deal with climatic cycles of less duration, although perhaps of equal magnitude. A good generic historical demonstration of the cycles of climatic variation with which hunters and gatherers would have to deal with on the scale of a single human lifetime is provided by an analysis of wet and dry cycles represented in the growth rings of old, living cypress trees in the southeastern United States (Stahle and Cleaveland 1994). This study first established, via comparison of the tree-ring record with the instrument data record for the historic period, that tree-ring thickness offer an accurate gauge of spring precipitation. The authors then utilized the tree-ring data to reconstruct cycles of above- and below-normal precipitation back to about A.D. 950. These data showed a constant oscillation from wet to dry on a scale of 10-30 year cycles. (Incidentally, while they cite no evidence of a protracted drought interval, the authors do note that the amplitude of fluctuations is higher during the Medieval Dry Period, A.D. 1000-1300.) While I would by no means argue that these southeastern data are applicable to the Study Area, it is certainly likely that the prehistoric inhabitants of this region had to deal with similar, to them protracted, periods of drought and ample rainfall.
FIGURE 2. HYPOTHETICAL DESCRIPTION OF THE FOREST/ PrairIE BOUNDARY WITHIN THE STUDY AREA, ca. A.D. 1000 -1200
3. Previous Investigations

A number of archeological investigations have been conducted in Southeast Texas that are relevant to this investigation. The dissertation Study Area is situated within a region that has been the scene of several major reservoir and flood control related projects. Other, smaller projects in the area have been conducted for small public works projects and by avocational archeologists. Previous investigations are discussed in the context of the watersheds that serve as analytical units in the dissertation investigations.

San Jacinto River Watershed

West Fork of the San Jacinto River

The first recorded archeological site on the West Fork of the San Jacinto River (41MQ1) was a Late Prehistoric site recorded in 1956 during a field trip to Montgomery County by Dr. E. Mott Davis of the Anthropology Department, The University of Texas at Austin. He recorded the site, conducted brief shovel tests, and documented local collections (TARL site files).

This area remained unexplored until the survey of the Honea Reservoir, now Lake Conroe, in 1965 by the Texas Archeological Salvage Project (TASP). This project was
conducted under the supervision of Harry J. Shafer (1966b) and represents the only major study involving this drainage. Twenty-two sites along the West Fork were recorded. Of this total, 19 sites were classified by Shafer (1966b:Table 1) as Neo-American based on the presence of pottery and/or arrow points.

An important site on this drainage is site 41HR616 which is located on the north bank within the limits of Lake Houston. It was recorded during a survey of the West Lake Houston Parkway project by Moore Archeological Consulting in 1988 (Moore and Pettus 1988). Significance testing was conducted in December of that year (Moore 1989b), and the site was mitigated in the fall of 1990 (Moore 1994b). It has been determined that 41HR616 dates from the middle Early Ceramic Period to the Late Ceramic Period. The site has additionally produced sherds of Caddo or Caddo-like ceramics, specifically Broaddus Brushed and Holley Fine Engraved. The West Lake Houston Parkway survey also recorded one additional prehistoric site (41HR615) which was found to lie outside the road alignment.

About ten miles north of 41HR616 is site 41MQ55. This site was tested by William E. Moore (1990) of Brazos Valley Research Associates in 1990 and found to contain significant research potential. The data suggest that this is a multi-component campsite containing Late Prehistoric and Early Ceramic/Late Archaic components.

The remaining sites along this drainage were recorded during cultural resource management projects involving small survey areas and by various individuals. The Anthropology Laboratory, Texas A&M University, recorded two sites in Walker County (41WA81 and 41WA82) during a survey of the Kaygal Recreation Area in 1975 (Shafer and Baxter 1975) and two sites in Montgomery County (41MQ45 and 41MQ46) during
a survey of the Texas Loop Pipeline in 1977 (Taylor 1979). An additional four sites were recorded in the 1980s by Espey, Huston & Associates, Inc. (41MQ57), the Texas State Department of Highways and Public Transportation (41MQ63 and 41MQ122), and the United States Forest Service (41MQ53). Information concerning these sites remains unpublished and is found only in the TARL site records.

In 1974, two sites on tributaries and one on the West Fork were recorded by William E. (Bill) Moore (1976) during a survey of Walker County. Other sites recorded by individuals include 41MQ59 and 41MQ62.

Controlled subsurface investigations at sites along the West Fork of the San Jacinto River are rare. Sites which have been shovel tested include 41HR615, 41HR616, 41MQ45, 41MQ46, 41MQ55, 41MQ57, 41MQ122, 41WA61, 41WA81, and 41WA82. According to the TARL site files, test pits were dug at sites 41MQ1, 41MQ32, and 41MQ62. Testing for National Register significance was carried out at sites 41HR616 by Moore Archeological Consulting (Moore 1989b), 41HR324, 41MQ45, and 41MQ46 by Heartfield, Price & Greene, Inc. (1984), 41MQ55 by Brazos Valley Research Associates (Moore 1990), and 41WA82 by Texas A&M University (McNatt 1978). Only three sites, 41HR616, 41MQ4 and 41MQ5 (Shafer 1968) have been intensively excavated.

Roger G. Moore recently identified a viable lithic source locality in the form of a gravel bar on the West Fork of the San Jacinto River approximately one to two miles upstream from the U.S. Highway 59 bridge. This locality may offer the southernmost source of lithic raw materials yet identified in the region.
Spring and Cypress Creeks

Archeological work in the Spring and Cypress creek tributaries to the West Fork of the San Jacinto began in earnest in the mid-1970s. The most ambitious project to date (Freeman and Hale 1978) was a survey of the Cypress Creek watershed conducted for the United States Army Corps of Engineers, Galveston District. This survey located 58 cultural resource sites in the field sample tracts and identified an additional 22 through archival resources. Of this total, 23 are Late Prehistoric.

Other work in the drainages of Spring and Cypress creeks includes additional sites recorded by avocational archeologists of the Houston Archeological Society (HAS) (Patterson 1986), the survey of the initial Jesse H. Jones Park tract on Spring Creek (Heartfield, Price & Greene, Inc. 1980), a subsequent survey of a park expansion of Jones Park (Moore 1988a), and the survey of a Missouri Pacific rail crossing of Cypress Creek (Heartfield, Price & Greene, Inc. 1981).

In the mid-1980s, a series of archeological surveys was conducted by Moore Archeological Consulting for various Harris County projects on Cypress Creek. These include a proposed extension of Cypresswood and Cutten Roads (Moore 1985a), an expansion of the Mercer Arboretum (Moore 1985b), and the Cypress Creek Golf Course (Moore 1988b).

The Archeological Research Laboratory at Texas A&M University surveyed the lower 13.5 stream miles of the Cypress Creek drainage from Kuykendahl Road to its confluence with Spring Creek (Ensor 1991). Three new prehistoric sites (41HR629
through 41HR631) and one new historic site (41HR628) were located. Fifteen previously recorded sites were evaluated and are discussed in the report.

Moore Archeological Consulting examined a 90 acre tract along the uppermost reaches of Cypress Creek in 1992 (Moore 1992). This effort recorded 7 prehistoric sites, 1 historic site, and relocated historic site 41HR394, the Old Washington Road. All of the prehistoric sites and the historic road segment were found to be eligible for nomination as State Archeological Landmarks.

Moore Archeological Consulting conducted a survey of 143 acres on Little Cypress Creek in northwest Harris County for the Harris County Flood Control District in 1993 (Moore et al. 1994). Two cultural resource sites were found; the historic Roeder/Becker Cemetery containing graves dating to the 19th and 20th centuries (41HR750) and a single flake recorded as prehistoric locality (L41HR1).

Moore Archeological Consulting conducted a survey of the 334 acre Burroughs Park tract on Spring Creek (Moore 1990). This survey combined intensive shovel testing with historic land use and geomorphologic studies. Three prehistoric sites (41HR625 through 41HR627) and one historic site were identified during the field survey. The historic site is of 20th century origin and is not considered significant. Sites 41HR626 and 41HR627 produced only very limited lithic debitage from shovel tests. Site 41HR625, the largest and most productive of the three sites, yielded aboriginal ceramics and a probable *Perdiz* arrow point fragment from shovel tests and two excavation units of 50 x 50 cm. This site is dated to the Ceramic Period and is believed to be a semi-permanent seasonal campsite.
A preliminary assessment of the proposed Spring Lake Reservoir in Montgomery County was performed by Moore Archeological Consulting in 1991 for the San Jacinto River Authority (Moore 1991b). A much more detailed prehistoric assessment including geomorphologic analyses subsequently was performed by the firm (Moore and Aronow 1994).

In 1993, Moore Archeological Consulting was once again involved in an archeological investigation involving Spring Creek (Moore 1993a). This project involved a cultural resources survey of three proposed segments of Gosling Road within the city limits of The Woodlands in Montgomery County. Three prehistoric sites (41MQ126 through 41MQ128) were found as a result of this study. It was recommended that site 41MQ126 be avoided during construction. The remaining two sites were determined to be out of the project area. Sites 41MQ126 and 41MQ128 were found a some distance from the current channel of Spring Creek and site 41MQ127 was found to be in association with a rather minor, presumably ephemeral tributary to the creek.

Brazos Valley Research Associates (W. Moore 1993) conducted a survey of the proposed Gosling Road extension on the Harris County side of Spring Creek that was performed concurrent with the above-mentioned study by Moore Archeological Consulting. No prehistoric sites were found during this study although the first and second terraces above Spring Creek contained deep sandy soils and the area appeared to the researchers to be a prime location for the presence of a prehistoric site. It should be noted that this investigation was limited to manual shovel testing and sterile bedrock clay was not reached. Recommendations were made for monitoring during bridge construction.
Lake Creek Reservoir

The field survey of this reservoir on a tributary of the West Fork of the San Jacinto River was preceded by two background studies conducted to prepare a scope of work for the Lake Creek project. They are a review of pertinent ethnohistoric sources conducted by Boyd and Button (1985) and a literature and records search listing all pertinent references and recorded sites for a ten county area by Bartholomew (1986).

The Lake Creek project was performed by the Texas Archeological Survey (TAS) and included ethnohistorical, historical, geomorphologic, and archeological research and a sample survey of ten tracts totaling 3570 acres or 20% of the reservoir flood pool (Bement et al. 1987:v). This work was designed to be a planning guide for Lake Creek, a major tributary of the San Jacinto River in Montgomery County, and the report serves as a research design for future work. The fieldwork was carried out in the summer of 1986.

Pedestrian survey accompanied by shovel testing recorded the locations of 46 prehistoric sites with 24 containing pottery and/or arrow points. Caddoan ceramics similar to Canton Incised and Maydelle Incised utility wares were found at 41MQ118, and a possible European trade pipe fragment was recovered from site 41MQ106 (Bement et al. 1987:7-14).
Buffalo Bayou Watershed

Addicks and Barker Reservoirs and Vicinity

The earliest major investigation in the Study Area region was Wheat’s (1953) survey of the Addicks Basin as part of the River Basin Survey program. A number of sites were excavated, and the Galveston Bay Focus, a component of the Neo-American Stage, was established on the basis of data recovered from these excavations (Suham, Kreiger, and Jelks 1954). The Archaic materials from these sites were later assigned to the La Harpe Aspect as defined by Johnson (1962).


Espey, Huston & Associates, Inc. conducted survey and testing along Buffalo Bayou west of Barker Reservoir in July and August of 1987. The results of the geomorphologic work has been summarized by David O. Brown (1988). The report describing the archeological investigations was not available at this writing.

Langham Creek
The most exhaustive work to be conducted on Langham Creek, a tributary of Buffalo Bayou joining the latter stream east of the Addicks and Barker reservoirs, consists of an intensive archeological excavation at site 41HR530 and National Register testing at site 41HR608. These sites were investigated in July and August of 1987 by the Archeological Research Laboratory, Texas A&M University (McReynolds, Ensor, and Carlson 1988). Site 41HR530 was discovered and recorded by personnel from Espey, Huston & Associates, Inc. during a survey of the proposed Langham Creek channel realignment project for the Harris County Flood Control District in 1984 (Espey Huston & Associates 1987).

In April 1985 and October 1986, National Register testing was performed by Espey, Huston & Associates, Inc. at 41HR530 with the result it was recommended for nomination to the National Register of Historic Places. The survey and testing are reported in a document by Espey, Huston & Associates, Inc. dated 1987. Site 41HR630 was identified by Carolyn Good, Staff Archeologist for the United States Army Corps of Engineers, Galveston District, during an inspection of the testing at 41HR530 (Espey, Huston & Associates, Inc. 1987). The site was shovel tested, and it was decided that site 41HR608, because of its close proximity to 41HR530, be tested in conjunction with the excavation of 41HR530.

An archeological survey of the Langham Creek Channel Improvement Project was performed by Moore Archeological Consulting in 1992 for the Harris County Flood Control District (Moore and Sanchez 1993). One previously unrecorded site (41HR729) was found during this survey. This site was classified as a Late Prehistoric campsite by
the surveyors and was determined to be eligible for nomination as a State Archeological Landmark.

Concurrent with the above-mentioned survey was an investigation of two detention basins on Langham Creek and Dinner Creek by Moore Archeological Consulting in 1992 for the Harris County Flood Control District (Moore and Sanchez 1992). No sites were found in the Dinner Creek basin, but prehistoric site 41HR729 (see above) was found to also be present within the proposed Langham Creek basin.

National Register testing was conducted at prehistoric site 41HR729 on Langham Creek by Moore Archeological Consulting in the winter of 1992 for the Harris County Flood Control District (Moore 1994a). While the investigation uncovered intact cultural deposits, it was determined that much of the natural ground surface had been removed leaving only remnant patches of the cultural deposits intact. It was concluded that this site is not eligible for the National Register of Historic Places.

Lower Buffalo Bayou and Tributaries

Considerable recent archeological work has been conducted downstream from Langham Creek and the Addicks and Barker reservoirs within the Buffalo Bayou watershed. For example, Moore Archeological Consulting conducted a survey in 1988 of 365.3 acres of land on and near Buffalo Bayou in the City of Houston Memorial Park (Moore, Moore, and Pettus 1989). This survey disclosed only historic features associated with the World War I Camp Logan training facility. Certainly the most productive of the recent investigations was the extensive excavations by the Archeological Research Laboratory,
Texas A&M University, at the Alabonson Road site (41HR273) situated along White Oak Bayou, a major Buffalo Bayou tributary (Ensor and Carlson 1991). The Archeological Research Laboratory also recently excavated a Late Ceramic bison kill site (41HR541), also on White Oak Bayou (McReynolds, Korgel, and Ensor 1988). Additional work on White Oak Bayou was performed by Prewitt and Associates, Inc. (Fields 1988).

There have been at least seven significant cultural resource surveys along Green's Bayou, another important tributary of Buffalo Bayou. The Archeological Research Laboratory, Texas A&M University, conducted a survey of a 1500 acre tract in the lower third of the bayou (Ensor, Aronow, Freeman, and Sanchez 1990). This survey was extremely productive and resulted in the location of 37 prehistoric sites. Two nearly concurrent surveys were conducted in 1991 within the upper two-thirds of the bayou. Prewitt & Associates, Inc. conducted a survey of a 150 meter wide band along 25% of a 25 mile reach of Green's Bayou extending from the Lake Houston Parkway to FM 1960 (Howard, Freeman, and Bousman 1991). This survey identified 13 prehistoric sites, 3 historic sites, and 1 site with both prehistoric and historic components. Moore Archeological Consulting has carried out three contiguous surveys totaling 1503 acres on Greens Bayou two kilometers upstream from the Texas A&M survey area (Moore 1993b, 1994c, report in preparation). A total of twenty-five tightly clustered prehistoric sites were discovered in the course of these surveys. The firm also conducted a survey of a 160 acre tract located approximately eight kilometers from the upstream end of the bayou (Moore 1991b). This survey identified one unrecorded prehistoric site and a historic cemetery site.
Moore Archeological Consulting performed surveys of a 14 acre tract on Carpenter's Bayou (Moore 1991a) and of a 174-acre section of Herman Brown Park on Hunting Bayou (Moore 1989a), both minor tributaries of Buffalo Bayou. The latter survey identified one multi-component prehistoric and historic site (41HR622); the low density prehistoric component dated to the Ceramic Period.

Trinity River Watershed

Lake Livingston

This reservoir located on the Lower Trinity River was the site of archeological survey and excavation in Polk and San Jacinto counties. The cultural resources of this reservoir were evaluated by archeologists from the Texas Archeological Salvage Project (TASP), University of Texas at Austin, and the Houston Archeological Society (HAS) in the early 1960s (Nunley 1963).

Site excavation was conducted during the 1965 and 1966 field seasons by TASP personnel with assistance from HAS volunteers (McClurkan 1967, 1968). During the first season, two sites in Polk County (41PK8, 41PK21) and two sites in San Jacinto County (41SJ16, 41SJ19) were tested. The next season saw continued work in the area; this time a major excavation was conducted at 41PK88 with limited testing performed at 41PK89. All six sites are Late Prehistoric.
Not related to the Lake Livingston Reservoir investigations, but equally relevant to the current study, are the excavations by the Archeological Research Laboratory, Texas A&M University, at the Crawford site (41PK69) which is situated on the central Trinity River uplands in Polk County (Ensor and Carlson 1988). Excavations at this site yielded a long occupational sequence spanning the Early, Middle, and Late Archaic and the Early and Late Ceramic periods. Caddoan affinities, particularly relevant to the current inquiry, were noted among the latest inhabitants of the site.

Wallisville Reservoir

This reservoir is located on the Lower Trinity River near its mouth and east of the current Study Area. It was the site of several archeological investigations, primarily in the 1960s and 1970s. Prior to this period Woolsey (1932), of the University of Texas at Austin, excavated two sites in the Wallisville Lake area in 1932.

The first archeological survey of the reservoir area was conducted by TASP in 1965 (Shafer 1966a). This project recorded 47 sites of which 43 are shell middens. Forty of the sites are Late Prehistoric. Trade is indicated by a Tchefuncte Stamped sherd at 41CH17, and historic contact is evidenced by a glass bead at 41CH20, a gunflint at 41CH38, and the second site of Presidio San Luis de Ahumada (41CH53).

The survey continued in 1968, and an additional 95 sites were recorded (Ambler 1970:1). At least 35 of these sites are Late Prehistoric (Ambler 1970:Table 1) and belong to the Lost River Phase or Galveston Bay Phase as described by Ambler (1970:5-6).
Testing and excavation of prehistoric and historic sites was carried out by various individuals. Three prehistoric sites near Cedar Bayou were examined by Ambler in 1966 (Ambler 1967). Tunnell and Ambler (1967) explored the site of Presidio San Agustin de Ahumada in 1967. In 1972, Kathleen Gilmore (1974) excavated a Late Prehistoric shell midden (41CH110) containing historic artifacts of the Spanish period. Additional analysis of prehistoric sites was conducted in 1973 by Ambler (1973) and Dillehay (1975). Additional work in the reservoir area was conducted by Fox, Day, and Highley (1980) in 1979. Late Prehistoric sites, Historic Indian sites, and historic sites were evaluated. Geomarine, Inc., of Plano Texas, has executed recent site excavations which among other things has produced a French flintlock musket lock from a historic shell midden site (Personal communication: B. Ensor, 1994). Aten (1983a) conducted a study of discrete habitation units in Trinity River delta shell middens. Coastal Environments, Inc. (Weinstein et al. 1988) tested five sites (41CH273 through 41CH274 and 41LB54 through 41LB56) within dredge disposal sites associated with the related “Channel to Liberty” project.

Oyster Creek/Brazos River Region

The most important research thus far conducted in the Oyster Creek/Brazos River region would be Hall's (1981) investigations at Allen's Creek and other sites along the Brazos
River in Austin County. Other archeological studies in this region include a recent survey by Moore Archeological Consulting of Joseph and Lucie Cullinan Park in Fort Bend County (Moore and Moore 1991) which disclosed 25 archeological sites including 8 prehistoric sites, 13 historic sites, and 3 multi-component prehistoric and historic sites. Of the total number of prehistoric sites and components, eight sites can be assigned to the Late Prehistoric period.

Coastal Environments, Inc. conducted significance testing at the important Flat Bank Creek site (41FB99) in 1986 (Kelly et al. 1986). Other investigations by Espey, Huston & Associates, Inc. include survey and testing of the New Territory development in Fort Bend County (Voellinger and Moore 1988; Voellinger and Smyth 1989), survey of the Natchez development in Fort Bend County (Voellinger, Smyth and Moore 1988), and work at the Cinco Ranch in Fort Bend and Harris counties (Voellinger, Gearhart, Frederick, and Moore 1987)

Littoral Sites: Clear Lake/Galveston Area

Studies conducted in the Galveston Bay region include surveys of the shoreline of Galveston Bay (McGuff and Cox 1973; McGuff and Ford 1974), a survey of Armand Bayou (Hole 1974), and excavation of a cemetery site located on Clear Lake (Aten et al. 1976). Other work in the Clear Lake/Galveston Bay region includes published and
unpublished excavations at site 41GV66 on Galveston Island (Ricklis 1994), a survey for area channel improvements (Mercado-Allinger et al. 1984), and test excavations at site 41HR10 (Fields and Reese 1984) and 41GV16 (Voellinger and Voellinger 1985). Prewitt and Associates, Inc. recently conducted extensive data recovery excavations at several nearby shell midden sites located on Peggy Lake on the opposite bank of the San Jacinto River (Gadus and Howard 1990) and archeological reconnaissance for the Clear Creek Flood Control Project (Howard, Freeman, and Bousman 1992).

Peripheral Studies

More peripheral studies, include work in the Big Thicket (Shafer et al. 1975), archeological survey in the Davy Crockett National Forest (Bond and Moore 1980); testing within the Sam Houston National Forest, Walker County (McNatt 1978); excavations at the Jamison site (41LB2) in Liberty County (Aten 1967), and testing of four shell midden sites at the mouth of the San Bernard River (Espay, Huston & Associates, Inc. 1989).
Archeological Syntheses

Works which have sought to synthesize prehistoric data relevant to the prehistory of southeast Texas include an early contribution by Sayles (1935), Suhm, Krieger and Jelks (1954), Shafer (1975), Shafer et al. (1975), Patterson (1976, 1979, 1983, 1991, 1993c), Ambler (1973), Story (1981), and Aten (1983b). The final work, an expansion of Aten's 1979 doctoral dissertation, is a particularly ambitious and useful attempt to integrate ethnohistoric, archeological, paleoclimatic, and geomorphologic data for the upper Texas coastal margin. A broader overview of the Gulf coastal plain to southern Arkansas and Oklahoma is provided in a new synthetic work commissioned by the United States Army Corps of Engineers, Southwestern Division (Story et al. 1990).
4. Archeological Background

Both Aten (1984) and Shafer (1975) have referred to the indigenous Ceramic period cultures of southeast Texas as "Woodland" in order to emphasize their ties to the southeastern United States. While it was not their intent to suggest that these cultures shared the critical hallmarks of eastern Woodland cultures, much less the chronological implications which Woodland carries in the east, I believe that Story (Story et al 1990) has introduced a more meaningful and useful concept with her "Mossy Grove" tradition: "Mossy Grove can be viewed as both a general cultural pattern and as a regional tradition that partly parallels development of the Caddoan tradition to the north. And, like the Caddoan tradition/culture, it encompasses the archeological remains of what were surely different ethnic (and possibly even linguistic) groups" (Story et al 1990:256). Thus, the Mossy Grove tradition defines the broad context of related late prehistoric cultures within which are situated the sites and peoples examined in this dissertation.

The generality of the definition of Mossy Grove thus permits us to begin with the unifying threads linking peoples sharing similar culture histories, technological traditions and adaptations, even when these similarities are underlain by uncertainties of ethnic affiliation. Given that they all participated in the same broad cultural tradition, we may then be justified in seeking analytical units which will help to expose the more fundamental divisions at the level of ethnic group, village and minimal band. It is expected that culturally meaningful variation will be detected at these finer levels of analysis.

The Mossy Grove tradition region is subdivided at two levels: first, there is a distinction between the coastal and inland manifestations. Within the coastal segment are the
"Sabine Lake," "Galveston Bay" and "Brazos Delta-West Bay" subdivisions, all sub-regions initially established by Aten (1979, 1983b). Again following Aten's example, an inland "Conroe-Livingston" area including the upper and middle section of the San Jacinto River drainage and the upper section of the Lower Trinity River drainage. Also within the inland Mossy Grove are the "Allens Creek" area on the lower Brazos River basin and the "Neches-Angelina" area, encompassing "much of the central part of the east Texas woodlands, roughly from the confluence of the Neches and Angelina rivers northward to a line provisionally drawn at 31 degrees 45 minutes North Latitude" (Story et al 1990:277). The current Study Area extends from the San Jacinto River on the east to the Brazos River on the west, and from immediately north of Spring Creek on the north to some distance south of Buffalo Bayou on the south (Figure 1). The Study Area thus consists of both the eastern portion of the "Allens Creek" area and the undesignated (by Story) inland region encompassing much of Harris County which extends north from the Galveston Bay area to the southern edge of the Conroe-Livingston segment and west to the eastern edge of the "Allens Creek" area.

While Story is not explicit on the matter, it is clear that the "tradition" in the Mossy Grove tradition definition is a technological one insofar as it is reflected in the material remains of these peoples. Mossy grove sites are principally united by their ceramics, overwhelmingly dominated for a very long time by plain, sandy-paste pottery, specifically, Goose Creek Plain. While ceramics are moderately common at most sites, decorated sherds form a small (<10%) portion of most assemblages. Reconstructed vessel forms consist of simple wide-mouth beakers, jars and bowls, sometimes with conical bases (Story et al 1990:256). The frequency of Caddoan ceramics increases with proximity to the Caddoan border, and the Caddo apparently expanded peacefully into the northern Mossy Grove area ca. A.D. 800-900. Archeological as well as
historical evidence suggests that friendly relations were maintained for the most part between the Caddoan and Mossy Grove populations.

Story characterizes the Mossy Grove lithic assemblage as "not very distinctive," with *Gary* and *Kent* dart points dominant during the Early Ceramic period. *Gary* is a ubiquitous late Archaic/early Late Culture type, while *Kent* is probably a regional expression of a style that includes the *Yarborough* type to the north and the *Darl* and *Godley* types to the west and northwest" (Story *et al* 1990:256). The bow and arrow entered the region as early as A.D. 500-600, with an accompanying change from direct core or very large flake reduction to the reduction of small flakes. Story suggests that strongly expanding stem arrow points such as the *Scallorn*, *Agee* and *Homan* types did not become popular in the more southeasterly portion of the region, while *Alba*, *Catahoula* and *Perdz* types are "widespread and shared with many non-Mossy Grove groups" (Story *et al* 1990:256-257).

Aside from a shared technological tradition, the major element linking the Mossy Grove peoples was that they were uniformly hunter and gatherers moving in seasonal rounds. Some groups spent these rounds exploiting exclusively inland resources while others shuttled from the coast in the late spring and early summer to the inland, usually in the cold season. Limited evidence of bison exploitation and of occurrence of the beveled knife and small end scraper tool kit associated with bison hide processing is available within the region after A.D. 1300.

Story's broad and generalized Mossy Grove tradition is deficient in only one point - the very one which Shafer and Aten sought to emphasize through their use of the term "Woodland." It seems that in terms of external relations and affiliations she looks too
much to the Caddo north and the west and not enough to the east, where several of the principal ethnic groups of this area had direct ties to the Atakapans of Louisiana and on, in general terms, to inhabitants of the Gulf coastal margin and the vast forests of the rest of the southeastern United States. The fact that the Mossy Grove is the westernmost outpost of the broad forest-dwelling Eastern Woodlands cultural area is too critical a factor to ignore.

The archeological review in detail begins with an examination of contrasting opinions on one of the more basic chronology-building exercises in prehistoric investigations: projectile point sequences. This examination serves to emphasize that the prehistory of Southeast Texas is still incompletely defined despite 40 years of fieldwork. Much of the ambiguity in the data can probably be ascribed to the paucity of excavation data from deeply and “cleanly” stratified sites that offer unmixed components (Ensor 1990).

Evidence for occupation of the Upper Texas coastal region is scarce in the Paleo-Indian period and rather ambiguous through the Middle Archaic (Patterson 1983; Aten 1983b:156-157). However, Patterson (1983:255) has defined a sequence of projectile point types for the region from early Paleo-Indian through Late Prehistoric times. The Study Area falls in his Western Transitional Zone subdivision of this sequence (Table 1).
Table 1. Projectile Point Sequence for Southeast Texas

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Dates</th>
<th>Projectile Point Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Paleo-Indian</td>
<td>12,000-10,000 BP</td>
<td>Clovis(?), Folsom, early side-notched</td>
</tr>
<tr>
<td>Late Paleo-Indian</td>
<td>10,000-7000 BP</td>
<td>Plainview, Scottsbluff, Angostura, San Patrice, Golondrina, early stemmed</td>
</tr>
<tr>
<td>Early/Middle Archaic</td>
<td>7000-3500 BP</td>
<td>Bulverde, Pedernales, Gary/Kent, Marcos, Lange, Ensor, Wells, Bell (?)</td>
</tr>
<tr>
<td>Late Archaic/Early Ceramic</td>
<td>3500-1400 BP</td>
<td>Gary/Kent, Pedernales, Ellis, Ensor, Ponchartrain, Fairland, Palmillas, Travis, Darl, Wells, Marcos, Yarbrough, transitional arrow points as classified by Patterson</td>
</tr>
<tr>
<td>Late Prehistoric</td>
<td>Edwards, Alba, Scallorn, Perdiz, Catahoula, Gary/Kent</td>
<td></td>
</tr>
</tbody>
</table>

Patterson's point sequence has come under recent, detailed criticism from Ensor (1991) and others. It is appropriate to cite extensively both the substance of this criticism and its philosophical basis (Ensor 1990:5-6):

Given the lack of definitive data regarding the temporal and stratigraphic position of certain point types found at inland Southeast Texas sites, which often exhibit compressed, mixed deposits, this author prefers to take into account Coe's (1964:9) observation that "when an occupation zone can be found that represents a relatively short period of time the
usual hodgepodge of projectile point types are not found - only variations of one specific theme.” Closer to home, Story (Story et al. 1990:214) states that “when a number of different types of points are recovered from the same excavation level or geologic zone, it’s best to regard the context as temporally mixed.” This contrasts with assumptions implicit within a tentative projectile point sequence developed by Patterson (1983) for the Upper Texas Coast. For example, Patterson, based on limited data, suggests that side-notched points may be associated with Clovis points during the early Paleo-Indian period.

Although Patterson (1989) cites examples of “notched” points allegedly associated with fluted points in Southeast Texas and elsewhere, the “associations” are dubious since only a single fluted point is ever found “associated” with the “notched” points at any one site. Further, the terminology employed in his discussion of so-called “early notched” points is less than precise, making communication between researchers difficult. For example, Patterson (1989:34) uses the terminology “notched base,” referring presumably to “early notched points;” this leaves one to speculate on whether it is actually the base which is notched (as in a Montell point) or the haft element (as in a Big Sandy point). These imprecisions are largely the outgrowth of the lack of a system of integrated terms describing point morphology.

These important details aside, it seems doubtful if side- or corner-notched points ever played a significant (if any) role in Clovis or Folsom tool kits.
At any rate, the data are much too sketchy and incomplete to suggest any such an association.

Patterson places *Ensor* points within both the Middle and Late Archaic time periods, while *Bulverde* points are suggested to begin the early Middle Archaic and extend into the Late Archaic. *Gary/Kent* points are said to begin in the Middle Archaic and continue “throughout all later prehistoric periods” (Patterson 1983:257)

Further, Kindall and Patterson (1986:17) go so far as to state that *Gary* and *Kent* points “possibly start in the Early Archaic.” This effectively means that *Gary* and *Kent* points, according to these authors, were possibly manufactured for approximately 7000 years or from the Early Archaic through the Late Prehistoric. If this is the case, then obviously these types, as defined by Suhm and Jelks (1962), are of little value in either chronology building or in assessing cultural-historical affiliations in Southeast Texas. This author does not agree with Patterson’s suggestions that *Gary* and *Kent* points were manufactured from the Early Archaic through the Late Prehistoric periods in Southeast Texas. One bit of evidence which does not support Patterson’s placement of *Gary* points is from Patterson’s own site (41WH19), where possibly the best stratified deposits to date have been excavated in Southeast Texas (Story *et al* 1990). An examination of Patterson’s tables which associate point types with different strata indicates that no *Gary* points were found below the upper portion of Stratum 2 (Patterson *et al* 1987). In fact, they were found only in Stratum 1a and the upper portion of Stratum 2 or Patterson’s Transitional Early Ceramic/Late Prehistoric levels and
Transitional Late Archaic/Early Ceramic levels, respectively. However, Patterson et al. (1987:8) state that “the general time placement of projectile points in this report is consistent with previous publications by Patterson.” This placement of Gary points may be generally consistent, but their stratigraphic position does not support Patterson’s view of such a long temporal duration for this type. Better evidence for a Middle Archaic association with Gary-like points (not typed as Gary by Hall) possibly comes from the Allen’s Creek site (Hall 1981).

Besides the questionable placement of some types within such a wide range of temporal/cultural affiliations, other placements of specific types contradict the best data available. A case in point is Patterson’s placement of Wells, Pedernales, and Travis points in the Late Archaic when all other available data from Central Texas strongly suggests Early-Middle Archaic affiliation based on both typological and stratigraphic data (Sorrow et al. 1967; Prewitt 1981; Ensor 1988; Prikryl 1987; Turner and Hester 1993; Story et al. 1990).

It is strongly felt by the author that, given the nature of the current data regarding the temporal and cultural affiliations of the point types in Southeast Texas which Patterson (1983:254) himself recognizes as being insufficient to provide “definitive data concerning precise, narrow time periods,” the best option is to be conservative in our placements. It seems unlikely, based on work at well-stratified sites in the eastern United States (Coe 1964; Broyles 1971; Chapman 1975, 1977), that, as a rule, single types spanned three or more major periods of Southeast Texas prehistory. This is not to suggest that the Eastern Woodlands data can or should be
used as a model for Southeast Texas cultural development. However, it does indicate that close attention should be paid to those important findings and their implications should be considered in light of the Southeast Texas data. Furthermore, it is doubtful if the time occurrence of such Central Texas forms as Ensor, Marcos, Travis, Pedernales, and Wells differ enough from these same sites in Southeast Texas to warrant placing them in different cultural periods, especially when the evidence is so weak. In short, the approach of assigning types to wide-ranging cultural periods when the benefit of doing so seems trivial, is counterproductive to the growth of archeological understanding in Southeast Texas.

Ensor (1991:Figure 1) presents his own, alternative configuration of a Southeast Texas projectile point sequence in the same article. It is presented here as Table 2.

Two other broadly-based attempts at regional synthesis are relevant to the Study Area. These major efforts include work by Shafer et al. (1975) in southeast Texas and Aten’s (1979; 1983b) work on the upper Texas coast. Shafer places greater emphasis on inland sites, while Aten concentrates on the littoral, estuarine, and deltaic portion of the coastal plain. A convenient summary of Shafer’s East Texas chronology by McNatt (1978:11) is presented as Table 3. Shafer’s chronology, while encompassing entire assemblages, is based primarily on projectile point types for the Lithic (Archaic) Period. Projectile points considered diagnostic for the periods defined above are taken from Shafer et al. (1975) and presented as Table 4.
Table 2. Southeast Texas Projectile Point Sequence

<table>
<thead>
<tr>
<th>Period</th>
<th>Date</th>
<th>Cluster/Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleo-Indian</td>
<td>10,000-8000 BC</td>
<td>Lanceolate Paleo-Indian Cluster/Clovis, Folsom, Angostura, Plainview, Golindrina</td>
</tr>
<tr>
<td>Early Archaic</td>
<td>8000-5000 BC</td>
<td>San Patrice Cluster/San Patrice</td>
</tr>
<tr>
<td></td>
<td>(8000-7500 BC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7500-5000 BC)</td>
<td>Early Side-Notched Cluster</td>
</tr>
<tr>
<td>Middle Archaic</td>
<td>5000-1000 BC</td>
<td>Early Expanded Haft Cluster/Yarborough, Trinity, Carrolton</td>
</tr>
<tr>
<td></td>
<td>(5000-2000 BC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2000-1000 BC)</td>
<td>Palmillas Cluster/Palmillas</td>
</tr>
<tr>
<td>Late Archaic</td>
<td>1000 BC - AD 400</td>
<td>Gary/Kent Cluster/Gary, Kent</td>
</tr>
<tr>
<td>Early Ceramic</td>
<td>AD 400 - AD 800</td>
<td>Gary/Kent Cluster/Gary, Kent</td>
</tr>
<tr>
<td>Late Ceramic</td>
<td>AD 800 - AD 1750</td>
<td>Catahoula Cluster/Catahoula, Frilley</td>
</tr>
<tr>
<td></td>
<td>(AD 800 - AD 900)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(AD 900 - AD 1100)</td>
<td>Alba Cluster/Alba, Bonham</td>
</tr>
<tr>
<td></td>
<td>(AD 1100 - AD 1200)</td>
<td>Scalorn Cluster/Scalorn</td>
</tr>
<tr>
<td></td>
<td>(AD 1200 - AD 1750)</td>
<td>Perdiz Cluster/Perdiz, Clifton</td>
</tr>
</tbody>
</table>

Table 3. Chronology of East Texas

<table>
<thead>
<tr>
<th>Period</th>
<th>Estimated Dates</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Lithic</td>
<td>7000 - 4000 B.C.</td>
<td>Lanceolate dart points, scrapers, gouges, notched pebbles</td>
</tr>
</tbody>
</table>
| Middle Lithic| 4000 - 1000 B.C.| Expanding stem dart points, hammerstones, pitted stones, unstemmed bifaces }
Late Lithic  1000 - 200 B.C.  Parallel and contracting stem dart points, unstemmed biface failures, pitted stones, retouched flakes

Early Ceramic  200 B.C. - A.D. 900  Sandy paste ceramics, dart points (contracting and parallel stemmed), retouched flakes, possibly parallel stemmed arrow points near the end of the period

Late Ceramic  A.D. 900 - A.D. 1700  Sandy paste, bone-tempered, and grog-tempered ceramics, contracting stemmed arrow points, flake blades, and retouched flakes

Table 4. Diagnostic Projectile Points of the Lithic Period

<table>
<thead>
<tr>
<th>Period</th>
<th>Point Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Lithic</td>
<td><em>San Patrice, Meserve, Lerma, and Plainview golindrina</em></td>
</tr>
<tr>
<td>Middle Lithic</td>
<td><em>Wells, Morrill, Calf Creek, and Bulverde-like dart points (all associated with the atlatl)</em></td>
</tr>
<tr>
<td>Late Lithic</td>
<td><em>Gary, Kent, and Palmillas</em></td>
</tr>
</tbody>
</table>

Shafer considers only the Late Lithic, Early Ceramic, and Late Ceramic periods as reasonably well defined in Southeast Texas. Definition of the Late Lithic is based principally on inland sites, since preceramic coastal middens produce few lithics. Sites of the Late Lithic period are common “on the sandy knolls and other higher areas along
major rivers and their tributaries in Southeast Texas” (Shafer et al. 1975:16). He believes the abundance of Late Lithic sites may indicate:

1. substantial population increase;
2. greatly increased mobility; and/or
3. the time span estimated for the period is too short.

Walnut shells, deer, turtle, beaver, and possibly bison remains were recovered from Late Lithic sites at Lake Conroe. Burned rock is common at inland sites of the period. Sites nearer the coast, where rock is scarce, exhibit fired clay balls late in the period. Social units operating at the time are suggested to be minimal on the evidence of small campsites and the unspecialized tool kit.

Shafer (1975:19-20) views the introduction of pottery in the Early Ceramic as having little effect on the lifeways of prehistoric residents of Southeast Texas. He regards the dominant pottery as “clearly the product of an indigenous ceramic tradition probably born out of Tchefuncte but following its own development separate from that of the Lower Mississippi Valley.”

In contrast, Shafer (1975:20) feels that during the Late Ceramic Period, the “appearance of several material traits about A.D. 900 suggests a widening interaction between populations in East Texas.” Examples of these traits include changes in the lithic technology accommodating the use of the bow and arrow and the appearance of Caddoan ceramic types in assemblages still dominated by sandy paste wares. While these Caddo ceramics have been recovered as far south as Lake Conroe and Lake Livingston, not one was found during the Cypress Creek survey (Freeman and Hale 1978) or at sites
in the Trinity River Delta discussed by Aten (1979, 1983b). Confirmed Caddo or Caddo-like ceramics have, however, been recovered by this investigator (Moore 1989b) at the Kingwood site (41HR616) situated on the West Fork of the San Jacinto River downstream from the Spring Creek confluence.

The settlement pattern remained essentially the same as for the Early Ceramic period, though Shafer believes some evidence exists for more permanent residence on Lake Conroe. He links the Late Ceramic populations of Southeast Texas to the historic Atakapans. On the basis of continuity in material traits, Shafer (1975:273) considers the Atakapan groups to represent the “historic survival of Woodland culture in East Texas.”

We may now turn to a somewhat contrasting view of Southeast Texas prehistory, one written from a coastal perspective by Aten (1979, 1983b). Aten asserts that the Upper Texas Coast region has broad archeological importance because (1) it is an area of dynamic surface geology which constitutes an excellent laboratory to study culture-environment interactions; (2) it is peripheral to ranked societies of Caddo culture in northeast Texas and of the Lower Mississippi Valley and is a good place to study the relationships between these ranked societies and their marginal hinterlands. Aten seeks to develop a nested, hierarchical system of models (definition of model: simplified representations of reality having three properties: scale, resolution and degree of simplification [13]) which encompass the basic elements of the cultural system: population, a structure relating elements of the population, a material technology to articulate this structure to its environments, and a means of transmitting information through this structure. Aten's (1983b:14) basic objectives are: (1) description of the characteristics of native groups in the Study Area; (2) determination of how to differentiate among the various archeological remains in the Study Area; and, (3)
unification of the ethnohistoric and archeological data into a more integrated system of models about the indigenous cultures of the Study Area. The approach to achieve his objectives includes: (1) recognition first of a social structure; (2) identification of the spatial scales at which the social structure operates; (3) correlation of artifacts, artifact associations, and other behavioral phenomena (e.g., habitation seasonality) with these spatial scales; (4) postulation of organizational characteristics at each of these scale levels; and, (5) descriptions of historical vectors of change in these levels.

Aten outlines continuing problems in coastal research covering the “Early Cultures” periods (Paleo-Indian through Late Prehistoric-Woodland). He suggests that a framework correlating cultural patterns with changes in geomorphology and climate is preferable, especially considering the directly dependent relationship between natural environment and many cultural sub-systems such as settlement and subsistence of this period (Aten 1983b:142-144):

Linking the conceptual frameworks for these two environments together, especially when understanding of the cultural environment is so primitive, provides at least a preliminary basis for deriving useful and testable hypotheses about both. This strategy is made even more necessary because the cultural chronologies thus far developed to make operational the Paleo-Indian and Archaic stages in the Texas coast are based on putative correlations with poorly dated artifact sequences elsewhere, and have almost no spatial significance at a scale facilitating regional research. At the same time, the late Quaternary geological history of the upper coast ... makes clear that many sequential sedimentary deposits and
landforms are laterally offset rather than just superimposed. Because of this relationship, the geological stratigraphy and morphostratigraphy provides both a chronological and a spatial organizing framework for the area based on field interpretations that lead directly to interpretation of ancient geography, climates, habitats, and archaeological data.

He then proceeds to draw up an intriguing, preliminary series of associations between ancient landforms and sites of probable Late Wisconsin-Early Holocene, Middle Holocene, and Late Holocene ages and provides suggestions to direct further work.

Aten's local, post-Archaic chronologies are based principally on ceramic seriation, with his Galveston Bay chronology verified by more than 60 radiocarbon dates. The ceramic periods he defines are "not intended to describe anything more than an assemblage of ceramic types, varieties, or attributes" (Aten 1979:384).

The Aten ceramic chronology for the Galveston Bay/Trinity River Delta consists of the following periods (Aten 1979:404-410; 1983b:287-289):

1. Clear lake Period (A.D. 100-425): This first ceramic period exhibits a greater variety of ceramic classes than any subsequent period. It is characterized by the presence of several types and varieties associated with the Tchefuncte of southern Louisiana (e.g. Tchefuncte Plain, Tchefuncte-style rocker stamping) in addition to early phases of Goose Creek types. The early portion of the period is dominated by Mandeville Plain, with subsidiary classes of Goose Creek Plain,
Tchefuncte Plain, and O'Neil Plain, variety Conway. In the Late
Clear Lake times, Goose Creek Plain (variety unspecified) is the most
frequent class, with secondary occurrences of Goose Creek Incised,
Goose Creek Stamped, and Tchefuncte Plain.

2. Mayes Island Period (A.D. 425-650): This period is characterized by
very little diversity in ceramic classes, in direct contrast to the
preceding period. The Mayes Island ceramic assemblage consisted
almost entirely of Goose Creek Plain (variety unspecified), with
occasional occurrences of Goose Creek Incised and Goose Creek
Red-Filmed.

3. Turtle Bay Period (A.D. 650-1000): While Goose Creek Plain
remains dominant, this period is “notable for a resurgence in Goose
Creek Red-Filmed and especially for the elaboration of design motifs
on Goose Creek Incised (Aten 1979:406).

4. Round Lake Period (A.D. 1000-1350): This period is “marked by [in
the Galveston Bay/Trinity River Delta area] the initial appearance of
grog-tempered ceramics and by the relatively rapid decline to near
extinction of the sandy paste wares (Aten 1979:406). By the end of
the period, Baytown Plain, variety Phoenix Lake is dominant.
Secondary classes include Goose Creek Plain, variety unspecified,
Goose Creek Incised, Goose Creek Red-Filmed, San Jacinto Incised,
variety Jamison, and variety Spindletop, and a few bone-tempered
sherds.

5. Old River Period (A.D. 1350-1700): While Baytown Plain, variety
Phoenix Lake remains dominant early in the period, Goose Creek
Plain, Goose Creek Incised, and Goose Creek Red-Filmed resurge,
with Goose Creek Plain once again dominant by the end of the period. Grog-tempered wares decline, and bone-tempered ceramics become well-established. Since the period overlaps the protohistoric interval in the Galveston Bay area, the possibility exists that historic material may be recovered from late Old River sites.

6. Orcoquisac Period (A.D. 1700-1810) The period of initial Euro-American settlement is characterized by the near extinction of grog-tempered wares and declines in all classes of ceramics except Goose Creek Plain. European trade goods can be expected at most sites of the period.

Story et al. (1990:166) regard Aten’s ceramic periods sequence as “the best defined and dated” in her broad gulf coastal plain region.

In addition to his chronology defined exclusively on the basis of ceramic assemblages, Aten (1979:425-456) has compiled a history of technological change on the Upper Texas Coast. He believes that ceramics first appeared in the Galveston Bay Area by A.D. 100 and had spread as far north as the Conroe-Livingston area by A.D. 500. He further perceives the following sequential changes in ceramic technology in the region (Aten 1979:426):

1. temperless wares (Tchefuncte, Mandeville, Goose Creek);
2. tempered wares:
   a. sand (Alexander, O’Neal);
   b. grog (Baytown);
   c. bone (Leon).
Aten notes that intentional shell tempering is unknown on the Texas coast and is convinced that Galveston ceramics share origins with the Lower Mississippi Valley and the Louisiana coast. One additional note is in order regarding the chronological significance of changes in ceramic attributes: ceramic analysts Frank Winchell and Linda Wootan Ellis have found indications that—at least for inland sites—surface treatment may be a chronologically significant ceramic attribute at the Alabonson Road (Ensor and Carlson 1991) and 41HR616 (Moore 1989b) sites.

Aten marks the appearance of arrow points in the Galveston Bay area to during the Mayes Island Period (A.D. 425-650). While the appearance of arrow points in the Conroe-Livingston area is about contemporary with their appearance at Galveston Bay, dart points are no longer made in the Bay area after the end of the Clear Lake Period (A.D. 425). In contrast, they continue to be produced at the Inland Conroe-Livingston sites.

Aten (1979:Figure 52; 1983b:Figure 3.1) produced a carefully reconstructed map of the locations of aboriginal groups in early Historic times. He then compared it to a series of plots of the occurrences of certain artifact categories. Correspondence of attributes and ethnohistorically known group territories led him to the tentative conclusion that these boundaries were in existence by the middle of the first millennium A.D. Aten identifies the Akokisa as the prehistoric inhabitants of the Galveston Bay area with proto-Akokisa and Akokisa territory further encompassing the current Study Area.
Aten (1979:470-474) perceives five important phases in the development of the proto-Akokisa and Akokisa people's occupation of the upper Texas coast subsequent to the beginning of the Late Archaic and the initial exploitation of littoral resources:

1. No major technological changes took place prior to A.D. 100.

2. The period from A.D. 100 to about A.D. 800 "contains major changes in technology and mortuary practices which imply significant changes in subsistence, cognition, and possibly social organization" (Aten 1979:471). This is the period in which Aten's polythetic sets of artifact distribution begin to parallel historic Akokisa tribal boundaries. Among the important technological changes are the introduction of ceramics, the initial use of the bow and arrow, and the probable usage of tidal fish weirs. Aten suggests that the latter changes mark a shift in subsistence emphasis "from exclusively larger animals to a wider range of species and smaller individual body sizes" (Aten 1979:471). The more efficient adaptation is seen as a response to increasing competition for food, increasingly long stays at particular locations, reduction in the procurement range available at a given location, changes in the division of labor, and changes in the availability of certain food resources (e.g. declining bison availability). The period is also marked by the first visible mortuary practices and the establishment of cemeteries in conjunction with habitation sites, practices seen as ritually reflecting the increasing organization and subdivision of the region and its resources.

3. A.D. 800-1700 is marked by innovation in ceramic design and demographic changes reflected in mortuary data. Late in this time
span (during the Old River Period), usage of the bow and arrow is seen to expand significantly, either in response to the return of the bison to the southern ranges or (very late in the period) in response to the European fur trade.

4. A.D. 1700-1750 was the brief period in which the fur trade, the mission system, and European diseases began to seriously disrupt native Akokisa patterns.

5. A.D. 1750-1820 marks the Akokisa period of decline and extinction.
5. Ethnohistoric Review

Sources of information on the Indians of southeast Texas are quite limited. Before the arrival of the Spanish major portions of the southeast Texas Study Area region were sparsely settled by the Akokisa, also referred to as the Orcoquisa, Arkokisa and Orcoquiza. They spoke Atakapan, a southeastern Indian language family of the Tunican stock, and were related to the nearby Patri, Bedais, and Atakapa proper groups (Newcomb 1961: 316). Spanish army officer Joaquin Orobio Bazterra estimated their population as 300 families in five villages in 1747; estimates spanning the same period by de Bellisle, La Harpe and Sibley ranged more on the order of 200 to 300 persons (Swanton 1979: 86). Aten (1983b:63) carefully estimates their population from an examination of various ethnohistoric sources as between 1333-2000 individuals in A.D. 1700. Patterson (1993c) has attempted to calculate relative inland population sizes from Paleoindian to Late Prehistoric times based on archeological site frequency data alone.

The historic Akokisa have been demonstrated to move in a yearly round from small, dispersed “band-sized or less groups during the warm seasons” to aggregated villages during the colder months (Aten 1979:466; Newcomb 1961). At least some of the Akokisa lived in family groups and fished along the upper of reaches of Galveston Bay in the summer. As winter approached, they have been reported to retreat to the interior and congregated in loosely organized, semi-permanent villages under a single headman or chief (Bolton 1970: 333-335; Aten 1983b: 36). (Just how far to the interior the coastal population retreated and whether there was a permanently inland residential population is a topic of debate which will be considered at further length below.) The tribe, for the Atakapa, Bedais and Akokisa, consisted of a group of affiliated villages sharing language, customs and a common territory (Aten 1983b; Ricklis 1994). Aten
suggests, based on Atakapan data, that the concept of tribal identity was strengthened by
virilocal band exogamy.

Aten (1983b:Figure 3.1) has tentatively reconstructed the boundaries and size of the
territory occupied by the Akokisa. The eastern portions of the Buffalo Bayou and
Spring and Cypress creeks drainage are within the northern segment of the territory,
purported to be occupied during the winter months. The western balance of the
drainages as well as portions of Oyster Creek and the Brazos River fall within a "Buffer
Zone" between the Akokisa and the Tonkawa territories according to the Aten depiction.

Europeans may have traversed the Study Area and encountered its indigenous
population on two occasions in the 16th and 17th centuries. Cabeza de Vaca may have
encountered the Akokisa when he was shipwrecked on the coast at Galveston in 1528.
La Salle's party camped at the head waters of Cypress Creek (near the present day town
of Hockley) and crossed Spring Creek, which he called the d'Eure River, on February 12,

De Vaca and his companions from the Navvaro Expedition were shipwrecked on the Isla
de Malhado, which may or may not be Galveston island but was certainly on the upper
Texas coast, in 1528 (Aten 1983b:25; Bandelier 1905; Covey, 1961; Ricklis 1994).
There he encountered two Indian groups, the Capoque and the Han. Aten (1983b:34-
35) makes the case that the Capoque were the Coco, a Karankawan group, and that the
Han were Akokisas.

De Vaca indicated that the Indians stayed on the Isla de Malhado stayed on the island
from October through the end of February, subsiding on fish caught in weirs and on
roots of water plants. They then moved mainland in order "to gather shellfish, berries, and, though not specifically mentioned, doubtless to hunt as well" (Ricklis 1994:26).

The residents of the Isla de Malhado had "no other weapons than bows and arrows with which they were most dexterous." (Bandelier 1905:65). Lodges consisted of mat-covered huts which could be quickly erected and dismantled but offered little protection against the elements.

De Vaca engaged in work as a healer and a trader between Indian groups while in southeast Texas, occupations which carried him from Galveston perhaps even to Oklahoma. He and a black companion, Esteban, eventually made their way back to Mexico in 1536 after eight years of wandering within the southwest.

While Swanton (1979), Newcomb (1961), and Aten (1983b:25) accept that Cabeza de Vaca spent some portion of his time in southeast Texas with the Akokisa, Freeman cites de Bellisle's captivity among the Akokisa in 1719 as the first significant European entry into the inland Study Area region, as well as the first source of reliable ethnographic data on the Akokisa (Freeman and Hale 1978:119). Simars de Bellisle, a French officer, landed at Galveston Bay with four companions. They were part of the crew of a ship that intended to land in Louisiana; however, the craft ran aground in Galveston Bay and de Bellisle's party went ashore to either help guide the ship or to forage for food. Undoubtedly much to their chagrin, they were inexplicably deserted on the beach and left to fend for themselves.

The five men began to search for a navigable river or a penetrable prairie and eventually reached the San Jacinto River (Freeman and Hale 1978:119). During the course of this
trek de Bellisle's four companions died and shortly thereafter de Bellisle sighted Indians on an island in Galveston Bay. He met them and while they took his clothing, they did deign to fed him. He joined the band as a glorified servant and, as his attempts to contact European settlements failed, accompanied them on their migrations.

Some time later he was rescued with the assistance of the Hasinai Indians and made his way to New Orleans. His saga was verified when he returned to Galveston Bay in 1721 and he was recognized by the local Indians. While there is no way to be certain of the specific areas visited by Bellisle, his accounts of his adventure among the Indians are considered indicative of the day to day life of the Akokisa.

Bellisle indicates that the Akokisa were a migratory group whose life was dominated by the seasons and a constant search for food. They wintered in camps and spent the summers on the coast hunting, fishing and gathering. No mention is made of their dwellings but they did have canoes and hunted with bows and arrows. While it is possible that they may have grown a little maize, according to Newcomb (1961:323), the captive Simars de Bellisle "stated specifically that the Akokisa did not raise any crops." Newcomb (1961:317) characterizes these people as "hunters, gatherers, and fishermen, making use of deer, bison, antelope, shellfish, and other wild foods." Bellisle states that "I passed the entire summer with them in this country with them going everywhere in search of food because they possess no cabins or fields. That is why they travel in this manner the entire summer. The men kill a few deer and a few buffaloes and the women search for wild potatoes" (Folmer 1940:216).

Ricklis (1994:41) notes that the Spanish explorer Oborio y Bazterra reports that by 1748 the Akokisa on Trinity Bay had small plots of corn and vegetables under cultivation. He
raises the question as to whether this apparent subsistence shift might indicate a change in the lifeway of the indigenous people described by de Vaca and de Bellisle, or whether it might represent that "a culturally somewhat different group is represented." His skeletal data from the Mitchell Ridge Site on Galveston indicates that the former is more likely the case, as there is considerable dietary evidence for a substantial subsistence shift among the indigenous population during the first half of the eighteenth century.

The arrival of winter marked by the aggregation of these minimal bands into larger groups. "When the winter came we all left [the area of summer activities] to join a band of their people who were waiting for us at the end of the bay. We arrived there at the end of seven or eight days" (Folmer 1940:217). Ricklis (1994:31) asserts that the meeting on the bayshore suggests "a shift from the summer reliance on mobile hunting to a winter emphasis on estuarine resources."

Akokisa hunting and war parties made sorties westward from their winter village bases (Folmer 1940:218-220; Newcomb 1961:323; Aten 1979:72). Ricklis (1994:31) notes that winter hunting was thus "not within the context of the entire socioeconomic band, as seems to be implied for the summer. Rather, it was an activity carried out by male hunting parties which set out with the specific goal of procuring meat and then transporting it back to the larger group." Late in the period the Akokisa hunted deer, buffalo and bear and in order to the pelts with the French traders, notably Joseph Blancpain, who came west from New Orleans. (Freeman and Hale 1978: 119-122). De Bellisle's account of the eating of a victim of such a war party is accepted by Newcomb (1961:327) as proof of Akokisa cannibalism.
The initial period of Euro-American settlement of the Study Area (1719-1820) is characterized by sporadic incursions of French and Spanish representatives, aimed at establishing trade with the native populations and securing the territorial claims of European colonial powers. With the founding of New Orleans in 1718, the French presence in Texas became more pronounced as the traders moved in and by 1730 regular routes were established. This presence was not lost on the Spanish who also felt they had a claim on the land. Expeditions were sent forth, the first in 1745-1746 headed by Joaquin Orobio y Bazterra. In March of 1746 he established a camp, Puesto de San Rafael, at what was most likely Spring Creek, a tributary of the West Fork of the San Jacinto River. Eventually a mission, San Agustín de Ahumada, was established near present day Anahuac and the mouth of the Trinity River. The mission, built in 1756, was not successful; the Indians were too scattered and the climate and mosquitoes too inhospitable for the Spaniards. Heeding their complaints, Governor Jacinto deBarrios ordered surveys for the founding of a new mission near Spring Creek, northeast of present day Tomball. However, the relocation of the mission never took place (Freeman and Hale 1978:123; American Association of University Women 1977: 6-7).

By 1756 the Spanish had succeeded in establishing the Atascosito Trail which ran from south Texas to Louisiana. It served as a landmark for Spanish and Mexican landgrants and traversed north Harris County from south of the present city of Tomball to cross the San Jacinto River east of the town of Humble (American Association of University Women 1977: 6).

The western San Jacinto River watershed, including Buffalo Bayou, Spring and Cypress creeks emerges as important to our understanding of the inland historic Akokisa Indians and to the Spanish colonial presence in Southeast Texas (Bolton 1970:332), having by
careful study identified Spring Creek (a tributary of the West Fork of the San Jacinto) as the Arroyo Santa Rosa de Alcazar of 18th century Spanish records, describes this region as "the center of population of the Orocoquizac (Akokisa) tribe" and the location of three of their four or five villages. The village of Chief Canos was located within a gunshot of the confluence of Spring Creek with the San Jacinto; Chief El Gordo’s village was perhaps 20 miles upstream at the junction of two small branches and somewhere "above" this point was the village of Mateo.

While the Spanish had been present at Nacogdoches and actively missionizing Indians for some time by the mid-18th century, the Spanish authorities had ignored the lower Trinity and San Jacinto watersheds and were in fact surprisingly ignorant of the geography and inhabitants of the region (Bolton 1970). Freeman (Freeman and Hale 1978) cites De Bellisle’s captivity among the Akokisa in 1719 as the first significant European entry into the Study Area region. Bellisle’s accidental foray among the Akokisa was followed, beginning in 1729 or earlier, by Blancpain’s initiative at establishing a fur trading relationship between the French and the natives. The Spanish only began to investigate the area when it became apparent that their territorial prerogatives were being encroached upon by these French traders operating out of Louisiana.

This French initiative prompted a Spanish response to secure the territory and its inhabitants for the Spanish crown (Bolton 1970:332-374). The Spanish fielded an expedition under Joaquin Oborio y Bazterra in 1745-1746 to search for evidence of French trade and habitation. He traveled from Nacogdoches via the Bidais Trail, establishing a camp called Puesto de San Rafel, probably located on Spring Creek at the village of El Gordo ("The Fat"). After the arrest of French trader Blancpain in 1754, the Spanish proposed to establish a mission, the Villa Santa Rosa de Alcazar, at El Gordo’s
village. The Spanish authorities dithered, however, and the mission was never constructed.

Bolton (1970:350) places the village of El Gordo at the juncture of Mill Creek and Decker Brook. Alternately, however, local tradition maintains that this important historic Akokisa village site, the proposed location of Puesto de San Rafael and the never-constructed Santa Rosa de Alcazar mission, was located at a topographic feature designated as "Indian Hills" (American Association of University Women 1977:6-7, "Points of Interest Map"). There is no site currently on record at or near this location which could conceivably be the purported major Akokisa village. A 1981 survey of an undeveloped portion of The Woodlands located only small, temporary campsites on the north (Montgomery County) side of Spring Creek in the vicinity of Indian Hills (Greiner Engineering Sciences, Inc. 1981; TARL files [sites 41MQ64 through 41MQ69]).

Site 41MQ44, at Bolton's suggested location at the confluence of Decker and Mill creeks to form Spring Creek, has been proposed as an alternative location for El Gordo's village and Santa Rosa de Alcazar. This site may have also been the location of Oborio Bazterra's Puesto de San Rafael. Site 41MQ52, located some distance downstream between Cypress Creek and the West Fork of the San Jacinto River, has been suggested as the location of Cano's village as well as another purported site of Santa Rosa de Alcazar.

The Akokisa are described by Aten (1979, 1983b) as having "passed into oblivion" by 1830; however, research for the Telge Road Park survey (Moore 1992) has disclosed—to our considerable surprise—that oblivion for at least perhaps a few of the Akokisa and/or certainly for the closely related Bidais did not come until well into the 20th
century. A group of Indians which apparently described themselves as Bidais settled near the home of Mathew and Sallie Burnett, the first Anglo settlers on Cypress Creek. And, even more surprisingly, oral evidence indicates that this group of Indians remained in the locality until well into the 20th century.

The Bidais, an Atakapan group closely related to the Akokisa, lived along the Trinity River north of Livingston in protohistoric times (Aten 1983b:37-38). We can surmise that the group of Indians reported dwelling on Cypress Creek and vicinity during the 19th century was a composite band of Akokisa and Bidais that formed after the drastic population declines of the 18th and early 19th centuries as reported by Aten (1983b:320). While the group referred to itself, or was referred to by the Anglos, as Bidais, it is assumed that the group may have, at least in part, consisted of Akokisa, since the village was within the Akokisa area. In any event, since the Bedais are a Mossy Grove group with clear linguistic and cultural affinities to the Akokisa, any new ethnohistorical information regarding them is relevant to this investigation.

Mathew Burnett established the first Anglo homestead on Cypress Creek at its crossing by the Old Washington Road in 1836. By this time the Indian group referred to above was resident along Cypress Creek within his land grant. The Burnetts maintained cordial relations with these Indians, and in fact were indebted to them for their lives when the Bedais fended off a threat to the family by raiding Comanches affiliated with the Mexicans during the Texas Revolution (Moore 1992:Appendix II). It is fortunate that Rebecca Burnett Lee, a daughter of Mathew, composed a recollection of her early life on this homestead before her death in 1926. Portions of this manuscript deal with the family's Bedais neighbors and are summarized below.
Burnett describes the Bedais settlement as a "little wigwam town" presided over by "the chief of this division [of the Bedais]... Francisco." His division usually (or previously) resided further north in Harris County and perhaps in Montgomery County, undoubtedly along Spring Creek. Thus, we may hypothesize that the group is descendent from one of the Spring Creek villages mentioned earlier. Anecdotal ethnographic information in Rebecca Burnett's manuscript includes the following:

1. There is an account of a Bedais dance. A pavilion of bark was erected and Chief Francisco played the musical accompaniment on an instrument consisting of stretched alligator hide over which a small stone was rubbed, producing a "honk-honk" sound. A song was sung which Mrs. Lee transcribed as "something like 'Ki-yo-bully-kay-ya'" (Moore 1992:110).

2. Mortuary customs are recounted in the funeral of a woman. Her remains were cremated and Mrs. Lee describes cremation as the customary means of disposal of the dead for the Bedais. The woman's bones were later scraped up into a small mound.

3. The production of a bread known as Pontuck is described. The bread was made from the root of a wild plant, most likely of the Similex plant (see Plant Economies, Appendix II). A woman "would chip up this root with hatchets. Two holes were then dug in a moist place, one a little higher than the other, and a bunch of moss placed between them. The chipped particles were placed in the higher hole. The woman would work them up, throw off the coarser particles, and
allow the finer to filter through the moss, settling in the lower place. Later it was dipped up to be cooked. This wild root, if treated under scientific processes, would probably furnish the most delicious kind of bread" (Moore 1992:110).

In addition, the reference to Francisco as the chief of a "division" of the Bedais implies that the tribal division into aggregated maximal band villages, each affiliated with a headman, was still functional in 1836.

Rather amazingly, Mr. Chester Telge of the German family which bought the land including the Indian settlement from the Burnettts in the late 1850's, related (without prompting) that Indians resided on the property until a time after his birth in 1918. It is not presumptuous to assume that these Indians represent the surviving members of the group described by Mrs. Lee. The Indians were described as living in hide tents on floodplain pimple mounds, certainly a continuation of a very old settlement pattern in the region. They still spoke their native language among themselves and were described as a friendly people who maintained the same good relations with the Telges as they had with the Burnettts before them. Mr. Telge related that his father and grandfather gave them beef and hides periodically and went on to cite a fascinating incident of reciprocity; on baking day his grandmother would wrap up a large loaf of bread and leave it on the back porch. By sundown, it would have been exchanged by the Indians for a large catfish. Mr. Telge stated that fish were, in fact, a major portion of their diet.

The Indians who died were buried in the mounds, in contrast to Mrs. Lee's cremation account. The end of the Bedais occupation was marked by the day in the early 1920's that the loaf of bread remained on the porch past sundown. Chester's grandmother
brought the bread back into the house, announcing in German that "The Indians are no more." The last survivor, an old man, had apparently wandered off never to return.

External Relations and Trade

Aten draws a distinction between indigenous exchange relationships and those which were introduced by European traders early in the eighteenth century (Aten 1983b:83):

The upper Texas coast has been considered essentially as a unit from which materials were imported and into which other materials were imported. For prehistoric and protohistoric aboriginal exchange, these 'external' relationships were primarily with inland areas; for the historic period, we cannot exclude considering that precontact patterns of aboriginal exchange still persisted, but so far as the available data are concerned, the very active European trade has obscured any view of them except for the single report of Lake Charles Atakapa trade by Dyer.

Aten posits two probable prehistoric exchange mechanisms: 1) a person-to-person chain-like exchange; and, 2) through the activities of roving traders. Cabeza de Vaca functioned as one such trader for part of his time among the aboriginal inhabitants of Texas (Covey 1961:66-67):

My principal wares were cones and other pieces of sea snail, conchs used for cutting, sea-beads, and a fruit like a bean [from mesquite trees] which the Indians value very highly, using it for a medicine and for a ritual beverage for their dances and festivals. This is the sort of thing I carried
inland. By barter I got and brought back to the coast skins, red ochre
which they rub on their faces, hard canes for arrows, flint for arrowheads,
with sinews and cement to attach them, and tassels of deer hair which
they dye red.

Aten has summarized ethnohistorical records regarding aboriginal trade items (Aten
1983b:Table 84). This compendium is recapitulated as Table 5 below.

Table 5. Contents of Aboriginal and Historic Exchange-Trade.

<table>
<thead>
<tr>
<th>Aboriginal Exchange</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exports</strong></td>
<td></td>
</tr>
<tr>
<td>Subsistence:</td>
<td></td>
</tr>
<tr>
<td>Dried, smoked fish</td>
<td>Maize</td>
</tr>
<tr>
<td><strong>Utilitarian:</strong></td>
<td></td>
</tr>
<tr>
<td>Seaweed (medicinal)</td>
<td>Lithic materials</td>
</tr>
<tr>
<td></td>
<td>Canes</td>
</tr>
<tr>
<td></td>
<td>Sinews</td>
</tr>
<tr>
<td></td>
<td>Cement</td>
</tr>
<tr>
<td></td>
<td>Skins (deer, bison, bear)</td>
</tr>
<tr>
<td></td>
<td>Ceramics</td>
</tr>
<tr>
<td></td>
<td>Sandstone for abraiders, net weights, and small manos and metates</td>
</tr>
<tr>
<td><strong>Symbolic or ornamental:</strong></td>
<td></td>
</tr>
<tr>
<td>Olive shell tinklers</td>
<td>Red ocher</td>
</tr>
<tr>
<td>Columella beads</td>
<td>Deer hair tassels</td>
</tr>
<tr>
<td>Columella pendants</td>
<td>Ground stone beads or</td>
</tr>
</tbody>
</table>
Shark teeth
Bird feathers (heron, crane, pelican, wild geese)

Historic Trade

<table>
<thead>
<tr>
<th>Exports</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early:</td>
<td></td>
</tr>
<tr>
<td>Skins (deer, bison)</td>
<td>Trade beads, &quot;trinkets&quot;</td>
</tr>
<tr>
<td>Animal fat</td>
<td>Firearms</td>
</tr>
<tr>
<td>Horses</td>
<td>Clothing</td>
</tr>
<tr>
<td>Corn (Bedais only)</td>
<td>Tobacco</td>
</tr>
<tr>
<td>Late - circa 1810:</td>
<td></td>
</tr>
<tr>
<td>Dried, smoked fish</td>
<td>Miscellaneous goods from captured vessels</td>
</tr>
<tr>
<td>Spanish moss (bedding)</td>
<td>Flint and chert nodules for the Flakannawa &quot;market&quot;</td>
</tr>
<tr>
<td>the</td>
<td></td>
</tr>
<tr>
<td>Flint and chert nodules from Atakapa for retrade</td>
<td></td>
</tr>
<tr>
<td>to the Karankawa</td>
<td></td>
</tr>
</tbody>
</table>

Aten (1983b:85) hypothesizes that Akokisa exchange would have taken place in a manner consistent with that modeled by Rappaport for the Maring of New Guinea. In this model if an exchange system revolves principally around items which are crucial for survival, then a "serious inconvenience" will result if either of the trading partners fail to produce an item needed by the other side. Rappaport's perceived solution to this problem is to broaden the exchange to include nonutilitarian items which have the same exchange value. This diversification creates the probability that one side will always have something that the other side needs. Aten reports that much of the exports from
the coast consisted of such nonutilitarian items in exchange principally for utilitarian inland goods.

Aten (1983b:86-88; Figure 5.1) applies Sahlin's (1965) model of reciprocity to the prehistoric and protohistoric Akokisa:

1. 'generalized reciprocity' to denote "transactions in which there is no necessary expectation of return." Generalized reciprocity consists of the one-way exchange of foodstuffs within a close kin group.

2. 'balanced reciprocity' to denote "a direct exchange - value for value, more or less." This quid pro quo exchange demands two-way exchange in order to be maintained, and slight inequities in the values of materials exchanged between groups "are a prime mover in maintenance of the relationship by causing subsequent exchanges." These transactions more typically involve the exchange of goods and marital arrangements than foods.

3. 'negative reciprocity' to denote "that conducted in the presence of the most distant kin or when [kinship] relations are absent." These transactions range from sociable commercial exchange to outright theft. The appropriate "reciprocation ranges from cleverness or skill in bargaining to mounting counterforce measures."

In terms of our Akokisa social units, Aten expects that generalized reciprocity is confined to the family and the minimal band, while balanced reciprocity is characteristic
of relations between maximal bands (villages) and with related tribes. All 'foreigners' (including Europeans) are subject to negative reciprocity. Thus, exchange relationships form a continuum with one's family members at one end and unrelated tribes at the other. Aten uses these expectations, combined with his reconstruction of tribal locations, to produce a schematic contour map of exchange expectations (Aten 1983:Figure 5.1b)

"In this schematic representation, which is really little more than an application of Sahlin's concentric model (Sahlins 1965:154), it is shown that generalized reciprocity occurs within numerous local centers. As kinship distance (a de facto function of geographic distance in our model) increases, a gradual shift away from generalized reciprocity takes place. The rate of falloff in this is related to group social relations in the larger environment" (Aten 1983b:87).

It is interesting to note that Aten, in his Figure 5.1b, without explanation includes the Coco in the isopleth defining balanced reciprocity, as with related tribes. The depiction of the Coco as a related tribe is ostensibly problematical, since Aten as well as several others have classified the Coco as a Karankawan (rather than Atakapan) subgroup. The issue - as I recognize it - of the Coco and their inland neighbors will be discussed at the conclusion of this chapter.

The scope of exchange with Europeans was considerably narrowed - at least in regard to exports. The Indians provided principally subsistence items for colonists and the skins in demand for the fur trade. Aten emphasizes the impact of the fur trade, noting that the French trader Joseph Blancpain had 2300 deer hides in his possession at the time of his 1747 arrest.
Ricklis (1994) has conducted a survey of French efforts at Indian trade in Louisiana and Texas as a portion of the background investigations for a report on the Mitchell Ridge Site on Galveston Island. This trade took two forms: that conducted from formal trading posts and that carried out by backwoodsmen (couriers de bois) who lived with the Indians, adopted native ways and often married Indian women. It is apparent that most of the fairly significant degree of French trade with the Akokisa and especially their Bedais brethren was carried out by these couriers de bois, of whose number Blanpain may be counted.

Word of these traders reached Spanish ears and, as mentioned earlier, the Spanish authorities dispatched an expedition headed by Joaquin Orobio y Bazterra in 1745-1746. His group traveled to Bedais country on the Trinity River some distance above Galveston Bay. There he found seven Bedais rancherias or villages of bearskin tents (their regular winter dwellings according to Bolton [1970:330]) and conferred with a chief on French activities in the region. He was told that:

every year the French came with guns, cloth, knives and other goods used by the Indians; that some of the French usually came along the seacoast in canoes and entered either the Trinity River, the Neches, or the Brazos de Dios [Brazos River]; and that other Frenchmen, who had settled six years ago, more or less, within the boundaries of the Pachina nation [almost certainly the Atakapa, according to Ricklis], which extends from the Savinas [Sabine] River to the Mississippi usually come by land as far as the Orcoquisac [Akokisa] nation, which occupies the [region] from the Neches River to halfway between the Most Holy Trinity [River] and the

The chief further related that a group of Akokisa had visited the Bedais last year to announce that the seafaring French planned to build a more formal trading post in the area and bring their families into Akokisa country; the Bedais were invited to come and trade at this facility. Responding to this intelligence and an invitation by a contingent of Akokisa, Orobio y Bazterra went south to two Akokisa villages on Trinity Bay at the mouth of the Trinity River. He learned that the French settlement had not yet been built but that it was expected the following summer. Thus, while the Spanish had had no contact with the Indians of southeast Texas prior to 1745, it is clear that the French had been trading among them regularly since at least 1740. Ricklis (1994:37) speculates that these French contacts could date to considerably earlier since they began trading with the Atakapa in the 1720's.

By 1754 the promised French trading post had indeed materialized, to the consternation of the Spanish. The Spanish secured the support of the Bedais and Akokisa in the effort to dislodge this French occupation by virtue of abundant gifts and the promise of spoils from the trading post. Lieutenant Marcos Ruiz and his party reached the outpost on 10 October 1754, finding crude buildings and a few men under the command of Blancpain. The Frenchmen were arrested and Blancpain was transported to Mexico City for interrogation (where he eventually sickened and died in prison). Before he expired he confessed that a civilian settlement of 50 families was planned for the post site of Orcoquisac, and that the French had been trading among the Akokisa since 1722. Blancpain further provided a very lengthy list of the items for trade in his inventory which Ricklis (1994) recapitulates in his Table 4.2. While Ricklis does not believe that
the Akokisa had become dependent on European goods, he is certain that these goods were in extensive use among the Indians of southeast Texas by the mid-eighteenth century.

As previously related, the Spanish reacted to these incursions with the founding of Presidio San Agustine de Ahumada and the mission Nuestra Señora de la Luz del Orcoquisac at the Trinity Bay village of Orcoquisac in 1756. While never successful and abandoned by 1771, the Spanish outposts certainly served to suppress French trading activities in the area to a certain extent.

The Question of the Coco and Their Neighbors to the North

Aten (1983b) and others identify the coastal Coco, who dwelled immediately southwest of the Akokisa territory along a narrow littoral zone extending from western Galveston Island to Matagorda Bay, as a Karankawan group. While I have been able to find no direct confirmation it is assumed that this attribution is made on a linguistic basis. However, Aten (1983b:290) opines that Goose Creek Plain sandy-paste ceramics are by far the major class of artifacts in this region, which is defined as his Brazos Delta-West Bay subarea. Further, as mentioned previously, he includes the Coco among the groups with which the Akokisa would have carried out balanced exchanges, typical of the relations between related tribes.

Story (Story et al 1990:Figure 39) places both the coastal Coco territory and the adjacent inland region within the Mossy Grove tradition cultural area on the basis of archeological remains, to wit, the sandy-paste Goose Creek pottery which is the defining characteristic of this tradition. The Coco territory coincides with her (and Aten's)
"Brazos Delta-West Bay" subdivision of the coastal Mossy Grove tradition. It is interesting that no investigator seems to question why this ostensibly Karankawan group utilized significant quantities of Goose Creek ceramics rather than exclusively the Rockport series wares that are the principal hallmarks of Karankawan occupation further to the south (c.f. Ricklis 1992). Perhaps the presence of the Goose Creek ceramics is a reflection of the balanced exchange posited by Aten.

It should be noted that there is a dissenter to assigning Karankawan affiliation to the Coco. Gatschet (1891:35) believed that the Coco were affiliated with the Atakapa. This assertion may be based in part on accounts that state that a Cocos group was living with the Atakapa in Louisiana in 1820.

Further research, both documentary and archeological, will be necessary to approach a resolution of the correct characterization of the Coco. However, it is clear that if the Coco are Karankawans, they are anomalous Karankawans as reflected in important aspects of their material culture and external relations. One might even suggest, as a working hypothesis, that they were 'Atakapanized' Karankawans.

The historical record unfortunately contains no clear references to the inland Mossy Grove sandy-paste pottery tradition aboriginal groups which occupied the sub-region to the west of the documented Akokisa territory and north of the Coco. This sub-region extends from the western portion of Buffalo Bayou (including the Addicks reservoir sites excavated by Wheat [1953] and 41FB200 discussed in detail in this volume) to the San Bernard River in Wharton and Austin counties. All references to peoples in this area originate in the eighteenth century, when a great deal of movement was taking place in the area due to pressures out of central Texas and when group affiliation was fluid.
Story has assigned the inland sites found around Allens Creek within the sub-region under discussion to the Mossy Grove. Story does, however, say that the assignment of the Allens Creek area (situated at the western edge of the Mossy Grove tradition) "does not come easily. The main concerns are the many traits shared with Late Cultures found to the west, in south-central Texas, and the uncertainty of the geographic extent of the territory exploited by the groups who occasionally camped on Allens Creek" (Story et al 1990:269). Still, Story believes that it is justifiable to include the Late Prehistoric remains of the lower Brazos River (including Allens Creek) given the areal context of her study.

The Mayeye are placed within this sub-region at times, but they have been identified as a central Texas Tonkawan band (Bolton 1970; Newcomb 1961). It is interesting, however, that they came to be affiliated with the Deadose, an Atakapan group which had moved from its east Texas homeland to the Trinity River and hence further west after 1721 (Bolton 1970:144-148). An anonymous eighteenth century Spanish account quoted by Bolton (1970:147) states that the Deadose were "a band of Viday [Bedais] Indians who, being dismembered from its vast body, which has its moveable abode between the Trinity and Sabine rivers, have lived for more than twenty years, for the sake of the trade afforded them by the transit of the Spaniards, on this [western] side of the Trinity River, and, extending as far as Navasotoc [Navasota], ... are accustomed to join the Mayeyes, who reside in the thickets of the Brazos." The same document places the Deadose in a position habitually forty leagues east of the Mayeye.

Whoever the inhabitants of the western portion of the Study Area might have been, it would appear that either the prehistoric extent of the Akokisa has been underestimated
or, more probably, that there may have been an (undoubtedly fluid) ethnic territorial boundary within or near that portion of the Study Area. Interesting archeological questions which might be addressed by the detailed spatial and technologic analyses attempted in this dissertation are posed in either case. Certainly one might attempt to assess the qualitative character of this purported ethnic boundary: are there means to estimate the degree of integration and relatedness and indeed the fundamental validity of a social boundary between these eastern and western peoples?
6. Review and Critique of Relevant Hunter-Gatherer Theory

The theoretical focus of this investigation is, both by circumstance and intention, relatively narrow. I am constrained from the application of Optimal Foraging Theory, for example, by the absence of the necessary background data for this region. A more important constraint, however, is derived from the objectives of this investigation. I seek to examine variability within a hunting and gathering system which can be characterized by long-term stability and superficial homogeneity. It is my conviction that a new perspective on archeological variability within the region may not only extract culturally meaningful variation from the warp and woof of this stability and homogeneity but also approach a more generally applicable explanation for hunter-gatherer persistence against a background of contemporary agricultural peoples.

The avenue of choice to seek culturally meaningful variability is an analysis which examines fine-scale geographical variation in settlement and technological attributes within the inland southeast Texas region. Thus, the investigation is inclined to embrace theoretical perspectives which lend themselves to such an analysis. The general theoretical model best meeting this criteria is Binford's (1980) "Willow Smoke and Dogs Tails" forager-collector continuum; therefor, this model will be discussed in detail.

Further, any analysis of southeast Texas prehistory must deal with pre-existing theoretical constructs for the region and preeminent among these is Aten's (1979, 1983) "Akokisa Model." This model must both be summarized and eventually critiqued in the light of the outcome of the current analysis.
General Hunter-Gatherer Theory

Bettinger (1987, 1991a, 1993) has sought to examine recent contributions to archeological research on hunters and gatherers derived from what he refers to as "theories of limited sets," theories which are not general and abstract but rather are "by design practical and intended for application in the real world: they are theories that have, in archeological parlance, direct test implications" (Bettinger 1987:121). He defines two such limited theories which have dominated archeological studies of hunters and gatherers in the last 15 years: middle-range theory and optimal foraging theory. Prior theories regarding hunters and gatherers include:

1. The long-dominant thesis which cast hunters and gatherers as remnant primitives living at the edge of starvation and disaster;

2. The succeeding neofunctionalist model of "hunter-gatherer as lay ecologist," deriving from a burst of 'Man the Hunter' ethnographic studies in the 1960's and rendering hunter-gatherer behavior as rational and adaptive, group oriented, and homeostatic. This systemic perspective was well-suited to the concurrent growth of the New Archeology but Bettinger essentially dismisses neofunctionalism as a dead-end, excessively vague and impossible to integrate with field observations.

Bettinger contends that archeology fled from the "theoretical disarray of neofunctionalism" by seeking less general theories which could more easily be related to real world archeological observations. A major effort to define such less general and
more specific theories took the form of the tremendous expansion of ethnoarcheological research among living hunter-gatherer groups. These less general theories come under Bettinger's (1987:124) philosophical rubric of "theories of limited sets", which "reconcile general principles to particular cases by showing how such cases result from the general principle in the presence of special conditions." His major complaint with such attempts in hunter-gatherer studies is that he believes they have inappropriately turned archeologists' attentions away from the necessity of developing more general and abstract archeological theories; indeed, he casts the true purpose of theories of limited sets as serving as "either interim steps in the construction of general theories or means of articulating extant general theory" (Bettinger 1987:124).

Principal (at least to this analysis) among Bettinger's theories of limited sets is the middle-range theory of hunter-gatherer subsistence and settlement constituting the forager-collector continuum (Binford 1980). Middle-range theory building has been defined by Thomas (1979:389) as the means "to bridge the gap between the known, observable archeological contexts and the unknown, unobservable systemic context."

Middle-range theory is thus seen as necessary to link the archeological record to the past behavior that created that record. Binford (1977:6) states that middle-range theory seeks to explain

(a) how we get from contemporary [archeological] facts to statements about the past, and (b) how we convert these observationally static facts of the archeological record to statements of dynamics."

Bettinger (1991a:64-65) has provided an apt summary with which to begin our discussion of Binford's model. He characterizes this work as
an elegantly constructed model in which the availability of natural
resources is seen to dictate differing combinations of social, economic and
settlement organization. Together these combinations describe a
continuum of subsistence-settlement systems with highly mobile foragers
at one end and highly sedentary collectors at the other....In the simplest of
terms, Binford explains the difference between foragers and collectors
with reference to variability in the quantity and seasonal distribution of
resources at their disposal. He argues that in environments that are
productive and at the same time spatially and temporally homogeneous
(usually tropical), there are no seasons of relative shortage and hence no
intrinsic need for immediate consumption. Under these conditions, the
organization of subsistence and settlement is extremely simple and
redundant across time and space. Where these conditions do not pertain,
for example, where there are seasonal shortfalls in resources, the
organization of hunter-gatherer subsistence and settlement becomes
increasingly complex as adaptations to these challenges.

Binford's model is seen as critical to the current analysis principally because it presents a
structure for the dissection of the local subsistence-settlement system. The model
provides a theoretical basis for defining distinctions between site types and is
simultaneously compatible with the spatially-oriented components of the Mossy Grove
Model. It further defines material consequences for the archeological record which are
in accord with the level of locally available data.
Binford defines the differences between "mapping on" and "logistics," between foraging and collecting in hunter-gatherer groups. "Foragers move consumers to goods with frequent residential moves, while collectors move goods to consumers with generally fewer residential moves" (Binford 1980:15). Foraging is characterized by seasonal residential moves between resource patches or in largely undifferentiated areas, as within tropical rain forests. Foragers do not store food but "encounter" and gather food daily, bring it back to their residential bases for immediate consumption. Foragers may move frequently but only for short distances within dense resource patches, while they may break up into minimal social units and scatter to exploit larger areas in regions of scarce and dispersed resources. Very mobile foragers would produce sites with little archeological visibility due to their short duration, and scattered but ubiquitous resources would lead to infrequent site reoccupation. In contrast, in areas were critical resources (like waterholes) are limited and dispersed then "tethered nomadism" (sensu Taylor) might result in highly redundant occupations. Specialized work parties such as hunting expeditions may depart residential camps and pursue game via a strategy of encounter.

Binford contends that forager systems are apt to leave only two types of sites: "residential bases" and "locations." The residential base is the "hub of subsistence activities, the locus out of which foraging parties originate and where most processing, manufacturing and maintenance activities take place" (Binford 1980:9). Residential mobility may vary in duration and in spacing between sites as well as in adjustments in group size. Redundancy of occupation via tethering increases archeological visibility through the obvious agency of the cumulative build-up of remains.

A location is defined by Binford (1980:9) as "a place where extractive tasks are exclusively carried out." Since foragers do not tend to store foodstuffs or other raw
materials, the extraction which is carried out at locations can be characterized as "low bulk," producing small quantities of the target resource over brief periods of occupancy. The ephemeral duration of occupancy will result in the exhaustion and discard of few (if any) tools and scattered remains which Binford chooses not to characterize as sites. Redundancy around fixed resources may produce palimpsest aggregations which "look like sites" but lack internal structure and are the product of accretional formation histories.

Binford (1980:9-10) summarizes forager systems as typically having "high residential mobility, low-bulk inputs, and regular daily food procurement strategies. The result is that variability in the contents of residential sites will generally reflect the different seasonal scheduling of activities (if any) and the different duration of occupation. The so-called functionally specific sites [locations] will be relatively few, given low-bulk inputs and short or limited field processing of raw materials such locations will have low visibility" though long periods may result in more discernible palimpsests.

Collecting takes a fundamentally different form: collectors are operate on a logistical basis and this operation is expressed by the formation of specially organized task forces to supply the group with specific resources. "Collectors are characterized by: (1) the storage of food for at least part of the year and (2) logistically organized food-procurement parties" (Binford 1980:10). These procurement parties may leave residential camps to establish special-purpose field camps where (assuming the party was successful in its objective) "the obtained food may be field processed to facilitate transport and then moved to the consumers at the residential base camp" (Binford 1980:10). [see quote 3] Procurement task groups do not go out looking for any kind of resource they might encounter; rather, they have a specific objective and a specific
context in which they expect to find that objective. [A non-food oriented example of such a task force would be a lithic procurement party visiting a distant quarry site in a largely stoneless region like southeast Texas.] This is an important point of distinction from 'pure' foragers, who seek any and all foods on an encounter basis.

In addition to the two forager site types (residential base and location) Binford states that collectors create at least three additional site types: the field camp, the station and the cache. "A field camp is a temporary operational center for a task group. It is where a task group sleeps, eats, and otherwise maintains itself when away from the residential base. Field camps may be expected to be further differentiated according to the nature of the target resources, so we may expect sheep-hunting field camps, caribou-hunting field camps, fishing field camps, etc." (Binford 1980:10). Binford attempts to distinguish (only partially successfully, in my view) field camps from locations by stating that collectors actually procure and process their objectives at locations; he states that these locations are apt to be far more visible archeologically than forager locations since the volume of resource obtained and processed is much higher since it is intended to feed larger populations elsewhere. It seems that the principal distinction between these more visible locations and field camps is the temporary residential status of the latter. Binford notes, however, that logistical functions need not be independently located; rather, archeological variability may be increased by the combinations of logistical functions at the same locality. "The point is simple. the greater the number of generic types of functions a site may serve, the greater the number of possible combinations, and hence the greater the range of intersite variability which we may expect" (Binford 1980:12).

An appropriate example of a combination of functions would be Athabascan salmon run trapping sites, where residential field camps are situated at the water's edge and salmon processing takes place within the confines of the camp.
Stations are defined on the basis of their function as a locus for information-gathering. "Stations may be ambush locations or hunting stands from which hunting strategy may be planned but not necessarily executed. These are particularly characteristic of logistically organized systems, since specific resource targets are generally identified and since for each there is a specific strategy which must be 'informed' as to the behavior of game before it can be executed" (Binford 1980:12). It is my impression that there is an arbitrary element in this definition, since foragers are certainly no less in need of information than their more logistical counterparts; for example, foragers on hunting trips within their territory are quite likely to be aware where good lookout and ambush spots are located and utilize them. Stations may be more critical to a logistic system than to a forager one, but it is hardly unique to the former. Information-gathering sites would, at least for southeast Texas, be a class of sites with only infinitesimal archeological verifiability; every hilltop in the Katy Prairie region could have been a lookout for bison movement (and likely was) but what trace remains of this activity?

Bulk procurement creates the requirement for Binford's third class of logistical sites, the cache: since small work parties acquire and process large quantities of resources for later consumption by a larger group, formal provision must be made either at the collection site or back at the residential base for the long-term storage of these resources. Caches may also consist of stockpiled tools and supplies strategically situated to be available for later use.
Binford makes the important point that in referring to foragers and collectors he is not speaking of:

two polar types of subsistence-settlement systems, instead we are discussing a graded series from simple to complex. Logistically organized systems have all the elements of foraging systems and then some. Being a system, when new organizational properties are added, adjustments are made in the components already present such that residential mobility no longer plays the same roles it did when the system had no logistical component, though important residential moves may still be made. Given basically two strategies, 'mapping on' and 'logistics,' systems that employ both are more complex than those employing only one and accordingly have more implications for variability in the archeological record. It should be clear that, other things being equal, we can expect greater ranges of intersite variability as a function of increases in the logistical components of the subsistence-settlement system (Binford 1980:12; emphasis his).

In an attempt to build an explanation for the subsistence-settlement system variability he has identified Binford then compares the energy and entropy structure of various environments (as conveniently represented by their effective temperature [ET] measures) against ethnographic data on residential mobility. The results of this comparison indicate that mobility is greatest in tropical and arctic settings, where biological productivity is highest and lowest respectively, while the highest degrees of sedentism and semi-sedentism are recorded in the temperate and boreal zones. He suggests that "since mobility is a 'positioning' strategy, it may well be most responsive to structural properties of the environment, that is to say the particulars of food distribution that are not directly
correlated with the more intuitively appreciated conditions of food abundance" (Binford 1980:14). "Mapping on" will work only if all the critical resources can be reached within a convenient foraging radius of a residential base. Collectors adopt logistical strategies to solve problems of spatial incongruities in the distribution of critical resources. "Hunter-gatherers move near one resource (generally the one with the greatest bulk demand) and procure the other resource(s) by means of special work groups who move the resource to consumers" (Binford 1980:15).

Temporal incongruity of resources is solved by the agency of storage but this solution may at the same time increase spatial incongruity: one may have high bulk items stored in one place at the same time that the scheduled availability of another resource favors relocation elsewhere. Binford cites the systemic law of requisite variety as creating the expectation that as environmental challenges in the form of seasonal variability increase, the number of critical resources exploited will multiply in order to maintain homeostasis. Thus the role of logistical mobility will increase proportionately with the increase in seasonal variability.

It seems to me, however, that one can keep the explanation on simpler terms: the lesser the extent that critical resources overlap temporally, the more one must respond to these scheduling problems through the agency of logistical mobility, principally in the form of bulk food storage. The problem becomes acute, as Binford says, when one reaches latitudes in which surviving a winter season of profoundly reduced productivity becomes a necessity; there, the only options are to hunt the animals which remain or to store sufficient plant and animal resources collected during the growing season to survive. "Given the arguments presented here, we should therefore see a reduction in residential mobility and an increase in storage dependence as the length of the growing season
decreases" (Binford 1980:15). Increases in storage rates with decreases in ET are also supported by cross-cultural data.

Binford points out that if there are other factors such as 'crowding' by neighboring groups, competition between groups for access to similar resources or "any condition that restricts residential mobility of either foragers or collectors, we can expect (among other things) a responsive increase in the degree of logistically organized production" (Binford 1980:17).

"Willow Smoke and Dogs' Tails" is concluded by a discussion of the implications of the forager-collector continuum and its settlement system components upon interassemblage variability. Binford reviews his prior (1978) definitions of coarse-grained and fine-grained assemblages and reiterates his axioms (1) that the more fine-grained the assemblage, the greater the probable content variability among assemblages since the composition of assemblages are responsive to event differences and spatial differentiation between serially occurring events will keep the residues of these events separated; and, (2) that residential mobility is the factor which regulates assemblage grain size, such that high mobility [short-term sites] results in fine-grained assemblages while low mobility [long-term sites] results in coarse-grained assemblages.

Binford (1978) concluded that a trend toward increasing interassemblage variability would be a result of seasonal patterns produced by increasingly profound seasonal climatic changes within solar radiation input and rainfall patterns. Here he argues that coarser grain size and declining interassemblage variability will be a result of decreasing residential mobility. He ostensibly combines the two arguments to state that residential sites occupied in comparable seasons within a settlement system should be coarse-
grained and exhibit little interassemblage variability (Binford 1980:18). I find his example rather more comprehensible: in a system in which one finds high residential mobility in the summer and low residential mobility plus higher logistical mobility in the winter, the overall effect of the yearly cycle would be high interassemblage variability. The winter residences should be more internally complex and diverse while they should vary only slightly in qualitative assemblage content from one another. Winter low-mobility villages should differ categorically in content from the highly mobile summer campsites. Assemblage content should be highly variable between sites but less complex at each particular site within the class of summer campsites. Binford's (1980:19) point is "that logistical and residential variability are not to be viewed as opposing principles (although trends may be recognized) but as organizational alternatives which may be employed in varying mixes in different settings. These organizational mixes provide the basis for extensive variability which may yield very confusing archeological patterning."

Thomas (1988:381-382) pointing out further confusions in the record, notes that:

- hunter-gatherer cultural geography tends to be redundant: abandoned base camps are reoccupied as temporary field camps; functionally different field camps are re-established at the same camp site; diurnal exploitative areas overlap spatially as seasonally restricted resources ripen. Given sufficient time, residential assemblages commonly become comingled with various logistical assemblages. Discrete logistic assemblages accumulate at certain favorable loci, one behavioral accumulation inextricably mixing with another. Rarely is a given location utilized in only one way, and the palimpsest accumulation is an archaeological fact of life.
Due to the introduction of special purpose sites and changes in the character and context of locations in a logistically organized system Binford (1980:19) argues that:

other things being equal, we may anticipate regular environmentally correlated patterns of intersite variability deriving from increases in the number and functional character of special-purpose sites with decreases in the length of the growing season. In addition to such quantitative changes, given the more specialized character of resource 'targets' sought under logistical strategies, we can expect an increase in the redundancy of geographical placement of special-purpose sites and a greater buildup of archeological debris in restricted sections of the habitat as a function of increasing logistical dependence.

Binford (1980:19) states that there is a need for studies of long-term strategies of land-use in different environments. He has just dealt on the scale of the yearly cycle in this paper and states that the short-term strategies discussed here are not sufficient to understand "patterning that results from variable redundancy in geographic positioning of the total subsistence-settlement system". He says that "a detailed consideration of the factors that differentially condition long-term range occupancy or positioning in macrogeographical terms is needed before we can develop a comprehensive theory of hunter-gatherer subsistence-settlement behavior. The latter is of course necessary to an understanding of archeological site patterning."
Beyond Subsistence Collecting

Binford's brilliantly insightful "Willow Smoke and Dogs' Tails" model has provided enormous stimulus to hunter-gatherer studies since its initial publication. However, there is a certain implicit fuzziness in the model which bears further analysis since it is relevant to the application of the model to inland southeast Texas. I would like to explore a level of ambiguity in Binford's discussion of the collector mode: Binford discusses collection (explicitly, at least) exclusively in terms of the bulk procurement and storage of foodstuffs. He seems not to acknowledge that the key logical elements which are the crux of his definition of collection have implications which extend both beyond and parallel to that of subsistence.

My best effort to distill these key elements without which the collector system could not be defined leads to the conclusion that the elements are the collection and storage by special task groups of surpluses ("bulk") beyond the immediate consumption needs of the hunter-gatherer group. Whether or not this collection of surpluses for deferred use can or should be arbitrarily restricted to the collection and storage of foodstuffs emerges as the critical issue. I am led to this assertion by a consideration of the nature of trade and its potential systemic and archeological consequences. I believe that any prehistoric or protohistoric hunter-gatherer system that includes a significant trade component must of definitional necessity be logistically organized, since trade (including, but not restricted to, foodstuffs or hunting by-products such as hides) requires the intentional, special-purpose collection and storage of surpluses until such occasions as trading can take place. The actual collection may even on a foraging basis in which foragers bring home surpluses of materials normally consumed by the hunter-gatherer group (defined as "incidental collection") but it is still qualitatively logistic in that bulk surpluses are
produced and stored. Rather than eventually being consumed by the hunter-gatherer
group, these surpluses are utilized as objects of barter to obtain resources and materials
unobtainable by the group's technology or within the group's geographical range.

Obvious (and potentially locally relevant) examples would be the exchange of meats and
hides for domestic grains and the exchange of littoral resources for lithic raw material.
In each example the input from barter constitutes a potentially significant contribution to
the hunter-gatherer group's subsistence and technological systems - as well as to the
maintenance of that system itself.

Binford characterizes the spectrum between foragers and collectors as a continuum
based on increasing levels of bulk subsistence procurement and correspondingly
increasing levels of settlement complexity. He is quite correct in this sense but I would
contend that he is focused too exclusively on the within-group consumption of
resources, whether it is immediate as in a foraging unit or deferred as in a collector
group. The possibility of exchange beyond the immediate boundaries of the economic
and social unit are unexplored, but may alter the economic, systemic, and archeological
consequences of the collector paradigm. As I have stated, I believe that the existence of
a significant trade component within a hunter-gatherer system creates the logical
imperative that this trade component be placed on the collector side of the spectrum due
to the necessity of the creation of surpluses. The forager-collector continuum would be
a 'cleaner' concept if we were able to (as Binford appears to do) restrict all discussion to
issues of within-group subsistence. But how are we to do this when it is likely that the
objects of exchange included at one or both ends subsistence items such as the Punan
exchange of meat for grains (Hoffman 1984)?
Might a valid distinction between collector (sensu Binford) and collector (sensu stricto, defined exclusively on the basis of collection and storage of any surplus) be in the existence of what can loosely be termed "markets" for exchange items? Markets drive the collection of surpluses for trade, especially of items for which there is limited internal need such as the camphor and gutta percha collected by the Punan for eventual exchange to the Chinese (Hoffman 1984). The recognition of a distinction between 'internal subsistence collection' and "market-oriented collection" thus serves to differentiate between these two parallel and not necessarily complementary generators of stored surpluses. But what are the systemic and visible archeological consequences of market-oriented collection in terms of settlement organization and site variability? Market-oriented collection would create (or in the case of foragers, initiate) new spatial incongruities and considerations of transport costs in the system through the distance between the stored bulk items and their markets. Groups who otherwise subsist by foraging would thus be compelled to introduce more logistical elements into their settlement system. Importantly, they would also find it propitious to adopt new technical systems such as the production of ceramics to enhance their storage, processing and transport capabilities. Groups which already exhibit internal subsistence collection logistical elements would have to reconcile these spatial incongruities with those introduced by the need to get their goods to market.

Perhaps it is time for a slightly more explicitly generalized definition of "bulk procurement": bulk procurement is the procurement of any class of resource in quantities constituting a surplus beyond the immediate needs of the collector group; it matters little in terms of the logical consequences of logistical procurement if the volumetric bulk of the surplus is in cubic yards or cubic inches. The production of material surpluses for trade might indeed not be "high-bulk" in a conventional sense: a
deerskin sack of bifacial cores might be a very high-value item in trade to the Texas Gulf coast but compact in volume.

Why, other than the issue of volumetric bulk, should we wish to provide a more generalized definition of bulk procurement? Binford (1980: 10) speaks of specialized food-procurement task groups as an equal hallmark of the collector system but it seems that on the basis of logic this distinction is excessively narrow: why is a foray to a spatially restricted lithic source quarry to obtain cobbles for later use (and perhaps trade) less specialized than the mobilization of a bison-hunting party? Such a cache of tested cobbles comprising the Carl Mehrkam Site, 41HR365, is evidence of intentional, logistically-organized lithic procurement in the Study Area region (Freeman and Hale 1978:90-98; TARL files). The site consisted of 50 large cobbles, many with one to a few flakes removed. The cobbles were obviously removed from their quarry of origin and cached for storage at this locality by a task-specific group operating in an explicitly logistical manner to collect a non-food item in bulk.

Even "ritual" exchange, though not explicitly economic in character, may imply logistical organization since the production of ideotechnic items often necessitates the existence of a specialized, skilled task group which carries out the production of the copper earspools, Hopewell pipes, etc. It matters not at all that this workgroup might have carried our their task in the comfort of the residential base camp rather than at some remote field camp if one is to classify subgroups engaging in specialized production activities as logistical. (Note that I do offer the distinction that the group is engaged in production; a raiding party certainly has a specific task, one which even requires the establishment of field camps, stations to look for human prey and locations at which that prey is slain. While the site formational products are quite intriguingly homologous, I
would not consider a raiding party relevant to the collector-forager continuum since its usual products in spatially stable aboriginal societies are limited to revenge and prestige.)

Thus, one might suspect that hunter-gatherer systems exist which reflect duality rather than continuity in regard to the forager-collector question: a hypothetical group's direct subsistence activities may be wholly within the foraging mode, while ostensibly non-subistence elements such as the collection of lithic raw material or forest products is carried out in the collector mode. We may look further at the Punan of Borneo (Hoffman 1984) as an example of a neotropical group for which barter has important implications for both the continuation and, indeed, the very existence of a forest hunter-gatherer lifeway adjacent to contemporary agricultural groups. The example of the Punan is potentially relevant to the issue of southeast Texas prehistory in that I believe that the persistence of hunting and gathering through historic times is a critical issue for archeology of this region.

"Punan" is a generic term for hunter-gatherer groups in Borneo, referring to geographical location and behavior characteristics (mobile hunters, etc.) rather than any single ethnic or linguistic group. They reside in the primary forests of Borneo. Punan territories are the headwaters and tributaries of a river that is occupied in its lower reaches by a sedentary Dayak agricultural group. Each Punan group more closely resembles its agricultural neighbor in language and customs than it does other Punan groups. The Punan exist in a long-term symbiotic trading relationship with its paired, downstream agricultural group. A historical reason for this affinity has been suggested: linguistic and historical evidence indicates that the Punan (as well as all Austronesian hunter-gatherer groups) are certainly descendent from originally agricultural peoples. Thus, they have abandoned sedentary agriculture to pursue a nomadic life in the primary
forest interior. An important impetus to this transition was an enduring (ca. 2000+ years) market for forest products to long-range sea traders from China, as well as a trade of meat for domestic vegetable foods with their Dayak affiliates. Since the primary forest was not easily accessible from agricultural villages, the parent sedentary groups fissioned, with a portion of population adapting a specialized hunter-gatherer and forest product collector lifeway.

Hoffman (1984:144) thus posits that we should distinguish primary hunters and gatherers from secondary hunters and gatherers: "Primary hunters and gatherers would be those groups who do in fact appear to be aboriginal, autochthonous peoples of their respective regions, groups for whom there exists at present no cultural, historical or linguistic evidence of a prior agricultural adaptation... Secondary hunters and gatherers are those groups that clearly derive from sedentary agricultural peoples. These are groups for whom hunting and gathering is essentially a readaptation to a specialized ecological niche." The later groups are united by symbiotic trading relationships with settled agricultural peoples worldwide and are posited to include "most or all of the hunting and gathering peoples of the Indian subcontinent and most if not all of the hunting and gathering groups of the tropical forest zone of South America." (145) Hoffman (1984:146) classifies these secondary groups as "commercial" (as opposed to subsistence) hunters and gatherers.

In regard to local prehistory, there is no evidence that the Akokisa were formerly agriculturalists or that their hunting and gathering was not primarily subsistence in focus; however, the example of the Punan may suggest one reason why the Akokisa remained hunters and gatherers despite an undoubted exposure to the agricultural ways of the Caddo to the north. It is possible that they fulfilled a similarly efficient economic role as
collectors and traders of forest products with not only the Caddo to the north but with their equally non-agricultural coastal Akokisa neighbors.

Griffin (1984) provides an examination of another comparable forager group in the humid tropics with an intent to prepare a model of possible prehistoric foraging adaptations. The Agta hunt the largest game of the Phillipine forests (deer and pig), fish the rivers, gather plant and animal foods for consumption and exchange and sometimes plant small swiddens. They have a long-established pattern of trading forest products (usually meat) for domesticated roots and grains as well as other items. Griffin posits that tropical foragers would have typically passed fluidly through time in subsistence emphasis between swiddening, hunting and gathering, and again perhaps the exchange of foods and goods with other ethnic groups.

The issue of tropical rain forest hunter-gatherer groups is further treated by Bailey et al (1989). This article presents a brief survey of hunters and gatherers in tropical rain forests worldwide based on ethnographic and archeological data. The authors contend rather broadly that both lines of evidence support the assertion that hunter-gatherer groups can only penetrate the rain forest as a result of the actions of nearby or adjacent agriculturists. While the environment of southeast Texas is clearly not that of a tropical rain forest, this review of hunter-gather groups is relevant to the extent that it cites numerous instances in which trade in forest products assists in maintaining the viability of a hunting and gathering way of life. For example, in reference to Congo River Basin pygmy groups they assert that these people "live by hunting and gathering meat, honey, and other forest resources which they consume or trade to neighboring Bantu- or Sudanic-speaking horticulturalists. In return they receive cassava, rice, bananas, and
other food crops, as well as material goods such as clothes, pots, axes, and other metal objects" (Bailey et al 1989:62).

**Other Aspects of Hunter-Gatherer Theory**

The forager-collector continuum (*sensu* Binford) proceeds from the general assumption that the environment is the overriding factor in determining hunter-gatherer adaptation: "Where access to resources is temporally or spatially restricted, hunter-gatherers extend the utility of these resources by storing them (gaining temporal utility) and by caching both resources and gear (gaining spatial utility)" (Bettinger 1987:127). Bettinger (1987, 1991a) roughly equates middle-range research with the analysis of site formation processes, the recognition of static archeological structures which can be identified with specific cultural behaviors. He is emphatic that middle-range theory need not spring forth solely from observations of living peoples but rather that it derives from the logical construction of processes and principles that transcend any actual cases that might have inspired their formulation. (Bettinger [1991a:79] is thus convinced that the contribution of Binford the thinker is much more critical than that of Binford the observer.) Bettinger faults middle-range theory principally in its lack of explicit adherence to more general and abstract theory. Bettinger (1987, 1991a, 1993) argues that the results of long-term archeological investigations in the Great Basin of the western United States are beginning to approach this level of more general and abstract theory.

The focus of Great Basin archeology has been less on culture history and more on seeking an understanding of how aboriginal populations made use of natural resources in a hostile environment. Most Great Basin archeologists approach the high degree of archeological variability in the region with attempts to simplify and understand this
variability in a manner that illuminates general principals. They set out to narrow the range of their empirical inquiries in a manner which renders numerous variables constant. This tactic is purported to make the meaning of the remaining, uncontrolled variables more comprehensible in relation to environmental context. They look at extreme conditions such as high altitude and wetland sites while maintaining a broader, regional viewpoint which seeks to articulate these extreme adaptations with larger regional patterns.

For example, the character of aboriginal alpine exploitation in the Great Basin changed rapidly and radically around AD 600 with the establishment of villages with well-built dwellings in the alpine zone. Bettinger (1991b) examines the nature of this development and seeks an explanation for its cause, which he believes was the result of population pressure and the inception of intensive pinon-nut harvesting; the alpine villages represent a compromise to survive the over-wintering problem without incurring the enormous transportation costs that would have been incurred to transport these bulk resources to winter valley villages. Thus, the population stayed near its bulk accumulations in these high-altitude villages. Interestingly, the alpine villages were uniformly abandoned with the initiation of Euro-American settlement in the region. Bettinger ascribes this depopulation to plummeting valley populations as well as a diversification of subsistence options with the coming of Euro-American settlers.

Bettinger (1993) asserts that the "simple, unrealistic" models based on time and calories (optimal foraging theory) have been pushed to their limit and archeologists now seek to develop better, more meaningful models. Bettinger then argues for the need for a "unifying theory" which would permit the construction of better models. He says (Bettinger 1991a:131) that "to be viable that general theory must present, minimally, a
coherent explanatory matrix in which materialist explanation and a concern for evolutionary processes figure prominently. I assume, further, that just as these features will characterize any modern theory of hunter-gatherers, so must they characterize any modern general theory of anthropology."

This unifying theory strategy purports to differ from prior tactics in that "it actively seeks (rather than limits) contextual variability" (Bettinger 1993:49). Contingency-based optimal foraging models assume that prehistoric peoples foraged on the basis of expected immediate return (in calories $V$'s time); they thus did what was momentarily optimal and did not adhere to any particular subsistence tactic. Bettinger contends that these models are fine unless the foraging system is subject to other constraints - and that such constraints are not at all uncommon, especially as a prehistoric group becomes more "collector"-like and less "forager"-like. "That follows because forager-like systems tend to produce immediate returns on foraging investment and, in that sense, approximate fairly closely the expectations of contingency models. Collector-like systems, on the other hand, incorporate many long-term, delayed-return strategies, implying a host of constraints that tend to make the expectations of contingency models unrealistic" (Bettinger 1993:50)

Bettinger concedes that it is necessary to ignore some aspects of variability in order to get anything done archeologically. However, he asserts that there are two common abuses in ignoring variability in the archeological record: (1) field programs which fail to engage functional variability at the regional level; and, (2) "when variability is ignored when it is difficult to reconcile with current theory, especially when this is accompanied by reluctance to develop new theory and method to manage that variability.
Great Basin archeologists seem too ready to respond in this way to variability potentially explicable in terms of ethnicity" (Bettinger 1993:52).

**Aten's Akokisa Model**

Bettinger might well approve of Lawrence Aten's approach to upper Texas coast prehistory since a consideration of ethnicity and a concern for evolutionary process are keystones of the latter's models. I have already discussed Aten's general research program in regard to the upper Texas coast and his interpretations of cultural chronology and technological change during the Ceramic Period in this region. I may now turn to a more specific discussion of his "Akokisa Model" of prehistoric occupation in southeast Texas.

Aten is quite explicit that his Akokisa Model is largely derived from the relatively abundant data on the Galveston Bay (littoral) Akokisa. His period of study extends from the beginning of the Late Archaic (the time of initial coastal occupation) through historic times and thus begins approximately 1000-1500 years before the term of the current investigation. His model begins with reconstructions of tribal population in the upper Texas coast at the beginning of the historic period. He assumes that the region began with a very small population and that a steady but low rate of population growth accounts for the end population and the infilling of habitation in the region. He hypothesizes that this infilling took place through repeated budding of new social groups which moved into previously unoccupied territories.

Aten (1979:Figure 52; 1983b:Figure 3.1) then produced a carefully reconstructed map of the locations of aboriginal groups in early Historic times. This distribution was in turn
compared it to a series of plots ("polythetic sets") of the occurrences of certain artifact categories. Correspondence of attributes and ethnohistorically known group territories led him to the tentative conclusion that these boundaries were in existence by the middle of the first millennium A.D. Aten identifies the Akokisa as the prehistoric inhabitants of the Galveston Bay area with proto-Akokisa and Akokisa territory further encompassing the eastern portion of the current Study Area.

The Akokisa populations are purported, based on ethnohistoric and archeological data, to be "dispersed in small, band-sized or less groups in the warm seasons, and were aggregated into villages during cold seasons" (Aten 1983:319). The seasonal round, according to Aten, involved the movement of the population from dispersed coastal sites in the warm season to these inland, aggregated villages during the cold season.

There were five such cold season villages - three of the five inland, and discussed previously in the ethnohistoric background section of this document - in existence during the early historic period. He estimates a minimum village size of 200 persons and a maximum in the range of 400-500 individuals. These ranges are based on hypothetical demographic constraints: "populations below about 200 individuals could not function and group sizes above approximately 450 individuals necessitated a fissioning process in which a group sufficiently large to function independently as a village budded off. In this manner Akokisa social organization could have replicated itself when the need arose" (Aten 1983:320).
Aten (1983:321), in turn, depicts this model of population growth and social unit replication as providing a framework for considering the evolution of indigenous cultures on the upper Texas coast through the gradual expansion of a sociologically more generalized small population experiencing infrequent interaction with other groups. As demographic expansion of this population took place, the social process of boundary formation accelerated. As population increased, the relationships among population size, technology, and available resources must have been adjusted. This may be the basis for understanding the reconstructed average family size of 6.4 persons at the Harris County Boys School Cemetery (ca A.D. 700-900) declining to 4 persons at the Jamaica Beach Cemetery (ca A.D. 1500). The decline in the birth rate may have been one of the essential adaptive mechanisms late in the prehistory of the Akokisa territory.

Based on reconstructions of technological change, Aten partitions his model into at least five sequential parts (Aten 1979:470-474; 1983:321-323):

Late Archaic (ca. 900 B.C.-A.D. 100): No major technological changes took place after the initial adaptation of Late Archaic technology until A.D. 100.

A.D. 100-A.D. 800: The period from A.D. 100 to about A.D. 800 "contains major changes in technology and mortuary practices which imply significant changes in subsistence, cognition, and possibly social
organization” (Aten 1979:471). This is the period in which Aten’s polythetic sets of artifact distribution begin to parallel historic Akokisa tribal boundaries, and are thus in his view the earliest time such boundaries existed. Among the important technological changes are the introduction of ceramics, the initial use of the bow and arrow, and the probable usage of tidal fish weirs. Aten suggests that the latter changes mark a shift in subsistence emphasis “from exclusively larger animals to a wider range of species and smaller individual body sizes” (Aten 1979:471). The more efficient adaptation is seen as potentially signifying an increasing level of competition for food, increasingly long stays at particular locations, reduction in the procurement range available at a given location, changes in the division of labor, and changes in the absolute availability of certain food resources (e.g. declining bison availability). The period is also marked by the first visible mortuary practices and the establishment of cemeteries in conjunction with habitation sites, practices seen as ritually reflecting the increasing organization and subdivision of the region and its resources.

A.D. 800-1700: The third period is marked by innovation in ceramic design and by demographic changes reflected in mortuary data. Late in this time span (during the Old River Period), usage of the bow and arrow is seen to expand significantly, either in response to the return of the bison to the southern ranges or (very late in the period) in response to the European fur trade. [Aten minimizes the impact of the return of the bison upon coastal subsistence.]
A.D. 1700-1750 was the brief period in which the fur trade, the mission system, and European diseases began to seriously disrupt native Akokisa patterns.

A.D. 1750-1820 marks the Akokisa period of decline.

Thus, Aten (1983:323) has presented a model which:

describes a generalized cultural system expanding into unoccupied spaces in the Late Archaic following the formation or expansion of more favorable habitats in the Middle Holocene. These generalized cultures subsequently diversified into more specialized systems. The model describes a sequence of alternating phases of cultural growth (i.e., when the available cultural elements expanded into the social and/or geographic space available), and cultural development (i.e., when new cultural elements were coming into being).

The two phases which Aten characterizes as "developmental" spanned from roughly A.D. 100-900 and from A.D. 1700-1770. He (Aten 1983:323-324) attributes the following systemic changes to the earlier, more extended period:

1. A major rise in energy demand resulting from population increases;

2. Adoption of a technology which permitted focusing food and other raw materials acquisition on previously inaccessible quantitative and
qualitative segments of the area's biotic resources [diversification of the prey population; acquisition of littoral resources];

3. Improvements in the efficiency of energy-harnessing technology [the bow and arrow; ceramics];

4. Use of cemeteries to signify or assert entitlement to resources thereby controlling or attempting to control the absolute size of the energy reservoir [boundary establishment];

5. Use of mortuary symbolism to gain support, seek intervention, or to neutralize any negative impact of the supernatural upon secular affairs;

6. Improvements in "social efficiency" by introduction of coordination mechanisms including the establishment of formalization of ethnic boundaries, and increases in organizational and demographic complexity...

What factors in the larger ecological setting of the Akokisa cultural system stimulated these developmental phases is unclear. At a minimum, the bison [availability] data make it clear that there were alterations occurring in the natural environment. Whether these were sufficient to stimulate cultural systemic reactions is not known.

The changes in technology, "social efficiency" and mortuary symbolism with the A.D. 100-900 period are seen by Aten as systemic feedback channels which served to stabilize
the system in the face of purported population and environmental stresses. The society then entered a phase of stable "cultural growth" during which there was expansion of the society without the introduction of significant new cultural elements. Aten proposes for future research that the entire span of southeast Texas prehistory can be investigated from this perspective of periods of stress and recovery from stress.

I will for the moment defer critical analysis of the Akokisa Model; however, one of the more interesting aspect of Aten's model concerns the ability of the Akokisa social system to replicate itself in response to gradual population growth without undergoing radical structural change. This model of stasis through fissioning is theoretically quite feasible as long as social and environmental conditions provided the absence of external constraints to the budding process. Under ideal conditions this model could, by itself, account for the persistence of the hunting and gathering lifeway in the region: given a stable environment and infinite room for expansion there would theoretically be an absence of the stresses which might motivate significant changes in subsistence, technology and social organization. I am convinced by Aten that - to a certain extent - both conditions applied in the upper Texas Coast after 900 B.C.; it seems supportable that the region had a fairly low initial population (and thus provided considerable room for territorial expansion without crossing major environmental boundaries) and that the environment was relatively stable. However, I am skeptical that this process of budding and expansion could have proceeded relatively unfettered for 2500 years. Similarly, I have doubts that simple expansion and replication would have been sufficient motivation to adhere to a hunting and gathering lifeway in the face of ample opportunity to borrow agricultural practices. These issues will be examined in more detail in subsequent chapters.
Other Interpretations of Southeast Texas Prehistory

It would be remiss to conclude any discussion of models of prehistoric organization and change in southeast Texas without reference to the work of the Houston Archeological Society, as expressed principally by the pen of Leland Patterson. While these reconstructions are generally simplistic and frequently interpretively controversial, they represent a synthesis of a large volume of relevant survey and excavation data from the region. Thus, they will now be examined critically. Since much of the work is principally concerned with technological and typological sequences the discussion will represent something of a digression to the preceding chapter dealing with cultural chronologies.

Patterson (1976) reviewed data on prehistoric technological change from 26 inland sites in Harris County in this study (9 Late Prehistoric, 6 mixed Late Prehistoric/Woodland, 5 woodland, 1 mixed Archaic/Woodland, 1 pure Archaic and 4 with all time periods represented. By component: 19 Late Prehistoric, 16 Woodland, 6 Archaic). Patterson contends that there were a larger number of smaller, less frequently occupied sites in the Ceramic period and a smaller number of larger, more frequently occupied sites in the Archaic because Ceramic period sites have less lithics than Archaic sites. [Do lithics define a whole cultural system? The number of sites may have some merit but the relative quantities of lithics seems a dubious measure of site duration. The introduction of ceramics would have simplified the processing and storage of plant foods and would have potentially changed the settlement system and the assemblage character of later sites.]
Wheat (1953) and Patterson's work is cited to support the contention that pottery declines in frequency during the Late Prehistoric period. "This could mean less use of pottery and/or a lower frequency of site use. it is felt that less pottery was used in the late prehistoric period because the ratio of pottery to flakes decreases then. Together with the information that sites tend to be smaller and more numerous in late time, this may indicate a shift in subsistence pattern after the Woodland." (Patterson 1976:175). Patterson sees a reduction in utilized flake size during the study period. He regards this reduction as "evolutionary rather than sudden" (Patterson 1976:180) and beginning at the beginning of the Woodland period. He found no significance to lithic materials utilization other than that silicified wood was 'overutilized' and red jasper was 'underutilized.'

While Patterson concludes by citing evidence for technological continuity in the 4500-year archeological record, much of this continuity is based on his questionable insistence for long use spans for several classes of artifacts (dart points in general, specific dart and arrow points, the bow and arrow), as his dismissal of some artifact types as chronologically undiagnostic. [Naturally the chronological utility of an artifact type is diminished if you insist it remains in use for thousands of years.] He concludes by asserting that the use of smaller sites in greater numbers, use of smaller lithic tools, and decline in pottery use imply increasing mobility in the Late Prehistoric.

Patterson's general conclusions regarding technological change in Harris County are summarized in a later article (Patterson 1983:265):

1. A stable settlement pattern, utilizing a broad-based subsistence regime, was characteristic of inland areas from the late Paleo-Indian
through the Late Prehistoric periods. Many sites have very long occupation sequences.

2. Coastal margin sites oriented toward greater use of marine food resources become more important in the terminal Archaic.

3. Differences in projectile point styles between the upper Texas coast and the western transitional zone begin as early as the early Paleo-Indian period. These differences may have been caused by external influences.

4. There are several inter- and intra-regional differences in pottery types, most of them apparent in the Late Prehistoric period. These differences possibly indicate cultural differences between and within the regions.

5. Some of the differences in cultural traits between inland and coastal margin sites may reflect development tied to restricted territorial uses.

6. The upper Texas coast represents the western end of a general Archaic foraging lifeway common to the entire eastern Gulf coastal plain.

7. Technological differences and similarities within the geographic area discussed here show that cultures did not remain static, even though
settlement and subsistence patterns remained stable over long periods of time.

8. There seems to have been a continued population increase from the Paleo-Indian to the Late Prehistoric, judging by the relative numbers of sites found to date for each time period.

The utility of Patterson's synthetic writings is significantly undermined in the minds of many by his persistent underestimation of the effects of bioturbation and other disturbances in the sandy soil sites of inland southeast Texas. The consequence of this underestimation is Patterson's unique projectile point chronologies and consequent interpretations. While Patterson may be correct in his assertion that point chronologies should not be expected to equate fully with, for example, central Texas chronologies it seems unreasonable to expect that a whole suite of point types - each with well-established extra-regional chronologies which are not restricted to central Texas - would exhibit peculiar periods of use solely in southeast Texas. One or a few points, perhaps, but not many. It seems clear that his chronologies result from the attribution of excessive significance to the simple stratigraphic position of minor numbers of points in the predominantly shallow palimpsest sites of his own excavation and to the application of the same too-literal standards in his reading of the works of others in the region. Patterson's chronology has been directly criticized by Ensor (1990) and Ricklis (1993b) and more obliquely by Story (Story et al 1990:214) for his literal interpretation of stratigraphic superposition.

It is apparent that these disputes have their origin in conflicting assumptions. Ensor (1991) and Story (Story et al 1990) both adhere to the viewpoint (based, yes, on central
Texas data but also on an repeatedly-demonstrated archeological principle derived from the excavation of well-stratified sites worldwide) that points should most frequently have relatively short temporal distributions with limited temporal overlap. Patterson (1990a:24) counters that this principle ignores the demonstrated long temporal ranges which he argues are well-established for many southeast Texas point types. A universal agreement on chronology is thus unlikely as long as the investigators continue to work from these inherently contradictory assumptions.

While real resolution of this disagreement will probably have to await the excavation (if ever) of one or more indisputably well-stratified sites in the region, my reflections on the issue are based as much on arguments of reasonability as it is on my professional experience in southeast Texas. First, I would point out that the ground-rules for stylistic change must be rather different for projectile point types from those applied to ceramics, where overlapping ranges and minority types seem to be an accepted fact of life and form the basis for ceramic seriation. (Seriation, however, is an excellently approximative way to deal with sites which are stratigraphically 'fuzzy' due bioturbation.) Secondly, while the Law of Superposition is real, so is the fact of nearly universal bioturbation in southeast Texas sites. (Patterson himself reports that 100% of the inland southeast Texas sites coded in his (1989) archeological database publication are listed as "sand middens.")

It is quite true that there are a number of relatively well-stratified sites which have been excavated in southeast Texas. However, I must conclude that the key word is 'relatively.' These sites represent trends in point and ceramic succession quite well but it is a mistake to read the archeological record at any one site with a sense of inerrancy; some vertical migration of artifacts is almost inevitable. It seems most reasonable that
the consequence of these migrations is Patterson's unorthodox chronologies. There is no reason to think that southeast Texas was in any way strange, which it would have to be in order for a number of types to vary from their established chronologies elsewhere. We have to conclude, instead, that the peculiarities of vertical point distribution he describes are the consequence of cultural and biogenic disturbances of the oft-repeated 'long occupation sequence' (Patterson 1983:258-259) sites of the region.

I would suggest, in conclusion, that investigation of a series of single-component sites (comparatively scarce as Patterson would suggest they are locally) may constitute a slightly more feasible means of resolving the chronological issue. Such sites (which would probably tend to be small as well as relatively ephemeral, given the tendency for repeated occupation of residential camps) can offer a solution if they yield the types in question and if they can be absolutely dated with confidence. (Those, of course, are two very big ifs for southeast Texas sites.) 'Stacking' a series of such sites temporally should be a closer approximation of the stylistic sequence exhibited under truly discrete stratigraphic superposition than that disclosed by multicomponent but bioturbated sites. On a more practical level, we may get a better idea of whose assumptions are correct if excavated ephemeral sites are found repeatedly to contain only one or two - as opposed to potentially many - point types or vice-versa. [It should further be obvious that the potential interpretive significance of the numerically abundant but under-appreciated small, low-artifact-density, ephemeral sites should not be underestimated.]

Patterson (1993c) presents summary results of a database of 182 published sites for inland southeast Texas. The greatest utility to the current analysis of this database derives from its geographical division into eastern (San Jacinto, Liberty, Chambers, Polk, Hardin, Jefferson, Orange, Jasper and Newton counties), central (Walker, Grimes,
Montgomery, Harris and Galveston counties) and western (Washington, Waller, Austin, Fort Bend, Wharton, and Brazoria counties) zones.

Quantitative differential distributions of point types and other artifacts can be demonstrated across the Study Area. I note the following in Patterson's (1993c) distribution tables:

1. Patterson presents a seemingly intuitively reasonable (but see below!) estimate of population trends based on the raw number of sites (or components?) per period divided by the length of the period times 100 (Table 6):

<table>
<thead>
<tr>
<th>Period</th>
<th>Length, yrs</th>
<th>No. of sites</th>
<th>Relative Pop. Factor</th>
<th>Relative sum</th>
<th>% of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Paleoindian</td>
<td>3000</td>
<td>58</td>
<td>1.9</td>
<td></td>
<td>3.6%</td>
</tr>
<tr>
<td>Early Archaic</td>
<td>2000</td>
<td>33</td>
<td>1.7</td>
<td></td>
<td>3.2%</td>
</tr>
<tr>
<td>Middle Archaic</td>
<td>1500</td>
<td>70</td>
<td>4.7</td>
<td></td>
<td>8.9%</td>
</tr>
<tr>
<td>Late Archaic</td>
<td>1600</td>
<td>104</td>
<td>6.5</td>
<td></td>
<td>12.3%</td>
</tr>
<tr>
<td>Early Ceramic</td>
<td>500</td>
<td>120</td>
<td>24.0</td>
<td></td>
<td>45.5%</td>
</tr>
<tr>
<td>Late Prehistoric</td>
<td>900</td>
<td>125</td>
<td>13.9</td>
<td></td>
<td>26.3%</td>
</tr>
</tbody>
</table>

Patterson's application of his factor index discloses a sharp population increase in the Early Ceramic followed by a less pronounced decline in the Late Prehistoric. Expressed as percentages of the hypothetical total, cumulative indigenous population from Late Paleoindian to Late Prehistoric times, 71.8% percent of this hypothetical population lived
during the post-ceramic era. It might be less than naive to suggest that the preceramic sites are under-represented due to differential conditions of preservation (i.e., more sites eroded away) or observation (i.e., more deeply buried sites). However, another explanation must presumably be found for the decline in the index in the Late Prehistoric, where differential preservation should not be an issue unless Late Prehistoric sites tended more often to be situated on unstable landforms.

Note that Patterson's population factor values are dependent upon his own assessments of the lengths of the major prehistoric periods. Slightly different results will derive from utilizing, for example, the period lengths presented in Ensor's Table 4.2 (in Moore 1994b) rather more conventional chronology (Table 7):

<table>
<thead>
<tr>
<th>Period</th>
<th>Length, yrs</th>
<th>No. of sites</th>
<th>Relative Pop. Factor</th>
<th>% of sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleoindian</td>
<td>2000</td>
<td>58</td>
<td>2.9</td>
<td>5.1%</td>
</tr>
<tr>
<td>Early Archaic</td>
<td>3000</td>
<td>33</td>
<td>1.1</td>
<td>1.9%</td>
</tr>
<tr>
<td>Middle Archaic</td>
<td>4000</td>
<td>70</td>
<td>1.8</td>
<td>3.2%</td>
</tr>
<tr>
<td>Late Archaic</td>
<td>1400</td>
<td>104</td>
<td>7.4</td>
<td>13.0%</td>
</tr>
<tr>
<td>Early Ceramic</td>
<td>400</td>
<td>120</td>
<td>30</td>
<td>52.6%</td>
</tr>
<tr>
<td>Late Ceramic</td>
<td>950</td>
<td>131*</td>
<td>13.8</td>
<td>24.2%</td>
</tr>
</tbody>
</table>

* Sum of Patterson's Late Prehistoric and Historic sites
Under this method of calculation the purported population increase in the Early Ceramic becomes even more pronounced, as is the expectable bias against older sites. As to the decline in the factor value between the Early Ceramic and Late Prehistoric/Late Ceramic, I suggest that this decline may have as much or more to do with changes in settlement pattern and site visibility as it does with raw population numbers.

Having made a straightforward presentation of Patterson's population model, I must now point out its serious mathematical flaw. Patterson often cites (and I will later document) that sites in this area have long histories of re-occupation. Presume that we have a stable population re-occupying most of their sites consistently from the Early Ceramic through the Late Ceramic period. Given this re-occupation, the number of sites remains about the same for both periods (as in fact the newest real-world data indicates). We thus have constancy in both number of sites and population (the analysis objective) but the fact that the Late Ceramic is substantially longer than the Early Ceramic will inevitably result in the calculation of a spuriously lower Patterson Relative Population Factor number for the Late Ceramic.

2. There is a pronounced east-west differential in the distribution of Gary and Kent points: only 6.7% of the Gary and Kent points found in the Study Area occur in the western zone as opposed to 37.1% and 56.2% in the central and eastern zones respectively (Patterson 1993:Table 5). I am at a loss as to why Patterson seems to minimize
this lopsided distribution by characterizing the points as only "somewhat more numerous" (Patterson 1993:264) in the central and eastern zones.

3. While Patterson (1993:266) states that *Scallorn* points are most common in the western portions of the Study Area and that *Alba* and *Catahoula* points are most common in the eastern portions, he does not remark that the *Perdiz* distribution is likewise biased to the east (Patterson 1993c:Table 6). Converting the distribution of these points to percentages by zone presents the following picture (Table 8):

<table>
<thead>
<tr>
<th>Point Type</th>
<th>Western</th>
<th>Central</th>
<th>Eastern</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Perdiz</em></td>
<td>7.8%</td>
<td>39.6%</td>
<td>52.5%</td>
</tr>
<tr>
<td><em>Scallorn</em></td>
<td>48.5%</td>
<td>42.9%</td>
<td>8.4%</td>
</tr>
<tr>
<td><em>Catahoula</em></td>
<td>1.0%</td>
<td>41.5%</td>
<td>57.4%</td>
</tr>
<tr>
<td><em>Alba</em></td>
<td>1.4%</td>
<td>5.9%</td>
<td>92.7%</td>
</tr>
</tbody>
</table>

4. As to ceramic distributions Patterson (1993c:266) enigmatically states that *Goose Creek* ceramics are dominant in all three zones while the distributional data indicates otherwise (Patterson 1993c:Table 7). The distribution of the most numerically important ceramic categories is as follows (Table 9):
Table 9. Selected Ceramic Type Distributions.

<table>
<thead>
<tr>
<th>Ceramic Type</th>
<th>Western</th>
<th>Central</th>
<th>Eastern</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goose Creek Plain</td>
<td>1754</td>
<td>7608</td>
<td>10114</td>
<td>19476</td>
</tr>
<tr>
<td>Rockport Plain</td>
<td>4835</td>
<td>2</td>
<td>5</td>
<td>4842</td>
</tr>
<tr>
<td>Rockport Decorated</td>
<td>3220</td>
<td>0</td>
<td>0</td>
<td>3220</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9809</td>
<td>7610</td>
<td>10119</td>
<td>27538</td>
</tr>
</tbody>
</table>

The fact that *Goose Creek Plain* constitutes only 17.9% of the total of these three types in the western zone would seem to contradict Patterson's assertion of the universal dominance of the type within the Study Area. It does, however, indicate that the western zone is likely to be one of major cultural transition, in this case between the *Rockport* focus, identified with the historic Karankawa, and the *Goose Creek*-using, Mossy Grove Akokisa and Bedais peoples.

5. Unfortunately Patterson does not provide geographical breakdown of the distribution of artifact classes other than lithics and ceramics.

Patterson (1993d) discusses evidence for the separation of inland and coastal settlement patterns and the location of the boundary between the two systems. He has proposed that the coastal margin peoples after 500 BC utilized an inland zone running parallel to
the bay and estuary coast line for a distance of 15-20 miles. The coastal and inland settlement patterns are distinguished on several lines of evidence:

1. Faunal collections exhibit reliance on similar terrestrial fauna but are differentiated on the basis of salinity for aquatic resources.

2. There is generally greater quantity of lithic artifacts at inland sites.

3. Patterson also contends that the dart point and spearthrower remain in use at inland sites while it is abandoned at coastal sites at the beginning of the Late Prehistoric. This assertion remains an opinion that has been questioned by a number of investigators.

4. Grog-tempered ceramics are found in significant quantities in Late Prehistoric coastal sites but are scarce in inland sites.

5. Shell tools are restricted to the coast and bone tools are common on the coast but scarce inland.

6. The distribution of fired clay balls is restricted to inland sites.

Patterson briefly hypothesizes that the introduction of pottery to the southeast Texas coast may have been via a movement of coastal peoples out of southwestern Louisiana with the consequent potential for hostility between the coastal and pre-existing (?) inland groups. There is some appeal to the hypothesis of the movement of coastal peoples in that the coastal areas were largely uninhabited prior to the Late Archaic and might have
thus provided an empty ecological niche upon the development of the barrier island and estuarine system. However, both the inland and coastal folk were Akokisa or Bedais (and both definitely out of a southwestern Louisiana Atakapan language stock). Given the cultural continuities evident in the archeological record up to and after the occupation of the coastal zone, I think it more likely that the innovators of coastal habitation arose from an in situ group of earlier Atakapan origin. I am quite in agreement with the thesis that there were distinctive inland and coastal settlement systems operating from the end of the Late Archaic through historic times. These territorial divisions may have, in fact, restricted the movement of peoples and led to occasional hostilities.

Patterson's suggestion of the exploitation of a relatively narrow inland zone by the coastal peoples echoes that of Ricklis (1992) for the Karankawan Rockport Phase and earlier occupation on the central Texas coast.
7. The Mossy Grove Model

In order to produce a study which goes beyond a recapitulation of the empirical data collected by myself and others on southeast Texas prehistory I am compelled first to follow Bettinger's (1993) injunction to attempt to define a unifying theoretical perspective for the inquiry. For such a perspective to succeed in the Study Area, I believe that it must encompass the following criteria:

1. It must be kept simple and concise in order to be able to draw on and unify data from diverse surveys and excavations.

2. It must be modest in the level of temporal precision it requires to operate in this region of highly bioturbated sites, somewhat muddled chronology and extreme cultural conservatism which has long led the area to be characterized as a 'marginal,' 'peripheral' and 'provincial' archeological backwater (Newcomb 1961: 315). It must similarly be able to deal with differing levels of data ranging from the superficial to the sophisticated and detailed, the latter exemplified by the ceramic technological analyses conducted for several Moore Archeological Consulting excavation projects cited herein.

3. Despite its simple and undemanding nature, the model must nevertheless be able to discern meaningful variability in the archeological record and generate meaningful hypotheses regarding the prehistoric occupation of the region.
I believe that a model which incorporates two foci can satisfy these criteria and provide a unifying theoretical perspective on southeast Texas prehistory. The first of these foci examines site typology in the context of middle-range theory and defines a trimodal continuum of functional site categories. The other major element in the model is the application of a geographically-based paradigm for archeological analysis and interpretation to southeast Texas. This geographically-based element creates analytical units which are based on the assumption that one can regard for the purposes of archeological interpretation the divisions between watersheds as direct expressions of technological, social and cultural divisions within the superficially homogeneous southeast Texas of the Ceramic Period.

**Definition of the Model**

Since any successful archeological model must have a succinct and catchy name, I will henceforth refer (with apologies to Story) to the "Mossy Grove Model" of long-term forager-collector adaptations in inland southeast Texas. The model may be defined thusly:

**Area of application:**

1. The broad region of the model's potential application is that of the "Mossy Grove" sandy paste ceramic tradition of southeast Texas as defined by Story (Story *et al* 1990: 256).

2. The core area of the model's current application within the Mossy Grove tradition is the network of short streams which all flow into Galveston Bay, as well as the adjoining streams to as far west as the
Brazos River. This Study Area encompassed most of the historically documented inland Akokisa territory as well as a portion of that of their ethnically undefined neighbors to the west. This Study Area, not coincidentally, also encompasses major and minor excavations as well as numerous surveys carried out by Moore Archeological Consulting.

**Mossy Grove model definition:**

1. Following Aten and others, that the Akokisa and related Mossy Grove groups encompassed within the Study Area were "dispersed in small, [minimal] band-sized or less groups in the warm seasons, and were aggregated into [maximal band] villages during cold seasons" (Aten 1983:319).

2. Again following Aten, that stability of the system in the face of growing population was maintained principally by a process of maximal band fissioning and the consequent budding off of new villages. The fundamental Mossy Grove social organization could thus replicate itself when the need arose without undergoing radical alteration.

3. The maximal band/village budding formation process would in turn promote the formation of multiple layers of social boundaries dividing band from band and groups of inter-related bands (through fairly recent common ancestry) from less closely related or unrelated groups of bands (i.e., other tribes) participating in the same broad Mossy Grove technological tradition.
4. Underlying the maximal band/village and tribal levels of social boundaries would be those associated traditionally with minimal band (i.e., lineage) units.

5. Each maximal band/village social unit would (especially within its own territory) generate a continuum of functional site categories which reflects the Mossy Grove position on the forager-collector continuum and the minimal band/maximal band seasonal round.

6. Prehistoric occupation for the whole of the Ceramic Period in this study region is focused upon stream channels as the loci of settlement. Intervening areas of forest and especially prairies are essentially devoid of significant settlement (Freeman and Hale 1978; Moore 1991:Appendix I). Thus, components of the inland Mossy Grove site category continuum can be found arrayed principally along these stream channels.

7. The previously perceived cultural conservatism of the region in terms of settlement patterns, broad technology and subsistence (Patterson 1983) bespeaks a degree of cultural stability that might make analysis based on watershed divisions justifiable.

8. This very cultural conservatism and continuity masks real cultural, social and technological divisions within the region; and,
9. It is reasonable to assume, given the posited Mossy Grove social organization and the long-term technological, subsistence and settlement stability of the region, that these streams would come to both define and reflect linear, socioculturally meaningful territories of stable occupation within the region. (In plainer terms, that social boundaries would distinguish the folk who habitually live on Spring Creek from those others who live down on Greens Bayou.)

10. Given that assumption, we may utilize stream drainages and their subdivisions to create geographically-based analytical units which are hypothesized to replicate extinct social boundaries.

11. Hypotheses concerning prehistoric behaviors may be generated based on the logical assumption that the archeological record will reflect, to varying degrees, the divisions between the layers of social boundaries exhibited in the Mossy Grove cultural system. These hypotheses will generate archeological expectations which may be tested via the measurement of archeological variation between the linearly-arrayed, geographically-mandated watershed analytical units which partition the archeological record.

Thus, I postulate that a map of the stream drainages in inland southeast Texas simultaneously represents a map of the sociocultural relationships between the prehistoric peoples of the region. Looking below the major divisions between the watersheds, one might find variations which are to some degree congruent with tributary order within a single drainage. These may be functional differences rather than of
differing social groups; the people on Spring Creek, for example, may move up Cypress Creek (a westward-extending tributary channel) to establish temporary hunting camps to provide access to the bison when they are on the surrounding prairie.

I should not hesitate to admit that the watershed analysis aspect of the Mossy Grove Model is naive in some of its assumptions. However, its hoped-for utility is not so much predicated on its ultimate validity as it is upon the model's capacity to generate testable hypotheses. One can quite readily define a theoretical hierarchy of expected social relationships on the basis of the physical relationships between watershed units and test this hierarchy against field data. For example, under the Mossy Grove Model one would expect sites along Spring Creek (a first-order tributary of the West Fork of the San Jacinto River) to be more closely related to sites on the San Jacinto than to sites on Buffalo Bayou and its tributaries. Moving to a more important physical threshold, sites on all the streams tributary to Galveston Bay should be more closely related than the sites of the Trinity River to the east or the Brazos River to the west. I will attempt, to the extent that available data permits, to formulate and test such hypotheses below.

Again, it is really of rather secondary importance whether an arbitrary watershed-based model of social relations is exhaustively valid for Mossy Grove occupation in southeast Texas. The model is principally an interpretive tool, one that gives us a framework for perceiving variability in archeological data (Bettinger 1993). As such, it can be as instructive in failures of its application as it can be in its successes. The model has superseding value if it will permit the integration and meaningful interpretation of data, especially that drawn from diverse sets such as that generated by contract archeology and avocational archeologists. Further, it defines a paradigm for the interpretation of
forager-collector sites which may prove fruitful in application far beyond the confines of southeast Texas.

I initiated the discussion of the Mossy Grove Model by stating that its two critical foci were the watershed analytical model and the application of middle-range forager-collector spectrum theory (especially Binford 1980) to southeast Texas site data. Thus far explication of the latter focus has been limited. I have suggested that the Mossy Grove settlement system exhibits a trimodal continuum of functional site categories, and that the fundamental generator of this site continuum is the maximal band/village social unit. Further, the continuum of functional site categories finds its origin in the position of the Mossy Grove system on the forager-collector continuum and in the minimal band/maximal band seasonal round of dispersal and aggregation. The archeological justifications for these sweeping assertions, as well as corollary interpretations will be dealt with as a consequence of the examination of three "exemplary sites," 41FB200, 41HR616 and 41HR755, each investigated by Moore Archeological Consulting. (I might note that these sites are termed 'exemplary' rather than 'type' sites to emphasize their position on a continuum and to avoid the intellectual baggage that 'type site' implies.)

These three exemplary sites (plus others cited from the literature) are examined in an attempt to define the universe of site types in the inland Southeast Texas region. Each of these classificatory exercises is relevant to our assessment of the proper place which the Ceramic Period residents of the region should occupy on the forager-collector continuum. The three sites are exemplary because, within the Mossy Grove model, they are held to represent each mode of a trimodal division of the Mossy Grove settlement continuum into residential base camps, residential camps and locations.
Data from these and other sites will be examined from a number of perspectives in order to secure insights into the extent of logistical activity and bulk procurement carried out in the subsistence/settlement system and factors which might have promoted the stability of the hunter-gatherer lifeway pursued within the Study Area. In addition, data from the sites will provide for an initial examination of the thesis that archeological variability will become visible and comprehensible when it is viewed from a watershed-partitioned perspective.
8. Justifications for a Watershed Perspective

Since much in the Mossy Grove Model is contingent upon the professed linkage between prehistoric groups and the streams they are argued to reside in proximity to, it is necessary first to use archeological data to demonstrate that the association between prehistoric occupancy and stream channels is real. This justification will be established quantitatively through study of archeological sites along Cypress Creek, a tributary of Spring Creek and hence the West Fork of the San Jacinto River in the northern portion of the Study Area. This analysis will also endeavor to identify a suite of essentially stream-related topographic variables which influenced prehistoric site location.

Cypress Creek Settlement Analysis

The author has been involved in a long-term analysis of inland settlement patterns in the southeast Texas region based in part on his work in the Cypress Creek drainage (Moore 1985b, 1988b, 1992). The current settlement analysis is based on a rigorously designed, statistically valid 20% sample survey of the drainage conducted in 1978 (Freeman and Hale 1978). The data from this survey are considered critical to an understanding of area prehistoric settlement patterns because the Cypress Creek survey has been the only drainage-wide project conducted to date in the region which systematically included both floodplain and upland sampling strata. The initial survey data have thus been updated as work by the author has identified ten additional sites within the original 20% sample tracts (Moore 1985b, 1988b, 1992).
This review and re-analysis of the Cypress Creek settlement system seeks to examine the following variables in site location:

1. Preferences in prehistoric settlement between forested and prairie environments,
2. Preferences as reflected in floodplain versus upland site distributions,
3. Preferences in proximity to sources of potable fresh water,
4. Patterns of site frequency and density along the watershed, and
5. Locational preferences in regard to soils and topography.

The 1978 survey by Hale and Freeman was based on the selection of 60 sample units which constituted a 20% sample of the Cypress Creek watershed. This sample was systematically stratified to cover the length of the drainage and to ensure the inclusion of roughly equivalent areas of uplands and floodplain. Site data were also broken down by stream mile, enumerated from the Cypress Creek headwaters at stream mile 54 to stream mile 0 at the confluence of Cypress Creek and Spring Creek. The further survey work conducted by the author has resulted in the identification of 2 additional sites within Hale's (Hale and Freeman 1978) Sample Unit 228, 1 additional site within Sample unit 216, and 7 sites within Sample Unit 152 (Table 10). We shall first simply
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*Square Kilometers

enumerate the revisions to their summary observations resulting from the discovery of these new sites within the sample universe:

1. The total number of sites identified within the 20% survey sample is increased to 48 sites.
2. The total number of sites identified by shovel testing increases from 16 sites (42% of the total sites identified) to 26 sites (54%).

3. The number of floodplain sites increases from 36 sites (94.7% of total sites identified) to 46 sites (95.8%), while the number of upland sites remains unaltered at 2.

It should be noted that all sites located in this survey are treated as if they were coeval. I have little choice in treating these sites as though they were all occupied essentially simultaneously, since chronologically diagnostic artifacts are unavailable at many of the sites. However, I believe that this assumption is justifiable, at least at this initial level of investigation. This based on the following:

1. Most of the sites that have been dated can be ascribed to the Ceramic Period, and it is unlikely that most of the undated sites are from the Ceramic Period (or at least have Ceramic Period components) since they are by far the most numerous and commonly preserved sites in the broader Southeast Texas region.

2. There is considerable evidence for conservatism in subsistence, settlement, and technology from the Archaic through the Late Ceramic periods in Southeast Texas (Aten 1983).
The first culturally meaningful issue of settlement preference to be discussed in the current analysis deals with site location in forested versus prairie environments. Freeman and Hale (1978:39-40) state that stream mile 36 (approximately at U.S. Highway 290) is the boundary between the riparian piney hardwoods to the east and the grassland prairie to the west. This boundary also forms an obviously significant line of demarcation in regards to prehistoric settlement; 46 sites, or 95.8% of the total sites identified within the sample universe, were located east of stream mile 36 within the riparian forest. It should be intuitively evident that this demarcation between forest and prairie was of cultural significance to the prehistoric occupants of the watershed with an overwhelming preference for settlement within the woodland.

The same site distribution figures coincidentally also represent a cultural choice between settlement in the uplands and settlement within the Cypress Creek floodplain; there are 46 floodplain sites (95.8% of the total sites discovered) and only 2 upland sites identified within the 20% survey. This distribution again obviously indicates that the prehistoric occupants of the Cypress Creek region strongly preferred to locate their encampments within the floodplain and its tributaries.

The presence of 95.8% of sites within the Cypress Creek floodplain likewise illustrates a strong preference for site location in relatively close proximity to sources of fresh water. One can immediately suggest that the simple presence of sites within the floodplain implies that they are located a short distance from current or former sources of water.
However, it is possible to quantify this variable from information in Table 3 of the
Freeman and Hale report; these data appear as Table 11 in this report. The distance to
water in the second column of this table is derived from the distance to Cypress Creek or
the distance to any old creek meander or tributary gully associated with a particular site,
since the old meander or tributary could have, likewise, served as a proximate source of
water. The distance to the current Cypress Creek channel is given in the third column of
Table 11.

It is apparent from Table 11 that proximity to a source of fresh water is indeed a primary
cultural consideration in the location of prehistoric sites in the Cypress Creek region.
Disregarding one anomalous upland site outlier, the maximum distance to water is 250
m, and the mean distance for all sites is 55.66 m. The maximum distance to the current
channel of Cypress Creek is 3300 m, and the mean distance for all sites is 164.49 m.
Over 81% of all sites are located less than 150 m from a source of potable water. The
distribution of distances to water appears graphically in Figure 4.
Table 11. Distance to Water from Cypress Creek Sites.

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<th>Distance to Creek (meters)</th>
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Table 11. (continued).

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<th>Distance to Creek (meters)</th>
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As I have suggested, the abrupt drop-off in sites, which occurs as one moves west into the prairie environment, implies that the prairie was strongly selected against in the placement of prehistoric sites. Thus, the dichotomy of forest versus prairie may well be the dominant settlement rule in the Cypress Creek region. There is apparently a very strong cultural factor that mitigates against the location of prehistoric sites in the open prairie environment west of U.S. Highway 290.

It must be conceded, however, that the settlement variables of forest versus prairie, floodplain versus upland, and distance to water, are not truly independent variables east of the prairie boundary since the banks of Cypress Creek are uniformly wooded, and floodplains are naturally found only adjacent to streams. We would have to look at settlement patterns outside the Cypress Creek drainage in a more completely forested region to determine conclusively the strength of proximity to water as an important variable in seeking a preferred settlement location. That is beyond the scope of this report, but my experience in the region suggests intuitively that proximity to water is
Figure 4. Distance from Water to Cypress Creek Sites.
indeed the second order settlement rule in the selection of site locations east of the prairie boundary.

We have thus far been able to define a preferred Cypress Creek settlement zone based on the co-occurrence of forest, floodplain, and proximity to water. We may now utilize the data from the Freeman and Hale (1978) 20% sample to examine variables of site frequency and density within that preferred settlement zone. In the original survey report Hale and Freeman employed a simple plot of site frequency per stream mile between the mouth of Cypress Creek (stream mile 0) and the headwaters of the creek (stream mile 55). This graph was notable for the presence of several gaps in site distribution within the forested portion of the watershed. A version of this graph incorporating the 1992 data on site distribution appears as Figure 5.

It was reasoned that a more meaningful view of site distribution could be obtained by examining site distribution by sample unit rather than stream mile across the preferred settlement zone. This line of analysis would permit the calculation of site densities (number of sites per square kilometer) for each sample unit within the region. And, since the sample units are arrayed in sequential numerical order along the drainage, this approach yields results on site distribution which are comparable to the use of stream mile intervals to subdivide the watershed linearly (Figure 6).
Table 12. Floodplain Site Density per Cypress Creek Sample Unit.

<table>
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<tr>
<th>Sample Unit</th>
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<th>Sites Per Square Kilometer</th>
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Table 12. (continued)

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Figure 5. Number of Floodplain Sites per Stream Mile Along Cypress Creek.
Figure 6. Number of Floodplain Sites per Sample Unit Along Cypress Creek.
Figure 7. Site Density per Sample Unit Along Cypress Creek.
Floodplain site densities per sample unit can be calculated from information contained in Table 1 in the Freeman and Hale (1978) report. Site density data are potentially quite informative, since it automatically corrects for variations in the amount of land surveyed at various points and within various sample units along the drainage. These data are presented in Table 12 and Figure 7 of this report. The possible significance of this correction is apparent when one looks at Sample Unit 216. While this relatively small floodplain sample area (0.315 square km) produced only three sites, the site density within the unit (9.523 sites per square km) approaches that of one of the numerically most productive units, Sample Unit 182. This sample unit yielded seven sites in a floodplain survey area of 0.730 square kilometers for a site density of 9.59 sites per square kilometer. Viewed from the perspective of site density, Freeman and Hale's (1978:38) qualified recognition of a "consistent but relatively low frequency of site occurrence" between stream miles 0 through 12 becomes questionable.

To fully examine this issue, however, we must evaluate the relationship between the number of sites identified and the amount of floodplain surveyed. If floodplain site density is, in fact, constant across the drainage, then the frequency of sites per sample unit will simply be a direct function of the amount of floodplain area surveyed per unit. This analysis has been accomplished by the creation of a scattergram of the floodplain area surveyed per unit (X) versus the number of sites located in that unit (Y) and the
calculation of the coefficients of correlation (r) and determination (r²) for the resulting graphed values.

For this graph (Figure 8), I have elected to include those sample units between stream miles 33 and 54 (west of U.S. Highway 290), coinciding mostly with the very sparsely inhabited grassland prairie portion of the Freeman and Hale (1978:40) survey area. These survey units are plotted to further illustrate that their distribution is clearly divergent from that of the downstream piney hardwoods; here, it is intuitively evident that sites are so scarce that variation in the amount of floodplain surveyed has almost no effect on the probability of locating sites. Floodplain survey areas per sample unit in this portion of the Project Area ranged from 0.001 square kilometers to 1.0 square kilometers (mean = 0.512 square kilometers), but only three floodplain sites (those restricted to the eastern, downstream end of the segment) were located.

Isolating the more productive downstream portion of the Project Area (east of U.S. Highway 290), a graph seems to intuitively indicate that a relationship does exist between amount of floodplain surveyed and number of sites identified. Indeed, with 21 degrees of freedom the correlation coefficient value of \( r = 0.6911 \) indicates that we can entertain a 99.9\% level of confidence that the correlation between the variables was not the result of chance. However, this correlation does not mean that the number of sites per sample unit was merely a function of the size of the survey area per unit. The
Figure 8. Number of Sites Versus Amount of Floodplain Area Surveyed.
coefficient of determination value of $r^2 = 0.4776$ indicates that the size of the Project Area explains only 47.8% of the variance in site numbers observed per unit. Thus, we can return to the evaluation of the meaning of the graph of site density per sample unit (Figure 7). This investigator would argue that the balance of the variation in site densities noted is the result of cultural and environmental factors (settlement rules), variation in the effectiveness of site discovery methods, or differential site preservation.

While variations based on cultural and environmental rules for site location are of primary interest to this inquiry, I believe that a very significant portion of this variation can be accounted for by differing rates of success in site discovery based on the presence or absence of shovel testing and the intensity with which the technique is applied. Shovel testing was employed only in certain areas of the original Freeman and Hale survey sample. In contrast, intensive shovel testing was responsible for the location of all ten new sites found by this investigator. This intensive shovel testing has thus accounted for 21% of the total floodplain sites identified in less than 1% of the total floodplain area surveyed. Such figures strongly suggest at least that the total number of sites in the drainage is much higher than one would expect from the Freeman and Hale survey data alone and that further intensive shovel testing would fill in the gaps in site distribution along the creek.

We may further pursue for the moment the topic of estimation of the number of sites in the drainage based on intensive shovel test data. In extrapolating to portions of the
watershed outside of Freeman and Hale's systematically designed sample universe, we are, of course, entering into the realm of speculation. However, in the light of the discovery of seven sites in the intensive Telge Park survey (Moore 1992), it is relevant to present an overall picture of known site distribution in the Cypress Creek watershed.

While each of the recorded sites is considered low-density or diffuse in terms of artifact recovery, it must be noted that the site density is remarkably high within the Telge Road Park tract when compared with previously surveyed areas of the Cypress Creek floodplain. Given that 100% of the Project Area is within the floodplain, the demonstrated site density is 0.08234 sites per acre or 0.2035 sites per hectare. The latter figure yields the density of 20.35 sites per square kilometer of floodplain. This figure compares with an average of 3.264 sites per square kilometer for Freeman and Hale's (1978) 20% survey of the drainage as adjusted for the additional sites found within the 1978 sample units by the author in his Mercer Arboretum and Cypress Creek Golf Course surveys (Moore 1985a, 1985b, 1988). Indeed, the most productive previously surveyed 1978 sample unit yielded a site density of 9.88 sites per square kilometer. The current 20.35 sites per square kilometer figure thus falls far above the high end of the range calculated on the basis of Freeman and Hale's sample data and seems to confirm that we can expect many sites (especially small sites) to be located along the unsurveyed portions of the Cypress Creek drainage.

It would seem justifiable for the sake of argument to assume that this site density figure is representative of floodplain site distribution for the entire watershed east of stream
mile 36. If we similarly assume (with better justification) that the total floodplain (9.068 square kilometers) surveyed in Freeman and Hale's (1978:Table 1) 20% sample is equally representative of the total floodplain area in the drainage, we can calculate that the total floodplain area in this segment of the stream is 45.34 square kilometers. Based on this figure and the 20.35 sites per square kilometer density, we can boldly estimate that about 922 prehistoric sites can be expected to have existed between the confluence of Spring and Cypress creeks and the intersection of Cypress Creek with U.S. Highway 290.

This assertion of a uniform high site frequency and density across the forested portion of the watershed is based, of course, on the assumption of a likewise uniform distribution of the environmental factors which were selected for culturally by the prehistoric inhabitants of Cypress Creek. We have thus far isolated riparian forest, proximity to water, and selection of floodplain locations in preference to the uplands as environmental factors selected for by these denizens of Cypress Creek. Each of these environmental factors are essentially broadly linear in character and can be assumed to be uniformly distributed along the drainage. The specific location of sites within this uniform forested/floodplain/close-to-water zone must thus either be the result of chance or the distribution of additional, as yet unidentified environmental factors. These environmental factors would result in the selection of specific locales for prehistoric site locations within the desirable forested/floodplain/close-to-water zone.
The fact that additional survey is in the process of filling in the gaps noted by Freeman and Hale in the site distribution along Cypress Creek suggests that if environmental factors control specific site locations, then these environmental factors are, in fact, relatively uniformly distributed up and down the forested portion of the watershed.

I can suggest that one of these factors is well-drained soils; another lopsided distribution is evident when we contrast well-drained soils (principally sands through sandy loams) with poorly-drained soils (principally clay loams through clays) as defined by the United States Department of Agriculture, Soil Conservation Service (USDA-SCS) in Wheeler (1976). When sorted by these soil criteria, 43 sites (89.6%) are located on well-drained soils, while only 5 sites (10.4%) are situated on poorly drained soils. These soils are found in discrete bodies, but these bodies are distributed relatively uniformly along the Cypress Creek watershed.

Topographic position can be expected to be another variable in site location which reflects cultural preference. It is possible to broadly group the Cypress Creek sites into categories based on their topographic situation. The distribution of sites sorted along these broad categories is presented in Table 13:
Table 13. Topographic Context of Sites.

<table>
<thead>
<tr>
<th>Category</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling Prairies</td>
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</tr>
<tr>
<td>High Terraces</td>
<td>21 sites</td>
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<tr>
<td>Low Terraces</td>
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<tr>
<td>Floodplain Ridges or Mounds</td>
<td>14 sites</td>
</tr>
<tr>
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<td>1 site</td>
</tr>
</tbody>
</table>

We can further lump floodplain sites into two categories which seem to reflect cultural preference. These are low-lying versus elevated sites. We may combine high terraces and floodplain ridges or mounds to yield a category of sites which are elevated above the base level of the floodplain. We find that of the 44 sites, 35 (79.5%) are elevated. It, thus, seems reasonable to conclude that high ground was a preferred locality for site location.

To review, we have defined a hierarchy of settlement decisions based on cultural preferences for the following:

1. A preference for site locations in forested environments.
2. A preference for site locations in the Cypress Creek floodplain.
3. A preference for site locations in proximity to sources of potable water.
4. A preference for site locations on well-drained soils.
5. A preference for site locations on topographic high points.

This set of rules may seem simple to the point of being trivial, but it is felt that they effectively represent the dominant factors in site location on Cypress Creek for at least the last 1300 years of prehistory. Thus, while they may be simple, they are hardly trivial. I believe that, having adequately defined the issues which influenced site location, we may now turn our attention towards such issues as measures of site size and complexity as reflections of the operating settlement system.

**Hunter-Gatherers and Rivers**

I find that Griffin's comments regarding the Agta of Northeastern Luzon and riverine-oriented settlement by hunters and gatherers (1984:104-105) are so close to the issue as to bear repeating:

Settlement, dispersal for subsistence, and social identification all begin with flowing waters. Rivers, or sections of rivers and their tributary streams, are the principal foci of identification of one's origins and belonging. Rights to live along the river, to exploit it and surrounding areas, and to restrict other Agta who are not so identified follow from location of one's own birth, one's parents births, and of one's childhood years. Each Agta regards himself as coming from a certain river drainage system, and through residence in adulthood may not coincide with this system, one nevertheless remains associated with it, though not with a clearly defined territory.
Dialect groups do not covary with explicitly defined and delimited sets of rivers but do amalgamate units of extended families residing on adjacent rivers. At this level the Agta system exhibits its greatest fuzziness and allows no clear boundaries to be marked. Some clarification can be obtained by moving back to the single-river system, where one or more extended families may reside, depending on the size of the river, fortune and misfortune of the local population, and external environmental impacts. The extended family lives in nuclear-family residential dwellings, either small rainy season pole houses or lean-tos, and two to six houses comprise the cluster.

Bettinger (1991a:71) discusses the Great Basin Reese River and Owens Valley Paiute, groups which are identified by their association with particular stream valleys. These groups are more meaningfully distinguished by exhibiting differing positions on the forager-collector spectrum, certainly implying that the geographical distinctions mark significant cultural distinctions as well.

I cannot close this anecdotal discussion without relating that one of the two possible translations for Akokisa given by Swanton (1979:216) is "river people." (The other is "western people.")
9. Site 41HR616

Site 41HR616 is a prehistoric site located on the north shore of the West Fork of the San Jacinto River in northern Harris County. The site size is about 40 x 40 meters and is located on a low terrace or bench above the present waters of Lake Houston. The site was located during a survey of the West Lake Houston Parkway alignment conducted by Moore Archeological Consulting on November 4 and 6, 1988 (Moore and Pettus 1988). The site was identified through the recovery of cultural material from three shovel tests within the right-of-way. These tests produced lithic debitage and two sherds of aboriginal ceramics to a depth of approximately 85 cm below the ground surface.

The Harris County Engineering Department determined that site avoidance was not a feasible option with respect to the Kingwood site. Therefore, National Register eligibility test excavations were conducted by Moore Archeological Consulting in December, 1988. Eight 1 x 1 meter test units were excavated to a depth of almost two meters. Results of this test excavation have been fully reported in Moore Archeological Consulting, Report of Investigations Number 26 (Moore 1989b). Testing revealed that the Kingwood site is a relatively intact, stratified site which has the potential to reveal new information concerning the Ceramic period prehistory of the San Jacinto River drainage. The site was thus considered potentially eligible for inclusion in the National Register of Historic Places, and intensive data recovery excavations were recommended prior to the construction of the West Lake Houston Parkway. A site map depicting excavation units appears as Figure 9.
Figure 9. Site Map of Site 41HR616.
An archeological research design for a data recovery excavation program at the
Kingwood site was developed in consultation with the archeological staff of the United
States Army Corps of Engineers, Galveston District, and the federal Advisory Council
on Historic Preservation. Moore Archeological Consulting conducted extensive
excavations at 41HR616 in September and October, 1989. In all, 54 test units (1 x 1
meters) were dug in six block excavations.

Data recovery excavations were placed utilizing the grid established during testing phase
evacuations at the site, overlain on the topographic map created during the testing phase.
The grid for site 41HR616 had been established to approximately parallel the right-of-
way of the proposed West Lake Houston Parkway. Horizontal control stakes remaining
from the earlier excavations were relocated in order to re-establish this grid. The entire
site lay within the northwest quadrant of the grid. A primary elevation control datum,
assigned an arbitrary elevation of 100.00 meters, had been set during testing by driving a
nail into a large pine tree near the approximate center of the site. This datum was,
likewise, relocated for use during the data recovery phase excavations.

Manual excavation was conducted by arbitrary 10 cm levels in the apparent absence of
physical stratification of the site. Level 1, containing a thick mat of surface roots and
recent historic trash, was discarded without screening since testing data indicated that
the upper boundary of the cultural deposits was buried more than 20 cm below the
surface. Vertical control within the excavation blocks was maintained by transit
measurement relative to the primary elevation datum. A daily log of instrument height
was maintained. original ground surface elevations were taken at each 1 x 1 meter unit
corner prior to excavation. All horizontal measurements were made relative to the metric
grid with the southeast corner providing 1 x 1 meter unit designations.
Shovel skimming was the predominant method of manual excavation employed in the uniformly sandy deposits at 41HR616. Skimming was carried out in thin, successive sweeps (1 cm or less) across the entire unit surface to maintain level floors in which stains, features, and artifact concentrations could readily be observed. Trowels were employed when circumstances warranted and to clear unit floors prior to drawing and photography. Munsell soil color readings were taken at the completion of each level. Excavated soil matrix from each unit level was placed in a wheelbarrow along with a plastic provenience tag and carried to the water screening station on the bank of Lake Houston.

All matrix was water screened through 1/16 inch hardware cloth. Water for screening was pumped directly from Lake Houston via a two inch gasoline powered pump. All screen residue was collected in drying flats and then bagged. Material from each discrete excavation provenience was bagged separately, and each bag was assigned a unique field sack number from a running log. Excavation was ceased when, in the judgment of the Principal Investigator and Field Director, the base of the cultural deposit had been reached.

Basic documentation of the excavation was carried out through the use of level record forms and field notes. A unique level record form was maintained for each 10 cm level of each 1 x 1 meter unit within the excavation blocks. The level record forms included plan maps including artifact and soil stain plots for each level. The unique field sack number for each excavation unit/level was recorded on the level record form. These field sack numbers thus provided a redundant cross-reference for provenience data. All animal burrows, root trails, and other soil stains were plotted on the level record forms.
Stratigraphy was recorded through profile drawings and descriptions as well as black-and-white photographs and color slides. Profiles were executed of at least one wall of each excavation block. These profiles were drawn on metric graph paper and measurements were made relative to a level line. The elevation of this level line was established by transit measurement.

Radiocarbon samples were collected whenever carbon was judged to be present in sufficient quantities to permit dating. These samples were collected without contact with the excavator's hands and were wrapped in aluminum foil prior to bagging. A record of these samples was maintained on a project radiocarbon log.

Soil matrix column samples were collected for potential later analysis. The locations of these samples were noted on excavation profiles. Each sample was given a unique field sack number as recorded on the project field sack log.

Screen material residue arrived at the laboratory in a dry state in the original field sacks. Due to the sandy soil matrix at the site and to the water screening process, artifact washing was not required. The screen residue was next sorted and rebagged by categories which consisted of aboriginal ceramics, lithic tools and utilized flakes, lithic debitage, bone shell, floral material, dispersed charcoal, gravel, burned clay, and historic artifacts.

Approximately 800 excavation levels (10 cm) were excavated in 54 units (1 x 1 meter) during data recovery at 41HR616. The site was moderately productive in terms of cultural materials recovered, yielding a total of 127 lithic tools, 7391 flakes, and 726
Figure 10. Graph of Artifact Recovery at Site 41HR616.
Figure 11. Contour Map of Debitage Distribution, Site 41HR616.
Figure 12. Contour Map of Ceramic Distribution, Site 41HR616.
analyzeable sherds in addition to minor amounts of faunal and floral material, charcoal and fired clay fragments. The artifact return is illustrated in Figure 10, an artifact recovery graph. An average of 153 artifacts were recovered from each 1 x 1 meter unit. Eight radiocarbon assays were submitted from the site and seven were accepted for analysis.

The investigators elected to terminate most units at Level 15. Deeper tests in selected units produced very sparse artifact recovery. This minimal recovery could easily be ascribed to downward migration of a few artifacts due to the effects of bioturbation. No evidence of pre-ceramic occupation was disclosed at the site.

No features were disclosed in the excavation and very little of the frequent Upper Texas Coast hearth-lining constituents of fired clay balls, caliche nodules, or fire-cracked sandstone were recovered. No evidence of discrete occupational surfaces was discernible. Intrasite artifact patterning was weak and variable from level to level when viewed on a simple artifact distributional basis. Gross artifact distributional patterning is visible only when total artifact recovery from the site is examined (Figures 11 and 12). However, some patterning becomes evident at a higher level of analysis. Lithic studies (Ensor, Appendix IV) indicates that the density of formal lithic tools is significantly higher within excavation Block E. Further, Ensor has identified a possible horizontal segregation of the Early Ceramic component to Block B and the Late Ceramic component to Block A based on differential lithic reduction stage distribution.

This excavation, consistent with the prior testing results, disclosed that the soils at 41HR616 consist of an unbroken column of two or more meters of fine sand. The origin of these sands is principally ascribed, based on the presence of pea-sized gravel in the matrix, to alluvial deposition. It is also possible that alluvial soil deposition was
supplemented, at least occasionally, by colluvial or eolian deposition. No clear-cut
evidence of erosional episodes was present.

Virtually all of the visible soil stratification at site 41HR616 is restricted to color changes
and is pedogenic in origin. Soil stratigraphy was relatively uninformative at 41HR616.
The soil zones, an expression of pedogenic phenomena, could not be related to
depositional events of cultural or chronological significance. An attempt to segregate soil
depositional events via grain size analysis during the testing phase excavation was
unsuccessful.

Gravel weight per level from the testing phase exhibited a multi-modal distribution which
suggested that these peaks might represent discrete depositional episodes which could in
turn be related to the cultural stratification at the site. However, data from the current
excavation rather strongly suggests that these peaks were merely an artifact of sampling
error. No such distinctive peaks are visible in a graph of gravel weight by level from the
data recovery excavations. Thus, our second attempt to determine a physical
stratigraphic corollary to the cultural stratification at the site met with failure.

However, the gravel study is not wholly without merit. The apparently continuous and
relatively constant deposition of gravels does support the general model of site
formation. The continuous deposition of river-transported gravels tends to confirm the
hypothesis of the site forming by aggradation within an alluvial depositional environment.
The absence of observed gravel “pavements” (which would be reflected as spikes in the
distributional graph) additionally suggests that the site has not been subjected to periods
of extensive erosion and deflation. Such erosion and deflation would have served to
concentrate the gravels within the eroded matrix upon the erosional surface.
Physical evidence of bioturbation at 41HR616 was limited. Krotovina were scarce, though they might well have been leached out of the very permeable soils. Skeletal remains of pocket gophers were absent from the recovered faunal taxa despite fine mesh water screening of 100% of the matrix. Again, however, the absence of these remains may be a consequence of the character of the soils at 41HR616 since faunal preservation at the site was presumably very poor. Burrowing animals are not currently active at the site. An irregular base to the visible soil stratification may be ascribed to disturbance by tree falls.

While projectile point data do not offer a reliable means for establishing site stratigraphy, it can be observed that the placement of Catahoula points below Perdiz/Cliffton points and the tendency for Gary and Kent dart points to be situated in Level 8 or below are consistent with the generally accepted sequence for these points. Further important evidence regarding site integrity can be derived from the analysis of ceramic sherd fitters (Ellis, Appendix V). Of the 110 fitters with old breaks, only two sherds were paired with non-adjacent units from different levels. As Ellis observes (Moore 1994b:87),

cross-mending of sherds indicates only minimal displacement of sherds after initial deposition....The observed occurrence of cross-mended sherds argues against any significant vertical mixing unless one is willing to argue that downward migration is was constant across the site.

Further evidence of site integrity can be seen in other aspects of the lithic and ceramic data. Ensor (Moore 1994b) asserts that a study of flake ratios indicates that site refuse is
in its primary depositional context. Further, the confinement of bone-tempered and Caddo ceramics to the upper 90 centimeters of the site is consistent with expectations for a Late Ceramic component and provides additional support for the stratigraphy integrity of the site. Likewise, the deep occurrence of a cord-impressed sherd (approximately 135 cm below surface) is consistent with the beginning with the Early Ceramic period.

While these lines of evidence indicate that vertical mixing at 41HR616 is limited, I would suggest that one must accept that a degree of interpretively confounding vertical displacement must be accepted as a given at sandy matrix sites on the Upper Texas Coast. First, I am in agreement with Enor’s assumption (Appendix V) that at a perfectly preserved multi-component site single types would be confined to a relatively restricted vertical position and that different point types would not co-occur at the same level. (Indeed, an attempt to circumvent the chronological uncertainties produced by the somewhat muddled stratigraphy of Upper Texas Coast inland sites forms a major focus of the concluding chapter of this volume.) Secondly, it is apparent from an examination of the depths at which historic artifacts were recovered in excavation blocks A and B some vertical displacement did in fact take place.

Primary among methodological advances presented in the 41HR616 excavation must be the significant methodological innovations presented in the lithic and ceramic technical analysis and cross-dating chapters (Appendices IV, V; Ellis and Ellis in Moore 1994b). Aside from its considerable substantive insights, the technological modes of analysis offer a model of one means to get beyond the constraints of strictly typological analysis in the study of prehistoric ceramics. Such an avenue for research is sorely needed in an
area where (as the cross-dating study [Ellis and Ellis in Moore 1994b] has demonstrated) conventional typologically-based seriation yields weak and ambiguous results.

To summarize the results of the inquiry, we have at 41HR616 a site dating to both the Early and Late Ceramic periods. Initial, primary, and secondary stage lithic reduction was carried out at the site. A suite of ceramic technological preferences has been identified with primary preference for medium sandy paste wares with floated/unburnished surfaces and fine sandy paste wares with floated/unburnished surfaces.

Moreover, Linda Wootan Ellis has demonstrated that these preferences were only two out of a wide range of previously unacknowledged technological alternatives. The overwhelming preference for these two manufacturing sequence options suggests that the potters sought to make standardized ceramics which had been found to be best suited for their intended function and that other less often selected suites of options may have produced vessels intended for different functions.

Ensor has made a strong case that the site was occupied by a fairly mobile population using the site as a residential camp over a considerable period of time. It appears to be rather more substantial than several residential camps previously investigated but qualitatively different from base camps as typified by the Alabonson Road site. He sees little change in the basic lithic tool kit and, by inference, in basic subsistence practices between the Early and Late Ceramic periods. He concludes by characterizing Southeast Texas prehistory as a record of the same basic hunter-gatherer lifeway of mobile populations shifting seasonally to take advantage of locally available resources.
Site 41HR616 and Mossy Grove Perspectives on the Forager-Collector Continuum and Settlement System Configuration

The data from site 41HR616 will now be utilized as a means of presenting a spiraling series of arguments supporting the development of some of the middle-range theoretical aspects of the Mossy Grove Model. The site will be examined particularly in relation to its position on the forager-collector continuum and to its implications for functional site classification within the inland Mossy Grove settlement system. These arguments begin with a consideration of subsistence and seasonality at the site.

We have some slight evidence as to the season of occupation at site 41HR616. The presence of reptile remains (snakes and turtles) suggests an occupation during the warmer months of the year (Story et al. 1990:271). McClure (Moore 1994b) has suggested that the charred hickory nut fragments and hackberry seeds were the byproducts of human consumption. These fruits suggest a fall occupation of the site, though the hackberry ripens in early September when reptiles are certainly still likely to be active (Texas Forest Service 1963:66). Thus, we may tentatively suggest that the site was inhabited throughout the fall season.

I have assumed that the relative scarcity of faunal materials at 41HR616 is the result of poor preservation. However, even given poor preservation, it is thought-provoking that bone is as scarce as it is at the site. It seems reasonable to expect that if bone was originally present in some considerable quantity that, given the extensive nature of the excavation and the employment of water screening, that we would have recovered larger numbers of small bone fragments. Thus, I will tentatively suggest that the scarcity of
faunal remains at the site reflects a functional difference in the nature of the occupation rather than exclusively an accident of poor preservation.

It is thus appropriate to entertain an alternate hypothesis for the small amount of bone material at 41HR616: that the subsistence emphasis at 41HR616 (and the site's *raison d'être*) is upon the collection of vegetal foodstuffs. The aforementioned charred hickory nuts and hackberry seeds offer a bit of direct confirmation of the local exploitation of floral resources as well as of a fall season of occupation for the site.

The absence of milling implements at 41HR616 may be taken as evidence against extensive exploitation of floral resources at the site (Story *et al.* 1990:271). However, if this floral emphasis is upon nuts, berries, fruit, and honey as Bement *et al.* (1987:8-6, 8-7) suggest for inland Bedais sites, then the need for milling stones might have been minimal. Rather, the use of storage containers such as baskets, skin bags, and pottery vessels might be a better material reflection of such a floral exploitation emphasis. While baskets and bags are hardly preserved at Southeast Texas sites (and not at all at 41HR616), we can posit that the quantity of sherds recovered at any site inevitably reflects in some fraction the importance of storage vessels at the site. Similarly, I can assume that the projectile points present at any site are directly related to hunting activities.

Given these simple assumptions, I can hypothesize that the ratio between the number of sherds and the number of points and point fragments will be a crude measure of the relative importance of floral versus faunal exploitation at any particular site; while a certain amount of pottery utilized for cooking and other non-food storage functions will be present at all but the most ephemeral Ceramic Period campsites, it seems an inevitable
conclusion that pottery will be present in a higher proportion in those sites where the storage of floral foodstuffs is an important subsistence component.

It must be acknowledged, of course, that few sites are likely to be exclusively floral or exclusively faunal in subsistence emphasis; thus, it is unlikely that the calculation of an exhaustive series of ratios would produce a clear bimodal distribution. However, the ratio values should reflect the relative importance of the two subsistence sub-systems. And the calculation of ratios for a series of sites should enable them to be arranged in a spectrum of relative values ranging from hypothetically primarily faunal to primarily floral in subsistence emphasis.

While the framework for analysis thus far described is a construct based on simplistic, logical hypotheses generated by a series of reasonable assumptions, it is important that the line of analysis is at least potentially amenable to independent testing. Direct comparison of ratio values to food residues would, of course, be possible at those elusive, ideal hunter-gatherer sites at which both plant and animal remains are well preserved. One avenue of independent testing available at site 41HR616 will be explored at the conclusion of this discussion.

We may now attempt an application of this method of intersite comparison. In order to make this test as unambiguous as possible, I have selected for comparison four inland Southeast Texas exclusively Ceramic Period sites at which the recovery of large volumes of faunal remains leave little doubt of the importance of hunting in the sites' spheres of subsistence activities. These sites are Alabonson Road (41HR273), reported on by Ensor and Carlson (1991); a White Oak Bayou bison kill site (41HR541), reported on by McReynolds, Korgel, and Ensor (1988); the Flat Bank Creek site (41FB99), reported on
by Kelly et al. (1986), and data from Block A testing at 41FB200 on Oyster Creek (in preparation by Moore Archeological Consulting). The outcome of the tests are reported in descending ratio values in Table 14 below.

Table 14. Comparison of Projectile Point/Ceramics Ratios at Selected Sites.

<table>
<thead>
<tr>
<th>Site Number</th>
<th>Number of Points and Point Fragments</th>
<th>Number of Sherds</th>
<th>Ratio Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>41HR541</td>
<td>4</td>
<td>79</td>
<td>4.8%</td>
</tr>
<tr>
<td>41HR273</td>
<td>567</td>
<td>13,391</td>
<td>4.1%</td>
</tr>
<tr>
<td>41FB99</td>
<td>5</td>
<td>140</td>
<td>3.4%</td>
</tr>
<tr>
<td>41FB200</td>
<td>30</td>
<td>1199</td>
<td>2.5%</td>
</tr>
<tr>
<td>41HR616</td>
<td>26</td>
<td>1644</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

While this test is, of course, limited in scope and tentative at best, the results seem to suggest intuitively that there is some merit to this framework for comparison. It is gratifying to note that the highest ratio value (4.8%) is recorded for 41HR541, the bison kill site. I can certainly assert on the independent grounds of the nature of the site that 41HR541 does in fact reflect an exclusive emphasis on faunal exploitation. A comparison of all of the values exhibits a steady, linear decline culminating in a figure of 1.6% for site 41HR616.

I can state without reservation that the projectile point/ceramic ratio has some relationship to site function; it is, of course, rather more speculative to assert, as I do here, that the ratio value is a reflection of the relative importance of faunal versus floral exploitation at any Southeast Texas inland site. This is obviously an avenue of analysis which requires much more exhaustive testing against the body of archeological data available for the region. However, it is equally obvious that there must be some systematic difference in site function between a site that exhibits a ratio value of 4.8%
and one for which that value is only 1.6%. Since we are very much in need of some method of differentiating site function in inland Southeast Texas, I believe that however naive, the application of the analysis is fully justified. I will go further out on a limb to suggest that additional analysis may suggest a ratio value (2.0%?) which demarcates the transition from a site with principal emphasis on faunal exploitation to one at which plant food collection is primary.

I can terminate this discussion with the citation of an independent line of evidence that faunal exploitation may have not been all that important at the site. Jacob (Moore 1994b) conducted a soil phosphorus analysis of samples from 41HR616. Those values were found to be perplexingly low. I would suggest, in closing, that these low values are an independent reflection of the fact that relatively few bones accumulated at the site since its prehistoric inhabitants were preoccupied with the collection and storage of nuts and other floral foodstuffs (which I will henceforth refer to for convenience as the “nuts-and-berries” subsistence focus).

In the preceding arguments, we have almost inadvertently crossed the line into the more complex realm of hunter-gatherer middle-range theory building. Since the crude attempt to relate artifact ratios to subsistence foci has brought us into the more treacherous, but potentially more meaningful, realm of establishing middle-range connections between archeological data at 41HR616 and past behavior, it is now appropriate to examine the site as a whole more explicitly in the context of established hunter-gatherer theory.

Any discussion of general hunter-gatherer middle-range theory must begin with Binford’s (1980) very influential “Willow Smoke and Dogs’ Tails” model, as we have already expounded upon at length. I will thus now endeavor to evaluate site 41HR616
in light of this model of settlement and subsistence organization. Fortunately I will not be obligated to try to shoehorn 41HR616 into either a “forager” or “collector” box; as Binford (1980:12) states, he does not mean to imply mutually exclusive polar opposites in defining these two strategies but rather “a graded series from simple to complex.” In making the assessment of the relative complexity of site 41HR616 and the settlement system in which it was a component, Binford (1980:12) suggests that “other things being equal, we can expect greater ranges of intersite variability as a function of increases in the logistical components of the subsistence-settlement system.” Thus, an attempt at recognition and refinement of regional site categories and in particular of site category classification of 41HR616 will be a part of this attempt.

Other thorny issues which are relevant to the placement of 41HR616 in its proper position on the forager to collector continuum include (1) the question of whether resource procurement at the site was “low bulk” (for immediate use) or “high bulk” (requiring storage and sufficient for use at another time and perhaps another place) and (2) whether the residents of 41HR616 were foragers “mapping onto” a resource by a residential move or collectors constituting a special procurement task force to supply their group with a particular resource. A level of uncertainty exists in both the interpretation of the material remains at 41HR616 and in the regional picture of Ceramic Period site typology to make the attempt to place the site in its proper context in regard to the Binford model a daunting task for this investigator.

The following appraisals will constitute our approach to the integration of 41HR616:

1. An assessment of environmental conditioning operating on the subsistence-settlement system.
2. An evaluation of site characteristics and formation which are relevant to a typological categorization of the site.
3. An attempt to grasp the extent to which logistical activities were carried out at 41HR616.

In an attempt to assess site 41HR616 in the light of this model we will begin by calculating the value of the site region's "Effective Temperature," Binford's quantitative measure of general resource potential. (Effective Temperature [ET] is a measure of the available warmth controlling for seasonal variations—and is hence a direct measure of plant productivity at any particular location.) Calculation of ET for Houston based on data on temperature data in Ruffner and Bear (1987) yields an ET value of approximately 15.9. With this value, 41HR616 sits at the cusp of the differentiation between predominantly foraging and increasingly logistical collecting modes of production (Figure 13). Thus, on the grounds of ET alone one would expect 41HR616 to be an expression of an overwhelmingly foraging-oriented system.

Reality is more complicated than ET would suggest, however. There are temporal incongruities with the nuts-and-berrries resource base in that despite our mild climate these resources are indeed only available seasonally. Similarly, there are spatial incongruities in that these resources (at least in regard to the bottomland nut component
Figure 13. Effective Temperature (ET) for the Study Area Region.
like pecans) are linearly arrayed along the riverine systems of the southeast Texas region. Further, the general Ceramic Period (and earlier) settlement pattern exhibits the overwhelming confinement of at least archeologically visible sites to the riverine forests of the region with very little visible settlement found on the intervening prairies (Freeman and Hale 1978; Moore 1992:Appendix I).

The following comment by Binford (1980:17) is highly relevant to this riverine-oriented linear settlement array:

with any condition that restricts mobility of either foragers or collectors, we can expect (among other things) a responsive increase in the degree of logistically organized production.

While waterways like the West Fork of the San Jacinto River form efficient prehistoric highways and thus potentially enhance mobility, a strongly riverine settlement orientation in some respects dictates that this axis of mobility can have considerable length but comparatively little breadth. This essentially two-dimensional axis of mobility would certainly constitute a restriction on mobility in the sense meant by Binford above. Add into the mix the temporal restrictions imposed by the seasonality of the nuts-and-berries portion of the resource base and the net result should be a fairly strong impetus toward logistical organization within the inland southeast Texas subsistence and settlement system of which 41HR616 was a component.

I alluded above to an essentially linear distribution of the nuts-and-berries plant resources exploited at 41HR616. Since this distribution of resources is discontinuous across the
broader landscape of riverine forests and intervening prairies it can be expected to create a tether to the riverine forest portion of the landscape. Such a tether would partly account for the fact that 41HR616 was reoccupied repeatedly over time. However, since the tether is (so far as we know) only to being near the river and not to a discrete resource patch, tethering is not sufficient in itself to account for the repeated reoccupation of the site over a very long period. Given the assumption of the continuous distribution of riverine resources along the West Fork of the San Jacinto and perhaps its tributaries, I would propose that considerations of central place must be the other factor conditioning the redundant occupation of the site. Consequent to this argument we would expect to find sites functionally equivalent to 41HR616 strung out at "comfortable" and roughly equal intervals along the river.

We may now turn to the issue of site type classification for 41HR616 and, more broadly, to an attempt to define the universe of known site types in the inland Southeast Texas region. Each of these classificatory exercises are relevant to our assessment of the proper place which the Ceramic Period residents of the region should occupy on the forager-collector continuum and to aspects of the Mossy Grove Model.

Site 41HR616 shares certain characteristics with a "location" defined for the forager system by Binford (1980:9) as "a place where extractive tasks are exclusively carried out." I would certainly argue that resource extraction was the reason for the site's very existence. Like locations tethered to a specific resource, the site is a repeatedly occupied palimpsest which has an accretional formation history and lack of much in the way of internal structure. However, the site differs importantly from a location in respects centering around Binford's use of the qualifier "exclusively." Site 41HR616 cannot by any lens be viewed as an exclusively extractive locus. There is entirely too much
evidence for a broader range of on-site activities (typified by the complete span of lithic production) to consider the site purely extractive.

With the addition of these elements of manufacturing and presumably processing, 41HR616 could qualify if viewed out of regional context as a residential base in a forager system (Binford 1980:9). I would argue, however, that while it is more than a location it is simultaneously less in one respect than a forager residential base: if the hypothesis regarding the scarcity of faunal material at the site is correct, then 41HR616 represents a locus of activities more specialized and less generalized than one would expect at a forager residential base. All things considered, however, I believe that the strongest evidence that site 41HR616 is neither a forager residential base or a location comes to light when one examines the regional context of the site. Simply put, this regional context indicates that there are too many known categories of sites to be accommodated by a purely forager subsistence and settlement model. The universe of inland site types initially defined by Ensor referring to 41HR530 on Langham Creek (McReynolds, Korgel, and Ensor 1988) and the Alabonson Road site (Ensor and Carlson 1991) and discussed by Ensor in the 41HR616 report (Moore 1994b) recognizes two site classes: Group I (residential) and Group II (base camps) posited on the basis of the presence or absence of a suite of qualitative variables.

While I believe (and will discuss below) that this site classificatory construct is too restricted to reflect archeological reality in the region, it is important for now to note that both of the classes of sites are residential in character and differ typically in “intensity” of residence as reflected in the qualitative range of activities taking place at the site. The simple fact that both classes of sites are recognizably residential in character yet are qualitatively distinguishable from one another offers strong evidence that a settlement
and subsistence system with a higher level of complexity than purely foraging-based was in operation in Southeast Texas during the Ceramic Period.

Ensor has classified 41HR616 as a site at the upper end of the Group I residential camp continuum. We currently have only one example, 41HR315 on Cypress Creek, of an excavated Group II base camp on the West Fork of the San Jacinto and its tributaries though 41MQ44 and 41MQ48, the Neidigk Lake sites on Spring Creek exhibited a high artifact density and may additionally qualify. Moreover, these sites are at the location identified by Bolton (1970:350) as the position of the historic Akokisa village of El Gordo. The very existence of four or five historic inland Akokisa village sites as discussed by Bolton (1970) offers strong support to the contention that a higher level of residential settlement than that represented by 41HR616 existed within the San Jacinto River watershed.

While we might not yet have an excavated example of a residential base camp on the West Fork of the San Jacinto, Ensor (McReynolds, Korgel, and Ensor 1988; Ensor and Carlson 1991) has definitively demonstrated that such a qualitatively and quantitatively distinguishable class of sites does exist in the broad inland Southeast Texas region. He classifies the aforementioned 41HR315 on Cypress Creek and the Doering, Kobs, and Alabonson sites, being within the Buffalo Bayou watershed as Group II sites. I would add site 41FB200 on Oyster Creek (discussed later in this volume) to this list on the basis of materials and features unearthed by excavations this site. Among the qualitative characteristics which may be present to distinguishing Group II residential base camps are a greater quantity and diversity of artifacts and materials as well as exotic items, hearths, and burials.
I have mentioned that I believe this two-fold site classification system conflicts with archeological reality in some respects. The reason I perceive a shortfall in the model is immediately relevant to the question of the degree of logistical activity in the inland Ceramic Period settlement and subsistence system. I would assert, based on extensive survey experience, that the classification system overlooks an important class of low visibility sites which are ephemeral in nature, rarely reoccupied and in all probability purely extractive in nature. In short, these sites are “locations” by Binford’s definition. (It must be kept in mind that Binford [1980] emphasizes that settlement complexity is additive: as a system transitions from the forager toward the collector end of the spectrum it retains the settlement elements that it had before as it adds to the more logistical ones.)

I am led to insist that this third element be incorporated into the settlement model by the outcome of numerous surveys in the region. These surveys, typified by work at Telge Park on Cypress Creek and to be discussed in more detail later, have located large numbers of small, ephemeral sites through the agency of intensive shovel testing. The Telge Park survey, for example, located seven small sites situated on pimple mounds. The density of artifacts at each of these sites was quite low but that in no means is an indication that they are insignificant. Rather, I am sure that they are a critical element of the subsistence and settlement system probably representing brief hunting camps based on the occurrence of an Alba point at site 41HR720. These sites, further, should be fine examples of “an assemblage accumulated over a short period of time, for instance a two-day camp [representing] a fine-grained resolution between debris or by-products and events” (Binford 1980:17).
There is one excavated site, the White Oak Bayou bison kill site (41HR541) reported on by McReynolds, Korgel, and Ensor (1988), which I would reclassify into this location category. The site is clearly ephemeral in duration, purely extractive in nature, and fine-grained in its resolution, meeting all of the essential criteria outlined by Binford (1980) for such a classification.

The importance of the addition of a location class to the settlement model for inland Southeast Texas lies in the fact that the reality of the class creates a settlement system which could be regarded as three-tiered, or perhaps more accurately trimodal, consisting of sites which can be principally classified as residential base camps, residential camps or locations. It should be obvious that as we recognize additional elements to the settlement system we must also acknowledge increasing complexity for that system. Thus, the addition of the location class to the prior two-level grouping supports the contention that there is some degree of logistical organization in the Mossy Grove subsistence and settlement system.

I argue that the generating social unit for the trimodal settlement array is the maximal band/aggregated village group, a social entity whose existence has been confirmed ethnographically for the Mossy Grove Study Area. Likewise documented is the seasonal round of the annual dissolution of these aggregated villages into their component minimal bands. This annual cycle is readily reflected archeologically in the formation of residential base camps (winter villages) and of residential camps like 41HR616 (minimal band camps). The existence of multiple examples of both residential base camp sites and residential camp sites (and of no 'higher order' of site) in the Mossy Grove Study Area is further a reflection of Aten's posited ability of the Akokisa to replicate socially by the process of maximal band fissioning and village budding.
We may now turn to the last element in our integration of the data from 41HR616 and its region into Binford’s “Willow Snake and Dogs’ Tails” model: an appraisal of the extent to which logistical activities were carried out at the site. This issue is perhaps the most difficult and ambiguous to assess since there is no direct evidence at the site of high-bulk extraction or foodstuffs transport or storage. The issue is further clouded by the fact that settlement and subsistence systems, even if they have logistic elements, can pass freely between collecting and foraging modes at different times of the year (Binford 1980:18):

in some environments we see high residential mobility in the summer...and reduced residential mobility during the winter, with accompanying increases in logistical mobility. The overall effect from a regional perspective would be extensive interassemblage variability derived from both conditions. We may also expect minor qualitative difference among assemblages from the winter villages. These are likely to be categorically different from the mobile summer residences which would be highly variable....Comparisons among winter residences would clearly warrant a categorical distinction of these from summer residences and they would be a “cleaner,” less noisy category of greater within assemblage diversity. Summer sites would be more variable within themselves but also less internally complex.

Thus, rather than a logistical high-bulk nuts-and-berries extractive site, 41HR616 may be a residential camp for a small group mapped onto the nuts-and-berries during a portion
of the year that the Group II base camps are broken up and family groups are dispersed up and down the watershed.

Alternately, sites like 41HR616 may represent high-bulk extraction sites in the manner previously defined. An appropriate ethnographic analogy for such a system is cited by Bettinger (1991a:71) for the Owens Valley Paiute:

The Owens Valley Paiute are easily classified as collectors. For most of the year, from spring through early fall, they maintained permanent residential bases on the valley floor out of which both gathering and hunting were conducted and in which resources were stored for winter use. During the late fall, they moved from these permanent residential bases and established temporary residential bases (or field camps) to harvest pinon nuts. Bumper crops sometimes caused these “temporary” residential bases to be occupied throughout the winter. Generally, however, they were occupied only until the harvest was complete, after which groups returned to their valley floor villages.

Binford’s general description of summer dispersal and the description of the Owens Valley Paiute are similar in that both accounts involve the annual fission of residential base camps and the dispersal of microbands across the landscape. The essential difference between the two accounts is that the mobility of the Paiute example implies the logistical mobility, the dispersion to collect a seasonally available resource (pinon nuts, the functional equivalent of our nuts-and-berrys) for transport back to the residential base, storage, and later use.
The vexing matter in the analysis of 41HR616 is that it seems very difficult to distinguish archeologically between dispersal for the purpose of mapping onto a resource for immediate consumption from logistical dispersal for the purpose of high-bulk resource extraction. This is especially so if the resource target is riverine nuts-and-berries which are likely to be found in the immediate area of a residential base camp as well as at its dispersed extraction sites. Proving resource extraction archeologically would be much simpler in the Owens Valley since pinons presumably do not grow there; the presence of charred pinon seeds in valley sites could be a direct demonstration of their extraction and transport from mountain groves. Meanwhile, the presence of charred hickory nuts at a residential base on the San Jacinto River doesn’t tell you a lot since there might be a dozen hickory trees within 200 meters of camp.

Thus, the key issue which decides whether 41HR616 is a site operating within a foraging mode or a collector mode with regard to nuts-and-berries is whether those nuts-and-berries (or whatever) were collected to serve the immediate consumption needs of the group resident at the site or these people plus perhaps others at some other (residential base camp) place. And this key issue is difficult to resolve through direct archeological means.

We are led back to the original, highly speculative analysis that led to the assertion of a nuts-and-berries resource focus at 41HR616: the presence at the site of a disproportionately high number of storage vessels in the form of ceramic pots. The question now becomes the nature and duration of storage in these pots: are they storage vessels only in the sense that they are collecting receptacles and containers for temporary storage until consumption by the residents of 41HR616? Or, are they longer term
storage containers for the accumulation and eventual transport of nuts-and-berries back
to a residential base camp for later consumption? I am unable to perceive a means to
test these alternatives from the available archeological data at 41HR616.

One final point might be made in regard to the existence of high-bulk extraction at
41HR616 and in the region. Bement et al. (1987:8-6 to 8-9) suggested that the inland
Akokisa traded resources (nuts-and-berries traded for corn are especially mentioned)
with the Caddo to the north. A few Caddo or Caddo-inspired sherds were recovered at
41HR616. The presence of these sherds and other exotic materials at sites in the region
are *prima facie* evidence of high-bulk extraction if these exchanges are primarily
economic and not primarily ritual in character: economic exchange requires the
accumulation of a surplus of the goods that constitute the medium of that exchange. The
point, of course, is that foragers in the classic sense neither need to exchange (for
subsistence) nor to have the mechanism in place to accumulate sufficient quantities of
goods for economic exchange. Thus, (given the ability to distinguish economic
exchange) the presence or absence of exchange exotics has implications for a conclusion
as to whether the site reflects a logistically organized system.

While the question of whether 41HR616 has a logistical function remains unresolved,
there are some data available on the broader inland Mossy Grove subsistence settlement
system which indicate that logistical mobility in relation to subsistence did take place in
the Ceramic Period. These data are from the Alabonson Road site, 41HR273 (Ensor and
Carlson 1991:228), where selected vertebrate body parts were transported to the site
from field butchering locations.
We may conclude this discussion with a final attempt to place site 41HR616 in its proper place on the forager-collector continuum. I believe that sufficient evidence based on environmental conditioning and site typology has been presented to demonstrate that there are logistical elements to the inland Southeast Texas Mossy Grove settlement system as a whole. While I have argued that 41HR616 may constitute a high-bulk extraction site in the absence of direct evidence for that condition I will concede that Occam’s Razor suggests that we propose the simplest and least complicated explanation for the existence of the site. Thus, I will posit that the site represents the residential camp of a small probably inter-related group of people mapping onto seasonally available resources during a portion of the year when the primary mode of production of the subsistence-settlement system is through foraging. The archeological character of the assemblage is consistent with that presented by Binford in a previous quote regarding peoples who congregate logistically in the winter and disperse in a foraging mode during the summer: 41HR616 presents an assemblage that is considerably less diverse and an internal structure (or lack thereof) which is much less complex than that of known residential base camps in the region.

I have earlier suggested that 41HR616 may be situated by central place considerations along a linear band of available seasonal resources which consists of the riverine forest. It was further observed that repeated re-occupation of the site has created a palimpsest of stacked but unfortunately indistinguishable living surfaces. It is now appropriate to examine cultural factors which may have given rise to and reinforced that central place positioning. First, we can probably assume that what I am characterizing as the linear central place position of the site came about as the potential resource band was divided up more or less equitably between smaller units of the broad social group occupying the watershed. Once divided, I think it is reasonable to hypothesize that an identification
with the 41HR616 locality took place which is similar to that cited by Bettinger (1991a:71) for another Great Basin group, the Reese River Shoshone:

The Reese River Shoshone exhibited essentially the same pattern of summer mobility observed for the Kawich Shoshone: small family groups moving from short-term camp to short-term camp in the lowlands. Fall, winter and spring residence, however, tended to be more regularly fixed in location, families occupying the same general area within the pinon woodland often enough to warrant claiming exclusive ownership of it.

Similarly, I believe that the repeated re-occupation of site 41HR616 (and that of many more sites in the area) is more than the mark of repeated random selection of a pleasant and productive fall campsite; it carries with it the baggage of both territoriality and lineage. Indeed, the potential that the overwhelmingly nonrandom preference for two ceramic manufacturing sequences represents habitation of the site by a single, historically continuous group has been acknowledged elsewhere by Ellis (1992:169) as one of a set of alternative hypotheses to account for this long technological continuity. While Ellis did not have comparative technological data available from other sites at the time she wrote her thesis, subsequent work performed by her at sites 41HR729 (Moore 1994a) and 41FB200 (Appendix VI) for Moore Archeological Consulting has demonstrated that these two technological preferences are not universally shared across the region. Thus, the possibility is enhanced that these preferences reflect a lineage-based tradition of ceramic manufacture passed down over a long period at site 41HR616. The issue of the possible correspondence between watersheds and social boundaries, another of the key elements of the Mossy Grove Model, will be developed in further detail below.
Interestingly, if this lineage-based interpretation of a consistent ceramic tradition is correct and if our characterization of the nature of settlement organization in the region is likewise correct, then it is entirely likely that this tradition could only be distinguished fully at a site like 41HR616. This is a consequence of the hypothesized cycle of aggregation and dispersal. Should a technological analyst examine the ceramics from an aggregated residential base camp, then he or she would, by the definition of the site, be examining the co-mingled products of numerous, albeit socially closely related lineages. If each of these lineages possesses its own long-standing ceramic technological tradition and if each of these traditions varies slightly from the next, then the result of the deposition of their multiple ceramic products in a single midden would obviously blur the lines of distinction and make individual lineage traditions impossible to distinguish.

Only at a site like 41HR616 occupied during the dispersed stage of the annual cycle would it thus be possible to examine the ceramic products of a single lineage tradition. We may look back to Binford (1980) for some provocative interpretive analogies. As with looking at full site assemblages between aggregated sites and dispersed sites, we should expect to see significant differences in diversity: aggregated sites should have a much higher degree of within-assemblage technological preference diversity than dispersed sites. Dispersed sites would be less complex but considerable intersite variation should be visible when we examine the ceramic assemblages from a group of dispersed sites.

The effects of aggregation and dispersal should further be analogous to Binford’s (1980) discussion of archeological grain size. Just as a two-day camp is fine-grained in that there is a high degree of correspondence or resolution between archeological debris and the
events which produced them, dispersed site ceramic assemblages should be fine-grained in that there is a close correspondence between the ceramic remains and the lineage group which produced them.

Conversely, the artifact assemblage from a site that was occupied for a year is posited as coarse-grained in that the resolution between artifacts and the specific events that produced them is poor because the products of each event are co-mingled with the aggregated products of all the other events that took place during that year. Coarse grain emerges in ceramic assemblages because the one cannot distinguish the products of a single ceramic tradition because they are likewise intermingled with the multiple products of other traditions.

Having characterized the ceramic assemblage of an aggregated base camp as coarse-grained is not to say that it will necessarily produce a random series of technological preferences. It should be remembered that aggregated sites are themselves the reflection of a larger social unit of a group of families which share a common group identity and in fact might be interrelated by blood. Thus, it would not be surprising to see broad technological preference patterns emerge from an internally diverse assemblage.

It is tempting to turn this line of reasoning on its head: to state that if the analysis of ceramic technology from a site exhibits fine-grained consistency and a low degree of diversity (like 41HR616), then that assemblage is prima facie evidence that the site in question was inhabited by a single lineage. Conversely, we may take a highly diverse ceramic assemblage as direct evidence that one is dealing with an aggregated site.
Let us, before closing our discussion of the position of Site 41HR616 on the forager-collector continuum and within the inland Mossy Grove settlement system, present an idealized depiction of settlement elements within the seasonal round for one band unit (Figure 14). This band, after passing the winter with their kindred in the aggregated village, joins the dispersal and occupies a series of residential camps. These camps, located on streams of the home watershed, are situated to take advantage of specific sets of seasonal resources which may be ubiquitous within the watershed or may occur in discrete patches. Meanwhile, throughout the year parties decamp on hunting and foraging forays, sometimes spending a night or two in temporary camps (often on convenient pimple mounds) and occasionally going out onto the prairie to kill bison. Once during the course of the year a special party sets out to bring back lithic material from a gravel bar located far upstream. While there is fluctuation in this pattern due to short-term variations in local resources and longer-term environmental shifts, there is also a high degree of consistency: many well-favored sites tend to be reoccupied periodically for hundreds of years. I will now examine in detail the other elements of this admirably stable settlement system.
10. Residential Base Camps: Site 41FB200

Site 41FB200 is a Late Ceramic site situated between White Lake and Oyster Creek within the City of Houston, Cullinan Park tract. Prehistoric site density is high within portions of this 750-acre park property, with 11 prehistoric sites recorded in the initial park survey (Moore and Moore 1991). Perhaps the most significant of these sites is 41FB200. This chapter is based upon the results of excavation of the 2 X 2 meter Block 1 unit. This unit was situated within the area of densest artifact concentration at 41FB200 as revealed by a systematic shovel testing program across the site. The report of this investigation is still under preparation, though some of the supporting artifact and faunal analyses are available in draft form. Hence, the discussion of this site will be rather abbreviated despite its obvious importance, although much of the data from the site is incorporated into analyses presented elsewhere in this dissertation.

The site is situated near Oyster Creek, which has been interpreted as a former channel of the Brazos River abandoned sometime around 1000 B.P. (Aronow in Moore and Moore 1991). The site is located on a small sandy ridge composed of Yahola Fine Sandy Loam at an elevation of 75-80 feet above mean sea level. The site also contains a 19th century historic component located on the opposite end of the 190-meter-long ridge. The site may have been first occupied slightly before or soon after the abandonment of the Oyster Creek channel by the Brazos River based on the ceramic typological analysis and the date ranges of projectile points recovered from the site. No radiocarbon dates are as yet available from the site.

Excavation was carried out at the site through a combination of shovel skimming and trowelling. Excavation was made more difficult by the fact that the soil was, at the time
of the excavation, baked by summer Houston heat into a brick-like consistency. The hardness of the soil necessitated the use of picks in order to loosen the soil. The site was excavated in 10 centimeter arbitrary levels with fill dry-screened through 1/4-inch hardware cloth. The 2 X 2 meter block was dug to the base of Level 16 for a total of 64 individual 10-centimeter excavation levels removed. The great majority of the cultural materials were recovered between Level 1 and Level 8; the materials found below Level 8 are likely to be the result of down-migration resulting from the very extensive bioturbation (especially rodent burrowing) at the site.

Basic documentation of the excavation was carried out through the use of level record forms and field notes. A unique level record form was maintained for each 10 centimeter level of each 1 X 1 meter unit within the excavation block. The level record forms included plan maps including artifact and soil stain plots for each level. The unique field sack number for each excavation unit/level was recorded on the level record form; these field sack numbers thus provided a redundant cross-reference for provenience data. All animal burrows, root trails and other soil stains were plotted on the level record forms.

The Field Director examined each day's records and artifact bags every evening to ensure that the records were in good order. Black and white prints and color slides documented all aspects of the excavation. A record of these photographs was maintained on separate project photo logs.

Stratigraphy was recorded through profile drawings and descriptions as well as black and white photographs and color slides. Profiles were executed of the walls of the excavation block. These profiles were drawn on metric graph paper and measurements
were made relative to a level line. The elevation of this level line was established by transit measurement. In addition, a backhoe trench was excavated through the site under the supervision of the project geomorphologist. The geomorphologist's report is unfortunately not yet complete at this writing.

The density of artifacts and faunal materials was very high at site 41FB200. The Block I testing at site 41FB200 yielded 1199 ceramic sherds, 19 projectile points, 58 other bifaces, 61 utilized flakes, 3723 pieces of un-utilized debitage, many mammal bones (mostly deer), 837 pieces of reptilian bone (mostly turtle), 1390 bivalves, 4420 gastropods, and a few shell and bone tools and ornaments. Over 95% of this material can be estimated to have been recovered from the 32 individual 10-centimeter levels excavated between the surface and Level 8. Stratigraphic integrity, however, was not well-preserved due to the extensive bioturbation within the site.

Ellis (Appendix VI) has provided the following discussion of ceramic typology and dating implications for the site:

According to the typological criteria (Aten 1983) widely accepted by archeologists in the upper Texas coast, the majority of sandy paste sherds belong to one or another Goose Creek type and should be classified as Goose Creek, spp. At least two of the decorated sherds fit the typological definition of Goose Creek, Incised. The grog-tempered sherds have no attributes that would allow for a confident distinction between Baytown Plain and San Jacinto Incised. While none of the recovered sherds resemble any of the defined Rockport Black-on-Gray types, there
are certain similarities with regard to specific attributes, such as the presence of asphaltum and certain decorative elements.

A reliable chronology for the Brazos delta area has yet to be fully developed, although Aten (1983) has provided a preliminary seriation for both the coastal area, Brazos Delta-West Bay Area Seriation, and the inland area, Inland Brazos Valley (Big Creek) Area Seriation. Each of these sequences was correlated with the Galveston Bay Area chronology in order to provide a rudimentary basis for the chronological ordering of archeological data (Aten 1983: 291-292, Figures 14.3 and 14.4). Although a recent study by Ellis and Ellis (in Moore 1994b.) shows that ceramic data alone cannot provide a basis for identifying ceramic assemblages of different ages for most of the Galveston Bay area seriation, it is, nevertheless, possible to make some general observations about the site's occupation. The ceramic material recovered from 41FB200 suggests a possible occupation period of approximately A.D. 1000 or later. The presence of grog-tempered sherds suggests a post A.D. 1000 date, while the presence of one bone-tempered sherd suggests an occupation date of post A.D. 1300 (Aten 1971:51-52; 1983: Figure 14.4).

The draft ceramic technological analysis appears as Appendix VI of this report.

The lithic tools from 41FB200 appear to fall into three broad categories; flake tools predominantly used for scraping, small bifacial arrowpoints and specialized tools, and larger bifaces used for cutting tasks. Site 41FB200 yielded 19 identifiable projectile
points or projectile point fragments. Several arrow point types were identifiable within the collection of whole and partial arrow points. These types included Scallorn (n=9), Perdiz (n=3), Alba (n=2), Fresno (n=1), Cliffton (n=1), Bonham (n=1), and Group I, or Catahoula-like (n=1). An additional Scallorn point was recovered from a nearby shovel test. Eleven untyped arrow point fragments were additionally recovered. Block I of 41FB200 yielded a total of 78 bifaces and biface fragments in all. A total of 61 flakes (3%) were identified as utilized, compared to 3723 pieces of un-utilized debitage. Lithic tools from Block I conform to a general pattern of utilized flake scraping tools and utilized flakes opportunistically used for other purposes; small bifacial arrowpoints and a few bifacial drills or perforators; and larger bifacial cutting tools.

Presented below are date ranges suggested by Patterson, Turner and Hester, and Ensor for the diagnostic points or point fragments from 41FB200 (Table 15):

Table 15 Comparison of Various Projectile Point Date Ranges by Authors

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<tr>
<td><strong>Scallorn</strong></td>
<td>AD 600 - AD 1800</td>
<td>AD 700 - AD 1200</td>
<td>AD 1100 - AD 1200</td>
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<tr>
<td><strong>Perdiz</strong></td>
<td>AD 600 -</td>
<td>AD 1200</td>
<td>AD 1200 - AD 1750</td>
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<tr>
<td></td>
<td>AD 1800</td>
<td>AD 1600</td>
<td></td>
</tr>
<tr>
<td><strong>Alba</strong></td>
<td>AD 600 -</td>
<td>AD 1200</td>
<td>AD 900 - AD 1100</td>
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<td></td>
<td>AD 1500</td>
<td>AD 1600</td>
<td></td>
</tr>
<tr>
<td><strong>Fresno</strong></td>
<td>___ ___</td>
<td>AD 1200</td>
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<tr>
<td></td>
<td>___ ___</td>
<td>AD 1600</td>
<td></td>
</tr>
<tr>
<td><strong>Catahoula</strong></td>
<td>AD 600 - AD 1500</td>
<td>AD 700 - AD 1200</td>
<td>AD 800 - AD 900</td>
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<tr>
<td></td>
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<td>AD 1200</td>
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Two conch columella beads similar to those illustrated from Late Archaic burials (Hall 1981, Allens Creek report) were recovered from the midden context at 41FB200. The shell beads are roughly cylindrical, biconically drilled columellae. Both have been abraded & polished smooth, though both retain the natural columella spiral groove.

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
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<tbody>
<tr>
<td>Weight</td>
<td>12.9 g</td>
<td>37 mm</td>
<td>14.5 mm</td>
<td>4.8 mm</td>
</tr>
<tr>
<td>A2/6</td>
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|        | 15.0 g | 36.6 mm | 16.5 mm | 6.5 mm |
| A1/5.10:1 |       |         |         |        |

These shell beads were manufactured from the central columella of a marine gastropod, most likely of *Busycon contrarium*, the lightning whelk. (Hall 1981:190-192). Similar beads were found by Hall among the Group 2 burials at site 41AU36, the Ernest Witte site, reported in Hall 1981, and also at the Harris County Boy's School Cemetery, reported in Aten et al 1976. Aten, in discussing the reasons for studying the Harris County Boys' School sites, mentions the scarcity of artifacts associated with graves on the Upper Texas Coast, "other than occasional columella beads" (Aten et al 1976:1)

I suggest that site 41FB200 is a residential base camp in the trimodal settlement type continuum proposed in the Mossy Grove Model. In his discussion of problems in differentiating residential base camps from field camps Thomas (1988:380) states that "residential positioning among hunter-gatherers is generally conditioned by exigencies of adequate lifespace, protection from the elements, and a location sufficiently central to
key survival resources. Base camps inhabited for several months are closely tied to such factors. Short-term field camps are less heavily patterned by lifespace considerations. Areas of strictly diurnal resource extraction ['locations'] are selected without reference to lifespace."

Base camps are to date best recognized by structural consequences: the existence of things like patterned areas of sleeping, maintenance and trash discard, as well as storage facilities in systems with logistic content. Thomas asserts that in distinguishing settlement system components we should assess degrees of relative assemblage diversity within the system. Such an assessment is based on the assumption that long-term residential base camps will be the scene of the greatest variety of cultural residue-producing activities and should exhibit the highest degree of technological and typological diversity within the system. Field camps will produce more homogeneous assemblages and locations will produce the most homogeneous assemblages within the settlement system. One can plot relative diversity in terms of absolute assemblage size on the X-axis and absolute assemblage diversity on the Y-axis. Thomas (1988:Figure 144) contends that an idealized such plot would generally exhibit three lines of differing slopes, one line with the steepest slope of increasing diversity with increasing assemblage size representing long-term residential base camps, the next steepest representing field camps and the flattest, locations.

Preliminary data suggests that site 41FB200 meets many of Thomas' structural characteristics for designation as a residential base camp. The midden area is believed to represent a patterned area of trash disposal based on the density of material and the high occurrence of burned lithics within the midden deposits. The assemblage diversity is certainly much higher than that recovered at either the 41HR616 residential camp or the
41HR755 location. Lifespace would be adequate for a fairly large group of hunters and
gatherers on this 190-meter-long ridge (especially if site 41FB199, located 200 meters
away and at least roughly coeval, was occupied simultaneously). Site furniture is present
at both sites in the form of fired-clay-ball-lined hearths.

Ensor and Carlson utilized qualitative assemblage diversity as one measure differentiating
their Group I residential camps from Group II base camps. They list the presence or
absence of 20 variables, with the division between the classes placed between 9 and 13
positive occurrences. Site 41FB200 exhibits the presence of at least 13 of these
occurrences (initial, primary, and secondary reduction products, stone points, decorated
pottery, worked bone, other bone, exotic materials, midden development, hearths,
worked shell, other shell, and decorated bone) and thus can clearly be regarded as a base
camp by these criteria.
11. Locations: Site 41HR755

I will next examine location-level sites and the interpretive implications derived from limited excavations at one of these sites. I have asserted, based on survey literature and my own survey experience, that locations comprise an important but under-represented and under-appreciated functional class of sites in the Mossy Grove settlement system. These sites typically exhibit low visibility, low artifact density, are ephemeral in nature, and are rarely reoccupied. Most are in all probability purely extractive in nature and thus are classic, fine-grained “locations” by Binford’s (1980) definition. In most cases these sites have no surface visibility and due to their low artifact density can only be identified by the agency of intensive shovel testing. Location site 41HR755 was thus located by Moore Archeological Consulting (Moore 1995) on the upper reaches of Cypress Creek in extreme western Harris County and was subsequently subjected to very limited testing. This testing along with that from the other sites discussed has led me to examine a number of issues, some more intimately related to the Mossy Grove Model than others but all deserving consideration in an examination of area prehistory.

Site 41HR755 is a prehistoric site located on nearly level Katy fine sandy loam on the coastal prairie, approximately 42 meters south of Cypress Creek, at an elevation of 161 feet. 41HR755 is located in an area previously used for rice cultivation and is presently fallow with light grazing. The southernmost edge of the riparian area (uncultivated and wooded) adjacent to Cypress Creek is located approximately 6 meters north of 41HR755.

Based on shovel tests, 41HR755 is believed to be approximately 400 square meters in size. Artifacts were found between 20 cm and 60 centimeters below surface from 6
shovel tests and consisted of nine small pressure flakes. This site is classified as a temporary campsite tentatively dating, at least in part, to the Late Ceramic period with some evidence for an additional component dating to the Early Ceramic or earlier.

Two 1X1 meter controlled excavation units (designated Test Units "A" and "B") were excavated at the site in order to collect further information to evaluate the integrity and research potential of site 41HR755. The units were excavated by shovel skimming and trowel with all matrix dry screened through 1/4 inch hardware cloth. The excavation was carried out in 20 centimeter arbitrary levels due to time and budgetary restraints. The soil profile consisted of a dark brown to yellow brown sandy loam and clayey sand terminating in yellow brown clay with red and black mottling. Excavation was halted when sterile basal clay was reached between 60 and 70 CMBS.

A total of 132 pieces of debitage, one utilized chert flake and 351.6 grams of fired clay lumps were recovered during the site testing investigation at 41HR755. All fired clay lumps were restricted to Unit B, with 15.8 grams (n=21) recovered from Level 1, 190.3 grams (n=93) from Level 2 and 145.5 grams (n=58) from Level 3.

Notable in Level 3 (40-60 CMBS) within the northwest quadrant of Unit B was a concentration of large flakes, a considerable percentage of which bear cortex on their dorsal surfaces. Many of the flakes are of quite similar color and texture and my conclusion is that they are the in situ result of the reduction of a single cobble. Only one of the flakes within this concentration (and indeed, of all the debitage recovered at the site) was utilized. Given the fact that the chert-bearing Willis formation outcrops within a mile of the site, I suggest that this cobble represents an example of local lithic raw material procurement.
I would argue that Site 41HR755 is a good example of what I have termed, following Binford (1980) a 'location' in the trimodal model of settlement for inland southeast Texas (Moore 1994b:162 and above). The site, from the available survey and limited testing data, appears to be the result of a relatively ephemeral occupation which I believe to be the campsite of a group of hunters seeking game on the adjacent Katy Prairie as well as access to lithic raw materials from the hypothetical nearby Willis gravels outcrop; in either, or both cases the site is clearly extractive. While the site is relatively large and more productive compared to, for example, the seven pimple mound sites found downstream at Telge Park (Moore 1992) and likewise categorized, the recovery of a considerable number of pressure flakes apparently generated by lithic tool maintenance supports the hypothesis of an ephemeral occupation by a group of hunters. However, it would appear that added to the remains of hunting activities are those of primary lithic reduction and probably lithic acquisition.

The limited testing at site 41HR755 demonstrated that the site is both more enigmatic and more intriguing than first assumed on completion of the survey phase. It was initially assumed that the site represented a straightforward ephemeral hunting camp. However, debitage data from the additional investigations has forced a revision of this view.

A general overview of the lithic debitage collection from site 41HR755 suggests that the principal lithic activities at the site were tool maintenance and the reduction of cobbles, perhaps leading to the creation of bifacial cores or flake blanks to be exported elsewhere. This data on debitage size and decortication as well as fired clay lump distribution also suggests that the two test units might have sampled portions of the site which were
functionally, and perhaps as well chronologically distinct. There was a quite skewed distribution of decortication flakes between Units A and B (Figure 15). The two units were likewise differentiated in terms of mean debitage size (Figures 16 and 17). Viewed vertically, flake size is seen to increase significantly in Level 3 (40-60 CMBS) in both units (Figure 18).

It can readily be suggested that the differences in mean flake size and rate of recovery of decortication flakes represent spatial separation of functional lithic tasks: primarily tool maintenance, producing smaller, interior flakes in Unit A, and primarily (or at least, importantly) cobble reduction in Unit B. However, the distribution of flake sizes should be examined in more detail since an interpretation with chronological implications is possible.

It has frequently been noted in southeast Texas lithic analyses that there is a decline in flake size between the Early and Late Ceramic periods as there is a shift from reducing cobble core to fashion dart points to the production of arrow points from flake blanks (Ensor in Moore 1989b and 1994b; Patterson 1976, 1980, 1983, 1990b) A flake size profile and scattergrams of flake length by width for site 41HR755 are presented in Figures 19, 20, and 21.
Figure 15. Decortication Flakes by Unit at Site 41HR755
Figure 16. Mean Debitage Size by Unit at Site 41HR755
Figure 17. Mean Debitage Size of Interior Flakes at Site 41HR755
Figure 18. Mean Debitage Size by Level at Site 41HR755
The possible significance of the flake size profile emerges more clearly when we collapse the size categories less than 15 millimeters long and compare the profile with those of the Early Ceramic and Late Ceramic components recovered at 41HR616 during the testing phase at that site (Moore 1989; data from testing is directly comparable to the work at 41HR755 due to the fact that both investigations screened through 1/4 inch mesh hardware cloth). Figures 22 and 23 illustrate these debitage profiles in both normal and log plottings. It is apparent from both these graphs that the overall debitage profile from 41HR755 most closely resembles that previously demonstrated for the Early Ceramic. When we additionally recall (Figure 18) that mean flake size is larger in the lowest productive level at 41HR755, we may very tentatively (in the absence of temporally diagnostic artifacts) suggest that there may be two components present at the site, one dating to the Late Ceramic and another dating to the Early Ceramic or earlier. It is highly unlikely, however, that the site was repeatedly occupied over a long period like the Owen Site or 41HR616 (Patterson 1980; Moore 1994b). Further excavation will be necessary to confirm or deny these speculations.

It seems reasonable to interpret the primary lithic production activity area in the northwest corner of Unit B at 41HR755 as representing early stage bifacial reduction. [The cobble(s) worked at this locality may have been reduced for the production of flake blanks, although the number of good-quality, large flakes discarded at the locus of production seems to argue against this alternative.] Sassaman (1992:255) in a discussion of the relationship between lithic technology and mobility, states that numerous authors
Figure 19. Debitage Size Profile of Site 41HR755
Figure 20. Scattergram of Flake Length by Width, Site 41HR755
Figure 21. Log-Log Scattergram of Flake Length by Width, Site 41HR755
Comparison of Debitage Size Profiles from Site TS-1 with 41HR616, Early and Late Ceramic Components.

Figure 22. Comparison of Debitage Size Profile from Site 41HR755 with 41HR616, Early and Late Ceramic Components
Figure 23. Log Comparison of Debitage Size Profile from Site 41HR755 with 41HR616, Early and Late Ceramic Components
have come to "look at biface technology as an adaptive solution to the spatial and
temporal incongruity between tool production and tool use." Because sources of lithic
raw materials and other critical resources are often not at the same place, lithic tools
must be transported. Sassaman elaborates further (1992:255-256):

And because functional requirements for stone tools cannot always be
predicted, stone tool technology must also be flexible. Thus, mobility
simultaneously dictates access to raw material, tool needs, and portability.
Throughout North America, bifacial core technology was used to meet
the organizational contingencies of mobility.

Several authors have commented on the advantages of bifacial core
technology to mobile hunters and gatherers. For instance, Kelly (1988)
suggests that formalized bifacial technology was selected whenever
mobile settlement systems included occupations in areas lacking lithic raw
material. Under these conditions, bifaces served as portable cores that
could be reduced for usable flakes and shaped into formal tools that were
flexible, maintainable and recyclable.

Kelly (1988:719-720) is quite explicit about the consequences of discontinuous
distribution of lithic raw materials:

Along a gradient of increasing raw-material scarcity, it is likely that there
is a threshold at which hunter-gatherers can presume that no raw material
will be available where it is needed. Given that stone tools are required
for the tasks to be conducted, and given that residentially mobile hunter-
gatherers must occupy an area of low raw-material density for an
extended period of time, we can expect bifaces to be used as cores, since
they will maximize the total amount of stone cutting edge while
minimizing the amount of stone carried. The protohistoric Pawnee, for
example, left their winter villages during the summer and moved about
the plains hunting bison and antelope, during which time they were highly
mobile and, being on the plains, had no steady access to stone raw
material. The lithic assemblages at these summer encampments contain
evidence of bifacial reduction and are dominated by jasper, a strong but
highly workable material. The Pawnee apparently "geared up" for the
summer hunt at quarries near their winter villages by making bifaces to
use as efficient cores.

These hypotheses are clearly relevant in a study region like southeast Texas where much
of the prehistorically occupied area is removed from nearby access to lithic raw
materials. An important and at least locally necessary corollary to discontinuous raw
material distribution and the use of a bifacial core technology (or a flake blank
technology, for that matter) as the basis for the importation of lithic material is that lithic
procurement must of necessity be logistically organized (at least by my definition),
requiring the collection and transportation of surpluses exceeding the demands of
immediate use at the extraction site. The necessity for inland southeast Texans to
produce and transport a surplus of bifacial cores or flake blanks for their own use in their
own territory in turn evokes possibility of trade to people (for example, along the coast)
even further removed by both distance and territorial boundaries from raw material
sources. (Recall that Cabeza de Vaca was engaged in such trade.) The existence of such
trade would amplify the pre-existing need to logistically create surpluses of bifacial cores and/or blanks.

The general relationship between the littoral sites of Galveston Bay and the universe of inland sites in Southeast Texas should be examined before delving deeper into this topic. It has been previously posited that the Akokisa lived in dispersed settlements in the littoral zone during the summer months and congregated into aggregated villages in the upper (inland) portion of their territory during the winter (Aten 1983:36, 319). However, the concept of transhumance between the littoral and inland zones has been questioned by recent authors (Patterson 1979, 1983; Ensor and Carlson 1991). In the Alabonson Road site report Ensor and Carlson (1991:229) state:

It is becoming increasingly clear that a separate inland settlement pattern, distinct from the coastal littoral pattern, is present during the Early Ceramic and most likely the Late Ceramic periods at inland sites.

The data from site 41HR616 seems to support this assertion. There is a complete absence of items of marine origin at this site. Ellis and Ellis (Moore 1994b) note the much higher frequency of the (nevertheless scarce) class of bone-and-clay tempered pottery at 41HR616 than in Aten’s Galveston Bay sites. They also cite the presence of Caddoan or Caddoan-influenced ceramics as a point of distinction between 41HR616 and the Galveston Bay area sites. Finally, while they state that the ceramic assemblage at 41HR616 is very much like that of the Galveston Bay area, they additionally note that it may be in a zone exhibiting a shift from the Galveston Bay to the Livingston/Conroe area assemblage.
A general point should be made regarding the model of summer coastal dispersal and winter inland aggregation. The model of winter aggregation implies that residential sites should be relatively infrequent in the inland zone since the population was concentrated in village sites. I would suggest that this implication is in direct conflict with archeological settlement fact in the inland zone. First, there are a large number of Ceramic Period sites recorded within the inland zone. While a percentage of these sites are probably not more than ephemerally residential, enough significantly longer-term residential sites (a class which would include 41HR616) exist to belie a simple model of congregation of the Akokisa into a few winter villages and depopulation for the rest of the year as the people moved to the coast.

The second settlement system factor which I believe is in conflict with the thesis of coastal to inland migration looks more closely at the categories of sites found in the inland zone. I have earlier argued that a well-integrated at least three-tiered system of site types exist in the inland zone. The existence of this multiple level system of residential base camps, residential field camps and locations suggests that the inland settlement system is sufficient unto itself to accommodate the annual yearly round of the inland peoples. Indeed, such a relatively complex settlement array should not have come into being at all if the region was depopulated for the better part of the year. In conclusion, while I do not doubt that there was close linguistic, technological, and social kinship between the littoral and inland elements of the Akokisa population, I do not accept that these two groups were one and the same or that large numbers of people made annual treks from one region to the other and back again. If they did so the direct archeological evidence of this transhumance should be much more visible than is the case.
Returning to stone tools, the inland southeast Texas prehistoric groups, in regard to their stoneless coastal neighbors, would thus control the Brazos and San Jacinto sources which were the means of production (in a crudely Marxian sense) for lithics. In order that they minimize dependence on these imported resources, the coastal folk quite predictably for the most part utilized alternative raw materials such as shell in the production of essential tools, as the shell midden record amply reflects. The general scarcity of lithics and frequency of shell tools in coastal sites is thus an important line of evidence against yearly transhumance between the coast and the inland as proposed by Aten (1979, 1983). Recall the Pawnee practices above; an annually transhumant Akokisa population would certainly be well aware that it was entering a stoneless area when it moves to the coast. It would thus seem to be an act of inefficient folly that they would fail to make the investment of time and energy to bring a few months' supply of quality [stone] raw materials to their littoral retreats.

The only fly I can see in the ointment of this argument is that the prehistoric inhabitants may have truly considered the available alternative tool materials of the coast as good enough not to bother transporting lithics. This might, in fact, be the case as it was in regard to lithic sources at Fort Hood, where people seemed to utilize inferior lithic materials close at hand despite the fact that quality cherts were available a few kilometers away (Ellis and Abbott 1994), as well as in a recent study by Andrefsky (1994). Andrefsky's very interesting article suggests that mobile populations may shift from the production of formal tools in areas of high-quality lithic resources to the use of informal tools in areas with abundant low-quality resources. Thus, our hypothetically transhumant Akokisa might be shifting from a formal tool technology while inland to an informal, shell-based industry while on the coast. (Shells are certainly super-abundant if
you are living on a shell midden.) While this possibility deserves further investigation, I would cite Andrefsky (1994:29) for support of my contrary reasoning above:

The extent to which local lithic materials is employed is a function of their abundance. When scarce, nonlocal resources are procured, and are fashioned into formal tools. *This relation may be altered in prehistoric systems that have easy access to nonlocal raw materials. In such cases nonlocal raw materials may be as abundant as local materials by way of exchange or population movements.* [emphasis mine]

Since the relation is not altered and lithics are scarce on littoral sites I would again suggest that population movement between the coast and the inland was not a significant and annual activity in southeast Texas. Rather, I think Andrefsky is correct in his thesis that low-quality material in abundance (be it stone or shell) begets an informal tool industry. I have simply appended above that shell tools possessed an economic advantage in addition to their convenience: their use helped to circumvent complete reliance on exchange for a resource controlled by a territorially and socially distinctive (if related) inland Mossy Grove population.

Lithic raw material utilization at site 41HR755 is depicted in Figure 24. Material recovered from the site consisted of 98.5% cherts, 0.75% quartzite and 0.75% unidentified material. One flake from Unit B, Level 2, was composed of a very light gray banded chert which appears exotic, perhaps Hill Country in origin.
Figure 24. Lithic Raw Material Utilized at Site 41HR755
I have noted that ceramic technological preference information suggests that 41HR729, 41HR273, and 41HR616 reflect potential information sharing, and speculated that the degree of these social affinities corresponds roughly to their relative positions on the San Jacinto watershed. Site 41HR755, while it produced no pottery, is also situated on a tributary of the San Jacinto River. Site 41FB200, meanwhile, is on a different watershed and seems to participate in a somewhat distinct ceramic tradition. It is interesting to observe that lithic analysis data (including that from site 41HR755) seem to cross-cut these supposed social boundaries in one respect: lithic raw material utilization. While paste preference and the rarity of interior smudging links 41HR729, 41HR273, and 41HR616 in a manner which I feel is plausible to regard as traditional and stylistic, 41HR729 and 41HR755 (as well as 41FB200) are distinct from 41HR273 and 41HR616 in regard to the scarce utilization of silicified wood at the site. It is perhaps enlightening to compare the ratios of chert to silicified wood at the five sites (Table 16):

Table 16. Percentage Utilization of Silicified Wood.

<table>
<thead>
<tr>
<th>Site</th>
<th>Percentage of Silicified Wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>41HR616</td>
<td>45.3% silicified wood</td>
</tr>
<tr>
<td>41HR751</td>
<td>14.3% silicified wood</td>
</tr>
<tr>
<td>41HR273</td>
<td>14.2% silicified wood</td>
</tr>
<tr>
<td>41HR729</td>
<td>2.7% silicified wood</td>
</tr>
<tr>
<td>41HR755</td>
<td>0.0% silicified wood</td>
</tr>
<tr>
<td>41FB200</td>
<td>0.0% silicified wood</td>
</tr>
</tbody>
</table>

The frequency of silicified wood has been linked to the lithic source areas utilized: common in assemblages collected from Spring Creek/San Jacinto sources and scarce in Brazos watershed sources. We might suggest that lithic raw material source selection is
perhaps a matter of expedience rather than “traditional” preference. The rank order of these sites reflects their relative distance from the Spring Creek/San Jacinto River lithic source areas. The percentage values seem to suggest that the rate of silicified wood utilization is an inverse function of distance from Spring Creek/San Jacinto River source areas. The farther away from these sources, for example, the less silicified wood is used. This relationship suggests that raw material source utilization is more a matter of convenience than tradition. If the selection of raw material sources was ruled by local tradition it would be more reasonable to expect more constant ratios; that is, either the consistent presence or absence of a significant percentage of silicified wood rather than the linear relationship observed above. This pattern shows up at Fort Hood in the chert-rich Hill Country, where poor quality chert resources close to a site may be heavily exploited even when high quality cherts are available only a few kilometers away (Ellis and Abbott 1994).

Those observations regarding raw material selection are in line with the thrust of the observations by Ricklis and Cox (1993). They again seem to reflect a distance decay function in which the primary consideration in lithic procurement is cost efficiency. A greater utility to the data is seen, however, when it is cross-referenced as above with the information and interpretations derived from the ceramic technological analysis. The ceramic data provide fine-grained information which reasonably can be assumed to reflect information-sharing networks.

One previously investigated site deserves discussion before we depart the topic of lithic procurement. A cache of tested cobbles comprising the Carl Mehrkam Site, 41HR365, is evidence of intentional, logistically-organized lithic procurement in the 41HR755 vicinity (Freeman and Hale 1978:90-98; TARL files). The cache is located north of US
Highway 290 between Cypress Creek and Spring Creek, or about 11 kilometers due north of site 41HR755. The Carl Mehrkam Site consisted of 50 large cobbles, many with one to a few flakes removed. The raw material of all of the 25 remaining cobbles from the cache is described as good to excellent quality chert. All the cobbles are stream-rounded, though the presence of a calcite crust on the cobbles is interpreted as evidence that the stones come from a fossil gravel bed; this soft, soluble crust would have been worn away or redissolved had the cobbles been retrieved from an active stream bed. The cortex colors consist of browns, grays and whiles, while the interior is almost always a dark shade of brown.

It seems probable to this investigator that these cobbles were cached for later reduction (as at 41HR755) to bifacial cores or flake blanks prior to their importation to the east and south. In any case, the presence of this significant cobble cache is strong evidence that lithic procurement was an important activity in this portion of western Harris County. Freeman and Hale (1978:92) report that:

the cobbles are much larger and heavier than characteristic locally-known lithic resources. Together the cobbles weigh 24,910.8 grams or 55.3 pounds. They range in weight from 506.1 grams or 1.1 pounds to 1,994.3 grams or 4.4 pounds. The longest cobble measures 15.9 centimeters; the average length is 13.2 centimeters.

Origin of the materials is ascribed tentatively by the authors to Brazos River gravels near Bryan, Texas, or Colorado River gravels near Columbus, Texas. I might suggest in addition that the range of lithic potential in fossil gravel beds in the nearby Willis
formation is insufficiently known to eliminate this potential (and very much closer) source.

Interpretation of the site is hampered, of course, by the absence of temporally diagnostic artifacts; indeed, the cobbles were the only category of artifact found at the site. Freeman and Hale (1978:93) can thus only make limited interpretive statements regarding the cache:

The origin of the cobbles, the method of transport, and the reasons for abandonment are open to question... The [original] combined weight of the cobbles (approximately 100 pounds) would imply either group action or multiple deposition by one individual. The cache was probably stored or hidden with only the small [natural undrained] depression as a marker. There was no evidence of camping at the site as only cobbles were observed. The site is not altogether inexplicable since it would be easily accessible for trading along Cypress or Spring creeks or when a lithic supply was needed for personal use. It is possible the cache contained stockpiled material to supply an area which lacked convenient lithic resources.

Restrictions on interpretation notwithstanding, the Carl Mehrkam Site seems to be a clear-cut example of logistically-organized lithic procurement. I will also note that the exclusive occurrence of chert from the Carl Mehrkam Site is consistent with the model which I have presented of declining silicified wood utilization in the western portion of the Study Area.
12. Further Consideration of Lithic Acquisition Reduction and Use

Ricklis and Cox (1993) argue that the nearby central Texas coast is an excellent field for the study of lithic technological organization due to (1) the dearth of raw material on the coast and the known, single locus of material inland; and, (2) because the spatial patterns of Late Prehistoric subsistence, settlement and residential mobility are purported to be well-understood, enabling lithic technology and settlement/subsistence patterns to be analyzed as independent lines of empirical evidence. While our understanding of the local subsistence and settlement system is not so refined, I have asserted that the nearest lithic sources available to coastal and inland Mossy Grove peoples are at localized occurrences. These occurrences are outcrops exposed via stream erosion into fossil stream gravels and the somewhat less localized downstream movement of these cobbles in active stream gravel bars; the distance of movement for the latter sources is rather restricted and excludes much of the current inland southeast Texas Study Area as well as all of the littoral zone. Thus, southeast Texas should likewise provide an informative area to study the effects of localized resource distribution on the lithic technological system.

I will first examine some rather contrasting views of the implications of assessing residential mobility on the basis of lithic reduction technology as it relates to the use of formal versus informal stone tools. Parry and Kelly (1987) indicate that a review of lithic technology in North America reveals a significant distinction between expedient and standardized core reduction. This distinction is expressed by a transition from the predominance of standardized core reduction producing formal tools to one of unstandardized, expedient reduction and the use of informal tools in the Late Woodland period. They hypothesize that this transition in preference from hafted formal tools to
informal tools (utilized flakes) is a reflection of changes in residential mobility, with the increasing incidence of expedient reduction associated with decreasing mobility. This association is asserted on the basis of a “tradeoff between the costs of transporting tools and raw material (which are high for expedient core technology) and the costs of manufacturing and using tools (relatively high for formal, lower for expedient)” (Parry and Kelly 1987:299). Thus, one would expect a highly-mobile people to utilize a formal tool technology in an effort to decrease their transportation costs since hafted bifaces are far easier to carry around than the cobbles from which expedient tools could be struck. A sedentary group, freed from continuous assessments of transportation cost by their very immobility, would benefit from the lower tool production costs of expedient tools.

Ensor (in Moore 1994b) has held that these "interpretations of tool kit composition and group mobility seem to hold true for the southeast Texas region and 41HR616. Formal tools such as projectile points are ubiquitous throughout the archeological record, with utilized flakes and other expedient tools such as edge-trimmed pebbles also found throughout all occupations. No increase in the use of expedient tools which might indicate a more sedentary population is evident at southeast Texas sites, including 41HR616."

While we know that the Mossy Grove inhabitants of southeast Texas were a fairly mobile people, we should consider the implications of recent publications which have integrated the issue of lithic raw material availability into the consideration of the significance of technological choices between the formal-tool and informal-tool alternatives. I have already suggested that limitations on raw material availability had important consequences for southeast Texas prehistory. Andrefsky (1994) argues that ethnographic examples of stone-tool makers in Australia and archeological examples
from three areas in the western United States indicate that the availability of lithic raw materials is an important variable in conditioning stone-tool production technology. Attributes of availability such as abundance and quality of lithic raw materials condition the production of formal- vs. informal-tool types. Poor-quality raw materials tend to be manufactured into informal tool designs. High-quality raw materials tend to be manufactured into formal-tool designs when such materials occur in low abundance. When high-quality materials occur in great abundance both informal- and formal-tool designs are manufactured. Other factors, such as residential mobility or sedentism are found to be less-important determinants of lithic-production technology.

Andrefsky defines formal tools as bifaces, formally prepared cores and retouched flake tools. There are several advantages which accrue to the users of formal tools: (1) they can be used repeatedly and renewed by resharpening; (2) they can be used for many different tasks; (3) bifaces also function as highly efficient cores with less overall weight in relation to cutting edge and represent the most efficient form of usable cutting edge storage; (4) retouched flakes represent a particularly effective tool form for mobile groups since they are multi-function.

In contrast, "informal tools [utilized flakes] are unstandardized and casual with regard to form" (Andrefsky 1994:22). Their manufacture and use period is short and they are wasteful of raw materials but they can be produced quickly and with little work effort. They have been argued to be the tool of choice for sedentary peoples for whom tool portability (via weight restrictions and transport costs) are no longer a primary consideration. Andrefsky suggests, however, that "mobile prehistoric populations would not necessarily produce formal tools if good-quality raw materials were readily accessible at needed locations. Similarly, if sedentary populations did not have access to readily
available lithic raw materials, the production of wasteful informal tools would not necessarily be a common practice" (Andrefsky 1994:23).

Utilizing ethnographic and archeological data Andrefsky derives a matrix which purports to illustrate the mix of local lithic production technologies in regard to high and low levels of raw material availability and quality. This matrix anticipates a fairly even mix of formal and informal technologies in an area of high lithic availability and quality, primarily informal tool production in areas of high availability but low quality, primarily informal tool production in areas of low availability and low quality (but a great majority of tools recovered proved to be of the formal variety but produced elsewhere from non-local materials), and primarily formal tool production in areas of low availability and high quality.

The following assumptions underlie Andrefsky's reasoning: (1) that informal-tool production is most efficient in terms of the energy cost of production while formal-tool production is most efficient in terms of the energy cost of transport; and, (2) that the utility of both classes of tools widely overlap, and the two tool classes are thus to a large extent functionally interchangeable.

While Andrefsky mentions localized vs. nonlocalized lithic raw material sources I believe that that this dichotomy deserves further consideration. Localized raw material would tend to promote the use of a formal-tool technology since transport cost becomes a primary consideration in an "isolated" lithic procurement system lacking both significant ubiquitous deposits and long-range raw material inputs. If transport cost consideration are paramount due to localized resources then a formal tool technology may be an imperative regardless of local lithic raw material quality. A variable which might reflect
both the "isolation" of the local lithic technological system and the abundance and localization of resources is the degree of effort to improve the quality of raw materials via intentional heat treating. A consistent effort at heat-treating could be an indication of scarce and/or highly localized low-quality materials which preclude the use of wasteful informal tools and necessitate the "improvement" of the raw materials to permit the manufacture of the formal tools required by considerations of transport cost. Conversely, the incidence of heat-treatment should be low in areas where low-quality materials are abundant and sufficiently ubiquitously distributed to permit the use of an informal-tool technology.

Applying Andrefsky's model within the Study Area, I would argue that it would fall within the functional equivalent of his "Low Abundance/ High Quality" cell, promoting primarily the local production of formal lithic tools. The local raw materials are frequently not of the highest quality but they can be demonstrated to be the only game in town on the basis of the scarcity of non-local materials (hence, we are viewing an 'isolated' system, as above). Further, their restricted spatial distribution (the functional equivalent of low abundance) precludes extensive use of informal tools over most of the area and places a high utility value on items which can be transported easily, used for a variety of tasks, and renewed when necessary - qualities all inherent in formal tools. Thus, whether the local material was really of good quality or not, the local prehistoric inhabitants were compelled to use it as though it were the highest quality obsidian. A consequence of these arguments is that we cannot facilely link the absence of an increased incidence in the use of informal tools to continued high residential mobility.

I will now look to the work of Sassaman, who presents a different perspective on expedient tools in the archeological record; I should say at the outset that I find his
perspective more stimulating and locally relevant than his specific conclusions since there is no evidence within the Mossy Grove of a rise in expedient tool use in the Ceramic Period. "Nearly all recent attempts at modeling hunter-gatherer lithic technology have treated groups as if they were composed of undifferentiated members. The issue I want to address in this article is simply whether or not we can continue to develop models of lithic technology while ignoring the sexual division of labor. It seems apparent that most lithic analysts have implicitly assumed that only men made and used stone tools" (Sassaman 1992:250). He thus suggests that the transition from formal to expedient core technology often viewed with onset of ceramics may represent the initial sampling of female-related domestic locales where both men and women may be employing expedient tool technology rather than the oft-cited indication of increased sedentism. He has introduced a consideration of gender in order to identify variation that cannot be fully explained by tool function, raw material constraints, or group mobility. Sassaman (1992:251-253) argues from the following assumptions:

1. the perceived transition from formal to expedient core technology is in part shaped by the categories used to order archeological time.

2. Let us assume that there was a basic division of labor by which men hunted game, and women collected plants and small animal resources.

3. Let us also assume that hunting technology was distinct from other lithic technology, and that the technological requirements of hunting game contributed to the regularities in tool design that are now useful in dividing archeological time into meaningful phases or periods.
4. It follows that [pre-ceramic] time-space systematics in archeology are largely based on continuity and change in the design of tools used by men; in North America these consist largely of hafted bifaces, both projectiles and other bifacial tools associated with hunting activity.

This systematics perspective changes when pottery replaces bifaces as the primary means of subdividing time in the late prehistoric; it follows that late prehistory is principally subdivided temporally by "variations in a technology usually attributed to women." (Sassaman 1992:251) Looking at sites with points as opposed to sites with pottery means that you are looking at gender-based samples of settlement variation. Sassaman (1992:253) presumes (perhaps too much) the "spatial separation of men's and women's activities at the intersite level of analysis." And Sassaman thus views the "sudden" dominance of expedient tool technology as an expression of looking for the first time at the arena of women's activities.

Sassaman asserts that in the transition from bifacial core dart points to flake blank-produced arrow points we see the following:

this change from long-lived, curated bifaces to short-lived, throw-away bifaces marks a significant change in the technology of men's hunting weapons, but it does not necessarily reflect a major organizational change in men's activities per se. Rather, the change in men's technology may in part reflect the increased contribution of women to raw material procurement and core reduction at residential sites. The removal of flakes for immediate on-site use and for the manufacture of projectiles for
hunting now fell under a single production trajectory (Sassaman 1992:258).

Relating his model to lithic availability Sassaman suggests that when a group was away from a raw material source flake production was dependence on a male-linked bifacial core technology, with the result that "women may have had little direct access to usable flakes, and instead depended on the byproducts of men's work" (Sassaman 1992:257). At residential camps near lithic resources, men and women could have would have had equal access to stone and both sexes could have manufactured and used tools.

I find Sassaman's article most locally relevant principally in his attribution of a male-female dichotomy reflected in formal tools versus ceramics. I have previously suggested that the ratio of points to ceramics reflects a hunting versus gathering subsistence dichotomy; it is a small step from this assertion to one that identifies gender linkages for these sites. One might assume that the points/ceramics ratios may represent a very rough indicator of the relative economic contribution of males versus females at any particular site. Attribution of male activity seems obvious for the many hunting camp locations such as site 41HR755 within the Study Area. Further, any spatial divisions I propose on the basis of ceramic technological patterning are assumed to be predicated on the basis of a "women's technology." Spatial interpretations based on [male] lithic procurement and technology cross-cut these divisions so it is not surprising if there are incongruities.

I might suggest that Mossy Grove mobility is in fact relatively high since despite the Ceramic Period focus on [women's] residential sites we still find no significant increase in the use of expedient tools. Perhaps, however, the correct interpretation is that economic activities and/or distribution of lithic raw materials forces continued reliance on formal,
hafted bifacial tools even while the 'female' aspect of the economic system is suddenly expanded and/or made visible by the advent of ceramics. Sassaman's comments regarding the scarcity of flakes and hence expedient tools at sites in areas of low raw material availability are very cogent, especially if one chooses to place less reliance on the primary use of expedient tools by women: suitable flakes would be scarce for both men and women. This factor might well account in part for the fact that expedient technology never became dominant locally.

The number of sites in the region with long preceramic occupations preceding ceramic components suggests a basic stability in the system, with the most apparent change taking the form of women's sudden visibility via ceramics. Basic residential stability continues even with the major change in lithic technology, the adoption of the bow and arrow and shift from bifacial core to flake blank-based lithic technology.

Ricklis and Cox (1993) studied a series of Ceramic Period sites associated with the Rockport Phase (A.D. 1200-1700) and the historic Karankawa on the central Texas coast. These sites encompassed a discrete, watershed-based settlement system including Group 1 fall-winter aggregated coastal sites and Group 2 dispersed spring-summer upland prairie sites, as well as the single local chert source at the inland terminus of the system. They view lithic technological organization as "an economic model of the trade-off of costs and benefits. Costs... are strictly related to distance from the lithic source. Benefits are presented in terms of systemic utility (the output of technological organization). Efficiency is seen only in its technological sense - the ability of technological organization (the supply of tools) to meet the requirements of the overall adaptive system for a certain gross utility (output) in order to maintain the lifeway."
(Ricklis and Cox 1993:445)
An observed distance-decay function in the ratio of debitage to tools is presented as evidence that as the cost of procurement and transport rose with increasing distance from the lithic source, the transport of raw material became increasingly inefficient; that is, lithic transport was ruled by considerations of cost-efficiency. Data on flake type and (for the most part) flake length indicates that the unit of transportation was cobbles rather than bifacial cores or flake blanks. The distance decay function operated independently of the subsistence and settlement system since it cross-cut both their Group 2 dispersed spring-summer upland prairie sites and Group 1 fall-winter aggregated littoral sites. Ricklis and Cox (1993:456) term this function as lithic technological Mode I: governing "Procurement, Transport, and Reduction of Raw Materials".

Ricklis and Cox found that there is an increase in the percentage of utilized flakes (expedient tools) and bifacial thinning flakes and a continuous decrease in Perdiz point lengths proportionate to increasing distance from the lithic source. These trends are posited as evidence for lithic technological Mode II ("Extension of Material Use Life"): that the increasing costs of transportation were compensated for by (1) the expedient utilization of an increasing percentage of the flake byproducts of Mode I behavior; and, (2) an increasing distance-dependent emphasis on the rejuvenation of tools. Both these behaviors are considered evidence to represent an increasing value (obviously derived from scarcity) placed on lithic materials as one moves further from their source.

Their Mode III deals with Material Substitution and Scavenging: "At a critical distance from the lithic source area, the costs associated with material procurement and reduction strategies yielded sufficiently diminishing returns that the organization of lithic
technology per se became inefficient (i.e., in terms of the return on the investment of
time and effort, the increasing marginal costs associated with the replenishment of lithic
tools exceeded the marginal value of these tools. At this point, marine shells... began to
be substituted for chert as tool materials." (Ricklis and Cox 1993:457) In addition, there
is evidence of scavenging of lithic materials from older Archaic sites.

Ricklis and Cox recognize that lithic trade could represent a forth mode of organization
but state that it was not a factor on the central Texas coast.

Ricklis and Cox (1993:458) conclude that:

There are significant implications here for reconstructing the spatial
patterns of hunter-gather adaptive systems using lithic data. Site function
can be expected to influence the kinds of lithic tools used and discarded at
a given site, but not necessarily the kind or intensity of tool production
that was carried out. For example, at Group 1 fishing campsites,
arrows points outnumber end scrapers approximately three to one, whereas
at Group 2 hunting camps, end scrapers and arrow points are found in
approximately equal numbers. This is expectable, since it is known from
regional ethnohistorical documentation that the bow and arrow was used
commonly in both hunting and fishing activities, whereas the snub-nosed
end scraper was primarily used in the processing of hides. The degree
and intensity of tool production at a site, however, was significantly a
function of the organization of lithic technology, with its concern for the
maintenance of efficiency in relation to the availability of raw material.
Ricklis and Cox go on to caution that attempts to infer site function and overall settlement pattern from the kinds and proportions of lithic tools and debitage categories may suffer if there is insufficient attempt to consider lithic technological organization (procurement and production). Care should be taken in ascribing site class on the basis of, for example, abundant or scarce debitage. Aggregated residential base camps in resource-void areas (like their Group 1 fishing camps) may exhibit little evidence of lithic production, but this attribute is a function of the cost of bringing raw materials into these camps rather than the functional position of the camp within the regional settlement system.

In regard to the use of shell tools on Galveston Bay, I have suggested alternatively that the use of shell was the functional equivalent of Andrefsky's demonstration that poor quality but abundant local materials tend to be utilized for the production of expedient tools even when quality materials are available at some distance. While this viewpoint is a different perspective from that of Ricklis and Cox, it again suggests that considerations of transport cost are the dominant factor governing lithic procurement. I also suggested that shell tools might have been utilized by the littoral Akokisa as an alternative to costly trade with their inland cousins for higher-quality lithic materials from northern and western Harris County.

It is interesting to contrast Andrefsky's model reconcile with that of Ricklis and Cox (1993). Under the tenets of Andrefsky's model one would expect an elevated incidence of informal tools at habitation sites in proximity to a localized lithic source and that this incidence would decline precipitously as one moves away from the source locality. In contrast, Ricklis and Cox found that there is an increase in the percentage of utilized flakes (expedient or informal tools) proportionate to increasing distance from the lithic
source. They ascribe this increase to compensation for the increasing costs of
transportation by the expedient utilization of an increasing percentage of the flake
byproducts of their Mode I behavior (governing "Procurement, Transport, and
Reduction of Raw Materials"). This contradiction is vexing, as both arguments are
based on presumably strong empirical data and Andrefsky's implicit assertion that when
material is abundant it will tend to be used carelessly is intuitively compelling. The
Ricklis and Cox observation that the Karankawa transported cobbles rather than formal
tools, in contrast, seems irrational given the transportation cost merits of formal tools.

The keys to these contradictions may lie in (1) the fact that 41NU258, the lithic
procurement site, is described as "clearly nonresidential" and most of the Group 2 inland
sites are not very close to this source, impeding the wasteful use of informal tools; and
(2) the cobbles from 41NU258 are relatively small (pea-sized to ca. 15 centimeters long)
and thus would not weigh a great deal more than the bifacial cores that might be
produced from them. In addition, deferring bifacial reduction until after transport would
make available the flake byproducts which were in fact utilized during Mode II of the
system. Thus, the transportation of cobbles may constitute a compromise in which the
value of the additional stone provided where it is needed outweighs its somewhat
increased transportation cost. This logic deserves further local consideration given the
generally small size of the cobbles available within the Mossy Grove Study Area.

Ricklis and Cox are independently in agreement with my assertion that lithic
procurement and technology must be organized on a logistical basis in an area of
localized source materials: "the spatial structure of lithic technological organization was
the product of a logistical pattern of procurement and transport of raw materials that was
not correlated to the residential mobility patterns inherent in subsistence." (Ricklis and Cox 1993:445)

The debitage to formal tool ratio (excluding preforms and trimmed pebbles) at site 41HR616 is 168:1. The waterborne distance to the nearest known lithic resource procurement area, gravel bars upstream on the West Fork of the San Jacinto River, is approximately 18 kilometers. It is informative to compare the flake:tool ratio and the procurement distance to the data from the central Texas coast presented by Ricklis and Cox (1993:Figure 3). As I have just discussed, Ricklis and Cox posit a distance decay function on the flake:tool ratio based on increasing cost of lithic procurement with distance from the source. These distance decay function data are presented in two sets, one representing probable overland travel and the other representing probable river travel via canoe.

I have previously (Moore et al. 1994; Moore 1994a) noted that the flake:tool ratios exhibited at sites 41HR751 on Greens Bayou and 41HR729 on Langham Creek approximately fit the Ricklis and Cox model's expected values suggested by the distances and probable modes of travel to their respective, most likely lithic procurement areas. It is, thus, increasingly of interest to note that the ratio at 41HR616 likewise generally conforms to the Ricklis and Cox model's expected value for waterborne transport (Figure 25).

Intriguingly, while Ricklis and Cox found no systematic relationship between distance to lithic resource area and flake class (primary, secondary, interior, and bifacial thinning) percentages, the proportion of decortication flakes at 41HR616 is 61%. While Ensor (in Moore 1994b) found this high percentage perplexing, perhaps it can be related to the
rather short distance via canoe to the nearest lithic source upstream on the San Jacinto River and the potential that, like the Karankawa, the Akokisa on the San Jacinto River sometimes engaged in the transport of cobbles rather than bifacial cores or flake blanks.

We may examine support for this hypothesis at site 41HR751 on Greens Bayou, a tributary of Buffalo Bayou and hence the San Jacinto River located a short distance above Interstate Highway 10 in eastern Harris County (Moore et al 1994). The site is clearly a considerable distance from any known or likely lithic resource area. In terms of its geographic position and degree of utilization of silicified wood it fits nicely into the procurement model presented in the site 41HR755 discussion above. However, other aspects of its lithic system are quite divergent from ordinary expectations for a Ceramic Period site in inland southeast Texas. These divergences (if not the result of sampling error) are most visible in terms of the flake size profile for the site and the percentage of decortication flakes recovered at the site. It is very interesting in regard to the interpretation of site 41HR751 to observe that these patterns of divergence somewhat parallel what we have observed at site 41HR755.

It was posited at site 41HR616 that the unusually high proportion of decortication flakes related to the fact that the site is not far removed from cobble source areas (Moore 1994b:167). If my hypothesis that a thus far undiscovered gravel bar is located somewhere nearby, then the same might well be said of site 41HR755, with 28.6% decortication flakes. Site 41HR751 is, however, clearly far removed from any lithic source and its percentage of decortication flakes is a hefty 40% of the admittedly small survey-level lithic sample (Moore et al 1994:70).
Figure 25. Scatter Diagram Showing the Relation Between Flake:Tool Ratios and Site Distances from Lithic Source Areas
I have already discussed that 41HR755 seems to have (at least in its lowest level where most of the decortication flakes were found) a debitage profile which is skewed towards larger flakes, perhaps representing the production of bifacial cores. We can observe that the flake size profile at 41HR751 is skewed significantly further towards the presence of larger flakes (Figure 26). It seems quite likely that both the proportion of decortication flakes and the debitage profile at 41HR751 reflect the importation of whole or nearly whole cobbles (rather than bifacial cores or flake blanks) to that site for reduction into formal tools, despite its distance from a quarry source. This, again, may largely be a function of the relatively small size of the transported cobbles and the availability of canoe transport.

I am also producing new evidence in general support of the contention that lithic procurement is governed principally by considerations of transport cost in the form of my data on the distance-determined transition from chert/silicified wood sources to chert only sources within Harris County. This locally-observed east-west shift from chert and silicified wood to exclusively chert reflects both the localization of resources and the primacy (per both Andrefsky 1994 and Ricklis and Cox 1993) of transportation cost considerations in lithic procurement. I compared this data with that from ceramic technological analyses which has been interpreted as reflecting social groupings and found that lithic procurement cross-cut hypothetical social boundaries, just as Ricklis and Cox found that it cross-cut site functional site categories.
Figure 26. Comparative Flake Size Profiles, Sites 41HR616, 41WA99, 41HR751, and 41HR755
13. Applying the Mossy Grove Model

It might justly be said that I have raised more questions than I have provided answers in this dissertation. For example, while I have suggested that trade may be one factor which contributes to the long-term stability of the hunter-gatherer system in southeast Texas I have been specific in this discussion only in (1) citing historical documentation of trade; (2) citing ethnographic examples of the role of trade in the maintenance of hunter-gather lifeways; and, (3) suggesting that the distribution of lithic resources would provide an impetus toward trade and that the data offers indirect evidence that trade has taken place. I have demonstrated that streams can be regarded as a key to the settlement system. From this basis I have argued that watersheds mark important social boundaries but I will be able to put forward only general distributional data and the limited available data on ceramic technological analysis to support this hypothesis. I have, on firmer footing, provided evidence that lithic acquisition in the region was organized in a logistical footing and that the acquisition process was governed largely by consideration of transport cost. I have redefined the elements of the Ceramic Period settlement system in southeast Texas, describing a series of site categories and relating them to the annual band dispersal-aggregation round. I have dealt exhaustively but in some respects ultimately inconclusively with middle-range theoretical considerations regarding the forager-collector continuum. Thus, since there remains so much to do to provide a full test of the Mossy Grove Model, recommendations for future research will be freely interspersed within my concluding remarks.

As the reader is very aware, I have repeatedly suggested that social groups in the Mossy Grove Study Area were organized on the basis of watersheds and have produced
analogous examples of such organization from hunter-gatherer groups around the world. I have proposed that the employment of geographical analytical units will make it possible to test novel hypotheses regarding the prehistoric organization of the region. Technological models are particularly suitable to the thesis that geographic subdivisions of the Study Area form meaningful analytical units since they reveal subtle archeological variability which is often masked by conventional typological analysis. As Ellis (Appendix VI) puts it in regard to ceramics from 41FB200:

Many of the sherds recovered from 41FB200 fit the typological description of Goose Creek ware (as defined by Aten 1983). Thus, the assemblage at 41FB200 is very much like the assemblage one might find at sites in Harris County and the Galveston Bay area. However, at the level of analysis of technological style, subtle differences emerge among vessels. These differences are obscured by accepted typological classes, and an examination of these differences leads to paths of comparison and contrast that otherwise would not be available. In particular, comparing and contrasting the 41FB200 assemblage with assemblages from other sites shows that there may be dimensions along which it may be possible to identify relatively small areas of the broader upper Texas coast region within which different approaches to technological style may provide a basis for identifying historically cohesive communities of potters who transmitted relatively localized ceramic-production knowledge from generation to generation.

The fine-grained divisions and the potential for variably overlapping sets of choices provided by technological analysis offers an independent means of testing a wholly
abstract model of social relationships defined by watersheds. Unfortunately, I am still at an initial stage in the collection and integration of ceramic technological analyses with the result that the current application of this data is at an impressionistic level, based on ceramic technological data from only a few sites in the region.

Another consistently-applied mode of technological analysis does exist for the region and should eventually be able to address some of the same issues as ceramic analysis. Moore Archeological Consulting has consistently, in recent survey and excavation projects, applied a systematic and replicable methodology for lithic analysis and description. Projectile points were described using a formal account system following Ensor (1988, Appendix IV). Ensor credits Futato (1977, 1983) for the origination of this system. The system employs a series of nine morphologically descriptive variables and seven metric variables to describe the shape and size of a projectile point, with the goal of being able to describe the variability within and between projectile point types in a region (Appendix IV). It is only though the application of such a system, combined with the careful selection, excavation and absolute dating of sites within the region, that we can begin to succeed at resolving the issues of projectile point succession in the region. We should further be able to utilize these data to cross-examine hypotheses drawn from ceramic observations.

This interplay between independent sets and subsets of data might take the form of the generation of formal polythetic sets. Aten (1979, 1983:Figure 16.1) made an initial application of polythetic sets in his work on the upper Texas coast in regard to comparing artifact distributions with ethnohistorical tribal boundaries. Thomas et al
provide both a theoretical definition and an explicit example of polythetic set definition from the Great Basin (Thomas et al 1976:271-272):

"The essence of polythetic procedures is that several variables are incorporated in one definition, but concern is with the overall implications of all variables, rather than any specific variable. The several variables in a polythetic definition must satisfy two important criteria: (1) All the defined objects must exhibit most of the characteristics stated in the definition. (2) Each of the defining variables must characterize most of the defined objects."

[The boundaries of an explicit, applied polythetic set is defined by] "a series of variables: e.g., for potential site loci, $f_1$, the locus should be on a ridge or saddle; $f_2$, the ground should be relatively flat (<5% slope); $f_3$, the locus should be in the low foothills >250 meters above the valley floor; $f_4$, $f_5$, $f_6$...$f_7$.

Group K (the set of all potential pinon ecotone habitation loci in the Upper Reese Valley) is defined in terms of a set $G$ of properties $f_1$, $f_2$, $f_3$...$f_7$ such that:

1) Each locus possesses a large (>5) number of the properties in $G$;
2) Each $f$-variable in $G$ is possessed by large numbers of these loci; and, for the potential loci to be considered truly polythetic:
3) No $f$ in $G$ is possessed by every loci in the aggregation.

The presence of 5 out of 7 variables was arbitrarily chosen as a definition threshold for set inclusion. The reader may further recognize that this polythetic set example is very
reminiscent of the set of co-occurring site location criteria cited in my Cypress Creek
settlement study above. The Cypress Creek exercise could rightly be considered
polythetic set definition, however it remained through my ignorance of the procedure at
an intuitive and inexplicit level of definition.

In this era the obvious route for the establishment of polythetic sets and testing of
hypotheses through their application is via the generation of comprehensive,
computerized databases. While there has been some success in this effort (Patterson
1993b, c), the organization of the currently available data is too geographically coarse to
permit the types of application I propose, and my own efforts at creating such a database
are in their infancy. However, we can look to data from Patterson and from Aten's prior
syntheses to make some broad-brush geographical statements, plus a few other
interesting observations. These statements and observations support the thesis that using
geographical analytical units is a worthwhile occupation.

Aten (1983) has noted the following distributions (my own comments regarding issues
discussed previously are given parenthetically):

(1) Bone-tempered ceramics encircle the Akokisa territory but are
infrequent within it.

(2) Caddoan ceramics occur not at all in the Brazos Delta-West Bay
area, in trace percentages in the Galveston Bay area, and as a significant
minority type in the Conroe-Livingston region. (Site 41HR616, which
produced several Caddo sherds, is situated within a transitional zone
where the occurrence of Caddoan ceramics becomes more frequent.)
(3) *Goose Creek Incised* and *San Jacinto Incised* pottery are scarce within the Conroe-Livingston region.

(4) Secondary cortex to interior flake ratios are 0.20 in the Brazos Delta-West Bay area, 0.45 in the Galveston Bay area, and 1.18 on the single inland Brazos River site included in the analysis. (It would certainly seem that site 41FB11, the inland Brazos site, must be situated at some point convenient to a lithic source. This observation is supported by a lithic flake density average [mean flake yield per 10-centimeter level] of 78.4 for this site as opposed to 12.9 for the Galveston Bay area and 5.6 for the Brazos Delta-West Bay region. These figures are reminiscent of site 41FB200, where 44% of the 3723 flakes were decortication and the average level yield was 58.2 flakes. Site 41FB11 was an earth midden site which included a cemetery and was by all appearances a residential base camp.)

(5) Raw material usage in the Brazos Delta-West Bay area reflects that which we have seen in more inland sites in that 100% of debitage from this western region is composed of chert. In contrast, silicified wood forms a significant minority material from the Turtle Bay period on until historic times in the Galveston Bay area but Aten (1983b:Table 15.1) notes very interestingly that usage of both silicified wood and quartzite decline steadily with time in the region (Table 17):
Table 17. Raw Material Utilization by Period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Silicified Wood (%)</th>
<th>Quartzite (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orcoquisac</td>
<td>12.9</td>
<td>-</td>
</tr>
<tr>
<td>Old River</td>
<td>25.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Round Lake</td>
<td>31.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Turtle Bay</td>
<td>38.3</td>
<td>10.6</td>
</tr>
</tbody>
</table>

I would, based on my previous arguments, suggest that items 1-3 above are likely to relate to social boundaries. These distributions certainly seem to indicate that ethnic boundaries separated Galveston Bay and its tributaries from the Brazos River watershed to the west. The latter region will be recalled to be the home of the historic Karankawan Coco group and Story's atypical western Mossy Grove people. Likewise, the upper segment of the San Jacinto River watershed, corresponding to the historic Bedais homeland and Aten's Conroe-Livingston region, seems to be clearly enough differentiated from the lower reaches of that river within the current Study Area. The distributions in items 4 and 5, in contrast, relate to the primacy in the lithic system of considerations of technological efficiency regarding transport costs and raw material distribution.

It has been repeatedly asserted in this dissertation that the inland Mossy Grove settlement pattern exhibits a high degree of stability revealed in the form of repeated re-occupations of many sites. It would be well taken to provide hard documentation of this assertion at last. This documentation is available through on-line access via the Paradox database program to Patterson's inland site data base. Fully 149 (52.3%) of the 285 sites currently listed in his database have two or more components in the span ranging from
the Late Archaic through the Historic Period. These sites are distributed throughout the three zones (Eastern, Central and Western) into which his data is subdivided.

Looking over the entire span of prehistory the current database reveals that there are 74 out of 285 total sites in the database with Paleolithic components, 45 sites with Early Archaic components, 89 sites with Middle Archaic components, 136 sites with Late Archaic components, 171 with Early Ceramic components, and 173 sites with Late Prehistoric [Late Ceramic] components. Consideration of this distribution leads me to take a further look at some of Patterson's (1976, 1986, 1993b) and Ensor's (1987a, 1988) hypotheses regarding southeast Texas prehistory. Both Patterson and Ensor have suggested that there some degree of shift in subsistence and an increase in mobility in Late Ceramic times. These hypotheses seem reasonable as consequences of the introduction of the bow and arrow at the beginning of the period and the environmental change that brought the return of the bison by A.D. 1200-1300.

Patterson (1976:175) has based his assertion regarding increased mobility on an apparent decline in pottery use and an increase in the number and decline in the size of Late Ceramic sites. Site 41HR616 can be said to support his reasoning since the site exhibited a gradual increase in pottery recovery until the end of the Early Ceramic and then a gradual decline in recovery throughout the Late Ceramic. I do not have the data to comment on any change in site size but the database information permits me to point out that the total number of sites from these two periods are almost equal. The data above on site re-occupation further does not seem to imply a radical shift in the locus of settlement between the two periods. If anything, there is an increase in locational redundancy as there are 105 sites with both Late Archaic and Early Ceramic components, while there are 124 sites with both Early and Late Ceramic components.
Looking back in time at the depth of this settlement redundancy I note that there are 81 sites with both Middle and Late Archaic components. 40 sites with both Early and Middle Archaic, and 35 sites with both Paleoindian and Early Archaic components. I would suggest that the less than complete occupational redundancy between adjoining periods suggests incremental shifts in the settlement system in response to environmental change. The impression of incremental change is reinforced when we look at groups of three periods combined: there are 31 sites with Paleo-Middle Archaic components, 40 sites with Early-Late Archaic components, 67 sites with Middle Archaic-Early Ceramic components, and 91 sites with Late Archaic-Late Ceramic components. (Please note that I can make these period-by-period comparisons only for the sites for which Patterson has not lumped the Archaic into a field which states that all archaic periods are present; there are 37 such sites in the database. Of these 37 sites for which I cannot discriminate between Archaic periods I note that there are 23 sites within the database Study Area with a continuous range of occupation from Paleoindian to Late Ceramic.)

The three-period cluster figures can be made more comparable with a little mathematical manipulation. We first sum the total number of components (multiple or single) for each of the groups of periods. We than multiply the number of sites with all three components by three to yield the total number of components which exist in sites dating to all three periods. We then figure the percent of the total components which are found in sites with all periods combined (Table 18):
Table 18. Percent of Occupational Redundancy.

<table>
<thead>
<tr>
<th>Periods</th>
<th># of Sites (X3) = # of Components</th>
<th>Total # of Components</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleo-Middle Archaic</td>
<td>31 = 91</td>
<td>208</td>
<td>44.7%</td>
</tr>
<tr>
<td>Early Archaic-Late Archaic</td>
<td>40 = 120</td>
<td>270</td>
<td>44.4%</td>
</tr>
<tr>
<td>Middle Archaic-Early Ceramic</td>
<td>67 = 201</td>
<td>396</td>
<td>50.7%</td>
</tr>
<tr>
<td>Late Archaic-Late Ceramic</td>
<td>91 = 273</td>
<td>480</td>
<td>56.9%</td>
</tr>
</tbody>
</table>

One could probably put any number of spins on these figures; for example, one could argue that the gradual increase in percent of occupational redundancy represents the consequence population infilling of the database Study Area. I will merely suggest that the degree of overlap within each three-period span represents those sites which remained 'suitable' in environmental and subsistence terms from one period to the next within the three-period span. The sites that do not overlap, on the other hand, represent the new locations which were abandoned or occupied for the first time in response to changing environmental conditions or subsistence needs.

I will return to the earlier topic of the purported decline in pottery, subsistence shift and increased mobility at the end of the Early Ceramic. I suggest that if the decrease in pottery usage is real, it reflects a decline in women's visible economic contribution due to some shift in the balance of subsistence focus between floral and faunal resources as much or more than it does the mere portability of pots. This decline in women's gathering may have been a consequence of increased large mammal (bison) predation and hence increased residential mobility and the shift of a significant portion of women's
economic activity to the processing of meat and hides. While this hypothesis is speculative for the prehistoric period, I would be very surprised if it was not an accurate depiction of the historic period during the active French trade in deer and other hides.

I have noted, based on Patterson's published data (1993b, c) that Scallorn points are common in his Western Zone and scarce elsewhere, while Perdiz, Alba and Catahoula types are less common in that zone than they are in the Central and Eastern zones. This relationship continues to hold true when accessing the current version of his inland database, again indicating that the western (Brazos River) zone is transitional and has greater ties to the west and south. I suspect that with sufficient geographical discrimination we would find that most of the Scallorns in the Central Zone occur in western Harris County. We can further observe that the distribution of the Bonham type, which Ensor (in Moore 1994b) affiliates with Alba as the other component of the Alba Cluster of types, is restricted to the Eastern and Central zones. (Unfortunately Patterson has not coded the Frilley of the Catahoula Cluster or the Cliffton of the Perdiz Cluster.) The restriction of Rockport ceramics to the Western Zone still holds true in the most recent version of the database.

I have already noted that Patterson's data indicates that the distribution of Gary and Kent dart points is largely restricted to his Central and Eastern zones. These points have a wide woodland distribution in east Texas and Louisiana (Turner and Hester 1993) and are the predominant points in most Early Ceramic Mossy Grove sites. While Gary/Kent dart points and Scallorn arrow points date to succeeding periods, I would like to suggest that their almost mutually exclusive distribution reflects the two autochthonous groups that gave rise to the Mossy Grove in southeast Texas. I would identify the Gary/Kent distribution area (extending back into Late Archaic times) with the incursion or
population expansion of the Atakapan stock peoples who became the Akokisa and Bedais. The Scallorn distribution, in contrast, represents those sandy-paste pottery-using people from the Brazos River to the San Bernard River watersheds whom Story (Story et al 1990) characterized as 'atypical' Mossy Grove. These people may be 'Atakapanized' Karankawan Coco, an intermingling of the Coco and an Atakapan group or a group whose identity is lost to the historic record. In any case, I believe that this is an instance in which the basis of Mossy Grove classificatory construct crosses a significant ethnic boundary and unites two peoples of differing origins. This fairly unique situation should offer considerable research potential in the further study of ethnic boundary situations. And let me note that this study is not restricted to boundary formation; the homogenization of these two peoples by shared aspects of the Mossy Grove complex offers the opportunity to study the equally interesting issue of boundary disintegration.

Two further distributions segregating the western inland zone relate to mortuary data from the Late Archaic through the historic period. First, cemetery sites are much more common in the Western Zone: the West contains 13 burial sites with a total of 380 individual interments as opposed to only 5 sites with 13 interments in the combined Central and Eastern zones. This startlingly lopsided distribution could relate to several factors:

1. It is a result of sampling error in that the cemetery sites in the two eastern inland zones remain undiscovered;
2. There is a distinction in mortuary practices such as between interment and cremation which would affect the distribution of burials between the zones. McClurkan (1968) excavated the cremated remains of...
two individuals (as well as three inhumations) within a seven square meter area at the Jones Hill Site (41PK8) within the Livingston Reservoir, and Aunt Peggy Lee recalled a Bedais cremation on Cypress Creek (Moore 1992:Appendix II).

3. Post-depositional factors could have negatively affected cemetery site preservation in the eastern zones. For example, we know that bone preservation is usually poor in the sandy soil of inland sites in the Eastern and Central zones. This argument is undermined, however, by the fact that the cemeteries in the Western Zone are all within sites classified by Patterson as sand middens. Urban development with consequent site destruction has affected much of the Central Zone. While it is merely hearsay, I have been told (by proverbial oldtimers) that a large Indian cemetery was destroyed when Allen Parkway (then Buffalo Drive) was constructed on the south side of Buffalo Bayou west of downtown.

Whatever the case with inland sites, it is quite interesting to note that the rarity of cemeteries in the Eastern and Central zones does not hold true when littoral sites are examined: there are a total of 9 littoral cemetery sites in these zones, with a total of 130 interments - and only one coastal Western cemetery with 8 interments. This distribution raises questions regarding my assessment of Aten's Akokisa Model. He considers (rightly, I'm sure) the establishment of formal cemeteries as one of the mechanisms for establishing a group's territorial claims. The scarcity of cemeteries in the inland zone could be considered an indication that he is correct in his assertion of annual inland/littoral transhumance if most of the people participating in the annual round were therefore buried in formal tribal cemeteries on the coast. I would question, however,
why such formal cemeteries would be placed on the coast - during the dispersed phase of the annual round - rather than at the aggregated band inland village sites; it would seem that if there was a place that warranted territorial validation by the presence of a cemetery that it would be the communal village site. Thus, I believe that these littoral cemeteries validate the territories of the segment of the Akokisa population which remained on or near the coast all year long. I will point out in closing that the prospects for post-depositional burial preservation are infinitely higher in these shell midden sites.

The other specifically mortuary-associated item in the database I will mention in passing is the distribution of shell and bone beads, most (but not all) of which are found in burial associations. While scarce, the distribution of these beads seem to be confined to the Western Zone. In addition, while not listed as a mortuary item, 10 of the 11 occurrences of incised bone are restricted to the Western Zone. Ochre, in contrast, is approximately equally distributed through all three zones.

Patterson (1993d) has demonstrated that the occurrence of fired clay balls is largely confined to the inland zone and cites this distribution as one line of evidence in distinguishing coastal from inland peoples. A query of his database discloses that these hearth-lining clay lumps are uniformly distributed throughout his three regions.

The last geographical distributional item derived from the Patterson database which I will discuss is intriguing but inconclusive. Lithic cores have been found throughout his Study Area but blade cores show a much more limited distribution: over 95% of the artifacts thus classified have been found in Harris County. Pinpointing the location of the sites yielding these materials could be quite informative in the context of prior discussions of the utility of core technology if they are not some artifact of the classificatory process.
While the avenues of geographical inquiry using Patterson's data base are for the moment exhausted, I will now employ it to examine a chronological and environmental issue: the debate regarding the initial date and origin of the *Perdiz* point type and the correspondence of its arrival with the reappearance of bison within the Study Area ca. A.D. 1200. I have presented the strong evidence gathered by Dillehay (1974) that the bison returned to the Southern Plains ca. A.D. 1200-1300, and discussed the associated Toyah horizon which includes the *Perdiz* type. Further, I have mentioned that Patterson's dates for a number of projectile points have been controversial. One of the points of debate has been the origin and initial date of the *Perdiz* point. Robert Booth, in the report in preparation on site 41FB200, has summarized this debate to date:

Specifically regarding the Late Prehistoric on the Southeast Texas Coast, Patterson (Patterson 1991a, b) strongly criticized applying the transition from *Scallorn* to *Perdiz* points, which has been documented for Central Texas, to the Upper Texas Coast. He referred to the presence of *Scallorn* and *Perdiz* points in the same deposits in support of this position. Ensor noted (Ensor 1990) that many sites on the coast are mixed or compressed, and cited Coe and Story in support of his position that sites representing brief occupations generally have only one point type (Coe 1964:9), and that sites with a variety of types within one level should be considered temporally mixed (Story et al 1990:214).

More recently, Patterson and Ricklis debated along similar lines regarding the chronological placement and sequence of use of arrow points during
the late Prehistoric in Southeast Texas. Patterson (1993a:28) maintained the position that:

...the Perdiz arrow point starts earlier (A.D. 600) in Southeast Texas (Patterson 1991) than in South Texas (Ricklis 1992) and Central Texas (Prewitt 1981)..." and that therefore, "...the possibility of diffusion of the Perdiz point from Southeast to the west seems straightforward.

He supported this position with data from site 41WH12 (Patterson and Hudgins 1989) at which a Perdiz point was found in the arbitrary 5 cm level (25-30 cm stratum) below a level (20-25 cm) containing Rockport bone-tempered and Goose Creek ceramics and some mussel or clam shell which was radiocarbon dated at A.D. 900 (Patterson 1993a:28, 29) (1050 ±80 BP, Patterson 1989:2)

Ricklis (1993b) responded that:

Contrary to his claims, the arrow point chronology [which Patterson posits] in the region is neither well-dated nor stratigraphically demonstrated. A brief examination of some key examples of site data which Patterson (1991, 1993a) uses to support the proposed south-east Texas arrowpoint chronology suffices to demonstrate this point.
Ricklis then examined the vertical distribution of point types at 41WH12, 41WH19, and 41HR315, some of the sites which Patterson cited in support of his position, as evidence that these were multicomponent sites which had been significantly mixed. He also questioned the degree of association of the radiocarbon date and the Perdiz point at 41WH12. In his conclusion, Ricklis (1993b:36) stated "Patterson's sites have produced only small samples of arrowpoints, and these appear to be from vertically mixed, relatively thin deposits."

Ricklis' response to Patterson (Ricklis 1993b) relied heavily on acceptance of the widely accepted Central Texas based chronology for projectile points. Patterson argued for the continued use of dart points in Southeast Texas through the protohistoric on essentially the same evidence, though in his 1994 response to Ricklis he added an historic account of Spaniards having been attacked on the Gulf Coast at the Mississippi River by Indians wielding spears and spear throwers in 1543 (although he cited a secondary source, Hudson 1976 (Patterson 1994:22)).

The question which remains under debate is the reliability of various points, Perdiz in particular, as cultural chronological indicators in Southeast Texas. It seems that there is an element of circularity in using the unstratified positions of different point types to argue against their concurrent use. If Patterson's position is correct, then the vertical distribution of types at these sites is perfectly reasonable. What must be demonstrated is the disturbance of the sites, without reference to point
typology, before the positions of the different point types become relevant to the discussion. Differentiating disturbed sites from undisturbed sites in Southeast Texas becomes the key question.

I must say that I think Booth's point is well taken regarding the circularity of the argument presented by the advocates of the central Texas chronology.

Since the Perdiz point and its associated Toyah tool kit have been found to be so strongly associated with bison hunting in central and south Texas (Ricklis 1992), I think it might be useful to look at the strength of this association in southeast Texas. I searched both Patterson's inland and coastal databases and found 23 sites which had produced bison remains. Perdiz points were recovered in all but one of these 23 sites, and the single anomalous site produced Gary dart points and thus would have dated to the earlier bison Presence Period ending in A.D. 500. No other point type exhibited anything near this consistent degree of association. I will be quick to point out that there are very many more sites in southeast Texas which produced many more Perdiz points without associated bison remains. However, it is interesting to note that of the 64 sites which have Perdiz points, all but 19 also produced scrapers, an important element of the Toyah tool kit.

I will also concede that if Patterson's long use range for the Perdiz is correct then the association of the type with bison remains is meaningless. However, I find the very consistency of the association provocative, given the type's strong identification with a bison-hunting complex elsewhere in the state; it seems to give some credence to the thesis that this association is true for southeast Texas as well. And if the Perdiz point
and accompanying scrapers are part and parcel of a bison-hunting tool kit here as well as elsewhere, then why should the date of the point's origin precede the return of the bison?

I will make one final comment regarding bison and the Patterson point chronology debate. I note that the White Oak Bayou bison kill site (41HR541), reported on by McReynolds, Korgel, and Ensor (1988) produced - in addition to three Perdiz points - one point classified as an Alba type. I have discussed 41HR541 as prototypical of an ephemeral hunting location. If this Alba point is correctly classified (and that was a topic of some debate to the authors of the report), and if it is truly associated with the bison kill then it lends considerable strength to Patterson's contention that point types had overlapping distributions in this area.

I think it is appropriate to examine some of the geographical variables which should be incorporated into a database in order to facilitate a geographical analysis based on Mossy Grove Model principles. The most important of these is geographical specificity; one cannot define microgeographical polythetic sets without a high degree of geographic definition in the database. Some or all of the following variables should be included in any such database:

(1) Site location via Universal Transverse Mercator coordinates.
(2) Watershed name.
(3) Watershed number by reference to an established map key.
(References by number will be convenient during the database sorting and querying process).
(4) Tributary name.
(5) Tributary number.
(6) Tributary order number by the standard geographical tributary order numbering system.

(7) Geomorphic setting.

(8) Published soil type.

(9) Site elevation.

(10) Site size.

This geographical portion of the site record will be followed by both quantitative and qualitative archeological data. The ability of database programs to provide calculated fields based on the data in numeric fields would be extremely useful. One such field might, for example, automatically calculate the debitage to formal tool ratio which Ricklis and Cox (1993) utilized in their lithic technological system analysis. I have created and begun to compile such a database but there are currently insufficient entries to attempt meaningful analysis.

Let us return to the sites for which we do have the necessary locational data and technological information to conduct finer-grained distributional studies, and for which we have some degree of synthesis currently at hand. Ellis (1994b) states that in regard to upper Texas Coast ceramics "the tendency has been to view pottery as time markers only, and ceramic research has been devoted almost exclusively to research problems involving cultural/historical relationships. By looking at manufacturing techniques, we can begin to build classification schemes based on technological variables. Such variables provide a more effective means of addressing process oriented research problems." She has suggested that the accumulation of a database on ceramic technological variation in the region will permit this profitable inquiry to take place The data from ceramic technological analyses conducted for Moore Archeological Consulting excavations
carried out subsequently to the work at 41HR616 is still modest but now permit initial comparisons of 41HR616 (Moore 1994b), 41HR729 (Moore 1994a), 41FB200 (Ellis in Appendix VI), and 41FB199 (Ellis n.d.a) and smaller samples from a few other sites. In addition, some comparable details available from previous work the Alabonson Road Site (41HR273; Ensor and Carlson 1991) on White Oak Bayou in the Buffalo Bayou watershed and the Copperhead Site (41BO13; Hamilton 1988) on Oyster Creek in the Brazos drainage. These comparisons will be made in the context of geographical analysis of the Mossy Grove Model.

Ellis (in Appendix VI) argues that ceramic technological analysis offers "a basis for mapping temporal and regional variation in ceramic technological style, for mapping possible areas with relatively localized ceramic traditions, and, eventually, for identifying functional characteristics of ceramics." These capabilities are obviously quite suitable for use in the context of geographical analytical units such as the watershed-based system offered under the Mossy Grove Model. Technological analysis pointed to affinities between site 41HR729 and the Alabonson Road site (41HR273). Paste choices at the two relatively nearby sites exhibit a similar broad-ranging preference for sandy pastes at the finer end of the paste spectrum. These paste choices are contrasted to markedly different ones exhibited at the more distant sites 41HR616 and 41FB200 where medium-to-fine sandy pastes were preferred. Site 41HR616 also exhibits a higher probability for the employment of grog-tempered paste. Linda Ellis, in the 41HR729 report (Moore 1994a), tentatively suggests that the geographic distribution of paste preferences may reflect differing distributions of the information exchange networks that trained potters.

The Mossy Grove model posits that a logical geographic basis for shared information exchange system is that of watersheds. Both 41HR729 and 41HR273 are situated within
the Buffalo Bayou drainage, while site 41HR616 is within the West Fork of the San Jacinto River watershed and 41FB200 lies within the Oyster Creek drainage. It has previously been established that stream channels are the most important focus for prehistoric settlement patterns in the inland Upper Texas Coast, as evidenced by the Cypress Creek analysis above. I have stressed evidence from 41HR616 and many other sites that the settlement pattern was stable in the sense that many sites show evidence of frequent re-occupation through the Ceramic Period. We have what I believe to be considerable indication that, at least at 41HR616, these re-occupations involved the same group of people thanks to the technological analysis of the ceramics from the site.

Ellis additionally notes, in the 41HR729 report (Moore 1994a), that with regard to interior smudging, site 41HR729 most resembles sites 41HR273 and 41HR616 in the rarity of smudging in contrast to its common occurrence at sites 41FB200 and the Copperhead site, 41BO13, also on Oyster Creek. She concedes that the geographic distribution of smudging does not coincide with that of paste preference in that 41HR616 is not grouped with 41HR729 and 41HR723 for the latter preference. While we may acknowledge that smudging may have a functional significance which renders its distribution independent of local ceramic manufacturing traditions, there is an intriguing alternative explanation. That is, variability in the number of contemporary, shared technological preferences may be a measure of "social distance" between local population groups. Thus, we can posit that sites 41HR729 and 41HR273 exhibit a closer degree of social interaction with 41HR616 than they do with sites 41FB200 and 41BO13. And, again, we can note a watershed-based topographic correspondence in that sites 41HR729, 41HR273, and 41HR616 are all situated on streams which are tributary to the San Jacinto River and ultimately to Galveston Bay. This hypothesis is of
course consistent with a number of lines of evidence I have cited for a significant social boundary between the Galveston Bay and Brazos River drainages.

Hamilton (1988:138-139) cites the occurrence of decoration on ceramics as appearing later and being much less common in the Brazos Delta/ West Bay area than in the Galveston Bay area. The incidence of decoration on ceramics is, however, substantially higher at 41FB200 (3%) than at 41BO13 (0.15%). However Ellis (in Appendix VI) finds that when 41FB200 is compared to sites 41HR273, 41HR729, and 41HR616 in Harris county, "the percentage of vessels with exterior enhancement is very similar and, with the exception of 41HR616, so is the frequency of lip decoration." Interesting in the decorated ceramics at 41FB200 is the appearance of motifs which are associated with the Rockport phase of the central Texas coast. Site 41BO13 also differs from 41FB200 in a preference for very fine-to-fine sandy pastes.

Since I seek to break up a Study Area into geographical segments as units of analysis there is an implicit assumption in the Mossy Grove Model that sites in close proximity should exhibit a high frequency of shared characteristics. Based on later mitigation excavations we are now able to make interesting comparisons between 41FB200 and site 41FB199 (Ellis n.d.) which are highly relevant to this issue since it is situated only 200 meters from 41FB200. Site 41FB199 shares with its neighbor a high incidence (24%) of smudging and the frequencies of decorated ceramics match exactly (3%). Dominant preference for floated/unburnished exteriors were virtually identical at both sites: 81.2% of classifiable, uneroded sherds at 41FB200 and 79.2% at 41FB199. The same high degree of correspondence was exhibited in the preference for floated/unburnished vessel interiors: 86.2% at 41FB200 and 87.2% at 41FB199. Site 41FB199 potters showed a substantially higher (83.6% as opposed to 56.8%) preference for fine to very fine sandy
pastes. On the whole, however, I believe that the numerous correspondences offer some support to the models' underlying assumption.

I will now examine site 41HR751, a site on Greens Bayou that appears to be significantly anomalous to the broader geographic trends previously discussed. This site has already been cited as somewhat anomalous in regards to lithic reduction. I must caution, though, that the ceramic data on this site is based on only 33 sherds from an extensive program of small, exploratory shovel tests excavated at the site. While sampling error may thus be a significant problem at the site, its incidence of two factors is atypical. First, Ellis (in Appendix VI) has described smudging as common in the Brazos watershed but quite scarce on the tributaries to Galveston Bay but 66% of these widely-dispersed sherds had exterior smudging. Surprising even for the Galveston Bay area is the 12% incidence of decoration on these sherds. Perhaps the fact that both lithic and ceramic data from this site has unexpected characteristics is an indication that it is a special-purpose site of some kind. Further excavation will be necessary to resolve these apparent anomalies.

The subject of possible environmental change, and consequent shifts in subsistence and settlement have not been dealt with adequately in this dissertation. I have examined certain hypotheses regarding changes in settlement held to take place between the Early and Late Ceramic periods but these issues have been dealt with at a rudimentary level at best. It is obvious that we need a better understanding of whether significant environmental changes did take place in southeast Texas during the study period. For example, it would be important to know whether changes in the environment affected the
very important deer population during the study period as was suggested in the Trinity River watershed southeast of Dallas (Bruseth and Moir 1987). I will essay another gross comparison based on Patterson's database, comparing the number of sites producing deer remains from the Early and Late Ceramic periods. This query reveals that deer have been recovered at 32 sites with Early Ceramic components and 35 sites with Late Ceramic components. However, the utility of this comparison as an index of potential change or lack of change in the deer population is severely undermined by the fact that 30 of these sites have both Early and Late Ceramic components. This fact potentially lends a level of support to the underlying assumption in this dissertation of fundamental stability in the prehistoric subsistence system but only to the extent (indeterminable from the database) that deer were present in both components.

It is obvious that crude efforts such as the one performed above will not lead to much in the way of further insights into any potentially significant environmental changes or subsistence shifts between the within the Ceramic Period. We first need real data on changes in the environment in southeast Texas within the study period (as well as the rest of the prehistoric period). Location of a thus far elusive bog with a good pollen record would be immensely helpful. Detailed geomorphic studies may reveal the physical effects of changes in rainfall regime and stream flow. It would be very interesting to apply Stahle and Cleaveland's (1994) tree-coring rainfall reconstruction technique locally if suitable trees can be found.
We may find useful indices of climate change in the identification of moist- versus dry-loving fauna in the local archeological record. It could be quite informative if there are local equivalents to Toomey’s (1993) desert and woodland shrews from Halls’ Cave in the Edwards plateau; one potential area to examine would be that of moist-loving versus dry-loving species of land snails since snails tend to be common in a number of local sites. Some insight may be gained by examining the ratio of species between archeological components of the same site but this effort will frequently be hampered by the ambiguous stratigraphy due to bioturbation of the many multicomponent sites of the area. Site 41FB200 is a fair example of such a liability although it dates exclusively to the Late Ceramic Period. A large and fairly diverse quantity of faunal material was recovered from this site but the very extensive pocket gopher disturbance within its sandy soils precludes looking at changes in the faunal assemblage over the 300 or more year period in which the site was occupied. However, site 41FB200 does compromise a useful Late Ceramic faunal assemblage which might profitably be compared for content with other single-component sites in the region. I note that deer are super-abundant in the 41FB200 assemblage and remind the reader that the French trader Joseph Blancpain had 2300 deer hides in his possession at the time of his 1747 arrest.

We need to pursue other diachronic issues within the Mossy Grove region with greater diligence and precision. This effort must be supported by the accumulation of radiocarbon dates in better contexts such as within hearths or in good association with discrete geomorphic features (Johnson 1994). I will suggest that detailed technological
analysis offers a promising means to approach chronologic issues in the region. Ellis has made a fruitful, if preliminary pursuit of diachronic changes in the many variables within the ceramic technological system in the sites that have been excavated by Moore Archeological Consulting (Appendices V and VI).

Further investigations in the region would also benefit from more extensive and rigorous linkages between human settlement, soils, and geologic landforms. For example, I have stated that there is a pronounced tendency for sites to be located within the floodplain on the basis of analysis of data from Cypress Creek. While this statement is fundamentally true, it should be broadened to include narrow bands of floodplain margins situated upon the scarps from adjoining older upland geologic units. A limited study has pointed this out for portions of Spring Creek. Twenty-nine sites are classified by geologic context, soils and other environmental and cultural factors in Appendix VII.

The location of the 29 sites in Appendix VII conform generally to the model of association of prehistoric sites with current or ancient streams and other water sources. Soils also substantially conform to the Cypress Creek model's assumption that well-drained soils will be preferred. The sites are all situated within the natural gallery forest associated with Spring Creek. The sites further fall within the zone defined between the floodplain and the floodplain/upland margin. Prehistoric site types are uniformly open campsites, with some apparently occupied long ago enough to permit burial of the occupational zone by considerable overburden. The presence of several buried sites
emphasizes the necessity of subsurface exploration as a part of any successful survey methodology in the region.

An important pattern to emerge from the known site data on Spring Creek is that there seems to be some degree of preference for situating sites on the Lissie and/or Willis slopes topographic zone: for the region between the confluence of Cypress Creek with Spring Creek, and the confluence of Spring Creek with the West Fork of the San Jacinto River, there are 13 previously recorded prehistoric sites, and 12 are located on or near the Lissie and/or Willis slopes. This area has been the scene of both casual, avocational survey and of one intensive effort: this investigator's survey of Jesse Jones Park (Moore 1988a). Of the four recorded sites along the West Fork of the San Jacinto, one site is on the Willis or Lissie Slope and three are on the river terrace.

This suggestion of a pattern of preference for the Lissie and/or Willis slopes is reinforced when we look at the fairly intensively studied upstream reach of Spring Creek around the proposed Spring Lake (Appendix VII: Burroughs, Woodlands and Neidigk Lake and Gosling Road surveys). Here, eight of the fourteen sites recorded in the area are located within the Willis or Lissie Slope zone. The conclusion is further supported by data from the topographically-similar City of Houston Cullinan Park on Oyster Creek in Fort Bend County (Moore and Moore 1991). Here, a large percentage of prehistoric sites were found on the Pleistocene Beaumont upland margin scarp, the topographic equivalent of the Lissie andr Willis slopes.
Dr. Aronow and I followed the model of Bement et al. (1987) in an attempt to derive tabular evaluations of site likelihood for the proposed Spring Lake project based on the ages and formation processes of the geomorphic units within the project area and the limited available survey data recapitulated in Appendix VII (Moore and Aronow 1994). Table 19 examines overall site potential by geomorphic unit, while Table 20 attempts to predict the occurrence of cultural materials by depth below surface.

Table 19. Spring Lake Site Potential Assessment by Geomorphic Unit.

<table>
<thead>
<tr>
<th>Geologic Unit</th>
<th>Site Potential by Archeological Period:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willis Slope (Qws)</td>
<td>All periods: Moderate</td>
</tr>
<tr>
<td>Lissie Slope (Qlls)</td>
<td>All periods: Moderate</td>
</tr>
<tr>
<td>Lower Lissie Surface (Ql2)</td>
<td>All periods: Moderate</td>
</tr>
<tr>
<td>Terrace (Qt)</td>
<td>Paleo-Indian - Middle Archaic: Moderate</td>
</tr>
<tr>
<td></td>
<td>Late Archaic - Late Prehistoric: High*</td>
</tr>
<tr>
<td>Alluvium (Qal)</td>
<td>Paleo-Indian - Middle Archaic: Low</td>
</tr>
<tr>
<td></td>
<td>Late Archaic: Moderate</td>
</tr>
<tr>
<td></td>
<td>Late Prehistoric: High</td>
</tr>
</tbody>
</table>

* Buried by eolian cover.

Table 20. Spring Lake Site Potential Assessment by Depth Below Surface.

<table>
<thead>
<tr>
<th>Geologic Unit</th>
<th>Site Potential by Depth:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willis Slope (Qws)</td>
<td>0-100 cm or base of colluvium: High</td>
</tr>
<tr>
<td></td>
<td>(colluvial deposits); 100-300 cm: Low</td>
</tr>
<tr>
<td></td>
<td>(original, ancient Willis materials)</td>
</tr>
<tr>
<td>Stratigraphic Unit</td>
<td>Depth Range</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Lissie Slope (Qlls)</td>
<td>0-100 cm or base of colluvium: High (colluvial deposits); 100-300 cm: Low (original, ancient Lissie materials)</td>
</tr>
<tr>
<td>Lower Lissie Surface (Ql2)</td>
<td>0-100 cm or base of colluvium: High (colluvial deposits); 100-300 cm: Low (original, ancient Lissie materials)</td>
</tr>
<tr>
<td>Terrace (Qt)</td>
<td>0-20 cm: Low (recent deposits); 20-100 cm: High; 100-300 cm: Moderate? (insufficiently tested)</td>
</tr>
<tr>
<td>Alluvium (Qal)</td>
<td>0-20 cm: Low (recent deposits); 20-100 cm: High; 100-300 cm: Moderate? (insufficiently tested)</td>
</tr>
</tbody>
</table>

These efforts are rudimentary at best and intended to guide subsequent survey for the Spring Lake project but they do offer an avenue by which to continue the similar investigations begun by Aten (1983b).

I have pursued the Mossy Grove Model as far as possible with the data currently available to me. In the final analysis the tenets of the Mossy Grove Model remain incompletely supported. However, I hope it will be apparent that the model, and the thought that went into its creation and application, have provided a productive structure for this inquiry into southeast Texas prehistory. The structure is one that both demands thinking in a synthetic vein and provides the means to integrate diverse data. Bettinger has rightly insisted that hunter-gatherer studies are in need of unifying theory if our understanding is to continue to advance. This presentation certainly does not explain every aspect of late prehistory in southeast Texas but it does have the virtue of unifying data while at the same time seeking variability in that data. I believe that the general features of the model may be profitably exported into other regions and other inquiries. This effort will have indeed been worthwhile if that is the case.
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EXPLANATION

Barrier island and beach deposits, Qih, mostly fine-grained sand normally without shell material; surface slightly higher than that of surrounding deposits, characterized by numerous pinacle mounds and rounded depressions; probably part of "Deaseville" barrier-island system; thickness less than 20 feet. Physical properties: "Dominantly clay, high to very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, low rigidity and depressed relief, high shear strength, and low plasticity. Geologic units include beach, foresands, barrier strandplain, barrier sandplain, esker, vegetated flats, Pleistocene barrier and strandplain sands."

Lissie Formation
Upper part, clay, silt, sand, and very fine siliceous gravel of granule and small pebble size, gravel more abundant westward, locally calcareous, concretions of calcium carbonate, iron oxide, and iron-manganese oxides common in zone of weathering; fluvialite; surface flat and featureless except for numerous rounded shallower depressions and pinacle mounds. Lower part, clay, silt, sand, and minor amount of gravel, gravel slightly coarser than in upper part, noncalcareous, iron oxide content more abundant than in upper part; fluvialite; very gently rolling, thickness 1 500 feet.

Willis Formation
Clay, silt, sand, and minor siliceous gravel of granule to pebble size containing some petrified wood; sand coarser than in younger units. Deeply weathered and lateritic, indicated by clay and cemented by iron oxide locally, concretions of iron oxide common, maximum thickness 75 feet.

Tertiary rocks on Hockley salt dome
Sandstone, very fine grained, hard, abundant porphyroclastic to opaline cement, poorly bedded, jointed, grayish white, possibly Calahonda Formation (Snelson, 1968) (See Index of Geologic Mapping for reference.)

CR
Outcrops of caprock reported on Damon Mound
Not found. Reportedly used for building stone (Briere, 1956)

U
Fault
U. upthrown; D. downthrown side

10,000-meter Universal Transverse Mercator grid ticks, shown in blue

CONTOUR INTERVAL 50 FEET
WITH SUPPLEMENTARY CONTOURS AT 25 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION
The Mossy Grove Model of Long-Term
Forager-Collector Adaptations in Inland Southeast Texas

by

Roger G. Moore

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## APPENDIX I

**Floristic List**  Welker Unit (Jesse Jones Park)

### Pinaceae
- *Pinus echinata*  Shortleaf Pine
- *Pinus palustris*  Loblolly Pine
- *Taxodium distichum*  Bald Cypress

### Hamamelidaceae
- *Liquidambar styraciflua*  Sweetgum

### Fagaceae
- *Quercus nigra*  Water Oak
- *Quercus stellata*  Post Oak
- *Quercus falcata*  Southern Red Oak
- *Quercus marilandica*  Blackjack Oak
- *Quercus alba*  White Oak
- *Quercus phellos*  Willow Oak
- *Quercus shumardii*  Shumard Oak

### Rosaceae
- *Crataegus spp.*  Hawthorne
- *Rubrus spp.*  Dewberry, Blackberry
- *Prunus caroliniana*  Cherry Laurel

### Aquifoliaceae
- *Ilex vomitoria*  Yaupon
- *Ilex opaca*  American Holly
- *Ilex decidua*  Possum Haw

### Verbenaceae
- *Callicarpa americana*  American Beautyberry

### Longiaceae
- *Gelsemium sempervirens*  Carolina Jasmine

### Strycaceae
- *Halesia diptera*  Two-Wing Silverbell

### Caprifoliaceae
- *Lonicera japonica*  Japanese Honeysuckle
- *Viburnum dentatum*  Arrowwood Viburnum
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Viburnum rufidulum</em></td>
<td></td>
<td>Rusty Blackhaw</td>
</tr>
<tr>
<td><em>Berchemia scandens</em></td>
<td></td>
<td>Alabama Supplejack</td>
</tr>
<tr>
<td><em>Smilax spp.</em></td>
<td></td>
<td>Greenbrier</td>
</tr>
<tr>
<td><strong>Bignoniaceae</strong></td>
<td><em>Campsis radicans</em></td>
<td>Trumpet Creeper</td>
</tr>
<tr>
<td></td>
<td><em>Anisostichus capriolatus</em></td>
<td>Crossvine</td>
</tr>
<tr>
<td><em>Ebenaceae</em></td>
<td><em>Diospyros virginiana</em></td>
<td>Common Persimmon</td>
</tr>
<tr>
<td><em>Myricaceae</em></td>
<td><em>Myrica cerifera</em></td>
<td>Southern Waxmyrtle</td>
</tr>
<tr>
<td><em>Vitaceae</em></td>
<td><em>Parthenocissus quinquefolia</em></td>
<td>Virginia Creeper</td>
</tr>
<tr>
<td></td>
<td><em>Ampelopsis arborea</em></td>
<td>Peppervine</td>
</tr>
<tr>
<td></td>
<td><em>Vitis spp.</em></td>
<td>Grape</td>
</tr>
<tr>
<td><em>Corylaceae</em></td>
<td><em>Batula nigra</em></td>
<td>River Birch</td>
</tr>
<tr>
<td></td>
<td><em>Carpinus caroliniana</em></td>
<td>American Hornbeam</td>
</tr>
<tr>
<td></td>
<td><em>Ostrya virginiana</em></td>
<td>Eastern Hophornbeam</td>
</tr>
<tr>
<td><em>Juglandaceae</em></td>
<td><em>Carya tomentosa</em></td>
<td>Mockernut Hickory</td>
</tr>
<tr>
<td></td>
<td><em>Carya aquatica</em></td>
<td>Water Hickory</td>
</tr>
<tr>
<td><em>Salicaceae</em></td>
<td><em>Populus deltoides</em></td>
<td>Eastern Cottonwood</td>
</tr>
<tr>
<td></td>
<td><em>Salix nigra</em></td>
<td>Black Willow</td>
</tr>
<tr>
<td><em>Sauraceae</em></td>
<td><em>Saururus cernuus</em></td>
<td>Common Lizardtail</td>
</tr>
<tr>
<td><em>Ulmaceae</em></td>
<td><em>Celtis laevigatae</em></td>
<td>Sugar Hackberry</td>
</tr>
<tr>
<td></td>
<td><em>Ulmus alata</em></td>
<td>Winged Elm</td>
</tr>
<tr>
<td></td>
<td><em>Ulmus americana</em></td>
<td>American Elm</td>
</tr>
<tr>
<td></td>
<td><em>Ulmus crassifolia</em></td>
<td>Cedar Elm</td>
</tr>
</tbody>
</table>
Moraceae
  *Morus rubra*  Red Mulberry

Polypodiaceae
  *Polypodium polypodides*  Resurrection Fern

Schizaeaceae
  *Lygodium japonicum*  Japanese Climbing Fern

Equisetaceae
  *Equisetum spp.*  Horsetail

Compositae
  *Ambrosia spp.*  Ragweed
  *Xanthium spp.*  Cocklebur
  *Baccharis halimifolia*  Eastern Baccharis
  *Aster spp.*  ---
  *Eupatorium coelestinum*  Mistflower
  *Eupatorium compositifolium*  Yankee weed
  *Grindelia spp.*  Gumweed
  *Iva annua*  Seacoast Sumpweed
  *Helinium amarum*  Sneezeweed
  *Solidago spp.*  Goldenrod
  *Elephantopus spp.*  Elephant's Foot

Leguminosae
  *Cercis canadensis*  Eastern Redbud
  *Schrankia uncinata*  Catclaw Sensitivebriar
  *Sesbania dromondii*  Drummond Sesbania
  *Sesbania desicaria*  Bagpod Sesbania
  *Desmodium spp.*  Tickclover Sesbania
  *Erythrina herbacea*  Coralbean

Typhaceae
  *Typha spp.*  Cattail

Guttiferae
  *Ascyrum hypercoides*  Saint Andrew's Cross

Anacardiaceae
  *Rhus spp.*  Sumac
  *Rhus toxicodendron*  Poison Ivy
Ericaceae
  *Vaccinium oboreum*  
  Farkleberry

Rubiaceae
  *Cephalanthus occidentalis*  
  Common Buttonbush
  *Mitchella rapens*  
  Partridge Berry

Plantanaceae
  *Plantanus occidentalis*  
  American Sycamore

Oleaceae
  *Fraxinus pennsylvanica*  
  Green Ash

Sapindaceae
  *Sapindus drumondii*  
  Western Soapberry

Cormaceae
  *Corus floridiana*  
  Flowering Dogwood
  *Nyssa sylvatica*  
  Blackgum

Magnoliaceae
  *Magnolia grandiflora*  
  Southern Magnolia
  *Magnolia virginiana*  
  Sweetbay

Lauraceae
  *Sassafras albidum*  
  Common Sassafras

Euphorbiaceae
  *Euphorbia bicolor*  
  Snow-on-the-Mountain
  *Croton capitatus*  
  Wooly Croton

Gramineae
  *Chasmanthium sessileflorum*  
  Woodsgrass
  *Digitaria texana*  
  Texas Crabgrass
  *Axonopus affinis*  
  Carpetgrass
  *Cynodon dactylon*  
  Bermudagrass
  *Oplismenus hirtellus*  
  Basketgrass
  *Setaria geniculata*  
  Knotroot Bristlegrass
  *Sporobolus piovertii*  
  Rattail Smutgrass
  *Panicum spp.*  
  Panicums
  *Paspalum spp.*  
  Paspalums
  *Andropogon glomeratus*  
  Bushy Bluestem
Solanaceae
   Solanum spp.  Nightshade

Bromeliaceae
   Tillandsia usneoides  Spanish Moss

Convolvulaceae
   Cuscuta spp.  Dodder

Palmaceae
   Sabal minor  Dwarf Palmetto

Malvaceae
   Malvaviscus drummondii  Turkscap

Labiatae
   Monarda spp.  Beebalm

Cyperaceae
   Cyperus spp.  Sedge
   Carex spp.  Sedge

Juncaceae
   Juncus spp.  Rush
APPENDIX II

Plant Economies

by

Carmine Stahl  Park Naturalist

Jesse Jones Park
Southeast Texas flora at the end of the Pleistocene would have included species that were typical of much cooler climates. Pollen and macrofossil evidence indicates that area forests were similar to those of present-day Nebraska-to-Ohio latitudes. The Holocene has been marked by wide variations in rainfall, making the moisture factor more important than that of temperature. Forest and prairie in the study area have advanced or retreated in response to rainfall. During the study period, ca. A.D. 400 to 1850, the edge of the forest has made small but significant moves, marked by incursions of bison as prairie advanced, and by the absence of these animals as the forest again intruded. A survey of present flora would include many species of herbaceous plants and several shrubs and trees that have been introduced from the old world and which have become important factors in the environment. Chinese tallow trees, particularly, have advanced the forest westward. This paper will concentrate on those species of plants that were indigenous to the study area and which were important to local native American cultures prior to 1850.

Information about plant usage for food, fiber, construction, materials, medicines, tools and weapons comes from both archaeological evidence and historic records. While both these sources are somewhat limited in regard to the small, indigenous native American associations of this area, historic records, particularly from the southeastern United States, indicate similar plant economies for this region. Trade and the exchange of ideas
and information, as well as Muskhogeans language origins, linked most of the local Indian
groups to larger and better known culture groups eastward.

The study area includes the southwestern most extension of the great southern pine-
hardwood forest, which at present reaches across northern and eastern Harris and
southern Montgomery counties. The western part of the study area is largely prairie,
with some bottomland hardwoods along the streams. At the southeastern corner is San
Jacinto Bay and the upper part of Galveston Bay, where brackish marsh flora dominates.

This rich floristic area gave local Indians access to many plants and trees that were
widely utilized across the gulf coastal region by native American groups. Those that
were particularly useful for food, fiber, shelter, tools, weapons and medicines will be
listed here, along with their known uses.

**Plant Food Sources**

Cattail (*Typha latifolia, T. angustifolia and T. dominguensis*). This tall march plant,
ubiquitous to the entire northern hemisphere, can be found in the study area wherever
water and sunshine coexist. It grows in saline as well as fresh water situations. Cattail is
a highly nutritious food source from root to bloom, and has no toxic parts. The roots
were baked by the fireside and eaten, or dried and pounded for soups or breads. The
young shoots can be eaten raw, having a similar crispness and taste of celery. In the
spring the upper (staminate) parts of the bloom stalks can be harvested to be boiled and eaten like young corn, or stripped of their buds for use in soups. Later, the bloom spikes produce a mass of pollen that can be added to soups or baked into breads. (It should be noted that many Indian groups keep soups going constantly, adding whatever was available, and that they also baked breads of grasses and other materials such as the cattail pollen.) Field and laboratory tests have shown that an acre of cattails has more nutrition that an acre of potatoes.

Bulrush (*Scirpus californicus* and other species). The giant bulrushes that grow in marshy areas around San Jacinto and Galveston bays, as well as larger bodies of water inland, were an important food source. The rootstocks were baked or boiled, and the swollen bases of new shoots could be eaten raw or boiled. The seeds provided a fall harvest of grain.

American Lotus (*Nelumbo lutea*). Lotus grows in scattered freshwater locations around the study region, sometimes covering acres of shallow lakes or ponds. The large rootstocks were baked for food, and the seeds, resembling those of chestnuts, were eaten baked, raw, or ground into meal.

White Water Lily (*Nymphaea odorata*) and Yellow Water Lily (*Nuphar advena*). The water lilies have large, swollen rootstocks which were boiled or baked, and the seeds were cooked while the pods were still green.
Arrow-head (*Sagittaria latifolia*). Another widespread plant of shallow water, *Sagittaria* has enlarged tubers that were sought for food by many Indian groups. Because the tubers may be on thin roots far from the parent plant, Indian women waded the mud and probed with their toes for them. The release tubers would then float to the top of the water.

River Cane (*Arundinaria gigantea*). The young spring shoots of river cane, our only member of the bamboo family, can be boiled and eaten like bamboo shoots. This food source would be available here from April through June. The unpredictable fruiting of river cane, occurring years apart, was an occasion of much feasting.

Greenbrier (*Smilax smallii, S. laurifolia*). These two high-climbing, evergreen vines have large clusters of potato-like tubers just underground at their bases. Numerous records exist of Indian food uses of these woody clusters, which may weigh as much as 70 pounds, and appear to be a favored source of breads and soups wherever they grow. They were chopped, then pounded into a flour. A close relative of these briars from tropical America was the source of the drink sasparilla, and the two above, chopped and boiled together with sassafras, was the original root beer. *Smilax smallii* is very common in the piney woods, while *S. laurifolia* is ubiquitous on small trees and shrubs in sunnier locations throughout this area.
Dewberries and Blackberries (*Rubus* species). The many *Rubus* species are constantly hybridizing, and only specialists attempt to classify them. However, they may easily be separated into two general groups, the dewberries and blackberries. Dewberries are low, procumbent vines that bloom in this area in March, and produce large, sweet berries in April. Blackberries are tall, stiff and very spiny briers that bloom in April and produce their tart berries in May. Both were valued by Indians to the extent that some accounts indicate all else was abandoned while these berries were ripe and available. This area produces prodigious amounts of dewberries and blackberries each spring.

Persimmon (*Diospyros virginiana*). American persimmon is common throughout this area. The fruit, extremely astringent when green, is very sugary and sweet when ripe, and was much valued by American Indians. These fruits were also popular with Stephen Austin’s colonists, but are little eaten at present.

Mulberry (*Morus rubra*). As with the above fruit, red mulberry was highly valued by both Indians and early Texas colonists, but is very little utilized at present. The syncarps, which resemble blackberries, ripen locally in April and May.

Pecan (*Carya illinoiensis*). Pecans are most common in the stream bottoms of the western part of the study area. The nuts were eagerly gathered and eaten by Indian groups in fall. The harvest of these thin-shelled nuts was truly prodigious across the eastern half of Texas.
Black Hickory (*Carya texana*). Several species of hickory are native to east Texas, but only this one is common in the study area. It is one of the dominant trees on dry slopes and deep sands, such as on the edge of floodplains. Its shells are thick, but the nutmeats are sweet and nutritious. Indians crushed the nuts in their corn-pounders, then boiled them to separate the shells, nutmeats, and the valuable oil.

Black Walnuts (*Juglans nigra*). Another eagerly sought nut, *Juglans nigra* grows in our study area at present mainly along the Brazos River and its tributaries. This has probably been a long-standing condition, as black walnut cannot compete for light with the tall trees of the piney woods.

Acorns (Various oak species). Although practically no use is made at present of acorns as food, this was a prime food source for many Indian groups. Acorns must be leached of their tannic acid content to be edible. This was done either by boiling, or by placing them in baskets in streams for hours. Once leached, these nuts are very nutritious and can be ground into flour for breads or incorporated into soups. White oak (*Quercus Alba*) was most valued, as the acorn are large and have lesser amounts of tannic acid. However, any species of oak’s acorns could be and were utilized.

Grapes (*Vitis species*). The dominant grape in the piney woods is the *Muscadine* (*Vitis rotundifolia*), which is also the finest native grape of North America. This common vine
produces its fruits prolifically in July and August. In the western half of the study area, the mustang grape (*Vitis candicans*), sprawls over trees and shrubs everywhere. The fruits ripen earlier than those of muscadine, and are also a prolific harvest. However, mustang grapes cannot be eaten raw because of a strong acid in the hull. They are edible after being cooked into various preparations.

**Grasses (Gramineae).** Various grass seeds were gathered as grains, and Indian breads were usually mixtures of several kinds, perhaps also mixed with acorn flour, greenbrier tuber flour, or other crushed and sifted materials. Few grasses can grow in the woodlands’ deep shades, but the adjacent prairies contain many species.

Other plants available and gathered for food in the area included various docks (*Rumex* spp.), pokeweed (*Phytolacca americana*), Thistles (*Cirsium* spp.), Nettles (*Urtica* spp.), ground cherries (*Physalis* spp.), sunflowers (*Helianthus* spp.), and elderberries (*Sambucus canadensis*). In this mild climate, some herbaceous plants were available almost year around.

**Plants used for Fiber and Construction**

Cattail (*Typha* spp.). The long strap-like leaves of cattail are excellent weaving and cordage material. The leaves were allowed to dry after gathering, then soaked before using to make them more flexible.
Bulrush (*Scirpus* spp.). Various *Scirpus* reeds made good cordage and basketry materials, and were used for mats and thatching also.

River Cane (*Arundinaria gigantea*). River cane was utilized by some Indian groups for construction of beds against their hut walls. They were also used for weirs and traps.

Alabama Supplejack Vine (*Berchemia scandens*). Supplejack, also called rattan vine, is very strong and flexible, and was used to tie together the small trees used as frameworks for huts. The vines are flexible enough to tie into knots, and were invaluable in all kinds of construction.

Palmetto (*Sabal minor* and *Sabal louisiana*). Palmettos are common in the study area in creek and river bottoms. The fronds are excellent thatching, and shed rainwater very well. They were universally used along the coastal plain where they grow. A dwelling could be quickly thatched by overlapping the fronds, beginning at the bottom just as shingles are laid today. The thatching would have to be replaced about once a year.

Grasses (*Graminae*). Tall growing grasses such as the bluestems (*Andropogon* spp.) were used for weaving, thatching and bedding. Summer houses have elevated platforms on which grasses were laid as bedding, and bear and buffalo skins were then placed upon them for sleeping.
Baldcypress (*Taxodium distichum*). Area Indians were admired by early Spanish and French explorers for the fine dugout canoes they made from cypress. Both small (Pirogue type) canoes and very large ones were hewn from cypress trees. Because of the long lasting quality of cypress when exposed to water, this wood was used wherever poles and logs touched the soil.

Red Mulberry (*Morus rubra*). Red mulberry has a fine, soft bark that can be peeled off in long strips. It was much used in cordage and bundling, and as cloth. Indian women of many groups wove skirts from mulberry bark.

**Tools and Weapons**

Black Bum (*Nyssa sylvatica*). This tree was favored for both drums and corn pounders. The wood has a good resonance and imparted a sweet taste to the corn and other grains.

Dogwood (*Cornus florida*). Dogwood was a favorite bow wood among southern Indians. Hickory and ash were also used for this purpose.

River Cane (*Arundinaria gigantea*). Cane was used for arrow shafts and for spears. Other arrow and spear shaft materials were arrowwood (*Viburnum dentatum*), green ash (*Fraxinus velutina*), and marsh cane (*Phragmites communis*).
Ironwood (*Carpinus caroliniana*). Ironwood, or American hornbeam, is an extremely tough wood that was used for handles of such things as axes, tomahawks, etc. Other woods used similarly were the many species of hawthorns.

**Medicinals**

Willow (*Salix* spp.). Willows were the original sources of aspirin, whose chief ingredient is acetylsalicylic acid, names for the genus. Almost everywhere across the northern hemisphere, wherever there is water, willows will be found, and willow bark tea was universally used to reduce a fever or cure a headache. It was also used in poultices and as an astringent for wounds. Our common willow is black willow (*Salix niger*).

Sassafras (*Sassafras albidum*). Although modern medical research has found no real medicinal value in sassafras, it seems that American Indians revered it as Orientals do Ginseng. This idea of the curative powers of sassafras was borrowed by European colonists, and at one time sassafras bark was literally worth its weight in gold in England. Sassafras is common across northern Harris and southern Montgomery counties.

Dock (*Rumex* spp.). Various docks were used as astringents and as a soothing remedy for poison ivy dermatitis. These are cool weather plants, growing fall through spring in the study area.
Hercules Club (*Zanthoxylum clava-herculis*). This tree, also known as 'toothache tree' and 'tickle-tongue', has a natural anesthetic in its bark and leaves that was used to alleviate toothache. Mothers applied it to teething babies' gums. This small tree, characterized by cycry prickle along the trunk, is common in this area in hedgerows and other sunny locations.

The Indian *materia medica* has been the subject of many books, but the above are a few of the most common medicinals of this area.

**Other Plant Uses**

Dyestuffs. Sassafras produced striking red, orange and yellow dyes. *Smilax* tubers yield a russet-to-purple color. Willow roots were used for reds and yellows. Dock roots produce bright brown and amber shades. Red oak bark was widely used for reds and blacks. Walnut hulls produce strong yellows and browns.

*Oddenda*. The fluffy seed heads of Cattail plans were used in Cradle boards as absorbents for babies' discharges, or as wipers. They were also stuffed in moccasins for warmth in cold weather. Walnut hulls were crushed and put into waterways as a fish poison. Sumac berries were used to freshen muddy or stale water. Slippery elm twigs were used for teeth cleaning. Silverbell seed pods were held in the mouth as thirst
quenchers. Sections of grape vines were used as paint brushes. With a wealth of plant life in the study area and thousands of years to develop their practical possibilities, local Indians had a botanical treasure, and utilized it.
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APPENDIX III

Geomorphology and Surface Geology of Harris County and Adjacent Parts of
Brazoria  Fort Bend  Liberty  Montgomery  and Waller Counties  Texas

by

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INTRODUCTION

The study area (Volume I:Figure 1) covers almost all of Harris County, and adjacent parts of Brazoria, Fort Bend, Liberty, Montgomery, and Waller counties, Texas. The geology depicted on Figure 1 is a portion of Beaumont and Houston sheets of the Geologic Atlas of Texas (Barnes, 1982, 1992a). This map, with its 1:250,000 scale, has the largest scale of any published map showing formational units. Other maps with formational, allostratigraphic, and environmental units covering all or part of the study area include Barnes (1992b), Doering (1956), Fisher et al (1972), Richmond et al (1990), St. Clair et al (1975), Saucier and Sneed (1991), Van Siclen (1986, 1991), and Winker (1991b).

The soils of the several counties in the study area are mapped and described in several soil surveys: Harris County (Geib and Bushnell, 1928; Wheeler, 1976), Brazoria (Crenwelge et al. 1981), Fort Bend (Mowery et al. 1955), Liberty (Griffith, in press), Montgomery (McClintock et al. 1972), and Waller (Greenwade, 1984) The relationship between the geology and soils of these counties is also discussed in these reports: Harris (Aronow, 1976), Brazoria (Aronow, 1981), Fort Bend (Mowery et al. 1955;25), Liberty (Aronow, in press), Montgomery (Aronow, 1972) and Waller (Aronow, 1984).

The drainage basin of Buffalo Bayou is the major one of the study area. It covers the central and western part of the study area and most of Harris County. Buffalo Bayou enters the lower reaches of the main stem of the San Jacinto River ~9 miles (~14 km) above the river's
entrance into Galveston Bay. The northern part of the study area is in the drainage basin of Spring Creek which is a tributary of the West Fork of the San Jacinto. Spring Creek forms the northern boundary of Harris County. Cypress Creek is a major tributary to Spring Creek. Most of the drainage east of the San Jacinto in the eastern part of the study flows into Cedar Bayou which empties directly into Galveston Bay just east of the study area. The drainage of the southeastern part of the study area is to Clear Creek which enters Galveston Bay via Clear Lake. The bulk of the drainage of the southwestern part of the study area is directly into the broad floodplain of the Brazos River. South of this floodplain the drainage is also to the Brazos. Drainage into the Brazos floodplain from the northeast is negligible.

The study area falls in the in the West Gulf Coastal Plain geomorphic unit (Hunt 1974; Walker and Coleman 1987) in which the surface and near-surface sediments dip gulfward at less than two degrees and crop out in gulf-paralleling bands. The surface geologic units (Figure A; see map pocket, Volume II) in the study area are upper Tertiary or Cenozoic to Holocene in age. The units are

(1) the Miocene Catahoula Formation
(2) the Plio-Pleistocene (?) Willis Formation,
(3) the Pleistocene Lissie Formation,
(4) the late Pleistocene Beaumont Formation
(5) the late Pleistocene to early Holocene Deweyville Formation or terraces, and

(6) the Holocene alluvium in the floodplains of the several streams.

**CATAHOULA FORMATION**

Small outcrops of silica-cemented fine-grained sandstone are exposed in the banks of Rock Hollow, a stream flowing southward across the Hockley Dome in northwestern Harris County. Stenzel (1946: 207-208) describes the cement as "whitish and porcellanous..." with some pores filled with "bluish-white, translucent, waxy, opaline or chalcedony cement." The opaline cement suggests to him that the sandstone is Catahoula. These outcrops may be of archaeological interest in that they provide a source of projectile point material.

This outcrop was lifted to its present surface position where it is surrounded by the Willis Formation (i.e., an inlier) by the rise of a salt plug. According to Halbouty (1979:127) the top of the salt is 1010 feet (∼308 m) below the surface; the top of the superadjacent caprock, 76 feet (∼23 m) below the surface.

**WILLIS FORMATION**

The Willis Formation was first named by Doering (1935) after exposures in the vicinity of the community of Willis (north of Conroe) in Montgomery County. A slope break known in the
Texas Gulf Coast as the Hockley scarp, named after its crossing of U. S. Highway 290, northwest of Houston near the community of Hockley. It can be traced northeastward to the Sabine River and southwestward to the Guadalupe River. In the vicinity of the U. S. Highway 290 crossing the scarp is an active fault (Barnes, 1982).

The Willis Formation is fluvial in origin and, as exposed in many road cuts and pits, contains many cross-bedded sand and gravel beds. In some places, the cross-bedded material consists of clay clasts eroded from contemporaneous overbank deposits or from the underlying clayey Fleming Formation. The breakdown of these beds of clay clasts may explain some of the puzzling massive gravelly silts and clays seen in many surface exposures. The extensive surface weathering of the Willis producing an iron oxide-rich laterite-like surface material with attendant strata-destroying volume changes may also contribute to these massive beds. Churning of surface materials by colluviation may also destroy and homogenize bedding. Weathering effects, as seen in sand and gravel pits, in places extend to depths of over 10 feet below the surface.

The seemingly extensive deposits of sand and gravel, well-displayed in many pits, suggests a bed-load braided stream origin for the Willis in this part of Texas. A perusal of the soils maps of many East Texas counties (e.g., McClintock et al. 1972) will show many soils developed on the Willis with clayey and silty parent materials of probable overbank origin. Smith and Meylan (1983) promote a braided stream genesis for the Citronelle, the probable Willis correlative in Mississippi. Self (1986), proposes a braided stream-alluvial fan genesis in
eastern Louisiana. Proctor and Hall (1974:126, Figure 3) map the Willis outcrop area as a Pleistocene alluvial fan system and describe it in the following as a...

...belt of tree covered sands and gravels... Interspersed within the coarse-grained alluvial deposits are isolated prairie areas composed of overbank deposits...

Van Siclen (1972:415) suggests that the Willis "appears to represent deeply weathered Goliad (Pliocene) material redeposited by small streams" or a "regolith" on the Goliad surface (Van Siclen 1985:figures 8-9) correlative with the Williana and Willis of Bernard and LeBlanc (1965).

The surface of the Willis is moderately dissected by streams. Stream margins with and without floodplains have broad graded slopes. In many places undissected interfluvies have slopes towards the Gulf of ~10 feet/mile (~1.9m/km) (Bernard and LeBlanc 1965:Figure 10). A few undrained depressions and pimple mounds (see later discussion) are also present on some of these surfaces.

Few clues exist concerning the streams that deposited the Willis. Paleo-streams, precursors to the modern Brazos, San Jacinto and Trinity Rivers probably laid down the Willis Formation.
The soils of the Willis in the study area are shown in the soil surveys for Harris, Montgomery, and Waller counties (Wheeler 1976; McClintock 1972; and Greenwade 1984). The principal soils are the Boy, Conroe, Depcor, Gessner, Hockley, Katy, Monaville, Splendor, Segno, and Wockley. Almost of these have thick surfaces (A and E horizons) ranging in texture from fine sand to loamy fine sand to fine sandy loam to loam. These surface layers should be capable of site formation either by colluvial, overland-flow or eolian burial, or bioturbation.

Doering (1935) assigned a late Pliocene or early Pleistocene age to this formation. In a later paper (Doering 1956), he correlated the Willis with the Citronelle of Mississippi, Alabama, and northwestern Florida and placed them both in the early Pleistocene. In his last paper on Gulf Coast geology, Doering (1958) found that an early pre-Nebraskan Pleistocene age was "as plausible as one of late Pliocene." A Plio-Pleistocene age was also accepted by Rosen (1969), Isprioting and Lamb (1971), Smith and Meylen (1983), Self (1986), and Morton et al. (1988). Barnes (1968a, 1992a) adopts a Pleistocene age but a short time later (Barnes 1992b) reverts to the Pliocene age of Darton et al. (1937). A major problem concerning the age assignment of the Willis revolves around its possible genetic relationship to glacio-eustatic changes in sea level, i.e., which side of the Pleistocene/Pleistocene boundary it falls. This discussion, however, now has an archaic flavor because it assumed that glacio-eustatic sea level changes in the late Cenozoic were confined to the Pleistocene.

Controversy concerning the definition of the opening date (in absolute terms) of the Pleistocene and the relationship of this date to major continental glacial expansion, makes the
problem of the Pliocene vs. Pleistocene age of the Willis more complex. The most commonly used date for the beginning of the Pleistocene is about 1.7 million years B. P. (before present) which is slightly younger than a prominent paleo-magnetic reversal (the Olduvai at 1.77 million years B. P.). As noted by Anderson and Borns (1994: 36)

many Quaternary scientists were none too happy with this definition. They were used to considering the Quaternary as more or less identical with the time of late Cenozoic mid-latitude glaciations, which covers approximately the last 2.5 million years...In addition, the oldest remains of humans seem to be about 2.5 million years old, and many geologists have considered the Quaternary to be the "Era of humans." Therefore, there are still attempts made to have this boundary redefined.

In the Gulf Coast region in particular the older approximately 2.5 million-year date is still widely used because of well-defined micro-fossil markers found in the cored sediments of the Gulf. For further discussion the reader is referred to Aguirre and Pasini (1985), Beard et al. (1982), Frakes et al. (1992), Morrison (1991), and Richmond and Fullerton (1986a: 7-8; 1986b: 185-186).

The Willis is probably older than 1.7 million years and thus, older than the latest Pleistocene/Pliocene temporal boundary interpretation, falls in the Pliocene. This may be rationale behind Barnes' (1992b) placement of the Willis in the Pliocene. The problem of
whether the deposition of the Willis is related to glacio-eustatic sea level changes remains unresolved. The lack of age-significant vertebrate and invertebrate fossils, and of radiometrically useful ash beds seems to preclude a finite age at the present time.

LISSIE FORMATION

The Lissie Formation was first defined by Deussen (1914:78-80) from sediments exposed in the vicinity of the community of Lissie in northern Wharton County, Texas. Deussen referred to the unit as the "Lissie gravel."

The Lissie Formation overlies the Willis and has a regional slope of ~2.5 to 3.5 feet/mile (~0.5m/km to 0.7m/km) (Bernard and LeBlanc 1965:Figure 10), considerably less than that of the Willis. Compared to the Willis the surface is only slightly dissected but stream channels with and without floodplains have similar long graded sloping margins. Interfluves are fairly flat and areally extensive.

Like the Willis the Lissie is fluvial in origin and rarely displays any relict fluvial morphology. The outcrop area parallels the present-day coast but in a few places like along Spring Creek in the study area the Lissie has a stream-paralleling terrace position.

The commonest surface signature of the Lissie are circular to elliptical undrained depressions and pimple mounds (to be discussed later) both of which, at least in part, eolian in origin.
Vertisols are rare on the Lissie surface, though potential "fat" or plastic clays are abundant in the subsurface. The loss of fluval morphology on the older Pleistocene units (i.e., the Willis and the Lissie) when compared with late Pleistocene and Holocene surfaces was referred to by Fisk (1940) as "landscape deterioration."

This report follows Barnes (1992a, 1992b) in recognizing the Lissie as the next youngest formation in the study area. For a brief time on some of the maps of the Geologic Atlas of Texas (e.g., Barnes 1968a, 1968b; cf. Bernard and LeBlanc 1965) the Lissie outcrop area was divided into an older Bentley Formation and a younger Montgomery Formation. These formation names were introduced into Texas by H. A. Bernard (1950) in a Ph.D. dissertation covering southeastern Texas between the Sabine and Neches Rivers. Bernard (1950) utilized a Pleistocene classification devised by H. N. Fisk (1939, 1940, 1945) for Louisiana. This Fiskian system for subdividing the Pleistocene sediments has been abandoned for both Texas (Barnes 1992b) and Louisiana (Snead and McCullah 1984).

The Lissie Formation, fluval and deltaic in origin, was deposited during several interglacial high sea level stages similar to the present (Bernard and LeBlanc 1965; Aronow 1976). Probably early in its history the Lissie surface had preserved on its surface a fluval depositional topography similar to that preserved on the younger more gulfward Beaumont Formation (Bernard and LeBlanc 1965; Fisher et al. 1972; Aronow 1976). Since their deposition during at least two high interglacial sea level stands, the surfaces of the Lissie units have been water-eroded, mass-wasted, modified by wind deflation and deposition, churned by
burrowing organisms and tree roots, and disturbed by windthrown trees. All of these have obliterated the original topography.

The Lissie outcrop in the study area is confined to Fort Bend, Harris, Liberty, Montgomery, and Waller counties and the soils are described in Mowery et al. (1955), Griffith (in press), Wheeler (1976), McClintock et al. (1972), and Greenwade (1984), respectively. The major soils are the Addicks, Aris, Clodine, Gessner, and Wockley which occur on the major grassland or prairie part of the Lissie outcrop. The Wockley and Gessner were also found on the Willis surface. These soils with thick-surfaced (A and E horizons) loams to fine sandy loams. The principal soils of the forested Lissie are the Boy, Hockley, Kirbyville, Segno, Splendora, and Sorter. These are likewise thick-surfaced loamy fine sands, fine sandy loams, silt loams and loams. Undrained depressions were mainly the sites of the Gessner under grasslands, Waller in forested areas. The Kirbyville soil is confined to Liberty County. As was noted for the Willis these soils are potential places of site formation by bioturbation, colluvial, overland-flow, and eolian burial.

The age of the Lissie units is not known but it is probably over 0.15 million years in age. Fisk (1944) placed the upper part of the Lissie (Montgomery) in the high sea-level Sangamon interglacial which he believed to be centered around 0.2 million years B.P.; the lower part of the Lissie (Bentley) in the Yarmouth interglacial, 0.4 to 0.6 million years B.P. (Bernard and LeBlanc 1965:146). Beard et al. (1982:159) place the Sangamon in a time interval between 0.07 to 0.1 million years B.P.; the Yarmouth, 0.8 million years B.P. to 1.3 million years. In a
recent summary (Anderson and Borns 1994:44-45) assign the Sangamon to the 130,000-
115,000 year B. P. interval (the 5e deep-sea oxygen-isotope stage) though they note that
some would prefer a 130,000-75,000 year B. P. interval (the complete 5 deep-sea oxygen-
isotope stage). The upward time-wise extension may include at least two minor glaciations
(see Richmond and Fullerton 1986a:6-7; 1986b:190-191). The Yarmouth interglacial
concept has been abandoned (Richmond and Fullerton 1986b:183-184). Probably the both
parts of the Lissie were deposited in interglacials older than the Sangamon which should
probably be reserved for some part of the Beaumont Formation.

The traditional concept of a four-fold Pleistocene sequence of world-wide continental glaciers
and accompanying low sea level stands (used by Fisk 1939, 1940, 1944) has become less
likely with over a dozen world-wide glaciations (Richmond and Fullerton 1986a, 1986b).
The several Pleistocene formations of the Gulf Coast, that is, the several parts of the Lissie,
the Beaumont, and possibly the Willis may be products of many interglacial high sea level
stands (Morrison 1991; Saucier 1991; Winker 1991b).

Not in dispute their regressive alluvial-deltaic origin during interglacial high sea-level stands
similar to the present (Bernard and LeBlanc, 1965). The somewhat simplistic picture,
however, of the overwhelming influence of glacio-eustatic sea level changes on alluvial-
deltaic coastal plain development, proposed earlier by Fisk (1938, 1944) has been altered by
some recent work (see summaries in Blum, 1992, p. 243-247 and Mossa, 1991).
BEAUMONT FORMATION

The Beaumont Formation is the youngest coast-wise or coast-paralleling Pleistocene unit in the Texas Gulf Coast. It was first named by Hayes and Kennedy (1903:27-29) from clayey exposures and well logs reporting clays in the vicinity of Beaumont, Texas. They referred to the unit as the "Beaumont clays" and noted its occurrence in southwestern Louisiana where it is currently called the "Prairie Terraces" (Snead and McCullah 1984) or the Prairie Formation. In the study area (see Figure 1) the Beaumont flanks parts of the East and West Forks of the San Jacinto River as terraces. The writer believes that some of these terraces should be mapped as Deweyville (see below).

The Beaumont Formation has a regional slope of ~1 to ~2 feet/mile (~0.2 m to ~0.4 m/km). Stream channels are sharply incised in the Beaumont surface with steep, ungraded margins. The surface is less dissected than that of the Lissie. Flat, uneroded surfaces, poorly drained surfaces are abundant. The surface displays a relict depositional fluvial, deltaic, and to a minor extent, barrier island and strandplain topography. Vertisols, absent form the surface of the Willis and Lissie, but developed on exposed relict flood-basin deposits, are widespread.

On a regional scale the Beaumont Formation crops out in a vast arc paralleling the northwestern Gulf coast from east of the Holocene floodplain of the Mississippi in Louisiana where it is called the Prairie Formation (see Snead and McCullloch, 1984) to northeastern Kleberg County, Texas where it disappears beneath the sands of the South Texas Sand Sheet
(Barnes, 1975; Bernard and LeBlanc, 1965, figure 2). Most of the Beaumont was deposited as an overlapping group of alluvial or deltaic plains by the ancestors of most of the modern streams now draining into the western Gulf of Mexico. Other, minor, parts of the Beaumont are of barrier island, strandplain, beach, mudflat, and lagoonal origin.

In many areas of Beaumont outcrop the surface is crossed by a relict depositional topography of paleo-meander-belt or distributary ridges that rise less than 10 feet (3 m) above the surrounding and intervening paleo-floodbasins and paleo-interdistributary areas. The higher areas are generally underlain with sandy and loamy soils and display in many places relict meandering stream patterns, both as isolated fragments, and as segments with continuities of several kilometers. The flanking swales are the sites of clayey soils and show relatively smooth, featureless surfaces. The landforms and soils on the parts of the Beaumont laid down by the Pleistocene precursors of the larger streams such as the Trinity, Brazos and Colorado exhibit well-defined meander-belt ridges and flood basin swales nicely partitioned by distinctive soil series.

The floodbasin areas are generally the sites of vertisols, that is, soils that are clayey to the surface, and expand and contract upon wetting and drying. In many places the volume changes produce on the surface a micro-relief complex of depressions and ridges called gilgai; in the subsurface, intersecting striated shiny shear planes called slickensides (Wilding and Tessler 1988; Yaalon and Kalmar 1978). The limiting depth for the development of
slickensides below a presently existing surface is in the order to 10 to 12 feet (3 to 3.5m).

Buried surface can be recognized by the presence of slickensides at depths greater than these.

The meander ridges, in addition to their locally prominent but not ubiquitous meandering stream patterns, in most places display a microrelief in the form of small shallow undrained depressions and pimple mounds.

Much of both the gilgai topography of the paleo-floodbasins, and the undrained depressions and pimple mound of the paleo-meander ridges has disappeared in the past century under the onslaught of row-crop tillage, pasture improvement, ditching for drainage, land-leveling and levee construction for rice cultivation, and logging operations. Maps like the ca. 1916 1-foot contour interval series, and successive air photos from the early 1930's record the progressive disappearance of these forms of micro-relief in the Houston area.

In the upper Texas coast region these depositional patterns are illustrated in Bernard and LeBlanc (1965, Figure 5); Van Siclen and Harlan (1965, Plate 1), and the Environmental Geology maps in Fisher et al (1972, 1973) and McGowen et al (1973).

On a regional to local scale the pattern of the meander-belt ridges is anastomosing. These paleo-courses were not all active at the same time--only one was active at any one time. The interconnectedness is the result of avulsions and stream captures, as channels overflowed during floods into adjacent lower flood basins, some with previously existing minor drainage.
Most of the fluvial and deltaic sands in the Beaumont, except perhaps some of those
deposited by the paleo-Colorado, -Brazos, and -Mississippi rivers, are fine to very fine, and in
most places, silty and clayey. The high clay, silty clay and sandy clay content of the
Beaumont as seen in surface exposures, and described in the logs of water wells and
geotechnical boreholes, suggests that is largely the product of suspended-load streams, as
described by Galloway and Hobday (1983, p. 68-75).

The fluvial and deltaic sands of the Beaumont can be seen only in deep sand pits or viewed in
the form of well cuttings or cores. Exposures in road cut or shallow sand pits are rare. In
most places, including the meander-belt ridges, the sands are covered by drapes, 10 feet to 30
feet (3 m to 10 m) thick, of overbank clays, silty clays, sandy clays, and clayey loams. These
were probably laid down by floodwaters of subsequent, adjacent active meander-belts. Some
of these finer-grained deposits may also be the upper parts of upward-fining sequences of
point-bar deposits.

This contemporaneous blanketing of the previous meander belts deposits, was probably were
the first stage in the loss of detail of the original depositional topography. Factors in the
subsequent progressive "homogenization" of the surface might include lateral and vertical
displacement of surface material by mass-wasting, by sheet flood erosion and deposition, by
wind erosion and deposition during episodes of aridity, by the small-scale but cumulative
effects of burrowing organisms, by tree root expansion, and later decay of roots, and by windthrows.

The areas of fluvial deposition assigned to the several paleo-streams depositing the Beaumont have been identified by the scale and orientation of relict fluvial depositional patterns that are displayed on much of the Beaumont surface, and by some characteristic soils.

In the study area most of the Beaumont was deposited by a paleo-Brazos River from the western part of the outcrop to Galveston Bay; the part adjacent to the San Jacinto River on the west and the most remainder of the study area east of the river, by a paleo-San Jacinto; a small portion east Cedar Bayou, by a paleo-Trinity River. A small-scale map in Galloway (1982:Figure 2) shows these regional relationships.

The areal segregation of meander-belt vs. floodbasin soils, the areally varying degrees of local drainage of each of these groups, and the differences of grassland vs. forest vegetation have generated a complex pattern of soils. As a broad generalization, the delineations of non-vertisols in the study area are all potential places of site formation; the delineations of vertisols, unlikely places other than strictly surface occurrences. The principal vertisols are the Beaumont, Garner, Lake Charles, and Vamont soils.
The question of the "age" of the Beaumont, like that of the "age" of the Lissie may not yield an unequivocal answer in that it may be the product of several high sea level stands including the Sangamon. Some bracketing dates are

(a) the last great sea level drop 18,000 to 21,000 years B. P. (see Kutzbach et al. 1993; Peltier 1994) during which the previously deposited Beaumont was entrenched by streams draining into the Gulf to more distant Gulf shorelines. This effectively ended any large-scale Gulfward progradation and

(b) the several high sea level stands of deep-sea oxygen-isotope stage 5 (−130,000 to −75,000 years B. P.), especially 5e (−130,000 to 115,000 years B. P.—the Sangamon) during which the progradation of the Beaumont was perhaps initiated. The time interval between the start of stage 5e and the last great drop in sea level has five or six warming trends (see Anderson and Borns 1994:figures 1-20, 1-21, 1-25, 2-8, 2-17) which probably affected sea level.

The age of the Beaumont—and its Louisiana correlative, the Prairie Formation—has been controversial probably because it may represent the products of several high sea-level stands. Some investigators attempting a single depositional event have placed it's deposition during the high sea-level stand of the Sangamon interglacial, −75,000 to 140,000 years BP. (e.g., Bernard and LeBlanc, 1965; McFarlen and LeRoy, 1988); others, in an intra- Wisconsin
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high-sea level stand, perhaps less than 35,000 years BP (e.g., Shideler, 1986; Autin and others, 1988).

Several radiocarbon dates on wood found in fluvial sand deposits in the Beaumont area are of interest for the upper Gulf Coast. A sample collected in a sand pit in northern Galveston County near Manvel (Gaston, 1979 p. 96, 99) was dated at 34,610 +/- 1990 years prior to 1950. Two samples were found by the writer (Mc-Bride-Ratcliff and Associates, Inc., 1992, p. D-9) in a sand pit in northeastern Fort Bend County and were dated at 43,600 +/- 1,270 years and 39,600 +/- 680 years prior to year 1950. Beard and others (1982) have supplied at least two intra-Wisconsin high sea levels. More are given in Richmond and Fullerton (1986).

Later writers (e.g., Saucier, 1991; Winker, 1991a) have suggested that the Beaumont and its Louisiana equivalent, the Prairie, are "complexes" of fluvio-deltaic deposits that may encompass more than one interval of late Pleistocene interglacial high sea levels. Van Siclen (1991) designates the Beaumont Formation of Barnes (1982) as a Beaumont Group which he divides into two formations, a younger Eunice, and an older Oberlin. The study area on Van Siclen's map (1991, Figure 6) in the outcrop of the Oberlin Formation. These several units would be the products of different high sea-level stages, a notion with which Saucier (1991) and Winker (1991a) would probably agree; they might not endorse Van Siclen's (1991, Figure 5) specific number and location of units.
Van Siclen's sub-dividing of the Beaumont follows a similar, earlier attempt by Doering (1956) from which the names "Eunice" and "Oberlin" were derived. The confusion concerning the "age" of the Beaumont probably will be resolved with the "deconstructive" approach adopted by Doering (1956) and Van Siclen (1991).

Timewise the most extensive deconstruction is in a recent paper by Blum and Price (1994) which suggests, based on thermoluminescence dating of sands in the paleo-Colorado River part of the Beaumont, that the Beaumont was deposited intermittently over a period of 600,000 years or more.

Much of the current discussion of the timing and multiplicity of glacial maxima and accompanying eustatic changes in sea level is against a background of (a) the climatic control or forcing by Milankovitch's astronomical (earth-orbital) cycles and (b) proxy climatic data supplied by oxygen isotopes in micro-fossils recovered from deep ocean cores. Again, this cannot be pursued in this short report. For a general background and summary accounts the interested reader is referred to Imbrie and Inbrie (1986), Imbrie et al. (1984), Frakes et al. (1992:99-188), and Anderson and Borns (1994); for the Beaumont Formation in the upper Gulf coast Smyth (1991), Thomas (1990) and Thomas and Anderson (1991). The last three references also discuss the Pleistocene and Holocene units in terms of sequence or seismic stratigraphy.
DEWEYVILLE FORMATION

The Deweyville Formation or terraces in the study area are found along the East and West Forks of the San Jacinto and along the main stem below their confluence. They seem to be absent along the Brazos River.

The Deweyville terraces were first reported on by H. A. Bernard (1950) in his much-Xeroxed and much-referred to Ph.D. dissertation on the Quaternary geology of southeast Texas between the Sabine and Neches rivers. Bernard (1950:31) originally named these terraces the "Deweyville beds (?)" from their occurrence along the Sabine River near the town of Deweyville in Newton County, about 12 miles north of Orange, Texas.

Where identified in areas of a Beaumont-surfaced upland, the terraces are intermediate in elevation between the super-adjacent Beaumont upland and the sub-adjacent Holocene alluvium. Where they are sub-adjacent to older Pleistocene and Tertiary formations they have usually been traced into these areas on the basis of continuity from areas of the Beaumont or on the basis of elevation.

Although referred to as a "Formation" in Barnes (1968a, 1968b, 1982, 1992a), this unit has never been properly defined as a formation and the informal term "terrace" will be used in relation to their surface occurrence. In the subsurface, the sediments underlying the terrace surfaces will also be referred to informally--as Deweyville "sediments" or "deposits."
The Deweyville terraces-sediments-deposits in the latest American version of the rules of stratigraphic nomenclature (North American Commission on Stratigraphic Nomenclature, 1983:865-867) would be classified as an "allostratigraphic" unit, "...a mappable stratiform body of sedimentary rock that is defined and identified on the basis of its bounding discontinuities" (p. 865), one of which may be a geomorphic surface (p. 866). The stratigraphic code (p. 866) further says that "An allostratigraphic unit is extended from its type area by tracing the boundary discontinuities or by tracing or matching the deposits between discontinuities." The Deweyville as an allostratigraphic unit has not been defined in the area of the "Deweyville beds" along the Sabine River where it was originally identified in southeast Texas (see below). Also of interest here is whether it could be "legally" carried outside of the valley of the Sabine River to other drainage basins even if there properly defined.

The Deweyville, both in areas of the Beaumont Formation and of older Quaternary to Tertiary uplands, has been recognized or identified by a preserved relict topography which displays meander radii, arcuate point bar complexes, channels, and meander scars cut into adjacent uplands larger than those on the younger sub-adjacent Holocene alluvium.

In many places, such as along the Guadalupe River in Victoria County, Texas and along the Trinity River in Liberty County, Texas, the Deweyville deposits are much coarser than the Holocene alluvium and are sources of commercial supplies of sand and gravel.
Terraces with these characteristics have been located in Louisiana along the Sabine, Calcasieu, Red, Pearl, and Ouachita rivers (Snead and McCulloh 1984); in Arkansas, along the Arkansas and Ouachita rivers (Saucier 1974, Saucier and Fleetwood 1970); and in Texas, along the Sabine, Neches, Trinity, San Jacinto, Guadalupe, Nueces, and Rio Grande rivers.

The large fluvial forms and the coarser sediments of some of the Deweyville probably indicate discharges under higher flow regimes than at present, possibly resulting from higher runoff and ultimately higher precipitation. Lower evaporation, type of materials in which the meander forms, and rates of sea level changes have also been suggested as major or contributing factors in the formation of the large fluvial forms and coarse sediments (Baker 1983; Saucier 1977; Goudie 1983; Gagliano and Thom 1967; Alford and Holmes 1985; Gagliano 1991).

Most of the very large meander loops on the lower reaches of the San Jacinto and large meander scars cut into the Beaumont upland are relict Deweyville forms.

Soils on the Deweyville in Harris County as shown in Wheeler (1976) are mainly the thick-surfaced loamy Aldine and Ozan soils which also occur on the superadjacent Beaumont surface. The earlier soil survey of Harris County (Geib and Bushnell 1928) does a better job of identifying the Deweyville by mapping the loamy Kalmia soil pretty exclusively on the Deweyville.
In Montgomery County (see McClintock et al. 1972) the major soil on the Deweyville is the thick-surfaced sandy Albany soil which is not restricted to the Deweyville but also occurs on the slightly higher Beaumont. The relationship and accurate mapping of these units on the west side of the West Fork of the San Jacinto has yet to be worked out in a satisfactory manner.

Estimates on age of the Deweyville range from over 30,000 years (Bernard and LeBlanc 1965:149) to less than 10,000 years (Alford and Holmes 1985).

The close proximity of the Deweyville to streams with potable water, fish and shelled invertebrates, and the good potential for site formation in the sandy and loamy surface horizons makes this unit an interesting archeological target.

**HOLOCENE ALLUVIUM**

The term "Holocene" refers to the time interval from about 10,000 years B.P. to the present (Hopkins 1975; Roberts 1989). Some of the Deweyville terraces may overlap into this time interval but will discuss only fairly recent floodplains.

The major areas of Holocene floodplain deposits are along the Brazos and San Jacinto Rivers. Most of these areas flood periodically and are actively meandering. Unless deeply
buried, infrequently flooded by high velocity flows, or not affected by very recent meandering, Holocene deposits are probably not good targets for undisturbed sites. Burial by low-velocity fluvial currents, covering by eolian, overland flow and colluvial deposits may lead to undisturbed site formation.

**UNDRAINED DEPRESSIONS**

Among the most abundant local features on the Lissie and Beaumont surfaces are the many rounded to irregular undrained depressions, 50 to 250 meters in largest dimension of probably wind-deflation origin. These are best seen shown on the one-foot contour interval maps prepared before 1925. On the these maps the many of the undrained depressions are partly enclosed by raised rims less than two feet (0.65 m) in height. Similar depressions are found in a few places on flatter parts of the Willis surface.

On the Lissie and Willis surfaces the depressions seem to be randomly scattered; on the Beaumont surface they are confined to the sandy and loamy soils on meander ridges.

The rims probably accumulated as the result of vegetation trapping sand and aggregates of silt and clay that were blown out of the depressions during dry periods. Though the older one-foot contour interval maps show these rims by the hundreds, land-leveling for and cultivation has destroyed almost all of them. These small scale features of the Lissie surface have not been extensively described in the geologic or soils literature. One of the few
references to them is in Geib and Bushnell (1928:1942), where they are described in passing in the discussion of the Edna very fine sandy loam:

Drainage is imperfect and many crawfish holes have been formed. The areas are flat or billowy, similar to the areas of other prairie soils and have numerous mounds and depressions. These depressions are from 6 inches to 2 feet below the general level of the surrounding plain....Many of these depressed areas are surrounded by low ridges of sandy material, probably of wind-blown origin, which range from 6 to 12 inches in height and from 10 to 20 feet in width.

The main rival theory for the origin of these undrained depressions on the Pleistocene surfaces on the Louisiana and Texas Gulf Coast was proposed by H. N. Fisk (1940:75-78) who suggested that the undrained depressions are the last unfilled parts of the deeper parts (thalwegs) of abandoned and avulsed point bar swales, and channel remnants of the streams that deposited the several Pleistocene formations. The point bar swales and channels were mostly filled with flood basin or overbank deposits during the terminal slackwater stages of flooding contemporaneous adjacent active streams. He referred to these depressions as "pocks" or "pock marks" in a facetious dermatological analog to "pimple" mounds.
Fisk's views were supported by several of his students and collaborators: Bernard (1950:108-110), Holland et al. (1952:62-67), Varvaro (1957:47-51), and Bernard and LeBlanc (1965:171).

Holland et al. (1952:62-64) calls the undrained depressions "bagols," a contraction of the term "Bay Gall" which was first used in 1873 to refer to a dense thicket in the marshes of Louisiana in part occupied by Bay Galls, a variety of magnolia. Other writers such as (Holland et al. 1952:64-65) have named them "lacs ronds" and "natural ponds."

Fisk (1940:77) illustrated his hypothesis by a sequence of sketches showing the gradual isolation and development of these depressions on surfaces ranging in age from Pleistocene to Fisk and most of the members of his "school" of fluvial genesis mapped in comparatively high rainfall areas in Louisiana and southeast Texas. Bernard and LeBlanc, whose 1965 paper covered the whole of the northwestern Gulf Coast from the Mississippi delta to the delta of the Rio Grande, modified their views subsequent to Bernard's (1950) dissertation. Pock marks are defined by Bernard and LeBlanc (1965:171) as

very small circular depressions or intermittent lakes. Their rounded margins are the result of erosion and deposition. Very small low ridges occur on the flank of many depressions. Most pock marks in Texas and Louisiana are incompletely filled parts of abandoned river channels and swales between point bars and beach ridges and swales.
Some pock marks are deflated, "blow-out" depressions within the
aeolian plain [= South Texas Sand Sheet]. Most pock marks have
been wallowing ponds for animals.

The notion of rims has been added along with those of eolian origin, at least for the South
Texas Sand Sheet. The rims or "ridges" remain unexplained for the higher rainfall areas and
animal effects are noted.

**PIMPLE MOUNDS**

The pimple mounds in the Gulf Coast region, referred to elsewhere as "mima" or "prairie"
mounds, are circular to elliptical hillocks ~20 to ~150 feet (~6 to ~45 m) in diameter, and up
to 4 feet (~1.2 m) in height. The gross internal characteristic of the mounds, the thickening of
the A and E (if present) horizons over more or less flat clayey substrate, is common to most
Gulf Coast mounds for which detailed profiling is available (e.g., Carty, 1980; Carty *et al*,
1988).

Theories of their origin have generated an immense and diverse literature (see references in
Washburn, 1988). Discussions relevant to Harris County and nearby counties, or to
archeological sites include Aronow (1988), Aten and Bollich (1981), Carty (1980), Carty and
Hypotheses of their genesis include their formation as

(a) residual hillocks left after wind erosion, sheetflood erosion (possibly with a core of tree-root bonded surficial material—see Cain, 1974), or fluvial erosion;

(b) accumulations of wind-transported sand, silt, or clay pellets or chips around clumps of vegetation;

(c) eolian accumulations whose sites were started by, or topographically enhanced by, erosional processes;

(d) the result of the "fluffing up" of, or the decreasing the bulk densities of solum materials and the lateral or centripetal transport of surface materials by burrowing animals such as pocket gophers, with possible eolian increments (Cox, 1984; Price, 1949) --the most "high-profile" or "popular" of hypotheses;

(e) very modified hillocks, in areas of former permafrost, produced by freezing and thawing of surface materials (cryoturbation processes);
(f) the result of seismic (earthquake) vibration of silty and sandy surface materials (Berg, 1990); and most recently as

(g) accumulations around or modifications of tree-tip mounds or cradle knolls (Howard et al., 1991).

Some of these hypotheses such as (e)---relics of permafrost conditions---and (f)---the seismic theory---seem unlikely for the Texas Gulf coast. All the others are potentially applicable to and in one form or other have been suggested for the mounds of the Gulf Coast. For mounds in the Gulf Coast region, the writer favors hypotheses (c) and (d) involving eolian effects. Eolian accumulation suggests a partly non-pedogenic origin for the thickened A and E horizons and perhaps drier climates than at present, a possible factor in the origin of the undrained depressions with the now destroyed rims (Aronow, 1992).
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APPENDIX IV

Lithic Analysis for Site 41HR616

(Chapter 6 in Archeological Data Recovery Excavations at the Kingwood Site 41HR616 Harris County Texas. Moore Archeological Consulting Report of Investigations Number 100.)

by

H. Blaine Ensor
This chapter presents a detailed description and analysis of the lithic materials recovered from excavation areas or blocks A-F (see Figure 1.2) 41HR616. The analysis is based on 110 manufacture-modified stone artifacts and a sample of 7,391 flakes ordebitage, 17 of which showed evidence of use. The following report first presents a short background section describing previous lithic studies in east and southeast Texas which are deemed most significant in their ability to aid in understanding the lithic remains from 41HR616. Next is a discussion of the classification systems employed for the various analyses of the lithic materials. These sections are followed by a complete description of all manufacture-modified implements and a discussion of the debitage analysis. An interpretive section follows the presentation of the descriptive data. The data are summarized here with regard to important aspects of the lithic collection. In addition to examining the distribution of the various lithic types and categories at the site, the 41HR616 lithic data are examined in light of a series of hypotheses. These hypotheses were formulated to allow inferences regarding the nature of lithic reduction practices at the site through time, as well as to the integrity of site deposits and the type of settlement represented. These data can be used in conjunction with other site data to help in overall interpretation of the site in its regional context.

Previous Lithic Studies

A number of lithic analyses have been conducted in east and southeast Texas which are pertinent to the present analysis. Most noteworthy are the seminal studies of Shafer
(1973) and Girard (1982), both of which concentrated on elucidating behavioral data based on the systematic classification of lithic materials according to methods of lithic reduction. Although the lithic materials studied are from sites to the north of 41HR616 in the Caddo area of northeast Texas, the raw materials available are basically the same. Shafer’s and Girard’s detailed treatment of the mechanics of silicified wood manufacture are particularly helpful.

Shafer’s (1973) analysis of the lithic technology at the George C. Davis site concluded that Caddo peoples used mainly local resources of chert, silicified wood, and quartzite. The majority of tools consisted of utilized flakes produced from small pebble cores. Flake blanks were used to produce patterned bifacial tools such as arrow points and awls. Although it was not his primary interest in the analysis, Shafer’s study of lithic materials from a preceramic site, 41MQ4, in Montgomery County, Texas, provided a basis of comparison for the Davis site Caddo materials. Interestingly, he found that 41MQ4 materials, in contrast to the Davis site materials, consisted almost entirely of bifaces and unaltered debitage. This he attributed to the nature of the local raw materials. The small pebbles available to the prehistoric knapper were most often reduced directly into dart points, or the pebbles were split with suitable pieces used as dart point blanks (Shafer 1973:73).

Girard (1982) provides perhaps the most thorough treatment of the fracture mechanics involving silicified wood use in east Texas based on his work with the DeShazo site
Girard notes that flakes removed from this material vary in their overall form depending on the direction of force used to remove them (i.e., perpendicular or parallel to the longitudinal axis of the nodule or pebble). He noted that relatively large flakes are removed easier parallel to the axis due to the nature of internal cleavage planes. In contrast, flakes removed perpendicular to the long axis tend to be smaller, short and wide, and most often terminate in step and hinge fractures due to the internal structure of the material (Girard 1982:108). Girard indicates that over 70% of the artifacts from DeShazo, representing both the Early Ceramic and Caddoan occupations, were made of silicified wood. However, he found that during the later occupation, chert appears to have been emphasized in the manufacture of flake tools, in particular, arrow points. His data also supported Shafer's (1973) contention that pre-Caddoan lithic technology in east Texas is based primarily on pebble core reduction techniques while Caddoan technology emphasized flake reduction. Silicified wood was used extensively throughout both time periods, however, to make expedient tools.

Girard produced technological models of reduction for silicified wood, chert, quartzite, and fused volcanic glass. For silicified wood he recognized four major categories of blanks used in tool manufacture: (1) blocky or very thick tabular nodules, (2) thin tabular nodules or thick tabular flakes, (3) thin flakes, and (4) angular spalls and shatter. Additionally, Girard recognized two primary methods of reduction: non-invasive margin
retouch and invasive thinning or shaping. These two methods were applied on occasion to all of the blank categories recognized by Girard at DeShazo.

In addition to the studies of Shafer and Girard, an analysis of the lithic materials from the Crawford site was conducted in 1985 (Ensor and Carlson 1988). This site contained stratified deposits related to Early Archaic through Late Prehistoric time periods. Lithic materials were classified according to three separate systems: (1) morphological, (2) techno-morphological, and (3) hafted biface morphology. Additionally, all debitage was size graded and analyzed by raw material. The overall goal of the lithic analysis was to provide data on diachronic variation in lithic reduction practices at the site. It was determined that silicified wood was used throughout all occupations to manufacture expedient pebble tools. As noted by Girard at the DeShazo site, this may have something to do with the relatively larger size and tabular form of this material. This would have made it easier to use and better suited for certain tools. However, examination of raw material variation at Crawford indicates that some preferences are detectable through time. In particular, it appears that red chert, much of which appeared to be heat treated, was the preferred material for arrow point manufacture in the Late Prehistoric levels. Late Archaic-Early Ceramic period artifacts consisted primarily of dart points made from silicified wood and chert pebbles as well as expedient flake and pebble tools made from silicified wood. The Early-Middle Archaic lithic assemblages differed from the succeeding Late Archaic-Early Ceramic artifacts in that initial core reduction to produce flake blanks was emphasized and most dart points were made from yellow chert.
Quartzite was used frequently for the manufacture of heavy duty chopping/pounding tools.

Other studies relevant to understanding lithic reduction practices at 41HR616 include that of Ensor and Gauthier (1987) at Cinco Ranch, Mueller-Wille et al. (1991) at Alabonson Road (41HR273); and Dockall et al. (1990) at the Al Soloman II site (41HR375). All of these sites are located in either Harris or Fort Bend counties.

The work at Cinco Ranch involved the analysis of lithic materials from four sand mound sites on the floodplain of Buffalo Bayou. The cultural components represented ranged from the Middle Archaic through Late Prehistoric; however, only the Early and Late Ceramic material was definitely in place. Most of the lithic materials were from Early Ceramic occupation(s). In contrast to the sites further east which have been reviewed above, most of the lithic artifacts from Cinco Ranch were made from chert pebbles. This was probably due to these sites’ relatively close proximity to naturally occurring chert gravel bars in the Brazos River to the west. The majority of the stone raw material used by the Cinco Ranch occupants was a tan chert similar to that documented by Ensor and Korgel (1988) from a source in the nearby Brazos River. Virtually all of the dart points, other bifaces, and cores were of chert. This obviously indicates a different territorial range for these inhabitants than for those further east. The Early Ceramic lithic component at these sites contained a full range of bifacial reduction practices from core reduction to primary and secondary biface manufacture. A use-wear analysis of tools
indicated that a variety of cutting, sawing, scraping, and boring, as well as hunting
activities, was carried out. One interesting revelation was the occurrence of two basic
types of utilized flakes, one apparently used primarily for cutting/sawing, the other for
scraping. This pattern has also been detected recently in a sample of flakes from
41HR375 (Dockall et al. 1990).

Turning further to the north and east, two fairly recent studies have provided new data
on the lithic reduction practices at an intensively occupied Early Ceramic period site and
a Middle-Late Archaic site. First, the lithic assemblage from the Alabonson Road site has
been described by Mueller-Wille et al. (1991) and Ensor (1990a). Perhaps the largest
and best documented sample of Early Ceramic period Gary and Kent points from
Southeast Texas was recovered here. A total of 1142 manufacture-modified implements
was recovered from a discrete midden context which dated primarily between A.D. 400
and A.D. 800 with a minor Late Prehistoric component. Artifacts were classified in a
manner similar to that of the Crawford site and Cinco Ranch site materials. In addition to
244 Gary and 84 Kent points, numerous initial primary and secondary stage lithic
materials, including 49 Gary preforms, were recovered. A model of Gary production
was formulated based on the archeological materials and replication experiments
performed by Carey Weber (1991). Two basic methods of Gary point manufacture were
delineated, one based on pebble core reduction and the other on flake blank reduction.
A wide range of other implements also was associated with the midden, including cores, tested pebbles, edge-modified tabular nodules, biface fragments, drills, gravers, pics, gouges, pointed spalls, unifaces, and hammerstones. A comparison of raw material and tool categories at this site resulted in the determination that among finished implements (such as projectile points) manufactured from chert or silicified wood, the number made of chert was higher than expected. On the other hand, more initial and primary stage bifaces than expected were made of silicified wood. The authors consider this to be a logical outcome of the physical characteristics of the two materials, with silicified wood being considerably more difficult to knap and less likely to produce a successful patterned bifacial tool. Consequently, a much higher early failure rate was noted in silicified wood than for chert. These findings tend to support the findings of Bailey et al. (1988) who determined, based on an analysis of lithic materials from the Whiteoak Bayou area, that successful projectile point manufacture was largely dictated by the raw materials used. Small pebbles were most often available to the Alabonson Road knappers, and their tool repertoire reflects this fact. An interesting finding at Alabonson Road involved the discovery that re-tooling or hafting of dart points was a common practice at the site, with asphaltum widely used as a mastic.

The majority of lithic remains which have been systematically analyzed in southeast Texas has been from either Early Ceramic or Late Ceramic period sites. However, a few sites, in addition to the ones mentioned above, have yielded some data on Archaic lithic reduction practice. Aten's (1983a) work on the Upper Texas Coast has provided limited
data, as has that of Gadus and Howard (1990) for the Peggy Lake area of Galveston Bay and Hall (1981) for the lower Brazos River Valley. Recently, a site tested on Cypress Creek in Harris County (41HR375) has provided a basis for contrasting Middle-Late Archaic lithic technology with Early and Late Ceramic period lithic technology. In this intensive study, essentially the same methods employed at Crawford, Cinco Ranch, and Alabonson Road were utilized. The following summarizes the results of that analysis. Examination of the raw material counts for the debitage by level indicated that the Late Ceramic levels were characterized by a tendency to produce more chert and silicified wood than the Early Ceramic to Archaic levels. A larger number of small flakes than expected by chance is present in the Late Ceramic levels, providing additional support for the same pattern detected by Patterson (1980) at the Owen site. Overall, the lithic assemblages of the Archaic and Early Ceramic levels are more similar to each other than to the Late Ceramic assemblages. Interpretation of site function based on a use-wear study and evaluation of the lithic reduction practices indicated to the authors that the site was a seasonally occupied camp site. Biface manufacture, tool resharpening, and recycling were common. Core reduction was evidently not an important activity to produce flakes; rather local pebbles were directly reduced to dart points resulting in aborted initial-, primary-, and secondary-stage bifaces and biface fragments.

While these studies are not the only contributions to our understanding and knowledge of prehistoric southeast Texas and east Texas lithic industries, they do represent a fairly well documented set of data. Other studies should be consulted to obtain a thorough
update on this subject. These include the work of Patterson (1976, 1980), Patterson and Hudgins (1985), McReynolds, Ensor et al. (1990), McReynolds, Korgel et al. (1988), Shafer (1968), McClurkan (1968), Jelks (1965), Studer (1982), and Story (1990), among others. Finally, a report on the lithic materials recovered at 41HR616 during the testing phase is available (Moore 1989).

Classification Systems

Several different specific analyses will be presented below. Because each analysis has its own peculiar requirements, it is necessary to discuss the classification systems that will be used.

**Projectile Point Classification**

The method of projectile point classification or description is based on and adapted from a formal account of projectile point morphology developed by Futato (1977, 1983). The theoretical and methodological content of the system is also presented in Ensor (1987a, 1987b, 1989a).

The system uses a combination of nine nominal attributes to model the shape of a projectile point. Point shape definition is generated from a logical system of units and rules which comprise the system (Futato 1983). Class definitions are based on (1) vertex...
class or shape complexity, (2) blade shape, (3) base shape, (4) base orientation, (5) shoulder shape, (6) shoulder orientation, (7) lateral haft element shape, and (8) lateral haft element orientation. Class definitions serve to define the shape variability within a particular point type.

Some traditional aspects of projectile point classification are not dealt with in the formal account. Attributes such as flaking patterns, edge grinding, and bevelling are not taken into account within the present system. However, they are included as appropriate under individual class definitions. A series of metric variables defined by Futato (1983) were measured. These include (1) maximum length, (2) maximum width, (3) maximum thickness, (4) basal width, (5) shoulder width, (6) juncture width, and (7) haft element length.

The format for projectile point description includes (1) metric data, (2) raw material, (3) derivation of class shape (form) for each type using the units and rules defined by Futato, (4) a discussion of technology, and (5) a comment section. Type names are those established by Suhr and Jelks (1962) and later expanded by Turner and Hester (1985).

**Technological Analysis**

The classification system utilized in the technological analysis of stone implements is derived from Boisvert et al. (1979:60-65). The system encompasses all aspects of lithic
manufacture- and use-behavior and is comprehensive. The theoretical basis underlying
the system is derived principally from Collins (1975). This system has been previously
enlarged to examine technological variability at several sites in southeast Texas (Ensor
1987a; Ensor and Carlson 1988; Mueller-Wille et al. 1991; Fields 1988). In addition, this
system was used by Ensor (1989b) in the analysis of projectile points from testing at
41HR616. Each artifact is placed into a reduction stage (product group) referred to as a
technological state. These states are produced through the intersection of row and
column values for each reduction stage (rows) and technological stage or condition
(columns). The result is a paradigmatic classification of intersecting rows and columns
with 16 possible technological states. Each artifact was classified according to one of the
cell values. The row values included (1) core preparation or initial reduction, (2) primary
trimming, (3) secondary trimming, and (4) reworking/recycling.

In general, it must be stated that initial stage artifacts have not been substantially altered
from the original blank. These artifacts are considered to have been discarded prior to
completion or as unusable. They exhibit hard-hammer flaking only. Primary stage
artifacts are those which exhibit primary flaking, either by hard-hammer or soft-hammer
percussion, resulting in a substantial modification of the original blank. No secondary
retouch is present. Secondary artifacts are those hypothesized to have passed through a
primary flaking stage and are the result primarily of soft-hammer and pressure flaking.
Manufacturing operations likely to have been carried out during this stage include
serrating, edge straightening, grinding, and haft modification. Reworked or recycled
artifacts generally exhibit evidence of resharpening in the former case and transformation from one artifact form to another in the latter case.

In addition to the row values, column values designate the whole or fragmentary status of a specimen and whether the abandonment of the tool was due to manufacture error or some other reason. The column values include (1) unbroken (exhibits no evidence for abandonment during manufacture), (2) unbroken (exhibits evidence for abandonment during manufacture), (3) broken (exhibits evidence that breakage occurred during manufacture), and (4) broken (cause of breakage not determinable). Breakage and manufacture errors were recorded during the analysis. These are described under the lithic category descriptions below. Fracture types are taken largely from Boisvert et al. (1979), Crabtree (1972), and Johnson (1979).

**Techno-Morphological Analysis**

A techno-morphological system was created which involves a macro-morphological sorting of all flaked stone specimens combined with the technological reduction stages described above. Specimens were sorted using overall form and technology to categorize them into a total of 26 categories including dart and arrow points. The defined categories build on those from the testing phase of the project (Enor 1989b). The artifacts were classified according to the nature of the original blank, such as pebble or flake, as well as the placement and extent of flaking. The flaked stone collection \( n = 127 \) was limited in
terms of formal variation. A breakdown of the tool categories recovered is presented in Table 6.1. Tables 6.2-6.3 summarize the tool categories by major provenience.

The lithic categories other than projectile points are described using the following format: (1) metric data, (2) raw material, (3) form, (4) technology, (5) and comments. Metric attributes which are unmeasurable are designated as such. Measurements are to the nearest tenth of a millimeter. Note that a description of raw materials potentially available to 41HR616 occupants is presented prior to a description of the lithic categories.

Debitage Analysis

Analysis of flaking debris or debitage closely followed the procedures used during the testing phase of the project (Ensor 1989b). The method involved size grading each flake using a method established by Leland W. Patterson (1982). The theoretical and methodological basis of this technique has been explained by different individuals (Ahler 1975; Raab, Cande, and Stahl 1979; Ensor and Gauthier 1987). A series of metric squares was used to place each flake/flake fragment into a series of eight sizes: (1) >35 mm, (2) 30-35 mm, (3) 25-30 mm, (4) 20-25 mm, (5) 15-20 mm, (6) 10-15 mm, (7) 5-10 mm, and (8) <5 mm. Each flake was classified in this manner regardless of its completeness. Size determinations were made according to whether or not the flakes' maximum dimensions fit inside the square (i.e. perpendicular to the sides of the square).
This did not include the diagonal of the square which is naturally larger than any side.
Additionally, interior (lacking cortex) and decortication flakes were quantified. Raw
material was also noted being classed as chert, petrified wood, or other. The results of
the debitage analysis are presented below in the interpretive section.

Raw Materials

Raw materials suitable for aboriginal knapping are ubiquitous throughout the east and
southeast Texas regions. As noted by Ensor (1989b:81), naturally occurring siliceous
pebbles of chert, silicified wood, and quartzite occur in alluvial deposits within the San
Jacinto River drainage. Outcrops of the Willis formation to the north and west of
41HR616 also contain cherts, quartzite, and silicified wood. Gravel bars within the San
Jacinto River may have served as the source of materials for 41HR616 occupants.
Extensive use of chert and silicified wood pebbles has been documented throughout east
Texas by previous researchers such as Kegley (1969), Shafer (1968, 1973), Jelks (1965),
and Ensor and Carlson (1988), among others. Patterson (1976) has noted that naturally
occurring chert resources are rare in inland Harris County. Ensor and Korgel (1988) and
Hall (1981) have documented the presence of gravel bars containing suitable material for
knapping in the lower Brazos River west of Houston.

The composition and utility of the various mineral resources evidently vary quite a bit
throughout the east Texas area. For example, Kegley (n.d.) conducted a survey in the
vicinity of the George C. Davis site where he reported raw materials in the following
quantities: chert or flint (16%), quartzite (69%), and silicified wood (15%). Analysis of a sample of gravels from the base of the Crawford site in Polk County (Ensor and Carlson 1988) indicates the composition of the sample breaks down in the following manner for the small pebbles larger than 1.27 cm in diameter: silicified wood (4%), quartzite (47%), and chert (49%). If this sample is representative of other gravel deposits in the area the results of the analysis indicate that good quality siliceous materials conducive to biface manufacture is limited. The largest pieces were of quartzite and silicified wood, generally of poor quality. A high degree of selectivity was probably used in procuring materials for bifacial reduction as chert pebbles were generally too small and of too poor quality for patterned biface manufacture. This same situation probably existed over most of the east Texas area, although it would require well controlled surveys and analysis to document this.

Occasionally the presence of exotic chert is noted in east and southeast Texas; almost invariably the tools are hafted patterned bifaces or specialized ones such as end scrapers or drills. The abundant chert outcrops and terraces of central Texas were the prime source of this material. Additionally, as noted by Shafer (1973), Ensor and Carlson (1988), and Brown (1976), Manning fused glass or volcanic tuff was used infrequently by some prehistoric populations. Gadus (1990) has reported the first occurrence of Tallahatta quartzite in southeast Texas at a Peggy Lake site on Galveston Bay. This material was widely traded in the Eastern Woodlands for a long period of time beginning with the Paleoindian period and extending through the Middle Woodland period (Dunning 1964; Ensor 1981). Mallouf (1976) has noted the presence of novaculite from
Arkansas and some sites in northeast Texas. Aten (1983a:342-346) has noted the occasional use of alligator gastroliths at sites in the Galveston Bay area.

Description of Lithic Categories

Category 1—Dart Points

Gary
Class: 1.
N = 1
Raw material: quartzite.
Form: This point has a shape complexity of 7, a diagonally modified haft element, incurvate blade edges, straight base, nonangular base orientation, straight tapered shoulders, and straight contracting lateral haft element edges. Cross-section is biconvex. Technology: The flaking on this point is a combination of soft-hammer and pressure retouch. The point is intact except for a small portion of the tip. Extensive resharpening is noted along the blade edges which has resulted in the obliteration of one shoulder. No cortex is present, and the nature of the original blank is undeterminable. Comments: Gary points may date as early as the Middle Archaic but appear to be most prevalent during the Late Archaic and Early Ceramic periods at inland Southeast Texas sites (Story 1990; Ensor et al. 1990; Ensor 1990b). If this point is associated with an Early Ceramic occupation at the site, it most likely dates between A.D. 350 or A.D. 400 and A.D. 800 based on recent data from the Alabonson Road site (Ensor and Carlson 1991).
Gary

Class: 2.

$N = 2$

Raw material: 1 quartzite and 1 chalcedony.

Form: These points have a shape complexity of 7, diagonally modified haft elements, straight blade edges, excursive bases, nonangular base orientations, incurvate tapered shoulders, and straight contracting lateral haft element edges. Cross-sections are biconvex.

Technology: These specimens exhibit primarily hard-hammer percussion with little secondary retouch. The tip of one point is slightly fractured. Numerous step fractures are present on one blade surface. No cortical material remains on either specimen, and the nature of the original blank cannot be determined. The reddish color on one point may indicate that the specimen has been heated. One has been extensively resharpened.

Comments: Like the Class 1 specimen above, these points could date from the Middle Archaic to the Early Ceramic. However, it probably dates to the Early Ceramic period from A.D. 350 or A.D. 400 to A.D. 800.

Gary

Class: unclassed.

$N = 1$

Raw material: chert.

Form: The haft element is slightly contracting and one intact shoulder is straight and horizontal.

Technology: The point exhibits secondary retouch on the haft element in the form of soft-hammer percussion. It is broken close to where the blade and haft element meet, evidently the result of use. It appears to exhibit "haft snap." The nature of the original blank is unknown, and no cortex is present.
Comments: This fragmentary specimen appears to conform to the *Gary* type. It probably dates to the Early Ceramic period at 41HR616 or between A.D. 350 or A.D. 400 and A.D. 800.

*Kent*

Class: 1.

\(N = 1\)

Raw material: silicified wood.

Form: This point has a shape complexity of 7, a diagonally modified haft element, angular blade edges, straight base, nonangular base orientation, incurvate horizontal shoulders, and straight parallel lateral haft element edges. Cross-section is biconvex.

Technology: This point has been recycled into another form. Percussion flaking in the form of hard- and/or soft-hammer has resulted in the creation of an angular blade edge which is obtuse. It is similar in form to a hafted end scraper except that the retouch on the transverse blade edge is not steep. Cortex is present on both surfaces of the haft element, and the recycled point was made from a pebble.

Comments: No definite evidence of use was noted for this specimen, although several small bending/hinge fractures may indicate that it possibly was used. *Kent* dart points date possibly as early as the Middle Archaic and seem to extend into the Early Ceramic period (*Ensor et al. 1990; Enson 1990b*) in Southeast Texas. *Kent* points were found in apparent association with *Gary* points at the Alabonson Road site and dated between A.D. 400 and A.D. 800. It seems likely that this point dates to the Early Ceramic period at 41HR616.

Category 2—Dart Point Fragments

\(N = 6\)

Metric data: unmeasurable.

Raw material: 5 chert, 1 silicified wood.
Form: No definite assessment of overall form is possible.
Technology: One basal fragment and five distal fragments are present. All exhibit some type of secondary retouch, primarily in the form of soft-hammer percussion or pressure flaking. One specimen is fractured due to unknown causes. Three exhibit transverse break or snap, while the remaining two are thermally fractured. A single specimen retains cortex on one surface, while the remaining ones do not. Three show evidence of being burned or heated, while the others do not.
Comments: These appear to represent fractured portions of dart points. All have been secondarily flaked, although it is not possible to say all were completed and broken during use. The one basal fragment may be from a Gary point, but this is not certain.

Category 3 — Arrow Points

*Catashaula*

Class: 1.

\(N = 1\)

Raw material: silicified wood. Form: This arrow point has a shape complexity of 7, diagonally modified haft element, incurvate blade edges, straight base, nonangular base orientation, recurvate horizontal shoulders, and straight parallel lateral haft element edges. Cross-section is flattened.

Technology: This point exhibits fine pressure retouch along blade margins. The pressure flaking seems associated with blade rejuvenation or resharpening. One shoulder is fractured. The removal of pressure flakes diagonal to the mid-line has created the appearance of notches or strong shoulders. No cortex is present, and the nature of the original blank is uncertain, although a flake seems mostly likely. No burning or heating was noted.

Comments: This point conforms to the Catahoula type as described by Suhm and Jelks (1962) and Turner and Hester (1985). Catahoula points appear to be among the earliest
arrow point types in Southeast Texas (Shafer 1988; Ensor et al. 1990; Ensor 1990b) and date between A.D. 750 or 800 and A.D. 1200.

*Catahoula*

Class: 2.

\[ N = 1 \]

Raw material: silicified wood.

Form: This point has a shape complexity of 7, diagonally modified haft element, incurvate blade edges, straight base, nonangular base orientation, recurvate horizontal shoulders, and straight parallel lateral haft element edges. Cross-section is biconvex.

Technology: This point has been manufactured using mainly pressure flaking. It appears to be made from a small pebble as cortex is present on both faces of the point. Pressure flaking along blade margins evidently was intended to resharpen or rejuvenate the point.

Comments: This point conforms to the *Catahoula* type and dates to the Late Ceramic period from about A.D. 750 to A.D. 800 to A.D. 1200.

*Catahoula*

Class: unclassed.

\[ N = 1 \]

Raw material: chert.

Form: This point has a shape complexity of 9, diagonally modified haft element, incurvate blade edges, indeterminate base shape, nonangular base orientation, angular horizontal shoulders, and indeterminate lateral haft element shape. Cross-section is flattened.

Technology: This point has been manufactured using a pressure flaking technique. The strong shoulders are formed by the removal of narrow flakes perpendicular to the basal plane which extend distally 5-7 mm. Extensive resharpening has occurred on the blade margins. A small patch of cortex is present on one surface, and it appears that the original blank was a flake. The point does not appear to have been burned or heated.
Comments: This form corresponds to the *Catahoula* type and probably dates between A.D. 750 and A.D. 800 and A.D. 1200 in Southeast Texas.

*Perdiz*

Class: 1.

$N = 1$

Raw material: chert.

Form: This point has a shape complexity of 7, diagonally modified haft element, straight blade edges, straight base, nonangular base orientation, incurvate barbed shoulders, and straight contracting lateral haft element edges. One has a flattened cross-section, while the other is biconvex.

Technology: The specimen has been flaked using a combination of soft-hammer and pressure retouch. The point is probably made on a flake. It has been fractured transversely on the blade, however, the cause is uncertain.

Comments: *Perdiz* points date to the Late Ceramic period in Southeast Texas, principally after A.D. 1200 (Shafer 1988; Ensor *et al.* 1990; Ensor 1990b).

*Perdiz*

Class: 2.

$N = 1$

Metric data: see Table 10.

Raw material: silicified wood.

Form: This point has a shape complexity of 7, diagonally modified haft element, incurvate blade edges, straight base, nonangular base orientation, recurvate horizontal shoulders, and straight contracting lateral haft element edges. Cross-section is flattened to biconvex.

Technology: This point exhibits pressure flaking on blade and haft element surfaces. It is fractured on the blade and on one shoulder. No cortex is present, and the nature of the
original blank is unknown, although it was probably a flake. No evidence of burning or heating is present.
Comments: This point conforms to the Perdiz type and dates to the Late Ceramic period after A.D. 1200.

Cliffton
Class: 1
N = 1
Raw material: chalcedony.
Form: This arrow point has a shape complexity of 5, diagonally modified haft element, straight blade edges, angular external base, angular base orientation, straight horizontal shoulders, and no lateral haft element edges. Cross-section is flattened.
Technology: This point has been pressure flaked over virtually the entire blade area. It appears to have been made on a flake. Cortex is present on the base, and there is no definite evidence of heating. Blade edges are serrated.
Comments: Flaking on this point is more characteristic of Catahoula than Perdiz or Cliffon. However, the angular contracting base would place it typologically within the Clifton type which probably dates to A.D. 1200 or later (Turner and Hester 1993).

Cliffton
Class: 2.
N = 1
Metric data: see Table 10.
Raw material: chert.
Form: This point has a shape complexity of 7, diagonally modified haft element, straight blade edges, straight base, nonangular base orientation, incurvate barbed shoulders, and straight contracting lateral haft element edges. Cross-section is biconvex.
Technology: This artifact appears to have been made on a flake by pressure flaking. It
has been extensively burned, and both surfaces are heavily pot-lidded. A patch of cortex
is present on one blade margin. The tip is missing.
Comments: Cliffton points are closely related to Perdiz forms and seem to have the same
general time range (Turner and Hester 1993). They probably date to A.D. 1200-1500 or
later at 41HR616.

Cliffton
Class: unclassed.
N = 1
Raw material: chert.
Form: Although not complete enough to classify, the point has straight blade edges and
straight barbed shoulders along with a biconvex cross-section. The haft element is
fractured and what is remaining indicates either a straight contracting or straight parallel
form. Basal form cannot be determined.
Technology: This point has been created through pressure flaking. It has been burned
and a large pot-lid fracture occurs on one blade surface. No cortex is evident, and it
seems likely that the point was made on a flake due to its thinness.
Comments: This point belongs to the Cliffton category and dates after A.D. 1200.

Untyped Arrow Point
Class: 1.
N = 1
Raw material: chert.
Form: This point has a shape complexity of 7, diagonally modified haft element, straight
blade edges, straight base, nonangular base orientation, straight barbed shoulders, and
straight parallel lateral haft element edges. Cross-section is flattened.
Technology: The point has been pressure flaked over both blade surfaces. The haft
element has been created by the removal of long, narrow pressure flakes slightly diagonal
to the mid-line. No cortex is present, and the point appears to be made on a flake. It appears to have been heated, and the tip and one shoulder are fractured, the former possibly the result of impact.

Comments: This point form does not correspond to a particular point type although it resembles *Perdiz* and *Alba* points in some ways. It dates to the Late Ceramic period, probably between A.D. 750 or A.D. 800 and A.D. 1500 in Southeast Texas.

Untyped Arrow Point

Class: unclassed.

$N = 1$

Metric data: see Table 10.

Raw material: silicified wood.

Form: A lateral margin and the basal area have been either fractured or remain unretouched. The overall form is unclear although it appears that the blade edges were straight, the shoulders recurve horizontal, and the lateral haft element edges straight. Cross-section is flattened to biconvex.

Technology: One blade margin remains essentially un-thinned leaving some doubt as to whether this point was actually finished. Pressure flaking occurs over the majority of both blades and the haft element is well formed. The blade is fractured, evidently due to heat. Cortex is present on the surfaces so it appears that the original blank was a pebble. Comments: It is not possible to state with certainty whether this point was completed. It does not appear to conform to an established type although it resembles both the *Perdiz* and *Catahoula* types superficially. It potentially dates to the Late Ceramic period after A.D. 750 or A.D. 800 until A.D. 1500 or slightly later.

Category 4— Arrow Point Fragments

$N = 5$

Metric data: unmeasurable.
Raw material: 2 chert, 2 silicified wood, 1 chalcedony.

Form: Two of these specimens are represented only by the distal portions of blades. Two others are bifacially flaked arrow point fragments whose haft elements have fractured along with other portions of the blade, including tips and shoulders. One of these specimens exhibits straight blade edges, while the other has incurvate blade edges. One appears to have a straight barbed shoulder, while the other has a recurvate shoulder. One specimen appears to have had straight horizontal shoulders, a straight parallel haft element, and a straight base.

Technology: All specimens have been pressure flaked. All appear to have been made on flakes although this is not certain. None of the specimens has cortex present. Two have transverse snaps and two have been thermally fractured, while the fifth has a fracture of unknown cause. Only the two specimens with thermal fractures appear to have been burned or heated. One specimen is represented by a section of one face of a point which separated from the rest of the point due to heat.

Comments: One specimen is probably a Perdiz (Figure 6.2d), one is possibly an Alba (Figure 6.2c), and the remaining two are too fragmentary to suggest a type association. All appear to be fragments of arrow points that were broken during use or manufacture.

Category 5—Dart Point Preforms

$N = 3$

Raw material: 1 chert, 2 silicified wood.

Form: Two specimens have irregular to straight blade edges and straight bases. Of these, one has a diagonally modified haft element, straight tapered shoulders, and straight parallel lateral haft element edges (Figure 6.2f). One of the other two specimens has no lateral haft modification or shoulders (Figure 6.2g). The other preform has straight blade edges, a straight base, diagonally modified haft element, nonangular base orientation, straight tapered shoulders, and straight contracting lateral haft element edges (Figure 6.2h). Cross-sections are thickened to biconvex on all preforms.
Technology: All specimens exhibit primary hard-hammer percussion flaking as the primary means of flake removal. One specimen may also have received some soft-hammer flaking. Two have no indication of burning or heating, while the third may have been heated. One preform has cortex on one surface and two on both surfaces. In terms of knapping errors, one exhibits evidence of edge collapse or crushing and two appear to have been discarded due to a failure to thin and/or unsuccessful shaping.

Comments: One of these specimens appears to have been a preform for a Gary point (Figure 6.2h) as it exhibits early haft formation similar to that defined by Ensor (1990a) for Gary preforms at the Alabonson Road site. The other two probably represent aborted Kent points (Figure 6.2f,g). All probably date to the Early Ceramic period from A.D. 350 or A.D. 400 until A.D. 800 at 41HR616.

Category 6— Arrow Point Preforms

$N = 2$

Raw material: 1 chert, 1 silicified wood.

Form: One preform has an excravate base and straight to irregular blade edges, while the other specimen appears to have had excravate blade edges, incurvate, concave lateral haft element edges, and a straight base. One specimen has a biconvex cross-section. The other is flattened.

Technology: One specimen exhibits soft-hammer percussion flaking over both surfaces, while the other has been pressure flaked, mainly along lateral blade margins. One retains no cortex, while the other has cortex on two faces. One is made on a small, thin pebble. The nature of the original blank for the other is uncertain. One appears to have been heated, and the other does not. In terms of manufacture errors, one has a perverse fracture, and the other exhibits edge collapse.

Comments: Both of these specimens may be preforms for Perdiz points, although this is uncertain. They both appear to date to the Late Ceramic period after A.D. 750 or A.D. 800.
Category 7—Biface Fragments

$N = 12$

Metric data: unmeasurable.

Raw material: 1 chert, 2 silicified wood, 2 chalcedony.

Form: The fragmentary nature of these specimens precludes interpretation of their original form. Most possess one or more straight edge segments.

Technology: The majority of these ($n = 10$) has been secondarily flaked bifacially, primarily by soft-hammer percussion and pressure flaking. One has been reworked, while another exhibits only primary flaking. Most appear to be fragments of dart or arrow points. Eight fragments retain no cortex, while four have cortex on one surface. Six have evidence of burning or heating, while six do not. Two are fractured by unknown causes, seven have transverse breaks or snaps, one has a perverse fracture, and two exhibit thermal fractures.

Comments: These pieces represent largely fragmented projectile points, either dart or arrow points, with fragments from earlier stages of reduction present but uncommon. Not one of these specimens can be definitely assessed as to age.

Category 8—Uniface Fragments

$N = 4$

Metric data: unmeasurable.

Raw material: 3 chert, 1 silicified wood.

Form: Nothing definite can be stated about the original form of these fragmentary specimens.

Technology: One exhibits initial flaking, while the other three have been flaked to a primary stage of reduction. One specimen exhibits intentional pressure retouch along a single edge resulting in a denticulate appearance (Figure 6.2a). The rest only exhibit
evidence of hard-hammer percussion. Two do not have any cortex, while two have
cortex on one surface. One appears to have been heated, and the other three do not give
this impression. The cause of fracture on three specimens is unknown, while one has a
transverse fracture.

Comments: These specimens probably represent fragments from core/biface reduction
except for the piece serrated by pressure retouch. The function of this artifact is not
known.

Category 9— Initial-Stage Bifaces (Pebbles)

$N = 6$

Raw material: 5 chert, 1 silicified wood.

Form: These specimens are generally amorphous in shape taking on, in general, the form
of the natural pebble on which they are made. Cross-sections are generally irregular and
thick.

Technology: These artifacts have been flaked principally by hard-hammer percussion
with some soft-hammer percussion evident. No secondary thinning or retouch is present.
In all cases, the original blank appears to have been a small, thin pebble. One has cortex
on a single surface, while the remaining five have it on both surfaces. Three show
evidence of burning or heating, and one is extremely burned and fire-crazed. Three do
not appear to have been heated or burned. Manufacture errors are present. Two
specimens were abandoned due to hinge terminations, two due to a flaw in the material,
and one due to a transverse fracture. The cause of fracture in the remaining specimen is
unclear.

Comments: The majority of these specimens represents pebbles little modified from their
original form. They were probably intended to be dart points. No specific age or
cultural/historical placement can be made based on the morphology. However, quite a
few were found in level 10 or below, perhaps indicating an association with an Early
Ceramic period component at the site.
Category 10— Initial-Stage Bifaces (Flakes)

\( N = 2 \)

Raw material: 1 silicified wood, 1 chalcedony.

Form: One specimen has a slightly excrurate base and straight blade edges (sub-triangular) in shape. The other has a straight base and lateral margins. Both are flattened so that their overall morphology cannot be determined.

Technology: Both have been percussion flaked by hard- and/or soft-hammer percussion. Neither specimen has been secondarily retouched. One has no cortex, while the other has cortex on the base. Neither specimen exhibits evidence of heating or burning. One has a transverse fracture, and the other a perverse break.

Comments: These appear to represent manufacturing failures and were probably intended to be dart point or arrow points. No definite age assessment can be made. One was found in the Early Ceramic levels, while the other was present in Late Ceramic levels.

Category 11— Initial-Stage Bifaces (Indeterminate)

\( N = 2 \)

Metric data: see Table 10.

Raw material: 1 chert, 1 silicified wood.

Form: These artifacts have no particular shape, being largely amorphous in form.

Technology: Both artifacts exhibit hard-hammer percussion flaking. No secondary retouch is evident. The nature of the original blank is unknown; however, one specimen retains cortex on one surface. One appears to be hafted, while the other does not. One artifact exhibits edge collapse, while the other appears to have been abandoned due to a failure to thin.
Comments: Both of these artifacts appear to represent biface manufacture failures, either for dart or arrow points. No age range is suggested other than they date to the Early-Late Ceramic periods at 41HR616.

Category 12—Initial-Stage Unifaces (Pebbles)

$N = 2$

Raw material: silicified wood.

Form: Both specimens are amorphous, taking the natural shape of the pebble.

Technology: Hard-hammer percussion flaking is present on both artifacts. One specimen has cortex on one surface, while the other has cortex on both surfaces. Neither appears to be burned or heated. One specimen is intact with no obvious cause for abandonment, while it appears that hinge fracture termination caused the other to be abandoned.

Comments: One of these may have been intended for dart point manufacture, the other possibly for arrow point manufacture. However, this is uncertain. These forms are not diagnostic of any cultural period.

Category 13—Initial-Stage Unifaces (Flakes)

$N = 2$

Raw material: silicified wood.

Form: These specimens are amorphous in shape, largely taking on the shape of the flake.

Technology: Both specimens have been flaked by soft- and/or hard-hammer percussion along an edge segment. One artifact has cortex on one surface, while the other has it on both surfaces. One appears to have been burned, while the other does not. One is intact, while the other exhibits edge collapse or crushing. Comments: These may have been destined for further reduction into some tool forms as they show no indication of being finished. No assessment of their cultural affiliation is possible other than their stratigraphic position within the site.
Category 14—Primary-Stage Bifaces (Pebbles)

$N = 3$

Raw material: silicified wood.

Form: One specimen is roughly oval in shape with one strongly excurvate lateral margin. Another is sub-triangular in shape with an excurvate base and irregular lateral margins. The third has straight parallel lateral margins and the rudiments of a contracting haft element.

Technology: Two of these artifacts have been percussion flaked over the majority of one surface. The other has been edge trimmed around the entire circumference by hard-hammer percussion. All specimens have cortex on opposing surfaces. One appears to have been heated. The remaining two do not appear heated or burned. In terms of manufacturing errors, one is transversely fractured, while the others possess hinge termination.

Comments: These appear to be manufacture failures. The intended end products were probably dart points or arrow points. No age estimate or cultural affiliation can be determined for these artifacts based on their morphology.

Category 15—Primary-Stage Bifaces (Indeterminate)

$N = 2$

Raw material: 1 chert, 1 silicified wood.

Form: Both specimens appear to have been oval in shape. However, they are both fractured, making assessment of overall form impossible.

Technology: A combination of hard- and soft-hammer percussion flaking is evident on these artifacts. One contains no cortex, while the other retains cortex on one surface. One specimen appears to have been heated, while the other does not appear to have been heated. Both are transversely fractured.
Comments: These bifaces appear to be rejects. They were perhaps intended to be dart points. No assessment of cultural affiliation or age is possible other than to note their stratigraphic position.

Category 16—Secondary-Stage Bifaces (Indeterminate)

\[ N = 4 \]

Raw material: 2 chert, 1 silicified wood, 1 chalcedony.

Form: Three of these specimens are oval in shape with excursive bases. They have been fractured, precluding determination of their overall form. The remaining specimen has straight parallel lateral margins which converge to a point. The base is fractured. Two do not have cortex while two retain cortex. Two appear to be hafted while the other two do not.

Technology: In terms of manufacturing errors, two have transverse breaks or snaps, one is thermally altered, and one possesses a fracture of unknown cause.

Comments: These specimens are bifaces aborted during the process of manufacture. They were probably intended to be dart points or arrow points. No assessment of cultural affiliation is made based on morphology. However, they all probably date to the Early Ceramic or Late Ceramic periods.

Category 17—Bifacially Trimmed Pebbles

\[ N = 4 \]

Raw material: 2 chert; 2 silicified wood.

Form: Two of these specimens are roughly oval in shape, while the other two are sub-rectangular. One is elongated and narrow; the other broader.

Technology: These artifacts have been percussion flaked by hard-hammer which has resulted in acute bifacial edges. No secondary retouch occurs. One specimen has an acute pointed tip (Figure 6.4j), while another possesses a narrow, transverse working
edge (Figure 6.4i). Another has a broader transverse working edge (Figure 6.4g), while the remaining artifact has a single acute bifacial edge (Figure 6.4h). All specimens have cortex on both surfaces of the pebble. One appears to be heated, while the others do not and no specimens are fractured.
Comments: These artifacts appear to represent finished pebble tools, probably used in a variety of cutting and scraping or adzing activities. Working edges vary from transverse to the mid-line to parallel to it, depending on use. Two of these implements are similar to Jelks' (1965) Perkin Pikes. Similar tools were recovered from the Crawford site (Ensor and Carlson 1988) in Polk County and the Alabonson Road site (Mueller-Wille et al. 1991) in Harris County. Girard (1982) and Shafer (1973) have described these implements based on work at the DeShazo and George C. Davis sites, respectively. These artifacts probably date to the Early or Late Ceramic periods at 41HR616.

Category 18— Unifacially Trimmed Pebbles

\[ N = 1 \]

Raw material: silicified wood.

Form: This artifact is basically oval in shape, taking on the form of the pebble.
Technology: Hard-hammer percussion flaking is present on one surface only. All flaking is directed perpendicular to the mid-line. Hinge terminations are present. A thin, acute edge has been created as a result of the flaking. Cortex is present on both surfaces. No evidence of heating or burning is present. The specimen is intact.
Comments: This artifact appears to be an expedient tool, perhaps used for cutting or scraping. This artifact may date to the Early Ceramic period based on its stratigraphic position.
Category 19— Biface Drill/Perforator

$N = 1$

Raw material: chert.

Form: This specimen appears to have an expanded haft area which was attached to a narrow bit.

Technology: Soft-hammer percussion flaking with some pressure retouch is evident in this piece. It is transverse fractured, making interpretation difficult. No cortex is present and the specimen appears heated.

Comments: This specimen appears to be the proximal portion of a drill or perforator. However, the supposed bit is unusually thin if it was used as a drill. It is also possible that this artifact represents a rejected dart point whose haft element is snapped.

Category 20— Uniface Scraper

$N = 1$

Raw material: chert.

Form: This scraper is sub-rectangular in shape with an excurvate working edge and parallel lateral margins.

Technology: This specimen is made on a flake which has been steeply retouched along the distal end and a portion of one margin. The proximal end of the scraper is fractured. Pressure retouch scars travel 3-5 mm from the distal working edge into the body of the artifact. No cortex is present, and it does not appear burned or heated.

Comments: This artifact is said to have a scraping edge using conventional terminology. Since no use-wear study was conducted, the actual use or uses are unknown. It seems likely that the specimen was hafted and used in some type of scraping or shaving activity; possibly wood and/or bone. No estimate of cultural affiliation is made based on morphology. However, its stratigraphic position indicates that it could date to the Early
Ceramic period at 41HR616. It is made of a fine-grained translucent brown chert, not indigenous to this area. The most likely source is central Texas.

Category 21 — Tested Pebbles

\(N = 12\)

Raw material: 4 chert, 7 silicified wood, 1 chalcedony.

Form: The shape of the artifact corresponds closely with that of the original pebble blank. In most cases, this is a tabular to oval or irregular-shaped piece of silicified wood. Technology: These specimens have been flaked using a hard-hammer with usually only one or two flakes removed before abandonment. All twelve have cortex on both surfaces, and not one exhibits traces of heating or burning. Four are intact and two have fractures of unknown cause. Two have transverse fractures, two appear to have been aborted due to hinge terminations, and two were abandoned because of a flaw in the material.

Comments: These specimens appear to represent pebbles which were selected for testing the quality of the raw material. All were abandoned after removal of one or two hard-hammer flakes. While it is possible that these artifacts could have served as a flake source, it seems most likely that they represent the former activity. The vast majority of these artifacts was found in the Early Ceramic levels at the site, level 10 or below.

Category 22 — Cores

\(N = 5\)

Raw material: 3 chert, 1 quartzite, 1 silicified wood.

Form: These artifacts have a form similar to the testing pebbles above, being rectilinear to irregular or oval in shape, dependent on the shape of the original pebble. Technology: Reduction is the result of hard-hammer percussion blows which removed one or more flakes using the natural cortex as a platform. No secondary retouch is
present. All have cortex on two faces. Two do not appear to be heated or burned, while three are most likely burned and/or heated. Three specimens are intact while two are fractured, possibly as a result of core reduction.

Comments: These artifacts appear to have served as flake sources, although it is difficult to distinguish aboriginal intent. Some have been tested for suitability for further reduction. Similar to the tested pebbles, the majority was found in level 10 or below suggesting an Early Ceramic association.

Category 23—Core Fragments

$N = 3$

Raw material: chert.

Form: These specimens are fragmented and irregularly shaped.

Technology: All have been fractured by hard-hammer percussion flaking. Two have cortex on one side, and the other has cortex on two faces. Not one exhibits evidence of burning or heating.

Comments: These appear to represent fragments of pebble cores removed from the parent mass during reduction. Like the cores, two of the three were found in level 10 or below.

Category 24—Irregularly Flaked/Broken Pebbles

$N = 13$

Raw material: 5 chert, 8 silicified wood.

Form: These specimens take on the form of the natural pebble, from rectilinear-blocky to ovoid or irregular in shape.

Technology: The cause of the flaking or fracture on these pieces is not always clear. In some cases intentional flake removal is present but in others the fracture may have been initiated by natural forces. Four have cortex on one face, while the remaining nine have
cortex on both faces. Eight do not appear to be burned or hafted, while the other five exhibit some evidence of either burning or heating. Eleven examples are intact, one has a fracture of unknown cause, and another possesses hinge termination.
Comments: These artifacts probably represent either pebbles broken or flaked by natural forces or constitute examples of intentional pebble reduction with the cause or reason unknown.

Category 25—Use-Modified Flakes

N = 13
Form: These artifacts have the shape of the flake removed from the core. These are generally expanding to parallel sided.
Technology: No intentional manufacturing step is noted. Rather, the flake removals are very small and appear to have been created through use. Four have no cortex, while the other nine have cortex on the ventral surface. Five are either heated or burned, while the remaining eight show no such evidence.
Comments: These flakes appear to have been used mainly for scraping or cutting. Since no intensive use-wear study was performed, the nature of the material being worked is unknown. They are found in both the Early Ceramic and Late Ceramic levels at 41HR616. The presence or absence of wear was determined using low magnification from 10x-30x.

Category 26—Use-Modified Blade-Like Flakes

N = 4
Raw material: 2 chert and 2 chalcedony.
Form: These specimens are generally narrow and long, at least twice as long as wide, as the label indicates.
Technology: Although blade-like in form, these artifacts are, in general, not the products of a standardized blade technology. Rather, they appear to be fortuitous removals for the most part. One example possesses negative blade-like scar removals on the dorsal surface indicating that it may have been produced intentionally from a prepared core. Two have no cortex, while the other two retain cortex on their dorsal surface. One appears heated, while the other three are not burned or heated. All are intact. Flake removals along lateral margins are small but regular.

Comments: These artifacts appear to be expedient tools, used in their unmodified state. They were most likely used in cutting or scraping activities, but this is uncertain.

Results of Analysis

Projectile Point Analysis and Site Chronology

Twenty-six projectile points and projectile point fragments were recovered during mitigation efforts at 41HR616. Of these, 10 are dart points or dart point fragments, and 15 are arrow points or fragments. Not all of these were diagnostic since many were fragmentary specimens. The dominant dart point type recorded was the Gary point \((n = 4)\) followed by a single example of a recycled Kent point. The most common arrow point types are Cliffton \((n = 3)\) and Catahoula \((n = 3)\) followed closely by Perdz \((n = 2)\).

Additionally, three untyped arrow points were recovered.

All diagnostic points are graphed together in Figure 6.7 to examine their vertical distribution. The types Perdz and Cliffton were combined for the purpose of graphing.
since they appear to be very closely related in both manufacturing technology and
temporal placement (Turner and Hester 1993). Similarly, due to their close
morphological and temporal relationships and sample size, Gary/Kent points were
lumped together for graphic presentation.

One can see that all arrow points are confined to levels 3-9 with Catahoula points
clustering in levels 5-9 and Perdz/Cliffton slightly more common in levels 3-6.
However, the highest frequency of Perdz/Cliffton points is in level 8. Likewise, Gary
points are most abundant in level 8, but also occur in levels 12 and 16. The single Kent
point recovered is from level 9. The projectile point data do not offer a reliable means for
establishing site stratigraphy due to the small sample size. No single type is confined to a
relatively restricted vertical position in the site.

However we must note the general placement of Catahoula points below Perdz/Cliffton
points and the tendency for dart points Gary and Kent to occur in level 8 or below.
Regardless of our ability to relate specific cultural components to vertically discrete
positions within the site matrix, it seems likely that the projectile point data represent at
least three separate occupations at 41HR616.

The earliest, as noted by Ensor (1989b) in the testing report for the site, is an Early
Ceramic period component represented by Gary and Kent dart points. The Early
Ceramic component at 41HR616 probably falls toward the latter half of that period, from
A.D. 600 to A.D. 800. This occupation may have overlapped with a Late Prehistoric or later Ceramic period occupation beginning around A.D. 750 or A.D. 800 as represented by the *Catahoula* arrow point form. This type has been found to occur stratigraphically above *Gary/Kent* dart points and below *Perdiz/Clifton* arrow points at the Crawford site (Ensor and Carlson 1988), at the Alabonson Road site (Ensor and Carlson 1991), at other Lake Livingston sites (McClurkan 1968), and at other southeast Texas sites in general (Shafer 1988; Story 1990). This type is succeeded at 41HR616 by the *Perdiz/Clifton* types which represent the final occupation. It probably began by A.D. 1200 and may have extended until A.D. 1500 or slightly later (Turner and Hester 1993; Ensor 1990b).

Analysis of the projectile points from testing (Ensor 1989b) indicated that at least two separate components were present, an Early Ceramic and a Late Ceramic. This analysis does not detract from that view and further refines the Late Ceramic occupation to include an early Late Ceramic component represented by *Catahoula* arrow points. Other lithic evidence supporting the presence of these three components is presented below.

**Reduction Practices by Cultural Component**

Analysis of the 41HR616 lithic collection using the classification systems described in an earlier section has resulted in the definition of 26 categories. Applying both the technological and macro-morphological sorting criteria, all stages of reduction are
apparent in the sample throughout occupation at the site. Figures 6.8 and 6.9 graph the frequency of initial, primary, secondary, and reworked artifacts by level for Block A and all blocks combined respectively. As detected previously during the testing phase, there appears to be a distinct technological break between levels 9 and 10. This break seems to represent a fundamental shift in reduction technology between Early Ceramic and Late Ceramic occupations (Figure 6.10). The most striking aspect of the Early Ceramic lithic assemblage is the extremely high frequency of initial reduction artifacts, particularly tested pebbles, irregularly flaked pebbles, cores, and initial stage bifaces. These are most likely the discarded remains of a bifacial dart point reduction technology. The large number of tested pebbles probably reflects the relatively poor quality of the local raw material and the corresponding need to be selective in the procurement process. The presence of bifacial reduction is consistent with the occurrence of other late stage bifacial material representing intermediate and final stage dart point manufacture in these levels.

While a full range of bifacial manufacturing technology appears to be present in the upper levels associated with Late Ceramic occupation, the emphasis shifts from dart point manufacture to arrow point manufacture. The higher frequency of secondary and reworked artifacts associated with Late Ceramic occupation is a function of the predominance of small bifacial arrow points, many of which had been resharpened. Since there is evidence that many arrow points were made from flake blanks, this probably accounts, at least partially, for the lower proportion of initial stage artifacts such as tested pebbles. It was probably easier to obtain a single suitable flake as opposed to a
suitable pebble. However, evidence of arrow point manufacture failure is present in the sample.

The major distinction between dart point and arrow point manufacture at the site notwithstanding, the remainder of the assemblage appears fairly similar. As noted above, all stages of reduction are present in both Early Ceramic and Late Ceramic contexts. Very little artifact diversity is present in either assemblage, a point to be discussed later. Utilized flakes are present in low numbers throughout both Early and Late Ceramic contexts. The only other artifact types recognized, edge-trimmed pebbles, a uniface scraper, and a possible drill/perforator, were found in such small numbers that little can be said regarding their association with a particular occupation. However, edge-trimmed pebbles have been found at other sites in southeast Texas associated with virtually all cultural components (McClurkan 1968; Ensor and Carlson 1988; Jelks 1965). Likewise, drills have a long temporal distribution. Not much is known about the temporal distribution of uniface flake scrapers in southeast Texas; however, they were found in primarily an Early-Middle Archaic context at the Crawford site as well as in Early-Late Ceramic levels there (Ensor and Carlson 1988). Recent data from site 41HR375 on Cypress Creek in Harris County has documented unifacial scrapers in a Middle-Late Archaic context (Dockall et al. 1990). These are common forms at San Patrice sites (Webb et al. 1971) in northwestern Louisiana and east Texas as well as at Archaic and Late Prehistoric sites in central Texas (Weir 1976; Ensor 1987b).
When one examines Figure 6.9 regarding the vertical distribution of technological states at 41HR616, one can see a hint of three components as suggested by the projectile point data base. There appear to be three "peaks," one associated with levels 4 and 5, another with levels 7 and 8, and the final peak in level 10. Another possible peak occurs in level 14, but no data on projectile points are available in sufficient quantity to suggest another component at the bottom of the site. There is, however, a fairly dramatic decrease of formal tools/implements in level 13 across the entire site, suggestive of another occupation.

These three peaks may represent, in chronological order from earliest to latest, an Early Ceramic *Gary/Kent* component, a Late Ceramic *Catahoula* component, and a Late Ceramic *Perdiz/Cliffton* component. The separation of these components is not as good as one would desire. Evidently, some vertical displacement has occurred, which is not unusual for east Texas sandy sites. However, site integrity seems to be sufficient to allow recognition of these basic components. Technological change through time appears minimal other than the dramatic break apparently represented by the Early-Late Ceramic transition in level 9. Below level 9, dart point manufacture is predominant. Above that level arrow points predominate, although dart points were also found in levels 8 and 9, perhaps due to vertical displacement or a brief overlap with arrow point technology.
Vertical Distribution of Raw Materials

Examination of the vertical distribution of raw material types used for tools at 41HR616 (Table 6.9) confirms that silicified wood was used continuously throughout the site’s occupation. The same can be said of chert. Only three artifacts were made of quartzite, and two of these were confined to the lowest levels of the site. Interestingly, chalcedony peaks in levels 7 and 8, while chert artifacts are most abundant in level 10. Another interesting observation concerns the possible presence of a fourth component at the site in level 14 and below, as previously mentioned. Raw materials used in tool manufacture in level 14 are exclusively silicified wood. The sample size is too small, however, to suggest the meaning of this. The peak in the use of chert in level 10 may be related to dart point manufacture since an attempt would probably have been made to obtain the most internally consistent material available for biface manufacture. A heavy reliance on chert in Early Ceramic period dart point manufacture was noted at the Alabonson Road site (Ensor and Carlson 1991).

Tool Diversity

A simple measure of tool diversity was employed to quantify the number of tool types by major component at the site. This method has been recently employed to examine between-site tool diversity in the Colorado River drainage (Ensor and Mueller-Wille 1988). Since the major transition from Early to Late Ceramic is most likely represented
by level 9, all tool types below level 9 were counted by category. Likewise, those found above level 9 were similarly tabulated by frequency and category. Level 9 was excluded from the tabulation. A total of 21 tool categories was present in both samples with the total number of tools represented differing only slightly—55 in the Late Ceramic levels and 59 in the Early Ceramic levels. Obviously, if one were to plot the number of tool categories by the total count for each they would fall very close in space. This seems to substantiate the intuition above that the basic lithic tool kit remained unchanged at 41HR616 throughout prehistoric occupation except for the shift from dart point to arrow point technology. This may allow a further inference that basic subsistence practices remained relatively constant, assuming that the addition of arrow point technology did not greatly alter hunting practices, an assumption largely untested at southeast Texas sites.

**Intra-Site Comparisons**

As mentioned above, lithic tools were recovered from Blocks A-F at 41HR616. The majority \( n = 49 \) was found in the largest block excavated (Block A), which had a surface area of 30 m\(^2\). However, Block E contained a much higher density per cubic meter excavated. It was only 2 m \( \times \) 4 m in size yet contained 60% of the formal tools. Given the relatively low numbers of lithic implements recovered per cubic meter, statistically valid comparisons between individual blocks or areas within the site are difficult to make. However, tabulations of reduction stages were made by block (Table
6.10). An examination of this table indicates that Blocks D and F contained too few tools for formal comparison. Likewise, the Block C data are fairly limited in numbers. However, some differences do seem to exist in terms of reduction stage between certain blocks.

Perhaps the most notable difference is between Blocks A-B where there seems to be a disproportionate number of initial stage bifaces versus secondary and reworked bifaces. Table 6.11 indicates that a cross-tabulation of these two blocks by reduction stage yields a statistically significant chi square value of 10.391 \((p < .05)\) indicating that differences do occur that we would not expect by chance. However, the strength of the relationship is weak to moderate as indicated by the value of Cramer’s V. Additionally, the sample size was limited resulting in an expected count of less than five in one cell. Nevertheless, there does appear to be significantly more initial reduction in Block A when compared with Block B and more secondary reworking in Block B when compared to Block A. This may indicate that a substantial Late Ceramic occupation occurred in the vicinity of Block B while the Early Ceramic occupation was more concentrated in Block A. No significant difference in the numbers of arrow points versus dart points is present between the two blocks.

A comparison between Block A and Block E (Table 6.12), which together contained the majority of the artifacts, detected no major difference beyond the higher density of tools noted above. Most reduction stages were present in about equal proportions between the
two blocks, perhaps indicating that an intensive Early Ceramic occupation was present in
the vicinity of Block E. Again, the sample size is small for some reduction stages,
resulting in expected cell chi square values of less than 5 in two cases. One difference
was noted in the comparison, however, such as the complete lack of reworking in Block
E. By inference, Block E is less similar to Block B than to Block A.

These results indicate that an Early Ceramic component or components were present in
the vicinity of Blocks A and E while a Late Ceramic component must have been present
in the vicinity of Block B. The Block C lithic collection is too small for formal
comparison with the other blocks but appears in general more like Blocks A and E than
Block C. Blocks D and F contained too few artifacts for comparison.

Debitage Patterning and Site Integrity

Debitage analysis for this phase of the project attempted to build on work accomplished
during testing (Ensor 1989b). In that analysis, a distinction was made between the
percentages of large and small flakes for the Late Ceramic and Early Ceramic
components at the site. Significantly, more flakes <15 mm in size were present in levels
1-9 than in level 10 or below. At the same time, most of the larger flakes, >15 mm in
size, were found in level 10 or below. However, it was inferred that all stages of
reduction were present at the site for both components.
Results from this phase of the project do not detract greatly from the interpretations gleaned during the testing phase. However, with a much larger sample size, interpretations can be made with more reliability.

Figures 6.11 and 6.12 graph the vertical percentage of flake sizes by level and elevation respectively. It can be seen that the majority of all flakes fall within the 10-15 mm size range. This would include all flakes caught in a 1/16 inch screen and most from a 1/4 inch screen. Flake sizes above 20 mm were relatively scarce at the site. If one examines these two figures, it can be seen that the larger flake sizes increase proportionally with depth, while the smaller flake sizes stay about the same. There is one exception to this. Flakes 25-30 mm in size increase in level 3 at the site.

Figures 6.13 and 6.14 graph the mean and absolute flake counts per zone (elevation) at the site. Here it can be said that most flakes occur in level 9 or below with flake density dropping dramatically after elevation 0.89. Additionally, flakes between 5 mm and 15 mm present almost a bimodal distribution with one peak at elevations 0.70 and 0.89 and another at elevations 0.30-0.49. The proportion of very small flakes peaks at level 4, between elevations 0.30 and 0.39. A third possible peak is seen centering on elevation 1.20-1.29 in level 13.

When comparing these data with that from the stone tool analysis, we note a general agreement between stone tool density and debitage density by level. A total of three
peaks and a possible fourth were noted based on the sample of stone tools; one in levels 4 and 5, as with the debitage, one in levels 7 and 8, one in level 10, and possibly in level 14. This latter possible peak is strengthened by the debitage data as a distinctive increase in flakes is noted in level 13. However, the presence of two separate occupations, as suggested by the tool data, cannot be substantiated using the debitage data.

It appears that only two components, a Late Ceramic in levels 4 and 5 and an Early Ceramic in levels 7 and 8, are suggested by these data. However, the peak in stone tools and ceramics in level 10 do suggest either an earlier ceramic period component or the downward vertical displacement of larger objects below the original living surface. An examination of Figure 6.15 may give some indication of which interpretation to favor here. This figure graphs the vertical distribution of large and small gravels according to their mean weight by level. It can be seen that both large and small gravels increase with depth beginning in level 4, perhaps lending support that a separate Early Ceramic component is present at the site, centering on level 10.

No distinctive shift in reduction technology is evident based on the debitage data other than the shift from dart point to arrow point manufacture noted earlier here and in Ensor (1989b). The complete range of bifacial reduction activities seems to be represented in all components at the site.
As discussed elsewhere in the report, intra-site distribution of debitage indicates that Block A was either on the edge of the site or represents an area where specific activities were carried out. No specific activity areas, as might be inferred from concentrations or "hot spots," were noted on the debitage density contour maps.

One other interesting comparison was made with the debitage. As noted recently by Mueller-Wille et al. (1991) and Dockall et al. (1990:63), small or micro-debitage is frequently used as an indication of primary versus secondary archeological deposits. Drawing on the work of Behm (1983) and others, an attempt has been made by these authors to distinguish between the two. It is carefully noted, however, that these studies were designed to control primarily for cultural differences in refuse disposal and do not take specifically into account other site formation processes such as erosion and bioturbation. Both Mueller-Wille et al. (1991) and Dockall et al. (1990) used flake-size ratios (including micro-debitage) to assess the likelihood that a deposit is primary or secondary. The reasoning here is that relatively undisturbed deposits should contain flake ratios which indicate that as the overall flake number increases, the ratio between that number and the number of small flakes also increases. According to Behm, a flake-size ratio of 1.48 or greater between overall flake-size count and small-size debitage count should reveal a primary deposit. In order to determine whether the deposit at 41HR616 is more likely to be relatively undisturbed or a secondary deposit, a ratio was calculated using six of the flake categories. All flakes less than 10 mm were counted as micro-debitage, while all flakes 10-20 mm were counted as the next largest grouping to be
divided into the micro-debitage count. The total number of 0-10 mm flakes was 5130, while the total number of the next largest grouping (10-20 mm) was 2071. Dividing 2071 into 5130 yields a ratio of 2.48, above Behm’s cutoff of 2.14. This indicates that the deposit is most likely to be primary in nature, disturbed only by the usual post-depositional processes at east Texas sandy sites such as bioturbation and erosion. This corresponds well to the occurrence of ceramic “fitters” at the site (Ellis, this volume).

In summary, the majority of debitage recovered was micro-debitage, which generally is not recovered at a site unless fine screening is employed. All stages of reduction are represented by the debitage as the proportional representation of different flake sizes attests. The ratio of 1.59, of decortication to interior flakes, seems higher than one would expect from a bifacial technology based on the local pebble resources, especially since the majority of the flakes were less than 15 mm in size. This contrasts sharply with other lithic assemblages in the area (Dockall et al. 1980:62), Ensor (1987a), and Mueller-Wille et al. (1991). One would normally expect small flake size to be negatively correlated with cortex and large flake size to be positively correlated. No ready explanation comes to mind to account for this phenomenon. However, the percentages of the different flake sizes seem reasonable and are directly comparable to other lithic assemblages in the area.
The Nature of Hunter-Gatherer Settlement at 41HR616

The preceding analysis and descriptions of lithic materials from 41HR616 have documented a basic stability in artifact content throughout the Early-Late Ceramic periods. The shift from dart point to arrow point manufacture is signified by the high incidence of initial reduction failures/discards during the Early Ceramic period and the relatively high incidence of secondary or reworked bifaces during the Late Ceramic period. The technological changes have been demonstrated by examination of both the vertical and horizontal distribution of tool categories using statistical tests as a measure of association. In addition, debitage provided an ancillary line of evidence supporting these interpretations.

However, the nature of hunter-gatherer technological practices and settlement at 41HR616 must be explored further using a set of basic research hypotheses. These must be designed to answer questions regarding the mobility strategies of the site’s occupants and how these strategies related to regional settlement models. This section, therefore, discusses a series of hypotheses which are testable in principle using the lithic database from 41HR616. The hypotheses are used as heuristic devices to assess the nature of settlement at 41HR616 for both the Early Ceramic and the Late Ceramic periods.
Theoretical Orientation

The theoretical orientation is grounded in cultural and human ecology and the economic choices faced by hunter-gatherers since there is no evidence that the groups under study were organized at any higher level of social organization. After Steward (1955), Jochim (1976), Binford (1980), Yellen (1977), and Thomas (1979), hunter-gatherer behavior is viewed as resulting from a series of conscious choices within their environment and from minimization of effort. The decisions made ultimately determine the nature of the subsistence-settlement round of a particular cultural group. The concept of resource scheduling and exploitation or, in general, how a particular group adapts to its natural environment is the critical area of study.

Binford (1979, 1980) and Carlson (1979) have discussed mobility strategies and how hunter-gatherers adapt to their environment. Two basic strategies have been noted. They are referred to by Binford (1980) as foraging versus collecting and viewed by him as organizational alternatives which are used by hunter-gatherers in particular situations. Foragers are usually highly mobile groups which must move often to exploit widely dispersed resources. The entire group generally moves to the resource(s) being exploited.

Collectors, in Binford's view, generally move resources back to a base camp and, in this sense, are logistically organized. Foraging strategies generally result in a series of
residential camps and field locations. Logistically organized systems may have a series of site types focused on the base camp or where groups aggregate to exploit a dependable resource or set of resources (Binford 1980; Carlson 1979). According to Carlson (1979), residential mobility strategies are most common where overlapping resource zones can be effectively exploited by small groups while logistical strategies are more likely to develop where “a single resource determines site location as a result of abundance or necessity” (Carlson 1979:118). Site types associated with base camps may consist of field camps, stations, and caches (Binford 1980). Since the majority of the material remains at 41HR616 are lithics, research topics which may be approached using these data are emphasized.

Using the models and theory of hunter-gatherer mobility strategies and adaptive behaviors discussed above, it is possible to formulate specific research hypotheses which are potentially testable given the nature of the data base. These hypotheses are derived primarily from Binford (1979, 1980), Carlson (1979), and Lurie (1982, 1987). At the site level, a number of research opportunities are available which may ultimately serve to help build regional models of subsistence and settlement. The series of topics and test expectations designed to examine the lithic assemblage variability related to hunter-gatherer mobility strategies by Lurie (1987) seem appropriate to the site under study. The following discusses a series of research hypotheses along with relevant test expectations which may be used to evaluate the nature of settlement at 41HR616.
Research Hypotheses

Drawing on Binford's and Carlson's distinctions between base camps and residential camps and logistical versus extractive strategies, Lurie attempts to link the technological subsystem expected with each to modes of raw material acquisition, options in tool manufacture, and strategies of tool use (Lurie 1987:238-240). Appropriate research hypotheses for the 41HR616 lithics are as follows and are modified from Lurie (1987:238-240). Other sources consulted include Shott (1989), Keeley (1982), and Mueller-Wille et al. (1991). The first two hypotheses relate to raw material acquisition, numbers three and four to manufacturing options, and numbers five and six to tool use strategies. All are designed to help differentiate 41HR616 as to the type of settlement present, such as a base camp versus a residential camp or, perhaps, some other more ephemeral kind of occupation. While it is realized that adequate comparative data from other sites currently may not be available to fully test these hypotheses, an initial examination of each hypothesis can be conducted based on data from 41HR616 and other sources.

Raw Material Acquisition

1. Site 41HR616 is a base camp, and its residents had low mobility.

(a) We would expect to find tools manufactured from fair to poor quality materials since the chances of raw material exhaustion are greater.
(b) More recycling and conservation of material may occur along with restriction of good quality materials to tools requiring more complex manufacturing techniques. Tools may be smaller, on the average, than at residential camps.

(c) Thermal alteration of siliceous stone may increase as an adaptive advantage if resources are being depleted.

(d) There may be significant proportions of the tool assemblage manufactured from non-local or exotic stone, especially for elements of the assemblage requiring more refinement or complexity in manufacture.

2. Site 41HR616 is a residential camp, and its residents had high mobility.

(a) We would expect raw materials used in tool manufacture to be of overall high quality since chances of resource depletion are diminished.

(b) Tool size will be, on the average, larger than at base camps and tool classes will, in general, be manufactured from higher quality materials than at base camps.

(c) Incidence of thermal alteration will be lower.

(d) A small quantity of non-local cherts, primarily associated with hafted or more complex tool forms which are finished, will be present.
Manufacturing Options

3. Site 41HR616 is a base camp, and its residents had low mobility.
   (a) A wider range of tool forms will be found along with evidence of increased energy in manufacture.
   (b) Tool forms will be more complex, and hafted tools such as projectile points will be more frequent.

4. Site 41HR616 is a residential camp, and its residents had high mobility.
   (a) There will be a more restrictive range of tool forms with expedient tool manufacture most prevalent.
   (b) Less complex tool forms may be expected along with more multi-purpose tools.

Tool Use Strategies

5. Site 41HR616 is a base camp, and its residents had low mobility.
   (a) Tool resharpening and recycling will be more common and, in general, tools will appear more intensively used.
   (b) A high percentage of tools will be broken, the tool assemblage more fragmented, and tools will be more often burned or otherwise thermally altered.
   (c) Maintenance activities such as re-tooling of hafted implements will have a higher incidence.
6. Site 41HR616 is a residential camp, and its residents had high mobility.

   (a) Resharpening and recycling will be notably reduced when compared to base camp assemblages.

   (b) Relatively few tools will be broken, and the degree of fragmentation will be less than at base camps, with less burning and thermal alteration.

   (c) Re-tooling of hafted implements will be less frequent than at base camps.

Conclusions

In order to assess the relationships between the lithic reduction/raw material acquisition practices at 41HR616 with a specific pattern of hunter-gatherer mobility, the hypotheses posed above will be addressed to the fullest extent possible using the 41HR616 data. The first two hypotheses dealing with raw material acquisition are addressed first, followed by those relating to manufacturing techniques and tool use strategies.

With regard to the first two questions, which posit alternatively that 41HR616 served as a base camp or residential camp and that the groups had high or low mobility, the lithic data are somewhat equivocal. For example, it is difficult to assess so called “good quality” materials given the local resource base which is generally of poor quality. Certainly no evidence of widespread importation of good central Texas chert is evident with only one such example, a hafted end scraper, present. The presence of the single hafted end scraper made of exotic chert is more in line with the expectation of the notion
of a highly mobile group who stayed at the site for a short period of time. Only one example of recycling was noted in the sample, a *Kent* dart point reworked into a scraper. However, given the ubiquity of such chert and silicified wood pebbles in southeast Texas, albeit of poor quality, it is doubtful if material was ever “conserved” in that sense. Detecting thermal alteration is difficult on the materials used in tool manufacture, especially silicified wood. Therefore, the evidence of intentional thermal alteration is unknown.

However, it is prudent to note that 4 of 11 dart points and dart point fragments exhibited evidence of heating while 7 of 15 arrow points and arrow point fragments had such indications. It is difficult to compare tool size with that expected from base or residential camps in southeast Texas since no well established site typology exists. The best candidate we have for a possible base camp with which to compare the 41HR616 data is 41HR273, the Alabonson Road site (Ensor and Carlson 1991). At that site, *Gary* points averaged 39.4 mm in length and 22.9 mm in width. The three measured *Gary* points at 41HR616 have an average length of 31.4 mm and an average width of 20.8 mm. However, the sample size at 41HR616 is so small that no statistically meaningful comparison can be made.

Perhaps a better comparison is in the size of the original pebble blanks used, although this may have been, in part, a function of the size of the pebbles closest to a particular settlement and not a reflection of any resource depletion. The average tested pebbles at
41HR616 are 42.7 mm long, 24.9 mm wide, and 9.9 mm thick. In contrast, tested pebbles at 41HR273 averaged 46.4 mm in length, 32.0 mm in width, and 19.5 mm in thickness. According to the expectations of the model, the inhabitants of 41HR616, with their use of smaller raw materials than at Alabonson Road, may have experienced a shortage of materials leading to use of the smaller parent pieces. However, this interpretation is not favored here. Rather, it is considered more of a function of the local resource base exploited, perhaps indicating a difference in territorial range for the Alabonson and 41HR616 inhabitants. Why this interpretation is favored will be explained below.

The next set of hypotheses involve manufacturing options. As described earlier, no appreciable differences were noted in tool diversity between Early and Late Ceramic occupation at 41HR616. One expectation of a base-camp tool kit, as opposed to a tool kit at a residential camp, is that the former will retain a wider range of tool forms. Again, our ability to compare the 41HR616 collection with those from other base or residential camp sites is limited. If we examine material from 41HR616 qualitatively and compare it with the expectations of the site type model postulated by Ensor in McReynolds, Ensor et al. (1988) and Ensor and Carlson (1991) for inland coastal prairie sites in southeast Texas, we see a close correspondence to the site Type 1 (residential camp) assemblage. Initial, primary, and secondary reduction products, including stone dart and arrow points, are present as well as a possible drill and uniface scraper. However, most of the items associated with Type 2 (base camp) sites such as atlatl weights, red
ochre/pigments, and ground stone are absent at 41HR616. Quantitative comparisons are more difficult, however. A total of 24 categories was recognized in a sample of 110 implements (excluding utilized flake/blades) from 41HR616. At Alabonson Road (Ensor and Carlson 1991), however, slightly different categories were used. Twenty-nine categories were recognized in a sample of 1442 artifacts, while at Cinco Ranch (Ensor and Gauthier 1987) only 13 categories were described in a sample of 58 artifacts. McReynolds and Ham (1988) describe only 7 categories (other than utilized flakes) in a sample of 12 artifacts at the Langham Creek mound (41HR530). John Dockall (Dockall et al. 1990) describes 14 lithic categories in a sample of 52 artifacts from the Al Soloman II site (41HR375) on Cypress Creek in Harris County. A plot of these values (i.e., number of tools by number of lithic categories) is presented in Figure 6.16. This approach has been used recently at 41BP280 (Ensor and Mueller-Wille 1988). It can be seen that 41HR616 appears to have more diversity than 41HR375, the Langham Creek Mound site, or the Cinco Ranch sites. It also has at least twice as many tools as any of these sites, which is not unexpected given the volume of dirt excavated at 41HR616 compared to the other sites. On the other hand, Alabonson Road, despite less volume of dirt excavated than at 41HR616, had more categories and over ten times the number of tools. This indicates that 41HR616 probably falls near the upper end of Type 1 sites in terms of duration of occupation. Additionally, at least 50% of the tool forms found at Alabonson Road, excluding utilized flakes, were complex tool forms such as hafted dart points and arrow points. In contrast, only 23% of the tools at 41HR616 were dart or arrow point fragments. This seems to conform to the expectation of research hypotheses.
3 and 4 above that at base camps complex tool forms will be more frequent than at residential camps. The question of frequency of multi-purpose tools cannot be addressed since no systematic use-wear studies have been conducted.

The final set of hypotheses pertains to tool use strategies. Here, the best comparative data comes from Alabonson Road, a probable Early Ceramic base camp on Whiteoak Bayou (Ensor and Carlson 1991). At that site tool resharpening, especially Gary point rejuvenation, was a common practice. Many points have been intensively resharpened so that the shoulders had been obliterated. Recycling into other tool forms was not common, however. Frequent tool maintenance appears to have occurred as indicated by the large number of discarded and worn dart points, many with a tar-like mastic still adhering to their haft elements (Mueller-Wille et al. 1991). In terms of tool fragmentation, it is estimated that more than 30% were so fragmented that they were unclassifiable. Only 25% of the 41HR616 stone implements were so fragmented. This percentage is lower but surprisingly close to the estimate for Alabonson Road. Complex tools such as dart/arrow points made up only 23% of the 41HR616 flaked stone tool inventory, while complex tools made up more than 50% of the inventories at Alabonson Road. This indicates that substantially less maintenance activity and re-tooling occurred at 41HR616 when compared to Alabonson Road.

In terms of burning or thermal alteration, at 41HR616 45 of 127 (35%) specimens exhibited evidence of burning or heating. This appears to be a fairly high percentage
when compared to the estimate of 25% for burned flakes at 41HR375 (Dockall et al. 1990) and the 12% of flakes reported as heat shatter from Alabonson Road (Mueller-Wille et al. 1991). However, comparisons of this type are difficult to make since recognition of burning/heating is often difficult. The amount of heat shatter in the 41HR616 debitage collection was not quantified.

In summary, evaluation of the lithic data from 41HR616 in terms of the research hypotheses outlined earlier tends to support a fairly mobile population which used the site as a residential camp through time. It appears to fall in the upper end of duration of occupation within Type 1 sites as defined by Ensor (McReynolds, Ensor, et al. 1988; Ensor and Carlson 1991). However, it contrasts distinctly with Alabonson Road, both in sheer artifact density and in the types of activities carried out (such as re-tooling and maintenance).

Parry and Kelly (1987) have made a distinction between expedient and standardized core reduction as practiced in North America. They indicate that beginning around Late Woodland times, a major shift occurs away from formal, standardized core reduction to an emphasis on expedient core reduction. They postulate that this relates to permanence of site occupation or degree of sedentism. Utilized flakes, as opposed to more complex hafted tool forms become preferred. They indicate that the choice between an expedient or formal technology involves a “tradeoff between the costs of transporting tools and raw material (which are high for expedient core technology) and the costs of
manufacturing and using tools (relatively high for formal, lower for expedient)” (Parry and Kelly 1987:299). Their interpretations of tool kit composition and group mobility seem to hold true for the southeast Texas region and 41HR616. Formal tools such as projectile points are ubiquitous throughout the archeological record, with utilized flakes and other expedient tools such as edge-trimmed pebbles also found throughout all occupations. No increase in the use of expedient tools which might indicate a more sedentary population is evident at southeast Texas sites, including 41HR616. This tends to support the notion that the same basic, hunter-gatherer lifeways persisted throughout southeast Texas prehistory and into historic times. No evidence of permanent villages is available; there are only the remains of highly mobile groups who moved seasonally to take advantage of specific resources. In the case of 41HR616, it appears that the site served a similar function during the Early-Late Ceramic periods, although the population may have been greater during Early Ceramic times.
Tables and Figures: Appendix IV
Table 6.13. Total debitage recovery by area and elevation.

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<tr>
<th>Elevation (cm below surface)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
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<td>0.00-0.09</td>
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<td>0</td>
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Table 6.14 Mean debitage yield by flake size for each area at 41HR616.

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<th>Elevation (cm below surface)</th>
<th>Area A</th>
<th>Area B</th>
<th>Area C</th>
<th>Area D</th>
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Figure 6.7 Vertical distribution of projectile point types at 41HR616, all excavation blocks
Figure 6.8 Vertical distribution of technological states in Block A
Figure 6.9 Vertical distribution of technological states at 41HR616, all excavation blocks
Figure 6.10 Reduction stages represented by component
Figure 6.11 Percentages of flake size categories by level.
Figure 6.12 Percentages of flake size categories by elevation.
Figure 6.14 Absolute flake count by depth below surface.
Figure 6.15 Mean weight of unmodified gravels by level
Figure 6.16 Plot of relative diversity of tool types at selected Southeast Texas sites.
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APPENDIX V

Ceramic Analysis from Site 41HR616

(Chapter 7 in Archeological Data Recovery Excavations at the Kingwood Site 41HR616 Harris County Texas. Moore Archeological Consulting Report of Investigations Number 100.)

by

Linda Wootan Ellis
The historical development of ceramic analysis for the upper Texas coast has been controversial, revolving largely around the emphasis on paste as the principal diagnostic attribute for pottery types. Research to date has primarily focused on cultural/historical relationships, and studies have concentrated on the development of formal classification systems that define cultural/historical types. In developing these systems, researchers have focused predominantly on the presence or absence of inclusions, such as grog or bone, and the presence or absence of sand temper. Decorative attributes such as incising, red-filming, and rocker stamping have served to split the major paste types into specific varieties. Despite the usefulness of the currently defined types for providing chronological data, use of the current typology has a limited applicability to non-cultural/historical questions. In effect, establishing descriptive pottery “types” has most often been the objective in upper Texas coast ceramic analyses, and little research has been done regarding the array of cultural behaviors reflected in ceramic assemblages. Consequently, this chapter will take an alternative approach to the study of upper Texas coast ceramics and will move beyond cultural/historical types.

This study does not address the chronological suitability of the most widely used typology (Aten 1983a). Indeed, Aten’s research was a significant first step in the study of upper Texas coast ceramics. However, the utility of any classification scheme lies in its ability to order a specific group of things with regard to a specific problem (Dunnell 1971). Aten’s goal was to identify unequivocal, reproducible artifact classes (types and varieties) that would aid in the establishment of a chronological seriation for the area (Aten 1983a:206-209), and his classification scheme was designed to address only cultural/historical problems. As no one classification scheme will accommodate all problems, other methods are necessary in order to incorporate upper Texas coast ceramics into broader research aims such as function and trade. However, an analysis of
the ceramic manufacturing behavior reflected in upper Texas coast ceramics is a necessary prerequisite to achieving these broader aims. This study, therefore, will (i) examine the manufacturing sequence of upper Texas coast ceramics and devise a meaningful set of definitions for the range and combination of attributes used in the manufacture of upper Texas coast ceramics and (ii) apply those criteria to the ceramics recovered from site 41HR616 in Harris County. The analysis will attempt to identify preferences for approaches to pottery making among the occupants of the site.

**Historic Development of Ceramic Analysis in the Upper Texas Coast**

Prior to the 1950s, relatively little archaeological research had been done in the upper Texas coast. Consequently, the ceramic sequence of the area was poorly understood and few formal designations of ceramic types had been established. Wheat (1953) made the first systematic attempt to define upper Texas coast ceramics. On the basis of ceramics from the Addicks Dam Basin, Wheat (1953:184) noted that the pottery of the region consisted of "a single, highly variable ware divided into two subtypes, decoration serving as the primary criterion for the separation." He designated the two subtypes Goose Creek Plain and Goose Creek Incised following then unpublished criteria proposed by Campbell (subsequently included in Campbell [1957]). Moreover, the attributes recognized in Wheat's analysis have remained important to the classification of upper Texas coast ceramics ever since (Fields 1988; Fields et al. 1986; Hamilton 1988; Howard and Freeman 1983; Howard and Kotter 1983; Kotter and Fields 1983; McReynolds 1988; McReynolds, Korgel, et al. 1988; Winchell and Ellis 1991). Wheat described the ceramic sequence of the area, noting that clay temper (or "grog") appeared late in the sequence, but that sand-tempered pastes predominated throughout
all stratigraphic levels. He (Wheat 1953:194) concluded that the vertical ubiquity of Goose Creek wares gave them “little value as time markers.” However, a wide range of attributes Wheat subsumed under one or the other of the Goose Creek names (e.g., sand or clay temper, red-film) have since become the definitional criteria for other ceramic types (cf. Aten 1983a).

Beginning in the 1960s, archeological investigations in the area were accompanied by attempts to refine the formal classification of the ceramics of the upper Texas coast. Shafer (1966), using Wheat’s criteria, sorted ceramics on the basis of decoration, but further subdivided his classes according to paste attributes. He noted that the size and amount of sand present in the paste varied considerably, but he also suggested that clay temper and very coarse sand temper might have chronological significance. Shafer (1968) used paste as a basis for classifying sherds recovered from the San Jacinto River Basin. This time, sherds were sorted first by temper and then by decoration. Shafer noted grog and bone temper in addition to sand temper. An analysis of the sherd distribution indicated that the decorated, sand-, bone-, and grog-tempered pottery were probably late additions to the ceramic inventory (Shafer 1968).

Tunnell and Ambler (1967) excavated an early historic site in Chambers County that included aboriginal ceramics. Although the ceramics resembled Goose Creek wares, they made no attempt to assign the sherds to particular types. Instead, they first sorted the sherds into descriptive categories by decoration. Each category was subsequently divided according to paste, showing the presence of sand- and bone-tempered sherds at the site. The sand- and bone-tempered sherds were further subdivided according to predominant grain size. Among the sherds recovered with stratigraphic controls, “all temper classes were found in all levels in approximately the same proportions” (Tunnel
and Ambler 1967:87). Although Tunnell and Ambler referred to their types as “sand-
tempered” wares, they claimed that the sand in the sherds was probably a natural
occurrence rather than an additive. A later study by Ambler (1973) at Wallisville
Reservoir followed the same basic procedures but employed standardized scales for
determining temper sizes. In this study, Ambler defined the Wallisville Plain and Lost
River Plain types in an attempt to distinguish earlier types while avoiding a typology
that implied undemonstrated cultural/historical continuity among ceramics that might be
classified as the same type by paste, but differentiated by other geographically or
chronologically significant characteristics.

A consistent problem in many of these early studies (and, indeed, an ongoing problem)
was the use of the term “temper.” As Rice (1987:406-413) points out, temper can be
used as a noun referring to the coarse material in a paste, or it can be used as a verb
referring to the intentional action of adding that material. In upper Texas coast
ceramics, the presence of bone and/or clay in a paste can be used to denote ceramics
with temper (coarse material) and ceramics that are tempered (coarse material
intentionally added). However, for sherds that are sandy in texture, these distinctions
are difficult to make. Sizable sand grains can be easily recognized as naturally occurring
inclusions (i.e. temper), but it is much more difficult to determine whether they were
intentionally added (i.e. tempered). In early studies, these terms were often used
interchangeably. Pastes with considerable quantities of naturally occurring sand
inclusions were classified as sand-tempered even though no clear distinctions were
made with regard to intentionality.

In a report on the ceramics from the Jamison site, Aten (1967) addressed the
“tempering” problem. He believed that the indigenous pottery was composed of
materials utilized in their natural association. Following the suggestion of Nunley (1963:33), Aten (1967:10-11) proposed that the ceramics of the area be referred to as "sandy paste" wares rather than sand-tempered wares unless tempering could actually be demonstrated.

Aten's analysis of the ceramics recovered during the Jamison excavations also introduced several attribute distinctions into the classification of upper Texas coast ceramics. He used paste categories as the major definitional criteria for the ceramics. In addition to separating grog-tempered types out of the Goose Creek rubric, Aten (1967:13) proposed that the occurrence of a red film or wash on the surface of the sandy paste ceramics of the Galveston Bay area represented a distinct type which he termed Goose Creek Red-Filmed. Thus, the Goose Creek designation came to refer to a narrower range of ceramics than that formalized by Wheat.

Using these newly refined type designations, Aten and Bollich (1969) attempted to establish a ceramic seriation based on paste categories. Sandy paste wares in the Galveston Bay area were the only wares present during the early part of the time sequence. At the Dow-Cleaver site in Brazoria County (Aten 1971), sandy paste Goose Creek wares were present throughout the stratigraphy, while bone-tempered wares occurred only in the upper levels. Excavations at the Harris County Boys School site enabled Aten (Aten et al. 1976) to correlate the Galveston Bay area sequence with a set of chronological periods beginning in A.D. 100 and ending in the historic period. Aten's ceramic chronology was established on the basis of a typological framework in which the principal criteria for separation were the presence or absence of temper, paste category, paste texture, and decoration (Aten et al. 1976). Revising his previous position (cf. Aten 1967), this study also formally defined the type Conway Plain as a
sand-tempered ware that could be distinguished from the *Goose Creek* sandy paste wares by a discontinuity in the size range of nonplastic inclusions.

Aten (1979, 1983a) continued his synthesis of the ceramic typology of the upper Texas coast area. Aten rejected Ambler’s (1973) attempt to establish Wallisville Plain and Lost River Plain as distinct types, defining the latter instead as the Anahuac variety of *Goose Creek Plain*. Aten’s study also reclassified the Conway Plain type, recognizing it instead as a variety of the O’Neal Plain type as defined by Phillips (1970; cf. Ford and Quimby 1945; Haag 1939). The resulting ceramic classification system was developed along the lines of Phillips’ (1970) type-variety system of classification with the expressed goal of developing a chronological seriation (Aten 1983a:206). Aten’s work has become the standard reference for ceramic studies in the area. (For examples of Aten’s influence, see Ensor 1987; Fields 1988; Fields *et al.* 1983; Fields *et al.* 1986; Hamilton 1988; Howard and Freeman 1983; Howard and Kotter 1983; Kotter and Fields 1983; McReynolds 1988; McReynolds, Ensor, *et al.* 1988; McReynolds, Korgel, *et al.* 1988; Winchell and Ellis 1991). However, even Aten (1983a:207) denies that this “approach will serve all purposes,... or even that this formulation is the only one possible at present.”

**The Current Typology**

Aten believed that the key to an integrated taxonomy for the area was the recognition of the evolutionary sequence that occurred with regard to changes in the basic ceramic paste technologies. Following Phillips’ (1970) scheme for the Lower Mississippi Valley, this sequence began with untempered wares (such as *Tchefuncte* and *Goose Creek*) and
was followed, first, by sand-tempered wares (such as Alexander, O'Neal, and Conway), then grog-tempered wares (such as *Marksville*, *Baytown*, and *San Jacinto*), and later bone- and shell-tempered wares (Aten 1983a:219-220). His taxonomic designations were devised on the basis of these changes in paste technologies, with various decorative treatments being used to split gross paste types into finer types (i.e., *Goose Creek Red-Filmed*) or to denote the specific varieties within each type.

The types and varieties proposed by Aten (1983a:206-209) were developed to “map” the time/space distribution of ceramic artifacts in the region. Once types were established, a “lenticular time-frequency distribution” or seriation was produced for each type in the Galveston Bay area following several lines of evidence.

To summarize Aten’s chronology, ceramics first appeared in the region around A.D. 100 during the Clear Lake Period (Aten 1983a:284-287). These early ceramics were untempered sandy paste wares that included the early *Goose Creek* types, as well as a group of loosely consolidated, contorted paste ceramics, resembling the *Tchefuncte* types from the Lower Mississippi Valley (Ambler 1970:20; Aten 1983a:210; Wheat 1953:190). The *Tchefuncte*-like ceramics dropped out of the sequence by about A.D. 425 (Aten 1983a:286), but the *Goose Creek* types continued. The first appearance of tempered ceramics also occurred during the Clear Lake period, but Aten indicates only a short temporal span. These O’Neal, variety Conway ceramics extended into the early Mayes Island Period (A.D. 425-650) (Aten 1983a:287-288).

The Mayes Island Period was dominated almost entirely by the *Goose Creek* types, as was the Turtle Bay period from A.D. 650 to about A.D. 1000. There were, however, continued modifications of design motifs on the *Goose Creek Incised* varieties, as well
as a resurgence of the red-filmed varieties. While there was no significant change in paste technology during these periods, the first evidence of grog-tempered ceramics appeared at a few isolated sites.

A major shift to grog-tempered ceramics began during the Round Lake Period (A.D. 1000-1350). Grog-tempered ceramics increased in frequency and were accompanied by a relatively sharp decline in the Goose Creek types. Grog-tempered ceramics reached their peak shortly after the beginning of the Old River Period (A.D. 1350-1700) and then began to decline rapidly. By A.D. 1700 the Goose Creek types were once again the dominant types. Bone-tempered ceramics began to appear consistently during the Old River Period.

The Orcoquisac Period extended through the beginning of the nineteenth century. During this period, there was a steady decline in all aboriginal ceramics, except for the Goose Creek Plain types (Aten 1983a:287-288).

An Alternative Method of Analysis

Although researchers have viewed Aten (1983a) as the definitive analysis of upper Texas coast ceramics, Aten apparently did not intend his study to be taken that way. He (Aten 1983a:231) explicitly states that “a more holistic approach is needed.” A large body of ceramic data has been accumulated over the last 40 years, and Aten (1983a:231) suggests that “if these data are to be used productively, it will be as a result of proposing new hypotheses extending beyond this study.” One such holistic approach would be an attempt to infer sociocultural characteristics (e.g., function, use,
exchange) from ceramic variables (e.g., paste, decoration, manufacturing techniques; see, e.g., Rice 1984:252, 1987:286-288). However, such approaches will be premature in the upper Texas coast area until alternative methods of ceramic classification are developed. One such method could be based on technological analysis. It will be shown below that conventional classification criteria for upper Texas coast ceramics obscure a significant range and number of distinguishable technological variations, which in turn results in a diminished capacity to describe ceramic manufacturing behavior. If, in fact, there is any relationship between such behavior and sociocultural variables, then an analysis of the ceramic manufacturing behavior reflected in upper Texas coast ceramics is a necessary prerequisite to addressing the place that upper Texas coast ceramics occupied in the sociocultural system. Such technological methods have proved to be valuable tools in both ethnographic studies of ceramic behavior (e.g., Foster 1960; Reina and Hill 1978; Shepard 1976) and archeological studies of lithic tools (Tringham et al. 1974).

**Important Elements of the Technological Perspective**

The existing typology is not useful for studying the ceramic technology of the upper Texas coast. Aten (1983a:231, citing Phillips 1970:30-34), notes that "type descriptions are not an effective vehicle for conveying ceramic technological data, especially if the types are defined to be historical classes." The pottery "type," as defined under the type-variety system of classification, lends itself to chronology building. If a pottery type, consistently formulated, uniformly applied, and rigorously tested, adequately addresses a particular chronological problem, then it is a useful classification scheme for that problem. However, difficulties arise when the same type classifications are inappropriately applied to other problem areas for which they are unsuited. Further,
because types focus on attribute norms, this often has the effect of obscuring subtle changes in "non-selected attributes" which may, in fact, be significant. These changes are rarely noticed in that once specific types and varieties become entrenched, it is often difficult to break the constraints of those types in order to reformulate classes (Shepard 1976:317). Therefore, rather than focusing on specific types, an alternative is to use independent, unordered, unweighted, dimensional (i.e. mutually exclusive) attributes (Dunnell 1971:70-86; Rice 1987:249; Shepard 1976:306-322) to classify groups of artifacts. These analytical (Rouse 1960) or paradigmatic (Dunnell 1971) classification schemes analyze attributes in an effort to isolate and describe "modes." Simply put, classes are formed on the basis of one or more diagnostic attributes. These attributes are the observable, repetitive, physical phenomena (such as texture, shape, decoration) that are indicative of the patterned human actions that produced them.

These actions include those techniques, concepts, or standards that conform to the community's customary way(s) of manufacturing vessels. These standards constitute modes (Rouse 1960:313). Modes function "to isolate sets of attributes which are cultural in a particular context" (Dunnell 1971:156). Two types of modes have been discerned: conceptual and procedural. "Conceptual" modes relate to the form and style of the vessel and include such attributes as decorative treatment and shape. "Procedural" modes relate to the manufacture and use of the vessel (Rice 1987:277; Rouse 1960:315). Because procedural modes relate directly to the potter's customary procedure for manufacturing vessels (cf. Rye 1981), these modes can also be used to infer manufacturing behavior patterns. Because pottery is the product of structured human behavior and its qualities are determined by its raw materials and method of manufacture (Braun 1983:126; Shepard 1976:2), analyzing manufacturing techniques should tell us something about the relationship between human behavior and the
material culture preserved in the archeological record. Thus, the first step in analyzing manufacturing techniques is to understand the pottery manufacturing sequence.

The Pottery Manufacturing Process

The starting point for any vessel is the raw clay. Once the raw material has been acquired and processed, there are three basic stages in the construction of a vessel: primary forming, secondary forming, and surface modification. At each stage, techniques that often leave detectable attributes on the clay surface are used in a particular sequence. By necessity, some procedures must have occurred before others, thus enabling us to reconstruct the process (Rye 1981:62). Reconstructing the process or processes used by potters constitutes an analysis of the technological style(s) that inform pottery making, providing a basis for discovering the ways in which culturally structured knowledge and performances influenced ceramic production.

During the procurement and processing of the raw material, the potter makes a series of decisions. He/she must decide: (i) which clay is the most appropriate and where to gather it, (ii) how to prepare it, and (iii) how to process it. In other words, the potter decides what clay source is to be used and then he/she manipulates the clay into a workable state.

The study of forming techniques is “the study of the manner in which pressure was applied to the clay” (Rye 1981:58). During primary forming, the workable clay is gradually converted into a rough form resembling the finished vessel and includes such primary forming techniques as coiling, drawing, pinching, and throwing (Rye 1981:66-83).
Secondary forming techniques and surface modifications supplement the basic manufacture of the vessel. During secondary forming, the rough vessel is defined and shaped. During, between, and/or after the primary and secondary forming stages, the vessel may be partially dried, rewet, and subjected to a variety of surface modifications. Secondary forming techniques (such as beating, scraping, or trimming) may alter both the dimensions of the vessel and the surface characteristics, while surface modifications are performed after the vessel has attained its final shape and affect only the surface (Rice 1987: 136-138).

There are two general categories of surface modification: surface finishing and surface enhancement. Surface finishing produces a more regular surface and includes such techniques as smoothing, burnishing, and polishing. It can be the final treatment before the vessel is fired, or it can be a prelude to additional enhancement. The surface enhancement of a vessel is embellishment beyond forming and surface finishing. It can include one or more techniques that either displace or penetrate the surface (such as incising, stamping, or punctating) or are added to the surface (such as slips, glazes, or appliques). Although differentiated analytically, this in no way implies an unambiguous distinction between surface finishing techniques and surface enhancement, as both may be part of the decorative quality of the vessel and both are often interrelated (Rice 1987: 144-152).

Once the vessel has been formed and its surfaces finished and enhanced, the vessel must be carefully dried and fired in order to irreversibly transform the plastic clay into a rigid vessel (cf. Arnold 1985; Shepard 1976).
Thus, the pottery making process involves a set of intentionally structured choices or decisions that occur in some nonrandom order that follows from the nature of the pottery making process itself. These decisions or choices are based on the potter’s technological knowledge. The potter’s technological knowledge, in turn, is very likely to be influenced by the community’s culturally accepted modes or standards of manufacturing vessels and, by implication, functional, environmental, and/or aesthetic considerations that may be idiosyncratic or cultural.

Identifying Attributes and Process Sequences

Because upper Texas coast potters were active agents in the manufacturing of pots, they made specific technical choices at each stage in the manufacturing process, choices that determined the formal and material properties (i.e., attributes) of their pots (cf. Schiffer and Skibo 1987:599). These attributes remain part of the physical structure of the pot and can often be associated with certain process sequences (Rye 1981). For example, the decisions made involving the choice of clay and temper occur during the procurement and processing stage of pottery manufacture. Therefore, paste attributes are most closely associated with the early stage of the process sequence(s) of ceramic manufacture. Similarly, other attributes are most closely associated with other stages of the process sequence(s) of ceramic manufacture. Clearly, however, some decisions in any given process sequence may not be preserved at all or may not be preserved in the form of unambiguously identifiable attributes. For example, it will always be impossible to tell whether a potter added raw materials to water or water to raw materials to produce a paste. Furthermore, a later stage of the process sequence may obscure or obliterate evidence of previous stages because pottery making is a sequential process
within which it is relatively easy for a potter to negate an earlier choice by changing his/her mind at a later stage of production. Thus, even though the ceramic analyst has access only to those attributes that survive the specific process sequence(s) used by a potter, classifying upper Texas coast pottery on the basis of surviving attributes enables us to closely approximate and discern the net results of the decisions made at each stage of the process sequences associated with each pot. By identifying the surviving attributes that reflect the net results of the decisions made in the process sequences for a number of pots, the ceramic analyst can determine which (if any) process sequences recur through time and/or space. This, in turn, provides a basis for determining whether some process sequences are idiosyncratic or cultural and, ultimately, for determining how the intermediate technology of pottery manufacture is integrated with the end-state technology of pottery use. Thus, classifying upper Texas coast pottery on the basis of one or more surviving attributes enables us to closely approximate and describe the net results of each stage of the process sequences associated with each pot, thereby allowing us to identify the mutually exclusive attributes that occur most frequently in each sequence. With this in mind, the following discussion looks at the inadequacies of the present classification scheme for studying ceramic technology and presents a set of definitions for the range and combinations of attributes used to manufacture upper Texas coast pottery.

The Procurement and Processing of Raw Material
The geologic formations in the upper Texas coast area consist of overlapping fluvial and deltaic deposits of Quaternary age. The deposits nearest the coastline belong to the Beaumont Formation which is composed of clays (60%), overlain by pockets of silt (20%) and sand (20%). Moving inland, these deposits are unconformably underlaid by the Montgomery (Lissie) Formation which is composed of thick beds of sand (60%)
containing lenses of gravel (10%) interbedded by clay (10%) and silt (20%) (Aten 1983a:104-195; Sellards et al. 1932:791). Clay minerals in the region are of the smectite (montmorillonite) group. They are expanding and swelling clays in that they have weak bonding layers that allow excessive amounts of water to intrude between the layers and expand the mineral structure (cf. Gertjejansen and Shenkel 1983:39; Shepard 1976:337). Due to this excessive shrinkage, the problems associated with using pure smectitic clays (i.e., cracking, warping) can be lessened by the addition of non-plastic inclusions. Given the overlapping nature of the mineral deposits in the upper Texas coast area, it is highly likely that the non-plastic sand inclusions found in most ceramics are naturally occurring inclusions. As Rice (1987:409) points out, “behaviorally, this is ‘untempered’ clay, but technically and functionally the inclusions modify its properties.”

To date, analysis of upper Texas coast pottery has emphasized differences in paste. Although the chronological analysis of upper Texas coast ceramics has been greatly facilitated by Aten’s paste-based typology, the current classification scheme does not enable us to discriminate the full range of paste attributes present on upper Texas coast ceramics. There are also a number of problems associated with the identification of some upper Texas coast types that are differentiated by sand-tempered and sandy pastes. Using Aten’s typological criteria, the identification of Tchefuncte-like ceramics has been relatively easy (Aten et al. 1976; Dillehay 1975; Winchell and Ellis 1991). The clay-tempered (Ambler 1967, 1970; Aten 1967, 1983a:210,213; Aten and Bollich 1969:243-247) and bone-tempered ceramics (Ambler 1970; Aten 1967, 1971, 1983a; Ellis and Ellis 1989; Tunnell and Ambler 1967) are also easily distinguished. However, there are some problems associated with the criteria used to classify bone-and-clay-tempered ceramics, as well as some degree of ambiguity with regard to the identification of ceramics with mineral inclusions.
During his analysis, Aten found two bone-and-clay-tempered sherds in his sample of more than 15,000 sherds. Although Aten’s focus on paste as the primary classification criterion would imply that bone-and-clay-tempered sherds should be classified as a distinct type, Aten (for unstated reasons) chose to lump these ceramics with the bone-tempered ceramics (Aten 1983a). His treatment of the bone-and-clay-tempered sherds is odd given that the two Goose Creek Stamped sherds and the single Tchefuncte Stamped sherd he found are given typological status in his seriation. In terms of Aten’s chronology, lumping these two paste types slightly inflates the frequency of bone-tempering in the Old River Period. In terms of its ability to adequately address technological issues, lumping these two paste types obscures the presence of another distinctive tempering agent that should serve as the basis for a distinctive typological category within Aten’s specified criteria. Consequently, combining these two paste categories not only hampers our ability to discriminate the full range of paste attributes that may be present on upper Texas coast ceramics, it also makes it more difficult to determine any regional or temporal variations which may be associated with bone-and-clay-tempered sherds.

A review of the literature does, in fact, indicate that bone-and-clay-tempered sherds have been reported elsewhere in the region, both inside and outside the area from which Aten’s seriation was constructed. For example, within the area from which the seriation was drawn, five bone-and-clay-tempered sherds have been recovered from two sites (41CH103 and 41CH109) in the Wallisville Reservoir area (Ambler 1970:18). North of the area included in Aten’s seriation, bone-and-clay-tempered sherds have been recovered from site 41HR301 on White Oak Bayou (Fields 1988:113), site 41HR616 on West Lake Houston (Ellis and Ellis 1989), and site 41MQ6 in the San Jacinto River Basin (Shafer 1968:49). In fact, at site 41HR616, bone-and-clay-tempered sherds (n=6)
slightly outnumber bone-tempered sherds (n=5). While the occurrence of bone-and-clay-tempered sherds appears to be even less frequent than bone-tempered sherds, any regional or temporal variation that may be associated with bone-and-clay-tempered sherds can not be adequately addressed until our classification schemes recognize and identify sherds with this distinctive paste attribute.

Sorting ceramics with mineral inclusions has also been difficult. For Aten, differences in grain size, frequency, and continuity are the basic sorting criteria, and they can be identified only through the examination of freshly broken sections with a binocular microscope at low power (10x to 20x; Aten 1983a:221). Unfortunately, the criteria Aten uses to distinguish sand-tempered pastes (i.e., O’Neal types) from sandy pastes (i.e., Goose Creek types) have been problematic. The most conspicuous problem involves the ability to distinguish sand-tempered pastes from pastes with naturally occurring sand inclusions. Aten (1979, 1983a, cf. Rice 1987:411) has given the most definitive account of what he believes is the difference between a sand-tempered paste and a sandy paste, and recent researchers have used his standard definitions as guidelines. Essentially, Aten (1983a:231) defines sand-tempering as “a major discontinuity in size distribution between the clay and sand [that] is unlikely to occur naturally on the upper coast and probably indicates a tempered ware.” The presence of this discontinuity refers to an intentional act by the potter: the addition of sand to an otherwise non-sandy paste. By contrast, Aten (1983a:231) defines an untempered sandy paste as having naturally occurring sand sediments in the clay which are “rarely well sorted; grain sizes grade from the largest present (usually fine grained, but medium or very fine also are common maximum sizes) down to the clay matrix.” This definition implies that the potter intentionally chooses to use clayey raw materials that are naturally sandy. The two definitions are confusing in that the continuity or discontinuity
in any given paste could refer either to a naturally occurring discontinuous clay/sand mixture, or to an intentional combination of poorly sorted sand and pure clay. Given the nature of the clay sediments (i.e., high sand-to-clay ratio) and the stacked depositional pattern in the upper Texas coast region (cf. Aronow 1976a, 1976b; Aten 1983a), such distinctions are highly problematic. Until a more detailed assessment of clay source variability has been done for the area, the continuity/discontinuity problem will persist.

Even with the use of standardized granulometric (particle-size grade) scales, it is often difficult to make clear and consistent distinctions in the uniformity of grain size. Having examined Aten's type collection (Texas Archeological Research Laboratory, The University of Texas at Austin), as well as several thousand sherds from a number of sites throughout the region, I find that distinguishing pastes that are intentionally tempered from those that simply contain temper is a tenuous endeavor at best. For this reason, attempting to distinguish mineral inclusion pastes that are "tempered" from those with "tempering" pastes will necessarily be a difficult task.

This dilemma is not unique to the Upper Texas Coast. Although Aten (1979, 1983a) derives his definition of the O'Neal types directly from Phillips' (1970) classification scheme for the Lower Mississippi Valley, sorting ceramics with mineral inclusion pastes presents similar problems in the Lower Mississippi Valley and its adjacent areas, where the tempered vs. untempered debate has been ongoing (Weaver 1963; Saffer 1979). In addition, it has been difficult to consistently sort tempered ceramics on the basis of grain size (Connaway 1980; Jenkins 1981; Rafferty 1986; Rucker 1974). And, as Dunnell (1971:74,80) points out, if two classes cannot be reliably sorted, they cannot serve as a basis of comparison. The continuity/discontinuity problem aside, the use of standardized granulometric (particle-size grade) definitions can be effective for
determining the size class of non-plastic inclusions in upper Texas coast pottery. Indeed, the use of such scales has become standard practice in recent years. However, it is important to bear in mind that: (i) categories are established on the basis of the predominant grain size, and (ii) that these categories do not describe the specific size distribution of mineral inclusions, but refer instead to the class limits within which most of the mineral inclusions fall. To insure consistency the specific scale being used must be stated (i.e., the Wentworth scale [Wentworth 1922, 1933]). Further, use of a standardized template is recommended in order to maintain reliability (cf. Winchell and Ellis 1991).

With this in mind, this study considers paste attributes as part of the procurement and processing stage of manufacture. Further, it establishes paste categories based on the type of non-plastic inclusions (i.e. sand, clay, and/or bone). For paste with mineral inclusions, paste categories will also be established on the basis of predominant grain size. However, because of the problems associated with the continuity/discontinuity issue, no attempt will be made to differentiate mineral inclusions with regard to an intentional distinction between tempered and untempered pastes.

**Primary Forming**

Once the clay has been manipulated into a workable state, certain decisions are made regarding the basic form of the vessel. It is in this stage of manufacture that the potter produces the overall size and shape of the vessel. Decisions are also made regarding the basic technique used to form the clay body. While there are a number of techniques used to construct pots, common ones are pinching and/or drawing, molding, joining, coiling, and throwing (Rice 1987:124; Rye 1981:66-83). In the upper Texas coast area, a coil-and-scare technique was used. In this technique, rolls or coils of clay were
layered one on top of the other producing a ridged surface. The ridges were then flattened and scraped in order to produce an even surface.

Evidence of primary forming techniques appear in several forms. First, vessels tend to break along coil junctures, revealing edges sheared downward on the exterior side of the sherd and upward on the interior (Ambler 1973; Aten 1967, 1971; Aten et al. 1976; Dillehay 1975; Fields 1988; Hamilton 1988; Winchell and Ellis 1991). Second, given the sandy texture of most upper Texas coast pottery, scraping often left visible grooves or striations that were never fully obliterated during surface finishing. Many of these grooves have varying orientations (Dillehay 1975; O’Brien 1974; Winchell and Ellis 1991). Third, there are irregular or random variations in sherd thicknesses caused by the scraping process (cf. Rye 1981:67).

Few whole pots have been recovered in the area and many of the nearly complete vessels are held in private collections (Marshall Black, personal communication cited in Howard 1989). As a result, most of what is known of vessel form is based on reconstructed vessel sections and rim and base profiles (see Figure 7.2 for an example). Based on the available information, upper Texas coast vessels had predominantly simple, unrestricted or somewhat restricted orifices with spherical or ovoid shaped outlines (Aten 1971, 1983a; Winchell and Ellis 1991:94-95; cf. Rice 1987:215-222, 241). They have been variously described as “cylindrical to conical without any constriction of the vessel wall” (Ambler 1973); “simple contoured, deep-sided pots” (Winchell and Ellis 1991:95); “jars” (Ambler 1967: Figure 14; Fields 1988: Figures 35 and 36; O’Brien 1974: Figure 13; Wheat 1953: Plate 31), or “bowls” (Ambler 1967: Figure 14; Fields 1988: Figure 35 and 36; O’Brien 1974: Figure 13; Wheat 1953: Plate 31).
Rim form varies. However, most upper Texas coast vessels can be classified as having rim forms that fall into one of three general categories: “flared” (Ambler 1973: Figure 16; Winchell and Ellis 1991: Figures 28-36; O’Brien 1974: Figure 15), “direct” (Aten 1973: Figure 5; Winchell and Ellis 1991: Figures 28-36), or “in-curving” (Ambler 1967: Figure 15; Howard 1989: Figure 58f; Winchell and Ellis 1991: Figures 28-36).

Bases are most commonly described as “rounded” (Ambler 1967: Figure 15; 1973; Aten 1971: Figure 6; O’Brien 1974: Figure 14; Winchell and Ellis 1991: Figure 37) or “conical” (Ambler 1967: Figure 15; Aten 1971: Figure 6; Fields 1988: Figure 39; Winchell and Ellis 1991: Figure 37). However, “noded” (Ambler 1967: Figure 15; Aten 1971: Figure 6; Aten et al. 1976: Figure 5) and “flat” (Ambler 1973; Wheat 1953: Figure 21; Winchell and Ellis 1991: Figure 37) bases also occur.

Most studies of upper Texas coast ceramics provide descriptive information, and only a few studies have attempted to deal with vessel form in more than a cursory manner. One study done by Howard (1989) calculates maximum diameter to height ratios in order to discern overall vessel size. Another study by Winchell and Ellis (1991) examines rim orientations in order to discern overall vessel configuration. In an analysis of seven vessels recovered from three sites in Harris County and two sites in Polk County, the orifice diameter of each vessel was compared to its height (Howard 1989:338-340). The calculated diameter/height ratios ranged from 0.71 to 2.83, with ratios falling into three discernible groups. The first group consisted of three vessels with diameter/height ratios of less than 1.0 that under current classificatory criteria (Rice 1987:215-217) could be categorized as jars. That is, the height exceeds the maximum diameter. Two of these vessels were sufficiently complete to obtain volume
estimates of approximately 2.975 liters each. The second group consisted of three vessels with diameter/height ratios between 1.0 and 2.0. Because their height was less than one-third of their maximum diameter these vessels have been classified as bowls. The remaining vessel had a diameter/height ratio of 2.83. While this vessel is technically a bowl, its height is not much greater than one-third its diameter placing it much closer to a dish than the other three vessels also classified as bowls.

In an additional study, Howard (1989:341-343) correlated orifice diameter, rim orientation, decoration, and thickness attributes for 68 vessel sections. The correlation produced two mutually exclusive groups of vessels. Group 1 consisted of nine vessels with diameters of less than 20 cm, inverted rims, decoration, and mean body thicknesses of less than 5 mm. Group 2 consisted of five undecorated vessels with orifice diameters greater than 25 cm, everted rims, and mean body thicknesses of 5 mm. The remaining 45 vessels occupy an intermediate position between the two groups and contain several unique forms such as a small, inverted bowl (Howard 1989: Figure 58f), an open bowl or dish (Howard 1989: Figure 58e), and an everted flat bottomed vessel (Howard 1989: Figure 58d). She also notes (Howard 1989:342) that several of the “45 vessels in the intermediate group would fall into Group 1 except for the lack of decoration.” The results lead Howard (1989: 342) to surmise that the attributes “served to define two end-points on a continuum of vessel form, thickness, and decoration. Thus, these pots may not have been designed to serve particular functions but instead represent a generalized ceramic assemblage which served a variety of purposes.”

Howard’s conclusion stands somewhat in contrast to that arrived at in the study of 237 rim sherds recovered from site 41HR273 (Winchell and Ellis 1991). Although no whole vessels were recovered, Winchell and Ellis (1991:94- 95, Figures 40 and 41) measured
rim angles and rim diameters in an attempt to discern vessel configuration. Rim angles varied from 60° to 125°, with a mean rim angle of 91.0° plus or minus 13.03°. Measurements indicated that 61.6% (n=146) of the vessels at 41HR273 had vertical sides (80°-100°). Another 21.6% (n=51) had slightly out-curving or everted walls (125°-105°), while 16.8% (n=39) had slightly in-curving or inverted walls (75°-60°). Rim diameters ranged from 5 cm to 40 cm, with a mean vessel diameter of 16.07 cm plus or minus 5.4 cm. Measurements indicated that the vast majority of vessels at 41HR273 (80.6%; n=191) had orifice diameters that fell between 10 cm and 22 cm. Another 13.1% (n=31) had orifice diameters that ranged from 23 cm to 40 cm, while 6.3% (n=15) had orifice diameters that ranged from 5 cm to 9 cm.

Using the obtained measurements for each rim, rim angles were plotted against orifice diameters to produce a vessel configuration layout (Winchell and Ellis 1991: Figures 40 and 41). The resulting layout showed that the majority of the vessels at 41HR273 had rim angles between 80°-100° and orifice diameters between 10 cm and 20 cm. This data seems to indicate a rather standardized set of small to medium sized vessels with vertical walls and rounded bases. Given the preponderance of unrestricted, vertical sided pots, this seems to suggest that functionally these vessels may have been designed to (i) accommodate a variety of uses, that is, they were multi-purpose vessels or (ii) to accommodate one overwhelmingly dominant use.

While the above studies reveal interesting information about vessel form, much work remains to be done. Because of the heavy chronological focus of most ceramic research in the area and the lack of ceramic technological studies, research addressing vessel form and, ultimately, function are almost non-existent. These limitations are exacerbated by the paucity of whole pots. Thus, while studies of upper Texas coast
ceramics have described the more common primary forming attributes, research that adequately addresses the attributes of size and shape are severely lacking.

As can be seen, the attributes that establish the basic form and size of the vessel are acquired in the primary forming stage of manufacture. As a result, this study will consider size, shape, and thickness attributes to be part of the primary forming stage of manufacture. It will also note the presence of attributes, such as exterior and interior scraping marks, that indicate vessel construction techniques.

**Surface Finishing**

As noted earlier, techniques that affect the surface characteristics of a vessel can be carried out during all stages of pottery manufacture. For analytical purposes, these techniques can be “divided into those which are auxiliary to the basic construction, carried out on wet pliable clay, and those which figure in the finishing of dry vessels” (Reina and Hill 1978:22).

Auxiliary construction techniques, because they are performed on wet pliable clay, can be considered an additional stage in the manufacture of the vessel and, therefore, part of the secondary forming stage. One such technique used frequently in the upper Texas coast area was surface “floating” (Aten 1983a; Ellis and Ellis 1989; Hamilton 1988; O’Brien 1974; Wheat 1953; Winchell and Ellis 1991). Floating is a process in which the surface of the vessel is smoothed or wiped with a soft, pliant tool or the potter’s wet hand while the clay is still wet and pliable (cf. Reina and Hill 1978; Rice 1987; Shepard 1976). This process redistributes the clay particles, with finer clay particles being “floated” to the surface, thereby creating a thin film or coat of clay (cf. Shepard 1976). Also referred to as a mechanical slip (Wheat 1953) or a self slip (cf. Rice 1987), this
film is most often the same color as the clay used in the manufacture of the vessel. However, on some upper Texas coast ceramics a red pigment was mixed with water and, hence, with the wet clay during the floating process, producing a floated red surface. Both types of floated surfaces penetrate the clay surface and can be distinguished by their crazed or cracked appearance.

Supplementary techniques used in the finishing of dry or leather-hard vessels can be considered part of the surface modification stage. In the upper Texas coast area these techniques included two distinctive surface finishing procedures: dry-smoothing and burnishing. The more common procedure was dry-smoothing, a process in which a smooth object was wiped across the surface of the partially dried or leather-hard vessel, causing a plastic flow on the surface of the clay. This procedure produced a compacted surface that exhibits a matte finish that is smooth to the touch.

The next most common procedure was burnishing. As with smoothing, a hard, smooth object was rubbed across the surface of the vessel, compacting and reorienting the clay particles. In this case, there is sometimes a surface luster but always the presence of distinctive parallel linear facets (cf. Shepard 1976:186-193). The high shrink-swell ratio of the locally available clays (Sellards et al. 1932) and the variability in firing temperatures (Aten 1983a; Black 1988; Fields 1988; Winchell and Ellis 1991), may easily explain variations in surface luster, which may have been lost during firing or post-depositional weathering.

Because no prior attempt has been made to analyze the technological style of upper Texas coast ceramics, the surface treatment attributes present on upper Texas coast pottery have been defined indiscriminately. Surfaces have been alternately described as
“smoothed” (Ambler 1973; Dillehay 1975; Ellis and Ellis 1989; Hamilton 1988; Howard 1989; Suhr and Jelks 1962; Winchell and Ellis 1991), “polished” or “burnished” (Dillehay 1975; Howard 1989; Ellis and Ellis 1989; Winchell and Ellis 1991), “eroded” (Howard 1989; Winchell and Ellis 1991), “cracked” or “crazed” (Ambler 1973), and/or “floated” (Aten 1983a; Ellis and Ellis 1989; Fritz 1975; Hamilton 1988; O’Brien 1974; Wheat 1953; Winchell and Ellis 1991). Although these terms often are used interchangeably, only some represent mutually exclusive attributes. Because the current classification scheme conveys no information about the manufacturing process, differentiating those attributes that are mutually exclusive from those that are not is much more difficult. And, with the exception of Ellis and Ellis (1989), Hamilton (1988), and Winchell and Ellis (1991), no concerted effort has been made to develop standardized criteria for discriminating the various surface treatment attributes.

There is, therefore, not only a definitional problem, but a general confusion about the mutual exclusivity of the most common surface treatment attributes. For example, in an analysis of upper Texas coast ceramics from the Peggy Lake Site, Howard (1989:337) has remarked that “as larger sections of vessels are examined, the surface treatments are more varied; several vessels are burnished, smoothed, and eroded, so these categories are not mutually exclusive.” The first problem with this statement involves the association of “eroded” sherds with other surface treatment techniques. Eroded surfaces are not the consequence of a particular manufacturing technique. Rather, the erosion of a sherd’s surface occurs either during use or as the result of post-depositional factors. Consequently, the eroded surface of a sherd/vessel could not, indeed, should not be expected to reflect the original surface treatment techniques used to finish the sherd/vessel, thereby assuring the mutual exclusivity of these categories.
Sherds with eroded surfaces, therefore, should be excluded from analyses of surface treatment in technological style studies.

Second, Howard (1989:326) recognizes only two surface treatment attributes. In her work, "smoothed" apparently denotes a "floated" surface and "burnished" apparently denotes a "smoothed surface polished to a luster." Thus, Howard does not distinguish a surface that was smoothed without floating the finer particles to the surface. Moreover, Howard identifies all of the sherds in her report as being either smoothed or smoothed and burnished. Although Howard claims that these criteria do not constitute mutually exclusive attributes, they are in fact attributes that are acquired at different stages in the manufacturing sequence. The fact that they are acquired at different times guarantees their mutual exclusivity and makes it possible for any combination of them to co-occur. Thus, Howard's approach to class definition does not include clear distinctions between post-depositional attributes and sequentially acquired surface finishing attributes. Nor does it allow for the fact that any different combination of floating and/or burnishing can occur on the same sherd/vessel. Such misjudgments are understandable considering how little research has been done on the manufacturing sequence of upper Texas coast ceramics.

Surface floating has a distinctive place in the manufacturing sequence, as do smoothing and burnishing. All three techniques help establish the basic surface of the vessel by either permeating or compacting the basic surface. This study will regard these techniques as a dimension for classification, and will classify upper Texas coast ceramics according to the constellation of surface attributes that can be acquired at different times during the surface finishing stage. By their nature, these constellations will be mutually exclusive. The attributes that will be identified with respect to this
stage of manufacture are: (i) floating, (ii) floating with the addition of red pigment, (iii) smoothing, (iv) burnishing, (v) burnishing over a surface floated with water, and (vi) burnishing over a surface floated with a mixture of clay and red mineral pigment. Floating with the addition of red pigment could be considered a decorative attribute. However, because we cannot determine whether unpigmented, floated surfaces had aesthetic appeal apart from any functional intention floating may have served, and because the addition of a floated red pigment occurs in the stage that establishes the vessel's basic surface, this attribute will be regarded analytically as part of the vessel's basic surface finish.

Surface Enhancement

As noted earlier, surface enhancement is defined as embellishment of the vessel surface beyond forming and surface finishing. In other words, surface enhancement adds to the detail of the overall surface and can involve additions to (or over) the existing surface finish (e.g., slips, glazes, washes), displacement of the existing surface (e.g., incising, stamping, punctating), or some combination of both. As with surface finishing, the presence of one technique does not necessarily preclude the presence of another (e.g. Rice 1987). For example, consider a vessel the surface of which has been floated. Once the floated surface has dried, incisions are made on the upper body, after which a slip is applied over the incising. As a final step the slip is burnished. Because pottery manufacturing is an additive process, the original floated surface has been concealed and the vessel in its final form is described as having an incised, slipped, and burnished exterior surface. In such a case, we must assume that although the individual attribute(s) that correlate with a specific technique may be concealed or obliterated by another technique(s) used at a later stage, ceramicists, like all archaeologists, must be concerned with the net surviving and, therefore, recognizable attributes (cf. Rye
1981:58). Indeed, the additive nature of the process, including the possibility that the potter might change his/her mind at some point during the process, forces analysts to limit themselves to a conservative description of the minimal set of techniques used on any particular vessel.

Thus, any surface finishing attribute or combination of attributes can be closely intertwined with any surface enhancement attribute or combination of attributes. Their interrelated nature does not, however, prevent each surface enhancement attribute from occupying a distinctive place in the manufacturing sequence, since different enhancement techniques produce distinctive attributes and therefore convey information about the procedures, concepts, or standards representative of the potter’s (and/or the community’s) customary way(s) of decorating or enhancing vessel surfaces. (This will be more clearly illustrated below with regard to the application of red-pigment to vessel surfaces.)

With few exceptions (Ellis and Ellis 1989; Winchell and Ellis 1991), secondary analysis criteria for upper Texas coast ceramics have focused on enhancement (decorative) attributes rather than surface finishing attributes. The most common enhancement technique present on upper Texas coast ceramics consists of sets of horizontally incised lines (Aten 1983a:233). However, techniques such as excising (engraving), punctation, cord-marking, and stamping also appear (Ambler 1967:13-19; Aten et al. 1976:20-21; O’Brien 1974:55; Wheat 1953:189; Winchell and Ellis 1991:76-78). A less common technique is the application of a veneered surface which, from a technological standpoint, can be a considered a variant of a slipped surface (cf. Winchell and Ellis 1991:85-86).
Surface modification techniques such as “red-filming” and “incising” have most often been used as secondary sorting criteria (Aten 1979, 1983a; O'Brien 1974). As with paste criteria, however, the attributes “red-filming” and “incising” have often been defined and applied loosely.

Aten’s typology includes five major Goose Creek types differentiated on the basis of enhancement attributes: Goose Creek Plain, Goose Creek Incised, Goose Creek Stamped, Goose Creek Cord-marked, and Goose Creek Red-Filmed. The type Goose Creek Plain represents the default category (i.e., no decorative attributes are present). Two types, Goose Creek Stamped and Goose Creek Cord-marked, are differentiated on the basis of one distinctive technique that produces one distinctive decorative attribute. Only sandy paste sherds that exhibit stamping are assigned to the Goose Creek Stamped type, and only sandy paste sherds that are cord-marked are assigned to the Goose Creek Cord-marked type. By contrast, sandy paste sherds included in the type Goose Creek Incised and Goose Creek Red-Filmed include a broader range of attributes.

Aten (1983a:233) defines the type Goose Creek Incised as decorated primarily by incision, but “occasionally by excision (or engraving) and punctations.” Therefore, decorated sandy paste sherds that are not red-filmed, stamped, or cord-marked are lumped by default into the broader type Goose Creek Incised, with no attention to other distinctive attributes that may be present. Thus, the Goose Creek Incised name does not discriminate the full range of enhancement attributes that may be present on sherds of this type.
Beyond this, the present classification scheme does not allow discrimination of the stage in the manufacturing sequence at which any decorative technique may have occurred. For example, if a pot is incised while the clay is still wet, the line margins where the clay has been displaced will be elevated and the beds uneven. If the incisions were made after the pot had dried to a leather-hard state, the line margins will be sharp and the beds more even and smooth. It is also possible to tell if the incising was done pre- or post-slip (Rye 1981:90; Rice 1987:145-147). This latter distinction has implications for the type termed Goose Creek Red-Filmed.

The present classification scheme assigns all sandy paste sherds possessing a distinctive red-pigmented surface to the type Goose Creek Red-Filmed. However, the present classification criterion does not discriminate the full range of techniques present on sherds of this type. For example, sherds classified as Goose Creek Red-Filmed may also possess other enhancement attributes such as incising (Ambler 1967; Aten 1967, 1983a), excising or engraving (Ambler 1967; Winchell and Ellis 1991), or cord-marking (Ellis 1992). Therefore, the type Goose-Creek Red-Filmed may include enhancement attributes that could also belong to other major types. Because Aten’s classification scheme provides no distinctive categories for co-occurring attributes, the full range of attributes included in the Goose Creek Red-filmed type is obscured. By its definition, therefore, the analyst is forced to argue for the precedence of one attribute (e.g., red-filming) over another (e.g., incising, excising; cf. Dunnell 1971). Regardless of which way the argument goes, technological information is lost in the classification.

In addition, the existing classification scheme classifies Goose Creek Red-filmed sherds on the basis of their sandy texture and the presence of a fugitive red-film or wash. Aten (1983a:236) notes that “this film easily can be worn or washed off the sherd.”
However, examination of sherds from site 41HR616 indicates the use of at least two distinctive techniques involving red mineral pigments. One of these techniques, by definition, occurs during the surface finishing stage and penetrates the basic surface of the vessel (the interior and/or exterior surface of the vessel was floated with a mixture of water and a red mineral pigment). However, the second technique occurs during the surface enhancement stage and is applied over the basic surface of the vessel (a red mineral pigment was washed over the interior and/or exterior surface of the vessel while the clay was still somewhat plastic, “fixing” the color to the surface). Corroboration of this second technique exists in the form of a cord-marked sherd recovered from 41HR616 in which the red wash fills the displaced lines rather than cutting into the red surface of the sherd (Ellis 1992).

Evidence also supports the use of a third technique involving red mineral pigment. Ambler (1967:38), in his description of pottery recovered from Cedar Bayou, notes that one partial vessel was “covered with a thin layer of hematite, applied after the incising and after the vessel was fired (the ochre partially fills the incising, and vessel body shows firing clouds partially covered by the ochre).” Sherds reflecting post-firing washes were not recovered from 41HR616.

As pointed out earlier, surface enhancement and surface finishing techniques are often interrelated. However, for analytical purposes, this report will make a distinction between the red-pigmented surfaces that penetrate the basic surface of the vessel (e.g., red-floated) and those that are added to or applied over the vessel’s finished surface (e.g., red wash). The possibility of this distinction is lost in classifications that apply the traditional “red-filmed” rubric.
A less common technique used in the embellishment of upper Texas coast pottery was the application of a veneered surface. It appears that the surface of the vessel was either smoothed or lightly floated. After the vessel had dried to the leather-hard stage, a thick slurry of finer clay was plastered over the clay underbody, producing a stucco-like veneer. In most cases, the veneered surface was burnished, and in some cases, incised or engraved (cf. Winchell and Ellis 1991: Figures 32 and 34). Differences in clay density between the clay veneer and the clay body underneath often cause a shrinkage differential between the two surfaces, resulting in a poor bond. When viewed in profile, there is often a distinctive raised boundary between the veneered surface and the surface of the vessel. As a result, the veneered surface exfoliates readily and can easily be flaked off or separated from its clay undersurface. Veneering technically could be considered a variant of a slipped surface. However, it differs from a slip in that a slip, being relatively watery, penetrates the surface pores of the clay body, whereas a veneer merely sits atop the surface. The difference probably results from failure of the relatively viscous mixture to penetrate a surface that has already dried substantially prior to application of the veneer.

Clearly, surface enhancement has a distinctive place in the manufacturing sequence, as does each individual enhancement technique. This study will classify upper Texas coast ceramics according to the mutually exclusive constellation of enhancement attributes present on each sherd. The attributes identified with respect to this stage of manufacture are: (i) those that displace the surface: incised, stamped, fingernail punctated, brushed, and cord-marked; and (ii) those that are applied or added to the surface: veneer or wash.
Firing Attributes

Upon completing the vessel, the potter must transform it into a sturdy, useable product. To do this, at the very least, the remaining water must be removed. First, the vessel must be carefully dried in order to control shrinkage and cracking. Second, it must be fired in order to irreversibly transform the plastic clay into a rigid vessel (Arnold 1985; Shepard 1976).

Drying time and firing success are affected by a number of factors. Climatic conditions, the size and shape of the vessel, and the amount and size of non-plastic inclusions in the paste are some of the more important (Arnold 1985). For example, although low temperatures and high relative humidity increase drying time, these factors would be offset somewhat by large amounts of non-plastic inclusions in the paste. However, firing success will be reduced in an overly humid climate or during rainy weather (cf. Arnold 1985). In a marine climate, such as that found along the Upper Texas Coast, climatic conditions would have significantly increased drying time and made it more difficult to control open-air firing temperatures.

Experiments attempting to replicate the firing of upper Texas coast pottery have been conducted by Black (1988), Fields (1988), and Winchell and Ellis (1991). Data from these studies indicate that upper Texas coast pottery was fired in an open, uncontrolled atmosphere with firing temperatures ranging from as low as 500°C to as high as 885°C. Color is also an indicator of the variability in firing temperature. Sherd/vessel surfaces are usually mottled and cores are variegated (Ambler 1973; Aten 1971; Dillehay 1975; O'Brien 1974; Winchell and Ellis 1991). Fire clouds are also quite common (Ambler 1967; Aten 1971; Fields 1988; Winchell and Ellis 1991). Although several researchers have attempted to use surface color as a classification criteria on upper Texas coast
pottery (Ambler 1970, 1973; Dillehay 1975), color attributes are questionable sorting
criteria given the fact that color variations can be the result of variables other than firing
(e.g., sediment source, impurities in the clay; cf. Rice 1987:333; Shepard 1976:103-106). Variability in surface color also results from post-depositional factors (Rye

Surface color variability can also result from use. However, this factor is less
problematic in that upper Texas coast area vessels rarely exhibit the characteristic
accumulation of exterior sooting normally associated with cooking vessels (cf. Hally
1983). The presence of fired clay balls at many sites in the area (Ambler 1967, 1973;
Fields 1988; Winchell and Ellis 1991) suggests that if the Indians in this area were using
vessels for cooking they must have used a modified version of the “stone boiling”
method of cooking (O’Brien 1974:66-67; Patterson 1976:183) or some other method
that involved the indirect application of heat.

These problems notwithstanding, there is one color attribute that may provide
information about at least one of the technical choices associated with the firing of
upper Texas coast vessels. Sherds recovered from several sites in the region bear
Smudging results from an extreme reducing atmosphere wherein carbon is deposited on
the surface and in the pores of the vessel producing a dark gray to black finish (Shepard
1976:88-90). These characteristic blackened surfaces are the result of specific firing
techniques and differ from the blackened surfaces that result from using clays with large
quantities of organic material.
For clays with significant amounts of organic matter, heating of the organic materials moves the carbon to the surface of the clay where it is burned off in the form of CO$_2$ gas. However, under open-air firing conditions, temperatures and/or air flow may not be sufficient to completely oxidize the carbon. As a result, both the core and the surface of the sherd/vessel are characterized by their distinctive black color (Rice 1987:334). By contrast, smudged surfaces appear to result from the deposition rather than the elimination of carbonaceous material and are usually distinguishable in sherd cross section by their blackened color at or just below the surface that stands in contrast to their lighter colored core. These distinctive surfaces can be the consequence of several techniques. For example, the polished blackwares created by the potters of Santa Clara result from a particular firing technique. When the fire has reached its maximum heat, it is smothered with a layer of fine organic material (e.g., manure or sawdust) that effectively closes off the supply of oxygen and deposits carbon on the surface and in the pores of pots (LeFree 1975:63-65). This process normally produces a pot with smudging on both the exterior and interior surfaces.

In the upper Texas coast area, smudging generally occurs only on the interior surface of the pot, indicating a somewhat different technique than that described above. For example, as Hamilton (1988:85) notes in his discussion of the ceramics recovered from two sites in Brazoria County, the interior smudging, the overlapping of the smudging onto the external rim surface, the cores with reduced zones along the inner surface, and an oxidized zone in a double band effect along the outer surface suggest that the pots were fired mouth down. Further, Hamilton (1988:85) suggests that the presence of smudging only on the interior surface may result from the packing of organic matter inside the vessel prior to firing. If this was the case and the vessel was fired mouth down, carbon would have been deposited on the interior surface as the organic material
burned off. However, as the smoke built up and escaped, the flames could have oxidized the carbon before it could have been deposited on the exterior surface of the vessel. This would account for those instances where the smudging overlapped onto the external rim.

While upper Texas coast ceramics with smudged surfaces appear to be rare, this may be due to a lack of documentation rather than their rarity in general. Although ceramics with smudged surfaces have been identified in assemblages recovered from sites in Brazoria County (Hamilton 1988), Fort Bend County (Ellis 1991), and Harris County (Ellis 1992; Fields et al. 1983), there is no way to adequately assess how common this firing technique may have been throughout the region. For example, ceramics with dark gray to black surfaces have been recovered from a number of sites in the region (Ambler 1973; Aten 1967, 1971; Dillehay 1975; O'Brien 1974; Winchell and Ellis 1991). However, these reports make no distinction between blackened surfaces that are due to the presence of organic material in the clay and those that evince smudging. Given the questionable sorting criteria associated with surface color and the lack of research involving attributes of technological style, it is not surprising that most researchers have not recognized these distinctive surfaces or their potential for telling us something about the firing practices associated with upper Texas coast ceramics. Because of this potential, this study considers smudging to be a distinctive technological attribute that is acquired during the firing stage of pottery manufacturing.

Beyond this, only general comments are made regarding color attributes. Although drying and firing represent important stages in the manufacturing sequence, this study is primarily concerned with the attributes acquired during the forming stages. Therefore, the only color attributes differentiated on the basis of Munsell Color Chart (Kollmorgen
Corporation 1975) numbers are those exhibiting a red-floated surface. Other sherds are described in terms of general coloration only and will be categorized as either oxidized (lighter colors such as those in the tan, orange, light brown, to red range) or unoxidized (dark colors such as dark browns, grays, or blacks; cf. Shepard 1976:103-106).

Post-Firing Attributes

Sherds often exhibit some type of post-firing modification. This modification may be deliberate. For example, holes were often drilled adjacent to cracks in the vessel wall in an attempt to repair the vessel, or, broken sherds may be reused for some secondary purpose, such as scraping and flattening the coil junctures during the primary forming stage of vessel manufacture. Post-firing modification may also be the result of post-depositional factors, as in the case of eroded sherds. Modification can also be some combination of both deliberate modification and/or post-depositional factors. For example, a sherd may be burned on the exterior, indicating that it may have once been part of a cooking vessel, or, it could be charred through indicating that when the vessel broke, pieces of it fell into the fire.

Upper Texas coast sherds also exhibit the use of asphaltum. Although vessels/sherds with asphaltum coatings are common along the Central Texas coast (Suhrm and Jelks 1962; Campbell 1962), asphaltum appears less frequently on upper Texas coast pottery (O'Brien 1974; Gilmore 1974; Winchell and Ellis 1991). Asphaltum was used to bind the cracks in upper Texas coast vessels (O'Brien 1974; Winchell and Ellis 1991) and to coat the interior and/or exterior surface. Sherds with patches of asphaltum have also been found. Although the use of asphaltum appears to be deliberate, O'Brien (1974:52-53) suggests that the asphaltum may also be a residue from the boiling of tar in an effort to remove impurities.
A less common post-firing modification is the application of a post-firing wash of red mineral pigment (described earlier). Although sherds exhibiting this attribute do not occur at 41HR616, evidence from at least one other site in the region suggests that this technique was also used (Ambler 1967). For purposes of this study, the presence or absence of post-firing modifications will be noted and described. However, any attempt to assign functional explanations to these descriptive categories is outside the scope of this report given its exploratory focus.
Application of the Technological Perspective

The ceramics recovered from 41HR616 were examined with respect to the manufacturing techniques employed by Upper Texas potters. Both the variety and frequency of techniques are discussed and the attributes associated with each technique are isolated. Techniques are grouped according to the sequence in which they were acquired and are summarized in Table 7.1. Given this, the following discussion starts with the first step in the pottery manufacturing process and logically progresses through each stage in the process.

The Sample of Ceramics

The sample of ceramics from 41HR616 totaled 1812 sherds, consisting of 1644 sherds recovered from excavations during Fall 1989, and 168 sherds recovered from testing during December 1988.

Sorting Procedures

The initial sorting procedure involved two levels of analysis. First, each sherd was examined in an effort to find all sherds that could be joined together. Second, if sherds could be joined it was noted whether the joined edges represented a “fresh break” (i.e., those broken during excavation) or an “old break” (i.e., those broken prior to excavation). “Fitters” were glued together with conservation adhesive and treated as single sherds for purposes of analysis. Treating fitters as single sherds served three purposes. First, it permitted a more accurate estimate of the minimum and maximum number of vessels at the site, and second, it helped to avoid skewing the analysis toward attributes over-represented by multiple fragments of a single vessel. Third,
distinguishing sherds with fresh breaks from old breaks provided information concerning site formation processes and the movement of artifacts over the course of time (cf. Burgh 1959; Skibo et al. 1989; Sullivan 1989).

With these purposes in mind, the sherds from each excavated area were examined in four stages. First, the sherds within each field sack were examined in order to identify sherds that fit together. Once the fitters within each field sack were identified, the second sorting procedure involved examination of sherds across vertical levels within each unit. Third, sherds from different units were examined across horizontally adjacent levels. Fourth, sherds were examined across units. When all fitters within each excavated area had been identified, sherds were examined across areas. The nature of the break (i.e., fresh or old) was recorded for all sherds that could be fitted with mates. A total of 356 sherds (20% of the recovered sherds) were cross-mended, reducing the sample size to 1456 sherds.

After fitters were identified, all undecorated body sherds with a maximum dimension of less than 3/8 inch were culled. Each “sherdlet” was counted and recorded by provenance. Although sherdlets were too small to analyze in detail, the surface of each was examined with the aid of a binocular microscope in an attempt to determine the presence of distinctive surface characteristics. Size-grading eliminated 40% of the recovered sherds (n=730), leaving a total of 726 sherds in the analyzed sample.

**Discussion of Fitters**

During the processing of recovered ceramics, 356 sherds were fitted with mates. Of these, 60% (n=214) had fresh breaks that occurred during excavation or processing, 13% (n=45) had old breaks that occurred prior to excavation, and 18% (n=65) were
comprised of some combination of fresh and old breaks. No inferences could be made with regard to the remaining 9% (n=32) of the sherds.

Fitting sherds, along with the identification of distinctive paste and/or surface characteristics, enabled a crude estimate of the minimum number of vessels present at the site. The presence of 87 (post-fit) rim sherds possessing distinctive paste and/or surface characteristics and two bone-tempered body sherds evincing distinctive surface treatments indicates that, at a minimum, 89 different vessels were represented in the analyzed sample. Analyzing the vertical and horizontal distribution of fitted sherds provides an indication of the degree of displacement that may have occurred following initial deposition (cf. Beals et al. 1945; Burgh 1959; Skibo et al. 1989; Smith, W. 1971; Sullivan 1989). Table 7.2 presents the total number of fitted sherds in each excavated area.

Of the 356 sherds paired with mates, 110 sherds were classified as having old breaks or some combination of fresh and old breaks. Of those, 65 sherds were paired with sherds from the same block, unit, and level. Thirteen sherds were paired with sherds from the same unit but from different levels within 10 cm vertically. Twenty-eight sherds were paired with sherds from adjacent units that were found within 2 cm to 17 cm vertically.

Only two sherds were paired with sherds from non-adjacent units at different levels. Four fitted sherds (old breaks) from Block A, Unit 5, 94 centimeters below surface (CMBS) were paired with a sherd from Block A, Unit 21, 100 CMBS. In addition, two fitted sherds (old breaks) from Block A, Unit 3, 146 CMBS were paired with a sherd from Block A, Unit 24, 123 CMBS.
Only two matchings occurred between blocks. Three fitted sherds (old breaks) from Block F, Unit 53, 120 CMBS were paired with two fitted sherds (old breaks) from Block E, Unit 51, 130 CMBS. In addition, one sherd from Block C, 60 CMBS was paired with one sherd from the test trench. Given that Blocks C and F and the test trench (Figure 1.2) are located on a downward slope toward Lake Houston, the displacement of artifacts from these excavated blocks is probably due to washing. With the exception of the two matchings between areas and the two matchings across non-adjacent units in Block A, cross-mending of sherds indicates only minimal displacement of sherds after initial deposition. Given the downward slope of the site, in general, and the sandy nature of the soil, a certain amount of movement is not surprising. However, the observed occurrence of cross-mended sherds argues against any significant vertical mixing unless one is willing to argue that the rate of downward migration was constant across the site.

Discussion of Sherdlets

With the aid of a binocular microscope, the surface of each sherdlet was examined for distinctive surface characteristics. Of the 730 sherdlets removed from the analysis, 97% exhibited eroded or ambiguous surface characteristics. However, enough of the surface remained on 21 sherdlets (3%) to be able to identify the presence of four distinctive surface attributes. A total of 11 sherds had remnants of an asphaltum coating on the interior and/or exterior surface of the sherd. Three sherds had a red-floated exterior and/or interior surface, and one sherd had remnants of a red-wash on both the exterior and interior surface. Five sherds had blackened interior surfaces and one sherd was burned on both the interior and exterior surface.
Several factors could account for the large number of sherdlets. First, the friable nature of the ceramics, coupled with the sandy nature of the soil and the climatic conditions, lends itself to rapid deterioration. As a result, once freshly broken edges were exposed they would quickly begin to erode. Second, trampling by both the prehistoric inhabitants, as well as excavation personnel, was probably a significant factor. This is supported by the large number of fresh breaks on fitters (60% of the cross-mended sherds were fresh breaks). It is further supported by the fact that a sizeable number of the examined sherdlets also appear to have fresh breaks.

**Technological Attributes at 41HR616**

**I. Procurement and Processing Attributes Present at 41HR616**

During the procurement and processing stage, the potter decides which clay is the most appropriate, where to gather it, and how to prepare and convert it into a workable state. In other words, raw materials are combined to form a paste which is then used to shape pots, with the raw materials being the input and the paste being the output (van der Leeuw 1984b:57). Paste attributes are, therefore, the primary attributes of technological style.

Paste attributes were based on the type (i.e., clay, sand, bone, etc.) and predominant size of non-plastic inclusions. The paste categories established for this study are based on a consideration of those employed by Aten 1967, 1983a; Aten and Bollich 1969; Ambler 1970, 1973; and Tunnell and Ambler 1967. The author has examined Aten’s type collection at the Texas Archaeological Research Laboratory, University of Texas at Austin, to cross-check paste categories with those described by Aten (1983a).
A fresh break along the edge of each sherd was examined under 10x-20x microscopic magnification. During examination, the breaks were compared against a grain-size scale (cf. Shafer 1968). The scale was made by adhering size-graded mineral fraction samples to a cardboard backing. The size-grades used for this analysis were based on the Wentworth scale and include the following fractions:

(1) Silt (0.004-0.063 mm)
(2) Very fine sand (0.063-0.125 mm)
(3) Fine sand (0.125-0.25 mm)
(4) Medium sand (0.25-0.5 mm)
(5) Coarse sand (0.5-1.0 mm)
(6) Very coarse sand (1.0-2.0 mm)

Comparison of breaks with the grain-size scale enabled a determination of the predominant grain size present in the paste. Each of the sherds recovered from 41HR616 was assigned to a paste category according to: (i) type of non-plastic inclusions and (ii) predominant size of non-plastic inclusions.

A. Sandy Paste Categories

Of the 726 sherds analyzed, 92% (n = 668) were classified as having a sandy paste. Based on the average size of the non-plastic inclusions, the following paste categories were determined.

Very Fine Sandy Paste: “Very fine sandy” denotes a paste in which the predominant grain size is 0.063-0.125 mm; there are either no larger non-plastic inclusions or so few
that their presence is regarded as a random occurrence; and there are sufficient smaller mineral particles to suggest a continuous range of inclusions from silt through very fine sand. Of the 668 sandy paste sherds in the sample, 54 (7% of the sample) were classified as having a very fine sandy paste.

Fine Sandy Paste: “Fine sandy” denotes a paste in which the predominant grain size is 0.125-0.25 mm; there are either no larger non-plastic inclusions or so few that their presence is regarded as a random occurrence; and there are sufficient smaller mineral particles to suggest a continuous range of inclusions from silt through fine sand. Of the 726 sherds analyzed, 268 sherds (37% of the sample) were classified as having a fine sandy paste.

Medium Sandy Paste: “Medium sandy” denotes a paste in which the predominant grain size is 0.25-0.5 mm; there are either no larger non-plastic inclusions or so few that their presence is regarded as a random occurrence; and there are sufficient smaller mineral particles to suggest a continuous range of inclusions from silt through medium sand. The largest percentage of sherds (48%, n = 344) in the sample were classified as having a medium sandy paste.

As noted earlier, sandy paste categories identified at 41HR616 do not distinguish between tempered and untempered pastes. Under Aten’s classification scheme, the sandy paste sherds recovered from 41HR616 typologically approximate the type Goose Creek and most analysts would probably classify them as such because there is no identifiable discontinuity in the size distribution of inclusions. No sherds with predominantly coarse or very coarse sand inclusions were found. Had such sherds been found, it is likely that most analysts would regard them as O’Neal ceramics under the
traditional typology if for no other reason than there is no defined untempered type with coarse or very coarse sand inclusions.

B. Tempered Paste Categories

Of the 726 sherds in the sample, 8% \( (n = 57) \) were classified as having tempered pastes. Based on the type and size of non-plastic inclusions, the following paste categories were defined.

Clay-Tempered: “Clay-tempered” (or “grog-tempered) denotes a paste that includes detectable amounts of clay (grog) embedded in a silty-to-medium-sandy clay matrix. Clay temper may be visible on the interior or exterior surfaces of the sherd. Of the tempered sherds, the largest percentage (6%, \( n = 46 \)) had clay temper: 14 had clay temper embedded in a silty clay matrix and 32 had clay temper embedded in a very fine to medium grained sandy paste.

Bone-Tempered: “Bone-tempered” denotes a paste that includes easily detectable amounts of bone embedded in a silty-to-very-fine-sandy clay matrix. The bone may be visible on the interior or exterior surfaces of the sherd. Only 1% of the recovered sherds \( (n = 5) \) contained bone temper: three had bone temper embedded in a silty clay paste and two had bone temper embedded in a very fine sandy paste.

Bone-and-Clay-Tempered: “Bone-and-clay-tempered” denotes a paste that includes detectable amounts of both bone and clay embedded in a sandy clay matrix. One or both tempering agents may be visible on the interior or exterior surfaces of the sherd. Of the 726 sherds, only 1% \( (n = 6) \) were tempered with a combination of bone and clay. All six sherds had bone-and-clay temper embedded in a very fine sandy paste.
II. Primary Forming Attributes Present at 41HR616

During the primary forming stage certain decisions were made regarding the basic form and size of the vessel. On pottery recovered from 41HR616, these decisions are reflected in the following attributes.

A. Sherd Class: The analyzed sample of sherds recovered from 41HR616 were grouped into gross morphological categories consisting of 87 rim sherds (12% of the sample), 627 body sherds (86.3% of the sample), and 12 basal sherds (1.7% of the sample).

B. Exterior Scraping Marks: On upper Texas coast pottery, striations on the exterior and/or interior surface of the vessel can be most closely associated with the primary forming stage. When vessels are formed by coiling, the coils are flattened and scraped in order to produce an even surface. Given the sandy texture of upper Texas coast pastes, scraping often left linear scars or ridges that were never fully obliterated during the surface finishing stage (O’Brien 1974, cf. Rice 1987:137). A total of 43 sherds (6% of the sample) evinced linear scars or scraping marks on the exterior surface. These marks tended to be unidirectional and were oriented either vertically or horizontally on the surface.

C. Interior Scraping Marks: A higher percentage of the sherds recovered from 41HR616 had interior scraping marks. A total of 101 sherds (14% of the sample) evinced scraping marks on the interior surfaces. Unlike most of the exterior scraping marks, these marks are often randomly oriented on the surface.
D. Base Characteristics: Of the 12 basal sherds recovered from 41HR616, the largest number \((n = 5, 41.6\%)\) were rounded (Figure 7.1, A). Three of the rounded flat bases exhibit distinctive interior scraping marks that are randomly oriented on the surface. One base was rounded flat, one base was conical shaped (Figure 7.1, B), and the remaining five were too fragmentary to accurately determine their shape.

E. Diameter: The maximum diameter of the vessel includes that portion of the vessel with the greatest enclosed volume, while the orifice diameter is the measurement of the mouth opening. If the orifice diameter is equal to or greater than the maximum diameter, then the vessel is described as having an unrestricted orifice. If, however, the orifice diameter is less than the maximum diameter, the vessel is described as having a restricted orifice. Thus, these are attributes that were determined as the vessel was formed.

Measurements, where possible, were estimated by sliding the body sherd or rim along a standard diameter-measurement template. For body sherds, diameters were estimated only on large sherds or for reconstructed sherd sections. Rim sherds were horizontally aligned and set flush against the template. Diameters were measured along the outer edge of the rim. No diameter measurements were taken on basal sherds.

Of the 628 body sherds in the sample, only 26 sherds (4\% of the sample) were large enough to confidently estimate diameters. Diameters ranged from 8 cm to 46 cm, with the smallest diameter reading being taken from the reconstructed vessel section of a small bowl.
Of the 87 rim sherds recovered, 30 (35%) were either too small or too fragmented to obtain orifice diameters. The remaining 57 rim sherds (65%) represented vessels whose orifices ranged from 8 cm to 37 cm in diameter. Among the measurable rims, the mean vessel diameter was estimated at 20.1 cm ± 6.6 cm. One rim sherd with a diameter of 30 cm appears to belong to an imported vessel (a Caddo-like sherd). Because this sherd was considered anomalous, it was not included in the mean diameter calculation. Interestingly, the smallest diameter reading (8 cm) belongs to a small red-filmed vessel with a relatively rare cord-impressed design.

**F. Rim Profile:** The rim is the margin of the vessel orifice. This margin is distinctive only when it is set off by some change in contour or thickness. When the wall of the vessel is carried to the rim without a break in contour or a change in thickness, the rim is said to be “direct” (Shepard 1976:245). When the rim is set off from the wall of the vessel by a curve or an angle, the rim is described as articulated. Where this change exists, the rim is said to either be expanding or contracting (i.e. thinned).

The shape of the rim in profile was noted for each rim sherd recovered at 41HR616. The largest percentage (70%; n = 61) of rim sherds were thinned in profile (Figure 7.1, C, D). Twenty-one rims (24% of the sample) were classified as direct (Figure 7.1, E, F), while one sherd had an expanding-contracting rim (Figure 7.1, G). This relatively unusual rim profile appears to belong to an imported vessel (a Caddo-like sherd that resembles the type Holly Fine Engraved). The profile shape of the rim was indeterminate on 5% (n = 4) of the rim sherds.

**G. Rim Form:** The form of the rim is distinguished by the change in orientation between the wall or the neck of the vessel and lip. An articulated rim is set off by a
curve or an angle while a direct rim has no change in orientation (Rice 1987:214). Rim form was observable on only 60 (69%) of the rim sherds recovered from 41HR616. Of those, two primary forms predominant. Forty-six rims were straight, while 14 were slightly out-flaring. The Caddo-like sherd (Figure 7.1, G) had an out-flaring rim. The remaining 27 rims (31%) were too fragmentary to accurately assess the form.

**H. Rim Angle:** The rim angle is the actual curvature of the rim as measured in degrees. In order to accurately define the angle, the rim must be set flush against a flat, horizontal surface (such as a small piece of board). This requires that the uppermost edge of the rim be aligned so that at least three points, the two ends and the mid portion, are in contact with the board (cf. Rice 1987:222-223). Once the rim is properly aligned, the board is tilted and the rim angle is measured using a template that illustrates angles (cf. Rice 1987:223).

Of the 87 rims recovered, 37 (43%) were either too small or too fragmented to obtain rim angles. Measurements obtained from the remaining 50 rim sherds indicate that the vessels used at 41HR616 had simple contours, with relatively unrestricted orifices. The mean rim orientation was $89.5^\circ \pm 9.09^\circ$. Forty-three (86%) of the vessels had vertical sides ($80^\circ$-$100^\circ$). Four vessels (8%) had slightly in-curving walls ($70^\circ$-$75^\circ$), while two vessels (4%) had slightly out-curving walls ($105^\circ$-$110^\circ$). Although one vessel had a wall orientation of $130^\circ$, this rim sherd appears to belong to an imported vessel (the Caddo-like sherd; Figure 7.1, G). Because this sherd was considered anomalous, it was not included in the calculation of mean rim orientation.

**I. Lip Profile:** The lip of the rim is the edge or margin of the rim bordering the mouth of the vessel. The shape of the lip varies depending on the position of the thumb and the
fingers. If finished entirely by hand, the lip edge will be rounded, tapered, or rounded flat. A flattened lip edge is distinguishable from other forms because it results from the use of a straight-edged tool rather than manipulation by the fingers alone (Shepard 1976:247). In profile, the largest percentage (39%, n = 34) of the rim sherds recovered from 41HR616 exhibited lip edges that were tapered rounded, 5% (n = 4) were rounded, and 6% (n = 5) exhibited lip edges that were rounded flat. Twenty-four rims (28%) had lip edges that were interior rounded and five rims (6%) had lips that were exterior rounded. Ten rims (12%) had lip edges that were flattened. One rim (1%) had an interior beveled lip, the Caddo-like rim sherd (1%) had an exterior beveled lip, and three rims (3%) were too fragmented to assess the shape of the lip.

In summary, the majority of vessels represented at site 41HR616 had simple shapes and embodied two basic forms: deep-sided globular jars and deep, wide-mouthed bowls. They were vertical sided and typically had straight rims that were thinned in profile. For example, Figure 7.1 (U) illustrates a vessel section that probably represents a deep, wide-mouthed bowl. This vessel measured 25 cm in diameter and had a rim orientation of 90°. Figure 7.2 illustrates a large rim section that probably represents a deep-sided jar. This vessel had a rim diameter of 20 cm and an approximate rim orientation of 85°. However, this sherd was difficult to measure in that one side is slightly warped.

There also appear to be at least two small jars represented in the assemblage. One was a cord-marked vessel (Figure 7.1, H) with a rim diameter of 8 cm and a rim orientation of 85°. The second small jar is corroborated by a reconstructed lower body section having a diameter of 8 cm. This vessel was extremely thin, measuring only 4 mm in thickness.
Four vessels with slightly incurring (inverted) walls had rim diameters greater than the mean, ranging from 20 to 26 cm. Of the two vessels with slightly everted walls, one had a rim diameter of 11 cm, while the other had a rim diameter of 28 cm. The majority of vessels were vertical sided jars or bowls, with rim diameters that ranged from 8 to 32 cm.

*J. Thickness:* The thickness of the vessel wall was determined as the vessel was formed and its coils obliterated. For body and basal sherds the average thickness was determined by taking measurements from a minimum of four sides. For rim sherds, average thickness was calculated from measurements taken along the edge opposite the rim edge (Table 7.3).

**III. Surface Finishing Attributes Present at 41HR616**

During the surface finishing stage, the basic surface of the vessel is established. Six basic surface finishing techniques were used in the finishing the exterior and interior surfaces of upper Texas coast pottery. The first set of techniques (auxiliary construction techniques) used to establish the basic overall surface of upper Texas coast pottery were performed while the clay surface was still wet. The second set of techniques (supplementary techniques) were used in the finishing of dry or leather-hard vessels.

**A. Auxiliary Construction Techniques**

*Floated with Water:* After initial forming, the surface of the vessel was worked while still wet. A moistened smooth object, such as the potter’s hand, was repeatedly wet and lightly wiped over the surface of the vessel, resulting in a redistribution of clay particles. In effect, the finer clay particles were “floated” to the surface creating a thin film or coat of clay (Shepard 1976; Rice 1987). In some cases, the floated surface is quite
thick, and gives the appearance of a self-slip (cf. Rice 1987). Surfaces are often crazed or cracked from differential shrinkage between the floated surface and the underlying paste. Floated surfaces weather more easily, and it is possible that sherds classified as having indeterminate or eroded surfaces once had floated surfaces (cf. Wheat 1953).

Of the 726 sherds analyzed, the largest percentage had floated exterior and interior surfaces. A total of 439 sherds (61% of the sample) had floated exterior surfaces and 453 sherds (63% of the sample) had floated interior surfaces.

_Floated with a Mixture of Red Mineral Pigment and Water:_ The surface of the vessel was initially floated. While still wet, a mixture of red mineral pigment and water was rubbed into the surface of the vessel, resulting in a floated red surface. On some sherds, this surface is more like a thin red-film, while on others it is quite thick, giving the appearance of a red slip. Coloration (Table 7.4) varies from a dark reddish brown (5YR 4/4) to a bright red (10R 4/6) on the Munsell Color Chart (Kollmorgen Corporation 1975). A total of 34 sherds (5% of the sample) evinced a floated red surface. Of that number, fifteen sherds had red-flated exterior surfaces, eleven sherds had red-flated interior surfaces, and eight sherds had red-flated interior and exterior surfaces.

**B. Supplementary Techniques**

_Unflated, Dry-Smoothed:_ After initial forming and smoothing, the surface of the vessel was allowed to partially dry. Pressure was applied to the surface, resulting in a compaction of the clay particles. Unlike the process of floating that levitates the finer clay particles to the surface, dry smoothing compresses the clay particles. Dry smoothing with a hard tool produces a uniform surface with a matte finish that is smooth to the touch (Shepard 1976; Rice 1987; Rye 1981). There are, however, none
of parallel linear facets that characterize burnishing. Of the 726 sherds analyzed, 8.8% 
(n = 64) had dry-smoothed exterior surfaces, and 9.2% (n = 67) had dry-smoothed interior surfaces.

Unfloated, Burnished: After the surface of the vessel was initially formed and smoothly, it was allowed to dry to the leather-hard stage. A hard, smooth object (such as a pebble or a piece of gourd) was rubbed across the surface of the vessel, compacting and reorienting the clay particles. While this process often produces a surface luster, there is always the presence of distinctive parallel linear facets (Shepard 1976:186-193). On upper Texas coast pottery, surface luster could easily have been lost during firing given the high shrink-swell ratio of the locally available clays and the variability in firing temperatures (Aten 1983a; Black 1988; Fields 1988; Winchell and Ellis 1991).

Ethnographic evidence indicates that vessels are often burnished in stages: (i) initial burnishing with one hard tool and (ii) a finer burnishing with a different hard tool (Dietler and Herbich 1989). If surface luster on upper Texas coast pottery is a function of the nature of the clay sources and the firing procedures, then it is quite possible that dry-smoothing represents a cursory attempt at burnishing.

Of the 726 sherds in the sample, only 1% (n = 10) had burnished exterior surfaces and less than 1% (n = 5) had burnished interior surfaces.

Burnished Over a Surface Floated with Water: The surface of the vessel was initially floated. Once the vessel had dried to the leather-hard stage, a hard, smooth object was rubbed across the floated surface, resulting in a compaction and reorientation of the
clay particles. As noted above, this surface luster could easily have been lost during firing. In this sample, 57 sherds (8%) had been burnished over a floated exterior surface and 25 (3%) had been burnished over a floated interior surface.

_Burnished Over a Surface Floated with a Mixture of Red Mineral Pigment and Water:_ While still wet, a mixture of red mineral pigment and water was rubbed into the surface of the vessel, resulting in a floated red surface. Once the vessel had dried to the leather-hard stage, a hard, smooth object was rubbed across the floated surface, resulting in a compaction and reorientation of the clay particles. Seven sherds (1% of the sample) were burnished over a red-floated exterior surface and one sherd was burnished over a red-floated interior surface.

**IV. Surface Enhancement Attributes Present at 41HR616**

Surface enhancement, defined as embellishment beyond forming and finishing, adds to the overall detail of the vessel. Exterior and interior surface enhancement attributes are defined on the basis of the presence or absence of any enhancement technique on the exterior and interior surface of the sherd, including lip decoration on rim sherds. On upper Texas coast ceramics, enhancement techniques can be differentiated in two ways: (i) The enhancements were either cut into or displaced the clay surface or (ii) they were added to or applied over the clay surface. Only 7% \((n = 51)\) of the sherds recovered from 41HR616 evidenced enhanced exterior surfaces. Of the 51 sherds that were decorated, 23 were rim sherds and 28 were body sherds. Only one sherd had a decorated interior surface. Five distinctive techniques were noted.

_A. Displacement of the Surface While the Paste Is Still Wet:_ While the clay surface was still wet, patterns were cut or impressed into the surface. Because the clay was still wet,
the line margins have a distinctive appearance. Incising on a wet paste leaves a clean line. However, where the clay was displaced, the line margins are elevated and the beds uneven. Of the 726 sherds analyzed, 2% ($n = 14$) had patterns cut into the surface of the sherd while the clay was still wet (Figure 7.1, K, Q).

B. Displacement of the Surface After the Paste Has Dried to the Leather-Hard Stage:
If incisions or impressions were made in the clay after the pot had dried to a leather-hard state, the line margins are sharp and the beds even and smooth. Of the decorated sherds recovered from 41HR616, 4% ($n = 28$) had patterns cut into the surface after the surface had dried to the leather-hard stage. Of those, fifteen were rim sherds and thirteen were body sherds.

C. Displacement of the Surface After the Paste Has Dried Completely: Patterns were cut into the surface after the pot had dried. This technique, most often referred to as excising or engraving, leaves a more uneven line and there is noticeable chipping at the margins of the line. The only sherd with an engraved exterior surface (Figure 7.1, G) is one that resembles the Caddoan type Holly Fine Engraved (Harry Shafer, personal communication, 1989).

D. Application of a Veneer: The surface of the vessel was smoothed or lightly floated. Once the floated surface had dried, a thick paste of liquified clay (the same as that used in the basic construction of the vessel) was plastered over the floated surface (Winchell and Ellis 1991:85). From a technological standpoint, a veneered surface can be a considered a variant of a slipped surface (Rice 1987). As with the floated surface, the finished surface is often crazed or cracked from differential shrinkage between the floated surface and the underlying paste. Unlike the floated surface, there is a distinctive
boundary between the smoothed clay underbody and the veneered surface and plate-like sections of the veneer can easily be flaked off. Of the 726 sherds analyzed, one sherd had a veneered interior surface, nine sherds had veneered exterior surfaces, and one sherd had both a veneered interior and exterior surface.

*E. Application of a Red Wash:* The surface of the vessel was first floated. After the vessel had dried completely, a mixture of red mineral pigment and water was washed over the surface, leaving a spotty red covering that can easily be worn or flaked off. As a result, these surfaces are often difficult to see without the aid of a binocular microscope. Six sherds had traces of a red wash on the exterior surface and three sherds had traces of a red wash on both the interior and exterior surface.

*F. Enhancement Motif:* The combination and configuration of design elements on the exterior and/or interior of the vessel was noted. By far the largest percentage of decorated sherds (5%) were comprised of straight, horizontal lines. However, vertical and diagonal line motifs were also present, as well as, sherds with several distinctive design motifs. One rim sherd has three horizontal-banded cord-marked designs (Figure 7.1, H). Three sherds, resembling the Caddoan type Broaddus Brushed, have brushed exterior surfaces. The curvature of the sherds indicates that the brushing was vertically oriented on the vessel(s) (Figure 7.1, I). One rim sherd (Figure 7.1, G), resembling the Caddoan type Holly Fine Engraved, has vertical lines that descend from just below the lip to intersect angular lines. The intersecting lines appear to form two opposing fields of decoration separated by vertical lines. One sherd has two crescent-shaped lines resembling the rocker-stamp design motif. Three sherds have pendant triangle motifs. One rim sherd has two fine horizontal bands with the remnants of three short lines that appear to be a pendant triangle suspended from the lower band. One rim sherd has nine
horizontal lines with pendant triangles suspended from the bottom line. Pairs of vertical lines were also cut across the horizontal lines in two places (Figure 7.1, J). One body sherd has the remnants of a pendant triangle design, and the sherd was broken along what appears to have been the suspension line. Of the remaining sherds, fourteen have straight, horizontal lines (Figure 7.1, E, L, O, P) and one has both wavy and straight horizontal lines. Seven sherds have one or more vertical lines cut into the surface, six sherds have diagonal lines cut into the surface (Figure 7.1, K), and four sherds have some combination of horizontal, vertical, and/or diagonal lines (Figure 7.1, M, Q). Three sherds exhibit distinctive patterns produced by some combination of opposing diagonal lines: one sherd has a chevron shaped design (Figure 7.1, N) and two sherds have cross-hatching designs.

**G. Lip Decoration:** The presence or absence of decoration on the edge of the lip was noted for all rim sherds. Of the 87 rim sherds recovered from 41HR616, 20% \( (n = 17) \) had some type of decoration on the lip. Seven sherds had tick-marks along the top edge of the lip and two sherds had tick-marks along the interior edge of the lip. One sherd had an incised line drawn along the top edge of the lip, bisected by tick-marks apart. One sherd had a crenelated lip (Figure 7.1, F) and one sherd had a crenelated lip with tick-marks.

**V. Firing Attributes Present at 41HR616**

Although color is the consequence of several variables (e.g., size, distribution, and amount of impurities, presence of organic material) some of the most important are the time, temperature, and atmosphere of the original firing (Rice 1987:333). However, due to the large number of factors affecting sherd color and the defined scope of this study, Munsell Color Chart (Kollmorgen Corporation 1975) comparisons were made on only a select group of sherds. For all other sherds in the sample, the general coloration was
recorded and then categorized as being either oxidized or unoxidized. Light colors indicate greater oxidation (i.e., greater free oxygen), less organic matter initially present in the clay, and/or a more constant firing temperature. Dark colors indicate incomplete oxidation; this could result from less free oxygen in the atmosphere or a shorter firing period and/or a lower firing temperature (cf. Rice 1987:323, 343; Shepard 1976:103-106). Four color attributes were recorded for each sherd in the sample: the presence of smudging, exterior color, interior color, and paste color.

A. Smudging: As defined by Shepard (1976:216-220), smudging results when pottery is fired in a reducing atmosphere that causes carbon to be deposited on the surface. Of the 726 sherds analyzed, 5% (n = 33) had smudged interior surfaces.

B. Exterior Color: For exterior vessel surfaces, the only color attributes differentiated on the basis of Munsell Color Chart (Kollmorgen Corporation 1975) numbers were those exhibiting a red-floated exterior and/or interior surface (n = 23). Of the remaining sherds in the sample, 47% (n = 331) had light, oxidized exterior surfaces and 53% (n = 372) had dark, unoxidized surfaces.

C. Interior Color: For interior vessel surfaces, the only color attributes differentiated on the basis of Munsell Color Chart (Kollmorgen Corporation 1975) numbers were those exhibiting a red-floated surface (n = 18) (Table 7.4). Of the remaining sherds in the sample, 43% (n = 303) had light, oxidized interior surfaces and 57% (n = 405) had dark, unoxidized interior surfaces. Sherds exhibiting smudged interior surfaces make up only a small percentage of the sherds with dark, unoxidized surfaces.
D. Paste Color: Of the 726 sherds analyzed, 38% (n = 276) had light, oxidized paste colors and 62% (n = 450) had dark, unoxidized paste colors.

VI. Post-Firing Modifications Present at 41HR616

The presence or absence of any post-firing modification was noted and described for each sherd in the sample. Six post-firing attributes were recorded.

A. Asphaltum: Although asphaltum coatings are uncommon on upper Texas coast sherds, two sherds recovered from 41HR616 had exterior surfaces that were lightly coated with asphaltum and 25 sherds (3% of the sample) had asphaltum coated interior surfaces. Ten sherds had patches of asphaltum on the exterior and/or interior surfaces.

B. Drill Holes: Four sherds had drill holes (Figure 7.1, R).

C. Abrasion: Three sherds had abraded edges.

D. Notches: Twenty-three sherds (3% of the sample) evinced notching on one or more sides (Figure 7.1, S, T).

E. Burned: Thirteen sherds (2% of the sample) were burned on the exterior and/or interior surfaces.

F. Eroded Surfaces: Of the 726 sherds analyzed, 18% (n = 134) had eroded exterior surfaces and 22% (n = 157) had eroded interior surfaces.
Analysis of Selected Attributes

During the examination of the 41HR616 ceramics, several interesting, intuitive patterns emerged. These patterns imply that it may be possible to identify the preference structure that guided ceramic manufacturing decisions. If it is possible to identify such a structure, then it is possible to identify at least one cultural element that relates to the manufacture and, by extension, use of ceramics by the occupants of 41HR616. Here, it is important to keep in mind that manufacturing a vessel involves a series of decisions. Simply put, the potter must decide what paste to use, how to finish the surfaces of the vessel, and whether or not to further enhance or decorate the vessel. His/her decisions may be based on the community’s culturally accepted modes or standards of manufacturing vessels and, by implication, on functional, environmental, and/or aesthetic considerations. These culturally-based considerations, to the extent that they influence the manufacturing process, should lead to patterned production in systemic context. Given that a wide array of production choices can be made at any given stage in the manufacturing sequence, patterned production in systemic context could appear in several forms: (i) the consistent selection of a wide array of techniques for any given stage of ceramic manufacture with little or no patterning of choices from stage-to-stage; (ii) the consistent selection of a wide array of techniques for any given stage of ceramic manufacture with relatively highly patterned choices from stage-to-stage; (iii) the consistent selection of relatively few techniques for any given stage of ceramic manufacture with little or no patterning of choices from stage-to-stage; and (iv) the consistent selection of relatively few techniques for any given stage of ceramic manufacture with relatively highly patterned stage-to-stage choices. Thus, by determining which combinations of attributes recur, we can tell whether the individual
choices and/or sequences of choices recur, and we can determine the nature of the preference structure that influenced pottery production, including determining whether production is governed by a preference structure at all.

Although identifying a preference does not identify the reason why the potter chose a particular technique, the net outcome of the choice is, in fact, a particular paste, surface, or decorative attribute. Therefore, for the purposes of this study, identifying a "preference" is identifying a particular outcome at a particular stage in the manufacturing process. The main premise is based on the assumption that a nonrandomly high frequency of specific techniques implies a preference for those techniques.

Definition of Analytical Levels

In order to incorporate diachronic variables into the analysis, several considerations were deemed important. First, it is important to be able to stratigraphically place attributes within an appropriate context. As such, only sherds recovered from the six stratified blocks (A through F) were included in the detailed analysis of selected attributes ($n = 639$).

Second, at 41HR616, there are some cases where excavation levels do not appear to conform to apparent natural surfaces. Given this lack of natural levels and the ground slope, this author chose to use centimeters below surface (CMBS) readings rather than level designations. Therefore, this analysis will use samples constructed on the basis of CMBS readings taken from the bottom elevations of an excavation level.
Third, given the lack of a detailed chronometric profile for the site and clearly identifiable natural levels in the stratigraphy, the grouping of artifacts for analysis is necessarily arbitrary. Therefore, it is desirable to have sample sizes large enough to provide a reasonable chance of containing sherds with relatively rare attributes or combinations of attributes. By comparison, in Aten’s (1983a:282) seriation, levels were grouped by excavation levels in order to “enhance sample sizes for each seriated unit,” with the median sample size in Aten’s Galveston Bay Area seriation being identified as 92 sherds. Thus, one factor in determining sample size was to obtain samples at least as large as Aten’s median. This should maintain comparability of results between this study and Aten’s, as well as maintaining sample sizes at 41HR616 that are large enough to enable statistically valid comparisons.

The fourth consideration was to obtain samples of approximately equal size. Since the analysis attempts to isolate several different clusters of attributes for individual discussion, the smallest of these, basic interior surface treatment, was identified. It was determined by trial and error that this group could be divided into four groups larger than Aten’s median but not into five groups larger than Aten’s median. This necessarily assures that other individual clusters will be analyzed in groups at least as large. However, as it turns out, they are all approximately equal to each other. The net result is that the same provenances will be maintained throughout the analysis although there will be slight variations in the number of sherds discussed with respect to each provenance. Based on these considerations, four analytical levels were defined:

Analytical Level 1 (AL1): 0-92 CMBS;
Analytical Level 2 (AL2): 93-111 CMBS;
Analytical Level 3 (AL3): 112-129 CMBS; and
Analytical Level 4 (AL4): 130 >CMBS.

Lithic evidence tends to support the grouping of these analytical levels. In the analysis of the lithic assemblage at 41HR616, Ensor (1992) notes a distinct technological break in the lithic technology between excavation levels 9 and 10. According to Ensor (1992:45), "this break seems to represent a fundamental shift in reduction technology between Early Ceramic and Late Ceramic occupations." This shift is characterized: (i) by a shift from a dart point manufacturing technology during the Early Ceramic period (e.g., Gary and Kent) to an arrow point manufacturing technology during the Late Ceramic period (e.g., Clifton, Perdiz, and Catahoula), and (ii) by an extremely high frequency during the Early Ceramic period of initial reduction artifacts, including cores and initial stage bifaces, with a shift to a higher frequency during the Late Ceramic period of secondary and reworked artifacts. Converting Ensor's level 9 coordinates to CMBS readings, it was found that the average CMBS reading for Level 9 was approximately 92 CMBS. In addition, the occurrence of bone-tempered sherds (normally associated with the Late Ceramic period) is confined to the upper 90 centimeters of the site and the presence of three Caddo sherds at 75, 76, and 80 CMBS is consistent with a florescence of Caddo ceramics in the Late Ceramic period (Aten 1983a). Thus, both lithic and ceramic evidence tends to support the chronological association of AL1 with the Late Ceramic period. In the absence of a very detailed chronometric profile for the site, it is not possible to make any finer chronological distinctions than this.

Lithic evidence also supports the AL4 grouping. Based on a fairly dramatic decrease in formal tools/implements (e.g., dart point preforms, initial stage unifaces, bifaces, use modified flakes) in Level 13 and below, Ensor (1992:47) suggests that the earliest
levels represent an Early Ceramic component. A large majority of the CMBS readings in Ensor’s Level 13 fell below 130 CMBS. In addition, one cord-impressed sherd (normally associated with the early half of the Early Ceramic period) occurs at 135 CMBS. Thus, both the lithic and ceramic data place AL4 in the Early Ceramic period (A.D. 100-800), with no finer distinctions possible in the absence of a detailed chronometric profile.

Ensor’s analysis of the lithics recovered from 41HR616 indicates that there were no significant technological changes in lithic technology between levels 13 through 9. Based on the presence of a relatively homogeneous lithic technology and the lack of distinctive ceramic evidence, no clear temporal distinction could be drawn with regard to the excavation levels comprising AL2 and AL3. Coupling diagnostic artifacts with quantified ceramic cross-dating for the levels comprising AL2 and AL3 (Ellis and Ellis, this volume) does little more than place them sometime before the middle Round Lake period (i.e., before ca. A.D. 1200). This is consistent with the Late Ceramic period assessment for AL1 and the Early Ceramic period assessment for AL4. Thus, the arbitrary procedure used to define AL2 and AL3 defines analytical provenances that at least do not conflict with the artifactual evidence. In the absence of detailed chronometric data, there is no basis for determining whether any arbitrary subdivision of the excavation levels comprising AL2 and AL3 is more or less appropriate than any other subdivision. In any event, the gross nature of the analytical levels reflects general time spans that are consistent with the exploratory nature of this study.
Analysis of Attributes

We will begin our exploratory analysis by focusing on several basic attributes of technological style. Using binomial hypothesis testing, we will attempt to discern which attributes of technological style are culturally preferred in each of three specific stages of the manufacturing sequence. Beginning with the procurement and processing stage of pottery manufacture, we will look first at paste preferences. Next we will examine the attributes of technological style associated with basic exterior surface treatment and basic interior surface treatment. Finally, we will examine several surface enhancement techniques.

Paste Preferences

As the literature review amply demonstrates, paste has been the primary focus of most upper Texas coast ceramic analyses. Therefore, the question naturally arises: Did potters frequenting this site randomly choose the type of paste used in the construction of pots or did they prefer particular pastes? Based on the numbers of sherds recovered from the stratified units at 41HR616 (Table 7.5), the obvious intuition is that they preferred sandy pastes.

The first step toward confirming or rejecting this intuition is to determine whether the distribution of pastes reflects any demonstrable preference. If there are no demonstrable preferences, then the distribution of pastes should be random. Thus, the intuition that some pastes were preferred over others implies the test hypothesis that the distribution of pastes is nonrandom. This test hypothesis, in turn, implies the null hypothesis that paste distribution is random. We may test the null hypothesis with a two-tailed binomial distribution test at a 0.05 level of significance. If the null hypothesis is true, the number
of sherds in each paste category should fall within the expected range of a binomial
distribution predicted by

\[ p(\text{medium sandy}) = p(\text{fine sandy}) = p(\text{very fine sandy}) = p(\text{clay}) = p(\text{bone-}
\text{and-clay}) = p(\text{bone}) = 0.1666. \]

If the test hypothesis is true, then the number of sherds for at least one of the six paste
categories should fall outside the expected range. The BINOM program (Carlson n.d.a)
was used to test the above hypothesis and all of the binomial hypotheses that follow
below. Calculations are summarized in Table 7.6.

Table 7.6 shows that the null hypothesis can be rejected both for the site as a whole and
in each analytical level, indicating that the distribution of pastes is unlikely to be the
result of a random selection process. This is because the number of sherds in one or
more paste categories is either too high or too low to reflect a random outcome. This
result implies that the most frequently chosen paste in each provenance is the preferred
paste. Medium sandy pastes are preferred at the site level and in AL1, AL2, and AL3;
fine sandy paste is preferred in AL4.

There may be differences in preference among the less frequently chosen pastes. If so,
then the distribution among the five remaining paste categories should be nonrandom.
Table 7.6 shows that there is an apparent second-rank preference both at the site level
and in each analytical level. Among the remaining pastes, fine sandy pastes are
preferred in AL1, AL2, and AL3, and medium sandy pastes are preferred in AL4.
This procedure can be carried further in order to determine whether there are additional preference distinctions. Table 7.6 indicates that at the site level and in AL3 and AL4 there is an apparent third-rank preference for very fine sandy paste, with a fourth-rank preference for clay-tempered paste. In AL1, there is an apparent third-rank preference for clay-tempered paste, with a fourth-rank preference for very fine sandy paste. In AL2, very fine sandy paste and clay-tempered paste appear to be equally preferred as a third-rank choice. Bone-tempered paste is preferred over bone-and-clay-tempered paste at the site level and in AL1.

Thus, at the site level there is an apparent first-rank preference for medium sandy pastes; a second-rank preference for fine sandy pastes; a third-rank preference for very fine sandy pastes; a fourth-rank preference for clay-tempered paste; and a fifth-rank preference for bone-tempered paste. Bone-and-clay-tempered paste appears to be the least preferred. However, this apparent preference structure does not hold in its entirety if we look at the site diachronically. The first-rank preference for medium sandy pastes and the second-rank preference for fine sandy pastes in AL1, AL2, and AL3 is reversed in AL4, with fine sandy pastes in the first rank and medium sandy pastes in the second rank. Although clay-tempered pastes are the third-rank preference in AL1, very fine sandy pastes are the third-rank preference in AL3 and AL4, and clay-tempered pastes and very fine sandy pastes appear to be equally preferred at the third rank in AL2. Bone-tempered pastes are preferred over bone-and-clay-tempered pastes as a fifth-rank preference in AL1. Bone- and bone-and-clay-tempered pastes are equally unpreferred in all other analytical levels, there being no sixth-rank preference. Although bone-tempered and bone- and-clay-tempered pastes appear only in AL1, they are tied in a fifth-rank preference in AL2-AL4 by virtue of their non-occurrence. Their non-
occurrence in AL2-AL4 may be a function of their rarity in general or it may reflect the fact that these tempers were not part of the cultural repertoire.

Thus far, the discussion has emphasized the apparent preference structure. If the above preferences are supportable, then there ought to be discernible differences between the first- and second-rank preferences, the second- and third-rank preferences, and so on. That is, the number of sherds in the first-rank preference ought to be greater than the number expected in a sample that includes only the first- and second-rank preferences. This implies the null hypothesis that in any pair of preference ranks, the larger number is less than or equal to the number expected. Thus, a series of pairwise tests will confirm or disconfirm the apparent preference ranking if it is valid.

Table 7.7 lists each paste in order of decreasing frequency for the site as a whole and for each analytical level. In each column the most frequently occurring paste was paired with the second most frequently occurring paste. This pair was treated as a series of $N$ trials where

\[ N = n(\text{most frequent}) + n(\text{second most frequent}), \]

and

\[ p(\text{most frequent}) = p(\text{second most frequent}) = 0.5. \]

Binomial distributions were calculated for a one-tailed hypothesis test that the number of sherds with the most frequent paste is less than or equal to the number expected at a significance level of 0.05. If the number is not less than or equal to the number
expected, then the most frequent paste is preferred over the second most frequent paste. If the number is less than or equal to the number expected, then the most frequent paste is not preferred. Superscripts were assigned to each member of the pair according to whether or not there is a preference. Thus, the most frequent paste is preferred over the second most frequent paste if the two have different superscripts. If they have the same superscript, then the most frequent paste is not preferred.

This procedure was repeated for the most frequent paste and every other paste in each column. In other words, the most frequent paste was paired with the third most frequent paste, the fourth most frequent paste, and so on. The second most frequent paste was paired with the third most frequent paste, the fourth most frequent paste, and so on. The procedure was repeated to produce pairwise tests for every possible combination of more frequent pastes with less frequent pastes. Thus, in any given column any pastes with the same superscripts are equally preferred at a significance level of 0.05.

Table 8 shows that the apparent first-rank preference for medium sandy paste and the apparent second-rank preference for fine sandy paste are confirmed at the site level. However, at the site level, the tests disconfirm the third-rank preference for very fine sandy paste over clay-tempered paste and the fourth-rank preference for bone-tempered over bone-and-clay-tempered paste. Thus, the pairwise tests show that overall there was a first-rank preference for medium sandy pastes; a second-rank preference for fine sandy pastes; an approximately equal third-rank preference for very fine sandy pastes and clay-tempered pastes; and an approximately equal fourth-rank preference for bone-tempered and bone-and-clay-tempered pastes.
Within the analytical levels, a much different picture emerges. The apparent preference for medium sandy pastes was sustained only in AL1. In AL2 and AL3 pairwise tests indicate no discernible preference for medium sandy pastes over fine sandy pastes. Although fine sandy pastes outnumber medium sandy pastes in AL4, the pairwise test indicates no discernible preference for fine sandy pastes over medium sandy pastes. Thus, medium and fine sandy pastes are approximately equal first-rank preferences in AL2, AL3, and AL4. Pairwise testing also indicates that in all four analytical levels there is no discernible preference for very fine sandy pastes over clay-tempered paste. Thus, these two pastes constitute an approximately equal second-rank preference in AL2-AL4 and a third rank-preference in AL1. Pairwise testing confirms a preference for clay-tempered pastes over bone-and-clay tempered pastes in all analytical levels. However, bone- and bone-and-clay-tempered pastes are approximately equally preferred in all analytical levels. Thus, the non-occurrence of bone-tempered and bone-and-clay-tempered pastes reflects a distinct third-rank preference, either as a function of rarity or absence from the cultural repertoire.

These results seem to indicate that grain size and temper type are important criteria. The test hypotheses above indicate a subtle but gradual shift in paste choice through time, moving from a more or less equal preference for both medium and fine grained pastes in AL4 to an overall preference for medium grained pastes in AL1.

As a word of caution, it is necessary to point out that although the use of arbitrary scales to subdivide grain size categories enables us to create a preference hierarchy, the categories defined in the hierarchy have distinct boundaries, whereas these boundaries may have been less distinct or in different places for upper Texas coast potters. Even so, they still overwhelmingly and nonrandomly chose pastes that fall within our
admittedly arbitrary medium and fine grained categories. As Bunzel pointed out in her study of southwestern potters, potters often have no quantitative sense of proportions during the mixing of paste, but are instead guided by their tactile senses and experience. Yet, the surety with which they mix the paste without having to stop in the midst to grind more sherds, or fetch more clay, shows that they are guided by some such sense of quantitative relations; but certainly they are quite unconscious of it, and unable to say when asked whether they use equal amounts of clay and tempering, or if not, what proportions prevail [Bunzel 1972:6].

Dietler and Herbich (1987) also note such distinctions among the Luo potters of Kenya. For example, they note that although Luo potters do not classify soils according to the functional distinction between clay and temper, they are aware of the difference. Moreover, potters often have very definite opinions about the relative properties and merits of different clays [Dietler and Herbich 1987:152].

Thus, the preferred paste category of 41HR616 potters may be fairly distinctly defined somewhere between the limits of the medium and fine grained categories in the Wentworth Scale. Although one can only speculate as to how and why upper Texas coast potters may have chosen one grain size over another or what criteria they used to determine grain size, the above test hypotheses point to more than a simple random process with regard to the selection of paste.
Basic Exterior Surface Treatment Preferences

In their analysis of the ceramics recovered from 41HR273, Winchell and Ellis (1991) found that ceramics with floated exterior surfaces increased through time, while ceramics with smoothed exterior surfaces decreased through time. Given the interesting findings at 41HR273, it seemed logical to ask: did the potters who frequented 41HR616 prefer one particular surface treatment technique over another? Results of the analysis indicate that there were four basic techniques employed in the finishing of the pottery recovered from 41HR616. During the primary forming stage, the vessel surface was initially scraped and smoothed to eliminate coil junctures. Subsequently, potters either (i) allowed the paste to dry to the leather-hard stage without any additional treatment of the wet paste, or (ii) continued finishing the surface by floating it while the paste was still wet and then allowing it to dry to the leather-hard stage. At the next stage in the sequence, the potter could make one of several choices. In the event that the paste was allowed to dry without floating, the potter might choose to dry smooth the surface. Furthermore, regardless of whether the surface was floated or dry-smoothed, the potter might chose to burnish the surface or to leave it as is. Clearly, other things could be done to the vessel surface during this process. For example, incising or punctating could be done while the paste was still wet or a red pigment could be added during the floating process.

Table 7.9 lists the distribution of basic exterior surface treatment techniques found on sherds recovered from 41HR616. An examination of this table seems to indicate that potters frequenting 41HR616 preferred floated/unburnished exterior surface treatments. The first step toward confirming or rejecting this intuition is to determine whether the distribution of surface treatments reflects any demonstrable preference. The intuition
that some treatments were preferred over others is equivalent to the test hypothesis that the distribution of exterior surface treatment is nonrandom. This test hypothesis, in turn, implies the null hypothesis that the distribution is random. We may test the null hypothesis with a two-tailed binomial distribution test at a 0.05 level of significance (see Thomas 1986). If the null hypothesis is true, the number of sherds in each surface treatment category should fall within the expected range of a binomial distribution predicted by

\[ p(\text{floated/unburnished}) = p(\text{floated/burnished}) = p(\text{dry-smoothed/unburnished}) = p(\text{unfloated/burnished}) = 0.25. \]

If the test hypothesis is true, then the number of sherds for at least one category should fall outside the expected range. The BINOM program (Carlson n.d.a) was used to test the above hypothesis. Calculations are summarized in Table 7.9.

Table 7.9 shows that the null hypothesis can be rejected both for the site as a whole and in each analytical level, indicating that the distribution of surface treatments is unlikely to be the result of a random selection process. This is because the number of sherds in one or more surface treatment categories is either too high or too low to reflect a random outcome. This result implies that the most frequently chosen surface treatment in each provenance is the preferred treatment. Table 7.9 indicates that floated/unburnished surfaces are preferred at the site level and in all analytical levels.

There may be differences in preference among the less frequently chosen surface treatment modes. If so, then the distribution among the three remaining surface treatment categories should be nonrandom. Table 10 shows that there is an apparent
second-rank preference both at the site level and in each analytical level. Among the remaining surface treatment modes, floated/burnished surfaces are preferred at the site level and in AL1 and AL3, while dry-smoothed/unburnished surfaces are preferred in AL4. However, in AL2, dry-smoothed/unburnished exterior surfaces and floated/burnished exterior surfaces are approximately equally preferred.

This procedure can be carried further in order to determine whether there is any demonstrable preference between the two least frequent surface treatment modes. Table 7.9 also indicates that at the site level and in AL1 and AL3 there is an apparent third-rank preference for dry-smoothed/unburnished surface treatments, while in AL4, there is an apparent third-rank preference for floated/unburnished surfaces. Dry-smoothed/burnished exterior surfaces appear to be the least preferred surface treatment modes both at the site level and in AL1, AL3, and AL4.

Thus, at the site level there is an apparent first-rank preference for floated/unburnished exterior surface treatments, a second-rank preference for floated/burnished exterior surfaces; and a third-rank preference for dry-smoothed/unburnished exterior surfaces. However, this apparent preference structure does not hold in its entirety if we look at the site diachronically. Although the first-rank preference for floated/unburnished surfaces holds for all analytical levels, the preference structure for the remaining surface treatment modes varies through time. The second-rank preference for floated/burnished surfaces is maintained in AL1 and AL3, while dry-smoothed/unburnished surfaces are the second-rank preference in AL4, and floated/burnished and dry-smoothed/unburnished surfaces appear to be equally preferred at the second rank in AL2. The third-rank preference for dry-smoothed/unburnished surfaces is maintained in AL1 and AL3, while floated/burnished surfaces are the third-rank preference in AL4.
However, in AL2, there appears to be an anomalous relationship between dry-smoothed/unburnished, floated/burnished surfaces, and dry-smoothed/burnished exterior surfaces in that these surface treatment modes are tied in a third-rank preference. Because dry-smoothed/unburnished surfaces and floated/burnished surfaces also are equally preferred as a second-rank preference, then dry-smoothed/burnished exterior surfaces, by implication, share a second-rank preference with the two more frequent treatments. In summary, it appears that given a choice between floating and not floating while the vessel was wet, the potters who frequented 41HR616 overwhelmingly and nonrandomly chose to float the vessel surface. Furthermore, once vessels had dried, it appears that potters preferred to leave the surfaces unburnished.

So far, the discussion has emphasized the apparent preference structure for exterior surface treatment modes. If the above preferences are supportable, then there ought to be discernible differences between the first- and second-rank preferences, the second- and third-rank preferences and so on. That is, the number of sherds in the first-rank preference ought to be greater than the number expected in a sample that includes only the first- and second-rank preferences. This implies the null hypothesis that in any pair of preference ranks, the larger number is less than or equal to the number expected. Thus, a series of pairwise tests will confirm or disconfirm the apparent preference ranking.

Table 7.10 lists each surface treatment mode in order of decreasing frequency for the site as a whole and for each analytical level. In each column the most frequently occurring surface treatment was paired with the second most frequently occurring surface treatment. This pair was treated as a series of \(N\) trials where
\[ N = n(\text{most frequent}) + n(\text{next most frequent}), \text{ and } p(\text{most frequent}) = p(\text{next most frequent}) = 0.5. \]

Binomial distributions were calculated for a one-tailed hypothesis test that the number of sherds with the most frequent surface treatment is less than or equal to the number expected at a significance level of 0.05. If the number is not less than or equal to the number expected, then the most frequent surface treatment is preferred over the second most frequent surface treatment. If the number is less than or equal to the number expected, then the most frequent surface treatment is not preferred. Superscripts were assigned to each member of the pair according to whether or not there is a preference. Thus, the most frequent surface treatment mode is preferred over the second most frequent surface treatment mode if the two have different superscripts. If they have the same superscript, then the most frequent surface treatment mode is not preferred.

This procedure was repeated for the most frequent surface treatment mode and every other surface treatment mode in each column. In other words, the most frequently occurring surface treatment mode was paired with the second most frequently occurring surface treatment mode, the third most frequently occurring surface treatment mode, and so on. The procedure was repeated to produce pairwise tests for every possible combination of more frequent surface treatments with less frequent surface treatments. Thus, in any given column any pastes with the same superscripts are equally preferred.

Table 7.10 indicates that the apparent first-rank preference for floated/unburnished exterior surfaces is confirmed at the site level. However, at the site level, the tests disconfirm the preference for floated/burnished surfaces over dry-
smoothed/unburnished surfaces. Thus, the pairwise tests show that overall there was a first-rank preference for floated/unburnished exterior surfaces; an approximately equal second-rank preference for floated/burnished and dry-smoothed/unburnished exterior surfaces; and a third-rank preference for dry-smoothed/burnished exterior surfaces.

Diachronically, this pattern also holds. In the pairwise tests, floated/unburnished surfaces maintain their first-rank preference in all analytical levels. In AL1 and AL3, the apparent second-rank preference for floated/burnished surfaces is demonstrated to be approximately equal in rank to dry-smoothed/unburnished surfaces. Thus, in all analytical levels there is a tied second-rank preference for these two surface treatment modes. In all analytical levels, dry-smoothed, burnished surfaces appear to be the least preferred surface treatment mode. Therefore, when viewed diachronically, there is little change in the preference structure for exterior surface treatment. However, it seems apparent that the potters who frequented 41HR616 did, indeed, prefer to establish the basic surface of the vessel while the paste was still wet and then simply allow the pot to dry. This seems to indicate that the upper Texas coast potters who frequented this site preferred working on a wet paste as opposed to a leather-hard or dry paste.

Basic Interior Surface Treatment Preferences

Tests involving exterior surface treatment techniques indicate that the potters frequenting 41HR616 preferred pots with floated exterior surfaces. Given this apparent preference, the next logical question to ask is: were pots with floated interior surfaces also preferred? Results of the analysis indicate the same four techniques employed in the finishing of the exterior surfaces were also employed in finishing the interior surfaces. There were, however, some interesting differences.
Table 7.11 lists the distribution of interior surface treatment techniques found on sherds recovered from 41HR616. An examination of this table indicates that, as with exterior surface treatment, potters at 41HR616 apparently preferred floated/unburnished interior surface treatments. The first step toward confirming or rejecting this intuition is to determine whether the distribution of interior surface treatments reflects any demonstrable preference. The intuition that some treatments were preferred over others is equivalent to the test hypothesis that the distribution of interior surface treatments is nonrandom. As with the tests conducted for exterior surface treatments, we may test the null hypothesis with a two-tailed binomial distribution test at a 0.05 level of significance (see Thomas 1986). If the null hypothesis is true, the number of sherds in each surface treatment category should fall within the expected range of a binomial distribution predicted by

\[
p(\text{floated/unburnished}) = p(\text{floated/burnished}) = p(\text{dry-smoothed/unburnished}) = p(\text{unfloated/burnished}) = 0.25.
\]

If the test hypothesis is true, then the number of sherds for at least one category should fall outside the expected range. The BINOM program (Carlson n.d.a) was used to test the above hypothesis. Calculations are summarized in Table 7.12.

Table 7.12 shows that the null hypothesis can be rejected both for the site as a whole and in each analytical level, indicating that the distribution of interior surface treatments is unlikely to be the result of a random selection process. As with the exterior surfaces, potters apparently chose to float the interior surfaces and then leave them unburnished. Among the remaining surface treatment modes, dry-smoothed/unburnished surfaces are a second-rank preference both at the site level and in all analytical levels. Although
floated/burnished surfaces are a third-rank preference at the site level and in AL4, floated/burnished and dry-smoothed/burnished interior surfaces are approximately equally preferred choices in AL1, AL2, and AL3.

So far, the discussion has emphasized the apparent preference structure for interior surface treatment modes. If the above preferences are supportable, then there ought to be discernible differences between the first- and second-rank preferences, the second- and third-rank preferences and so on. That is, the number of sherds in the first-rank preference ought to be greater than the number expected in a sample that includes only the first- and second-rank preferences. This implies the null hypothesis that in any pair of preference ranks, the larger number is less than or equal to the number expected. Thus, a series of pairwise tests will confirm or disconfirm the apparent preference ranking.

Table 7.13 lists each interior surface treatment mode in order of decreasing frequency for the site as a whole and for each analytical level. The most frequently occurring interior surface treatment in each column was paired with the second most frequently occurring surface treatment. This pair was treated as a series of N trials where

\[ N = n(\text{most frequent}) + n(\text{next most frequent}), \text{ and } p(\text{most frequent}) = p(\text{next most frequent}) = 0.5. \]

Binomial distributions were calculated for a one-tailed hypothesis test that the number of sherds with the most frequent surface treatment is less than or equal to the number expected at a significance level of 0.05. Superscripts were assigned to each member of the pair according to whether or not there is a preference. Thus, the most frequent
interior surface treatment is preferred over the second most frequent interior surface treatment if the two have different superscripts. If they have the same superscript, then the most frequent surface treatment mode is not preferred. As with paste and exterior surface treatment, this procedure was repeated for each combination of more frequent surface treatments in each column.

Results of the pairwise tests confirm the apparent preference structure. Table 7.13 indicates that overall there is a first-rank preference for floated/unburnished interior surfaces; a second-rank preference for dry-smoothed/unburnished interior surfaces; a third-rank preference for floated/burnished interior surfaces; and a fourth-rank preference for dry-smoothed/burnished interior surfaces.

Diachronically, the pairwise tests also confirm the apparent preference structure. Floated/unburnished interior surfaces maintain their first-rank preference and dry-smoothed/unburnished interior surfaces maintain their second-rank preference in all analytical levels. In AL1, AL2, and AL3, floated/burnished interior surfaces are demonstrated to be approximately equal in rank to dry-smoothed/burnished interior surfaces, and in AL4, floated/burnished interior surfaces maintain their third-rank preference. In AL4, dry-smoothed/burnished surfaces appear to be the least preferred surface treatment mode. Therefore, when viewed diachronically, there is no change in the preference structure for interior surface treatment.

As with exterior surface treatment, it seems apparent that the potters who frequented 41HR616 preferred to establish the basic interior surface of the vessel while the paste was still wet and then simply allow the pot to dry. For both interior and exterior surfaces, there is a first-rank preference for floated/unburnished surfaces. However,
hypothesis testing indicates differences with regard to second- and third-rank preferences. For interior surfaces, the preference structure is more clearly defined. Hypothesis testing indicates that there is a second-rank preference for dry-smoothed/unburnished and a third-rank preference for floated/burnished interior surfaces, whereas for exterior surfaces, there is an approximately equal preference for dry-smoothed/unburnished and floated/burnished surfaces. This seems to indicate that interior surfaces were treated somewhat differently than exterior surfaces. Although it is not possible to determine why upper Texas coast potters may have treated these surfaces differently, the above test points to more than a simple random selection process with regard to the choice of interior and exterior surface treatment modes.

Enhancement Technique Preferences
Although only a small percentage of the sherds recovered from 41HR616 were decorated, several interesting enhancement techniques were represented in the sample. The 31 decorated sherds recovered from the stratified units evinced 4 basic techniques. Sherds were incised \( n = 25 \), brushed \( n = 3 \), cord-marked \( n = 1 \), and engraved \( n = 1 \). One sherd was both brushed and incised. Intuitively, the relatively large number of incised sherds seems to indicate a preference for this technique. The first step toward confirming or rejecting this intuition is to determine whether the distribution of enhancement techniques reflects any demonstrable preference. The intuition that some techniques were preferred over others is equivalent to the test hypothesis that the distribution of enhancement techniques is nonrandom. This test hypothesis implies the null hypothesis that the distribution is random. We may test the null hypothesis with a two-tailed binomial distribution test at a 0.05 level of significance by determining whether the number of occurrences of each decorative technique falls within the range predicted by
\[ p(\text{incised}) = p(\text{brushed}) = p(\text{cord-marked}) = p(\text{engraved}) = 0.25. \]

If the test hypothesis is true, then the number of occurrences of at least one decorative category should fall outside the expected range. Note that more than one technique was used to decorate one of the sherds in the sample. Theoretically, any combination of decorative attributes could occur on any sherd. Because we are interested in the range of decorative techniques that were used, the test hypothesis involves a distribution of 32 occurrences of decorative attributes on 31 sherds. The calculations are summarized in Table 7.14.

Table 7.14 shows that the null hypothesis can be rejected both for the site as a whole and in each analytical level, indicating that the distribution of enhancement techniques is unlikely to be the result of a random selection process. The number of sherds in one or more categories is either too high or too low to reflect a random outcome. This result implies that the most frequently chosen enhancement technique in each provenance is the preferred technique. Because the observed number of incised sherds \((n = 26\) out of 32) falls outside the expected range (4 to 12) it is improbable that their occurrence could be the outcome of a random selection process. Twenty-six sherds, therefore, falls into the rejection region for the null hypothesis. Since the null hypothesis is rejected, we may conclude that there was an apparent preference for incising. However, among the less frequently chosen enhancement techniques there appears to be no apparent preference for one technique over another.

Since the choice of decorative treatment appears to reflect a demonstrable preference, there ought to be a discernible difference between the first- and second-rank
preferences, the second- and third-rank preferences, and the third- and fourth-rank preferences. In order to confirm the apparent preference ranking, a series of pairwise tests was conducted. All pairwise tests are one-tailed binomial hypothesis tests of a null hypothesis that the number observed is less than or equal to the number expected at a significance level of 0.05. Table 7.15 summarizes the results of the pairwise tests. Note that in any given column any enhancement techniques with the same superscripts are equally preferred.

Table 7.15 indicates that the apparent preference for incising is confirmed at the site level and in AL2, but there is no demonstrable preference in AL3. The preference structure is not as straightforward in AL1 and AL4.

In AL1, incising is preferred over cord-impressing and engraving, but not over brushing. However, brushing is not preferred over cord-impressing or engraving. This implies that there is a complex preference structure with regard to these techniques. However, any judgments about this preference structure requires consideration of several factors. First, cord-impressed sherds are very rare (in the examination of over 15,000 sherds, Aten found none), so their absence in AL1 does mean that this technique was not used during the period of the original deposition of AL1. According to Aten (1983a), cord-impressed ceramics are generally associated with the Clear Lake period (A.D. 100-425), but they have been found in later Early Ceramic period (before A.D. 1000) contexts (Winchell and Ellis 1990). However, according to Ensor (1992) the excavation units comprising AL1 have a late prehistoric date. Therefore, it is likely that the cord-impressed technique has a low preference in AL1 because it was no longer part of the manufacturing repertoire.
Second, the three brushed sherds in AL1 resemble the Caddo area type, Broadus Brushed. Given the fact that brushing is not a technique normally associated with Goose Creek pottery, these sherds were either locally produced vessels that incorporated exotic design elements or they were imported from the Caddo area. Moreover, the one engraved sherd recovered from AL1 also resembles a Caddo type (Holly-Fine Engraved). This is also consistent with a florescence of Caddo ceramics in the Late Prehistoric period (after A.D. 1000) in the Galveston Bay area (Aten 1983a: Figure 15.1). Therefore, given the late prehistoric date for AL1, it is quite likely that these sherds are, in fact, from imported vessels. Consequently, the approximately equal preference for the techniques of brushing and incising in AL1 may mask a difference between local production and local use in that the ceramics in use at 41HR616 include examples of brushed and engraved ceramics produced according to non-local preference structures. If the engraved and brushed sherds are eliminated from the sample under the assumption that they were imported, then incising is the first-rank preference in AL1.

In AL4, incising is preferred over brushing and engraving but not over cord-impressing. According to Ensor (1992), the excavation levels that comprise AL4 date to the Early Ceramic period (before A.D. 1000). Therefore, the presence of the cord-impressed sherd in this analytical level is consistent with the known distribution of this very rare type. However, the fact that a common technique, incising, is not preferred over a very rare technique is counter-intuitive unless the absence of a demonstrable preference is due to the small sample size.

In summary, there is a shift from no demonstrable preference for incising in AL4 and AL3 to an apparent preference for incising in AL2 and AL1, especially if the brushed
sherds are considered imports. The absence of brushed sherds in AL4-AL2 is not surprising if, in fact, the Caddo-like sherds recovered in AL1 were imported. If the brushed sherds in AL1 are not imports, this would imply the adoption of a new technique at 41HR616 during the time period represented by AL1. Given that brushing has never been reported as a technique indigenous to the upper Texas coast area in general, this would further imply that brushing was a localized phenomenon, perhaps diffused from the Caddo area. The diachronic pattern for cord-impressed ceramics conforms to what would be expected for a very rare technique with an early distribution. Given that AL4 probably dates earlier than Turtle Bay period (A.D. 650-1000), the presence of a cord-impressed sherd in AL4 is consistent with the known occurrence of this technique in the upper Texas coast area. Its absence in AL1 is consistent with the disappearance of this technique before the Late Ceramic period (after A.D. 1000). The absence of cord-impressed sherds in AL3 and AL2 could be the function of either rarity or their disappearance from the cultural repertoire. Because engraved sherds have traditionally been lumped with incised sherds, it is not possible to determine whether the distribution at 41HR616 is consistent or inconsistent with any known pattern, no matter how one regards the Caddo-like sherd.

There is an apparent first-order preference for incising at the site level. (It seems intuitively likely that the lack of a preference in AL3 and AL4 is a function of small sample size, and that the preference probably holds for each analytical level.) Given the preference at the site level, the fact that there is variation among incising techniques makes it possible to explore whether there are levels of preference for varying incising techniques. Potters had the option of incising on either a wet paste or a leather-hard paste. Because we can differentiate incised lines that were cut into a wet paste from those that were cut into a leather-hard paste, it is possible to infer whether or not there
is a preference for one incising technique over the other. Of the 26 incised sherds found in the defined analytical levels, 21 were incised on a leather-hard paste. Table 7.16 illustrates the results of the test hypothesis.

Table 7.16 indicates that incising on a leather-hard paste was the preferred technique at the site level and in AL1. However, in AL2, AL3, and AL4 there is no discernible preference for incising on a leather-hard paste over incising on a wet paste. Given that there appears to be an overall shift from no demonstrable preference for incising over other enhancement techniques in AL4 and AL3 to an apparent preference for incising as the preferred enhancement technique in AL2 and AL1, the shift in preference from one incising technique to another is certainly feasible. However, the lack of a demonstrable preference could easily be due to the small sample size in AL2, AL3, and AL4.

In conclusion, it appears that the potters frequenting 41HR616 chose to enhance or decorate their vessels infrequently. However, when potters did choose to decorate their vessels, the preferred enhancement technique was incising on a leather-hard paste. Although other techniques occur too infrequently to be able to discern any clear preference, the presence and/or absence of brushing, cord-impressing, and engraving in all analytical levels seems to be consistent with known diachronic patterns for these techniques. However, the relatively high frequency ($n = 4$) of Caddo-like sherds in AL1 raises two interesting points. First, the presence of Caddo-like ceramics suggests a flow of goods or ideas between the two areas. Second, the presence of Caddo-like sherds extends the boundary of Caddo ceramics closer to the Galveston Bay area. Although Caddo ceramics are more frequently represented in the ceramic assemblages of the Conroe/Livingston area, they are extremely rare in the ceramic assemblages of the Galveston Bay area. As 41HR616 is located approximately mid-way between the
Conroe/Livingston area and the Galveston Bay area (as defined by Aten 1983a), the presence of Caddo-like sherds in the ceramic assemblage at this site may suggest a closer affiliation with the Conroe/Livingston area. However, before such an affiliation can be substantiated more sites in this area will need to be excavated.
Process Sequence Preferences

Having discussed the patterns of preference for the major stages of primary forming and surface treatment, the next logical question to ask is whether there is a discernible preference for one or more sequences of paste selection, wet surface preparation, or dry surface preparation. In order to explore this aspect of the ceramic assemblage, it is necessary to look at all of the sequences that potters could have chosen, regardless of whether there actually were any occurrences of a given sequence. Indeed, each individual surface treatment occurs in each analytical level, so each was a known possible choice during the time each analytical level was deposited. Although each paste does not occur in each analytical level, it is implausible to suggest that there was an environmentally determined process governing paste choice since bone was available for temper as soon as the occupants of the site killed an animal, and grog was available for temper as soon as the first pot was broken. Thus, an examination of the preference structure for paste and exterior surface treatment choices will deal not only with what was chosen, but also with what was not chosen. Dealing with sequences that were not chosen acknowledges that it is not always possible to tell whether a sequence is absent because it was very rare in systemic context, or absent because it was culturally foreign to the ceramic-manufacturing process.

Table 7.17 summarizes the frequencies of the various sequences that are possible on the basis of the paste and exterior surface treatments that actually occur at 41HR616. Table 7.18 summarizes the results of tests of the null hypothesis that the distribution of sequence choices is random. An examination of Tables 7.17 and 7.18 shows that at the site level two possible sequences occur at frequencies higher than expected and sixteen
sequences occur at frequencies lower than expected in a random distribution. Furthermore, at least eight possible sequences have frequencies less than the number expected in a random distribution. In each analytical level, at least two possible sequences occur at frequencies higher than expected and at least eight possible sequences occur at frequencies lower than expected in a random distribution. Thus, the distribution of process sequences is not homogeneous, either overall or within any analytical level. Therefore, it is apparent that some sequences were preferred over others. However, to say that some sequences were preferred over others is not to say which sequences were preferred.

In order to explore the nature of the preference structure for paste/surface treatment sequences, the sequences for each analytical level were ranked from highest to lowest on the basis of frequency of occurrence. Table 7.19 lists the process sequences in order of an initial rank from most to least frequent. Where two or more sequences have equal frequencies, they are ordered arbitrarily, and assigned an initial rank equal to the average of the ranks with the same frequency (see Thomas 1986). Next, a series of pairwise tests was run to identify pairs of sequences whose values are too close to reject a null hypothesis that the sequence with the higher value is preferred over the sequence with the lower value. The pairwise tests compare the highest ranked sequence with each lower-ranked sequence, the second-highest ranked sequence with each lower ranked sequence, and so on. Where testing shows that the null hypothesis cannot be rejected for a given pair of sequences, a superscript numeral is assigned to each member of the pair. Thus, sequences with the same superscript are statistically equally preferred compared to the highest ranked sequence with that superscript. Therefore, the members of any set of sequences with the same superscript occupy a statistically identical rank in the preference structure.
An examination of Table 7.19 shows that the preference structure for paste/wet-surface/dry-surface sequences is not particularly straightforward. Although there is an apparent across-the-board, first-rank preference for fine and medium sandy paste with floated/unburnished surfaces, the situation with respect to lower-rank preferences is both ambiguous and variable. For example, in AL4, fine sandy paste with floated/burnished surfaces (rank 3) is not preferred over very fine sandy paste with floated/unburnished surfaces (rank 4), but it is preferred over medium sandy paste with dry-smoothed/burnished surfaces (rank 10). On the other hand, very fine sandy paste with floated/unburnished surfaces (rank 4) is not preferred over medium sandy paste with dry-smoothed/burnished surfaces. Thus, whereas ranks 3 and 4 occupy roughly the same position in the structure and ranks 4 and 10 occupy roughly the same position in the structure, ranks 3 and 10 do not. Consequently, there are no unambiguous lower-rank preferences.

Examination of Table 7.19 also shows that six possible process sequences occupy the lowest overall position in the preference structure as a result of zero frequencies in all analytical levels (Table 7.20). These sequences all are based on clay-, bone-, or bone- and clay-tempered paste. It is tempting to suggest that these “non-choices” resulted from a manufacturing tradition that did not include them as culturally and/or functionally acceptable sequences. Clay-tempered paste with dry-smoothed/burnished surfaces does not occur despite the fact that one or more sequences with clay-tempered paste occur in every analytical level. However, the frequency of clay-tempered sequences is low overall, and the absence of this one sequence could easily be a matter of sampling error.
In the case of the other "non-chosen" sequences, an additional consideration emerges because all of the bone- and bone-and-clay-tempered sequences that do occur at 41HR616 occur in Analytical Level 1. Ensor (1992) notes on the basis of lithic evidence that the pattern of diagnostic points indicates a Late Ceramic period occupation in the upper nine excavation levels at the site, and an Early Ceramic period occupation at lower excavation levels. The upper nine levels roughly coincide with AL1 in this analysis. According to Aten (1983a:288), bone-tempered ceramics are "clearly established" in the Old River period (A.D. 1350-1700) after an "ambiguous early occurrence" in the Turtle Bay period (A.D. 650-1000; Aten [1983a: Table 14.2] found three bone-and-clay-tempered sherds, and classified them as "bone-tempered.") This suggests that the emergence of some bone- and bone-and-clay sequences in AL1 coincides with the introduction of bone- and bone-and-clay-tempered ceramics as a new element in the ceramic manufacturing tradition. This implies that the absence of bone- and bone-and-clay-tempered sequences in AL2 through AL4 resulted from their not being culturally conceivable choices. However, bone-temper first occurs in the Galveston Bay area in the Clear Lake period (A.D. 100-425; Aten 1983a: Table 14.2, Figure 14.1), and the absence of bone-tempered sherds is statistically consistent with every time period (Ellis and Ellis 1992). Thus, it is not at all clear that the presence of bone- and bone-and-clay-tempered sequences in AL1 reflects the introduction of new culturally acceptable choices in the preference structure relative to the earlier analytical levels. Furthermore, there are Caddo-like design elements on two bone-tempered sherds. This could suggest that the presence of bone-tempered sequences reflects the presence of trade goods. In any event (consistent rarity, late adoption, or Caddo imports), the bone- and bone-and-clay sequences do not constitute a major component of the pottery manufacturing process evidenced at 41HR616.
Given that the preference structure for paste/surface treatment choices is not clear, it may be worthwhile to take another approach to assessing variability in the choice of process sequences. This approach is graphic and intuitive. Given that two sequences are always tied for a first-rank preference and six sequences are always in the last rank by virtue of zero frequencies in all analytical levels, let us ignore these sequences because they do not contribute to variability in choice of process sequence at 41HR616. Furthermore, let us modify the ranking of the remaining sequences. Given that all of the variable sequences are members of more than one set of statistically equally preferred sequences in at least one analytical level (i.e., have more than one superscript in at least one column of Table 7.21), we can determine their overall ranking in any given analytical level by determining their average statistical rank. For example, in AL4, the sequence of fine sandy paste with floated/burnished surfaces (initial rank 3) belongs only to statistical rank 2, whereas the sequence of very fine sandy paste with floated/unburnished surfaces (initial rank 4) belongs to statistical ranks 2 and 3, reflecting the fact that the former is preferred to a sequence that the latter is not. Thus, whereas the overall rank of the former is 2, the overall rank of the latter is 2.5. The overall ranks, therefore, are compromise distinctions between statistical equality and numerical difference. Table 22 lists the overall ranks produced by averaging the statistical ranks.

In order to illustrate variability of sequence preference, changes in overall preference from analytical level to analytical level have been plotted against a scale of overall rank (Figure 7.3). A change in the overall rank of a given sequence (relative to other sequences) shows up as a line that crosses the lines plotted for other sequences. The disorderliness of Figure 7.3 shows that overall rank is highly variable. (If there was no variability, all lines would be nonintersecting.) Thus, Figure 7.3 shows that much of the
diachronic change in preference structure occurs in the form of variable selection of relatively uncommon process sequences. However, at an intuitive level, Figure 7.3 also shows that there are some relatively restricted ranges of variability among the uncommon sequences.

To better visualize the range of variability presented in Figure 7.3 the midpoint for each analytical level was calculated, with the midpoint being the average of the highest and lowest overall rank in each analytical level [see Thomas (1986:41-45) for a discussion of frequency distributions and class midpoint]. For example, in AL1 the highest overall rank (2.0) and the lowest overall rank (7.0) were averaged to obtain a midpoint of 4.5, whereas in AL2, the midpoint is 4.0 (the average of 2.0 and 6.0). Calculating the midpoint enables us to more clearly distinguish those sequences that more frequently fall within the higher ranks and those that more frequently fall within the lower ranks. Figure 7.4 illustrates that five sequences (a, b, c, f, and g) fluctuate within the range at or above the midpoint in all analytical levels. Figure 7.5 illustrates that six sequences (h, i, j, k, l, and p) fluctuate within the range at or below the midpoint. Figure 7.6 illustrates that there are five sequences (d, e, m, n, and o) that fluctuate erratically above and below the midpoint.

Of the five sequences that fluctuate in the range at or above the midpoint, all are first- or second-rank preference choices for paste and/or surface treatment. Three sequences (a, c, and g) consist of first- or second-rank paste preferences that exhibit second-rank surface treatment preferences. Although two sequences (b and f) consist of third-rank paste preferences, they exhibit first-rank surface treatment preferences. Intuitively, this seems to suggest that there were several relatively highly ranked combinations that may
have been relatively preferred over time. In other words, they constitute an array of consistent high-preference choices among the uncommon sequences.

By contrast, the six sequences that fluctuate within the range at or below the midpoint tend to have lower ranking paste and/or surface treatment preferences. Although two sequences (h and j) consist of first- and second-rank paste preferences, they exhibit the least preferred surface treatment. One sequence (i) consists of a third-rank paste preference with a second-rank surface treatment preference and one sequence (l) consists of a third-rank paste preference with a third-rank surface treatment preference. Intuitively, this seems to suggest that these four sequences may constitute an array of relatively low-preference but nonetheless consistent choices. The remaining two sequences that fluctuate at or below the midpoint hold a somewhat more ambiguous position in the preference structure. These two sequences (k and p) have bone- and bone-and-clay tempered pastes (fourth-rank preferences) that exhibit first- and second-rank exterior surface treatment preferences. As these paste types occur only in AL1 they always share the lowest rank in AL2, AL3, and AL4 by virtue of their zero frequency. While their overall rank in AL1 is still at or below the midpoint, it is difficult to speculate as to their actual overall preference given the problems associated with these paste types (i.e., consistent rarity, late adoption, or Caddo imports).

Figure 7.6 illustrates the five sequences (d, e, m, n, and o) that fluctuate above and below the midpoint. One sequence (d) appears high in AL3 and AL4 and then drops off dramatically in AL2 and AL1. Intuitively, this seems to indicate a possible decline in preference over time. The remaining sequences (e, m, n, and o) fluctuate fairly erratically, suggesting that they may reflect the results of experimentation or idiosyncratic choice.
Thus, there appears to be a fairly consistent pattern of choice and non-choice among at least some of the process sequences. The pattern of choice of process sequences (Table 7.22) appears to be structured at least to the extent that two sequences—medium sandy paste ceramics with floated/unburnished surfaces and fine sandy paste ceramics with floated/unburnished surfaces—are always nonrandomly preferred. Recalling that the arbitrary boundary between medium and fine sandy paste may not coincide with an indigenous category, it is quite possible that sandy pastes in the fine-to-medium grained categories represented a single sequence of preferred paste. In either case, the overwhelming preference for vessels with fine-to-medium sandy pastes and floated/unburnished surfaces appears to reflect a preferred set of choices that form the core of the pottery manufacturing tradition present at 41HR616 over a period of time.

It also appears that among the less frequently chosen sequences there is a weak, two-tiered preference structure. It is tempting to suggest that the members of the upper tier (Table 7.22) reflect an array of routine choices for producing special-purpose ceramics (where special-purpose includes aesthetic appeal as well as utility and/or ritual purposes) more than they reflect experimentation or idiosyncrasy. It is also tempting to suggest that the members of the lower tier (Table 7.22) reflect either low preference choices or sequences that result from experimentation or idiosyncratic choices more than they reflect routine special-purpose choices.

In order to explore this idea further, it may be useful to examine rim diameter for all rim sherds in the sample for which a process sequence can be distinguished ($n = 45$). A vessel’s diameter is believed to be related to its intended use (Braun 1983; Erickson et al. 1972; Smith 1983; Shapiro 1983). Therefore, if any of the process sequences go
with vessels generally manufactured for specific intended purposes, there could be
differences in mean diameter of vessels manufactured according to different process
sequences. In particular, if one or both of the most preferred process sequences (i.e.,
medium sandy paste ceramics with floated/unburnished surfaces and fine sandy paste
ceramics with floated/unburnished surfaces) accompany manufacture of vessels with an
emically identified function (even if that function is “all purpose”), there could be
differences in diameter between vessels with one or both of the preferred sequences and
vessels with one or more of the less preferred sequences if the less preferred sequences
go along with vessels having different intended functions. Differences in diameter
would be revealed by statistically significant differences between the mean diameters of
the rim sherds in each process sequence group. An analysis of variance was conducted
using PROC GLM (SAS Institute 1988) to test the null hypothesis that there is no
significant difference between the means. The analysis of variance compares the mean
diameters of vessels with each possible pair of process sequences, testing the null
hypothesis in a series of pairwise, two-tailed t-tests (equivalent to Fisher’s least-
significant-difference; SAS Institute 1988:568-570). Table 7.23 details the mean rim
diameters for vessels with each process sequence, and Table 7.24 summarizes the
results of the analysis of variance with respect to acceptance or rejection of the null
hypothesis.

The mean diameter for vessels with medium or fine sandy pastes and
floated/unburnished exterior surfaces (the two preferred process sequences) are 18.2
cm (SD = 6.61 cm) and 18.3 cm (SD = 6.65 cm) respectively. The statistics show that
there is no significant difference in mean diameter for these process sequences. This
may be ambiguously interpreted as either (i) weakly reinforcing the notion that the two
sequences may be based on a single emic paste category that approximates the fine and
medium sand classes on the Wentworth scale, or (ii) demonstrating that if the process sequences correspond to emically distinguished paste categories, then no functional difference can be distinguished for these vessels on the basis of rim diameter.

It should be noted, however, that the second interpretation may be weakened by the fact that the smallest vessel in the class of vessels with fine sandy pastes and floated/unburnished exterior surfaces is also the smallest vessel in the entire assemblage, and also was red-washed and cord-marked in the surface enhancement stage of manufacture. Both of these enhancement techniques are very rare in the assemblage, and their co-occurrence on the smallest vessel is highly suggestive of a set of choices oriented toward a special purpose vessel. If this vessel is eliminated from testing as an outlier, repeating the comparison still shows no difference in mean diameter between vessels with the dominant process sequences. Interestingly, the diameter of the red-washed/cord-marked vessel (8 cm) within the 95% confidence interval (7.26-31.34 cm) of the remaining vessels with fine sandy pastes and floated/unburnished exterior surfaces, and one-tailed t-test at a significance level of 0.05 does not support rejection of the null hypothesis that the diameter of the red-washed/cord-marked sherd is too small to belong to the distribution of diameters for vessels with the same paste and exterior surface treatment. Thus, if there is a functional difference between the red-washed/cord-marked vessel and the other vessels with fine sandy pastes and floated/unburnished exterior surfaces, that functional difference does not relate to diameter in the assemblage at 41HR616.

The mean diameters of vessels with medium or fine sandy pastes and dry-smoothed/unburnished exterior surfaces (two uncommon process sequences) are 31.0 cm (SD = 6.56 cm) and 27.7 cm (SD = 3.79 cm) respectively. The statistics show that
there is no significant difference in mean diameter between these process sequences, but that they are significantly different from vessels with the most preferred process sequences in comparisons that include and exclude the red-marked/cord-marked vessel. Vessels with medium or fine sandy pastes and dry-smoothed/unburnished exterior surfaces, therefore, appear to have larger rim diameters than vessels with the most preferred process sequences. This suggests that there may be diameter-sensitive functional differences between vessels manufactured according to these two uncommon process sequences and vessels with the most preferred process sequences. This suggestion is supported by the fact that the mean diameters of vessels with medium or fine sandy pastes and dry-smoothed/unburnished exterior surfaces are statistically different from the mean diameters of vessels with any uncommon process sequence that involves a floated exterior surface, although this support is weak because all of these other comparisons involve very small sample sizes ($n <= 4$).

In summary, the overwhelming preference for vessels with fine-to-medium sandy pastes and floated/unburnished surfaces appears to reflect a preferred set of choices that form the core of the pottery manufacturing tradition present at 41HR616. Beyond that, there is reason to believe that vessels in several of the low-preference sequences may have been manufactured for specific purposes. Whether this same preference structure is reflected in the ceramics at other upper Texas coast sites remains to be tested.
Conclusions

The preceding analysis has classified the ceramics recovered from 41HR616 on the basis of technological attributes that survive after production, use, and post-depositional processes. It shows that an emphasis on surviving technological attributes makes it possible to describe the range of choices made at any particular stage in the pottery manufacturing process. This description in turn makes it possible to describe the range of sequences of choices that follow upon the decision to make a pot. Thus, classification in terms of technological attributes makes it possible to propose and test hypotheses regarding the preference structure that governed ceramic production activities among the occupants of 41HR616. Table 7.25 summarizes that structure.

This analysis yields a number of plausible insights into upper Texas coast pottery production. First, the pottery-making system is more multi-faceted than can be captured or described by the dominant classification scheme currently in use by archeologists in the upper Texas coast area. Although two manufacturing sequences were predominantly preferred, these sequences were not the only known sequences. As this analysis revealed, a wider array of choices were available to any individual potter than has been previously acknowledged in upper Texas coast archeology. For example, the floated/unburnished surface is the most common surface treatment technique, however, three other surface treatment techniques (floated/burnished, dry-smoothed/unburnished, and dry-smoothed/burnished; five if one counts the presence of red-floated/burnished and red-floated/unburnished surfaces) were also used to finish the surface of vessels recovered from 41HR616. Obviously, the cultural repertoire of pottery-making techniques also included these techniques, however, potters chose them less frequently.
Why they were chosen less frequently remains to be seen. However, the fact that each individual surface treatment mode occurs in each analytical level points to intentional choice rather than mere accidental occurrence.

Second, although a wide array of choices are available to any individual potter, the pattern of choice appears to be highly structured in that two manufacturing sequences are always nonrandomly preferred over all others. At the core of the manufacturing tradition is the undecorated vessel that has a fine-to-medium sandy paste with a floated/unburnished exterior and interior surface. While this finding does not necessarily offer new or startling insight into the typical upper Texas coast vessel, it does point to a structured, nonrandom pattern of choices among a wide array of alternatives.

Third, because two pottery manufacturing sequences are overwhelming preferred, this narrows the range of ceramic variability. Narrowing the range of ceramic variability has functional implications. As Braun (1983:108-109; also see Schiffer and Skibo 1987) has pointed out, the characteristics of vessel morphology, composition, and manufacture are constrained by their intended use and, conversely, the mechanical performance characteristics of a vessel are conditioned by the method of manufacture, vessel morphology, and paste composition. Thus, the potter must establish a compromise with regard to the selection of raw material and manufacturing techniques as they relate to the vessel’s intended use and, by implication, its form. During the process of manufacturing a pot, the potter is forced to make certain compromises or cost/benefit decisions, such as the amount of time and labor invested relative to the desired life expectancy and use of the vessel. Therefore, as Braun (1983:109) notes,
variation in mechanically sensitive attributes of morphology and composition indicates variation in the relative importance of the factors conditioning the compromise. In theory, then, these mechanically sensitive attributes, when their mechanical meaning is recognized, provide the archaeologist with the means for explaining ceramic technical variation, rather than just describing it.

Consequently, the fact that two manufacturing sequences were overwhelmingly preferred would seem to suggest that the factors conditioning the construction of fine-to-medium sandy paste vessels with floated/unburnished exterior surfaces represented dominant concerns. This seems to suggest that functionally these vessels may have been designed (i) to accommodate a variety of uses, that is, they were multi-purpose vessels or (ii) to accommodate one overwhelmingly dominant use. By contrast, the fact that several less frequently chosen sequences appear to be nonrandomly preferred over other less frequently chosen sequences, suggests that the factors conditioning their construction represented less dominant but, perhaps, nonetheless specific concerns. This idea is further supported by the statistically significant differences between the mean diameters of at least two categories of vessels with less frequently chosen manufacturing sequences. This seems to suggest that the cost/benefit ratio conditioning the construction of these particular sequences made them appropriate choices for some as yet unknown function or functions.

While the ceramic assemblage at 41HR616 exhibits a structured pattern of choice with a rather narrow range of ceramic variability, this is not to say that this range would be the same for other upper Texas coast sites in that the processes that governed ceramic manufacturing at 41HR616 may have differed at other sites. Indeed, ceramic studies at
41HR273 indicate that different preference structures may very likely be in operation. At 41HR273, dry-smoothed/unburnished exterior surfaces are predominant in the lower excavation levels while floated/unburnished exterior surfaces are predominant in the upper excavation levels. Intuitively, this suggests a change in the preference structure through time. Whether hypothesis testing would confirm or disconfirm this intuition remains a subject for further study. However, such findings strongly suggest the presence of other preference structures, and they illustrate the need for the reanalysis of existing collections in order to incorporate a wide range manufacturing attributes. Only then will we be able to develop a regional database of the occurrence of technological attributes and, along with it, a regional database of similar and different approaches to pottery production.

In upper Texas coast research, the tendency has been to view pottery as time markers only, and ceramic research has been devoted almost exclusively to research problems involving cultural/historical relationships. By looking at manufacturing techniques, we can begin to build classification schemes based on technological variables. Such variables provide a more effective means of addressing process oriented research problems. Only by expanding our theoretical and methodological research designs for upper Texas coast ceramics can we begin to discuss the role that ceramics may have played among native groups in the upper Texas coast region.
Tables and Figures: Appendix V
Table 7.1 Attributes of technological style in the Upper Texas Coastal region.

I. Procurement and processing attributes
   A. Sandy paste categories
   B. Tempered paste categories

II. Primary forming attributes
    A. Sherd class
    B. Exterior scraping marks
    C. Interior scraping marks
    D. Base characteristics
    E. Diameter
    F. Rim profile
    G. Rim form
    H. Rim angle
    I. Lip profile
    J. Thickness

III. Surface finishing attributes
     A. Auxiliary construction techniques
     B. Supplementary techniques

IV. Surface enhancement attributes
    A. Surface displacement of wet paste
    B. Surface displacement of leather-hard paste
    C. Surface displacement of dry paste
    D. Application of a veneer
    E. Application of a red wash
    F. Enhancement motif
    G. Lip decoration

V. Firing attributes
   A. Smudging
   B. Exterior color
   C. Interior color
   D. Paste color

VI. Post-firing attributes
    A. Asphaltum
    B. Drill holes
    C. Abrasion
    D. Notches
    E. Burned
    F. Eroded surfaces
Table 7.2 Fitted sherds.

<table>
<thead>
<tr>
<th>Area</th>
<th>Fresh Breaks</th>
<th>Old Breaks</th>
<th>Fresh &amp; Old Breaks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>ST</td>
<td>4</td>
<td>100.0</td>
<td>0</td>
</tr>
<tr>
<td>A</td>
<td>107</td>
<td>67.7</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>38</td>
<td>60.3</td>
<td>16</td>
</tr>
<tr>
<td>C</td>
<td>29</td>
<td>76.3</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>9</td>
<td>81.8</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>17</td>
<td>43.6</td>
<td>17</td>
</tr>
<tr>
<td>F</td>
<td>10</td>
<td>90.9</td>
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</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>66.0</td>
<td>45</td>
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Table 7.3 Mean thickness of sherds (in cm).

<table>
<thead>
<tr>
<th>Unit</th>
<th>Body Sherds</th>
<th>Basal Sherds</th>
<th>Rim Sherds</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.529</td>
<td>0.573</td>
<td>0.546</td>
</tr>
<tr>
<td>Unit A</td>
<td>0.514</td>
<td>0.480</td>
<td>0.557</td>
</tr>
<tr>
<td>Unit B</td>
<td>0.543</td>
<td>0.600</td>
<td>0.551</td>
</tr>
<tr>
<td>Unit C</td>
<td>0.559</td>
<td>0.500</td>
<td>0.504</td>
</tr>
<tr>
<td>Unit D</td>
<td>0.504</td>
<td>None</td>
<td>0.500</td>
</tr>
<tr>
<td>Unit E</td>
<td>0.535</td>
<td>None</td>
<td>0.545</td>
</tr>
<tr>
<td>Unit F</td>
<td>0.549</td>
<td>None</td>
<td>0.625</td>
</tr>
<tr>
<td>Test Pits</td>
<td>0.521</td>
<td>0.850</td>
<td>0.646</td>
</tr>
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</table>

Table 7.4 Munsell color of red mineral pigmented sherds.

<table>
<thead>
<tr>
<th>Sherd Number</th>
<th>Exterior Color</th>
<th>Interior Color</th>
<th>Exterior Color</th>
<th>Interior Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark-Red-Floated</td>
<td>Red-Floated</td>
<td>A01/1501</td>
<td>5YR6/6</td>
<td>5YR3/2</td>
</tr>
<tr>
<td>A03/0601</td>
<td>5YR4/3</td>
<td>5YR3/4</td>
<td>A06/0702</td>
<td>2.5YR3/6</td>
</tr>
<tr>
<td>A03/1404</td>
<td>5YR5/3</td>
<td>5YR3/4</td>
<td>A07/0601</td>
<td>2.5YR3/6</td>
</tr>
<tr>
<td>A03/1501</td>
<td>5YR4/6</td>
<td>5YR3/4</td>
<td>A07/0701</td>
<td>2.5YR4/4</td>
</tr>
<tr>
<td>A06/0901</td>
<td>5YR4/4</td>
<td>5YR3/2</td>
<td>A16/1001</td>
<td>2.5YR4/4</td>
</tr>
<tr>
<td>A06/1301</td>
<td>5YR4/4</td>
<td>5YR3/2</td>
<td>A17/1102</td>
<td>2.5YR5/6</td>
</tr>
<tr>
<td>A06/1401</td>
<td>5YR4/4</td>
<td>5YR3/4</td>
<td>A17/1108</td>
<td>10R4/6</td>
</tr>
<tr>
<td>A06/1403</td>
<td>5YR4/6</td>
<td>5YR3/4</td>
<td>A21/1201</td>
<td>10R4/6</td>
</tr>
<tr>
<td>A06/1402</td>
<td>5YR4/4</td>
<td>5YR4/6</td>
<td>B35/0802</td>
<td>2.5YR4/4</td>
</tr>
<tr>
<td>A14/1601</td>
<td>5YR4/4</td>
<td>5YR5/6</td>
<td>E48/1202</td>
<td>2.5YR4/4</td>
</tr>
<tr>
<td>A27/1702</td>
<td>5YR4/4</td>
<td>5YR5/6</td>
<td>E50/1101</td>
<td>2.5YR4/4</td>
</tr>
<tr>
<td>B34/1102</td>
<td>5YR4/4</td>
<td>5YR4/3</td>
<td>E50/1102</td>
<td>2.5YR3/4</td>
</tr>
<tr>
<td>C40/1006</td>
<td>5YR4/4</td>
<td>5YR4/3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F54/1002</td>
<td>5YR6/3</td>
<td>5YR5/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F54/1101</td>
<td>5YR4/4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPD/1002</td>
<td>2.5YR3/4</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>
### Table 7.5 Paste categories by analytical levels.

<table>
<thead>
<tr>
<th>Levels</th>
<th>Sandy Paste</th>
<th>Clay-Tempered</th>
<th>Bone-Tempered</th>
<th>Bone &amp; Clay Tempered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n$</td>
<td>%</td>
<td>$n$</td>
<td>%</td>
</tr>
<tr>
<td>AL1</td>
<td>141</td>
<td>84.4</td>
<td>17</td>
<td>10.2</td>
</tr>
<tr>
<td>AL2</td>
<td>142</td>
<td>94.0</td>
<td>9</td>
<td>6.0</td>
</tr>
<tr>
<td>AL3</td>
<td>155</td>
<td>95.7</td>
<td>7</td>
<td>4.3</td>
</tr>
<tr>
<td>AL4</td>
<td>151</td>
<td>95.0</td>
<td>8</td>
<td>5.0</td>
</tr>
<tr>
<td>All</td>
<td>589</td>
<td>92.2</td>
<td>41</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Division within sandy paste category by analytical levels

<table>
<thead>
<tr>
<th>Levels</th>
<th>Medium</th>
<th>Fine</th>
<th>Very Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n$</td>
<td>%</td>
<td>$n$</td>
</tr>
<tr>
<td>AL1</td>
<td>73</td>
<td>51.7</td>
<td>53</td>
</tr>
<tr>
<td>AL2</td>
<td>75</td>
<td>52.8</td>
<td>58</td>
</tr>
<tr>
<td>AL3</td>
<td>81</td>
<td>52.3</td>
<td>64</td>
</tr>
<tr>
<td>AL4</td>
<td>68</td>
<td>45.5</td>
<td>70</td>
</tr>
<tr>
<td>All</td>
<td>297</td>
<td>50.4%</td>
<td>245</td>
</tr>
</tbody>
</table>
Table 7.6 Tests for randomness of paste choice.

Null Hypothesis: Choice among all six pastes is random (i.e., \( n \) observed = \( n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>Trials</th>
<th>( p )</th>
<th>Min/Max</th>
<th>( n )</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>MSP</td>
<td>639</td>
<td>0.1666</td>
<td>3/297</td>
<td>88-125</td>
<td>95.6</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>MSP</td>
<td>167</td>
<td>0.1666</td>
<td>3/73</td>
<td>18-37</td>
<td>96.1</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>MSP</td>
<td>151</td>
<td>0.1666</td>
<td>0/75</td>
<td>16-34</td>
<td>96.1</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>MSP</td>
<td>162</td>
<td>0.1666</td>
<td>0/81</td>
<td>18-36</td>
<td>95.4</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>FSP</td>
<td>159</td>
<td>0.1666</td>
<td>0/70</td>
<td>17-36</td>
<td>96.6</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Null Hypothesis: Choice among five least frequent pastes is random (i.e., \( n \) observed = \( n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>Trials</th>
<th>( p )</th>
<th>Min/Max</th>
<th>( n )</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>FSP</td>
<td>342</td>
<td>0.2000</td>
<td>3/245</td>
<td>9-22</td>
<td>96.8</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>FSP</td>
<td>94</td>
<td>0.2000</td>
<td>3/53</td>
<td>0-6</td>
<td>99.2</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>FSP</td>
<td>76</td>
<td>0.2000</td>
<td>0/58</td>
<td>1-7</td>
<td>98.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>FSP</td>
<td>81</td>
<td>0.2000</td>
<td>0/64</td>
<td>2-9</td>
<td>97.2</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>MSP</td>
<td>89</td>
<td>0.2000</td>
<td>0/68</td>
<td>1-7</td>
<td>97.4</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Null Hypothesis: Choice among four least frequent pastes is random (i.e., \( n \) observed = \( n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>Trials</th>
<th>( p )</th>
<th>Min/Max</th>
<th>( n )</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>VFSP</td>
<td>97</td>
<td>0.2500</td>
<td>3/47</td>
<td>7-16</td>
<td>96.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>CLAY</td>
<td>41</td>
<td>0.2500</td>
<td>3/17</td>
<td>0-3</td>
<td>100.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>VFSP or CLAY</td>
<td>18</td>
<td>0.2500</td>
<td>0/9</td>
<td>0-4</td>
<td>100.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>VFSP</td>
<td>17</td>
<td>0.2500</td>
<td>0/10</td>
<td>1-6</td>
<td>98.4</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>VFSP</td>
<td>21</td>
<td>0.2500</td>
<td>0/13</td>
<td>1-6</td>
<td>98.4</td>
<td>Reject</td>
</tr>
</tbody>
</table>
Table 7.6 (continued). Tests for randomness of paste choice.

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>N Trials</th>
<th>p Value</th>
<th>Min/Max Expected</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>CLAY</td>
<td>50</td>
<td>0.3333</td>
<td>3/41</td>
<td>39-63</td>
<td>95.7</td>
</tr>
<tr>
<td>AL1</td>
<td>VFSP</td>
<td>26</td>
<td>0.3333</td>
<td>3/15</td>
<td>5-15</td>
<td>96.0</td>
</tr>
<tr>
<td>AL2</td>
<td>VFSP</td>
<td>9</td>
<td>0.3333</td>
<td>0/9</td>
<td>7-19</td>
<td>96.2</td>
</tr>
<tr>
<td>or CLAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL3</td>
<td>VFSP</td>
<td>7</td>
<td>0.3333</td>
<td>0/7</td>
<td>8-20</td>
<td>95.3</td>
</tr>
<tr>
<td>AL4</td>
<td>VFSP</td>
<td>8</td>
<td>0.3333</td>
<td>0/8</td>
<td>8-21</td>
<td>96.6</td>
</tr>
</tbody>
</table>

Null Hypothesis: Choice among three least frequent pastes is random (i.e., n observed = n expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>N Trials</th>
<th>p Value</th>
<th>Min/Max Expected</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>BONE</td>
<td>9</td>
<td>0.5000</td>
<td>3/6</td>
<td>2-7</td>
<td>96.1</td>
</tr>
<tr>
<td>AL1</td>
<td>BONE</td>
<td>9</td>
<td>0.5000</td>
<td>3/6</td>
<td>2-7</td>
<td>96.1</td>
</tr>
<tr>
<td>AL2</td>
<td>Both = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL3</td>
<td>Both = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL4</td>
<td>Both = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypotheses accepted/rejected at 0.05 significance level

- MSP = medium sandy paste
- FSP = fine sandy paste
- VFSP = very fine sandy paste
- CLAY = clay-tempered paste
- BONE = bone-tempered paste
- B&C = bone-and-clay-tempered paste

Table 7.7 Rank preferences for paste choice.

<table>
<thead>
<tr>
<th>All Levels</th>
<th>AL1</th>
<th>AL2</th>
<th>AL3</th>
<th>AL4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paste</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>MSP</td>
<td>2971</td>
<td>MSP</td>
<td>731</td>
<td>MSP</td>
</tr>
<tr>
<td>FSP</td>
<td>2452</td>
<td>FSP</td>
<td>532</td>
<td>FSP</td>
</tr>
<tr>
<td>VFSP</td>
<td>473</td>
<td>CLAY</td>
<td>173</td>
<td>VFSP</td>
</tr>
<tr>
<td>CLAY</td>
<td>413</td>
<td>VFSP</td>
<td>153</td>
<td>CLAY</td>
</tr>
<tr>
<td>BONE</td>
<td>64</td>
<td>BONE</td>
<td>64</td>
<td>BONE</td>
</tr>
<tr>
<td>B&amp;C</td>
<td>34</td>
<td>B&amp;C</td>
<td>34</td>
<td>B&amp;C</td>
</tr>
</tbody>
</table>

Ranks with different superscripts are different at 0.05 significance level

- MSP = medium sandy paste
- FSP = fine sandy paste
- VFSP = very fine sandy paste
- CLAY = clay-tempered paste
- BONE = bone-tempered paste
- B&C = bone-and-clay-tempered paste
Table 7.8 Frequencies of basic exterior surface treatments.

<table>
<thead>
<tr>
<th>Level</th>
<th>DS/NB</th>
<th>DS/B</th>
<th>F/NB</th>
<th>F/B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL1</td>
<td>16</td>
<td>1</td>
<td>90</td>
<td>17</td>
<td>124</td>
</tr>
<tr>
<td>AL2</td>
<td>12</td>
<td>4</td>
<td>100</td>
<td>12</td>
<td>128</td>
</tr>
<tr>
<td>AL3</td>
<td>11</td>
<td>1</td>
<td>109</td>
<td>15</td>
<td>136</td>
</tr>
<tr>
<td>AL4</td>
<td>17</td>
<td>4</td>
<td>99</td>
<td>15</td>
<td>135</td>
</tr>
<tr>
<td>All</td>
<td>56</td>
<td>10</td>
<td>398</td>
<td>59</td>
<td>523</td>
</tr>
</tbody>
</table>

DS/NB = dry-smoothed/unburnished  
F/NB = floated/unburnished  
DS/B = dry-smoothed/burnished  
F/B = floated/burnished

Table 7.9 Tests for randomness of exterior surface treatment choice.

Null Hypothesis: Choice among all four surface treatments is random (i.e., \( n \) observed = \( n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>( N )</th>
<th>( p )</th>
<th>Min/Max</th>
<th>( n )</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>F/NB</td>
<td>523</td>
<td>0.2500</td>
<td>10/398</td>
<td>111-150</td>
<td>95.6</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>F/NB</td>
<td>124</td>
<td>0.2500</td>
<td>1/90</td>
<td>22-40</td>
<td>95.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>F/NB</td>
<td>128</td>
<td>0.2500</td>
<td>4/100</td>
<td>22-42</td>
<td>96.7</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>F/NB</td>
<td>136</td>
<td>0.2500</td>
<td>1/109</td>
<td>24-44</td>
<td>96.2</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>F/NB</td>
<td>135</td>
<td>0.2500</td>
<td>4/99</td>
<td>24-44</td>
<td>96.2</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Null Hypothesis: Choice among three least frequent surfaces treatments is random (i.e., \( n \) observed = \( n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>( N )</th>
<th>( p )</th>
<th>Min/Max</th>
<th>( n )</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>F/B</td>
<td>125</td>
<td>0.3333</td>
<td>10/59</td>
<td>31-52</td>
<td>96.2</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>F/B</td>
<td>34</td>
<td>0.3333</td>
<td>1/17</td>
<td>6-17</td>
<td>96.9</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>DS/NB or F/B</td>
<td>28</td>
<td>0.3333</td>
<td>4/12</td>
<td>5-14</td>
<td>95.7</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>F/B</td>
<td>27</td>
<td>0.3333</td>
<td>1/15</td>
<td>4-14</td>
<td>97.7</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>DS/NB</td>
<td>36</td>
<td>0.3333</td>
<td>4/17</td>
<td>6-18</td>
<td>97.7</td>
<td>Reject</td>
</tr>
</tbody>
</table>
Table 7.9 (continued). Tests for randomness of exterior surface treatment choice.

Null Hypothesis: Choice among two least frequent surfaces treatments is random (i.e., \( n \) observed = \( n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>( N )</th>
<th>( p )</th>
<th>Min/Max Observed</th>
<th>( n ) Expected</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>DS/NB</td>
<td>66</td>
<td>0.5000</td>
<td>10/66</td>
<td>25-41</td>
<td>96.3</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>DS/NB</td>
<td>17</td>
<td>0.5000</td>
<td>1/16</td>
<td>5-12</td>
<td>95.1</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>F/B</td>
<td>16</td>
<td>0.5000</td>
<td>4/12</td>
<td>4-12</td>
<td>97.9</td>
<td>Accept</td>
</tr>
<tr>
<td></td>
<td>or DS/NB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL3</td>
<td>DS/NB</td>
<td>12</td>
<td>0.5000</td>
<td>1/11</td>
<td>3-9</td>
<td>96.1</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>F/NB</td>
<td>19</td>
<td>0.5000</td>
<td>4/15</td>
<td>5-14</td>
<td>98.1</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Hypotheses accepted/rejected at 0.05 significance level

DS/NB = dry-smoothed/unburnished
F/NB = floated/unburnished
DS/B = dry-smoothed/burnished
F/B = floated/burnished

Table 7.10 Rank preferences for exterior surface treatment.

<table>
<thead>
<tr>
<th>All Levels</th>
<th>AL1</th>
<th>AL2</th>
<th>AL3</th>
<th>AL4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>( n )</td>
<td>Surface</td>
<td>( n )</td>
<td>Surface</td>
</tr>
<tr>
<td>F/NB</td>
<td>398\textsuperscript{1}</td>
<td>F/NB</td>
<td>90\textsuperscript{1}</td>
<td>F/NB</td>
</tr>
<tr>
<td>F/B</td>
<td>59\textsuperscript{2}</td>
<td>F/B</td>
<td>17\textsuperscript{2}</td>
<td>DS/NB</td>
</tr>
<tr>
<td>DS/NB</td>
<td>56\textsuperscript{2}</td>
<td>DS/NB</td>
<td>16\textsuperscript{2}</td>
<td>F/B</td>
</tr>
<tr>
<td>DS/B</td>
<td>10\textsuperscript{3}</td>
<td>DS/B</td>
<td>13\textsuperscript{3}</td>
<td>DS/B</td>
</tr>
</tbody>
</table>

Ranks with different superscripts are different at 0.05 significance level

DS/NB = dry-smoothed/unburnished
F/NB = floated/unburnished
DS/B = dry-smoothed/burnished
F/B = floated/burnished

Table 7.11 Frequencies of basic interior surface treatments.

<table>
<thead>
<tr>
<th>Level</th>
<th>DS/NB</th>
<th>DS/B</th>
<th>F/NB</th>
<th>F/B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL1</td>
<td>20</td>
<td>2</td>
<td>96</td>
<td>6</td>
<td>124</td>
</tr>
<tr>
<td>AL2</td>
<td>16</td>
<td>0</td>
<td>105</td>
<td>4</td>
<td>125</td>
</tr>
<tr>
<td>AL3</td>
<td>11</td>
<td>3</td>
<td>10\textsuperscript{9}</td>
<td>4</td>
<td>127</td>
</tr>
<tr>
<td>AL4</td>
<td>17</td>
<td>0</td>
<td>104</td>
<td>6</td>
<td>127</td>
</tr>
<tr>
<td>All</td>
<td>64</td>
<td>5</td>
<td>414</td>
<td>20</td>
<td>503</td>
</tr>
</tbody>
</table>

DS/NB = dry-smoothed/unburnished
F/NB = floated/unburnished
DS/B = dry-smoothed/burnished
F/B = floated/burnished
Table 7.12 Tests for randomness of interior surface treatment choice.

Null Hypothesis: Choice among all four surface treatments is random (i.e., $n$ observed = $n$ expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>Most Frequent</th>
<th>N Trials</th>
<th>$p$</th>
<th>Min/Max Observed</th>
<th>$n$</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>F/NB</td>
<td>503</td>
<td>0.2500</td>
<td>5/14</td>
<td>107-145</td>
<td>95.5</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>F/NB</td>
<td>124</td>
<td>0.2500</td>
<td>2/96</td>
<td>22-40</td>
<td>95.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>F/NB</td>
<td>125</td>
<td>0.2500</td>
<td>0/105</td>
<td>22-41</td>
<td>96.0</td>
<td>Reject</td>
</tr>
<tr>
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<td>F/NB</td>
<td>127</td>
<td>0.2500</td>
<td>3/109</td>
<td>22-41</td>
<td>95.9</td>
<td>Reject</td>
</tr>
<tr>
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<td>F/NB</td>
<td>127</td>
<td>0.2500</td>
<td>0/104</td>
<td>22-41</td>
<td>95.1</td>
<td>Reject</td>
</tr>
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</table>

Null Hypothesis: Choice among three least frequent surfaces treatments is random (i.e., $n$ observed = $n$ expected)

<table>
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<tr>
<th>Level</th>
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<th>N Trials</th>
<th>$p$</th>
<th>Min/Max Observed</th>
<th>$n$</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
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<td>DS/NB</td>
<td>89</td>
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<td>5/64</td>
<td>21-38</td>
<td>95.6</td>
<td>Reject</td>
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<td>DS/NB</td>
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<td>0.3333</td>
<td>2/20</td>
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<td>DS/NB</td>
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<td>0.3333</td>
<td>0/16</td>
<td>3-11</td>
<td>96.9</td>
<td>Reject</td>
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<tr>
<td>AL3</td>
<td>DS/NB</td>
<td>18</td>
<td>0.3333</td>
<td>3/11</td>
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<td>97.9</td>
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</tr>
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<td>DS/NB</td>
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<td>0.3333</td>
<td>0/17</td>
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<td>97.5</td>
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</table>

Null Hypothesis: Choice among two least frequent surfaces treatments is random (i.e., $n$ observed = $n$ expected)

<table>
<thead>
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<th>Level</th>
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<th>N Trials</th>
<th>$p$</th>
<th>Min/Max Observed</th>
<th>$n$</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
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<td>5/20</td>
<td>8-17</td>
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<td>F/B</td>
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<td>2/6</td>
<td>1-7</td>
<td>99.2</td>
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<td>0/4</td>
<td>0-4</td>
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</tr>
<tr>
<td>AL3</td>
<td>F/B</td>
<td>7</td>
<td>0.5000</td>
<td>3/4</td>
<td>1-6</td>
<td>98.4</td>
<td>Accept</td>
</tr>
<tr>
<td>AL4</td>
<td>F/B</td>
<td>6</td>
<td>0.5000</td>
<td>0/6</td>
<td>1-5</td>
<td>96.9</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Hypotheses accepted/rejected at 0.05 significance level

DS/NB = dry-smoothed/unburnished  
F/NB = floated/unburnished  
DS/B = dry-smoothed/burnished  
F/B = floated/burnished
Table 7.13 Rank preferences for interior surface treatment.

<table>
<thead>
<tr>
<th>All Levels</th>
<th>AL1</th>
<th>AL2</th>
<th>AL3</th>
<th>AL4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>n</td>
<td>Surface</td>
<td>n</td>
<td>Surface</td>
</tr>
<tr>
<td>F/NB</td>
<td>414(^1)</td>
<td>F/NB</td>
<td>96(^1)</td>
<td>F/NB</td>
</tr>
<tr>
<td>DS/NB</td>
<td>64(^2)</td>
<td>DS/NB</td>
<td>20(^2)</td>
<td>DS/NB</td>
</tr>
<tr>
<td>F/B</td>
<td>20(^3)</td>
<td>F/B</td>
<td>6(^3)</td>
<td>F/B</td>
</tr>
<tr>
<td>DS/B</td>
<td>5(^5)</td>
<td>DS/B</td>
<td>2(^3)</td>
<td>DS/B</td>
</tr>
</tbody>
</table>

Ranks with different superscripts are different at 0.05 significance level

DS/NB = dry-smoothed/unburnished  
F/NB = floated/unburnished  
DS/B = dry-smoothed/burnished  
F/B = floated/burnished

Table 7.14 Tests for randomness of enhancement techniques.

Null Hypothesis: Choice among all four techniques is random (i.e., n observed = n expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>N Trials</th>
<th>p</th>
<th>Min/Max Observed</th>
<th>n</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
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<td>1/26</td>
<td>3-13</td>
<td>97.7</td>
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</tr>
<tr>
<td>AL1</td>
<td>12</td>
<td>0.2500</td>
<td>0/8</td>
<td>1-6</td>
<td>95.4</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>9</td>
<td>0.2500</td>
<td>0/9</td>
<td>0-4</td>
<td>95.1</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>4</td>
<td>0.2500</td>
<td>0/4</td>
<td>0-3</td>
<td>99.6</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>6</td>
<td>0.2500</td>
<td>0/5</td>
<td>0-3</td>
<td>96.2</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Null Hypothesis: Choice among three least frequent techniques is random (i.e., n observed = n expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>N Trials</th>
<th>p</th>
<th>Min/Max Observed</th>
<th>n</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>6</td>
<td>0.3333</td>
<td>1/3</td>
<td>0-4</td>
<td>98.2</td>
<td>Accept</td>
</tr>
<tr>
<td>AL1</td>
<td>5</td>
<td>0.3333</td>
<td>0/8</td>
<td>1-6</td>
<td>95.2</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
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<td>0.3333</td>
<td>0/1</td>
<td>0-1</td>
<td>100.0</td>
<td>Accept</td>
</tr>
</tbody>
</table>

Null Hypothesis: Choice among two least frequent techniques is random (i.e., n observed = n expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>N Trials</th>
<th>p</th>
<th>Min/Max Observed</th>
<th>n</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>2</td>
<td>0.5000</td>
<td>1/1</td>
<td>0-2</td>
<td>100.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
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<td>0.5000</td>
<td>0/1</td>
<td>0-1</td>
<td>100.0</td>
<td>Reject</td>
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<tr>
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<td>0.5000</td>
<td>0/1</td>
<td>0-1</td>
<td>100.0</td>
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</tbody>
</table>

Hypotheses accepted/rejected at 0.05 significance level.
Table 7.15 Rank preferences for enhancement techniques.

<table>
<thead>
<tr>
<th>All Levels</th>
<th>AL1</th>
<th>AL2</th>
<th>AL3</th>
<th>AL4</th>
</tr>
</thead>
<tbody>
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<td>Tech.</td>
<td>n</td>
<td>Tech.</td>
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<tr>
<td>IN</td>
<td>26₁</td>
<td>IN</td>
<td>8₁</td>
<td>IN</td>
</tr>
<tr>
<td>BR</td>
<td>4²</td>
<td>BR</td>
<td>4₁²</td>
<td>BR</td>
</tr>
<tr>
<td>CRD</td>
<td>1²³</td>
<td>ENG</td>
<td>1²³</td>
<td>CRD</td>
</tr>
<tr>
<td>ENG</td>
<td>1²³</td>
<td>CRD</td>
<td>0²³</td>
<td>ENG</td>
</tr>
</tbody>
</table>

Ranks with different superscripts are different at 0.05 significance level

IN = incised  BR = brushed  CRD = cord-marked  ENG = engraved

Table 7.16 Tests for preference of incising techniques.

Null Hypothesis: Incising on leather-hard paste is not preferred (i.e., \( n \) observed \( \leq n \) expected)

<table>
<thead>
<tr>
<th>Level</th>
<th>N Trials</th>
<th>p</th>
<th>Min/Max Observed</th>
<th>n</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Reject</td>
</tr>
<tr>
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</tr>
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<td>0.5000</td>
<td>4</td>
<td>≤4</td>
<td>100.0</td>
<td>Accept</td>
</tr>
<tr>
<td>AL4</td>
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<td>0.5000</td>
<td>3</td>
<td>≤4</td>
<td>96.9</td>
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</table>

Hypotheses accepted/rejected at 0.05 significance level
Table 7.17 Frequencies of process sequences.

<table>
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<th>Paste Choices</th>
<th>Surface Treatment Choices</th>
<th>Level</th>
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<th>DS/B</th>
<th>F/B</th>
<th>F/NB</th>
<th>Total</th>
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<td>8</td>
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<td>66</td>
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<td>3</td>
<td>4</td>
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<td>58</td>
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<td>39</td>
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<td></td>
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<td>5</td>
<td>6</td>
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<td>23</td>
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<td>0</td>
<td>3</td>
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<td></td>
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<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>B&amp;C</td>
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<td>4</td>
<td>1</td>
<td>5</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
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<td>ALL</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

DS/NB = dry-smoothed, unburnished
F/B = floated, burnished
F/NB = floated, unburnished
MSP = medium sandy paste
FSP = fine sandy paste
VFSP = very fine sandy paste
CLAY = clay-tempered paste
BONE = bone-tempered paste
B&C = bone-and-clay-tempered paste
Table 7.18 Tests for randomness of process sequence choice.

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>p</th>
<th>Min/Max</th>
<th>n</th>
<th>C.I. (%)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>523</td>
<td>0.0417</td>
<td>0/190</td>
<td>13-31</td>
<td>98.0</td>
<td>Reject</td>
</tr>
<tr>
<td>AL1</td>
<td>124</td>
<td>0.0417</td>
<td>0/41</td>
<td>1-10</td>
<td>97.7</td>
<td>Reject</td>
</tr>
<tr>
<td>AL2</td>
<td>128</td>
<td>0.0417</td>
<td>0/52</td>
<td>1-10</td>
<td>96.7</td>
<td>Reject</td>
</tr>
<tr>
<td>AL3</td>
<td>136</td>
<td>0.0417</td>
<td>0/31</td>
<td>2-11</td>
<td>96.7</td>
<td>Reject</td>
</tr>
<tr>
<td>AL4</td>
<td>135</td>
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<td>0/46</td>
<td>2-11</td>
<td>96.1</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Hypotheses accepted/rejected at 0.05 significance level

Table 7.20 Process sequences with zero frequencies in all analytical levels.

- Clay-tempered, dry-smoothed/burnished
- Bone-tempered, dry-smoothed/burnished
- Bone-tempered, floated/burnished
- Bone-tempered, floated/unburnished
- Bone-and-clay-tempered, dry-smoothed/burnished
- Bone-and-clay-tempered, dry-smoothed/unburnished

Table 7.21 Overall rank of sequences in each analytical level.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Overall Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AL4</td>
</tr>
<tr>
<td>Fine sandy paste, floated/burnished</td>
<td>2.0</td>
</tr>
<tr>
<td>Very fine sandy paste, floated/unburnished</td>
<td>2.5</td>
</tr>
<tr>
<td>Medium sandy paste, dry-smoothed/unburnished</td>
<td>3.0</td>
</tr>
<tr>
<td>Fine sandy paste, dry-smoothed/unburnished</td>
<td>3.0</td>
</tr>
<tr>
<td>Very fine sandy paste, dry-smoothed/unburnished</td>
<td>3.0</td>
</tr>
<tr>
<td>Clay-tempered, floated/burnished</td>
<td>3.0</td>
</tr>
<tr>
<td>Medium sandy paste, floated/burnished</td>
<td>3.5</td>
</tr>
<tr>
<td>Medium sandy paste, dry-smoothed/burnished</td>
<td>4.5</td>
</tr>
<tr>
<td>Clay-tempered, dry-smoothed/unburnished</td>
<td>5.0</td>
</tr>
<tr>
<td>Fine sandy paste, dry-smoothed/burnished</td>
<td>6.0</td>
</tr>
<tr>
<td>Bone-tempered, dry-smoothed/unburnished</td>
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</tr>
<tr>
<td>Very fine sandy paste, dry-smoothed/burnished</td>
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</tr>
<tr>
<td>Very fine sandy paste, floated/burnished</td>
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</tr>
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<td>Bone-and-clay-tempered, floated/unburnished</td>
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</tr>
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</table>

Overall rank equals the mean statistical rank (average of superscripts in Table 7.19).
Table 7.19 Rank preferences for process sequence choice.

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<tr>
<th>Rank</th>
<th>AL1</th>
<th>Rank</th>
<th>AL2</th>
<th>Rank</th>
<th>AL3</th>
<th>Rank</th>
<th>AL4</th>
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<tbody>
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<td>52 MSP/F/NB&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1</td>
<td>51 MSP/F/NB&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1</td>
<td>46 MSP/F/NB&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>3</td>
<td>11 CLAY/F/NB&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3</td>
<td>7 MSP/DS/NB&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3</td>
<td>8 MSP/F/B&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3</td>
<td>11 FSP/F/B&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
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<td>6 VFSP/F/NB&lt;sup&gt;2,3&lt;/sup&gt;</td>
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<td>0 VFSP/DS/B&lt;sup&gt;5,8&lt;/sup&gt;</td>
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<td>0 BONE/DS/B&lt;sup&gt;5,9&lt;/sup&gt;</td>
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<td>0 BONE/F/B&lt;sup&gt;5,9&lt;/sup&gt;</td>
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<td>0 B&amp;C/DS/B&lt;sup&gt;4,8&lt;/sup&gt;</td>
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<td>0 B&amp;C/F/B&lt;sup&gt;5,9&lt;/sup&gt;</td>
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<td></td>
<td>20.5</td>
<td>0 B&amp;C/DS/B&lt;sup&gt;5,9&lt;/sup&gt;</td>
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<td>18</td>
<td>0 B&amp;C/F/B&lt;sup&gt;5,8&lt;/sup&gt;</td>
<td>18.5</td>
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</table>

Process sequences with different superscripts are different at the 0.05 significance level.

**AL1, AL2, AL3, AL4**

- **MSP** = medium sandy paste
- **FSP** = fine sandy paste
- **VFSP** = very fine sandy paste
- **CLAY** = clay-tempered
- **BONE** = bone-tempered
- **B&C** = bone-and-clay-tempered
- **F/NB** = floated, unburnished
- **F/B** = floated, burnished
- **DS/NB** = dry-smoothed unburnished
Table 7.22 Overall preference structure for process sequences.

Most Preferred Choices:
- Medium sandy paste, floated/unburnished
- Fine sandy paste, floated/unburnished

Upper Tier Among Uncommon Sequences:
- Fine sandy paste, floated/burnished
- Very fine sandy paste, floated/unburnished
- Medium sandy paste, dry-smoothed/unburnished
- Medium sandy paste, floated/burnished
- Clay-tempered, floated/unburnished

Lower Tier Among Uncommon Sequences:
- Fine sandy paste, dry-smoothed/unburnished
- Very fine sandy paste, dry-smoothed/unburnished
- Medium sandy paste, dry-smoothed/burnished
- Clay-tempered, dry-smoothed/unburnished
- Fine sandy paste, dry-smoothed/burnished
- Bone-and-clay-tempered, dry-smoothed/unburnished
- Very fine sandy paste, dry-smoothed/burnished
- Very fine sandy paste, floated/burnished
- Clay-tempered, floated/burnished
- Bone-tempered, floated/burnished

Least Preferred Choices:
- Clay-tempered, dry-smoothed, burnished
- Bone-tempered, dry-smoothed, unburnished
- Bone-tempered, dry-smoothed, burnished
- Bone-and-clay-tempered, dry-smoothed, burnished
- Bone-and-clay-tempered, floated/unburnished
- Bone-and-clay-tempered, floated/burnished
- Bone-tempered, floated/unburnished
Table 7.23 Mean diameter of rim sherds with known paste and exterior surface treatment.

<table>
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<tr>
<th>Paste</th>
<th>Exterior Surface</th>
<th>N</th>
<th>Diameter Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSP</td>
<td>DS/NB</td>
<td>3</td>
<td>31.0</td>
<td>6.56</td>
</tr>
<tr>
<td>MSP</td>
<td>F/NB</td>
<td>10</td>
<td>18.2</td>
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</tr>
<tr>
<td>FSP</td>
<td>DS/NB</td>
<td>3</td>
<td>27.7</td>
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</tr>
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<td>FSP</td>
<td>F/NB</td>
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<td>18.3</td>
<td>6.65</td>
</tr>
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<td>FSP</td>
<td>F/B</td>
<td>2</td>
<td>18.5</td>
<td>3.54</td>
</tr>
<tr>
<td>VFSP</td>
<td>DS/NB</td>
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<tr>
<td>VFSP</td>
<td>F/NB</td>
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<td>16.3</td>
<td>3.21</td>
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<td>DS/NB</td>
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<td>23.3</td>
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<td>F/NB</td>
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<td>BONE</td>
<td>DS/NB</td>
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<td>22.0</td>
<td>0.00</td>
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</tbody>
</table>

DS/NB = dry-smoothed, unburnished
F/B = floated, burnished
MSP = medium sandy paste
VFSP = very fine sandy paste
CLAY = clay-tempered paste

DS/B = dry-smoothed, burnished
F/NB = floated, unburnished
FSP = fine sandy paste
BONE = bone-tempered paste
B&C = bone-and-clay-tempered paste
Table 7.24 Summary of tests for significant differences in mean rim diameter.

Null Hypothesis: Mean rim diameters of vessels with different process sequences are equal

<table>
<thead>
<tr>
<th></th>
<th>MSP/DS/NB</th>
<th>MSP/F/NB</th>
<th>FSP/DS/NB</th>
<th>FSP/F/NB</th>
<th>FSP/F/B</th>
<th>VFSP/DS/NB</th>
<th>VFSP/F/B</th>
<th>CLAY/DS/NB</th>
<th>CLAY/F/NB</th>
<th>CLAY/F/B</th>
<th>B&amp;C/F/B</th>
<th>BONE/DS/NB</th>
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<tbody>
<tr>
<td>MSP/DS/NB</td>
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<tr>
<td>MSP/F/NB</td>
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</tr>
<tr>
<td>FSP/DS/NB</td>
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<td>B&amp;C/F/B</td>
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Null hypothesis accepted/rejected at .05 significance level; critical value of t = 2.0345

DS = dry-smoothed
F = floated
B = burnished
NB = unburnished
MSP = medium sandy paste
FSP = fine sandy paste
VFSP = very fine sandy paste
BONE = bone-tempered paste
CLAY = clay-tempered paste
B&C = bone-and-clay-tempered paste
Table 7.25 Cultural and idiosyncratic preferences for techniques and process sequences at 41HR616.

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<td>Incising</td>
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<td><strong>Secondary Cultural Preferences:</strong></td>
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Figure 7.1 Selected sherds from 41HR616. A. rounded base; B. conical base; C. rim thinned in profile; E. rim with one horizontal line, direct in profile; F. direct, crenulated rim.
Figure 7.1 (continued) Selected sherds from 41HR616. G, sherd with expanding-contracting rim; resembles Caddo type Holly-Fine Engraved. H, cord-marked, red-washed rim sherd from a small bowl; I, bone-tempered body sherd with brushed exterior surface; resembles Caddo type Broaddus brushed; J, rim sherd with multiple incised lines and pendant triangle motif; K, body sherd with multiple diagonal lines cut while the paste was still wet.
Figure 7.1 (continued) Selected sherds from 41HR616. L, rim sherd with two horizontal lines; M, re-floated rim sherd with cross-hatching; N, body sherd with chevron shaped design; O, rim sherd with two horizontal lines; P, rim sherd with one horizontal line; Q, rim sherd with horizontal and vertical lines cut into surface while paste was still wet.
Figure 7.1 (continued) Selected sherds from 41HR616. R, sherd with drill hole; S, sherd with multiple notches; T, sherd with multiple notches.
Figure 7.1 (continued) Selected sherds from 41HR616. U. Rim sherd from a deep-sided jar.
Figure 7.2 Reconstructed vessel section from a deep, wide-mouthed bowl.
Figure 7.3. Changes in overall rank of uncommon process sequences.
Figure 7.4. Uncommon sequences always at or above overall rank midpoint.

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Overall Rank Midpoint
Figure 7.5. Uncommon sequences always at or below overall rank midpoint.

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Figure 7.6. Uncommon sequences with highly variable overall rank.

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APPENDIX VI

Draft Ceramic Analysis from Site 41FB200
(Figures and Tables not available)

by

Linda Wootan Ellis
Both archaeological and ethnohistoric information indicate that during the late
dehistoric there were at least two relatively distinct cultural groups present in the area,
with one of the primary means of differentiation being based on ceramic attributes (see
Central Gulf Coast, from southwest of Galveston Bay south to Corpus Christi Bay, was
populated by several "bands" known collectively as the Karankawa (Aten 1983:28-34;
Newcomb 1961:315-316). The Upper Texas Coast, from southwestern Louisiana to
Galveston Bay, was populated by several linguistically different groups, primarily the
Akokisa, the Bidai, and the Atakapa, (Aten 1983:34-42). The area between the
Galveston Bay and the Brazos River was inhabited by a Karakan group called the
Coco (Aten 1983:28-30) and an Akokisa group known as the Han (Aten 1983:35). Site
41FB200 probably is located somewhere in this area, and its ceramics appear to reflect
characteristics of a group whose approach to ceramic production reflects traits of major
ceramic traditions of the Galveston Bay area in southeast Texas and the Coastal Bend
area between Corpus Christi and Matagorda Bay.

Sorting Criteria
The sorting procedure involved two levels of examination. First, each sherd was
examined in an effort to identify all sherds that could be joined together. Second, if
sherds could be joined it was noted whether the joined edges represented a "fresh break"
(i.e., those broken during excavation or processing) or an "old break" (i.e., those broken
prior to excavation). "Fitters" were glued together with conservation adhesive and
treated as single sherds for purposes of analysis. Treating fitters as single sherds served
three purposes. First, it permitted a more accurate estimate of the minimum number of
vessels represented in the sample, and second, it helped to avoid skewing the analysis
toward attributes over-represented by multiple fragments of a single vessel. Third,
distinguishing the vertical and horizontal distribution of sherds with fresh breaks from those with old breaks provided an indication of the degree of displacement that may have occurred following initial deposition (cf. Burgh 1959; Skibo et al. 1989; Sullivan 1989).

Testing at site 41FB200 yielded 1199 sherds. During examination, 148 sherds were fitted with mates, reducing the total sample to 1051. After fitters were identified, all undecorated body sherds with a maximum dimension of less than 1 cm were culled. Each sherd was counted and recorded by provenance. Size grading eliminated 612 (51%) of the recovered sherds, leaving a total of 439 sherds in the analyzed sample (Table 1).

Discussion of Fitters
Of the 148 sherds fitted with mates, 98% (n=145) had fresh breaks that occurred during excavation or processing and 2% (n=3) had old breaks that occurred prior to excavation. Of the sherds with fresh breaks, 140 sherds (97%) were paired with sherds from the same block, unit, and level. Five sherds (3%) were paired with sherds from the same block and unit, but from adjacent levels. The three sherds having old breaks were paired with sherds from the same block, unit, and level. The cross-mending of sherds indicates that there was negligible displacement of sherds after initial deposition.

Classification Criteria
This analysis looks at the technological style (i.e., the method of manufacture and execution involved in pottery making) of the pottery recovered from 41FB200. Pottery-making is an additive process in which some steps must take place before others. Thus, the pottery-making process involves a set of intentionally structured choices or decisions that occur in some non-random order. By reconstructing the sequence of choices that
were made during the various stages in the process (cf. Ellis 1992: Chapter 6), it is possible to reconstruct the preference structure that characterizes a ceramic assemblage (cf., Ellis 1992: Chapter 7). For a detailed discussion of manufacturing sequences for Upper Texas Coastal pottery, as well as definitions of the major attributes, the reader is referred to Ellis (1992: Chapters 4 and 5). For a discussion of specific Fort Bend areal ceramics the reader is referred to Ellis (1991) and Hamilton (1988).

Eight different attributes were recorded for each sherd in the selected sample. These included:

1) **Paste**: Sherds were microscopically examined under 10x20 power magnification and compared to a grain-size scale based on the Wentworth Scale (Wentworth 1933). Comparison of fresh breaks along the edge of each sherd enabled a determination of the presence or absence of non-plastic inclusions and predominant grain size. The paste categories established for this study are based on a consideration of those employed by Aten (1967, 1971, 1983), Ambler (1970, 1973), Ellis (1992), and Tunnell and Ambler (1967).

The size-grades used for this analysis include the following fractions:

1. Silt (0.004-0.063 mm)
2. Very fine sand (0.063-0.125 mm)
3. Fine sand (0.125-0.25 mm)
4. Medium sand (0.25-0.5 mm)
5. Coarse sand (0.5-1.0 mm)
6. Very coarse sand (1.0-2.0 mm)

Each of the sherds recovered from 41FB200 was assigned to a paste category according to: (1) type of nonplastic inclusions and (2) predominant size of nonplastic inclusions.
2) **Exterior Surface Treatment:** After the vessel has reached its final shape, modifications are made to the surface. These modifications produce a more regular surface. For each sherd, the basic finish of the exterior surface, irrespective of decorative technique, was noted.

3) **Interior Surface Treatment:** For each sherd, the basic finish of the interior surface, irrespective of decorative technique, was noted. For a detailed description of basic exterior and basic interior surface finishing techniques see Ellis (1992), Hamilton (1988), and Winchell and Ellis (1991).

4) **Exterior Decorative Treatment:** Once the basic exterior surface of the vessel was established, the vessel's surface may be further enhanced or decorated. This enhancement could include one or more techniques that either displace or penetrate the surface (such as incising, brushing, or stamping) or are added to the surface (such as slips, glazes, or washes). The presence or absence of any decorative technique on the exterior surface of the sherd was noted.

5) **Interior Decorative Treatment:** The presence or absence of any decorative technique on the exterior surface of the sherd was noted.

6) **Sherd Class** - Each sherd was classified according to its gross morphological category: rim, body or base.

7) **Thickness:** The average thickness was calculated for body and basal sherds. For rim sherds, the average thickness was calculated for the edge opposite the rim edge.
8) **Post-Firing Modification:** These are modifications to the sherd that occur after initial firing. These modifications may be deliberate (i.e., drilling, grinding, notching, asphaltum coatings) and/or the result of post-depositional factors (i.e., erosion). All post-firing modifications present on the sherd was noted.

9) **Smudging:** Color attributes were recorded only for sherds with that evinced a specific firing technique known as smudging.

Smudging appears to represent a distinctive areal attribute. Sherds recovered from several sites in the region bear evidence of smudging, a distinctive variant of open-air firing (cf. Rice 1987:158). Smudging results from an extreme reducing atmosphere wherein carbon is deposited on the surface and in the pores of the vessel producing a dark gray to black finish (Shepard 1976:88-90). These characteristic blackened surfaces are the result of specific firing techniques and differ from the blackened surfaces that result from using clays with large quantities of organic material.

For clays with significant amounts of organic matter, heating of the organic materials moves the carbon to the surface of the clay where it is burned off in the form of CO2 gas. However, under open-air firing conditions, temperatures and/or air flow may not be sufficient to completely oxidize the carbon. As a result, both the core and the surface of the sherd/vessel are characterized by a distinctive black color (Rice 1987:334). By contrast, smudged surfaces appear to result from the deposition rather than the elimination of carbonaceous material and are usually distinguishable in sherd cross section by a blackened color at or just below the surface that stands in contrast to their lighter colored core.
Although ceramics with smudged surfaces have been identified in assemblages recovered from sites in Brazoria County (Hamilton 1988), Fort Bend County (Ellis 1991), and Harris County (Ellis 1992; Fields et al. 1983), there is no way to adequately assess how common this firing technique may have been throughout the region. Upper Texas coast ceramics with smudged surfaces appear to be rare, however, this may also be due to a lack of documentation rather than their rarity in general. The documentation of this attribute may prove be valuable in assessing regional firing practices.

Finally, for each rim sherd, four additional attributes were recorded. These included:

1) Rim Profile - The rim is the margin of the vessel orifice. This margin is distinctive only when it is set off by some change in contour or thickness. When the wall of the vessel is carried to the rim without a break in contour or a change in thickness, the rim is said to be "direct" (Shepard 1976:245). When the rim is set off from the wall of the vessel by a curve or an angle, the rim is described as articulated. Where this change exists, the rim is said to either be expanding or contracting (i.e. thinned).

2) Rim Form - The form of the rim is distinguished by the change in orientation between the wall or the neck of the vessel and lip. An articulated rim is set off by a curve or an angle while a direct rim has no change in orientation (Rice 1987:214).

3) Lip Profile - The lip of the rim is the edge or margin of the rim bordering the mouth of the vessel. The shape of the lip varies depending on the position of the thumb and the fingers. If finished entirely by hand, the lip edge will be rounded, tapered, or rounded and flattened. A flat lip edge is distinguishable from other forms because it results from the use of a straight-edged tool rather than manipulation by the fingers alone (Shepard 1976:247).
4) Lip Decoration - The presence or absence of decoration on the edge of the lip was noted for all rim sherds.

Analysis of Ceramic Attributes

**Paste Characteristics:** The sherds from 41FB200 include both tempered and untempered paste categories. Of the 439 sherds in the analyzed sample, 431 sherds (98%) have untempered sandy pastes. Of the 431 sherds with sandy pastes, 195 sherds (44%) have fine sandy pastes, 186 sherds (42%) have medium sandy pastes, and 50 sherds (11%) have very fine sandy pastes.

Eight sherds (2%) have tempered pastes: seven are grog-tempered and one is bone-tempered. Of the seven grog-tempered sherds, three sherds have grog embedded in a medium sandy paste; one sherd has grog embedded in a fine sandy paste; one sherd has grog embedded in a very fine sandy paste; and two sherds have grog embedded in a silty paste.

The bone-tempered sherd has both burned and unburned chunks of bone embedded in a fine sandy paste. Bone flecks are clearly visible on the exterior surface.

**Exterior Surface Treatment:** Of the 439 sherds in the analyzed sample, 310 sherds (71%) have floated exterior surfaces and 46 sherds (10%) have floated/burnished exterior surfaces. Seventeen sherds (4%) have dry-smoothed exterior surfaces and six sherds have dry-smoothed/burnished exterior surfaces. The exterior surface of 60 sherds (14%) are too eroded to accurately determine the surface treatment.
Interior Surface Treatment: The largest percentage of sherds (72%; n=317) also have floated interior surfaces. Of that number, 16 sherds (4%) have burnished/floated interiors surfaces. A total of 31 sherds (7%) have dry-smoothed interior surfaces and one sherd has a dry-smoothed/burnished interior surface. The interior surface of 99 sherds (20%) are too eroded to accurately determine the basic surface treatment or had been smudged (n=25), thereby, making it difficult to accurately determine the basic finish.

Exterior Decorative Treatment: Twelve sherds (3%) evince enhanced exterior surfaces. Of these, three sherds are incised on a leather-hard paste. One upper body sherd has a straight, horizontal line cut into the surface. One rim sherd has a straight, horizontal line cut into the surface just below the rim. Immediately below this line are two rows of cross-hatched lines, however, the sherd is too small to determine how many rows of cross-hatching there may have been or whether there may have been any patterned design. On one body sherd, there is a segment of a wide wedge-shaped design that has been cut into the surface, however, the fragmentary state of the sherd makes it impossible to see more that this single element.

Two sherds have brushed exterior surfaces. The curvature of one sherd indicates that the indentions formed a diagonal pattern and the unevenness of the line margins indicates that the brushing was done on a wet paste. The indentations on the other sherd appear to have been vertically oriented. Interestingly, the exterior surface of this sherd was burnished after the brushing had taken place, giving the appearance of polished ribs on the surface.
The exterior surfaces of five sherds exhibit three or more relatively shallow grooves or lines that were scraped across the surface of the sherd. One burnished rim sherd has the remnants of three horizontal lines that run parallel to the rim. During the process of burnishing the exterior, the shallow lines had been partially obliterated. One body sherd has four shallow lines that were oriented diagonally across the surface. The exterior surface of two body sherds have a rather distinctive appearance. The exterior was floated over a surface that had been coated with a black film. After the surface had dried to the leather-hard stage, an object had been scraped across the surface producing patterned grooves that displaced the brown floated surface allowing the blackened surface to show through as series of lines. The exterior surface of one body sherd is entirely covered by grooved lines that appear to be the result of scoring with an object such as a bivalve. The interior surface of this sherd resembles the enhancement motif of the two previously described sherds.

**Interior Decorative Treatment:** Only one of the recovered sherds has an enhanced interior surface (described above).

**Form:** The sample consists of 402 body sherds (92%), 22 rim sherds (5%), and 15 basal sherds (3%). The body sherds range in thickness from 0.30 cm to 0.80 cm, with an average thickness of 0.55 cm (± 0.086 cm). The 15 basal sherds range in thickness from 0.50 cm to 1.05 cm, with an average thickness of 0.76 cm (± 0.122 cm). The 22 rim sherds range in thickness from 0.30 cm to 0.70 cm, with an average thickness of 0.52 cm (± 0.097 cm).

**Base Characteristics:** Eight basal sherds are rounded in profile, while the remaining seven bases are too fragmentary to adequately determine their shape.
**Rim Profile:** The shape of the rim in profile was noted for each rim sherd recovered at 41FB200. The largest percentage (68%; \( n = 15 \)) of rim sherds were thinned in profile. Six rims (24% of the sample) were classified as direct. The profile shape of the rim was indeterminate on one of the rims.

**Rim Form:** Rim form was observable on 19 (86%) of the rim sherds recovered from 41FB200. Twelve rims (55%) are straight, while 7 rims (32%) are slightly out-flaring. Three rim sherds (14%) were too fragmentary to accurately assess their form.

**Lip Profile:** In profile, the largest percentage of the rim sherds recovered from 41FB200 exhibit lip edges that are interior rounded (36%, \( n = 8 \)). Four rim sherds (18%) exhibit lip edges that are tapered rounded, two rim sherds (9%) are rounded, and one rim sherd (5%) is exterior rounded. Six rim sherds are flat (27%) and one rim sherd (5%) is rounded flat.

**Lip Decoration:** Of the 22 rim sherds recovered from 41FB200, 54% (\( n = 12 \)) had some type of decoration on the lip. Three sherds have tick-marks along the top edge of the lip and two sherds have tick-marks along the interior edge only. One flattened rim has tick-marks that have been cut into both the exterior and interior edges of the lip, however the incisions do not extend across the top of the lip. Three rim sherds have crenelated lip edges. Two rim sherds have deep notching that form a saw-toothed (sometimes referred to as V-notched) edge. The lip of one of these sherds has been folded.

**Post-Firing Modifications:** Of the 439 sherds in the analyzed sample, 131 sherds (\( % \)) evince some form of post-firing modification. Of the 131 sherds with post-firing
modification, 31 sherds show evidence of deliberate modification, while the
modifications on 100 sherds are due to post-depositional alteration. Five post-firing
attributes were noted:

1) Asphaltum: Fourteen of the sherds recovered from 41FB200 have interior
surfaces that are coated with asphaltum and one sherd has an asphaltum coated interior
surface. Four sherds had patches of asphaltum on the exterior and/or interior surfaces.
One sherd (which also has a drill hole) has asphaltum along the edge of an old break,
indicating that asphaltum may have been used in an attempt too mend a crack in the
vessel wall.

2. Drill Holes: Two sherds have drill holes.

3. Notches: Five sherds evince notching on one or more sides.

4. Burned: Five sherds are burned on the exterior and/or interior surfaces.

5. Eroded Surfaces: Of the 439 sherds in the analyzed sample, 41 sherds have
eroded exterior surfaces, 32 sherds have eroded interior surfaces, and 27 sherds are
eroded on both the exterior and interior surface.

Smudging: Of the 439 sherds in the analyzed sample, 180 sherds (41%) have smudged
interior surfaces.

Typological Characterization

According to the typological criteria (Aten 1983) widely accepted by archeologists in the
upper Texas coast, the majority of sandy paste sherds belong to one or another Goose
Creek type and should be classified as Goose Creek, spp. At least two of the decorated
sherds fit the typological definition of Goose Creek, Incised. The grog-tempered sherds
have no attributes that would allow for a confident distinction between Baytown Plain
and *San Jacinto Incised*. While none of the recovered sherds resemble any of the defined *Rockport Black-on-Gray* types, there are certain similarities with regard to specific attributes, such as the presence of asphaltum and certain decorative elements.

A reliable chronology for the Brazos delta area has yet to be fully developed, although Aten (1983) has provided a preliminary seriation for both the coastal area, *Brazos Delta-West Bay Area Seriation*, and the inland area, *Inland Brazos Valley (Big Creek) Area Seriation*. Each of these sequences was correlated with the Galveston Bay Area chronology in order to provide a rudimentary basis for the chronological ordering of archeological data (Aten 1983: 291-292, Figures 14.3 and 14.4). Although a recent study by Ellis and Ellis (1994) shows that ceramic data alone cannot provide a basis for identifying ceramic assemblages of different ages for most of the Galveston Bay area seriation, it is, nevertheless, possible to make some general observations about the site's occupation. The ceramic material recovered from 41FB200 suggests a possible occupation period of approximately A.D. 1000 or later. The presence of grog-tempered sherds suggests a post A.D. 1000 date, while the presence of one bone-tempered sherd suggests an occupation date of post A.D. 1300 (Aten 1971:51-52; 1983: Figure 14.4).

**Technological Analysis**

Alternative approaches to ceramic analysis have recently emerged in Upper Texas Coastal archeology (Hamilton 1988; Winchell and Ellis 1991; Ellis 1992, 1994). These approaches examine aspects of ceramics different from those on which more standard approaches are based. Ellis' (1992, 1994) approach, in particular, focuses on a technological analysis of ceramics that is similar to many technological analyses of lithics. This new approach is intended to lay the foundation for studies of the role(s) ceramics
played in the hunter-gather adaptation of prehistoric groups in the Upper Texas Coast (see Ellis 1992, especially Chapters 2, 3, and 8).

Using the attributes of technological style, it is possible to identify a sequence of choices made during paste selection and the finishing of exterior surfaces. Binomial hypothesis testing (Thomas 1986) indicates that the distribution of some pastes and exterior surface treatments is unlikely to be the result of a random selection process (see Ellis 1992 for a discussion of the application used here).

**Statistical Properties for Selected Attributes of the 41FB200 Ceramics**

The following section describes the preference structure for certain attributes of the ceramics from 41FB200. In particular, we examine the preferences for paste, basic exterior and interior surface treatments, and manufacturing sequences of paste and exterior surface treatment. As a frame of reference, we compare the preferences to ceramics from 41HR616 in northeast Harris County in order to provide an initial examination of the respects in which the patterns of pottery-production choices at 41FB200 are demonstrably similar to or different from the patterns of choices at 41HR616. However, before moving on to the discussion of the 41FB200 preferences, it is necessary to describe the procedures we will use to describe the assemblage.

The typical practice used to describe ceramic assemblages in the Gulf Coast area is to list the frequency and relative frequency of various ceramics either by type-definition (e.g., Aten 1983) or some other classification (e.g., Winchell and Ellis 1991). Relative frequencies especially serve as the basis for graphically and/or numerically characterizing an assemblage and for comparing it to other assemblages. For example, in a seriation,
observed relative frequencies in a series of stratigraphic units serve as the measures of diachronic change or stability in a ceramic tradition.

This procedure, however, is overly simple because it does not account for the possibility that the observation of different relative frequencies for the same kind of object in two or more different stratigraphic units may not represent a real difference in the relative frequency of that kind of object in systemic context. This follows for two reasons. Apparent differences in relative frequency may result from sample size because the relative frequencies of an item in a very small and a very large assemblage do not control for differences in sampling error. A larger sample has a better chance of accurately representing the properties of a population than a smaller sample, so it follows that a small sample is inherently characterized by a high degree of uncertainty about its representativeness, a level of uncertainty that accompanies any relative frequencies calculated from that sample. Hence, in samples of widely diverging size, differences in relative frequency cannot be distinguished from differences in the effects of uncertainty.

Furthermore, people sharing common cultural ideas or norms may act on those ideas or norms with variable frequency. Therefore, a number of different people acting on the same culturally shared idea or norm can be expected to produce a range of behavior that varies around some average value. Thus, apparent changes in relative frequency can (and often do) occur as a result of variation that does not reflect a change in basic behavior patterns.

Ceramic production is an example of a behavioral sphere in which people frequently act on shared norms, but express those norms in variable ways (Bunzel 1972). To the extent that potters use knowledge they have accumulated from their teachers and peers, they
produce vessels according to norms shared by others. This knowledge is cultural by
definition by virtue of being shared. To the extent that potters use knowledge they have
accumulated from personal experience, they may deviate (slightly or significantly) from
the procedures used by others. Differential raw material availability may lead to further
development as potters attempt to adapt what they know how to do to constraints imposed
by the raw materials currently available. Hence, the members of any given community of
potters, even if they are working within a highly culturally structured framework, can be
expected to produce a variable assemblage of pottery which ultimately should show up in
the archaeological record as a variable assemblage of ceramic artifacts.

The description of a systemic assemblage from an archaeological assemblage must take
into account the fact that choices are made by individual potters on specific occasions.
Consequently, to the extent that individual potters expressed shared cultural norms, a
systemic assemblage should be reflected in an archaeological assemblage that at least
broadly corresponds to cultural patterning. Cultural patterning will show up in the
record as nonrandomly high frequencies of artifacts with certain characteristics. For
example, if it is part of the cultural tradition to prefer coarser sandy pastes to other
pastes (whether for functional or aesthetic reasons), the frequency of sherds in a ceramic
assemblage should reflect nonrandomly high frequencies of coarser pastes because the
preference for coarse sandy pastes would have been acted on more frequently than other
less-preferred options. Stated another way, whenever a potter decided to make a vessel,
there was a higher probability that she or he would choose a coarse sandy paste than
another paste.

Hence, one way to explore the nature of a ceramic tradition is to identify the probability
structure that characterizes a ceramic assemblage. If one can identify the probability
structure, one is in a position to determine which manufacturing choices were preferred over others and which choices were equally preferred. If one identifies choices which had absolutely and relatively high probabilities, it is likely that these choices reflect the influence of cultural norms on ceramic production unless an environmental or other variable accounts for high frequency of occurrence. If one identifies choices which had absolutely and relatively low probabilities, it is likely that these choices reflect idiosyncratic behavior unless trade or unusual function accounts for low frequency of occurrence. The principal task in identifying the nature of a ceramic tradition, therefore, is to identify the probability functions that correspond to the production choices reflected in a ceramic assemblage. From the description of probability functions, one is in a position to determine which choices are likely to reflect cultural norms, and which are not. This in turn means that one must somehow estimate the probability of a given choice.

One might be tempted to regard the relative frequency of a choice reflected in an archaeological assemblage as an estimate of that choice's probability of occurrence in systemic context. This move, however, would be unwarranted. Even if the assemblage in question is assumed to be representative of the range of behavior of the people who produced the archaeological assemblage, relative frequency tells us nothing about how accurately it represents that range of behavior. Indeed, to use observed relative frequencies as the basis for describing the probability functions governing choice requires an additional assumption, namely, not only is the assemblage representative; it also is an extremely accurate representation of a range of behavior. This assumption is unwarranted, especially when one is characterizing an assemblage with largely unknown cultural and behavioral significance (such as the one at 41FB200).
A sounder procedure would be to assume for purposes of analysis that the assemblage in question at a given site is representative of range of behavior that is not unique to the assemblage. It is possible to use this initial assumption of representativeness and to describe the range of probabilities that could have produced what is assumed to be a representative assemblage that reflects a ceramic tradition. In the long run, this assumption may turn out to be false for any number of reasons. For example, the assemblage could occur at a function-specific site for which occupation involved the products from only a small part of a ceramic tradition. Or, it could occur at a site that was alternately occupied by members of groups who used pots manufactured in different ceramic traditions. In either event, however, the assumption of representativeness establishes a baseline from which to characterize ceramics from a large number of sites and/or stratigraphic units and, thence, to determine whether geographic and/or diachronic variability results from functional, sociocultural, environmental, or other causes. For example, if one ultimately judges that the assemblage at 41FB200 (or any other site) is, say, functionally specific, that judgment will at least implicitly be based on the notion that vessels with certain characteristics had a higher probability of being made and used for that function than vessels with other characteristics.

By itself, however, the initial assumption of representativeness does not go far enough to successfully establish a basis for describing the assemblage at 41FB200 in terms of probability functions because the initial assumption is qualitative. Let us, therefore, quantify the assumption of representativeness by assuming that the frequencies of occurrence of the various attributes observed in each stratigraphic unit at the site fall somewhere within a statistical confidence interval of 95%. For example, let us assume that the frequency of medium sandy paste (xx sherds) in levels 1 and 2 (Table X.1 is within the range of values that would be found in 95% of provenances containing
ceramics produced contemporaneously in the same ceramic tradition. Let us also assume that the frequencies of all the other pastes in levels 1 and 2 fall within the range of values that would be found contemporaneously in 95% of provenances reflecting the same ceramic tradition. This is the equivalent of saying that for provenances contemporary to levels 1 and 2 and in the same ceramic tradition, there is a probability \( p(MSP) \) of finding a sherd with medium sandy paste, a probability \( p(FSP) \) of finding a sherd with fine sandy paste, and so on for each possible paste, and that the frequency of each paste in a stratigraphic unit at 41FB200 falls somewhere within the 95% confidence interval of that paste's respective probability distribution. However, what we do not know is where the value of xx sherds with medium sandy paste falls in the distribution predicted by \( p(MSP) \), where the value of xx sherds with fine sandy paste falls in the distribution predicted by \( p(FSP) \), and so on for each of the other possible pastes.

Fortunately, we do know the following:

(a) Any sherd we do find has one or another of the pastes. As a result, if we find xx sherds in levels 1 and 2, we have the equivalent of xx trials of a Bernoulli process which has a limited number of possible, mutually exclusive outcomes. (i.e., the outcome of any given trial is the observation of one and only one paste. xx outcomes in levels 1 and 2 were observations of medium sandy paste.) Given that the identification of pastes is a Bernoulli process, the statistical properties of the distribution of pastes can be described in terms of binomial probability distributions (see Thomas 1986 for details on this and what follows).

(b) Binomial probability distributions closely approximate the properties of normal distributions. In a normal distribution, a 95% confidence interval is the area contained in the region defined between \(-1.96 \leq Z \leq 1.96\). As a result,
the probability of finding n particular outcomes in N trials at a confidence interval of 95% can be estimated by solving for p in the formulas

\[
1.96 = \frac{n - Np}{\text{SQR}(Np(1 - p))}, \quad \text{and}
\]

\[
-1.96 = \frac{n - Np}{\text{SQR}(Np(1 - p))}.
\]

The first formula yields an estimate of the maximum p that would yield n outcomes in N trials, and the second formula yields an estimate of the minimum p that yields n outcomes in N trials.

(c) Therefore, for example, we can find the maximum p(MSP) for levels 1 and 2 by solving for p in the formula

\[
1.96 = \frac{xx - xxp}{\text{SQR}(xxp(1 - p))},
\]

and the minimum p(MSP) for levels 1 and 2 by solving for p in the formula

\[
-1.96 = \frac{xx - xxp}{\text{SQR}(xxp(1 - p))}.
\]

In the case in (c) above, the maximum p(MSP) is .xxx, and the minimum p(MSP) is .xxx. This means that at any probability higher than .xxx, more than xx sherds with medium sandy paste would have been found, and that at any probability lower than .xxx, fewer than xx sherds with medium sandy paste would have been found. Thus, the \( p(MSP) \geq .xxx \) at a site in the same ceramic tradition and the same age as levels 1 and 2 if it can be assumed that levels 1 and 2 fall somewhere within the range of 95% for a contemporary ceramic tradition.

Calculation of the range between minimum and maximum probabilities establishes the parameters for testing hypotheses to determine whether assemblages reflect the same preference structures with respect to given attributes. Because each minimum/maximum probability range represents the probability extremes that are consistent with 95%
confidence intervals for their respective attributes, each probability range therefore
describes the acceptance region for a statistical hypothesis that the probability of
occurrence of an attribute (or attributes) are equal at a .05 level of significance. If, for
example, the probability ranges for two pastes in the same level overlap, then it is
possible that the probabilities of choosing these two pastes were equal. This follows
because the actual probabilities of choice are unknown, and the overlap in probability
ranges shows that there are no known grounds for concluding (at .05 significance) that
there was a difference in the probability of choice in systemic context. Hence,
overlapping probability ranges meet the criteria for accepting a hypothesis that there is
no demonstrable preference among the two paste attributes.

Conversely, each probability range describes the limits beyond which other probability
ranges must fall if they represent demonstrably different probability distributions. If, for
example, there is no overlap in the probability ranges for two pastes in the same level,
then there are grounds for concluding that there was a difference in preference because
the most optimistic possible estimates of the respective probabilities of occurrence of the
pastes are mutually exclusive at 95% confidence. This follows because the probability
ranges are calculated under the assumption that each paste in an assemblage falls
somewhere in a 95% confidence interval. If two probability ranges do not overlap, then
the pastes from which those ranges were calculated are members of different confidence
intervals. Thus, nonoverlapping probability ranges meet the criteria for rejecting a
hypothesis that there is no demonstrable preference among the two paste attributes at 0.5
significance.

These hypothesis testing parameters also apply in diachronic and geographic contexts.
For example, if probability ranges for a given attribute overlap from level to level at a
given site, then there is no demonstrable temporal change in preference for that attribute over time because the same probability distribution could account for the frequencies observed in each level. If probability ranges do not overlap from level to level, then there is a demonstrable temporal change in preference for that attribute. Similarly, if the probability ranges for a given attribute at proveniences in different sites overlap, then there is no evidence that the ceramic traditions at those sites differ with respect to that attribute. On the other hand, if probability ranges at different sites do not overlap, there is evidence from which to conclude that the ceramic assemblages represent different traditions. Of course, functional or other variables could account for differences in probability range from level to level or from site to site. However, as implied earlier, this means only that the testing structure provides the analyst with a means for determining whether apparent diachronic and geographic differences in ceramic traditions are better explained by other variables. Given the currently poorly developed state of detailed knowledge of site function and the geographic distribution of cohesive sociocultural territories and information-exchange networks within the Gulf Coast area, attributing differences in preferences to different traditions is the best—if also possibly temporary—explanation.

Note that the minimum/maximum probability ranges normalize descriptions of assemblages with respect to variation in sample size while simultaneously avoiding spurious accuracy that is implicit in descriptions based on relative frequencies. Variation in sample size affects only the size of the probability range (with smaller samples yielding broader ranges that reflect greater uncertainty) so that hypothesis testing involving samples of different sizes is automatically adjusted for sampling error. Moreover, attributes that were rare in systemic context are fairly weighted in comparison to attributes that were more common. Still further, the probability ranges normalize
assemblage descriptions with respect to variation in use-life in the event that some attributes are specific to vessels having properties that affect their longevity. Hence, the procedures described above provide a robust framework within which to identify the preference structure for ceramic-production techniques at 41FB200 and to compare it to the structure evident at 41HR616.

To summarize, the following analysis describes the preference structure for certain ceramic-production techniques by interpreting the ceramic-technology data in terms of probabilities of choice. The analysis assumes that potters' decisions are governed by preference structures within which each potter ranks her or his preferences. If a potter favors one technique over another, that technique has a higher probability of being chosen during production precisely because it is preferred. The empirical issue at stake here is whether or not individual potters' choices are governed by the same probabilities of choice as other contemporary potters in the same community. To the extent that potters' preference-rankings coincide, an individual potter's preferences are culturally structured in the sense that individual potters share ideas about more ideal ways to make pots, about less ideal ways to make pots, and about inappropriate ways to make pots. Hence, the probability that any two or more potters will produce vessels in similar ways is higher to the extent that most potters make culturally structured choices, and lower to the extent that most potters act on idiosyncratic preferences. This is equivalent to defining a ceramic tradition as a probability table in which some culturally structured choices are made more probable than other culturally structured choices, and all culturally structured choices are more probable than idiosyncratic choices. As a result, then, the minimum/maximum probability ranges which will be used to characterize choice and preferences below represent an initial attempt to identify cultural and idiosyncratic
preferences by attempting to build an initial model of the probability parameters that characterize the ceramic tradition reflected in the assemblage from 41FB200.

**Paste Preferences at 41FB200**

Table X.1 lists the frequencies of pastes at 41FB200. Figure X.1 depicts the minimum/maximum probability ranges that are consistent with the frequencies for each paste. These probabilities (and probabilities for all of the following analyses) were calculated using the formulas in (b) above for consecutive pairs of excavation levels. Excavation levels were paired to increase sample size, thereby reducing the size of minimum/maximum probability ranges and, as a result, increasing the likelihood of identifying choices that reflect different preferences. Also, note that all judgments of statistical similarity and difference below are made at a .05 significance level.

Figure X.1 shows that in levels 9 and 10, medium sandy paste was the most preferred choice. The fact that its probability range does not overlap that of any other paste means that the probability of choosing medium sandy paste can be judged to be higher than the probability of choosing any other paste. Among the other pastes, however, there is no definite evidence that one was more preferred than the others. The scant overlap between fine sandy paste on one hand and grog-, bone-, and grog-and-bone tempered pastes on the other shows that it is fairly unlikely that fine sandy paste reflects the same probability of choice as the others. However, these three less frequent pastes, despite their zero values, must each occur at the uppermost tail of their respective probability distributions while fine sandy paste must occur at the lowermost tail of its distribution, which seems intuitively unlikely.
A diachronic shift occurs in the transition to levels 7 and 8. The difference in probability of choice between medium sandy paste and fine and very fine sandy pastes no longer holds, and a difference in probability of choice emerges between all sandy pastes and the tempered pastes. Fine sandy paste shows a higher probability of choice than very fine sandy paste. No discernible difference in preference among medium and fine sandy pastes occurs in levels 5 and 6, 3 and 4, and 1 and 2. Furthermore, although very fine sandy paste fluctuates with respect to its detectable preference over the tempered pastes in the upper levels, it remains consistently less preferred than fine and medium sandy pastes.

Medium and fine sandy pastes therefore appear to have been culturally structured preferences by virtue of their absolutely and relatively high probabilities of choice. The three tempered pastes consistently rank at the bottom of the preference structure with both absolutely and relatively low probabilities of choice. Bone-and-clay-tempered paste (given its zero values in all levels) is very likely to have its low rank because it was not a combination recognized as a suitable choice, judging from the extreme rarity of this combination elsewhere in the area (Ellis 1992). Clay- and bone-tempered pastes, on the other hand, are likely to represent either very low-ranked cultural preferences (relative to medium and fine sandy pastes), trade wares from an area where they were higher-ranked cultural preferences, or idiosyncratic choices.

The relationships between paste choices can be explored further and compared to the preferences at 41HR616 to show that there may be some interesting similarities and differences between assemblages. Some of the differences may reflect geographic or diachronic variability. Unfortunately, no dates are available to show how the sequences to the two sites coincide in time. Hence, identification of differences at this point only
identifies candidates for potential regional variability without demonstrating whether that variability is geographic, temporal, or both.

Medium sandy paste appears to occupy a very high preference rank throughout the sequence. However, in the diachronic shift from levels 9 and 10 to levels 3 and 4, the probability of choice declines in absolute terms as indicated by the absence of overlap in the probability ranges (Figure x.2). Indeed, the diachronic shift in probability ranges for medium sandy paste is suggestive of and consistent with a gradual decline in probability of choice throughout the sequence, although the only the differences between levels 9-10 and 3-4 are demonstrable. Note from Figure x.2 that no such shift is detectable in the sequence from 41HR616, but that there is no detectable difference in preference between any pair of levels at 41FB200 and any level at 41HR616. This entails that although there are no detectable geographic or diachronic differences in preference for medium sandy paste between the sites, 41FB200 and 41HR616 could represent local variants of diachronic change within a more or less uniform regional preference for medium sandy paste.

Fine sandy paste begins with a relatively low preference rank and reaches a very high preference rank that is indistinguishable from medium sandy paste. Diachronically at 41FB200, there are no demonstrable changes in probability of choice for fine sandy paste (Figure x.2). However, there is minimal overlap between the probability range for levels 9-10 and the ranges from levels 5-6, 3-4, and 1-2, suggesting that there may be an undemonstrated diachronic increase in the probability of choice for fine sandy paste. If so, the trend at 41FB200 is the inverse of the pattern that occurs at 41HR616, where the probability of choice decreases sometime between AL4 and AL1. This entails that to the extent that any levels at these two sites are contemporary, there may be geographic
and/or diachronic differences in preference for fine sandy paste, especially since the range for AL1 at 41HR616 does not overlap with the ranges for levels 1-2 and 5-6 and has minimal overlap with the range for levels 3-4.

All other pastes at 41FB200 have probabilities of choice that are initially absolutely low and remain that way throughout the sequence. None vary significantly in a demonstrable way, although the pattern for very fine sandy paste appears to involve some fluctuation at an intuitive level. Furthermore, the only discernible difference between 41FB200 and 41HR616 appears in the probability range for grog-tempered paste. In AL1 at 41HR616, the probability of choice for grog temper is higher than that in levels 3-4, 5-6, and 7-8 at 41FB200. This implies that there may be a geographic and/or diachronic difference in the preference for grog-tempered pastes between the two sites.

**Exterior Surface Treatment Preferences at 41FB200**

A floated/unburnished exterior starts off as the most preferred surface treatment in level 9-10 at 41FB200 and remains a first-rank preference throughout the sequence (Figure x.3). Floated/burnished exteriors initially are not preferred over the remaining treatments in level 9-10, but occupy a clear second-rank position in level 7-8. The relative preference for floated/burnished over dry-smoothed/unburnished exteriors disappears by level 5-6, and the relative preference for floated/burnished over dry-smoothed/burnished exteriors disappears by level 3-4. There is no clear second-rank preference by level 1-2. Thus, the demonstrable diachronic pattern reflects a consistent first-rank preference for floated/unburnished exteriors. A second-rank preference for floated/burnished exteriors emerges in level 7-8, and then gradually declines.
This pattern is evident (albeit, undemonstrably) in the diachronic pattern of probability ranges for each surface treatment (Figure x.4). The probability of choice for floated/unburnished exteriors is absolutely high in all levels at 41FB200. On the other hand, the probability of choice for floated/burnished exteriors appears to fall steadily from level 9-10 to level 1-2, although this intuition is not statistically demonstrable since all probability ranges for this treatment overlap at least slightly. (However, the chances that the ranges for levels 9-10 and 7-8 are equal to the ranges for level 1-2 are very small.) The other surface treatments start off at absolutely low probabilities of choice and remain so throughout the sequence, with no striking intuitive or demonstrable shifts or fluctuations.

There also are no demonstrable differences in the probabilities of choice for any surface treatment between 41FB200 and 41HR616, although the probability ranges for some surface treatments (dry-smoothed/unburnished and floated/unburnished) in some levels at 41FB200 have a very small chance of being identical to their counterparts in some levels at 41HR616. This implies that there is no demonstrable geographic and/or diachronic variation between the two sites, although the scant overlap of some probability ranges implies that there are intuitively supported differences.

**Smudging**

Figure x.5 depicts the probability ranges for smudging at 41FB200 and 41HR616. At 41FB200, the probability of choice for smudging is initially relatively weak in level 9-10, becomes stronger in levels 7-8, 5-6, and 3-4, and then slacks off slightly in level 1-2. Although there is no statistically demonstrable change in the probability of choice at 41FB200, it is intuitively unlikely that the probability is the same in all levels because the overlap between probability ranges in levels 7-8, 5-6, and 3-4 and the range in level 9-10
are quite small. The diachronic pattern of choice for smudging at 41FB200 therefore
intuitively appears to increase from level 9-10 to the middle levels, and (perhaps) to
decrease slightly from the middle levels to level 1-2.

The contrast with 41HR616 is striking. In all levels at 41HR616, smudging has
absolutely low probabilities of choice. This implies that there may be substantial
geographic differences between the sites with respect to smudging. The only indication
of similarity between the sites occurs in the form of a very slight overlap of the
probability ranges for level 9-10 at 41FB200 and AL3 at 41HR616. However, the very
small overlap implies that there is only a very small chance that the probabilities of choice
are equal.

Enhancement Attributes

In the Galveston Bay area, decorated ceramics occur early and are relatively constant or
increasing through time. However, in the Brazos Delta/West Bay area, decorated
ceramics appear later in time and appear to be much less common (Hamilton 1988:138-
139). At the Copperhead site (41BO13), Hamilton (1988:94,98) found one decorated
rim sherd and one rim sherd with lip decoration in a sample of 661 sherds. By contrast,
the preference for decorated vessels appears to higher at 41FB200, where 12 sherds
(3%) have decorative exteriors and 12 rim sherds (3%) have lip decoration. (Note that
the total number of analyzed sherds at 41FB200 reflects the number after "fitters" and
culling.) Among the decorative motifs noted at 41FB200, five sherds exhibit motifs
more characteristically associated with the Central Texas Coastal groups. Three of the
sherds have been "scored," one sherd has a flattened rim with a saw-toothed lip
decoration, and one rim sherd has an interior lip overhang, with a saw-tooth lip
decoration. These decorative motifs are similar to motifs that are common on *Rockport Black-on-Gray* ceramics (Potter 1930; Corbin 1963; Campbell 1962).

**Discussion**

Many of the sherds recovered from 41FB200 fit the typological description of *Goose Creek* ware (as defined by Aten 1983). Thus, the assemblage at 41FB200 is very much like the assemblage one might find at sites in Harris County and the Galveston Bay area. However, at the level of analysis of technological style, subtle differences emerge among vessels. These differences are obscured by accepted typological classes, and an examination of these differences leads to paths of comparison and contrast that otherwise would not be available. In particular, comparing and contrasting the 41FB200 assemblage with assemblages from other sites shows that there may be dimensions along which it may be possible to identify relatively small areas of the broader upper Texas coast region within which different approaches to technological style may provide a basis for identifying historically cohesive communities of potters who transmitted relatively localized ceramic-production knowledge from generation to generation. The discussion that follows, therefore, focuses on placing the foregoing analysis into a regional framework in order to illustrate the potential for identifying areas within the upper Texas coast region which may reflect localized approaches to pottery production.

As noted above, there is a general preference at 41FB200 for sandy pastes at the fine-to-medium sandy portion of the Wentworth scale. Deviations from the general pattern occur in level 9-10 (where only medium sandy pastes are clearly preferred) and level 7-8 (where the general fine-to-medium preference is complicated by an equal preference for very fine and medium pastes). A similar pattern occurs at 41HR616, where an apparent
long-term occupation reflects a continuous and overwhelming preference for fine-to-medium sandy pastes. However, 41FB200 and 41HR616 contrast rather distinctly to 41HR273 (the Alabonson Road site on White Oak Bayou in west Houston), 41FB199 (ca. 200 m east of 41FB200), 41HR729 (on Langham Creek in northern Harris County), and 41B013 (the Copperhead site, on Oyster Creek in Brazoria County). At 41HR273, which represents a long-term occupation, the overwhelming preference appears to be for pastes in the silty-to-fine sandy range. At 41FB199 and 41HR729, fine sandy pastes were clearly preferred. At 41BO13, very fine-to-fine sandy pastes were preferred.

Thus, paste preferences at 41FB200 show a closer resemblance to the preferences at 41HR616 than they do to preferences closer by in Harris, Fort Bend, and Brazoria Counties. This would appear at first glance to be anomalous at a general level. The contrast between a fine-to-medium sandy paste preference at 41FB200 and the generally finer pastes at relatively nearby sites is unlikely to result from limitations on availability of raw materials: pots at all of the previously mentioned sites (except, perhaps, 41BO13) have very fine, fine, and medium sandy pastes. Thus, any choice apparently was available. Hence, the anomalousness of the 41FB200 preference may follow from functional variation among sites within the area of Fort Bend, Harris, and Brazoria Counties, or from the absence of a sufficiently robust chronometric data base that would allow us to distinguish temporal variation from regional variation. Whatever the source of the apparent anomaly, however, paste preferences at 41FB200 show at least some affinities to sites in the Galveston Bay area.

With respect to some other elements of technological style, ceramics from 41FB200 resemble those recovered from 41BO13. The Copperhead Site is part of Aten's seriation for the Brazos Delta-West Bay area and he correlates this site to the Round Lake Period
of the Galveston Bay area. Sherds with floated exterior surfaces and smudged interior surfaces are common at both sites. In his analysis of 41BO13, Hamilton (1988:94) suggests that these techniques may have regional and/or temporal significance.

However, evidence from the Harris County/Galveston Bay area is ambiguous with respect to the temporal qualities of floated surfaces. In an analysis of ceramics recovered from 41HR273, floated surface treatments have demonstrated temporal significance (Winchell and Ellis 1991). However, at 41HR616, floating does not show any significant temporal variation including some time spans that may be contemporary with portions of the sequence at 41HR273 for which there is temporal variation. In this respect, then, 41FB200 more closely resembles 41HR616 than it does 41HR273 (which is closer to 41FB200 than 41HR616 is). Indeed, the incorporation of floated/unburnished surfaces into technological style at 41FB200 very closely matches that at 41HR616 where floated/unburnished surfaces are the overwhelming preference throughout the sequences represented at both sites. Indeed, the only difference in surface treatment preferences appears to be an intuitive, slight diachronic weakening of the preference for floated/unburnished surfaces at 41FB200. Furthermore, the regional significance of floated surfaces also is ambiguous. Floating is very common at 41B013, and floated/unburnished surfaces are the clear preference at 41FB199 and 41HR729. The occurrence of floating therefore appears to be a trait that 41FB200 shares with sites distributed over a wide area of Fort Bend, Harris, and Brazoria Counties.

Thus, it appears for the time being that floating in general is widespread at various times (perhaps sometimes contemporaneously) in the Fort Bend/Brazoria County area and the Harris County/Galveston Bay area. Unfortunately, chronometric data are not yet available to determine rigorously the temporal relationships between these sites. Without
a chronometric comparative basis, it is not possible to determine whether regional
differences and similarities in the occurrence of floating can best be attributed to
functional or cultural-historical sources. Furthermore, the 41FB199 and 41FB200
assemblages are not wholly comparable to the 41HR616 and 41HR273 assemblages
because the former are small testing assemblages, whereas the latter are large mitigation
assemblages. Still further, the Copperhead and Alabonson Road assemblages were not
analyzed along the same dimensions as the 41FB199, 41FB200, 41HR729, and
41HR616 assemblages. Thus, clarification of the possible regional significance of
floating (both with and without burnishing) awaits the accumulation of a widely
distributed body of well-dated ceramic assemblages that have been analyzed in
comparable ways for technological style.

There also is considerable ambiguity with respect to the regional and/or temporal
significance of smudging. Smudging appears to be common in Brazos Delta/West Bay
sites (Hamilton 1988; Ellis 1994), but not elsewhere in the upper Texas coast region.
This firing technique is relatively common at 41FB200 (where 41% of the analyzed
sherds had smudged interiors) and at the Copperhead site. As noted above, it is very
uncommon at 41HR616 and 41HR729, and it is very unlikely that the probability of
choice for smudging at the latter two sites is identical to that at 41FB200. Although
precise data are not available, the frequency of smudging also appears to be very low at
41HR273. This suggests at least one variable for which there was regional difference in
technological style, especially since the probability of choice for smudging also appears
to have been higher at the Copperhead Site than at 41HR616, 41HR729, and 41HR273.

With respect to smudging, therefore, 41FB200 appears to have greater affinities with
sites to the south than to sites in the Harris County/Galveston Bay area.
Interestingly, however, only one sherd (7%) with a smudged interior surface was recovered from 41FB199, only 200 m from 41FB200. This indicates that the regional and/or diachronic pattern for smudging preferences may be very complex, and may be accounted for by one or more of several considerations. 41FB199, 41FB200, and the 41HR729/41HR273/41HR616 area may have been occupied by different groups whose pottery traditions each reflect different approaches to technological style. This explanation, however, would appear to cast 41FB199 as an anomaly because of the apparent widespread frequency of smudging at sites in Fort Bend and Brazoria Counties. Alternatively, 41FB199 and 41FB200 may represent functionally different sites in the same ceramic tradition so that differences in the frequency of smudging reflects different functional applications for pottery at two closely spaced sites. In this case, differences in the apparent general frequency of smudging between the Fort Bend/Brazoria County area and the Harris County/Galveston Bay area may reflect regional differences in approaches to technological style and in functional applications for pottery if smudging is related to some unknown use for ceramic vessels. Third, the ceramic assemblages at 41FB199 and 41FB200 may not overlap in time, in which case a temporal change in technological style (with respect to smudging) in the Fort Bend/Brazoria County tradition may reflect a change in tradition that has no parallel in the Harris County/Galveston Bay area.

As previously noted, the proportion of decorated vessels (3%) at 41FB200 is higher than that reported for the assemblage at the Copperhead site. If this disparity is not due to sampling error and decorated ceramics do, in fact, appear later in time in the Brazos Delta/West Bay area than in the Galveston Bay area, then it is quite likely that 41FB200 was occupied later in time than the Copperhead site. However, when 41FB200 is compared to sites 41HR273, 41HR729, and 41HR616 in Harris county, the percentage
of vessels with exterior enhancement is very similar and, with the exception of 41HR616, so is the frequency of lip decoration. While the number of decorated sherds at 41HR273 is somewhat difficult to calculate, it appears that approximately 2% of the analyzed sherds had exterior surface enhancement and 3% of the rim sherds had lip decoration. At 41HR729, 2% of the sherds were decorated and 3% had lip decoration. At 41HR616, 4% of the sherds were decorated, however, 12% of the rim sherds had lip decoration. Thus, it appears that a similar preference for decorative exteriors may have existed at various times (perhaps sometimes contemporaneously) for at least some sites in the Fort Bend/Brazoria County area and the Harris County/Galveston Bay area. Interestingly, 41FB199 again appears to be an anomaly because 7% of the sherds have decorated exterior surfaces. This appears to be unexpectedly high if decorated sherds are supposed to be rare at Fort Bend County sites in comparison to Harris County/Galveston Bay area sites.

The types of decorative motifs present at 41FB200 are suggestive of ceramic motifs found in both the Galveston Bay area and the Coastal Bend area to the south. Of the 12 decorated sherds recovered at the site, 3% (n=4) have linear incised lines typical of Goose Creek ceramics. Five sherds (4%) have design motifs more typically found on Rockport Black-on-Gray ceramics from the Coastal Bend area, however, the paste and basic exterior surface treatment differs from typical Rockport patterns. Hence, some of these decorated sherds show simultaneous affinities to technological traditions to the northeast and to the south. There are also three sherds with unusual design elements that do not appear to be common in either area. One sherd has a segment of a wide wedge-shaped design that has been cut into the surface. Two sherds have brushed exterior surfaces more reminiscent of Caddo designs. In all, the design motifs present on the ceramics recovered from 41FB200 suggest either a mixed assemblage or the
presence of a distinct technological tradition that incorporates elements of both the Galveston Bay area ceramic tradition and the Coastal Bend area ceramic tradition.

Conclusion

Judging from the comparisons and contrast to assemblages at sites in the area of Fort Bend, Brazoria, and Harris Counties, the ceramic assemblage at 41FB200 offers considerable capacity to serve as a basis for mapping temporal and regional variation in ceramic technological style, for mapping possible areas with relatively localized ceramic traditions, and, eventually, for identifying functional characteristics of ceramics. This well stratified site is especially well suited for constructing an initial seriation of technological style for this part of Fort Bend County because it is deeply stratified, rich in ceramics, and very well located among a growing list of well-excavated sites with consistently analyzed ceramic assemblages. Thus, the 41FB200 ceramics provide interesting research opportunities with regard to the regional and temporal aspects of ceramic technology as it relates to both the Brazos Delta-West Bay region and the upper Texas coast region in general.
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## Appendix VII: Previously Recorded Sites in the Spring Creek Region

### Woodlands Survey:

<table>
<thead>
<tr>
<th>Site No.</th>
<th>41MQ64</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Landform:</strong></td>
<td>Toeslope (Willis or Lissie Slope above Spring Creek floodplain and terrace); 150 meters to marsh marking possible former Spring Creek channel; 640 meters to current Spring Creek channel.</td>
</tr>
<tr>
<td><strong>Soils:</strong></td>
<td>Well-drained fine sand</td>
</tr>
<tr>
<td><strong>Elevation:</strong></td>
<td>150 ft AMSL</td>
</tr>
<tr>
<td><strong>Site Description/Age</strong></td>
<td>Small short-term habitation with low artifact density. Cultural remains buried at depth of 30 - 50 CM below surface. Prehistoric: Ceramic period.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site No.</th>
<th>41MQ65</th>
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</thead>
<tbody>
<tr>
<td><strong>Landform:</strong></td>
<td>Toeslope (Willis or Lissie Slope above Spring Creek floodplain and terrace); 120 meters to minor ephemeral tributary of Spring Creek; 600 meters to current Spring Creek channel.</td>
</tr>
<tr>
<td><strong>Soils:</strong></td>
<td>Well-drained fine sand (Eustis)</td>
</tr>
<tr>
<td><strong>Elevation:</strong></td>
<td>145 ft AMSL</td>
</tr>
<tr>
<td><strong>Site Description/Age</strong></td>
<td>Small short-term habitation with low artifact density. Prehistoric: Ceramic period.</td>
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</table>

<table>
<thead>
<tr>
<th>Site No.</th>
<th>41MQ66</th>
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</thead>
<tbody>
<tr>
<td><strong>Landform:</strong></td>
<td>Willis or Lissie Slope above Spring Creek floodplain and terrace; 130 meters to minor ephemeral tributary of Spring Creek; 540 meters to current Spring Creek channel.</td>
</tr>
<tr>
<td><strong>Soils:</strong></td>
<td>Well-drained fine sand (Eustis)</td>
</tr>
<tr>
<td><strong>Elevation:</strong></td>
<td>145 ft AMSL</td>
</tr>
<tr>
<td>Site Description/Age</td>
<td>Surface find of 3 lithic flakes; utilization unknown. Prehistoric</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Site No.</td>
<td>41MQ67</td>
</tr>
<tr>
<td>Landform:</td>
<td>Willis or Lissie Slope above Spring Creek floodplain and terrace; 100 meters to very minor ephemeral tributary of Spring Creek; 680 meters to current Spring Creek channel.</td>
</tr>
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<td>Soils:</td>
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<td>Elevation:</td>
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</tr>
<tr>
<td>Site Description/Age</td>
<td>Small short-term habitation with low artifact density. Cultural remains buried at depth of 30 - 45 CM below surface. Prehistoric: Ceramic period.</td>
</tr>
<tr>
<td>Site No.</td>
<td>41MQ68</td>
</tr>
<tr>
<td>Landform:</td>
<td>Toeslope (Willis or Lissie Slope above Spring Creek floodplain and terrace); 200 meters to marsh marking possible former Spring Creek channel; 370 meters to current Spring Creek channel.</td>
</tr>
<tr>
<td>Soils:</td>
<td>Well-drained fine sand (Eustis)</td>
</tr>
<tr>
<td>Elevation:</td>
<td>160 ft AMSL</td>
</tr>
<tr>
<td>Site Description/Age</td>
<td>Surface find of 1 lithic flake; utilization unknown. Prehistoric</td>
</tr>
<tr>
<td>Site No.</td>
<td>41MQ69</td>
</tr>
<tr>
<td>Landform:</td>
<td>Toeslope (Willis or Lissie Slope above Spring Creek floodplain and terrace); 200 meters to possible extinct minor tributary of Spring Creek; 450 meters to current Spring Creek channel.</td>
</tr>
<tr>
<td>Soils:</td>
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<tr>
<td>Elevation:</td>
<td>135 ft AMSL</td>
</tr>
<tr>
<td>Site Description/Age</td>
<td>Small short-term habitation with low artifact density. Cultural remains buried at depth of 20 - 30 CM below surface. Prehistoric: Ceramic period.</td>
</tr>
</tbody>
</table>
Burroughs Park Survey:

Site No. 41HR625

Landform: Lissie Slope above Spring Creek floodplain and terrace; 200 meters to marsh marking possible former Spring Creek channel; 860 meters to current Spring Creek channel.

Soils: Well-drained Loamy Fine Sand (Kinney)

Elevation: 165 ft AMSL

Site Description/Age Open Campsite with high artifact density. Cultural remains buried at depth of 30 CM below surface and extend as deeply as 100 CM below surface. Prehistoric: Ceramic period.

Site No. 41HR626

Landform: On low ridge on Terrace above Spring Creek channel and below Lissie Slope. 50 meters to current Spring Creek channel.

Soils: Well-drained Loamy Fine Sand (Kinney)

Elevation: 130 ft AMSL

Site Description/Age Open Campsite with low artifact density. Cultural remains (flakes) buried at depth of 40 CM below surface and extend to 60 CM below surface. Prehistoric.

Site No. 41HR627

Landform: On Terrace at foot of Lissie Slope beside marsh possibly formed by ancient meander or scour of Spring Creek. Marsh appears fed by seep springs. 600 meters to current Spring Creek channel.

Soils: Well-drained Loamy Fine Sand (Boy)

Elevation: 130 ft AMSL
Site Description/Age: Open Campsite with low artifact density. Cultural remains (flakes) buried at depth of 60 CM below surface and extend to 80 CM below surface. Prehistoric.

Neidigk Lake Project:

Site No. 41MQ44
Landform: Terrace above Spring Creek channel and below Willis Slope [?]. Ca. 100 meters to confluence of Decker Brook and Mill Creek to form Spring Creek channel.
Soils: Not Available
Elevation: 147.5 ft AMSL

Site Description/Age: Open Campsite with high artifact density (currently highly disturbed). Prehistoric: Late Paleo-Indian, Early Archaic and Ceramic Period components. Site is at approximate location of El Gordo's Akokisa village and proposed site of Villa Santa Rosa de Alcazar as placed by Bolton (1970: 350).

Site No. 41MQ48
Landform: Terrace above Spring Creek channel and below Willis Slope [?]. Ca. 200 meters to confluence of Decker Brook and Mill Creek to form Spring Creek channel.
Soils: Not Available
Elevation: 150 ft AMSL

Site Description/Age: Open Campsite with high artifact density. Lithic tools and debris recovered from 40-140 CM below surface. Prehistoric: Archaic, Ceramic Period (?).

Houston Archeological Society Spring Creek Survey:

Site No. 41MQ51
Landform: Crest of hill; site is associated with two seep springs; 250 meters to Spring Creek.
Soils: Not described
<table>
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<tr>
<th>Elevation:</th>
<th>ca. 70+ ft. AMSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Description/Age</td>
<td>Surface observation of lithic debris and charcoal. Prehistoric. Posited by original recorder of site as location of Villa Santa Rosa de Alcazar mission.</td>
</tr>
<tr>
<td>Impact:</td>
<td>This site is located within the Bahr/Kirkpatrick tract but is within the 100-year floodplain.</td>
</tr>
<tr>
<td>Site No.</td>
<td>41MQ52</td>
</tr>
<tr>
<td>Landform:</td>
<td>Crest of Willis or Lissie Slope directly above Spring Creek. 30 meters to Spring Creek.</td>
</tr>
<tr>
<td>Soils:</td>
<td>Sandy Loam above Clay</td>
</tr>
<tr>
<td>Elevation:</td>
<td>ca. 75+ ft. AMSL</td>
</tr>
<tr>
<td>Site Description/Age</td>
<td>Eroded surface observation of lithic debris and ceramics in pipeline alignment. No artifacts visible on undisturbed surfaces. Ceramic Period: Campsite. Posited by original recorder of site as location of Canos' Akokisa village.</td>
</tr>
<tr>
<td>Impact:</td>
<td>This site is located within the Bahr/Kirkpatrick tract above the 100-year floodplain.</td>
</tr>
<tr>
<td>Site No.</td>
<td>41HR411</td>
</tr>
<tr>
<td>Landform:</td>
<td>Crest of hill within Lissie Slope adjoining old Spring Creek Meander scar. Eroded surface observation of cultural material in pipeline alignment. No artifacts visible on undisturbed surfaces. 400 meters to Spring Creek.</td>
</tr>
<tr>
<td>Soils:</td>
<td>Not described</td>
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<tr>
<td>Elevation:</td>
<td>ca. 85+ ft. AMSL</td>
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<tr>
<td>Site Description/Age</td>
<td>Lithic debris and ceramics in pipeline disturbance Ceramic Period: Campsite</td>
</tr>
<tr>
<td>Site No.</td>
<td>41HR414</td>
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<tr>
<td>Landform:</td>
<td>Within Lissie Slope above Spring Creek. 80 meters to Spring Creek.</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Soils:</td>
<td>Not Available</td>
</tr>
<tr>
<td>Elevation:</td>
<td>ca. 75+ ft. AMSL</td>
</tr>
<tr>
<td>Site Description/Age</td>
<td>Buried midden site exposed in gully wall with midden deposit at 0.3 M below surface. No artifacts visible on undisturbed surfaces. Lithic debris and ceramics exposed. Ceramic Period: Campsite.</td>
</tr>
</tbody>
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**Jones Park Survey:**

<table>
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<th>Site No.</th>
<th>41HR597</th>
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<tbody>
<tr>
<td>Landform:</td>
<td>Site is located on low ridge on the Lissie Slope edge of upland on the west side of a small gully which flows north onto the Spring Creek floodplain at a large, old meander scar and meander belt which forms a wide terrace within this segment of Spring Creek and separates the site from the current Spring Creek channel by ca. 500 - 600 M.</td>
</tr>
<tr>
<td>Soils:</td>
<td>Wockley Fine Sandy Loam</td>
</tr>
<tr>
<td>Elevation:</td>
<td>ca. 85+ ft. AMSL</td>
</tr>
<tr>
<td>Site Description/Age</td>
<td>No cultural material was observed on the surface in the area of Site 41 HR 597. Lithic debitage was recovered from one shovel test at a depth between 20 and 32 cm. below surface. Prehistoric: Campsite.</td>
</tr>
<tr>
<td>Site No.</td>
<td>41HR598</td>
</tr>
<tr>
<td>Landform:</td>
<td>Site is located on the Lissie Slope edge of the upland on the south side of Spring Creek, near the rather abrupt drop-off to the Spring Creek terrace. It is situated on a low ridge between a small gully flowing north into the Spring Creek terrace at an old meander scar, and a larger gully which flows east to a less well-defined drop-off into the terrace. The terrace separates the site from the current channel of the creek by ca. 500 - 600 meters.</td>
</tr>
<tr>
<td>Soils:</td>
<td>Wockley Fine Sandy Loam</td>
</tr>
</tbody>
</table>
Site Description/Age: No cultural material was observed on the surface in the area of Site 41HR598. Lithic debitage was recovered from two shovel tests at a depth between 15 and 35 cm. below surface. Prehistoric: Campsite.

Site No.: 41HR599

Landform: Site is located on the Lissie Slope edge of the upland on the south side of Spring Creek, near the rather abrupt drop-off to the Spring Creek terrace. It is situated on a low ridge between a small gully flowing north into the Spring Creek terrace at an old meander scar, and a larger gully which flows east to a less well-defined drop-off into the terrace. The terrace separates the site from the current channel of the creek by ca. 500 - 600 meters.

Soils: Wockley Fine Sandy Loam

Elevation: ca. 85+ ft. AMSL

Site Description/Age: No cultural material was observed on the surface in the area of Site 41HR599. Gary dart point and lithic debitage were recovered from one shovel test at a depth between 38 and 43 cm. below surface, within a light yellow to yellow-orange clay loam stratum. Late Archaic to Early Ceramic periods: Campsite.

Site No.: 41HR600

Landform: Site is located on the Lissie Slope edge of the upland on the south side of Spring Creek, near the rather abrupt drop-off to the Spring Creek terrace. It is situated on a low ridge between a small gully flowing north into the Spring Creek terrace at an old meander scar, and a larger gully which flows east to a less well-defined drop-off into the terrace. The terrace separates the site from the current channel of the creek by ca. 500 - 600 meters.

Soils: Wockley Fine Sandy Loam

Elevation: ca. 85+ ft. AMSL
Site Description/Age: No cultural material was observed on the surface in the area of Site 41HR600. One lithic flake was recovered from one shovel test at a depth of 0 and 8 cm. below surface. Prehistoric: Campsite.

Site No.: 41HR601

Landform: Site is located on the Lissie Slope edge of the upland on the south side of Spring Creek, near the rather abrupt drop-off to the Spring Creek terrace. It is situated on a low ridge between a small gully flowing north into the Spring Creek terrace at an old meander scar, and a larger gully which flows east to a less well-defined drop-off into the terrace. The terrace separates the site from the current channel of the creek by ca. 500 - 600 meters.

Soils: Wockley Fine Sandy Loam

Elevation: ca. 85+ ft. AMSL

Site Description/Age: No cultural material was observed on the surface in the area of Site 41HR601. Lithic debitage recovered from two shovel tests at a depth between 15 and 25 cm. below surface. Prehistoric: Campsite.

Site No.: 41HR602

Landform: Site is located on the Lissie Slope edge of the upland on the south side of Spring Creek, near the rather abrupt drop-off to the Spring Creek terrace. It is situated on a low ridge between a small gully flowing north into the Spring Creek terrace at an old meander scar, and a larger gully which flows east to a less well-defined drop-off into the terrace. The terrace separates the site from the current channel of the creek by ca. 500 - 600 meters.

Soils: Wockley Fine Sandy Loam

Elevation: ca. 80+ ft. AMSL

Site Description/Age: No cultural material was observed on the surface in the area of Site 41HR602. A biface fragment, a utilized flake and lithic debitage were recovered from three shovel tests at a depth between 0 to 46 cm. below surface. Prehistoric: Campsite.
Site No. 41HR603

Landform: Site is located on the Lissie Slope edge of the upland on the south side of Spring Creek, near the rather abrupt drop-off to the Spring Creek terrace. It is situated on a low ridge between a small gully flowing north into the Spring Creek terrace at an old meander scar, and a larger gully which flows east to a less well-defined drop-off into the terrace. The terrace separates the site from the current channel of the creek by ca. 500 - 600 meters.

Soils: Wockley Fine Sandy Loam

Elevation: ca. 80+ ft. AMSL

Site Description/Age No cultural material was observed on the surface in the area of Site 41HR603. A single, very small sherd of prehistoric ceramics was recovered from one shovel test at a depth between 0 and 20 cm. below surface. Ceramic Period: Campsite.

Site No. 41HR606

Landform: Site is located on the Lissie Slope edge of an erosional remnant of upland isolated by a large relict, meander scar to the north and northwest, to the east by the Spring Creek terrace, and to the south by a gully flowing east to the Spring Creek terrace. It lies near the rather abrupt drop-off to the Spring Creek terrace at the old meander scar. The site is situated on a low ridge linking the isolated upland erosional remnant to the broad upland to the west. This ridge divides the old meander scar from the adjacent, large east-flowing gully. The site is separated from the current channel of Spring Creek by ca. 400 - 500 meters.

Soils: Wockley Fine Sandy Loam

Elevation: ca. 75+ ft. AMSL

Site Description/Age No cultural material was observed on the surface in the area of Site 41HR606. Lithic debitage was recovered from two shovel test at a depth between 11 and 36 cm. below surface. Late Archaic to Early Ceramic periods: Campsite.
0 West Fork  San Jacinto Surveys:

Site No. 41MQ57

Landform: Terrace finger above the West Fork of the San Jacinto River adjoining small gully which is probably old river meander. Site discovered by shovel testing. 80 meters to small gully; 300 meters to the San Jacinto River.

Soils: Sandy Loam

Elevation: ca. 75+ ft. AMSL

Site Description/Age Buried site with Gary dart point and lithic flakes and charcoal 0.5 M below surface. Late Archaic: Campsite (?)

Site No. 41MQ59

Landform: Terrace finger above the West Fork of the San Jacinto River. Buried site exposed in road cut bank profile; cultural material is 0.3-0.8 M below surface. Possibly situated on terrace rise. 150 meters to the San Jacinto River.

Soils: Sand

Elevation: ca. 60+ ft. AMSL

Site Description/Age Buried site with lithic flakes, biface, arrow and dart points and ceramics. Prehistoric: Late Archaic and Ceramic Period Campsite

Site No. 41MQ60

Landform: Willis or Lissie Slope above the West Fork of the San Jacinto River and adjacent to Evans Gully. Possibly situated on terrace rise. Site exposed in road cut bank profile. 250 meters to Evans Gully; 900 meters to the San Jacinto River.

Soils: Sand

Elevation: ca. 75+ ft. AMSL

Site Description/Age Observation of lithic debris and ceramics in road cut. Ceramic Period: Campsite.