INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF CORRUGATED WARES AND BROWNWARES FROM THE TEXAS SOUTHERN PLAINS AND SOUTHEASTERN NEW MEXICO

THESIS

Presented to the Graduate Council of
Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree

Master of ARTS

by

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San Marcos, Texas
August 2008

ACKNOWLEDGEMENTS

This thesis would not have been possible without the help and support of many individuals. I would like to thank my committee members, Dr. C. Britt Bousman, Dr. Christina A. Conlee, and Dr. James Garber, for their comments and advice on this thesis.

The analyses included in this study were made possible by a number of researchers and institutions who allowed me to use their data or who granted me access to their collections. Darrell Creel was generous in permitting me access to his Ochoa Indented Brown INAA data and for sharing his extensive knowledge of New Mexico and Texas prehistoric ceramics which helped guide this research. John Speth provided access to the ceramic sherd assemblages from Henderson Pueblo, the Merchant site, and Arthur Jelinek's Middle Pecos River Valley Survey. I would also like to thank Doug Boyd, whose knowledge of Texas Southern Plains prehistory also helped guide this research. I appreciate the support of the Texas Archeological Research Laboratory, University of Texas at Austin, in particular Laura Nightengale.

Private landowners, including Faskin Oil and Gas Ltd. and Jorge Guenther, generously allowed me access to their lands for the raw material survey. Access to the Merchant site was made possible by the efforts of Calvin Smith and permission to collect raw materials on public lands was granted by and sample collection was supervised by George MacDonell, Martin Stein, Rebecca Hill, and Bruce Boeke of the Carlsbad Field Office, Bureau of Land Management.

Financial support for this study was supported by a research grant awarded by Darrell Creel and *The Friends of TARL*, the Texas Parks & Wildlife Foundation Conservation Scholarship, and the Archaeometry Program at the Research Reactor Center, University of Missouri, Columbia (NSF grant number SBR-9802366), under the direction of Michael Glascock.

I would like to thank my colleagues at Texas Parks and Wildlife Department Cultural Resources Program for being supportive and encouraging. I thank my fellow classmates for making graduate school a more enjoyable experience. I owe the deepest gratitude to my parents, Evangelina and Luis A. Alvarado, and my sister, Jennifer Alvarado. Their love, support, and patience have been a blessing through this challenging journey.

This manuscript was submitted July 9, 2008.

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CHAPTER 1

INTRODUCTION TO THE STUDY

The recent emphasis on pottery production systems in part derives from methodological advances in chemical and mineralogical characterization analyses, which allow relatively precise determination of the chemical composition of clays used for ceramic manufacture and the inferred locations of ceramic manufacture (Bishop et al. 1982). In the prehistoric American Southwest, archaeologists often use ceramic production and distribution data to explore regional social and economic organization. This study examines the validity of Ochoa Indented Brown as a Southern Plains pottery type and addresses issues concerning Pueblo-Plains interaction during the Ceramic period (ca. A.D. 950 to 1500) using the results of Instrumental Neutron Activation Analysis (INAA) of selected ceramic samples from the Southern Plains and the New Mexico Pecos River valley and Sierra Blanca regions.

The nature and extent of the interaction between Southern Plains bison-hunting groups and sedentary agricultural Puebloan people has long been a popular topic of archaeological discussion and debate (Boyd 2002; Creel 2001; Speth 1991; Spielmann 1991). This interaction is often described as a symbiotic relationship involving the exchange of bison products, such as meat and hides, for agricultural products such as corn, cotton, and tobacco (Boyd et al. 2002:111; Creel 2001).

Archaeological evidence of this Pueblo-Plains exchange is generally limited to the nonperishable artifacts that may have been only a minor component in the trade. In the Southern Plains, items from the Puebloan Southwest, including turquoise, obsidian, and Pacific *Olivella* seashells, occur widely and provide evidence of exchange with people living in what is now New Mexico (Boyd et al. 2002; Creel 2001). In addition, various kinds of Southwestern ceramics also occur at these sites. The ceramics found in prehistoric archaeological sites are often the most tangible and common forms of archaeological evidence of this exchange (Boyd et al. 2002).

Evidence for post A.D. 1300 late prehistoric Pueblo-Plains trade and exchange can be found in Southern Plains and extreme southeastern New Mexico sites attributed to the Ochoa Phase (A.D. 1300-1450) of the Eastern Jornada Mogollon culture (Collins 1968; Corley 1965; Leslie 1979). The Salt Cedar Site (41AD2) and the Merchant Site (LA 43414) are two Ochoa Phase sites with archaeological evidence that indicate the occupants of these sites were involved in the Plains-Pueblo exchange system. Notably, the ceramic assemblages from these two sites include distinctive decorated wares of Puebloan manufacture, including Chupadero Black-on-White, El Paso Polychrome, and Lincoln Black-on-Red (Collins 1968; Leslie 1965b). In addition, a significant portion of both assemblages include plain and corrugated/indented utility wares whose origins are in question (Collins 1968; Leslie 1965b).

A particular utilitarian ware of interest, Ochoa Indented Brown, is attributed to the Ochoa Phase (A.D. 1300-1450) of the Eastern Jornada Mogollon culture. Ochoa Indented Brown includes all observed variations of surface treatments that range from corrugated to indented (Boyd 1997; Runyan and Hedrick 1987; Wiseman et al. 1999).

The distribution of Ochoa Indented Brown is restricted to a relatively small area that encompasses portions of the Texas Southern Plains and extreme southeastern New Mexico. Collins (1968) and Leslie (1965a) propose that Ochoa Indented Brown is a ceramic type representing Southern Plains manufactured utilitarian vessels.

In this thesis I use INAA of Ochoa Indented Brown pottery fragments and clay samples from key sites to address questions concerning the production locales of Ochoa Indented Brown, Late Prehistoric Southern Plains settlement, and Late Prehistoric Pueblo-Southern Plains trade and exchange networks. First, INAA may determine whether Ochoa Indented Brown is a meaningful ceramic type representing Southern Plains produced utilitarian vessels, as suggested by Collins (1968) and Leslie (1965a). Secondly, the results may require the reconsideration of longstanding Southern Plains Late Prehistoric settlement models. The appearance of Southwestern-style corrugated/indented pottery in pueblolike villages on the Southern Plains may represent an influx of Puebloan groups or at least, considerable expansion of their cultural influence among neighboring people (Collins 1968). In addition, these INAA data may provide clues that will contribute to our understanding of Pueblo-Southern Plains trade and exchange networks within the Eastern Jornada Mogollon culture area through the incorporation for INAA of utilitarian wares such as Corona and Seco Corrugated wares originating in central New Mexico and brownwares from the New Mexico Pecos River valley; these data may identify patterns of trade and exchange. Additionally, these data could provide information regarding differences in the movement of utilitarian vessels versus decorated wares produced in the Sierra Blanca region.

Organization of the Thesis

Chapter 2 addresses the physiography, flora and fauna, and geology of the Sierra Blanca, Pecos River valley, and the Southern High Plains regions. The brief summaries of the geology of the study regions are provided in this chapter to help the reader understand the regional geologic variation and its role in defining compositional reference groups which will be discussed in Chapter 6.

Chapter 3 provides the culture historical background of the study regions and descriptions of the ceramic samples analyzed for this study. An understanding of the regions and their culture history is necessary to place these ceramics in their proper context. A primary goal of this study is to determine the production area of a ceramic type thought to have been produced on the Southern Plains (i.e. Ochoa Indented Brown), but several pottery types from the Pecos River valley and the Sierra Blanca regions were included in this study as a comparative sample.

Chapter 4 provides a brief description of the INAA techniques and statistical analyses employed to construct compositional reference groups. INAA is generally considered the most powerful chemical characterization method for sourcing ceramic materials. For this study, INAA was determined to be the most appropriate compositional technique to more thoroughly investigate production of Ochoa Indented Brown and trade and exchange between the regions.

Chapter 5 provides the background for analysis of this study. The main goal in selecting ceramic collections for the database was to obtain a sample of ceramics from roughly contemporaneous sites in the regions for INAA. In order to address ceramic production in the regions, a geographically diverse sample spanning multiple phases was acquired for analysis. Eleven clay samples were also submitted for INAA.

Chapter 6 summarizes the results of the INAA statistical analyses employed to construct compositional reference groups. The compositional reference groups, unassigned samples, and clay samples are summarized and briefly discussed in this chapter.

Chapter 7 provides a detailed discussion that reviews the implications of the INAA data. The chapter concludes with final remarks and recommendations for future study. Chapter 7 is followed by Appendices A, B, and C.

CHAPTER 2

ENVIRONMENTAL BACKGROUND

This chapter provides a brief summary of the environmental background (e.g. physiography, biology, and geology) of the Sierra Blanca, Pecos Valley, and Southern Plains regions. A brief summary of the geology of the study regions is provided in this chapter to help the reader understand the regional geologic variation and its role in defining compositional reference groups; a basic understanding of the geology of the study regions will allow the reader to better understand the INAA compositional data to be discussed in Chapter 6.

Sierra Blanca Region

Geographic Setting

The Sierra Blanca region encompasses the roughly 12,950 km^2 area of southeast New Mexico east of the Gallinas, Sacramento, and Sierra Blanca mountains and west of the Pecos River (Figure 1). A number of large drainage systems arise along the flanks of the Sacramento and Sierra Blanca mountains and flow eastward to join the middle Pecos River (Clark 2006:47).

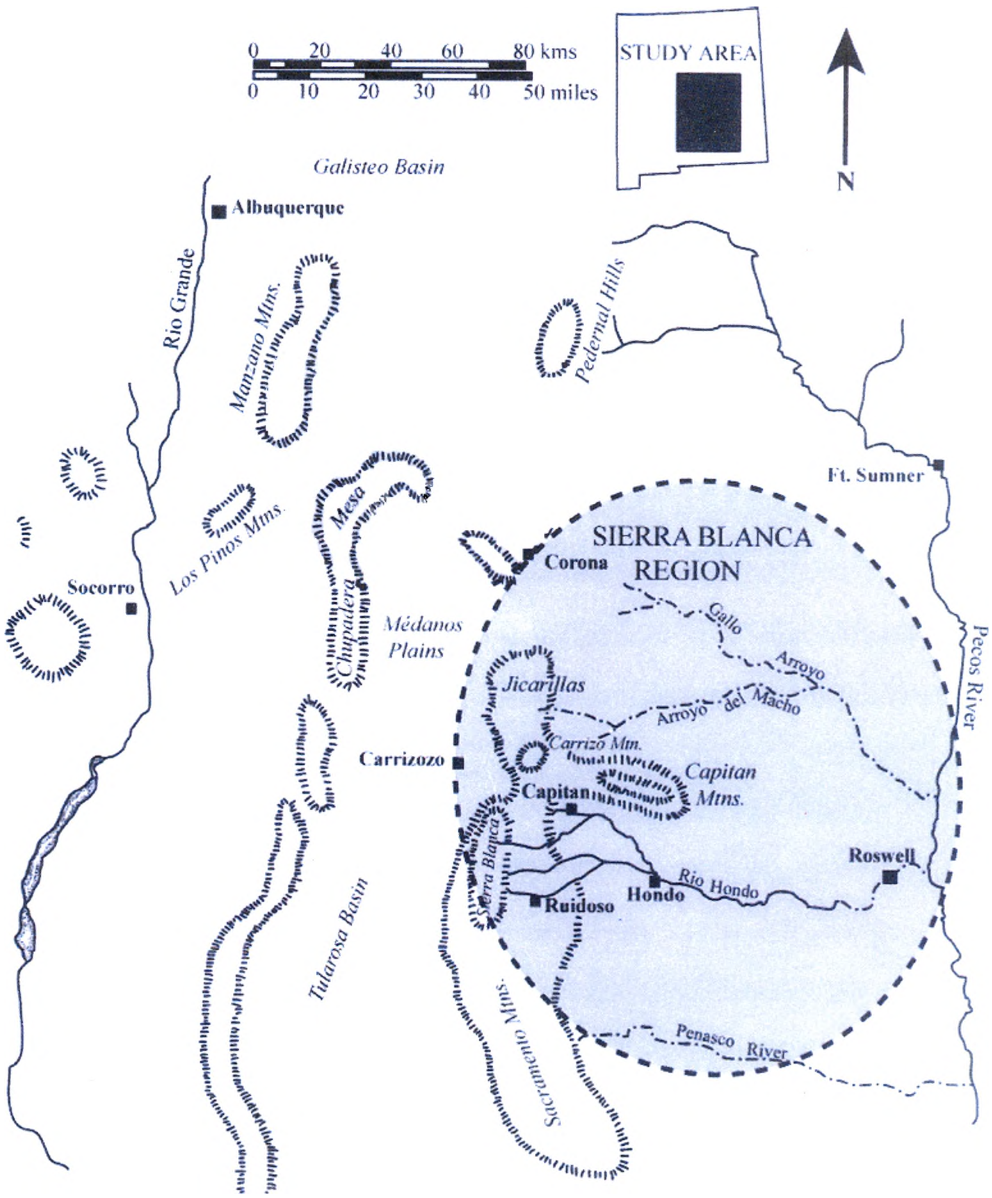

Figure 1. Map of the Sierra Blanca region (Clark 2006).

These drainages (north to south) include the Gallo, Macho, Hondo, and Peñasco Valleys. All of these rivers in the Sierra Blanca region, excluding the Hondo, are intermittent streams that carry water during summer rains (Clark 2006:47; Kelley 1984:167).

Natural Setting

Several biotic communities are present in the Sierra Blanca region. Fir and pine conifer forests are the dominant vegetation in the mountains and the upper reaches of the drainage valleys (Clark 2006:47; Pase and Brown 1994). Continuing east and moving down the drainage systems, juniper-piñon woodlands dominate at elevations between 1,646 and 1,890 m, with riparian species such as oak (*Quercus* sp.), walnut (*Juglans* sp.), and cottonwood (*Populus* sp.) occupying areas along the drainages (Brown 1994; Clark 2006:47). The middle and lower reaches of the drainages located below 1,646 m in elevation consist of open semidesert grasslands that contain a variety of perennial grasses with scattered yucca (Y*ucca* sp.), prickly pear (O*puntia* sp.), and cholla (*Opuntia* sp.) (Brown 1994; Clark 2006:47).

Geology

Permian age limestone and dolomite of the San Andres formation comprises much of the surficial geology of the Sierra Blanca region (Figure 2). Yeso deposits, underlying the San Andres rock, are exposed in the upper and lower reaches of the Hondo and Peñasco Rivers, where streams have cut into the sandstone, siltstone, and limestone that characterize this sedimentary formation (Allen and Foord 1991;Clark 2006:123). Clay lenses and beds suitable for construction purposes and making pottery can be found in the San Andres and Yeso Formations (Kelley 1984:2).

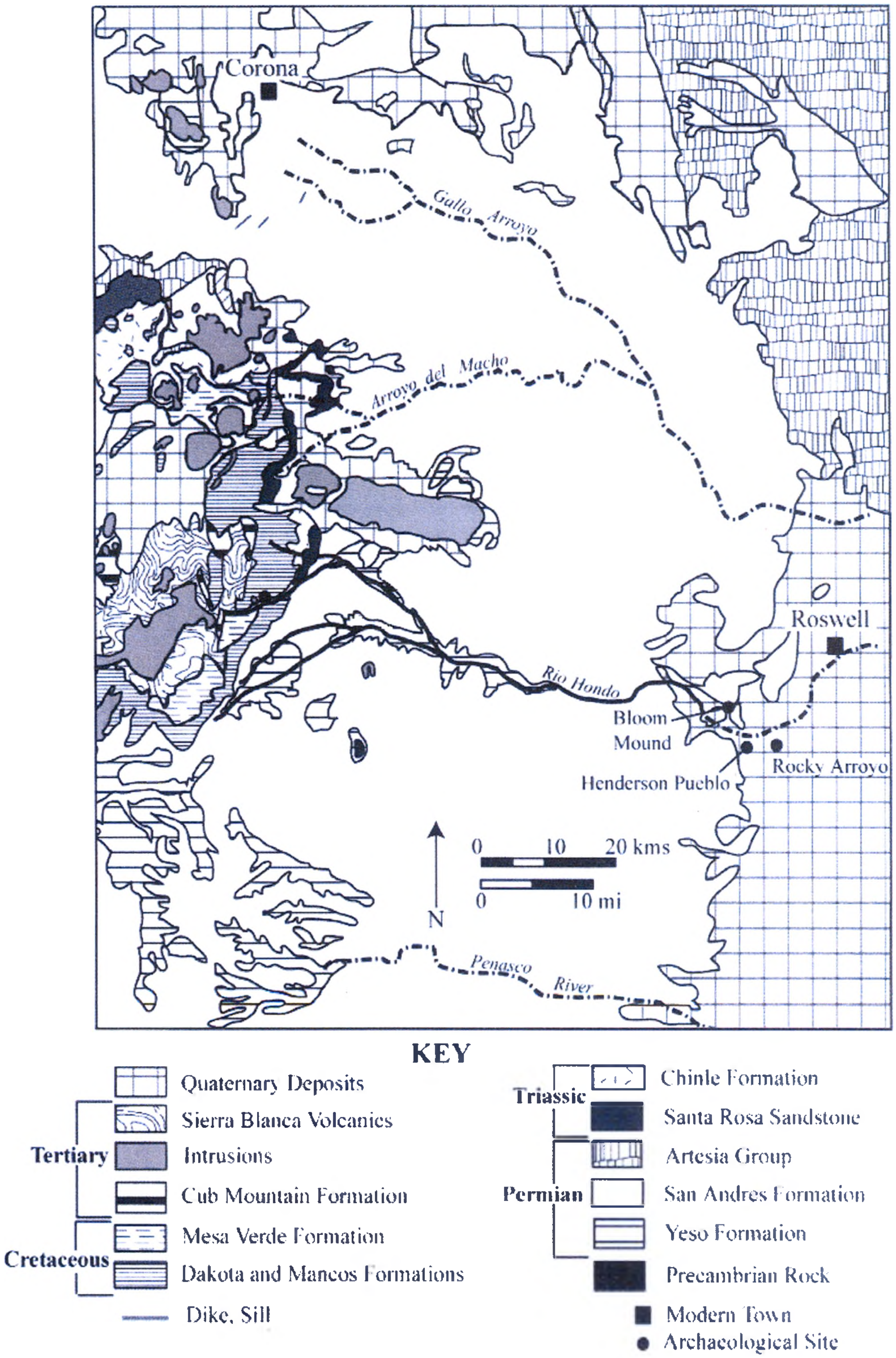

Figure 2. Geology of the Sierra Blanca region (Clark 2006).

In this area the Triassic is represented by two formations, the lower Santa Rosa sandstone and the upper Chinle shale (Allen and Foord 1991; Clark 2006:123). The Cretaceous Period is represented by Dakota sandstone, Mancos shale, and the Mesa Verde group Outcrops of Mesozoic sedimentary rock are also found in the Sierra Blanca region. These deposits primarily occur in the higher elevations where Tertiary intrusive rocks have pushed up younger sedimentary deposits that overlay San Andres limestone. Together, these units form a suite of sedimentary rocks that surround and are intruded by a series of Tertiary igneous dikes, sills, and irregular rock masses (Allen and Foord 1991; Clark 2006:123).

The Tertiary period in the Sierra Blanca region is marked by widespread igneous activity, resulting in a series of volcanic flows and intrusions (Allen and Foord 1991:99; Clark 2006:123). Rocks associated with these volcanic flows and intrusions are generally alkalic and range from mafic (tephrite, phonotephrite, trachybasalt) to intermediate (andesite and latite) to felsic (rhyolite, trachyte, and phonolite) in composition (Barker et al. 1991; Clark 2006:123). A period of rifting coinciding with a second pulse of igneous activity lead to the formation of mafic, alkalic dikes and granitic plutons (Barker et al. 1991). During this period, a number of granitic intrusions were also formed in the Sierra Blanca complex (Thompson 1972).

The Quaternary geology of the Sierra Blanca is highly variable. Along the lower elevations in the Pecos Valley, extensive terrace deposits are present that are composed of sandy brown silt with lenses of gravel and caliche. The Quaternary sediments in upland valley locales derive from alluvial fans that extend out from the base of the Tertiary instrusives (Kelley 1984:2).

The composition of these alluvial deposits varies and can contain boulders, poorly sorted rounded to angular cobbles, sand, silt, and clay deposits (Clark 2006:124).

Pecos River Valley Region

Geographic Setting

The Pecos River and its tributaries represent the second largest drainage system in New Mexico (Jelinek 1967:5). The Pecos River follows a southeasterly direction from its source in the Sangre de Cristo Mountains of North Central New Mexico to the Fort Sumner area; at this point the river changes direction going southward to about 65 km north of the Texas-New Mexico border, where it again assumes a southeast direction to its confluence with the Rio Grande (Jelinek 1967:5; Figure 3).

The upper Pecos Valley (north of Fort Sumner) is bordered on the east by rolling uplands, valleys and basins, and occasional areas of broken terrain (Sebastian and Larralde 1989:4). Isolated hills and mesas predominate in the north and in portions east of the Pecos River, while level to undulating topography occurs west of the Pecos River (Sebastian and Larralde 1989:4).

The middle Pecos Valley begins in the vicinity of Fort Sumner and extends south to the Texas-New Mexico state line. In the northern reaches of the middle Pecos, drainages enter the valley from the west, while eastern tributaries consist of draws and arroyos originating at the Mescalero Ridge (i.e. Caprock Escarpment) (Sebastian and Larralde 1989:4). Further south along the middle Pecos River, major west-bank tributaries originate in the Capitan, Sierra Blanca, and Sacramento mountains, while eastern tributaries also consist of draws and arroyos originating at the Mescalero Ridge (Sebastian and Larralde 1989:4).

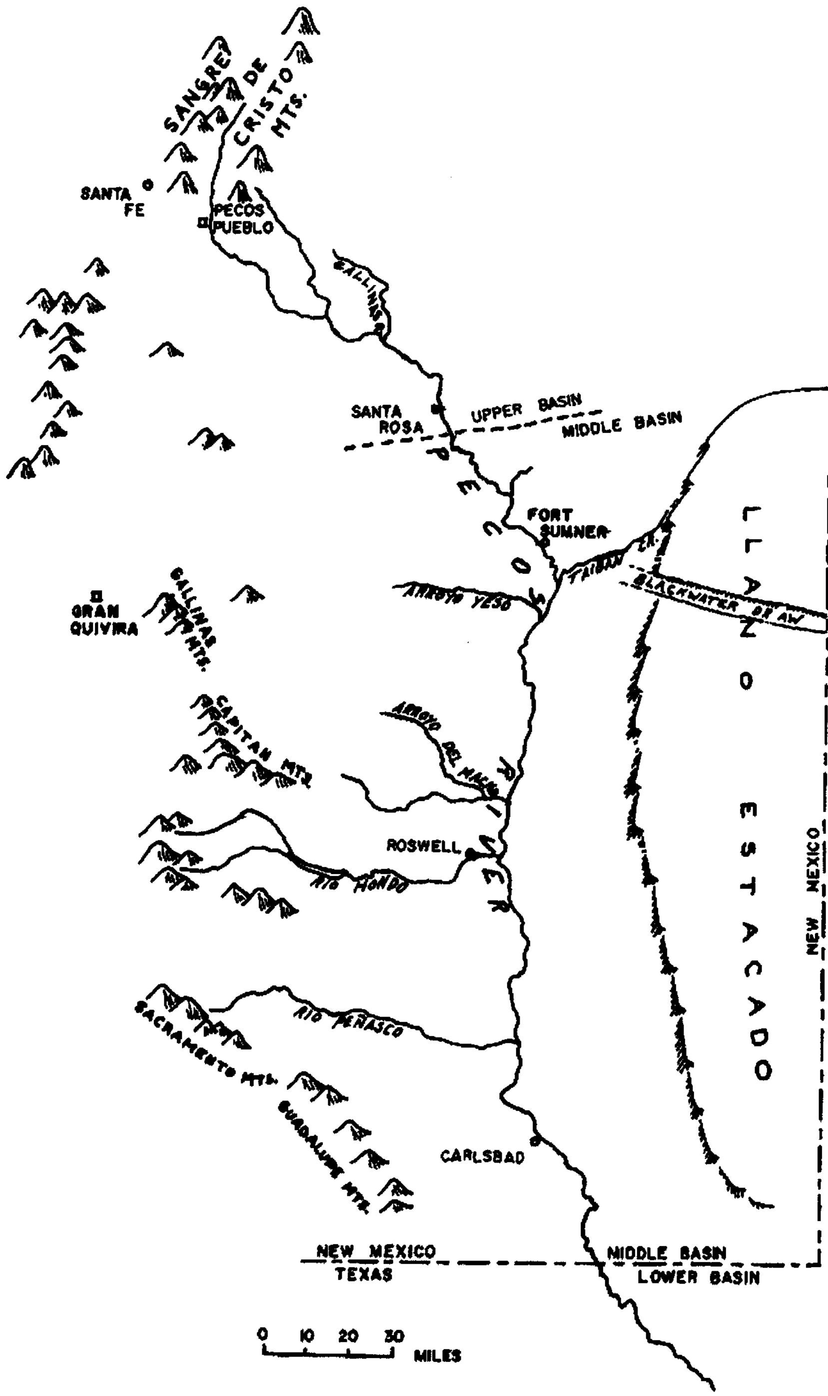

Figure 3. Map of the Pecos River valley (Jelinek 1967).

Natural Setting

The Pecos Valley lies within the northeastern edge of the Chihuahuan Desert, gradually transitioning to the High Plains to the north and east (Polk et al. 2004). Therefore, the natural vegetation of the Pecos Valley falls on the eastern margin of the Southwest but also closely resembles the High Plains, supporting both desert grassland and riparian communities. The desert grasslands are dominated by gramma (*Bouteloua* sp.), tobosa (*Hilaria mutica*), and alkali sacaton (*Sporobolus airoides*) grasses. These communities also support a variety of cactus and brush species such as cholla (O*puntia* sp.), prickly pear (O*puntia* sp.), mesquite (*Prosopis juliflora*), creosote (*Larrea tridentate*), black greasewood (*Sacrobatus vermiculatus*), and shinnery oak (*Quercus havardii*). Local riparian species, largely limited to areas along the Pecos River, typically include cottonwood (*Populus* sp.), willow (*Salix* sp.), tamarisk (*Tamarıx* sp.*)*, and cattails (*Typha domingensis*). However, the present-day vegetation of the area has been altered by lowering of the water table and overgrazing, reducing the native vegetation cover and favoring an increase in more drought-resistant species.

Geology

The Pecos River valley lies west of the Southern High Plains. The drainage originally headed in the Sacramento Mountains but by late Pleistocene times had become integrated with the Upper Pecos-Brazos system headed in the Sangre de Cristo range (Fiedler and Nye 1933). The bedrock underlying the Pecos Valley mainly dates to the Triassic, Permian, and Quaternary (Figure 4). Upland areas of the valley are comprised of extensive pediments, while five erosional surfaces have been recognized (Fiedler and Nye 1933). The uppermost erosional surface is called the Sacramento Plain.

This surface lies west of the Pecos River and corresponds to the Ogallala Formation of the Southern High Plains (Fiedler and Nye 1933).

Below the Sacramento Plain is the Diamond A Plain, an early Pleistocene surface located 122 to 400 m below the level of the Sacramento Plain. The Diamond A Plain is confined to the eastern foothills of the Sacramento Mountain foothills (Fiedler and Nye 1933:14). The corresponding surface of the Diamond A Plain on the east side of the Pecos River, between the river and the Southern High Plains, is the Mescalero Plain (Fiedler and Nye 1933).

The Mescalero Plain is a broad area of low relief located between the Pecos River and the Southern High Plains consisting of low, rolling plains dotted with playas and in some places covered with extensive dunes (Hogan 2006:6; Speth 1983:7). The bedrock of this plain consists of the Permian Artesia Group, characterized by alternating beds of red, brown, and green siltstones and extensive layers of grayish gypsum (Hogan 2006:6; Speth and Parry 1980:4). The surficial geology of the region is characterized by an eolian sand sheet called the Mescalero Sands. The Mescalero Sands are composed of two sand layers; an older late Pleistocene layer and a younger early Holocene layer (Hogan 2006:6). Other surficial deposits in this area include areas of Holocene to Pleistocene eolian sand, isolated outcrops of Holocene alluvium, Pleistocene alluvium, and red beds of the Chinle (Triassic), and Artesia (Permian) Groups (Hogan 2006:6).

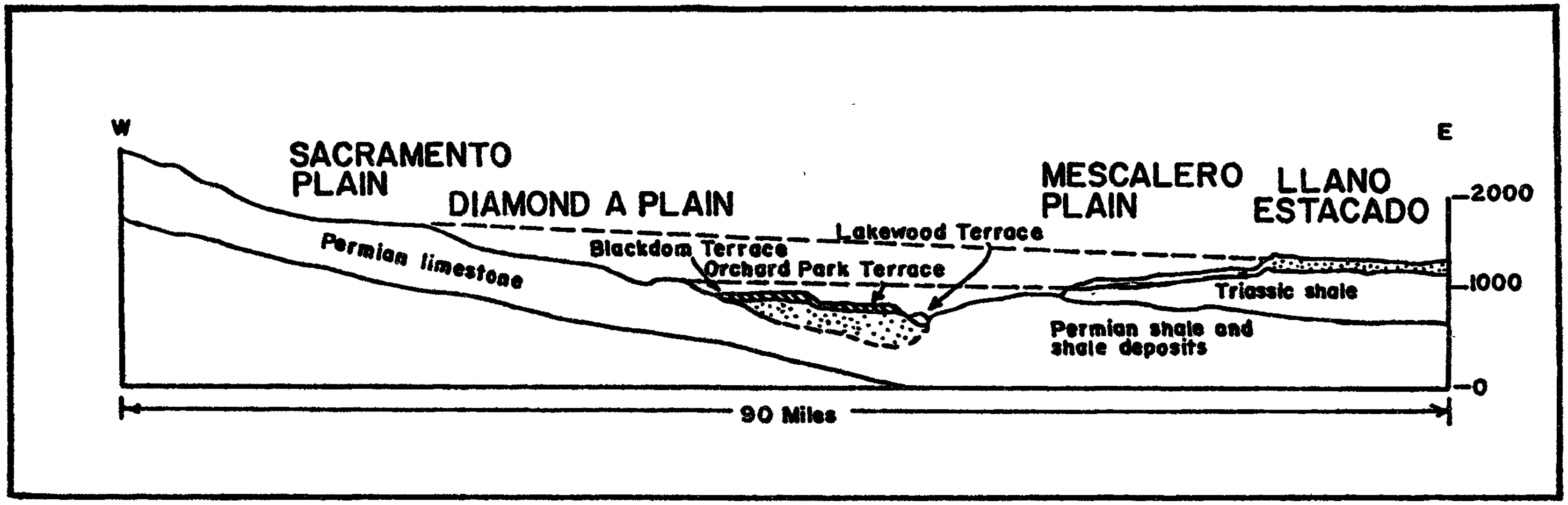

Figure 4. Geologic cross section of the Pecos Valley (Sebastian and Larralde 1989).

Below the Diamond A and Mescalero surfaces and adjacent to the Pecos River lie three terraces. From oldest to youngest these are the Blackdom, Orchard Park, and Lakewood Terraces (Jelinek 1967:7; Fiedler and Nye 1933:10). The Lakewood Terrace, the youngest of the three terraces, is characterized as a floodplain which varies in depth between three and nine meters above the current river channel (Jelinek 1967:7; Fiedler and Nye 1933:10). The terrace is composed of unconsolidated silts, sands, and gravels (Jelinek 1967:7; Fiedler and Nye 1933:10). The Orchard Park Terrace lies above the Lakewood Terrace and is characterized as a flat alluvial plain exhibiting minimal erosional dissection (Jelinek 1967:7; Fiedler and Nye 1933:11). These terrace sediments are mainly comprised of poorly consolidated sands and gravels; clay deposits are occasionally present and are reportedly suitable for producing ceramics (Jelinek 1967:7; Fiedler and Nye 1933:11). The Blackdom Terrace, the oldest of the three terraces, lies above the Orchard Park Terrace and is characterized as a deposit that is fairly well cemented, forming hard conglomerates and sandstones. Clay deposits are occasionally present, reportedly suitable for producing ceramics (Jelinek 1967:17; Fiedler and Nye 1933:12).

Southern High Plains

Geographic Setting

The Southern High Plains (i.e. Llano Estacado) is an extensive plateau covering about 120,000 km^2 and bordered by escarpments on the north, east, and west (Figure 5). The western escarpment separates the plateau from the Pecos River valley, and the northern escarpment separates the plateau from the Canadian River valley,

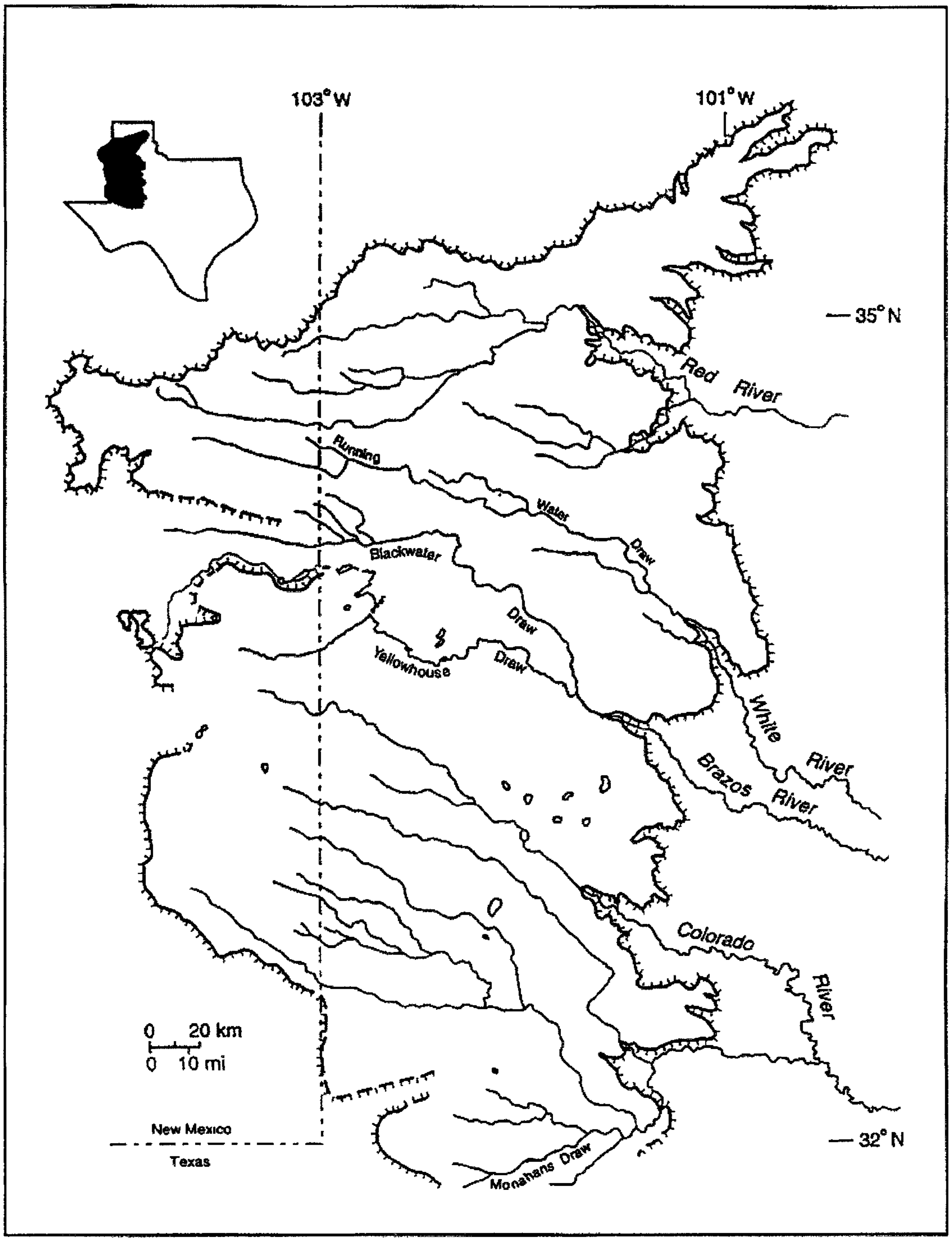

Figure 5. Map of the Southern High Plains (Johnson 1989).

while the eastern escarpment, formed by the headward erosion of tributaries of the Red, Brazos, and Colorado rivers, separates the plateau from the Rolling Plains (Holliday 1997:9). The southern portion of the Southern High Plains grades into the Edwards Plateau province of Central Texas (Holliday 1997:9; Johnson and Holliday 2004:283).

The Southern High Plains is a near featureless surface with a regional slope to the southeast with altitudes ranging from 1,700 m in the northwest to 750 m in the southeast (Holliday 1997:10). Minor topographic relief is provided by small lakes, dunes, and dry valleys or draws. Approximately 25,000 small seasonal lakes or playas (<5 km^2) can be found on the landscape, while 40 larger basins (tens of km^2), known as salinas, are scattered throughout the region (Johnson and Holliday 2004:283). These playa and salinas basins often contain the only available surface water on the Southern High Plains (Johnson and Holliday 2004:284). The dry valleys or "draws" are northwest to southeast trending tributaries of rivers located on the Rolling Plains to the east (Holliday 1997:10).

Natural Setting

The natural vegetation of the Southern High Plains is mixed-prairie grassland (Blair 1950; Johnson and Holliday 2004:284). The dominant native plant community is short-grass; which includes types of gramma (*Bouteloua* sp.), little bluestem (*Andopogon scoparius*), and buffalo grass (*Buchloe dactyloides*). This community also supports a variety of cactus and shrub species such as cholla (O*puntia* sp.), prickly pear (O*puntia* sp.), honey mesquite (*Prosopis glandulosa*) and shinnery oak (*Quercus havardii*). Trees are limited to areas along draws, escarpments, and reentrant canyons and typically include redberry juniper (*Juniperus pinchotii*), cottonwood (*Populus* sp.), and willow

(*Salix* sp.). Because of heavy cultivation across the Southern High Plains, native plant communities occur in few areas of the region today.

Geology

The rocks and sediments of the Southern High Plains are primarily Cenozoic deposits; these deposits overlie Mesozoic sedimentary rocks and the two are separated by an early Tertiary erosion surface (Evans and Meade 1945; Holliday 1997:10) (Figure 6). The majority of the Cenozoic deposits are Miocene-Pliocene eolian and alluvial sediments of the Ogallala Formation, derived from mountains in New Mexico (Holliday 1997:10). The upper Ogallala Formation retains a pedogenic calcrete (i.e. Caprock Caliche) that is a thick and highly resistant ledge-forming unit located near the top of the escarpment (Evans and Meade 1945; Holliday 1997:10).

The Blanco Formation, another Pliocene deposit, is a layer of lacustrine dolomite and clastic sediment deposited in basins incised into the Ogallala; a calcrete also formed at the top of the Blanco Formation (Holliday 1997:10). Additional, more localized lacustrine deposits of the region include the Tule Formation (early to middle Pleistocene) and the Double Lakes and Tahoka Formations (both late Pleistocene), and other, unnamed deposits (Evans and Meade 1945; Holliday 1997:10).

The Blackwater Draw Formation is the major surficial deposit of the Southern High Plains and covers all other formations. The formation is composed of thick eolian sediments derived from the Pecos River valley and deposited during the Pleistocene; it varies in thickness and particle size from a thin veneer of sandy loam in the southwest to a thick deposit of clay loam in the northeast (Evans and Meade 1945; Holliday 2007:10; Johnson and Holliday 2004:283).

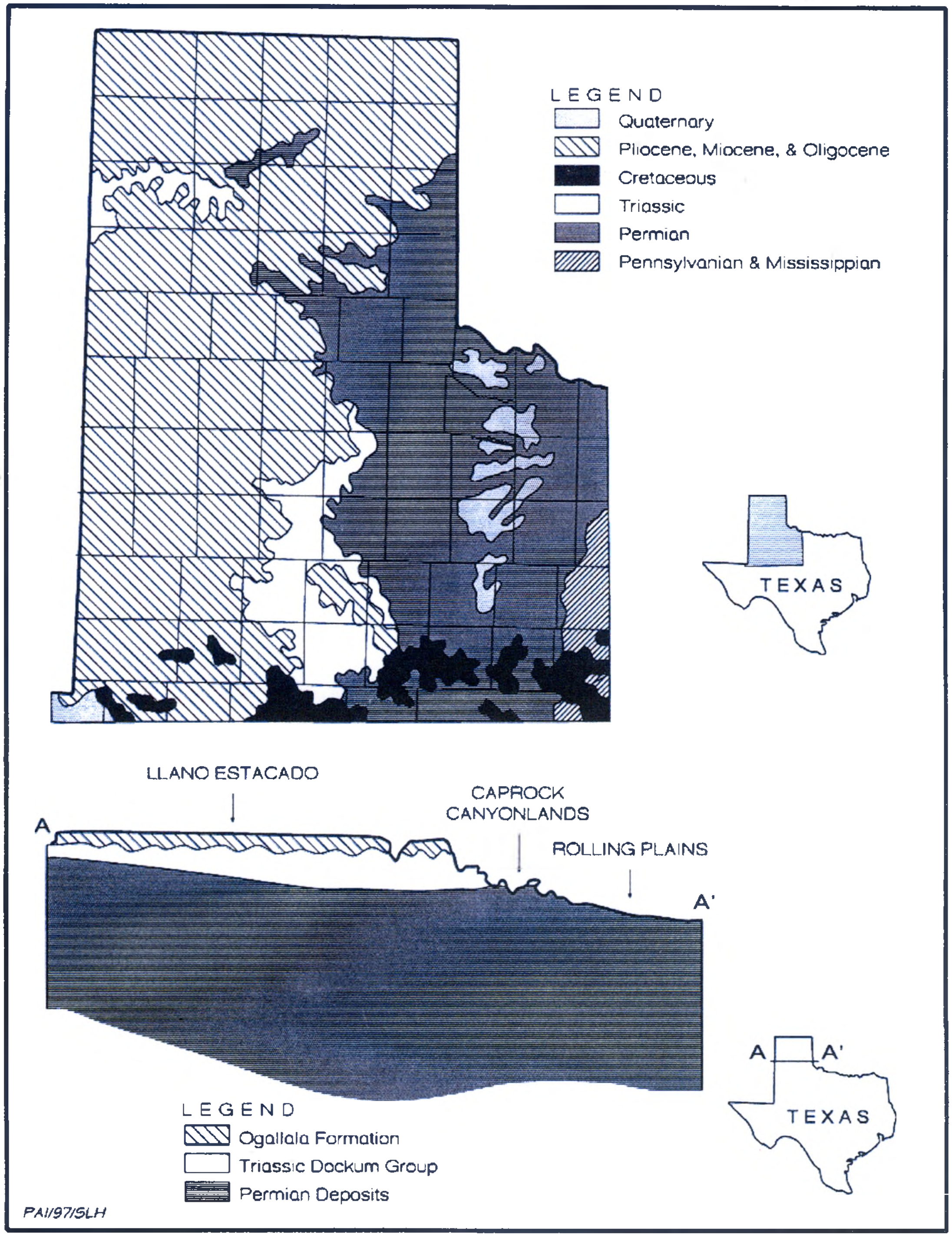

Figure 6. Surface geology and generalized cross section of the Southern High Plains (Boyd et al. 1997).

The Late Quaternary (post-Blackwater Draw Formation) stratigraphic record, containing the in situ archaeological record, is found in draws, playas, salinas, and dunes (Holliday 1997:11; Johnson and Holliday 2004:284). The draws are inset into the Blackwater Draw Formation and locally cut into lake beds or the Ogallala Formation; the areas between these draws have no integrated drainages (Holiday 1997:11). Along with buried soils, a variety of late Pleistocene and Holocene paludal, lacustrine, alluvial, and eolian deposits can be found in these draw systems (Holliday 1997:11).

Playas and salinas, lake basins inset into the Blackwater Draw Formation and locally older units, contain late Pleistocene and Holocene lacustrine and paludal sediments (Holliday 1997:11). A portion of the late Pleistocene sediments are deemed members of the Tahoka Formation; however, other late Pleistocene fills are non-Tahoka members, while all of the Holocene fills are considered post-Tahoka sediments (Evans and Meade 1945; Holliday 1997:12).

Dunes, in the form of lunettes or sand dune fields, occur in or adjacent to playa and salinas basins. Lunettes, typically located on the northeast, east, or southeast sides of the lake basins, represent localized accumulations of eolian sediment deflated from lake basins in the late Pleistocene and Holocene (Holliday 1997:12). Dune fields located along the western margin of the Southern High Plains consist of Holocene sands that likely originated in the Pecos Valley (Holliday 1997:12).

Summary

The Sierra Blanca, Pecos River, and Southern High Plains regions exhibit distinctive physiography, biology, and geology. A basic understanding of the geology of the study regions is required in order to understand the INAA compositional data to be discussed in Chapter 6, thus brief summaries of the regional geology are provided.

CHAPTER 3

CULTURE HISTORICAL BACKGROUND

This chapter provides a brief summary of the cultural history of each region included in this study. Because pottery samples from multiple cultural periods were analyzed for this study, a complete culture history of the Ceramic Period is provided for the regions. Three major phase sequences have been used to order discussions of the Ceramic Period prehistory of the study regions: those proposed by Kelley (1984), Jelinek (1967), and Leslie (1979; based on Corley 1965). These phase sequences will be discussed in the following paragraphs; Figure 7 shows the areas to which these sequences have been applied, and Figure 8 shows the temporal relationships of the phase sequences to each other. The Ceramic Period of the Texas Panhandle, located further north on the Southern Plains, is also briefly discussed. This chapter also addresses the different ceramic types analyzed in this study.

Culture History

Sierra Blanca Culture History

During the 1950s, Jane Holden Kelley conducted investigations in the Sierra Blanca region for her Ph.D. dissertation research.

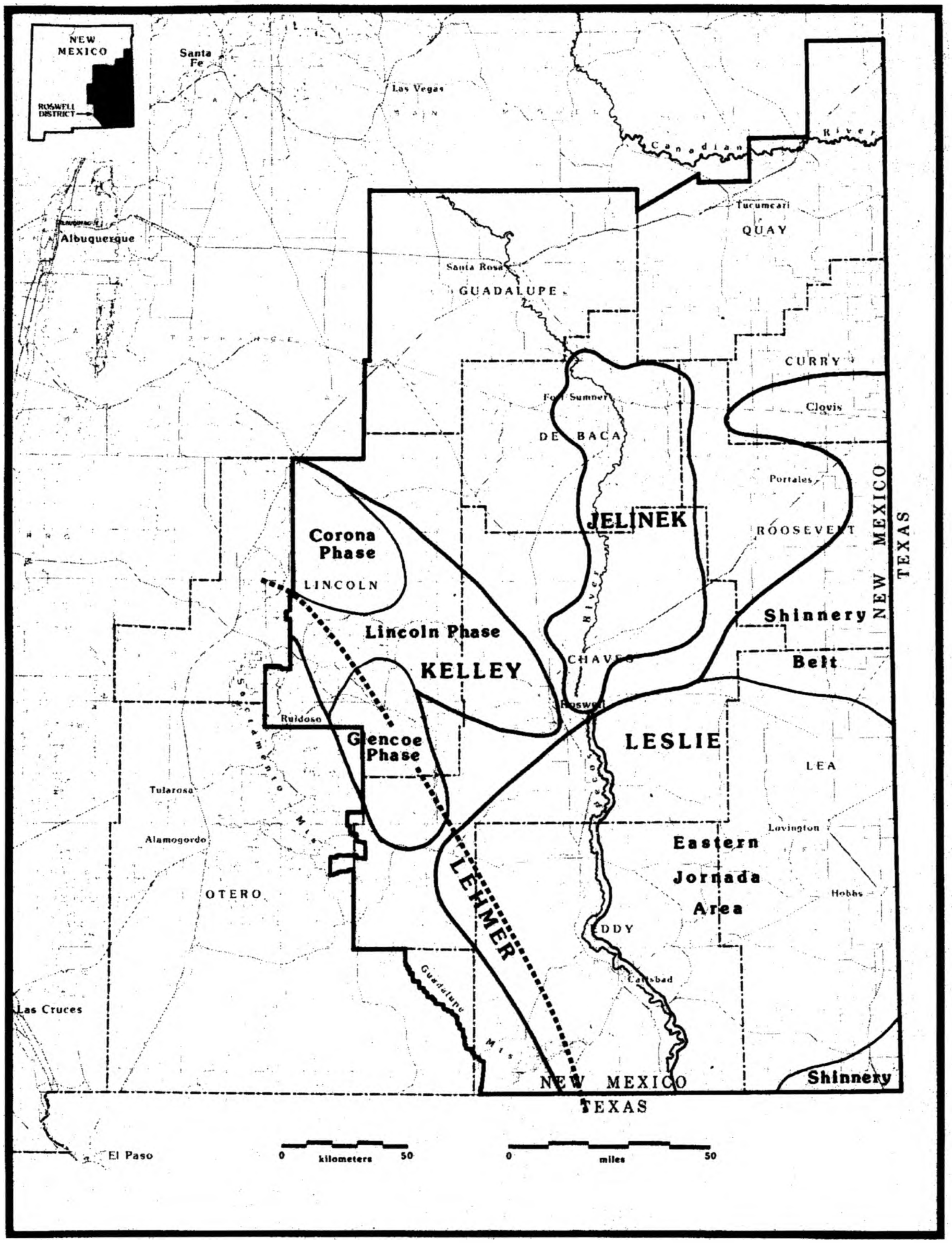

Figure 7. Study areas discussed by Jelinek (1967), Kelley (1984), and Leslie (1979) (Sebastian and Larralde 1989).

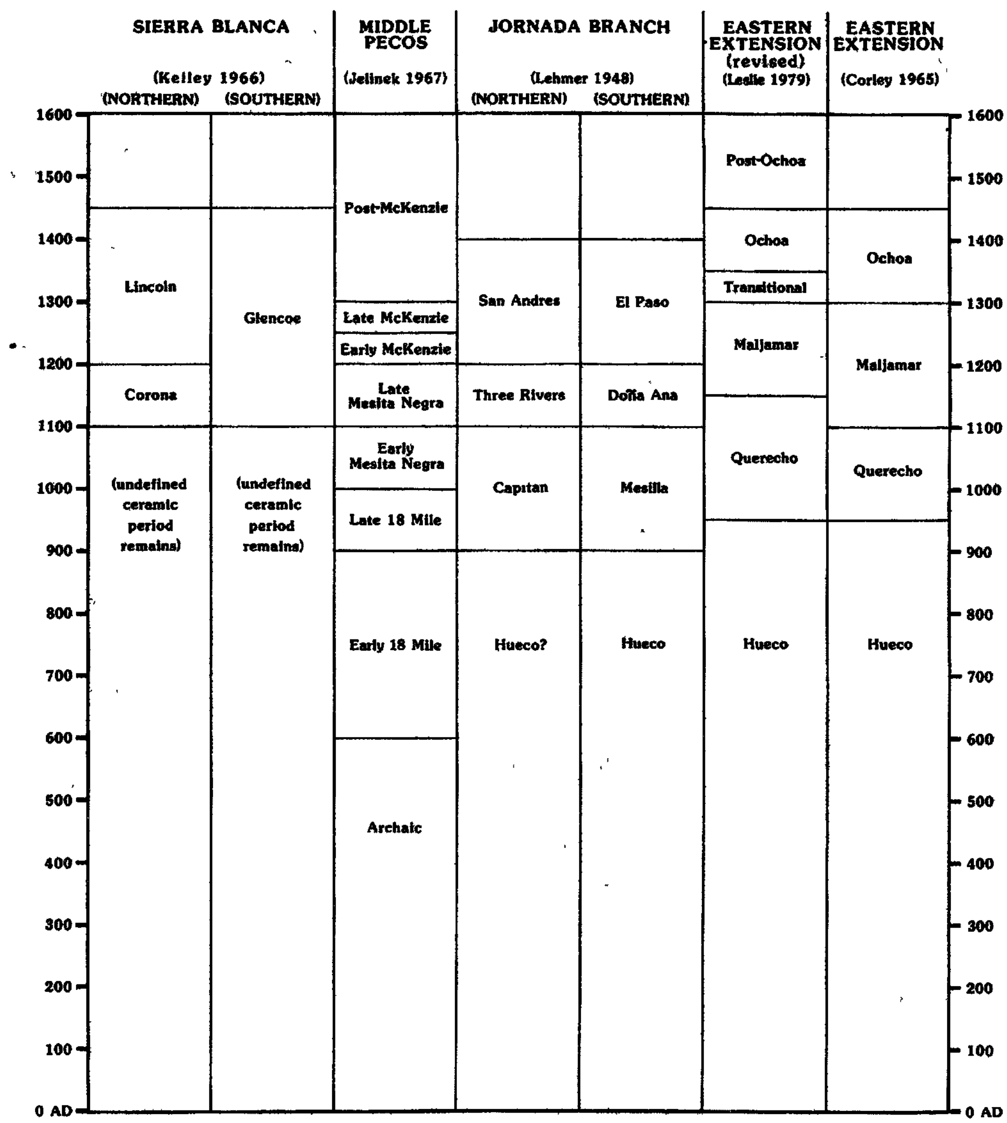

Figure 8. Comparative phase sequences for the Ceramic Period in southeastern New Mexico and the southern Llano Estacado (Sebastian and Larralde 1989).

As a result of her research, Kelley (1984) divides the Ceramic Period occupation of the Sierra Blanca region into three phases: Corona (ca. A.D. 1100 to 1200), Lincoln (ca. A.D. 1200 to 1400/1425), and Glencoe (ca. A. D. 1100 to 1400/1425).The Corona and Lincoln Phases are sequential and pertain to the northern portion of Kelley's Sierra Blanca study, while the Glencoe Phase occurs in the southern portion of the Sierra Blanca region and is contemporaneous with both the Corona and Lincoln Phases (Kelley 1984; Sebastian and Larralde1989:77: see Figure 7 and Figure 8).

Corona Phase (ca. A.D. 1100 to 1200) sites occur in the Upper Gallo and Upper Macho Drainages along the north and southeast slopes of the Capitan Mountains. Sites consist of scattered arrangements of small house units outlined with upright stone slabs and supposed jacal-like superstructure; village size varied from a few to 50 or more house units (Kelley 1984:51-52). The two most prevalent pottery types for this phase are Jornada Brown and Chupadero Black-on-White (Kelley 1984:51).

Lincoln Phase (ca. A.D. 1200 to 1400/1425) sites are found in the same area as the Corona Phase sites but also extend south into the Hondo Drainage. Villages are comprised of multi-room pueblos of stone masonry or coursed adobe, arranged in a linear fashion facing east onto a plaza or constructed as a block around a plaza (Kelley 1984: 52-53). In the ceramic assemblage, Jornada Brown was largely replaced by corrugated wares, while Lincoln Black-on-Red was being locally produced. Chupadero Black-on-White, El Paso Polychrome, and Three Rivers Red-on-Terracotta were popular imported wares (Kelley 1984:53; Sebastian and Larralde 1989:78).

Glencoe Phase (ca. A. D. 1100 to 1400/1425) sites occur on the eastern slopes of the Sacramento and Sierra Blanca Mountains, extending from the Peñasco Valley north to the Ruidoso and Bonito valleys of the Hondo drainage (Kelley 1984; Clark 2006:48). Sites consist of open arrangements of scattered pithouses, five to ten pithouses would have been occupied at any one time. Evidence of above ground structures is lacking at early Glencoe sites, but surface jacal-like structures are associated with late phase villages. The ceramic assemblage for early Glencoe Phase sites mainly consists of Jornada Brown and small amounts of Chupadero Black-on-White, Mimbres Boldface Black-on-White, and Three Rivers Red-on-Terracotta. Ceramic assemblages of late Glencoe Phase sites are largely comprised of corrugated wares, Chupadero Black-on-White, El Paso Polychrome, Lincoln Black-on-Red, and Three Rivers Red-on-Terracotta.

Pecos Valley Culture History

Between the mid-1950s and mid-1960s Arthur Jelinek conducted a survey and testing project along the Pecos River between Fort Sumner and Roswell (see Figure 7). Jelinek (1967) formulated a four phase sequence (see Figure 8) of the Ceramic Period for the Middle Pecos Valley; the first three phases are divided into an early and late subphase (Jelinek 1967; Sebastian and Larralde 1989:78).

The Early and Late 18 Mile Phase (ca. A.D. 800 to 1000) sites appear to be the earliest sedentary settlements consisting of pithouse communities with some surface rooms appearing late in the phase. The ceramic assemblage of the early subphase is comprised of Jornada Brown and Lino Gray. In the late subphase ceramic assemblages, a locally produced Jornada Brownware (Middle Pecos Micaceous Brown) dominates the assemblages.

The Early and Late Mesita Negra Phase (ca. A.D. 1000 to 1200) sites account for the widest utilization of the Middle Pecos Valley. Although architectural information is limited, it appears that pithouses remained the most common structures (Jelinek 1967; Sebastian and Larralde 1989:78). In the early subphase, Middle Pecos Micaceous Brown remains predominant. The late subphase ceramic assemblages indicate a decline in Middle Pecos Micaceous Brown and an increase in Roswell Brown, increasing amounts of local graywares, and the first appearance of Chupadero Black-on-White in significant quantities (Jelinek 1967:149).

Early and Late McKenzie Phase (ca. A.D. 1200 to 1350) sites have yielded minimal architectural data, but known structures consist of rectangular, slab-based surface rooms (Jelinek 1967:152-158; Sebastian and Larralde 1989:78). Ceramic assemblages from the early subphase indicate that McKenzie Brown begins to replace the more common Middle Pecos Micaceous Brown of the preceding phase. In late McKenzie assemblages, Chupadero Black-on-White predominates with lesser amounts of McKenzie Brown and other brownwares; however, the brownwares that are present are corrugated (Jelinek 1967:152-158; Sebastian and Larralde 1989:78).

Southern High Plains Culture History

The Ceramic Period (A.D. 900 to 1542) on the Texas Southern Plains is typically subdivided into an early and late ceramic period (Johnson and Holliday 2004:292). However, in the southernmost reaches of the Texas Southern Plains, or the southern Llano Estacado, Ceramic Period sites have traditionally been attributed to the Eastern Extension of the Jornada Mogollon culture (Corley 1965; Leslie 1979), closely related to the Jornada Mogollon as defined by Lehmer (1948).

The Eastern Extension of the Jornada Mogollon In 1965 John Corley, of the Lea County Archeological Society (New Mexico), proposed that extreme southeastern New

Mexico and portions of the southern Llano Estacado were occupied during the Ceramic Period by populations closely related to the Jornada Mogollon, as defined by Lehmer (1948: see Figure 7); for a complete discussion of the Jornada Mogollon the reader is referred to Lehmer (1948). Corley (1965) formulated a four phase sequence for the Eastern Jornada area which was slightly revised in 1979 by Robert Leslie, also of the Lea County Archeological Society (see Figure 8). Sites attributed to the Eastern Extension of the Jornada Mogollon have been largely reported from southeastern New Mexico but components have also been reported from the Salt Cedar Site (41AD2) in Texas (Collins 1968, 1971) and "are recognizable in excavation and survey reports at many other sites in the Texas part of the Southern Plains" (Hughes 1989:27). The phase sequence for the Eastern Extension of the Jornada Mogollon, from earliest to latest, is comprised of the Querecho, Maljamar, and Ochoa phases.

The Querecho Phase (A.D. 950 to 1150) is marked by the initial occurrence of ceramics and the appearance of corner-notched arrow points. Nonstructural sites are typical for the early portion of the phase but prepared clay floor "pads" have been reported (Leslie 1979:188). At the end of the Querecho Phase, small rectangular pit rooms were in use and possible surface room floors have been reported (Leslie 1979:190; Sebastian and Larralde 1989:77). Locally manufactured variants of Jornada Brown and imported Mimbres and Cebolleta Black-on-White ceramics are the main ceramic types found on sites of this phase.

The Maljamar Phase (A.D. 1150 to 1300) is representative of a more sedentary lifestyle. Sites typically occur at the same locations of the previous phase and include both nonstructural gathering camps and pithouse villages, some containing 20 to 30 small rectangular structures. Local variants of Jornada Brown continue to dominate ceramic assemblages with some corrugated utility wares appearing near the end of the period. Chupadero Black-on-White is the major intrusive ware, accompanied by small amounts of El Paso Brown, El Paso Polychrome, and varieties of Three Rivers Red-on-Terracotta. Additionally, a shift from corner-notched to side-notched arrow points occurs in the middle of the phase after A.D. 1200. Leslie (1979) notes that at the end of the Maljamar Phase (ca. A.D. 1300), extreme southeastern New Mexico experienced a period of transition; the region was either temporarily abandoned or experienced a population dislocation. Thus, Leslie (1979) proposes a post-Maljamar and pre-Ochoa transitional phase, which possibly represents a short lived re-population or intrusion into the Eastern Jornada area. Evidence supporting this transitional period is based on a ceramic assemblage containing later decorated pottery types and the appearance of new types that include Glaze A Red and Yellow types, Gila Ramos, El Paso Polychrome, and Lincoln Black-on-Red (Leslie 1979:191).

The Ochoa Phase (A.D. 1300 to1450/1500) includes sites with jacal-like surface structures as room blocks and as single units with stone and adobe foundations. The ceramic assemblage is dominated by a locally produced type, Ochoa Indented Brown, and also contains intrusive wares such as Chupadero Black-on-White, Glaze A Red and Yellow types, Gila Ramos, El Paso Polychrome, and Lincoln Black-on-Red (Collins 1968, 1971; Leslie 1965). Additionally, Collins (1968:100) reports sherds of Nocona Plain, representative of pottery produced in northwest Central Texas. Side-notched arrow points, beveled knives, "thumb-nail' end scrapers, shaft polishers, bone pins, bone awls, and notched "rhythm bones" of bison ribs are predominant in artifact assemblages. An increased dependence on bison is suspected for this period.

Texas Panhandle Ceramic Period. The ceramic period in the Texas Panhandle is subdivided into an early Late Prehistoric I (A.D. 500 to 1100/1200) period and the Late Prehistoric II (A.D. 1100/1200 to 1541) period. The Late Prehistoric I (A.D. 500 to 1100/1200) period appears to have been a time of transition from the traditional Archaic lifeway to those based on the adoption of technological changes resulting from the introduction of ceramics, the bow and arrow, pithouses, and limited gardening and horticulture (Hughes 1991:24; Johnson and Holliday 2004:292). Under influences from the southwest Mogollon tradition and the northeast Woodland tradition, began a transformation from a foraging to a more sedentary lifestyle (Boyd 1997:493; Hughes 1991:24). In the Panhandle Plains, the Lake Creek Complex is found mainly in the Canadian Breaks and northward, whereas the Palo Duro Complex is found mainly in the Red River drainage and northward into the Canadian Breaks (Hughes 1991:25: Figure 9).

The Lake Creek Complex is characterized as a western extension of the Plains Woodland. Diagnostic Lake Creek artifacts include Woodland cordmarked pottery, Scallorn and Scallorn-like arrowpoints, and occasional Mogollon plain brownwares (Boyd 1997:492; Hughes 1991:25). Lake Creek sites are clustered in and north of the Canadian River valley (Boyd 1997:492).

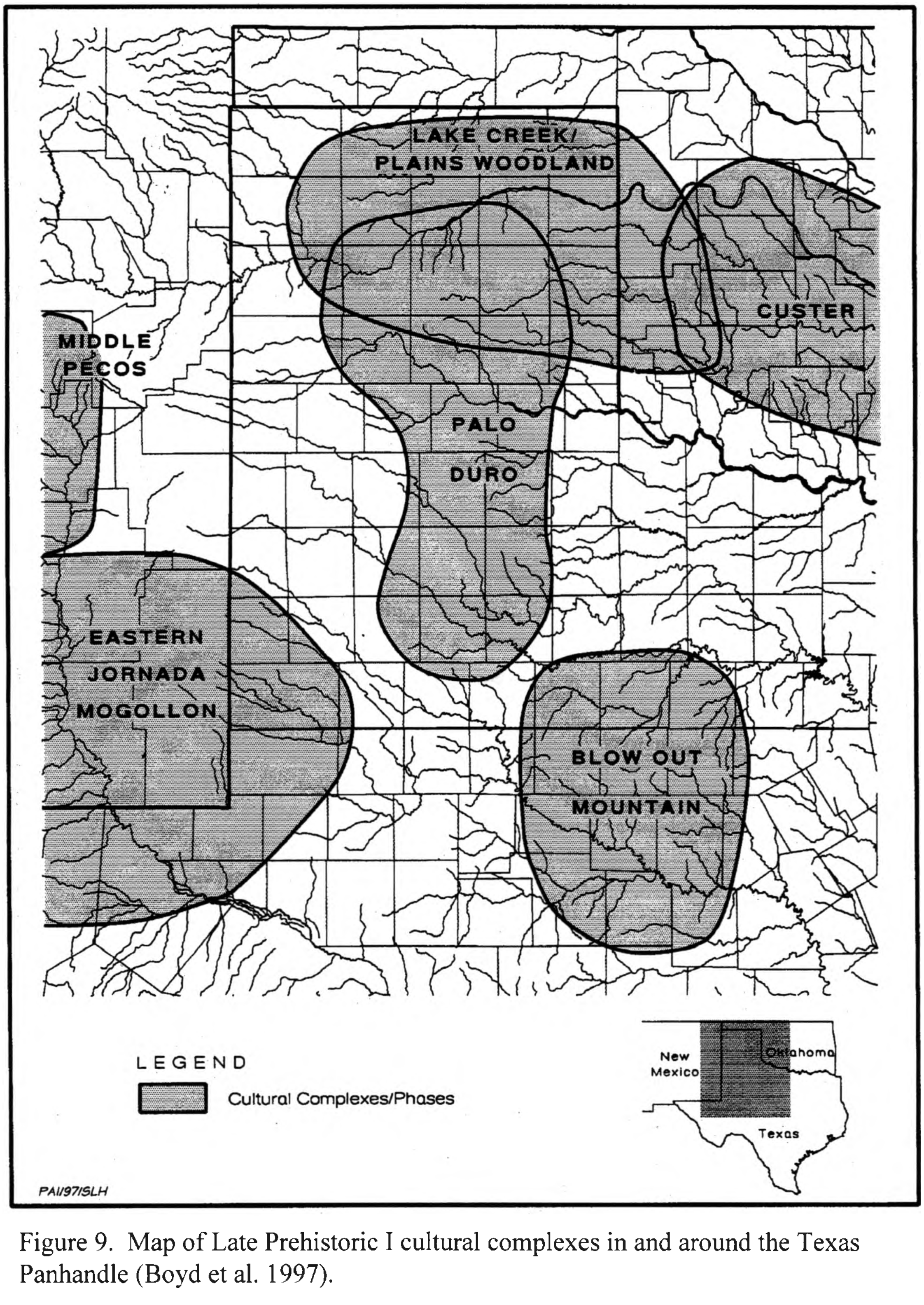

Figure 9. Map of Late Prehistoric I cultural complexes in and around the Texas Panhandle (Boyd et al. 1997).

The Palo Duro complex is another Late Prehistoric I cultural manifestation. Archaeological evidence suggests that Palo Duro groups occupied residential base camps with pithouse structures, rockshelters, and open camps during different times of the year (Boyd 2004; Boyd et al. 1997; Hughes 1991:26-27). Palo Duro groups were generalized hunter-gatherers who procured and processed a range of wild plant foods throughout the year; however, evidence of horticulture has yet to be identified (Boyd 1995:508). Scallorn and Deadman arrowpoints, unifacial tools, and edge modified flakes are predominant in artifacts assemblages (Boyd 1995:486). The Palo Duro Complex is believed to be in place by A.D. 500 and continued until about A.D. 1100 (Boyd 2004:311), placing it as contemporary with Woodland Complexes in the Texas Panhandle and the pithouse periods on the southern Llano Estacado and in southeastern New Mexico (i.e. Querecho and Maljamar phases of the eastern extension of the Jornada Mogollon and the 18 Mile and Mesita Negra phases of the Middle Pecos Valley).

The later Ceramic Period (A.D. 1100/1200 to 1541) is distinguished by a mixed assemblage of pottery (e.g. Borger Cordmarked and Jornada Brownwares) and Plains lithic tool types such as side-notched triangular and triangular arrowpoints (Johnson and Holliday 2004:293). These groups shifted their economic focus to bison while incorporating horticulture or foraging subsistence. These Texas Plains Village cultures—the Antelope Creek phase and the Buried City phase—are closely related in terms of archaeological traits and are concentrated in and north of the Canadian River valley (Figure 10).

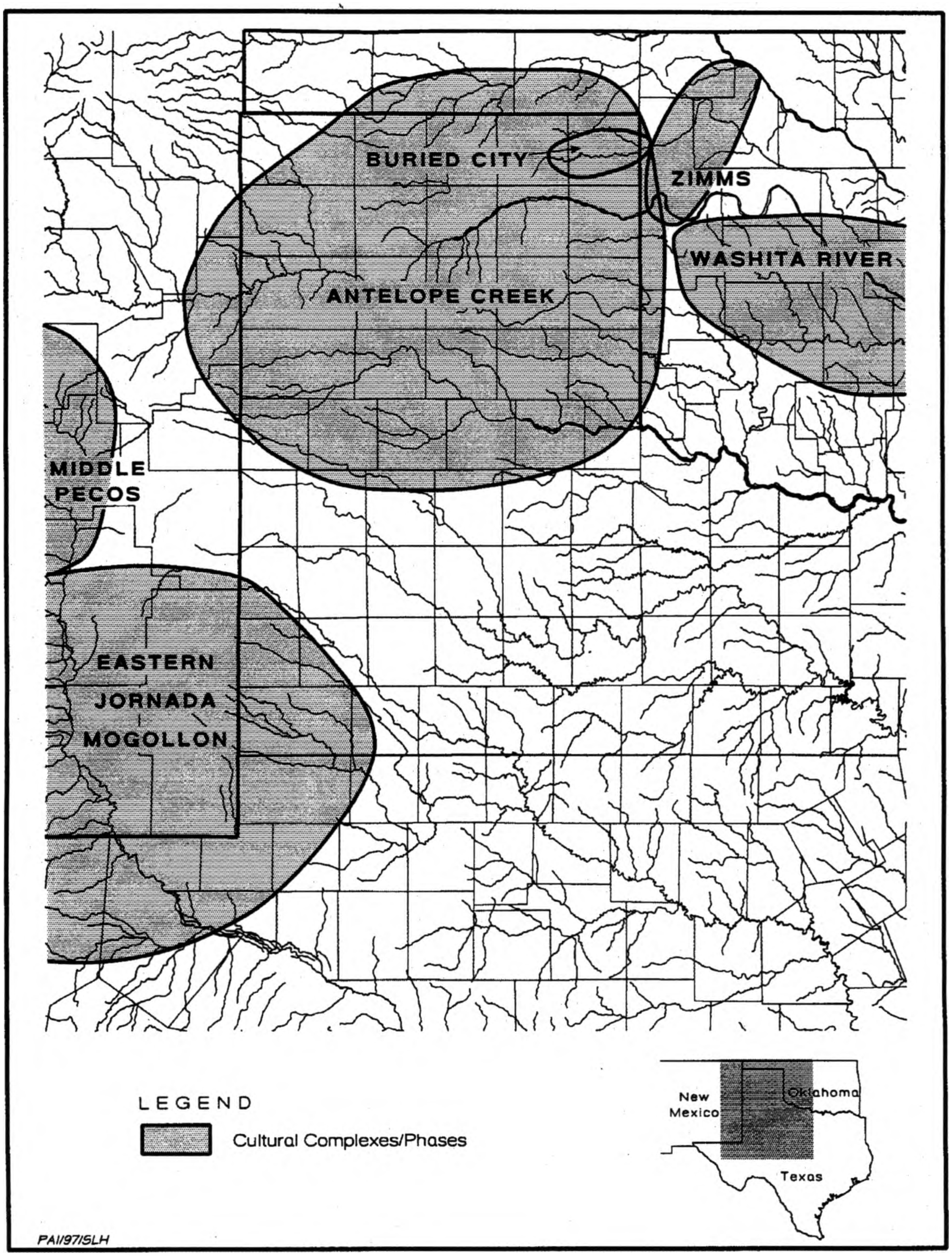

Figure 10. Map of Late Prehistoric II cultural complexes and phases in the Texas Panhandle-Plains and surrounding areas (Boyd et al. 1997).

The Antelope Creek Phase, the better known complex, is characterized by single and multi-room slab structures, Borger Cordmarked pottery, triangular arrowpoints (Harrell, Washita, and Fresno types), beveled knives, thick grinding slabs, and bison bone tools (Hughes 1991:31; Suhm et al. 1954:66-67; Lintz 1986). Antelope Creek residential sites are heavily concentrated in the Canadian River breaks (Hughes 1991:31). Investigation of numerous Antelope Creek components indicates a semi-sedentary residence pattern and subsistence reliant upon hunting, wild plant foraging, and limited horticulture (Hughes 1991:31; Lintz 1986). Archeomagnetic assays place the Antelope Creek phase between A.D. 1200 and 1500 (Brooks 2004:335), a contemporary of late pithouse periods on the southern Llano Estacado and in southeastern New Mexico (i.e. Maljamar and Ochoa phases of the eastern extension of the Jornada Mogollon and the Mesita Negra and McKenzie phases of the Middle Pecos Valley).

The Ceramic Samples

Little work has been published on the ceramics of the southern Llano Estacado and extreme southeastern New Mexico. Most of the existing studies for the region have focused on establishing broad ceramics types rather than producing detailed studies (Whalen 1981), while a few have sought to identify the origins and placement of the pottery type in Southwestern and Plains ceramic traditions (Jelinek 1967; Leslie 1965, 1979; Runyan and Hedrick 1973; Wiseman 1999). Few pottery types found on the southern Llano Estacado and extreme southeastern New Mexico are believed to have been locally produced; however, it has been proposed that Ochoa Indented Brown is a product of the Eastern Extension of the Jornada Mogollon and produced on the southern Llano Estacado (Collins 1968; Leslie 1965a).

This section provides descriptions of the pottery types analyzed for this study. Along with Ochoa Indented Brown, samples of roughly contemporary corrugated wares (Corona and Seco Corrugated) from the Sierra Blanca region and brownwares (McKenzie Brown, Middle Pecos Micaceous Brown, and Roswell Brown) from the Pecos Valley were included in the study as a comparative sample.

Ochoa Indented Brown

Type Description. Ochoa Indented Brown was first described and named by Leslie (1965a) as a product of the Eastern Extension of the Jornada Mogollon. Ochoa Indented Brown is considered to be a moderately compact to friable pottery whose most distinguishing trait is a corrugated and indented exterior surface. Exterior corrugations tend to be irregular due to individual coils being pressed down in scallop like ridges over the preceding coil; the resulting pattern is semi-circular indentations that occur in horizontal rows and vertical columns or in haphazard patches (Figure 11). The depth and size of the individual indentions vary considerably but tend to be fairly uniform. Surface scraping or burnishing obliterates the corrugation in some specimens but leaves a distinctive uneven surface. Interior surfaces are smoothed and typically exhibit varying degrees of polish, while a few specimens are reported to retain evidence of smudging (Leslie 1965a). Temper typically observed include sand and crushed rock (i.e. limestone and anhydrite); sand temper ranges from fine to coarse, while crushed rock particles up to 5 mm in diameter are often visible on interior and exterior surfaces (Collins 1968:101).

Figure 11. Various surface treatments of Ochoa Indented Brown.

The most common Ochoa Indented Brown vessel forms are jars and bowls. Jars tend to be small to medium in size, exhibiting rounded bottoms, strong shoulders, short necks, and small to medium sized mouth openings. Jar rims are short and tend to join the body in gentle to sharp curves, while lips are flared and usually rounded (Figure 12). Although little data exists for bowls, they are described as small to medium in size, exhibiting vertical and slightly tapered rims. Lips are rounded, flat, and are rarely tapered, while some tend to flare out slightly (Figure 12).

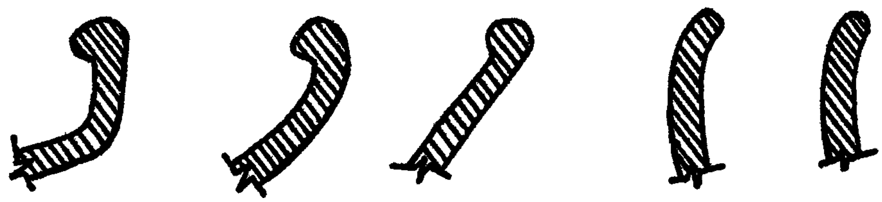

Figure 12. Ochoa Indented Brown jar and bowl rim and lip forms, vessel exteriors to the left (Leslie 1965a).

Vessel Function. Morphological and physical attributes suggest that Ochoa Indented Brown jars were primarily used for storage and cooking. These vessels are characterized by small to medium diameter orifices (ca. 15 cm), short and wide necks, and globular bodies (Collins 1968: Figure 13). The unrestricted orifice diameter would permit easy access to the contents allowing the hand or utensils to be used for mixing and stirring and for holding goods to be used frequently. Accordingly, a wide-necked vessel may be more appropriate for storing goods that are sometimes poured or scooped out, dry goods such as grains and seeds might be stored in such a vessel. Ochoa Indented Brown jar rim and lip forms are characteristic of vessels that may accommodate a skin cover to be tied beneath the flange with a cord; this feature is especially common for long-term storage (Collins 1968; Rice 1987:241). Although direct evidence of Ochoa Indented Brown jars being utilized as cooking vessels is lacking (Collins 1968), globular vessels were typically utilized for heating and cooking (Rice 1987:241). Ochoa Indented Brown bowls are small to medium in size; these shallow, open containers allow easy access to contents; bowls are typically believed to have been used for serving and eating or utilized for very short-term storage (Rice 1987:241).

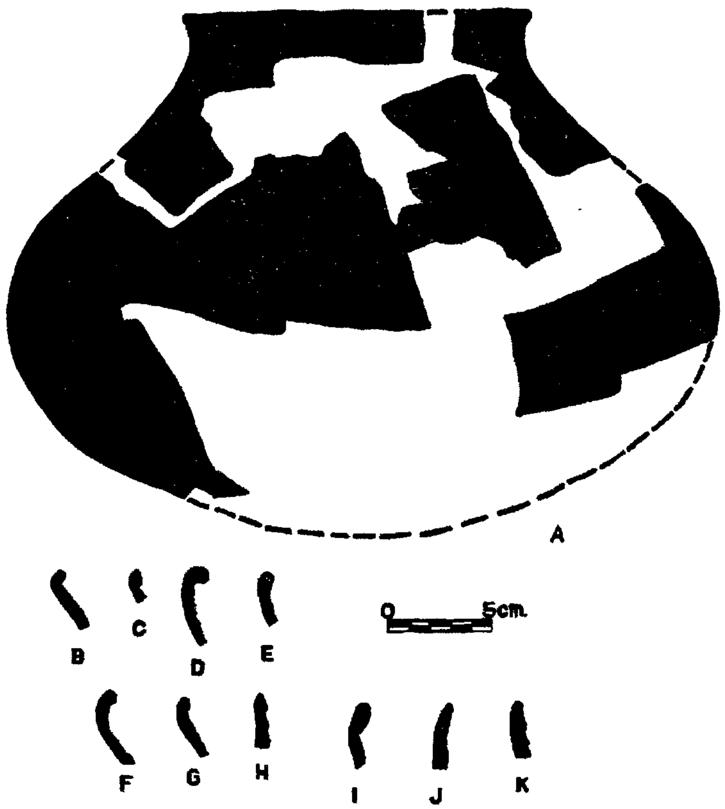

Figure 13. Salt Cedar site, Ochoa Indented jar and rim forms: (A) partially restored jar, (B-G) jar rim forms, (H-K) bowl rim forms. Vessel exteriors to the right (Collins 1968).

Dates of Production Determining the dates of Ochoa Indented Brown pottery production is made difficult by the lack of research conducted on Ceramic Period sites on the southern Llano Estacado and extreme southeastern New Mexico. Because of the lack of chronometric information, researchers have largely relied on the presence of dated non-local ceramic types that are found in association with Ochoa Indented Brown pottery to estimate the dates of manufacture. Non-local ceramics commonly associated with Ochoa Indented Brown include Chupadero Black-on-White, Three Rivers Red-on-Terracotta, El Paso Polychrome, Rio Grande Glaze I Red and Yellow, Ramos Polychrome, and Playa Red Incised (Collins 1968, 1971; Leslie 1965). Using this technique of cross-dating, researchers estimate a production span between A.D. 1300 and 1450/1500. However, Ochoa Indented sherds recovered in association with a hearth at the Salt Cedar site (41AD2) radiocarbon dated to A.D. 1530 (Collins 1968:179).

Range of Distribution Leslie (1965a) provided an initial characterization of the distribution range of Ochoa Indented Brown. Based on the examination of surface collections from archaeological sites on the Llano Estacado and southeastern New Mexico, Leslie (1965a) proposed that the production of Ochoa Indented Brown was limited to a small area of the southern Llano Estacado and extreme southeastern New Mexico. Specifically, Leslie (1965a, 1979) proposed that the distribution range of Ochoa Indented Brown was limited to areas east of the Pecos River, an area that includes southeastern Eddy and southern Lea Counties, New Mexico, as far north as Chavez County, New Mexico, east into Gaines and Andrews Counties, Texas, and south to Winkler and Loving Counties, Texas (Figure 14). In addition to the distribution area reported by Leslie (1965a, 1979), Ochoa Indented Brown has been reported from sites

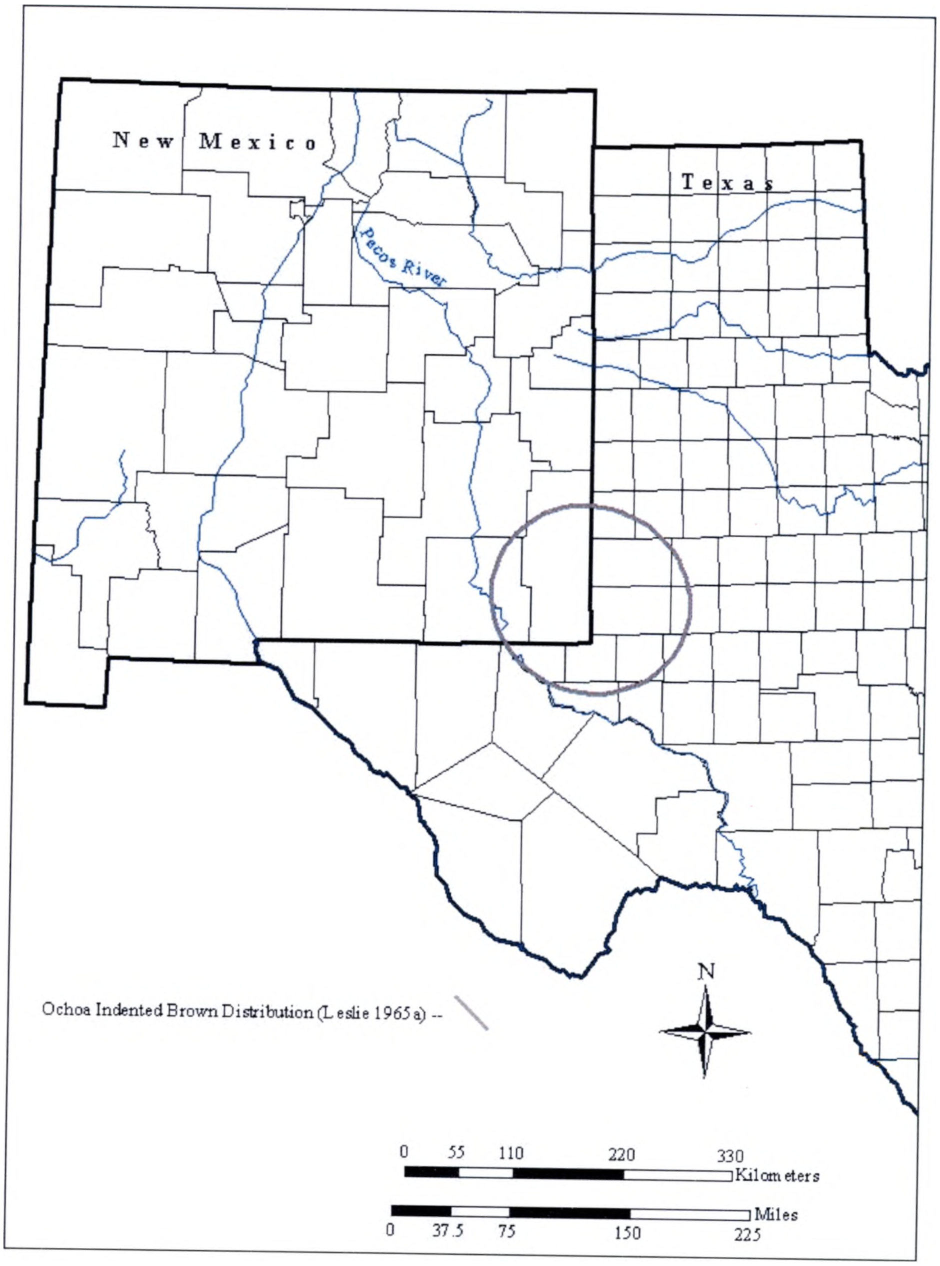

Figure 14. Ochoa Indented Brown distribution (Leslie 1965a).

along the southeastern fringes of the Texas Southern Plains in Glasscock, Irion, and Sterling Counties, Texas (Collins 1968; Creel, personal communication, 2008). Ochoa Indented Brown is also reported from Lubbock and Taylor counties, the northern and easternmost most known occurrence of Ochoa Indented Brown in Texas (Creel personal communication, 2008; Johnson 1993:222). Taking these additional reports into consideration greatly expands the distribution range of Ochoa Indented Brown (Figure 15). Despite the expanded distribution range, a review of roughly contemporary ceramic assemblages curated at the Texas Archeological Research Laboratory (TARL), University of Texas at Austin, suggests that Ochoa Indented Brown is relatively rare on the Texas Southern Plains.

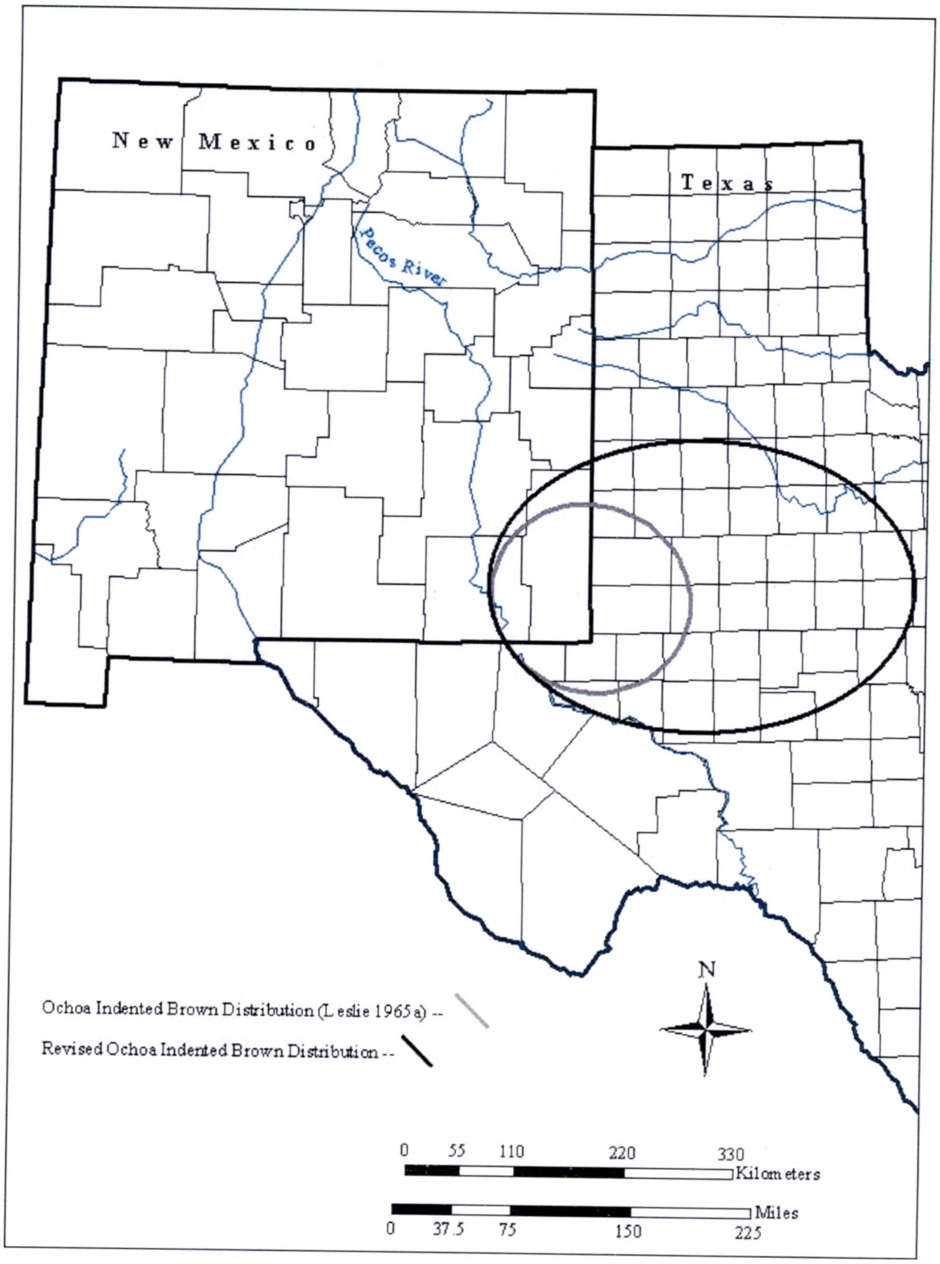

Figure 15. Revised Ochoa Indented Brown distribution.

Comparative Samples

Although a primary goal of this study is to determine the production area of Ochoa Indented Brown, comparative samples of roughly contemporary corrugated wares (Corona and Seco Corrugated) from the Sierra Blanca region and brownwares (McKenzie Brown, Middle Pecos Micaceous Brown, and Roswell Brown) from the Pecos Valley were included in the study to provide possible alternative source area compositional signatures should the INAA data indicate that Ochoa Indented Brown is not a Southern Plains type. The INAA data could also provide information addressing regional interaction; Table 1 depicts the number of specimens from each site.

Corona Corrugated

Type Description. Corona Corrugated was proposed and described in Hayes et al.'s (1981) report on the Gran Quivira ceramics by combining two utility types (Corona Rubbed-Ribbed and Corona Rubbed-Indented) originally described by Mera (1935). Corona Corrugated is considered to be a moderately compact to friable pottery whose most distinguishing trait is a corrugated exterior surface. Exterior corrugations range from simple unindented clapboard bands to narrow indented corrugations (Hayes et al. 1981). Vessels were often rubbed or scraped horizontally to flatten ridges, often blurring the demarcation between separate coils (Hayes et al. 1981:65). Coil obliteration was often more intense near the bottom of jars; the lower third of jar exteriors were typically scraped and smoothed to contrast with the corrugated area above (Hayes et al. 1981:65). Interior surfaces were scraped smooth and typically exhibit polish and smudging.

Table 1. Specimens and sites from the study regions.

Site	Sample Type	Number of INAA Samples
Southern Plains Region		
41GA1 (Curry Farm #1)	Corona Corrugated	1
41WK23	Corona Corrugated	1
L.3·5	Corona Corrugated	1
L:10:2	Corona Corrugated	1
L.10 4	Corona Corrugated	1
L·10 5	Corona Corrugated	1
LA43414 (Merchant)	Ochoa Indented	28
LA66104 (Paducah Breaks)	Corona Corrugated	1
Q:10.2	Ochoa Indented	1
Q:10:8	Ochoa Indented	1
Q:10:10	Ochoa Indented	1
Pecos Valley and Sierra Blanca		
L7	Roswell Brown	10
L10	Middle Pecos Micaceous	6
LA1549 (Henderson Pueblo)	Corona Corrugated	20
	Seco Corrugated	10
P4c	McKenzie Brown	10
Sample Total		94

Temper observed for Gran Quivira specimens include medium to coarse crushed rock such as quartz mica schist, angular quartz grains and white feldspar, and biotite felsite (Hayes et al. 1981:64). Jars tend to be medium in size and retain an overall "egg shape", while rims are short, tapered, slightly flared, and exhibit rounded lips (Hayes et al. 1981:65).

Corona Corrugated from the Henderson Pueblo (LA 1549), located in the Sierra Blanca region, fit the type description in Hayes et al.'s (1981) report on Gran Quivira; however, they do not represent the total surface treatment variation reported for the Gran Quivira materials (Wiseman 2004:73). Wiseman (2004:73) reports that the Henderson Pueblo sherds also differ from the Gran Quivira Corona Corrugated in temper and vessel form. At Gran Quivira, the most common tempering material is quartz mica schist, while at Henderson it is crystalline rock (i.e. Capitan alaskite). This difference in tempering materials is indicative of the areas of manufacture. Bowl forms are absent at Gran Quivira; however, they are comparatively common at Henderson Pueblo but scarcer than jars (Wiseman 2004:73).

Dates of Production. Corona Corrugated replaced Jornada Brown in the Sierra Blanca and Salinas regions as the utility ware companion of Chupadero Black-on-White. At Gran Quivira, associations indicate that corrugated pottery was introduced between the late 1100s and the early 1300s. A time range of about A.D. 1225 to roughly 1460 is indicated for Corona Corrugated (Hayes et al. 1981:64).

Range of Distribution. Hayes et al. (1981:64) provided an initial characterization of the distribution range of Corona Corrugated. Gran Quivira appears to be near the center of the area of distribution but the precise area of distribution is uncertain. It is found as far east as the east slope of the Gallinas Mountains and it appears in the northern Jornada del Muerto to the west. Hayes et al. (1981:64) place the southern limit of the distribution of Corona Corrugated as the southern end of Chupadera Mesa; however, Corona Corrugated is a major component of Lincoln Phase assemblages in the Capitan Mountains sites and is found in some quantity in late sites in the Roswell area (Kelly 1984; Wiseman 1982:6). Additionally, Corona Corrugated is found in small quantities across the Texas Southern Plains.

Seco Corrugated

Type Description. Seco Corrugated was first described and named by Wilson and Warren (1973). The exterior surface is corrugated by finger indenting that typically covers the entire vessel; however, jars occasionally show corrugations on the neck while portions of the vessel body are scraped smooth. Indentations are smoothed over in a way that coil separations and individual indentations are smoothed and obscured but not obliterated. The smoothing was accomplished by scraping, resulting in the more elevated areas appearing polished. Exterior corrugations and indenting tend to be irregular and haphazard. Interior surfaces are typically smudged and burnished but interiors may occasionally be either scraped smooth and smudged or scraped smooth with no smudging. Wilson and Warren (1973) report that a rhyolite ash flow tuff was the preferred tempering material for Seco Corrugated at the Las Animas site (LA 3949) located in Sierra County, New Mexico. Large bowls and jars are the common vessel forms.

Dates of Production. Wilson and Warren (1973) place Seco Corrugated in the Pueblo III period (A.D. 1200 to 1350) but do not offer a beginning and ending date. Other researchers (Lekson et al. 2002:88; Schleher and Ruth 2005:3) indicate that the ware is typically observed in late 14th century pueblos in southwestern and southcentral New Mexico.

Range of Distribution. Due to the widespread production and utilization of a variety of corrugated wares across southcentral and southwest New Mexico, the distribution of Seco Corrugated is somewhat difficult to identify. Researchers (Lekson et al. 2002:88; Schleher and Ruth 2005:3) indicate that the ware is typically observed in late 14th century pueblos in southwestern and south-central New Mexico.

McKenzie Brown

Type Description McKenzie Brown was first described and named by Jelinek (1967). The type is characterized as friable and typically exhibits fractured and weathered surfaces. Exterior and interior surfaces are usually smoothed but specimens occasionally exhibit exterior surface polish. Crushed quartz fragments are the dominant temper; the crushed quartz fragments are abundant and are typically accompanied by large rounded quartz grains, mica, biotite, and feldspar (Jelinek 1967:52). Little data regarding vessel shape and size are available, but jars and bowls are reportedly the common vessel forms (Jelinek 1967:52).

Dates of Production. Jelinek (1967:65) dates McKenzie Brown to the period A.D. 1100 to 1300, with the period of greatest abundance being A.D. 1200 to 1300.

Range of Distribution. Jelinek (1967) proposes that the distribution of McKenzie Brown was concentrated in the Pecos River valley in the vicinity of Fort Sumner and south to an undetermined distance. The type is commonly found to the east at sites on the Mescalero Plain and the Llano Estacado; Boyd (2004:317) reports McKenzie Brown from Palo Duro Complex residential base camps, such as Deadman's Shelter (41SW23), Kent Creek (41HL66), and Sam Wahl (41GR291), located on the Llano Estacado and in the Caprock Canyonlands.

Middle Pecos Micaceous Brown

Type Description. Middle Pecos Micaceous Brown was first described and named by Jelinek (1967). The type is characterized as being consistently friable. Exterior and interior surfaces appear to be tool smoothed, while most specimens retain smoothing tool marks. Tempers consist of crushed granitics and metamorphic derivatives, with an abundance of mica flakes distributed throughout the paste and surface walls (Jelinek 1967:49-50). Jars and bowls are the common vessel forms. Jar rims are direct and minimally extended resulting in a relatively short neck, while bowl sherds are very rare and offer little morphological data.

Dates of Production. Jelinek (1967:65) dates Middle Pecos Micaceous Brown to the period ca. A.D. 900 to ca. 1300, with the greatest period of abundance being A.D. 900 to 1200.

Range of Distribution. Jelinek (1967) proposes that the distribution of Middle Pecos Micaceous Brown was concentrated in the Pecos River valley in the vicinity of Fort Sumner and south to an undetermined distance. The type is commonly found to the east at sites on the Mescalero Plain and the Llano Estacado; Middle Micaceous Brown is also reported at Palo Duro Complex sites, such as Deadman's Shelter (41SW23), Kent Creek (41HL66), and Sam Wahl (41GR291), located on the Llano Estacado and in the Caprock Canyonlands (Boyd 2004; Boyd et al. 1997; Hughes and Willey 1978). Micaceous variants of Jornada Brown are known from the Gran Quivira region of central New Mexico; Wiseman et al. (1999) proposes that Middle Pecos Micaceous Brown was produced in these areas of central New Mexico.

Roswell Brown

Type Description Roswell Brown was first described and named by Jelinek (1967), but the type was formerly designated as Polished Brown by Jane Holden (1952:101). Roswell Brown is characterized as moderately compact to friable. Exteriors of jars and bowl interiors were smoothed and polished; interiors and exteriors were also occasionally decorated with broad red lines. Temper consists of crushed granitic derivatives, with little to no mica or magnetite. The weathered granitic particles are occasionally oxidized to an orange-red color; these red specks in the temper are a diagnostic attribute. Jars and bowls are the common forms; jars have a wide mouth and neck, while no morphological data is available for bowls.

Dates of Production Jelinek (1967:65) dates Roswell Brown to the period between A.D. 1150 to 1250, with the greatest period of abundance being sometime around A.D. 1240.

Range of Distribution. Roswell Brown is concentrated in the Pecos River valley in the vicinity of Roswell, New Mexico, the Hondo River valley to the west, and continues as far west as Ruidoso, New Mexico. Roswell Brown is commonly found to the east at sites on the Mescalero Plain and the Llano Estacado; Boyd (2004:317) and Hughes and Willey (1978) report it at Palo Duro Complex sites, such as Deadman's Shelter (41SW23), Kent Creek (41HL66), and Sam Wahl (41GR291).

Summary

The Ceramic Period on the Llano Estacado and the adjacent areas of southeastern New Mexico, like many areas of the Southwest, experienced several important changes in prehistoric settlement adaptations. These transformations include changes in architectural form, settlement structure, subsistence, and technology, including decreased mobility along with increased agricultural dependence (Boyd 2004:299-300; Clark 2006:53-55; Collins 1968; Kelley 1984; Miller 2004:236-238; Brooks 2004:335-336). The differences between these areas lie in the reported differences in degrees of sedentism and reported degree of dependence on agriculture (Sebastian and Larralde 1989:80).

By the tenth and eleventh centuries, insubstantial pithouse architecture emerges across the Llano Estacado and southeastern New Mexico. Domesticated plant species were utilized but appear to have been a minor component in what continued to be a mobile hunter-gatherer adaptive system (Miller 2004:237). From at least A.D. 1100 onwards, the dispersed jacal and pithouse settlements were replaced by larger pithouse villages throughout the Pecos Valley and Sierra Blanca regions; villages were comprised of substantial architectural remains that included large pithouses and surface jacal roomblocks. On the Llano Estacado, similar but less spectacular developments are represented by the Antelope Creek Phase sites of the Canadian River valley and the Ochoa Phase sites located on the southern Llano Estacado and extreme southeastern New Mexico.

Cultigens are reported to be a significant component in the diets of sedentary groups in the Pecos Valley and Sierra Blanca region (Jelinek 1967; Kelley 1984; Speth 2004). On the Southern Plains, cultigens are also an important component in the subsistence economy of the Antelope Creek Phase (Brooks 2004:338-339; Hughes 1991:29; Lintz 1986). However, botanical data are either totally lacking or flotation samples have failed to identify evidence of cultigens for Ochoa Phase sites and other contemporary sites on the southern Llano Estacado and extreme southeastern New Mexico; researchers suggest that these sedentary populations largely depended upon a hunting and gathering economy, forgoing agriculture altogether (Collins 1968, 1971; Sebastian and Larralde 1989:83). The faunal assemblages from sites across southeastern

New Mexico and the Llano Estacado indicate an emphasis on the procurement of larger prey species in the Late Ceramic Period, antelope and deer in the uplands and bison in the Pecos Valley and the Llano Estacado (Collins 1968, 1971; Jelinek 1967; Speth 2004).

Beginning around A.D. 1400, permanent occupation at many sites in the Sierra Blanca region, the Pecos Valley, and Llano Estacado came to an end (Brooks 2004:343-344; Clark 2006:55; Jelinek 1967:162; Kelley 1984). The specific causes of these regional abandonments are not well understood but researchers have proposed that environmental changes or an influx of immigrant populations may in part explain abandonment of the regions (Brooks 2004:343-344; Clark 2006:55; Hughes 1991:34; Jelinek 1967:162). Though there are some temporal differences in the establishment of late Ceramic Period sites in the regions, the available data suggests that many of the settlements had roughly contemporaneous occupational spans and similar subsistence strategies that extended from the A.D. 1100s into the mid or late-1400s (Boyd 2004:299-300; Brooks 2004:335-336; Clark 2006:53-55; Collins 1968; Kelley 1984; Miller 2004:236-238).

Although the regional archaeological data suggests that the regions followed similar cultural and adaptive trajectories, some differences are evident as well. Detailed ceramic analysis has the potential to address questions of adaptation, the role of ceramics in the adaptive strategies of the region, site function, and ceramic production and distribution. These data provided in this study are a first step towards gaining an understanding of ceramic origins, plus these data provide information on systems of distribution in the region.

Little work has been published on the ceramics of the Southern Plains and extreme southeastern New Mexico. Regional ceramics studies have focused on establishing broad ceramic types rather than producing detailed studies (Whalen 1981), while a few have sought to identify the origins and placement of the pottery type in Southwestern and Plains ceramic traditions (Jelinek 1967; Leslie 1965a, 1979; Runyan and Hedrick 1973; Wiseman et al. 1999). Cross-dating techniques and a single radiocarbon date (Collins 1968:179) place Ochoa Indented Brown in the Ochoa Phase (A.D. 1300 and 1450/1530) of extreme southeastern New Mexico and the southern Llano Estacado. Ochoa Indented Brown appears to be rare on the Southern High Plains, but the lack of large scale surveys in the region are likely responsible for its low visibility in ceramic assemblages from the region. Its range of distribution has historically been reported to be limited to a relatively small area in extreme southeastern New Mexico and the Southern Plains; however, Ochoa Indented Brown is reported as far north as Lubbock County, Texas, and is reported in sites along the eastern and southeastern fringe of the Southern High Plains, greatly expanding its original distribution. Morphological and physical attributes suggest that Ochoa Indented Brown vessels were utilized for storage and cooking.

Though a primary goal of this study is to determine the production area of Ochoa Indented Brown, samples of roughly contemporary corrugated wares (Corona and Seco Corrugated) associated with the Lincoln Phase (ca. A.D. 1200 to 1400/1425) of the Sierra Blanca region and brownwares (McKenzie Brown, Middle Pecos Micaceous Brown, and Roswell Brown) associated with Pecos Valley sites spanning multiple phases were included in the study as a comparative sample should the INAA data indicate that Ochoa

Indented Brown does not represent a Southern Plains produced pottery type. The dates of production for the ceramic types included in this study span multiple phases and range in time between A.D. 900 to 1460. Utilizing the technique of INAA, compositional data of the ceramic and clay samples may determine the region of production of these ceramic types and address questions relating to Pueblo-Plains trade and exchange during the Ceramic Period.

CHAPTER 4

ANALYTICAL METHODS

Instrumental Neutron Activation Analysis (INAA)

INAA is generally considered the most powerful chemical characterization method for sourcing ceramic materials. Operating on the principal of radioisotope decay, INAA measures a large number of major, minor, and trace elements present within a given sample (Glascock 1992). INAA is predicated on the idea that archaeological ceramics and clays can be grouped according to similar chemical compositions, and that these compositional groups represent unique material sources resulting from local production loci (Bishop et al. 1982; Neff 2002). This analytical technique has been shown to be highly precise, accurate, and extremely sensitive to a large number of trace elements (Bishop 1980; Bishop et al. 1982, 1990).

For this study, INAA was determined to be the most appropriate compositional technique for characterizing the production of Ochoa Indented Brown for two reasons. First, researchers have successfully employed INAA to differentiate ceramic production areas and groups in the regions included in this study (Clark 2006; Creel et al. 2002; Meier 2006).Second, Darrel Creel of the University of Texas at Austin had generously allowed me access to the Ochoa Indented Brown INAA data that had been generated from previous Chupadero Black-on-White compositional studies (Creel et al. 2002) and the Texas Archeological Research Laboratory (TARL) Central Texas Ceramics Project (CTCP), investigating mobility and the ceramic technology of the Central Texas Late Prehistoric period. The use of these existing INAA data provided a baseline of information from which to more thoroughly investigate production of Ochoa Indented Brown and trade and exchange between the regions. An abbreviated description of the INAA techniques and statistical analyses employed to construct compositional reference groups are described below.

Sample Preparation and Methodology

The sample preparation and analysis procedures that are summarized below are those currently used at the Archaeometry Laboratory at the University of Missouri Research Reactor (MURR). The reader is referred to Glascock (1992) and Glascock and Neff (2003) for more detailed descriptions of the analytical techniques associated with INAA.

Prior to analysis, each specimen is first assigned a unique analytical identification code. Samples included in this study were numbered LAA001 to LAA105. Ceramic samples were prepared by burring off the exterior of the sherd with a silicon carbide drill to remove possible contaminants adhering to the sample surface. Samples were then crushed into a fine powder, dried, measured, and transferred into vials for irradiation. Due to the TARL collections policy, samples LAA085 to LAA094 were powdered by the author using a silicon carbide Dremmel bit. Following irradiation, radioactive isotopes of various elements within a given ceramic specimen were allowed to decay and give off gamma rays with energies that are characteristic of the different isotopes. The concentrations of these elements within a ceramic sample were then determined by measuring the gamma ray emissions using a germanium detector. Specimens were counted in three different stages to measure short-lived, medium-lived, and long-lived elements. A list of the half-lives and gamma energies for the 33 elements that were measured is provided by Glascock (1992). Sample elemental concentrations were determined by comparison to standards with known elemental concentrations that are analyzed with each batch of specimens (Glascock 1992:14).

Statistical Methods and Analysis

The complex associations between elements require the use of multivariate statistical procedures to identify groups of chemically similar compositional specimens. Though the analysis of compositional data may be undertaken utilizing a variety of quantitative techniques, researchers tend to follow a general set of procedures and approaches. Neff (2002:16) suggests that typical data analysis often proceeds along similar lines and involves 1) an initial transformation of variables, 2) a search for possible subgroups within the multivariate concentration space, and lastly 3) an evaluation of the multivariate coherence of suggested subgroups. Detailed descriptions of the various approaches for compositional data reduction and interpretation are presented by Duff (1999, 2002), Glascock (1992), and Neff (2002); the following summary is primarily taken from Clark (2006) and Duff (1999). Statistical analysis of the INAA compositional data was primarily performed by the GAUSS computer package.

Normalization and Missing Data. The first step in analysis was to convert the raw data to base 10 logarithms, which produced a more normal distribution for many of the elements by essentially equalizing the contribution of concentrations of major, minor, and trace elements that would otherwise vary by orders of magnitude (Glascock 1992;

Neff 2002). Missing values were replaced for those cases that had concentrations of a particular element that fell below the instrumental detection limits. This practice of substitution avoided the elimination of cases with single missing values. The GAUSS program was utilized to temporarily substitute values that minimized the Mahalanobis distance from the centroid of the compositional group to which the sample was believed to belong. Once a sample with missing values for a particular element was definitively assigned to a compositional group, those missing values were replaced with group specific values.

Grouping Procedures. Given that the compositional data matrix includes information on a large number of elements, the number of dimensions must be reduced in order to visually examine relationships between cases (Neff 2002:19). Principal component analysis (PCA) is one of the most common data reduction techniques utilized by archaeologists to recognize patterns (i.e. groups and subgroups) in chemical composition data. PCA locates the orientations of axes of greatest variance in a data set by eigenvector extraction, and then produces corresponding eigenvalues that indicate the length of each eigenvector; these reference axes are arranged in order of decreasing variance (Baxter 1994; Davis 1986; Shennan 1997). According to Glascock (1992:18), the first three principal components (PCs) account for more than 70 percent of the total variance in the chemical data set, with over 90 percent of the variance accounted for in the first ten principle components. Plotting cases with respect to these axes provides a way to display relationships between samples and to search for groups and subgroups in an undifferentiated data set (Clark 2006:128; Duff 1999).

The PCA simultaneous R- and Q- mode technique allows variables (elements) and objects (individual analyzed samples) to be displayed on the same set of principal component reference axes (Baxter 1992; Neff 1994). This procedure allows the researcher to evaluate the contributions of specific elements to group separation and to the distinctive shapes of the various groups; these "biplots" refer to the simultaneous plotting of objects and variables (Baxter 1992; Neff 1994). The variable interrelationships that are discerned from these biplots can be further verified by inspection of bivariate elemental concentration plots (Clark 2006:128). Through the examination of these graphical displays, tentative groups may begin to be defined in the compositional data; Duff (1999) refers to this analytical step as the exploratory phase.

Group Evaluation Once preliminary compositional groups have been visually defined using PCA, the coherence of the group needs to be evaluated. Typically, Mahalanobis distance (MD) is the primary statistical method used to describe the separation between groups or between individual points and groups on multiple dimensions. The MD statistic measures the squared Euclidean distance from a sample to the group centroid using log transformed compositional data (Neff 2002:30). The probability of each sample belonging to the group is generated using the Hotelling's T^2 statistic that is converted to an F-value (Bishop and Neff 1989:68; Glascock 1992:19). In performing such calculations, researchers suggest "cross-validating" the sample (i.e. remove the sample being evaluated from the calculation of the group centroid) so as not to influence the centroid in the direction of the sample (Baxter 1994; Leese and Main 1994). The resulting set of data provides the analyst with the probability of membership for a sample in each of the defined groups; the defined set of criteria for group membership is a 90 percent confidence interval (Bishop and Neff 1989:68; Glascock 1992:19).

The calculation of MD probabilities on logged elemental concentration data requires that the number of specimens in each group must be one more than the number of variables (elements) used in the analysis. Since 30 elements were reliably detected for the samples, each group needed to have at least 31 members for group evaluation. Unfortunately, the principal components do not define the groups well in this study, thus the Mahalanobis distance calculations based on principal components are ambiguous. Although principal components were of little value in assessing the statistical validity of the groups, the groups separate well in bivariate plots with chromium and transition and rare earth metals.

Summary

This chapter provides a brief description of the INAA techniques and statistical analyses employed to construct compositional reference groups. INAA is generally considered the most powerful chemical characterization method for sourcing ceramic materials. INAA is based on the idea that archaeological ceramics and clays can be grouped according to similar chemical compositions, and that these compositional groups represent production loci (Bishop et al. 1982; Neff 2002). This analytical technique has been shown to be highly precise, accurate, and extremely sensitive to a large number of trace elements (Bishop 1980; Bishop et al. 1982, 1990). For this study, INAA was determined to be the most appropriate compositional technique to more thoroughly investigate production of Ochoa Indented Brown and trade and exchange between the regions.

CHAPTER 5

THE SITES AND SAMPLES

Brief descriptions of each site by region and a brief history of archaeological investigation for each site are provided in this chapter. In total, twelve sites from the Southern Plains, three sites from the Pecos Valley, and one site from Sierra Blanca region were selected for study. The goal in selecting samples for the INAA database was to obtain samples from roughly contemporaneous sites in the study regions. Ideally, these samples would provide compositional signatures for each of the regions, providing a means to determine what Southern Plains, Pecos River valley, and Sierra Blanca produced ceramic types are and possibly provide information on ceramic production areas and trade and exchange between the regions. Additionally, clay samples from the Texas Southern Plains and Mescalero Plain were collected for analysis.

The Sites

Southern High Plains Sites

Ceramic samples from thirteen sites on the Southern Plains were included in this study: eleven located on the Southern Plains of Texas and two located on the Mescalero Plain in extreme southeastern New Mexico (Figure 16). Although the two sites located on the Mescalero Plain, the Merchant site (LA 43414) and the Paducah

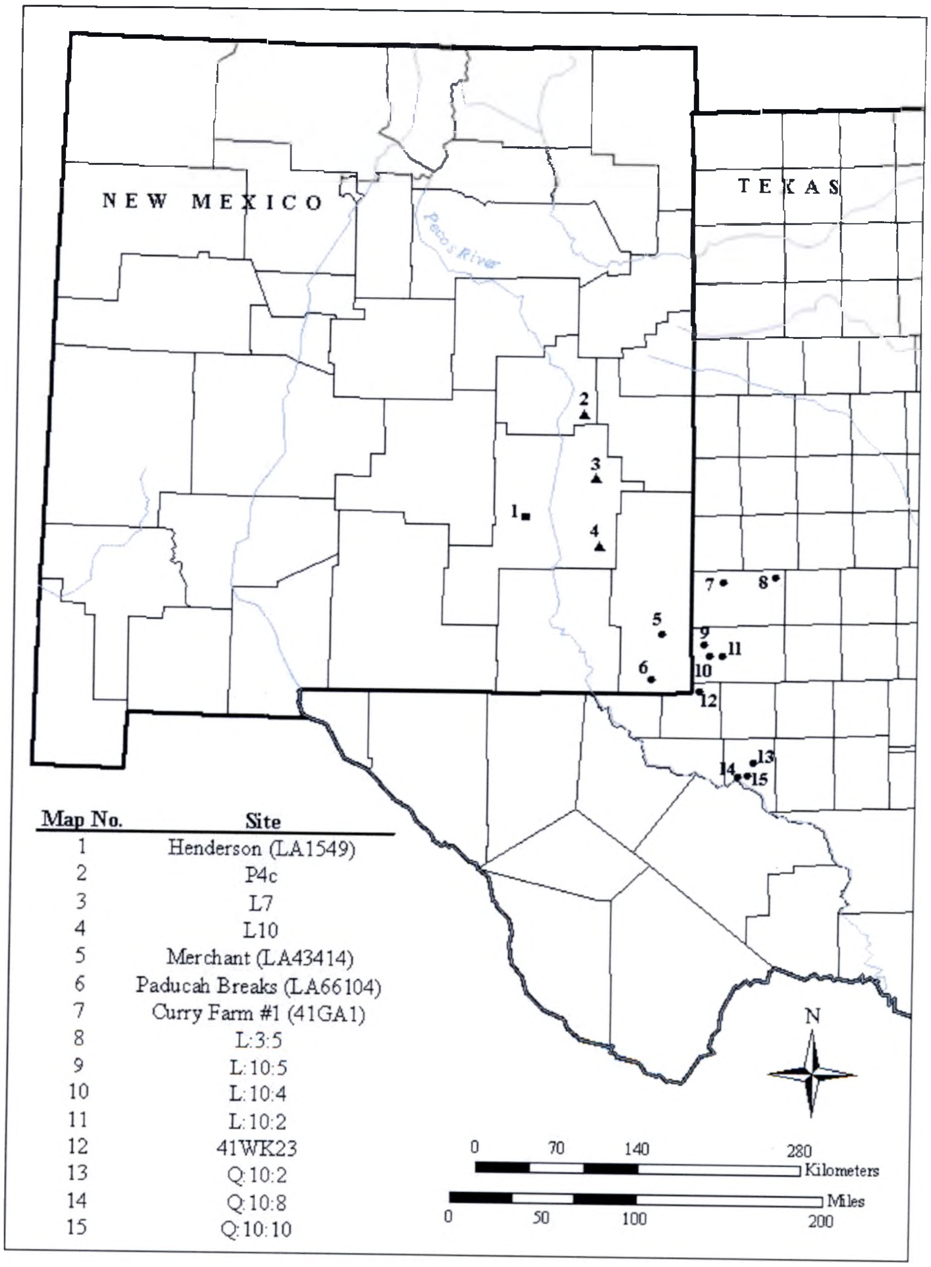

Figure 16. Map showing sites on the Southern Plains, Pecos River valley, and Sierra Blanca region.

Breaks site (LA 66104), are technically located in the Pecos Valley, late Ceramic Period sites located along the southwestern margin of the Llano Estacado have traditionally been considered Southern Plains sites, because of their close proximity to the Southern Plains and similarities in adaptive strategies, architecture, and artifact assemblages (Collins 1968, 1971; Leslie 1965).

The majority of recorded sites on the Southern Plains were recorded by avocational archaeologists, while professional investigations are typically limited to the occasional pipeline survey. In this chapter, recently recorded sites are either identified by their Smithsonian trinomial or their New Mexico Archeological Records Management Section (ARMS) site numbers (LA); however, this chapter also refers to sites and artifacts recorded and collected by E.B. Sayles in the early 1930s (Sayles 1935). In the early 1930s and with support of the Gila Pueblo in Medalon Arizona, Sayles surveyed and recorded sites across large areas of Texas, including the Llano Estacado (Sayles 1935). Sayles designated sites following survey methods described by Gladwin and Gladwin (1928), which designated archaeological sites through the use of USGS topographic survey sheets by assigning letters and numbers to identify a specific topographic sheet, followed by a site number (e.g. L:10:2). The reader is referred to Gladwin and Gladwin (1928) and Sayles (1935) for a complete discussion of the survey and site designation methodology.

41AD2 (Salt Cedar) The Salt Cedar site is one of several sites, collectively known as the Andrews Lake Sites, located on the shores of a large playa in eastern Andrews County, Texas. Between 1964 and 1965, the Salt Cedar site was investigated by the Midland Archeological Society. The site was further investigated between 1965 and 1966 by Michael B. Collins of the University of Texas at Austin for his MA thesis research. The Salt Cedar site yielded extensive midden debris, evidence of contiguous room structures, clay lined and rock lined hearths, and burials, all clear evidence of semi-permanent occupations (Collins 1968). Artifact, ceramic, and radiocarbon data indicate that the most intensive occupation of the sites occurred between A.D. 1200 and 1530 (Collins 1968). One prehistorically fired clay sample from 41AD2 was provided by TARL for this analysis.

41GA1 (Curry Farm #1). The Curry Farm #1 site is located approximately 48 km (30 mi) northwest of Seminole, Texas, adjacent to a small playa. The site was recorded by local avocational archaeologists in 1965 and was reported as a surface scatter of lithic artifacts, groundstone (i.e. manos and metates), and ceramics; no features were reported. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from 41GA1 was provided by TARL for this analysis.

41WK23. Site 41WK23 is located approximately 10 km west of Monument Draw in southwest Winkler County, Texas. The site was recorded in 1990 by an unknown party as a small, dispersed scatter of lithic material, burned caliche, and ceramics encompassing 2704 m^2. No intact features were observed but the presence of the burned caliche fragments suggest that hearths may have existed or remain buried. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from 41WK23 was provided by TARL for this analysis.

L.3·5. Site L:3:5 is located 40 km northeast of Seminole, Texas, along the north shore of Cedar Lake, a large salinas basin. The site is situated on a hill approximately 305 m from the north shore of Cedar Lake. In 1932, Sayles recorded the site as an open campsite encompassing 2,730 m². Artifacts reported include lithic material, ceramics, and groundstone (i.e. manos and metates). A burial was also reported but no details are available. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from L:3:5 was provided by TARL for this analysis.

L 10:2. Site L:10:2 is located 11 km northwest of Andrews, Texas, along the southern shore of Shafter Lake, a large salinas basin. The site is situated adjacent to a spring fed drainage that once provided fresh water to the basin. In 1932, Sayles characterized the site as an open campsite with small hearths, Sayles also reported that the site was actively eroding from the lake bank for a distance of approximately 91 m. Artifacts reported include projectile points, bifaces, scrapers, debitage, groundstone (i.e. manos and metates), and ceramics. Features reported include an undetermined number of small hearths. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from L:10:2 was provided by TARL for this analysis.

L:10.4. Site L:10:4 is located approximately 14 km southwest of Andrews, Texas, along the southwest shore of Shafter Lake, a large salinas basin. The site is situated adjacent to a spring fed drainage that once provided fresh water to the basin. In 1932, Sayles characterized the site as an open campsite measuring 27,755 m². Artifacts reported include projectile points, bifaces, scrapers, debitage, groundstone (i.e. manos and metates), and ceramics. Features reported include six oval shaped bedrock mortars. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from L:10:4 was provided by TARL for this analysis.

L.10 5. Site L:10:5 is located 14 km southwest of Andrews, Texas, and approximately 1.6 km north of Shafter Lake. The site was recorded in 1932 by Sayles as an open camp with an associated artifact scatter encompassing an estimated 161,874 m^2. Artifacts reported include projectile points, bifaces, scrapers, drills, debitage, groundstone (i.e. manos and metates), and ceramics. Features reported include an undetermined number of hearths. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from L:10:5 was provided by TARL for this analysis.

LA 43414 (Merchant). The Merchant Site is located in south central Lea County, New Mexico, on a low ridge overlooking a large playa. The site was initially investigated by the Lea County Archeological Society between 1959 and 1965 (Leslie 1965b). Evidence of both pit houses and surface rooms exists at Merchant; although, it is unclear whether the pithouse and surface structures are contemporary or represent multiple occupations over time. Of the 7,000 ceramic sherds recovered from the Merchant Site, approximately 96 percent of the total ceramic collection is Ochoa Indented Brown. Artifact and ceramic data indicates that the Merchant site dates to the fifteenth century (Leslie 1965b). Twenty-eight sherds of Ochoa Indented Brown from the Merchant site were provided by John D. Speth of the Museum of Anthropology, University of Michigan for this analysis.

LA 66104 (Paducah Breaks). The Paducah Breaks site is located in southeast Lea County, New Mexico. The site was originally recorded in 1987 by an unknown party, and revisited in 1995 by Prewitt and Associates, Inc. of Austin, Texas, and again in 1999 by Lone Mountain Archeological Services of El Paso, Texas (State of New Mexico, Office of Cultural Affairs, Historic Preservation Division, Archeological Records Management Section [ARMS] 2008). The site covers 27,000 m² and is reported as a multi-component site retaining evidence of an Archaic and a Late Prehistoric component. The artifact assemblage reported for the site includes projectile points, groundstone, burned rock, debitage, and ceramics. Reported features include ash stains, bedrock mortars, and burned rock concentrations. Artifact and ceramic data indicates that the Paducah Breaks site Late Prehistoric component dates between A.D. 750 and 1400. One sherd of Corona Corrugated from the Paducah Breaks site was provided by TARL for this analysis.

Q·10.2. Site Q:10:2 is located in Crane County, Texas, approximately 24 km east of Grand Falls, Texas. The site was recorded in 1931 by Sayles as an open campsite with an associated artifact scatter covering approximately 4,047 m². Artifacts reported include projectile points, burned bone, and ceramics, while no features were reported. Based on the presence of Ochoa Indented Brown, the site roughly dates to A.D. 1300 to 1500. One sherd of Ochoa Indented Brown from site Q:10:2 was provided by TARL for this analysis.

Q 10 6. Site Q:10:6 is located in Crane County, Texas, and approximately 32 km southeast of Monahans, Texas. The site was recorded in 1932 by Sayles as an open camp with an associated lithic scatter, no indication of site size was provided. A burial of an adult was reported at this site; associated artifacts include a lignite pendant with turquoise inlays, two unidentified shaped stones, three metates, shell fragments, adobe, bifaces, and hematite concretions. Ceramics were not reported at the site so an estimated period of occupation is unavailable. One prehistorically fired clay sample from site Q:10:6 was provided by TARL for this analysis.

Q 10 8. Site Q:10:8 is located in Crane County, Texas, and approximately 39 km southeast of Monahans, Texas. The site was recorded in 1932 by Sayles and was characterized as an open camp with an associated lithic scatter covering approximately 60,190 m^2. Artifacts reported include projectile points, bifaces, scrapers, chert and obsidian debitage, groundstone (i.e. manos, metates, a pestle, and an arrow shaft polisher), shell fragments, and ceramics; however, no features were reported. Based on the presence of Ochoa Indented Brown, the site roughly dates to A.D. 1300 to 1500. One sherd of Ochoa Indented Brown from site Q:10:8 was provided by TARL for this analysis.

Q.10 10. Site Q:10:10 is located in Crane County, Texas, approximately 48 km southeast of Monahans. The site was recorded in 1932 by Sayles and was characterized as an open camp with an associated artifact scatter covering approximately 12,141 m^2. Artifacts reported include projectile points, bifaces, groundstone (i.e. manos and metates), and ceramics; however, no features were reported. Based on the presence of Corona Corrugated, the site roughly dates to A.D. 1225 to 1460. One sherd of Corona Corrugated from site Q:10:10 was provided by TARL for this analysis.

Pecos River Valley and Sierra Blanca Sites

Ceramic samples from three sites in the Pecos River valley were included in this study: two sites (L7 and L10) located on the western Mescalero Plain, immediately adjacent to the Pecos River, and one (P4c) located in the Pecos River valley proper (see Figure 16). The Henderson Pueblo (LA 1549), located along the lower Hondo River, represents the Sierra Blanca region (see Figure 16). Site L7 dates to the Late 18 Mile and Early Mesita Negra Phases (A.D. 900 to 1100), while site L10 dates to the Late Mesita Negra and the Early McKenzie Phases (A.D. 1100 to 1250). Site P4c dates to the Late McKenzie Phase (A.D. 1250 to 1300) and Henderson Pueblo dates to the Lincoln Phase (A.D. 1200 to 1400).

L7, L10, and P4c Jelinek's (1967) Middle Pecos Valley site numbering system was initiated in 1956, when sites on the western Mescalero Plain and Pecos River valley were being investigated. Jelinek (1967) distinguished between sites located in the Pecos River valley (site numbers preceded by the letter "P") and sites located on the Mescalero Plain (preceded by "L" and representative of "Llano" sites). The reader is referred to Jelinek (1967) for a complete discussion of the survey and site designation methodology. Jelinek's survey notes indicate that site location data was recorded via the United States Geologic Survey (USGS) Public Land Survey System (PLSS), so site locations could only be identified to a specific PLSS section block (i.e. 640 acres).

Jelinek (1967) provides little to no site specific data for sites L7, L10, and P4c. Sites L7 and L10 are located in Chavez County, New Mexico; however, no additional site data are provided by Jelinek (1967). Site P4c is located in DeBaca County, New Mexico, on the Blackdom Terrace near the 18 Mile Bend of the Pecos River. The site consists of "several hundred flakes and/or sherds and occasional indications of permanent architecture" (Jelinek 1967). A sample of 10 sherds of McKenzie Brown from site P4c, 10 sherds of Roswell Brown from site L7, and 6 sherds of Middle Pecos Micaceous Brown from site L10 were provided by John D. Speth of the University of Michigan from collections curated at the Museum of Anthropology, University of Michigan.

LA 1549 (Henderson Pueblo). Henderson Pueblo sits on a low terrace along the southern bank of the lower Hondo River approximately 17 km southwest of Roswell, New Mexico. The site contains an above ground adobe structure totaling 100 to 130 rooms (Speth 2004). Ceramic seriation data suggest that the roomblock experienced two major periods of construction (Speth 2004:20).

Radiocarbon and archeomagnetic dates, along with ceramic seriation data, indicate that the initial period of occupation at Henderson Pueblo occurred between A.D. 1250 and 1300, with later reoccupation in the late A.D. 1300s and early 1400s (Speth 2004:20-21). A sample of 20 sherds of Corona Corrugated and 10 sherds of Seco Corrugated from Henderson Pueblo were provided by John D. Speth of the University of Michigan from collections curated at the Museum of Anthropology, University of Michigan.

Sampling Considerations

The selection of samples for the chemical compositional analysis was in large part guided by the existing INAA data on ceramics in the regions (Boyd et al. 2002; Clark 2006; Creel et al. 2002; Meier 2006; Miller 2004). Additionally, ten Ochoa Indented Brown sherds from the Salt Cedar Site (41AD2) had been submitted to MURR for INAA study as part of a Creel et al.'s (2002) study investigating Chupadero Black-on-White production and distribution, and an additional four samples had been submitted for analysis for the TARL CTCP. Using the existing Ochoa Indented Brown INAA data as a baseline, the original sample was expanded by selecting an additional 31 Ochoa Indented Brown sherds from four sites. Corrugated wares believed to have been produced in the Sierra Blanca region were submitted for INAA; these samples include 27 Corona

Corrugated sherds and 10 Seco Corrugated sherds. Additionally, brownwares believed to have been produced in the Pecos River valley were also submitted; these additional sherds include 10 McKenzie Brown sherds, 10 Roswell Brown sherds, and 6 Middle Pecos Micaceous Brown sherds. These samples were all analyzed at MURR. The initial goal was to acquire a sample of at least 25 sherds per site; however, in most cases this target could not be met because of the limited number of samples that were available for destructive analysis and financial constraints.

Several factors were considered when selecting the individual sherds for INAA study. Large sherds were selected for analysis, as this would allow remnants to be used in subsequent studies. Sampling larger sherds also enabled MURR to archive a portion of each analyzed sherd. The selection of multiple sherds from the same vessel was avoided by comparing temper, paste color, and surface treatment.

The Database

The database for this study consists of compositional data on Ochoa Indented Brown, brownwares, and corrugated wares from sixteen sites on the Southern Plains, Pecos River valley, and the Sierra Blanca regions (Table 2). John Speth of the University of Michigan provided most of the key samples from collections curated at the Museum of Anthropology, University of Michigan, while Darrell Creel of the University of Texas at Austin provided additional samples from the collections curated at the Texas Archaeological Research Laboratory (TARL), University of Texas at Austin.

For this study, a geographically diverse sample spanning multiple phases was acquired for analysis. Considering the large scale of this study, use of such samples was deemed appropriate.

Table 2. Ceramic database showing distribution of Southern Plains, Pecos Valley, and Sierra Blanca compositional data sets.

Site	Sample Type	Context of Origin[1]	Number of INAA Samples	Repository of Collection[2]
Southern Plains Region				
Curry Farm #1 (41GA1)	Corona Corrugated	S	1	TARL
41WK23	Corona Corrugated	S	1	TARL
L 3:5	Corona Corrugated	S	1	TARL
L:10:2	Corona Corrugated	S	1	TARL
L 10·4	Corona Corrugated	S	1	TARL
L:10 5	Corona Corrugated	S	1	TARL
Q·10 2	Ochoa Indented	S	1	TARL
Q 10 8	Ochoa Indented	S	1	TARL
Q 10 10	Ochoa Indented	S	1	TARL
Merchant (LA43414)	Ochoa Indented	E*	28	UM
Paducah Breaks (LA66104)	Corona Corrugated	S	1	TARL
Pecos Valley and Sierra Blanca				
L7	Roswell Brown	S	10	UM
L10	Middle Pecos Micaceous	S	6	UM
P4c	McKenzie Brown	S	10	UM
Henderson Pueblo	Corona Corrugated	E	20	UM
	Seco Corrugated	E	10	UM
Sample Total			94	

[1] E = excavation, S = surface

[2] Repository Abbreviations TARL (Texas Archeological Research Laboratory, University of Texas at Austin) and UM (Museum of Anthropology, University of Michigan)

* samples obtained from backdirt

Clay Samples

In addition to ceramic sherds, a small number of clay samples were submitted for INAA. The initial goal was to acquire five to seven clay samples from the vicinity of key sites thought to represent production locales of Ochoa Indented Brown. Due to the paucity of Ochoa Indented Brown available for analysis, it was virtually impossible to identify possible production locales with the exception of two sites, the Salt Cedar site (41AD2) and the Merchant site (LA 43414). Five raw clay samples were collected from the vicinity of both the Merchant and Salt Cedar sites; however, the compositional results of the clay samples collected from the vicinity of the Salt Cedar site were not available for this study. One prehistorically fired clay sample from the Salt Cedar site and a prehistorically fired clay sample from site Q:10:6 located in Crane County, Texas, were submitted for analysis An additional four raw clay samples were collected from various geographic settings in Gaines County, Texas. The Gaines County raw clay samples represent a small area of the Texas Southern Plains, but given the geologic homogeneity of the Texas Southern Plains, these few samples may provide a compositional signature for the region.

Clay samples of approximately 2 kg (4 lbs) were collected from the various locales. Most of the raw clay specimens derive from primary, sedimentary deposits that were exposed by roadcuts. A description of each clay sample submitted for analysis is provided in Table 3, while the locations of these clay sources are indicated in Figure 17.

Table 3. Clay sample descriptions

Sample No. (LAA)	Location	Context	Geological Formation	Description	Color[1]
095	41AD2	Excavation	Unknown	NA	2 5YR5/6 - red
096	Q 10 6	Surface collection	Unknown	NA	7 5YR6/8 - reddish yellow
097	LA 43414	Exposed outcrop	Chinle	Triassic red clay	2 5YR4/4 - reddish brown
098	LA 43414	Exposed outcrop	Chinle	Triassic gray clay	5YR6/2 - light olive gray
099	LA 43414	Exposed outcrop	Chinle	Triassic red clay	2 5YR4/4 - reddish brown
100	LA 43414	Exposed outcrop	Ogallala	clay loam	2 5YR4/6 - red
101	LA 43414	Exposed outcrop	Ogallala	clay loam	2 5YR4/6 - red
102	Gaines County, TX	Roadcut	Blackwater Draw	sandy clay loam	2 5YR4/3 - reddish brown
103	Gaines County, TX	Playa	Blackwater Draw	clay loam	2 5YR5/6 - red
104	Gaines County, TX	Roadcut	Tahoka	clay loam	5YR6/1 - gray
105	Gaines County, TX	Roadcut	Tahoka	clay loam	7 5YR4/2 - brown

[1] Assigned Munsell color values (*Munsell Soil Color Charts* 1990)

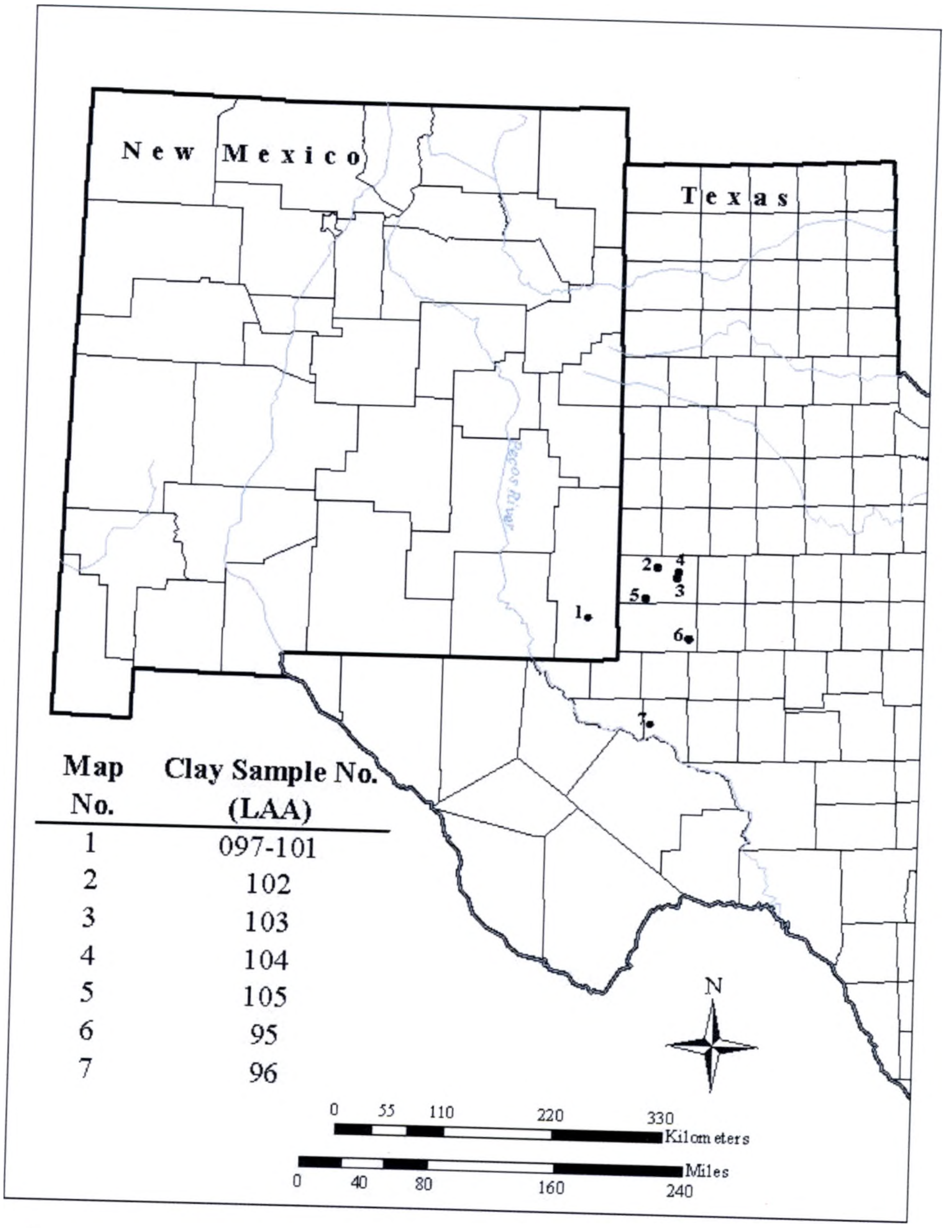

Figure 17. Map showing locations of raw clay sources.

Summary

The main goal in selecting ceramic collections for the database was to obtain a sample of pottery from roughly contemporaneous sites in the regions for INAA. In order to address ceramic production in the regions, a geographically diverse sample spanning multiple phases was acquired for INAA, to the extent that a few specimens provenienced only to the county level. Nine clay samples were submitted for INAA; seven raw clay samples of approximately 2 kg (4 lbs) were collected from various locales across the Southern Plains and Mescalero Plain and two prehistorically fired clay samples were also submitted for analyses. Utilizing the technique of INAA, compositional data of the ceramic and clay samples are used to determine the region of production of these ceramic types and address issues concerning Pueblo-Plains trade and exchange during the Ceramic Period.

CHAPTER 6

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS RESULTS

For this study, INAA compositional analysis is used to determine the region of production of Ochoa Indented Brown, and provides compositional profiles for corrugated wares and brownwares from the Sierra Blanca and the Pecos Valley. The INAA technique proves to be sensitive enough to detect compositional differences between ceramic types produced in the different study regions, while also detecting compositional differences between ceramic types produced in the same region. This chapter discusses the compositional reference groups identified for this study.

Compositional Reference Groups

For this study, 94 ceramic samples, 9 raw clay samples, and 2 prehistorically fired clay samples were submitted for INAA. Statistical analysis of the INAA data results in assignment of most samples (n = 78) to five compositional groups; the remainder (n = 16) are unassigned to any presently recognized compositional group (Appendix A).

Although principal components were of little value in assessing the statistical validity of the groups, the groups separate particularly well in bivariate plots with chromium (Cr) and transition and rare earth metals. These compositional groups exhibit clear chemical differences between the groups (Figure 18); Figure 19 shows a plot of just the assigned samples. The chemical composition and members of the five groups are discussed below.

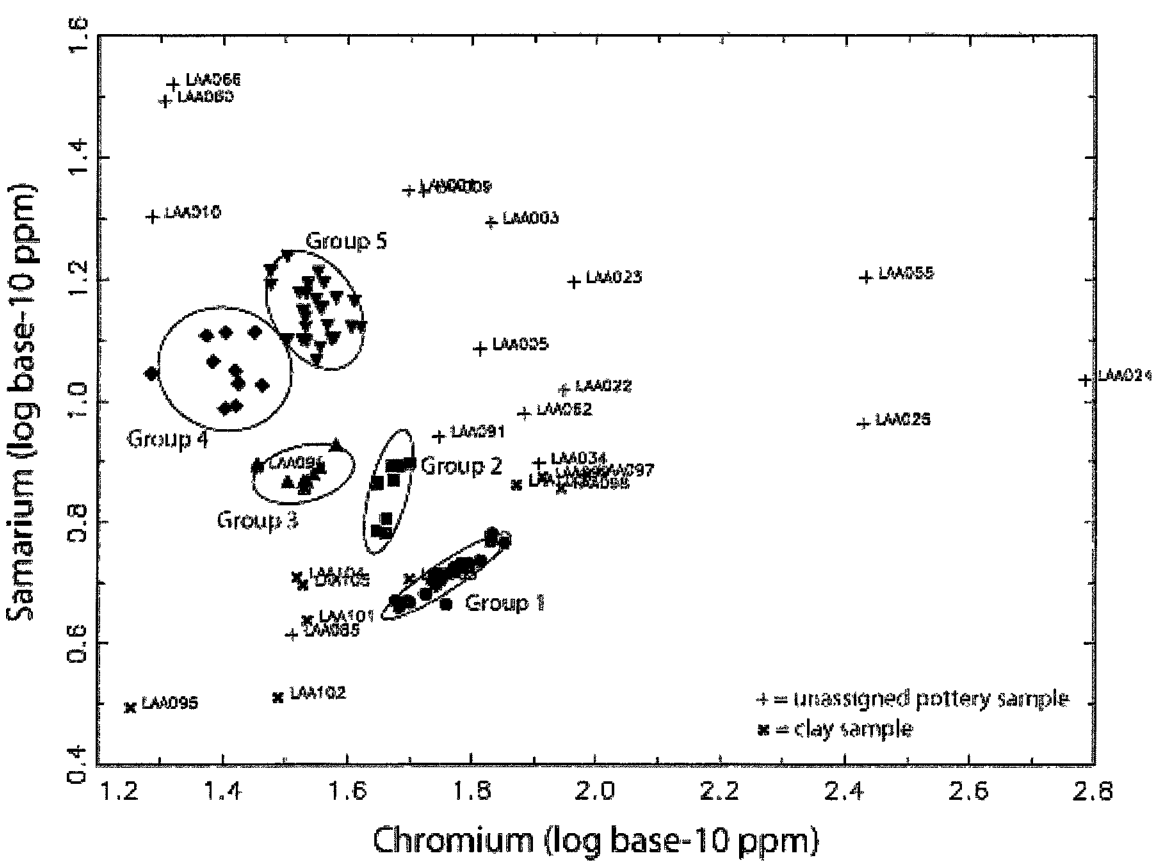

Figure 18. Bivariate plot of chromium and samarium base-10 logged concentrations showing all five groups, the unassigned samples, and the clay samples. Ellipses represent a 90 percent confidence level for membership in the group.

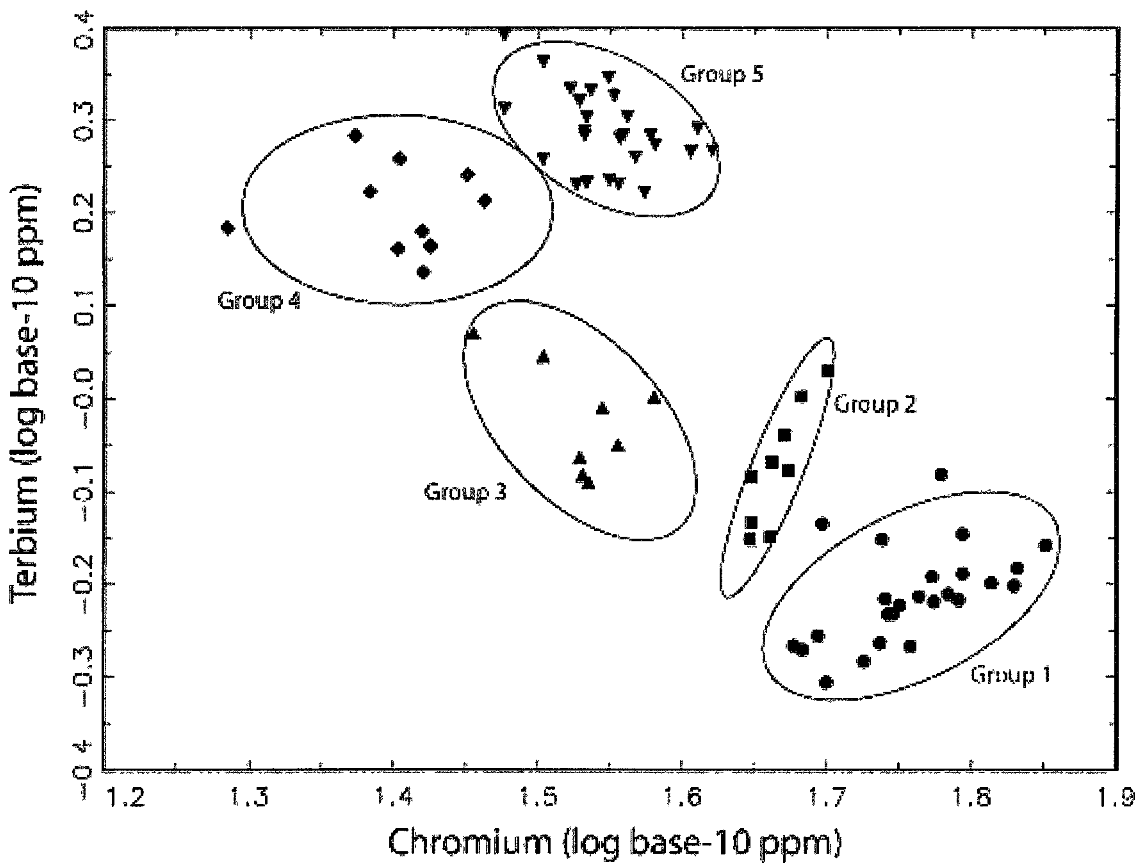

Figure 19. Bivariate plot of chromium and terbium base-10 logged concentrations showing all five groups. Ellipses represent a 90 percent confidence level for membership in the group.

Group 1

Group 1 is the second largest and most compositionally distinct group in the study. Group 1 samples are all Ochoa Indented Brown samples from the Merchant site (LA 43414), located in Lea County, New Mexico; this group includes 90 percent (n = 25) of the sherds submitted for analysis from the site (Appendix A, Table A.2). The members are comparatively low in all rare earth metals, lanthanum (La), lutetium (Lu), hafnium (Hf), zirconium (Zr), and sodium (Na), while they are enriched in chromium (Cr), arsenic (As), and antimony (Sb)(Ferguson and Glascock 2007). The high levels of arsenic (As) and antimony (Ab) suggest a greater inclusion of phosphorus compounds in Group 1 members. Group 1 is also well supported by the descriptive information; all members are from the same site, time period, and ceramic type.

Group 2

Group 2 is one of the smaller groups with only nine members; it does not represent a unified group of samples. The group is composed of several different pottery types which include Corona Corrugated (n = 1), McKenzie Brown (n = 1), Ochoa Indented Brown (n = 3), and Seco Corrugated (n = 4). The four Seco Corrugated and one Corona Corrugated sherds are all from the Henderson Pueblo (LA 1549), representing 55 percent (n = 5) of the sherds in this group. The three Ochoa Indented sherds are from Southern Plains sites (i.e. Merchant, Q:10:2 and Q:10:8), while the one McKenzie Brown sherd is from site P4c located in the Pecos Valley (Appendix A, Table A.3). The group separates well in plots of chromium (Cr) and rare earth metals, but in many other plots it is quite similar to Group 3. The overlap with Group 3 is evident in the overlapping probabilities listed in Appendix B. Groups 2 and 3 might have been combined, but Group 3 has a more limited distribution by location, type, and time period.

Group 3

This group consists of only eight members that cluster in between the other groups (see Figure 19). Five (n = 62 percent) of the samples in this group are Seco Corrugated sherds. One sherd of Corona Corrugated from Henderson Pueblo, one Middle Pecos Micaceous Brown sherd from Pecos Valley site L10, and one Roswell Brown sherd from Pecos Valley site L10 complete Group 3 (Appendix A, Table A.4).

Ninety percent (n = 9) of the total Seco Corrugated sample are assigned to compositional Groups 2 and 3. As mentioned above, there is some similarity between Groups 2 and 3, but less so the opposite direction (Appendix B).

Groups 4

Group 4 is more closely related to Group 5 (see Figure 19), although they are quite different in the ceramic types of the members. Group 4 (n = 10) is composed of 90 percent of the total Roswell Brown sample from site L7 submitted for this study, while one McKenzie Brown sherd from site P4c completes the group (Appendix A, Table A.5). There are no bivariate plots with chromium (Cr) on the x-axis where the 90 percent confidence ellipses of Group 4 and Group 5 do not at least touch.

Group 5

Group 5 (n = 26) is composed almost entirely of Corona Corrugated (n = 20, 77 percent) collected from sites on the Southern Plains and Henderson Pueblo in the Sierra Blanca region, while three sherds of McKenzie Brown from site P4c, one sherd of Ochoa Indented Brown from the Merchant site, and one sherd of both Middle Pecos Micaceous Brown from site L10 and Seco Corrugated from Henderson Pueblo complete the group (Appendix A, Table A.6). There are no bivariate plots with chromium (Cr) on the x-axis where the 90 percent confidence ellipses do not at least touch. A second possible interpretation of these data would be to combine Groups 4 and 5 into a single large group with two meaningful subgroups.

Unassigned Samples

Seventeen percent (n = 16) of the ceramic samples are not assigned to any of the groups (Appendix A, Table A.7); most of the unassigned samples are distant outliers. This percentage is lower than the usual 30 to 35 percent unassigned rate that is typical in chemistry-based provenance research (Creel et al. 2002:118). Appendix B lists the probability of group membership for each of the unassigned samples. Sixty six percent (n = 4) of the Middle Pecos Micaceous Brown and 50 percent (n = 5) of the McKenzie Brown are unassigned, but a larger study might generate enough of these outliers to begin to form small groups. Corona Corrugated samples LAA060 and LAA066 from Henderson Pueblo are classified as unassigned, but they always plot very close to each other in bivariate plots. If their temper were not different, they might have been considered as samples from the same vessel. For now they could be considered as a very small outlier group. There are a number of samples with relatively high probabilities of membership in Groups 2 and/or 3, but they have much higher chromium (Cr) values as shown in Figure 18.

Clay Analysis

The statistical standards for assigning clays to compositional groups are generally lower than pottery samples, but unfortunately the probabilities based on Mahalanobis distances using principal components are not very useful in this study. The probabilities of group membership for each of the clays are listed in Appendix B. Sample LAA101, a clay loam sample from the Merchant site (LA 43414), among other samples have reasonably high probabilities of membership in Group 2, but this most likely is a result of Group 2 not representing a very unified group of samples. One sample, LAA103, consistently plots within the 90 percent confidence ellipse for Group 1, except it is higher in hafnium (Hf) and zirconium (Zr) (Ferguson and Glascock 2007). These elements are often characteristic of sand inclusions in the clay, suggesting that this clay sample may represent a similar deposit, but the potters may have either selected their clay from an area with better natural sediment sorting or levigated out the sand prior to pot production (Ferguson and Glascock 2007). These INAA data links clay sample LAA103 to Group 1 comprised of Ochoa Indented Brown from the Merchant site (LA 49414) in New Mexico, yet clay sample LAA103 was collected in Texas. This match is not totally unexpected since Ochoa Phase settlements and pottery are reported from sites across the southern Llano Estacado and extreme southeastern New Mexico. The prehistorically fired clay samples from the Salt Cedar site (LAA095) and site Q:10:6 (LAA096) did not show a greater likelihood of matching the ceramics than the raw clay samples did.

Geographic Comparison

The distribution of the various groups by geographic region is shown in Table 4, and by site in Table 5. The data suggests that there is a clear region of origin for three of the compositional groups: Groups 1, 4, and 5. Group 1, comprised of Ochoa Indented Brown, is entirely from the Southern Plains. Group 4, comprised mostly of Roswell Brown collected from Pecos Valley site L7, appear to be from the Pecos River valley; however, distribution data indicates that the type is commonly found in the Sierra Blanca region (Jelinek 1967). Group 5 is largely composed of Corona Corrugated from the Henderson site (LA 1459) located in the Sierra Blanca region. While the geographic distributional data suggests that Groups 4 and 5 represent distinct regions, the compositional data suggests that Groups 4 and 5 could be combined to represent a larger group possibly representing the Sierra Blanca region (see Figure 19). Meanwhile, Groups 2 and 3 are dominated by Seco Corrugated from Henderson Pueblo.

Table 4. Breakdown of compositional group by region.

	Compositional Group						
Region	**1**	**2**	**3**	**4**	**5**	**Unas.**	total
Southern Plains	25	3			1	2	31
Pecos River valley		1	2	10	4	9	26
Sierra Blanca		5	6		21	5	37
total	25	9	8	10	26	16	94

Table 5. Breakdown of compositional group by site.

	Compositional Group						
Site	**1**	**2**	**3**	**4**	**5**	**Unas.**	total
Curry Farm #1					1		1
Henderson		5	6		15	4	30
Merchant	25	1			1	1	28
41WK23					1		1
L:10:2,4,5					3		3
L:3:5						1	1
L10			1		1	4	6
L7			1	9			10
P4c		1		1	3	5	10
Q10:10,2,8		2				1	3
Paducah Breaks					1		1
total	25	9	8	10	26	16	94

Although Groups 2 and 3 are predominantly composed of ceramic types from Henderson Pueblo, the samples generally exhibit a dissimilar chemical composition compared to that of the Corona Corrugated from Henderson Pueblo.

Comparison with Other MURR Samples

Ten Ochoa Indented Brown samples from the Salt Cedar site (41AD2) had been previously analyzed for the Creel et al. (2002) Chupadero Black-on-White study, while an additional four Ochoa Indented Brown samples were analyzed for the TARL CTCP. The Creel et al. (2002) samples were not assigned to one of the Chupadero groups, but were instead left unassigned.

Thirteen of these previously analyzed samples seem closely related to Group 2 of this study (Figure 20; Table 6), while sample UT257 is a distant outlier. Bivariate plots of chromium (Cr) and rare earth metals show the relationship between the Creel et al. (2002) and TARL CTCP samples and Group 2; arsenic (Ar) was the only element that did not match these samples well with Group 2 (Ferguson and Glascock 2007).

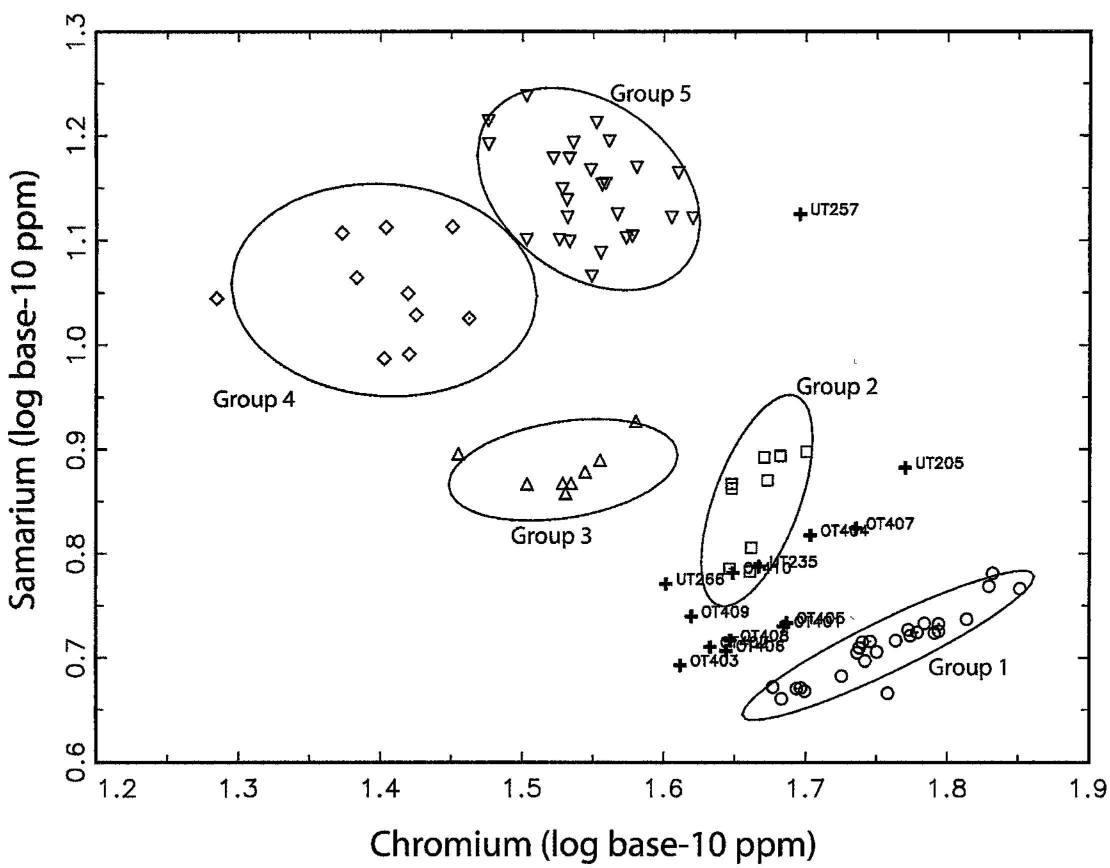

Figure 20. Bivariate plot of chromium and samarium base-10 logged concentrations showing all five groups, including the Creel et al. (2002) and the TARL Central Texas Ceramics Project (CTCP) samples, crosses represent the Creel et al. (2002) and TARL CTCP Ochoa Indented Brown samples.

Table 6. Ochoa Indented Brown samples from Creel et al. (2002) and TARL Central Texas Ceramics Project (CTCP) including site information and probable compositional group matches.

		Compositional Group (Probable Match)						
Site	**Sample #**	**1**	**2**	**3**	**4**	**5**	**Unas.**	**total**
41AD2	OT401-410		10					10
41TA202	UT235		1					1
41NL10	UT257						1	1
41TA123	UT266		1					1
41IR38	UT205		1					1
total			13				1	14

However, based on a cluster analyses, the Creel et al. (2002) and TARL CTCP Ochoa Indented samples should not be combined with Group 2; Group 2 may actually represent two separate clusters. The first cluster being comprised of Ochoa Indented Brown, while the second cluster is comprised of Corona Corrugated (n = 1), McKenzie Brown (n = 1), and Seco Corrugated (n = 4); however, this interpretation requires additional samples to clearly define the proposed subgroups (Figure 21). Additionally, cluster analysis reveals a link between the Creel et al. (2002) and the TARL CTCP Ochoa Indented samples and clay sample LAA103. Clay sample LAA103, Southern Plains Holocene playa clay, is the clay sample that also closely matches the Ochoa Indented Brown that comprises Group 1 (Figure 21).

Three other samples (OT451, 452, and 471) analyzed by Creel et al. (2002) have a significant probability of matching samples analyzed for this study (Table 7). These samples were not assigned to one of the Chupadero groups, but were instead left unassigned. They were listed by type as Corona Corrugated (OT451, 452) and Ochoa Indented Brown (OT471). All three consistently plot within Group 5. This is not altogether surprising since 77 percent (n = 20) of the Corona Corrugated sherds in this study were assigned to Group 5; Group 5 also has one other Ochoa Indented sherd from the Merchant site. Figure 22 plots the three Creel samples against the ellipses generated for this study.

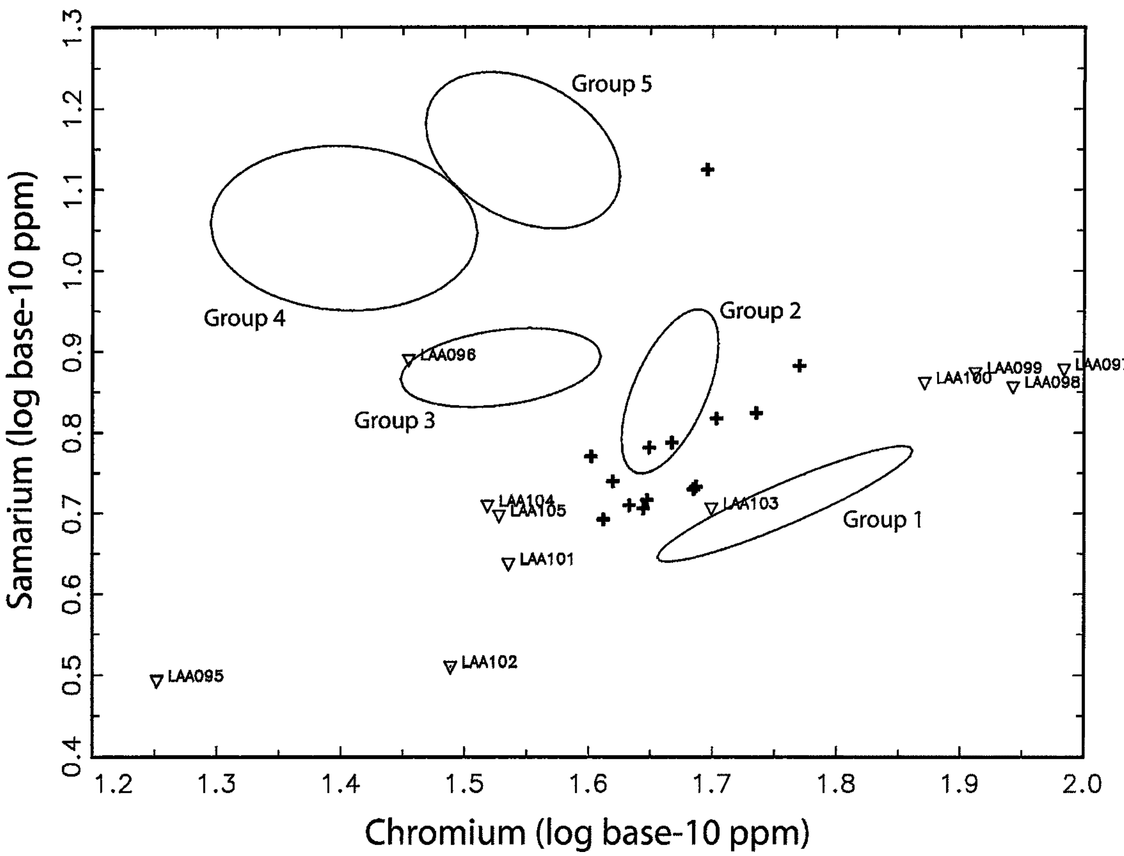

Figure 21. Bivariate plot of chromium and samarium base-10 logged concentrations showing all five groups, the clay samples, the Creel et al. (2002), and the TARL Central Texas Ceramics Project (CTCP) samples, Crosses represent the Creel et al. (2002) and TARL CTCP Ochoa Indented Brown samples and inverted triangles represent clay samples.

Table 7. Corona Corrugated and Ochoa Indented Brown samples from Creel et al. (2002).

Sample #	Ceramic Type	Compositional Group (Probable Match) 1	2	3	4	5	Unas.	Total
OT451	Corona Corrugated					1		1
OT452	Corona Corrugated					1		1
OT471	Ochoa Indented					1		1
Total						3		3

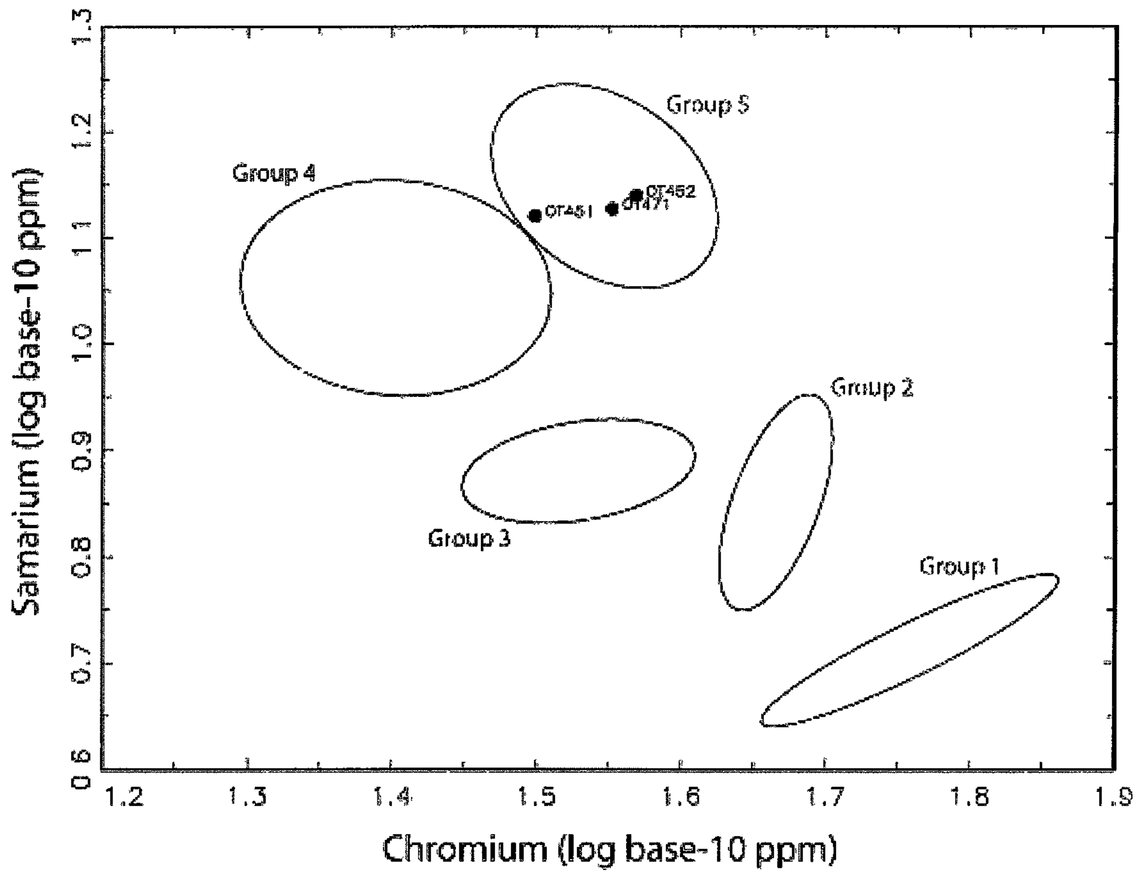

Figure 22. Bivariate plot of chromium and samarium base-10 logged concentrations showing the compositional groups from this study and matching Creel et al. (2002) samples. Ellipses represent a 90% confidence level for membership in the group.

A search of the MURR ceramic database found some additional matches with other samples from the region. A number of the samples submitted for this study had small Euclidian distances with a number of samples analyzed for Rex Harris (Neff and Glascock 1999). Neff and Glascock (1999) reported five compositional groups for Harris, one of which overlaps with Groups 4 and 5. Figure 23 plots the compositional groups of this study and the Harris groups (Neff and Glascock 1999). Harris Groups 3 and 3a overlap Groups 4 and 5, but numerous other bivariate plots demonstrate the lack of similarity.

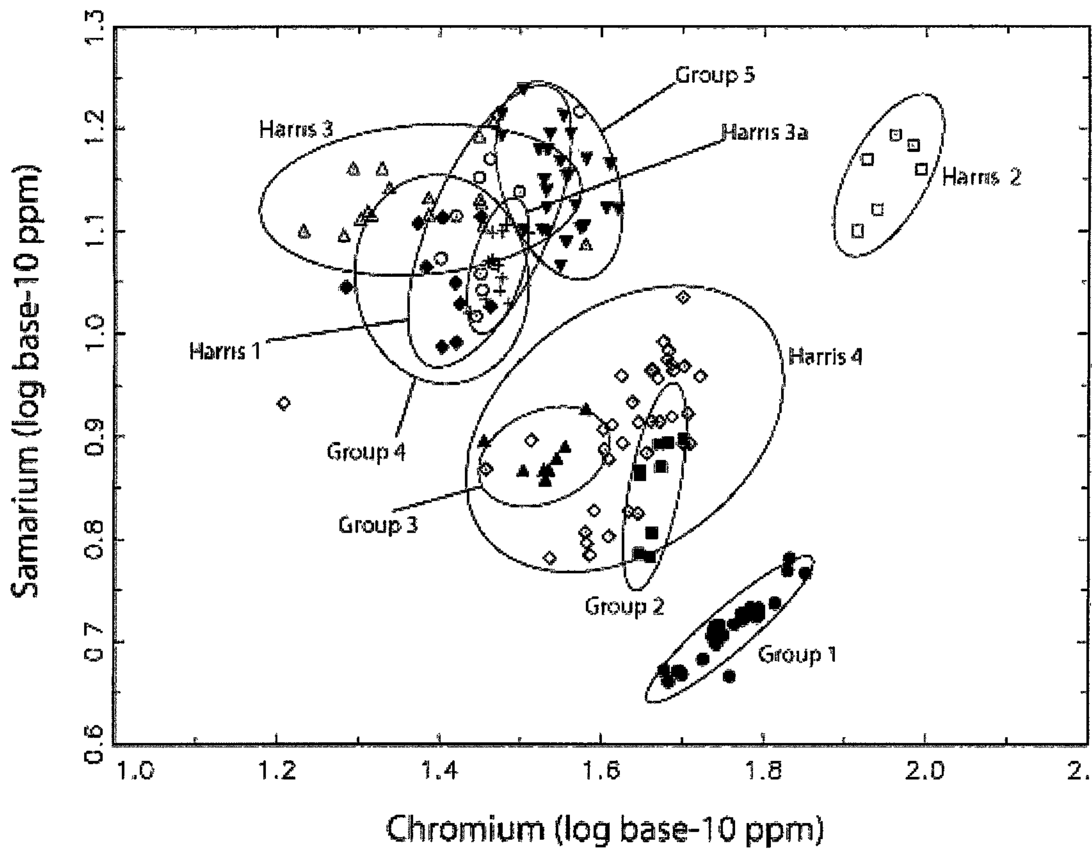

Figure 23. Bivariate plot of chromium and samarium base-10 logged concentrations showing the compositional groups from this study and Neff and Glascock (1999). Ellipses represent a 90% confidence level for membership in the group.

Harris Group 4 often overlaps with Groups 2 and 3; however, a Mahalanobis distance projection using all of the elements showed no probabilities of membership in the Harris Group 4 greater than 0.4 percent for any assigned samples of this study (Neff and Glascock 1999). The Harris Group 1 does consistently plot with Groups 4 and 5. The members of Harris Group 1 come from three sites located in three different counties in the Texas Panhandle: Sam Wahl (41GR291), Kent Creek (41HL66), and Deadman's Shelter (41SW23). Harris submitted ceramic samples of Middle Pecos Micaceous Brown, Jornada Brown, and Roswell Brown from these three Texas sites. Comparing the groups, the samples that comprise Group 4 were recovered in the Pecos Valley, while 21 of the 26 members of Group 5 were recovered in the Sierra Blanca region; the remaining five samples were recovered in Texas. The compositional data suggests the three groups are a possible match. Boyd (2004; 1997) and Hughes and Willey (1978) report that small of amounts of brownwares (e.g. McKenzie Brown, Middle Pecos Micaceous Brown, and Roswell Brown), believed to have been produced in the Middle Pecos area, are commonly found at many Palo Duro Complex sites, including Sam Wahl (41GR291), Kent Creek (41HL66), and Deadman's Shelter (41SW23).

Summary

The 94 sherds and 11 clay samples analyzed from Texas and New Mexico revealed a compositional group structure. The INAA data result in assignment of most samples (n = 78) to five compositional groups; the remainder (n = 16) are unassigned to any presently recognized compositional group. Due most likely to the influence of tempers on the chemical composition of the sherds, the clays were not assigned to the any of the five compositional groups, but cluster analysis reveals a link to clay sample LAA103 and most of the Ochoa Indented Brown samples. Additionally, there were some interesting matches with previously analyzed sherds from the region.

CHAPTER 7

DISCUSSION AND CONCLUSIONS

Implications of the Data

Statistical analysis of the INAA data results in assignment of most samples (n = 78) to five compositional groups; the remainder (n = 16) are unassigned to any presently recognized compositional group. These data suggest that Group 1, composed of Ochoa Indented Brown from the Merchant site (LA 43414) located in extreme southeast New Mexico, represents a distinct pottery type with a chemical signature unlike those of the Sierra Blanca corrugated wares or the Pecos Valley brownwares. This interpretation is further supported by the analysis results from fourteen Ochoa Indented Brown sherds analyzed for Creel et al. (2002) and the TARL CTCP. These data show a similarity between the Creel et al. (2002) samples, the TARL CTCP samples, and Group 2. It appears that the Creel et al. (2002) and the TARL CTCP samples may represent an Ochoa subgroup. Additionally, clay sample LAA 103, Southern Plains Holocene playa clay, consistently plots within the 90 percent confidence ellipse for Group 1 and closely matches the Creel et al. (2002) and TARL CTCP Ochoa Indented Brown samples; thus, these compositional matches support the interpretation that Ochoa Indented Brown represents a valid type produced on the Southern Plains by Ochoa Phase groups inhabiting the Southern Plains.

However, a much larger ceramic and clay sample from the region is needed to further strengthen this interpretation and to further distinguish the Ochoa Indented Brown subgroups. With the addition of the Creel et al. (2002) and TARL CTCP Ochoa Indented sample and site location data, the distribution of Ochoa Indented Brown must be reassessed. The presence of Ochoa Indented Brown in west Central Texas sites greatly expands its area of distribution, plus raises new questions regarding interaction between groups inhabiting the Southern Plains and western Central Texas during the Late Prehistoric period.

Groups 2 and 3 comprise the smallest groups of the study; the two groups are sufficiently similar that the two groups could be combined. Further examination of the types comprising the two groups indicates that Groups 2 and 3 account for 90 percent (n = 9) of the Seco Corrugated wares submitted for analyses. Based on these data, Groups 2 and 3 could represent subgroups of a larger Seco Corrugated group. This interpretation is also supported by the proposal to split Group 2 into two separate clusters; the first cluster consisting of Ochoa Indented Brown and the second cluster being comprised largely of Seco Corrugated. However, this interpretation needs further investigation. These INAA data also reveal that the Seco and Corona Corrugated from Henderson Pueblo have distinct compositional profiles; Wiseman (2004:73) suggests that the majority of the Henderson Pueblo Corona Corrugated may represent local varieties. Thus, it appears that the Seco Corrugated from Henderson Pueblo was likely imported into the site. Additional INAA data and complementary petrographic analyses are needed to further define the compositional groups and ultimately determine the source of the Seco Corrugated at Henderson Pueblo.

Groups 4 and 5 may have the greatest potential of these data to address questions regarding regional interaction during the Ceramic Period. Group 4 (n = 10) is composed of 90 percent of the Roswell Brown sample (n = 10) submitted for this study, while 77 percent of Group 5 (n = 26) is composed almost entirely of Corona Corrugated (n = 20) collected from sites on the Southern Plains and Henderson Pueblo in the Sierra Blanca region. There are no bivariate plots with chromium (Cr) on the x-axis where the 90 percent confidence ellipses do not at least touch. An alternative interpretation of these data would combine the two groups into a single large group with two meaningful subgroups. Additional distribution and temper analyses data for these two ceramic types could provide information addressing regional interaction. Wiseman's (2004) temper analysis of a portion of the Henderson Pueblo Corona Corrugated identifies crystalline rock (Capitan alaskite), biotite felsite, and vitric tuff/pumice as the common temper materials; however, the crystalline rock (Capitan alaskite) is the most common. The crystalline tempers derive from Capitan Mountain and major peaks to the north and west in the adjacent Jicarilla Mountains (Wiseman 2004:73), while the biotite felsite is documented from the Gran Quivira area (Hayes et al. 1981; Wiseman 2004:73). It is currently unknown if other sources of these materials exist in the vicinity of Roswell (Wiseman 2004:73).

Jelinek (1967) identifies crushed granitic derivatives as the common temper material for Roswell Brown; granitic materials also occur in the Sierra Blanca region. Roswell Brown is concentrated in the Pecos River valley in the vicinity of Roswell, New Mexico, the Hondo River valley to the west, and continues as far west as Ruidoso, New Mexico. Considering the INAA data and the Roswell Brown distribution, while also taking into consideration that the major temper material for Roswell Brown and the Henderson Pueblo Corona Corrugated occurs in and around the Sierra Blanca, Capitan Mountain, and the Jicarilla Mountains, the production area for most of the Henderson Pueblo Corona Corrugated and Roswell Brown from site L7 could be located somewhere in the Sierra Blanca region.

Additionally, a search of the MURR ceramic database found some interesting matches with a number of samples analyzed for Rex Harris (Neff and Glascock 1999). The Harris Group 1 consistently plots with Groups 4 and 5 of this study; the members of Harris Group 1 come from three sites attributed to the Palo Duro Complex of the Texas Panhandle: Sam Wahl (41GR291), Kent Creek (41HL66), and Deadman's Shelter (41SW23); Harris submitted ceramic samples of Middle Pecos Micaceous Brown, Jornada Brown, and Roswell Brown from these three Texas sites. Brownwares (e.g. McKenzie Brown, Middle Micaceous Brown, and Roswell Brown) found in Palo Duro Complex sites, including the sites listed above, are thought to be types from the Middle Pecos Valley (Boyd 2004; Boyd et al. 1997). Together, these INAA data indicate that later ceramic types (i.e. Corona Corrugated) from Henderson Pueblo and those found at Southern Plains sites are compositionally similar to earlier ceramic types (e.g. Roswell Brown) from the Sierra Blanca region and brownwares found at early Ceramic Period sites (i.e. Palo Duro Complex) on the Southern Plains; thus, these INAA data and ceramic distribution data may document a history of contact between the Sierra Blanca region and the Southern Plains that possibly endured throughout the Ceramic Period. Additional INAA data in conjunction with petrographic studies could identify a specific area of production for these ceramic types in the Sierra Blanca region and further define regional interaction during the Ceramic Period.

Seventeen percent (n = 16) of the ceramic samples are not assigned to any of the groups; this percentage is lower than the usual 30 to 35 percent unassigned rate that is typical in chemistry-based provenance research (Creel et al. 2002:118). Most of the unassigned samples are distant outliers; however, a larger study might generate enough of these outliers to begin to form small groups (Ferguson and Glascock 2007). The clays all show a general similarity to the groups, but one sample, LAA103, consistently plots within the 90 percent confidence ellipse for Group 1, except it is higher in hafnium (Hf) and zirconium (Zr) (Ferguson and Glascock 2007). These elements are often characteristic of sand inclusions in the clay, suggesting that clay sample LAA103 may represent a similar deposit to that used to produce the Merchant site Ochoa Indented Brown (Ferguson and Glascock 2007). Additionally, clay sample LAA103 matches Ochoa Indented samples analyzed for Creel et al. (2002) and the TARL Central Texas Ceramics Project. These compositional matches with Group 1 support the hypothesis that Ochoa Indented Brown was produced on the Southern Plains. However, analysis of additional ceramic and clay samples are needed to support these initial interpretations.

Conclusion

The compositional data for this study provided a characterization of the production area of Ochoa Indented Brown, Corona and Seco Corrugated wares, and brownwares submitted for INAA. The Ochoa Indented Brown and clay samples from sites on the Texas Southern Plains and extreme southeastern New Mexico combined with the previously analyzed Ochoa Indented samples for Creel et al. (2002) and the TARL Central Texas Ceramics Project indicate that Ochoa Indented Brown was produced on the

Southern Plains. These data suggest that Ochoa Phase potters preferred the Southern Plains Holocene playa clays for pottery production, apparently forgoing the Pleistocene clays available in the vicinity of the large salinas basins and the Triassic and Holocene clays found in the Mescalero Plain in extreme southeastern New Mexico. Additionally, since the Southern High Plains is fairly geologically homogenous, these INAA data may provide a compositional profile for the Southern Plains and provide a compositional profile for ceramics produced on the Southern Plains. However, a much larger sample of both sherds and clay are needed to gain a full understanding of Ochoa Indented Brown production on the Southern Plains and extreme southeastern New Mexico.

These INAA data provide little information that addresses the existing Ceramic Period settlement models proposed for the Southern Plains. The appearance of Southwestern-style corrugated/indented pottery in pueblo-like villages on the Southern Plains may represent an influx of Puebloan groups or at least, considerable expansion of their cultural influence among neighboring people (Collins 1968; Leslie 1965). One possible avenue of research that can bring us closer to answering this question involves the investigation of the *technological style* used to produce Ochoa Indented Brown. The term *style* is commonly used among archaeologists to refer to the outward appearance of an object (Hegmon 1992). Whereas, *technological style* refers to the process by which an object is made, a process that may not be completely apparent in the objects appearance (Hegmon et al. 2000:219). Technological styles are typically learned as a result of close interaction among producers and/or through hands-on instruction, thus technological style can indicate migration or co-residence as the means of transferring information for producing the local ware (Hegmon et al. 2000; Zedeño 1994). In addition, Habicht-

Mauche (1991) has proposed the movement of Pueblo women to Plains settlements, based on the presence of Pueblo-like pots produced with local Plains material, on Plains sites (Hegmon et al. 2000). If it can be determined whether the Pueblo-style pots on the Southern Plains were made using a Pueblo process; it can be argued that the pots were made by Pueblo groups or people who learned to make pots from the Pueblo groups (Hegmon et al. 2000).

Trade in ceramics between the regions seems to be uni-directional. Wiseman (2004) reports no Ochoa Indented Brown from the roughly contemporary Henderson Pueblo ceramic collections, and the available distribution data indicate that Ochoa Indented Brown does not occur west of the Pecos River (Collins 1968; Leslie 1965a; Wiseman et al. 1999:22). However, Corona and Seco Corrugated wares are not reported at the Salt Cedar site or the Merchant site (Collins 1968; Leslie 1965b); thus, it is unclear whether these roughly contemporary corrugated wares found on the Southern Plains were acquired by Ochoa Phase groups or other contemporary groups inhabiting the region. Interaction between the Sierra Blanca pueblos and the Southern Plains during the Ochoa Phase is evident and is supported by the occurrence of Chupadero Black-on-White and Three Rivers Redwares at the Salt Cedar and Merchant sites (Clark 2006:187-189; Collins 1968; Creel et al. 2002; Leslie 1965). The occurrence of imported wares from southwest New Mexico, such as El Paso Polychrome, Gila Polychrome, and Ramos Polychrome, along with Rio Grande Glazewares from north-central New Mexico may indicate interaction with other contemporary groups (Collins 1968; Leslie 1965).

Early Spanish explorers reported an active trade between Pueblo and Plains groups during the sixteenth, seventeenth, and eighteenth centuries, where Plains hunter-gatherer groups would travel to certain pueblos to trade bison products for agricultural products (Boyd et al. 2002; Creel 2001; Speth 1991); archaeological evidence of this exchange has been documented for the Protohistoric period in the eastern Rio Grande region (Boyd et al. 2001; Habicht-Mauche 2000; Spielmann 1991). Clark (2006:221) proposes that a similar type of mutualistic exchange developed in the Sierra Blanca region during the early Pueblo IV period. The presence of bison bones at Lincoln phase settlements suggests that agricultural groups traded agricultural products and vessels (e.g. Chupadero Black-on-White and Corona Corrugated) for bison products. The movement of these vessels across great distances on the Southern Plains suggests that some of the pottery acquired directly from the pueblo groups may have moved further east across the Plains via down-the-line exchanges (Renfrew 1975, 1977) between hunter-gatherer groups (Clark 2006:221). This interaction would also likely involve down-the-line exchanges of El Paso Polychrome, Gila Polychrome, Ramos Polychrome, and Rio Grande Glazewares between the southwest and north-central New Mexico groups, Sierra Blanca groups, and Plains groups.

Speth and Rautman (2004:13) propose that Pueblo groups residing in the Sierra Blanca lowlands, located near the Pecos River (e.g. Henderson Pueblo, Rocky Arroyo, and Bloom Mound), made forays onto the nearby Plains to hunt bison. These long-distance hunting expeditions may partly explain the occurrence of later Sierra Blanca ceramic types (i.e. Corona Corrugated and Chupadero Black-on-White) at southern Plains sites. Considering the widespread distribution of these Sierra Blanca ceramics, particularly Chupadero Black-on-White, throughout the southern Plains, their presence cannot be attributed solely to Pueblo group hunting forays. It is likely that a variety of mechanisms such as mutualistic trade, down-the-line exchanges between hunter-gatherers, and movement of pottery by Pueblo hunters, were responsible for the circulation of Sierra Blanca ceramics during the late Ceramic Period (Clark 2006:222).

These INAA data also provide some insights into the regional interaction between the Southern Plains and Sierra Blanca groups during the early Ceramic Period, the Texas Late Prehistoric I period (A.D. 500 to 1100/1200). A comparison of compositional data produced for this study and those produced for Rex Harris (Neff and Glascock 1999) indicate that a portion of the brownware ceramics found in the Texas Panhandle at Palo Duro Complex sites such as Sam Wahl (41GR291), Kent Creek (41HL66), and Deadman's Shelter (41SW23), were likely produced in the Sierra Blanca region and traded to the Texas Panhandle hunter-gatherer groups. Unfortunately, Harris did not report the ceramic names or types analyzed for his study (Neff and Glascock 1999). However, Boyd (2004; 1997) and Hughes and Willey (1978) report that small amounts of brownwares (e.g. McKenzie Brown, Middle Pecos Micaceous, and Roswell Brown), believed to have been produced in the Middle Pecos River area, are commonly found at many Palo Duro Complex sites, including Sam Wahl (41GR291), Kent Creek (41HL66), and Deadman's Shelter (41SW23). These data suggest that interaction between the Sierra Blanca and Southern High Plains regions endured throughout the Ceramic Period.

Together, these data provide some insights into the production and circulation of Ochoa Indented Brown, brownwares, and corrugated wares from the Southern Plains and southeastern New Mexico. On a basic level, this study provides data that add to the expanding INAA database of Southwestern ceramic types. This study also demonstrates that the INAA technique proves to be sensitive enough to detect compositional differences between ceramic types produced in the different study regions, while also detecting compositional differences between ceramic types produced in the same region. The INAA data addresses the basic questions of this study, but before these INAA data can be of further use, some very basic regional data needs must be addressed. The general complexity, together with the lack of chronometric data and an unsatisfactory understanding of adaptation strategies and trade networks, do not allow researchers an adequate understanding of the Ceramic Period on the southern Llano Estacado and extreme southeastern New Mexico.

APPENDIX A

CHEMICAL GROUP ASSIGNMENTS AND DESCRIPTIVE DATA FOR POTTERY AND CLAY

Table A 1 Chemical Group Assignments

ANID	Group	Subregion	Site Name	Material	Ceramic Type
LAA001	Unas	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA002	5	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA003	Unas	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA004	4	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA005	Unas	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA006	5	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA007	5	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA008	2	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA009	Unas	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA010	Unas	Middle Pecos Valley	NA	Pottery	McKenzie Brown
LAA011	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA012	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA013	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA014	3	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA015	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA016	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA017	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA018	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA019	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA020	4	Middle Pecos Valley	NA	Pottery	Roswell Brown
LAA021	5	Middle Pecos Valley	NA	Pottery	Middle Pecos Micaceous
LAA022	Unas	Middle Pecos Valley	NA	Pottery	Middle Pecos Micaceous
LAA023	Unas	Middle Pecos Valley	NA	Pottery	Middle Pecos Micaceous
LAA024	Unas	Middle Pecos Valley	NA	Pottery	Middle Pecos Micaceous
LAA025	Unas	Middle Pecos Valley	NA	Pottery	Middle Pecos Micaceous
LAA026	3	Middle Pecos Valley	NA	Pottery	Middle Pecos Micaceous
LAA027	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA028	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA029	1	Southern Plains	Merchant	Pottery	Ochoa Indented

ANID	Group	Subregion	Site Name	Material	Ceramic Type
LAA030	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA031	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA032	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA033	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA034	Unas	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA035	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA036	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA037	5	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA038	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA039	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA040	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA041	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA042	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA043	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA044	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA045	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA046	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA047	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA048	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA049	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA050	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA051	2	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA052	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA053	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA054	1	Southern Plains	Merchant	Pottery	Ochoa Indented
LAA055	Unas	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA056	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA057	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA058	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA059	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA060	Unas	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA061	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated

ANID	Group	Subregion	Site Name	Material	Ceramic Type
LAA062	Unas	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA063	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA064	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA065	2	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA066	Unas	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA067	3	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA068	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA069	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA070	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA071	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA072	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA073	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA074	5	Middle Pecos Valley	Henderson	Pottery	Corona Corrugated
LAA075	2	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA076	3	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA077	3	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA078	3	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA079	2	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA080	3	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA081	5	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA082	2	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA083	2	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA084	3	Middle Pecos Valley	Henderson	Pottery	Seco Corrugated
LAA085	Unas	Southern Plains	NA	Pottery	Ochoa Indented
LAA086	5	Southern Plains	NA	Pottery	Corona Corrugated
LAA087	5	Southern Plains	NA	Pottery	Corona Corrugated
LAA088	5	Southern Plains	NA	Pottery	Corona Corrugated
LAA089	2	Southern Plains	NA	Pottery	Ochoa Indented
LAA090	2	Southern Plains	NA	Pottery	Ochoa Indented
LAA091	Unas	Southern Plains	NA	Pottery	Corona Corrugated
LAA092	5	Southern Plains	Curry Farm #1	Pottery	Corona Corrugated
LAA093	5	Southern Plains	NA	Pottery	Corona Corrugated

ANID	Group	Subregion	Site Name	Material	Ceramic Type
LAA094	5	Southern Plains	Paducah Breaks	Pottery	Corona Corrugated
LAA095	clay	Southern Plains	Salt Cedar	Fired Clay	NA
LAA096	clay	Southern Plains	NA	Fired Clay	NA
LAA097	clay	Southern Plains	Merchant	Raw Clay	NA
LAA098	clay	Southern Plains	Merchant	Raw Clay	NA
LAA099	clay	Southern Plains	Merchant	Raw Clay	NA
LAA100	clay	Southern Plains	Merchant	Raw Clay	NA
LAA101	clay	Southern Plains	Merchant	Raw Clay	NA
LAA102	clay	Southern Plains	NA	Raw Clay	NA
LAA103	clay	Southern Plains	NA	Raw Clay	NA
LAA104	clay	Southern Plains	NA	Raw Clay	NA
LAA105	clay	Southern Plains	NA	Raw Clay	NA

Table A 2. Group 1

ANID	Ceramic Type	Site	Region
LAA027	Ochoa	Merchant (LA43414)	Southern Plains
LAA028	Ochoa	Merchant (LA43414)	Southern Plains
LAA029	Ochoa	Merchant (LA43414)	Southern Plains
LAA30	Ochoa	Merchant (LA43414)	Southern Plains
LAA031	Ochoa	Merchant (LA43414)	Southern Plains
LAA032	Ochoa	Merchant (LA43414)	Southern Plains
LAA033	Ochoa	Merchant (LA43414)	Southern Plains
LAA035	Ochoa	Merchant (LA43414)	Southern Plains
LAA036	Ochoa	Merchant (LA43414)	Southern Plains
LAA038	Ochoa	Merchant (LA43414)	Southern Plains
LAA039	Ochoa	Merchant (LA43414)	Southern Plains
LAA040	Ochoa	Merchant (LA43414)	Southern Plains
LAA041	Ochoa	Merchant (LA43414)	Southern Plains
LAA042	Ochoa	Merchant (LA43414)	Southern Plains
LAA043	Ochoa	Merchant (LA43414)	Southern Plains
LAA044	Ochoa	Merchant (LA43414)	Southern Plains
LAA045	Ochoa	Merchant (LA43414)	Southern Plains
LAA046	Ochoa	Merchant (LA43414)	Southern Plains
LAA047	Ochoa	Merchant (LA43414)	Southern Plains
LAA048	Ochoa	Merchant (LA43414)	Southern Plains
LAA049	Ochoa	Merchant (LA43414)	Southern Plains
LAA050	Ochoa	Merchant (LA43414)	Southern Plains
LAA052	Ochoa	Merchant (LA43414)	Southern Plains
LAA053	Ochoa	Merchant (LA43414)	Southern Plains
LAA054	Ochoa	Merchant (LA43414)	Southern Plains

Table A.3. Group 2

ANID	Ceramic Type	Site	Region
LAA008	McKenzie Brown	P4c	Pecos Valley
LAA051	Ochoa Indented	Merchant (LA43414)	Southern Plains
LAA065	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA075	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA079	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA082	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA083	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA089	Ochoa Indented	Q.10 2	Southern Plains
LAA090	Ochoa Indented	Q 10.8	Southern Plains

Table A 4 Group 3

ANID	Ceramic Type	Site	Region
LAA014	Roswell Brown	L7	Pecos Valley
LAA026	Middle Pecos Micaceous	L10	Pecos Valley
LAA067	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA076	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA077	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA078	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA080	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA084	Seco Corrugated	Henderson (LA1549)	Sierra Blanca

Table A 5 Group 4

ANID	Ceramic Type	Site	Region
LAA004	McKenzie Brown	P4c	Pecos Valley
LAA011	Roswell Brown	L7	Pecos Valley
LAA012	Roswell Brown	L7	Pecos Valley
LAA013	Roswell Brown	L7	Pecos Valley
LAA015	Roswell Brown	L7	Pecos Valley
LAA016	Roswell Brown	L7	Pecos Valley
LAA017	Roswell Brown	L7	Pecos Valley
LAA018	Roswell Brown	L7	Pecos Valley
LAA019	Roswell Brown	L7	Pecos Valley
LAA020	Roswell Brown	L7	Pecos Valley

Table A 6. Group 5

ANID	Ceramic Type	Site	Region
LAA002	McKenzie Brown	P4c	Pecos Valley
LAA006	McKenzie Brown	P4c	Pecos Valley
LAA007	McKenzie Brown	P4c	Pecos Valley
LAA021	Middle Pecos Micaceous	L10	Pecos Valley
LAA037	Ochoa Indented	Merchant (LA43414)	Southern Plains
LAA056	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA057	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA058	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA059	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA061	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA063	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA064	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA068	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA069	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA070	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA071	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA072	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA073	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA074	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA081	Seco Corrugated	Henderson (LA1549)	Sierra Blanca
LAA086	Corona Corrugated	L.10 2	Southern Plains
LAA087	Corona Corrugated	L 10:4	Southern Plains
LAA088	Corona Corrugated	L.10:5	Southern Plains
LAA092	Corona Corrugated	Curry Farm #1 (41GA1)	Southern Plains
LAA093	Corona Corrugated	41WK23	Southern Plains
LAA094	Corona Corrugated	Paducah Breaks (LA66104)	Southern Plains

Table A.7 Unassigned

ANID	Ceramic Type	Site	Region
LAA001	McKenzie Brown	P4c	Pecos Valley
LAA003	McKenzie Brown	P4c	Pecos Valley
LAA005	McKenzie Brown	P4c	Pecos Valley
LAA009	McKenzie Brown	P4c	Pecos Valley
LAA010	McKenzie Brown	P4c	Pecos Valley
LAA022	Middle Pecos Micaceous	L10	Pecos Valley
LAA023	Middle Pecos Micaceous	L10	Pecos Valley
LAA024	Middle Pecos Micaceous	L10	Pecos Valley
LAA025	Middle Pecos Micaceous	L10	Pecos Valley
LAA034	Ochoa Indented	Merchant (LA43414)	Southern Plains
LAA055	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA060	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA062	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA066	Corona Corrugated	Henderson (LA1549)	Sierra Blanca
LAA085	Ochoa Indented	L:3·5	Southern Plains
LAA091	Corona Corrugated	Q.10·10	Southern Plains

APPENDIX B

PROBABILITY OF GROUP MEMBERSHIP DATA

Table B 1. Probabılıtıes of group membershıp for all assıgned samples based on a Mahalanobıs dıstance calculatıon usıng the first sıx prıncıpal components

The following specımens are ın the file Group 1

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA027	11 132	17 878	0 675	0 038	0 000
LAA028	52.128	0 770	0 549	0 025	0 000
LAA029	58.501	2.254	0 549	0.029	0 000
LAA30	42 225	2 262	0.584	0 018	0 000
LAA031	85 366	1.613	0 683	0.021	0 000
LAA032	2.162	0 193	0 841	0 019	0 000
LAA033	2 030	1 065	0 433	0.011	0 000
LAA035	90.048	12 973	0.608	0 028	0 000
LAA036	57 237	1 177	0.433	0.017	0 000
LAA038	88 276	2 866	0 497	0 016	0 000
LAA039	16.545	4 689	0 624	0 017	0 000
LAA040	96.130	1 308	0 737	0 029	0 000
LAA041	62 676	2 751	0 415	0 017	0 000
LAA042	94 622	2 246	0.536	0.022	0.000
LAA043	53 703	6 463	0 473	0.017	0 000
LAA044	34 719	1 105	0 648	0 024	0.000
LAA045	10 925	3 967	0 712	0 045	0.000
LAA046	34.338	5 723	0 551	0 015	0 000
LAA047	97.029	1.189	0 707	0 025	0 000
LAA048	83 940	0 935	0.818	0 034	0.000
LAA049	92 317	3.332	0 508	0 024	0 000
LAA050	46.009	1 647	0 549	0 015	0 000
LAA052	81.345	1.648	0 525	0 014	0 000
LAA053	43 359	1 095	0 644	0 027	0 000
LAA054	0 110	59 663	1 159	0.078	0 000

The followıng specimens are ın the file Group 2

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA008	0 000	1 825	10 254	0 472	0.002
LAA051	0 000	77.779	2 360	0 143	0 000
LAA065	0 000	8 272	4 425	0 016	0 004
LAA075	0 000	72.254	23 505	0 163	0 464
LAA079	0.000	95 014	71 492	0.050	0.057
LAA082	0.000	44.633	11 525	0 209	0 284
LAA083	0 000	14.535	17 222	0 073	0 034
LAA089	0 000	41 921	2 651	0.007	0 000
LAA090	0 000	82.993	1.579	0.111	0 000

Table B.1. Contınued.

The followıng specımens are ın the file Group 3

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA014	0 000	0.210	5.889	2 711	0 001
LAA026	0 000	1.536	2 977	0 575	0 004
LAA067	0 000	3 589	0 098	0 006	0 039
LAA076	0.000	1 531	55.347	0 028	0 006
LAA077	0.000	2 798	86 285	0 029	0.007
LAA078	0 000	1 603	82 546	0 024	0.024
LAA080	0 000	1 855	91.820	0 020	0 014
LAA084	0.000	44 460	17 656	0.017	0 012

The followıng specımens are ın the file Group 4

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA004	0 000	0 663	2 572	0 778	40 016
LAA011	0 000	0.614	9 212	63.904	0 077
LAA012	0.000	0 499	7.520	53 885	0.321
LAA013	0 000	0.460	2 770	23 135	0 396
LAA015	0.000	0 568	2.878	74 355	0 031
LAA016	0.000	0 365	2.416	82.587	0 047
LAA017	0 000	0.046	1 497	38 804	0.005
LAA018	0 000	0 987	4 814	69 540	0 116
LAA019	0 000	0 332	2 463	26 434	0 233
LAA020	0 000	0 651	4 489	86 402	0 015

Table B 1 Contınued
The followıng specımens are ın the file Group 5

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA002	0.000	0 230	2 965	4.233	18 566
LAA006	0 000	0 132	1 254	5 935	6 667
LAA007	0 000	0 463	1 617	3 469	49 820
LAA021	0 000	1 221	4 939	28 828	0 890
LAA037	0 000	1 986	3 347	3 437	61 143
LAA056	0 000	3 009	3 689	0 751	91 755
LAA057	0 000	1 551	2 877	0 336	12 108
LAA058	0 000	4 912	4 128	2 222	84 746
LAA059	0 000	1 166	1 084	0 010	73 424
LAA061	0 000	4 473	2 398	0 038	75 672
LAA063	0 000	1 304	2 503	0 019	44 618
LAA064	0 000	1 739	2 390	0 017	86 584
LAA068	0 000	1.149	1 174	0.026	76 760
LAA069	0 000	2 403	1 707	0 034	87 558
LAA070	0 000	1 933	1 094	0 017	72 913
LAA071	0 000	2 692	1 987	0 065	80 913
LAA072	0 000	1 160	1 033	0 010	27 660
LAA073	0 000	1 432	1 225	0 017	51 894
LAA074	0 000	2 302	2 774	0 026	70 779
LAA081	0 000	1 580	5 337	0 030	26.078
LAA086	0 000	7 154	2 450	0 092	29 850
LAA087	0 000	2 057	1 881	0 035	95 269
LAA088	0 000	1 470	1 785	0 009	0 248
LAA092	0 000	1 001	3 645	0.723	45 697
LAA093	0 000	1 150	2 179	0 549	53 347
LAA094	0 000	2 031	1 785	2 936	46 936

Table B 2 Probability of group membership for each of the clay samples based on a Mahalanobis distance projection using the first six principal components

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA095	0 000	4 262	0 315	0 005	0 000
LAA096	0 000	0 012	0 079	0.003	0 000
LAA097	0.000	4 965	0 435	1 196	0 000
LAA098	0 000	0 772	0 412	0 574	0 000
LAA099	0.000	9 148	0 468	1 308	0 000
LAA100	0 000	7 064	0.419	0.852	0 000
LAA101	0 202	10 076	0.373	0.016	0 000
LAA102	0 000	9 464	0 347	0 003	0 000
LAA103	0.001	1 726	0 391	0 031	0.000
LAA104	0.000	0 199	0.241	0.023	0 000
LAA105	0 000	0 536	0.262	0 031	0 000

Table B 3 Probability of group membership for each of the unassigned pottery samples based on a Mahalanobis distance projection using the first six principal components.

ANID	Group 1	Group 2	Group 3	Group 4	Group 5
LAA001	0.000	0.314	1 927	2 391	0 029
LAA003	0 000	4 380	0 988	0 136	0 000
LAA005	0 000	12 909	9 013	5 923	1 465
LAA009	0 000	2.986	1 429	0 982	0 000
LAA010	0 000	0 105	0 674	0 344	1 993
LAA022	0 000	0 091	3 401	0 008	0 000
LAA023	0 000	0 038	1 504	0 003	0 000
LAA024	0.000	0.004	0 845	0 001	0 000
LAA025	0.000	0.020	3.375	0 005	0 000
LAA034	0 000	11 606	0 705	1 446	0 000
LAA055	0 000	0 037	0 704	0 012	0 000
LAA060	0 000	0 096	0 224	0.003	0 000
LAA062	0.000	0 456	1 698	0 060	0 000
LAA066	0 000	0.094	0 214	0 003	0 000
LAA085	0 000	28 700	0 666	0 003	0 000
LAA091	0 000	16 862	1 697	0 696	0 002

APPENDIX C

INAA RAW DATA

Table C.1 INAA Raw Data

ANID	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu
LAA001	8.7669	80 5159	1.2069	85.4118	20 5020	3.2112	8 6310	152 6851	19.6077	45.9128	13.3429	2.3600
LAA002	4 8486	63 4000	0 9152	66.3060	14 9486	4 1891	6.4416	115 1740	8 0572	32.8126	7.4655	1 5784
LAA003	8.2128	64.3708	0 8799	75.3643	18.3459	7.3052	6.6367	123.2119	28.8479	63.2732	6.5061	2.3335
LAA004	4 6447	60.2799	0 7722	57.3167	12.5285	2.8691	5.0865	123 9097	9 4531	27.2481	4.9039	1.9572
LAA005	6.1506	50.1829	0 8004	50 5054	11.6775	2 8306	5.2243	100.7063	10 3770	62 2911	6 1362	1.5070
LAA006	5.1438	65.7563	1 2832	66 6847	15.7620	4.0286	9.6684	122.6823	7 7716	28.7466	5 6035	1 7073
LAA007	4.2532	63.6222	0.7995	62 2855	15 0823	2 4181	5 7364	118 8171	7 2296	28.9541	5 1667	1 6510
LAA008	4 7205	46 0726	0 3600	36 0276	6.9631	2 3453	2.4763	80 7154	7.7092	42 4777	2.8305	1 7636
LAA009	7.2748	77.2852	1.1211	84.8056	20 6920	3 3655	8 4007	124 4133	26.8339	49 3799	13 7576	2.7422
LAA010	3.1823	87 4544	0.9639	98.2817	20 0954	4 1175	7 3966	161.4969	4.6663	19 3265	4 6983	1 7303
LAA011	5.7934	46.9990	0 6819	48.9873	11 2050	3 5006	5 1546	93 7334	3.3267	26.2505	3.4317	0 9550
LAA012	5.8187	40.0945	0 7049	44.2029	10 6067	3 6791	5 3204	91 5979	3.6927	28 9939	3 3828	0 9521
LAA013	5.5259	46 5231	0.8342	51 1946	12.7973	3 3932	5.7931	103.7848	3 0610	23 5988	2.6551	1.1400
LAA014	7.2871	34 9227	0 6529	33 1805	7.8486	4 2839	4 3011	93 0907	5.1724	28 5009	3 8575	0 8045
LAA015	3 4717	45.4377	0 6843	46 2872	10.6872	4 0486	5 2162	94 5172	3 8765	26 6018	3 0184	0.8859
LAA016	5 3004	48 3224	0 7382	47.7285	11.5998	3.0271	5 6491	102 7354	2 6129	24 1616	2 9127	0 9926
LAA017	4.2038	42.2315	0.6872	43.6316	11.0856	1.9342	5.1390	100 2677	2.6820	19 2487	2 4764	0 9235
LAA018	4 7450	42 9765	0.6324	43 9602	9 8056	2.7914	4.7223	92.6708	3 1171	26 3033	2.6858	0 8741
LAA019	4.9094	53 5428	0.7679	52 6079	12 9584	2.8383	5.8050	111 8326	3 2368	25 3292	3 4017	1 1031
LAA020	3.7882	42 8840	0 6454	40.7886	9 7092	3.0086	4.7502	83.1592	3 9282	25 2597	3 0093	0 8708
LAA021	5.2767	60 3111	0.9083	60.7413	13 9966	3.4745	6.3516	107.3734	13 1218	38.9572	8 2515	1 7121
LAA022	4.8810	51.7227	0.4355	45.6479	9 5225	2.9897	3.1876	101.2429	21.8553	81.1838	3 1923	2 6050
LAA023	3.9063	70 0889	0 5202	66.5357	14 1499	2.5079	3.9909	128.5032	27.0365	82.8727	3.1119	3 5943
LAA024	3.1585	48 2694	0 4687	46 3204	9.3929	1 4745	3.0440	98.0131	42.1006	528.6359	2.2997	2 4620
LAA025	3.8022	48.4362	0 3551	43 1866	8.4207	2.1137	2 6941	87.9964	23.4416	246.8498	2.4271	2.2428

ANID	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu
LAA026	5.3333	32 4384	0.5084	30.3948	7.0659	1.5130	3.5784	62 6157	13 9616	30.6619	2 7494	1.8562
LAA027	5 3259	26 3653	0.2865	22.0027	4 4694	1.8953	2.0615	51.4424	8.3324	47.3651	3.9804	0 8677
LAA028	11.7366	26 8448	0 2930	21.0310	4 5933	2.7517	2.1764	51 7134	6.9666	49 2168	4 2565	0 8738
LAA029	9.1076	28 4660	0 3572	22.6421	4 7113	2.4056	2 0758	54 2076	7 5779	55 1589	5.2131	0 8907
LAA030	7 4663	24.6914	0.3156	22.4965	4.0858	2 3029	1.9232	45 9844	6 4086	43 3414	4.0505	0.7790
LAA031	8.6953	28 1260	0.3065	22 9323	4.7025	2.2303	2 1698	53.2334	7 1035	52.2186	4.8520	0.9064
LAA032	11.0137	25 1261	0.2861	31 1146	4 2730	2.1048	2.0465	47.8354	6 5980	45 6018	4 3091	0.8064
LAA033	9.1603	24 8437	0.2744	19 1156	4 1581	2 5427	1.8392	46.3267	6.4667	44.7062	4 7679	0.7889
LAA034	8.3404	31.8985	0 4452	30 1314	6 1238	2.7531	2.6594	64 2563	12 0032	62.7072	4 8579	1 2365
LAA035	7 9416	26 9474	0.3020	22.0928	4.6172	1.9521	2.0560	51.9820	7.2042	55 1217	4 5745	0 8722
LAA036	12.5808	25 2588	0.2741	19 4253	4.1024	2 1984	1 9400	47.1083	6.3932	45 2737	3 7195	0 7687
LAA037	4 6692	47 5741	0.8478	53 8786	12.6414	3 1598	6 1411	92 9663	4.0649	31 8263	3 3209	1.2468
LAA038	7.3658	25 4853	0 2610	21.5013	4.3131	1 9889	1.7852	47.7030	6.8125	46 3914	4 8104	0.8310
LAA039	7.2184	28 7996	0.2849	23 4249	4 6709	1 7626	2.0193	53 8106	7.4515	54 5253	5 2948	0 9002
LAA040	8.7395	29 5265	0.3250	23.6230	4.8916	2 5790	2 3005	55 7022	8 0740	56 3309	5 0778	0 9484
LAA041	9.7932	21 7391	0 2449	18.2884	3 6604	2 2962	1 7915	40 9609	6.1122	45 2192	3 3495	0 6872
LAA042	9.1836	26 8893	0 3356	23.8398	4.5672	2 1263	2 1158	51 1842	7.5202	51.5669	4 8024	0 8696
LAA043	7.2970	27.3192	0 3090	24.1632	4.6404	2 5185	2 1415	52 2910	7 2410	51.4296	5.5625	0.8866
LAA044	9.4907	26 5590	0.2932	24.1213	4.4578	1 7590	2 0471	49 5164	7.2590	49.6796	5.0449	0.8438
LAA045	8.5914	30 4910	0 3828	27.1821	5 1416	2 1626	2 4367	57 4589	8 0860	62 5476	5.8004	0.9936
LAA046	8.4046	25 6603	0 2889	22.4675	4 3188	1 6139	2 1458	47 6213	6 6112	43 6931	3.6841	0 8377
LAA047	9.1776	28.6068	0 3569	25.7031	4 8603	2 1469	2 2709	53.9639	7 7236	54.6509	5.0072	0 9289
LAA048	8.1934	27.1129	0 2944	25.6219	4.6131	2 4512	2 2579	51 8492	7.5735	52.2847	4.6301	0 8882
LAA049	8.5203	23.0865	0.3162	22 7220	4 0017	1 8800	1.9520	44 3755	6 8257	44 3694	3.8345	0 7479
LAA050	9.1382	25 7337	0 3275	20.8913	4.3278	2 0143	1 9856	49 0428	6 4469	45.5711	3 7648	0 8072
LAA051	3.1629	31 7260	0 3743	26 9440	5 5936	1 9343	2 7586	63 3207	7 8901	40.1399	4 3960	1 0774
LAA052	10.0997	25 7680	0 2954	22 9512	4 3134	1 8692	1 9477	48 5854	6 2964	45 5089	4.3077	0.8053

ANID	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu
LAA053	9 1280	30 0724	0 2814	23 9195	5 0779	2.1904	2.1837	58.6130	7.7715	58 4062	6.2124	0 9733
LAA054	4 3254	29 7792	0.2963	25.0248	5.1583	2 0221	2 2927	61 0146	8 6552	58 0101	4.8444	1.0289
LAA055	6 2589	56 1246	0 8207	60 3102	14 3740	1.8912	6.8468	100 8849	32.6709	243 9003	9.0208	2.7828
LAA056	4 8910	52 2070	0 6915	48 5468	12 7381	2 5240	6.3156	118 1178	6 7995	37 7967	3.6936	1 4157
LAA057	2 9702	50 0851	0.7307	48.3153	11 6614	2 7889	5 9381	124 2522	9 9552	35.3872	3 0515	1 3898
LAA058	4.5440	50 4408	0 7012	50 6377	13 2715	2 5039	6.0567	125 8963	7 3580	34 0159	4 1451	1 4282
LAA059	2.3442	56 4894	0 7769	51.0829	13 8314	3.0317	5.9960	89 0309	2.7000	35 0008	4.8752	1.5070
LAA060	1.8231	134.6424	1 7452	135.3669	31.0555	2 4910	14.3224	231 3688	3 7502	20 2272	2.9808	1 9546
LAA061	4 7944	53 2524	0 8547	58 0259	13 7939	3 1204	6 6946	138 8300	8.2893	33.9907	4.4600	1.4449
LAA062	6 0476	39 3922	0.3037	40.0323	7 7122	2 1891	2 5488	87 5951	20 0578	61.8996	4 2441	1 7273
LAA063	4 6834	48.8711	0 7854	52.8094	13 3671	2 9786	6 0430	99.4852	4.4644	36 8878	3.6795	1 3455
LAA064	4.8148	49 5687	0 7314	53 2084	12 6856	2 8163	5 9793	102.2388	4.4679	37 4326	3 7969	1 2995
LAA065	6.2226	38.5457	0 4829	35 7055	7 6678	1 8653	3 4577	86.5677	12 1241	48 6608	5.7900	1 5513
LAA066	1 6100	144 6956	1 7898	140 5919	33.1570	3.6808	14.5826	244.3488	3 9566	20.8310	3 0602	2 0861
LAA067	3.4714	38 5328	0.4957	38.1847	8.4320	3.6711	3 8450	85 0732	6.6384	38.0349	4.0031	1 3515
LAA068	4.2688	64 9710	0.9847	61.9909	14.7253	2 6166	7.5715	125 5789	3.4601	35 3158	5 2792	1 5309
LAA069	3.9904	59 8359	0 8072	60.6060	15.1081	3 5597	6.5779	151.0589	5.5581	33 2438	4 5820	1 4693
LAA070	3.1048	64.9060	0.9245	59.3980	14.1225	2 4231	7.1374	130.7124	4 4151	33.7281	5 2340	1 4951
LAA071	6.4249	59.0263	0 7864	63.1095	14 7133	3 1082	6 3545	143.9041	7 0031	33.2411	3.4575	1 5067
LAA072	1.8981	57.0759	0 7642	57 3923	13 2697	3 2643	6 1050	91 8017	2.9539	40 2968	5 2437	1 5126
LAA073	3 0611	58.7080	0 7947	55 7408	13 2454	3 0190	6.2419	104 2876	3 2474	41 7018	3 7504	1 5493
LAA074	4.6372	43.0247	0 7292	47 9275	12 2831	3.4510	5.8108	94 1256	4 7508	35 9165	3.8234	1.2451
LAA075	4 2960	53.6058	0 4645	41 4506	7.5431	3.3313	3 7079	105.2990	11 4904	46 3269	4 7577	1 4993
LAA076	3 8860	43 6402	0 4575	31.5224	7 0120	2.6287	3 2358	89.2073	10.2190	32.2112	10.6062	1 4566
LAA077	3 7581	44 5274	0 4391	33.3264	7 0371	2 7343	3.1142	90 5818	10 0888	32 7746	10.0296	1 4764
LAA078	3 7963	46.3572	0 4874	37.6579	7 4381	2.5069	3.6555	96 9142	10 5381	34 4745	12 2562	1 5351
LAA079	3 4762	42 8649	0 4471	40.5202	7 0638	2 8048	3.0374	87.4210	10.7904	42.6505	5.8901	1.4275

ANID	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu
LAA080	3 5157	45.1106	0 4694	33.1517	7.2345	2.8839	3.2178	91.8493	10.1441	33.5827	11.7025	1 4885
LAA081	3 8478	52.0722	0.7755	54 0731	12.5874	3.3573	5.9509	106 9784	4.1806	34 1264	3.3344	1 4178
LAA082	5 2998	44.8673	0 5174	32 9442	7.5260	4.1800	3.4424	89 2547	11.1157	45 1624	4.2672	1 4394
LAA083	4 1357	45 0814	0 4100	41 1456	7.1081	3 5194	3.1020	90 1339	13.5779	45 1610	5.5803	1.4768
LAA084	2 7031	43.3891	0.4125	33.7181	6.8623	2.2261	3.0333	87.6054	10.1732	32 3913	8.8310	1 4228
LAA085	4.2720	23 8781	0.2861	23.2844	4 1159	1 8044	1.9192	45.4091	5 5751	32 4161	2.4385	0 7134
LAA086	7.0460	64.2913	0 8259	68 7535	16 3417	2.5047	6.6693	203.1807	11 7718	35.6580	4 4705	1.4656
LAA087	4.0889	49.3891	0.8466	58.8669	14 2607	3 8331	6.6448	104.5807	4 7118	35.9702	4 3649	1 3259
LAA088	5.2797	63 1639	0 9018	67 8572	17 3450	3 1761	7.3781	456.2859	6.8993	31 8333	3.4535	1 6114
LAA089	2.8199	33.1020	0 3895	29 8312	5 8835	2.5024	2.6719	68.8340	8.2512	42 7078	4 3424	1 0201
LAA090	3.9330	32.3691	0 3935	32 9932	6 0615	2 1147	2.7898	67 1884	7 5129	45.7908	4.7526	1 0783
LAA091	6.5535	43 8235	0 4786	39.9039	8 4672	1.6928	3.7584	85.4621	11 2932	54.0619	6.7610	1.6492
LAA092	4.1916	37 6238	0.7779	50.3663	12 6404	3.0791	5.9241	89 4186	3 6438	33 5768	2 8757	1 1794
LAA093	5.0169	57.9146	0.8650	64 3710	15.6891	3.7140	6 9334	125.8758	4.5408	36 4090	2.7677	1 3902
LAA094	4.0468	51 3834	0 8502	65 9514	14.8182	3 2069	7.0001	114.6637	6 5000	38 0767	3 9987	1.4012
LAA095	5.9263	15.1859	0 1926	14 0189	2.8078	2 2466	1 2178	28.3536	2 2569	16 1021	1 6528	0 4523
LAA096	133.9597	26 8662	0 7354	30 6781	7 2629	18 4390	3.4650	63 6267	12.5283	26 6313	4.7370	1 0407
LAA097	8.6651	41.2840	0 4408	34.8338	7.0681	3 8006	3.3564	89 1730	19.1302	90 1127	8 8869	1.4129
LAA098	6.5448	36.5074	0 4667	32.7405	7 1882	5 6024	3.4230	82.7509	33 8824	87.6709	8.6948	1 3643
LAA099	12.2901	38 1857	0 4788	31.8314	7 2066	5 0054	3.8487	78 5722	14.7996	78.7256	7 6920	1.4073
LAA100	8 2106	30 6563	0 3632	27 2334	6.0469	4.2523	2.6366	63 2794	12.5365	61 7915	6.0006	1 1887
LAA101	5.8711	22 4183	0.2330	18 5356	3.9788	1 9035	1 8211	45 4903	5 9307	31.4296	3 4403	0 7717
LAA102	4 4012	19.6795	0.2554	16 9580	3.2401	1 4641	1.6741	35.1209	3.8456	30.7931	2 9648	0 5667
LAA103	11.4131	30 0919	0.3550	26 6197	5.0877	2.7907	2.6218	58.9154	7 2624	50 0181	6 5447	0 9011
LAA104	19.8013	17.6840	0 3188	17 9945	3 6934	6 1545	1 5293	36 3335	4.2139	23.7696	2 7584	0.5592
LAA105	13.6777	17.4669	0 3292	18.0330	3 7931	7 6130	1 6150	36.0960	4 0121	25.6473	2 5222	0 5451

ANID	Fe	Hf	Ni	Rb	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr
LAA001	56629.7	5 2121	0.00	158.34	0 9740	23.1497	160.99	1 2607	2 8045	16.8609	130.70	151 92
LAA002	34639.2	8.6010	27.45	137.91	0 6523	13 7503	145.30	1 1754	2.0649	20.0681	63.59	159.17
LAA003	86195.4	6.1860	0.00	75.42	1 4880	35 7167	133.72	0 8676	2.6558	14.4212	128.43	186 71
LAA004	32064 2	6 9366	38 98	117.40	0.5803	9 7610	480.11	1 5774	1.6803	13 5342	56.06	162 28
LAA005	38045.5	6.6361	0 00	127.06	0.6035	14.0491	162 52	1 2944	1.4598	16.5521	70 48	132.37
LAA006	28416.7	7 1053	0.00	136.02	0.6461	10.4749	162 96	1.8607	2 3870	18 8454	73 06	148 70
LAA007	28076.8	6.8233	47 14	134 74	0.5530	10.4575	123.63	1.6217	1 9920	18 0643	59 72	164 88
LAA008	32199.1	6 4841	25.85	88 09	0 4050	7.4546	760.86	2.0667	0 7035	10 3945	59 53	167 59
LAA009	67751 8	5.4481	65.82	96 37	1 2916	28 2348	192.63	0.9758	3 0696	14 6951	119 04	127 39
LAA010	21978 3	6.3966	0.00	167.37	0 3685	9 6412	106.14	1.3221	2 5250	24.6185	47 79	145 28
LAA011	26518.2	11 2022	31.77	116.84	0 4749	8 1754	174.60	2.6875	1 5116	22 6690	68 12	228 15
LAA012	28717 4	11 3812	0 00	105.57	0.6405	9.0092	229.19	2.9178	1.6293	23.9489	61 20	225 26
LAA013	24785.1	10 4000	0 00	102.60	0.4514	7 9855	188.33	2.9646	1.9174	22 8568	61.69	186 21
LAA014	29972.9	10 3917	0 00	115.76	0 6891	9 2192	400.24	3.0443	1.1712	25.0228	76.55	214 06
LAA015	26477.6	11 5059	0.00	113.47	0 4621	8 8309	216.60	3.0522	1.4570	23.2137	71 62	226 89
LAA016	24866 9	12 3002	0 00	117.04	0 4690	8 4082	212 87	3 1649	1 6670	24 7455	62.69	223 63
LAA017	22716.2	11 4257	0.00	114.57	0.4183	7 0740	154 30	2.8909	1 5242	20 8034	60 08	221 34
LAA018	25519.9	10 1267	0.00	112.75	0.4775	8 4215	195 26	2 8335	1.3648	20.0559	63 80	183 92
LAA019	26689.1	9.1203	22.42	117 71	0.5165	8 5125	228 14	2.9481	1 8110	23.8259	70 10	174 49
LAA020	25401 2	10 7266	0 00	111 15	0.4698	8 4548	259 94	2 6803	1.4462	22.8151	68 26	187.01
LAA021	38709.4	7 2316	0 00	128.10	0.6701	15 3067	166 00	1 4001	1.8763	16 9946	64.26	161.94
LAA022	58718.0	8.3682	46 61	82 73	0.3738	15 9939	908 54	1 7743	1.0444	11 4749	94.81	216.15
LAA023	66670.5	8.7831	73 49	66.18	0.3340	22 4413	961 04	2 0228	1.6443	12.4742	110 26	239 66
LAA024	85064.9	7.5031	116.68	47.87	0 3070	30 0558	829 66	1 6877	1 3929	8 4004	114 98	140 16
LAA025	53050.3	7.5031	74 30	78 17	0.4325	17 2199	819 38	1 9322	0 8324	9.5430	78 40	201.08
LAA026	49853.4	5.7890	38 43	61 76	0.3726	17 2706	427 54	0.6813	1.0648	8.2860	42 49	143 47
LAA027	24978.0	4 3404	18 61	81 09	0.6318	9.0716	346.53	0.7378	0 5245	8.6527	64.68	98 98

ANID	Fe	Hf	Ni	Rb	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr
LAA028	27657 3	5 2492	0 00	84.44	0.5190	9 0478	345.35	0 7738	0 5179	8.5816	46.65	121 12
LAA029	29116 7	5.0731	26.36	93.69	0 6784	9 6236	283.22	0.7936	0.5739	9.0005	47.20	118.60
LAA030	24272.3	4.7552	0.00	75.32	0 4630	7.8730	295.29	0 6991	0 6385	7.6394	45 35	90.06
LAA031	28690.9	4 6954	0.00	87.75	0.5499	9.5053	336.68	0 7833	0.5666	8.7511	52 53	111 39
LAA032	25625.4	4.4486	0.00	80 02	0 6044	8.4202	415 27	0 7145	0 5879	8.0779	42.24	104 24
LAA033	24112 4	5.1220	0 00	85.57	0 5552	7 8327	248 46	0 7463	0 4416	7.3812	43.34	130 24
LAA034	44709.0	4.4124	34 96	94.43	0 6376	12 8649	305 42	0 9994	0 8516	9.7939	75 59	105 98
LAA035	28635.2	4.4261	35 07	81 49	0.5111	9 4531	321 58	0.7990	0.5358	8.6376	50 08	101 39
LAA036	23985.4	4.8766	28 11	68 95	0 4965	7 7349	360.31	0.6677	0 4437	7.5741	41 08	108.72
LAA037	22655.5	14.7638	0.00	111 93	0 4314	7 5661	158.60	2.3735	1.8144	15 5086	63 66	306 69
LAA038	25949.2	4 7435	0 00	83 77	0.5558	8.4276	353 43	0.7391	0.4639	7 9062	42 77	104.04
LAA039	28803 7	4 2719	28 68	87 99	0.5621	9 4575	260 69	0.7770	0.5355	8 7023	49 10	99.40
LAA040	31218 9	5 2238	0.00	89 48	0.5787	10.3233	319 40	0 8325	0 6472	9 2618	51.84	142.05
LAA041	20941 1	4 1591	0.00	63 91	0 4712	6 7946	327.64	0.6288	0 4270	6.7065	40 49	107 06
LAA042	27783 6	4 2770	33 13	88 02	0 5575	9 1635	293.78	0.7823	0 5242	8.3445	49 23	93.43
LAA043	28602.5	5 1417	0 00	93 15	0.6024	9.2996	240 15	0.7716	0.5473	8 6659	47.60	129 40
LAA044	27638 6	4 2679	0 00	85 28	0.5305	9.0581	371 26	0 7513	0 5240	8 2299	44 12	112 74
LAA045	32511.8	5 0569	34 03	98 10	0 6024	10.9334	296 97	0.9023	0 6119	9.6773	47 21	108 40
LAA046	24346 4	4 9257	26 38	75 37	0 4979	7 9877	311.96	0.7523	0 4979	7.7418	43 97	126 49
LAA047	30494 4	4 6921	24 45	87.54	0 5630	10 0478	343.83	0 8060	0 5535	9 0044	46.71	97 21
LAA048	28867 3	4.8868	0 00	87.61	0 6500	9.5038	238 83	0.8062	0.7203	8 7165	47.50	126.63
LAA049	24816 7	4.4223	12 95	72 02	0 5801	8.0499	279 34	0 6617	0 4707	7 4701	38 29	109 89
LAA050	24618.5	5 0599	0 00	72.54	0.5379	8 0121	193 52	0 7172	0 5066	7.9858	41 36	113 47
LAA051	24245.4	6 7629	0 00	79 31	0 4866	7 8493	249.25	0.9196	0.7477	9 6407	72.73	155 46
LAA052	24148 7	4.8322	44 49	73.74	0.4760	7 8789	233.48	0 7126	0.5112	7 7462	42 47	107 35
LAA053	31401 8	5 2951	23.26	110 79	0 6572	10 4056	267 10	0 8271	0 5437	9.3456	50 9495	154 4095
LAA054	28771.7	4.7390	27 20	95 13	0 5337	10 6399	232 03	0 8730	0 5609	9.9573	80.3746	139 1735

ANID	Fe	Hf	Ni	Rb	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr
LAA055	82407.7	7.8833	99.91	58 31	0.8069	30 4518	101 75	1.0087	2.1009	13 9946	120.8632	267 9191
LAA056	26998.7	13 8671	0 00	118.23	0.4431	9 0492	160 96	2.3738	1.9262	18 7887	86.2024	364 5055
LAA057	23304.0	13.4787	0.00	108 22	0.3974	8.3526	178 66	2 2111	1.7223	17 3138	71.0973	342 9050
LAA058	26632.8	11.8895	27 02	124.15	0 5162	8.7755	110 65	2.5299	1.9246	18.2395	88.3792	309 3043
LAA059	23238.0	11.0343	27 31	124 02	0 4203	9.1299	168 00	2 1616	1.8644	18.4712	84.9392	271 9411
LAA060	16694.3	6 4676	34.09	155 82	0 4366	7 5400	59.93	1.7057	4.7504	27.9141	32.6176	152.9702
LAA061	26849.3	16.0795	31 85	131 47	0 5159	8 5445	82 79	2.5322	1 9493	18 7199	71 7976	403.8696
LAA062	46070.5	5.9000	58 55	71 21	0 5192	14 2385	423 40	0.9941	0.8377	8 7959	126 4990	197 6589
LAA063	25525.3	14.1764	43 67	123 41	0 4562	8 4837	115 55	2.3515	1 8212	16 1620	76.0981	347.8204
LAA064	24598 7	13 5375	0 00	123.74	0.4280	8 4794	86 37	2.2756	1 6728	16 6162	73.8265	338 0282
LAA065	35216 2	6 8868	46 91	81 71	0 7723	12 0583	241.59	0.8789	1 0385	11.7167	75.4976	197 7531
LAA066	16616 8	8.3228	26 90	158.38	0 4280	7 7219	68.99	1 7514	4 8611	30.6130	36 4297	183.8287
LAA067	21068 5	9 6608	0.00	94.00	0 5621	7 6666	124.92	1.0397	1.0008	11 6225	51 2431	283.2263
LAA068	25636 5	13.3933	28 79	137 44	0.4564	9.8013	116.03	2.4543	2 2284	20 5074	73.0027	364.2191
LAA069	24101 5	13.0385	0 00	141 82	0.5151	7.8417	107 66	2.7263	2 1674	19 7987	76 5417	306 4001
LAA070	24215.1	11 7774	0 00	134.20	0 4276	9 7618	124 55	2.5323	2 1018	20 5498	94 3522	301 8605
LAA071	25736 9	13 3940	0 00	121 42	0 5470	8.0349	147.08	2 4495	1.9665	17 7500	79 5756	348.5295
LAA072	23269 9	11.6135	25 85	126.79	0.4715	10.0505	136 32	2.2184	1.8482	18 6084	92.0302	329 0905
LAA073	22674.3	11.0089	0.00	104.02	0.4755	9.7526	167 33	2.0369	1.8552	17 1318	85 9765	298 1667
LAA074	23469 8	13.1676	0.00	122 63	0.4242	8 1289	105 59	2 2331	1 7069	16.6200	72 5195	326 3089
LAA075	36416.0	10 4079	33 24	114 74	0 4703	10 2030	455.36	1 4202	0.9685	18 0427	93.2078	259.2844
LAA076	33031.5	8 4642	30 09	112 29	0 4415	9.0082	428.90	1.4242	0 8215	17.1673	81 5164	217 0988
LAA077	32642 4	8 3875	44 57	114.82	0.4390	9 1626	412.42	1.3765	0 7755	17 1971	85 6780	238 1254
LAA078	34302 5	7 9800	0 00	130.07	0.4670	9 6022	413 94	1.4619	0 8538	17.3612	89.6836	214.2525
LAA079	34617 5	9 2027	45 13	119 29	0.4590	9 6131	360 17	1 4440	0.7903	16 2033	92 9974	265 0677
LAA080	33469 1	7.3225	27 42	125 08	0 4647	9 5946	396 44	1.4164	0.9342	17 3008	88 4798	201.4843
LAA081	23063.0	12 5960	0 00	108.43	0 4110	8.4442	132 93	2 2076	1 7114	16 2017	75.3348	321 2876

ANID	Fe	Hf	Ni	Rb	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr
LAA082	36770 0	10 4352	53 62	111.58	0 4583	10.0792	378.17	1 4826	0.8799	36.6389	85 6933	261.6626
LAA083	39348 4	8.2389	38 71	131 54	0 4933	11.0537	353.76	1.5067	0 8024	15.3757	103.6177	232.4143
LAA084	32902.9	9.4410	0 00	104.08	0 4879	8 9704	414 04	1 3993	0.7869	16 7150	90.4615	254 0388
LAA085	16879.5	8 9869	0 00	51.60	0.6245	5.1244	129 83	0.7104	0.4374	6.8775	42.8163	243 8376
LAA086	30634.6	12.3684	0.00	117 05	0 6126	9 2356	352.46	2.5651	2.1309	20.1659	88.8462	336.9744
LAA087	25379.2	15.8827	0.00	118.68	0 5474	8.6963	105.20	2 4385	1 9137	19.4850	85.2145	399.5872
LAA088	23725.2	14.6054	21 50	104.78	0 5156	8 0222	75.27	2 6129	2 3226	18 8969	115 8735	370 9276
LAA089	24148.8	7 1522	28 01	79 96	0.6359	7 9035	187 75	1.0636	0.6799	10.1194	80 9066	199 9594
LAA090	25201.3	7 4661	0.00	91.33	0.6567	8.3995	173 77	1.0439	0.7086	10 7998	81 6685	236.1386
LAA091	37080.4	7 0303	47 03	84 94	0.7600	12 2950	187.43	0.9398	0.9727	12.0468	89 0155	198 6349
LAA092	22582.7	14 5031	0.00	106.70	0 4601	7 6091	78 06	2 4203	1.7043	16.0341	49.1347	391 0069
LAA093	25736.9	14 6451	45 11	113.80	0 5277	8.1826	38 95	2.7552	2 0211	19 7685	51 1294	392 2655
LAA094	29690 8	13 8036	0 00	114 66	0 6111	9.6252	95.67	2.7296	1 8808	20.9179	93.5183	304.5086
LAA095	8300 2	6 9244	0 00	37.53	0 6873	2 8111	526.14	0 4551	0.2747	4.2489	19.5830	200 0049
LAA096	193484.0	7.3458	0 00	60 03	6 4460	5.4058	148.18	0.8100	0.8171	6 1359	246 7564	350 7819
LAA097	58580.3	4 6466	42.52	151 95	1.0361	18 2913	141.76	1.2826	1 0082	13 1219	95.7997	147 4703
LAA098	32714 9	5.6377	51 62	159.65	0.5920	18.2590	310 01	1.3907	0 7709	13.9914	88 7490	173 3477
LAA099	58242.0	5.8961	35.67	143 67	0 9429	16 8323	203.11	1.3238	0 8177	13 1167	87.5334	195.9824
LAA100	33945 9	5 6062	36 73	115.54	0.8007	12.3320	1261 00	0.9058	0 6730	9 8449	62 6311	170 8787
LAA101	18305.1	5 4072	0 00	69 62	0 5827	5 7212	141 79	0 6004	0 4671	6.1985	37 7512	157 3525
LAA102	13971.7	7 8322	27.78	54 80	0.5462	4.1953	38 57	0.6111	0 3699	5 7406	32.8510	213.5852
LAA103	29414 5	9.0989	0 00	105.40	0.9564	8 6629	76.36	1 0311	0 5512	10.5693	77 2515	259 6191
LAA104	12645.6	5 8746	0 00	52.41	0 5064	3.9958	1302.92	0.5897	0.3712	5 5384	39.6806	189 5152
LAA105	12108.4	5.6486	0.00	49.75	0.4507	3 8384	1724.99	0 5729	0.3702	5.4013	47 5974	206.1544

Short Count

sANID	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
LAA001	72566 5	2312.5	30679 8	16.3714	23266 4	600 28	7718.9	4883 4	152 1
LAA002	69808.7	1912 0	17745.8	11.4163	26190 1	231 05	9000.2	3194 5	73 1
LAA003	78288 4	1668.6	25559.3	15.3558	14506.5	583 76	8430 4	7338 4	273.3
LAA004	78387.0	1864.7	13757 8	10 2103	26636.3	287.39	18059.2	2648 6	62.3
LAA005	75386 1	1134 4	15939.7	10.5355	26558 5	332.46	10871 7	4555.8	97.0
LAA006	75045 9	1883 9	15679.3	17.2662	33656.3	235.40	11868.1	2652 4	59.7
LAA007	77411 7	1695 0	13091.3	12.6890	30019 5	226 25	12146.9	2730 7	54.9
LAA008	91314 0	3583 9	17678.6	4 0222	23736 7	408.97	20960.9	3050.0	73 2
LAA009	73677 1	1388.9	25119.3	17 5944	17422 1	712 81	9474 0	6198.9	201.0
LAA010	71617.8	1039 7	8909 4	14.3297	38420 8	137 83	10708.7	1802 1	36.5
LAA011	89782 9	389.8	6109 8	9.8289	32970.7	373.39	19504 0	2674.3	38 1
LAA012	94704.4	518.8	4729 5	10 5036	30222 4	225 60	18743 4	2610.7	42 7
LAA013	92714 1	339.3	6549 2	12.3173	33733.3	244.20	21030.6	2062 0	31.8
LAA014	93124.7	789.0	7452.9	7.7983	32910.0	302.67	17581 3	2903.2	52 6
LAA015	88581 1	847.6	7266 5	10.1247	32338 6	419 47	18268 2	2463.7	30.0
LAA016	91099 6	601 3	6760.5	10 8674	32929.6	288 42	19949.0	2397 4	34 3
LAA017	87885 2	893 1	5817 0	8 9479	35977.5	262.86	22412 6	1996.3	35 9
LAA018	89338 7	633 3	7763 2	9.6808	31476.3	311.11	19983 1	3026 7	41.5
LAA019	87342 5	666 8	8343.7	12 8679	31388 5	416 47	18430.0	2474.4	35 0
LAA020	89458 5	696 9	8024.5	8 6657	32211.2	410.61	19138 1	2416 5	30.7
LAA021	80510 4	1535.2	17477.1	11.0167	27109.6	396 43	11408 2	3436 6	112 8
LAA022	88751 6	1906.6	33748 8	5.6373	24761 8	1156 51	20060.2	6651.2	212.6
LAA023	97636.7	2149.1	38930 6	7 6851	24941 0	1329 28	19129 9	7368 5	241 1
LAA024	76880 9	1493.0	53083.8	5 6474	12856.2	1412.14	12696.8	9150.0	297.0

sANID	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
LAA025	82875.2	2561.8	32039 4	5.2631	20515.3	855.33	16328.2	6397.7	175 4
LAA026	96113 7	2312.3	15006 2	6 0934	21267 7	378.10	24800.8	4327 7	143 3
LAA027	56597 3	874.9	55335.5	3.2290	23271 1	325.37	2617.3	3084 5	73.7
LAA028	57143.1	1233.9	46320.7	3 1155	19989.9	243.09	2235.8	2829 5	70.3
LAA029	61363.4	729 1	45369.4	3.5083	19907.6	253.76	2610.5	2843.3	72.9
LAA030	49510.2	773 0	51320.4	3.0523	19357.4	256 49	2250 7	2330 4	57 7
LAA031	57071.1	1192.0	47276.7	3 6051	18267.3	223 45	2211 8	2965.2	66 1
LAA032	51249.4	3309.0	66411.9	2 9867	18213.6	238 13	2121 4	2432 4	57.8
LAA033	51426 6	760 9	42657.5	3.3016	18754 8	259.38	2399 4	2421.3	61 0
LAA034	68295 0	548.7	89761 3	4 5113	20734 5	464 15	4673.5	3224.9	125 5
LAA035	61056 6	731 4	61443.6	3.8497	20405 9	273.84	2293 0	2913.4	74 4
LAA036	51146.1	776 7	59110 2	3.0506	18151 6	255.18	2339.4	2472 3	56 6
LAA037	77765.3	467 4	5886 9	10 3099	34206.3	201 68	17025.0	2568 5	54 9
LAA038	49292.3	761 2	59452.1	2 9663	19098.5	275 48	2044 6	2675.2	59 4
LAA039	59505 0	902 9	47088.1	3 4251	18191 0	257 47	2096 2	2609 6	65.4
LAA040	61404 7	1529.7	37730 4	3.7591	21587.2	273.88	2193.7	2626 0	74 8
LAA041	42377 3	679 1	84095 1	2.9519	16832.5	245.06	2152 2	2748 1	47.8
LAA042	56596 5	728.8	52819.0	3 3587	18746.6	266 14	2193 1	3125 0	59.9
LAA043	55826.8	540 5	34338.0	3.3793	18886.8	264 27	2155 9	2755.9	69 9
LAA044	56567 7	1482.1	57473.6	3 2426	20102 1	293 92	2197.1	2955 2	72 0
LAA045	68901 2	932 2	47687.7	3.4198	22128.8	260 97	2072 7	3135 8	80.0
LAA046	48918 2	859 4	32174 6	3.0536	18237.8	268 29	2255 9	2161 9	57.6
LAA047	63293.6	1279 6	40398 8	3 5905	20180.4	279 43	2280 6	2834 2	67.3
LAA048	59732.7	1830 0	51931.9	3 5052	18146 2	273 51	2295.4	2668.4	70.0
LAA049	52179.6	773 5	78421 0	3 0917	16941 3	256.00	2174 1	2485 8	64 9
LAA050	52139 1	1112.8	21711 7	3.0475	17866.1	293.31	2612 8	2556 1	54 9
LAA051	52184 3	1128 6	49991 0	4 2666	19429.6	501 90	3790 5	2907 6	55 2

sANID	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
LAA052	50427.7	986 3	31404 0	3 1419	17503 7	274 72	2492 4	2337 7	63.0
LAA053	61615.4	1358 2	54060 0	3 6129	18582 0	268 74	2089.9	2480 9	80.4
LAA054	61990.8	1010.5	58278.2	3.3759	21797 3	225.80	2837.7	2759 7	77 9
LAA055	82941 1	777.3	39480.3	12.0154	13219 5	1003.14	9009 6	5556 9	182 0
LAA056	82500.7	523 9	7438 8	10.8212	30027.1	334 34	15743 1	3021 0	52 7
LAA057	72168 6	702 7	4790 8	10 3879	29901 2	452 19	15918 4	3190 4	38.5
LAA058	80114 3	527 6	8270 6	11 0311	31395 4	376 42	15932 0	2532 5	48 3
LAA059	81991.4	577 5	13034 4	43 2428	28792 6	149 07	14033.6	3175 1	48 0
LAA060	69095 1	355 3	5954 1	102 0880	27124.8	29 83	8288 0	1541 0	26 4
LAA061	82607 7	388 4	7313.6	44 4210	32757.4	520 21	16453 9	2951 9	49 6
LAA062	75841.6	996 7	75823 3	18 9599	24594 0	801 73	9127.0	5643 9	134 2
LAA063	78663 9	286 1	5729 9	41.8069	31908 2	166 70	15785.6	3030.5	61 4
LAA064	87559 2	355 3	6663 6	43 6888	34990.5	174 36	16695 8	3055 7	55 7
LAA065	71484 5	990 2	11911.9	22 1884	18937 8	457 80	8519.8	3395 5	77 9
LAA066	70559 3	387 9	7553 7	98 2430	27599.1	35 16	8703 1	1143.0	25 4
LAA067	56070 1	743 5	4929 4	21.9840	22096 9	113 26	7166.2	2861 2	46 9
LAA068	86869 9	472 3	6023 6	46 9881	32517 8	233 38	16955 5	2130 8	60 7
LAA069	82694 6	349 2	5493 7	46 9992	31332 7	386 14	18179 0	2849 0	59 7
LAA070	89033.7	484 9	9431 8	50.7920	32696 7	335 06	18181.8	2705.8	53 5
LAA071	78093 6	755 0	10263.3	52 4750	33682.2	456.32	16467.3	2498 9	73.6
LAA072	86593 0	701 4	8724 1	40.9405	28292 9	153 11	14162 8	3800 0	59.3
LAA073	86188 3	870.3	9894.2	42 6906	30565 7	173.29	13111 1	3305 1	61.6
LAA074	81987.4	584.7	6213 3	38 7731	32153.6	200 69	16113 6	2716 5	60 3
LAA075	90134 4	1058.3	14600 7	17 8109	34434 5	548 30	17100.0	3969 5	73 5
LAA076	94601 8	1064 2	18372 6	18 9784	27479 5	502 09	18674 1	3502 1	67 4
LAA077	94690 6	907.0	16883.6	18 1101	26649.1	511 94	18358 5	3655 2	62 9
LAA078	97286 1	912.0	15537 9	20 3321	26037 1	540.31	17457.8	3535 5	64 4

sANID	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
LAA079	91748 7	1020 2	15977 7	17 8366	33361 3	492.50	15799 4	3946.3	74.7
LAA080	95091.8	837 3	16294 4	21 7261	26363 6	557.58	18106.5	3601.5	71.9
LAA081	75197.9	396.1	7138 7	2 2865	33077 9	221.94	16250.2	3279 6	43.6
LAA082	91239.3	677 6	14306.6	17.9699	29442 0	547.25	15770.6	4038 0	91.7
LAA083	89295 0	1022 9	16501.9	18.9101	28381 9	638.12	14252.9	4773 0	78 0
LAA084	90835 5	831.5	18106.8	20.4948	30170.5	541 92	17975 9	3562 2	73 4
LAA085	38482.5	769 8	5345.1	10.5622	13822.6	312 58	2565.6	1576.5	40 4
LAA086	83014.6	528.8	9596.7	46 3564	29953.3	880.89	14436 0	2805 8	60 7
LAA087	81785.1	624.2	8537 9	43.2447	28578.1	262.36	15740 4	3211.6	52.8
LAA088	79220 9	483.0	5594.2	3 3836	29077 2	312.78	16091 3	3504.8	55 6
LAA089	55401 7	748.9	14394.9	14.8841	22831 9	652.98	5392.0	2703.9	41 4
LAA090	61325 0	837.7	6955.2	4.3840	20707 6	500.90	5036 9	2716.8	56.0
LAA091	75135 0	618.4	12195.0	5 6904	17093 2	458.20	6739.6	3841 1	70 2
LAA092	75152 6	408 2	5424 4	10 7724	27391 2	129.23	14910 0	2855 7	65 4
LAA093	76089 3	362 9	4568 8	12 1682	26137.0	234.89	15523 4	3119 6	52.1
LAA094	81762 5	1466.5	9665 6	11 0425	27861 3	308.94	14297.8	3337 0	44.3
LAA095	21947.7	396 8	39189 4	1 6028	11755 2	85 97	5871 3	1692 8	72.2
LAA096	33242.9	133 0	25989 5	4 4094	13593.4	1230 50	3987 3	1588 4	113.7
LAA097	89096.6	317 8	26046 5	5.0763	23535.7	986 78	5145 2	4299.8	124.5
LAA098	93491.2	313 1	6927 4	4.3960	19933.1	1127 58	5149 8	3874.7	198.8
LAA099	90059.0	295 5	14770 8	5.6037	22325.6	377 90	7323 9	4817 3	158 6
LAA100	63518 4	345 8	67471.2	4.5219	19145.2	798 58	4946 1	3305 6	103.7
LAA101	35438.9	460 8	33489.4	2.3137	12695.8	495 90	3373.3	1762 7	46.3
LAA102	35113 4	310 8	3830.5	2 8272	11048 2	213.05	2635 7	2178 6	36.9
LAA103	61433 4	382 5	3718 2	3.4213	17106 3	248.70	3328.9	2685 8	70.5
LAA104	29156.1	309 7	111725.5	1 9924	11025 5	219.61	3715.6	1474 5	66 6
LAA105	29490 3	384 4	95507 7	2 2263	11817 7	223 22	3541.3	2031.5	94 0

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