FOLLOWING THROUGH

Papers in Honor of Phyllis S. Davis
Edited by: Regge N. Wiseman, Thomas C. O'Laughlin & Cordelia T. Snow
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Regge N. Wiseman, Thomas C. O'Laughlin
& Cordelia T. Snow
THE ARCHAEOLOGICAL SOCIETY OF NEW MEXICO: 27
2001
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Every volunteer organization has at least three kinds of members—the leaders who provide direction and vision, the general membership that supports the organization and participates in the activities, and the lieutenants who make the whole thing work. Lieutenants are always there, at beck and call of the leaders, doing every job, large and small, dirty and clean, tough and not so tough, but always demanding of time and energy. No organization can function without these individuals. To a large degree, the organization is a reflection of the quality of its lieutenants. The honoree of this volume, Phyllis Davis, has long filled the role for both the Archaeological Society of New Mexico and the Albuquerque Archaeological Society. We thank her profusely.
In 1968 Phyl and John moved from Española in northern New Mexico to Albuquerque and immediately joined the Albuquerque Archaeological Society. A few years later she joined the Archaeological Society of New Mexico and has been active in both societies ever since. Phyl has done excavation, lab work, publications, teaching, public outreach, and any and every chore, big and small, that needed to be done. She has always been available to the officers of both societies when help was needed.

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After education in eastern schools, Phyl attended the University of Arizona, concentrating in education and business. She graduated from a business school in New York, followed by employment in business. On returning to Tucson during World War II, she acquired an aircraft pilot's license and worked at Consolidated-Vultee Aircraft Company until the end of the war. This was followed by a two-year stint in Los Angeles as a stewardess for American Airlines.

In 1950, Phyl went to Japan where she worked as a civilian administrative assistant in operations at the Army Yokohama Engineer Depot. Her area of responsibility was administrative procedures (and their problems!) at nine large repair plants throughout the Tokyo-Yokohama-Sagami area during the Korean War. Transferring to Europe in 1954, Phyl became an editor of army logistical publications in the Headquarters, United States Army, Europe, in Heidelberg.
In 1957, Phyl married Lt. Col. John M. Davis and moved to Fort Knox, Kentucky and then to Hawaii. John retired in 1962, but Phyl was already moved into a home on 72 acres near Glorieta that they had bought on a between-assignments trip to New Mexico in 1961. The home needed immediate rescue from the tenant renters. Considerable repairs and remodeling were needed, most of which Phyl did during her year alone on the property. Living alone in the Glorieta-Pecos area offered some very interesting experiences, and Phyl cherishes the memory of pleasant interactions with her neighbors.

In the Albuquerque Archaeological Society, Phyl has held positions as treasurer, director-at-large, head of the curator committee (responsible for laboratory activities), nominating committee, director of book sales, and member of the audit committee. She has participated in all AAS field and laboratory projects except for sites AS-1 and AS-2, including being a crew chief for several of the projects. She also co-chaired two Archaeological Society of New Mexico annual meetings held in Albuquerque.

With the Archaeological Society of New Mexico, Phyl served seven years as an elected trustee as treasurer and as a member of the finance committee. In addition, she has been a member of the Certification Council for several years and worked 14 years as a crew chief at the ASNMs Gallup field school. In the latter position, Phyl taught field and laboratory techniques, participated in artifact processing and identification workshops, presented introductory lectures on Southwestern archaeology, and conducted a data analysis workshop at the end of each session for the last three years of the project.

Publications include several articles on archaeological subjects in the AAS newsletter; a report to the U.S. Forest Service on the Cosme Garcia homestead and other sites in Jaral Canyon (1984); and a paper on the Garcia homestead in the 1986 ASNM annual volume. Phyl has also co-authored reports on the AS-4 project (Cochiti Lake, 1972) and the excavation of pueblo AS-8 and an associated survey of Canada de las Milpas (1998). Co-authored reports in progress include the Cerrillos mine site (AS-5) and the Vidal site (ASNMs Gallup field school).

Other activities over the years saw Phyl volunteering as a research assistant working on the Speakman Collection of early Albuquerque aviation photographs at the Museum of Albuquerque. She helped conduct an outreach program for Pueblo grade schools sponsored by the Wheelright Museum in Santa Fe. The design and execution of a very successful simulated archaeological dig for an elementary school at Los Lunas consumed a year's time. In earlier years, the community of Espanola benefitted from Phyl's efforts when she helped found the San Gabriel Historical Society and served as treasurer of the Youth Concerts of New Mexico organization.
The analysis of archaeological survey data presents many challenges to the archaeologist. Once the data are collected comes the task of figuring out what can be done with them. The first step is to assign cultural affiliations to sites. For some traditional surveys, this is in fact the main goal of analysis. With that information, a settlement distribution can be constructed for each time period. However, most of us want to do something more. We may be interested in population density, in the different ways that sites are embedded in a yearly round, or in the technology or economy of past societies. Unfortunately, survey data are frequently inadequate. Perhaps not enough attributes were measured in the field, perhaps the samples collected were not sufficiently representative. Almost certainly, information on location is inadequate to the task of carrying out sophisticated statistical evaluations that may help us to discern archaeological patternning.

While it is impossible to foresee every research question, or to collect all possible kinds of information, I argue here that we no longer need to suffer with inadequately located survey data. GPS technology has advanced to the point that it can and should be routinely used by archaeologists.

In the following pages I discuss a traditionally conceived survey and some problems encountered in the analysis. After a discussion of some analytical needs, I propose a simple expedient to provide us with provenience data from survey that is up to the task of statistical analysis. The technology known as Differential Global Positioning Systems (DGPS) is not inexpensive, but it may soon prove to be indispensable.

The Clines Corners Project of 1999 kicked off the first season of the Las Tapias Escarpment Project. Under my direction, a team of six students conducted a survey on one quarter-section of land west of New Mexico Highway 3 south of Villanueva, San Miguel County. An Eastern New Mexico University field experience, the project was partly funded by grants from the Archaeological Society of New Mexico (ASNM) and the New Mexico Archaeological Council (NMAC). The Torrance County Archaeological Society helped us record sites.

The Las Tapias Escarpment Project aims to survey a portion of State Trust Lands in a 17 by 28 mile rectangle between Villanueva and Clines Corners, New Mexico (Figure 1). With about 46% of the land in eight USGS quadrangles owned by the State Land Office, there are 220 square
miles of land that could potentially be surveyed. The parcel surveyed in 1999 is in the piñon-juniper vegetative zone, with juniper dominating over a mostly grassy understory (Figure 2). The parcel becomes increasingly rocky as one progresses northwestward from the SE corner. The land rises to a gentle ridge running essentially north/south through the western half of the parcel. The high point of the ridge is at 6352 feet and is about halfway between the north and south boundaries of the parcel. The ridge top is a very gentle, nearly level woodland/parkland to the south, but becomes increasingly rocky to the north. West of the ridge top, along the whole length of the parcel, the land falls away quickly over a sandstone cliff. From the bottom of this cliff, a piñon-juniper covered talus slope drops quickly down to a meadow (with good water) and a county road. A remnant stand of ponderosa pine occupies the higher portions of the ridge and the upper part of the talus slope. Total relief from this drainage to the ridge top is about 250 feet. The parcel is presently used as grazing land for a small ranching operation. The land has also been used for wood cutting, and at least once for trash disposal. The impact of cattle grazing is not severe. A small arroyo is developing in the southeastern portion, but the bulk of the parcel is too rocky for severe erosion.
The visibility of archaeological materials was good, except where obscured by needle duff under the coniferous overstory.

BACKGROUND

There are two concentrations of Pueblo sites on either side of the study area. To the south, a series of sites in Pintada Arroyo (Figure 1) date mostly from the 13th century, with one site dating provisionally to the 12th century (Franklin 1997; Kneebone 1987). Another cluster has been recorded in the Pecos Valley from just south of Interstate 25 near the town of Rivera down to Villanueva. The ceramic assemblages at most of these sites point to PIII occupations (Stuart and Gauthier 1981).

Within the project area, there are two named PIII architectural sites in the Cañada del Pueblo circa 10 miles to the west of the parcel, along with three sites having components of PII through PIV. Two more PIII sites are located within two miles northwest of the parcel. Two Plains Village sites have been found in quadrangles immediately east and southeast. No Athapaskan sites have been identified in the study area. Further away to the west, but potentially important to this area, are

FIGURE 2
Parcel surveyed, showing sites and IOs recorded.
the Galisteo Basin and Salinas communities, which had large populations at Spanish Contact.

This study was stimulated by the poor knowledge of the area and its presence on the boundary between the Great Plains and the Basin and Range physiographic provinces, presumed also to represent a cultural boundary. Boundary studies have become popular in recent years (Lightfoot and Martinez 1995). These are areas where the archaeological record becomes very complex, as ceramic and lithic assemblages reveal combinations of materials from different regions. As the material record implies, the social history of such areas is also likely to have been dynamic and complex. Boundary areas may include frontiers between two or more polities at the same level of organization or between societies organized at very different scales with very different ways of meeting subsistence needs. In the latter case, it would be interesting to know how such societies negotiate the use of the same landscape.

Many researchers have addressed the issue of Plains-Pueblo interaction (Baugh 1991; Lintz 1991; Speth 1991; Spielmann 1991a, 1991b). Spielmann (1991a, 1991b) and Speth (1991) take a Neodarwinian approach, proposing that Late Prehistoric and Historic Period trade of bison for maize between Plains hunters and Pueblo agriculturalists was mutually beneficial because it increased the nutritional fitness of each participant in the exchange. Lintz (1991) and Baugh (1991) argue that trade was also carried on directly between Pueblo and Plains Village agriculturalists. Spielmann rejects this interpretation, reasoning that mutualism would not develop where both parties had the same dietary specialization (Spielmann 1991c: 12).

Nevertheless, Lintz argues that there was an expanded trade system and increased interdependency between Pueblo and Plains Village societies in the protohistoric period (Lintz 1991). Baugh proposes a macroeconomic region in which the Pueblos, Plains hunters, and Plains Villagers took part (Baugh 1991).

The evidence for this trade in prehistoric times comes from "exotic" items found in archaeological sites. Spielmann (1991a: 199-235) notes artifacts from eastern Pueblo sites that probably originated on the Plains, and articles found in Texas Panhandle contexts that stem from Puebloan sources. Distribution of trade goods also forms the basis for Lintz's (1991) and Baugh's (1991) arguments. Thus, the discussion emphasizes trade between groups. The presence of a boundary, and the use of land in boundary areas has not been addressed at all. This project was intended to help correct that problem.

SURVEY METHODS AND RESULTS

The survey was carried out over eight consecutive days in July, from the 7th through the 14th, and the weekend of July 31 and August 1, 1999. After the parcel boundaries were located and marked, and beginning from the southeast corner, we ran north-south transects with a 10-meter spacing between crew members. When sites were found, we flagged artifacts and marked provisional site boundaries; we returned later to each site to record it. The location of the center of each site was estimated on the USGS topo map, and a compass and pace sketch map was prepared. Boundaries and notable artifacts
DAVID C. BATTEN

were mapped, and all other artifacts were analyzed without being individually plotted.

Basic information was recorded for all artifacts. For lithics, we recorded the tool type, material type, condition, amount of cortex, platform preparation, and length, width, and thickness, if condition allowed. For ceramics we identified the ware as closely as possible, and the number of sherds. We collected only projectile points and other potentially diagnostic artifacts, unique items, or material types that were particularly interesting. No subsurface testing was performed.

Isolated Occurrences (IOs) were located as accurately as possible on the topo map, but these estimations were subject to large errors. The east-west dimension was probably accurate to within 30 meters or so, since the width of the transects was known and faithfully recorded on the parcel map. However, the north-south dimension was a matter of educated guessing; it was not possible to keep track of distance traversed through the thick piñon-juniper woodland.

Sites were defined according to practical considerations. If there were enough artifacts that in-field analysis and recording of artifacts as IOs threatened to interrupt the flow of the transecting procedure (too many people standing around, or unsystematically searching for artifacts), then we declared the artifact concentration a site. In practice this happened at around 10 to 15 artifacts. This is a totally arbitrary definition, of course, and in no way reflects patterned human behavior in the past.

We collected about 20 projectile points, dating from the Early Archaic to the Late Prehistoric periods. Since there is no established projectile point sequence for this part of New Mexico, it was impossible to closely date these points, but they suffice to demonstrate use of the parcel over vast reaches of time. However, there was no compelling reason to associate these points with the artifact clusters in or near which they were found, and I have refrained from using them to date the sites.

We recorded 14 sites and 66 isolated occurrences (Figure 2). Each site was a scatter of flaked stone artifacts, with occasional ceramics and ground stone. In four cases, artifacts were accompanied by tentative hearths or thermal features, but there is again no clear evidence that these were systemically related to the artifacts. Five sites had multiple clusters within their boundaries, making a total of 22 artifact loci. Many of the IOs consisted of more than one artifact, so that there were 160 artifacts in the 66 IO locations.

ANALYSIS

Analysis of Sites

Analysis thus began under these conditions: artificial clusters (sites) had been created in the field out of some of the data. The rest of the data were grouped into smaller clusters, scattered around the parcel and located with some consistency relative to each other, but without much precision (IOs). The parcel had begun to look like one large lithic distribution. A quick check of the validity of the discovered clusters was made by comparing the average artifact density within sites to the average artifact density over the entire parcel. Dividing the total number of arti-
TABLE 1
Density of artifacts within sites and within the parcel as a whole.

<table>
<thead>
<tr>
<th></th>
<th>Sites</th>
<th>Parcel</th>
<th>Parcel-25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total artifacts</td>
<td>800</td>
<td>960</td>
<td>960</td>
</tr>
<tr>
<td>Total area (m²)</td>
<td>155,936</td>
<td>647,220</td>
<td>485,415</td>
</tr>
<tr>
<td>Artifact density (#/ha)</td>
<td>51.30</td>
<td>14.83</td>
<td>19.78</td>
</tr>
</tbody>
</table>

TABLE 2
Results of statistical analysis.

a) Chi-square of material type by locus. Top three contributors to Chi-square statistic.
H₀: There are no differences in material type proportions between artifact loci.

<table>
<thead>
<tr>
<th>Locus</th>
<th>Chert*</th>
<th>Quartzite*</th>
<th>Misc*</th>
<th>Locus ( \chi^2 )</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>127895-1</td>
<td>0</td>
<td>10.22</td>
<td>19</td>
<td>6.90</td>
<td>8.88</td>
</tr>
<tr>
<td>127882-0</td>
<td>24</td>
<td>11.01</td>
<td>1</td>
<td>7.43</td>
<td>3</td>
</tr>
<tr>
<td>127892-0</td>
<td>2</td>
<td>9.04</td>
<td>2</td>
<td>6.10</td>
<td>19</td>
</tr>
</tbody>
</table>

**Note:** Sample Size = 641, \( \chi^2 \) with 38 df = 210.647, \( p = 0.001 \). a Expected and (observed) values given.

b) ANOVA of numeric variables by locus. H₀: population means are equal for all loci.

<table>
<thead>
<tr>
<th>Variable</th>
<th>p-value</th>
<th>Significant pairwise comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>0.0043</td>
<td>{LA 127892, all others}&lt;{all others, LA 127888 L2}</td>
</tr>
<tr>
<td>Rank length</td>
<td>0.0198</td>
<td>none</td>
</tr>
<tr>
<td>Width</td>
<td>0.0073</td>
<td>{LA 127 892, 893, all others}&lt;{all others, LA 127888 L2}</td>
</tr>
<tr>
<td>Rank width</td>
<td>0.0737</td>
<td>{LA 127892, all others}&lt;{all others, LA 127888 L2}</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.014</td>
<td>{LA 127892, all others}&lt;{all others, LA 127885 L2}</td>
</tr>
<tr>
<td>Rank thickness</td>
<td>0.0076</td>
<td>{LA 127892, all others}&lt;{all others, LA 127885 L2}</td>
</tr>
<tr>
<td>Cortex</td>
<td>0.0001</td>
<td>{LA 127 891, 892, 895 L1, 882, 888 L2, 893, all others}&lt;{all others, LA 127888 L1}</td>
</tr>
<tr>
<td>Rank cortex</td>
<td>0.0001</td>
<td>{LA 127 885 L2, 891, 888 L3, 892, 888 L2, 882, 893, 885 L1, 886, 895 L2, 890, 889, all others}&lt;{all others, LA 127888 L1}</td>
</tr>
</tbody>
</table>

c) ANOVA of numeric variables by material type. H₀: Population means are equal for all material types.

<table>
<thead>
<tr>
<th>Variable</th>
<th>P-Value</th>
<th>Groupings of Pairwise Comparisons</th>
<th>Groupings of Pairwise Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>0.0001</td>
<td>{O, CHA}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
<td>{O, CHA}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
</tr>
<tr>
<td>Rank of Length</td>
<td>0.0002</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
</tr>
<tr>
<td>Widths</td>
<td>0.0001</td>
<td>{O, CHA}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
<td>{O, CHA}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
</tr>
<tr>
<td>Rank of Widths</td>
<td>0.0001</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
</tr>
<tr>
<td>Thickness</td>
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<td>{O, CHA}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
</tr>
<tr>
<td>Rank Thickness</td>
<td>0.0001</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
<td>{O}&lt;{CHA, CHE, Q}&lt;{B, M}</td>
</tr>
<tr>
<td>Cortex</td>
<td>0.0179</td>
<td>{O, Q, M, B, CHA}&lt;{Q, M, B, CHA, CHE}</td>
<td>{O, Q, M, B}&lt;{M, B, CHA, CHE}</td>
</tr>
<tr>
<td>Rank of Cortex</td>
<td>0.0002</td>
<td>{O, Q, M, B}&lt;{M, B, CHA, CHE}</td>
<td>{O, Q, M, B}&lt;{M, B, CHA, CHE}</td>
</tr>
</tbody>
</table>

*Note: O=Obsidian, CHA=Chalcedony, CHE=Chert, Q=Quartzite, B=Basalt, M=Miscellaneous*
facts recorded within sites by the total estimated area within site boundaries yielded a density of 51.30 artifacts per hectare (Table 1). Dividing the total number of artifacts recorded in the parcel by the total area of the parcel yielded a density of 14.83 artifacts/ha. Taking into account the fact that a portion of the parcel was quite steep and had very few artifacts on it, and (generously) estimating this portion as a quarter of the total area, then the artifact density of the whole parcel comes out to some 19.78 artifacts/ha. These figures imply that our site clusters were real, but it is still not clear that they were caused by patterned human behavior.

To assess the possibility that the artifact scatters identified as sites had some cultural meaning, I performed a number of statistical tests on the assemblages. My chief concern was whether the distribution of lithic artifacts in the parcel represents patterned human behavior or just a collection of unrelated discard events confounded by natural processes. Evidence of assemblage differences between artifact loci might help to demonstrate that patterning. Because of the overwhelming majority of flakes in the assemblage, the importance of debitage in technological analysis, and the small numbers of artifacts in other categories, only flakes and flake tools were used for this analysis.

The final list of attributes analyzed included the categorical variable material type, and the numeric variables length, width, thickness, and cortex. The first two measurement variables were taken only if the flake was complete; thickness was measured in any case. Percent of cortex on the dorsal surface of the flake was estimated in increments of 10.

One way analysis of variance (ANOVA) is an appropriate test for numeric attributes compared across a categorical variable, while Chi square comparisons were used to compare categorical variables. The tests clearly indicated differences in assemblage composition between artifact loci. Chi-square revealed significant differences in raw material composition from locus to locus (p<0.001), while ANOVA picked up significant differences within the parcel in flake size data (Table 2).

ANOVA performed on size attributes by raw material indicates a considerable association between raw material and size. For many attributes, obsidian flakes were significantly smaller compared to every other material type (Table 2). On the other hand, flakes of basalt and miscellaneous materials were nearly always significantly larger than chalcedony, chert, and quartzite. Thus, three groups can be distinguished. The upper end of the size range is occupied by basaltic and miscellaneous materials. Obsidian flakes are smallest, and the middle range is occupied by chert, chalcedony, and quartzite. The percentage of cortex on the dorsal surface of flakes provides a somewhat different picture (Table 2). In this case, one locus (LA 127888, L1) was significantly different from six other loci. Cortex is also highly correlated with material type. ANOVA on cortex grouped by material type showed that as a group, obsidian flakes bore less cortex than chalcedony or chert, and that quartzite had less cortex than chert (Table 2). Thus, chert was the material type with the greatest percentage of cortex, and obsidian the least. Quartzite was closer to the lower end next to obsidian, and chalcedony was at the upper end next to chert. Basaltic and miscellaneous materials were in the middle. To see how this affected the
defined clusters of artifacts, consider that LA 127888, L1 contained a high proportion (17 of 22) of chert and chalcedony flakes, the two material types associated with the greatest amount of cortex.

How are we to interpret the statistical tests? It appears that there was at least some cultural selection involved in the creation of these sites. There is variability in size and cortex as well as material type from site to site. It seems likely that much of the variation in size and cortex is related to differences in material type, but there is not a one-to-one correspondence between the sites singled out by the Chi-square test and those identified as distinctive by ANOVA. Further, the amount of cortex is affected by material type in a different way than is size: chalcedony and chert switch places with miscellaneous and basaltic materials respectively. Chert and chalcedony tend to have fairly small flake sizes, but quartzite, basaltic, and miscellaneous materials had less cortex.

It is difficult to form a clear picture of what the patterning tells us about the origins of these artifact clusters, and the impression of a continuous, more or less random distribution of artifacts across the parcel cannot lightly be dismissed. Since IOs are a critical part of any artifact distribution, I consider them next.

**Analysis of IOs**

Standard analyses of archaeological artifact distributions involve Nearest Neighbor cluster analysis or k-means cluster analysis, either of which is designed to produce clusters, but which may also inform on the degree to which the distribution differs from the random. There were clearly clusters in my IO data (Figure 2), but it is not so clear that they were real.

Two problems left doubts. 1) Many of the artifacts in the parcel were removed from consideration due to their inclusion in sites. 2) Many of the IO locations contained more than 1 artifact (up to 12), automatically causing clusters in the data.

Analyses using Kintigh's ARCHANAL statistical package were revealing. Nearest Neighbor analysis held out the most hope for an initial evaluation of clustering. The advantage of this technique is that included in the output is a figure that compares the patterning with a random distribution. The Nearest Neighbor coefficient varies between 0 and 2.1491, with 0 indicating maximum clustering (everything at one point), 1 indicating random distribution, and 2.1491 indicating a maximally regular distribution (Earle 1976). Note that such an analysis requires piece-plotted artifacts (or features or sites). Since many of my IOs consisted of more than one artifact, the entire set of data could not be used. If there are five artifacts in one location, the distance to the nearest neighbor for each of those artifacts is zero. Already there is clustering in the distribution, but it is clustering that was impressionistically defined in the field, and then fixed in the data by the recording technique.

To illustrate, the Nearest Neighbor coefficient for the entire set of IOs was 0.38, and the probability of this being a random distribution was <0.05. This indicates distinct clustering of the artifacts on the ground. However, when the same test was run again with 66 data points instead of 160, the Nearest Neighbor coefficient was 1.05, just as clearly random. In order to confirm the indicators of cultural patterning discussed above, I would like to see if the various attributes observed in the field exhibit trends across the parcel, but since
DISCUSSION AND CONCLUSIONS

The pilot survey described here was designed for site discovery. I wanted to know what was out there, and the first summer could be considered a reconnaissance. I expected widely scattered architectural sites with low artifact density in between. Instead, I found little direct evidence of Pueblo use of the land, with a light density but nearly continuous lithic scatter throughout the quarter-section. That is, the materials discovered provided precious little information about the pattern of Puebloan settlement, and equally little about the use of the landscape by Puebloan or Plains peoples. The former problem could be solved simply by more survey of the same quality. The second problem can only be addressed by better survey methods and a more rigorous theoretical approach.

Central to a more rigorous theory is the question of how we distinguish artifact clusters that are created by organized human behavior (i.e., an occupation or an activity) from those that are created by random series of behavioral and natural processes over long periods of time. Without the ability to distinguish real behavioral clusters, we have no sites. It does not help to believe that a number of discrete sites were found in our parcel, if in fact there was a nearly continuous low-density distribution of lithic materials.

Ebert (1992) suggests that surface distributions are no more nor less disturbed than stratified sites. He reasons that at one time every artifact was a surface artifact. That is, subsurface artifact distributions have been subjected to the same kinds of natural and cultural reworking as have distributions that are presently on the ground surface. He suggests that the difficulties in sorting out the behavioral from the natural factors influencing these distributions are nearly insurmountable. For him, the most promising approach to interpreting surface distributions is to discard the concept of site. By treating all surface artifacts as a continuous distribution of varying density, one is more true to the complex processes of formation behind the surface archaeological record (Ebert 1992).

Ebert recommends analysis of the scale of discard. Different artifact classes are used and discarded at different spatial scales, and these allow considerable insight into the organization of prehistoric systems (Ebert 1992). However, Ebert's suggested methods do not distinguish between cultural groups or time periods. Rather, they measure the cumulative effects of thousands of years of cultural use of the landscape. While very interesting if the users of the landscape were always organized in the same way, it cannot answer questions concerning use of one landscape at one time by two different societies. To do that, we must be able to distinguish the random from the patterned elements of the distribution. The solution to this problem will probably entail some identification of elements of the landscape that may indicate instability, along with tighter control of time and location in space (of artifacts and natural and cultural features).
In the section on Analysis, we see that sites and IOs tell quite different stories. The sites suggest some patterning in raw material use. The IO data tell us little, but suggest a continuous low density distribution of artifacts on the parcel. Site densities suggest differences between sites and the rest of the parcel, but inadequacies in provenience data make it impossible to confirm this. It is impossible to analyze the distribution of different material types and artifact classes spatially within the sites or across the parcel. The definition of site clusters in the field masks considerable variability in artifact distributions, and creates clusters that may not exist.

Definition of IOs into clusters similarly severely weakens the spatial analyses that may be applied to the distribution of artifacts. By collapsing 166 artifacts into 60 locations, we essentially destroy our ability to use statistical techniques to detect clusters. Furthermore, analyses to differentiate associations or clusters of different artifact classes are also invalid. That is, patterns of artifact type, material type, or platform configuration cannot be identified when true locations are not known. Finally, the relationship between artifacts and natural features that may be related to processes of erosion and deposition are obscured by lumping IOs together in one location. The problems encountered in the analysis all stem from inadequate data collection techniques. Within the site, time considerations made it impractical to piece plot each artifact. Outside of the sites, the same problems of time and manpower made it more practical to consider each small group of artifacts discovered by pedestrian survey as one isolated artifact location. Those locations that were plotted were prone to a high error. Taken together, the methods of recording sites and IOs in space made it impossible to view and analyze the entire artifact distribution in the parcel.

Many of the problems posed in this paper are complex, and their solutions require advances in theory. However, some may be resolved by application of technology. Piece-plotting each artifact would be a good start. This has been attempted in the past, but with such expenditures of time, manpower, and money, that the average archaeologist considered the approach ludicrous. Piece-plotting with Differential GPS receivers is no longer ludicrous. I maintain that it is reasonable and in fact necessary.

**Global Positioning Systems**

GPS technology is based on the simple principle that the distances between a target and three known points yield the location of the target. In the case of the GPS receiver, the three known points are satellites flying a constant orbit, and distance is measured by the time it takes a time signal to travel from the satellite to the receiver. Time synchronization must be extremely exact, and a fourth satellite is required to control for it. The signals are broadcast on two different frequencies, one having a wavelength ten times smaller than the other. The larger wavelength is used by civilian receivers, the smaller can be accessed only by the military or specially licensed agencies. The military frequency can attain circa one meter accuracy in ideal conditions, and the civilian 15 meters (Leick 1995; Letham 1999).

Since the technology was devised and financed by the military, with military goals involving guidance systems for missiles and smart bombs, the time signal from the satellite has been intentionally
scrambled. Because of this "selective availability", the standard receiver was limited not just by the wavelength of the radio frequency received, but by this built-in error code. Thus, the expected error of an inexpensive GPS receiver was between 15 and 100 meters, and it was impossible for the user to know which. However, early on May 2, 2000, selective availability was turned off, and it should now be possible to get 15-20-meter accuracy from simple hand-held GPS receivers.

More sophisticated GPS receivers make use of differential processing. This requires a stationary base station on a known point and a mobile receiver that is close enough to receive data from the same constellation of satellites. This can be accomplished by means of two user-operated receivers in a relatively small area, or by using a single receiver corrected with data from stations set up by various government agencies or commercial operations for the purpose (these must be within 270 km of the mobile receiver). This allows errors, both intentionally introduced and due to other sources, to be identified and filtered out from the location data, resulting in rather spectacular accuracy. For example, Todd et al. (1999) have demonstrated that a double receiver system, with one working as a base station and one as a mobile receiver, are capable of 9 to 12 mm accuracy, when compared with locations measured by a total station. For real-time differential processing, the mobile receiver must be in constant contact with the base station. Post-processing requires somewhat less expensive receivers, but leaves the user unaware of problems in the base station that may result in lost or inaccurate data.

On-the-fly capability refers to the ability to take quick readings, of circa 30 seconds or less. Todd et al. (1999) found that measurements taken with 10 seconds time on target were just as accurate as measurements in which the receiver was positioned on the target for 30 seconds. While the hand-held receivers typically require a period of minutes to get a fix and calculate location with reasonable accuracy, the more expensive receivers are capable of highly accurate readings in approximately the amount of time it takes to do a quick infield analysis of an artifact.

Given that the scale of analysis is a quarter section, 804.5 meters on a side, accuracies to the centimeter or even decimeter are not called for. However, an accuracy of 20 meters, within the capability of inexpensive hand-held receivers in optimal conditions, would represent about a 2.5% error, too much for most researchers, considering that accuracy goes down when conditions are not optimal. More sophisticated DGPS receivers are capable of maximum errors of less than 10 meters even under a heavy forest canopy (Jasumback 1996). This represents an error rate of just over one per cent, which is quite reasonable. The cost of a quality DGPS receiver with on-the-fly capability is considerable, at between six and ten thousand dollars, depending on the features required. However, Total Stations were similarly priced 15 years ago, and they were still quickly brought into the standard tool-kit for archaeological excavation. GPS technology has the potential to revolutionize archaeological survey data collection the same way that laser technology revolutionized excavation data collection. It behooves us now to take the plunge, put
up the money for quality systems, and watch the quality of archaeological survey data rise dramatically.

What will this new spatial rigor do for us? First, it will allow use of the kinds of sophisticated statistical analyses that I discussed in the analysis section. Second, it can be combined with more detailed information on local natural features of the landscape that may be relevant to the depositional history of the artifacts. Location of dunes or surface erosion features may quickly be mapped relative to the artifact locations. These and government maps with detailed information on soil or bedrock types may be combined with accurate locations of individual artifacts in the field to help locate areas in which natural formation processes are particularly active. A strong geographic association between such landforms and artifact clusters may help rule out patterned cultural behavior. Where artifact clusters are associated with stable soils, an inference of cultural patterning would be stronger. Finally, combined with accurate and detailed maps of vegetation and topography, accurately mapped artifact distributions will provide a powerful tool for archaeologists such as myself looking into the use of landscapes. The Las Tapias Escarpment Project is currently on hold, while I explore funding, but I look forward to the summer of 2001, and the opportunity to put this program into practice.

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Since 1974, there has been increased archaeological work done in Southern New Mexico and West Texas due to contract archaeology. The surveys and excavations have produced a wealth of archaeological information. Most of this work is produced with tight time frames and budgets not allowing researchers to pursue interesting problems or data comparison from other "gray" literature projects.

One of these problems that has intrigued the author for over 35 years is the Bat Cave point originally defined by Herbert Dick (1965) in West Central New Mexico, and the Golondrina points found in the Big Bend Country of Texas.

There now appears to be enough archaeological evidence to point to a geographical continuum between these two almost, if not identical, point types (Figure 1). The author has seen shallower base indentations in the Big Bend area for the Golondrina points and deeper notched specimens of the Bat Cave points in the states of Chihuahua and New Mexico. All appear to have lateral edge grinding. A flake or a few crescent-shaped flakes are generally removed from the base.

In 1946, Herbert Dick discussed the possibilities of finding Paleo-Indian remains on the shore lines formed by a late Pleistocene lake called San Agustin (1965:vii). Dick spent the summers of 1947, 1948, and 1950 (Dick 1965) at Bat Cave. While his work resulted in partially defining San Pedro and Chiricahua Cochise sites in west central New Mexico, its greatest contribution was in the recognition of the early maize found in the Cochise levels. Dick (1965:29, Fig. 23) does not cite any direct evidence for Paleo-Indian occupation except for the deepest point found within the site itself. Projectile Point Type 17, which he does not name, was in the lowest level of the buff sand. It falls into recognized Plainview and its variations. Although Paleo-Indian occupation is evident in other localities in the Plains of San Agustin (Hurt and McKnight 1949; Beckett 1980).

Dick defines and names the Bat Cave point as follows:

Type 15 is a leaf-shaped point with slight lateral indentations below the base. The point has been named Bat Cave Point, to facilitate future reference. This point is concentrated in the buff sand horizon.
and the above two levels in the midden. It correlates stratigraphically with the Augustin Point (Dick 1965:32).

While Dick says that stratigraphically it correlates with the Augustin point, several comments are in order: 1) Augustin points go from the same level to later levels (Dick 1965:31); 2) Dick illustrates six Bat Cave points (Dick 1965:29); however, the two illustrated as Figures c and d have a distinctively different form from the other four; 3) Dick (pers. comm., 1967) expressed the opinion that the Bat Cave points “c” and “d” were from the earliest levels of the buff sand in Bat Cave, along with his Type 17, suggesting that they were probably late Paleo-Indian. His Type 17 and Bat Cave points are represented by Suhm and Jelks (1962:239-240) as Plainview points, evidently before the Golondrina Point was recognized as a separate entity.

The Bat Cave point is very similar to the Golondrina point found in south central Texas and the lower Pecos. The latter point dates ca. 7080 B.C. - 6830 B.C. (Turner and Hester 1985:103-104).

Johnson (1964:46-52), at the Devil’s Mouth site in Val Verde County, Texas, calls the Golondrina a variety of the Plainview type. He goes on to say:

....they share enough particular attributes to warrant classification as a distinctive variety of Plainview. Whereas classic Plainview points are lanceolate, have approximately parallel lateral edges, fine parallel flake scars, and a straight or slightly concave base, Plainview golondrina points are characterized by an expansion of the edges in the middle of the blade and by out-flaring basal corners or “ears,” resulting in a “recurved” edge. The golondrina points also have a deeper basal concavity and cruder, more random flake scars than classic Plainview points. Basal and lateral smoothing occurs on both forms.

An important difference between classic Plainview and most golondrina points is the way in which their bases were thinned. In the case of classic Plainview points several long, narrow flakes were removed from the base parallel to the long axis of the points. On the golondrina points, on the other hand, a single or small number of wide, crescent-shaped flakes were usually removed from the base, producing the characteristic lunate flake scars...(Johnson 1964:49).

Bat Cave points have also been found at the Rhodes Canyon site in South Central New Mexico (Beckett 1983:104), and as a surface find near Burris Ranch, Doña Ana County (Figure 1, middle). The point has lateral grinding from the base to its greatest width. They were also found on the Ft. Bliss survey (Carmichael 1986:89). While not common, they appear as frequently as other Paleo-Indian points in the region. The author has also identified several of these from rancher collections in Chihuahua, Mexico, and they also appear in Nuevo Leon, Mexico, at the San Isidro site (Epstein 1961:plate 2, A-C).

Because of this geographical continuum, we consider this to be fairly good evidence that the Bat Cave/Golondrina points are Late Paleo-Indian and are part of a broader regional dispersion then previously recognized.
A-B: Golondrina variety of Plainview (Johnson 1964:48, fig. 15)

Bat Cave Point. Dona Ana County, New Mexico

C-D: Bat Cave points; d: Plainview (Dick 1965:29, fig. 23)

FIGURE 1
Projectile Points
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ANCIENT PUEBLO APARTMENTS DEFINED
BY ARCHITECTURAL ELEMENTS

The purpose of this paper is to present a study of ancient apartments in seven prominent archaeological sites that have been reported upon in past years. Subjective definitions of what constitute an apartment were developed to cover such obvious features as the number and use of rooms, access, intercommunication, sources of heat for comfort and cooking, and the number of occupants to be housed. To aid in the study, early historical references to apartment sizes and arrangements were sought and the problem of defining apartments was then applied to the following pueblos: Pecos Quadrangle, Mound Seven at Gran Quivira, LA 70 (Pueblo del Encierro), Paa-ko, Kuaua, Hawikuh, and San Cristobal.

HISTORICAL NOTES DEFINING APARTMENT

Clues concerning apartment sizes are contained in the Gallegos Relations of the Chamuscado-Rodriguez expedition to New Mexico in 1581-1582 (Hammond and Rey 1927:51). In discussing the houses at Zuni, Gallegos states:

All the houses in the settlement had their corridors, windows, doorways and wooden stairways by means of which they ascend to them. There is not a house of two or three stories that does not have eight rooms or more.

Hammond and Rey (1927:10) display some skepticism concerning the Gallegos statement:

Regarding the census by Gallegos a comment must be made. He describes a total of fifty-seven pueblos. The houses vary from two to seven stories, the majority being of two or three stories. If we accept Gallegos’ figures regarding the number of houses in each pueblo, there were slightly over 6000 houses in fifty-seven towns. At only one time does he indicate the number of rooms in each house, and that is when describing Zuni. These he reported to contain as high as eight rooms or more per house. If these figures are worth anything at all they would indicate a larger population in the pueblo region at the time of the coming of the Spaniards than had been commonly accepted. It is doubtful that any very definite conclusions can be drawn from Gallegos’ figures, but they throw more light on the question of the native population than do other sources.

Nevertheless, the Gallegos statement of eight rooms or more per house in two and three story buildings provides a strong indication that the apartments were often-times large.
Some multistory data concerning certain twentieth century pueblos should be useful for application to ancient pueblos. The most readily available information is contained in Stubbs (1950) plan-view drawings and aerial photographs of twenty-five New Mexico and Arizona pueblos. The ratio of ground floor rooms to upper story rooms is of interest as a guide to estimating the upper story rooms that may have existed in the early pueblos of this study.

Those pueblos that had more than a scattering of upper stories are Taos, Tesuque, Acoma, Walpi, Mishongnovi and Shongopovi. A detail study of the maps shows the following distribution: for 100 ground floor rooms there were 33 second story rooms, 5.5 third story rooms and an occasional fourth story room. This is an overall ratio of 0.40 upper rooms for each ground floor room. Another ratio of 0.25 was developed in the Paa-ko section of this paper, providing a range of figures which could be tailored to the individual circumstances of the pueblo under consideration.

After a preliminary study of all the sites, the following guidelines for defining apartments were adopted:

1. Take the form of one or more adjacent files (rooms lined up behind each other).
2. Contain one or more ground floor rooms with direct access to the outside.
3. Contain a cooking center with one or more firehearths.
4. Provide space for storage and sleeping.
5. Provide some form of communication between rooms.
6. Contain a minimum of three rooms and a maximum of eight rooms. The three room minimum was adopted when it was found that allowing two rooms to define an apartment (living room with firehearth and storage room) would usually leave one or more non-firehearth rooms dangling with no apartment association. The eight room maximum seemed to develop naturally.

Upper floors may be indicated by:
1. Extra thick walls in ground floor rooms.
2. Rooms in which metates and ground slabs were found mixed in the fill.
3. Ground floor rooms without fire hearths.
4. When present, a ratio of upper story to ground floor rooms between 0.25 and 0.40.

Kidder (1958) excavated substantial portions of the Pecos pueblo between 1915 and 1929. Judging by the map of the site (1958: Figure 20), the pueblo may have contained about 400 ground floor rooms. Tree-ring dates and early pottery (Smiley, et al. 1953:33) indicate that early construction started by A.D. 1299, but not until 1493 was it started on the pre-planned quadrangle. The pueblo was then
continuously occupied until 1838 (Kessell 1979:492) when its 17 to 20 remaining occupants moved to the Jemez pueblo.

Kidder describes quadrangle apartments (1958:122-124) as consisting of three ground floor storage rooms (filled with garbage and trash in the late stages of the occupation) and upper rooms with covered balconies, all of which may have been four stories in height. Thus, the effective late size of the apartments was three to four rooms in the upper stories, and additional activity space on the open covered balconies.

The east side of the Pecos quadrangle has been chosen for the present study. The planview and elevation shown in Figure 1 contains 12 apartments. Each apartment was basically identical to the next but the fourth story rooms may have been intermittent. On the assumption that one-half of the apartments had a fourth story room, the average apartment size was 6.5 rooms. However, because of the poor utilization of the three ground floor rooms toward the end of the occupation period, the total useful space at this time was smaller.

No firehearths were found in the first floor rooms, although there was some evidence of deeply buried pre-quadrangle hearths. Good evidence was found in the fallen remains that firehearths had existed in those upper floor rooms that were not covered by another story (1958:136-137).

**Mound 7 at Gran Quivira**

Mound 7 at Gran Quivira in Salinas National Monument was fully excavated from 1965 through 1967 by Alden Hayes et al. (1981). It was a well preserved single story ruin with details of firehearths preserved in the floors and with stone

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*Figure 1. Pecos Quadrangle*  
Plan and Elevation of Apartments Proposed by Kidder  
After Kidder 1958 - Figures 24 and 27.
walls standing sufficiently high to provide some information on wall openings. The well documented history of its occupancy and decline provide an unparalleled opportunity to make apartment comparisons where the uncertainties are minimized.

The pueblo was built in three phases (1981:12-31) starting perhaps as early as A.D. 1300 with a circular pueblo. This complex was added to during the middle phase, but with the late phase, an essentially new rectangular unit was superimposed above the circle. The late phase structure was expanded through a series of twelve major increments, with remodeling having continued into the early 1600s. According to Vivian (1964:29-30) abandonment occurred rapidly during six years of drought, pestilence and severe Apache raids, ending in A.D. 1671-72.

The phase of Mound 7 used in this study is its terminal occupation shown by Hayes et al. (1981:26, Fig. 16h). By this time its size had peaked and it was slightly smaller than it had been at the time of its zenith.

Since the current study applies only to native Indian occupation, the convento and two adjacent rooms in the west end of the mound are not included. However, six rooms that at some time seem to have been used for ceremonial purposes are included. They are described by Hayes et al. (1981:47-48) as rooms that may have been associated with nearby kivas since they contained murals in some layers of the wall plaster. Nevertheless, there is evidence that at least some of them had been converted to living uses.

Because of the combination of good architectural preservation and excellent records, it was clear that no fire hearths had been missed, making it possible in this study to require that each apartment must have contained at least one firehearth. As Hayes et al. (1981:45) put it:

The hearth is not only a figurative home, it is the very real center of family life providing warmth for winter sleeping and the place for preparing and serving food.

Wall openings between rooms of an apartment could not always be archaeologically recorded because of tumbled walls or other wall disturbances. Therefore these communication pathways could not be made a strict apartment requirement, but when found, they aided in the definition. The openings that did exist were in the form of doorways or window-like pass-throughs, and were usually intra-apartment, but some inter-apartment units were noted.

Figure 2 shows the site layout with the proposed apartments, and Figure 3 shows the individual apartment schematics. The mound contained 33 apartments, ranging in size from three to eight rooms and averaging 4.6 rooms. Eight apartments, or 24%, are in forms other than linear files. Three apartments have more than 6 rooms, one of which is an eight room G-shaped unit located in the center of the house block where a scarcity of fire hearths existed. The sinuous nature of its inter-connecting rooms suggests some special use—perhaps communal storage.

The rooms of this pueblo were notably small, averaging 56 square feet (Hayes et al. 1981:36).
Figure 2. Mound 7 at Gran Quivira
Proposed Apartments at time of Latest Occupation
Map 5 modified by Figure 16h after Hayes 1981.

Figure 3. Mound 7 at Gran Quivira
Schematics of Proposed Single-Story Apartments.
LA 70, Pueblo del Encierro

This middle Rio Grande valley pueblo was completely excavated by the Laboratory of Anthropology in 1964-1965, so that much is known concerning the phases of its building and occupation. According to Snow (1976: i, xx, and A206) the pueblo started as a surface unit about A.D. 1350. Various rooms seem to have been abandoned starting at about 1450 and ending with the pueblo abandonment in 1539. It may have received migrants from Tunque during some of its occupational phases.

Compared to Mound 7, it was much less well preserved. Calculations showed the adobe walls averaged less than one foot high compared to 2.8 feet for Mound 7.

The pueblo took the form of a square plaza surrounded on all sides by house-blocks, with an opening in the NW corner and a wing extending east from the NE corner. Successive ground floors were found in many rooms. Fire hearths existed at the various levels, but this study has used only those rectangular firepits associated with the latest floor levels (Snow 1976: Fig. A-46). This study considers the pueblo to be multistoried, but the evidence is not fully conclusive.

Snow (1976:159) discusses the evolution of apartments with time.

The primary domestic unit in prehistoric Rio Grande Pueblo IV surface structures consisted of two rooms, front to back, with the plaza-facing room equipped with a firepit and, usually other features such as bins, cists, and other sub-floor pits.... The back room, lacking features, appears to have been designed for contiguous storage. ....With the construction of additional tiers of rooms... it seems apparent that living space increased dram-...The increase in living space over stor-... had tripled.

Figure 4 shows the proposed apartments layout. Snow (1976:xvi) uses 198 rooms in his analysis and notes that thirty or more additional rooms had eroded away. The drawing of the floor plan (1976: Fig. A2) shows approximately 250 rooms if one counts the rooms denoted by dotted lines. Of these, 247 were chosen for this apartment study.

Some areas were not included as apartments because their configurations suggest special use. One of these, in the outside middle of the East roomblock is a possible square kiva similar to those built into roomblocks of Kuaua and Paa-ko. Another consists of uncertain exterior rooms at the base of a possible wing extending southward from the SE corner of the plaza.

Heavy lines in Figure 4 show proposed second story rooms. When choosing these, Snow (1976:224) suggests that they were likely to be built above rooms not containing fire hearths since there would be a preference in firehearth rooms to vent smoke through the ceiling. He reasoned further that mealing bins were located next to inside walls of upper rooms and when their remains were found in ground floor fill, they were indicators of a second story.

The schematics for the 58 apartments are shown in Figure 5. The number of rooms per apartment is 4.2, and 64% of the apartments contain firehearths in the ground floor rooms.
LEGEND

- Apartment
- Firehearth
- Doorway or Passway
- Apartment Number
- Special Use Area on Ground Floor
- Not Included in Apartments
- Boundary of Second Story

Figure 4. LA 70 - Pueblo del Encierro
Proposed Apartments
Map after Snow 1975 Figure A2
Figure 5. LA 70 - Pueblo del Encierro
Schematic of Proposed Single-Story and Two-Story Apartments
Paa-ko

Paa-ko, a large pueblo lying on the east side of the Sandia mountains, was excavated by Lambert (1954). It was occupied during two distinct time periods. The prehistoric Communal House was begun no later than A.D. 1300 and abandoned by about 1425. The site was re-occupied (South Wing) about 1525 and abandoned again by 1672. For purposes of this study, the two occupations will be considered separately.

The Communal House, Figure 6, was irregular in shape, apparently having been added to over a period of time. It contained four square ceremonial rooms or kivas, with connecting passageways that clearly associated some of the rooms with the kivas. Other rooms also appear to be associated with the kivas by reason of position. In addition, portions of two rows of interior rooms, many of which were connected by passageways, seem to have facilitated interior communications.

In applying the apartment definitions, the kivas, and their associated rooms were excluded from consideration. Apartments were defined on the assumption that the excavation extended to the outer limits of the houseblock, although the map (1954: Fig. 2A) suggests that the rubble mound extended somewhat beyond. Lambert indicates (1954:13) that the prehistoric...
Communal House showed signs of more than one story. The locations of these probable second story rooms were project ed using the following guidance.

1. The two innermost kivas were covered over by rooms (Tichy 1938:77).
2. It was assumed that some of the extra-thick walls in the house supported upper rooms.
3. The ground floor communications network implies that the interior rooms had no hatchways to the roof but instead were covered with upper-story rooms.
4. Upper story rooms would favor ground floor rooms without firehearths because of the smoke removal problem. This assumption, however, may be at least partly in error since Reiter (1938: Fig. 4) shows upper stories at Unshagi that are above ground floor rooms with firehearths. Overall, the known number of apartments containing firehearths in ground floor rooms is 45%.

The historic South Wing, also shown in Figure 7, was a more regular house block. The ill-defined north edge is assumed to mark the outer limits of the house. The wing was thought to have contained more than one story along the north and west edge (Lambert 1954:22). Using these criteria, the upper story areas were delineated as shown by the heavy lines in the figure. In this wing, 68% of the apartments had ground floor firehearths.

Schematic apartments for both the Communal House and South Wing are shown in Figure 8. The ratio of upper story to ground-floor rooms for the combined units is 25%.

Kuaua

Located in the middle Rio Grande valley, Kuaua was one of about a dozen pueblos termed the Tiguex Province by early Spanish explorers. It is now known as the Coronado State Monument and is widely recognized for its kiva murals (Dutton 1963). The pueblo was excavated in the period 1934 through 1939 as a cooperative endeavor by several related organizations. The field records are now on file at the Laboratory of Anthropology in Santa Fe.

The pueblo is largely of adobe construction and arranged in a divided quadrangle. The extent of its time span has not been fully analyzed, but according to Vierra (1987:41):

The ceramic analysis supports occupation of the site from the A.D. 1300s to possibly in the 1700s. The site was probably abandoned by the original Indian occupants during the early 1600s and later reoccupied by the Spanish colonists....

Maps of Kuaua on file at the Laboratory of Anthropology include an overall map by Charles Heck, maps by E. Long, Gordon Page, an unknown mapper, and a map of the Lummis section by J. Charles Kelley. These maps were supplemented by an aerial photograph (Dutton 1963:21), making it possible to determine the full extent of the ground floor.

The results are shown in Figure 9. Crosshatched areas relating to kivas were eliminated from apartments consideration, but the the aerial photograph allowed additional rooms to be added to the east and west groups. The photograph, however, did not allow firehearths to be detected in the added ground floor rooms, a fact that biased the fire hearth percentages to the low side.
Kuaua was doubtless a multi-story pueblo. To accommodate this, the ground floor rooms were divided into as many apartments as the criteria would allow, and the upper story rooms were used to fill out the apartment sizes. Since no guidance existed concerning the placement of upper floor rooms, the distribution of rooms was handled as follows:

1. 33% (av. of 25% and 40%) was used as the ratio of upper floor to ground floor rooms.
2. The number of apartments defined by the ground floor study remained unchanged.
3. All two-room ground floor apartments were to have one upper story room added to make them into three-room apartments.
4. The remainder of the upper story rooms were distributed among the three to six-room+ ground floor apartments in proportion to the total number of rooms contained in each apartment size class.

The results are an average of 4.5 rooms per apartment and 56% of the ground floor rooms have hearths. Figure 10 shows the schematic apartments.

**Hawikuh**

Hawikuh provided an opportunity to make use of good archaeological data supplemented by historical records. Hodge excavated 340 rooms starting in 1917 and ending in 1923 (Smith, et al. 1966). The village was occupied ca. A.D. 1300 until its abandonment in 1680 at the time of
Prehistoric Communal House

LEGEND
Ground floor
( ) Without Number - Inside Wall
Firehearth
Doorway or Pass way
12 With Number - Outside Wall
Second Story

Historic South Wing

Figure 8. Paa-ko
Schematics of Proposed Single-Story and Two Story Apartments
Figure 9. Kuaua
Ground Floor Map of Proposed Apartments
Map after Charles Heck Map in
Files of Laboratory of Anthropology
the Pueblo rebellion. As a Zuni village, it was one of the earliest pueblos visited by the Spanish explorers, and data relevant to this study were provided in the chronicles of the entradas. The first historical reference to Hawikih is by Gallegos of the Chamuscado-Rodriguez expedition in 1581-1582 (Hammond and Rey 1927:51).

The fourth pueblo is named Aguico. It had one hundred and twenty-five houses of two and three stories.

Aguico is identified as Hawikuh (Eggan and Pandy 1979:481).

According to Smith et al (1966:12), during its active life, Hawikuh had seen successive occupancies in about 470 "columns" (rooms stacked one above the other). If all the ground floor rooms of these "columns" were occupied at the time of the Chamuscado-Rodriguez expedition, each house (apartment) would have contained an average of $\frac{470}{125} = 3.8$ ground floor rooms. On the other hand, in 1604, Zarate Salmeron reported that Hawikuh had 110 houses (Hodge 1937:77). If one chooses this number, stated 23 years later, the average would have been 4.3 ground floor rooms per apartment.

The ground floor apartments in the portions of the ruin denoted by Hodge as Sections A, C and E were defined using the apartment criteria and the details of firehearths and inter-connecting openings of the latest floors (Smith, et al. 1966:Figs. 1, 13, and 17). The apartments are shown on the site plan in Figure 11 and schematically in Figure 12. The average ground floor rooms per apartment is 4.0, which compares favorably to both the 3.8 and 4.3 figures derived above from the historical data.

Hawikuh was reported to be multi-storied. It was not possible from the available data to determine where the upper story rooms had been located. However, based on the modern pueblo comparisons, the larger concentrations of upper story rooms would likely have been in the densely packed, non-linear Section B. The other Sections, which are typically only three to four rooms in depth, probably would have had comparatively few upper story rooms. It was therefore judged that the 25% factor developed at Kuaua for the ratio of upper story to ground floor rooms should be used. From this, the apartment size became 5.0 rooms per apartment, with firehearths on the ground floors in 79% of the apartments.

The ground floors only of the apartments are shown in Figure 11, with schematics in Figure 12.

San Cristobal

The pueblo was established some time before A.D. 1400. The earliest tree-ring date quoted by Smiley, et al.(1953:20) for Building X is 1376 with others extending to 1437. After intermittent abandonment and re-occupation following the 1680 Pueblo Rebellion, the majority of the Tanos remaining in the Galisteo basin fled west, in 1696, mostly to the Hopi country (Nelson 1914:28-29).

San Cristobal was probably the largest of the Galisteo basin pueblos known to the Spaniards at contact time. Gallegos of the Chamuscado-Rodriguez expedition in 1581-1582 (Hammond and Rey 1927:49-50) states:

Four pueblos were discovered here, the first of which had three hundred houses five stories high. It was named Piedra Quita.
Figure 10. Kuaua
Ground Floor Schematics of Room Files
Divided into Proposed Apartments
Figure 11. Hawikuh
Ground Floor Map of the Proposed Apartments
Map after Smith, Woodbury & Woodbury 1966 - Figure 1

Figure 12. Hawikuh
Ground Floor Schematic of Proposed Apartments

LEGEND
Apartment
12 Apartment Number

LEGEND
Ground floor
( ) Without Number - Inside Wall
Firehearth
Doorway or Passage
12 With Number - Outside Wall
Piedra Quita is identified as San Cristobal by Schroeder (1979:248).

Nelson (1914:43, 66) estimated that the pueblo contained about 2000 ground floor rooms of which perhaps 650 had been occupied during the historic period. He further suggests that this number of rooms could be increased by about one-half to a total of 975 rooms to account for multiple stories. Using Gallegos' 300 houses, this would mean that the average apartment had only 3.3 rooms, a figure that is low compared to other pueblos in this study. In order to get a better estimate of apartment size, Nelson’s Building III was chosen for study.

In 1912, Nelson (1914:52-54) completely excavated Building III, a prehistoric houseblock thought to be in danger of washing away. It contained 72 rooms and the construction was mostly of stone with a few sections of adobe. Nelson makes the following observations concerning three aspects of this building:

Judging from the nature and occurrence of specimens collected, as well as from the height of the standing walls, and the amount of debris, the central portion of the building was originally more than one story high. ...There were... no fireplaces on the ground floor... but there was ample proof that there had been fireplaces on the floor above. ...Doorways were practically absent.

He also excavated Building X (1914:59-62), in which remains indicated that it had been occupied in historic times. It was shorter in length than Building III, but the ground floor plan was very similar. In this building, there was unmistakable evidence of second story rooms above the three inner rooms of five-room files.

Building III was chosen for this study because of its larger size, but both III and X were used to guide the choice of Building III second story rooms. Figure 13 maps the houseblock showing the outline of second story rooms, while Figure 14 shows schematics of individual apartments. As proposed, there were 38 second story rooms and 70 ground floor rooms. The 25 apartments average 4.3 rooms each.

APARTMENT STUDY RESULTS

A summary of the results of the apartment study is presented in Table 1. In the pueblo reports, the architectural information dealt largely with the ground-floor remains, but upper story forms were sometimes suggested by the excavators. The first section of the table relates to the Ground Floor Rooms. Line one records the number of rooms that could be measured from the site maps, and line two, the average room size in square feet.

Beyond the measured rooms, the maps contain the additional room outlines stated in line three. Line four shows those considered for study, but these had to be adjusted upward or downward by the amount noted in line five. The adjustments were based on circumstances encountered in the individual site studies. Line six states the ground floor rooms finally chosen.
Figure 13. San Cristobal -- Building III
Map after Nelson 1914 -- Plan I

Figure 14. San Cristobal -- Building III
Schematics of Proposed Two-Story Apartments
### TABLE 1
Apartment Study Summary

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SITE</th>
<th>PECOS</th>
<th>MND 7</th>
<th>LA 70</th>
<th>PAA-KO Prehist</th>
<th>PAA-KO Historic</th>
<th>KUAUA</th>
<th>HAWI</th>
<th>SAN CRIS</th>
<th>WHT'D AVE</th>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>Ground Floor Rooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Measurable Ground Floor Rooms</td>
<td>30</td>
<td>148</td>
<td>148</td>
<td>143</td>
<td>93</td>
<td>81</td>
<td>87</td>
<td>87</td>
<td>203</td>
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<tr>
<td>2 Average Room Area</td>
<td>77.8</td>
<td>56.0</td>
<td>75.0</td>
<td>68.6</td>
<td>86.1</td>
<td>83.3</td>
<td>75.0</td>
<td>77.4</td>
<td>73.4</td>
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<tr>
<td>3 Add'l Rooms Indicated by Map</td>
<td>30</td>
<td>166</td>
<td>239</td>
<td>143</td>
<td>93</td>
<td>368</td>
<td>111</td>
<td>111</td>
<td>203</td>
<td></td>
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<td>4 Add'l Rooms Considered</td>
<td>30</td>
<td>166</td>
<td>239</td>
<td>143</td>
<td>93</td>
<td>368</td>
<td>111</td>
<td>111</td>
<td>72</td>
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<td>5 Adjustments Made</td>
<td>6</td>
<td>-18</td>
<td>-22</td>
<td>-43</td>
<td>-5</td>
<td>-20</td>
<td>0</td>
<td>0</td>
<td>-2</td>
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<td>6 Total Ground Floor Rooms</td>
<td>36</td>
<td>148</td>
<td>217</td>
<td>100</td>
<td>88</td>
<td>348</td>
<td>111</td>
<td>111</td>
<td>70</td>
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<td><strong>Upper Story Rooms</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Estimated Upper Story Rooms</td>
<td>42</td>
<td>0</td>
<td>28</td>
<td>26</td>
<td>21</td>
<td>113</td>
<td>28</td>
<td>28</td>
<td>38</td>
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<td><strong>Totals</strong></td>
<td></td>
<td>78</td>
<td>148</td>
<td>245</td>
<td>126</td>
<td>109</td>
<td>461</td>
<td>139</td>
<td>108</td>
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<tr>
<td>Number of Apartments</td>
<td>12</td>
<td>34</td>
<td>59</td>
<td>29</td>
<td>25</td>
<td>101</td>
<td>28</td>
<td>28</td>
<td>25</td>
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<tr>
<td>Average Rooms/Apartment</td>
<td>6.5</td>
<td>4.4</td>
<td>4.2</td>
<td>4.4</td>
<td>4.3</td>
<td>4.6</td>
<td>5.0</td>
<td>4.3</td>
<td>4.5</td>
<td></td>
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<tr>
<td>Average Area/Apartment</td>
<td>506</td>
<td>244</td>
<td>311</td>
<td>303</td>
<td>372</td>
<td>380</td>
<td>375</td>
<td>334</td>
<td>344</td>
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<tr>
<td>% Apts w/ Grd Flr Fire-hearths</td>
<td>0</td>
<td>100</td>
<td>64</td>
<td>45</td>
<td>68</td>
<td>55</td>
<td>79</td>
<td>0</td>
<td>32</td>
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<td><strong>Apartment Size Percentages</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Three Room</td>
<td>--</td>
<td>38</td>
<td>29</td>
<td>24</td>
<td>24</td>
<td>20</td>
<td>7</td>
<td>32</td>
<td>22.6</td>
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<td>Four Room</td>
<td>--</td>
<td>26</td>
<td>36</td>
<td>31</td>
<td>36</td>
<td>29</td>
<td>25</td>
<td>16</td>
<td>27.6</td>
<td></td>
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<tr>
<td>Five Room</td>
<td>--</td>
<td>9</td>
<td>27</td>
<td>35</td>
<td>24</td>
<td>30</td>
<td>46</td>
<td>40</td>
<td>27.9</td>
<td></td>
</tr>
<tr>
<td>Six Room</td>
<td>50</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>16</td>
<td>15</td>
<td>11</td>
<td>12</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>Seven Room</td>
<td>50</td>
<td>6</td>
<td>--</td>
<td>3</td>
<td>--</td>
<td>5</td>
<td>7</td>
<td>-1</td>
<td>'6.0</td>
<td></td>
</tr>
<tr>
<td>Eight Room</td>
<td>--</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>4</td>
<td>--</td>
<td>'1.0</td>
<td></td>
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</tbody>
</table>

### TABLE 2

<table>
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<tr>
<th>Reporter</th>
<th>Date A.D.</th>
<th>Place</th>
<th>Family Size</th>
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<tbody>
<tr>
<td>Dominguez</td>
<td>1790</td>
<td>Pecos</td>
<td>3.70</td>
</tr>
<tr>
<td>Dominguez</td>
<td>1790</td>
<td>Tesuque</td>
<td>4.31</td>
</tr>
<tr>
<td>Dominguez</td>
<td>1790</td>
<td>Santa Clara</td>
<td>3.40</td>
</tr>
<tr>
<td>Dominguez</td>
<td>1790</td>
<td>Zuni</td>
<td>4.0+</td>
</tr>
<tr>
<td>Dominguez</td>
<td>1790</td>
<td>Taos</td>
<td>3.81</td>
</tr>
<tr>
<td>Dominguez</td>
<td>1790</td>
<td>Picuris</td>
<td>3.48</td>
</tr>
<tr>
<td>Kroeber</td>
<td>1917</td>
<td>Six Hopi Towns</td>
<td>4.7</td>
</tr>
<tr>
<td>Kroeber</td>
<td>1917</td>
<td>Cochiti</td>
<td>4.6</td>
</tr>
<tr>
<td>Kroeber</td>
<td>1917</td>
<td>Zuni</td>
<td>7.5</td>
</tr>
<tr>
<td>Woodbury, Parsons</td>
<td>ca. 1925</td>
<td>San Juan, Santa Clara, San Ildefonso, Tesuque, Nambe and Jemez</td>
<td>Average 5.0</td>
</tr>
<tr>
<td>Woodbury, Parsons</td>
<td>ca. 1925</td>
<td>Nambe alone</td>
<td>7.1</td>
</tr>
</tbody>
</table>
The next section relates to Upper Story Rooms whose presence is suggested by the apartment criteria applied to excavation report details and whose numbers are estimated.

The third section presents various totals and weighted averages, and the fourth section records the Apartment Size Percentages.

DISCUSSION

In comparing ground-floor room dimensions and areas, two significant facts stand out: 1) The rooms of Mound 7 are unusually small at 56 sq. ft. compared to the rooms in the other pueblos that range from 69 to 86 sq. ft; and 2) all pueblos except Mound 7 record multi-story rooms.

The weighted average rooms per apartment for all sites is 4.5 with Pecos and Hawikuh in the 5.0 to 6.5 range. The apartment areas range between 311 and 380 square feet for all sites except Mound 7 at 244 and Pecos Quadrangle at 506. This latter figure is high for the late occupation period inasmuch as only marginal use was made of the three ground floor rooms at this stage.

Mound 7, the single story pueblo, had ground floor fire hearths in 100% of the rooms which compares to the average of 52% in the ground floor rooms of multi-story pueblos. This indicates that when a ground floor was covered by an upper story, the occupants often chose to place the firehearth at the upper level. Pecos and San Cristobal apparently had all of their firehearths in upper rooms.

Finally, the number of rooms and shapes of the apartments: Except for Pecos, at 6 or 7 rooms per apartment, the other pueblos average between 4.2 to 5.0 rooms each. Leaving out Mound 7 at the low end and Pecos at the high end, the apartments of the remaining pueblos have a narrow range in average area from 303 sq. ft. to 380 sq. ft. A high proportion of the apartments shapes are in the form of files.

Estimates of Apartment Occupancy

The apartment sizes have implications concerning the number of occupants. The sizes ranged from three rooms to eight rooms and, if the criteria had allowed, a few 2-room apartments might have been noted. The occupancy no doubt varied from newly formed families to extended family units.

<table>
<thead>
<tr>
<th>Apartment Size</th>
<th>Occupants</th>
<th>Apartment Size</th>
<th>Occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 room</td>
<td>2 to 3</td>
<td>6 room</td>
<td>About 7</td>
</tr>
<tr>
<td>3 room</td>
<td>3 to 4</td>
<td>7 room</td>
<td>About 8</td>
</tr>
<tr>
<td>4 room</td>
<td>4 to 5</td>
<td>8 room</td>
<td>About 9</td>
</tr>
<tr>
<td>5 room</td>
<td>5 to 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Noting the number of people in the 6-room through 8-room apartments, it seems likely that they often housed extended families.
Kidder (1958:122, Table IV) prepares for a population discussion by estimating the population of the full quadrangle at Pecos. (It should be noted that only one wing of the quadrangle is discussed in the Pecos section of this paper.) His estimate totals 660 rooms occupied by 550 persons in 110 families. This converts to an average family size of five, with 1.2 individuals per room. He then lists family sizes reported by others in different time eras (1958:133-136). This information is summarized here in Table 2.

Kidder (1958:134) comments on the low 1790 family sizes:

...figures as to the size of the Pueblo family are from the years after the Revolt, and it is not improbable that for almost a century before 1680, diseases introduced by the Spanish may have taken a toll great enough to have reduced the family from a pre-1600 average not far from 5.

Kidder’s suggested number of five persons per average family will be used in making the following analysis:

If one assumes that the average family of five occupied the average apartment size of 4.5 rooms (Table 1), average occupancy would be 5 / 4.5 = 1.1 persons per room. Looking at it in another way, the average apartment contained 345 sq. ft. of floor space and each person required one/fifth of this area, or 67 sq. ft.

Using the number of 1.1 persons per room, the apartments would have had the approximate numbers of occupants noted in Table 3. Noting the number of people in the 6-room through 8-room apartments, it seems likely that they often housed extended families.

SUMMARY AND COMMENTS

A study of this type cannot be scientifically rigorous because of the nature of the data. Nevertheless, it is believed that the methods employed do present a reasonable picture, indicating that apartment sizes in the mature pueblos under study ranged from about three to eight rooms with the occupancy per room averaging about 1.1 persons. These basic figures could be used to make population estimates of entire pueblos if the percentage of rooms that were occupied at any given time was known. There is speculation in the literature of various sites concerning the time/occupancy percentages. However, it seems possible that when detailed information on the phases of construction is available, such as that presented by Hayes et al. (1981:26, Fig. 16), the occupied areas at given times could be projected with reasonable accuracy and populations calculated therefrom.
ACKNOWLEDGEMENTS

The author wishes to acknowledge the generous sharing of archival material by the Laboratory of Anthropology in making possible the San Cristobal and Kuaua portions of this paper.

Appreciation is extended to Margaret Bice for her encouragement and careful editing.

In preparing this paper in honor of Phyllis Davis, the author was prompted by the fact that she and I had worked together on archaeological projects for more than thirty years, and had co-authored a number of publications, a welcome joint task that is continuing. It is hoped that this paper will prove worthy as a contribution to her well deserved honors.

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Vierra, Bradley J.

Vivian Gordon
Archeology has changed markedly over the last several decades, and very much for the better. Progress sometimes has seemed frustratingly slow and it has not always been steady. I will not try to write anything resembling a comprehensive history of the developments of the twentieth century, but will simply trace advances as seen in how archaeologists have dealt with a single structural type, the Navajo hogan.

The earliest known hogan excavation was conducted in 1915 by Earl Morris at Old Fort (LA 1869), appearing in his field notes as “Site 3.” Unfortunately, Morris never published on this work. Roy L. Carlson (1965:1, 6-15) published a well-researched report on Morris’s investigations fifty years later. It is uncertain just how much regarding the hogan derives from observations in 1915 and how much Carlson was able to add, nor is it possible to correlate the artifacts collected with specific proveniences. The Morris investigations took place during a brief period of interest in Navajo archaeology from about 1912 to 1920 that did not continue into the following decade. It was not until the 1930s that interest in the Navajo past revived. A great many aspiring young archaeologists conducted surveys and a few also excavated some sites.

Among those who participated in this endeavor were Richard F. Van Valkenburgh over several years in the Dinetah, a region of dense former Navajo settlement in the drainages entering the San Juan River east of Bloomfield, New Mexico, Roy L. Malcolm in Chaco Canyon in 1937, Elizabeth Murphy in 1937 in the Dinetah and in the vicinity of Crownpoint, Malcolm Farmer in the Dinetah in 1935 and 1937, Betty H. and Harold A. Huscher in Colorado beginning in 1939, Wesley Hurt at Canyon de Chelly in 1941 and Dorothy Louise Keur at Big Bead Mesa in 1939 and in the Dinetah in 1940 (Farmer 1942, 1947; Hurt 1942; Huscher and Huscher 1942; Keur 1941, 1944; Malcolm 1939; Murphy 1938). World War II cut short this effort, but of those who published, Keur (1941) was the only one who produced a fully detailed monograph.

Following the war, interest in Navajo archaeology did not pick up until well into the 1950s. Since that time the pace has accelerated as various salvage or cultural resource management (CRM) projects have been required throughout the country currently or formerly occupied by Navajos.

The sophistication of research in archeology has increased in a similar fashion through the twentieth century. Navajo sites have not been given the degree of attention given sites of cultures more remote in time, but still there have been significant advances in theory, questions
addressed, and methodology. The intent of this paper is a cursory survey of the increasing complexity of research in the Navajo past by means of archaeology.

I have selected four hogans excavated in sequence in 1939 by Keur (1941), by personnel of the Navajo Reservoir Project in 1959 (Hester and Shiner 1963), by Charles D. James III (1976) in 1972, and by Gary M. Brown in 1991 (Brown et al., 1992). The first three hogans were included in large projects which encompassed many more sites and structures, requiring careful separation of the data relating to a single structure, while the last was the only hogan at the site investigated, resulting in a report focused on the occupation of that one structure. The first project was under the auspices of Columbia University and was a pure research undertaking as part of the requirements for Keur’s Ph.D. degree (Babcock and Parezo 1988:142-5). The three subsequent projects were occasioned by the need for clearances prior to development. A proposed dam required the work in 1959. In 1972 new road construction threatened the sites. In 1991, it was the need for a well pad for natural gas that could not be relocated. Only for the 1959 project were a series of volumes written. I have generally limited my consideration of the work done in each case to the report that includes the hogan selected, with the exception of allowing inclusion of the monograph that provides much of the anthropological and historical background in the 1959 example, but at slightly lesser ratings. In addition, it must be kept in mind that my ratings are to some degree subjective, especially where they deal with something other than simple presence-or-absence observations. (See Table 1 for examples.)

The earliest excavations considered are those at Big Bead Mesa by Keur. The hogan chosen is BH-1, a forked-pole hogan at her Site B. This hogan produced one tree-ring date of 1777+x, which is not a cutting date. The latest outside ring date from the Big Bead sites is 1795 and the site may date into the very early 1800s (Keur 1941:22-25, 30, 68, 76, 79, 81, 83, Plate 26).

From the second project, the Navajo Reservoir Project by the Museum of New Mexico, Hogan 4 at Site LA 4199, Ramada Village, was selected. This was an atypical structure, probably a leaning-log hogan, chosen because it was an unusually complex example for which more data are available than for many others. The site was estimated to date between 1700 and 1750 (Hester and Shiner 1963:6-25, 70).

The 1972 example is Hogan 1 at NA9713 near the north rim of Canyon del Muerto in Arizona. This was a burned forked-pole hogan, which probably dates somewhat later than the other three. Tree-ring dates were 1762vv, 1810vv, and 1813r (James 1976:31-34, 62-89, 123-124).

The single hogan at the Grassy Canyon Site, LA 80854, is located on the north side of a minor tributary of the Pine River in New Mexico. It was a forked-pole structure and is estimated to date sometime during the two centuries prior to 1680 (Brown et al. 1992).

My rating system, as presented in Table 1, scores a list of categories on a scale of one to five, five indicating the most complete representation of a category in the report describing the site. An explanation of these categories will help the reader understand my results.
The first item, I. Survey, deals with the extent of regional and local survey work. Where limited but thorough survey was required, as at LA 80854, the rating was only 2, while LA 4199, a part of a major project in which 454 sites were recorded, receives a 5. The other two projects fall in between.

The next, II. Research Design deals with a category not having formal recognition at the time of the two earliest projects, where it cannot be rated as such, but Keur did provide a clear explanation of both her initial postulates and of the methods she followed. Hester and Shiner did neither, but did refer to a publication on which they relied for methodology.

All four reports include Background Material (Item III) to a greater or lesser degree. Only James provided Climate data. Hester and Shiner’s report is notably deficient in the Culture History subcategory, but as noted above, Hester (1962) had produced a separate study that deals with all aspects of this domain for which the project is given some credit, taking into account that it is the work of one of the coauthors. The minimal use of ethnographic data by Brown et al. (1992) seems insufficient to merit any score.

The fourth category, IV. Fieldwork, deals with both the acquisition of evidence in terms of material collections and data in terms of observations at the site. The subcategory, A. Mapping, includes maps that show the site within a larger context in terms of geography and/or topography, site maps, hogan ground plans, and profiles. Photography includes views of the site location from a distance, of the site close up, and photos of the hogan and features before and at various stages of excavation. All sites produced Surface Collections, but the degree of care taken in making the collections as indicated in the reports is reflected in the ratings. Brown et al. (1992:23-25, 34-35) is the only report to specify piece plotting of objects on the surface and to include maps of these locations. Testing prior to complete excavation varied in intensity and detail in reporting. Excavation includes both excavation of the hogan interior, of associated exterior features such as hearths and ash dumps, and broadside excavation of exterior space around a hogan to discover buried features. Complete surface stripping of the site was done only at Grassy Canyon.

The fifth item, Laboratory deals with the analyses of collections in order to extract data that might enhance interpretation of the archaeological remains. The subcategories address the various materials collected with sub-subcategories for the kinds of analyses performed. The final subcategory, E. Chronometric, however, includes all materials amenable to some sort of chronometric analysis that were utilized in one or more projects.

Analyses of Ceramic collections, which consisted only of sherds at all four hogans, were quite detailed for each project. Descriptions, as a sub-subcategory includes the classic Southwesternist type descriptions along with some comparative matter. Only sherds from Grassy Canyon were subjected to Refiring and Thin-sectioning (Wilson 1992; Hill 1992).

Descriptions were provided of artifacts in all reports, as were attempts to identify the rocks and minerals of which they were made. Attention to Debitage appears only in the two more recent reports. The level of analysis of Lithics in Brown et al.
(1992:56-61, 75-90) far exceeds that in any of the other reports. Attention to the Use to which lithic artifacts were put is merely implied by type names or is minimal except in the two more recent reports.

Identification of Faunal remains was rather haphazard in the early days of Southwestern archaeology. As at other Navajo sites, the presence of domestic animals was of interest from almost the beginning. Beyond a mere recording of species, however, only the Grassy Canyon report includes complete faunal analysis by provenience, computation of Minimum Number of Individuals (MNI) per species and description of postmortem Modifications (Brown et al. 1992:61-63, 107).

The Botanical collections, aside from those used for chronometric purposes, were also quite limited and analysis was far from thorough, again in keeping with much earlier archaeological usage, except for the most recent project at Grassy Canyon, LA 80854, that report devoting an entire chapter to this long neglected source of information (Holloway 1992).

The Chronometric category includes dates derived by four different methods. In each case, except one, the rating denotes the number of dates derived from the hogan. The exception is the Tree-Ring score for Grassy Canyon, which recognizes the fact of the collection of forty specimens, none of which was datable (Brown et al. 1992:64-65), a sort of “A” for effort.

Finally, VI. Interpretation, considers the meaning and significance derived from the data, including the arrival at conclusions that might receive further testing in the future.

The various aspects of dating appear as four sub-subcategories. During the twentieth century there has been a remarkable increase in Chronometric techniques. As a subcategory, the Chronometric heading duplicates in some ways the similar subcategory under Laboratory Analysis, but here it pertains to the evaluation of the raw dates, including their integration with temporal indicators of other kinds. Typological considerations can be applied to all kinds of cultural remains, but pottery is, in the Southwest, one of the most sensitive to change through time. Known Navajo archaeological remains date largely from the protohistoric and historic eras, and data from the historical record is often significant in terms of dates and causes of change. Southwesternists have utilized various systems of Periodization. A system of named phases is currently most commonly in use in Navajo archaeology, one that was initially devised in the Navajo Reservoir Project (Hester 1962). Keur did not have access to a phase system at the time of her work and did not create one of her own, but her work at Big Bead became the primary basis on which the Cabezon Phase was later described.

Site Function is a subcategory that has received increasing attention in Southwestern archaeology generally. The Economic, Religious, and Defensive subcategories are self-explanatory. Number 5, Social, includes both demographic aspects and social organization. Habitation refers to use of a site as a residence, a central place for a family on either a seasonal or year-round basis. One site may, therefore, meet several needs of the occupants. My ratings are probably among the most subjective in this review. Almost all hogans today are residences, but they may also be used for religious ceremonies, as the living
# TABLE 1

Subject ratings of research emphasis at four hogans

<table>
<thead>
<tr>
<th></th>
<th>KEUR 1939</th>
<th>NA VAJO RESERVOIR 1959</th>
<th>JAMES 1972</th>
<th>BROWN 1991</th>
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<td>I. Survey</td>
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<td>B. Data</td>
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<td>4</td>
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<td>C. Methods</td>
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<td>III. Background</td>
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<td>A. Climate</td>
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<tr>
<td>B. Geology</td>
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<td>C. Topography</td>
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<td>D. Flora &amp; Fauna</td>
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<td>C. Surface Collecting</td>
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<td>3. Modifications (burnings, cuts, etc.)</td>
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<td>VI. Interpretation</td>
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### TABLE 1 (cont’d)
Subject ratings of research emphasis at four hogans

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<td>1. Within Site</td>
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<td><strong>E. Cultural</strong></td>
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<td><strong>F. Change through Time</strong></td>
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<td><strong>G. Abandonment</strong></td>
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<td><strong>H. Site Formation Processes</strong></td>
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<td><strong>Total Scores</strong></td>
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<td><strong>Total Categories Considered</strong></td>
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quarters for those caring for livestock, and various other purposes. Social indicators are of a rather subjective nature even in the field, but a combination of factors can often supply hints as to the size and nature of the group using the structure.

**Technology** has long been a major consideration in archaeological studies worldwide. Three subcategories are rated here along with the extent of the application of the **Comparative** method. Comparisons were an important approach to such studies in the early and mid portions of the twentieth century and this is apparent in the rating on the chart, declining from two to one to none.

Subcategory **D. Settlement Patterns** is here defined as inclusive of site layouts as well as regional distributions. **Seasonality** is especially critical for an understanding of Navajo settlement on the landscape.

**Cultural Interaction** is divided between those activities based on amity and those based on enmity.

The final three subcategories, **Change Through Time, Abandonment**, and **Site Formation Processes** seem all to be self-explanatory.

It will be noted that while it is clear that some theoretical stances have lost favor during the past century, the comparative method being perhaps the most obvious example, and many new advances in theory and methodology have gained prominence, Navajo archaeology has been rather slow to incorporate innovations. This can be attributed in large part to the rather peripheral status of the archaeology of such peoples as the Navajos and Apaches, the Utes and Paiutes, and the Pai peoples generally in the Southwest.

Given a low priority, resources to support many of the newer approaches have not been as readily available for these sites as for the sites of ancient periods that entail the romance of the origins of peoples and cultures and the Formative period sites that boast spectacular ruins of pueblos, cliff dwellings, platform mounds and the like. For the Navajos it has been the puebloid structures, the pueblitos, towers and fortified sites, that have attracted the most attention, providing a wedge to investigation of the often inconspicuous remains of hogans, hunting camps and sweat lodges, a wedge that has been lacking for the other non-Puebloan tribes. There has been very little attention to the past of these peoples in academia aside from speculation. Keur's (1941, 1944) studies comprise a major part of the corpus of purely academic investigations.

Salvage archaeology and land claims litigation, leading to full-blown cultural resource management, supplied the impetus that carried Navajo archaeology beyond the narrow opening made by Keur.

In the middle years of the century, archaeology applied for practical purposes fought to gain the recognition and status that would justify funding for research of remains not chosen solely for intellectual reasons. The funding came not from the traditional sources that have long supported academic research, but from a small percentage of the monies allocated for a diversity of projects having economic and development rationales; dams, roads, pipelines, mines, parks and litigation. Academia initially viewed such work with disdain and later, I suspect, with envy as cultural resource management gained its place in the world, one often associated with activities that provided generous sup-
port for quality research. At first, Navajo archaeology remained a low priority. The Navajo Reservoir Project, with its less ambitious aims, rates well below Keur's achievements some two decades earlier. It must be noted, however, that subsidiary studies in Navajo culture history such as Hester's (1962) work, which also had status as a doctoral dissertation, and Polly Schaaafsm's (1963) report on the rock art increased the scope of the reservoir research, although at bargain basement costs to the project.

By the 1970s, a highway project that impacted several Navajo sites had about equaled Keur in my rating system, but in a different manner. Whereas Keur's strengths lay largely in reliance on the social sciences, ethnology in particular, and humanities, especially history, James' elevated score derives more from other scientific fields such as biology, climatology, geology, typology and such archaeological concepts as site formation processes. Even so, he had inadequate funding for technical studies of his ceramics, faunal and botanical specimens, or chronometric determinations beyond tree-ring dating.

The former disdain of CRM work has subsided, not fully perhaps, but to a far lower volume of criticism. Projects based in the extraction of energy resources can afford to be sufficiently liberal that even Navajo sites can now receive investigation to standards applied to Early Man, Archaic and Formative sites, as can be seen in the much higher rating for Grassy Canyon, a single hogan that even a decade earlier would have been treated as a minor manifestation of a peripheral culture.

It should be noted, however, that the major gains have been in the technical application of methods and concepts from the biological and physical sciences. The role of the social sciences and humanities has decreased or stagnated, becoming not only proportionately less with time, but in absolute terms as well. This reflects quite accurately the major trend in archaeology over the past half-century or so. The trend to the greater use of scientific methods, especially in the statistical treatment of data, has helped us to deal with questions relating to social structure, intercultural relationships and other matters of human affairs that are extremely difficult to address objectively in any other manner. In addition, the hard sciences have brought us far more information relating to the environment, health and nutrition and similar spheres of knowledge. These domains do have major effects on human life and ultimately I believe that they will also allow us better to see the human side of former times. By contemplating the course of archaeology over the past century, we may be able to discern more easily where we need to apply more effort in the future.

ACKNOWLEDGEMENTS

I wish to thank Malcolm Farmer for insights into the Navajo archaeological efforts of the 1930s and early 1940s. His continuing interest in a field where he worked so long ago is very much appreciated. Thanks are also due Lauren Rimbert for a careful job of typing a rather difficult text and table. To the authors of the reports cited, my review is not a criticism of your work. All have made important contributions to the recovery of a lost past.
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THE KECHIPA CAPER, OR THE STRANGE CASE OF A MISTAKEN IDENTITY

Kechipa, or Kechiba, is a naturally occurring geologic material still used by the Zunis of New Mexico as an interior white-wash for room walls (Figure 1). Kechipa has long been believed to be the mineral gypsum (CaSO₄·2H₂O), but as will be shown in this paper, kechipa is not gypsum at all!

The misidentification of kechipa stretched into two centuries, from the late 1800s through the late 1900s. The word “kechipa” or “kechiba”, has been translated by Southwestern anthropologists to be the Zuni word for “gypsum whitewash”. Most recently Ferguson (Ferguson and Hart 1985) refers to Kechiba:wa [Kechipauan?] as a location on the Zuni reservation for the collection of gypsum plaster for white-washing. Eggan and Pandey (1979) state, “Kechepauan. The modern Zuni name kechiba:wa ‘gypsum place’ is attested from the late nineteenth century on.” Samples sent to the present author in 1992 were labeled as gypsum from the proveniences of Upper Nutria and Kechipauan, both traditional collection sites near Zuni Pueblo. But, as it develops kechipa has suffered a severe case of mistaken identity.

During most of the 1990s Theodore R. Frisbie and Sidney Denny of Southern Illinois University, Edwardsville, were conducting a summer field school at the Salomon Farmstead (ZAP-051-89) in Lower Nutria on the Zuni Reservation. In the spring of 1992, several mineral specimens collected in the field were submitted to me for routine analysis. Two bore the following provenience:

- Gypsum (Kechipa) Zuni traditional location ca. 3 miles N. on Gallup Rd.—near Nutria, herein called Sample #1.
- Gypsum (Kechipa) Zuni traditional location near Kechipuan.—herein called Sample #2.

These are both modern specimens of the material from the respective mines actively used by today’s Zuni. Both were whitish and, when dry-rubbed between the thumb and fingers, were slippery and very gritty.

SCANNING ELECTRON MICROSCOPY ANALYSIS

Methods

These samples were analyzed with a scanning electron microscope equipped with energy dispersive spectra (SEM/EDS) and
imaging accessories to gather data on quantitative elemental chemistry and morphology. For more comprehensive information on this technique and its application to archaeological materials studies see Kay (1994) and Kay and Phagan (1993). The instrument is calibrated to uniform standards and practices referable to the National Institute for Standards and Technologies. The methods are non-destructive, and the specimens are archived. The instrument is a JEOL model JSM-840 equipped with KEVEX DELTA FIVE accessories.

A customary practice when observing a specimen with SEM/EDS, is to undertake numerous scans with the KEVEX operative. This practice, coupled with accumulating spectra at various magnifications, provide an “average” elemental chemical analysis and supplies valid qualitative data. All the while the video monitor screen affords multitudes of visual morphological observations enlightening in and of themselves.

The resultant EDS spectra, while informative, can also be misleading and the reader should be cautious to bear in mind the following provisos: 1) only the energy levels or channels from left to right (or vice versa) are absolute data and provide standardized indicators for elemental identification, and 2) the height of each peak and the relative heights of all peaks are not quantitative and must not be compared.

Finally, to achieve optimum results when making photomicrographs, the samples in this study were coated with Au/Pd (gold and paladium) to provide an electrical ground between the mount and the specimen. In this effort the gritty (loose grains) proved to be a serious challenge to our ingenuity. Therefore, Au and Pd are indicated on some EDS spectra, but are laboratory procedures and are non-invasive.

Results

The EDS results are shown in Figures 2 and 3, and the explanation for each appears in it’s caption. These data were unexpected and are completely inconsistent with the mineral gypsum. As a consequence of the conflicting data (traditional identification of samples vs. chemistry), we also used high-power imaging to produce interpretable, high quality photomicrographs (Figures 4 and 5), which are morphologically consistent with kaolinite (Keller 1978; Pollastro 1990). Thus, the elements seen in the EDS represent the sum occurrence of each element from all constituent sources in a given sample (a mixture of substances cannot be discriminated) and should not be extrapolated in an effort to learn mineralogy. At this juncture, I telephoned Frisbie and learned that the two samples were in fact gathered from the traditional mines and were thought to be gypsum. The data so far were curious indeed. To strengthen the investigation, we used the collaborative tool of x-ray diffraction to achieve an association among elemental chemistry, photomorphology and mineralogy.

X-RAY DIFFRACTION ANALYSIS

Methods

Mineralogical identification of these samples was achieved by X-ray Powder Diffraction (XRD). A Phillips-Norelco Diffractometer with a Cu(copper)-tube was used and interpretation of the spectra
comply with the rules of the Joint Committee of Powder Diffraction Standards (JCPDS). The instrument is calibrated relative to quartz, and the method is non-destructive. The sample was archived.

Results

Figures 6 and 7 are graphic representations of the results of XRD which has identified both Sample #1 and Sample #2 as the mineral kaolinite (Al₄Si₂O₈(OH)₄) mixed with major quartz and a few significant, potentially differentiating minor components (or lack thereof) in each.

SAMPLE 3

A number of years then passed with little forward progress. While Frisbie and Denney found these data provocative, they needed to provide a cultural connection to show that these materials had indeed been used by the ancestral Zuni. Then in the spring of 1997, they sent a small (pocket-watch sized) chunk of wall material from Salomon Room 4 (Unit 3, 2c-1; FS#319) possessing several successive layers of white plaster, each about 1mm thick. This archaeological material dated to the late 1890s (Frisbie, pers. comm., 2001). After preparation, Sample #3 was examined using SEM/EDS and XRD.

Results

Figures 8, 9 and 10 present the results of observations on the white layers and are interpreted as follows. The feldspars (i.e., the K or potassium in the EDS) and the dolomite link the archaeological sample to the Nutria area mine (Sample #1). Figure 11, which shows the JCPDS stick file reference for kaolinite, also compares favorably.

Interpretation and Comparisons

It has been now shown that kechipa – both present and past – is the mineral clay kaolinite. It is not gypsum as stated in anthropological literature. However, some of the prehistoric peoples were aware of some sort of characteristic differences allowing them to use gypsum in several selective fashions (Kay and Phagan 1993), as shown by the following example.

At the request of Charles Adams, Director of the Homolovi Project, I traveled to the site of Homolovi in August of 1995 where I viewed a mural of the Niman Ceremony. This mural (Figure 12) was painted in white on one wall of a prehistoric kiva - excavated that season. Samples, which I recovered and analysed, provide the data in Figures 13, 14 and 15. Figures 16 and 17 present an SEM photomicrograph of gypsum grains and their EDS, respectively, for comparison with the kaolinite data from Zuni.

SUMMARY

Material called “kechipa” by the Zuni has been subjected to a variety of analyses, resulting in a conclusive identification of each sample as kaolinite. A survey of the pertinent literature shows that kechipa has long been called gypsum by anthropologists. Yet, Hodge (1907) actually described this substance well when he called it “spreading grit”. Even one Zuni I talked to in January, 2001, said kechipa means “gritty natural plaster”. Another called it “clay”. It’s likely that these two resident Zunis and their ancestors were
relying upon traditional understanding “of the ways” of this material rather than its chemistry. Kaolinite and gypsum are actually quite different physically, chemically, and in “the way they behave”. So the confusion may lay in the translation of the term.

Unfortunately, misidentification of materials is not an isolated phenomenon (for instance, that of red pottery slip, paste and decoration—Kay 1999). Now that the personnel, instrumentation, and reference materials are available, this particular problem can be addressed on a more regular, systematic basis.

ACKNOWLEDGEMENTS

The author thanks the following individuals and institutions for providing technical assistance.

• John E. McLane, Adolph Coors Brewing Company, Golden, Colorado.


• Ric Wendlandt, Colorado School of Mines, Golden.

FIGURES

FIGURE 1
A Zuni house interior of the 1890s, with white-washed walls that assist the lighting effects of the roof hatch and the oil lantern.

Photo Archives, Museum of New Mexico, Negative 5047.
Photographer Ben Wittick.
FIGURE 2
The EDS of the bulk Sample #1 shows the sum of constituent elements O (oxygen), Mg (magnesium), Al (aluminum), Si (silica), K (potassium), Ti (titanium) and Fe (iron). Note: There is no Ca (calcium) or S (sulfur) which constitute gypsum (see Fig. 10). Nutria collection site.

FIGURE 3
The EDS of bulk Sample #2 shows the sum of constituent elements O, Al, Si, Ti, and Fe. Note: No Ca or S (see Fig. 13). Kechipauan collection site.
FIGURE 4
SEM photo of the matrix in Sample #1 showing typical, characteristic platy structures consistent with layered silicates such as kaolinite (x8000). Salomon farmstead, Lower Nutria, New Mexico.

FIGURE 5
SEM photo of the matrix in Sample #2 showing typical, characteristic platy structures consistent with layered silicates such as kaolinite (x8000). Kechipauan site.
FIGURE 6
XRD mineralogical spectrum of Sample #1 establishing quartz, kaolinite and potassium feldspars as major constituents and dolomite as a minor presence in Sample #1. Kechipa from near Nutria, Zuni, NM.
Note: Spectrum is read right to left.

FIGURE 7
XRD mineralogical spectrum of Sample #2 establishing quartz and kaolinite as major constituents. Kechipa from Kechipauan, Zuni, NM.
Note: Spectrum is read right to left.
FIGURE 8
EDS of the white plaster (Sample #3) showing O, Mg, Al, Si, K, Ca and Fe (consistent with an aluminum silicate). Recall that the peak just to the right of Si is the Au coating. No Ca or S is present (see Fig. 4 and 5).
Salomon Farmstead, Room 4, Unit 3, FS 319, Lower Nutria, NM.

FIGURE 9
SEM thermo-photomicrograph (Sample #3) on heat sensitive paper of the undisturbed in situ layer showing platy structures consistent with kaolinite (see Figs. 5 and 6). However, in this case they are disarrayed by craftsmen’s workings. (x~7000), 2C-1, FS 319, Room 4, Unit 3 Salomon Farmstead, Lower Nutria.
FIGURE 10

XRD of bulk powder of archaeological white plaster (Sample #3) establishing kaolinite, quartz and feldspars as major constituents and dolomite as a minor presence. No gypsum is present. Consistent with and suggesting the Nutria mine of sample 1 as the source.

NOTE: Gypsum is seen at 11.5 degrees (on the bottom scale of an XRD) if it is present (not seen here). Kaolinite is seen at 12.5 degrees (seen here) (see Figs. 11 and 15). Room 4, Unit 3, 2C-1, FS 319, Salomon Farmstead, Lower Nutria, NM. Note: Spectrum is read left to right.

FIGURE 11

JCPDS stick file of kaolinite for reference...the portion of the spectrum called the "fingerprint area". Most significant information here given in degrees 2 Theta. Compare with Figure 15. (Not the same scale). Compare the degree bar at the bottom of Figures 10, 13, and 14 to the top of Figure 11.
FIGURE 12
An all-white pigment, prehistoric kiva mural of the San Francisco Peaks found at Homolovi. Note the spiral directly below the author's pointer, Homolovi State Park, Arizona. Photo by author, 1995.

FIGURE 13
EDS of Homolovi mural pigment fragment showing the elements O, Mg, Al, Si, S and Ca, again each representing the sum. Here the intensities imply relative abundance of Ca and S which is consistent with major gypsum or anhydrite.
FIGURE 14
XRD of bulk powder sample of the Homolovi mural establishing and identifying nearly pure gypsum, with only trace (CaMg)CO₃, (magnesium calcite) and the ever-present quartz. Compare with Kechipa Fig. 6 and 7. Spectrum is read left to right.

FIGURE 15
The same XRD spectrum as Fig. 14 showing the JCPDS stick file for reference. Compares with Fig. 11.
FIGURE 16
SEM photo of typical weathered gypsum grains to aid in comparison with those structures seen of kaolinite plates shown in Figs. 4 and 5.

FIGURE 17
EDS of Figure 13 showing the elements O, Si, S, Ca and Fe. Here, also, the intensities imply relative abundance of Ca and S as in Fig. 13.
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In the summer of 1972, archaeological excavations were conducted at Site LA 27951 (North Ponil 1) as part the Philmont Scout Ranch summer archaeology program. For over 40 years, the archaeology program has provided a hands-on opportunity for Scouts to learn about the scientific methods of archaeology. The Scouts excavate and screen cultural fill under the supervision of the archaeological program staff who provide instruction and interpretation. Tours are also given to several rock art panels and nearby archaeological sites in the North Ponil Canyon. In this paper, I present a brief description of a Pedregoso Phase (A.D. 700-900) structure excavated as part of the archaeology program.

Site LA 27951 is located in the North Ponil Canyon on the upper part of the terrace along the North Ponil Creek (Figure 1), near Cimarron, New Mexico. The site elevation is 2,140 m (7,020 ft). The North Ponil Creek has cut into the early Tertiary Poison Canyon and Raton formations (Figure 2). The Poison Canyon formation forms the cliffs while the Raton formation is exposed as talus slopes. The valley fill is Quaternary sand and gravel (Robinson et al. 1964:Plates 2,3).

The modern vegetation includes Gambles oak (Quercus gambelli), piñon (Pinus edulis), cottonwood (Populus sp.), juniper (Juniperus monosperma and J. scopularorum) and a few ponderosa pine (Pinus ponderosa) trees. Historic photographs show that at the turn of the century, the canyon was filled with ponderosa pine trees, that were being harvested for mine timbers and railroad ties. Now, 100 years later, it appears that ponderosa pine are becoming reestablished. Grasses and annual forbs, notably sunflowers (Helianthus annuus), lambsquarters (Chenopodium album), pigweed (Amaranthus retroflexus), and Rocky Mountain beeweed (Cleome serrulata) grow on the valley floor. Shrubs include banana yucca (Yucca baccata), squawbush (Rhus trilobata), mountain mahogany (Cercocarpus sp.), and chokecherry (Prunus americana).

PREHISTORIC CULTURAL CHRONOLOGY

The Cimarron District and the adjacent region has sparse evidence of Paleoindian and Archaic occupation when compared to the later Anasazi occupation. Projectile points from private collections include Folsom points and stemmed Archaic
FIGURE 1
Location of Site LA 27951 (NP 1) in the Cimarron district (map by Linda P. Hart) (3-D map)

FIGURE 2
Site LA 27951 seen from Site LA 28019 (NP 69); (a) Pedregoso Phase, (b) Escritores Phase, (c) Ponil Phase (Slab House), looking down canyon (Kirkpatrick 1972)
TABLE 1
Cimarron District Chronology (after Glassow 1972a:Table 1)

<table>
<thead>
<tr>
<th>Period or Phase</th>
<th>Duration</th>
<th>Dating Method</th>
<th>Dating Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jicarilla Phase</td>
<td>A.D. 1750-1900</td>
<td>Ceramic</td>
<td>Cimarron Micaceous</td>
</tr>
<tr>
<td>Cojo Phase</td>
<td>A.D. 1550-1750</td>
<td>Ceramic</td>
<td>Ocate Micaceous</td>
</tr>
<tr>
<td>Cimarron Phase</td>
<td>A.D. 1200-1300</td>
<td>Ceramic</td>
<td>Cimarron Plain; Neck-banded, Incised, Punctate and/or Santa Fe B/w</td>
</tr>
<tr>
<td>Ponil Phase</td>
<td>A.D. 1100-1200</td>
<td>Ceramic</td>
<td>Taos Incised or Punctate</td>
</tr>
<tr>
<td>Escritores Phase</td>
<td>A.D. 900-1100</td>
<td>Ceramic</td>
<td>Kiathuthlanna or Red Mesa B/w</td>
</tr>
<tr>
<td>Pedregoso Phase</td>
<td>A.D. 700-900</td>
<td>Radiocarbon 1200 +/- 80; 1195 +/- 80 (UCLA 1369a and 1369b)</td>
<td>Radiocarbon 1460 +/- 50 (UCLA 1407); Circular stone wall structures</td>
</tr>
<tr>
<td>Vermejo Phase</td>
<td>A.D. 400-700</td>
<td>Projectile point styles</td>
<td>Stepped dart points</td>
</tr>
<tr>
<td>Archaic Period</td>
<td>pre-A.D. 400</td>
<td>Projectile point styles</td>
<td>Folsom point</td>
</tr>
<tr>
<td>Lithic Period</td>
<td>?</td>
<td>Projectile point styles</td>
<td></td>
</tr>
</tbody>
</table>

points as the diagnostic artifacts (Glassow 1972:115-116). Anasazi populations began around A.D. 400 and continued to ca. A.D. 1300 (Table 1). The ceramic assemblages reflect a cultural relationship with the Anasazi populations in the northern Rio Grande region, including the Taos area. The area appears to have been abandoned until occupation by the Apache and Utes from ca. A.D. 1550 to ca. A.D. 1880s. Previous research in the Cimarron District and northeastern New Mexico has been presented in more detail in Kirkpartrick (1976a, 1976b).

PREVIOUS RESEARCH
AT SITE LA 27951

The first archaeological work was conducted by Eugene Lutes in 1956, who started the archaeological program. He excavated the architectural feature now known as the Slab House, a three room surface structure dating to the Ponil Phase (Lutes 1959). From 1963 through 1969, Michael Glassow conducted his excavations at the site, and at other sites. In the North Ponil Canyon, his work focused on the Escritores Phase pithouse and the Pedregoso Phase activity area north of the Slab House.
In 1972, the author continued the work in the Pedregoso Phase area, excavating an underground storage cist (Kirkpatrick and Ford 1977) and the structure described in this article. Field notes and artifacts are curated at Philmont Museum, Philmont Scout Ranch, Cimarron, New Mexico.

STRUCTURE 1, A POSSIBLE RAMADA

The excavations took place in Area 2 (E component) of Site LA 27951. The Pedregoso Phase is analogous to Basketmaker III of the Pecos developmental sequence. Previous excavations by Glassow revealed numerous underground bell shaped roasting ovens and storage pits, borrow pits, rock alignments, post holes, a broad activity area, and two possible pithouses. The area also had abundant amounts of fire-cracked and reddened rocks from the roasting ovens. Artifacts include flat grinding slabs, one-open-end trough metates, and about a dozen crude and thick pot sherds (Glassow 1972: 118-110, 135). He obtained radiocarbon dates of A.D. 750 (1200+/– 80 UCLA 1369a) and A.D. 755 (1195+/– 80 UCLA 1369b) on wood remains from hearth related contexts (Glassow 1972:256).

On Glassow's recommendation, the author's excavations were carried out in a series of grids on the west side of Area 2. Excavations from previous years indicated that there were several ovens and storage
pits and possibly a structure. Three different cultural strata were found above the floor. The top stratum was medium brown colored alluvium with a few artifacts. The next stratum was tan and gray colored with fire-reddened and fire-cracked rocks plus abundant charcoal fragments plus flakes, and burned bone. The third stratum was tan and sandy with fire reddened and cracked rocks, burned adobe fragments, flakes, and burned animal bone. Pottery sherds were not found in any of the levels.

The structure had been shallowly excavated into sterile native soil on the west side, and the east side had a low bank above sterile soil (Figures 3 and 4). Based on fire-reddened lines, the structure appears to have been 7.3 m (24 ft) long and 3.6 m (12 ft) wide. The excavated floor is relatively flat and level. Three post holes were found on the long axis of the structure. No other floor or subfloor features were present, including formal hearth features. Numerous rocks, the majority being fire-reddened, were scattered across the floor. The structure appears to have burned, based on the presence of fire-reddened lines around the perimeter, ash deposits, two areas of burned timber fragments, and burned roof adobe with timber impressions. The only artifacts found on the floor were two manos.
Because of the absence of good evidence for the superstructure, we offer the following speculative reconstruction. The only post holes found were the three spaced along the central axis of the structure, suggesting a central support rafter was used. Post holes were absent around the edge of the structure. This may indicate that any structural elements used on the sides were temporary and not set into the ground for more permanent stability. Whatever form the superstructure took, it had to have been substantial enough that when it burned, the heat caused the iron to oxidize and create the reddened soil. It is possible that the structure was not enclosed on all sides but only on two or three sides, making it a ramada rather than an enclosed habitation. This way, the occupants could view the rest of the activity area, as well as the valley floor.

Because a formal hearth was not found, the origin of the fire that burned the structure is unknown. It is possible that a shallow hearth was present and had been obliterated with any post-burning use of the area. Or sparks from an exterior hearth could have landed in the superstructure. While it is often assumed such fires are caused by accidents, the third possibility is that the ramada had been deliberately burned.

DISCUSSION

The Pedregoso Phase represents a time of change, as populations were shifting from hunters and gatherers to agriculturalists. As populations became more dependent on agricultural crops, they spent more time at one location, presumably to develop and maintain their fields and nurture their crops. Macrobotanical remains from an underground storage pit (Feature 64) near the structure, plus those from Site LA 28284 (MP 4) and Site LA 28019 (NP 69), both Vermejo Phase sites, were analyzed (Kirkpatrick and Ford 1977). The analysis revealed that native plant foods continued to be important to the diet, and may have been encouraged to grow in the agricultural fields.

With longer periods of occupation, people would have created features for storage and for processing food, as well as for defining exterior areas for activities and habitation. This is the case at Site LA 27951, where there are at least two possible pithouses, numerous underground ovens and storage cists for corn and other plant resources, and the possible ramada structure.

ACKNOWLEDGEMENTS

I would like to thank Michael A. Glassow for his support by providing me with my first opportunity to do independent field work. His assistance with getting me involved with the Philmont Scout Ranch and its archaeology program is greatly appreciated. I would also like to thank Robert Bums and David Spirtes who stood many hours in the North Ponil Creek doing water flotation for the macrobotanical samples from Feature 64.
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SETTLEMENT PATTERNS, POPULATION, AND CONGREGACION ON THE 17th CENTURY JEMEZ PLATEAU

Since 1990, there has been increasing recognition that the archaeology of historically documented periods has a greater role to play in our understanding of the encounter between Europeans and Native Americans. As Lightfoot’s review of California contact studies indicates, the use of archaeology as an independent method of historical investigation has been a revelation to many (Lightfoot 1995:202-204). To some extent, Southwestern researchers have long combined ethnohistory, documentary history, and archaeology to create a fuller picture of 16th and 17th-century native culture change. Modern Southwestern archaeology began with the excavation of historically known communities, including those conducted by Kidder at Pecos, Hodge at Hawikuh, Hewett at Guisewa, Nelson at the sites of the Galisteo, and Brew at Awatovi. However, most of this research flowed from historic documents to sites as subjects of research; Kidder, for example, selected Pecos for excavation so that his knowledge of the site could proceed from the historic known into the prehistoric unknown. Recent investigations in the Southwest, however, have internalized Lightfoot’s revisionist direction for archaeological research into the late prehistoric and early historic periods (Wendorf and Reed’s [1955] late Classic and Historic periods—A.D. 1500-1700). The work of some, including Preucel at Old Kotyiti (Preucel 2000), Ramenofsky at the Chama Valley sites of Ponsipa Akeri, Tsama and Nute (Ramenofsky 2000), and Lycett at the historic component of Paa-ko (Lycett 2000) have focused on Native American Pueblo occupations not under Spanish control. Others, such as Ramenofsky’s excavations at Comanche Springs (Ramenofsky et. al. 1998) have illuminated early Spanish occupations excluded from conventional colonial narratives.

There is good reason to chart a conjunctive role for multiple disciplines in the examination of the late prehistoric and early historic periods in the Eastern Pueblo world of the Northern and Central Rio Grande Valley. That reason relates fundamentally to the nature of the documentary record for these periods and this area. The problem is not quantity. While there is a dearth of records from the 16th century, prior to colonization, a large volume of records exist from the 17th century, as Scholes’s landmark research in the Archivo General de Indias, and Archivo General de la Nación revealed earlier in this century (Broughton 1993), and as the
prolific results of the Vargas project have more recently demonstrated (Kessell 1989, Kessell et. al. 1992, 1995, 1998). Rather, the primary factor limiting research has been the kinds of data available. Prior to the Pueblo Revolt of 1680, only records which were of relevance to higher ecclesiastical or secular authorities, such as mission supply or legal documents (Scholes 1930; 1937-41), were sent out of the province, and hence survived the Revolt (Beers 1979). Other documents, maintained at missions or in Santa Fe, were destroyed. In terms of documentary history, 17th century New Mexico is a black box. While the discovery of new documents in the future will certainly be of value (Wilson 1992), such discoveries cannot fundamentally correct for the lack of certain classes of documents which were maintained in the province rather than sent south to higher authorities.

One discipline particularly hobbled by this systematic bias in the survival of documents is historical demography. The very types of documents with which historical demographers ply their craft, tax and tribute records, and parish records of births, deaths and marriages (Willigan and Lynch 1982), are the very types of documents which were kept at the local level and destroyed in the Revolt of 1680 (Beers 1979:68; Gutierrez 1991:105). According to Beers, the only vital records to survive the 1680 Revolt are two prenuptial investigations dated to 1678 from Santa Clara (Beers 1979:70). Other vital records from Santo Domingo were documented by Fray Dominguez's inventory of New Mexican ecclesiastical documents in 1776, but were apparently later destroyed by floods in 1886 (Beers 1979:70).

Historical demography can be a valuable and powerful tool for assessing the nature and causes of population change among Pueblo populations, as Levine and LeBauve's (1997) analysis of post-Revolt vital records from Pecos has demonstrated. The lack of vital records or other data proxies such as tribute records for the 16th and 17th centuries, however, has led to intractable debate regarding the size of Protohistoric Eastern Pueblo populations from non-demographic population estimates alone (Dobyns 1983, 1990, 1993; Palkovitch 1985, 1994; Reff 1987, 1991; Upham 1986, 1992). We know that the Spanish entry and occupation of the U.S. Southwest had a profound impact on the size and structure of Puebloan populations; all sides agree on this. Determining the timing and magnitude of the demographic impacts, however, will require the creation of testable models of population change, on one hand, and data sets for testing those models, on the other. For both model construction and testing, we need to look to documentary history, historical demography, paleodemography, and demographic archaeology.

This paper focuses on population changes among the Pueblo population of the Jemez Plateau. The Jemez is well-suited to a demographic investigation which combines the methods and data of both archaeological and historical demographic approaches for two reasons. First, the mode of Spanish missionary policy on the Jemez, population congregación, has been examined elsewhere in the Spanish Borderlands for its demographic effects. Therefore, it is possible to generate some quantitative expectations for the consequences of missionization in the Jemez from these other examples. Second our knowledge of the Classic and Historic
archaeological settlement record is reasonably complete, allowing some ability to assess the actual results of Spanish mission policy on Jemez population

CONGREGACION: POLICY AND EFFECT

Congregación and reducción were mission-related Spanish colonial policies in New Spain designed to reorganize Native American settlement patterns. Beginning in the late 1500s, congregación was undertaken as a result of one of two circumstances. First, native populations which lived in small, dispersed communities were congregated to facilitate the process of proselytization, and instruction in European methods of farming and stock-herding by the various Catholic orders who established mission communities among the natives of New Spain. Second, congregation took place as reducción as native communities shrank in size as a result of disease and other factors contributing to population decline (Jackson 1994a:13).

Congregación was mission policy for much of the Spanish Borderlands where populations were either hunter/gatherers or subsistence agriculturalists who lived in dispersed communities, including Texas, northwestern Mexico, southern Arizona, and Baja and Alta Californias. In greater Florida and New Mexico, where native populations already resided in aggregated sedentary communities, congregación was generally not a policy, as either missions or visitas (unstaffed mission facilities) were established at pre-existing settlements (Weber 1992).

Robert Jackson has assessed the demographic effects of congregación on the native populations in several of the regions of the Spanish Borderlands, including the Californias, Arizona, and Texas (Jackson 1994a, 1994b, 2000: Chapter 5). Notwithstanding the effects of epidemic disease prior to colonization and missionization, Jackson concludes unequivocally that the process of congregación and the conditions of mission life led to a significant decline in native populations in each area the policy of congregación was enacted. In general, there are three factors, which characterized the demographics of congregated mission populations in all four areas studied by Jackson (Alta and Baja California, Southern Arizona, and Texas).

First, death rates exceeded birth rates. Second, mean life expectancy at birth remained lower than age of viable reproduction. And third, population levels were maintained only by congregating new converts, or by the reduction of several mission communities into a single settlement (Jackson 1994a, 1994b). The most logical explanation for the non-viability of mission populations was the occurrence of mortality crises in the form of introduced European epidemic diseases (Reff 1991). Missions served not only to facilitate disease transmission by crowding together potential hosts, raising morbidity, but missions also acted as endpoints for disease vectors, such as travelers, and resupply ships and trains. But Jackson points out that, while mortality events from disease were both common and devastating, they were in fact less prevalent than in Europe during the same period (Jackson 1994a:68).
In addition to adult mortality due to epidemic disease, Jackson implicates a combination of low fertility and high infant mortality as being the key factors behind long-term trends of population decline among native mission populations (Jackson 1994a:126; 2000: Chapter 5). High infant mortality appears to have been a consequence of the decreased sanitary conditions brought on by aggregating previously dispersed populations, which increased the prevalence of endemic ailments, and decreased nutrition. Over the long term, sustained infant mortality increased the mean age of the remaining population and depressed fertility as fewer females survived to reproductive age. In addition, policies, which discouraged reproduction, such as keeping men and women in separate dormitories, and high mortality among women of child-bearing age, also depressed fertility rates. More than high mortality, reductions in fertility may be the key to understanding why native populations in the Spanish Borderlands failed to recover from mortality crises of epidemic diseases, either as a consequence of disease introduction prior to Spanish colonization, or after the policy of congregación was put into effect. The role of fertility in Native American population decline is underscored by the forces which led to the growth and unexpected recovery of native populations after 1900. While not identifying a single factor, Nancy Shoemaker notes that the removal or amelioration of several causes of infertility, low fertility, and infant mortality, including abortion, wide birth spacing, tuberculosis and other endemic illness among mothers was a major contributor to Native American population growth over the last century (Shoemaker 1999).

Where the effects of congregación have been measured, the policy was devastating to native populations. Whether congregación in particular, or missionization in general, had the same effect on Eastern Pueblo populations cannot be assessed from historic documents alone, due to the lack of the necessary documents for population reconstruction. In the Jemez, examination of the settlement record can give some indication of the effectiveness of Franciscan mission policy, and its potential effect on Jemez population change during the 17th Century.

**JEMEZ SETTLEMENT PATTERNS**

The Jemez Plateau stretches from the confluence of the Jemez and Salado Rivers at the present-day town of San Ysidro on the south to Redondo Peak on the north, and from the Sierra Nacimiento on the west to the line of Peralta Ridge on the east. The area includes not only the Plateau proper, which is composed of long, north-south oriented mesas divided by deep, narrow canyons, but also the broad alluvial plain to the south where the present-day Jemez Pueblo (LA 8860) is located (Figure 1).

There is little evidence for substantial Developmental (pre-AD 1175) occupation of the Jemez, with a few sites known on the Jemez River flood plain and adjacent terraces from the village of Cañon south (Elliot 1991; Wiseman 1976). Many more sites may remain buried beneath the recent alluvium deposited since AD 600 by the Jemez River, the Rio Guadalupe, and Vallecitos Creek (Rogers 1996). The Coalition Period (AD 1175-1350) is well defined by unit- and small pueblo settlements, but these are mostly
FIGURE 1
Physiography of the Jemez Plateau, North-Central New Mexico. Shaded relief image from the Resource Geographic Information System, Earth Data Analysis Center, University of New Mexico.
confined to the canyon bottoms and alluvial floodplains of the southern portion of the Plateau (Elliott 1992, 1998). The greatest expansion of settlement occurred during the Classic Period, according to what Michael Elliott (1991) defines as the Jemez phenomenon. There are three characteristics to this phenomenon, which begins after A.D. 1400. The first was an increase in regional population and the expansion of settlement out of the Jemez River floodplain and associated drainages onto high altitude (2000+ meters) mesa tops. The second was the emergence of a dual settlement pattern of large pueblos of greater than 50 rooms and small limited activity field house sites of less than 5 rooms. The third was appear-
The combination of a lack of major post-World War II excavations and a current absence of seriated local ceramic types has meant that our understanding of the record of settlement succession in the Jemez is poor; in fact, in a recent survey of northern Rio Grande site data, Crown et al. (1996:191) give the Jemez their worst rating for data quality. However, working from surface collections of imported ceramics, and through qualitative observations of local ceramic change, Elliott (1991:21) has been able to create a rough description of settlement succession on the Jemez Plateau. In the period from 1350-1425, a variety of medium-sized villages, termed Plaza Pueblos, ranging in size from 50 to 600 rooms were constructed, along with attendant field houses, as well as a few larger pueblos, or Great Kiva sites (Figure 2). The bulk of the occupation was concentrated on the eastern portion of the Plateau, on the mesas on either side of Paliza Canyon, and along Vallecitos Creek. After 1425, most smaller pueblos were abandoned and settlement shifted to fewer and larger Great Kiva sites; field houses increase in number, and are located further away from large pueblos (Figure 3). Overall, settlement shifted to the west, the bulk concentrated in the Cañon de San Diego and the mesas west of that drainage, although occupation on the more easterly mesas persisted (Elliott 1991:21).
those Indian mountaineers, induced them to live in a pueblo, which with their help he founded in a very suitable place of this same nation" (Hodge et. al. 1945:69).

It is unclear how many pueblos were occupied on the Jemez Plateau during the first part of the 17th century, but Zarate, according to documents, reduced the number to two communities, the mission community of San Jose, at Guisewa (LA 679), and a second community of San

**FIGURE 3**
Distribution of plaza pueblo and great kiva sites, Jemez Plateau, during the late Classic Period, AD 1500-1650.
Diego, most likely located at Walatowa (Bloom and Mitchell 1938; Scholes 1938). After 1634, San Diego is the only mission community mentioned in documentation, and San Jose was certainly abandoned prior to 1658 (Scholes 1938).

Given Jackson’s quantitative assessment of dynamics in congregated mission populations, a substantial decline in Jemez population is to be expected through the majority of the 17th century. That proposition, however, cannot be assessed from the documentary evidence alone. First, we are unable to assess whether congregación was an effective policy in the Jemez area, as the Jemez mission in particular, and the Plateau region in general, are seldom mentioned in 17th century documentation (Scholes 1938). Indeed, most references to the area refer to troubles in the missionization effort, including the murder of a priest in 1639, the suicide of another in 1661, and uprisings and conspiracies by the Jemez and other nations throughout the 1640s and early 1650s (Scholes 1938).

Second, we cannot assess the actual effects of congregación through vital records as was done by Jackson for other portions of the Spanish Borderlands. What documentation there is indicates that the Jemez might have suffered substantial population decline through the first portion of the 17th century (Table 1). According to late 16th century estimates, Jemez population may have been as high as 30,000 (Hammond and Rey 1966), although this figure is in dispute (compare Palkovitch 1985 and Upham 1992). After 1623, Zarate reported baptizing over 6,000 individuals, and by the second half of the 1620s, according to Benavides, half of these had died (Ayer 1916:25). A total population of 1,860 was reported for the Jemez in 1642 (Scholes 1938:95). While

### TABLE 1

**Historic Estimates and Population Data for the Jemez, A.D. 1541-1752**

<table>
<thead>
<tr>
<th>Date</th>
<th>Reporter</th>
<th>Population Size</th>
<th># of Villages</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1541</td>
<td>Barrionuevo</td>
<td>7 or 10*</td>
<td></td>
<td>Hammond and Rey 1940:259</td>
</tr>
<tr>
<td>1581</td>
<td>Gallegos</td>
<td>15</td>
<td></td>
<td>Hammond and Rey 1966:107</td>
</tr>
<tr>
<td>1583</td>
<td>Espejo</td>
<td>30,000</td>
<td>7</td>
<td>Hammond and Rey 1966:223-224</td>
</tr>
<tr>
<td>1598</td>
<td>Oñate</td>
<td></td>
<td>11</td>
<td>Hammond and Rey 1953:322</td>
</tr>
<tr>
<td>1622</td>
<td>Zarate</td>
<td>6566</td>
<td>2</td>
<td>Millich 1966:26</td>
</tr>
<tr>
<td>1629</td>
<td>Benavides</td>
<td>3000</td>
<td>2</td>
<td>Ayer et. al. 1916:25</td>
</tr>
<tr>
<td>1642</td>
<td>None listed</td>
<td>1860</td>
<td>1</td>
<td>Scholes 1929:48</td>
</tr>
<tr>
<td>1680</td>
<td>Vetancurt</td>
<td>5000</td>
<td>1**</td>
<td>Vetancurt 1698:(431)100</td>
</tr>
<tr>
<td>1706</td>
<td>Alvarez</td>
<td>300+</td>
<td>1</td>
<td>Hackett 1923-37:(3)376</td>
</tr>
<tr>
<td>1752</td>
<td>General Census</td>
<td>207</td>
<td>1</td>
<td>Simmons 1979:185</td>
</tr>
</tbody>
</table>

*3 sites are identified as ‘Aguas Calientes’; these may be large sites in the Cañon de San Diego, or may refer to large sites located in the Ojo Caliente drainage northeast of present-day San Juan.

**Vetancurt states that prior to congregación, there were 5 Jemez pueblos.
Vetancurt (1698) listed a population of 5,000 at Jemez directly prior to the revolt, only between 200 and 600 were observed in the early 18th century, in the wake of the Revolts of 1680 and 1696, and the first actual enumeration of the Jemez, in 1752, recorded only 207 individuals (Simmons 1979:185). Regardless of what may be interpreted from any of these estimates at any point in time, one cannot arrive any closer to assessing the effects of congre-gación on populations from these numbers alone, insofar as—excepting the enumeration of 1752—the numbers do not constitute data, in that they are not aggregates of individual observations. Stated another way, estimates are not counts of individual people; nor are they observations regarding those peoples ages, or dates of birth or death, all facts critical to the demographer's ability to assess the validity of a particular count (Willigan and Lynch 1982). In that respect, estimates cannot serve as a substitute for vital records, which examine population change from a data perspective. This is not to say that any or all of the estimates made by Spanish observers of the 16th and 17th centuries were incorrect; it simply means that there is no objective or quantitative method for assessing the validity of the observers, and we are instead left to opine regarding their reliability (Upham 1992, Palkovich 1996: 187-189).

Nor can the archaeological record serve as a direct substitute or proxy for population reconstruction via vital records. On a certain level, the types of reconstructions made possible by the large-scale year-by-year dating of construction sequences at some Southwestern sites (Ahlstrom 1989; Crown 1991; Dean 1969) do allow for the assessment of population dynamics at a comparable scale. Crown and Kohler's (1994) reconstruction of changes in household organization at Pot Creek in particular echo the results of demographic studies from vital records such as family reconstitution, in analytical if not data similarity. But few sites enjoy such a high level of chronological resolution, or have the large-scale excavations, which make the reconstruction of community dynamics possible. On a more practical level, there has been little excavation conducted at large Jemez Classic period sites, precluding even the possibility for fine-grained population reconstructions.

**The Large Site Record**

In the Jemez, two domains of archaeological evidence are available for examining population change, large pueblos and small field house sites. The first, large pueblos, manifests itself as surface assemblages. At present, due to the complexity of occupation at large Rio Grande Classic pueblos, determining the timing and intensity of occupations at these long-lived sites is not possible from dating via ceramic surface assemblages alone (Cordell et. al. 1994). However, ceramic chronology from surface assemblages should provide information about the termination of site occupation (Ramenofsky 2000), which in turn can be used as a measure of assessing the success of congre-gación as a policy for modifying native settlement patterns.

In the Jemez, two particular temporal indicators in surface ceramic assemblages at large sites can be employed to measure site termination (Table 2). The first are qualitative changes in Jemez Black-on-white through time (Elliott 1991). The second is the occurrence of imported wares, primarily Rio Grande Glaze wares (Elliott 1982). The former indicator, early Jemez
# TABLE 2
Ceramic Dates for Large Jemez Classic Pueblos

<table>
<thead>
<tr>
<th>LA #</th>
<th>Site Type</th>
<th>Early</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
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<td>96</td>
<td>Mission</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>123</td>
<td>Plaza</td>
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<tr>
<td>128</td>
<td>Plaza</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>Great Kiva</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Plaza</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<td>189</td>
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</tr>
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<td></td>
<td></td>
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<td>Mission</td>
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<td>X</td>
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</tr>
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<td>Refugee</td>
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<td>X</td>
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<td>Plaza</td>
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<tr>
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<td>Plaza</td>
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<td>X</td>
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</tr>
</tbody>
</table>

* Includes Vallecitos b/w, early Jemez b/w, Glaze A-C.

** No Glaze F was found at LA 6680; however other types contemporaneous or later than Glaze F were recorded from waterline excavation trenches (Dodge 1982:64-71)

All dates are from Elliott (1982), except for: LA 679 and 2048, from Warren (1979), LA 6680 from Dodge (1982).
Black-on-white, which dates to between A.D. 1350 and 1500 (Elliott 1994), allows for the segregation of large and medium-sized pueblo communities abandoned prior to European arrival in the New World, 16 of the total 38 sites. The occurrence of late Glaze wares, D, E, and F series types date the remaining 22 communities. The dates given in (Table 3) for each of the three series are for the initial appearance of the series; the termination date for each series is not given.

It is legitimate to ask at this juncture whether the surface ceramic data available (Elliott 1982) constitutes an accurate reflection of the range of occupation at large and medium-sized Jemez communities, as much of the data is derived from subjective grab samples such as those conducted by Mera in the 1930s. The validity of the surface data can be roughly assessed by comparing the data available from Elliott (1982, 1991) regarding the ceramics present at LA 123 to the substantial excavated assemblage from that site (Reiter 1938). According to Elliott, only Glaze D and E are present in the surface assemblage; however, the excavated assemblage contains Glaze A, C, D, and E (Reiter 1938). When the dates from the surface ceramics are compared to the tree-ring dated occupation of the site however, the surface evidence dates the initial occupation of the site as too late (ca. 1400 according to the tree-rings), but accurately indicates the termination of the pueblo (after ca. 1605)(Reiter 1938:178).

According to the surface ceramic assemblages, of the 22 large and medium-sized communities occupied after A.D. 1500, eleven of these sites have occupations which post-date Spanish efforts of congregación (Table 4; Fig. 4). Of these, three sites are mission sites, and a fourth has only a refugee component. The remaining seven, however, indicate occupation of large Jemez communities outside of the context of mission life. There are several possible interpretations of why and how these sites continued to be occupied in the 17th century. First, it is possible smaller Plaza Pueblo settlements were eliminated

### TABLE 3
Initiation Dates for the Manufacture of Glazes

<table>
<thead>
<tr>
<th>Series</th>
<th>Composite Initiation Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glaze A (Red and Yellow)</td>
<td>1300-1350</td>
</tr>
<tr>
<td>Glaze B</td>
<td>1325-1400</td>
</tr>
<tr>
<td>Glaze C</td>
<td>1425-1450</td>
</tr>
<tr>
<td>Glaze D</td>
<td>1425-1490</td>
</tr>
<tr>
<td>Glaze E</td>
<td>1425-1515</td>
</tr>
<tr>
<td>Glaze F</td>
<td>1550-1650</td>
</tr>
</tbody>
</table>

Dates are derived from Breternitz (1966), Mera (1940), Sundt (1987), and Warren (1979). As Elliott’s descriptions of surface collections do not discriminate between types in each series; differing dates for each type are not given but are reflected in the range of the composite date. As more recent authors have observed (Breternitz 1966; Sundt 1987), the tree-ring dates for the last three of these series are poor. With this in mind, I have followed Haas’s (pers. comm.) suggestion that the date of first manufacture is all we can ascertain at present from the Rio Grande Glaze ware series.
as a consequence of congregación, but larger sites continued to be occupied. Six of the seven sites that indicate continued occupation are Great Kiva sites, and according to Elliott’s estimates of site size, these six are among the eight largest sites on the Jemez Plateau (Elliott 1991:31). Tree-ring dates from one of the sites, LA 136, suggest occupation during the 1650s and 1660s (Scholes 1938:94). Scholes suggested that this site might have been a visita to the San Diego mission at Walatowa (LA 6680), indicating continuing use of these settlements despite the formation of the mission communities. Second, it may be that Plaza Pueblo settlements were abandoned as part of a continuing process of aggregation independent from Spanish efforts of congregación, and remaining larger communities continued to be occupied. On the adjacent Pajarito Plateau, aggregation into fewer and larger
TABLE 4
Non-Mission, Non-Refugee Jemez Large Pueblos Occupied after ca. A.D. 1650

<table>
<thead>
<tr>
<th>LA #</th>
<th>Site Type</th>
<th>Ceramics Present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Early</td>
</tr>
<tr>
<td>96</td>
<td>Mission</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>137</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>189</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>248/2</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>303</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>373</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>385/3</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>395</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>398</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>403</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>478</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>479</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>481</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>482</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>483</td>
<td>Plaza</td>
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<tr>
<td>484</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>499</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>541</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>679</td>
<td>Mission</td>
<td></td>
</tr>
<tr>
<td>1825</td>
<td>Refugee</td>
<td></td>
</tr>
<tr>
<td>2048</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>5914/5931</td>
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<td></td>
</tr>
<tr>
<td>5918</td>
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<td></td>
</tr>
<tr>
<td>5920</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>6680</td>
<td>Mission</td>
<td></td>
</tr>
<tr>
<td>24553</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>24788</td>
<td>Great Kiva</td>
<td></td>
</tr>
<tr>
<td>24789</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>24790</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>24792</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>44000</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>44001</td>
<td>Plaza</td>
<td></td>
</tr>
<tr>
<td>46340</td>
<td>Plaza</td>
<td></td>
</tr>
</tbody>
</table>
sites through time is a documented pattern through the Classic Period (Kohler 1989; Orcutt 1991). And although less well documented, this pattern of aggregation appears to hold true for the northern and central Rio Grande as a whole (Cordell 1989). Or third, Plaza Pueblo settlements may have been abandoned as a consequence of depopulation from the introduction of epidemic diseases, and the remaining populations were consolidated into a few larger communities. Through both direct contacts with Spanish explorers and indirect connections to Central Mexico, it is possible that epidemics of European diseases affected Eastern Pueblo populations on several occasions during the 16th century (Dobyns 1983:15-23, 1992; Upham 1986, 1992). In any case, these remaining occupations indicate at least the partial failure of the policy of congregación among the Jemez during the 17th century.

The Small Site Record

A second source of archaeological evidence, occupations at small and limited activity sites, including the field house sites ubiquitous to most portions of the Jemez Plateau, support the notion that congregación in the Jemez was to some extent unsuccessful. Small site evidence is divided into two groups: the results from excavations of small sites, and information from surface ceramic assemblages from sites located on survey. At least two small sites with occupations dating to the middle portions of the 17th century have been excavated. The first, Bj 74 (LA 38962) is a small five-room pueblo built into a rock overhang on the south slope of the Banco Bonito, overlooking the East Fork of the Jemez River. The pueblo was excavated by the University of New Mexico in 1939 and 1949 (Luebben et al. 1988). While ceramic evidence indicates occupations at Bj 74 rockshelter dating back to the late Coalition or early Classic, the ceramics from the 5-room structure include Kotyiti Glaze polychrome (Glaze F), Zia paste red, and Mission Period red, suggesting an occupation after A.D. 1650 (Luebben et al. 1988:114). The second site, LA 69562, is a two-room field house located at the eastern base of Cebollita Mesa, just west of the confluence of San Antonio and Redondo Creeks. The Albuquerque-based contract firm TRC excavated the site as the land on which the site was located passed out of Federal government ownership (Acklen and Railey 1999). While somewhat ambiguous when taken as an aggregate, at least one of the chronometric dates from the site, a tree-ring cutting date from A.D. 1642, indicates either the construction or the repair of the field house during the middle 17th century.

Both the small pueblo of Bj 74 and the field house LA 69562 are unusual when compared to other excavated Jemez small sites dating to the 15th and 16th centuries (Elliott et. al 1988; Elliott 1991; Gauthier and Elliott 1989). Bj 74, in particular, is unusual, as it features 13 burials and a large chipped stone assemblage, neither of which are known from other excavations of small sites dating to the Classic period. While LA 69562 is a more conventional field house, several cached storage and serving vessels were found at the site, along with possible milling facilities. Together the two sites suggest that small, seasonally occupied sites were utilized more intensively during the early historic period by those abandoning or opting out of mission communities.
Surface evidence from field houses indicates that Bj 74 and LA 69562 are not anomalous. In a literature review and survey of potential 17th century field house sites conducted by the author in 1998 and 1999 for the Jemez mesas east of the Cañon de San Diego, at least 18, 17th century field houses were identified based on the presence of Glaze F sherds or Jemez Black-on-white bowl rims mimicking Spanish vessel forms (soup plates; see Lambert 1982)(Figure 5). Four other 17th century field houses were not identified from the literature survey, but were through a field inspection of a random sample of 36 field houses. Like Bj 74 and LA 69562, these field house sites yield more diverse ceramic assemblages, and more chipped and ground stone when compared to field houses dating to the

FIGURE 5
Distribution of early Historic Pueblo field house sites on the eastern Jemez Plateau, AD 1625-1700. Only sites known from the eastern portion of the plateau are shown; an unknown number of additional sites may be present west of the Rio Jemez.
13th through 16th centuries (Kulisheck 2000). Many of the 17th century sites also have extramural features, such as thermal stains, thermal rock concentrations, and bin-shaped rock alignments, which are unknown from earlier field houses (Figure 6). These 22 sites are a small percentage of the nine hundred-odd field house sites identified in a literature review of the eastern Jemez Plateau conducted by the author in 1998. But four of the sites identified as dating to the 17th century were field identified; they did not appear as dating to the early historic period based on their descriptions from previous recorders. This suggests that the total number of 17th century field houses on the eastern portion of the plateau is probably significantly higher; the number of early historic field houses on the western portion of the plateau is unknown. The 22 eastern plateau field houses, along with LA 69562 and Bj 74, suggest a widespread resistance not only to Spanish attempts at resettlement, but also to the Spanish effort to transform traditional Pueblo farming practices.

Taken together, the large and small site evidence indicate that an unknown but apparently significant number of Jemez Plateau natives opted out of mission communities and continued patterns of settlement and subsistence carried over from the period prior to missionization and congregación. A close examination of the scant documentary evidence relating to the Jemez Plateau in the 17th century provides some explanation for the failure of congregación in the Jemez. Resistance to missionary process was apparently consistent among the Jemez, from Zarate’s first efforts in the 1620s up to the time of the revolt in 1680 (Scholes 1938). While the mission at Jemez was maintained throughout the 1600s, that the mission population represented a true congregation of all Jemez populations may be more an idealization on the part of Benavides and Vetancurt (see Reff 1994), who described the congregation of the Jemez population, rather than the actual compliance of the Jemez themselves to the policy of congregación. Unlike in California (Jackson 1991, 1994a), it appears that the New Mexican Franciscans had little support
from secular authorities to ensure compliance with their efforts to resettle Jemez populations. On the contrary, secular authorities were often accused by missionaries of encouraging disobedience on the part of the Jemez and other Eastern Pueblo nations (Knaut 1995; Scholes 1936-37). While the surface ceramic evidence alone cannot quantify the degree to which non-mission pueblos and field houses continued to be occupied and utilized following attempts at congregación, the convergence of both archaeological and documentary evidence strongly suggests that the numbers were significant.

CONCLUSION

The above exercise hardly constitutes a model conjunction of historical and archaeological approaches to native demography at contact. In particular, it provides no insight on quantitative changes in the size of Jemez populations through time. Quantitative data on changes in population size will be necessary for resolving controversy regarding the timing and severity of population decline as a result of the introduction of European diseases.

However, indirect inferences regarding population change are possible. If congregación as a Spanish policy was effective on the Jemez Plateau, according to Jackson’s study of the effects of this policy elsewhere, population decline during the greater portion of the 17th century should have been dramatic. The settlement evidence, however, indicates that Spanish success at congregación may have been sporadic at best, meaning that population decline, if it actually took place in a significant fashion, was not attributable to direct Spanish policies. Such a finding does not preclude declines in Jemez populations during the 17th century from indirect consequences of the Spanish occupation of the Eastern Pueblo area, including epidemics and raiding by non-Pueblo groups. Population declines and abandonments are documented for other portions of the upper and middle Rio Grande region (Schroeder 1979a, 1979b, 1992).

The exercise does suggest that pursuing archaeological tests of historical propositions may be a fruitful avenue of research in contact studies of native population change (Ramenofsky 2000). While the archaeological record does not constitute a proxy for historical documents such as vital records, much of the weakness of the comparison of the Jemez settlement record to the propositions generated by Jackson’s demographic work on congregación result from a poverty of archaeological evidence from the Jemez, not from structural problems with the archaeological record as a source of demographic data. Improvements in dating surface assemblages, through more systematic investigations of large sites, and additional information about the dating of both glaze wares and endemic Jemez ceramics, will serve to clarify the process of site abandonment in the Jemez, and by extension, the timing and cause or causes of population decline.

ACKNOWLEDGEMENTS

An earlier version of this paper was presented at the 61st Annual Meeting of the Society for American Archaeology in New Orleans in 1996. Awards from the Arizona Archaeological and Historical Society, and the Dedman College Graduate Student Assembly of Southern Methodist University supported the paper. Major support for the fieldwork discussed in the paper was provided by Wenner-
Gren Foundation for Anthropological Research Dissertation Improvement Grant No. 6356. Additional fieldwork support was provided by the Institute for the Study of Earth and Man at Southern Methodist University, and by the New Mexico Historic Preservation Division.

Mike Adler and Ann Ramenofsky provided helpful comments on earlier drafts of this paper. David Wilson provided assistance in the preparation of diagrams. The ideas presented herein are my own.

ENDNOTES:

1 Decline in nutrition and increases in the impact of epidemic diseases are confirmed by paleopathological studies of the skeletal remains of Native Americans interred at missions in Florida (Larsen et al. 1990, 1996), Texas (Miller 1996), and Arizona and New Mexico (Stodder 1996, Stodder and Martin 1992).

2 The identification of two bin features at LA 69562 as milling bins appears to be based on the morphology of the features. There were no milling stones found at the site; the lithic analyst of the excavation suggested that milling stones may have been removed prior to the abandonment of the site (Torres in Acklen and Railey 1999:106). However, this conclusion is counterintuitive considering that at least 7 bowls and jars were left cached at the field house. No pollen or macrobotanical samples were analyzed from the possible milling features.

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ANTHROPOLOGY AND ARCHAEOLOGY IN CHACO CANYON
THE HYDE EXPLORING EXPEDITION

The words Chaco and the Hyde Exploring Expedition bring to mind Richard and Marietta Wetherill, the multistoried architecture of Pueblo Bonito (Figure 1), and artifacts that are outstanding in Southwestern prehistory. Discovered 100 years ago, the wealth of ceramics, lithics, wood, turquoise, shell, copper, and macaws reported by George Pepper have not been equaled elsewhere in sites from that period, and the large network that linked Pueblo Bonito to other places throughout the San Juan Basin between A.D. 900 and 1150 continues to be a fascinating topic of discussion. But there is more to this early story in which Richard Dodge (a geologist from Columbia University), William Curtis Farabee (a physical anthropology student from Harvard), and Ales Hrdlicka (a physician then affiliated with the American Museum of Natural History) all play a role.

Although the excavations at Pueblo Bonito were officially halted after investigations by S. J. Holsinger, a special agent from the General Land Office in Phoenix in 1901, these researchers pursued other interests. Because all of these men were linked to the Hyde Exploring Expedition and Frederic Ward Putnam (Curator of the Harvard Peabody Museum of Archaeology and Ethnology from 1874 to

FIGURE 1
Overview of Pueblo Bonito prior to excavations in 1896. Negative No. 16. Courtesy of the American Museum of Natural History Library.
1909 and Peabody Professor since 1887, part-time chair and Curator of the Department of Anthropology at the American Museum of Natural History from 1894 through 1903, and Director of the Hyde Exploring Expedition at Pueblo Bonito) (Phillips 1973), we can ask whether their projects were part of a broader research perspective of Putnam. If so, how did this effect participants involved with the expedition?

In 1895 when Richard Wetherill proposed excavations in Chaco Canyon to Benjamin Talbot Babbitt Hyde and Frederic Erastus Hyde, Jr., two young men who had accompanied him on earlier archaeological excursions in the Four Corners Area of the Southwest, he could not have envisioned the outcome. Frederic Hyde was a student of Frederic W. Putnam (Wissler 1922:347). Putnam had assisted George M. Wheeler assemble reports resulting from earlier explorations in the Southwest (Putnam 1879) and was familiar with reports on Chaco Canyon by Simpson (1850, 1852, 1964) and Jackson (1878). He understood the potential of excavating a large site, such as Pueblo Bonito, as well as the need to carry out this work within a broader anthropological framework (Hinsley 1999; Williams 1973). Here the work sponsored by the Hyde Exploring Expedition will be reviewed and the inference will be made that Putnam had much broader visions for the work in Chaco Canyon than Wetherill could have imagined.

RESEARCH OF THE HYDE EXPLORING EXPEDITION

No explicit research design for the Hyde Exploring Expedition has been recorded. The clearest statement of broad goals appears in Putnam (1900:166): “This expedition, which is supported entirely by the brothers B. T. B. Hyde and Fred E. Hyde, Jr., of New York, is planned for long continued and exhaustive research for the purpose of learning the true history of these prehistoric ruins in New Mexico, and the relation of their builders to the pueblo peoples of a later period and of the present time.” Snead (1999:260) quotes a letter from Talbot Hyde to Richard Wetherill in which the project would involve comparative study of the Uto-Aztecan stock. It is only by combining information from several reports of projects sponsored by the expedition that we can infer that Putnam’s research goals encompassed a broad range of anthropological questions that were not limited to Pueblo Bonito and that required multi-disciplinary efforts. Studies funded by the Hyde Exploring Expedition included geology, archaeology, ethnology, and physical anthropology; they were carried out by students and associates of Putnam.

Geology

Both George H. Pepper (1920:23) and Clark Wissler (1920:1-2), Curator of Anthropology at the American Museum of Natural History, indicate that geological studies undertaken by Richard E. Dodge of Columbia University during two seasons (1900 and 1902) were included in Putnam’s overall research plans for the excavations at Pueblo Bonito. (Snead [personal communication, 2000] indicates that Hyde introduced Dodge to Putnam.) The results of Dodge’s studies were to be correlated with the cultural information found during excavation. Pepper (1920:23) indicates that Dodge’s geological studies were also carried out to construct an accurate plan map of Pueblo Bonito.
FRANCES JOAN MATHIEN

Dodge (in Pepper 1920:23) reports that he addressed three topics of study during his first year of work: 1) geographical conditions at the time of the Pueblo occupation as compared with then present conditions; 2) any evidence of climatic or geographical change; and 3) any evidence as to the lapse of time since the desertion of the pueblos by their ancestral inhabitants. During his second year of fieldwork, Dodge (in Pepper 1920:24) examined a number of profiles in the excavations, in the trash mound, and on the cliff on the north side of the canyon, as well as mapped surface streams and arroyos at least between Pueblo del Arroyo and Pueblo Bonito. He was able to demonstrate changes through time, both prehistorically and historically. In addition to the information that was specific to the arroyo and other features in the area of Pueblo Bonito (Dodge 1910), Dodge wrote a paper on winds in the Chaco area (Dodge 1901), a landslide (Dodge 1902a, 1902b, 1903), and arroyo formation in the Chaco area (Dodge 1909, 1910).

Studies of Human Populations

As part of the work carried out during the excavations at Pueblo Bonito, Pepper (1920:376) indicates that there was an emphasis on finding a cemetery associated with Pueblo Bonito. He was aware that one had been found previously west of and near Pueblo Pintado, and he assumed there would be a similar cemetery for each of the large pueblos in the canyon. In 1896, the first year of excavation, Pepper and Wetherill spent considerable time and effort searching two small mounds on the south side of the Chaco Wash (Pepper 1920:339-351) and the Trash Mound in front of Pueblo Bonito (Pepper 1920:26) for human remains.

Similar pursuit of human remains was carried out in 1901 when two students from Harvard, Alfred Marsden Tozzer and William Curtis Farabee, explored four mounds and two masonry sites located approximately eight (8) miles west of Pueblo Bonito (Andrews 1970). Tozzer also assisted Putnam in the excavation of human skeletal remains at the Picture Cliffs Site (29SJ426) near Peñasco Blanco. In an appendix to Andrews’ (1970) report on this work, Farabee provides an analysis of the skeletal material. Unfortunately, most of the human remains were “in such an advance state of decay that it was impossible to preserve any long bones and but few fragments of skulls—no perfect ones.” As a result, Farabee retained only the fragments of six skeletons. He compared his material with other extant prehistoric collections. It is inferred that an understanding of the similarities and differences among prehistoric populations was among the goals of this work.

Understanding the physical characteristics and health of historic Native American populations was part of the larger research program. Ales Hrdlicka (1908) indicates that five of his six seasons in the Southwest between 1898 and 1905 were sponsored by the Hyde Exploring Expedition. McNitt (1991:241) indicates that Hrdlicka was director of the physical anthropology section of the Hyde Exploring Expedition, that he was present in Chaco frequently between 1899 and 1903, and that he (sometimes with the help of Marietta Wetherill) measured skeletons removed from the excavations. Hrdlicka measured the heads of Navajo living in the Chaco area and further west. His report includes studies of other Native
American tribes throughout the south-western states, excluding California, but including northern Mexico.

In 1899 during a visit to Chaco Canyon, Putnam also explored the area around Kin Neole (Kin Bineola)(Figure 2). Exactly what he did is not known, but Akins (1986:17,Table 1) indicates that 72 burials were recovered near Kin Bineola in 1899-1900 by Hrdlicka and that burials from Kin Neole are among those curated at the American Museum of Natural History. Akins (1986:10) also indicates that Orian Buck and Richard Wetherill both collected materials that were later purchased by the AMNH (Buck’s 1897-1898 material) or the Chicago Field Museum (Wetherill’s collection from the World’s Fair of 1904 in St. Louis).

Ethnological Studies

Ethnological studies were carried out by both Pepper and Tozzer. Pepper (1902) reported on the processes involved in making a Navajo blanket; he later (Pepper 1905a) described a Navajo man who, although confident with modern medicine, found it necessary to employ a medicine man to totally cure his cold and pneumonia. Pepper suggests a lesson to modern physicians who, in our culture, treat the physical problems; the need to consider traditional medicine that deals with the psychological is important when working with people of other cultures.

Tozzer was most interested in ethnology. Andrews (1970:4) reports that in a letter to his parents Tozzer had his first taste of archaeology in Chaco. The work that Farabee was doing did not appeal as much as his own research on linguistics, myths, and customs which was “headier” and more interesting. Three reports written by Tozzer (1902, 1908, 1909), based on this 1901 field work, focused on religious aspects of Navajo culture. Whether this work was supported by Hyde is not clear. Putnam (1901) indicated that one student studied language and myths of the Navajo courtesy of a generous patron of the Peabody Museum; this patron could have been Talbot Hyde.

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**FIGURE 2**

Kin Neole
(Kin Bineola) irrigation ditch in September 1899.
Putnam sits on horse in center of photograph.

Negative No. 1479.
Courtesy of the American Museum of Natural History Library.
FIGURE 3

Archaeological Excavations
The excavations at Pueblo Bonito were the main focus of the Hyde Exploring Expedition (Figure 3). Richard Wetherill, who had worked with Gustav Nordensjold at Mesa Verde, had considerable field experience and was acquainted with the basic tenants of stratigraphic excavations. (Reyman [1989] indicates that Pepper's unpublished field notes demonstrate basic stratigraphic concepts were employed during the excavations.) Other methods of excavation and recording were specified (Wissler 1920:1-2); careful measurements of rooms and observations of artifacts were to be kept, and a photographic record of important objects would record their in situ locations, all goals that Putnam had been teaching his students (Hinsley 1999:145).

Between 1896 and 1899, 190 rooms in Pueblo Bonito were excavated; the artifacts removed from this great house were so numerous and unusual that this work established Pueblo Bonito as a center in the prehistoric pueblo world. Pepper published a number of reports on this work; several dealt with specific rooms and their artifacts (Pepper 1899, 1905b, 1906, 1909) and one (Pepper 1920, 1996) addressed the entire site. The material in this volume includes tables constructed by Talbot Hyde (Pepper 1920:352, editor's note), and an appendix on ceramics from the trash mound excavated during two weeks in 1916 by Nels C. Nelson, with the assistance of Earl Morris. What Nelson found was not exclusively trash; there also was material from construction. Nelson also provided pottery descriptions and improvements to the map of Pueblo Bonito.

Excavations in smaller sites were carried out in 1901 by Tozzer and Farabee. In addition to the four burial mounds eight miles west of Pueblo Bonito, they excavated two structural sites. One, called the House Site (Figure 4), was a 17 x 60 ft. rectangular structure that had eight rooms. The other site, located on top of a mesa to the north, they called Wetherill Mesa Pueblo (Figure 5)(Andrews 1970). Farabee estimates this site to have had 40 rooms. One complex of rooms in the East
Group contained a key-hole kiva. The West Group of six rooms comprised a semi-circle 60 ft. long with a kiva on the open side and a circular room behind it. Andrews (1970:1-2) suggests that although Farabee prepared a hand-written report, the expedition "provided no major archaeological discoveries or contributions to the field, and it was probably for this reason that the material was not published."

**DISCUSSION**

The few published reports that resulted from these studies do not fulfill expectations of the "long continued and exhaustive research" expressed by Putnam (1900). This can be attributed to the problems that arose in 1900 and 1901 when investigations resulted in the closing down of excavations at Pueblo Bonito. The acquisition by Wetherill of antiquities from the local Navajo who were excavating other sites led to accusations of looting. By 1898 the Hydes were involved in financing trade in the area, and Snead (1999:262-263) suggests the two endeavors, archaeology and trade, often were confused and caused lack of focus for the project.

Problems were evident in the spring of 1900 when the Santa Fe New Mexican ran several articles about professional pot hunters vandalizing the ruins in Chaco Canyon. McNitt (1991:188) indicates that Edgar L. Hewett, President of the New Mexico Normal School and someone who was interested in the prehistoric ruins throughout the Southwest, had complained to the General Land Office which then sent Special Agent Max Pracht from Santa Fe to Durango to investigate these claims. Pracht did not go to the canyon because of the distance and time involved in travel. Based on inquiries in Durango, he advised the Secretary to work directly with Putnam to clear up the matter.
Pracht thought the undertaking was scientific, that it would take many years to complete, and that the material was going to the American Museum of Natural History. He knew of no law to prevent the exploration of ruins on public lands and thought that either a Presidential order or a system of permits and licenses issued through the Department of Interior would be needed to stop such excavations and prevent looting of sites for financial gain. The first round of investigations caused little worry.

On November 16, 1900 the Santa Fe Archaeological Society drafted a resolution requesting the Secretary of the Interior and Commissioner of the General Land Office to investigate the ruins of northwestern New Mexico, particularly those in Chaco Canyon, in order to preserve them and prevent them from destruction. Because of the political weight of Governor J. Bradford Prince who was involved in this complaint, on December 8, 1900 Commissioner Hermann assigned S. J. Holsinger, an agent in Phoenix to carry out a second investigation. At that time Commissioner Hermann also sent an order to Putnam to halt excavations at Pueblo Bonito pending the outcome of this investigation. Because travel in winter was not recommended, Holsinger did not appear in Chaco Canyon until April 23, 1901 to investigate the alleged plundering of antiquities from Pueblo Bonito (McNitt 1991:197). Like Pracht, Holsinger could find no misdeeds committed regarding the excavations. The materials were donated to the American Museum of Natural History. The trading post business that also was supported by the Hyde brothers was in order; the only complaint he could make was about the homestead claim of Wetherill, which had been switched from the agricultural area that included Kin Klizhin to the section that included Pueblo Bonito, Pueblo del Arroyo, and Chetro Ketl. Because Wetherill had failed to plant the prescribed number of acres of crops, the Commissioner interpreted Wetherill’s claim as a bid to possess the ruins (even though Wetherill offered to give them to the government) and issued a permanent order forbidding excavations in Pueblo Bonito.

McNitt (1991:203-208) indicated that Talbot Hyde had withdrawn support for the Hyde Exploring Expedition by 1902. By January 1903 he had bought out Fred’s share, was again manager of the Hyde Exploring Expedition, and Wetherill was relieved of all connections with the company that had heavily invested in trading posts during 1901. All assets of the Hyde Exploring Expedition were purchased in the spring of 1903 by J. W. Benham, an Arizona man who in 1902 became the manager for the expedition in New York.

Snead (1999:263) indicates that the decision to halt archaeological fieldwork in Chaco also had been made internally by 1901 and that efforts to catalog, publish, and exhibit finds came to the forefront. For all practical purposes, anthropological research by the Hyde Exploring Expedition in the Chaco had ceased. The work of Nels C. Nelson, who returned to Pueblo Bonito briefly in 1915 and for two weeks in 1916, was funded through the American Museum of Natural History.

In summary, several excavations were funded by the Hyde Exploring Expedition: Mounds on the south side of Chaco Wash, the trash midden at Pueblo Bonito, Pueblo Bonito, the Picture Cliffs burial, four small
mounds eight miles west of Pueblo Bonito, plus the House Site and Wetherill Mesa Pueblo. Although a number of individuals worked in Chaco Canyon at this time (Table 1), not all were supported by the Hyde Exploring Expedition. For example, in 1897 Warren K. Moorehead removed material from Rooms 53 and 56, now considered a part of the central burial complex at Pueblo Bonito. Moorehead’s purpose was to collect museum specimens for his patron, Charles S. Peabody (Moorehead 1906:33) – a common goal of archaeologists at the time, but one that soon would be superceded. His contrasting goal, collection alone, reflects different attitudes toward archaeology that were shifting slowly at that time.

Snead (1999) documents the changing attitudes and practices that occurred at the end of the nineteenth century. The practice of patronage, wherein wealthy sponsors (collectors and museums) often employed amateurs and professionals to obtain materials for private or public display was evolving into a more scientific approach to the study of man. Using Chaco and the Hyde Exploring Expedition as his case study, Snead examined the changing relationships between the sponsors and institutions, as well as the internal politics and personnel changes that affected the research in Chaco Canyon. Competition among department heads,

### TABLE 1
Research events related to the Hyde Exploring Expedition in Chaco.

<table>
<thead>
<tr>
<th>Date</th>
<th>Researcher</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1896-1899</td>
<td>George Pepper, Richard Wetherill and Company</td>
<td>Burial Mounds south of Pueblo Bonito</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trash Mounds at Pueblo Bonito</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pueblo Bonito</td>
</tr>
<tr>
<td>1897</td>
<td>Warren K. Moorehead</td>
<td>Pueblo Bonito: Rooms 53 and 56</td>
</tr>
<tr>
<td>1899</td>
<td>Frederic Ward Putnam</td>
<td>Kin Neole (Kin Bineola) area</td>
</tr>
<tr>
<td>1901</td>
<td></td>
<td>Picture Cliffs burial</td>
</tr>
<tr>
<td>1900, 1902</td>
<td>Richard Dodge (Columbia University)</td>
<td>Geological studies</td>
</tr>
<tr>
<td>1901</td>
<td>Alfred Marsden Tozer</td>
<td>Picture Cliffs burial (with Putnam)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wetherill Mesa Pueblo</td>
</tr>
<tr>
<td>1901</td>
<td>S. J. Holsinger (General Land Office)</td>
<td>Investigation into HEE</td>
</tr>
<tr>
<td>1898 - 1905</td>
<td>Aleks Hrdlička (Smithsonian Institution) (5 of 6 seasons sponsored by HEE)</td>
<td>Physical anthropology: Measurements of skeletal material from Pueblo Bonito and probably Kin Bineola, measurements of historic populations</td>
</tr>
</tbody>
</table>
among institutions, and between institutions in both the east and west, all affected the outcome. These were not issues that Richard Wetherill would have foreseen.

In addition to these shifting concepts among professionals and their relationships to sponsors was the campaign to preserve archaeological sites. By 1900 there was a draft before Congress of what became the Antiquities Act of 1906. In the Southwest, Hewett was particularly active in trying to preserve the Pajarito Park, but he also worked toward including many other archaeological areas from loss. Holsinger (1901) recommended boundaries for a Chaco Park; they were much larger than what was set aside as Chaco Canyon National Monument in 1907.

Given the climate of the times and the need to find sponsors for the work, Putnam may have found it best to take advantage of whatever opportunities presented themselves, whether they be funding by the Hyde brothers or scholarly interests of students and colleagues. As a result the role of individuals such as Wetherill diminished. Although a talented excavator and field manager, his needs and desires no longer coincided with those of Hyde and Putnam. Today as we try to understand Chaco Canyon and its role in Pueblo prehistory we have only a partial picture of the goals and results of the Hyde Exploring Expedition.

ACKNOWLEDGEMENTS

James E. Snead graciously read an earlier version of this paper, offered comments, and provided some information that will appear in a forthcoming volume. His input is much appreciated. Any errors in this presentation, however, are mine and not his.
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Firecracker Pueblo appeared to be a small and unremarkable pueblo when first visited in 1975. Located along Highway 54 in northeast El Paso, Texas, and 8 km south of the Texas-New Mexico border, the leveling of sand dunes had revealed adobe walls of what was thought to be a pueblo of some 6 to 10 rooms. Between 1975 and 1979, additional grading of the site area exposed more walls, dark soils, and a variety of ceramic and stone artifacts. Temporary fireworks stands were also placed on the site during this period and prompted its naming. Furthermore, vandals had begun limited digging in several rooms, and the area became part of an industrial park. Fearing greater damage or loss of the site, formal excavations to document this site were started in the summer of 1980 and ended ten years later.

Volunteers provided the direction and work force for the project, and literally hundreds participated in the excavation on weekends, holidays, and on occasion for one or two weeks in the summer. The youngest volunteer was four; the oldest over 80. Many were members of the El Paso Archaeological Society, but the location of the site next to a major highway lured numerous passersby into providing their assistance. Television and newspaper coverage also stimulated interest. Professors in a variety of disciplines from The University of Texas at El Paso spent time at the site, as did their students (sometimes for credit). Summer classes in art and archaeology through the local science museum included fieldwork at Firecracker Pueblo and an analysis of artifacts from the site. In 1986, the Texas Archaeological Society held its fieldschool at the site and over 200 participated in the eight-day event (Figure 1).

FIGURE 1
Pueblo room excavation, 1986 fieldschool of Texas Archeological Society.
The many years of work at Firecracker Pueblo reflected a necessary schedule of intermittent fieldwork by volunteers. However, a great deal of work was also required by a research design that included a systematic and extensive investigation of extramural areas and the discovery that the site was larger and more complex than first expected. Prior to the investigation of this site, there had been no systematic excavation of areas outside of pueblo rooms in the Jornada region. The testing of extramural areas revealed numerous and varied features, superimposed structures, and considerable trash. Some findings were expected; others were intriguing. Certain and more important aspects of this investigation are summarized here.

THE PUEBLO

It was anticipated that Firecracker Pueblo would be like many other El Paso phase pueblos of the Jornada region. At the time the excavation was begun, nearly 300 rooms had been excavated in more than two dozen sites (Marshall 1973; O’Laughlin 1982). Patterns exhibited by these rooms were: a tendency toward large size, hearths near the center of south or exterior walls, a variable posthole pattern, a normal distribution of floor areas skewed toward larger rooms, and no appreciable patterning of floor area and features (O’Laughlin 1985). Rooms generally had the same features regardless of

FIGURE 2

Plan of Firecracker Pueblo, Showing Structures and extramural features.
whether a site consisted of one or over
100 rooms. Smaller rooms often had two
primary roof supports on the east-west
axis of rooms, and larger rooms frequently
had four primary roof supports located
toward room corners. Very large rooms of
over 25 sq m were noted as having multi­
ple floor features, a pattern of two hearths
and other small pits along the north-south
axis, and a frequency of occurrence of
about one large room for every six to 10
rooms. Kiva, communal room, and clan
room were terms used to describe these
very large rooms (see Marshall 1973).

Some large pueblos with rooms arranged
around a plaza were known, but the over­
whelming majority of sites consisted of
one or more room blocks or pueblos with
a single or sometimes a double tier of
rooms oriented east-west. Excavations at
Firecracker Pueblo revealed that this was
a pueblo with the expected architectur­
al details.

The pueblo of Firecracker Pueblo turned
out to be larger than foretold by the sur­
fice evidence. However, room arrange­
ment, floor areas, floor features, and other
architectural details were generally as
anticipated. The pueblo consisted of 15
to 17 rooms in a one to two room wide,
linear, east-west room block (Figure 2).
The exact number of rooms was uncertain
with erosion of walls and floors in the
west central portion of the pueblo. Walls
were of adobe, and floors of plastered
caliche. Most measurable rooms ranged
in size from 7.8 to 20.2 sq m, had hearths
near the centers of the south walls, and
possessed two primary postholes. A larger
room of 28.1 sq m displayed a four-post
pattern. The largest room and possible
communal room had four primary post­
holes, two hearths and small pits along
the north-south axis, and a floor area of
54.2 sq m. Secondary postholes and mis­
cellaneous pits were encountered in some
of the rooms. Posts and beams were of
juniper and cottonwood, and secondary
posts and smaller beams were of mesquite.

Roof materials included mesquite, dropseed grass, reed, and stalks of yucca,
agave, and sotol. There was little evi­
dence for the modification or mainte­
nance of rooms, and few artifacts were
found on the floors and within the fills of
rooms. Construction had begun with a
core of two or four rooms, with rooms then
added to the east and west.

Excavations outside of the room block led
to the discovery of a small room against
the south side of the pueblo. It had an
unplastered floor of only 0.9 sq m and
lacked floor features. A similar room of
1.5 sq m was located 8 m south of the cen­
ter of the pueblo room block. Its position
above an earlier structure and several
extramural features suggested that it
belonged to the same occupation as the
pueblo room block (Figure 4). Small
rooms such as these had rarely been noted
in the Jornada region (O'Laughlin 1999),
and they may be underrepresented with
past emphasis on the excavation of
pueblo rooms. These "closets" undoubted­
ly served a limited range of activities that
possibly included storage.

Extramural excavations also led to the
finding of an isolated room that was at the
western edge of the site and that had
attributes indicative of occupation at the
same time as the pueblo room block. This
room differed from earlier structures in
that it was nearly square in plan, had
square corners and substantial adobe walls,
was not superimposed by other structures
or features, and was not trash-filled. This
room had a floor area of 9.4 sq m, no pri­
mary roof support, a sealed hearth near the center of the east wall, and another hearth near the center of the south wall. Although not common, isolated rooms had been reported for other Jornada pueblos (Marshall 1973).

THE PITHOUSES

The investigation of areas outside of the pueblo room block quickly furnished evidence of earlier structures. Many had been cut by later features, and many had trash dumped in them. Some were also beneath the pueblo room block. All together, 17 structures were identified (Figure 2). For convenience, they will be referred to as pithouses. The majority had been excavated into the ground only 15-25 cm, but floor depths ranged to over a meter. With the exception of two structures that may have shared a common wall, they occurred as isolated rooms.

The majority of pithouses had floor areas between 6.0 and 10.9 sq m. Most structures also tended to be rectangular and fairly narrow. Floors were plastered with caliche, and caliche or adobe plaster was still present on some pit walls. Above ground, walls were probably of adobe. Nevertheless, narrow wall stubs were located for only one of these structures, and few of the pithouses had wall-fall in their fill. Substantial roof supports were apparently not needed for the narrow, rectangular pithouses, as only two of them exhibited the pattern of two main roof supports. Two of four squarish structures, however, had two major roof supports, and a third had four main roof supports. The fourth square pithouse was poorly preserved. Secondary postholes and/or small pits were present in seven of the structures. Materials used for beams and roofs were the same as for the pueblo, excepting an absence of evidence for the use of juniper and cottonwood.

Three of the shallow pithouses had doorways in their south walls. Step entries through exterior pits were discovered for the south walls of two other pithouses and the north wall of a sixth structure (Figure 3). Variable placement of hearths also suggested variable entry patterns. Five of the six observed entries had a plastered hearth near the opening; the sixth had no hearth. For pithouses with hearths, 11 hearths were near the center of the south wall, three near the east wall, and one each near the north and west walls. One of these pithouses actually had a hearth near the south wall and another near the east wall, and a second pithouse had two hearths near the east wall. Two pithouses lacked plastered hearths.
and a third structure was poorly preserved. Again, the variable location of hearths seemed to indicate doorways or other entries in walls other than just the south wall. This, of course, was not unexpected for noncontiguous or isolated structures.

Two pithouses have floor areas that differ markedly from those of the other pithouses. One of these structures was very small, possessed a floor area of only 1.3 sq m, had a step entry on the north side, lacked floor features, and did not have a plastered floor but was excavated into a caliche layer. As with the small rooms associated with the pueblo, this structure possibly served as a storage facility. Also, one other pithouse of average size, without a hearth or other notable floor features, and excavated nearly a meter into the soil likely served as a storage structure.

Some functional differences between rooms may be indicated by room size and presence or absence of hearths. However, most rooms are of similar size and have hearths and other similar floor features. Although the pithouses are generally smaller than the surface pueblo rooms, it is argued that most pueblo rooms and pithouses had very general functions that served the needs of households and included storage. Indeed, floor assemblages of burned pueblo rooms of the Jornada region illustrate this very well (O’Laughlin 1985). That storage was also an important function of pithouses of average size and with hearths is demonstrated by considerable quantities of corn and beans found within one of these structures that had burned.

The second structure that has a floor area different from the other pithouses is also the largest of the pithouses with a floor area of 22.2 sq m. This structure is unusual in having numerous floor pits, a large hearth area on the floor (i.e., not in a plastered pit), an alignment of posts in the western third of the structure without a similar pattern of posts in the eastern part of the structure, a large antechamber or step entry, and what appears to be a wall or screen of posts between the main part of the structure and the antechamber (Figure 4). It is twice the size of any of the other pithouses and is located away from the other pithouses in the eastern part of the site. Although this structure does not reach the size of pueblo rooms described as ceremonial or communal rooms, it is obvi-

![FIGURE 4](Plan of Room 31.)
ously different from the other pithouses and may have had a function like that of the large pueblo rooms.

An examination of Figure 2 reveals that there are two principal distributions of pithouses. The first is comprised of four shallow pithouses forming a rough square in the southern part of the site. These structures seem to have been oriented toward one another or the area between them. Plastered hearths, and thus doorways, are located near a different wall of each structure and toward the central area. The second group is a linear alignment of 11 pithouses that is oriented east-west and is located mostly west of the pueblo room block. With one exception, all hearths are centered on south walls. The exception is a pithouse with one hearth near the south wall and another near the east wall. The four identifiable doorways or step entries are also through south walls. Although this group includes a large number of pithouses, their linear arrangement and orientation parallels that of the pueblo room block of Firecracker Pueblo and other pueblos of the region and indicates organizational principles that must have included all of these pithouses.

Pithouses are often associated with short-term, seasonal, and intermittent occupation (Gilman 1987). Further, the pithouses of Firecracker Pueblo are believed to reflect an anticipated short-lived occupation that may have been seasonal and certainly was intermittent. Several observations bear on this inference. First, the pithouses are not substantial in construction and are small in comparison to pueblo rooms. The architectural form best documented for the El Paso phase and seen as indicative of a relatively sedentary community is the pueblo (Whalen 1981). The construction of pithouses would then suggest that the occupation was not intended to be long-lived. Second, trash areas and extramural features could not definitely be assigned with the pithouse occupation but were clearly associated with the pueblo occupation. This again would intimate an ephemeral pithouse occupation. Third, two floors in one structure and cached objects in two other structures reference an intermittent pithouse occupation. The cached objects are ground stone that includes metates, manos, pestles, and a mortar. It is also interesting that unfired clay vessels and pottery making tools were located in one of the pithouses with cached ground stone and a third pithouse.

Prior to the fieldwork at Firecracker Pueblo, pithouses had not been recorded for the El Paso phase. Not long after the first few pithouses were uncovered at this site, other pithouses and isolated or ephemeral structures began to be recognized in the region (Browning et al. 1992; Duran and Batcho 1983; O'Laughlin and Martin 1990; O'Laughlin et al. 1988). Pithouses were also identified in earlier excavations of the region (Vernon Brook, personal communication 1980; Thomas O'Laughlin, Three Lakes Pueblo field notes 1975; O'Laughlin 1999). Unlike Firecracker Pueblo, no more than four pithouses or isolated structures were reported for any of these other sites. However, interpretations of these other sites follow the above inferences of ephemeral and possibly seasonal occupation, as well as limited activities akin to field houses.

The large number of pithouses excavated at Firecracker Pueblo does raise the question of whether they represent a single occupation or multiple occupations. Two groups of pithouses have been defined, and
it is believed that structures within groups are coeval. At least, no stratigraphic or other evidence suggests otherwise, and architectural details support this belief. However, it cannot be reasoned from available evidence whether the two groups are of the same or different occupations. Similarly, it cannot be said that all structures in the larger, east-west oriented group were occupied at the same time or whether there was a mix of occupied and abandoned structures.

It can, nevertheless, be said that there was little or no lapse in time between the pit-house and pueblo occupations. Deeper pithouses and pithouses closest to the pueblo had trash dumped directly on their floors. The pithouse farthest to the east, in the east-west oriented group of pithouses, and beneath a pueblo room had been occupied long enough for walls to be darkened by smoke. Upon abandonment, the two primary posts were removed, and the walls were knocked down to fill in the structure. One of the first rooms of the pueblo was constructed immediately above this pithouse, with the post and hearth pattern matching that of the lower pithouse. It is likely that the posts and beams from the pithouse were reused in the pueblo room and that the occupants of the two structures were the same individuals.

The next pithouse to the west of this structure and also beneath the pueblo had floor and wall plaster that was in very good shape (Figure 3). It too does not seem to have been in use long before its posts were removed and caliche was dumped in the structure to a depth of 60 cm and capped with a layer of trash. The alignment of the pueblo with the east-west pithouse group additionally suggests that the shift from the pithouses to the pueblo occurred quickly. Chronometric dates also are supportive of this conclusion.

THE DATES

Corrected and calibrated radiocarbon dates for Firecracker Pueblo are presented in Figure 5. These dates should provide greater accuracy than wood because they are all from seasonally produced materials that include corn, beans, grass, and agave stalks.

As is often the case when there are multiple radiocarbon dates, some are in agreement with one another and other dating methods and some are not. In this instance, two dates from Room 20 differ significantly from one another and from the other dates. The older of these two dates would suggest occupation between the 8th and 10th centuries and earlier than the conventional dating of the El Paso phase, A.D. 1200-1400. The second date for this room spans the 12th and 13th centuries and is within the generally accepted dates of the El Paso phase; however, it is still significantly older than the other radiocarbon dates. This structure is one of the pithouses in the larger group of east-west oriented pithouses. The reason the dates from this structure fall considerably earlier than the other radiocarbon dates is uncertain, but it is believed that they are erroneous and that their deviation may be attributed to recent disturbance. This is the only structure in which modern trash had been deposited and mixed with the fill. This disturbance includes the remains of a calf, glass and can fragments, fireworks debris, and oil deposits.
Another pithouse in the larger group of east-west oriented pithouses has an archaeomagnetic date of post A.D. 1350 to A.D. 1650 (Jeffrey Eighmy, Colorado State University, letter dated Sept. 27, 1994). In addition, there are two radiocarbon dates from Room 13, a pithouse in the group of four pithouses in the southern part of the site. The two sigma range on the average of these two dates is A.D. 1401-1450. Together, these dates support a pithouse occupation in the first half of the 15th century. It has additionally been argued that the pueblo was constructed soon after the pithouses, and the dates associated with the pueblo are 15th century as well.

Rooms 2 and 4 are part of the initial or core group of four rooms of the pueblo. Features 55 and 140 are pits that underlie rooms in the western part of the pueblo, and feature 140 was also cut into a pithouse (Room 25, Figure 3). The radiocarbon dates from these rooms and features are not significantly different from one another and indicate occupation during the early or middle 15th century; the two sigma range for the average of these dates is A.D. 1429-1491.

Excepting the dates from Room 20, radiocarbon dates from Firecracker Pueblo are not significantly different from one another at the .05 level of confidence and have a combined two sigma range of A.D. 1423-1473 (Figure 5). These dates are interesting, for they provide the first real evidence that the El Paso phase was alive and well in the 15th century. Additionally, these dates narrow the gap between the collapse of the pueblo system in the Jornada region and the first Spanish entrada. When the Spanish entered the El Paso area, they found hunters and gatherers who apparently did not make pottery or grow corn. These Manso Indians may or may not be related to the earlier puebloan peoples, and some will certainly use this new evidence to argue one way or another.

### THE POTTERY

El Paso Polychrome makes up over 90% of the ceramic material from Firecracker Pueblo and is typical of the late variety of the El Paso phase (Lehmer 1948; Perttula et al. 1995). Some are of the opinion that indigenous brownwares (i.e., El Paso Brown) are part of the ceramic complex for the El Paso phase (see Carmichael 1986; Mills 1988). However, it is the writer's experience that undecorated vessels are principally restricted to miniature and eccentric forms in El Paso phase sites and that the co-occurrence of local brownwares and El Paso Polychrome of the late variety is indicative of multiple occupation and mixed assemblages. At Firecracker Pueblo, the only undecorated piece of local manufacture is a small pinch bowl.

Unfired potters clay from two of the pithouses was subjected to an X-ray fluorescence analysis as part of a regional study (Bentley 1993). One of these samples matched a clay bed not far from the pueblo, suggesting local sources for ceramic materials in addition to the on-site manufacture of pottery.

An analysis of 1,037 rims of El Paso Polychrome is also of some interest, as little other than ceramic counts is available for excavated samples from El Paso phase sites. These rims are primarily from the pueblo occupation but include a substantial number from the pithouse occupation.
and exclude obvious examples from the same vessel. It should also be noted that there were no significant differences between the rim attributes of the pithouse and pueblo occupations. To begin with, jars outnumbered bowls by approximately four to one. Less common vessel forms represented by one rim sherd each are pitchers, ladles, and terraced-rim bowls. Jars have an average orifice diameter of 28 cm while bowls average about 21 cm. Several size classes, however, can be defined for each form. Eighty-eight percent of the jar rims are everted, and 53% of bowl rims direct. The rim sherd index, a measure of rim thickening, is 1.46 for jars and 1.29 for bowls. This index is fairly high in comparison to measures from surface collections in the region and indicates thickening of both jar and bowl rims. The thickening of rims and outward flaring of jar rims are generally considered diagnostic of the El Paso phase, and these figures should assist future chronological studies.

Rim and body sherds of El Paso Polychrome were also studied for general patterns of design application. This kind of study is difficult with El Paso Polychrome, for the use of wide lines, large elements and areas of massed paint make it hard to discern designs on individual sherds. With the excavated sample from Firecracker Pueblo it is possible to appreciate design as it relates to vessel form.
(Figure 6). The overall pattern is one of black design on a field of red, with the design panels being placed on the upper exterior bodies of jars and on the interior surfaces of bowls. The exteriors of bowls, interiors of jars, and exterior bottoms of jars were not painted.

Bowls tend to have simple designs that have a bilateral or two-fold rotational symmetry. Occasional examples of quadrilateral layouts also occur. Parallel lines, dividing lines, wide stepped lines or rectangles, and opposing stepped triangles or other solid elements are common.

**FIGURE 6**
El Paso Polychrome vessel forms and designs.
The approach to jars is different, with designs applied parallel to the rim. Small vessels may have nothing more than a series of parallel lines or lines that enclose a field of repeating elements, including wide-stepped lines or rectangles and other stepped and opposed elements. Medium-sized jars show the use of larger elements, rows of repeating elements, and panel layouts that often include both a neck and a shoulder panel with similar opposing elements that are frequently appended to bordering lines. Large jars exhibit the most complex designs for El Paso Polychrome but include all the elements of design of smaller jars and bowls. The principal difference is the greater use of parallel lines and the introduction of curving lines and elements as a conspicuous part of the design.

Two aspects of design that have chronological implications are that the tops of the rims are invariably painted red and that black bordering lines are painted below the red rim and on both the exterior and interior surfaces of bowls and jars. These, as well as rim thickening, everted jar rims, vessel form, and design layout, assist in differentiating the late variety of El Paso Polychrome.

Finally, some mention should be made of intrusive ceramics at Firecracker Pueblo. Quite a variety of intrusives was recovered and include Chupadero B/W, Gila Polychrome, polychromes and other wares of the Casas Grandes culture, and what appear to be Rio Grande Glaze A sherds. These types would not be unexpected for a site dating to the 15th century. However, some types do not fit so well, though, admittedly, they are not represented by many sherds and do not make up a substantial portion of the intrusive ceramics. They include Mimbres B/W, Magdalena B/W, Three Rivers R/T, and Tucson Polychrome. The Mimbres sherds are clearly earlier, and the other types should also have died out by the 15th century. All may have been retrieved from the many sites surrounding Firecracker Pueblo or perhaps represent heirloom pieces.

FOOD FOR THOUGHT

Faunal remains are largely of jackrabbit and cottontail, with the infrequent small bird, rodent, snake, or lizard. In addition to local small game, an occasional deer or antelope was taken, field dressed and butchered, but only a few elements, including those useful for tools, were brought back to the site.

Macrofloral remains were recovered during excavation. These include corn cobs and kernels, tepary and common beans, rinds of cucurbits and gourds, mesquite seeds and pods, tornillo pods, datil seeds, prickly pear seeds, and pinyon nuts.

A large number of flotation samples from floors, hearths, and fills of structures and the contents of all varieties of extramural features were analyzed and now represent the largest and best defined botanical data set for any El Paso phase site. Many taxa were identified (Figure 7). Aside from infrequently occurring taxa, few differences were noted between location and kind of feature sampled. Important native species identified among the remains parallel wild food species reported for the Mescalero Apache of this region (Basehart 1974). Of significance is the high frequency of occurrence of both corn cobs and corn kernels and the implication of considerable reliance upon corn and probably other cultigens. Flotation samples from
only one other site in the region exhibit this diversity of plant resources and a similarly high frequency of occurrence of corn cobs and kernels (O'Laughlin 1988). This is a late Transitional or Dona Ana phase village dating to about A.D. 1200 or slightly later (Scarborough 1989). Earlier Transitional and Pithouse period sites have yielded negligible amounts of corn and very low percentages of flotation samples with corn. This would seem to indicate a greater dependence on corn, reduced residential mobility, and changes in trash disposal patterns from the late Transitional period into the Pueblo period or El Paso phase (O'Laughlin 1988).

BEYOND ROOMS

The systematic investigation of extramural areas was an essential part of the research effort at Firecracker Pueblo. This had not been attempted at a pueblo site in the Jornada region, and it was hoped that new information on extramural features and their spatial distributions would be found. The approach was simple, and eventually just over 20% of the site area outside of structures was excavated. First, a checkerboard of squares was dug with a distance between the excavated one-meter squares of three meters. Then, another square was excavated in the middle of the area defined by every four excavated squares. This was followed by expanded excavations to learn more about particular features or deposits. Finally, backhoe trenches were run north-south across much of the site. These techniques enabled the definition of stratigraphy throughout the site, the recognition of patterned distributions of features and artifacts, and the recording of 243 extramural features and one burial.

In 1980 when the work was begun at Firecracker Pueblo, an average of one burial had been recorded for every 11 or 12 rooms excavated at El Paso phase pueblos. These inhumations were also almost all adults. With the extensive and systematic testing of extramural areas and the excavation of structures, only a single burial of an 18-22 year old woman was found in an extramural area at Firecracker Pueblo. There was no evidence for a cemetery, cremations or crematory areas, no secondary burials, and no children. Given the extensive work at this pueblo in extramural areas as well as in rooms, the supposition would appear to be supported that few burials will be found in El Paso phase sites and that this reflects relatively high residential mobility and short-lived communities (O'Laughlin 1982).

Numerous extramural features and substantial and extensive trash deposits would suggest an intensive and perhaps long occupation. However, there are some things about some features that could indicate intermittent and possibly seasonal occupation. But first a general description of the kinds of features and their distributions is in order.

As noted before, most extramural features, trash middens, and the trash within pithouses can be attributed to the pueblo occupation. This was ascertained through a thorough attempt to match sherds of the same vessel, fragments of groundstone objects, and unusual materials of groundstone and chipped stone. Over half of the pueblo room floors, nearly half of the extramural features, and nearly all of the
trash-filled pithouses had matches of artifacts. No match was found for objects on pithouse floors and within extramural features.

There is a general spatial pattern to extramural features and trash. Although this pattern was smeared or transposed as rooms were added to the pueblo, particularly to the west (Figure 2), four arcuate bands can be discerned. The first band is a space next to the south wall of the pueblo that is fairly clear of features and trash. The second, comprising small hearths and some trash, lies 4-8 m from the south wall and arcs towards the east and the west ends of the pueblo. These hearths appear either as lenses of ash and charcoal or as basin-shaped pits filled with ash and charcoal. The third band, comprising most of the features and trash, lies 6 m and 15 m from the pueblo. The features are varied and include small pits, postholes, small and medium-sized pits of irregular shape, and cylindrical pits that will be discussed shortly. Trash and features are most dense immediately to the south of the core rooms of the pueblo. The final band is the perimeter defined by large barrow pits, roasting pits or ovens, and diminishing trash.

**FIGURE 7**
Floral remains from flotation samples.
The roasting pits or ovens are interesting, for they are filled with ash, charcoal, and large fragments of burned adobe. The few complete specimens of adobe are plano-convex or gumdrop-shaped in cross-section and some 12 to 18 cm in size. No rocks occur naturally in the vicinity of the site, and adobe was obviously being substituted for rock in these ovens.

Again, the addition of rooms to the pueblo had the effect of moving these arcs of features and trash outward and blurring the described pattern. This is particularly apparent for the western part of the site, while the highway has removed the eastern distribution of features. Few features and little trash were noted on the north side of the pueblo. The evident spatial structure to features and trash would suggest an intensive and perhaps lengthy occupation that demanded maintenance of space and separation of activities with conflicting requirements. Two pieces of information, however, could suggest an alternative scenario.

First, nearly all of the ground stone associated with the pueblo occupation was found buried in extramural pits. These are not well worn and broken pieces of groundstone, but rather, are massive and little used metates and manos. If this represents caching behavior, it may indicate intermittent or seasonal occupation.

Second, there are 47 pits with circular outlines, vertical sides, and flat bottoms cut into a caliche layer. They are not plastered, but some contain shaped fragments of adobe that could be taken as evidence for a support for some sort of cover or seal of the opening. These pits range from 50 cm to 2 m in diameter and have surviving depths of 40 cm to 60 cm. Most are layered with trash and sand deposits, but some are filled only with clean blow sand.

These cylindrical and enigmatic features have been called storage pits when found in Pithouse or Archaic period sites of the region and the Southwest. However, exterior storage pits are not anticipated for adaptations with some dependence on corn and puebloan architecture (Gilman 1987). Exterior storage pits are often associated with populations that are seasonally mobile or practice some residential mobility and do not have a heavy reliance on stored foods (DeBoer 1988). In this case, storage pits function to conceal foodstuffs when the area is not occupied. If these features are storage pits and were used to conceal food, then they would provide yet additional evidence for intermittent occupation and residential mobility. Additional study is required before definite statements are possible. Nevertheless, it is noteworthy that similar extramural pits are not common on Pithouse period sites, but are fairly numerous (about 35) on the previously mentioned late Transitional period village with abundant evidence of corn (Scarborough 1989; Whalen 1994).

CONCLUDING REMARKS

Dryland farming of beans was practiced in the vicinity of Firecracker Pueblo as recently as 1915 (Land Office Survey Records, Bureau of Land Management, Santa Fe). With adequate soil moisture, the lands around Firecracker Pueblo would unquestionably have supported
prehistoric populations dependent on corn and other crops and is attested by the relatively dense and large pueblo sites in the area (Whalen 1978). This cluster of pueblos is located near the eastern flank of the Franklin Mountains and can receive considerable runoff. However, runoff and rainfall were probably no more dependable at the time Firecracker Pueblo was occupied than they are today. Additionally, summer rains account for the bulk of precipitation and surface water during the winter and spring may only have been available from springs several miles away in the Franklin Mountains or from the Rio Grande many miles away.

Spatial and temporal variability in rainfall and availability of surface water would have demanded an extensive land use pattern and residential mobility to compensate for local difficulties and distant opportunities. The evidence from Firecracker Pueblo does demonstrate that El Paso phase populations were living in pueblos, raising crops of corn and other cultigens, and making pottery as late as the early to middle 15th century. However, the presence of pithouses, the apparent caching of groundstone during the pithouse and pueblo occupations, the occurrence of only one burial, the general lack of modification and repair of structures, and questionably the finding of extramural pits that could have been used for storage and concealment of foods would all intimate that people were moving about the landscape and not living any one place very long.

It was neither anticipated nor desired that Firecracker Pueblo would take so many years to investigate and be so complex. It is hoped that some of the findings presented here will stimulate comment and promote additional research of the Pueblo period in the Jornada region.

REFERENCES

Basehart, Harry W.

Bentley, Mark T.
<table>
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<th>Author(s)</th>
<th>Year</th>
<th>Title</th>
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<tr>
<td>Duran, Meliha and David Batcho</td>
<td>1983</td>
<td>An El Paso Phase Pithouse and other Recent Discoveries from the West Mesa near Santa Teresa, New Mexico. Paper presented at the 1983 meeting of the New Mexico Archaeological Society.</td>
<td></td>
</tr>
</tbody>
</table>
Scarborough, Vernon L.

Whalen, Michael E.


1994 *Turquoise Ridge and Late Prehistoric Residential Mobility in the Desert Mogollon Region*. University of Utah Press, Salt Lake City.
Chaco Canyon has long been considered by many Southwestern archaeologists as the primary sociopolitical center within the San Juan Basin and perhaps much of the prehistoric Pueblo world during the late Pueblo II and early Pueblo III periods (AD 1050-1130) (Lekson and Cameron 1995). The regional system associated with Chaco is comprised of a number of outlier communities connected to the regional core by an extensive series of linear roads radiating from Chaco Canyon (Vivian 1997). The scale and complexity of the Chacoan system is evidenced by its material culture, monumental public architecture, and an extensive and far-reaching trade network.

It seems likely that with the large regional sphere of Chacoan interaction, the trade of material culture and raw materials also resulted in genetic exchange, not only with Rio Grande populations but also with groups in Arizona, Colorado, and perhaps Mexico. Gene flow out of Chaco Canyon, therefore, should be detectable in later related groups either by direct descent (i.e., descendent populations), or indirectly through genetic exchange with one or more descendent populations (i.e., by way of individual mates).

Archaeologists have often relied on the concept of migration to explain cultural change. The San Juan/Four Corners to Rio Grande area migration by Mesa Verde groups at the end of the 13th century is widely accepted as the most probable explanation for demographic growth in the Rio Grande region and for the transition from mineral-based to carbon-based paint in the production of Rio Grande decorated wares such as Santa Fe Black-on-white and Galisteo Black-on-white (Ford et al. 1972; Mera 1935; Wendorf and Reed 1955). Other researchers (Steen 1977, 1982), however, insist there is no real physical evidence of San Juan groups in the Rio Grande region during the 13th century, and that Rio Grande painted pottery reflects a generalized pattern found throughout much of the Puebloan world. Steen (1977:40) argues that ceramic production is “an art that can be passed quickly and easily from one cultural group to another,” and that “no movement of people, other than a few individuals who may be traders, is necessary to transmit a trait of this sort.”

The social mechanism (trade) suggested by Steen for the transmission of ceramic stylistic traits and methods of production might also represent a cultural system for
transmitting genetic traits among populations. Although it is possible that ceramic stylistic traits could be exchanged among groups without genetic exchange, it is not unreasonable to assume that sociocultural interaction such as trade might also have been associated with biosocial interaction resulting in modest gene flow among prehistoric populations. Variability in genetic traits, not unlike ceramic stylistic traits, therefore, can be used to determine patterns of relatedness between populations not only across geographic space but also through time.

Despite the fact that migration and gene flow by definition involves the movement of people and genes, the vast majority of research on migration in the Southwest has been concerned with either ceramics or architecture (cf. Cordell 1995; Ford et al. 1972; McNutt 1969; Mera 1935; Wendorf and Reed 1955). Other research, however, has concentrated on oral tradition (Ellis 1967) and linguistic evidence (Trager 1967). Although human skeletal metric and nonmetric variation has been studied by a number of researchers to determine biological relatedness among prehistoric Southwest populations (e.g. Akins 1986; Corruccini 1972; El Najjar 1974, 1978; Giles and Bleibtreu 1961; Hanna 1962; Hooton 1930; Hrdlicka 1931; Lumpkin 1976; Mackey 1977, 1980; McWilliams 1974; Schorsch 1956; Seltzer 1944; Spuhler 1954; Turner 1993), tracing possible routes of migration and gene flow among these populations has not been a primary focus of investigation.

FIGURE 1
Map of the study area showing site locations.
This paper presents results from our ongoing research concerning the historical biogeography of southwestern prehistoric Amerindians. Specifically, we are concerned with: 1) estimating the direction and degree of gene flow out of Chaco Canyon during the 12th century and 2) evaluating the late 13th century San Juan/Four Corners to Rio Grande area migration hypothesis described earlier (see also Cameron 1995). A provisional interpretation of biogeographical relationships between and among site populations in the San Juan and Rio Grande regions (Figure 1) is also presented.

MORPHOMETRIC VARIATION AND HISTORICAL BIOGEOGRAPHY

Morphometric variation of the craniofacial skeleton has been used extensively by biological anthropologists to assess population structure and genetic relatedness among human populations (e.g. Akins 1986; Corruccini 1972; El Najjar 1978; Howells 1973; Jantz 1997; Relethford 1991; Steele and Powell 1993; Williams-Blangero and Blangero 1989). Although measurement values for metric traits are a product of both hereditary and environmental factors, research presented in the anthropological literature concerning human quantitative genetics indicates a significant degree of genetic control for most cranial measurements (Cheverud 1988; Devor 1987; Konigsberg and Ousley 1995; McHenry and Giles 1971; Susanne 1977).

If we assume archaeological skeletal samples represent time transgressive, genetically cohesive lineages (see Konigsberg 1987), patterns of variation in inherited morphology can be interpreted as reflecting either patterns of gene flow among the groups they represent (Droessler 1981:2) or shared ancestry. Simply stated, morphological (phenotypic) similarities among groups can be interpreted as being roughly proportional to genetic similarity stemming from common ancestry and/or gene flow when selection effects due to environmental factors are held constant (see Konigsberg and Ousley 1995; Williams-Blangero and Blangero 1989:4). Patterns in craniometric variation among prehistoric groups can therefore be used to investigate patterns of gene flow through time and geographic space. In order to formulate informative hypotheses concerning gene flow and migration, these historical biogeographical relationships should be interpreted on a regional scale.

ENVIRONMENTAL FACTORS

Environmental factors influencing craniometric variation among the prehistoric southwestern Amerindian populations included in this study by way of differential natural selection would likely have been minimal because these populations all occupied similar semi-arid climates with little difference in latitude. Furthermore, because these populations relied heavily on maize agriculture, intersample variation in climatic conditions such as elevation, temperature, and moisture were constrained by the growing requirements of corn. Although disease and nutrition effect the size of many craniofacial traits, the shape of these traits are relatively unaffected by these environmental factors (see Hiernaux 1963:581).
We do not mean to say that environmental influences on craniofacial morphology did not exist, only that these influences would not greatly effect craniofacial morphology (shape) and that any comparisons of craniometric variation among prehistoric southwestern agricultural populations, therefore, would not be expected to suffer any great systematic bias stemming from environmental factors (see Buikstra et al. 1990, and Rothhammer and Silva 1990, for discussions on the influences of environmental variance). Because researchers are concerned with reducing the effects of environmental variance, statistical methods, such as variable transformation and the use of indices, have been developed for maximizing the influence of the genetically determined component of phenotypic variation on between group comparisons. Methods of variable transformation such as size correction (see below) are effective for reducing the influences of environmental factors on between-group comparisons of morphology when genetic relationships are the focus of study.

MATERIALS AND METHODS

Data Collection

Eleven craniofacial measurements (Table 1) were taken on 208 individuals from museum collections at the American Museum of Natural History, the United States National Museum, the Maxwell Museum of Anthropology, the School of American Research, and the Fort Burgwin Research Center. Individuals from 16 Pueblo Indian archaeological sites in the American Southwest are included in this sample (n=176) (Table 2). Pueblo Bonito in Chaco Canyon is represented by two samples, the skeletal series excavated by George Pepper in the late 1890s and the series excavated by Neil Judd in the 1920s. Of the 16 Pueblo Indian samples, only Mesa Verde represents a composite sample of individuals from more than one site.

Also included are non-Puebloan skeletal samples from the archaeological site of Ticoman in the Valley of Mexico (n=10), the Salado site of Togetzoge (n=8) from east central Arizona, and one composite sample of historic Navajos (n=12). The Ticoman sample was included to assess the potential of Mesoamerican ancestry for any of the prehistoric Puebloan samples included in our study. Togetzoge was added to our investigation to assess the potential for Pueblo ancestry for this Salado site, and to investigate possible gene flow between this site and contemporaneous Puebloan sites to the north and east. The Navajo sample was included because although a molecular genetic relationship between several present-day Pueblos and the Athabaskan-speaking Navajo has been investigated (Lorenz and Smith 1996), the biological relationship between the Navajo and prehistoric Pueblo populations has not received much attention in the literature (but see Turner 1993).

All individuals, except those from Arroyo Hondo, were measured by Schillaci using the same set of calipers. The Arroyo Hondo sample was measured by Ozolins. All measurements were taken to the nearest tenth of a millimeter using Mitutoyo "Digimatic" digital sliding calipers. Only those dimensions measuring facial growth were included in this analysis to avoid the influences of artificial cranial modification.
TABLE 1
List of craniofacial measurements.

<table>
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<th>Measurement</th>
<th>Abbreviation</th>
<th>Measurements</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>Upper facial height</td>
<td>UFH</td>
<td>n-alv</td>
<td>Bass (1995)</td>
</tr>
<tr>
<td>Left orbital height *</td>
<td>OBH</td>
<td>(\perp \text{dk-ek})</td>
<td>Howells (1973)</td>
</tr>
<tr>
<td>Right orbital height *</td>
<td>OBH</td>
<td>(\perp \text{dk-ek})</td>
<td>Howells (1973)</td>
</tr>
<tr>
<td>Left orbital breadth *</td>
<td>OBB</td>
<td>dk-ek</td>
<td>Howells (1973)</td>
</tr>
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<td>Right orbital breadth *</td>
<td>OBB</td>
<td>dk-ek</td>
<td>Howells (1973)</td>
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<td>Nasal height</td>
<td>NLH</td>
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<td>Howells (1973)</td>
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<td>Palatal breadth *</td>
<td>MPB</td>
<td>enm-enm</td>
<td>Bass (1995)</td>
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<td>Palatal length *</td>
<td>MPL</td>
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<td>Interorbital breadth</td>
<td>DKB</td>
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<td>Upper facial breadth *</td>
<td>UFB</td>
<td>fmt-fmt</td>
<td>Moore-Jansen (1994)</td>
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Notes: 1 See Howells (1973) for description.
* Significant at the .10 level for discriminating between groups using backwards elimination discriminant analysis.

TABLE 2
Skeletal sample information.

<table>
<thead>
<tr>
<th>Site</th>
<th>Sample Size</th>
<th>Time Period</th>
<th>Occupation</th>
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<tr>
<td>Judd's Pueblo Bonito</td>
<td>15</td>
<td>PII-PIII</td>
<td>AD 860-1129</td>
<td>Windes &amp; Ford 1996</td>
</tr>
<tr>
<td>Pepper's Pueblo Bonito</td>
<td>12</td>
<td>PII-PIII</td>
<td>AD 860-1129</td>
<td>Windes &amp; Ford 1996</td>
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<tr>
<td>Village of the Great Kivas</td>
<td>6</td>
<td>PII-PIII</td>
<td>AD 1000-1225</td>
<td>Adler 1996</td>
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<tr>
<td>Pindi</td>
<td>9</td>
<td>PII-PIV</td>
<td>AD 1000-1400</td>
<td>Adler 1996</td>
</tr>
<tr>
<td>Aztec Ruin (West)</td>
<td>20</td>
<td>PII</td>
<td>AD 1111-1260</td>
<td>Lister &amp; Lister 1987</td>
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<tr>
<td>Mesa Verde</td>
<td>7</td>
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<td>Awatobi</td>
<td>4</td>
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<td>AD 1250-1320</td>
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<tr>
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<td>AD 1300-1425</td>
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<td>Sapawe</td>
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<td>PIV-Prothistoric</td>
<td>AD 1300-1550</td>
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<td>PIV-Historic</td>
<td>AD 1300-1830</td>
<td>Adler 1996</td>
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<td>Togetzoge(^2)</td>
<td>8</td>
<td>PIV</td>
<td>AD 1300-1400s</td>
<td>Woodbury 1979</td>
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<td>Hawikuh</td>
<td>23</td>
<td>PIV-Historic</td>
<td>AD 1300-1680</td>
<td>Schorsch 1956</td>
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<tr>
<td>Pottery Mound</td>
<td>16</td>
<td>PIV-Prothistoric</td>
<td>AD 1325-1525</td>
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<td>Tsankawi</td>
<td>7</td>
<td>PIV</td>
<td>AD 1400-1600</td>
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<td>Otowi(^2)</td>
<td>9</td>
<td>PIV</td>
<td>AD 1400-?</td>
<td>Orcutt 1999</td>
</tr>
</tbody>
</table>

**Outgroups**

| Navajo                      | 12          | Occupation |
| Ticoman (Valley of Mexico)  | 10          | Historic   |

Notes:
1 Mesa Verde is a composite sample comprised of Oak Tree House (n=3), Mummy Lake (n=1), and "Montezuma Canyon" (n=3).
2 The decorated ceramic assemblages from Togetzoge are composed predominately of Gila Polychrome (Schmidt 1928:279) which dates from AD 1300 to sometime in the 1400s, being most abundant from the mid to late 1300s (Crown, 1994:19).
3 Reliable dates are not available.
Data Analysis

Because similarities in environmentally influenced size among groups can potentially outweigh intergroup differences in genetically determined shape, the effects of size are typically eliminated or "corrected for" in craniometric studies where genetic relationships are of primary interest (Jantz 1997). This correction reduces much of the environmental bias between population samples. Size correction has the added benefit of allowing males and females to be pooled when sample sizes are small. In this study, size correction was achieved by dividing each variable by the individual's geometric mean (Mosimann 1970) and logging the resultant value (Darroch and Mosimann 1985).

Because previous studies (e.g. Corruccini 1972; El-Najjar 1978; Turner 1993) have shown that prehistoric southwestern populations are largely biologically homogeneous, backwards elimination discriminant analysis was conducted on the log-transformed size-corrected variables in order to determine which variables best discriminate among the archaeological sites included in this analysis. Of the 11 original variables only 7 were significant in discriminating among sites at the .10 level (as referred to in Table 1). Discriminant functions (canonical variates), as well as Mahalanobis generalized distances ($D^2$) were then generated with these seven significant variables using multivariate canonical discriminant analysis (Table 3).

Canonical discriminant analysis was chosen for this investigation because similarities and differences across all variables among groups are determined simultaneously based on patterns of within- and between-group variance and covariance (Droessler 1981:77). Multivariate methods such as canonical discriminant analysis are powerful tools for investigating temporal and geographic patterns of genetic relatedness primarily because intertrait relationships are accounted for through use of variance-covariance matrices. This allows individuals to be treated as complete morphological units while accounting for between-group differences in patterns of trait variance and covariance. Morphogenetic distance studies such as this one must rely heavily on the assumption that phenotypic variation, like the craniometric variation used in this study, can reliably estimate genotypic variation. That is to say, phenotypic variation is proportional to genetic variation. Konigsberg and Ousley (1995), who showed that the additive genetic variance-covariance matrix is proportional to the phenotypic variance-covariance matrix, demonstrated the validity of this assumption. Because Mahalanobis generalized distances ($D^2$) are calculated using a pooled phenotypic variance-covariance matrix, the $D^2$ statistic is an appropriate measure of genetic distances among the population samples included in this study (see Williams-Blangero and Blangero 1989 and Relethford 1994).

Mahalanobis $D^2$ values were used as input for neighbor joining cluster analysis and multidimensional scaling (MDS). Both the neighbor joining cluster analysis and MDS are multivariate methods used for visually displaying relationships between groups using, in this case, Mahalanobis $D^2$ values describing biological distances among groups based on morphometric data.

All discriminant analyses, as well as variable transformations, were conducted using SAS statistical computer software (SAS Institute 1990). Multidimensional
scaling and cluster analysis were conducted using NTSYS-pc statistical computer software (Rohlf 1992). Two dimensional plots of group centroids for canonical discriminant function scores were generated using commercially available statistical graphing software for Macintosh (KaleidaGraph version 3.0).

Because we are interested in patterns of cranio metric variation through time, our sample was divided into two groups for analysis. The first group consists of those sites whose starting occupation dates begin during the Pueblo II and Pueblo III periods (A.D. 900-1300). The second group consists of sites whose starting occupation dates begin during the Pueblo IV period (i.e., after A.D. 1300). Although occupation at Togetzoge is estimated to have begun around A.D. 1300 based on the presence of Gila Polychrome pottery (see Schmidt 1928:279 and Crown 1994:19), it was included within the first group in order to investigate the possibility of indirect Puebloan ancestry for this Salado site.

**RESULTS**

**Canonical Discriminant Function Analysis**

The first two discriminant functions generated by our canonical discriminant function analysis of the Pueblo II-Pueblo III site samples were the only significant functions at the .05 level. A two-dimensional plot of site centroids for these first two canonical discriminant functions comprising 64.7% of the total variation revealed four groupings (Figure 2). The first group composed of Togetzoge and Te’ewi clusters on both the first and second discriminant axes. The second group composed of Awatobi and the Village of the Great Kivas also clusters on both axes. The third group consisting of Judd’s skeletal series from Pueblo Bonito, Pot Creek, and Pindi clusters tightly on the first discriminant axis but only loosely on the second. The fourth group composed of Pepper’s skeletal series from Pueblo Bonito and Heshotauthla forms a loose cluster on the first axis but clusters tightly on the sec-

**TABLE 3**

Mahalanobis generalized distances ($D^2$) between sites. Larger $D^2$ values correspond to greater genetic distances.

<table>
<thead>
<tr>
<th>SITE</th>
<th>Awatobi</th>
<th>Aztec</th>
<th>Bonito¹</th>
<th>Hesh</th>
<th>Kiva</th>
<th>Pot Creek</th>
<th>Bonito²</th>
<th>Pindi</th>
<th>Salado</th>
<th>Te’ewi</th>
<th>Mesa Verde</th>
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<tbody>
<tr>
<td>Awatobi</td>
<td>0</td>
<td></td>
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<td></td>
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<tr>
<td>Aztec</td>
<td>1.491</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Bonito¹</td>
<td>2.646</td>
<td>1.326</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Hesh</td>
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<td>1.808</td>
<td>2.659</td>
<td>0</td>
<td></td>
<td>3.559</td>
<td>3.898</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
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<td>Kiva</td>
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<td>2.501</td>
<td>3.329</td>
<td>1.872</td>
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<td></td>
<td>4.579</td>
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</tr>
<tr>
<td>Pot Creek</td>
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<td>3.898</td>
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<td>3.822</td>
<td>0.596</td>
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<td>4.579</td>
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<tr>
<td>Pindi</td>
<td>2.351</td>
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<td>2.062</td>
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<tr>
<td>Salado</td>
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<td>2.759</td>
<td>2.935</td>
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<td>5.198</td>
<td>4.065</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Several site names are abbreviated.
1 Judd’s skeletal series from Pueblo Bonito.
2 Pepper’s skeletal series from Pueblo Bonito.
FIGURE 2
Two-dimensional plot of Pueblo II - Pueblo III group centroids for the first two discriminant functions.

FIGURE 3
Two-dimensional plot of Pueblo II - Pueblo IV group centroids for the first two discriminant functions.
ond. Although Aztec Ruin does not plot with any of these groupings, it does appear intermediate to the second and third groupings on the second discriminant axis. The sample from Mesa Verde appears as an outlier on both the first and second discriminant axes.

A two-dimensional plot of Pueblo II through Pueblo IV site centroids for the first two significant canonical discriminant functions comprising 53.9% of the total variation revealed four groupings (Figure 3). The first grouping composed of Togetzoge and Te’ewi clusters on both the first and second discriminant axes as was seen in the plot of the Pueblo Il-Pueblo III discriminant functions. The second grouping consisting of Pindi, Pecos, Hawikuh, Arroyo Hondo, Sapawe, and Aztec Ruin occupies the center of this plot. The third grouping composed of Otowi, Pot Creek, and Judd’s skeletal series from Pueblo Bonito forms a tight cluster on both discriminant axes. Interestingly, the Navajo and Awatobi samples forming the core of the fourth grouping also cluster tightly on the first and second discriminant axes, suggesting gene flow between these groups historically (see Lorenz and Smith 1996). The Village of the Great Kivas, Heshotauthla and Pepper’s skeletal series from Pueblo Bonito appears to be a cluster on both discriminant axes. Interestingly, Aztec Ruin, which did not appear to cluster with any Pueblo II-Pueblo III site using discriminant functions (see Figure 2), is now grouped with this larger cluster. Pepper’s skeletal series from Pueblo Bonito is also grouped with this cluster but on only two of three dimensions. Togetzoge also appears to cluster with this larger grouping. The third Pueblo II-Pueblo III discriminant grouping consisting of Pot Creek, Pindi, and Judd’s skeletal series from Pueblo Bonito, again forms a tight cluster on all three MDS dimensions. Mesa Verde once again appears as an outlier to all groups.

Cluster Analysis

Results from the neighbor joining cluster analysis appear to be in close agreement with the results presented by MDS. The dendrogram generated from this analysis (Figure 5) indicates only two clusters at an approximate branching distance of 4.0. These groups consist of 1) Awatobi, Heshotauthla, Pepper’s skeletal series from Pueblo Bonito and the Village of the Great Kivas, and 2) Judd’s skeletal series from Pueblo Bonito, Pot Creek, and Pindi. Unlike the MDS plot, Aztec Ruins does not group with the first cluster. The remaining sites Togetzoge, Te’ewi and
Mesa Verde are not included within either of these clusters and together form an only distantly related cluster at a branching distance of approximately 6. Perhaps most interesting about this dendrogram is that Heshotauthla, Pepper's skeletal series from Pueblo Bonito, and the Village of the Great Kivas form a closely related cluster, as do Pot Creek and Judd's skeletal series from Pueblo Bonito.

The assertion by Judd (1954) that there were two separate populations at Pueblo Bonito is supported by the results of our analyses. Pepper and Judd's skeletal series from this Chacoan great house consistently appeared in well-separated clusters using the three different analyses described above. Our results are not the first based on biological evidence to support Judd's hypothesis, however (see Akins 1986:75). Assuming these two populations at Pueblo Bonito were contemporaneous as suggested by Judd (1954), we propose the genetic divergence demonstrated between these two populations might suggest a kinship system based on endogamous moieties or clans. Although it is possible to draw several conclusions about the direction of gene flow out of Pueblo Bonito during the Pueblo II and Pueblo III periods, determining the levels of this gene flow is difficult. The two Pueblo Bonito populations cluster with geographically and possibly linguistically distinct groups. Pepper's skeletal series from Pueblo Bonito clusters with the ancestral Zuni sites of the Village of the Great Kivas, Heshotauthla, as well as with the Hopi site of Awatobi indicating dispersal to the south and west. The second population at

![FIGURE 4](image)

Three-dimensional MDS plot of Pueblo II - Pueblo III groups (stress = .142 with 30 iterations).
Pueblo Bonito clusters with the ancestral Tiwa site of Pot Creek and the presumed Tano/Tewa site of Pindi indicating genetic dispersal to the northeast.

The direction of gene dispersal is inferred from the chronological position of sites relative to each other. Because Pueblo Bonito populations are earlier than those sites with whom they cluster, we believe the direction of migration or gene flow was out of Pueblo Bonito. The possibility that the observed biological affinities of the Chaco populations at Pueblo Bonito might merely be a function of an earlier ancestry from the northeast and from the south and west must also be considered, however.

The same pattern of dispersal is seen when Pueblo IV sites are included in the analysis (Figure 3). Despite the inclusion of two outgroups (historic Navajo and prehistoric Mesoamerican), the directions of dispersal out of Pueblo Bonito from the two distinct Pueblo Bonito populations remains the same. Pepper’s skeletal series from Pueblo Bonito still forms a loose cluster with the Village of the Great Kivas and Heshotauthla, as well as with Awatobi. Although the second population at Pueblo Bonito represented by Judd’s skeletal series is still grouped with Pindi and Pot Creek, this Chacoan population now clusters with other presumed ancestral Tanoan sites including Otowi (Tewa), Sapawe (Tewa), Pecos (Tano/Towa), and Arroyo Hondo (Tano).

The proximity of Pueblo Bonito to Otowi in the two-dimensional plot of canonical discriminant functions is compelling. Because the beginning occupation date for Otowi is roughly 260 years later than the abandonment of Pueblo Bonito by Chacoan groups, or almost 13 generations, this close proximity of plots cannot be interpreted as a site-unit intrusion into the Rio Grande. Reasonable explanations for this close relationship are that there were either strong genetic ties with an existing 12th century northern Rio Grande site, or possibly a site-unit intrusion from Pueblo Bonito to a Late Developmental site directly ancestral to Otowi not included within our sample. More than likely, these close genetic ties are the result of small social units migrating into the northern Rio Grande region over several generations rather than a large organized population movement (McNutt 1969: 109).

Although it is important to state that biological similarity does not equate to linguistic similarity (but see Hanna 1962), the inclusion of Aztec Ruin in this Tanoan grouping invites speculation that the occupants of this probable Mesa Verde community in the Totah district of northwestern New Mexico might have been Tanoan speakers. The proximity of Hawikuh to this apparent Tanoan grouping is somewhat enigmatic but may merely represent significant gene flow between the Zuni area and the Rio Grande region during the Pueblo IV period.

Our biological assessment of the hypothesized San Juan/Four Corners to Rio Grande area migration by Mesa Verde groups at the end of the 13th century yielded interesting results. The Mesa Verde sample comprised of cliff-dwelling sites appeared as an outlier in all of our analyses and there is no direct evidence of a site-unit intrusion into the Rio Grande area by San Juan/Four Corners groups. Although these results would seem to support Steen’s assertion that there is no direct evidence of San Juan groups occupying the Rio Grande region during Pueblo II and Pueblo III periods, there is
evidence of a genetic relationship between these two regions as is indicated by the close proximity of Aztec Ruin to Rio Grande sites on the two-dimensional plot of canonical discriminant functions (see Figure 2).

The skeletal sample from Aztec Ruin, a Chacoan outlier, is commonly thought to represent a later reoccupation of the site by Mesa Verde groups. If true, considerable genetic variability between these two Mesa Verde sites is indicated by the results of all our analyses. The Aztec Ruin sample does not plot close to the Mesa Verde sample comprised of cliff-dweller sites on either the two-dimensional plot of canonical discriminant functions, the three-dimensional MDS plot or the dendrogram generated from neighbor joining cluster analysis, indicating genetic dissimilarity between these two presumably Mesa Verde populations.

Assuming the Aztec sample represents a Mesa Verde population, this genetic dissimilarity between Mesa Verde populations has at least one important implication. This being that although there is no biological evidence of a site-unit intrusion into the Rio Grande area by Mesa Verde groups, an ancestor-descendent relationship between Mesa Verde populations and Rio Grande populations may exist. The observed relatedness between the Aztec Ruin population and later Rio Grande populations at Sapawe, Pindi, Pecos and Arroyo Hondo is likely the result of a genetic dispersal out of the northern San Juan Basin to the northern Rio Grande region during the second half of the 13th century. The alternative explanation of a close common ancestor for both the Aztec Ruin population and the Rio Grande sites must also be considered, however.

Genetic dispersal into the Rio Grande region could have occurred by way of several migrations of Mesa Verde people into pre-existing Rio Grande communities, or indirectly through intercommunity gene flow over several generations moving east and southeastward from northwestern New Mexico. In either case, this dispersal resulted in an ancestor-descendent relationship lending support to the San Juan/Four Corners to Rio Grande area migration hypothesis based on ceramic evidence.

**FINAL CONCLUSIONS**

Our interpretations of the results presented in this article are phenetic in nature and necessarily *post hoc*. They are interpretations of multivariate estimates of genetic similarity based on within and between group morphometric variation. While being far from conclusive, it is our hope that these interpretations represent provocative and testable hypotheses regarding interaction and migration among prehistoric Southwest Amerindian populations.

The results of our analysis emphasize the importance of incorporating historical biogeography into migration/affiliation studies within the field of archaeology. If migration was an important component of cultural change in the prehistoric Southwest, then the distribution of human morphometric variation across time and geographic space is of great archaeological interest. After all, it was humans who constructed pueblos, tended fields, produced ceramic vessels, and interacted with other groups, sometimes over great distances. Understanding the com-
plex pattern of covariation between [material] culture, language, and human biology should remain the common goal of anthropology and the focus of migration studies in southwestern archaeology.

ACKNOWLEDGEMENTS

This paper has benefited considerably from long discussions with S. Lakatos (Office of Archaeological Studies) on Southwest population history and prehistoric migration. We thank D. Hunt (United States National Museum), K. Mowbray (American Museum of Natural History), J. Powell (Maxwell Museum of Anthropology), D. Schwartz (School of American Research), T. Thibodeau (Museum of Indian Arts and Culture), and M. Adler (Southern Methodist University) for facilitating our research and for allowing access to their museum collections. We are grateful to J. Froehlich and J. Powell (University of New Mexico), and W. Bustard and Joan Mathien (National Park Service) for their helpful suggestions, comments, and criticisms of earlier drafts. We also thank E. Bedrick and E.A. Carson for their statistical guidance, C. Schillaci and M. Ozolins for editorial assistance, R. Stauber and W. Dorshow for assisting with computer generated graphics. Comments by P. Mintum and R. Towner were greatly appreciated. Responsibility for any and all interpretations, errors, and omissions rests solely with the authors.
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Crescentic bifaces, commonly known simply as crescents, have been recognized at eight localities extending from central Socorro County westward into eastern Catron County in west-central New Mexico (Figure 1). All occurred on eroded surfaces lacking in definitive cultural and stratigraphic contexts. These enigmatic objects have a wide distribution in the Far West in what Wormington has designated as the Paleo-western tradition (1957:21). Crescents have been reported previously from Pecos Pueblo, New Mexico, where six specimens were recovered, two of which are illustrated by Kidder (1932: Fig. 17e,f). Kidder suggested that these were possibly ceremonial forms. A large, but similar crescent-shaped object of obsidian was recovered by Kidder at Puye in an "...undoubtedly ceremonial cache." (Kidder 1932:35).

Tadlock, in his extensive survey of the distribution and attribute analysis of crescents, excluded the objects from both Pecos Pueblo and Puye because they were thick in cross section and had blunt edges (Tadlock 1966:663), but the two illustrated by Kidder (1932: Fig. 17e, f) appear to conform with Tadlock's Type 1 "Quarter-moon" crescents (Tadlock 1966:Fig. 1).

**FIGURE 1**

Map of Socorro and Catron counties showing the distribution of crescents in west-central New Mexico.
One of the eight crescents discussed herein (PC-157) was located within the Socorro town site, whereas the remaining seven were distributed along a linear trend across the Plains of San Agustin (Figure 2).

As shown in Figure 3-1, the Socorro specimen conforms closely with the Type I crescent of Tadlock from Long Valley Lake, Nevada (1966: Figure 3m), except for the blunter tips on the Socorro specimen, and with the concave-convex form from the Sunshine Well locality at pluvial Lake Hubbs in eastern Nevada (Hutchinson 1988: Figure 4). The Socorro specimen occurred near the western edge of the Socorro town site at the eastern foot of the Socorro Mountains where it probably was eroded from a local dark gray cienega (?) soil below a spring line. There were no directly associated artifacts, although Middle Archaic and Paleoindian points (Clovis, Folsom and Cody) have been recovered in the area. The crescent consists of mottled olive and dark olive, edge-translucent, silicified wood. One face bears a curved facet of the flake from which it was fabricated. The central part of both the concave and convex edges are lightly smoothed. It measures 53 mm in length, 20 mm maximum width, and 8 mm thickness. The weight is 16.0 g.

The following seven crescents (Figure 2) were distributed in a southwest-trending belt along the floor of pluvial Lake San Agustin. During the late Pleistocene, the

FIGURE 2
Map of Lake San Agustin at the 7050-ft (2149-m) shoreline showing the distribution of crescents on the Plains of San Agustin. Redrawn from Weber 1993: Figure 1.3.
structural and topographic intermontane basin of the Plains of San Agustin was inundated by an extensive lake system (Powers 1939; Osburn et al. 1993; Weber 1980, 1994) that at the 7050-ft (2149-m) maximum shoreline (Figure 2) was approximately 57 mi (82 km) long, and with a maximum width of approximately 19 mi (31 km) (Weber 1994: 10). Drying of the lake in the terminal Pleistocene-early Holocene interval proceeded from the northeast to the southwest through the interconnected basins of White Lake (in the northeast), C-N, and Horse Springs (in the southwest), with a vastly reduced lake possibly persisting into the mid-Holocene in the Horse Springs basin. Ephemeral ponding in playas characterizes the present environment.

Specimen Sa 1-38 (Figure 3-2) occurred on the beach slope of the low shore line of the White Lake section of the pluvial lake (Osburn et al. 1993; Weber 1994) overlooking the modern playa. It probably had eroded by deflation from the overlying brown older dune sand (unit D of the Ake site [Weber 1980: 234-235]). The form is that of a more sharply curved crescent resembling Figure 2b of Tadlock's Type I (1966) and Figure 4-1 of Hutchinson (1988), but lacks one tip (probably due to pervasive thermal crazing). The material is a pale pink (thermally altered?) chalcedony. Chipping style is more finely executed than the random pattern of the Socorro specimen. Metric attributes include a restored length of approximately 45 mm, maximum width 19 mm, and 7 mm thickness. Again, there is no clear cultural association with Paleoindian complexes that range from Clovis to Cody, but Middle Archaic manifestations are more abundantly represented in the surrounding area.

Specimen SA1-375 (Figure 3-3) occurred on the playa floor on the surface of lake beds of pluvial Lake San Agustin, southeast of the preceding. There were no archaeological manifestations nearby. This crescent may be unfinished, but extensive
damage due to frost (?) spalling makes a determination uncertain. The material is white opal that is a highly fluorescent yellow-green under ultraviolet light. These features are fully concordant with the fluorescent white opal from the Silver Creek rim source north of Socorro (Weber 1999). Length is, with one tip incomplete, 33 mm, width 15 mm, thickness 6 mm. Weight, after significant loss, is 3.7 g. This material is too brittle to yield a durable cutting or scraping implement, although it was used elsewhere for arrow points (Weber 1999: Fig. 1, 4).

Specimen SA1-360 (Figure 3-4) appears unfinished. It occurred on the eroded upper beach slope of the White Lake playa 0.4 km southwest of the preceding and was totally isolated from any other archaeological manifestations. The form is that of a more sharply curved crescent on a tabular flake with alternately beveled lateral flaking on both the convex and concave edges, thus resembling Figure 9c of Fagan (1988) from the Dietz site, south-central Oregon. The material is a gray chalcedony with spotted white patina. Length is 35 mm, width 18 mm, and thickness 5 mm, and weight is 5.5 g.

Specimen SA13-137 (Figure 3-5) was exposed by deflation in a shallow depression on the floor of Lake San Agustin southwest of the preceding. This location is within the C-N Lake section of the pluvial lake and subsequent playas (Weber 1980, 1994), east-northeast of the Ake site (Beckett 1980; Weber 1980: Fig. A2) (Fig. 2). Associated with it were flakes and chips of high-quality lithics and fragments of fossil bone. Middle Archaic San Jose points and much earlier Folsom material occur in the surrounding area. A snapped large portion of one end is missing and one face bears part of the original flake facet. Both convex and concave edges are lightly smoothed. The form is a wide, less sharply concave crescent. The material is dark red, granular jasper. Restored length is approximately 56 mm, width 23 mm, thickness 6.5 mm.

Specimen SA6-77 (Figure 3-6) occurred on the upper edge of the lowest beach slope of the C-N Lake section, southeast of the Ake site. Two diminutive Augustin points of obsidian were nearby, but not directly associated with the crescent. This too has a Type I quarter-moon form with a configuration similar to Figure 3m of Tadlock (1966), but of coarser workmanship. One face retains a short, curved flake facet. The material is a lustrous, brownish-gray and cream chalcedony resulting from silicification of fossil wood. Length is 44.5 mm, width 15 mm, and thickness 7 mm. Weight is 5.3 g.

Specimen SA-328 (Figure 3-7) occurred along a knickline on the floor of the lake basin in the Horse Springs section of Lake San Agustin, northeast of Bat Cave (Figure 2). There were no associated artifacts, although a San Jose point, slab metate, a hearth, and an arrow point were noted in the surrounding area. Only the extreme tip remains, composed of pale bluish-gray chalcedony. Too little remains for meaningful measurement.

Specimen SA-313 (Figure 3-8) was exposed on the sheetwashed surface of the pluvial lake beds just below a low shore line on the south side of the Horse Springs basin southwest of SA-328 (Figure 2-8). A cobble hearth, boulder metate, and a thin slab metate were noted eastward from the crescent. The lateral fragment of red-
speckled, pale bluish-gray chalcedony exhibits the fine workmanship and configuration of SA1-38.

Archaeological survey of the Horse Springs basin by Hurt and McNight (1949) was followed by excavations at Bat Cave by Dick (1965) and by Wills et al. (1984). Beckett (1980) excavated the Ake site in the C-N basin. No crescents were reported to have been recovered in these investigations, which is not surprising considering their very limited occurrence throughout the Plains of San Agustin.

CRESCENTS IN THE FAR WEST

Although 26 crescentic bifaces were recovered at the Hohokam site of Snaketown in Arizona (Gladwin et al. 1965: Plate XCII), these are markedly different, having the form of a truncated disc with a deep U-shaped notch. Otherwise, there is no indication of crescent distribution through Arizona to New Mexico from the main region of widespread occurrence in the Great Basin and adjacent areas of California (including the Channel Islands), Oregon, and Washington. Tadlock (1966) provides the most extensive inventory of the distribution of crescents throughout this region. Additional recent reviews of many of the crescent localities of the Far West can be found in Warren and Crabtree (1986) and in Willig et al. (1988). Throughout this region there is a close association of crescents with water features such as the shorelines of pluvial lakes and playas. There also is an apparent association of the prevailing surface finds with Western Fluted (Western Clovis) and Western Stemmed projectile points (Willig and Aikens 1988).

The 29 crescents from Long Valley Lake playa in east-central Nevada were discussed by Tadlock (1966:664-665, Fig. 3,4). The surface artifact assemblage there included one Folsom, two Clovis, three Scottsbluff, and four Angostura points, in addition to two other lanceolate points. Tuohy (1988: 222-223) summarizes later work at the Long Valley locality that yielded 120 crescents, as does Hutchinson (1988) and Price and Johnston (1988:236-237). The latter authors include crescents with their Sunshine Phase, dating from ±10,500-8,500 B.P., in association with Parman, Lind Coulee, and Silver Lake smaller stemmed points (Price and Johnston 1988:244-245). Zancanella (1988: Fig. 3) assigns crescents (sic) together with Silver Lake, Lake Mohave, Black Rock, and concave-base points to the Nyala phase of the Western Pluvial Lakes Tradition in south-central Nevada. Beck and Jones (1988: Table 4) include crescents and Cougar Mountain/Haskett, Parman, Silver Lake, and Great Basin Stemmed points with the Western Pluvial Lakes Tradition in Butte Valley, eastern Nevada.

Questions concerning the apparent association of crescents with Western Clovis points continue to plague the interpretation of the cultural affiliation of crescents. The inclusion of a classic Type I crescent with the Fenn Clovis Cache points and preforms (from an undocumented locality in the southwest Wyoming, northwest Utah, southwest Idaho area) (Frison 1991: 41-44; Frison and Bradley 1999: Plate 22) is highly suggestive of affiliation of crescents with the Clovis complex, a relationship not recognized in eastern (Rocky Mountain and Plains) Clovis assemblages. Use of Green River Formation chert in
the manufacture of many of the Clovis bifaces and the crescent adds to implications of their cultural-temporal affiliation.

At the Sunshine Locality in eastern Nevada (see Hutchinson 1988: Price and Johnston 1988: 236-237; Tadlock 1966:64-65; Tuohy 1988: 222-223), Jones et al. (1996: 27-29) excavated the bones of Camelops cf. hesternus together with a Western Stemmed Tradition projectile point, the basal section of a fluted point and a fragment of a crescent. A limiting radiocarbon date of 10,320 ± 50 yr B.P. was obtained 12 cm above the fluted point. The authors note that the sedimentary context suggests redeposition, although the bones appear not to have been transported.

The evidence at the Dietz site in the Alkali Lake Basin of southwestern Oregon is more convincing for the cultural association of the crescents with the Western Pluvial Lakes-Western Stemmed Traditions projectile points rather than with the Western Clovis points that also occur nearby (Fagan 1988; Willig 1988). At the Dietz site, five crescents and 14 ground stone artifacts were recovered in direct association with Western Stemmed tool clusters (Willig 1988:417). Fagan (1988:414) points to the location of the Clovis artifacts on the floor of the basin, whereas the higher ground was occupied by Western Pluvial Lakes people during a later, higher water stage.

The uses to which crescents may have been put remains highly speculative. Wallace and Riddell (1988:92) noted the growing tendency “...to identify them as transversely mounted projectile points employed in hunting waterfowl.” Hutchinson (1988:315) refers to the resemblance to small knife blades of the 120 crescents that he examined, the centrally ground surfaces suggesting that they may have been hafted in small handles to form a “sickle” for harvesting tules and root fibers. “Single, unhafted crescents could have been used to cut or slice fish and fowl and may even have been employed to catch fish and fowl.” Hutchinson further observed “…the unique association of large and small gravers, spurs and crescents as a group of tools in greater concentrations near lake margins…” “I believe that spurs, small gravers and crescents comprised a woman’s tool kit for gathering grass, roots and willows for twining and basketry, and for processing fish and fowl at the lake margins.” (1988:316).

CONCLUSIONS

The crescents reported in this paper from west-central New Mexico remain enigmatic as to their cultural affiliation and usage. Their close association with water features (springs and playas) parallels that of their western counterparts. With the exception of the jasper and the opal specimens, the remaining crescents were fabricated of high-quality cryptocrystalline varieties of silica, as were many of those in the Far West. The very weak possible association with Middle Archaic projectile points, which commonly exhibit high frequency of use of obsidian, is not reinforced by the materials used in the crescents. The materials used, however, are varieties that are available in the surrounding region.
The lack of significant use wear or gloss on the lateral margins is not what would be expected to result from harvesting plant materials. As transverse projectile points, they appear clumsy and ill-suited for hafting in view of their thick midsections, but perhaps they could have been cast into flocks of waterfowl with an atlatl. Clearly, no conclusions can be drawn as to the age, cultural affiliation and use of crescents in New Mexico on the basis of currently available evidence. The apparent lack of a corridor of transmission or diffusion from possibly earlier bearers of this tradition in the Far West adds to the puzzling occurrence of crescents in New Mexico. Information concerning additional occurrences of crescents in New Mexico would be appreciated by the writer.

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In the last decades of the 19th century and the early decades of the 20th century, archaeological research in the Middle Rio Grande archaeological province focused on the large, Pueblo IV (late prehistoric) and Pueblo V (early historic) villages. Many of these villages, or pueblos, are situated along the Rio Grande and its tributaries such as the Galisteo, Jemez, and Santa Fe rivers and along smaller drainages in the Pajarito Plateau (Wendorf and Reed 1955; Stuart and Gauthier 1981; Cordell 1979). These Classic period sites, many of them hundreds, or even thousands, of rooms in size, are directly ancestral to the living Pueblos dotted along the same drainages. Many even carry Keresan, Towa, Tiwa, Tewa, and Tano (Southern Tewa) names—further proclaiming the linkages that native peoples still retain to their recent past.

Starting in the 1930s, archaeologists began investigating prehistoric villages more distant in time, looking for ancestral ties between the large late sites and earlier occupations. In keeping with the theme that larger is better, these investigations into what we now call the Coalition period (Wendorf and Reed 1955) focused on the larger pueblos like Pindi and Forked Lightening that often contain dozens of rooms (Stubb and Stallings 1954; Kidder 1958).

The desire to build a regional chronology through tree-ring studies resulted in limited excavations in still earlier sites now referable to the Developmental period (Smiley et al. 1953), but the pattern was set. The smaller the site, regardless of age, the less chance it had of being investigated.

Starting in the 1970s, this situation was ameliorated to some degree with the advent of contract archaeology (CRM) (Biella and Chapman 1979; Hammack et al. 1983; Lange 1968; Hubbell and Traylor 1982; Post 1996) and its focus on all cultural manifestations, small as well as large. The areas investigated, however, were determined by the needs of highways, reservoirs, powerlines, and housing developments.

But, we still know too little about how, when, and why native peoples used areas away from the main river valleys. These areas constitute 95% or more of the land mass—and resource base—available to and necessary for sustaining people making a living on the land under aboriginal conditions. The sites in these hinterlands
are generally small and unobtrusive, but in the aggregate, they added critical foods, fuel, and materials to the health and welfare of native peoples for thousands of years.

The current paper summarizes information from four small surveys concentrated in one part of these hinterlands. The study area, which lies southwest of the lower Jemez River, would have been part of the resource area used by the late prehistoric and historic inhabitants of the Keresan-speaking village of Zia, located only 7 km to the northeast.

But another group, Towa-speaking peoples related to modern-day Jemez Pueblo, may also have used our project area. Limited archaeological excavations along the Jemez River due north of our study area reveal that ancestral Jemez peoples lived at least as far south as modern day San Ysidro. There, Franklin Barnett found Jemez Type C Rooms in a site he calls #142 (Barnett 1973; cf. Reiter 1938). Site 142 is 10 km from our study area and 5 km upstream from Zia Pueblo.

BRIEF CULTURE HISTORY OF THE MIDDLE RIO GRANDE PROVINCE

Numerous culture histories have been written about the prehistory and early history of the study region. The most enduring has been that by Wendorf and Reed (1955). In this work, the authors define several cultural periods, the Developmental, Coalition, Classic, and Historic periods being of most interest here. Although Wendorf and Reed assigned dates to their periods, we prefer the amendments offered by Dickson (1979). In a nutshell, the periods may be characterized as follows. The reader is referred to the authors just cited and the references they list for further details.

The Developmental period, dated A.D. 600 to 1200, derived from the Archaic period. The Developmental period saw the advent of pottery, settlement in pit-house-type structures, and an increased reliance on farming that, arguably, resulted in a reasonably sedentary life-style. By A.D. 900, the shift to above ground structures called pueblos was in progress, and by A.D. 1200 the transition was complete. By the end of the period, the average site contained a small pueblo of 5 to 10 rooms and associated pit-house/kiva. These sites probably housed extended families. But, some locations contained several small pueblos and constituted a village of several extended families. Population growth during the Developmental period appears to have been steady, probably as a result of natural increase in the indigenous population. The Developmental period has been subdivided into Early, Middle, and Late sub-periods based on changes in pottery and architecture.

The Coalition period, A.D. 1200 to 1325, is believed to have witnessed a greater population growth than the preceding period because of the rapid influx of peoples from outside the region. Thus, we see the creation of much larger villages, some pueblos being 50 to 100 rooms in size. Field-side sites or field houses of 1 to 3 rooms became much more common and are found at loci of arable land at some distance from the main villages. In some cases, such as the Pajarito Plateau between the Jemez Mountains and the Rio Grande, field houses or even small Coalition pueblos are so numerous that they literally
blacken the survey maps in the State of New Mexico's archaeological site record files. The Coalition period has its own distinctive pottery types and complexes that characterize different parts of the region.

The Classic period, A.D. 1325 to 1610, represents the apex of aboriginal population aggregation. Many of the main villages contain hundreds or even thousands of rooms. The field house pattern of seasonal farm-side use and/or residence continues. Reliance on farming and native farm products intensified to its highest pre-Contact levels. Pottery types change again, resulting in types and traditions that can be clearly linked to modern Pueblo peoples. The Classic period ends shortly after the effective colonization of New Mexico by the Spanish.

The Historic period, A.D. 1610 to present, saw restriction of the native peoples to smaller tracts of land, forced movement of populations into larger but fewer pueblos for administrative purposes, population loss due to introduced diseases and acculturation stress, and the introduction of European crops and animals to the Native American diet. The individual villages became fixed on the landscape. The Historic period continues to the present day.

THE STUDY AREA

The study area is situated in a shallow side-valley lying south (or southwest) of the lower Jemez River. The side-valley drains northward into the Jemez River, making it a third order drainage. The side-valley is approximately 11 km (7 mi) long. It can be divided into three sectors based upon characteristics of the topography (Figure 1):

Southern or Headwaters Sector

Here several small drainages start at the divide and flow north through narrow, rock-walled canyons. These canyons have little or no arable land. Since no archaeological surveys have been recorded for this sector, we do not know about the types and sizes of the sites that probably occur there. However, we would expect to find only ephemeral sites associated with wild plant collecting, hunting, and perhaps rock/mineral collecting. Farming was probably not possible in this sector. The north-south length of this sector is approximately 3.2 km (2 mi). Elevations range from 2020 m to 1790 m a.m.s.l.

Middle Sector

This sector, wherein lies our study area, is immediately north of and downstream from the headwaters sector. Here the several small drainages of the headwaters sector emerge from the rocky mesas and enter a broad alluvial basin that is approximately 3.2 km (2 mi) long north-south and 4.8 km (3 mi) wide east-west. Arable land within this sector is abundant. The application of modern farming techniques could bring hundreds or even a thousand or more hectares under cultivation. Farming under aboriginal, non-mechanized, non-irrigation (i.e., dry-farming) conditions would use only a fraction of this area. Elevations range from 1790 m to 1700 m a.m.s.l.
Lower Sector

The lower sector terminates at the edge of the valley of the Jemez River. It is similar to the middle sector and differs mainly in its lower elevation, presumably slightly higher temperatures, longer extent (approximately 4.8 km or 3 mi north-south) and somewhat narrower width (approximately 3.2 km or 2 mi east-west). Like the middle sector, the application of modern farming techniques within this

FIGURE 1
Study area location map.
sector could bring hundreds or even a thousand or more hectares under cultivation. Farming under aboriginal, non-mechanized, non-irrigation (i.e., dry-farming) conditions would use only a small fraction of this area. Elevations range from 1700 m to 1660 m a.m.s.l.

Survey Location

Our study area forms a discontinuous, east-west strip through the middle sector (Figure 1). The terrain is gentle, with the moderately broad valley separated from adjacent valleys by systems of low ridges. These ridges rise as much as 60 m above the valley floor. The drainage area above the study locale is approximately 16 square kilometers.

Natural Environment

The surface lithology of the study area is undivided Santa Fe Group rocks (Dane and Bachman 1965). Vegetation is stratified by topography as follows—isolated rocky elevations within the project area have scattered junipers and sparse grasses. Valley side-slopes are covered with desert grasses. The valley bottom along the main drainage supports juniper woodland. A juniper-pinyon woodland forms on the higher elevations in the headwaters sector immediately south of the study area and thickens as elevation increases to the south (Dick-Peddie 1993; Kuchler 1964).

Soils belong to the Shepard-Rough Broken Land Association (Maker et al. 1971). The valley bottom has deep Shepard soils that are formed from both alluvial and aeolian materials. They are highly permeable, "almost excessively drained", and have a brown loamy sand surface layer underlain by a pale brown loamy sand subsoil and substratum. Shepard soils are reasonably good for farming and, because they drain quickly, would be more productive during wet cycles. During dry cycles, the root zone of these soils might be expected to dry out somewhat as water moves readily into the substrate, thereby leaving the root zone of most plants and making farming more risky. Farming under dry conditions might be possible immediately adjacent to the drainage channels of the side-valleys but would be better at or near the main valley of the Jemez River several kilometers to the north.

Today, warm summers and cool winters characterize the climate of the project area. No temperature records are available for the immediate vicinity of the study area. The closest station with a reasonably long temperature record is the town of Bernalillo in the Rio Grande Valley 30 km to the southeast. At 1552 m (5045 feet) elevation, Bernalillo is 215 m (700 feet) lower in elevation than the study area. The average temperatures (Centigrade) at Bernalillo are: annual- 12.5 (54.5 F); January- 1 (33.9 F); July- 23.4 (74.2 F) (computed from data in Gabin and Lesperance 1977).

Since the study area is higher in elevation than Bernalillo, the temperatures there are presumably slightly cooler on average. The effective temperature (ET) is 13.2, compared to Bernalillo's ET of 13.5) (Cordell 1979). The frost-free season averages about 180 days in the study area and is slightly longer in Bernalillo (Tuan et al. 1972).

Normal annual precipitation for the study area is 280 mm (11 inches), with 165 mm (6.5 inches) falling in the growing season of May through September (Weather
Bureau, U.S. Department of Commerce 1967). Thus, dry farming would be precarious under modern conditions and presumably was also during the prehistoric and early historic past.

THE SURVEYS

The current data base for the study area derives from four small archaeological survey projects conducted in the middle sector between 1974 and 1996 (Wiseman 1974, Woolley 1975, Dennis and Grigg 1977, and McKenna 1996). It is important to note that only 374 ha out of a total of 1554 ha (or 925 of 3840 acres) of land within the middle sector of the drainage were surveyed for these projects. Thus, we have site information on approximately 24% of the land area within the middle sector. The areas surveyed, like the site locations and other details, are omitted here in order to protect the sites.

TABLE 1
Cultural periods, diagnostic artifacts, and dates represented in the study area.

<table>
<thead>
<tr>
<th>Periods</th>
<th>Artifacts</th>
<th>Dates</th>
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</thead>
<tbody>
<tr>
<td>Archaic</td>
<td>1-hand Mano</td>
<td>pre- 600</td>
</tr>
<tr>
<td>E. Developmental</td>
<td>Lino B/w *</td>
<td>600 - 900</td>
</tr>
<tr>
<td>M. Developmental</td>
<td>Red Mesa B/w</td>
<td>900 - 1100</td>
</tr>
<tr>
<td>Coalition</td>
<td>Santa Fe B/w</td>
<td>1200 - 1300</td>
</tr>
<tr>
<td></td>
<td>McElmo B/w *</td>
<td>1175 - 1300</td>
</tr>
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<td>Galisteo B/w</td>
<td>1300 - 1400</td>
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<tr>
<td></td>
<td>Glaze A</td>
<td>1325 - 1400</td>
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<tr>
<td>Middle Classic</td>
<td>Glaze C</td>
<td>1400 - 1542</td>
</tr>
<tr>
<td>Classic or Early Historic</td>
<td>Glaze unknown</td>
<td>1300 - 1900</td>
</tr>
<tr>
<td>Historic/Zia Pueblo</td>
<td>masonry style, sheep corral, rock art</td>
<td>19th - 20th C.</td>
</tr>
<tr>
<td>Undated</td>
<td>None</td>
<td>Uncertain</td>
</tr>
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</table>

* See comments in text about these pottery types.

SURVEY RESULTS

In total, the surveys recorded 23 sites and 2 IOs (isolated occurrences), representing 34 components. These components represent virtually the entire prehistoric and historic spectrum starting potentially as early as the Archaic period and ending with the 19th or 20th century (Table 1). These periods are the Archaic(?), Developmental, Coalition, Classic, and Historic (Zia Pueblo).

Assignment of the various components to periods has had one rather bizarre consequence. The identification of some of the sherds as McElmo Black-on-white for some of the sites is based on characteristics of paste, paint, slip, and, to the extent possible, design style. The implication is that we were dealing with Chaco-McElmo, rather than Mesa Verde McElmo. According to Breternitz (1966), Chaco-McElmo dates somewhat earlier than Mesa Verde McElmo. According to Breternitz (1966), Chaco-McElmo dates somewhat earlier than Mesa Verde McElmo. His suggested dates of A.D. 1025 to 1125 for Chaco McElmo places it in the Late Developmental period of the Rio Grande sequence.
To complicate matters further, the study area McElmo often occurs with earlier pottery types on some sites and later types on other sites. Since these sherds do not occur as the sole painted pottery on any site among the study sample, we cannot be certain that it represents independent components or a specific time period (e.g., the Late Developmental period).

Consequently, we must ask whether the Late Developmental period is truly represented among the study sample, especially in the absence of Kwahe'e Black-on-white. Kwahe'e is the major black-on-white type on Late Developmental sites in the Santa Fe area, and its known area of distribution brackets our study area (Mera 1935). Therefore, it is logical to expect that Kwahe'e be present at one or more of the study sites if the study area was used during the Late Developmental period.

More recent research indicates that a late variety of McElmo Black-on-white was made in the Middle Rio Grande province. Based on work at the site of Prieta Vista in the nearby Rio Puerco valley (Bice and Sundt 1972) and at numerous sites in the western tributaries of the Rio Grande (Sundt et al. 1983), Bill Sundt has documented a type that he describes in great detail as McElmo Black-on-white, Prieta Vista variety (Sundt 1972). This pottery was ultimately named San Ignacio Black-on-white in the AS-8 site report (Bice et al. 1998). Tree-ring and archaeomagnetic dates place the occupation of AS-8 in the 13th century A.D.

Among other differences, San Ignacio B/w generally has panel design layouts in bowl interiors and only rarely has the overall designs like those more typical of Chaco-McElmo and Mesa Verde McElmo. San Ignacio, then, is a logical precursor for Galisteo Black-on-white, a Rio Grande-made type long believed to have ultimately derived from a San Juan Anasazi pottery tradition (Mera 1935).

Before continuing, one other point must be mentioned. The literature contains two or even three names for late, eastern varieties of McElmo Black-on-white. We cannot be certain at this time whether Sundt's San Ignacio B/w, Lonnie Pippen's Guadalupe B/w (Pippen 1987), and Mike Burn's Loma Fria B/w (cited in Pippen 1987) refer to the same pottery, or only in part to the same pottery, or to separate but related pottery varieties. However, Pippen (1987:46) seems to think they are all the same pottery.

Given the preceding discussion, we conclude that the McElmo-like pottery sherds from our sites are probably referable to San Ignacio Black-on-white. Thus, they imply Coalition period occupation and temporal links with Santa Fe Black-on-white. The occurrence of McElmo/San Ignacio with Red Mesa Black-on-white at sites WH-3 (LA 11878) and WH-8 (LA 11883) probably represents reoccupations of the sites. We therefore conclude that the study area was probably not occupied and perhaps was not used during the Late Developmental period, A.D. 1100-1200.

Another question concerning pottery identification was encountered in one of the reports. Dennis and Grigg (1977) report finding Lino Black-on-white [sic] at several of their sites. Lino Black-on-gray is a northeastern Arizona type that did not seem to be popular outside the Four Corners region. A more likely possibility for the sherds from the study sites is San Marcial Black-on-white, the white ware
pottery most often associated with Lino Gray in the Middle Rio Grande (cf. Frisbie 1967). Thus, we assume here that the pottery of the Dennis and Grigg sites is San Marcial.

Returning to our summary of the study sites, all are small. Manifestation types range from isolated finds of a one-hand mano (Archaic?) and a Rio Grande Glaze C sherd, to sherd-and-lithic areas, field houses (1-2 room structures; also, an historic sheep corral), probable pithouse sites (of 1 or 2 structures each), pueblos (4-6 room structures), and a rock art panel.

Since many of the sites appear to have more than one period represented, the remainder of our discussion deals with components rather than sites.

The 34 components are distributed among the various cultural periods as follows (see also Table 2): the Archaic has 1 component; the Developmental period is best represented with 11; the Coalition period has 9 components; the Classic period has 4, and perhaps as many as 7 components; and the historic period also has 4 to 7 components. The confusion about component numbers for both the Classic and Historic periods is due to our inability to assign glaze body sherds to a specific type and therefore to a specific period. And finally, 2 components cannot be dated because of the absence of diagnostic artifacts.

Of all the periods, an Archaic presence is the most questionable. If present in the study area, the Archaic is represented by a one-hand mano. However, one-hand manos are often found in pottery period pueblos in the Rio Grande (Kidder 1932 [he calls them rubbing stones]; Stubbs and Stallings 1953). Thus, the specimen from our study area may or may not represent Archaic period use of the area.

The intensity of use of the study area can be estimated from the types of sites and manifestations of each period, as well as from the numbers of components. Thus, isolated artifacts (IOs) indicate the

### Table 2

<table>
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<tr>
<th>Manifest. Period</th>
<th>IO</th>
<th>SLA</th>
<th>PPH</th>
<th>FH</th>
<th>P</th>
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<td>13</td>
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**Notes:**
- IO: isolated object/artifact
- SLA: sherd and lithic area
- PPH: possible pithouse
- FH: 1 to 2 room field house
- P: small pueblo of 4 to 6 rooms
- RA: rock art
- SC: sheep camp
most ephemeral use, followed by rock art sites and sherd-and-lithic-areas. We assume, of course, that pithouses are not present at what appear to be surface scatters of potsherds and lithic manufacture debris. Such an assumption may not be warranted, but the matter can only be settled through excavation.

Field houses are the next most ephemeral type of site, for these structures are normally believed to represent seasonal use during the planting, tending, and harvesting of crops. People who employ the field house system have full-time residences elsewhere, usually in pueblo villages located in areas central to the socio-economic group as a whole (Ward 1978, especially the Ellis paper therein). We suspect that the historic site with the sheep corral also belongs to this pattern.

We view pithouses and small (4 to 6 room) pueblos as being essentially equal in their implications of habitation group size and degree of site longevity. That is, we see both architectural forms as being residences of a single nuclear family or an extended family for periods that probably spanned one to several years. We initially assumed that pithouses and pueblos represented a more intensive use of the study area than field houses. However, we discovered during the course of this study that this assumption is probably fallacious. This aspect is discussed below.

Given the unequal occupation lengths implied by the different site types, we can get a better estimate of occupation intensity by period if we perform a simple arithmetic exercise. That exercise entails assigning numbers to each occupation type as shown in Table 3. These results suggest that the occupations during the Developmental period as a whole and the Coalition period were approximately equal and that all other occupations both before and after were less intensive.

But one other aspect must be factored in. That is an adjustment for the lengths of the cultural periods. If we divide the weighted values in Table 3 by the lengths of the periods presented in Table 1, we obtain the following results (Table 4). These results essentially refer to number of occupations per year per period.

(1) The occupations/uses of the study area represented by the Archaic and undated sites are negligible at values less than .010, or less than 1 year out of 100.

(2) The occupations/uses of the study area during the Developmental, Classic, Classic/Early Historic, and Historic/Zia periods, as defined by the presence of components, are a little more intensive but are still less than 0.100, or less than 10 years out of 100.

(3) The occupations/uses of the study area during the Coalition period are the greatest of all at 0.310, or about 31 years out of every 100.

Thus, in spite of the actual component numbers, the heaviest use of the study area as defined by archaeological residues (artifacts, architecture) appears to have occurred during the Coalition period, A.D. 1200 to 1325.

The question then arises. What conditions resulted in the trends seen in these archaeological data? Two possibilities come immediately to mind—(1) a population increase through immigration, and (2) a shift in climate that permitted the hinterlands to be used more intensively.

Immigration of peoples into the Rio Grande following depopulation of the Mesa Verde and Chaco regions has been
posed for several decades (Wendorf and Reed 1955). In fact, the term coalition for the Rio Grande period dating A.D. 1200-1325 refers specifically to that hypothesis. And, as mentioned earlier, the presence of San Ignacio Black-on-white pottery on several of the study sites is suggestive. But, since none of the study sites produced San Ignacio B/w as the sole painted pottery, we cannot comfortably assume that immigra-

Climate, on the other hand, can affect human use of marginal areas. In this regard, climate is not seen as being causal or determining, but rather as being permitting or delimiting. Obviously, the technological and/or organizational status of the people in question is an important factor. The humans can choose, or perhaps be forced by social factors, to use an area or region if climatic conditions permit. But, they cannot use that area or region if those conditions do not permit them to do so without some corresponding change in technology or organization.

But the scope of this paper and the nature of our data do not permit us to investigate these questions per se. What we can do is compare our population/land-use shifts with the reconstructed climate as a heuristic exercise to see what correlations pertain, if any. To do this, we must digress temporarily in order to establish the climatic profile for our study area.

### TABLE 3
Weighted values of components by cultural period for the initial trial and the revision.

<table>
<thead>
<tr>
<th>Cultural Period</th>
<th>Sub-Period</th>
<th>Total Period</th>
<th>Sub-Period</th>
<th>Total Period</th>
</tr>
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<tr>
<td>Archaic</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Developmental:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>16</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>16</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coalition</td>
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<td>31</td>
<td>26</td>
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<td>11</td>
<td>11</td>
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<tr>
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<td>6</td>
<td>6</td>
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</tr>
<tr>
<td>Undated</td>
<td>6</td>
<td>6</td>
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</tr>
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</table>

**Notes on assigned values:**
- Isolated Object: initial- 1; revised- 1
- Sherd & Lithic Scatter: initial- 2; revised- 2
- Rock Art: initial- 2; revised- 2
- Field House: initial- 3; revised- 3
- Sheep Camp: initial- 3; revised- 3
- Pithouse Site: initial- 4; revised- 3
- Small Pueblo: initial- 4; revised- 3

Values applied to data on manifestation type in Table 2.
RECONSTRUCTION
OF THE CLIMATE, A.D. 680
TO THE PRESENT

In a little known but important study, Jeffrey Dean and William Robinson of the Laboratory of Tree-Ring Research produced a series of maps depicting paleoclimatic reconstructions for the northern Southwest for the period A.D. 680 to 1970 (Dean and Robinson 1977). The reconstruction—based on tree-ring data for 26 stations—is presented in terms of standard deviations from the mean for the entire period. Furthermore, the departures are in terms of positive and negative values from that mean. Positive departures indicate generally cooler/moister periods, and negative ones indicate generally warmer/drier periods. The maps give the values in 10 year increments for each station, with computer-generated isopleths representing 0.25 standard deviation departures for the intervening territory.

To derive the standard deviation values for a given point on the landscape lying between the stations, a clear piece of mylar was marked with the corners of the map grid. Then the position of the point of interest is estimated from the degrees latitude and longitude provided in the margins of the Dean and Robinson maps. This template is then overlain on each successive map, recording the departure values for each time interval at that point.

Since the point of interest often falls between isopleths, the departure values must be interpolated in the same way that one interpolates elevations between topographic lines on U.S. Geologic Survey quadrangle maps. Once the departure values have been obtained, then it is a simple process to calculate normalized values for any point on the landscape.

### TABLE 4

Occupation intensity of study area by cultural period, initial and revised formulations.

<table>
<thead>
<tr>
<th>Cultural Period</th>
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<td>.002</td>
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<tr>
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<td></td>
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<tr>
<td>Early</td>
<td>500 *</td>
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<td>.040</td>
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<tr>
<td>Middle</td>
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<td>.080</td>
</tr>
<tr>
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<td>.248</td>
<td>.208</td>
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<tr>
<td>Classic:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>242 **</td>
<td>.080</td>
<td>.080</td>
</tr>
<tr>
<td>Middle</td>
<td>100</td>
<td>.010</td>
<td>.010</td>
</tr>
<tr>
<td>Classic/Early</td>
<td>142</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Historic</td>
<td>400</td>
<td>.010</td>
<td>.010</td>
</tr>
<tr>
<td>Historic/Zia</td>
<td>200</td>
<td>.055</td>
<td>.055</td>
</tr>
<tr>
<td>Undated ***</td>
<td>1050</td>
<td>.006</td>
<td>.006</td>
</tr>
</tbody>
</table>

**Notes:**

@ The higher the value, the greater the intensity of occupation. Data sources are Tables 1 and 3. See text for explanation of how values are calculated.

* 500-year figure is for the Early and Middle Developmental sub-periods only since the Late Developmental sub-period is absent in the study sample.

** 242 year figure is for the Early and Middle Classic only, since representation of the full Classic period cannot be documented in the study area.

*** Both sites are described as field houses and therefore are probably date between A.D. 900 and 1950, basically the Middle Developmental period to the present day.
Interpreting the Graph

Several factors must be kept in mind when interpreting the climatic reconstruction graph (Figure 2). Each departure value represents 10 years of averaged data and is plotted at the midpoint of the decade. As can be readily seen in the figure, the differences from one decade to the next can be extreme, with few adjacent decades having identical or nearly identical values.

Application of the climatic reconstruction to the archaeological/historical record requires several assumptions. We are interested in assessing prehistoric and historic Native American farming in the vicinity of the lower Rio Jemez north of Albuquerque. We are assuming that dryland farming was the primary technique used through most of the prehistoric period. At some point in the late prehistoric period, or possibly as a result of contact with the Spanish in the early historic period, the Rio Grande pueblos took up ditch irrigation to increase the reliability of their yields. However, we have no evidence for irrigation in our study area.

But since our reconstructed climate is in terms of standard deviation departures from the mean for the entire period A.D. 680 to 1970, we need perspective on the meaning of the reconstruction values. Our only clue from Dean and Robinson (1977:8) is that "Variation that exceeds two standard deviation units in either direction [positive or negative] is considered to be significant in the sense that such departures are sufficiently rare to have had potential adaptive consequences for plant, animal, and human populations." While this statement helps define parameters, we would like to explore the data for greater precision.

One way to improve our perspective on these climatic data is to look at the climate of the 20th century, with the knowledge that homesteading based on dry-
farming was possible up into the 1920s in many places in New Mexico. In Figure 2 we see that the departure for the 1920s is at two standard deviations, indicating severe warm and dry conditions that put an end to dry farming in many areas of the state. In areas, the Jornada del Muerto of south-central New Mexico being one of them, even ranching became impossible simply because the grass failed to grow (W.F. Turney 1980, personal communication, 1980).

The 1930s at San Ysidro rebounded to a +1 standard deviation, suggesting a return to cooler, moister times. But, by that time, most of the farmers relying on dry-land techniques elsewhere in New Mexico had either lost their farms or moved into other lines of work. The thousands of formerly cultivated acres have since reverted to use as grazing range. Presumably, after a period of moist years, if some one was so inclined, some of those acres could again be dry-farmed. However, to this writer's knowledge, this has not happened.

Returning to our study area, in the introduction we suggest that dry-land farming using the presumed aboriginal techniques (i.e., planting, tending, and harvesting by hand) would be possible only under conditions of higher than mean precipitation of the climatic reconstruction (Figure 2). We suggest that dry-farming would be best between the mean (0) and +1.0 to +1.5 standard deviations of the mean. These optimal farming periods are shaded in the graph, plotting the +1.0 and +1.5 periods separately to look for trends and changes.

Those time periods on the graph having positive departures exceeding +1.5 standard deviations are designated with a question mark. Presumably the colder average temperatures during those periods would have seriously shortened the growing season and making plant growth and crop maturation much more risky and ultimately less successful than during the optimal periods. Thus, we cannot know which, if any, of the years within these periods would have permitted successful cropping.

Once the best farming periods had been defined, the information was simplified as a linear bar graph (Figure 1753). This was done as two discontinuous lines of bars, the upper one showing those periods between +1.0 and +1.5 standard deviations and the lower one showing periods between 0 and +1.0 standard deviations. These periods are discussed from here on as the +1.0 and the +1.5 optimal farming periods.

The final transformation of the data was to calculate the percentages of time represented by the +1.0 and +1.5 optimal farming periods within each cultural period (Early Developmental, etc.). The results are graphed in Figure 4. The bottom-most line in this figure shows the changes in use-intensity of the study area as reflected in the archaeological components.

RELATING CHANGES IN POPULATION AND/OR LAND-USE IN THE STUDY AREA TO CLIMATIC SHIFTS, A.D. 680 TO 1940

The curves for the +1.0 and +1.5 optimal farming periods in Figure 3 are most interesting. As expected, optimal farming periods occur sporadically throughout the
study period, A.D. 680 to 1940. In the Early Developmental period (A.D. 600-900), only three short periods of about one to two decades each fall strictly within the +1.0 optimal farming period. This is compensated somewhat by an additional four periods that occurred within the +1.5 optimal farming period. Altogether, the +1.0 and +1.5 periods account for only 41% of the total time represented by the Early Developmental period (Figure 4). Farming by dry-land methods was not reliable between A.D. 680 and 900.

In the Middle Developmental period (A.D. 900-1100), dry-farming improved measurably. During that time, there were five +1.0 optimal farming periods and two +1.5 periods. Although still intermittent and of relatively short duration, the optimal farming periods were somewhat warmer than during the preceding period, suggesting less trouble with early and late frosts. Altogether, the +1.0 and +1.5 periods account for 37% of the total time represented by the Middle Developmental period (Figure 4), with 29% of the time being the +1.0 period. Thus, farming by dry-land methods was still unreliable but improving between A.D. 900 and 1100. Concomitantly, human use of the study area increased somewhat during this time (see bottom-most line in Figure 4).

The Late Developmental cultural period (A.D. 1100-1200) witnessed a basic continuation in the amount of time within the +1.5 optimal farming conditions but a drastic drop in the amount of time in the +1.0. This means that conditions, while

FIGURE 3
Bar graph of optimal farming periods in the San Ysidro area, A.D. 680-1940.
still about the same overall as those in the Middle Developmental period (at least according to our criteria), were somewhat cooler and more like conditions during the Early Developmental period. Combined, the +1.0 and +1.5 conditions accounted for 40% of the total time represented by the Late Developmental period (Figure 4). Thus, farming by dry-land methods was not only still unreliable, the increase in cooler temperatures evidently had an effect on Native American use of the study area. As mentioned earlier, we have no unequivocal archaeological evidence that people used the study area during this period, A.D. 1100-1200.

The Coalition period saw an important change in dry-farming conditions. No clear-cut periods favorable for dry farming occurred during the first half of the 1300s, unless very short intervals occurred during the two climatic extremes centered in the first and fourth decades. In fact, the only favorable period of note did not start until the last decade, or about 1390. This period was so long (about 50 years) and favorable (all within +1.0 s.d.s) that it overlapped into the Early Classic period. So, even though the total period of optimal dry-farming conditions still only amounted to 35% of the time between A.D. 1200 and 1325, the situation for farming was

![FIGURE 4](image)

Trends in optimal farming periods compared to prehistoric and historic settlement/use intensity of the study area, A.D. 680-1940.
superlative. Not surprisingly, archaeological evidence for use of the study area is also plentiful and, so it would appear, is considerably more than for any other period before or after.

The situation continued into the Early (A.D. 1325-1400) and Middle Classic (A.D. 1400-1540) periods when conditions reached their peak for dry farming. At their best, the average length of each good period was on the order of 20 years long with one that spanned the Middle and Late Classic boundary being about 40 years long. Almost all of these optimal times were within the +1.0 range. At the peak during the Middle Classic period, optimal farming conditions totaled 51% or about one-half of the time, with 44% of them being within +1.0 standard deviations. These results remind us of the early Conquistador accounts that the pueblos strove to maintain a two-year supply of stored corn (Knaut 1995). The one surprise is that, as good as the Early and Middle Classic periods were for farming, the actual archaeological evidence for use of the study area dropped precipitously. This subject will be discussed shortly.

The Early Historic period (A.D. 1540-1610) saw a decided reverse in the amount of optimal dry-farming time. The long, strong period of climate within the +1.0 optimum that began toward the end of the Middle Classic period ended about A.D. 1560. From that time down to the present, the frequencies of both +1.0 and +1.5 optimal periods have been fewer in number and more widely spaced in time. The advent of ditch irrigation along major rivers, whether an independent Native American accomplishment or an introduction by the Spanish, was timely indeed. Returning to the decrease in habitation use of the study area during the Classic period, the question arises. Was the drop a reality or just the appearance of reality? When we look at the nature of the shift in use of the study area between the Coalition and the Classic periods, one thing becomes immediately obvious. The primary archaeological manifestation of the Coalition period is the small pueblo. These structures probably represented single nuclear or extended family residences that were inhabited either for the agricultural season or perhaps continuously for periods of one or more years. In previous periods, pithouses are also presumed to have served in the same way for the same approximate durations.

Classic period archaeological manifestations, on the other hand, are mainly field houses. That is, these small, flimsy structures presumably were used mainly, if not solely, during the farming season (Ward 1978, especially the Ellis paper therein). For the most part, they do not seem to have functioned as residences per se, but more likely served as places for temporary shelter from the elements and perhaps for short-term storage. The farmers might have used them only during the day or over certain nights as they tended their fields. Full time residence, as such, would have been at the main village(s) located along larger drainages like the Jemez River. The distance between the study area and the Jemez River is inconsequential for those who must walk everywhere.

Thus, while only one or two individuals may have used a given field house for a day or for an overnight stay, that use actually represented a family or an extended family located elsewhere. In a very real sense, then, the field house probably represents
approximately the same amount of use of the land within the study area as the small, Coalition period pueblo. The shift, then, was in residence location and not in use-intensity of the study area.

Given this shift in perception, we then returned to our data and revised our weighting of two categories— small pueblos and pithouses— to provide equivalency with field houses (and the one sheep camp)(see columns of revised calculations in Tables 3 and 4). When these results were regraphed (as shown in Figure 4), the trend of the line changed only slightly.

Although the revised curve is very similar to the initial one, it should be a more accurate estimation of changes in use of the study area for the period A.D. 680-1940. The chief differences between the two are that, in the revised curve, the values for the Early Developmental and the Coalition are somewhat lower because of the lower value assigned to pithouses and small pueblos. The overall effect is to accentuate the difference between the Early and Middle Developmental sub-periods and to reduce the contrast of the Coalition with all other periods and sub-periods.

SUMMARY AND CONCLUSIONS

Four small surveys in north central New Mexico recorded a total of 23 sites and 2 isolated objects, which, in the aggregate, represent 34 different occupational components. The study area lies within the central sector of a small tributary to the lower Jemez River. Approximately 24% of the land area within that sector was surveyed.

A variety of site types are present in the study area. These include isolated objects, sherd and lithic scatters, small pithouse sites, field houses, small pueblos, a sheep camp(?) with a small structure and corral, and a rock art panel.

These manifestations represent every cultural period and all but one sub-period from the Archaic to the recent historic. However, judging from the nature of the archaeological remains, the occupations and uses of the study area varied in intensity through time.

The raw or unweighted data profile for the sites and isolated objects suggest that the greatest period of occupation/use of the study area occurred during the Developmental period, A.D. 600 and 1200. Occupation during the succeeding Coalition period (A.D. 1200 - 1325) is somewhat less well represented, and all other occupations and uses appear to have been minimal by comparison.

Because of the differences in site types and the innate implications about occupation intensity/duration (sherd and lithic scatters versus small pueblos, for instance), the data were weighted in a crude effort to adjust for these disparities. The results of this weighted-data profile suggest that the Coalition period occupation/use of the study area easily exceeded that of all other periods combined.

A comparison of the population/use trends in the study area with the reconstructed climate for the region proves most interesting. Given certain assumptions, the climatic reconstruction indicates that conditions favorable for farming were episodic throughout the study period of A.D. 680 to 1940. During numerous interstitial periods, we believe that farming was either not
possible or was too marginal to have permitted reliance on cultigens as a major food source. Our findings in this regard are summarized as follows:

(1) The reconstructed climate suggests overall improvement in conditions for farming from Early Developmental through Middle Classic periods; that is, the periods optimal for farming became both more frequent and longer on average through time until about A.D. 1560;

(2) The weighted profile of archaeological use of the study area generally increased concomitant with the improving climatic trend for farming from the Early Developmental through the Middle Developmental periods;

(3) Conditions deteriorated somewhat during the Late Developmental and Early Coalition periods, and the study area evidently was used little if any at that time.

(4) Late in the Coalition period and extending somewhat into the early Classic period the climate improved greatly and was excellent for farming. We suspect that the Coalition period use of the study area occurred mainly, if not solely, during this interval (remembering that Coalition remains, according to the weighted profile, are the most obvious for the entire study period, A.D. 600 to 1940);

(5) The parallel trends of increasing use/population size in the study area and increasing frequency of favorable periods for farming seem to have diverged about A.D. 1325 or 1350; that is, population size and/or use of the study area appears to have decreased precipitously, even though conditions for farming continued to improve;

(6) When climatic conditions for farming deteriorated about A.D. 1560, the same seemingly low-level Native American use of the study area seems to have remained essentially unchanged;

(7) A reevaluation of our expectations about certain types of archaeological remains, specifically the residential and land-use implications of pithouses and small pueblos versus field houses, suggests that the shift from the former to the latter does not necessarily reflect a change of intensity of land use. More likely it mainly signals a shift in residence location from within the study area to some place outside but nearby the study area. In essence, dependence on the study area for sustenance may have changed little or not at all. Thus, pithouses, small pueblos, and field houses are probably approximately equivalent in their implications for intensity of land use.

(8) If our reading of the data is accurate, the mother-village/field-house pattern of settlement and land use in this part of New Mexico appears to have started early in the Classic period, or some time in the first half or middle of the 14th century A.D.

In final summation, three points are worthy of reiteration. Limited archaeological field investigations and analysis of data from small sites in hinterland situations can offer important insights on prehistoric and historic life-ways. Field house sites appear to have the same implications for intensity of land-use as do single pithouse sites and small pueblos, all three of which probably represent resource acquisition for single families or extended families. And, there seems to be a demonstrable, perhaps fairly direct, correlation between occupation/use intensity in hinterland areas and the frequency and duration of optimal farming periods.
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Wiseman, Regge N.  

Wooley, Jack  
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ERRATA

Volume 26: The First 100 years: Papers in Honor of the State and Local Archaeological Societies of New Mexico

p. 84 left col., para. 1, line 2- Bice citation date should be (1983).
p. 84 left col., para. 5, line 2- Brewer should be capitalized.
p. 91 Table 2, 3rd col. from right, should read- Brenda Wigglesworth.
p. 92 Table 2, far right col., should read- Elizabeth Kelley (3 places) and Barbara Munzer (1 place).
p. 93 Table 3, 3rd col. from right (for 1979), should read- Linda Linnaberry (2 places).
p. 93 Table 3, 2nd col. from right (for 1980), should read- R. Bice, G. Peacock (1 time).
p. 107 right col., para. 2, line 9, should read- "New Mexico rock art had been discussed..."
p. 113 right col., para. 2, lines 1-2, should read- "By the 1978 season, registrations stabilized near the limit of 30 people..."
p. 137 right col., para. 1, 3rd line, should begin- "The nature of archaeological programs..."
p. 170 right col., para. 2, line 8- delete was.
p. 180 right col., para. 1, 4th line, should read- "Spring— washing, ..."
p. 294 right col., para. 1, last line- "ad" should be "and"
p. 323 right col., para. 2, line 8- "handson" should be "handsome".
The 1901 excavations at the House site located 8 miles west of Pueblo Bonito during the Tozzer-Farabee Expedition in 1901.