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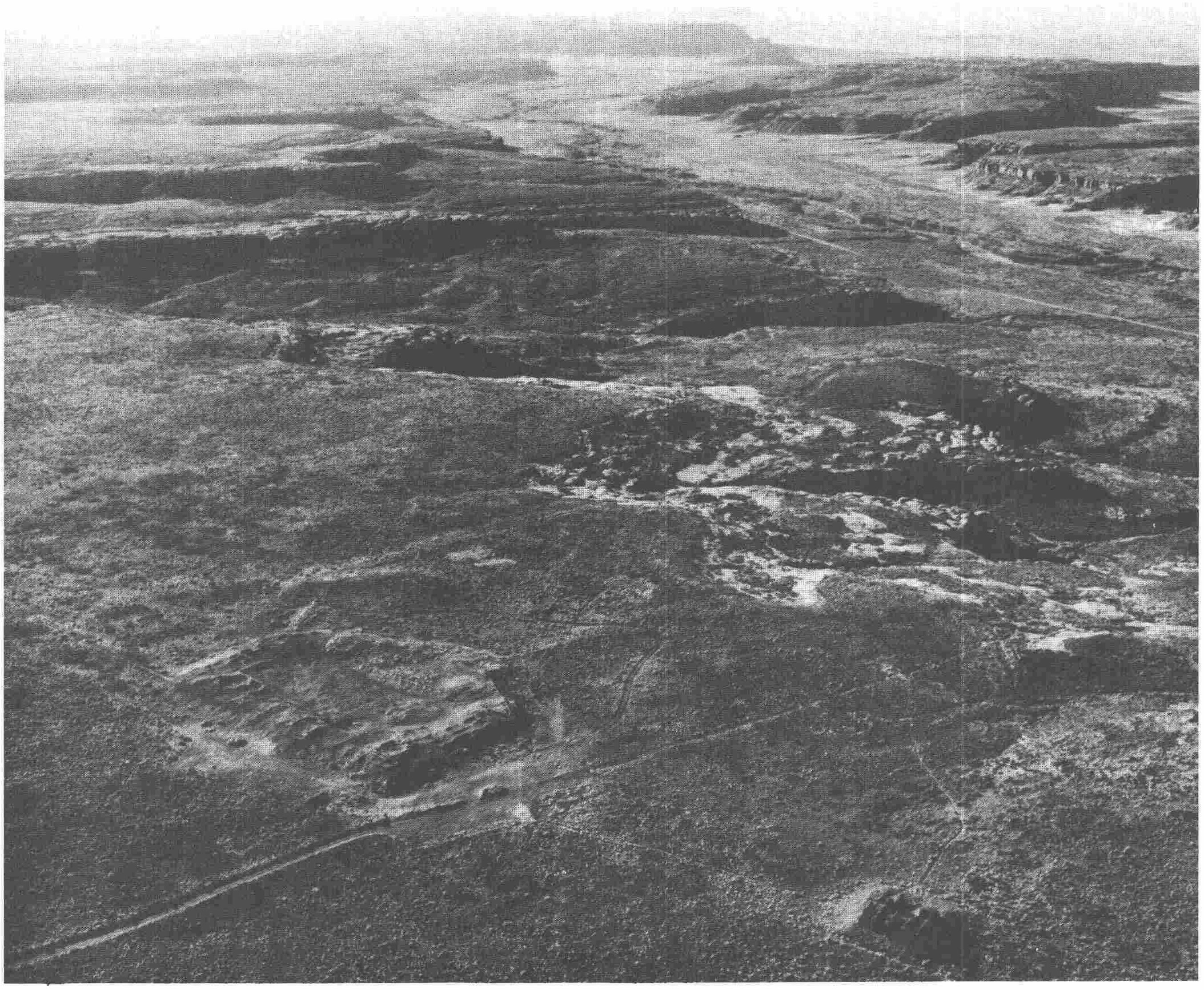
Investigations at the Pueblo Alto Complex

Chaco Canyon

Volume I



Investigations at the Pueblo Alto Complex

Chaco Canyon

New Mexico

1975-1979

Volume I

Summary of Tests and Excavations at the Pueblo Alto Community

Thomas C. Windes

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Chaco Canyon Studies

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Front cover: Pueblo Alto and New Alto on the mesa overlooking Chaco Canyon to the southeast (Courtesy of David Brill ©1980).

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Foreword

In 1971, a multidisciplinary National Park Service research team assembled in New Mexico to study past human adaptation to the seemingly harsh, semiarid environment of the four corners region of the American Southwest. A survey of Chaco Canyon National Monument and its environs led in 1980 to legislation that expanded its boundaries, protected 33 outlying Chacoan structures and communities, and redesignated the area as Chaco Culture National Historical Park.

While a number of sites were excavated during this project, only one of these was a large site or greathouse, Pueblo Alto. It was chosen for several reasons; among them was its location on the mesa on the north side of Chaco Canyon where a number of prehistoric roads either came together before entering the Pueblo Alto compound or came into the site in several places. Additional roads led from Pueblo Alto to the rim above Pueblo Bonito and Chetro Ketl where prehistoric stairways provided entrance into the canyon proper. What was the function of Pueblo Alto? Was it the same as other greathouses in the canyon? Was it a trading center located just above the canyon where peoples from the north brought food and other materials? Or was its function more specifically related to the Chaco road network, e.g., as a gatehouse? Because Pueblo Alto is the only greathouse excavated during the past three decades, information derived provides new insights into activities at this site, in the canyon, and in the entire Chaco Anasazi region.

I am pleased to introduce this comprehensive report which is the only report of a Chacoan greathouse that includes such a wealth of detailed data needed to answer more subtle questions about Chaco Anasazi sociopolitical organization and exchange networks. The new information greatly improves our knowledge about the interrelationships among greathouses, their different roles within the system, and provides new insight into the complex culture of the Chaco Anasazi.

William Penn Mott, Jr.
Director
National Park Service

Preface

The Branch of Cultural Research, formerly known as the Chaco Center, was established in 1971 to conduct multidisciplinary research in the area of Chaco Canyon, New Mexico. From 1971 through March 1986, this was a joint National Park Service/University of New Mexico facility housed on the University campus in Albuquerque. Effective April 1, 1986, the staff moved to the National Park Service facilities in Santa Fe; the collections and all their documentation (archival material) are curated by the Maxwell Museum of Anthropology of the University of New Mexico in Albuquerque.

One of the most important missions of the Branch of Cultural Research is to disseminate the results of its research to the professional community and to the interested public, in addition to park managers and interpreters. Reports on these research projects are issued either in the National Park Service Publications in Archeology series or in the Reports of the Chaco Center series. The latter was established in 1976 to provide economical and timely distribution of the more specialized research undertaken as part of the Chaco project studies. The former series contains the broader reports that appeal to a wider audience either because of archeological content or topics addressed. This comprehensive report on Pueblo Alto is the only one that will provide up-to-date, detailed information on a greathouse in Chaco Canyon.

While a total sample of approximately 10% of Pueblo Alto was excavated, the wealth of information obtained from this site was considerable. The detailed analyses of the various architectural features and artifact/ecofact groups, which depended on careful notetaking and mapping, allow the investigators to make better inferences about room function, site function, seasonal occupation, resource utilization, and exchange networks. The study of the road system in and around Pueblo Alto increases our knowledge of interaction among Chacoan sites both within Chaco Canyon and throughout to San Juan Basin. For no other site within Chaco Canyon is such a data base available.

Because of the detailed analyses and the tremendous amount of data involved, however, the report on Pueblo Alto is extensive as well as more comprehensive than many of the earlier studies on Chaco greathouses. As a result, we have had to divide it into several volumes. Volume I is a summary of the tests and excavations conducted in the Pueblo Alto community; Volume II deals with the architecture and stratigraphy; Volume III includes the separate analyses on various artifacts and biological material collected during excavations. In addition, other material has been placed on microfiche; all references to microfiche in the text of Volumes I-III are prefaced by MF. The microfiche document is available through Technical Information Center, Denver Service Center, National Park Service, 12795 West Alameda Parkway, P. O. Box 25287, Denver, Colorado, 80225. It will include material from all three volumes.

These volumes are being produced one at a time. While we have tried to make all of them available at the same time, the volume of material that has to be assembled precludes handling more than one complete book at a time. The remaining volumes will be made available as soon as possible; therefore, the final microfiche will not be completed until the last volume is ready and distributed.

The completed volumes are a tribute to the professional staff, all of whom devoted many additional hours of their own time to produce the final reports. In addition, Irene Mitchell edited the volumes, a considerable task given the number of pages, tables, and illustrations. Gigi Bayliss provided many of the illustrations under contract; Jerry Livingston, our Scientific Illustrator, was assisted by Ernesto Martinez. Dolores Guenzi and Sherry Ivey typed draft and camera-ready pages. To all these individuals, I owe my thanks; but most of all I want to commend Tom Windes for his endless hours of labor on all aspects of the research, analyses, and publication of the Pueblo Alto report.

The Branch of Cultural Research maintains an up-to-date listing of all published papers, reports, and monographs on Chaco or Chaco-related research carried out under the general auspices of the Chaco project, regardless of where they might be published. This list, entitled "Contributions of the Chaco Center," is available on request. Correspondence should be addressed to General Editor, Branch of Cultural Research, National Park Service, P.O. Box 728, Santa Fe, NM 97504-0728.

Frances Joan Mathien
General Editor

Preface

Notes on Abbreviations, Acronyms, and Name Changes

The Chaco Center has undergone a number of name changes that may bewilder the reader. Since its inception in 1969 as the New Mexico Archeological Center, the organization has been renamed as the Chaco Research Center, the Chaco Center, the Division of Cultural Research, and now the Branch of Cultural Research. Throughout this report, the Chaco Center, our seminal name, is the name used most frequently throughout the text. In addition, congressional legislation in 1980 enlarged the study area and gave it new status: what was Chaco Canyon National Monument since 1907 became Chaco Culture National Historical Park. Both names are used interchangeably in this report and sometimes are shortened to "Monument" or "Park."

The site of Pueblo Alto is now well known, although in the past the name may have referred to any of the three major sites in the Pueblo Alto community (Pueblo Alto, New Alto, and Rabbit Ruin), particularly New Alto (i.e., Hawley 1934:Plate 5.2; Vivian 1947). Pueblo Alto has also been known as Old Alto or Alto Grande in contrast with the smaller "McElmo" phase house nearby known as New Alto or Alto Chiquita. For this report, Pueblo Alto ("Old Alto") is frequently shortened to just Alto, whereas New Alto and Rabbit Ruin are always identified by those names. The name Pueblo Alto has also been applied to other sites found on elevated topography or to tall standing buildings, including Kin Ya'a (Lummis 1880), a Chacoan outlier near Crownpoint, New Mexico. For this report, however, it applies to that famous site in Chaco Canyon.

The project has interacted with a number of federal, state, and private agencies and organizations. The most commonly known are shortened here to their familiar acronyms:

BLM	=	Bureau of Land Management, U.S. Department of Interior
GSA	=	Government Services Agency
MNM	=	Museum of New Mexico

NPS	=	National Park Service, U.S. Department of Interior
SCS	=	Soil Conservation Service, U.S. Department of Agriculture
UNM	=	University of New Mexico
USDA	=	U.S. Department of Agriculture
USDI	=	U.S. Department of Interior
USFS	=	U.S. Forest Service, U.S. Department of Agriculture
USFW	=	U.S. Fish and Wildlife, U.S. Department of Interior

Other abbreviations used in the text can be found in the coding lists (Appendix MF-E) and the description of features (Chapter 8). In addition, prehistoric roads were field-identified by road segments, shortened herein to RS.

Pueblo Alto has been recorded by a number of different institutions and individuals over the past 60 years and given a variety of site numbers:

29SJ 389	National Park Service (1971)
Bc 251	University of New Mexico - Lloyd Pierson (1955)
LA 661	Laboratory of Anthropology - Museum of New Mexico (1930s)
SAR 4	School of American Research (1930s)
Site 11	William Jackson (1877)

For this project the Smithsonian Institution system assigned during the initial inventory survey performer under contract by W. James Judge and Dennis Stanford in 1971 is preferred. In this system the states are numbered by their alphabetical position (New Mexico is 29th), followed by the county abbreviation and with the sites numbered serially within the county (Hayes 1981:16). Because three counties in New Mexico start with the letters "Sa," the letters "SJ" were substituted for San Juan County.

Finally, a brief description of statistical tests and symbols used in this report was prepared by H. Wolcott Toll in the following Table P.1.

Storage Locations for the Pueblo Alto Materials

The materials collected from Alto are stored in a number of repositories, and future investigators should be aware of these locations. As of 1987, most of the cultural material is stored at the the Maxwell Museum at the University of New Mexico. Much of the ground stone, the soil samples not comsumed by analysis, and the spalls are housed in Pueblo Bonito at Chaco Canyon. Tree-ring samples are housed at the University of Arizona Tree-Ring Laboratory. Obsidian hydration rinds are on file in the Obsidian Hydration Laboratory at the University of California, Riverside, and at Mohlab at Pennsylvania State University. Unanalyzed charcoal samples left over from carbon-14 dating are stored at the dating labs at the Smithsonian Institution, Rockville, Maryland, or at Dicarb in Gainsville, Florida. All archeomagnetic samples submitted for dating are stored at the Earth Sciences Observatory at the University of Oklahoma in Norman. Pollen slides and the flotation seeds are housed at the Castetter Labora-

Table P.1. Summary of statistics and symbols used in various chapters.

Statistic	Symbol	Derivation and Use	Reference
NOMINAL DATA			
Chi-square	X^2	Test for difference in occurrence of attributes among groups.	Siegel 1956:175
Contingency coefficient	C	Measures the strength of association based on the X^2 distribution and controls for sample size; directly comparable only for contingency tables of the same size.	Siegel 1956:196
Fisher's Exact Test	p	Calculates the probability (p) that two samples are the same for two variables; used for small samples.	Siegel 1956:96
Diversity	H'	Measures the distribution of items in various categories (types, species) in a given sample; based on the logs of the percents in the categories.	Pielou 1969:229
Evenness	J	Compares the maximum possible value of H' with the actual value to give an index of the evenness of distribution (0 = all in 1 category, 1 = same percent in each category).	Pielou 1969:229
Richness	s	Used in conjunction with H' and J; the number of categories present.	Pielou 1969:229
Coefficient of Jaccard	S_J	Gives an index of similarity between two groups based on the co-occurrence of attributes.	Sneath and Sokal 1973:131
ORDINAL DATA			
Spearman's Rank Order Coefficient	r_S	Gives a coefficient of correlation between two groups that can be ordered on the occurrence of some attribute, or one group ranked by two variables.	Siegel 1956:202

Table P.1. (continued)

Statistic	Symbol	Derivation and Use	Reference
INTERVAL DATA			
Mean	$\bar{x}$	The average of a series of values.	
Coefficient of variation	CV	The standard deviation divided by the mean; gives a standardized value for variability expressed as a percent.	Thomas 1976:82
Standard deviation	sd	Measures the dispersion of cases around the mean and the variability of the sample; the percentage of cases falling within given numbers of standard deviations from the mean is known.	Kushner and DeMaio 1980
Student's t-test	t	Compares the means of two groups to determine whether the two are likely to be from the same or different populations.	Kushner and DeMaio 1980:156
F test	F	Compares the variance estimates for two samples as a ratio in order to determine whether or not the variances are the same; the result is compared to a known distribution.	Kushner and DeMaio 1980:175
ABBREVIATIONS			
degrees of freedom	df	Calculated variously for different statistics; concerns "the number of parameters that are allowed to vary" after "certain restrictions are placed on the data."	Kushner and DeMaio 1980:260 Siegel 1956:44
probability	p	Gives the likelihood that a larger value will be obtained for a certain statistic, given the df of the sample (see also Fisher's exact above).	

Table P.1. (concluded)

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tory, Biology Department, University of New Mexico, but will return to the National Park Service/Maxwell Museum after the ultimate conclusion of the Chaco Project. Finally, all notes and photographs generated by the project are currently housed at the Maxwell Museum in Albuquerque.

T. C. Windes

Acknowledgments

An outstanding crew (Appendix A and Appendix MF-A) contributed to the work conducted at Pueblo Alto (Plate A.1). When Alto was designated a long-term project by the personnel office, the NPS was finally able to hire staff archeologists for the term of the project instead of on a seasonal basis. Eleven archeologists with considerable field experience were hired; our first-year crew at Pueblo Alto combined nearly a century of field experience. A major contingent had worked for David Breternitz at the University of Colorado field school, and most others had gone through the field experiences in northern New Mexico for the University of New Mexico. Most of the archeologists hired for the work at the site stayed for the duration of the project. Unlike so many multiyear projects, this allowed excellent continuity among the staff and the ongoing work.

Many of the project archeologists literally spent their youth involved with Pueblo Alto and Chaco Canyon, and to them, especially, I am exceedingly grateful. We did not always agree on the direction and approach to the work but, for the most part, personalities melded to allow cooperation and achievement. I am sure none of us will forget the weather of Chaco, sometimes inclement (Plate A.2), nor the measures we took to beat it: working under fiberglass roofs in the rooms, heading for a splash after work in the muddy waters of the Chaco Wash at our favorite swimming hole, sneaking into stock tanks and the frigid waters of the Navajo Indian Irrigation Project (NIIP) canal on our gala runs into Farmington for movies and supplies, heading for the LaPlata and Chuska mountains for weekend "site" seeing, etc. The tasty goat roasts, playing volleyball until midnight, mooning the campers, avoiding some of the evil Park Rangers, losing our oats over the dilapidated killer Government Services Agency trucks and their innumerable flats and dead batteries, enjoying the annual Bastille Day blow-outs at the Salmon Ruins (thanks Cynthia), and getting into firefights in the trailers over July 4th, are some of the other memories that shall stay with us (as well as the Park staff) for a long time. Throughout it all, the field staff maintained an excellent quality of work, a devotion to the job over long working hours, a fine spirit of camaraderie, and many a fun time. I will never forget them.

Those members of the regular crew (Plates A.3-A.5) deserve the highest credit for the difficult task for which they so long and arduously worked: Nancy Akins, Cory Breternitz, Cathy Cameron, Marci Donaldson, Bill Gillespie, Stephen Lekson, Peter McKenna, Bob Powers, John Schelberg, Wolky Toll, Marcia Truell, and Chip Wills. Almost all have continued to work in the field of archeology, and several have started or achieved their Doctor of Philosophy degrees (Donaldson, Gillespie, Lekson, Schelberg, Toll, and Wills).

I particularly wish to thank Steve Lekson for his tolerance of the indignation he suffered from the Siamese "turquoise" frog recovered from room fill in which he was digging. It caused quite a stir, although the victim for which it was intended missed out. That little creature would have fooled me and, secretly, I believe that Steve took a special liking to the little guy.

Special thanks must go to our premier handyman, Bob Greenlee from Bend, Oregon, who started as a volunteer in 1975 and progressed to a seasonal staff member in 1977 and 1978 (Plate A.7A). Bob managed the necessary carpentry skills required around the site, worked with the often frustrating task of obtaining the overhead Whittlesey bipod photos, and handled many a task around the site, some pleasant and some not.

We simply could not have survived the toils of Alto without the wonderful lab personnel, Cathy Cameron, Marcia Truell, and Bruce Moore, who kept the materials processed almost as fast as we piled them up. Marcia, a real gem, lived in virtual isolation from the rest of us (thus, saving her sanity) in the lab trailer set up next to the site. She got a wonderful view of the Chaco sunsets and peace and solitude. I am also forever indebted to the volunteer lab ladies: Adrian White, Marci Donaldson, Mary Jo Windes, Mary Benson, Megan Monson, and Karen Wise, who processed the masses of flotation samples--bent over all day in the mud and hot sun with their hands in dirt and water--without the complaints they deserved to air.

Working with primarily a Navajo laborer crew was an experience. There were inevitable language and cultural barriers, but the crew did a good job. Paul Tso and Amos Hasuse did a fine job (Plate A.5C-D), in particular, although my fondest memories are of the old timers, John Wero and Jimmy Lopez, who had worked for many an archeologist. Wero, in fact, was born in Chaco Canyon and provided me with a number of adventures, as when I was forced to break into his hogan and car one night during a staff party after his wife had thrown the keys away while they were driving through Chaco with a trunk full of groceries. The work day at Alto when smoke from his burning shed brought the Alto crew in a hurry to help (too late) was another Wero escapade. They were all neat people. Sadly, since the cessation of work at Pueblo Alto, three of these workers have died in a variety of accidents (Jimmy Lopez, Eddy Garcia, and Victor Kee).

A large number of people volunteered at Pueblo Alto and were a tremendous asset to the work (Appendix A). Most of these are listed by the year they assisted us, although a few escaped before I could register their names and hometowns. Volunteers fulfilled a variety of tasks assisting in the excavations and in the laboratory. Their work usually was for a short period, although some spent considerable time with us, occasionally lasting the entire summer. Two crews of high school students from the Student Conservation Association (Charlestown, New Hampshire) also provided tremendous assistance at the site. Other volunteers helped on small projects related to Alto after the field work had ceased. Several came from Bennington College (Vermont) to help, while others came from the Albuquerque Public School system. In particular, Suzanne Hunt (e.g., Plate 10.10) and Kim and Kelley Cooper from Valley High School spent many weekends in Chaco providing help. Without a doubt, volunteers contributed much to the success of the project and made the staff's job much easier to accomplish.

Much of the credit for Pueblo Alto must go to Jim Judge (Plate A.7B), who endured the crushing bureaucratic entanglements while longing for days to be in the field once again. I cannot forget his support and guidance during our work in Chaco, and it is unfortunate that he has become a casualty of trying to mix long-term research with the complexities of the Federal Government and the sifting sands of political power. If things had worked out differently, this would have been his report, not mine.

Special thanks to Alan Rogers, LuAnn Wandsnider, and Bill Doleman for their considerable help with computor programming and the application of the SAS statistical packages. Jeffrey Dean and Richard Warren of the Tree-Ring Lab, and Bill Moir of the U.S. Forest Service provided valuable insights into tree species and tree characteristics in the San Juan Basin that contributed much to Chapter 7. Irene Stehli, Robert Stuckenrath, Erving Taylor, Bruce Smith, and Don Blakeslee provided much assistance concerning the radiocarbon dating at the site, while Bob Dubois worked closely with me in the archeomagnetic realm. Mollie Struever (Toll) and Anne Cully worked tirelessly on the Pueblo Alto macrobotanical materials and put much of their own time into the project, which helped immensely. Most of the photographic plates in this report from Pueblo Alto are the work of a volunteer, Francis Vogel (Plate A.6F), who became so interested in the job that he took night classes to help improve the product; what a fine job he did. Much of the logistic legwork for getting the photos in shape for the report, however, fell to another volunteer, Julian Anastasio (Plate A.7D). To all these friends, my sincere thanks.

My wife, Mary Jo, endured the nine long summers of my field work in Chaco with great patience and nary a sight of me, yet proved to be my greatest asset. I particularly remember when she took time from her own busy schedule to help in the field processing flotation. It was during work on Alto that both our children joined our family. Todd arrived so completely unexpectedly into my life that I fled home after work at Alto one evening in July 1976, nearly having two head-on collisions in the process (hey, not my fault!). By July 1977 the little guy was cutting his teeth at Alto strapped to the backhoe backseat while dad crashed around the site. Through the years he has helped out in Chaco, even while the final pages of this were being written (e.g., Plates 5.9B, 10.5, 10.9, A.6C). Alas, it was at Kin Bineola, when ceramic transects were being done, that he took his first mandatory driving lessons at the age of four that enabled us to push the dead Volkswagen to the road. Thanks, Todd, for being so happy a fellow in such a strange environment. Connor, born in 1978, also helped by keeping himself busy playing amongst the talus boulders, chasing lizards while his dad low-crawled along midden ceramic transects, and measuring rooms at Kin Bineola.

We all share a genuine appreciation for those of the Monument staff who proved to be so helpful, had an abiding interest in archeology and our work, and did not plague our lives with petty harassement and grievances. I especially wish to thank Archie Werito and Andrew Charlie, of Maintenance, and Cecil Werito, of Stabilization, for keeping our dilapidated GSA trucks running, fixing our flats, moving our equipment trailer, supplying us with water tanks and toilets, and the many other things that helped us along.

Finally, my thanks for the support of the Chaco Center staff not involved directly with the field work. Catherine Ross was a tireless worker who kept the archives functioning, the photos curated, and watched over us like a mother. F. Joan Mathien provided much help and guidance during the writing and editing process of this report, as well as helping with small projects in the field. Gigi Bayliss produced the final inked maps and graphs, and Jerry Livingston did a fine job running the entire illustrative process.

The three reviewers are to be especially thanked for their commitment to reviewing the final product. Jeffrey Dean, David Doyle, and Gwinn Vivian spent a great amount of time and effort looking over the report and offering constructive criticism for which I am most grateful. Dabney Ford, F. Joan Mathien, Larry Nordby, and Thomas Vaughn also provided very helpful reviews. Irene Mitchell tediously edited the manuscript and Sherry Ivey produced the final manuscript. All tried to steer me clear of the many pitfalls of poor writing, inaccuracies, and faulty thinking. Again, my deepest thanks to a fine supporting cast.

Chapter One

Introduction

The large tumulus of Pueblo Alto and the spire of interconnected walls of nearby New Alto that have stood as silent sentinels overlooking Chaco Canyon and its environs for a millennium (Figures 1.1-1.2, Plate 1.1) have long fired imaginations. Legends of possibly great antiquity about a powerful gambler who lived at the site have been kept alive among generations of Navajo, who first inhabited the area by at least the sixteenth century. Although Pueblo Alto does not exhibit the multistory architectural remnants that have brought Chaco Canyon and its ruins to archeological prominence, interest in Alto has endured since 1877. In that year, William Jackson, the famous photographer, first spotted the Pueblo Alto housemound and the silhouette of New Alto next to Pueblo Alto from Peñasco Blanco.

One of Pueblo Alto's most enduring aspects is its view. Its placement emphasizes a topographic setting rather than a concern with critical environmental advantages. Alto's visual range is beyond the canyon to the regions surrounding Chaco Canyon: north to the rolling plains and broad washes and south to the mesa tops bordering the canyon and beyond to rolling grasslands. The view of the entire San Juan Basin, the focus of the Chacoan Phenomenon, is surpassed by few other Chacoan sites (Figure 1.3). To the north rise the San Juan and La Plata mountains whose peaks are often snowcapped well into June. The small stacks of rock capping Huerfano Butte also interrupt the skyline, and this landmark may contain an important Chacoan signal station and shrine. Today the butte is extremely important in Navajo myth and is often associated with Chaco Canyon place names. To the west rise the Chuska Mountains where the ties to Chaco Canyon and Pueblo Alto appear strong. Washington Pass, a possible source for Chacoan lithics, ceramics, and trees, is easily identified along the Chuskan skyline. Both Ford Butte and Shiprock, prominent volcanic plugs on the western skyline, are also visible from Pueblo Alto.

To the south rises the Dutton Plateau, but much of this view is blocked by remnants of Chacra Mesa bordering the south side of Chaco Canyon. Pueblo Alto is situated, however, so that another prominent

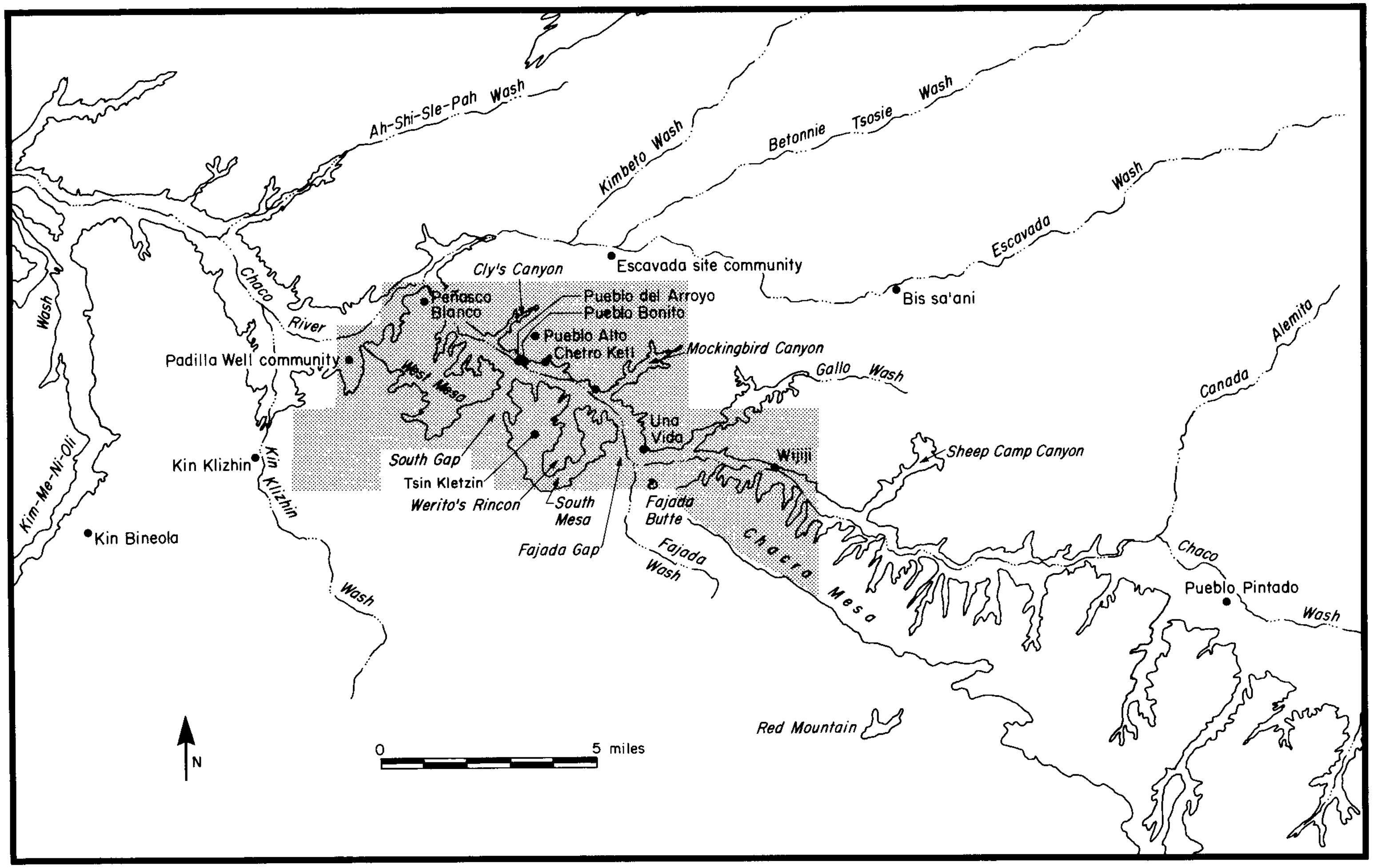


Figure 1.1. Important topographic features and greathouse sites in Chaco Canyon and its environs.

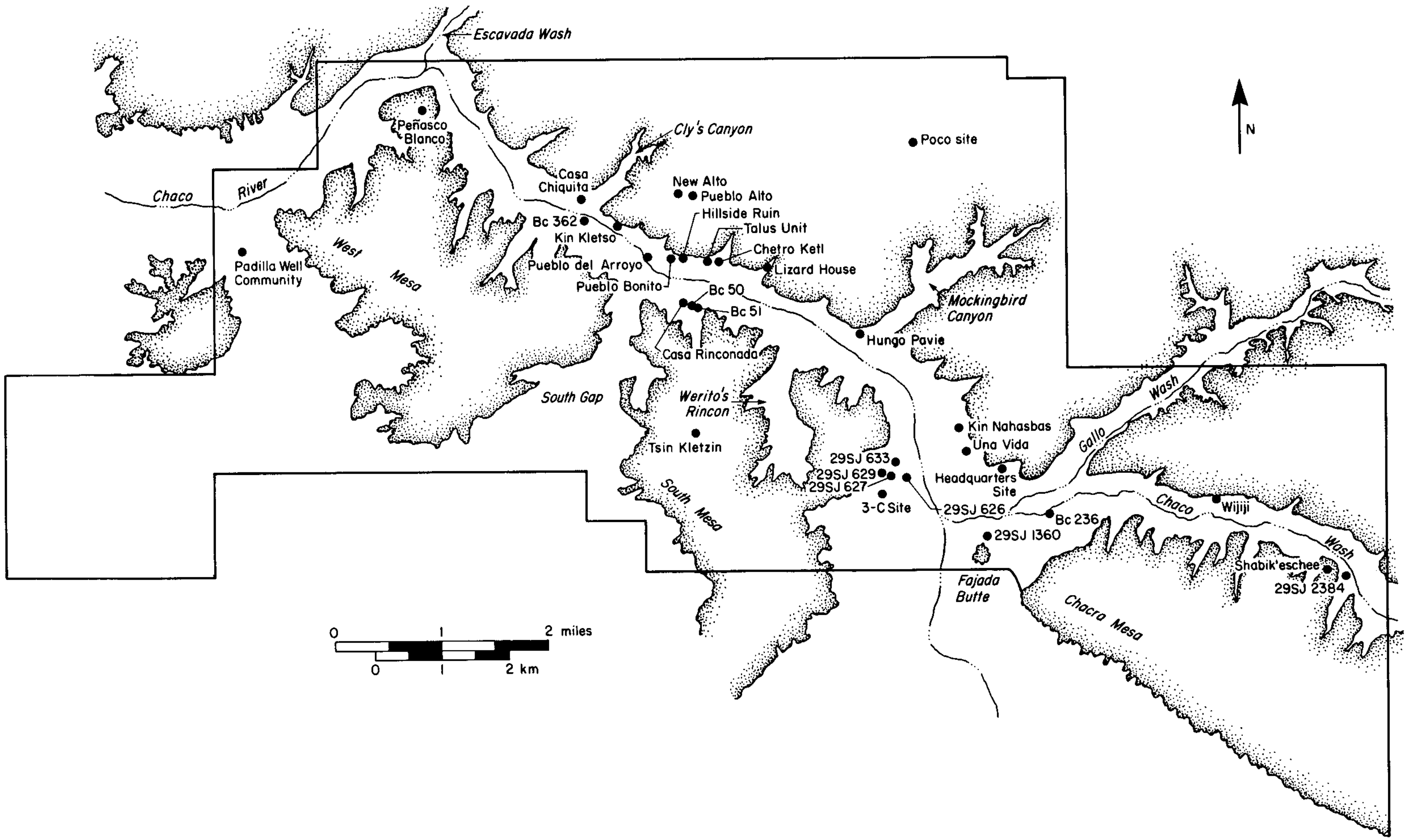


Figure 1.2. Important greathouse and small-house sites in Chaco Canyon.

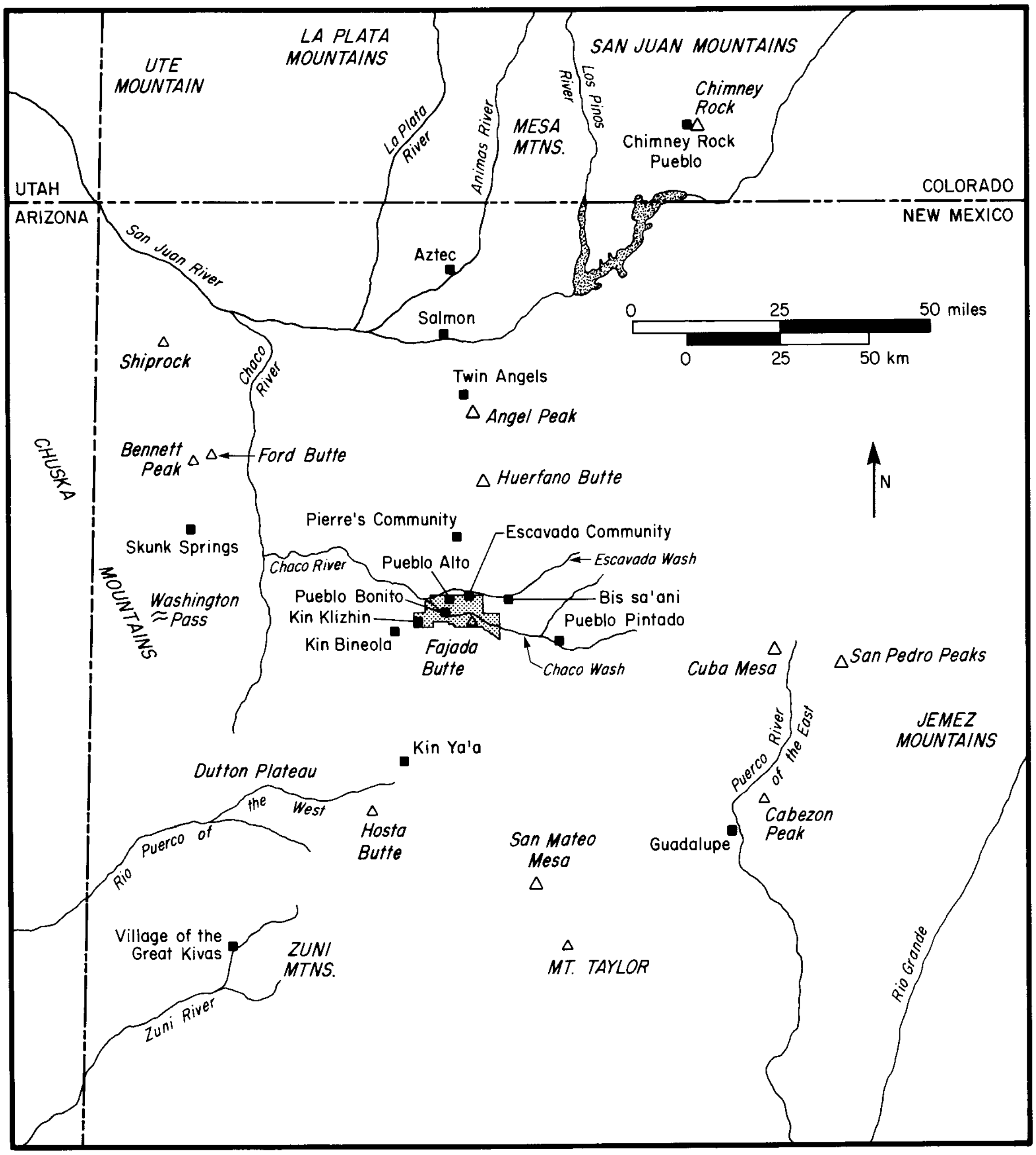


Figure 1.3. Some important sites and landmarks in the San Juan Basin and adjacent regions.

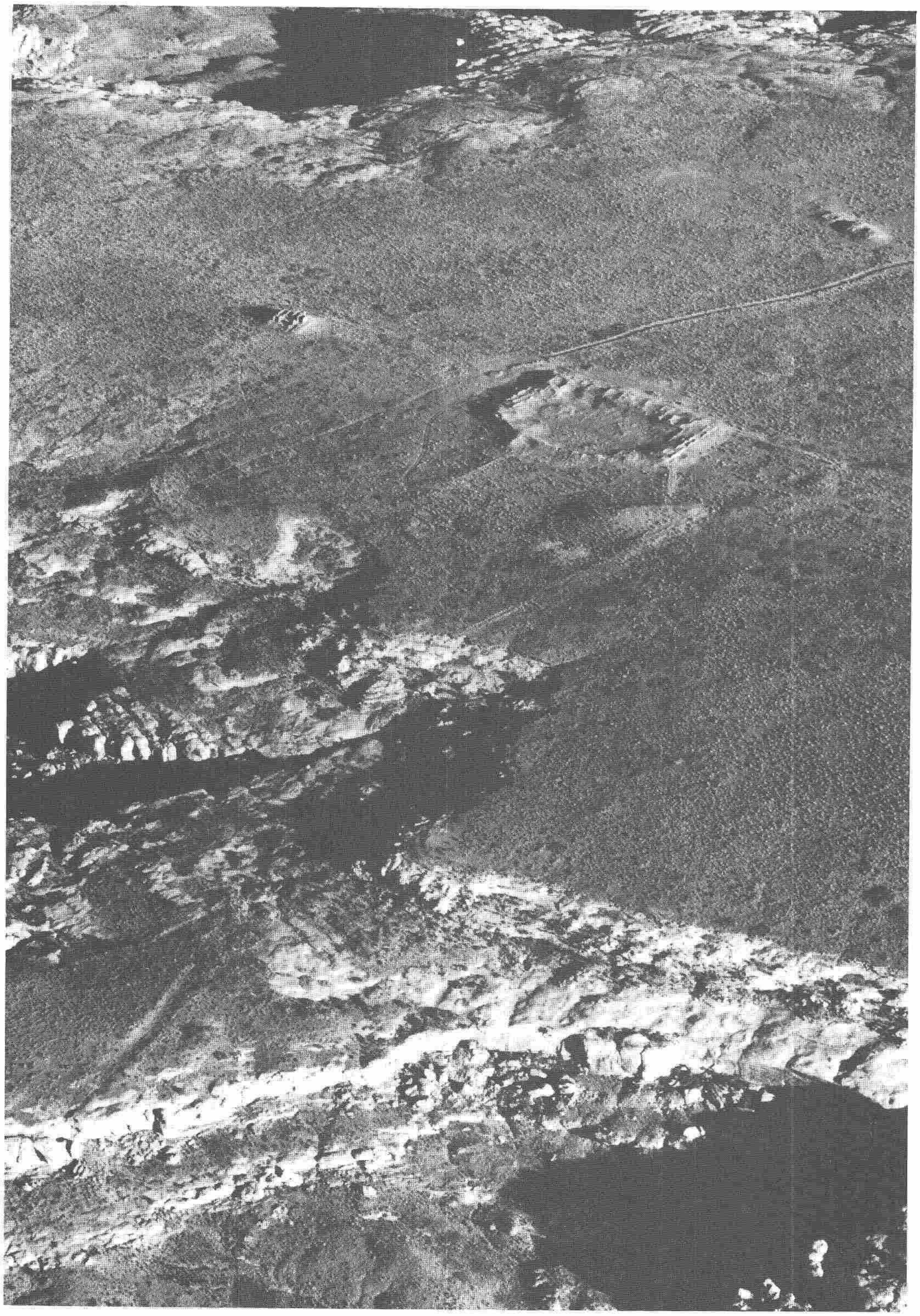


Plate 1.1. The Pueblo Alto community and its southern environs. Note shadow of prehistoric roads, particularly that in the lower left center. (Courtesy of David Brill, ©1980).

skyline feature, Hosta Butte, which also reveals shrine activity, can be seen south through South Gap. Another break in the mesa allows Mt. Taylor to be seen to the southeast through Werito's Rincon. The local prominent peak, Fajada Butte, also is easily seen to the southeast. Completing the visual rotation to the northeast brings into view much of the Jemez Mountains. Sacred peaks and areas of mythical importance to both Navajo and Pueblo Indians abound in the visual spectrum presented at Alto. Alto's lofty position above the canyon also affords it the first light of day and the last glows of amber from the setting sun long after canyon greathouses have fallen to more somber hues.

Romanticism aside, there is a plethora of cultural features in the vicinity that contributes to the special interest in Pueblo Alto. A pair of attendant houses, New Alto and East Ruin, attached, or nearly so, to the site by long masonry walls, stretch to the west and east, while a huge 4-m-high midden is situated just outside the Pueblo Alto walls to the southeast (Figure 1.4, Figure 4.1). Another masonry wall ties the midden directly to Pueblo Alto. Nearby, where the mesa is broken into a series of benches and cliffs that descend south to the canyon bottom, are a number of diverse esoteric features. Some may represent attempts at terrace farming at the nearest cliffs whereas others, at the cliff edge, may have served as special places for ceremonial activities. Directly south of Pueblo Alto on the mesa top across the canyon is another greathouse, Tsin Kletzin, that occupies a similar setting. Tsin Kletzin and Peñasco Blanco, at the mouth of Chaco Canyon on a mesa bench to the west of Pueblo Alto, are the only greathouses clearly visible from Pueblo Alto at ground level. In addition, Una Vida and Kin Nahasbas were visible from the Pueblo Alto rooftops.

But one feature type accentuates the aura of Pueblo Alto as an exciting archeological place--roads. Nowhere else can the profusion and clarity of roads be seen crisscrossing the landscape as around Pueblo Alto (Plate 1.2) and far to the north across the Escavada Wash. These avenues provide direct evidence for physical integration of the Pueblo Alto community with the sites below in the canyon and greathouses in the far distance. The roads weave Pueblo Alto into a sophisticated network of regional dimensions that only has been truly appreciated since the last decade. It is certain that the Pueblo Alto roads, in particular, have experienced the ebb and flow of traffic between the canyon and communities to the north and west as the tide of political and economic realities were imposed on the inhabitants.

This report, then, deals with the Chaco Center investigations at Pueblo Alto between 1975 and 1979. Although a wealth of information was gathered from the work, only a mere 10 percent of the site was excavated. Volume I of the Pueblo Alto report emphasizes the strategy, architectural and stratigraphic implications, chronological framework, and ancillary investigations of the roads, terraces, wood sources, small sites, and associated houses. The descriptive narration of the field methods and the architecture and stratigraphy at Pueblo Alto comprise Volume II. Studies of the cultural material, and human, faunal and botanical remains form

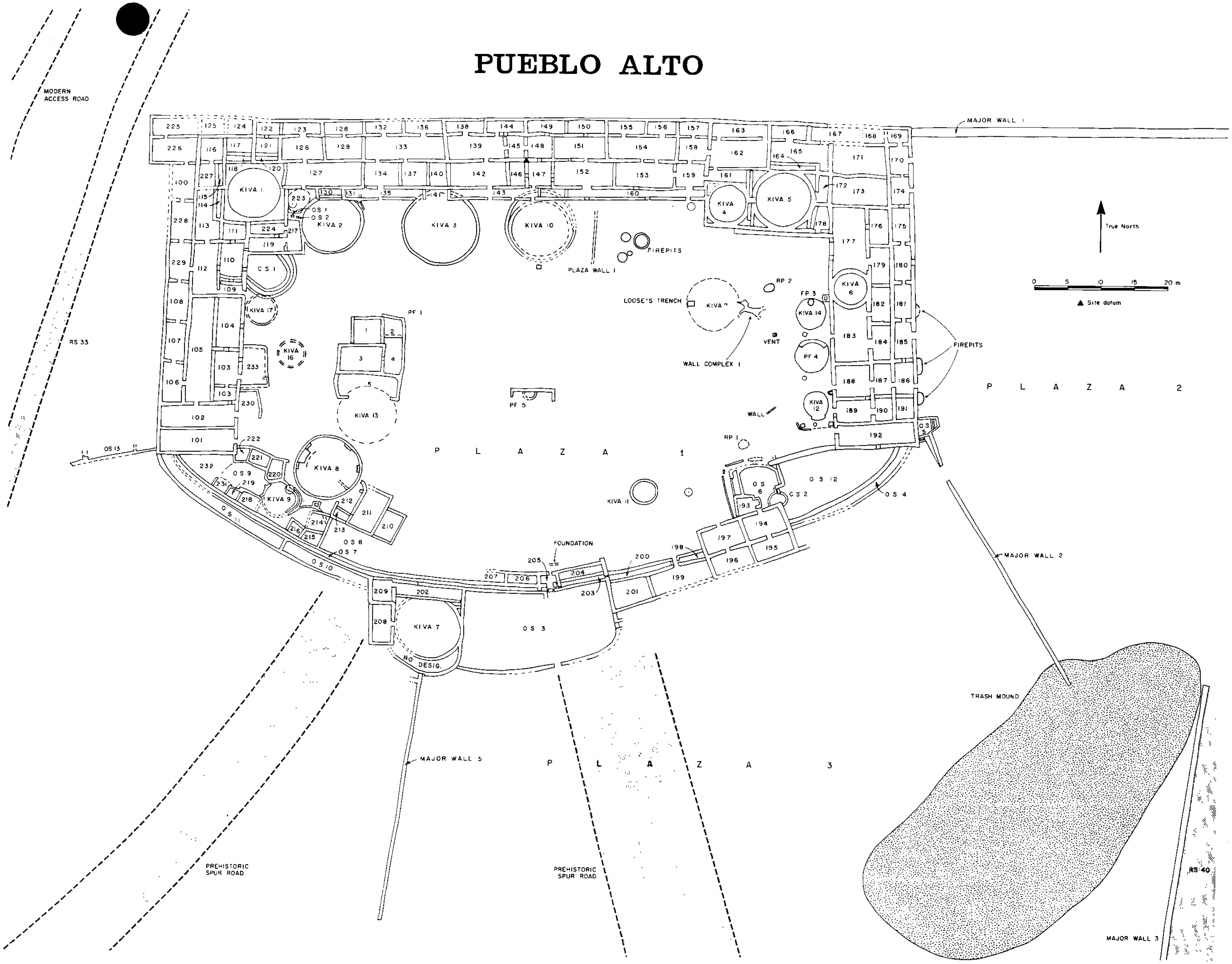


Figure 1.4. Pueblo Alto wall plan after wall clearing.

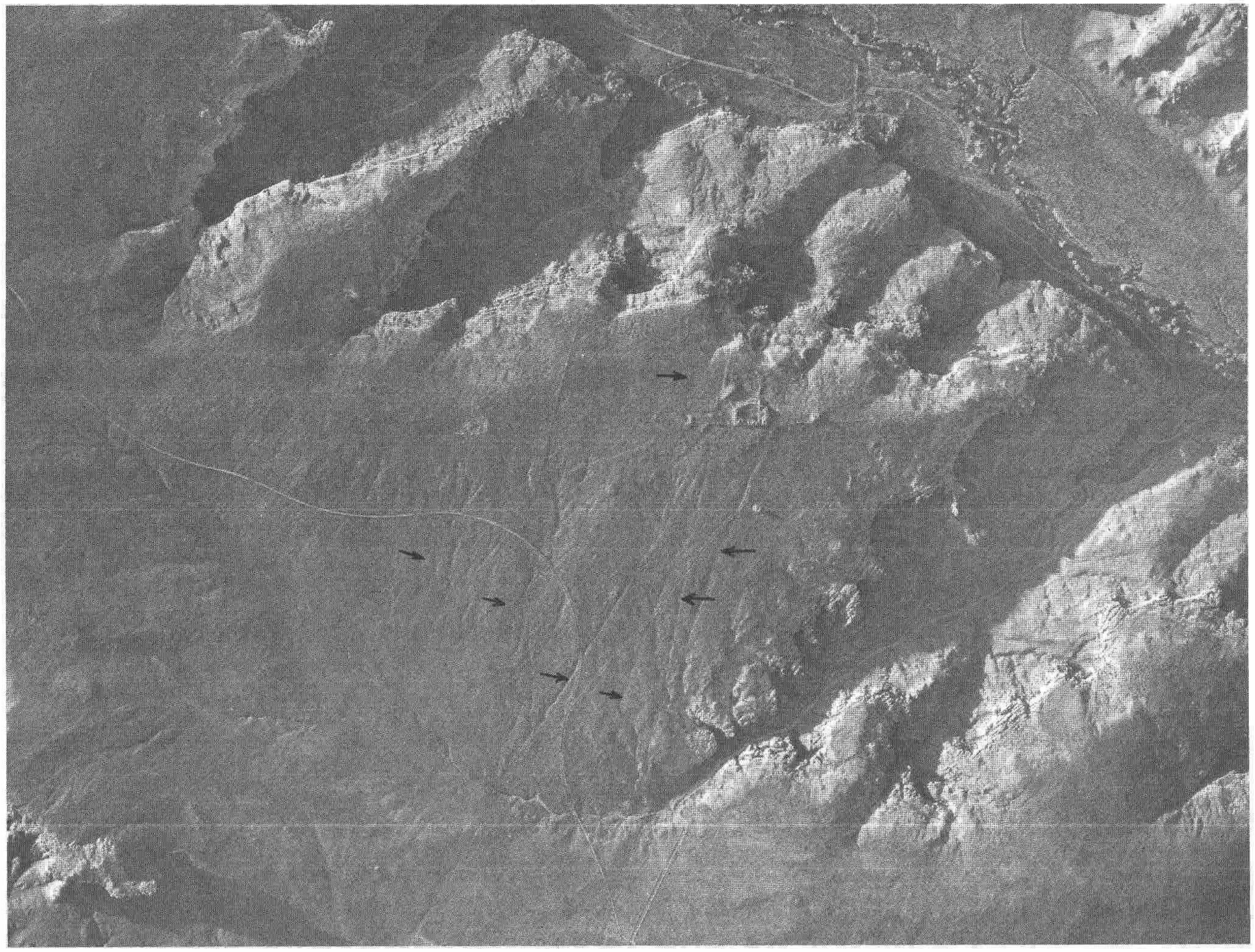


Plate 1.2. Prehistoric roads radiating out from Pueblo Alto. Photo taken during a low sun angle in October 1981. (Courtesy of the Bureau of Land Management, Albuquerque, NM.)

Volume III. Much of the data from all three volumes, however, is in microfiche and available separately from the three volumes.

Discovery

Because of its location high on the north mesa overlooking Chaco Canyon, Pueblo Alto was the next-to-the-last greathouse to be discovered and named during the nineteenth century exploration of the canyon. The first eye-witness reports of the ruins in Chaco Canyon were made by Lt. James H. Simpson of the U.S. Army in 1849 during a westward foray against the Navajo. His trek through the canyon missed Pueblo Alto (and Tsin Kletzin), and it was left to the photographer William Jackson to name and map Pueblo Alto after he noticed the low mounds while exploring Peñasco Blanco in 1877 (Jackson 1878:446-448). Jackson's attempt to reach Pueblo Alto resulted in several important discoveries concerning the prehistoric road network. These include the great ramp behind Chetro Ketl at the Talus Unit, the stairways east of Chetro Ketl, and the famous Jackson's Staircase near the head of the rincon behind Chetro Ketl. Robert Lister (personal communication 1979) believes that Jackson's Staircase was named for a young lad who fell from the stairs to his death in the 1930s rather than for the famous photographer. At Pueblo Alto, Jackson noted a few of the long walls extending out from the ruin, but failed to associate these with prehistoric roads. More important notes on Pueblo Alto and associated structures were left by Holsinger (1901) during his investigation into the excavations at Pueblo Bonito, but afterwards Pueblo Alto was left in obscurity for nearly 70 years while attention focused on the greathouses dotting the canyon floor.

Background

Pueblo Alto is one of 13 or 14 greathouses in Chaco Canyon in which the Bonito phase had been widely identified. Alto's classification as a Chacoan greathouse includes the complex of traits that Powers et al. (1983:15-16) have used to classify "Chacoan structures." These traits include large site size, large rooms with high ceilings, massive stone, core and veneer walls, and construction of large-scale units indicative of complex planning efforts. In this report, the Bonito phase is not restricted to sites of unusual size and architectural style. Instead, the Chaco Center has broadened the phase to include all sites in the period spanning about A.D. 900 to about A.D. 1150 (Judge et al. 1981; Toll et al. 1980). Any manifestations of the Chacoan Anasazi during that span now fall under the Bonito phase, and the phase is not restricted to greathouses as it once was.

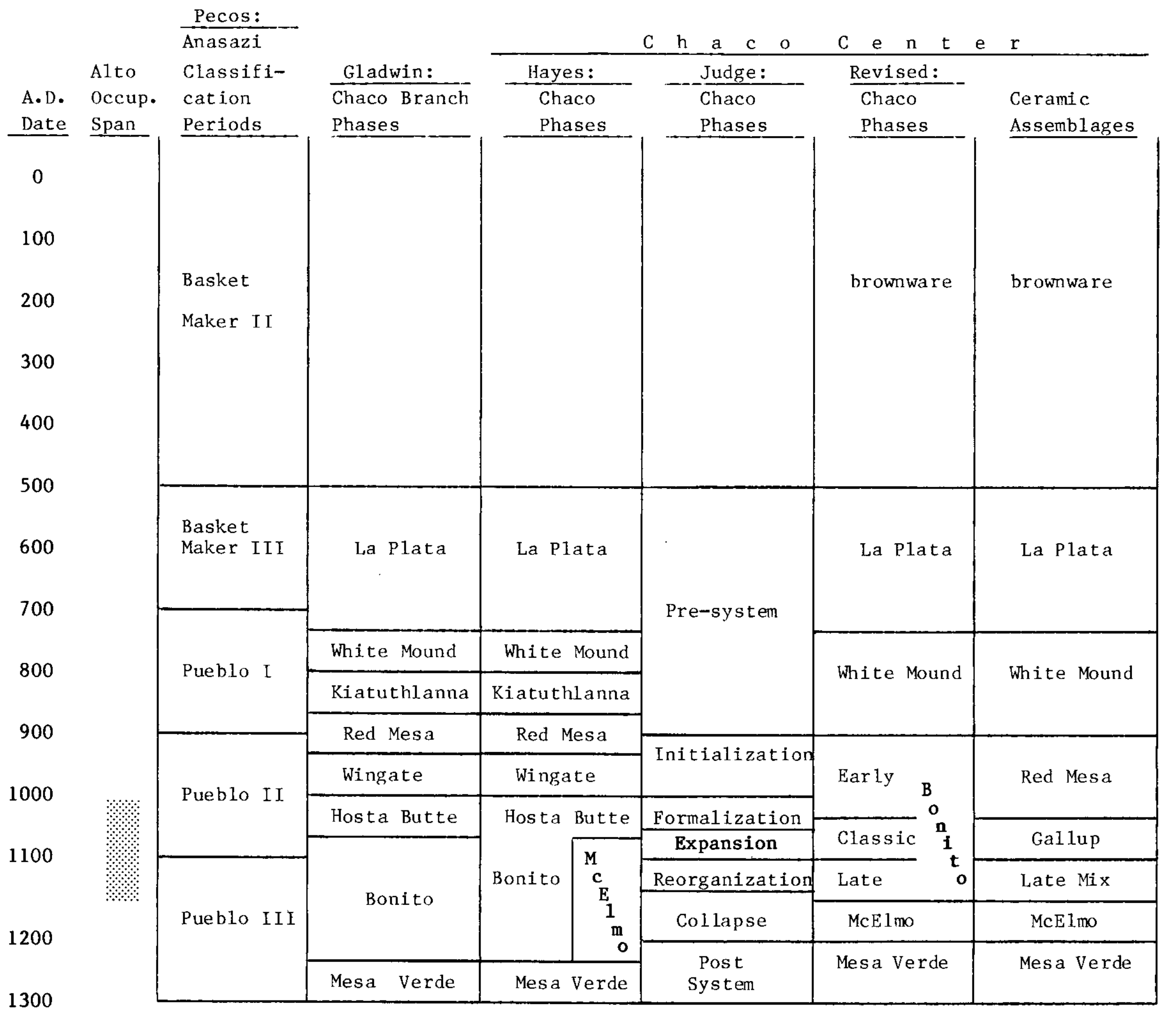
Much has been written about the period in Chacoan prehistory that has been designated the Bonito phase. The latter has been redefined from the period proposed by Gladwin (1945) to include the beginning of the greathouses, and the contemporary smaller sites, through the classic period and its demise (Judge et al. 1981; Toll et al. 1980), spanning approximately

A.D. 900 to A.D. 1140. The Hosta Butte and McElmo phases have found wide acceptance in the literature as contemporary periods of occupation that were congruent with the Bonito phase based on differences primarily in site size and architecture. These contemporary phases imply social, economic, and political differences that have not been demonstrated for the Chacoan occupation and distort examination of the overall process and organization of what is better recognized as a single, multidimensional, integrated system. For this reason, separate Hosta Butte and McElmo phases are not used in the discussion and explanation of Pueblo Alto and the Chacoan Phenomenon. Instead, the Early, Classic, and Late Bonito phases temporally divide the 240-year period (Figure 1.5). In this report, however, the term Bonito phase refers to the entire 240-year period of the Chacoan Phenomenon.

When the Chaco Project started field work in 1971, the 15-year project in Chaco Canyon was envisioned as culminating in the excavation of one of the large greathouses of the Bonito phase for which the canyon had been set aside as a national monument in 1906. Large-scale excavations had essentially ceased in the canyon with Edgar Hewett's last field season at Chetro Ketl in 1937 and Gordon Vivian's work at Kin Kletso in 1953. With the construction of the new visitor's center in 1957, Una Vida, a mere 300 m from the center, seemed an apt candidate for the NPS to expand visitor interpretation. Complete excavation of the site was planned by Gordon Vivian, who cleared 15 rooms at Una Vida in 1960 in just over a month to test the suitability of the site for future excavation and interpretation. Una Vida continued high on the priorities of the NPS for additional excavation, and it was targeted again for the Chaco Project.

The new knowledge gained from the inventory survey of the Monument (Hayes 1981) and the increasing awareness of the prehistoric road system that widened our understanding of the broad Chacoan development forced a reappraisal of the planned excavation of Una Vida. Pueblo Alto's association with numerous prehistoric roads tying it physically to a number of Chacoan greathouses made it a better candidate for excavation than Una Vida. In addition, the concurrent work at the Salmon Ruin, a large Chacoan outlier northwest of Chaco and connected to Pueblo Alto by the Great North Road, increased interest in excavations at Pueblo Alto to complement those at Salmon. By December 1974, Una Vida had officially been dropped from consideration in favor of Pueblo Alto.

At first there were some major differences in perception among the senior archeologists on the staff about the amount of excavation to be done at Pueblo Alto. Robert Lister, the Chief of the Chaco Center and acting Chief Archeologist of the NPS, favored large-scale work reminiscent of that of the early Chacoan archeological pioneers. This would have entailed supervision by several archeologists, but left the primary excavation effort to Navajo laborers. This pattern characterized the Center's work at small houses from 1973 through 1975. W. James Judge, a recent addition to the staff (1975) and soon to become the new Center Chief (1976), brought a background of sampling and computer-assisted analysis and inventory to the project from his recent work at a large Pueblo IV



[a]After Gladwin 1945; Hayes 1981:Figure 10; Judge 1983:Figure 3; Judge et al. 1981:Figure 1; McKenna 1986:Figure 1.2; Toll et al. 1980.

Figure 1.5. Various temporal classificatory schemes for the Chacoan Anasazi culture and Pueblo Alto's place within them.[a]

site (Judge 1974). His approach to Pueblo Alto called for smaller-scale work and a dramatic reduction in the low-archeologist to high-laborer ratio that had caused problems for the junior archeologists during earlier small house work. In addition, there was new direction toward conservation archeology that had been recently espoused by Lipe (1974). In the end, the plan for a smaller project at Pueblo Alto prevailed.

The main house at Pueblo Alto contained approximately 77 initial rooms (and 3-5 kivas), but later additions and renovations raised the total to 133 rooms. Not all of the latter rooms contained usable space; at least 15 were dead space created by walling off earlier rooms primarily for kiva placement, although some were trash filled. The 133 rooms and enclosed court plaza covered 8.0 hectares. The addition of two exterior plazas increases the site area to about 16.9 hectares. There is presently no reliable method, however, to delineate the immediate spatial boundaries of the site community when the associated houses, Trash Mound, and prehistoric roads are considered. When work started at Pueblo Alto in 1976, excavation of 12 to 15 rooms was planned along with widespread testing of other proveniences. These goals were essentially met in the three years of field work at the site along with some limited field work in 1979.

It is clear that we learned much from our work at Pueblo Alto. In particular, it allowed clearer vision of the entire Chacoan Phenomenon and its complexity while enabling many of the earlier misperceptions to be dispelled. There were few spectacular finds of artifacts at Pueblo Alto; rather, architectural and bulk artifact analyses, coupled with an examination of other greathouses throughout the San Juan Basin, provided the greatest information about the Chacoan system.

Work at Pueblo Alto in 1976 was covered by an interim report (Windes 1977b), and other parts of the final manuscript were written over the years between 1979 and 1982, although two more major Chaco field projects in 1982 and 1983 interrupted the flow of writing before its resumption in October 1984.

Laboratory analysis was hampered by the backlog of small-site materials collected before the work at Pueblo Alto. Analysis of these materials had been delayed until personnel were available year-round with the start of the Pueblo Alto excavations. From the viewpoint of project continuity, we were fortunate that the field archeologists also were responsible for analyzing the cultural materials. It produced, however, a tremendous amount of work for each individual and restricted analysis to the winter months. Work on the small sites enabled the analysts to have a clearer picture and direction before tackling the Pueblo Alto material. Approximately 202,700 items were recovered from Pueblo Alto (Table 1.1). Thus, by the time the term appointments for most of the staff archeologists on the project ended at the end of the fiscal year 1982, the official demise of the Pueblo Alto project, only some of the reports on the Pueblo Alto materials had been completed. Some classes of material were never analyzed, and others were left incomplete as analysts moved on to school or to other jobs.

Table 1.1. Materials recovered from Pueblo Alto (field inventory).

Material type	Number of specimens: Total	Class subtotals
Bone:		
Faunal fragments	ca. 50,000	30,509 analyzed
Human bones (scattered)	34	includes 7 teeth
Human burial	1	
Worked bone	243	
Chipped stone:	12,585	
cores		117
debitage		12,339
formal tools (except points)		40
points and point fragments		89
Corn kernels, cobs and fragments	6,182	
Eggshell fragments	1,346	
Fill samples:	2,545	
Conservation		288
Flotation		1069
Pollen		1105
Soil		83
Hammerstones	818	
Hammerstone/abraders	749	
Glass and cartridges	12	
Ground stone	1,482	
abraders		428
ax		1
manos and mano fragments		242
metates and metate fragments		243
other worked stone		568
Ornaments (non bone)	561	
Minerals (non ornamental)	2,810	
Manuports	2,498	
Roofing impressions	622	
Sherds	90,123	
Spalls	ca. 30,000	
Vegetal remains (non corn)	131	
Total	202,742	

The amount of material generated from the small sites, especially compared to other small sites excavated in the San Juan Basin, was unexpectedly large and gave us no respite in cleaning up the three-year small-site backlog before starting Pueblo Alto. In addition, the loss of three senior supervisory archeologist positions to retirement or moves (Alden Hayes in 1975, Robert Lister in 1976, and Tom Mathews in 1978) that were left vacated due to federal purse-string tightening also eroded staff strength, prevented some analyses, and the timely completion of the project. This, of course, increased everyone's responsibilities and work load and brought the brunt of the bureaucratic functions and hassles to the principal investigator, W. James Judge. Thus, this report is a tribute to the staff and, particularly, the archeologists.

Work at Pueblo Alto Before 1976

The Chaco Center's work at Pueblo Alto (Figure 1.4) revealed that someone had dug out the outside corners of the main houseblock, perhaps in the very early A.D. 1900s or earlier. This seems to be futile work for pothunting and suggests an effort at some scientific work, perhaps mapping. At the northeastern corner, next to Major Wall 1 that connects Pueblo Alto with the nearby East Ruin and 78 cm below the surface, was a rusted wire nail. At the southeastern corner next to the exterior wall of Other Structure 4 we recovered weathered green glass 60 cm deep as well as some from nearby Room 185. Next to Other Structure 13, at the southwestern corner, a .22 cartridge casing was recovered about 100 cm below the surface under the wall fall.

The .22 casing of copper (not brass) with black powder residue was best dated between A.D. 1900 and 1915, probably closer to the former date (Appendix MF-B). This date would correspond to the period when Richard Wetherill was active in Chaco Canyon and might indicate some work on his part at Pueblo Alto. On the other hand, it could date as early as 1877 when Jackson mapped Pueblo Alto (Figure 1.6) with a measuring tape and compass (Jackson 1929:287).

At about the same time, a turquoise necklace reportedly was recovered by a Navajo from one of the Pueblo Alto kivas, probably in the main roomblock, according to one of our workmen, Paul Tso, who heard the tale from his father, a sheepherder for Richard Wetherill. No other historical material was recovered during our work at Pueblo Alto except for a few domestic sheep bones found during wall clearing (Akins 1985a). Wetherill is well known to have grazed sheep and horses in and around Chaco Canyon, including the plains around Pueblo Alto (McNitt 1966), so the finds are not unexpected.

Unlike many other canyon greathouses, Pueblo Alto has long enjoyed minimal disturbance from looters, archeologists, and other curious folks, primarily because of its mounded condition with little standing architecture. The earliest reference to work at Pueblo Alto relates to some pottery being collected by an A. P. Davis in 1887 or 1888 (Powell 1892: xxxix). John Wetherill reported that a few graves were dug in one of the

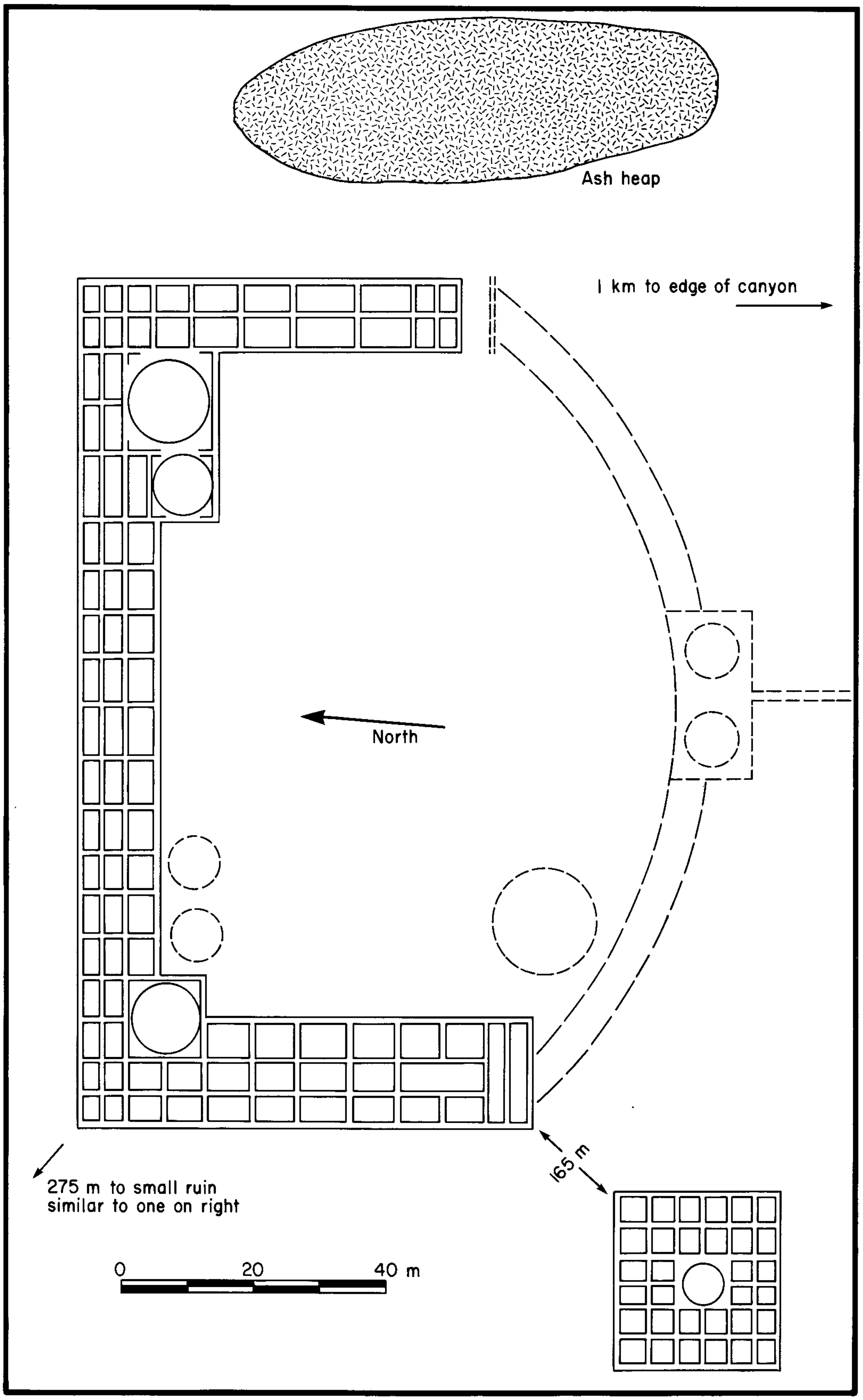


Figure 1.6. Map of Pueblo Alto and New Alto by William Jackson (1878).

mounds near Alto at about the turn of the century (Wetherill 1904). One of these graves yielded a hunch-backed human-effigy vessel, possibly the one that F. W. Putnam donated to the Peabody Museum (Morris 1924:224; Pepper 1906: 320, Plate 29). These mounds also yielded the two cylindrical jars and four pitchers obtained by the Field Museum of Natural History in Chicago from Richard Wetherill (Martin and Willis 1940:152, Plate 69).

It is difficult to believe that these relics came from Pueblo Alto if one considers the paucity of whole vessels recovered during the recent excavations. Indeed Judd (n.d.) reported on his first inspection of Pueblo Alto (Plates 1.3-1.4) that "not much digging has been attempted, although holes have been dug here and there." In a later note appended to a fairly accurate map of Alto he states that "little or no digging has been done perhaps because of the unimposing character of the ruin" (Judd n.d.). I presume the vessels came from another site nearby, although one must go a kilometer or more to find sites with the potential for yielding burials (i.e., that reveal distinct middens).

The earliest documented excavations at Pueblo Alto were done in 1926 by Frank H. H. Roberts, Jr., who placed two trenches across the short axis of the Trash Mound to obtain a stratified ceramic collection for comparative work ongoing at Pueblo Bonito and Pueblo del Arroyo (Roberts 1927). For the next 41 years there is little to report about Pueblo Alto.

Not until 1967 and again in 1970 and 1971 was archeological work conducted at Pueblo Alto. During that span, Gwinn Vivian and Robert Buettner investigated putative water control structures and roads at Alto by clearing parts of Major Walls 1, 2, and 3 and Plaza 2 (Figure 1.7) and trenching several roads (Vivian 1972).

After that, Pueblo Alto became the focus for several remote-sensing experiments. Prehistoric roads had been recognized running north from Alto to the Escavada Wash and beyond to the San Juan River as early as the turn of the century according to Marietta Wetherill [cited in Vivian (1948) and Holsinger (1901)]. The importance of the roads was recognized early by Neil Judd, who had planned but never completed a volume on the roads (Judd 1954:350). The interest in roads around Alto was renewed by Vivian's work, which prompted further investigation by Ware and Gumerman (1977) in 1972. Using aerial imagery they were able to pinpoint a possible entry in Major Wall 1 on the east side of Alto from which a number of roads radiated north to the Escavada Wash and beyond. The entry and several of the roads were verified by testing. A number of other studies focused on roads extending north from Alto (Brethauer 1978; Kincaid 1983; Morenon 1977b; Morenon and Amick 1977; Nials 1983; Trott 1980) while roads tying Alto to other canyon greathouses were reexamined in the early 1980s (see Chapter 5).

In 1974, Richard Loose tested the jog ("blockhouse") in Major Wall 1, a wall that connected Pueblo Alto to the East Ruin. The jog was thought to indicate a small room or part of a ramp leading over the wall; however, results of the work were inconclusive. A year later, Loose tested for

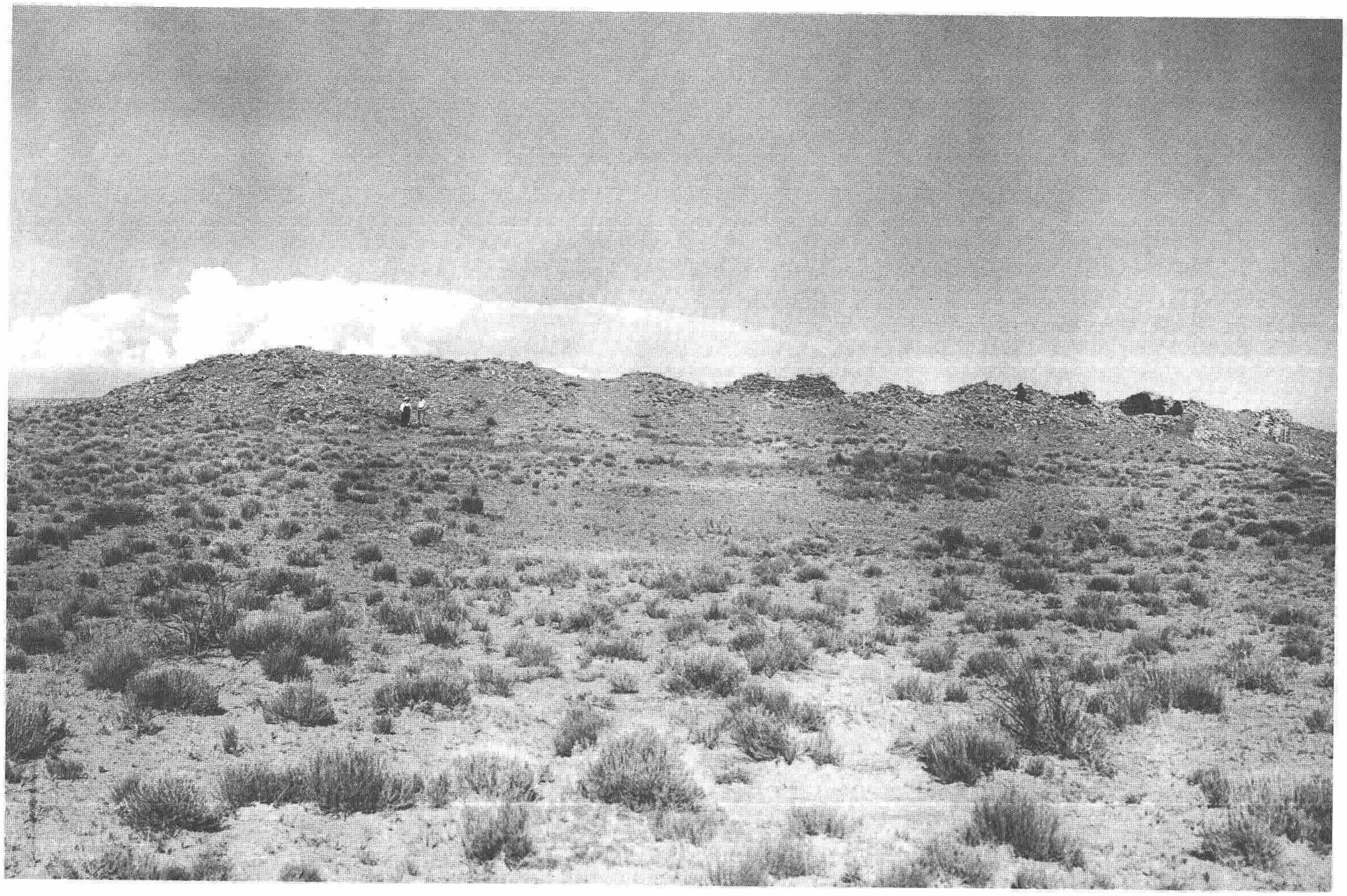


Plate 1.3. Pueblo Alto during an early inspection tour by Neil Judd, circa 1920. Looking northeast. Photo by Neil Judd. (© National Geographic Society.)

Plate 1.4. Pueblo Alto during an early inspection tour by Neil Judd, circa 1920. Looking northeast across the biwall structure, Kiva 2, and the Central Roomblock. Photo by Neil Judd. (© National Geographic Society.)

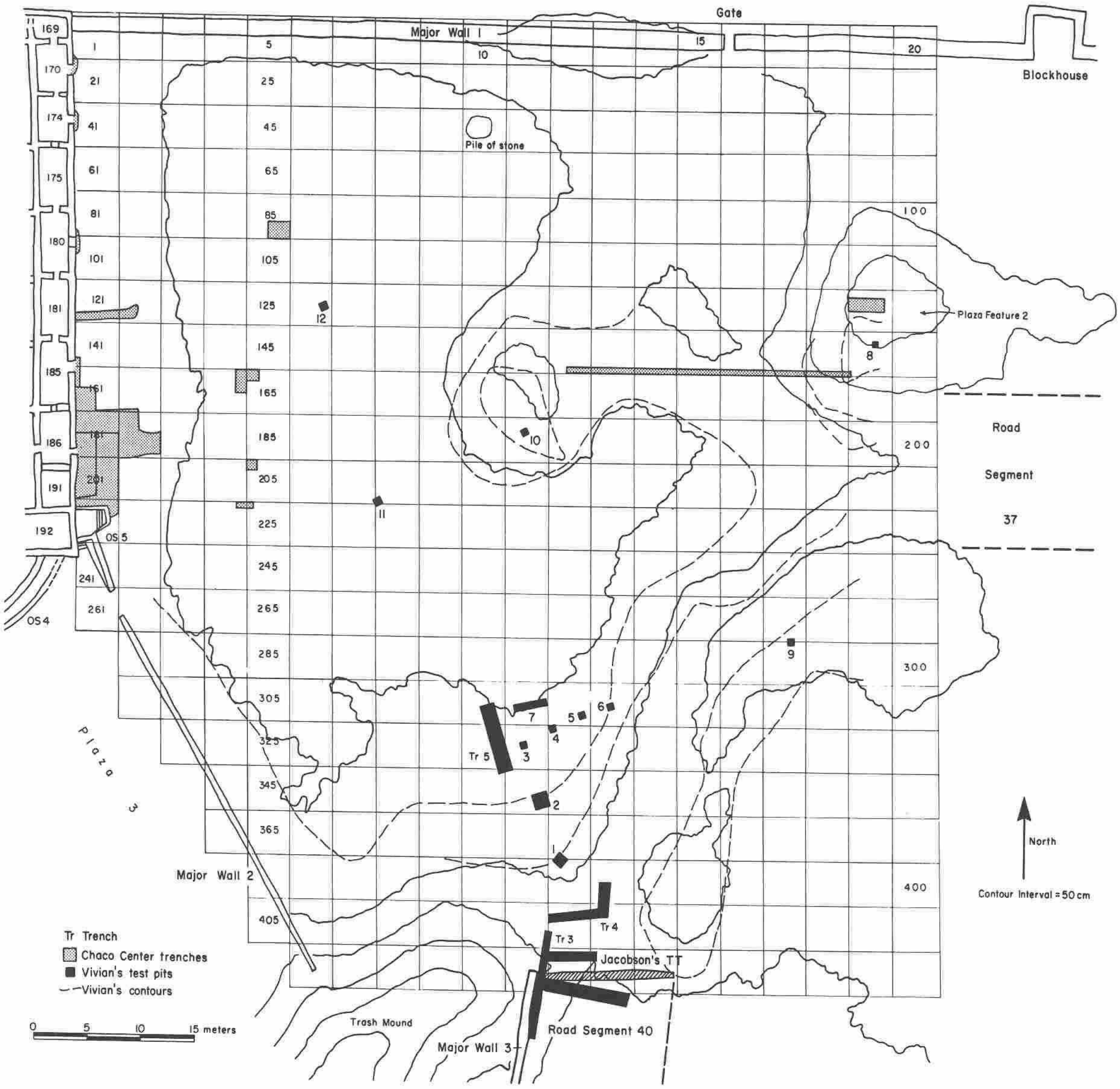


Figure 1.7. The Plaza 2 area at Pueblo Alto showing various test locations.

structures in the Pueblo Alto main plaza following subsurface radar experiments conducted by Vickers et al. (1976). Loose's work verified the existence of features detected by the radar and resulted in the discovery of a shrinelike structure in the center of the plaza and a probable trash-filled kiva that yielded, among other things, a copper bell. In addition, Loose, like Vivian before him, tested the road (Road Segment 40E) between Pueblo Alto and Chetro Ketl. Finally, the Chaco Center initiated large-scale testing at Pueblo Alto in 1976.

Legends About Pueblo Alto

Pueblo Alto has long been noted as the legendary residence of a very powerful being described by the Navajo in the Gambler Myth. When William Jackson endeavored to learn more about the site upon his discovery in 1877, he inquired of his elderly guide, Hosta, a war chief from Jemez Pueblo, about the site (Hosta had guided Lt. Simpson through Chaco in 1849). Hosta professed ignorance about the site but later recanted and told of the Jemez legend of a pueblo superior to all others (in the canyon) both in position and wealth and dominated by El Capitan (the captain) or El Jugador (the gambler). This rich gambler or chief lived in Pueblo Alto and bartered for the possessions and lives of the people in the canyon. Suspicious, Jackson felt that possibly Hosta had made up the story to atone for his initial lack of knowledge about Pueblo Alto.

The surprising tale, however, had amazing resilience. Matthews (1889:89-94) recounted it from his work with the Western Navajos except that he believed that Chetro Ketl was the chief's home. Furthermore, Matthews (1889:89) associated the story with part of the Navajo creation and migration myth. In 1896, two Navajos (one of whom had worked with Matthews) told the story to Pepper (1920:26) and named Pueblo Alto as the chief's house. A Kayentan Navajo version of the tale places the gambling activity at Pueblo Bonito but does not specify the site as the gambler's home (Wetherill and Cummings 1922), although it is so identified by a later informant (O'Bryan 1956:50). The spectacular finds unearthed at Pueblo Bonito in the 1890s may have enhanced Pueblo Bonito's role in the story, yet Pueblo Bonito did not replace Pueblo Alto in most oral traditions.

The story persisted and was retold to Judd (1954:351-354) during his work at Pueblo Bonito in the 1920s. Judd related that the chief's house was dominant in Navajo stories of the canyon and that the story of Noqoilpi, the Gambler, was the most frequently told. "Pueblo Alto is usually, Bonito sometimes, identified as his place of residence." Chapin (1940) also found that the Navajo considered Alto as the gambler's house, although most were reluctant to discuss the myth. Jimmy Lopez (personal communication 1976), a Navajo who worked at Pueblo Alto in 1976, believed that the gambler lived at the Rabbit Ruin (29SJ 390) just north of Alto, but gambled at Pueblo Alto. Another worker, not identified, affirmed the latter part of the story but prefered New Alto for the chief's home. In another Kayentan version, reported to Judd (1954:354) by Mrs. John Wetherill, when the gambler was finally defeated he was banished and died "where the cranes stand up." This locale is marked by a crane petroglyph on the south side of De-Na-Zin Wash about 30 km northwest of Alto (York 1982:3-297).

An old Navajo who lived at Kin Ya'a, a Chacoan outlier near Crownpoint, New Mexico, linked the myth with Jemez Pueblo by indicating that the gambler's wife was a Jemez woman who returned in triumph to her people after her husband's downfall (Judd 1954:351). Even today the myth persists among local Navajos, who refer to Pueblo Alto as "niyiilbiihi bighan" or "home of the one that wins (you) by gambling" (Fransted and Werner 1974:87) and describe it as the paramount village of the Anasazi (Hayes 1981:7). Pueblo Alto is also called "House on Top" (baghaa' kin), although this might be confused with Tsin Kletzin (Fransted and Werner 1974:18, 87) on the mesa top opposite Alto. Holsinger (1901:58) says the Navajos called Alto "nah-ho-behe-kin" or "Very Old House."

Interestingly, the large seeps (29SJ 1791) located just west of Pueblo Alto in Cly's Canyon are also associated with the gambler myth. Local Navajo oral tradition refers to the spot as the Great Gambler's Spring (Brugge 1973 field notes; Fransted and Werner 1974:88). In addition, the widespread Navajo Prostitution Way Chant legend also incorporates mention of Pueblo Alto and other greathouses (including Kin Bineola, Pueblo Bonito, and Aztec Ruin) and the gambler ("Earth Winner") (Kluckhohn 1944:102-104).

It is surprising that Pueblo Alto remained as the primary site for the tale despite the impressive architecture and archeological work at Pueblo Bonito and Chetro Ketl. Although Alto clearly dominates the canyon from its lofty position (as do Tsin Kletzin and New Alto), there was little architectural relief that would have marked it as the most important site. Perhaps its ruined condition suggested greater age and thus importance to the Navajo, although large mounded ruins are common in the San Juan Basin. The physical appearance of Alto is unlikely to have claimed such notoriety unless other factors contributed to the myth. For some explorers, at least, the low mounds discouraged investigation (Holsinger 1901:57-58; Judd n.d.).

It is unlikely that Hosta's tale was of the sort to become deeply ingrained in both Jemez mythology and Navajo tradition so quickly if it had been formed solely to satisfy Jackson. A widespread gambler myth could have been adapted by Hosta for the occasion, but the persistence of Pueblo Alto (and other canyon greathouses) in the story suggests a tale far older than Hosta. Hill and Hill (1943) note the extreme stability of the Navajo religious pattern in reference to another Navajo legend that had remained virtually unchanged since it was first recorded 60 years earlier by Washington Matthews.

The Jemez connection prompted David Brugge (personal communication 1980) to wonder if the story might have had some early historic connection because Puebloan refugees, particularly those from Jemez, exchanged many aspects of their culture, including legends, with the Navajo after the

Pueblo Revolt of A.D. 1680. Jemez Pueblo also seems to have had closer ties to the Navajo than did any other pueblo (Ellis 1956:27) and is incorporated in other Navajo legends as well (Hill and Hill 1943). The gambling story retold by Wetherill and Cummings (1922), in particular, is identified as puebloan by Cecil Werito (a Navajo employed as the chief of stabilization in Chaco) in 1983 and ethnohistorian David Brugge (personal communication 1985).

There are also certain parallels with the gambler myth and recent archeological thought. In view of Judge's (1979) model of an extensive exchange network centered in Chaco Canyon with ramifications of wealth and power for a few, the tale is not dissimilar from that of a gambler who wins possessions and control of others. It is also interesting that one of Judd's Navajo informants related that the gambler had rude watchtowers placed at intervals along the canyon rim where watchmen were stationed day and night to pass word to the gambler when strangers approached (Judd 1954:351). The recent discovery of a visually interconnected network of shrines spaced at intervals along the canyon mesa tops in view of Pueblo Alto (Hayes and Windes 1975) provides a surprising parallel to this aspect of the tale. Nevertheless, despite the skepticism of both Jackson and Judd regarding the gambler myth, there remain certain aspects of the story that hint at prehistoric origins.

Chapter Two

Natural Environment

Understanding the various parts of the paleoecosystem can add to our understanding of some of the conditions that may have influenced Pueblo Alto's initial placement on the mesa top overlooking Chaco Canyon. Although it cannot be demonstrated beyond a doubt that environment and resources were critical variables to prehistoric behavior, they must be considered as possible factors in Alto's initial settlement. Clearly, the factors influencing Alto's founding, operation, and abandonment are complex theoretical issues that were of major concern to the project. Nevertheless, those factors usually touted as being important for Anasazi site settlement patterns may not have been the most important determinants for the Alto community. Many aspects of the paleoenvironment are dealt with in more detail in the analysts' reports in Volume III. An overview of present and past conditions at and around Alto, however, can be useful here. Luckily Alto has become a target area for ecological studies over the past 15 years because of its locally unique setting outside the canyon, and, perhaps more important, service road access. This fortunate occurrence has produced a number of studies (e.g., J. Cully 1985; Scott 1980 a-f; Scott and Szekunda 1980) providing baseline information unrelated to the archeological work at Alto.

Over the past millennium since Pueblo Alto was planned and built, the environment apparently has changed very little (Betancourt 1984; Rose et al. 1982), although it was beset by seasonal fluctuations in climate that may have influenced the inhabitants' behavior. In addition, there is little evidence to suggest that the natural environment has changed much since Alto was occupied except for the introduction of livestock and some new plant species. Previous overviews of the Chaco environment have often focused upon the canyon itself because of the work being conducted on the canyon sites and the presence of measuring instruments to record baseline environmental data. Pueblo Alto, however, is located in a slightly different setting at the juncture of mesa and plain high above the canyon. The Chaco region is classifed as a semiarid environment of cold desert and winter dry conditions within the Koppen-Geiger climatic classification (Simons, Li, and Associates 1982:2.13).

Physiography

The physiography of Chaco Canyon has been succinctly summarized by Simons, Li, and Associates (1982:2.14, 2.16).

The Chaco drainage is located on the southern margin of the San Juan structural basin and is underlain by upper Cretaceous and lower Tertiary sandstones and shales which dip gently (3°) northwest. The shales characteristically are eroded into gently rolling slopes and broad flat surfaces, while the sandstones form cliffs and mesas.

The canyon itself is 32 km long and 500 to 1,000 m wide and has entrenched about 180 m into the Cliff House Sandstone and Menefee formation. Chaco Canyon follows the strike of the Cliff House Sandstone, while tributaries commonly follow the northeastern trend of the regional fracture pattern. Thirty meter high cliffs separated by benches comprise the canyon walls, while talus cones, pediments and fans have formed on the valley floor. The valley fill material is entrenched by the Chaco arroyo and other tributary drainages.

The depth to bedrock in the Canyon is highly variable, with an average of 91 feet (Ross 1978). An increase in depth occurs on the northern side, indicating an apparent downcutting into suballuvial bedrock. There is no bedrock exposure or geologic control in the Wash within the Park boundaries. The average depth to the water table is about 41 feet and dips gently west 1° to 5° (Ross 1978).

Pueblo Alto was built at the northern edge of the final group of benches and cliffs of Cliff House Sandstone that offer a maximum diversity of topographic relief before reaching the sweeping, grassy plateau that reaches north, east, and west from the site (Figure 2.1). The Cliff House Sandstone contains an abundance of macroinvertebrate fossils of which the most noticeable are the dark brown, fossilized burrows of Ophimorpha (-Thalassinoids) constructed by shrimp-like crustaceans (Siemers and King 1974). Despite the abundance of these fossils near Pueblo Alto, they were not utilized by the site inhabitants except as blocks for building materials. There is a gradual decline in plateau elevation as it extends 3.2 km north to the broad Escavada Wash except for a slight rise just north of the east-west swale that empties into Cly's Canyon.

Flanking the Escavada Wash are large, active, sand dunes, badlands, and two wide tributaries (Kimbeto and Betonnie Tsosie washes) that enter the Escavada from the northeast. Otherwise, the plateau rises beyond the Escavada for several kilometers before being dissected again by badlands and drainages. Unlike the deeply incised Chaco Wash, the Escavada Wash is characterized by an ephemeral, broad, meandering, alluvial channel with a shallow water table. North of Alto the Escavada Wash marks the southern boundary of exposed segments of the Upper Cretaceous Fruitland formation (now the focus for future coal strip mining) and the Pictured Cliffs Sandstone (Figure 2.1; Weide et al. 1979). Places in the badlands (Fruitland formation) yield burned beds of red shale that saw some prehistoric use as

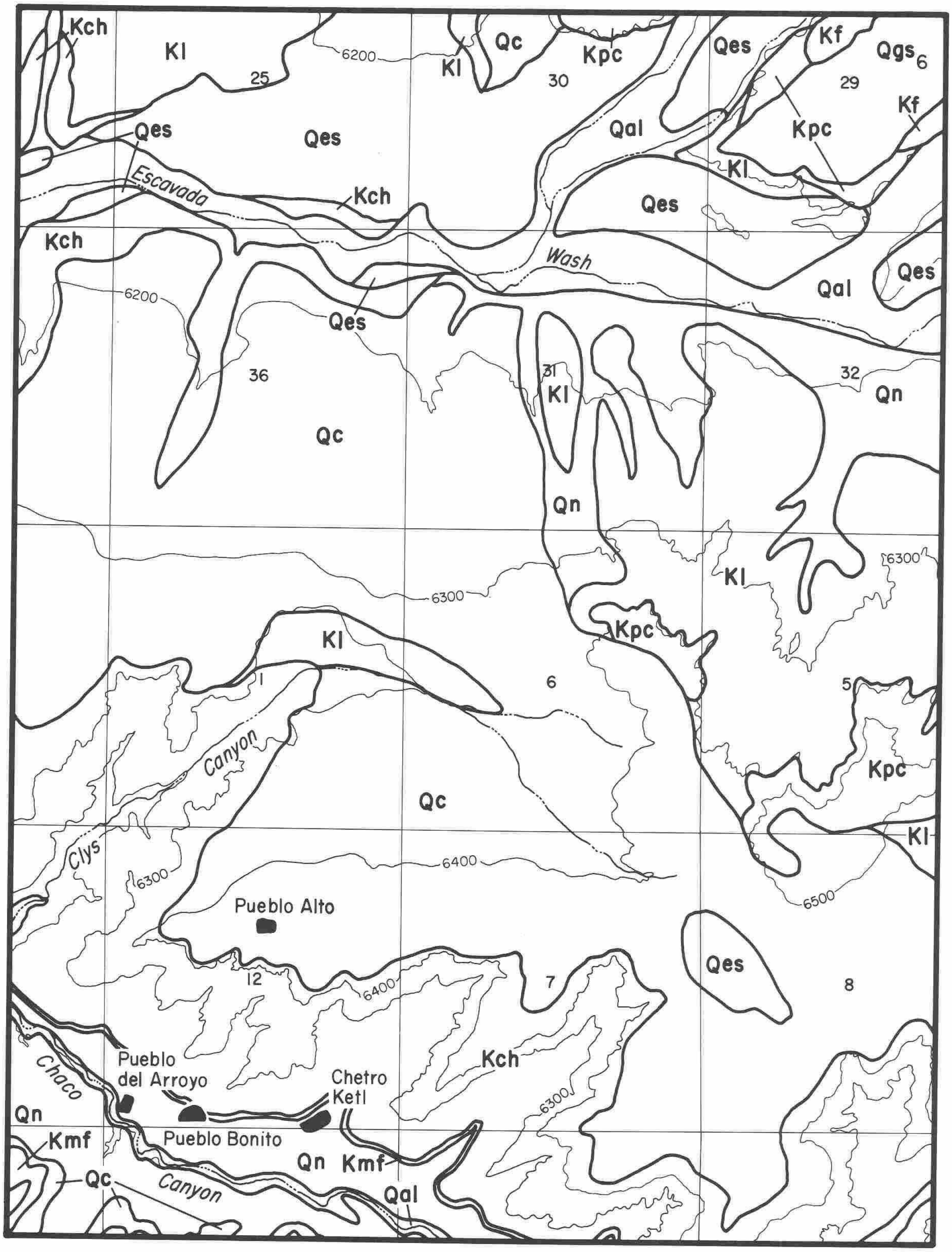


Figure 2.1. Topographic relief and geomorphology in the general vicinity of Pueblo Alto.

Description of map units for Figure 2.1[a]

Qal ALLUVIUM (HOLOCENE). Light-gray to white, fine sand and dark-gray silt derived from sandstone bedrock or reworked from deposits of older alluvium. Contains sparse well-rounded red quartzite pebbles and fragments of petrified wood. Fills channels and forms floodplains of larger ephemeral streams. Acts as a major source of shallow ground water. Maximum thickness is approximately 1.5 m.

Qn NAHA ALLUVIUM of Hack (1941) (HOLOCENE). Grayish-brown, poorly consolidated, friable to slightly hard, laminated and cross-stratified sand and silt filling washes of ephemeral streams. Contains some rounded chert and quartzite pebbles. Lacks zonal soil in the upper part. Thick deposits may contain as many as 5 buried clay or humus-rich layers. Forms terrace about 9 m above arroyo floors. Thickness ranges from 3 to about 6 m.

Qc SHEETWASH ALLUVIUM (HOLOCENE). Poorly consolidated clay, silt, and coarse to medium sand. Zonal soil in upper part contains yellowish-brown B horizon 15-61 cm thick having weakly developed coarse columnar structure, and clayey texture. Underlying Cca horizon 38-76 cm thick contains weakly developed floury or soft nodular accumulation of calcium carbonate. Sheetwash material derived from sandstone on valley sidewalls, from shale on gentle slopes, and from surficial deposits. Thickness is as much as 3 m.

Qes EOLIAN SAND (HOLOCENE TO UPPER PLEISTOCENE--PINEDALE AND YOUNGER AGE). White, well-sorted, cross-stratified, loose quartz sand in active linear dunes along valleys. Sand was blown from channels of major washes and from sandstone bedrock by winds having a prevailing direction of about N 60°-70° E. Clasts of chert, quartzite, and petrified wood commonly floor blowouts between dunes. Thin stabilized eolian sand overlies much of the gravelly sand. A discontinuous soil marked by a reddish-brown oxidized B horizon up to 25 cm thick, underlain by a firmly consolidated light-brown Cca horizon as much as 46 cm thick containing scattered carbonate nodules, is developed in the upper part of the older sand deposits. The soil is probably formed during the Altithermal--middle part of Holocene time--and shows that part of the sand has been stable for more than 4,000 years. Thickness ranges between 2 and 12 m.

Qgs_6 GRAVELLY SAND (PLEISTOCENE--PRE-PINDALE AGE). Very pale brown to grayish-orange gravelly sand containing pebbles averaging about 2.5 cm in diameter. Quartzitic sandstone and chert clasts are chiefly from the Ojo Alamo Sandstone which crops out 10 km north of the Escavada Wash; ironstone and clinker (rock baked by heat from burning coal) are chiefly from the Fruitland Formation. A soil zone in the

[a]After Weide et al. 1979.

upper part of each level of alluvium contains a dark-brown, hard clayey B horizon 0.6 m thick, and a white, very calcareous, friable, stoney Cca horizon that locally contains nodules of calcium carbonate. At least seven erosion surfaces and their associated gravelly sand deposits (Qgs_7-Qgs_1) are recognized in the drainage basin of the Chaco River. Each surface reflects an erosional episode related to changes in the grade of the Chaco River or the San Juan River--only Qgs_6 is closest to Pueblo Alto. Thickness of the gravelly sand is as much as 6 m.

Kpc PICTURED CLIFFS SANDSTONE (UPPER CRETACEOUS). Yellowish-gray to grayish-orange, thick-bedded and crossbedded, cliff-forming, fine-grained well-sorted friable sandstone comprises the upper part of the formation. Contains brown, hard, slabby calcareous sandstone concretations as large as 1.2 m in diameter. The lower part consist of alternating thin beds of yellowish-gray to moderate-brown, fine-grained to very fine-grained sandstone and light-gray to dark-gray silty shale. Contains fossil marine invertebrates and casts and impressions of Ophiomorpha major. Forms low bluff. Thickness is about 18 m.

Kl LEWIS SHALE (UPPER CRETACEOUS). The upper part is calcareous sandy shale that contains an increasing abundance upward of sandstone beds 0.3-1.5 m thick, and is transitional upward with the Pictured Cliffs Sandstone. The middle part is light-gray to dark-olive or olive-gray claystone and siltstone that contains a few thin sandstone zones and scattered beds of sandy concretionary limestone. The lower part is mostly sandstone and transitional downward with the Cliff House Sandstone. Concretions in the formation contain marine invertebrate fossils. Thickness is about 30 m.

Kch CLIFF HOUSE SANDSTONE--MAIN BODY (UPPER CRETACEOUS). White to dark-yellowish-orange, thin- to thick-bedded, lenticular and crossbedded, or massive sandstone. Contains gray or brown carbonaceous shale lenses or tongues. Shale tongues reach thickness of 55 m. Forms high bold cliffs and ridges. Intertongues with both the Lewis Shale and the Menefree Formation. Contains marine fossil invertebrates and casts of Ophiomorpha major. Only about 90 m is exposed in the Pueblo Alto region.

source material for ornaments, although such items are rare at Pueblo Alto and other canyon sites. North-facing cliffs of Pictured Cliffs Sandstone are exposed 2.4 km northwest of Alto with ridge fingers of Lewis Shale extending north to the Escavada Wash separated by alluvial-filled valleys. In addition, a small segment of Lewis Shale is exposed at the head of Cly's Canyon (Mytton 1979).

Local materials utilized at Pueblo Alto include the fine-grained, well-indurated, hard lenses of sandstone found in the Cliff House formation that were used in the early constructions. The hard, dark brown sandstone used in the earliest canyon greathouses was not used at Alto and, perhaps, was exhausted by the time Alto was built. Late construction preference was for softer, poorly cemented sandstone of the same formation. Although ground stone is thought to be locally procured, exact sources have not been identified. Material for chipped stone is widely dispersed on top of benches on both sides of Chaco Canyon. These have been described as siliceous pebbles and cobbles of quartzite, chert, and jasper, metavolcanic rocks, plutonic rocks, and foliated metamorphic rocks reworked from Late Cretaceous-Tertiary conglomerates (Ojo Alamo gravels) in the basin (Love 1983:188-189). Other clasts from the Ojo Alamo Sandstone found on erosional surfaces border the Betonnie Tsosie Wash 5 km northeast of Alto.

Soils

Soils around Pueblo Alto are shallow, mildly compacted, fine, clayey loam derived from erosion of the Cliff House formation sandstones and shales (Keetch 1977:Sheet 21; Roybal et al. 1983:16). Generally the soil has gentle slopes (0-5 percent) and is well-drained with moderate permeability that is slightly saline (pH = 7.4 or greater) to within 60 cm of the surface. Runoff from it is slow to medium and its available water supply high. Effective rooting depth for plants is about 150 cm, although the loamy surface deposits contain little organic matter. Loss of the soil from wind erosion is moderate to high. Compared to other soils in the county, this is rated poor for grain, seed, grass, and legume crops (Keetch 1977:Table 6). The zonal soil contains a B horizon 15-61 cm thick with weakly developed, coarse, columnar structure and clayey texture. This is underlain by a thicker unit (38-76 cm) that contains spotty accumulations of calcium carbonate (Weide et al. 1979) and is well compacted and extremely hard material. The lower horizon is the one preferred by the Alto builders for placing wall foundations. Soils directly around Alto have not been tested but those in the canyon bottom are high in sodium and strongly saline (Bradfield 1971:58-59; Judd 1954:60), making them unsuitable for crops.

Hydrology

One of the most important parts of an ecosystem and to living things within it is water. The San Juan Basin, of which Chaco is a part, is an area of water scarcity. Despite modern technology, water is a major concern for those who live and work in the San Juan Basin and must have been a critical factor for the prehistoric inhabitants. Chaco is classified as a semiarid environment of cold desert and winter dry conditions within the Koppen-Geiger climatic classification (Simons, Li, and Associates 1982: 2.13).

Drinking water can pose a major logistic and survival problem in a semiarid area such as Chaco. In the Chaco region, sandstones of wide areal extent and fluvial deposits along major streams are the most important sources of water near the surface (Roybal et al. 1983:56). As a result of the 3° dip to the northwest of the adjacent exposed formations, Cly's Canyon contains the largest and best pools of surface water known in the area historically. Seeps occur at the contact zone between lenses of carbonaceous shales and the overlying sandstone of the Cliff House Formation along the east side of Cly's Canyon (Figure 5.2). That these were also important sources of water during the occupation of Pueblo Alto is attested to by the presence of Anasazi stairways at the four probable sources and a prehistoric road (Road Segment 43; see Chapter 5) leading back to Rabbit Ruin and Pueblo Alto from near the largest seeps. In addition, the necessity for water storage may be confirmed by the abundance of ceramic jars at sites in Chaco Canyon, including Pueblo Alto.

The main limitation to prehistoric dry farming is water, as there is a minimal annual requirement of about 305 mm (Hack 1942:20). This level greatly exceeds the 234 mm of precipitation projected for around Pueblo Alto by Powers et al. (1983:Table 29). Evapotranspiration is greatest in the spring (Tuan et al. 1973:112-142), which allows the soil to dry out. This problem is particularly critical when sufficient soil moisture must remain from winter and early spring precipitation for seeds to germinate if adequate spring rainfall fails to materialize. From historic accounts (e.g., Brugge 1980), it is clear that a dry spring discourages planting. If crops are planted in the spring, then June is a pivotal month for precipitation and horticultural success.

Potential Farming Areas and Evidence for Water Control

At Pueblo Alto, runoff toward the south discharges in torrents across the benches and slickrock to eventually cascade over the cliffs to the canyon below. Prehistorically, this discharge was directed into canals and fields at the mouths of side canyons (see LaGasse et al. 1984; Vivian 1970a, 1974). The remaining rainfall at Alto is absorbed by the sands to the north, or if heavy rains, flows north into a huge swale that empties west into Cly's Canyon and eventually ends up in the Chaco Wash next to the greathouse Casa Chiquita. The swale drains approximately 325 hectares, and, added to Cly's Canyon (another 130 hectares), the runoff area is one of the largest for the north side of the canyon. The ancients may have recognized its potential, for there are the remains of a possible dam across the mouth of Cly's Canyon (Vivian 1970b:Figure 2), and small field houses are scattered near the edges of its upper drainage basin. Other features to retard or direct the runoff have not been recorded for Cly's Canyon, but the proximity of the two greathouses overlooking the head of the drainage basin (Pueblo Alto) and its mouth (Casa Chiquita) invites speculation as to their role in water control. The Navajos (i.e., Cly family) planted fields both at the mouth and in the upper canyon near the Great Gambler spring (29SJ 1791) to take advantage of storm runoff (David Brugge 1980, personal communication 1985; Ford 1985). If there were attempts at land modification to increase the water harvest at its head (see Kosse 1983a:115), then the residents of Pueblo Alto and, perhaps, the associated community, could be expected to have been involved.

Experiments with growing Hopi corn in the Doak-Avalon soils on the plain 1.2 km north-northeast of Pueblo Alto and in the bench dunes 700 m southeast of Alto, however, achieved mixed success (Toll et al. 1985). The dune planting was a complete failure while the plot north of Alto produced eight tasseled corn plants (from 30 sprouts) for each of the two years planted (1977 and 1978), although no cobs were formed despite constant hand watering. The plot did yield two tepary bean plants with mature pods, however. More corn planted in a possible prehistoric garden plot 500 m southeast of Alto (see Windes 1978:69-72, 194-195, for a description of the feature) also yielded no plants. According to Dan Cly, a Navajo who lived nearby, Navajo planting never was done on the plain around Alto because it was too dry (Ford 1985). Thus, it is unlikely that the plain around Alto could have been farmed on a regular basis, except, perhaps, during very wet years. Historic accounts seem to confirm the futility of practicing horticulture on the mesa tops even during the very wet periods (e.g., the early A.D. 1900s).

Precipitation: Present and Past

Most precipitation received by the San Juan Basin and Chaco derives from the northern Pacific in the winter and from the Gulf of Mexico and the tropical Pacific adjacent to Central America in the summer (see Gillespie 1985 for a summary of present climatic parameters). The important summer moisture, however, is considerably reduced in the San Juan Basin by the rainshadow effect of the Chuska Mountains to the west and the Zuni Mountains and Dutton Plateau to the south of Chaco. Chacra Mesa and its two western remnants (South Mesa and West Mesa) form an east-west strip of sandstone and shale that rises nearly 100 m vertically along its south face and may affect microrainfall patterns in the canyon. This barrier borders the south side of the canyon (Plate 2.1) and blocks the initial force of summer storms sweeping in from the south and southwest until they reach one of the openings into the canyon. The greatest density of Pueblo II and early Pueblo III sites is clustered in three of these gaps, across from Una Vida (Fajada Gap), Pueblo Bonito (South Gap), and near Peñasco Blanco (in the Padilla Well area near the mouth of the canyon). These are considered the critical areas for the beginnings of the initial greathouse construction and the Early Bonito phase in the early A.D. 900s (Judge et al. 1981; Vivian 1970b). These entries seem to

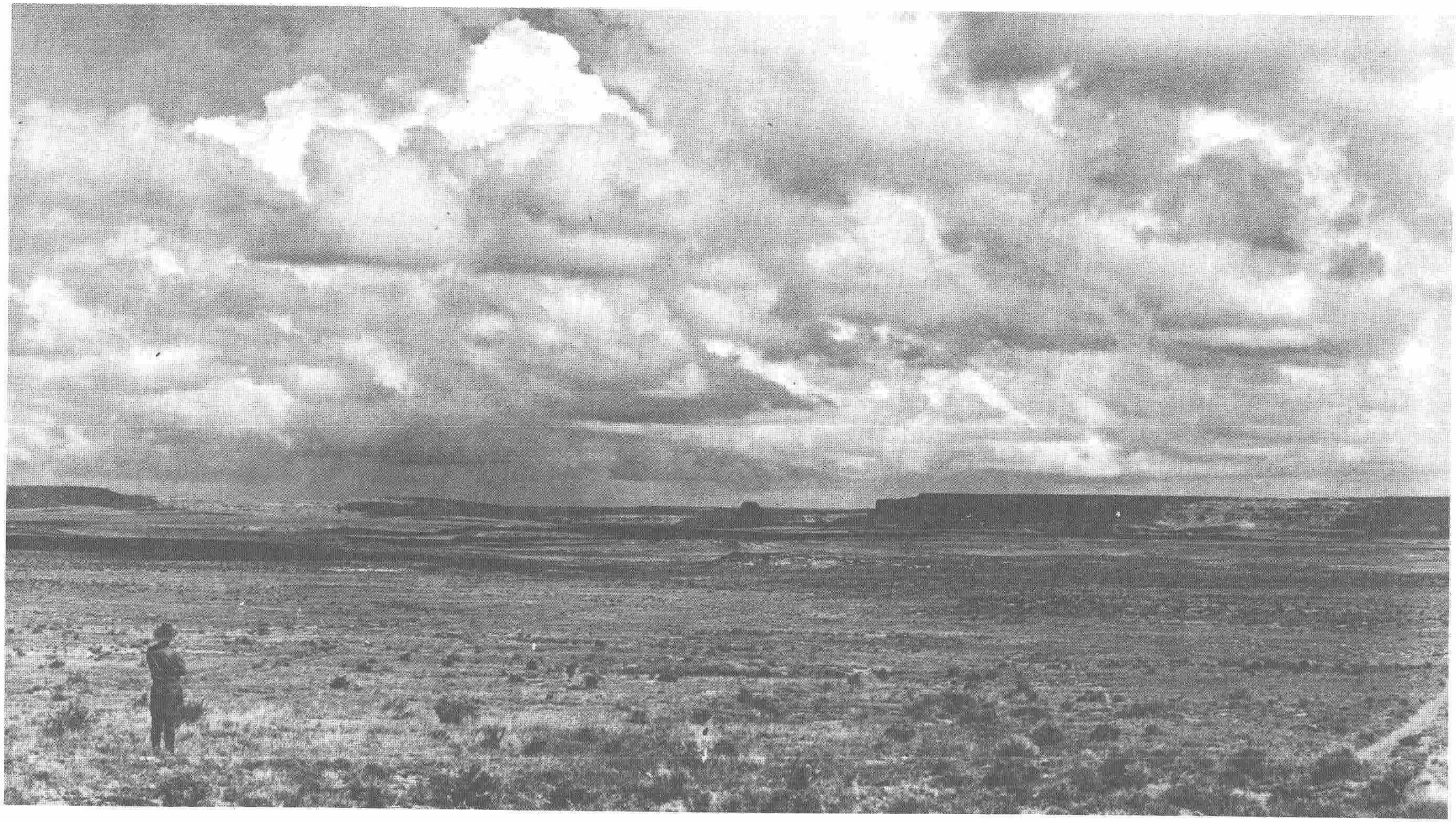


Plate 2.1. View of Chaco Canyon from the south. Note Fajada Butte, famous in Navajo mythology, in center of skyline flanked by South Mesa (left) and Chacra Mesa (right). Photo by O. C. Havens, circa 1925. Neil Judd in the left foreground. (© National Geographic Society.)

offer the best areas for maximum local precipitation and storm runoff, and, therefore, intensive horticulture.

Pueblo Alto, however, is located 100 m higher than the canyon bottom and 1 km north beyond the canyon proper. Thus, rainfall patterns in the canyon may not be directly applicable to events at Pueblo Alto. The area surrounding Alto is noticeably drier than the canyon bottom and supports a grassland. In contrast with the canyon bottom and Chacra Mesa on the opposite side of the canyon, woody, herbaceous perennial plants are sparse and trees absent.

The present precipitation pattern for Chaco Canyon is one of light snow and rain in the late fall, winter, and early spring, augmented by thundershowers in the summer and early fall that contribute about 60 percent of the total annual moisture. Chaco receives an average of about 220 mm (8.7 in.) of moisture a year, but this is highly variable with fluctuations as low as 85 mm and as high as 470 mm/year (Gillespie 1985; Simons, Li, and Associates 1982:2.13), and the rainfall can be notoriously localized (Toll et al. 1985). Because of its slightly higher elevation above the canyon, Powers et al. (1983:Table 29) project 234 mm of precipitation a year for Pueblo Alto. The greatest rainfall occurs during the summer when it is most beneficial for the maturation and fruition of domesticated plants, particularly maize, although the spring precipitation is no less important. At times, though, the torrential summer rains can plummet down at the rate of 30 mm/hr (Love 1983:188), damaging crops and accelerating soil erosion. August, with an average of 35 mm, is the wettest month, followed by July, September, and October, whereas June is the driest month, averaging 10 mm of rain (Gillespie 1985:18).

Climatic reconstructions for the San Juan Basin from A.D. 901 to 1969 suggest that Chaco has always been a dry place (Rose et al. 1982). Thus, environmental conditions must be considered a major factor influencing the socioeconomic system of the sedentary Chaco Anasazi (see Gillespie 1985; Gillespie and Powers 1983). The yearly mean reconstructed precipitation for the region is 250 mm (9.8 in.), or slightly more moist than for most of this century, with variation between 146 and 342 mm (sd = 37.1 mm)(Rose et al. 1982:384). This, of course, is much drier than the uplifted peripheries of the San Juan Basin to the south (in the Grants-El Morro-Ft. Wingate, New Mexico area) and to the north (in the Cortez-Mesa Verde-Pagosa Springs, Colorado, area except for Durango) that yield a mean of 290 mm (11.4 in.) and 411 mm (16.2 in.), respectively, for the same reconstructed period.

The Palmer Drought Severity Index (P.D.S.I.; Table 2.1), developed by Palmer (1965) using drought data from Kansas and Iowa, may be a better predictor of conditions relevant to human ecology because it incorporates temperature, precipitation, and soil-moisture retention properties into its calculation (Rose et al. 1982:244). The greatest influence on the P.D.S.I. calculations, however, comes from the precipitation yields from April through September. Reconstructions of the P.D.S.I. indices for the 1,069-year period implies some measure of covariation between tree-ring

Table 2.1. The Palmer Drought Severity Index classes for wet and dry periods (after Palmer 1965:Table 11).

P.D.S.I. value	Conditions	
≥4.00	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient drought	<------- Chaco Mean[a]
-1.00 to -1.99	Mild drought	
-2.00 to -2.99	Moderate drought	
-3.00 to -3.99	Severe drought	
≤-4.00	Extreme drought	

[a]The Northwest Plateau, of which Chaco is a part, exhibits a mean index of -0.98 for P.D.S.I. reconstructions between A.D. 901 and 1969 (Rose et al. 1982).

indices and agricultural yield (Rose et al. 1982:109). Drought severity probably is closely related to the degree that economic factors are disrupted (Rose et al. 1982:110), and, thus, the indices for Chaco and the San Juan Basin are relevant to understanding potential stress to the Chaco Anasazi.

In the dendroclimatic reconstructions, only the July P.D.S.I. indices were calculated because it is the month when there is the greatest demand for water, and major historically recorded droughts have tended to peak in July and August when tree growth is strongly affected. Recent attempts at horticulture in Chaco have also shown that the most rapid loss of corn plants occurs in July (Toll et al. 1985:19). Use of the reconstructed indices are probably most reliable for Chaco when portrayed as relative fluctuations of drought severity rather than as absolute values.

The mean July P.D.S.I. index for the San Juan Basin, including Chaco, is -0.98 (sd = 2.16) and indicates an environment that typically approaches mild drought conditions and is little different from the southern and northern peripheries of the San Juan Basin (-0.94 and -1.07, respectively). Climatic conditions in the A.D. 900s for the Chaco region, however, revealed a century of above-average moisture for the initial Bonito phase (Figure 2.2) when the first greathouses of Peñasco Blanco, Pueblo Bonito, Una Vida, and Kin Nahasbas (Lekson 1984; Mathien and Windes 1984) were built in Chaco. Favorable climatic regimes continued into the early A.D. 1000s but are interspersed with very dry periods (Figure 2.2). The 24 years from A.D. 1006 to 1029 were above average 67 percent of the time with an overall July P.D.S.I. value of -0.43, although the severity of the six worst years (all below -2.31) greatly affected the average. Without them, the July P.D.S.I. value rises to 0.42, well above the overall mean and probably a favorable period for horticulture. The 130-year period between A.D. 900 and 1029 corresponded to the ceramic dominance of Red Mesa Black-on-white and neckbanded culinary when small houses proliferated in the canyon (see Chapter 11).

In contrast, the following two decades (A.D. 1031-1050) were marked by an increase in poor years with a mean July index (-1.51) indicating that mild drought conditions were the norm. Favorable indices exceeded the 1069-year mean only 23 percent of the time. When Rose's 25-year periods are examined (Rose et al. 1982:Appendices 3-4), the period between A.D. 1026 and 1050 was the worst of the entire 250-year Bonito phase except for the A.D. 1126-1150 span that saw the demise of the system (Figure 2.3). The A.D. 1026-1050 period must have produced considerable stress on horticulture, and it is not surprising that this period is believed to be one when small-house population drops (see Chapter 11, Figure 11.4). Moisture conditions improved again in the A.D. 1060s and 1070s, when ceramic assemblages dominated by Gallup Black-on-white were the norm, but then plummeted between A.D. 1081 and 1099 to previous periods of drought marked by a mean July P.D.S.I. value of -1.62 (mild drought). Drought with moderate or worst indices occurred half the time, and seven years reveal conditions that are severe to extreme. Bad years often occurred in blocks during this 19-year period, so that intervening

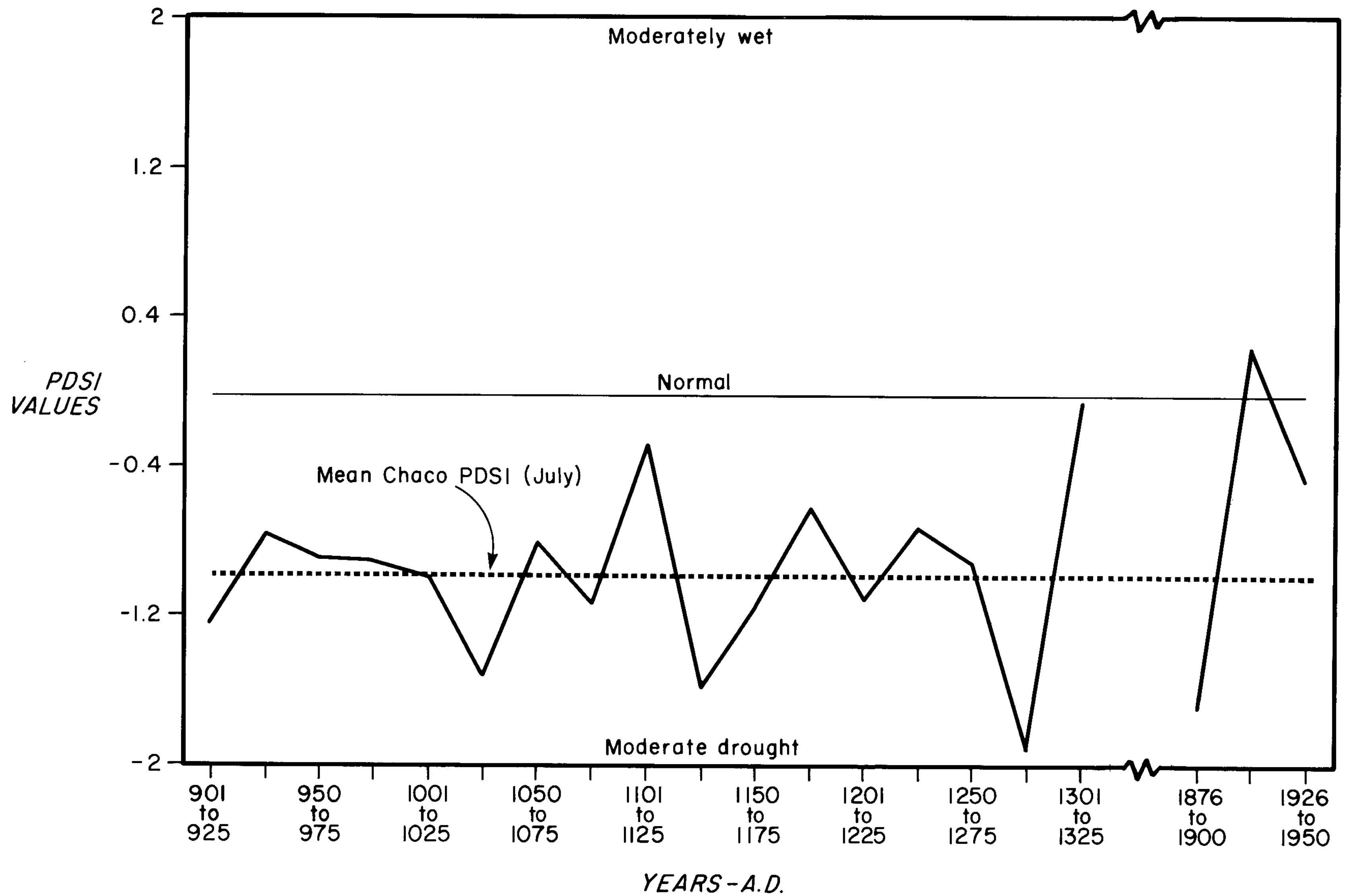


Figure 2.2. Drought severity in the Chaco area between A.D. 901 and A.D. 1325, and between A.D. 1876 and A.D. 1950 measured in 25-year increments. Note that the mean July P.D.S.I. for Chaco from A.D. 901 through A.D. 1969 was -0.98 (after Rose et al. 1982).

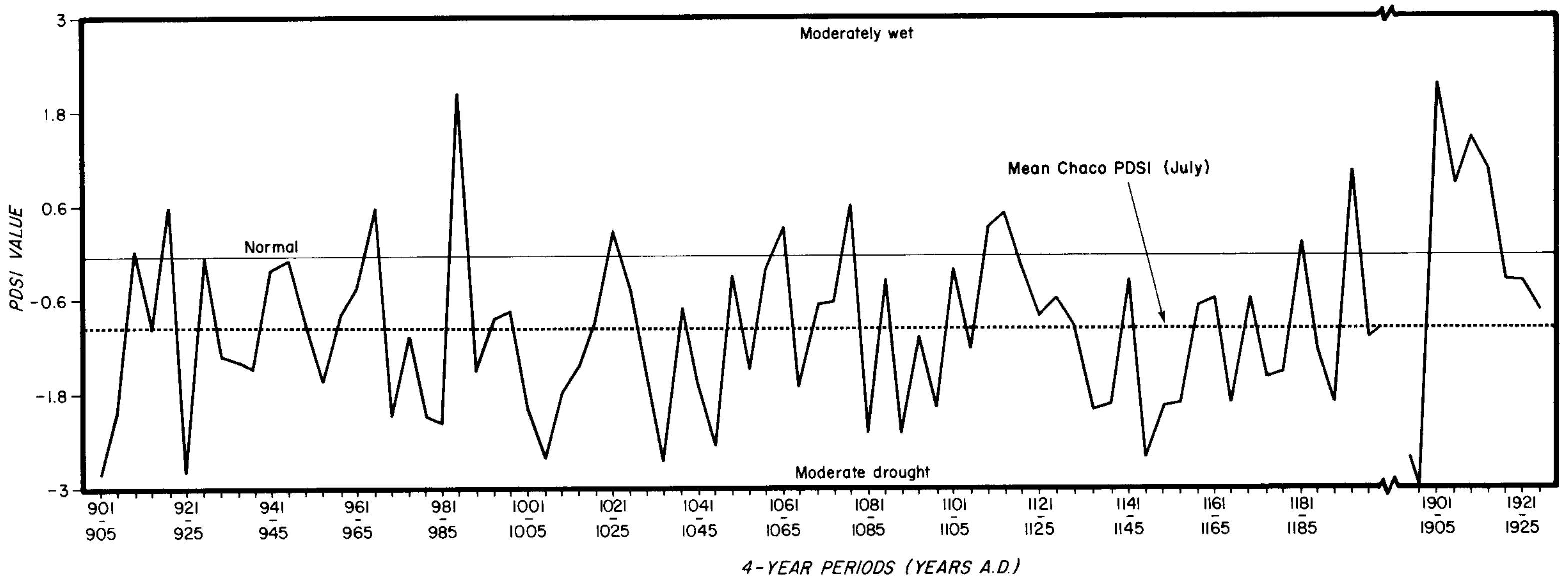


Figure 2.3. Drought severity in the Chaco area between A.D. 901 and A.D. 1201, and between A.D. 1897 and A.D. 1933 measured in 4-year increments. Note that the mean July P.D.S.I. for Chaco from A.D. 1969 was -0.98 (after Rose et al. 1982).

good years are unlikely to have offset the effects of the very dry years, particularly in terms of food surplus. This period, one of the worst of the entire Bonito phase, was likely to have had major repercussions on the socioeconomic system.

It is in the early A.D. 1100s, when small-house occupancy surges (Figure 11.4), that there is a corresponding climatic improvement (Figure 2.3). This correlation is unlikely to be fortuitous, and probably the two events were causally related. From A.D. 1100 to 1129, July P.D.S.I. values exceed the 1069-year mean 60 percent of the time with moderate or more severe drought conditions occurring just four (13 percent) times. The 25-year period (A.D. 1101-1125) is climatically the best over the 400-year period that encompasses the Bonito and Mesa Verdean phases (A.D. 901-1300) in Chaco Canyon (Figure 2.3) with a P.D.S.I. value of only -0.27 (Rose et al. 1982:Appendix 4), or a period that is near normal on the P.D.S.I. scale (and above the mean for Chaco).

The early A.D. 1100s period was similar to conditions between A.D. 1901 and 1925 (Figure 2.2) when Navajo farming practices in Chaco are well documented (see Appendix MF-C). From these historic accounts it was apparent that, despite the relatively moist conditions, crops still suffered from perilous times. The P.D.S.I. value for this historic period is 0.25, also considered near-normal conditions on the P.D.S.I. scale, but six years of the span were marked by moderate or worst drought conditions (in 1902, 1904, 1913, 1918, 1923, and 1925). The first two of these were droughts of extreme severity but, overall, 76 percent (19 of the 25 years) exceeded the mean regional value for the 1069-year period. The yearly amount of precipitation for the two periods in the A.D. 1100s and 1900s was identical (261 mm), although the spring seasons in the latter received more moisture (78 mm versus 91 mm). Reconstructed summer precipitation values were nearly identical (149 mm versus 150 mm). Thus, conditions in the early A.D. 1100s and early 1900s were very similar. Adaptive responses by the Navajos to horticulture may be informative regarding Anasazi practices despite the socioeconomic organizational differences between them.

For most of this century (A.D. 1916 to 1970) the Chacoan region has been subjected to incipient drought conditions (P.D.S.I. value of -0.70) with spring seasons drier by half on the average (44 mm) compared to springs during the Bonito phase, which generally yielded between 78 and 93 mm of moisture.

Potable Water Sources

The most abundant water occurs at 29SJ 1791, about 750 m north-northwest of Pueblo Alto. This always contains large pools of water that once served Navajo families living in Cly's Canyon (Brugge 1980:350; Holsinger 1901:11; Judd 1954:12, 344). Judd (1954:12) analyzed the water and found it "exceptionally pure" and much better than those samples taken from the Chaco Wash. The water was tested again in 1984 (Table 2.2) and

Table 2.2. Water analysis of the "Great Gambler's Spring," 29SJ 1791 (in milligrams per liter for minerals and residue).[a]

Minerals:	
Sodium	9.2
Potassium	0.39
Calcium	41.6
Manganese	11.2
Chlorine	8.3
Others:	
Hardness (as $CaCO_3$)	150.0
Alkalinity (as $CaCO_3$)	139.0
Bicarbonate (as HCO_3)	170.2
Carbonate (CO_3)	0.0
Sulfate (as SO_4)	31.9
Filterable residue	200.0
Foaming agent (as Las)	< 0.05
Conductance Micromhos 25°C	306.0
Color	10.0
Turbidity	5.9
pH	7.5 (neutral = 7.0)

[a]By the State of New Mexico, Health and Environment Department (December 1984).

still found to be excellent drinking water, according to the laboratory analyst and to drinking water guidelines (National Academy of Sciences-National Academy of Engineering 1972:48-104).

Discharge at 29SJ 1792 was 59 and 69 liters/day when measured in mid-May and mid-October 1985, respectively (Table 2.3), during a very wet season. A seep basin at 29SJ 1791 yielded 48 liters/day in mid-October, when it was first measured. The months immediately following August (the period of highest annual precipitation) probably yield the most ground water. Within limits, of course, the more basins that are dug out, the more water will accumulate. I suspect that under the sands surrounding each basin, there must be Anasazi structures that once impounded the discharge.

All the seeps in the area are recharged entirely from seasonal precipitation. Because the modern precipitation is little different from prehistoric times and both reflect similar P.D.S.I.s, the seep discharge is assumed to be about the same as when used by the Anasazi if the ground cover has not been radically altered. Only about 4 percent of the precipitation, however, becomes available for ground-water discharge (Roybal et al. 1983:50).

According to studies made on 8,500 soldiers in the arid Southwest and California, water requirements vary widely depending on many conditions, particularly outside temperatures. Average daily water consumption for the 8,500 soldiers ranged between 3.2 and 4.4 liters or higher for daytime, work-related activities (Adolph and Associates 1947:8-130, Table 8-D). An average for a sample of New Mexicans at rest in July was 2.8 liters of water consumed daily (Adolph and Associates 1947:Table 8-8). On the conservative side, two to four liters daily seems reasonable for survival under cool, minimal working conditions. It is not unreasonable, then, to consider the daily yield of the Great Gambler's Spring sufficient for only about 20-30 people. All four seep areas in Cly's Canyon accessible by stairs could have supplied something in the volume of 400-1,000 liters of water daily (but far less during prolonged droughts), enough for approximately 100-200 permanent residents. Besides available water for the Pueblo Alto residents, water was also provided to the canyon-floor inhabitants by Road Segment 44 leading from the Bonito Stairs (29SJ 1936) to Cly's Canyon.

Other potential sources abound along the bases of cliffs south of Pueblo Alto where the Cliff House Formation is exposed. The formation is known to be a reliable, low-yield aquifer (Bureau of Indian Affairs 1982:30; Bureau of Land Management 1979:II-40; DeAngelis 1972:52; Simons, Li, and Associates 1982:2.16). Potential water sources along the cliffs are marked by hydrophilic plants and shrubs (Hayes 1981:4), generally at the heads of rincons, although none have been active in recent memory. The moisture provided by this aquifer may have been used by the Anasazi for garden terraces (see Chapters 5 and 8) set on benches at the base of the cliffs near Alto and Chetro Ketl (Figure 5.2), although the tilt of the adjacent formations would have limited available moisture. Similar

Table 2.3. The 1985 and 1987 discharge rates of seeps near Pueblo Alto and the 1985-1987 precipitation in Chaco Canyon.

Site	Basin Location	Date Measured	Standing Pool Volume (liters)	Time Between Measurements (minutes)	Pool Recharge Volume (liters)	Daily[a] Rate (liters)
29SJ 1791	No.	5/18-19/85	0			0
	Mid.	5/18-19/85	27.5	1,467	25.1	24.7
	So.	5/18-19/85	110.4	1,478	34.7	33.8
Total						58.5
29SJ 1791	No.	10/12-13/85	7.0	1,458	4.75	4.7
	Mid.	10/12-13/85	86.5	1,459	31.0	30.6
	So.	10/12-13/85	202.0[b]	1,466	34.0	33.4
Total						68.7
29SJ 1791	So.	10/13-14/85	-	1,512	31.1	29.6
29SJ 1791	So.	10/14-15/85	-	1,419	30.6	31.1
29SJ 1791	No.	6/1-3/87	0			0
	Mid.	6/1-2/87	43.6	1,368	24.4	25.7
	So.	6/1-2/87	149.7	1,370	34.8	36.6
Total						62.3
29SJ 1791	Mid.	6/2-3/87	24.4	1,626	26.0	23.0
	So.	6/2-3/87	34.8	1,629	37.2	32.9
Total						55.9
29SJ 1792	-	10/13-14/85	167.5	1,527	50.6	47.7
29SJ 1792	-	10/14-15/85	-	1,412	47.5	48.4
29SJ 1792	-	6/2-3/87	184.8	1,554	91.8	85.0
29SJ 1792	-	7/1-2/87	235.0[b]	1,248	76.5	88.3

1985-1987 precipitation (mm) measured at the Visitor's Center in Chaco Canyon:

1985 Total: 299.8 mm	Jan.	21.1	Apr.	59.9	July	73.2	Oct.	20.6
(11.8 in.)	Feb.	1.8	May	8.6	Aug.	32.3	Nov.	17.3
	Mar.	16.0	June	5.3	Sep.	34.3	Dec.	9.4
1986 Total: 382.0 mm	Jan.	trace	Apr.	20.8	July	51.6	Oct.	30.2
(15.1 in.)	Feb.	37.1	May	5.6	Aug.	30.2	Nov.	83.6
	Mar.	18.3	June	24.6	Sep.	55.6	Dec.	24.4
1987 Total: incomplete	Jan.	24.6	Apr.	2.0	No data for the remaining months.			
	Feb.	26.7	May.	16.5				
	Mar.	11.9	June	0.0				

[a]Daily rate calculated from 1,440 minutes (24 hours).
[b]Slight overflow.

locations are prized by the Hopi as reliable sources of moisture for crops (Hack 1942:34).

The benches south of Pueblo Alto are pitted with bedrock tanks that serve as natural catchment basins. The largest ones can hold thousands of liters of water if properly blocked. Despite this potential, only a single huge crevice near Alto, with three series of steps leading into it, offers tangible evidence of prehistoric use (Windes 1978:105). The late summer rains provide the maximum volumes for filling the bedrock potholes. Richard Wetherill, like the Anasazi before him, found it convenient to supplement his water supplies from these clifftop tanks (McNitt 1966). The most predicable time for being ensured maximum water supplies close to Alto would be in the late summer-early fall.

Water from shallow wells would also have been available to the Pueblo Alto inhabitants from the Escavada Wash, 3.2 km north of Alto and connected to it by a number of prehistoric roads that apparently terminate there. Wells dug in the wash today supply the needs of the Navajos. Water from the alluvium may be of better quality than that from the adjacent bedrock aquifers where soluble minerals are likely contaminants (Bureau of Land Management 1979:II-46), although the tilt of the land north of Chaco must recharge the Escavada Wash ground waters from the same sources that feed Cly's Canyon. Historically, wells dug into the Chaco Wash, however, supplied water, although it was unsuitably high in minerals and salts (Judd 1954:12; Love 1980:342, Table 10). Sodium and salinity hazards are typically present in ephemeral arroyo flows largely because of the shallow coal deposits from which they drain (Roybal et al. 1983:38).

Intermittent stream flow may have been an important factor in supplying water seasonally to the Chacoan inhabitants. Both the Chaco and Escavada washes exhibit zero-base flows with streamflow occurring in direct response to infrequent area precipitation. Streamflow measured in Chaco between 1977 and 1983 reveals that major discharge periods occur biannually (but with considerable variation). Peak discharges usually occur in February, from melting snows, and in August or September from late summer rains (United States Geological Survey 1977-1983). These periods are similar to streamflow peaks on the lower Chaco River (at Burnham, New Mexico) where flows are highest in January and February, followed by smaller peaks in March, August, and October (Roybal et al. 1983:25). Unlike the Chaco Wash, which collects runoff from nonmountainous terrain, the lower Chaco River is provided its largest volumes from the nearby Chuska Mountains.

In spite of the aridity of the land, potable water supplies were probably adequate for the Pueblo Alto community from nearby seeps, potholes in the bedrock, and under ephemeral stream beds. Streamflow was probably difficult to forecast (at least during the warm months) and generally seems undesirable for drinking and irrigation. Whether local water supplies would have supported a large, permanent population is doubtful, but additional use of the Escavada Wash surely would have supplied all that was needed even by a large, prehistoric population (e.g., over a thousand).

Climate

Temperatures

The San Juan Basin is a shallow basin where air tends to stagnate and become either colder or warmer than if it were moving more freely (Tuan et al. 1973:65). Chaco Canyon exacerbates this condition by acting as a local airshed (Bureau of Land Management 1979:II-33) where air stagnates and cold-air drainage from side canyons contributes to lower-than-normal temperatures (Tuan et al. 1973:65). Between 1941 and 1970, temperatures in Chaco averaged 10°C/50°F (Gillespie 1985:18; Simons, Li, and Associates 1982:213) with highs in July (23°C/73°F) and lows in January (2°C/29°F). Extremes have ranged between -39°C/-38°F in the winter and over 38°C/100°F in the summer.

The temperature regime in the canyon bottom, where instrumentation has always been located, may not accurately reflect conditions at Pueblo Alto. It may be slightly cooler in the summer at Pueblo Alto and slightly warmer in the winter than the record indicates, and Alto would have longer sun exposure than do canyon sites. Greathouses in the canyon, however, may benefit from location along the north side of the canyon where the 30-m-high cliffs act as a passive solar system (Baxter 1982; Knowles 1974; Paul 1977a; Williamson 1978). During winter nights, the heat radiated by the nearby cliffs helps to maintain the greathouse room temperatures. Readings taken intermittently between 1979 and 1980 at Pueblo Bonito (Rooms 25 and 105) and Chetro Ketl (Room 93) revealed that room temperatures stabilized around 0°C/32°F despite much colder outside temperatures (some as low as -18°C/0°F). Even several days of subfreezing temperatures without sunlight did not deplete room warmth. Alto, of course, did not share this advantage of radiant energy from cliffs.

Temperature is also important for its effects on the cultural use of resources, particularly firewood. In addition, killing frosts and the evaporation of surface water and soil moisture are factors influenced by temperature. In Chaco, the availability of fuel and the length of the growing season may vary locally and may be important factors influencing canyon settlement patterns.

Frost-Free Periods

In the San Juan Basin and Chaco, severe late spring and early fall frosts are common. Recent estimates of frost-free seasons at Chaco have ranged between 126 days (Love 1983:188) and 150 and 160 days (Cordell 1979:Map 5; Hayes 1981:4; Tuan et al. 1973:98, Figures 37-38). A more recent examination by Gillespie (1985:18) has found that the frost-free period has dropped to about 100 days since 1960, the shortest period of any recording station in the San Juan Basin including stations at higher elevations than Chaco (Schelberg 1982:83-87). This change, in part, was influenced by the 3-km shift in 1960 of recording instruments in the canyon from Pueblo Bonito to the visitor's center near Una Vida (Gillespie 1985:19). In contrast, Zuni (where at least one Chacoan greathouse was located) exhibits a longer growing season and less seasonal variation than does Chaco (Tuan et al. 1973:98). A frost-free period of about 120 days is often considered necessary for the growth of corn (Bradfield 1971; Hack 1942). Although we cannot be certain what prehistoric periods were like, it is probable that horticulture, particularly for maize, was a high-risk venture in Chaco. From the standpoint of frosts, but not water, mesa-top farming might have been preferable. Historically, the Navajo practiced horticulture with mixed success in Chaco (see Appendix MF-C) and occasionally suffered regional crop losses because of frosts (Brugge 1980:461).

Wind

Rarely is wind taken into account as an environmental condition of prehistoric occupation because baseline data are seldom recorded. Spring in Chaco is the windiest season, with winds averaging 10 km/hr (National Park Service 1979:19), commonly from the west and southwest. Wind is a contributing factor in the annual moisture deficit caused by evapotranspiration (Tuan et al. 1973:112-142) and in soil erosion (Kosse 1983b:610-611). Paul (1977b) feels that the wind was an important architectural factor in the elliptical shape of Peñasco Blanco. Pueblo Alto's lofty position exposes it fully to the sweeping winds and other elements, although it avoids the drafts created by diurnal air channeling through the nearby canyons. Alto and the houses around it provide the only buffers to winds sweeping across the mesa. The interior and eastern plazas at Alto, at least, were partially protected from winds by the high room walls. We do not know what effect wind had on the placement of Alto, although knowledge of wind direction and velocity may have influenced the design of the room ventilating systems and the placement of the extramural refuse, as well as the walls bordering the prehistoric roads.

Biota

Flora

The Chaco area falls within the Upper Sonoran life zone (Bailey 1913). Around Pueblo Alto the present flora rarely exceeds a meter in height and consists of various woody stems interspersed with perennial grasses and a few succulents. During warm, moist seasons, a number of annuals and herbaceous perennials make a brief appearance. Several studies near Alto over the past decade or so have identified 76 species of plants, many of which were also found in the archeological record at Alto (Table 2.4). The dominant flora includes four-wing saltbush (*Atriplex*

Table 2.4. The flora around Pueblo Alto.[a]

Latin Name	Common name	Growth Habit[b]	Density Around Site[c]
Androstephium brevifolium	funnellily	HP[d]	
Aristida fendleriana	three awn	P	
Aster coerulescens	aster	HP[d]	
Artemisia frigida	estafiata	P	M
Artemisia filifolia	sand sage	P	
Artemisia tridentata	big sage	P	L
Astragalus calycosus	milkvetch	HP[d]	
Astragalus nuttallianus	milkvetch	A[d]	
Atriplex canescens	four-wing saltbush	P	H
Bahia neomexicana	bahia		
Bouteloua gracilis	blue grama grass	P	H
Ceratoides lanata	winterfat	P	H
Chenopodium desiccatum	goosefoot	A[d]	
Chenopodium fremontii	Fremont goosefoot	A	
Chenopodium leptophyllum	slimleaf goosefoot	A[d]	
Chrysothamnus greenei	rabbitbrush, chamisa	P	M
Comandra pallida	bastard toadflax		
Corispermum nitidum	bugseed	A	
Coryphantha vivipara	pincushion cactus	P	L
Cowania mexicana	cliffrose	HP	L
Cryptantha crassisepala	crypotantha, borage	A[d]	
Cryptantha flava	crypotantha, borage	HP	
Cymopterus fendleri	wafer parsnip	HP[d]	
Descurainia obtusa	tansymustard	A	
Descurainia pinnata	pinnate tansymustard	A	
Dithyrea wislizeni	spectacle pod	A	
Ephedra torreyana	joint-fir, Mormon tea	P	M
Eriogonum cernuum	daisy	A[d]	
Euphorbia fendleri	spurge	HP	
Euphorbia serpens	spurge	A[d]	
Festuca octoflora	six-weeks fescue		
Gutierrezia microcephala	snakeweed	P	
Gutierrezia sarothrae	snakeweed	P	H
Haplopappus spinulosus subsp. spinulosus	-		
Hilaria jamesii	galleta grass	P	H
Hoffmanseggia spp.	hog potato	HP[d]	
Ipomopsis aggregata	skyrocket gilia		
Ipomopsis pumila	trumpet gilia	A[d]	
Juniperus monosperma	one-seed juniper	T	

[a]After A. Cully 1985a; Cully and Cully 1985; Potter 1974; Potter and Young 1977; Scott 1980b, 1980e; M. Toll 1985b.
[b]Growth habit: A = annual, B = biannual, HP = herbaceous perennial, P = perennial, T = tree.
[c]Density: L = low, M = medium, H = high. Remainder are unknown or rare.
[d]Ephermerals.

Table 2.4 (concluded)

Latin Name	Common name	Growth Habit[b]	Density Around Site[c]
Kochia scoparia	summer cypress		
Lappula redowskii	stickweed	A[d]	
Leucelene ericoides	daisy	HP[d]	M
Lupinus kingii	-	A[d]	
Lupinus pusillus	lupine	A[d]	
Lygodesmia grandiflora	skeleton weed	HP	
Mentzelia albicaulis	stickleaf	A[d]	
Mirabilis multiflora	wild four o'clock		
Muhlenbergia torreyi	ring muhly grass	P	L
Munroa squarrosa	false buffalo grass	A[d]	
Oenothera albicaulis	primrose	A	
Opuntia hystricina	prickly pear cactus	P	
Opuntia polyacantha	prickly pear cactus	P	M
Opuntia whipplei	whip cholla		
Oryzopsis hymenoides	Indian ricegrass	P	H
Penstemon angustifolius	narrow-leaved beard tongue	HP	
Phacelia corrugata	scorpionweed, purple fringe	A	
Phacelia crenulata	scorpionweed, purple fringe	A	
Phacelia ivesiana	scorpionweed, purple fringe	A	
Pinus edulis	pinyon pine	T	
Plantago purshii	wooley Indian wheat	A[d]	
Rumex hymenosepalus	dock, sorrel	HP[d]	
Salsola iberica	Russian thistle	A[d]	
Salsola kali	Russian thistle	A	
Senecio millelobatus	butterweed, golden ragwort	?	
Senecio multicapitatus	threadleaf groundsel		
Sitanion hystrix	squirrel-tail grass	P	H
Sphaeralcea coccinea	globe mallow	P	
Sporobolus airoides	alkali sacaton grass	P	
Sporobolus cryptandrus	sand dropseed	P	
Stanleya pinnata	desert plume		
Stephanomeria sp.	skeleton weed	d	
Stephanomeria exigua	wire lettuce		
Stipa comata	needle-and-thread grass	P	
Thelesperma megapotamicum	Hopi or Navajo tea		
Thelypodium integrifolium	alkali crucifer	B	
Townsendia strigosa	Easter daisy	A[d]	
Tripterocalyx wootonii	sand verbena	A	
Yucca sp.	narrow-leaf yucca	P	L
Yucca navajoa	Navajo yucca	P	

[b]Growth habit: A = annual, B = biannual, HP = herbaceous perennial, P = perennial, T = tree.
[c]Density: L = low, M = medium, H = high. Remainder are unknown or rare.
[d]Ephermerals.

canescens), Indian ricegrass (Oryzopsis hymenoides), galleta grass (Hilaria jamesii), and snakeweed (Gutierrezia microcephala). These normally may be expected to produce over 90 percent of the cover (Potter 1974:Table 3). Four-wing saltbush, galleta grass, Indian ricegrass, joint fir (ephedra), blue grama grass, winterfat, and prickly pear are little affected by dry conditions and may even thrive and expand coverage (Scott 1980e). Prehistorically, these may have served as supplemental food supply for the Anasazi. Ephemeral plants (annuals or herbaceous perennials), however, are particularly susceptible to winter and spring drought, which results in poor seed crops (Scott 1980f).

Cultural disturbance of the Pueblo Alto area has resulted in favorable habitat for some plants that otherwise would have been reduced in quantity or absent. Moisture trapped by architectural features, high clay content in the soil (from collapsed roofs and walls), rocky subsoils (from collapsed masonry) and soil compaction (on plazas, floors, and roadways) may influence the growth of certain species of plants (Potter and Young 1977). Increased densities of galleta grass were found associated with the prehistoric roads, winterfat clustered on the rocky northern exposures of the sites, pinnate tansymustard favored housemounds and middens during moist springs and four-wing saltbush flourished in wetter areas. The latter was particularly dense in the southeast part of the Alto plaza, which encouraged prospects of finding the great kiva initially believed to be present at the site. After excavation and backfilling, Russian thistle and scorpionweed quickly took hold in the disturbed areas at Alto. Russian thistle was introduced historically, and its presence in the archeological record indicates contamination.

Fauna

A number of vegetative zones occur in the Pueblo Alto vicinity that correlate with the small mammal and bird populations. Temporarily transcending local zones are larger mammals and migratory birds. Knowledge of the present fauna not only assists in creating the setting for Alto but also may be an important factor in the archeological and postoccupational record of the site. Some species, especially small mammals, are sensitive indicators of the type of ecological zone present (for both the present and the past) and of areas of cultural disturbance.

The usual plethora of mice, ground squirrels, and rabbits expected in the grasslands is present at Pueblo Alto (Table 2.5). The site sits at the edge of two ecological zones--important for rabbit habitat. The grassy plains are dominated by speedy, black-tailed jackrabbits, whereas the nearby benches and ledges provide the greater cover preferred by quick, desert cottontails. Although there is some overlap at Alto, a distinct break between the species exists less than a kilometer north and south of the site. Chaco Canyon has been the exclusive domain of the cottontail, although there has been some incursion by jackrabbits through Fajada Gap since about 1980. Both species were economically important to the Anasazi at Alto and other sites in Chaco (Akins 1984, 1985a, 1985b). No prairie

Table 2.5. Present-day fauna in the Pueblo Alto vicinity.[a]

Species Name	Common Name
SMALL MAMMALS	
Ammospermophilus leucurus	white-tailed antelope mouse
Citellus spilosoma	spotted ground squirrel
Dipodomys ordii	Ord's kangaroo rat
Dipodomys spectabilis	banner-tailed kangaroo rat
Eutamias quadrivittatus	Colorado chipmunk
Neotoma stephensi	Stephen's woodrat
Onychomys leucogaster	northern grasshopper mouse
Perognathus flavus	silky pocket mouse
Perognathus flavescens	plains pocket mouse
Perognathus apache	Apache pocket mouse
Perognathus flavescens	pocket mouse
Peromyscus crinitus	canyon mouse
Peromyscus maniculatus	deer mouse
Peromyscus truei	pinyon mouse
Reithrodontomys megalotis	western harvest mouse
Spermophilus tereticaudus	round-tailed ground squirrel
MEDIUM to LARGE MAMMALS	
Canis latrans	coyote
Lepus californicus	black-tailed jack rabbit
Odocoileus hemionus	mule deer
Sylvilagus auduboni	desert cottontail
REPTILES	
Crotaphytus collaris auriceps	yellow-headed collared lizard
Sceloporus graciosus graciosus	sagebrush lizard
Uta stansburiana stanburiana	side-blotched lizard
Sceloporus undulatus elongatus	northern plateau lizard
Phrynosoma douglassi ornatissimum	mountain short-horned lizard
Cnemidophorus velox	plateau whiptail lizard
Pituophis melanoleucus	gopher snake
Crotalus viridis viridis	prairie rattlesnake
Sceloporus magister	desert spiny lizard/horned lizard
BIRDS	
Amphispiza belli	sage sparrow
Amphispiza bilineata	black-throated sparrow
Callipepla squamata	scaled quail
Eremophilia alpestris	horned lark
Spizella breweri	Brewer's sparrow
Passerculus sandwichensis	savannah sparrow
Pooecetes gramineus	vesper sparrow
Zenaida macroura	mourning dove
	turkey vulture

[a]After J. Cully 1985; Jones 1970; Potter 1974; Scott 1980c, 1980d.

dogs have been observed near Alto, although an old town lies just north of the site (Scott 1980e). The absence of prairie dogs is a recent phenomenon probably caused by sylvatic plague and poisoning campaigns (Findley et al. 1975:132, 134), but their former presence can be deduced from the frequency of their remains at Alto.

Medium-sized (e.g., coyotes) and large mammals (e.g., mule deer) are infrequent visitors to the Pueblo Alto area and generally are found south of the site in the nearby bench zone and canyon. Only mule deer occur in groups as large as 15 or more in the general vicinity, and they usually are restricted to the canyon environs. Generally, they are more common in wooded areas well beyond the Park (Lang 1957:8). Coyotes may occur singly or in small packs. Mule deer and coyotes are regular visitors to the major water sources at 29SJ 1791 in Cly's Canyon near Alto. Porcupines, bobcats, and badgers are solitary visitors who keep primarily to the canyon and adjacent benches, and even a mountain lion was spotted in 1976 in the badlands 12 km west of Alto (Robert P. Powers, personal communication 1976).

The grasslands sweeping north from Pueblo Alto are ideal antelope habitat although there are no historic records of sightings. Today introduced herds exist on the plains about 10-15 km to the northwest and 20-30 km south of Pueblo Alto, but herds probably covered the entire area in earlier times (Russell 1964:9, 44). Both mule deer and antelope parts were frequent finds at Alto, but other medium-sized to large mammals were scarce (Akins 1985a). Historically, the mesa tops and plains in the vicinity of Alto were also used for grazing by sheep and horses (McNitt 1966:226). Not surpisingly, several sheep bones came from the upper room deposits at Alto (Akins 1985a:28, Table 2.2).

A variety of birds inhabit Chaco seasonally, including large granivorous populations (Table 2.5). Horned larks are the most prevalent bird around Alto for most of the year, followed by smaller flocks of black-throated sparrows, scaled quail, sage sparrows and mourning doves (Scott 1980c). Horned lark bones were also recovered at Alto (Akins 1985a: Table 2.2), and a few were found in Alto coprolites (Clary 1984:269). Also present in the nearby canyon are woodland pinyon jays, brown towhees, Say's phoebe, and cliff swallows.

Predatory avifauna are infrequent visitors to the canyon area, except for kestrels, with only occasional nesting taking place. These include ravens, great horned owls, prairie falcons, golden eagles, and a large flock (about 17) of turkey vultures. The latter flock has resided at the mouth of Cly's Canyon over the past 12 summers where cliffs and side canyon updrafts and the cottonwoods in the wash provide suitable roosting and soaring conditions.

Reptiles and amphibians are widespread in the canyon and at Pueblo Alto. The most common of these in the Alto vicinity are lizards, gopher (bull) snakes, and prairie rattlesnakes.

Summary

Resources in the immediate vicinity of Pueblo Alto are not adequate to support a large population (e.g., over 100 residents) and, presumably, were not so in the past. Precipitation has approached mild drought conditions for the past 1,000 years. During wet periods, dry farming may have been possible on the surrounding plains, although historic farming practices suggest that normally it was not. Local soils are adequate for farming, however, providing there was sufficient rainfall or that pot agriculture was practiced. More likely, flood water farming in nearby Cly's Canyon and along the Escavada Wash and possible garden terraces at the base of the nearby cliffs provided crops for the Alto residents. Prehistoric roads leading from Pueblo Alto to Cly's Canyon suggest that seeps were a major source of water for the Alto residents. Drinking water is plentiful, particularly if hauled in quantities from the Escavada Wash.

Animal and plant resources are indicative of the dry conditions around Pueblo Alto. Vegetation is sparse and animals are limited primarily to small mammals, although there is a greater diversity of species and larger numbers of some species within Chaco Canyon nearby. Useful species, however, must have suffered considerable depletion in the 500 or more years of Anasazi occupation before Pueblo Alto was built. Judging from the scarcity of Anasazi sites in the greater vicinity of Alto, occupation must always have been locally unsuitable. In short, there are few natural resources to attract settlement on the mesa tops and plains in the vicinity of Alto that would not have been more plentiful in Chaco Canyon. The attractions for the placement of Pueblo Alto were probably unrelated or only marginally related to natural resources.

Chapter Three

Research Goals and Methods

Goals of the Chaco Project

The Prospectus for Chaco Canyon Studies (NPS 1970) served as the initial guideline for research during the Chaco Project and suggested that major fields of study should include: (a) an analysis on the present and past environment, (b) the availability and exploitation of natural resources, and (c) the definition and interaction of the "three distinct cultural systems" (i.e., Hosta Butte, Bonito, and McElmo) with emphasis on the impacts of urbanization, agriculture, water control, population growth, and exchange.

This simplistic guideline was supplemented by a more explicit research design written by Judge (1975) that gave additional direction to the ongoing small-site excavations and the forthcoming work at a Chacoan greathouse. Judge's goals are worth summarizing here because they set the theoretical groundwork for the excavation at Pueblo Alto. In this regard, though, the focus was on the project approach that linked the research for several sites.

A guiding tenet to our early work in Chaco was our belief that cultural developments in Chaco were predictable and normal for the Anasazi occupation of the Colorado Plateau, but with a departure from this occurring during the Bonito phase in the A.D. 1000s. Research, then, became the tool to test the normalcy of the early development and to examine its presumed logical outgrowth. In other words, the project was designed to define and examine the norm for the canyon occupation and its place in the larger Colorado Plateau Anasazi settlement. This culture-history approach oriented research to chronologically examining the Anasazi development in the canyon from its earliest beginnings.

From past work in Chaco Canyon, it was believed that cultural development became increasingly complex. Thus, the early small-house sites appeared to offer less complex formal and structural characteristics that would be easier to understand and to interpret. In addition, examination of small-house community growth and interaction (Judge 1975) would have provided a baseline for community development and normality in which to compare with Pueblo Alto. Experiences gained from the small-house work did increase our understanding of the large complicated greathouses. It is true, as Binford (1972:130, 158-159) has noted, that "large complicated archaeological sites are very difficult to understand," and, therefore, the small, simple sites should be dug first. Unfortunately, the complexity of some of the small houses due to long-term use and renovation proved in some ways to be more difficult than our work at Pueblo Alto. Although our initial small-house work was scattered throughout the canyon without thought to community or regional studies, by 1975 it was proposed that we concentrate work in three separate areas in the canyon to examine community growth and interaction (Judge 1975). These sample areas would have provided a baseline for the small-site community development, a measure of "normality," and a basis for comparison with developments in the greathouses. This new approach was aborted soon afterwards when the project was shortened by 5 years. Thus, only a single area, Marcia's Rincon, located near the visitor's center, received intensive scrutiny of the small-house occupation in Chaco Canyon (see McKenna 1986). Seven house sites in Marcia's Rincon were ultimately examined by testing or excavation, but the focus on community development was never achieved. These sites in and near Marcia's Rincon, however, became the basis of the small-house comparison to our later work at Pueblo Alto.

Judge's (1975) proposal also emphasized the importance of conserving the cultural resources in the canyon and the recognition that, because of its public funding, the project should not be narrowly exploitative to satisfy immediate, perhaps limited, research aims. Broadly framed research goals that anticipated future data requirements as well as specific ones to allow present interpretation were sought. In addition, nondestructive data gathering techniques were to be be planned and implemented.

A staged approach for the project was proposed to examine three major fields of interest coupled with earlier project goals: (1) changes in population parameters and population distribution that occurred during the early occupational periods, (2) changes in resource availability and resource utilization that took place at the same time, and (3) the concurrent changes in social organization and social control over resources. These would eventually allow assessment of the Pueblo III small-site occupation to the extent that it was a logical outgrowth of earlier times as well as the extent of its interaction with greathouses.

Understanding the relationships and parameters of the three contemporary Pueblo III phases in Chaco (the Hosta Butte phase for small houses, the McElmo phase for San Juan-like greathouses, and the Bonito phase for Chacoan greathouses) was a continual goal. Confusion in defining the three contemporary phases and segregating the sites within them resulted in dropping the McElmo and Hosta Butte phases during the project. The Bonito phase was retained but redefined to temporally order cultural events in Chaco between A.D. 920 and A.D. 1150 (see Figure 1.1). The final objective was to describe and explain the abandonment of the canyon in the thirteenth century, although subsequent emphasis focused on the Chacoan decline in the twelfth century rather than on the final Anasazi (Mesa Verdean) occupation and abandonment of the canyon. A heightened interest in the Chacoan occupation, the mass of data from our excavations, and the lack of time to pursue the terminal canyon occupation shifted our inquiry.

By 1976, the archeologists at the Chaco Center were beginning to gain a wider perspective of the Chacoan system. A reassessment of goals led to a serious attempt at expanding our knowledge of the system beyond the confines of the canyon. This enlightenment was influenced by several factors: the shift in theoretical thinking that espoused a regional perspective for investigating complex societies (e.g., Binford 1965; Flannery 1976); the beginning of massive energy exploitation in the San Juan Basin, where most of the Chacoan outlying sites are located, that forced a realistic look at those cultural resources and their importance to the Chacoan system; and the personal interest of some of the staff in investigating outliers.

In the fall of 1976, the Chaco Center surveyed three Chacoan outlying communities (Peach Springs, Bis sa'ani and Pierre's), thereby beginning an extended commitment to outliers (see Powers et al. 1983) concurrent with the work at Pueblo Alto. These communities and most others in the San Juan Basin were scarcely known, much less documented, before this period of interest. A similar, but less regional, examination of Chacoan outliers had been ongoing in the northern part of the basin by Cynthia Irwin-Williams and her staff to broaden their examination of the Chacoan Salmon Ruins. Shortly afterwards, in 1977, Richard Loose, a former member of the Chaco Center staff and an environmental scientist with the Public Service Company of New Mexico, and Thomas Merlan, New Mexico State Historic Preservation Officer, obligated their respective organizations to funding a survey to locate and document Chacoan communities in the basin (see Marshall et al. 1979). These surveys began to dovetail and increased the recognition of the role that outliers played in the Chacoan system. With the increased demands of energy exploration, more time and resources were devoted by the staff to outliers than were envisioned in the original project plans. Ultimately, these efforts resulted in the passage of Public Law 96-550 in 1980 (United States Congress 1981) that provided some federal protection for 33 outliers in the San Juan Basin.

By 1977, outliers had assumed an important new role in the project research design (Judge 1977) that sharpened the focus on the function and purpose of the system as well as its many components such as small houses and greathouses. Despite a broader perspective, little was known of the Chacoan system (even to the presence and identity of the large numbers of outliers that are now currently documented) and, therefore, Pueblo Alto remained the primary goal as an important component of the system with clear regional ties (i.e., the roads). In part, Alto would help establish a baseline suitable for future explanatory models to assess the rise, florescence, decline, and demise of the Chaco Phenomenon.

Finally, NPS management goals also greatly affected the research direction. Park management was interested in sites that would enhance the summer interpretative program during excavation as well as future exhibits when work was completed. On the other hand, sites were not to be chosen if undue deterioration of the natural environment might result, a difficult problem. Both Marcia's Rincon and Alto met these requirements, although work in Marcia's Rincon began as more of a trade-off between research and management goals than did the work at Alto. The desire to conserve the sites for visitor interpretation also had some minor effect in blocking investigation during excavation (i.e., there was considerable hesitation in dismantling the site to unravel its occupational history because nothing would remain to be stabilized). In the final assessment, however, current technology is inadequate to conserve buildings lined and built of mud, which require the sites to be backfilled.

Pueblo Alto Research Goals

As the Chaco Project evolved in the 1970s, so did the research focus. By the time of the Pueblo Alto excavations in 1976, there was a greater awareness and emphasis on behavioral strategies and the complexities of social interaction within the regional system. Thus, the revised Chaco Project research focus was to discern the nature and extent of interaction and dependency of the various components that comprised each level of the Chacoan system (see Judge 1977). In reality, not all components could be examined specifically at Pueblo Alto, of course, but Alto was to provide potential insights into at least some of these. The most important of these was to identify the relationships between contemporary small-house sites and greathouses, as represented by Alto, between Alto and other greathouses in Chaco Canyon, and between Alto and the outliers. The method for clarifying these relationships was to be based on the examination of resources, exchange, subsistance, and social organization. Ideally, these goals would help achieve some answers posed by a number of then-current models of the Chacoan system (e.g., by Grebinger 1973; Irwin-Williams 1977; Vivian 1970a, 1970b), as well as to provide a basis for future ones. The focus of hypothesis testing for the Alto project, however, was directed towards Judge's (1979) model of exchange as an organizing principle to explain the emergence and function of the Chacoan greathouses. Flexible research goals were desired to accommodate later questions posed by new models of which a number appeared during the Alto project (e.g., Altschul 1978; Breternitz 1982c; Judge 1983; Marshall et al. 1979: Powers et al. 1983; Schelberg 1982; Tainter and Gillio 1980; Winter 1980). A working research design that provided a framework and specific direction for the studies at Pueblo Alto, however, was never produced.

Some of the questions addressed by the research staff that developed before, during, and after the work at Pueblo Alto (see Appendix MF-D) are subsumed under topical headings listed below. These are not inclusive but illustrate the major directions research was taking to answer the goals stated above.

Subsistence

One of the best areas of preservation in the archeological record relates to resources in the form of material goods and fauna and plant remains. Despite some optimism to the contrary, it was clear that Chaco Canyon is not an oasis in the midst of barren surroundings except in a very relative sense. Some of the questions pertinent to our research goals, then, concentrated on the local resources and their utilization. How did the inhabitants deal with their surroundings? What was the nature of available wild food sources and the potential for horticulture? Was wood available for construction and heating, and what effects did a growing population have on the resources? Was there differential distribution of goods and storage in the site and between Alto and the small sites excavated that might imply social stratification? How, when, and where were resources procured, processed, and stored? What socioeconomic units had access to stored goods? Was storage available to resident and nonresident groups, and how were goods distributed? What task groups and spatial arrangements were necessary to carry out these functions? What can discard patterns tell us about the economy and the social organization?

Social Organization

The site architecture offers the first and best opportunity to identify socioeconomic resident groups (Service 1962) by the use and division of space, room interconnectiveness, and access to specific facilities (e.g., kivas and courtyards). These initial identifications might be supported by the study of shared artifact attributes, although at Pueblo Alto little material was left in situ at abandonment, thus discouraging such studies. At the site level, suites of interconnected rooms offer the first, and often the only, evidence of social correlates. Were there different kinds of suite arrangements, what were their purpose, and how might their residents have interacted? Household suites are difficult to identify in greathouses excavated in Chaco and, thus, we were particularly intent on identifying such units because of their importance to understanding site function, differential access to goods and services compared to small-site households, and the size of the site population.

In the greathouses there are many large blocks of rooms that cannot be ascribed association with any residential suites. Marshall et al. (1979) have seen these units as evidence of public architecture. If households were absent, then it would be difficult to make a case for greathouses as residences of the elite, and a case for public architecture would be supported.

From the identity of suites, a number of questions pertaining to the site and project goals can be addressed. How many groups were evident and what function did they serve? How did they change through time, and what other evidence in architecture and stratigraphy supports these changes? Were the groups hierarchically organized; what was their status and political organization? The latter may be inferred from the residence position within the site, relationship to ritual activity, spatial requirements, and architectural construction, as well as differential access to goods and the discard behavior. Because of the courtyard and great kiva dichotomy at Pueblo Bonito, Vivian (1970b:273) suggested that a moiety system existed there. Was this also evident at Pueblo Alto? What evidence was there for domination by a small group or an individual at the site? What mechanisms, revealed by architecture and features, may have integrated the various groups at Pueblo Alto and in the Alto community? Was there differential use of the site through time? Did it reflect major renovation and shifts in cultural behavior that might have implied a change in the social organization? If so, how did it change and what might have been the cause?

Burial practices can be a boon to understanding social ranking and other social correlates but Chacoan greathouses (except for Pueblo Bonito) have been notoriously devoid of human physical remains (e.g., see Akins 1986; Akins and Schelberg 1984; Morris 1924:224). Pueblo Alto proved no exception, and, therefore, other means of indirect evidence were needed to estimate population and social parameters at Pueblo Alto. Some aspects thought useful to this end at Pueblo Alto were trash volumes, household number, features, and household size.

Intersite and Interregional Relationships

Although this problem can be addressed during material analyses (e.g., exchange of basic and exotic goods, deficiency of local resources, etc.), there are physical ties (i.e., shrines and roads) that bind Pueblo Alto to other sites. Powers et al. (1983:274, 324) have taken site size as the major criterion for determining the hierarchial level of greathouses in the system. Pueblo Bonito and Chetro Ketl, therefore, were seen as being the paramount greathouses in the system. Pueblo Alto's close proximity and road ties to these two dominant sites posed a number of pertinent research questions. For instance, what was the relationship of these two greathouses to Pueblo Alto? What other greathouses were physically tied to Alto (by roads), and could we assess the level of interaction among them? To what degree was Alto dependent on local and nonlocal resources? Could the nature of interaction with other house groups be determined? What were the methods and implications of exchange (e.g., see Toll 1978)? What effect did exchange have on the power and influence of the inhabitants?

Population

Growth and Decline

How many people lived at or used the site and how did this vary through time? On what basis can population figures be estimated at the site level? What internal and external factors may have been responsible for the variation in population? Because of their absence, burials did not seem a viable source of information for population studies. Alternative estimates of the resident population can be made from the number of identified and projected resident suites or space and by the use of historic analogy (see Drager 1976; Hayes 1981). Another estimate can be derived from feature (e.g., firepits) frequency, feature contents, and discard behavior (Windes 1984). In conjunction with population estimates, were local resources adequate (see Akins 1984; Gillespie 1985)? If there was a discrepancy between population estimates and adequacy of resources, what factors may have been accountable?

Permanency

The traditional view of Chaco greathouses is one of permanent resident masses. What evidence was there for a permanent population at Pueblo Alto, and did it fluctuate through time? When was the site established, and when was it abandoned? Was there intermittent occupation or use of the site? If there was intermittent occupation or use, was it residential or nonresidential (i.e., trade fairs, seasonal rituals, etc.) or both? How did residence permanency relate to the site function and economy? Were there correlate resident changes at other greathouses that might suggest a common response to changing conditions?

Site Function

The association of smaller sites in the Pueblo Alto complex, the terraces, roads, and available resources provide avenues to assess site function. In addition, the association or nonassociation of suites within Alto to the roads also lent itself to interpreting a functional role for Alto. Did the site location reflect an adaptative response to environmental conditions and resources or an integrative role within a regional system? Why was the site so located? What activities took place at the site, and how did these relate to the regional context in which Alto was probably involved? What was the relationship of the house sites next to Alto?

Strategies

Introduction

The experiences gained by the staff from the small-site excavations allowed refinement of the excavation and recording techniques employed at Pueblo Alto. In particular, the difficulties encountered in converting to the new computerized artifact inventory at the small-house sites were averted. A revised methodological plan for Alto was compiled by the project staff during the winter of 1975-1976, which resulted in a procedural manual for field use (Judge et al. 1976). Discussion of the field procedures and feature indentifications is important here because it produced terminology sprinkled throughout the text that will be unfamiliar to many readers. A brief coverage of the inventory format also is in order, along with definitions of the new terminology (see Chapter 9 and Appendix MF-E).

In addition to the field procedures, remote-sensing techniques (i.e., aerial photography) were used for mapping the site at the end of each field season to record the yearly field progress (Plates 3.1-3.2; Ebert 1984:Figures 5.13-5.14), and pinpointing probable locations of prehistoric roads adjacent to the site. Maps from this work have figured prominently in reports on remote-sensing techniques (e.g., Camilli and Cordell 1983: Figures 17-19; Ebert and Lyons 1980:Figure 3, Plate 6). Subsurface radar (Vickers et al. 1976) and magnetometer studies to locate buried features (Appendix MF-F) were also conducted, but because of the limited scope of work, they did little to increase our knowledge of the subsurface archeology.

Sampling at Pueblo Alto

It was clear that only a small part of Pueblo Alto could be tested and excavated to achieve the goals listed above. Therefore, the sampling design for the work at Alto was of the utmost importance to the project. Because architectural patterning can produce behavioral information, we did not consider a simple random sampling of arbitrary units (i.e., grids) or architectural units (i.e., individual rooms and kivas) to investigate Pueblo Alto. Such an approach would have implied total ignorance of potential behavioral strategies at the site and ignored results of earlier and ongoing greathouse excavations in the San Juan Basin. The end result would have been a set of statistical statements telling us little about the sociocultural behavior. Data from the isolated excavational units that random sampling would have produced, and the architectural variability present, would have made it difficult to apply meaningful interpretations to behavioral (i.e., architectural) units larger than those excavated. In other words, isolated individual rooms or grids are simply too small a sampling unit in a site of Alto's size to confidently extrapolate to the suite or site level, when only a small part of the site could be dug (see Binford 1972:130).

The primary criteria used to stratify the site rooms and to pick those to be excavated were based on the following.

(1) The identification of architectural units (door-connected suites).

Suite delineation at Pueblo Alto required that most doors be located and identified as to primary or secondary construction. Luckily, the few primary doors uncovered in 1976 followed a systematic pattern of placement that permitted high reliability in predicting and identifying door presence. This pattern was consistent with door placement observed for other canyon greathouses (i.e., Chetro Ketl, Pueblo Bonito, Pueblo del Arroyo,

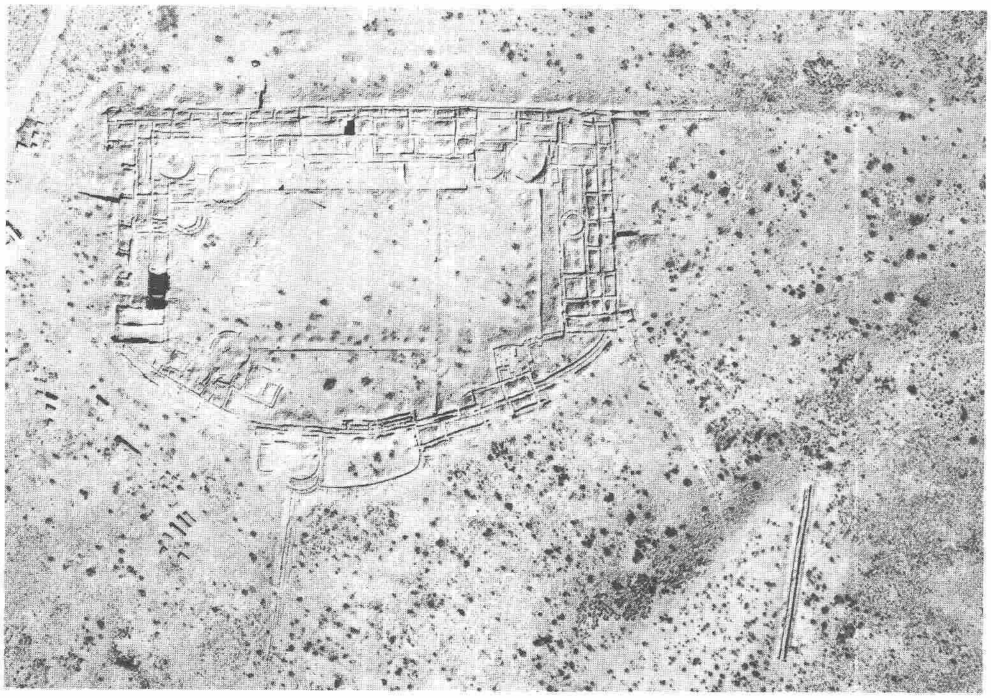


Plate 3.1. Aerial photo of Pueblo Alto after the 1976 field season. Black squares mark the two excavated rooms. Photo taken on 12 September 1976. Compare with Plate 3.2. (Courtesy of the Branch of Remote Sensing, NPS, Santa Fe, NM.)

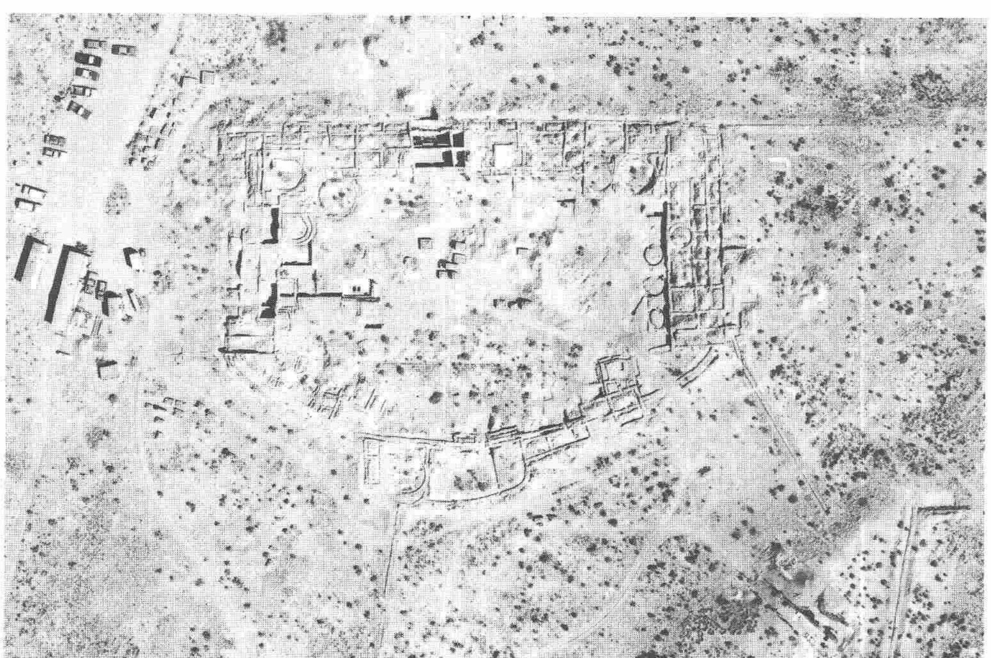


Plate 3.2. Aerial photo of Pueblo Alto after the 1977 field season. Large shadows within the roomblocks mark excavated rooms. Small squares in the center of the site are cairns of stone collected from cleared wall rubble. Compare with Plate 3.1 Photo taken on 9 September 1977. (Courtesy of the Branch of Remote Sensing, NPS, Santa Fe, NM.)

and Una Vida). The predictability of door location permitted testing in 1977 to confirm the basic door pattern and some suite perimeters at the site.

(2) Architectural unit types.

Different suite types were identified on the basis of the spatial arrangement of the individual rooms, the room areas and the arrangement of door connections. From this, several groups of similar types were projected as being functionally analogous, as excavation later verified; single units offered low potential for extrapolation to the site level.

(3) Frequency of similar units.

Because of the small amount of work to be done, suites could not be tested in all roomblocks. Suites were concentrated in three primary roomblocks (in the East and West Wings and the Central Roomblock) and the two secondary roomblocks added to the corners of the southern enclosing arc in the early A.D. 1100s. Our goal was to sample the most frequently represented units. Unique or rare units and single rooms that did not have clear association with other rooms or kivas were given low priority. Previous work at other canyon greathouses was examined to provide a pool of repetitive unit types common to several of the greathouses.

(4) Period of construction determined from masonry styles and wall abutments.

Although several masonry styles and construction phases were identified, accurate delineation of architectural time was best provided by an early (initial) versus late dichotomy observed during wall clearing and testing in 1976. Although we were not uninterested in the late occupation, the initial greathouse settlement could be better compared with other greathouses because the earlier occupations in the A.D. 900s and A.D. 1000s were better documented. On the other hand, occupation in the greathouses in the early A.D. 1100s and A.D. 1200s was poorly known, seemed to offer less systematic architectural patterning that crosscuts multiple sites, and exhibited short-term occupation that marks a shift in occupational behavior. Occupations after A.D. 1100, of course, are important avenues for investigation into the eventual decline and demise of the Chacoan system, but it was felt to be less important (and harder to distinguish contemporaneity on the basis of architecture when rooms were reoccupied) than understanding the system in the preceding "classic" period.

In reality, the two primary architectural units eventually selected for excavation were chosen on the above criteria, but with mitigating factors. The ideal sample was to have been selected after total wall clearing and exposure of the architectural plan at Pueblo Alto. This goal was affected by a second, and equally important, goal that sought information on the stratigraphic complexity and the problems of multistory buildings before the main excavational thrust of the second season.

Clearly, this information was also pertinent to the ultimate sample selection. Two rooms were chosen for excavation during the initial wall clearing to provide this information. Their selection was based on some of the same criteria covered above, but, most important, the time constraints and labor supply were such that these two rooms were to become deciding factors in the eventual selection of the two primary units selected for investigation.

Wall Clearing

Knowledge of the architectural plan of the Pueblo Alto complex was imperative before an approach to excavation could be formulated. Much of the site plan was evident and mapped by photogrammetry before excavation (Drager and Lyons 1983:39-40; Hayes 1981:Figure 40). Trenching along known and suspected walls to a depth of approximately 30 to 50 cm below the wall tops helped to clarify the final plan, however. Trenching served to define each wall, helped to locate buried crosswalls, permitted examination of corner ties and abutments, and allowed the stabilization crew to cap the walls with soil cement (see Appendix MF-G). Fill removed by trenching was piled alongside the trench toward the center of the room or kiva for later backfilling from where it was removed (see also Appendix MF-G). No screening or serious effort to collect artifacts from this fill was done. For the most part, little information was lost by the removal of fill, which consisted primarily of wall-fall, mortar, and sand. Along the southern enclosing arc, however, the architectural plan was difficult to predict and the rooms were shallow, so that, consequently, a much higher percentage of the postoccupational and occupational fill was disturbed (almost to the floors in a few shallow rooms).

Following the wall-clearing crews, Marcia Truell and Cory Breternitz investigated wall abutments, masonry styles, vents, doors, and other exposed wall features to clarify the architectural history of the site by defining construction units. Initially, a modified version of masonry style recording used by Pierre Morenon (1972; 1977a) at the Salmon Ruin and by Terrel and Durand (1979) at the Guadalupe Ruin was attempted, but the bewildering variety of styles exhibited within the same walls and the lack of time prevented completion of this ambitious project. Assistance from the Salmon Ruins Project staff finally permitted some comparable wall recording. The walls in Room 103 at Alto were recorded by Terry Fife of the Salmon staff. Bruce Burns, also of Salmon, later helped to record the masonry in Kiva 15/Room 110 before Kiva 15 was dismantled (see Terrel and Durand 1979:Figures 13-18, for illustrations of this recording technique). The data from both these efforts is on file at the Chaco Center, although studies comparing masonry styles of Alto and Salmon were never completed.

Following the clearing of walls and testing of major structural features, aerial photogrammetric flights were made over the site to permit mapping of the entire complex and Alto architectural plan (Plate 3.1). Additional flights were made near the conclusion of each field season to document the work and to add new features to the site map.

Room Selection, First Season (1976).

The goals for 1976 were to outline all the wall tops at Pueblo Alto to obtain a site plan (to aid in the identity of construction units), to test our revised field procedures, and to test two rooms for stratigraphic information and to assess the potential room functions based on the variables listed below. The wall clearing took longer than anticipated and, therefore, work started on the room excavations before the East Wing was cleared to insure completion that summer. Only rooms in the areas already cleared (the Central Roomblock and the West Wing) were considered for excavation. Unfortunately, this eliminated the East Wing from consideration, an important omission that affected subsequent sampling. The two rooms were chosen on the following basis:

(1) Size.

Wall clearing of the main structure revealed a range in room sizes between about 2 and 48 m^2 (Tables 3.1–3.2), although most fell into three general categories: large rooms over 30 m^2 (20), medium-sized rooms between 20 and 30 m^2 (13), and small rooms less than 20 m^2 (48). The numbers vary depending on the phase of occupation. Nevertheless, even without precise figures in the field to work from, room classes by size were easily separable. The short time remaining during the field season eliminated the largest rooms from consideration.

(2) Tier position.

The tier placement of rooms suggested the degree of association with the interior plaza, depending on the distance and access between the two spaces. In contemporary small sites, rooms opening onto the plaza are habitation rooms and those behind them are storage rooms. An analogous situation, but less reliable, exists at greathouses.

(3) Wing location.

Only two of the three roomblocks were candidates for room excavation because the East Wing had not been wall-cleared.

(4) Height of room remains.

We were drawn to the highest position on the houseblock because it offered the deepest stratigraphic deposits and the greatest number of potential stories. It also offered the best placement for the site datum.

Based on these variables, a small, second-tier room in the highest part of the site was chosen (Room 145) in the Central Roomblock. From its location and size, we suspected (accurately) that storage was the most likely function. Time being a factor in its excavation, the selection of the highest room was offset by its small size. Adjacent high rooms were huge and were unlikely to have been finished by the end of the field season. In contrast, a medium-sized, plaza-facing room of lower height in

Table 3.1. Pueblo Alto room measurements (in cm).[a]

Room	Length	Width	Room	Length	Width	Room	Length	Width
100	522	325	140	355	250	189	505	330
101	1110	330	141	320	120	190	340	250
102	1100	325	142/146	1130	360	191	315	270
103	750	340	142	835	360	192	1130	310
103N	505	360	143	640	130	193	250	250
103S	200	325	143/236	1280	130	194	580	355
104	760	340	144	550	170	195	590	270
105	1600	335	145	326	240	196	590	270
106	600	285	146	360	220	197	590	340
107	570	285	147	350	335	198	355	60
108	570	305	148	335	335	199	1520	325
109	350	145	149	550	190	199	900	295
110	770	330	150	540	190	200	970	60
110	500	330	151	755	325	201	565	360
111	770	330	152	870	365	202	990	150
111	330	230	153	855	375	203	720	55
112	780	350	154	1015	325	204	650	103
113	770	330	155	540	190	205	220	115
113	770	290	156	430	185	206	435	120
114	430	60	157	430	195	207	unk.	120
115	340	55	158	415	340	208	575	270
116	735	325	159	410	350	209	575±	275
116	330	325	160	2110	110	209	385	275
117	750	365	161	560	175	210	420	275
117	365	350	162	845	410	211	600	360
117	320	220	163	820	190	212	unk.	105
118	360	75	164	685	65	213	225	105
119	540	210	165	855	410	214	260	240
120	330	55	165	855	290	215	250	170
121	335	325	166	525	200	216	195	145
121	325	220	167	715	210	217	465	190
122	385	185	168	320	220	218	300	190
123	550	170	169	300	200	219	155	130
124	360	232	170	430	270	220	300	190
125	335	250	171	780	410	221	300	185
126/129	1180	340	172	415	140	222	180	180
126	600	340	173	820	410	223	not a room	
127	1215	360	174	415	260	224	500	155
128	565	185	175	510	260	225	670	255
129	535	330	176	530	280	226	650	355
130	380	90	177	1000	480	227	345	345
131	200	120	178	350	270	227	345	235
132	540	175	179	1190	270	228	570	320
133	1190	345	179	540	270	229	570	310
134	1140	360	180	535	245	230	500±	300
134	940	360	181	510	245	231	200	150
134	510	350	182	515	270	232	not a room	
135	930	120	183	900	490	233	560	340
136	550	190	184	525	255	234	not assigned	
137	670	360	185	555	250	235	360	130
137	380	360	186	860	265	236	640	130
138	560	170	186	475	265			
139	1180	330	187	870	250			
139	845	340	187	465	250			
			188	505	470			

[a]Measurements were taken between wall tops off aerial photo map of 1976. Excavated rooms may differ slightly in size. In all duplicate cases the original room is the largest but was later subdivided (Room 179 is uncertain).

Table 3.2. Pueblo Alto room area (m^2) and shapes.[a]

Room	Area	Shape	Room	Area	Shape	Room	Area	Shape
100	17.0	0.623	140	8.9	0.704	187	11.6	0.538
101	36.6	0.297	141	3.8	0.375	188	23.7	0.931
102	35.8	0.295	142/146	40.7	0.319	189	16.7	0.654
103	25.5	0.452	142	30.1	0.431	190	8.5	0.735
103N	18.2	0.713	143/236	16.6	0.102	191	8.5	0.857
103S	6.5	0.615	143	8.3	0.203	192	35.0	0.274
104	25.8	0.447	144	9.4	0.309	193	6.3	1.000
105	53.6	0.209	145	7.8	0.736	194	20.6	0.612
106	17.1	0.475	146	7.9	0.611	195	15.9	0.458
107	16.2	0.500	147	11.7	0.957	196	15.9	0.458
108	17.4	0.535	148	11.9	0.944	197	21.1	0.576
109	4.9	0.409	149	10.5	0.345	198	2.1	0.169
110	25.4	0.429	150	10.3	0.352	199	49.4	0.214
111	25.4	0.429	151	24.5	0.431	199	26.6	0.328
111	7.6	0.697	152	31.8	0.420	200	5.8	0.062
112	27.3	0.449	153	32.1	0.439	201	20.3	0.637
113	25.4	0.429	154	33.0	0.320	202	14.9	0.152
113	22.3	0.377	155	10.3	0.352	203	4.0	0.076
114	2.6	0.140	156	8.0	0.430	204	6.7	0.159
115	1.9	0.162	157	8.4	0.454	205	2.5	0.523
116	23.9	0.442	158	14.1	0.819	206	5.2	0.278
116	10.7	0.985	159	14.4	0.854	207	unk.	unk.
117	27.4	0.487	160	23.2	0.052	208	15.5	0.470
117	12.8	0.959	161	9.8	0.313	209	15.8±	0.478
117	7.0	0.688	162	34.6	0.485	209	10.6	0.714
118	2.7	0.208	163	15.6	0.232	210	11.6	0.655
119	2.5	0.389	164	4.5	0.095	211	21.6	0.600
120	1.8	0.167	165	35.1	0.480	212	unk.	unk.
121	10.9	0.970	165	24.8	0.339	213	2.4	0.467
121	7.2	0.678	166	10.5	0.381	214	6.2	0.923
122	7.1	0.481	167	15.0	0.294	215	4.3	0.680
123	9.4	0.309	168	7.0	0.689	216	2.8	0.744
124	8.4	0.644	169	6.0	0.667	217	8.8	0.409
125	8.4	0.746	170	11.6	0.628	218	5.7	0.633
126/129	40.1	0.288	171	32.0	0.526	219	2.0	0.867
126	20.4	0.567	172	5.8	0.337	220	5.7	0.633
127	43.7	0.296	173	33.6	0.500	221	5.6	0.617
128	10.5	0.327	174	10.8	0.627	222	3.2	1.000±
129	17.7	0.617	175	13.3	0.501	223	not a room	
130	3.4	0.237	176	14.8	0.528	224	7.8	0.310
131	2.4	0.600	177	48.0	0.480	225	17.1	0.336
132	9.5	0.324	178	9.5	0.771	226	23.1	0.546
133	41.1	0.290	179	32.1	0.227	227	11.9	1.000
134	41.0	0.316	179	14.6	0.500	227	8.1	0.681
134	33.8	0.383	180	13.1	0.458	228	18.2	0.561
134	17.9	0.686	181	12.5	0.480	229	17.7	0.544
135	11.2	0.129	182	13.9	0.524	230	15.0±	0.600?
136	10.5	0.345	183	44.1	0.544	231	3.0	0.750
137	24.1	0.537	184	13.4	0.486	232	13.5±	unk.
137	13.7	0.947	185	13.9	0.450	233	19.0	0.607
138	9.5	0.304	186	22.8	0.308	234	not assigned	
139	38.9	0.280	186	12.6	0.558	235	4.7	0.361
139	28.7	0.402				236	8.3	0.203

[a]Shape derived from width divided by length. Original room in duplicate series is one with the largest area. Excavated rooms may differ slightly in size from figures presented here.

the West Wing (Room 103) was considered the best balance for obtaining the information needed. The latter room also was considered to have excellent potential as a habitation room because of its position and size; again, a correct assessment.

Room Selection, Second Season (1977)

Wall clearing the first season and the aerial map produced of the site plan revealed much of the architectural organization (Plate 3.1). Although the discovery of many doors during the wall trenching enabled tentative room suites to be identified, further door investigation at the start of the second season was considered necessary for accurate delineation of all room suites. The first season's work revealed the probable pattern of site-wide systematic door placement. A thorough search at the middle of each wall was thought to be the most expedient method for finding the remaining initial doors. Overall, the door search proved a reliable method for identifying potential suites.

Enough doors and potential suites were identified from our first season's work to make a tentative selection of suites to be excavated. Although we did not wish to be tied to our first season's excavations (in Rooms 103 and 145), it was now clear that the time involved in clearing rooms was so great that the previous work had to be seriously considered in the expanded excavation scheme. Had we abandoned these rooms as simply exercises to refine our excavational procedures, we risked losing, or at least being unable to expand, our understanding of the room functions in relation to the suites in which they belonged. In addition, moving on to new suite areas jeopardized the completion of entire suites in the little time remaining (two seasons).

Minimally, the above considerations eliminated the East Wing from any excavation. In addition, repetitive units of rooms were rare in the East Wing. Two potential suites in the East Wing yielding a large plaza-facing room backed by two smaller rooms were similar in layout to the Central Roomblock, but the two suites were oddly separated by a kiva or a tower.

Central Roomblock Sample. Wall clearing in the Central Roomblock revealed five suites that closely resembled those at the three initial canyon greathouses of Peñasco Blanco, Pueblo Bonito, and Una Vida (see Judge et al. 1981; Lekson 1984). These suites consisted of one or two large rectangular rooms (over 40 m^2 each) backed by two small rooms between 8 and 10 m^2. Initially, the suites were joined to others by door access to common corridor rooms that separated the suites from the plaza. In arrangement, the suites were similar to the living room-storage room plan in Pueblo I houses except in scale. This similarity led us to believe that potential functional use of these suites at Pueblo Alto would also reflect a living room-storage room dichotomy. These five suites comprised the bulk of the initial construction at Alto, and, therefore, were important to understanding the original function of Alto as well as the initial beginnings at the other early greathouses. By good fortune, the excavation of Room 145 had chanced to be in one of these large suites (the central one). Thus, Room 145 committed our choice to the room suite in which it was located. Our goal, then, was to clear the entire suite, the attached corridor room, the adjoining plaza on which it opened, and the associated court kiva. For the most part, these goals were realized with the exception of one small back room left unexcavated and the kiva, which was only trenched.

West Wing Sample. In the West Wing, the suite arrangement was less clear, particularly with Room 103. There again seemed to be paired, medium-sized rooms backed by small rooms. The small rooms, located along the exterior of the wing, however, were door-connected end-to-end and rarely into the adjacent larger rooms in the central tier. The East Wing also had exactly the same arrangement of an exterior tier of small rooms. The string of small exterior rooms added to the west exteriors of Pueblo Bonito, Chetro Ketl, and Peñasco Blanco reveal similar door patterning. Thus, the strings of small rooms seem organized as functionally analogous units, but unrelated to the rooms and room suites opening on the plaza.

There seemed to be four or five paired suites of medium-sized (25-26 m^2) rooms facing the plaza in the West Wing at Pueblo Alto. Within these the southernmost, Room 103, was excavated only to the uppermost floor at the end of the first season. Although Room 103 appeared to have served for habitation during its final use, we needed to know its original intended function. Continued excavation, therefore, was considered mandatory. Doors in Room 103 led north into Room 104 and south into Room 102, but they appeared to be secondary doors. No connection to Room 105 directly behind Room 103 could be found, nor could a cross wall be found that would have divided Room 105 (54 m^2) into a pair of medium-sized rooms to match Rooms 103 and 104 in front. The remaining potential suites were formed by paired rooms of equal size and shape connected longitudinally and facing the plaza. Thus, the options were unclear as to which room, if any, might be functionally related to Room 103. Besides, Rooms 102 (37 m^2) and 105 (54 m^2) were huge, containing an overwhelming volume of fill.

Two of three northernmost suites in the wing were extensively modified by Kiva 1. This left the middle suite as the most viable option in order to maximize the information derived from Room 103. Room 110, in the suite analogous to Room 103 in position and size, exhibited a probable kiva built within its walls. The room was blocked on the plaza side by a late double-walled structure (Circular Structure 2).

Other factors also influenced the decision to move to a new potential suite in the West Wing. A number of roofing timbers had been uncovered in adjacent rooms or nearby during wall clearing. In addition, the uppermost wall plaster in Room 110 was smoke-blackened with spots of burning. The possibility of getting datable roofing timbers and a room that had burned were attractive inducements for the selection of this suite (although these turned out to be false hopes). We were taking a risk, of course, in selecting a suite to determine initial use when it had clearly been altered by a kiva and other late modifications. Upon excavation, however, the early room floors were found to have been undisturbed by the kiva.

Room Selection, Third and Final Season (1978)

By the third field season, room selection was essentially predetermined by the work done the first two seasons and guided by the goals for selection listed above. The goals of the previous summer had been blunted somewhat by the cave-in disasters in the Trash Mound (see Volume II), which siphoned off personnel from other projects. New work, however, was constrained by the need to finish everything by September and to backfill all our remaining work.

Central Roomblock Sample. Much work remained to be done before the suite under investigation could be completed. Work in huge Room 142 and the area partitioned from it (Room 146) had barely stopped in 1977, at the most recent occupational surfaces and finishing them was paramount. In addition, we needed to examine the back storage rooms (Rooms 138 and 144), the corridor room (Room 143) between Rooms 142 and 146, the plaza, the adjacent plaza area, and, finally, the adjacent court kiva (Kiva 10) to complete the suite. Room 147 also seemed promising because of its door connection to the corridor room, its position behind Kiva 10, and its conspicuously central location in the Central Roomblock.

The redundancy in position, size, shape, and access of Rooms 138 and 144 posed an alternate choice to digging both. Only Room 138 was dug, while allowing efforts to concentrate on Room 147 instead of Room 144. Nevertheless, there was too much work and several units were not completed. Room 147 was completed only to the last-used floor. Room 143 went deeper, but not to sterile deposits. The adjacent plaza grids were trenched and, then, the upper surfaces stripped mainly in Grids 8 and 9. Finally, an exploratory test was placed halfway across Kiva 10.

West Wing Sample. We had barely started the designated suite in the West Wing in 1977 and still needed to finish Room 110. Furthermore, because Rooms 112 and 229 needed excavation, completion of the sample was no small task. By the end of 1977, however, all rooms were completed, but we did not examine the adjacent plaza except by trenching.

Miscellaneous

In addition to the commitment of the room suite sample, we wished to examine adjacent plaza areas and kivas that were spatially associated with the room sample. In addition, testing of the Trash Mound, other plaza areas, including those adjacent to roads, and other community houses was considered necessary to address other project goals.

Trash Mound. Foremost among other excavation concerns at Pueblo Alto was the huge midden to the southeast. The initial remote-sensing estimate of a 3,400 m^3 volume made any reliable mathematical sampling strategy a ludicrous proposal, considering the time and logistic constraints. Instead, we originally planned for three exploratory cuts through the mound, two cross-wise and one longitudinal. The first crosscut yielded nearly sterile deposits so that work concentrated on the the second (Test

Trench 1). The second cut turned into such a major undertaking that others were not considered seriously. Work began in 1977 with the completion of a trench across the mound and then the removal, by natural units, of one and a half "telephone" booths of a projected six. In 1978, the remaining booths were completed (see Volume II).

Kiva Sample (Table 3.3). Kivas were planned for excavation when directly associated with a room suite. A single kiva met this criterion; the court kiva (Kiva 10) in front of the Central Roomblock suite being excavated. As it was, Park intervention during the initial testing of this kiva (the trench was too deep and considered unsafe) terminated excavation. If the structure had not been filled with trash, we could have safely removed the fill through mechanical means, but we were not willing in this case to sacrifice stratigraphic information to examine the kiva floor and features. Two other kivas were dug incidental to their location in rooms selected for excavation: Kiva 15 in Room 110, part of the West Wing suite sample, and a small kiva in an East Ruin room tested for its association with prehistoric roads.

There are a number of different kiva types that need to be defined before further discussion. Lekson (1984:50-61) has aptly covered the kind of kivas found in greathouses, and his different categories are used here except for terminology. Lekson describes three categories of kivas that can be separated primarily by size and internal features. At Pueblo Alto, we are primarily concerned with the semisubterranean, large court kivas and the small "clan" kivas. In greathouses the former range between 5 and 10 m in diameter (mean = 7.2 m, n = 37) and are part of a constellation of architectural greathouse structures built in the courtyards or plazas. In the late A.D. 1000s and early A.D. 1100s, some of them were placed over existing structures in the roomblocks. Although they contain the same array of features found in small kivas, they also include floor vaults, which are typical of great kivas. Their size suggests use by a large group of people, perhaps by a supra-ceremonial group. In contrast, small "clan" kivas are less than 5 m in diameter (mean = 4.3 m, n = 18) and do not appear in greathouses until the A.D. 1100s when there were major changes in the socioeconomic organization. Often these clan kivas are associated with small house units within the greathouses that resemble contemporary small site organization. In addition, some small semisubterranean, oval or rectangular rooms that contain features common to the small kivas (e.g., ventilator, firepit, and bench) and often built in the early A.D. 1100s are referred to as clan rooms for this report, although they may be typical of one type of early A.D. 1100s living rooms.

Plaza Sample. A number of goals were sought from plaza examinations, but the immensity of the plaza or court areas defied extensive systematic sampling. In Plaza 1 (the central court area covering 3.9 hectares of open space at abandonment), our foremost concern initially was to discover major features, particularly rooms and court kivas. From previous work at small sites and greathouses we knew that features concentrated close to room walls; therefore, linear trenching was employed parallel to the roomblocks during the 1976 discovery phase.

Table 3.3. Sizes of kivas and miscellaneous architectural units.[a]

Kiva No.	Size (cm)	(m^2)	Estimated period of use
1	790 x 757	47.0	late A.D. 1000s-early A.D. 1100s
2	1000 dia±	78.5±	A.D. 1020/1040-late A.D. 1000s
2 remodel?	860 dia	58.1	late A.D. 1000s-early A.D. 1100s
3	1110 x 1000	96.8	A.D. 1020/1040-early A.D. 1100s
4	580 x 560	25.5	late A.D. 1000s-early A.D. 1100s
5	830 x 810	52.8	late A.D. 1000s-early A.D. 1100s
6	487 dia	18.6	A.D. 1000s-early A.D. 1100s
7	1000?x 950?	74.6	A.D. 1020/1040-late A.D. 1000s
7 remodel	950 x 870	64.9	late A.D. 1000s-early A.D. 1100s
8	950 dia	70.9	A.D. 1020/1040-early A.D. 1100s
9	500 dia±	19.6+	early A.D. 1100s
10	1000±x 980	77.0±	A.D. 1020/1040-late A.D. 1000s
10 remodel	850 dia	56.7	late A.D. 1000s
11	330 dia	8.6	early A.D. 1100s
12	400 x 365	11.5	early A.D. 1100s
13	930 dia?	67.9±	mid A.D. 1000s
14	470 x 445	16.4	early A.D. 1100s
15	425 x 353	16.3	late A.D. 1000s & early A.D. 1100s
16	400 dia±	12.6±	early A.D. 1100s
17	400 dia±	12.6±	late A.D. 1000s-early A.D. 1100s
PF4	510 x 500	20.0	late A.D. 1000s-early A.D. 1100s
remodel	420 dia	13.9	early A.D. 1100s
Rm 6 kiva[b]	330 x 333	10.1	early A.D. 1100s
Kiva 1[c]	830 dia?	54.1±	mid A.D. 1000s-early A.D. 1100s
Room 223	400 x 300?	9.2±	early A.D. 1100s

Other Structure	Size (cm)	Area (m^2)	Comments
CS 1 inner	605 x 510	24.7	bi-wall structure
CS 1 outer	715 620	37.2	bi-wall structure
CS 2	240 x 160	3.3	odd tiny room
OS 1	114 x 60	0.7	a ventilator?
OS 2	65 x 38	0.2	a ventilator?
OS 3	2350 x 1080	251.5	an open space
OS 4	2235 x 47-53	15.0	plaza arc retaining walls
OS 5	315 x 310	7.7	outside dimensions of a stepped feature
OS 6	700± x 600±	22.0	an open space/kiva?
OS 7	6130 x 39-60	27.5	plaza arc retaining walls
OS 8	1000? x 470	40.2	an open space
OS 9	650± x 400±	20.0±	an open space
OS 10	1300 x 147±	21.1	plaza arc retaining walls
OS 11	2150 x 147	37.2	plaza arc retaining walls
OS 12	1800 x 869	104.6	an open space
OS 13	1250 x 70-80	none	a wall

[a] Some measurements taken from aerial photos. Kiva areas include bench and floor.

[b] Kiva built into Room 6, East Ruin.

[c] Court kiva at the East Ruin.

Four shallow test trenches, 1 m wide, crossed the 3.9 hectares of open plaza space. Three ran close to and paralleled the room blocks on the north, east, and south sides of Plaza 1. The fourth bisected the eastern half of the plaza, north-south, through an area suspected to contain a great kiva because of the high density of brush there (no great kiva was found). The desire to deep-test unusual findings during the trenching was generally stifled. Results from this testing yielded several kivas and other architectural features. For the most part, the plaza fill in the center was shallow aeolian sand with bedrock immediately underneath. The greatest depths of fill were found around the room periphery. The aeolian sand became deeper as the main architecture was approached, along with a corresponding increase in wall mortar, building stone, and use surfaces.

Testing in 1976 failed to yield the expected great kiva, so in 1977 backhoe pits were systematically dug in the large sections of the plaza not investigated, but these, too, failed to locate one. Because investigation of the plaza areas next to room excavations was considered the most important for understanding function and use of the suites, areas adjacent to the Central Roomblock and West Wing suites were examined. Another area, against the East Wing, was stripped to the uppermost use surface and tested. Although no rooms were dug in the East Wing, we did wish to examine both exits of the passage through the East Wing, which connected to the prehistoric roads in Plaza 2, to examine traffic patterns between the house and the roads, as well as the density and type of artifacts that may have entered and left the site.

As the nexus for a number of prehistoric roads, Plaza 2 was attractive for investigating regional questions related to Pueblo Alto (see H. Toll 1985). Initially, we focused on the southeastern corner of the East Wing's exterior because of wall openings connecting Plaza 2 and Plaza 3, and Plaza 2 and Plaza 1. In addition, the presence of a small structure (OS 5) built against the roomblock gave added prominence to the use of Plaza 2. This feature matched one similar in size and location at Pueblo Bonito (Judd 1964:176, Plate 81, upper).

Walls around Plaza 2 were cleared or tested. One of the mounds (Plaza Feature 2) flanking Plaza 2 on the east side was trenched in 1976 to assess its origins. Later, a few trenches were placed in the plaza to examine the prehistoric roads passing through it, although most work was concentrated at the southwestern corner of the East Wing. A systematic testing of the 4.8 hectare area was never accomplished. Although Plaza 3 was also considered for potential sampling, its 4.1-hectare area and the constraints of time and labor eliminated it from later consideration.

Road Sample. Little road-related work was planned by the Chaco Center during the Pueblo Alto excavations except for a few minor tests and some wall ("curb") clearing. The reasons for this are several. Much work has been done studying roads by the NPS Division of Remote Sensing (Ebert and Lyons 1976, 1980; Lyons and Hitchcock 1977) and others (e.g., Morenon 1975; Vivian 1972; Vivian and Buettner 1971) before our work at Alto, and there was a general feeling that more work was not necessary. More important, the work at Alto consumed all the labor available, leaving almost no staff resources to implement major road studies. After the excavations, however, it became increasingly apparent that additional work was needed on the roads to document and map the various feature components of each road segment in the vicinity of Alto.

Although the physical location of the major roads in Chaco were well known and mapped, no detailed maps existed of all individual roads and associated features, particularly those around Pueblo Alto. What maps had been done in the past were not available to us when our work started at Alto. In addition, despite much controversy over the age of the roads and what was being transported along them, no one had critically examined road artifacts, of which there was a plethora in the vicinity of Alto. Furthermore, in at least one case, a curbed road segment running by the East Ruin, discovered on survey in 1972, was missed by later Remote Sensing Division surveys. Finally, several staircases nearby had been missed by all parties concerned before 1979. The only concerted effort directed at examining the regional interaction of road traffic to Alto was in Plaza 2.

Thus, by 1979, field studies were begun around Pueblo Alto to enhance our knowledge of the roads and other features in the Alto vicinity. Three problems were addressed by the subsequent investigations. (1) Where were all the roads and associated features on the mesa top around Alto and where did those running south connect in the canyon? (2) Were materials found on the roads road-related or did they derive from widespread use of the mesa tops? (3) Could materials on the roads be used to date road use and to suggest road function? The results of these studies are summarized in Chapter 5. Most of this work was accomplished with volunteer help including the assistance of the new staff at Remote Sensing (Art Ireland, Joan Mathien, and Gretchen Obenauf).

Extramural House Site Sample. All housemounds within 2 km of Pueblo Alto were examined to establish their span of occupation, although those in proximity to Alto were also wall-cleared and mapped. Tentative plans to further investigate the houses within the complex did not materialize except for some testing at the Parking Lot Ruin and the East Ruin. We were particularly interested in nearby New Alto, as representative of the "McElmo" phase, an enigmatic site type despite the work at Kin Kletso (Vivian and Mathews 1965). Architectural studies by Lekson (1984) have helped to rectify New Alto's placement in the scheme of the Chacoan Phenomenon, but no excavation was carried out at the site except to clear the road(?) wall (Major Wall 6) running just north of the site. For the most part, houses in the vicinity of Pueblo Alto were built and occupied only in the early A.D. 1100s. Of the group, only New Alto is multistory, making suite identity impossible to decipher. The closest small-house mound (29SJ 2402), about 75 m northwest of New Alto, was superficially examined in 1985, but not wall cleared or tested.

Sampling Within Major Proveniences

The field procedural manual (Judge et al. 1976) covered the general excavation methods but much of the rationale on how to record and remove the fill was concerned with understanding the site formation processes. Initially we were concerned with the problems induced by multistory collapse of the architecture and cultural materials. Luckily, these problems did not fully materialize, and we discarded some techniques we had planned for detecting wall fall and upper floor patterns because Pueblo Alto was only single story.

Sampling and Examining the Fill

In Rooms. We were faced with two problems when digging major proveniences. (1) Do we sample the unit or dig it all? (2) How do we excavate and record the postoccupational fill? Although it is not uncommon practice in the Southwest to sample parts of rooms in large sites, on the basis of our previous Chacoan experience and the available literature we could not justify this strategy. We did not believe that a high rate of predictability about unit features and function could be achieved by excavating a piece of the room. Indeed, we had had difficulties interpreting some rooms at the small sites even with total excavation. More important, we felt that trying to decipher suite function and interrelationships within the larger site were doomed to greater speculative interpretation than if entire units were removed. The proposition is two-faced: to increase the number of sample units but know less about each one, or to decrease the number of units but examine them thoroughly. After much discussion, we chose the latter route. We also sought to rectify vertical sampling biases employed during earlier greathouse work when excavation was limited primarily to the uppermost floor and above. When possible, we resolved to go to sterile deposits before halting excavation.

A number of options were available on how to examine the room fill in order to scrutinize its characteristics and to plan its controlled removal. Quadrant sampling of the fill was tried and proved useful in small rooms where trenching would have removed a large part of the fill. In large rooms, however, two 1-m-wide test trenches were placed across the short axis of the rooms, dividing the room into thirds. Then a longitudinal subdivision of the room into equal halves allowed the fill to be removed in six equal blocks. This system was expanded across the two suites investigated so that continual profiles from the plaza to the exterior could be made. Control during excavation of the test trenches was maintained by arbitrary 20-cm levels. The materials recovered from these tests, when possible, were assigned to the proper natural unit after subsequent definition of the fill patterns. After profiling the two test trenches, excavation expanded into the adjacent units (grids) so that a longitudinal profile was also made as the work progressed. Except for the first two test trenches, all fill was removed in major natural units but subdivided into arbitrary levels if the unit was thick.

In Features. All room features encountered were excavated. The fill in features was removed in natural units when possible. Several plaza features (i.e., firepits, roasting pits, other pits, and ventilators) were outlined but not excavated. Our ability to predict the presence and position of wall features (except for ventilators and doors) under wall plastering was poorly developed, and, consequently, many of these features, particularly in Room 103, were probably missed. The difficulty in recording and removing the wall plaster rapidly to look for features, as well as the constraints of conservation, forced only limited investigation of wall modifications. For the most part, however, wall plaster in the upper half of the rooms had dissolved from natural events before exposure by the spade.

Floor Clearing. Horizontal areas of compacted fill and of prepared adobe and clay were treated as cultural units. These were cleared with trowel and brush, although we avoided major investments of time when dealing with numerous, thin replasterings stacked one upon the other. There simply was not enough time to trace every one of these. Areas with this problem were found in Rooms 103, 110, and 142, as well as the parts of Plaza 1 close to the rooms.

Collecting Soil Samples. Soil (fill) samples were collected for a number of reasons. Foremost among these was the identification of seeds (i.e., "flotation" samples) and pollen in the archeological record (see A. Cully 1985b and M. Toll 1985b) to increase our knowledge of economic plants used at the site, to assist recognition of activity loci and functional interpretations, and to provide support for stratigraphic correlations. Flotation samples also allowed calculations of material density and the identification of small mammals. Other samples were collected for archival storage to back up the pollen and flotation samples, as well as to preserve the fill matrix for future unanticipated needs. Work in the small sites had taught us to be more selective in our sampling procedures to reduce the volume of dirt that would produce poor results. Nevertheless, pollen and flotation samples were taken from every natural stratigraphic unit, from every feature, and from every floor or work surface excavated.

Floors and work areas were divided into blocks approximately 1 m^2, and samples taken from every other block (i.e., a 50 percent checkerboard sample). Samples from stratigraphic units were taken from several pinches along the profile face(s). Sterile bags designed for pollen (holding about 400 ml) were used to collect fill matrix in contact with the floor. In reality, this meant that part of the floor surface and about 5 mm of dirt above it were trowel-scraped into the bag. Matched samples for flotation were taken from the same units in which pollen was collected.

About 1 liter of fill matrix for each grid sampled was collected for flotation in new, heavy plastic bags and later washed in the field laboratory. Because of the requirements for greater volume, matrix for these included floor contact as well as 1 cm or so of dirt above the floor. Although this may seem to bias "floor" results, it is not uncommon to find a mantle of sand over prehistoric Chaco floors that apparently was deliberately deposited during occupation, perhaps to soften the floor surface and to preserve the flooring. Nevertheless, we can never be positive exactly what is being culturally sampled with the collection of pollen and flotation. Material left over from pollen and flotation analyses was curated.

Sampling the Material Culture

Cultural material was recovered by sieving almost all excavated deposits through 1/4-in. mesh. Selected finer screening (1/8-in. and 1/16-in. mesh) was employed for feature fill and in situations where small items were common. Exceptions to 1/4-in. screening are noted in the summary of each provenience description. Generally, the wall fall in most rooms was screened during excavation of the test trenches, but not during expansion from these. Cultural material was saved only when it was spotted during the wall-fall removal, and thus representativeness depended upon the eye and speed of the excavator as it does even for screening. For statistical purposes, however, total counts from units of wall fall probably are proportional to the actual totals.

Cultural material from the fill was not precisely located (piece-plotted) because of the investment of time involved and the probable minimal return of meaningful results. In retrospect, however, piece-plotting in the roof fall might have generated useful data for interpreting rooftop activities, although this strategy would have curtailed our room and other samples. Control was manifest for these items, nevertheless, by test square and the natural unit in which it was found. All items found on and in the floor were piece-plotted to their exact location. Postoccupational deposits banked against the rooms at the east and north sides of Plaza 1 were scraped clear with the backhoe and left unscreened.

Conversely, an effort, not always systematic, was made to retrieve and preserve the following materials that are often discarded by archeologists.

(1) Roofing adobe and sandstone spalls.

These two materials were constantly encountered in our work. Spalls from wall construction littered the bottom floors of rooms (up to 2,000 spalls per m^2) and filled the early stratigraphic units in the Trash Mound. Similarly, the postoccupational fill in rooms was often characterized by one or more units of fragmented roofing adobe. Initially, chunks of roofing adobe bearing the impressions of beams, shakes, and grasses were collected (haphazardly) to obtain information about roof construction. Stephen Lekson's interest in architecture prompted later attempts at systematic retrieval of these mundane bulk objects. In some rooms entire excavational units of these items were collected. In addition, all the stone from each natural unit excavated in the Trash Mound was collected and weighed. This strategy, of course, generated untold numbers of backbreaking boxes filled with adobe and stone. Preliminary analysis of this material proved illuminating (Appendix MF-H; Ingbar 1979; Lekson 1977) and justifies its recovery, although it is difficult to excite further interest in such studies, particularly among graduate students. Wall-fall stone was not saved but stacked in cairns to be measured for volume to estimate wall heights. It eventually was carted off for stabilization needs.

(2) Manuports.

Numerous pebbles of quartzite and other minerals were associated with units of roofing debris and were between some floors in the Central Roomblock. These manuports were small, water-rounded stones that probably had been derived from natural deposits utilized for roof construction or as intentional fill. Although some attempt was made to systematically collect these materials as behavioral manifestations, there were no cries of rage when this collection strategy died for lack of popular staff support.

(3) Wood.

Every piece of wood that seemed worthy of tree-ring dating was collected. Cory Breternitz, who had worked with the Tree-Ring Laboratory, made the final selections to be sent. He also was responsible for their collection, tagging, and numbering during wall clearing. Large logs uncovered during wall clearing were cut with a saw, leaving one piece in situ but with both pieces tagged. Complete or partial roofs did not materialize. Small wood pieces and scraps of wood were collected solely for species identification and for potential trace elements analysis. Shreds of juniper bark were common in the roofing deposits but were seldom collected. The omnipresent charcoal was not subject to collection in postoccupational fill. Concentrations on the floor and in features, (especially firepits and heating pits) were subject to grab samples for species identification and carbon-14 dating. When little was present, all of it was collected from burned features. All the charcoal larger than 1/4 in. from the stratigraphic column excavations in the Trash Mound was saved and weighed.

(4) Burned stone and adobe.

Occasionally burned slabs from firepits were collected because of their potential value for paleomagnetic and thermoluminescent studies, although there was no set policy for this. An attempt was made, however, to collect samples from every area of burned abobe and plaster, providing it was not too sandy. These were collected for archeomagnetic dating. Only in Room 110, where the number of heating pits overwhelmed us, did we fail to sample every burned feature. In a few cases, archeomagnetic samples were also collected from unburned foundation clays to assess their potential for dating.

Summary

Pueblo Alto's location on the mesa/plateau above Chaco Canyon afforded a view that was unsurpassed by other contemporary greathouses in the vicinity. In addition, the association of a number of prehistoric roads made Pueblo Alto an attractive choice for testing a Chacoan greathouse with clear regional ties. Although goals common to many archeological projects were desired (e.g., on subsistance, social organization, and site function), emphasis was on intersite and interregional relationships, resource procurement, and the dependency/interdependency among Pueblo Alto and other greathouses and the small house sites.

Excavation strategy and time dictated that only a small sample of the site could be excavated, so that only about 10 percent of the rooms was eventually cleared. Initial strategy focused on obtaining a site plan and the identity of individual room suites that hopefully replicated past behavioral groups. Although there was interest for investigating the function and relationships within the site of unusual and unique architectural units, emphasis was on excavating redundant units (i.e., a sample of identical door-connected suites) and their associated plaza areas. This strategy increased the predictability for explaining the function of similar units at Pueblo Alto and other greathouses, whereas unusual and unique units lack broad explanatory power. Other areas of the site and in the Pueblo Alto complex that seemed informative for answering specific research questions were also tested (e.g., the Trash Mound, the East Ruin, the plazas, and the roads).

Chapter Four

Associated Houses in the Pueblo Alto Complex

The close proximity of five contemporary house sites around Pueblo Alto (Figure 4.1) suggests close socioeconomic interaction and dependency among members of a community. Rabbit Ruin and 29SJ 2401 are the members farthest from Pueblo Alto, at 270 m and 360 m, respectively, and New Alto (at 146 m) and the East Ruin (at 143 m) are situated much closer. The Parking Lot Ruin is located only a few meters from Pueblo Alto's West Wing. It and the East Ruin were not inventoried as separate sites, and both are treated as features of Alto. These five sites and Pueblo Alto, known collectively as the Pueblo Alto Complex, were investigated to some extent by the Chaco Project (see Table 4.1). Detailed excavation notes of those that were tested (East Ruin, Parking Lot Ruin, and Pueblo Alto) are covered in Volume II.

In addition to these sites, a few small contemporary house sites (with less than eight rooms each) are scattered across the plain to the east of Pueblo Alto at distances of 450 m (29SJ 1979), 670 m (29SJ 1974), 920 m (29SJ 1973), 1150 m (29SJ 142), etc. These are found in an area criss-crossed by prehistoric roads, some of which connect to Pueblo Alto, but their relationship to the Pueblo Alto Complex, if any, is unclear. All appear to have been built in the early A.D. 1100s except for a cluster of houses at 29SJ 1586 dating in the A.D. 900s and early 1000s and located 3.3 km due east of Pueblo Alto. Houses occupied in the A.D. 1000s and 1100s on the plain bordering Chaco Canyon to the west of Pueblo Alto (to the Escavada Wash) do not exist. With the exception of 29SJ 1586, earlier houses appear to be absent along the crest of the plain east and west of Alto.

Overall house density in topographic settings similar to Pueblo Alto's was very low in contrast to canyon bottom occupation, and, thus, the largest houses in the general vicinity (East Ruin, New Alto, Pueblo Alto, and Rabbit Ruin) are considered part of the Pueblo Alto community. In addition, the large houses all reveal physical ties (i.e., of roads and walls) with one another (the discussion of roads follows this chapter). Some might argue that Pueblo Alto is part of yet a larger community

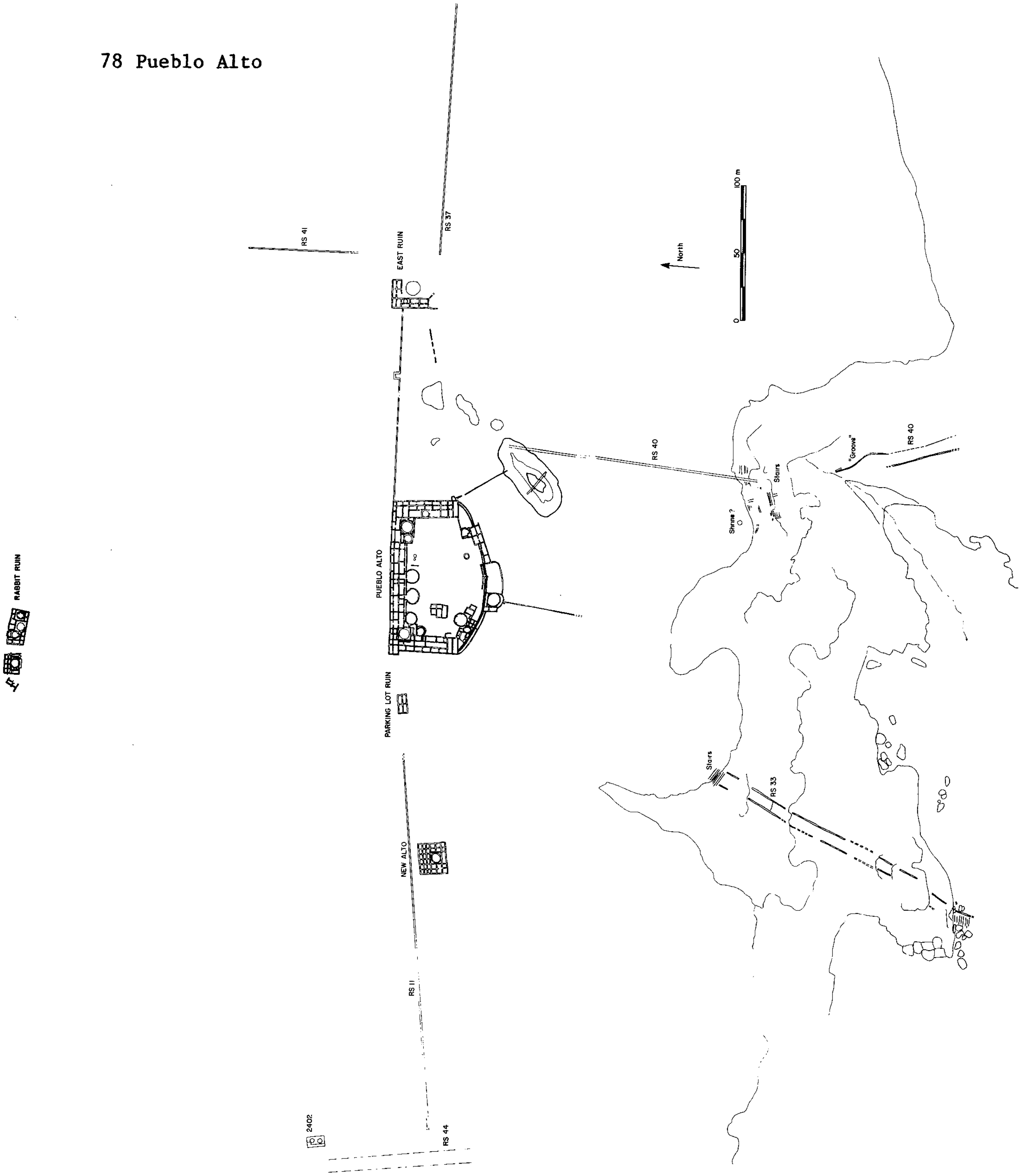


Figure 4.1. The Pueblo Alto community.

Table 4.1. Information on the six sites comprising the Pueblo Alto Complex.

Site	Approximate Occupation Span (A.D.)	Approximate Number of: A.D. 1000s		A.D. 1100s		Masonry Style(s)[a]	Associated Road Segments	Chaco Project Work
		Rooms	Kivas	Rooms	Kivas			
Pueblo Alto	1020/1040–1140/1150	95	10+?	21+	8+	Types II, III, IV, McElmo	RS 33, RS 37, RS 40, RS 42	wall cleared, tested, 14 rooms excavated
East Ruin	1050–1140	12	1	unk.	1+	Types III & IV	RS 37, RS 38?, RS 41	wall cleared, excavated 1 kiva
Parking Lot Ruin	1040–1080	4	0	0	0	unknown	RS 11, RS 33	wall cleared, 4 rooms tested
New Alto	1100–1140	0	0	58[b]	1	McElmo	RS 11	mapped
Rabbit Ruin	1100–1140	0	0	41+	5	Types II & III, McElmo	RS 33, RS 42	wall cleared
29SJ 2401	1100–1140	0?	0?	6±	2?	unknown	RS 44	mapped

[a]See Judd 1954, 1964; Lekson 1984.
[b]Includes 26 second-story rooms.

comprising Pueblo Bonito, Chetro Ketl, Talus Unit, and Pueblo del Arroyo (see Lekson 1984:267), and the road ties to these from Pueblo Alto support this notion. Nevertheless, the close spacing of a number of contemporary large houses in a setting generally devoid of house occupation (on the plain above the canyon) argues for the reality of a cultural community influenced or controlled by its largest member, Pueblo Alto. Perhaps the term subcommunity might be more appropriate here to distinguish the Pueblo Alto complex from a larger canyon greathouse-small site community in which Pueblo Alto may be a part.

East Ruin

Just 143 m east of Pueblo Alto is an L-shaped house with a large kiva and 12 rectangular, cored masonry rooms (Figure 4.2), one of which was excavated (see Volume II). This house, dubbed the East Ruin by project personnel, is connected to the northeast corner of Pueblo Alto by a long, meter-wide, cored masonry wall (Major Wall 1) that butts the house masonry but is tied to the East Ruin. Wall clearing revealed narrow room walls (about 35-45 cm wide) with cores of rubble and mortar faced with spalls and medium size tabular stones, similar to Judd's Type 2 style. Wall width suggests rooms were a single story high. Little rubble was encountered during the clearing, and subsequent excavation of one of the rooms revealed that the upper walls must have been salvaged prehistorically for stone. The remaining stone is very friable, and the meter-high walls are in poor condition. The recipient of the robbed stone is not readily apparent, although the stone is similar to some construction observed in the adjacent road walls and in Pueblo Alto.

Rooms are paired front to back with 80-cm-wide doorways located mid-way in the walls common to both (see Chapter 5). Interior rooms (i.e., those adjacent to the court kiva) are slightly wider (3.2-3.3 by 6.2-6.4 m) than their exterior counterparts (2.5-2.7 by 6.3-6.4 m), and the entire arrangement is symmetrical. Oddly, although door connections are evident between 5 of the 6 room pairs (the sixth door is inferred), none were found leading to the house exterior except, possibly, for Room 11. Excavations in Room 6 verified the door between Room 6 and Room 7 but failed to yield an exterior door, although the tiny kiva built into the room was not dismembered to search for it. A test outside Room 5 revealed only three courses of masonry left in the room's east wall. All the room walls adjacent to the court kiva had collapsed to a lower level than the others, probably eliminating elevated exterior doors. This seems a more reasonable explanation for their absence than to suggest roof entry into the house.

A 10-m-diameter depression was thought to mark the presence of a great kiva between the wings of the roomblock. Instead, a large court kiva, approximately 8.3 m in diameter, was verified by trenching that reached the kiva masonry benchtop 2.5 m below the surface. The small part exposed in the testing revealed a structure excavated into bedrock, although the masonry wall veneer had toppled from its sides. The kiva

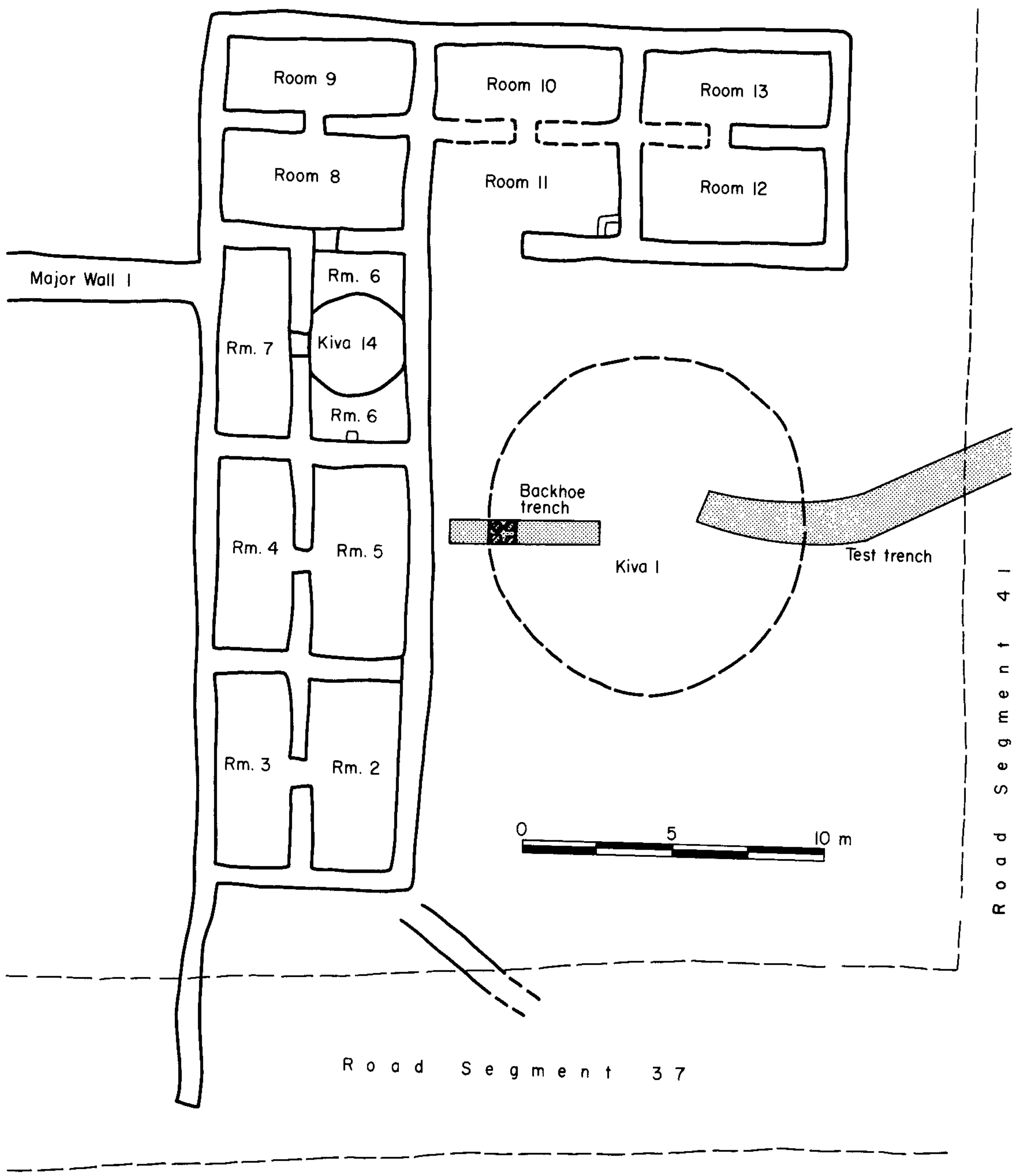


Figure 4.2. East Ruin, located to the east of Pueblo Alto.

fill consisted of clean aeolian sand with very sparse cultural material. In 1977, a magnetometer survey across the kiva, backfilled trench, and Room 5 failed to distinguish the trench and kiva (Appendix MF-F).

No absolute dates were obtained for the construction of the East Ruin. Masonry style and room layout link the site to eleventh century construction, while ceramics suggest construction took place in the mid-A.D. 1000s with occupation extending into the early A.D. 1100s. At least two small kivas were built in the rooms (Rooms 6 and 11) in the early A.D. 1100s. Excavations in Room 6 suggest that the East Ruin may have been abandoned and partly dismantled before the last occupation took place. Despite the twelfth-century occupation, there was no obvious sign of trash deposits in the house. A traditional distinct midden to the east or south of the rooms also was absent, suggesting short use of the site or atypical occupation.

The East Ruin sat next to two prehistoric roads (see Chapter 5). One (Road Segment 41) ran north-south directly east of the site while the other (Road Segment 37) was directly to the south and ran east-west into Plaza 2 and terminated at an exterior door in the Pueblo Alto East Wing. At the junction of the two road curbs (MW 7 and MW 8, see Volume II), southeast of the ruin, is a small midden (9 by 12 m) that must have been deposited by the East Ruin inhabitants. Its ceramics, dominated by Gallup and Red Mesa Black-on-whites, mark deposition in the mid-to-late A.D. 1000s, but not later. Two poorly defined walls of a single course of masonry extended off the southern corners of the East Ruin into Road Segment 37 and may have been road related. Parts of a wall (Major Wall 4) bordering the north side of Road Segment 37 ran from Plaza 2 toward the East Ruin but disappeared before actually reaching it.

New Alto
(29SJ 388)

New Alto, (Figure 4.3) has changed little from when it was first seen in 1877 by William Jackson (1878) and other early visitors (Plates 4.1 and 4.2), many of whom carved their names on the west wall of Room 5 (Table 4.2). The names of McCoy and Prince may also be early because they are deeply incised like the others of the period and patinated the same color.

Table 4.2. The earliest names recorded at New Alto, Room 5, west wall.

A.G. Grommet	Sept. 2, 1899	M. Cloud	Mar. 28, 1912
E.G. Howe	4/4/07	E.C. Johnson	Feb. 7, 1912
J. McCoy	? ?	F. McDonald	Feb. 7, 1912
J.C. Prince	? ?	J.D.	Feb. 23, 1912
		Etefo__?	1912

New Alto is a two-story greathouse of "McElmo" style masonry (i.e., of soft, dimpled blocks) and 58 rooms, 146 m west of Pueblo Alto. Com-

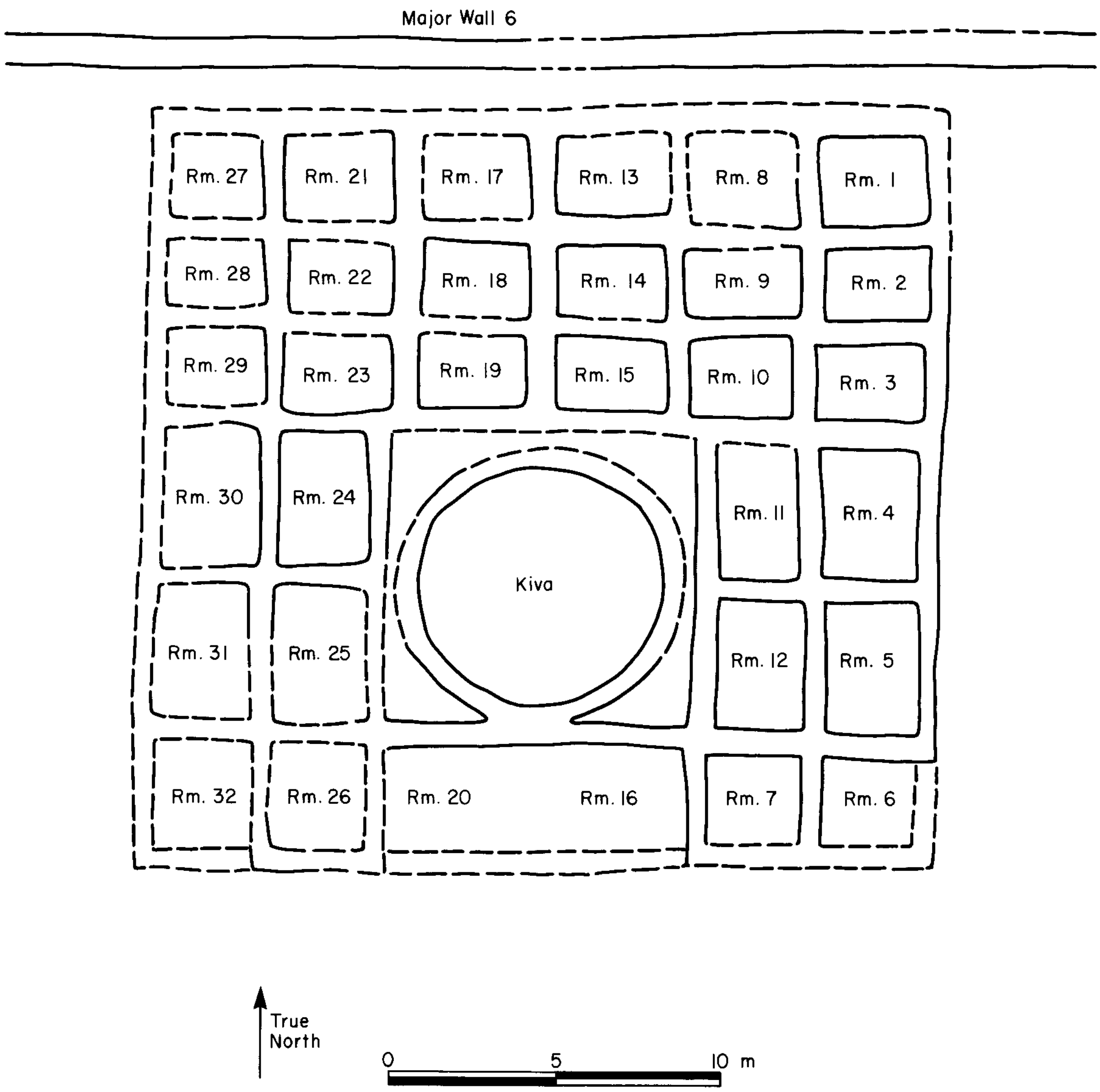


Figure 4.3. New Alto (29SJ 388), located to the west of Pueblo Alto.

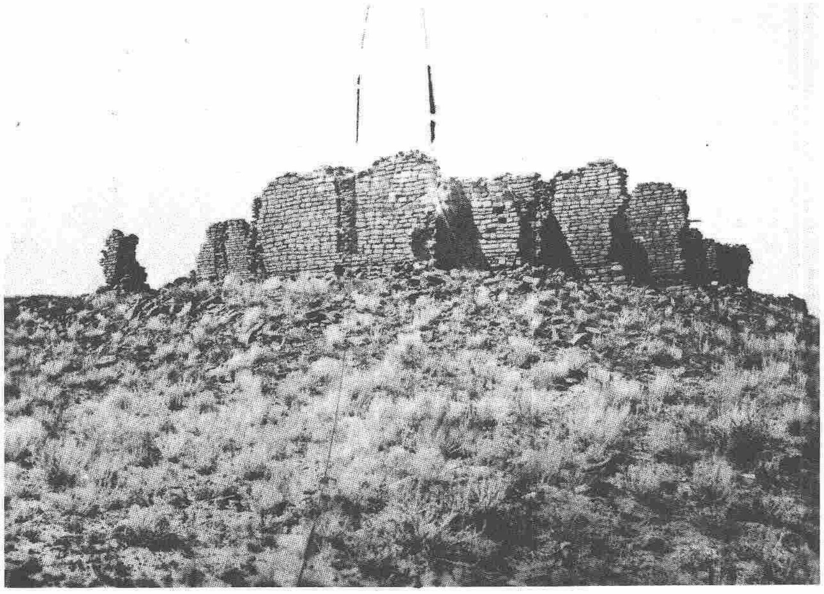


Plate 4.1. New Alto, looking southwest. Photographed by Victor or Cosmos Mindeleff in 1887-1888. (Courtesy of the Anthropological Archives, Smithsonian Institution)(NPS#31690.)

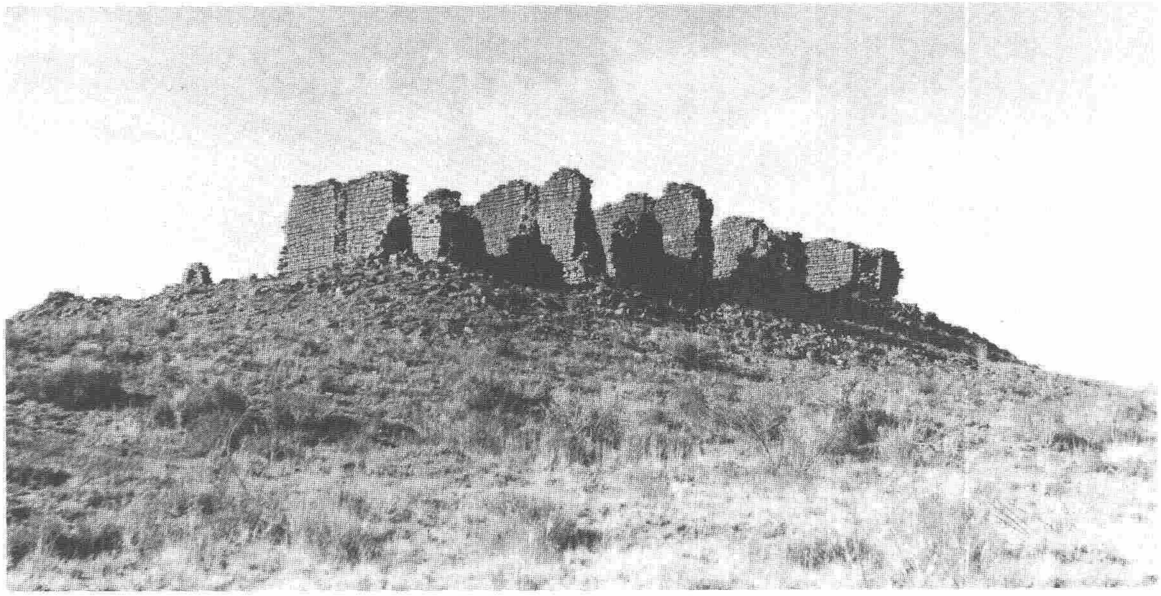


Plate 4.2. New Alto, looking southwest. Photographed by Neil Judd in the 1920's. Note the deterioration of the walls since the 1880s (see Plate 4.1.). (© National Geographic Society.)

parisons of photos taken by Pepper in 1896, Judd in 1920, and recently (Ebert 1984:Figure 5.15; Lekson 1984:Figures 4.101-4.103) reveal little structural deterioration. The ground floor rooms have all filled with sand and debris even though many of the second story walls remain standing, but we did no digging in the ruin. Despite its condition, no datable timbers have been recovered, and, presumably, visible ones were taken for construction and firewood long ago. New Alto's close similarity in plan and masonry style to Kin Kletso and Casa Chiquita suggests coeval construction and use in the period A.D. 1100 to 1130 (Lekson 1984:251) when blocks of small rooms surrounding a central large kiva were in vogue.

Lekson (1984:251-256) has provided a good description of New Alto. Room sizes are very uniform at the site, averaging about 7.1 m^2 (sd = 1.1) for first-story rooms and slightly larger for those above. First- and second-story doorways run from front to back away from (i.e., perpendicular to) the central courtyard/kiva area, as at Pueblo Alto. First-story rooms north of the courtyard and kiva may also run perpendicular to these, with a door in each room wall. The walls of a large court kiva, 7.75 m in exterior diameter, are evident within the houseblock. Its roof was once level with the second-story floors and probably served as a small courtyard.

A long masonry wall (Major Wall 6), badly deteriorated, runs east behind New Alto towards Pueblo Alto and west out into the sand dunes where it disappears. At about 80 m due north of where the wall disappears at its west end is the small ruin of 29SJ 2401 (or about 210 m west-northwest of New Alto). The wall appeared attached to New Alto, but clearing revealed it passed a meter or two just north of the roomblock. It probably was associated with a prehistoric road that ran parallel to the wall.

Rabbit Ruin
(29SJ 390)

Located approximately 270 m north of Pueblo Alto were two large mounds without standing walls. These apparently had not received close attention until the walls were defined in 1976, revealing two contemporary house blocks with another underneath (Figure 4.4). The cleared walls were capped with soil cement by stabilization crews but no further work was done at the site. The site was purported to have received its name because Alden Hayes avoided questions about it by pointing in the opposite direction and asking, "Did you see that rabbit?"

Walls exhibited narrow cores and dimpled, rectangular, block masonry veneers. Soft, dimpled blocks of sandstone, ground smooth on the exposed face and often referred to as "McElmo" style, characterized the construction. Walls with the veneer and core completely tied or butted appeared more frequently than at Pueblo Alto, although many still exhibited butted veneers and a tied core. No ventilators or viga holes were observed during wall clearing. The few doors recorded do not assist in delimiting room suites or patterns of access within the roomblocks.

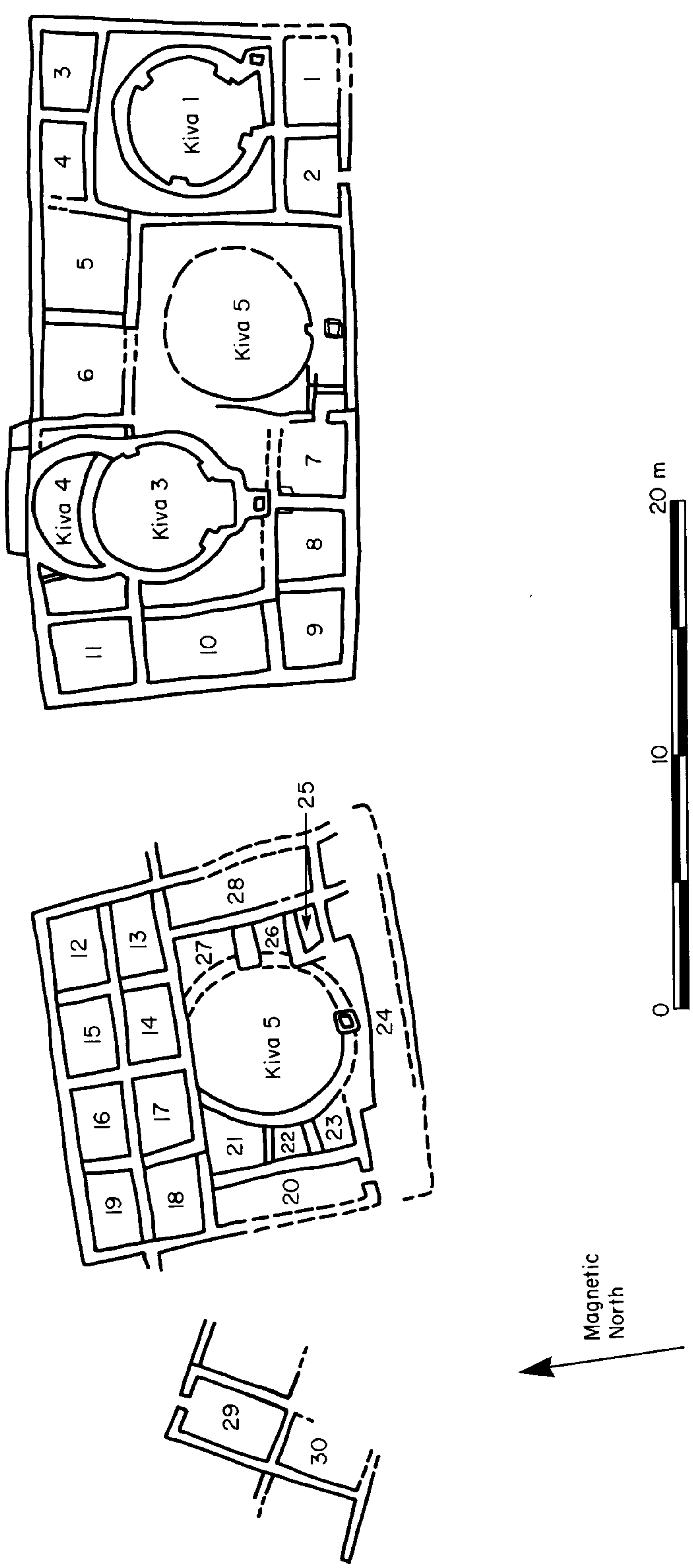


Figure 4.4. Rabbit Ruin (29SJ 390), located north of Pueblo Alto.

The large eastern mound consists of about 13 or more rooms and 3 small kivas. Originally it and the western roomblock may have resembled New Alto with its kiva surrounded by small rooms. Rooms vary in size (Table 4.3) but must be considered small when compared to those at Pueblo Alto. Two sizes were evident: eight were small (mean = 6.7 m^2, sd = 1.1), and three were nearly twice the size of the small ones (mean = 12.3 m^2, sd = 0.6), although two more large ones may have been destroyed by the building of Kiva 4. The several-meter height of the mound suggests a much intact two-story dwelling or high single-story rooms and kivas. Clearing Kivas 1 and 2 revealed four intact pilasters covered with several coats of plaster under the present surface. Kiva 3 was superimposed over an earlier kiva (Kiva 4) that was buttressed by a strip of masonry built against the north wall. Several pieces of wood incorporated into the buttress were sampled, yielding a single tree-ring date:

Tree-Ring Lab No.	Species	Date
CNM 353	ponderosa pine	1056p - 1088v

This date indicates that the wood was cut in or shortly after A.D. 1088, perhaps when the building was constructed. The amount of scavenging evident in Chaco, however, suggests that we can reliably state only that construction of the buttress and Kiva 3 occurred after A.D. 1088. Wall abutments reveal that the house was built during a single construction episode with later remodeling for kiva relocation.

The low western mound revealed a second house (probably one story) with about 14 rooms surrounding a single kiva. Renovation may have removed several rooms for the kiva emplacement. Spaces that were designated rooms immediately adjacent to the kiva were probably dead space created by buttress walls. A block of eight rooms at the north end of the kiva reveals little variation in size (mean = 5.6 m^2, sd = 0.3) while two larger rooms (mean = 9.2 m^2) flank the kiva (Table 4.3). Some renovation has clearly taken place, but the overall block of rooms appears to have been built in a single episode. The wall remains of a third house were discovered just to the west of the second house and may extend under it. This was probably the earliest of the three houses. In addition, there was a light scatter of trash, mostly ceramics, a few meters south of the three roomblocks but no midden. The few (33) bones recovered (Akins 1985a) were dominated, appropriately enough, by cottontail rabbits (61 percent). Room 11 yielded 3 historic sheep or goat bones, one of which revealed butchering marks and two that were completely burned. Turkey remains (3 bones, 3 MNI) were also present. Overall, there is a paucity of cultural material at the site.

The style of masonry veneer and the few ceramics recovered from wall clearing (Table 4.4) suggest that all the house units were built in the early A.D. 1100s. Furthermore, the layout of small rooms surrounding kivas is typical of "McElmo" construction (Lekson 1984) and the site, particularly the intact western roomblock, resembles nearby New Alto.

Table 4.3. Sizes and areas of Rabbit Ruin (29SJ 390) rooms and kivas.

EAST HOUSEBLOCK

Room	Length (cm)	Width (cm)	Area (m^2)
1	330	220	6.6
2	290	210	6.1
3	310	200	6.2
4	290	170	4.9
5	380	340	12.9
6	360	330	11.9
7	290	270	7.8
8	270	265	7.2
9	280	240	6.7
10	480	250	12.0
11	320	260	8.3

Small rooms: n = 8, x = 6.7 m^2, sd = 1.1

Large rooms: n = 3, x = 12.3 m^2, sd = 0.6

WEST HOUSEBLOCK

Room	Length (cm)	Width (cm)	Area (m^2)
12	290	200	5.8
13	300	180	5.4
14	280	190	5.3
15	285	200	5.7
16	285	200	5.7
17	280	210	5.9
18	290	210	6.1
19	290	180	5.2
20	600	150	9.0
28	590	160	9.4

Small rooms: n = 8, x = 5.6 m^2, sd = 0.3

Large rooms: n = 2, x = 9.2 m^2, sd = 0.3

Rooms 21-27 are kiva interstitial spaces or are of unknown size.

KIVAS

Kiva	Approximate diameter (m)	Area (m^2)
1	5.1	20.4
2	5.6	24.6
3	5.0	19.6
4	4.4	15.2
5	5.0	19.6

Table 4.4. Ceramics recovered from the wall clearing of Rabbit Ruin (29SJ 390).[a]

	plain gray	narrow neckbanded	unclass. indent. corr.	PII-III indent. corr. rim	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	unclass. mineral	plain whiteware	Chuska B/w	Toadlena B/w	unclass. Chuskan carbon	Kana'a B/w	Black Mesa B/w	Black Mesa/Sosí B/w	Mancos B/w	McElmo B/w	Forestdale Smudged	unclass. White Mountain redware	Tsegi orange ware	Tusayan Polychrome	Total	%
Room 2			2		1	1			1														5	
Room 3			3			2	1	1		2													9	
Room 4			2							1													3	
Room 5			3		1	1	1		2	1	1				1								11	
Room 7			2			2				1													5	
Room 8			2		1	1			1	3	1												9	
Room 10			1			1	1			1	2		1										6	
Room 11	1					5		2	2	15	1	1									2	1	30	
Room 18			1			1		1													4		7	
Room 19			1		1	2															1		5	
Room 20					2					1													5	
Room 21			2			1	1		2	1													3	
Room 22					2	2							1			1							7	
Room 24			3			1		1		2													6	
Room 27			18		7	4		1	7	6								1					7	
Room 29		1	6	1	2	2				2													44	
Kiva 1			9			1			3	5				1		1							20	
Kiva 2			4			4	1		5	9							2						25	
Kiva 3		1	22		4	10		3	16	29			2				1		1	1			90	
Kiva 4			4		2	4		1		2													13	
Kiva 5			3			1	1		2	1	1												9	
Total	1	2	88	1	23	46	6	10	41	82	6	1	4	1	1	2	3	1	1	1	7	1	329	
%	T	1	2	T	7	14	2	3	12	25	2	T	1	T	T	1	1	T	T	T	2	T		98
Ware %	28% culinary				38% Cibola					25% unknown	3% Chuska			1% Tusayan			1% Mesa Verde		T smudged	3% Wh Mt. Tsegi redwares				99

[a]T = trace (less than 0.5%).

Road Segment 43, leaving the north gate in Pueblo Alto's Plaza 2, passes by the Rabbit Ruin on its route to Cly's Canyon. On aerial photos, the road appears to dogleg directly in front (south) of the site as if to avoid it, leading me to suspect that a short road spur leads into the site. The proximity of the houses to Road Segment 43 suggests house function may have been associated with road activities, perhaps for traffic control, road maintenance, or in the movement of commodities (e.g., water).

Parking Lot Ruin

On the west side of Pueblo Alto is a small parking lot now used only for park ranger patrols. The lot had been constructed in the 1930s (Robert Lister, personal communication 1979). During initial work at Alto in 1976 a scatter of spalls, hammerstone/abraders, and ephemeral stone alignments attracted our attention to the parking lot. This area had been intermittently graded and much bedrock was exposed, so we were surprised to discover a small, four-room building (Figure 4.5). Unfortunately, little was left of the house except the foundation stones, but its presence and location suggest an association with prehistoric roads (see Chapter 5). Upon completion of testing (see Volume II), the ruin was covered with backdirt although it is still occasionally affected by motorized traffic.

29SJ 2401

The smallest house in the vicinity of Pueblo Alto is a mound about 210 m west-northwest of New Alto (and 360 m from Pueblo Alto) that contains about six rooms or less and possibly one or two small kivas enclosed with a retaining wall to the east (Figure 4.6). There is no definable trash mound although lithics and sherds are concentrated to the east of the rooms and kivas. An exotic chert (Brushy Basin, material type 1040) was particularly abundant in the lithic sample tallied from the midden transect area (21 percent of 86 pieces). Ceramics denote an early A.D. 1100s occupation of the site (Table 4.5). In size and layout, this small house appears similar to the multitudes of other contemporary small houses that are found in high densities in the canyon below (in the vicinity of Pueblo Bonito), along the Escavada Wash northeast of Pueblo Alto, and in other communities not far from the canyon (Bis sa'ani and Padilla Wash areas). Most of the small houses along the plain east of Alto are coeval in age with 29SJ 2401. Two aspects of the site seem to set it apart from other small houses. First, it is different from other sites in the close vicinity because of its few, small, single-story rooms. The next closest site similar to it is 450 m northeast of Pueblo Alto.

Second, the site appears unusual for its location within the Pueblo Alto community. A prehistoric road runs by the back of the house a mere 10 m away. The road is aligned true north-south, and the site's back wall appears to parallel it. The road alignment leads directly north to where

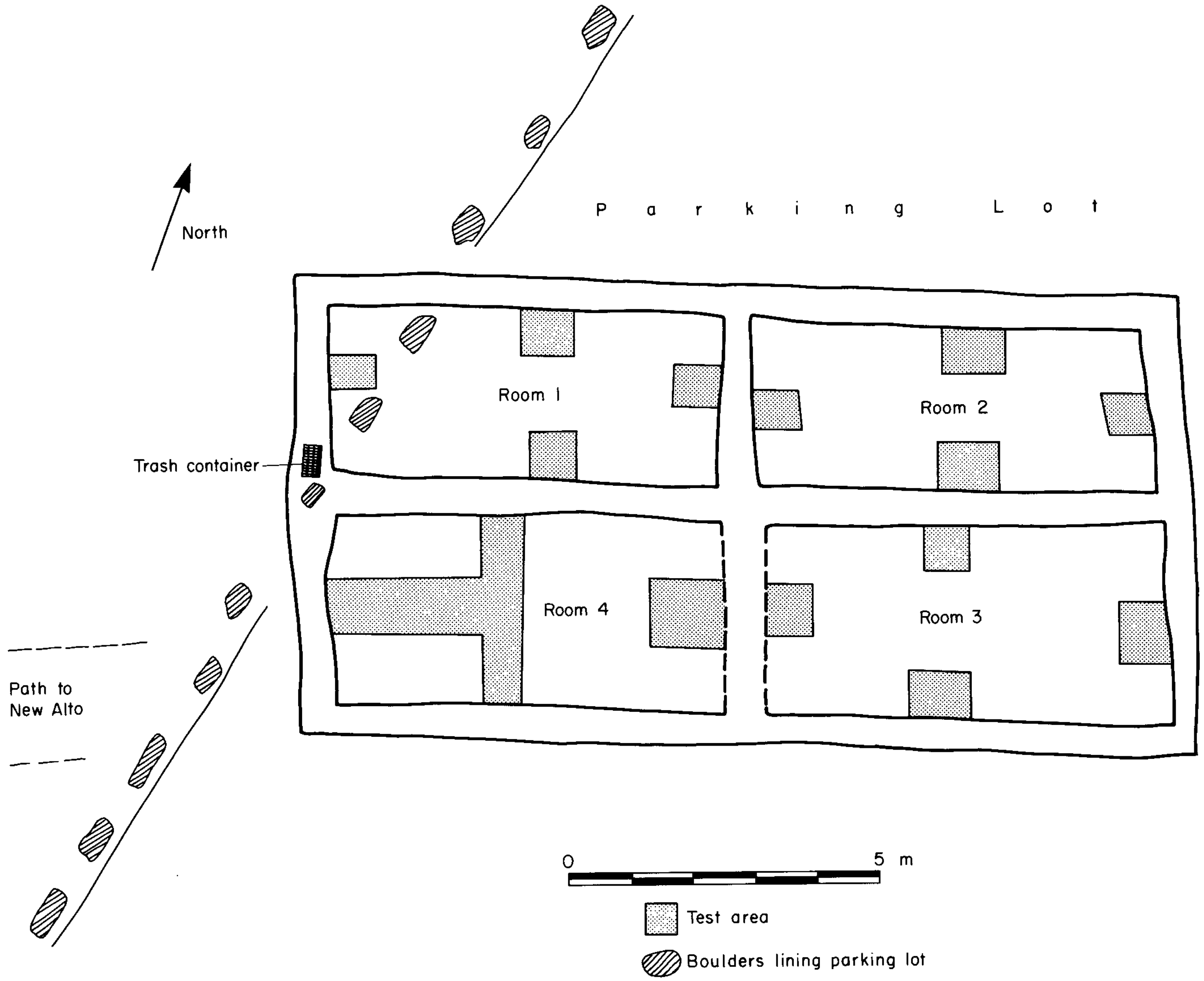


Figure 4.5. Parking Lot Ruin, located a few meters west of Pueblo Alto.

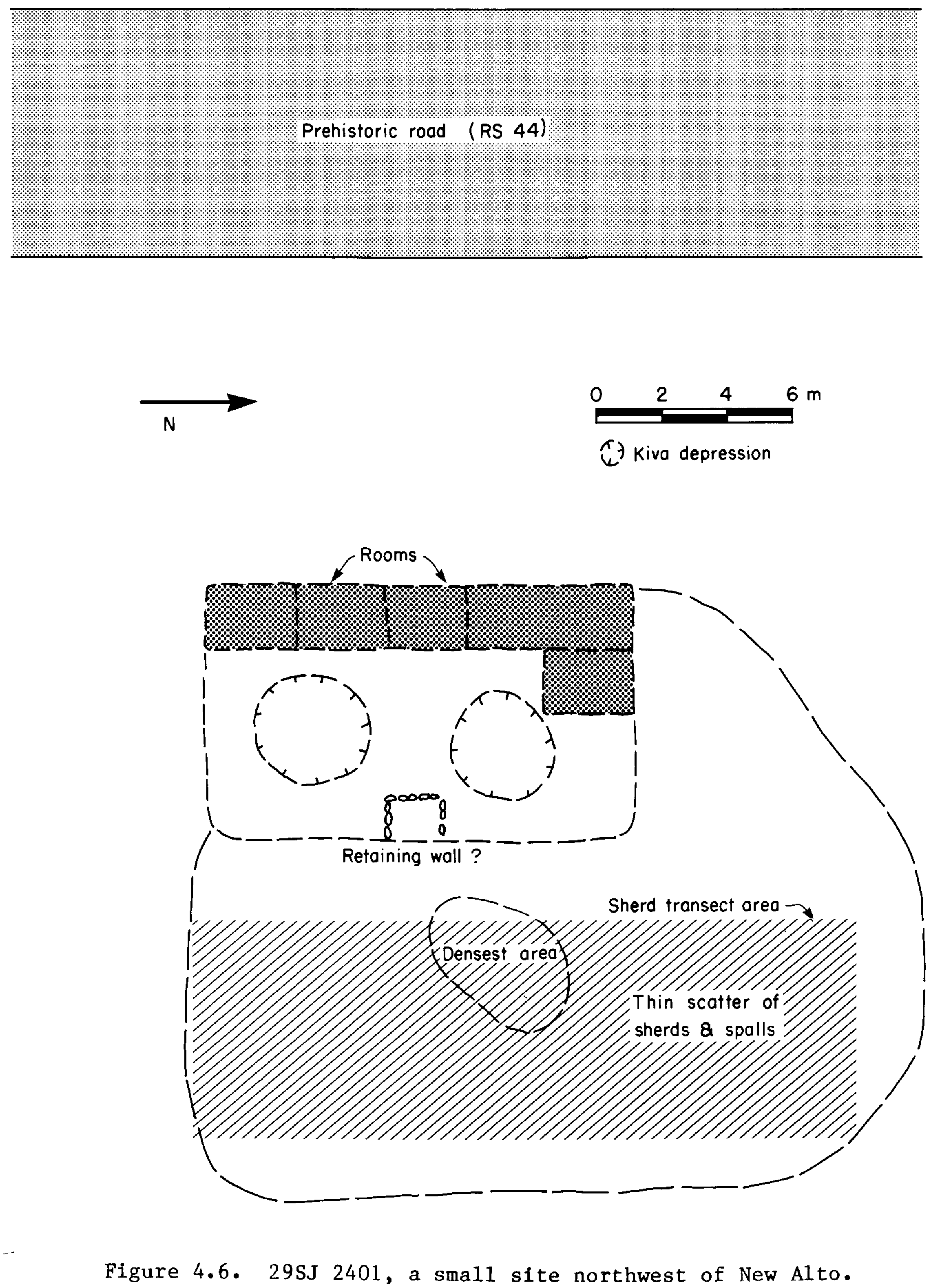


Figure 4.6. 29SJ 2401, a small site northwest of New Alto.

Table 4.5. Ceramics tallied from the transect area over the east midden area of 29SJ 2401 (see Figure 4.6).[a,b]

	plain gray	narrow neckbanded	unclass. indented corr.	PII indent. corr. rim	PII-III indent. corr. rim	PIII indent. corr. rim	unclass. rim fillet	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	Socorro B/w	unclass. Cibola mineral	plain whiteware	Chuska B/w	Toadlena B/w	unclass. Chuska carbon	Black Mesa B/w	Black Mesa/Sosi B/w	Holbrook B/w	Mancos B/w	McElmo B/w	Forestdale Smudged	unclass. White Mt. redware	Tsegi orangeware	Total	%
Total	2	6	234	3	8	2	11	4	2	28	39	4	22	1	36	78	1	4	8	2	3	1	4	1	6	2	1	513	
%	T	1	46	1	2		2	1	T	5	8	1	4	T	7	15	T	1	2	1	1	T	1	T	1	1	T T		99
Form:																													
bowl								2	2	18	20	2	12	1	15	25	1	4	4	2	3	1	4	1	6	2			
jar	2	6	234	3	8	2	11	2		10	17	2	10		21	53			4								1		
ladle											2																		
Temper:																													
sand	1	3	104	1	2		7																						
trachyte	1	2	63	1	4	1	3																						
sherd		1	60	1	2	1	1																						
rock			7																										
Ware %	52% culinary							27% Cibola								15% unk.	3% Chuska			1% Tusayan			1% Mesa Verde		1% smudged	1% Wh.Mt. Tsegi redwares			101
Chuskan %	28%																												

[a]Ceramics on the housemound were not sampled because of low frequencies.
[b]T = trace (less than 0.5%).

a number of seeps are located in Cly's Canyon and Road Segment 43 begins its descent into the same canyon (see Chapter 5). To the south the road leads the traveler easily down the first cliffs just south of New Alto and directly to the Pueblo Bonito Staircase (29SJ 1946) first noted by Jackson (1878:448). A sprinkle of sherds can be followed as one descends the route, although no modification of the cliffs closest to New Alto could be discerned along it. This route perpendicularly crosses the route bordered by the east-west wall (Major Wall 6) running by New Alto. Major Wall 6 disappears just before RS 44 crosses the top of the high part of the mesa/plain. The proximity of 29SJ 2401 to two prehistoric routes, when other sites are nonexistent in the near area, suggests that the small site may have served in conjunction with road activities. All other houses in proximity to Pueblo Alto also have prehistoric roads within a few meters.

Summary

A number of sites close to Pueblo Alto suggest the functioning of a small community and have implications for interpreting Pueblo Alto. Not all were contemporary, however. The East Ruin and the Parking Lot Ruin may have been built at about A.D. 1050, shortly after the construction of Pueblo Alto, to function with the prehistoric roads adjacent to them. Ceramics on the roads indicate that the roads and two sites were coeval (see Chapter 5). The low room walls suggest that the two sites were abandoned and robbed of stone before final abandonment of Pueblo Alto, although some occupation in the East Ruin continued.

Ceramics, the "McElmo" style wall veneer, and a single noncutting tree-ring date at the remaining three sites (New Alto, Rabbit Ruin, and 2401) to the west and north of Pueblo Alto indicate their construction in the early A.D. 1100s and abandonment a few decades later. These sites are adjacent to prehistoric roads and may also have functioned synchronously with them, in part. Direct association of a prehistoric road with New Alto has not been demonstrated, however, although a long masonry wall passing by it is interpreted as bordering a road.

The close similarity of New Alto with Kin Kletso suggests that New Alto comprised rooms devoted primarily to storage. On the other hand, the small rooms and kivas at Rabbit Ruin and 2401 suggest habitation sites. All the sites were associated with roads, but they may have functioned to link the community together during different periods of the occupation of Pueblo Alto. On the other hand, the spatial association of roads and sites in the Alto Complex may be partly fortuitous because of the plethora of roads. Because of its size, Pueblo Alto is thought to have exerted political and socioeconomic influence upon the surrounding sites, although the exact nature of these relationships remains unclear.

Chapter Five

The Pueblo Alto-Pueblo Bonito-Chetro Ketl Road Network

Prehistoric roads have long been known in Chaco Canyon and throughout the San Juan Basin (Wetherill in Vivian 1948; Judd 1954), and those around Pueblo Alto and Chetro Ketl were first described in detail by Holsinger (1901). Both the Hopis (Waters 1963:42-43) and the Navajos (O'Bryan 1956:60-62) refer to them as "race tracks," and they have identified them on the ground in Chaco.

Recent research has focused closely on the Chacoan roads throughout the San Juan Basin and reveals that most, if not all, greathouses were connected to roads (Marshall et al. 1979; Obenauf 1980; Powers et al. 1983). There also have been numerous investigations of the Chacoan roads in and around Chaco (e.g., Brethauer 1978; Kincaid 1983; Lyons and Hitchcock 1977; Morenon 1975; Nials et al. 1983; Obenauf 1980; Vivian 1972, 1983b; Ware and Gumerman 1977; Windes 1982c). A number of major routes have been recognized radiating out from Chaco Canyon and eventually terminating at or near outlier communities in areas of high resource productivity and diversity. The commonly held regional perspective of the Chacoan roads attributes to them a major economic role in the redistribution of resources that are normally differentially distributed within the Basin (see Vivian 1983b for a summary).

Roads in Chaco are outstanding for their on-the-ground clarity, the density of cultural debris that litters the routes, and the many associated features. Chaco is one of the few areas where roads can be traced directly into sites. Every greathouse on the plateau or mesa bordering Chaco Canyon (Pueblo Alto, Pueblo Pintado, Peñasco Blanco, and Tsin Kletzin) reveals roads in direct association, while those in the canyon bottom lack visible road association because of sedimentation.

It is likely that roads fulfilled a multiplicity of uses, as Obenauf (1980) and Vivian (1983a) suggest, and that in some areas roads served local purposes unrelated to the regional economic system. In particular, the road complex in the bench and mesa-top area between Pueblo Alto, Pueblo Bonito, and Chetro Ketl (termed the central canyon area) has been of considerable interest to archeologists. Most roads in this area converge on a single site, Pueblo Alto.

The number and proximity of roads around Pueblo Alto were major factor in Alto's ultimate selection for investigation between 1975 and 1979 (see Table 4.1). Because of previous road work (Ebert and Hitchcock 1980; Richard Loose 1975 field notes; Lyons and Hitchcock 1977; Vivian 1972; Ware and Gumerman 1977) and the interest in Alto itself, little field work on the associated road complex was started until after work at the site terminated. This section, then, clarifies the road network in the central canyon road area, examines it as an apt network for both local and regional perspectives, and discusses its ramifications at Pueblo Alto.

The Chaco Canyon Road Network

Two areas in Chaco are loci of prehistoric roads (Figures 5.1-5.2). One area, around the large mesa-top greathouse, Peñasco Blanco, is the point of entry and departure of roads extending west and northwest from the canyon (Windes 1982c). Routes also lead east from the site toward the central canyon area and northeast toward the Escavada small site community and Pueblo Alto. The other area is in the central canyon road area and perhaps includes South Mesa on which Tsin Kletzin is located. Major arterials run north and south from this area, which is dominated by the greathouse giants of Pueblo Bonito and Chetro Ketl as well as numerous small houses. This area is often considered the center of the canyon occupation. East-west roads may also originate from here but presently cannot be identified in the canyon bottom. Most roads in these areas were mapped during the 1972 inventory survey and given Road Segment (RS) numbers (Table 5.1).

In the central canyon area, road segments abound, merging with at least two (RS 33 and RS 40) or more major routes (see Avery and Lyons 1981:Figure 12). All terminate at or run close by Pueblo Alto (Figure 5.2). Two roads extend north-south past the East and West Wings of the site. The western one (RS 33) runs 270 m north past the Rabbit Ruin, a small Pueblo III ruin, and across the Escavada Wash to link with the Great North Road running north from the east side of Alto. To the south, RS 33 crosses a number of benches and ledges (Plates 5.1 and 5.2), and then diverges to three ramps and stairs (see Vivian 1983b:Figure A-6) that drop into the canyon just west of Pueblo Bonito (e.g., Plate 5.3). Its exact route from there is conjecture but is assumed to pass south by Pueblo del Arroyo and out through South Gap where a road is clearly visible on aerial imagery (Avery and Lyons 1981:Figure 6).

At Pueblo Alto this route passes another road (RS 11) presumed to border the 210-m-long masonry wall (Major Wall 6) that extends due west of Alto past the north side of New Alto. The ultimate route of this road is unknown but it probably links several cut stairways descending the cliff southward to a gardening terrace (RS 34) and a cliff-ledge, rock-art site

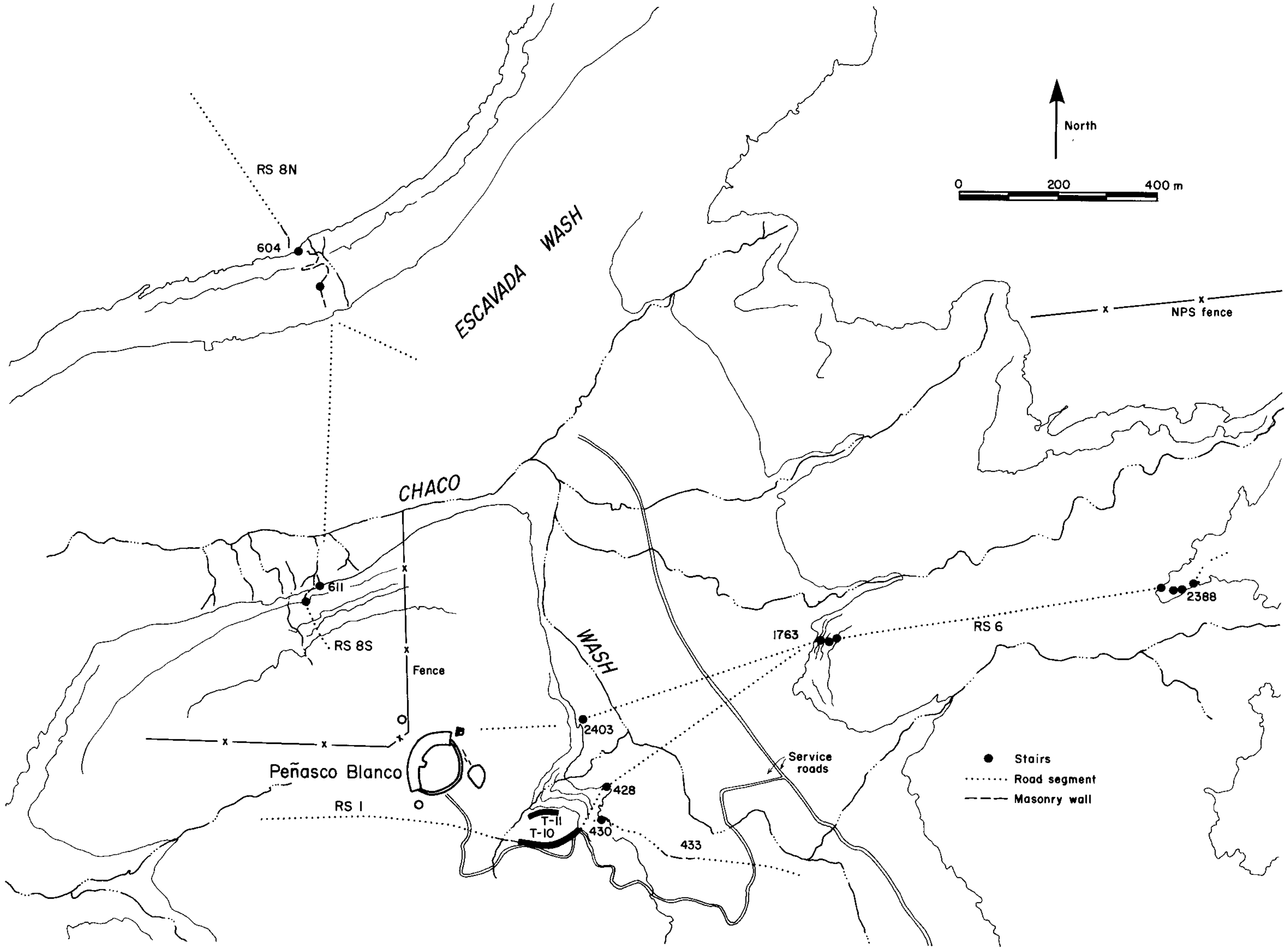


Figure 5.1. The prehistoric road system in the vicinity of Peñasco Blanco. Site numbers indicate stairways marked by circles, RS numbers indicate road segments, and T numbers mark ceramic transects.

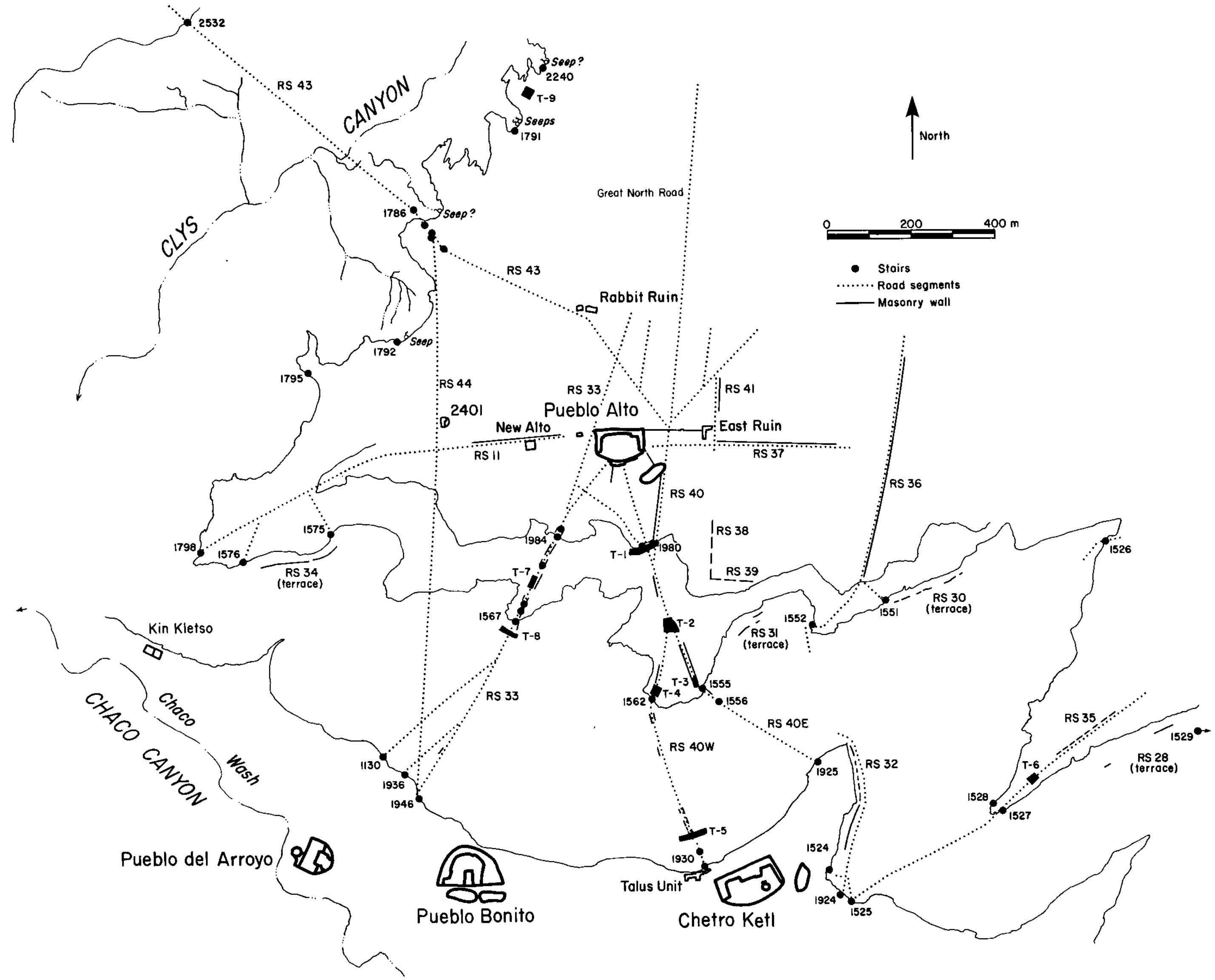


Figure 5.2. The prehistoric road system in the vicinity of Pueblo Alto, Chetro Ketl, and Pueblo Bonito. Site numbers indicate stairways marked by circles, RS numbers indicate road segments, and T numbers mark ceramic transects. Heavy black lines outline road curbing or the masonry retaining walls of terraces.

Table 5.1. A list of Road Segments and associated sites and areas.[a,b]

Road Segment	Closest site	Possible connections[c]
1	Peñasco Blanco	Peñasco Blanco and beyond
6	Peñasco Blanco	Peñasco Blanco - Pueblo Alto?
7	none	Pueblo Alto - Peñasco Blanco
8	Peñasco Blanco	Peñasco Blanco - Ahshislepah Canyon
11	New Alto	Pueblo Alto - RS 34
28	Chetro Ketl	terrace
30	Chetro Ketl, Pueblo Alto	terrace
31	Pueblo Alto	terrace
32	Chetro Ketl	Chetro Ketl - Pueblo Alto?
33	Pueblo Alto, Pueblo Bonito	Pueblo Alto[d] - Pueblo Bonito, Pueblo del Arroyo and beyond
34	Kin Kletso	terrace
35	Chetro Ketl	Chetro Ketl - Escavada community
36	Pueblo Alto	Chetro Ketl - Escavada community
37	East Ruin	East Ruin, Pueblo Alto - Poco Site and the Escavada community
38	Pueblo Alto	extension of RS 41?
39	Pueblo Alto	unknown
40[e]	Pueblo Alto, Chetro Ketl, Talus Unit 1	Pueblo Alto - Chetro Ketl (and sites north to Salmon Ruins)
41	East Ruin, Pueblo Alto	East Ruin, Chetro Ketl - Escavada community
43	Pueblo Alto, Rabbit Ruin	Pueblo Alto - Rabbit Ruin - Peñasco Blanco
44	New Alto	Pueblo Bonito - Cly's Canyon
50	Kin Ya'a	Chaco Canyon - Rio Puerco, Kin Ya'a

[a]Not all prehistoric roads have been assigned road segment numbers.
[b]Road Segments 6, 7, and 43 may be sections of the same road.
[c]These may not constitute terminal points.
[d]North of Pueblo Alto, this road may diverge to the Great North Road and to the Escavada community.
[e]Becomes the Great North Road north of Pueblo Alto.

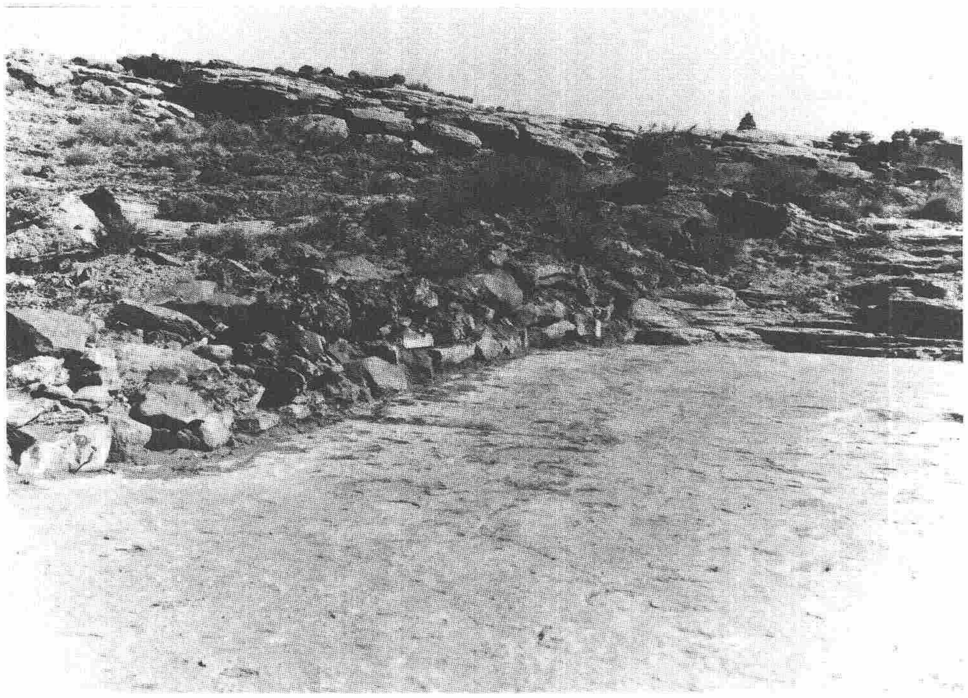


Plate 5.1. A section of prehistoric road, RS 33, between Pueblo Alto and Pueblo Bonito cleared by R. G. Vivian and R. Buettner in 1971. Looking north. (Courtesy of R. G. Vivian and the Arizona State Museum.)

Plate 5.2. Masonry staircase (29SJ 1567) along the Pueblo Alto-Pueblo Bonito road (RS 33) cleared in 1971 by R. G. Vivian and R. Buettner. Scale is 1 m. Looking north. (Courtesy of R. G. Vivian and the Arizona State Museum.)

(29SJ 2402) possibly related to astronomical sightings (William Gillespie, personal communication 1982). The terrace has been practically obliterated by the Civilian Conservation Corps road construction in the 1930s. Near the west end of RS 11, a cut in the crest of the topography suggests another road that crosses RS 11 at right angles. This cut is about 9.5 m wide and runs north past the only small house in the vicinity, 29SJ 2401 (see Chapter 4), toward the Cly's Canyon seeps and RS 43. It also appears to run directly south to the Bonito Staircase (see Plate 5.3).

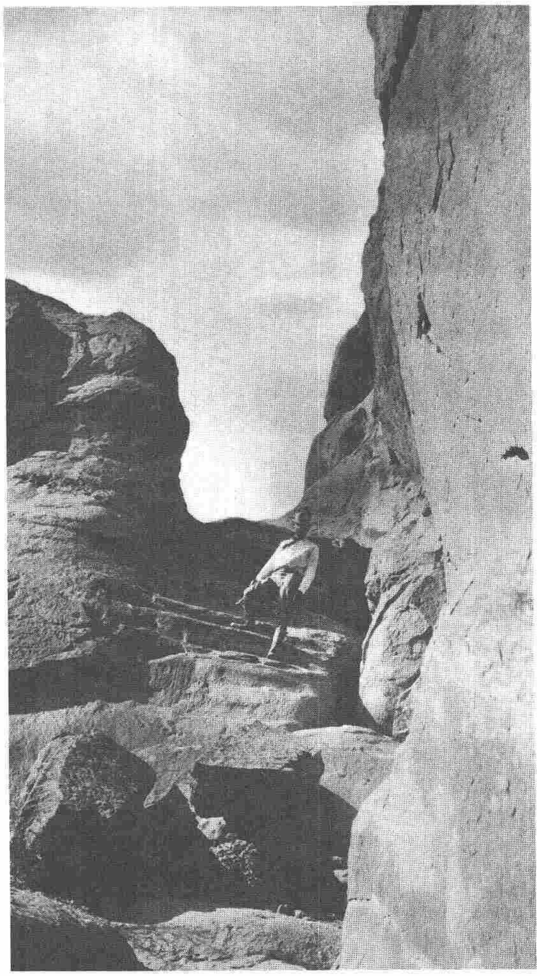
On the east side of Pueblo Alto, a road (RS 40) passes north through a meter-wide opening or gate in Major Wall 1 cleared by Prescott College in 1972 (Ware and Gumerman 1977) and then splits into five or more routes. This is the point that is often referred to as the end (or starting point) of the Great North Road that eventually connects to the Salmon Ruin on the San Juan River (Obenauf 1980). The Great North Road and its three major associated communities have been extensively investigated. Salmon Ruin, the probable terminus of the road (Powers et al. 1983:97), was being excavated at the time work commenced at Alto (Irwin-Williams 1972). Along the same route, Twin Angels Pueblo in Kutz Canyon was partly excavated by Earl Morris in 1915 (Carlson 1966).

Further south, Pierre's, the first major community associated with the road north of Pueblo Alto, 15 km distant, was inventoried by Morenon (1977b) and Powers et al. (1983). The first full-length investigation of the Great North Road was conducted by Pierre Morenon (1977b) in 1974. This was followed up by caloric studies using a respirator to measure the potential functional efficiency of the roads (Morenon and Amick 1977). Later studies of the road were conducted by the BLM (Kincaid 1983), and it has been trenched a number of times by different institutions (Brethauer 1978; Nials 1983; Trott 1980).

Several routes angle to the northeast from the Pueblo Alto gate in the direction of a small-site Pueblo III community along the Escavada Wash. Another (RS 43) goes northwest from the gate across RS 33 past the Rabbit Ruin and on to nearby Cly's Canyon and further to Peñasco Blanco.

Still on the east side of Pueblo Alto, yet another road (RS 37) runs due east from Alto's east plaza (Plaza 2) past the East Ruin and on for another 430 m, bordered by a masonry wall or curbing, to terminate close to another curbed road, RS 36. Another (RS 35) runs southwest-northeast from the mesa edge and a series of stairs, just east of Chetro Ketl, and past the Poco site, a collection of unusual above-ground, low-wall, circular rooms connected by masonry walls (Drager and Lyons 1983), and on to sites along the Escavada Wash.

The Great North Road (an extension of RS 40) extends south through the gate across Plaza 2 at Pueblo Alto, past the Trash Mound (bordered by Major Wall 3), and down the first set of ledges to the bench below (Plates 5.4–5.8) where it is paralleled by a long groove hammered into the bedrock (see also Judd 1964:Plate 40). Grooves such as this one have been associciated with stick-racers at Laguna and Zuni (Parsons 1923:258–259, Figures



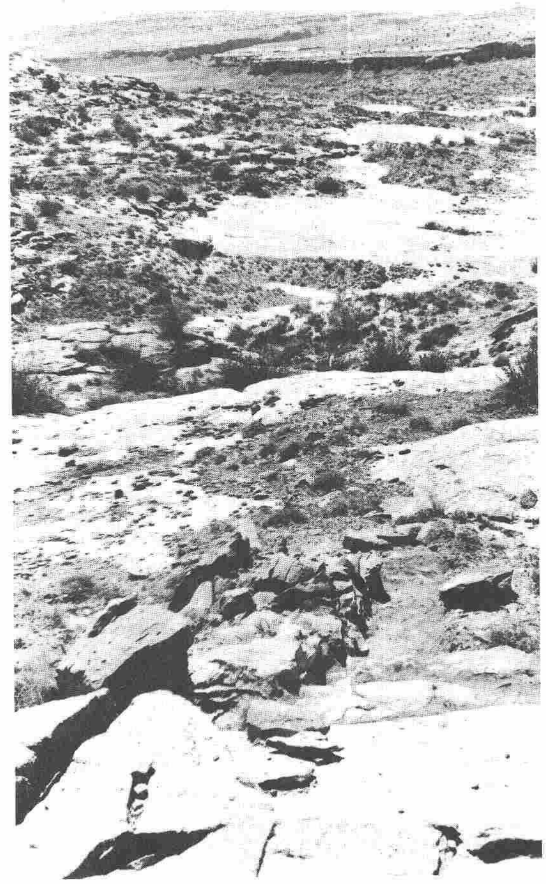


Plate 5.3. The Pueblo Bonito staircase (29SJ 1946). Photo by Charles Martin, 1920. (© National Geographic Society.)

Plate 5.4. Looking south across stairs (29SJ 1980) and RS 40 just south of Pueblo Alto with Chaco Canyon and South Mesa in the background. See Plates 5.5-5.8 for views from the opposite direction. (Courtesy of R. G. Vivian and the Arizona State Museum.)

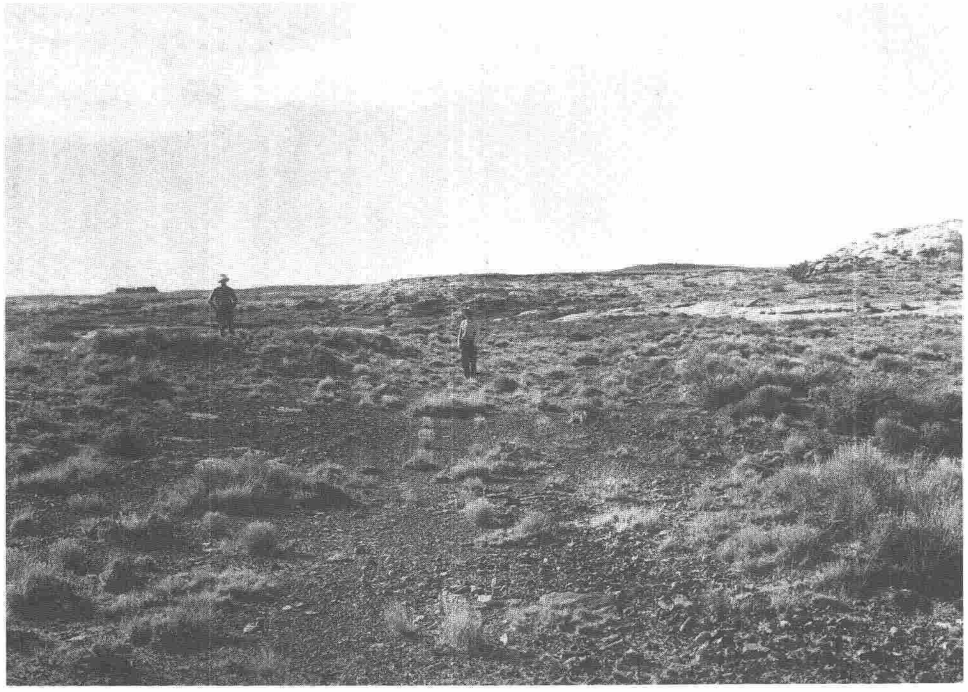


Plate 5.5. Road Segment 40E depression heading toward Pueblo Alto (mound on right center horizon) from stairs 29SJ 1555 and Chetro Ketl. New Alto on horizon above left figure. Photo by Neil Judd. (© National Geographic Society.)

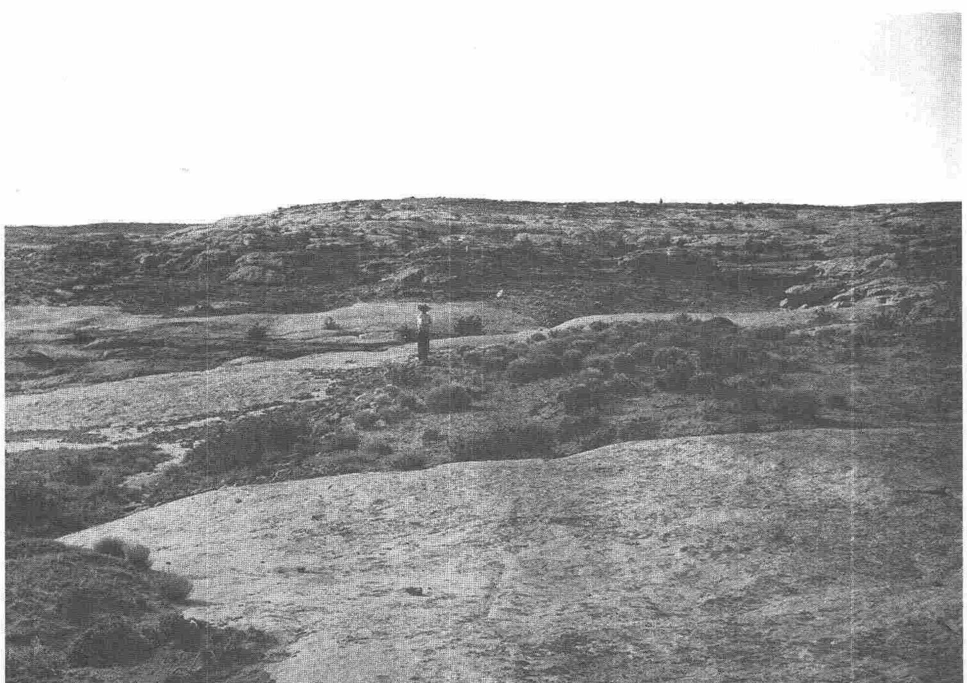


Plate 5.6. Road Segment 40 just north of the fork to RS 40E and RS 40W. Figure stands on the rubble of the deteriorated, masonry road curbing on the approach to Pueblo Alto. Arrow points toward groove along the road. Photo by Neil Judd. (© National Geographic Society.)

Plate 5.7. Road Segment 40 on the final approach to Pueblo Alto. Note groove bordering road, rubble of road curbing behind figure in foreground, and the cut rock steps in the background at location of second figure. Photo by Neil Judd. (© National Geographic Society.)

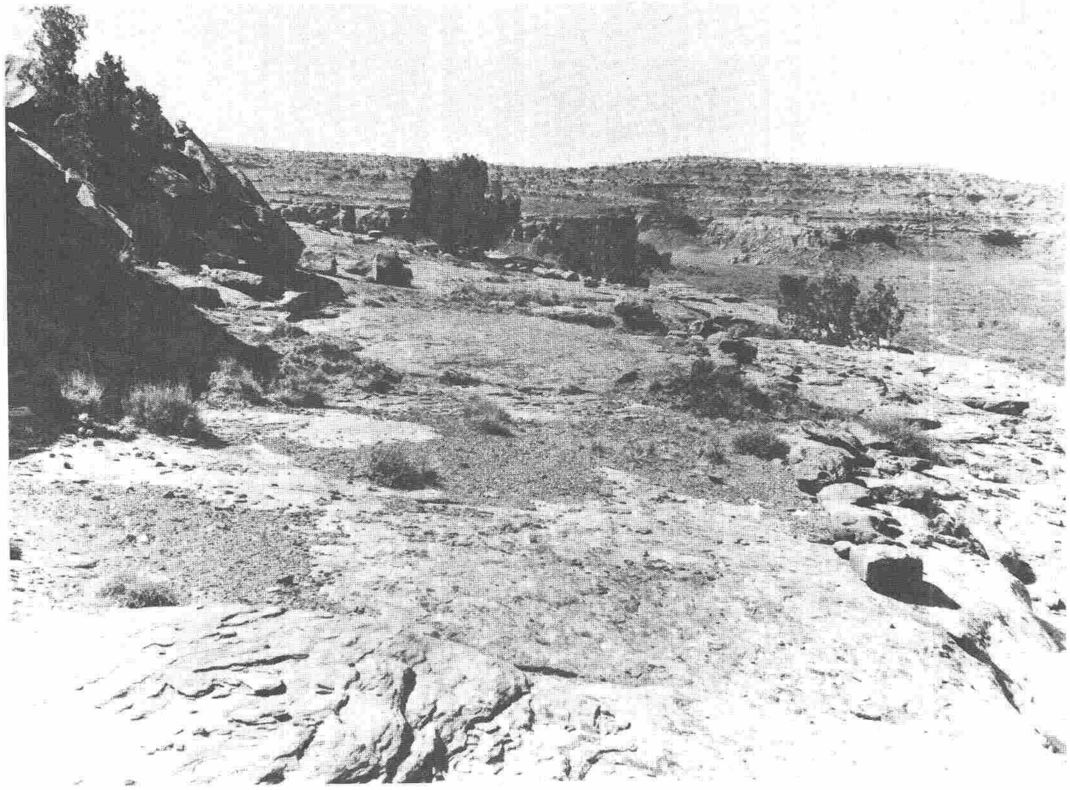
Plate 5.8. Road Segment 40 stairs (29SJ 1980) at the final ascent to Pueblo Alto. Photo by Neil Judd. (© National Geographic Society.)

20-22). The groove disappears at the point where the Great North Road (now RS 40) forks into two segments (RS 40E and 40W) that lead to ramps and stairways behind Chetro Ketl. An intermittent series of stairs, ramps, and wall segments allows a person to follow one segment (RS 40W) directly into the Talus Unit (see Lekson 1985d; Morain et al. 1981:Figure 8). Because of its connections, this route is known as the Pueblo Alto-Talus Unit Road. The other fork (RS 40E) leads to masonry stairs (29SJ 1925) or a ramp (Vivian 1983b:Figure A-1) in the rincon behind Chetro Ketl.

Road Segment 40E also continues around the bench top just east of Chetro Ketl (Plate 5.9), where it became RS 32, and then descends into Chaco Canyon by a series of closely-spaced stairways and possible ramps (29SJ 1524, 1525, and 1924). These ramps and stairs may be linked individually to specific roads (Gwinn Vivian, personal communication 1987) because a number of roads merge at this location. Across the canyon from this location is a spectacular and well-known cut-rock stairway, 29SJ 761 (Plate 5.10), which connects to a road running to Tsin Kletzin on top of South Mesa (route not shown on maps). The alignment of the two stairway sets suggests a continuous route that may stretch from Tsin Kletzin to Pueblo Alto. The setting of both sites on opposite mesa tops, and the association of stone animal figures (see below) with both, set the sites apart from the other canyon greathouses. The road to Tsin Kletzin is known to the Navajo as the "Zuni Trail" (Fransted and Werner 1974:75), a provocative reference to historic puebloan use. In fact, Chaco Canyon is considered by the Zuni as an ancestral site in Zuni migration legends, a place where prayer offerings are deposited (Ferguson 1981:Appendix 1).

Road Segment 40 and RS 32 are particularly intriguing in that they may have once been marked at high points by stone animal figures set alongside the roads, perhaps as road markers or shrines. Holsinger (1901:68) was the first to remark of "a shrine, around the rude carved figure of some animal" that formerly rested at the top of the 29SJ 1980 stairs cresting the final approach to Pueblo Alto. A small scatter of masonry (2.2 by 2.6 m) marking some feature is located 9 m back from the edge of the uppermost bench where RS 40 diverges into Pueblo Alto from the south. Could this be the shrine that Holsinger observed? In conversations with Gordon Vivian (1948), Mrs. Richard Wetherill confirmed the presence of the stone figure, although she places it "near the foot of the second mesa north." A collection of photographs made by Neil Judd's photographer, O. C. Havens and recently given to the Park, revealed a stone figure (Plate 5.11) that Havens remembered as having been found near Pueblo Alto (Havens, in conversation with Randy Morrison and John Stein, 1983). Judd (1954:296, Figure 80B) published this photo (although he had never seen the stone) but ascribed the figure to Kin Kletso. To add to the confusion, Marietta Wetherill (in Vivian 1948) believed that "some fellows from the university" broke it from the bedrock in which it was carved and that it ended up at the bottom of the slope because it was too heavy to carry off. Certainly this is not the stone figure illustrated.

Perhaps there were more than one such figure along the road to Pueblo Alto. "Shrines" marking the roads at Pueblo Alto and "across the wash"

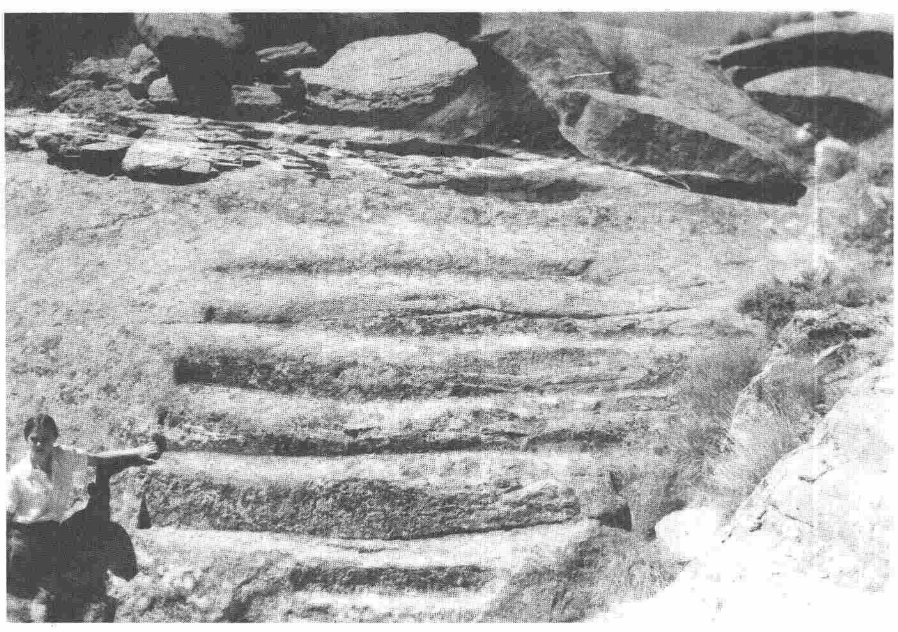


A

B

Plate 5.9. Looking south along RS 32 towards Chaco Canyon and South Mesa. Chetro Ketl is just out of photo to the right.
A) South end of road near descent to canyon bottom. (Courtesy of R. G. Vivian and the Arizona State Museum.)
B) North end of visible part of road. Hiker is Todd Windes. (NPS#28733).

A



B

Plate 5.10. The massive-cut steps of 29SJ 761 leading to the "Zuni Trail" road and Tsin Kletzin on top of South Mesa. A) The climber is the author, 1972 (NPS#3508). B) Note masonry pavement at the top of the landing. Circa 1930. (Courtesy of the Museum of New Mexico, MNM#66889.)

Plate 5.11. Stone figure found near Pueblo Alto. This is possibly the "carved figure of some animal" noted by Holsinger (1901:68) in a shrine between the Trash Mound and the 29SJ 1980 stairs of RS 40 at the final approach to Pueblo Alto. Photo by O. C. Havens, circa 1925. (Courtesy of O. C. Havens.)

were anticipated and found by a Hopi informant (Waters 1963:43), but without carved figures in them. Mrs. Wetherill referred to another figure "northeast of Chetro Ketl," which is where RS 32 is located. Finally, another stone figure, very similar to the one purported to be from Alto, was recovered in 1925 on the mesa top south of Alto at Tsin Kletzin (Judd 1954:295, Figure 80A). Despite confusion over location, it seems probable that carved-stone animal figures marked one or more of the roads in the central canyon complex.

Road-Related Features Around Pueblo Alto

Masonry curbing (low masonry walls that often border one side of a road), ramps, and cut and masonry stairs are frequent road associations in the central canyon area. Many of these extensive features are described in detail by Vivian (1983b) and Pattison (1985, 1986) and need not be covered here. Work at Pueblo Alto has revealed another category of road-associated structures--paired room units--that have not been recognized from previous work. The paired units common around Alto may exist in the vicinity of other greathouses, although none have been recognized to date with the possible exception of the small L-shaped ruin on the northeast side of Penasco Blanco.

Four spatially distinct blocks of paired rooms at Pueblo Alto appear road related, although their exact function remains problematical (Figure 5.3). All were built with the long axis perpendicular to passing roads. Each unit consists of two rooms joined along the long axis and, where wall is standing, connected by a centrally placed door. Lengths of each room are identical but one room is always slightly larger (wider) than the other. Very few rooms and no room pairs in the primary Alto roomblocks are similar in size to those of the paired units. In the group of 11 paired units there is little variation among the large rooms or the small rooms in mean dimensions and area, which suggests all were built from a standard plan:

	NO.	LENGTH		WIDTH		AREA	
		(cm)	(sd)	(cm)	(sd)	(m^2)	(sd)
LARGE ROOMS	11	629.1	(14.8)	324.4	(23.2)	20.4	(1.4)
SMALL ROOMS	11	627.7	(18.8)	264.5	(13.2)	16.6	(0.7)

The largest block, or East Ruin (see Chapter 4), consists of 6 paired units arranged in an "L" around a large Chacoan kiva. East Ruin is 143 m due east of Alto and connected to it by a massive masonry wall (Major Wall 1) through which the Alto-Chetro Ketl/Great North Road passes. Each leg of the house contains three paired units situated perpendicularly to RS 37 and 41. East Ruin was built in the mid-A.D. 1000s and occupied into the early A.D. 1100s (see Volume II).

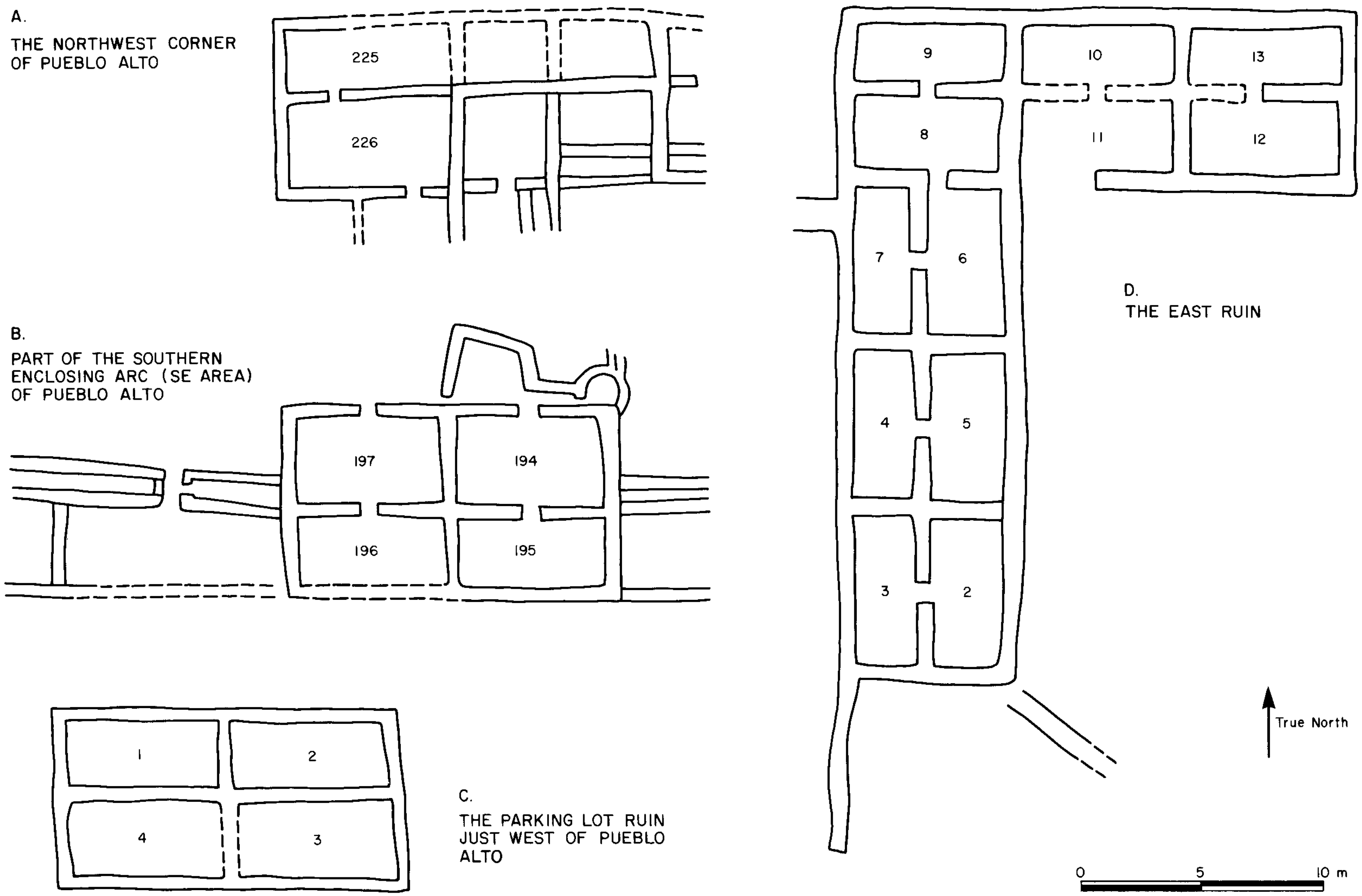


Figure 5.3. Road-associated paired-room units at Pueblo Alto. Room numbers identify members of paired units.

Two short segments of wall, a single stone high, extend into the path of RS 37 from the southernmost paired unit. Another wall extends into RS 33 from the southwest corner of Pueblo Alto. It would seem that the projection of these walls into the road would disrupt traffic patterns and, therefore, they may have served for traffic control. Similar projections into prehistoric roads have been noted at Kin Hocho'i and Ats'ee nitsaa in Manuelito Canyon and other greathouses further to the southwest in Arizona (John Stein, personal communication 1986).

A second block of paired rooms (Rooms 194-197) is located in the southern arc enclosing Pueblo Alto's interior plaza (see Figure 5.4). Although at first glance the block appears part of the large array of rooms, the masonry style and wall abutments mark a former discrete unit of four rooms incorporated into later remodeling. The masonry is closest to Hawley's (1934) Inferior or Superior Type III style and was constructed at Alto at about the mid-A.D. 1000s. The block may have been built as an isolated unit in front (south) of the main roomblocks, although the canter of the long axis of the set matches the present arc alignment (of later construction) and, thus, suggests an earlier enclosing arc of which this set was a part.

Rooms 194 through 197 lie just east of an entry into the Pueblo Alto plaza from outside. Aerial photos plainly show a road angling northwest off the Alto-Chetro Ketl (RS 40) route and into Alto at this point. When the spot was excavated, a 68-cm-wide, unblocked passage was revealed in the north wall of Room 199 between two narrow structures (Rooms 198 and 200). The south wall of Room 199 was never verified, although a short segment extending from adjacent Room 201 seems to assure its presence. Construction of Room 199 may later have prevented through traffic. Nevertheless, the perfect alignment of the road and the passage into Plaza 1 suggest that the association of Rooms 194 through 197 is not fortuitous.

A third set of rooms appears in the northwest corner of Pueblo Alto. This pair (Rooms 225 and 226) disturbs the otherwise symmetrical arrangement of the primary roomblock by jutting west beyond the adjacent rooms. The pair matches other road-associated units except for an off-center door common to them. The main Alto-Bonito thoroughfare (RS 33) is a clearly defined swale that passes by the two rooms a meter or two away.

Finally, a fourth set, the Parking Lot Ruin (see Chapters 4 and 8), was found a short distance away from the West Wing Alto rooms in the former visitor parking lot. The two contiguous pairs had been road-graded to the foundations, removing any traces of doors. The main Alto-Bonito thoroughfare (RS 33) passes by about 22 m to the east. Another (curbed) road (RS 11) may pass closely by the Parking Lot Ruin on the north side at the terminal end of a route coming west past New Alto. The position of New Alto and East Ruin equidistant from Pueblo Alto (to the east and west sides) and the respective association of similar walls and roads reveal symmetrical architectural pairings of road-related structures with Pueblo Alto.

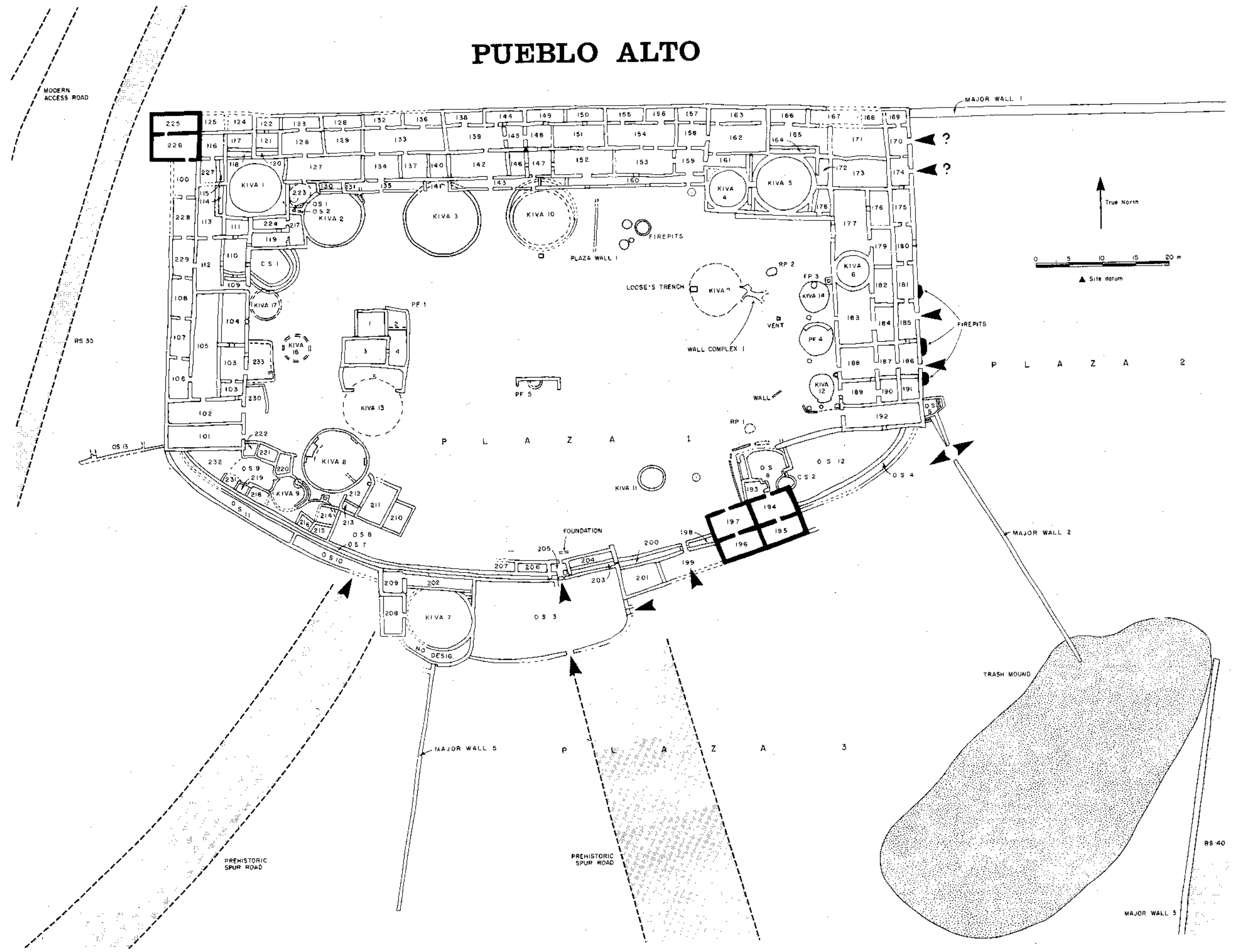


Figure 5.4. Road entries into Pueblo Alto (indicated by arrows). Note placement of large exterior firepits against east wall, next to entries, that may have been for signaling or directing travelers. Paired room units marked with dark outlines.

Road Entries at Pueblo Alto

There are several points at which roads pass through or terminate at gates or doors of the site aside from those mentioned above (Figure 5.4). A passage, 110 cm wide, extends through the enclosing arc west of the paired unit of Rooms 194 through 197. The passage (Room 205) underwent several remodelings prior to closure with masonry of the style preferred in the A.D. 1100s. South of Room 205, a small courtyard (10.8 by 23.5 m), designated Other Structure 3 (OS 3), was enclosed with a low wall, 120 cm wide, of large-block masonry. A test trench between Room 205 and the low wall revealed another entry due south of Room 205 through the enclosing OS 3 wall marked by a hard, yellowish, clay surface that may have been produced by foot traffic. The entry through the central point of the enclosing arc was apparently duplicated at Chetro Ketl where it is now marked by a distinct tranverse depression across the unexcavated arc rooms. Keen-eyed Jackson (1878:Plate 57) was the first to note this as a possible entryway.

A second entry allows access through OS 3. This enters the east side of OS 3 past Room 201 and is also blocked with masonry. It was about 52 cm wide but may have originally been as wide as 144 cm. Wall clearing and subsequent stabilization have altered the initial character of the entry, although there may have been a small masonry pillar on the south side of the entry.

A long masonry wall (Major Wall 5), typical of those bordering roads in the Pueblo Alto vicinity, extends 52.7 m south of OS 3. This one, however, runs tangentially to the suspected alignment of both roads that enter Alto from the southeast and southwest and, therefore, may serve to delineate exterior plaza space (i.e., Plaza 3) rather than a traffic route.

Finally, a third road segment appears on aerial photos to form a dog-leg northeast into the Pueblo Alto enclosing arc from the Alto-Bonito (RS 33) road. It is not known precisely where the road intersects the arc, because no breaks now occur in the expected entry area. Deep testing would be necessary in the much-remodeled arc to discover any entries that might exist. Rooms 208 and 209, nearby, may have been associated with this entry, although they are not perpendicular to the suspected route and are dissimiliar in other ways to the road-related units discussed above. Masonry veneer style suggests Stage IB or IC construction (see Chapter 6) of the two rooms in the early A.D. 1000s, which predates the other room pairs.

Road Function Suggested by Road Termini

Transport of raw and finished materials must be considered a major road function. The quantities of ceramics (Toll 1981), chipped stones (Cameron 1982) and construction timbers (Dean and Warren 1983) imported into Chaco Canyon, for example, indicate a widespread network of exchange and movement of goods unlikely to have been transported off-road. Despite the emphasis on nonlocal movement of economic goods, there are probably a variety of other functions attributable to roads within the canyon. The fragility of the ecosystem in Chaco may have required the Anasazi to channel local traffic (via roads) in order to minimize environmental destruction (Schelberg 1982:108). Morenon and Amick (1977) emphasize the efficiency of the roads outside Chaco Canyon even for mere traveling. Examination of canyon road termini and road-associated artifacts suggests that some roads were used primarily for local (nonregional) activities.

Water Procurement

RS 43 leaves Pueblo Alto from the north gate in Plaza 2 (as does the Great North Road) and runs northwest across RS 33 and past the nearby Rabbit Ruin. A number of stairs at the edge of nearby Cly's Canyon suggests multiple terminal points for this road (Figure 5.2). The clearest route lies directly west of Rabbit Ruin and crosses the exposed undulating bedrock (Figure 5.5). It is marked by a small causeway, several series of small cut steps, piles of collapsed stone ramps or masonry steps, and terminates in a series of wide cut steps at 29SJ 1786 (Plate 5.12). All the stairs descend near potential or active seeps. Those at 29SJ 1791 and 1792 have been dug out historically and are continually active during even the driest years (i.e., they contain standing water).

Holsinger (1901:11) noted that the seep at 29SJ 1791 was a source of water for the Navajo, as it was one of the few good sources in the canyon (Plate 5.13). Measurements in mid-May and mid-October 1985, revealed that it discharged 59-69 liters of water per day (Table 2.1) for a year with above-normal rainfall. Navajo oral tradition equates this seep with the water source for the mythical "Gambler" who inhabited Pueblo Alto, hence the Navajo name of "Great Gambler's Spring" (David Brugge, 1973 field notes; Fransted and Werner 1974:88). Jar fragments dominate the collection examined at the Great Gambler's Spring and 29SJ 1792 (Table 5.2), and olla jar fragments are scattered along the cliffs in the vicinity (Table 5.3).

RS 44, a spur route off of RS 33 between Pueblo Alto and Pueblo Bonito, leads to the seeps reached by RS 43 and may indicate that inhabitants at Pueblo Bonito and Pueblo del Arroyo were also drawn to these sources. The number of stairways associated with these major sources of water, the dominance of Pueblo II-early Pueblo III jars around the Gambler's Spring and 29SJ 1792 and on the nearby cliffs, and the roads leading from Pueblo Alto and Pueblo Bonito toward this area make it likely that the route was one for water procurement.

Three of the four potential or active seeps have simple hand-and-toe-hold steps descending nearby (mean distance between stairway and seep is about 15 m), and these must have been solely for access to water. Care was taken, however, to cut steps across the slightest bedrock rises along the route to the stairs at 29SJ 1786, which required no modification along

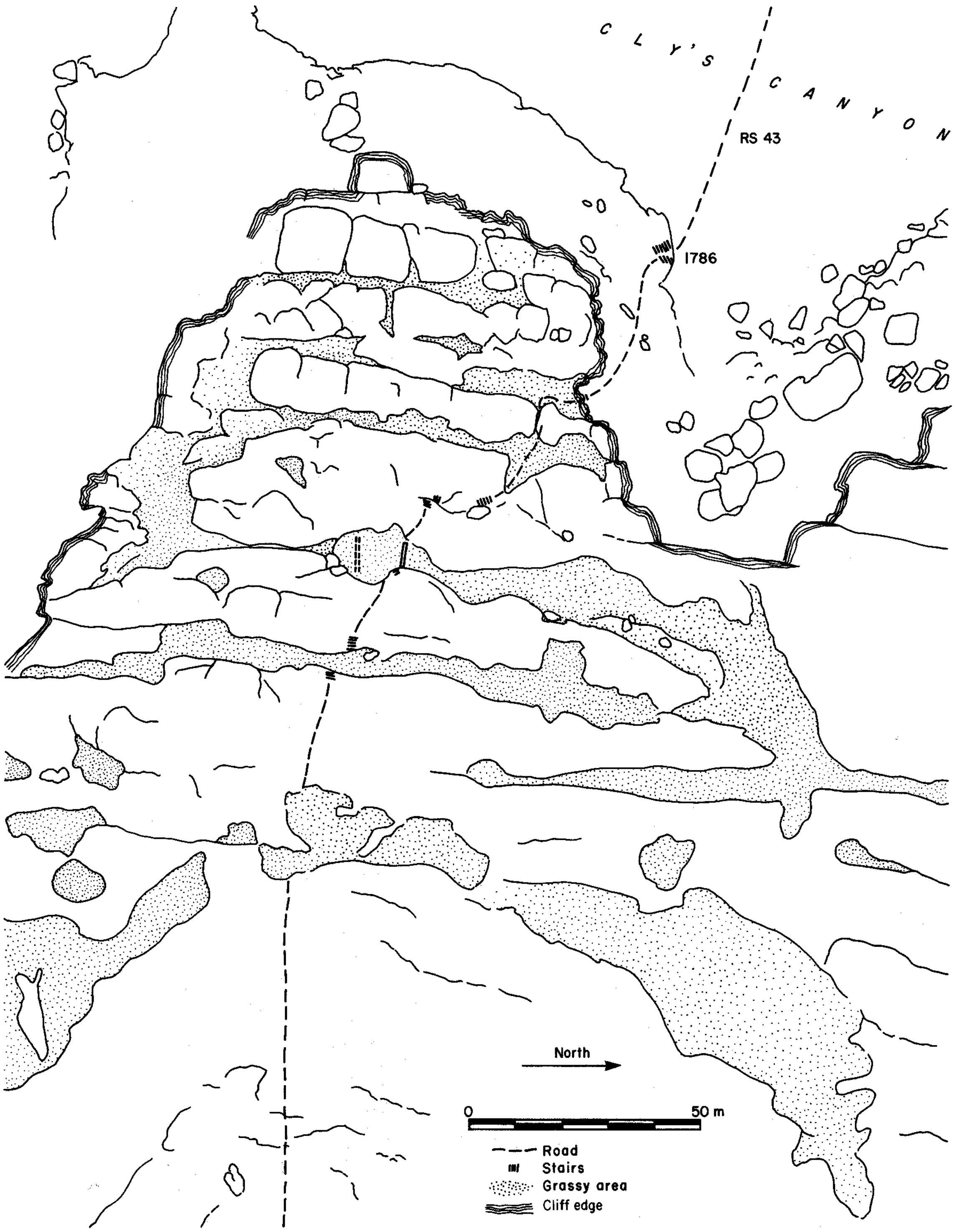
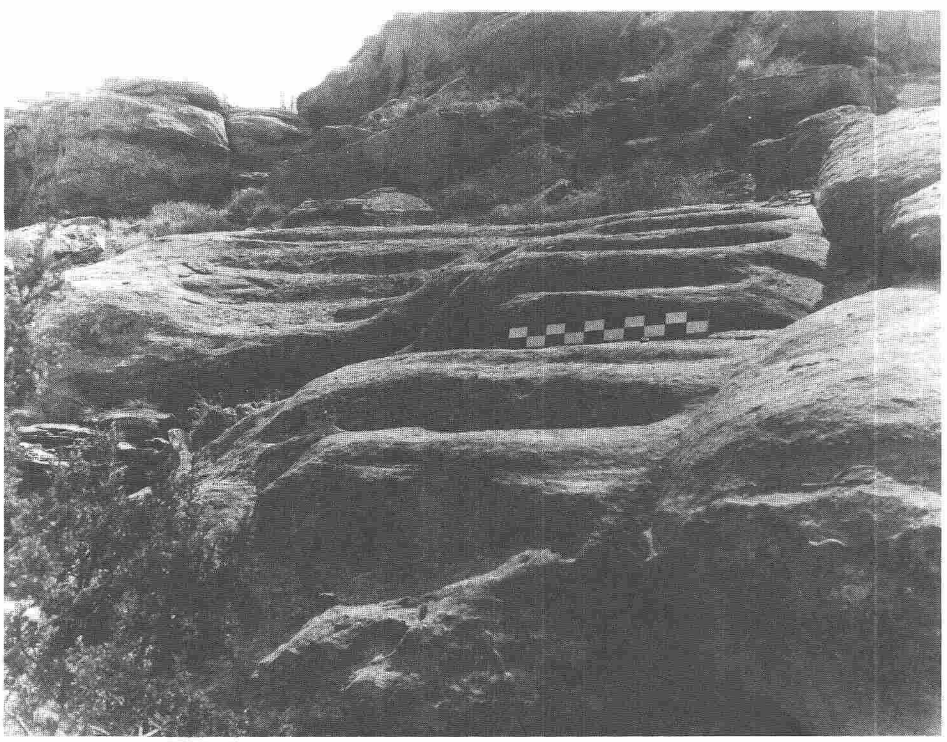


Figure 5.5. Route of RS 43 as it crosses the slick rock from Rabbit Ruin to Cly's Canyon on the route towards Peñasco Blanco.

A



B

Plate 5.12. The stairs of 29SJ 1786 descending into Cly's Canyon along RS 43 between Pueblo Alto and Peñasco Blanco. Looking east-southeast. Scale in B is 1 m. (Courtesy of R. G. Vivian and the Arizona State Museum.)

Plate 5.13. Active seep area (29SJ 1791) used historically for a water source by the Navajos and known by them as the Great Gambler Spring, in reference to the mythical chief who inhabited Pueblo Alto. Note the large basins to each side of John Thrift that were measured for discharge rates (see Chapter 2). (NPS#5060.)

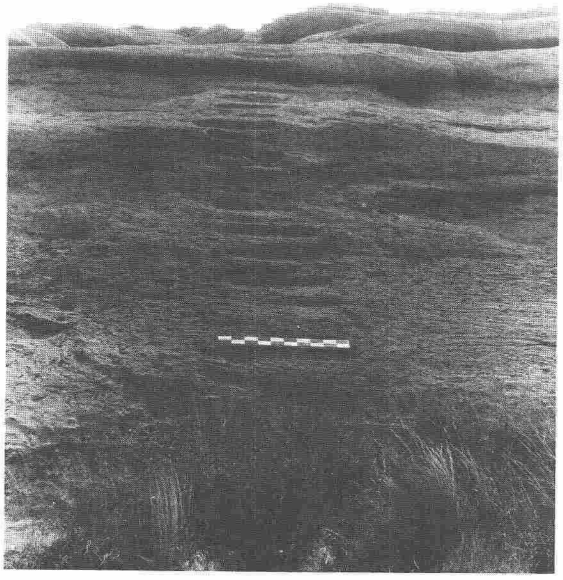


Plate 5.14. Staircase (29SJ 1763) leading from the bottom of Chaco Canyon east of Peñasco Blanco to RS 6. Scale is 1 m. (Courtesy of R. G. Vivian and the Arizona State Museum.)

Table 5.2. Ceramics tabulated at active seep areas in Cly's Canyon: Sites 29SJ 1791 and 29SJ 1792 (Great Gambler's Spring).

	plain gray (sand)	unclass. indent. corr. (sand)	unclass. indent. corr. (trachyte)	unclass. indent. corr. (sherd)	unclass. rim fillet (trachyte)	Puerco B/w	Gallup B/w	Chaco-McElmo B/w	unclass. mineral	plain whiteware	unclass. Chuska whiteware	unclass. Chuska carbon	Forestdale Smudged	Total	%
29SJ 1791:	1	2	2	3	1		2	3	2	20	2	1	1	40	
%	3	5	5	8	3		5	8	5	50	5	3	3		103
Form:															
bowl											1		1	2	5
jar	1	2	2	3	1		2	3	2	20	1	1		38	95
Ware %	23% culinary					18% Cibola				50% unknown	6% Chuska		3% smudged		100
29SJ 1792:		2		5		1	1			11				20	
%		10		25		5	5			55					100
Form:															
bowl										1				1	5
jar		2		5		1	1			10				19	95
Ware %	35% culinary					10% Cibola				55% unknown					100

Table 5.3. Ceramic samples from near RS 43 (Cly's Canyon) and on the mesa road (RS 50) leading southwest from Kin Ya'a.[a]

	plain gray	narrow neckbanded	unclass. indent. corr.	PII indent. corr. rim	PII-III indent. corr. rim	PIII indent. corr. rim	Red Mesa B/w	Puerco B/w	Gallup B/w	Chaco B/w	Socorro B/w	Cebolleta B/w	Chaco-McElmo B/w	McElmo/Chaco-McElmo B/w	unclass. Cibola mineral	plain whiteware	Toadlena B/w	unclass. Chuska carbon	McElmo B/w	Puerco B/r	Total	%
Near RS 43:																						
TRANSECT 9:			7					12	15	4				1	60	145	1	3			248	
%			3					5	6	2				T	24	58	T	1				99
Form:																						
bowl								1	3					1	4	6	1	1			17	7
jar			7					11	12	4					55	139		2			231	93
ladle															1						1	T
Chuskan culinary			2 29%																			
Ware %			3% culinary								37% Cibola					58% unknown	2% Chuska					100
RS 50:	12	2	58	1	1	1	13	21	51	1	2	1	2		66	197			3	1	433	
%	3	T	13	T	T	T	3	5	12	T	T	T	T		15	45			1	T		97
Form:																						
bowl							3	3	2						5					1	14	3
jar	12	2	58	1	1	1	10	18	49	1	2	1	2		61	197			3		419	97
Chuskan culinary	0	0	1 2%	0	0	0																
Ware %			17% culinary								36% Cibola					45% unknown			1% Mesa Verde	T White Mt.		99

[a]T = trace (less than 0.5%).

other Chacoan roads, but would have lessened the danger of stumbling with water-laden jars. Although there is a potential source of water nearby but at a greater distance (about 50 m or more) than all other seep-stair connections in the area combined, the construction of this route beyond the best water sources, its higher labor investment than needed for stairs next to seeps, and the absence of ceramics make its function for water procurement alone questionable.

It was suspected, then, that RS 43 served as a major route to the west across Cly's Canyon, but with spur routes leading to the several water sources. The main route, marked by the 29SJ 1786 stairs, led toward RS 6 and stairs (Plate 5.14) leading to Peñasco Blanco (Figure 5.1), although the inventory survey showed no stairways that provided access beyond the cliff bordering the west side of Cly's Canyon. A long groove (RS 7) cut into the bedrock midway between a projected route tying RS 6 with RS 43 strengthened the probability that the road segments connected. Grooves are known to divide Chacoan roads (Nials et al. 1983; Vivian 1983b), including the Pueblo Alto-Chetro Ketl (RS 40) road. When the projected route was retraced in 1983, an unrecorded stairway (now 29SJ 2532) was discovered at exactly the point where the projected route crossed the west side of Cly's Canyon, as predicted, firmly tying the Peñasco Blanco and Pueblo Alto routes together.

Another route (RS 8N) that led northwest from Peñasco Blanco to Ah-shi-sle-pah Canyon passed a series of deep potholes, the Los Aguages tanks, that were used historically as a source of water (Kincaid et al. 1983:9.76-9.77; Stein 1983:8.10). The high ratio of jar fragments recovered from the Ah-shi-sle-pah Road suggests that the Anasazi also had used the tanks for water (Table 5.4; Kincaid et al. 1983:9.77).

Terrace Farming

Some road segments in the vicinity of Pueblo Alto are associated with areas that could have served as garden plots or terraces (Plates 5.15-5.16; see also detailed descriptions in Volume II). At the base of the first cliff below Alto are four sections of bench bordered by masonry walls and backed by alluvial sands (Vivian 1970:69; Vivian and Mathews 1965:13). These were incorrectly identified as road segments (RS 28, 30, 31, and 34) during the 1972 survey. The sites face southeast (between 140° and 160°) in a position favorable for morning summer sun and shady afternoons. They are located where the Cliffhouse formation shales stop downward movement of ground water through the thick overlying sandstone, which results in moisture accumulation that produces the seeps in Cly's Canyon. Similar topographic settings are favored by the Hopi for small "seepage" fields (Hack 1942:34). Each terrace is bracketed by rock cut stairways, some terminating at the terrace and others as part of more extensive, passing road routes.

Associated artifacts are less informative regarding use of the terraces. Most are ceramics, although a possible digging tool (a

Table 5.4. Ceramic samples from stairs along the Ah-shi-sle-pah Canyon - Peñasco Blanco road on the north (RS 8N) and south (RS 8S) sides of the confluence of the Chaco and Escavada Rivers.[a,b]

	Lino Gray	plain gray	wide neckbanded	narrow neckbanded	unclass. indent. corr.	PIII indent. corr. rim	LaPlata B/w	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	unclass. Cibola mineral	plain whiteware	Chuska B/w	Toadlena B/w	unclass. Chuska carbon	unclass. Mesa Verde whiteware	Total	%
29SJ 611 stairs:																					
'72 survey	1	13		1	2	1		1	1	5	19	1		13	6	3	2	1		70	
'81 top	1	30	1		7		1	2		3	6	1	1	4	22	1	4	3		87	
'81 bottom	1	22			4			2		11	39	4		20	35	1	2	1	1	143	
Total	3	65	1	1	13	1	1	5	1	19	64	6	1	37	63	5	8	5	1	300	
%	1	22	T	T	4	T	T	2	T	6	21	2	T	12	21	2	3	2	T		98
Form:																					
bowl							1	3		3	2				2					11	
jar	3	65	1	1	13	1		2	1	16	62	6	1	37	61	5	8	5	1	289	
Chuskan culinary	0	0	0	0	5 38%	0															
Ware %			28% culinary								45% Cibola				21% unknown		6% Chuska		T Mesa Verde		100
Chuskan %			6%																		

[a]Samples collected in 1971 by Gwinn Vivian and Robert Buettner, in 1972 during the inventory survey (Alden Hayes/Tom Windes), and the remainder were tabulated on the ground in 1981 by Windes.
[b]T = trace (less than 0.5%).

Table 5.4. (concluded)[a,b]

	plain gray	narrow neckbanded	unclass. indent. corr.	PII-III indent. corr. rim	PIII indent. corr. rim	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	Socorro B/w	unclass. Cibola mineral	plain whiteware	Burnham B/w	Chuska B/w	Toadlena B/w	unclass. Chuska carbon	Cortez B/w	Mancos B/w	McElm B/w	Mesa Verde B/w	unclass. M. V. whitware	Wingate B/r	unclass. White Mt. redware	Tusayan B/r	unclass. Tsegi orangeware.	Total	%
29SJ 604 stairs:																													
1971 testing	1	1	12	1	1	7		5	20	2	8	1	23	40	1			1	1	10	3				1	1		141	
Feature 1			1					2	8				1	2				2										16	
Feature 5	1							1	1	1			4	3						3	2			1				17	
1972 survey	1		12			9	1		14	3	1		21	7		3				11	1	1			1			86	
1981 (top)	1		12					3	10	1	3		13	37		3		4		6			3					96	
1981 (bottom)		1	24			5		2	13	1	6		27	47		1	2	2		6	2	1	3		1		1	145	
Total	4	2	63	1	1	21	1	13	66	8	18	1	89	136	1	7	2	9	1	36	8	2	6	1	3	1	1	501	
%	1	T	13	T	T	4	T	3	13	2	4	T	18	27	T	1	T	2	T	7	2	T	1	T	1	T	T		99
Form:																													
bowl						7	1	5	7		3		17	10		1	2	3		14	3	2	1	1	3			80	
jar	4	2	63	1	1	14		8	59	8	15	1	72	126	1	6		6	1	22	5		5			1	1	421	
Chuskan	1	0	16	0	0																								
culinary	25%		25%																										
Ware %		14% culinary							43% Cibola					27% unknown		4% Chuska					11% Mesa Verde			1% White Mt.		T Tsegi			100
Chuskan %		24%																											

[a]Samples collected in 1971 by Gwinn Vivian and Robert Buettner, in 1972 during the inventory survey (Alden Hayes/Windes), and the remainder were tabulated on the ground in 1981 by Windes.
[b]T = trace (less than 0.5%).

Plate 5.15. Farming terrace (RS 31) southeast of Pueblo Alto. Note collapsed masonry retaining walls above David Barde and Lisa Thrift. (NPS#5530.)

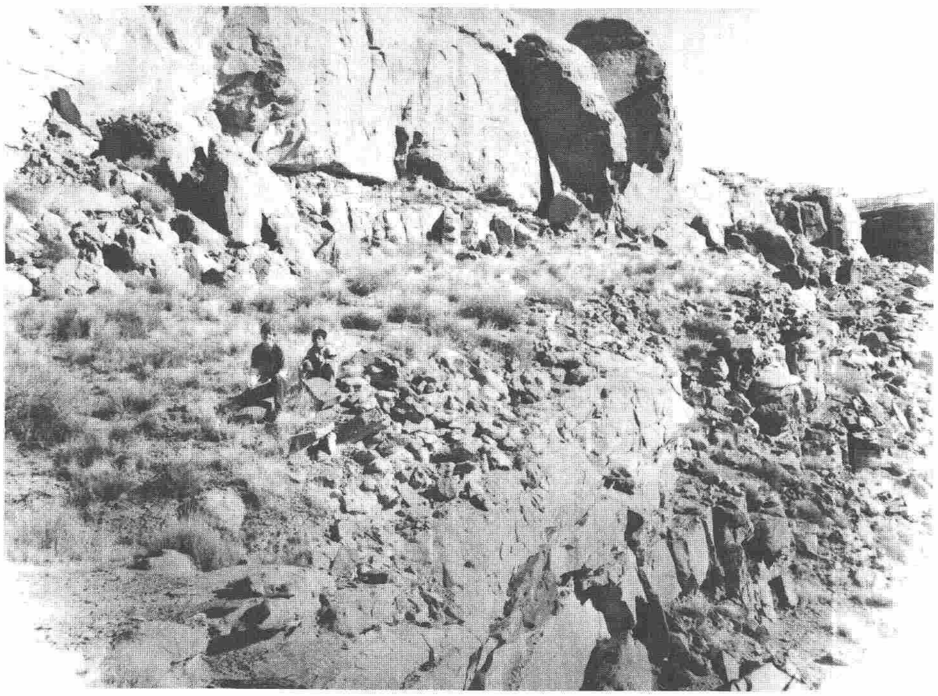


Plate 5.16. Farming terrace (RS 28) east-northeast of Chetro Ketl. Note collapsed masonry retaining walls along edge of bench top and next to Suzanne Hunt and Todd Windes. Stairway to lower level descends at the right of the photo. Looking northeast. (NPS#28728)

tchamahia) fragment that suggests agricultural activities was found on RS 31. It was expected that farming would require predominately large jars with which to water plants and carry produce, techniques that have historic analogues (Ladd 1979:Figure 12). Two terraces produced a quantity of ceramics (Table 5.5). One of these (RS 31) yielded the variety of types found in nearby greathouse middens, although it was dominated by whiteware jar sherds. The incidence of Chuskan culinary vessel fragments was low, however, as it was along the roads. Ceramics from RS 28 were also dominated by whiteware jars but with fewer culinary pieces present. This assemblage is similar to road refuse and closer to expectations for terrace refuse. RS 28 ceramics revealed a mixture of types that suggest use of the terrace in the early A.D. 1000s through the early A.D. 1100s, although a few early ceramics may be indicative of activities in the A.D. 900s. The latter, perhaps, mark events unrelated to the terrace construction and use.

In summary, the location and exposure of these walled benches and their similarity to Hopi seepage fields makes it probable that these features were an attempt by the Anasazi to maximize knowledge of the local hydrology to grow crops.

Local Exchange Routes

Two or more roads come together at the trio of stairways and ramps (29SJ 1524, 1525, and 1924) that descend the cliffs just east of Chetro Ketl. One (RS 32), discussed above, goes to Pueblo Alto and perhaps Jackson's Staircase (29SJ 1526). The other segment (RS 35) extends northeast and is bordered by a strip of masonry "curbing" on the mesa top as it heads for the Poco site, 29SJ 1010 (also connected to Alto by another route) and the community of early A.D. 1100 houses along the Escavada Wash, northeast of Alto. Roads leading beyond the Escavada community have not been found on aerial photographs (Obenauf 1983:Figure 4-13). Because water and other resources seem to be absent along this route, RS 35 may have served to facilitate local exchange and procurement between the canyon residents (particularly Chetro Ketl's) and those of the Escavada community in a situation analogous to the ties connecting Chaco with Bis sa'ani, a Chacoan outlier community situated on the Escavada Wash to the east of Alto (Breternitz et al. 1982). Alternatively, RS 35 may have facilitated traffic towards Tsin Kletzin from the Escavada area, instead. Ceramics assemblages found along it are from the early A.D. 1100s (Table 5.5), which indicates use contemporary with the communities it joins.

The proximity of Chetro Ketl to three or more stairways leading to RS 35 and RS 32 suggests considerable influence and traffic originating from Chetro Ketl. Of course, a number of roads also connect Pueblo Alto to the Escavada community, and others are suspected between the latter and Hungo Pavi and Peñasco Blanco. Thus, road ties between the canyon greathouses and the Escavada community suggest much interaction through the movement of people and goods, although the exact nature of the interaction must await further investigation. Different physical attributes may help to

Table 5.5. Ceramic samples from garden terraces (RS 28 and RS 31) between Pueblo Alto and Chetro Ketl (see Figure 5.2).

	Lino Gray	plain gray	narrow neckbanded	unclass. ident. corr.	PII indent. corr. rim	PII-III indent. corr. rim	PIII indent. corr. rim	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	Reserve B/w	unclass. Cibola mineral	plain whiteware	Toadlena B/w	unclass. Chuska carbon	Kana'a B/w	Cortez B/w	Mancos B/w	McElmo B/w	unclass. White Mt. redware	unclass. Tsegi orangeware	Total	%
RS 28:	1	11	2	10	1			15	1	7	17	2	4	1	17	15	1	4	4	1					114	
%	1	10	2	9	1			13	1	6	15	2	4	1	15	13	1	4	4	1						103
Form:																										
bowl									1		4	1	4		1		1	4							16	14
jar	1	11	2	10	1			14		7	13	1		1	16	15			4	1					97	85
ladle								1																	1	1
Chuskan culinary	0	0	1 50%	1 10%	1 100%																					
Ware %				23% culinary							56% Cibola					13% unk	4% Chuska		4% Tusayan		1% Mesa Verde					101
Chuskan %				12%																						
RS 31:				59		3	1	2		4	12	3	3		9	13	1				2	1	2	1	116	
%				51		3	1	2		3	10	3	3		8	11	1				2	1	2	1		101
Form:																										
bowl										1	1		2		4	4	1				2	1	1		17	15
jar				59		3	1	2		3	11	3	1		5	9							1	1	99	85
Chuskan culinary				6 10%		0	0																			
Ware %				55% culinary							28% Cibola					11% unk	1% Chuska				3% Mesa Verde		1% White Mt.	1% Tsegi		100
Chuskan %				10%																						

separate local and regional roads, but data on these were not utilized here.

Road Function Suggested by the Material Culture

Although the economic aspects of the Chacoan road system have at times been stressed (e.g., Ebert and Hitchcock 1980; Ebert and Lyons 1976:8-9), little effort has focused upon verifying this from road-associated artifacts. Previous collections have been made from the canyon roads, but only recently have such materials been analyzed and interpreted. It is known from these collections that ceramics comprise the major material recoverable from the Chacoan roads. Ceramics, therefore, are the primary artifact class with which to appraise road function and period of use.

Verification of Ceramic Association with Roads

Morenon (1977b) was the first to demonstrate that artifacts tended to concentrate along roads, although his samples were exceedingly small. Otherwise, there had been little work to verify that ceramics on roads actually related to road use. Anasazi ceramics in Chaco Canyon, in particular, seem to be found everywhere beyond house site peripheries, even on Archaic sites (Hayes 1981:19). Pottery is abundant along the strips of bedrock bordering the canyon in the same areas that roads are readily apparent. To avoid the problem of monitoring ceramics unrelated to road use, scatters were examined just above road stairways, where breakage related to stair and road use was presumed to have occurred. In addition, three transects along strips of bench bedrock perpendicular to obvious on-the-ground roads (i.e., curbed segments in the vicinity of Pueblo Alto, Pueblo Bonito, and Chetro Ketl) were monitored to assess whether ceramics along the roads were derived from road use. The results from the transects revealed that sherd density is associated with road proximity and is indicative of behavior related to road use and maintenance (Figure 5.6).

Ceramics are sparse or absent well beyond the roads and increase in density as the road is approached. Highest densities are immediately peripheral to the roads, where sweepings are likely to have been deposited, and lower densities are found directly within the road. These across-the-road samples were done in select areas of minimal topographic, geologic, and environmental diversity, so that artifact densities should reflect cultural, not natural, processes. In these samples, however, there was no discernible temporal or typological change in the ceramic assemblages within the road and beyond, which suggests relatively short-term use of the roads, primarily in the last half of the A.D. 1000s. It is thus unlikely that activities unrelated to road use would generate ceramics that followed the road alignments. Nials (1983) reports that bedrock detritus litters the road edges in a similar fashion, probably as a result of maintenance and sweeping activities.

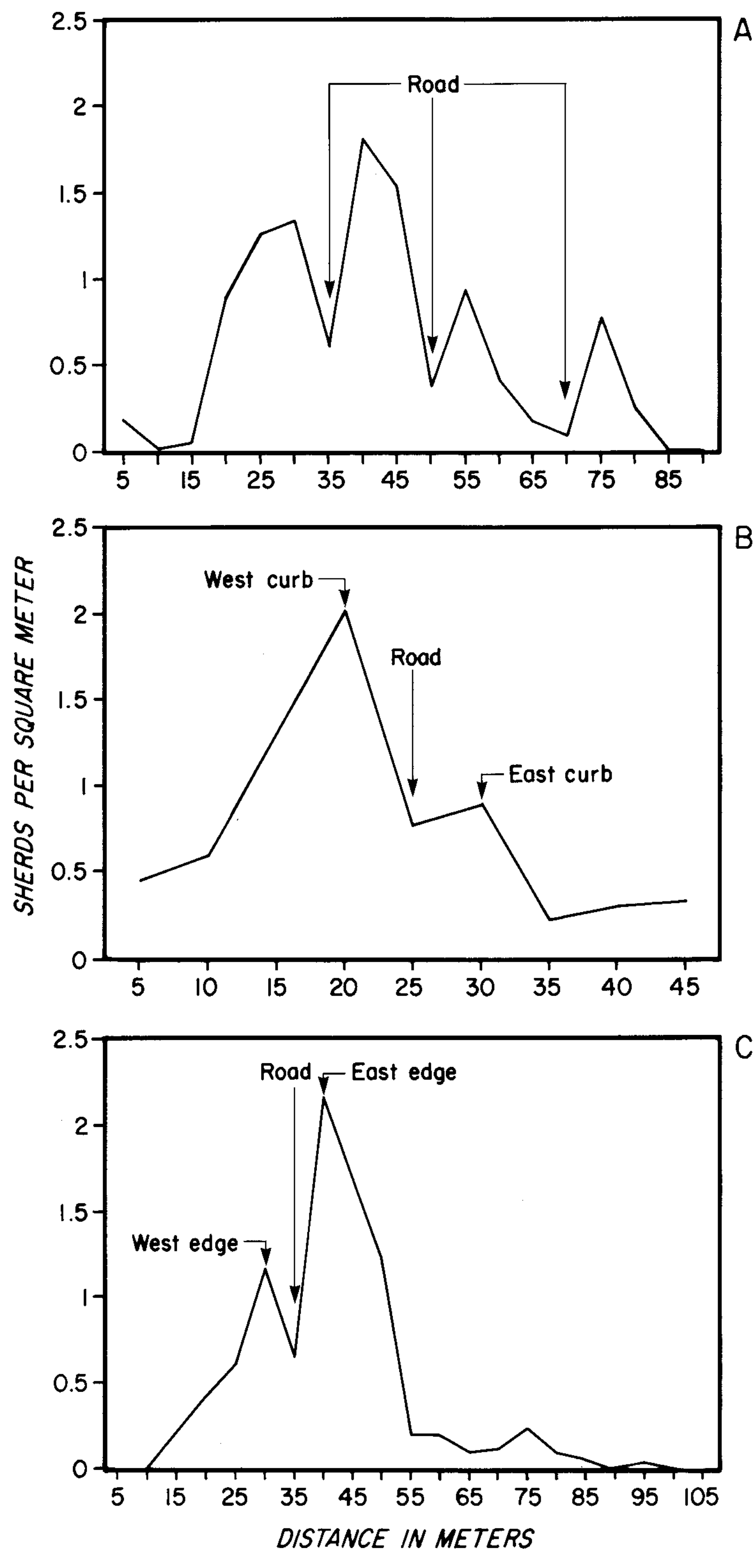


Figure 5.6. Sherd density variation along transects set perpendicular to visible prehistoric road alignments. A) Across the last flight of steps ascending towards Pueblo Alto from the Talus Unit and Chetro Ketl along RS 40 (Transect 1). B) Across RS 40 W just above the Talus Unit (Transect 5). C) Across RS 33 between Pueblo Alto and Pueblo Bonito (Transect 8).

Road Function Suggested by Ceramics

At the onset of the road study, it was expected that cultural material, particularly sherds, would mirror house inventories. Preliminary work by Morenon (1977b) suggested that this was the case for at least the Great North Road. Both local and nonlocal materials presumably were road transported, even if for a short distance, but ceramics made at a site would not need transport if they were consumed at the point of manufacture. Therefore, roads might yield higher ratios of trade (nonlocal) ceramics than would house sites. Although ceramics might be both imported and exported, Toll (1981) stressed the problems of producing local pottery. It is certain that many of the ceramics in Chaco Canyon during the A.D. 1000s and 1100s were imported, particularly Chuskan vessels, which occur in large numbers at the canyon sites (Toll 1981; Toll 1984; Toll et al. 1980).

In light of the importance of imported ceramics, it might be postulated that if road transport was primarily for importing goods, then higher ratios of imports would be found on the roads when compared with site assemblages. It also follows that roads would yield differential ratios of trade ceramics depending on the proximity of the road to the region of procurement. For instance, ceramics made in the San Juan region were expected to dominate assemblages or to be found in increased frequencies on roads leading into the canyon from the north as suggested by Morenon's (1977b) work. Tusayan and Chuskan ceramics, produced in northeastern Arizona and northwestern New Mexico, were expected to be found in large numbers along the western Chacoan roads. Conversely, some pottery that may have been locally made (some Gallup, Chaco, and Chaco-McElmo Black-on-white) found on the Great North Road suggests export to Chacoan outliers (Morenon 1975:7), such as the Salmon Ruin (Franklin 1980).

Thus, it is with some surprise that Chuskan and other imported vessels rarely occurred along the roads examined in the central canyon area and in the vicinity of Peñasco Blanco. This discrepancy may be related to different modes of transportation that depend on vessel size and distance of travel. Some vessels may be hand carried and as a consequence more prone to breakage, while others may be restrained by packs and nested for long-range transportation as is practiced today in Yucatan (Thompson 1958:Figure 28) and Guatemala (Reina and Hill 1978:Plate 382). Furthermore, some vessel classes are likely to be road transported only to their destinations, while others may constantly be on the move outside the home.

Obtaining water in Chaco must have required much water jar movement along the roads. These jars were probably hand carried or set on the head as in historic puebloan use (e.g., Garcia-Matson 1979:Figure 8; Voth 1903:Plate 92). Ultimately, most would be broken in service during transport. All ceramic assemblages examined on the canyon roads for this study were overwhelmingly dominated by whiteware jar sherds (Tables 5.3-4, 6-9), although this alone does not demonstrate that breakage was the result of

Table 5.6. Ceramic samples from roads northeast of Chetro Ketl (RS 32 and RS 35) (see Figure 5.2).[a]

	plain gray	narrow neckbanded	unclass. indent. corr.	PII-III indent. corr. rim	PIII indent. corr. rim	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	unclass. Cibola mineral	plain whiteware	Newcomb B/w	Chuska B/w	unclass. Chuska carbon	Kana'a B/w	Mancos B/w	McElmo B/w	unclass. White Mt. redware	unclass. Tsegi orangeware	Total	%
RS 32 (entire strip):																							
1971 Vivian		1	4		1	5		2	7	1	1	9	18								1	50	
1972 Hayes	4		4	2		2			4	1	1	12										30	
1981 Windes	1	1	4			7		4	7			21	16	1	1				1			64	
Total	5	2	12	2	1	14		6	18	2	2	42	34	1	1				1		1	144	
%	3	1	8	1	1	10		4	13	1	1	29	24	1	1				1		1		100
Form:																							
bowl						2		2	2		1	7	2		1						1	17	12
jar	5	2	12	2	1	12		4	16	2	1	35	32	1					1			127	88
Chuskan culinary	0	0	1 8%	0	0																		
Ware %	15% culinary					58% Cibola							24% unknown	1% Chuska				1% Mesa Verde			1% Tsegi		100
Chuskan %	5%																						
RS 35:																							
TRANSECT 6:	5		44	1	1	11	1	2	34		6	73	145		2	6	2	5		1	1	340	
%	1		13	T	T	3	T	1	10		2	21	43		1	2	1	1		T	T		99
Form:																							
bowl						3	1		9		4	23	11		1	2		2		1	1	58	17
jar	5		44	1	1	8		2	25		2	50	133		1	4	2	3				281	83
ladle													1									1	T
Chuskan culinary	2 40%		8 18%	0	0																		
Ware %	15% culinary					37% Cibola							43% unknown	2% Chuska			1% Tusayan	1% Mesa Verde		T White Mt.	T Tsegi		99
Chuskan %	20%																						

[a]T= trace (less than 0.5%).

Table 5.7. Ceramic samples from along the Pueblo Alto - Talus Unit - Chetro Ketl routes (RS 40) (see Figure 5.2).[a]

	plain gray	narrow neckbanded	unclass. indent. corr.	PII indent. corr. rim	PII-III indent. corr. rim	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	unclass. Cibola mineral	plain whiteware	Newcomb B/w	Chuska B/w	Toadlena B/w	Toadlena/Nava B/w	unclass. Chuska carbon	Sosi/Black Mesa B/w	unclass. Tusayan whiteware	Mancos B/w	McElmo B/w	Forestdale Smudged	Puerco B/r	unclass. White Mt. redware	Tusayan B/r	unclass. Tsegi orangeware	Total	%
'71 Vivian study (scattered tests):																													
Subtotal	3	2	23			9	1	30	143	13	4	109	119		4	3	2	2	2		3	2						474	
%	1	T	5			2	T	6	30	3	1	23	25		1	1	T	T	T		1	T							99
TRANSECT 1 (across 29SJ 1980):																													
Subtotal	4		39	2		4		7	39		1	37	125		4			2			1						1	266	
%	2		15	1		2		3	15		T	14	47		2			1			T						T		100
TRANSECT 2 (at road fork):																													
Subtotal	3	1	18			3		12	50			23	101	1							1					1	1	215	
%	1	T	8			1		6	23			11	47	T							T					T	T		97
TRANSECT 3 (above 29SJ 1555):																													
Subtotal	14	10	75		1	12		21	73	2	1	85	199			1		7			3	2		1	3		1	511	
%	3	2	15		T	2		4	14	T	T	17	39			T		1			1	T		T	1		T		99
TRANSECT 4 (above 29SJ 1562):																													
Subtotal	5	2	16	2		7		12	140	12	1	89	74		6			1	1		2							370	
%	1	1	4	1		2		3	38	3	T	24	20		2			T	T		1								100
TRANSECT 5 (above Talus Unit 1):																													
Subtotal	2	1	19					17	67	8	4	87	204			5		9		4	3		1				1	432	
%	T	T	4					4	16	2	1	20	47			1		2		1	1		T				T		99
Total	31	16	190	4	1	35	1	99	512	35	11	430	822	1	14	9	2	21	3	4	13	4	1	1	3	1	4	2268	
%	1	1	8	T	T	2	T	4	23	2	T	19	36	T	1	T	T	1	T	T	1	T	T	T	T	T	T		99
Form:																													
bowl						8	1	12	41	2	1	52	35	1		1		4	2	2	7	1	1	1	1	1	3	134	8
jar	31	16	190	4	1	27		86	471	33	10	378	787		14	8	2	17	1	2	6	3			2		1	1659	92
ladle								1																				1	T
Chuskan culinary	3 11%	4 25%	56 29%	1 25%	0																								
Ware %	11% culinary					50% Cibola							36% unknown	2% Chuska					T Tusayan		1% Mesa Verde		T smudg	T White Mt Red		T Tsegi Orange			100
Chuskan %	26																												

[a]T = trace (less than 0.5%).

Table 5.8. Ceramic samples from along the Pueblo Alto-Pueblo Bonito road (RS 33) (see Figure 5.2).[a]

	plain gray	narrow neckbanded	unclass. indent. corr.	PII indent. corr. rim	PII-III indent. corr. rim	Red Mesa B/w	Escavada B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	unclass. Cibola mineral	plain whiteware	Chuska B/w	Toadlena B/w	Toadlena/Nava B/w	unclass. Chuska carbon	Black Mesa B/w	Sosi B/w	Mancos B/w	McElmo B/w	unclass. White Mt. redware	unclass. Tsegi orangeware	LaPlata B/r	unclass. San Juan redware	Total	%
1971 Vivian testing:																											
Subtotal	3		34	1		5	2	3	24		17	31	44	3		1	1		1		1		1	1	1	174	
%	2		20	1		3	1	2	14		10	18	25	2		1	1		1		1		1	1	1		105
TRANSECT 7 (below 29SJ 1567):																											
Subtotal	1	1	6		1	1		2	11		2	23	31		1						1					81	
%	1	1	7		1	1		2	14		2	28	38		1						1						97
TRANSECT 8 (across road):																											
Subtotal	3	8	44	1	1	7		15	41	2	26	75	286	2	6		19	4		3	3	1	8			555	
%	1	1	8	T	T	1		3	7	T	5	14	52	T	1		3	1		1	1	T	1				100
Total	7	9	84	2	2	13	2	20	76	2	45	129	361	5	7	1	20	4	1	3	5	1	9	1	1	810	
%	1	1	10	T	T	2	T	2	9	T	6	16	45	1	1	T	2	T	T	T	1	T	1	T	T		99
Form:																											
bowl						1	2	5	13		9	13	19	1	4		4	3		1		1	5	1	1	83	10
jar	7	9	84	2	2	12		15	63	2	36	114	342	4	3	1	15	2		2	5		4			725	90
ladle												2														2	T
Chuskan culinary	0	0	23 27%	0	1 50%																						
Ware %			13% culinary						35% Cibola				45% unk		4% Chuska			1% Tusayan		1% Mesa Verde		T White Mt.	1% Tsegi	T San Juan			100
Chuskan %			23%																								

[a]T = trace (less than 0.5%).

Table 5.9. Ceramic samples from RS 1 and stairs 29SJ 2388 along RS 6, both along routes leading east or northeast from Peñasco Blanco. The numerous Basketmaker ceramics are intrusive from nearby sites.

	plain gray	wide neckbanded	unclass. indented corr.	LaPlata B/w	Red Mesa B/w	Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	unclass. Cibola mineral	plain whiteware	Chuska B/w	unclass. Chuska carbon	Mancos B/w	Total	%
RS 1:																
TRANSECT 10:	9	2	3	1	1		4		4	6	14				44	
%	20	5	7	2	2		9		9	14	32					100
TRANSECT 11:	9	1	4		3	2	3			9	13	1	2		47	
%	19	2	9		6	4	6			19	28	2	4			99
Total	18	3	7	1	4	2	7		4	15	27	1	2		91	
%	20	3	8	1	4	2	8		4	16	30	1	2			99
Form:																
bowl				1	3		3		3	4	3	1			18	20
jar	18	3	7		1	2	4		1	11	24		2		73	80
Chuskan culinary	1 6%	0	5 71%													
Ware %		31% culinary					36% Cibola				30% unknown	3% Chuska				100
Chuskan %		21%														
29SJ 2388 stairs:	1		9			1	6	1	1	4	9			1	33	
%	3		27			3	18	3	3	12	27			3		99
Form:																
bowl						1	3			3					7	21
jar	1		9				3	1	1	1	9			1	26	79
Chuskan culinary	0		1 11%													
Ware %		30% culinary					39% Cibola				27% unknown			3% Mesa Verde		100
Chuskan %		10%														

hauling water. More convincingly, the few whiteware jar rims observed (n = 61) along the roads revealed a preponderance of ollas, or water-storage jars (75 percent), with small numbers of pitchers (13 percent) and canteens (11 percent). Culinary-jar fragments, normally comprising half of the sherd assemblages from excavated house sites, were far below normal proportions with a single exception noted below, although massive numbers of the Chuskan variety must have been carried to the canyon greathouses along the roads. On the roads, culinary ceramics rarely comprised 20 percent of the total and often was half that.

In summary, most canyon ceramic breakage along roads was related to jar transport, particularly whiteware storage jars. Water would be a major requirement for inhabitants for drinking, mortar preparation, and pot agriculture, particularly at the mesa-top pueblos where water was located at some distance. Foodstuffs may also have been carried in large jars.

The ceramic collection recovered from the debris at the base of the 29SJ 1936 stairs of RS 33, just west of Pueblo Bonito, during the 1972 survey was a radical departure from the norm set by other road data. It yielded the highest percentages of bowls, culinary jars, and Chuskan pottery of any road sample (Table 5.10). In these respects, the sample was like any examined at the numerous house mounds and middens in the canyon. Its exception to the norm may be explained by behavior unrelated to road use, either from construction of the stairs or refuse derived from the small talus house nearby.

Other goods undoubtedly moved along the roads but there is little physical evidence for them. These are likely to have been perishable items or items minimally prone to accidental breakage and discard. Chipped stone debris is second to ceramics in frequency along the roads but almost always is limited to a very few pieces. Often, chipped stone was absent on the roads. The exception occurred along RS 35 between Chetro Ketl and the Escavada community. A transect along this route yielded a high density of chipped stone (5.2 per m^2; n = 179) from several sources, including 7 percent Washington Pass chert from the Chuska mountains about 83 km to the west. This chert is numerically abundant in the nearby Chetro Ketl, Pueblo Bonito, and Pueblo Alto trash mounds (Cameron and Windes 1980-1981 field notes) and may derive from ritual activities (Toll and McKenna 1983:154-155). The road debitage does not result from primary core reduction or tool manufacture, and thus, other sources of behavior (including ritual) must be considered. Other materials were so few in number that little can be said of them regarding road-use behavior.

Dating the Roads

Dating the roads generally relies on association with house sites and, ultimately, ceramics. The long occupation evident at many sites and the relative scarcity of road-related materials outside the canyon, how-

Table 5.10. Ceramic sample from the debris at the base of the 29SJ 1936 stairway west of Pueblo Bonito.[a]

	plain gray	wide neckbanded	narrow neckbanded	unclass. indented corr.	PII indented corr. rim	unclass. rim fillets	Gallup B/w	Chaco-McElmo B/w	unclass. Cibola mineral B/w	plain whiteware	Chuska B/w	unclass. Chuska corbon	Black Mesa B/w	unclass. Tusayan whiteware	McElmo B/w	unclass. Mesa Verde carbon B/w	unclass. White Mt. redware	unclass. Tsegi orangeware	unclassified San Juan redware	Total	%
29SJ 1936 stairs:																					
1972 survey	4	1	7	71	1	17	18	3	31	9	3	3	1	3	3	6	5	1	1	188	
%	2	1	4	38	1	9	10	2	16	5	2	2	1	2	2	3	3	1	1		105
Form:																					
bowl							4	2	9	3	3	3	1	3	3	4	5	1	1	42	22
jar	4	1	7	71	1	17	14	1	22	3						2				143	76
ladle										3										3	2
Chuskan	1	0	3	27	0	7															
culinary	25%		43%	38%		41%															
Ware %			54% culinary					28% Cibola		5% unknown	3% Chuska		2% Tusayan		5% Mesa Verde		3% White Mt.	1% Tsegi	1% San Juan		102
Chuskan %			38%																		

[a]Note that the relative frequencies of bowl, culinary, and Chuskan ceramics are the highest of any road or road-related feature sampled.

ever, have hampered chronological assessment of the Chacoan roads. Fortunately, Chaco Canyon affords the best potential for using site association and road materials because of the extent of excavation in road-related greathouses and the preservation of materials along roads.

Road-associated ceramics are apt to suffer from factors typical to surface surveys. Beyond Chaco, roads are commonly buried along with the artifacts. Among the many exposed patches of bedrock on the benches above Chaco, however, detritus often traps cultural material including that along the roads. Exposure, unfortunately, increases the effects of sand blasting and other detrimental effects to the ceramics, leaving most without paint and slip. Animal and human traffic have also reduced the size and number of the ceramics.

Even with these hazards, tabulations of ceramics collected during R. Gwinn Vivian's 1970-1971 investigations and the 1972 Chaco Center site inventory, and the noncollection counts made by the author in 1981-1983 (Tables 5.7 and 5.8) are remarkably consistent despite the different collection techniques. All ceramics from each project were re-sorted by the author to reduce variability of the typological assignments. The most noticeable bias in the collections was the absence of plain whitewares from the 1972 inventory survey, the result of collection methods (Hayes 1981:15).

Seriation of Road Ceramics

Recent efforts to date roads have relied on assigning dates to ceramic types present on roads (Kincaid et al. 1983). The sources for assigning dates in some cases were derived from work (i.e., Breternitz 1966) that had not been revised in decades. With the exception of the Peñasco Blanco area, the canyon road ceramics sampled appear to be a homogeneous lot, not biased by long-term deposition. A new multidimensional scaling program, KYST-2A (Kruskal et al. 1978), offers an objective, replicable seriation of taxonomic pottery assemblages and is useful for the present problem of dating road ceramics (see Chapter 8).

The results (Figures 5.7 and 5.8) suggest that refuse on the canyon road segments dates between about A.D. 1050 and 1140. In all program runs, the earliest positioning (at about A.D. 1050) was from RS 32, the rimrock road just east of Chetro Ketl, although a few late sherds suggest its continued use into the early A.D. 1100s. RS 28, a terrace, also seriated early but askew of the main curve because of the mixture of late and early sherds in the assemblage (Table 5.5). The early sherds may be unrelated to terrace activities. The remainder derive from the late A.D. 1000-A.D. 1100s. The Pueblo Alto-Talus Unit-Chetro Ketl roads (Table 5.7), the area around the Pueblo Alto-Cly's Canyon road (Table 5.3), those from the stairs north of Peñasco Blanco (RS 8S)(Table 5.4), and the road east to the Escavada Wash from Peñasco Blanco (Table 5.9) fall into the span between A.D. 1050 and 1100. Ceramic-type ratios of painted sherds

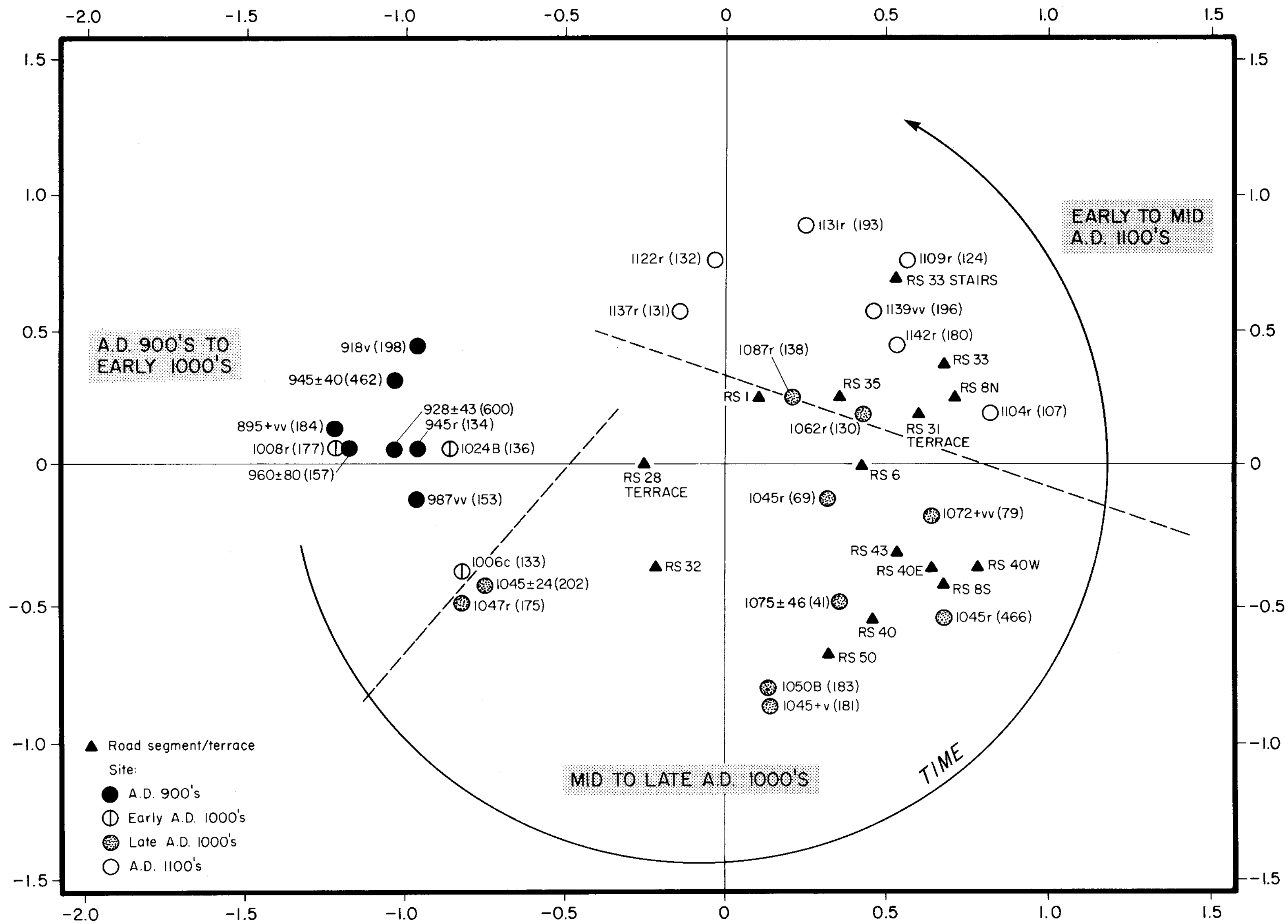


Figure 5.7. Multidimensional scaling plots showing the temporal associations of prehistoric roads and terraces (RS 28 and RS 31) with dated samples using the KYST-2A program in 5-dimensional space. The 2 x 1 dimension is shown. The stress factor is .12.

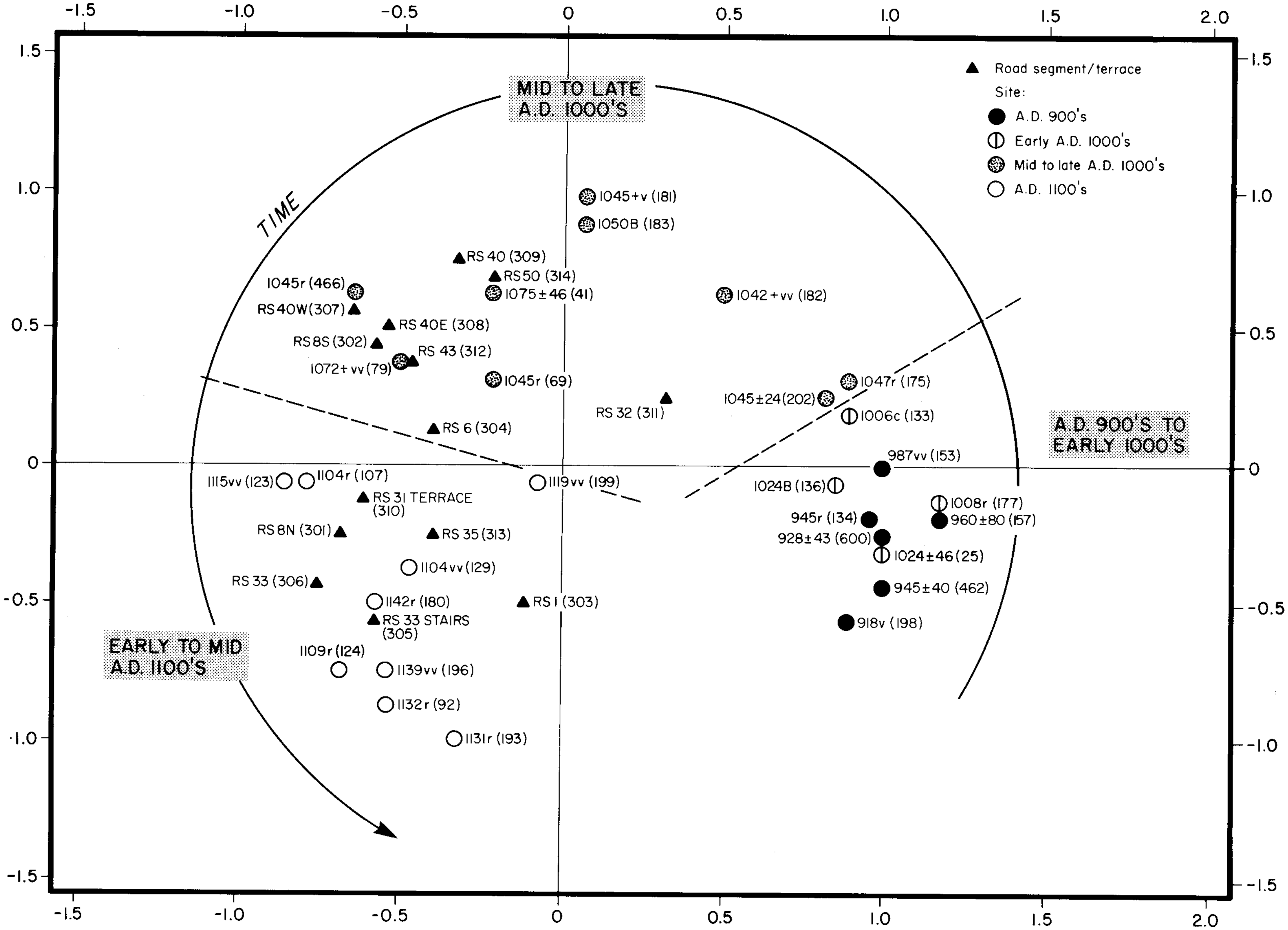


Figure 5.8. Multidimensional scaling plots showing the temporal associations of prehistoric roads and a terrace (RS 31) with dated samples, using the KYST-2A program in 5-dimensional space. The 2 x 1 dimension is shown. The stress factor is .13. Program is slightly modified from Figure 5.7.

from these are much like those of the large canyon greathouse trash mounds, although culinary discard differs.

Recent work by the BLM (Kincaid et al. 1983) has suggested that roads south of Chaco Canyon are much earlier (ie., A.D. 900s), although John Stein (personal communication 1983) believes that this inference is false and that the South Road reflects an A.D. 1000s use. The only road examined outside of Chaco during this study was a segment (RS 50) of the South Road that led southwest from Kin Ya'a (a Chacoan outlier near Crownpoint, New Mexico) onto the nearby mesas. In all KYST plots, this road clearly associates with the A.D. 1050-1100 span, supporting Stein's contention. The road assemblage (Table 5.3) is virtually identical to the painted ceramic assemblages associated with the main Kin Ya'a trash mounds and presumed to be contemporary with the late A.D. 1000s tree-ring dates from the site (see Volume II).

Early A.D. 1100s use is suggested for the Alto-Bonito segments (Table 5.8), the Chetro Ketl-Escavada community road (RS 35)(Table 5.6), the Escavada Wash/Ah-shi-sle-pah Road (RS 8N) north of Peñasco Blanco (Table 5.4), and RS 1 extending east up Chaco Canyon from Peñasco Blanco (Table 5.9). The road(s) leading north out of Pueblo Alto are also post-A.D. 1100 (Kincaid et al. 1983; Morenon 1975) and ceramically are a continuum of the Alto-Bonito road. Other roads in the canyon yielded few or no ceramics, partly because of aeolian deposits. Interestingly, the road to Tsin Kletzin crosses terrain identical to that around Pueblo Alto but yielded almost no ceramics. Ceramics were also absent along RS 7 between Pueblo Alto and Peñasco Blanco. This may suggest that use patterns differed between these bare roads and those roads littered with refuse.

To summarize, seriation suggests that formal Chacoan roads first appeared during the mid-A.D. 1000s, coincidental with other signs of the emerging Classic Bonito phase. Their use appeared to be relatively short lived with little evidence of extensive use beyond about A.D. 1140 or so. At Pueblo Alto, Kin Ya'a, and Peñasco Blanco, road refuse indicates that use along some segments was relatively brief and may have lasted only between about A.D. 1050 and 1100. In addition, ceramics at two terraces (RS 28 and 31) reflect early A.D. 1100s activities with some possibility of earlier use for RS 28. Because of the profusion of early and late types associated with RS 28, it plotted poorly (Figure 5.8) and consequently was dropped from the second seriation.

Conclusions

Roads around Pueblo Alto enter directly into the greathouse or pass by structures (paired room units) associated with Alto. All road traffic going north from Pueblo Bonito, Pueblo del Arroyo, Chetro Ketl, and Talus Unit 1 would have borne inspection by the inhabitants of Pueblo Alto. Thus, Alto's role for controlling access in and out of Chaco Canyon seems justified by the juxtaposition of the roads there. But not all roads around Alto may relate to long-range (regional) transport or communications. Roads leading to vital subsistence resources nearby may also have been necessary. Although we found no massed materials stored at Alto, the several paired-room units and the exterior rooms along the Alto wings appeared associated with roads (i.e., exterior doors open directly onto them; see Chapter 10) and, thus, the rooms are likely candidates for the storage of both local and regional transported road goods.

Despite widespread study of the roads, little is known of their actual function and association with most greathouses. The network of roads in the central canyon area provides some of the most illuminating data in this regard because of extensive work in that area's greathouses, the wealth of material culture found on the roads, and the on-the-ground clarity of the roads. Our knowledge of construction periods and length of occupation at Pueblo Alto, Pueblo Bonito, and Chetro Ketl suggest that Pueblo Alto was probably built as an initial step in expanding communications and exchange north along the Escavada Wash community in the early to mid-A.D. 1000s, and beyond to the San Juan River. Pueblo Alto, in turn, may have controlled all road traffic north of the central canyon area except for the two tangential roads running northeast from stairs east of Chetro Ketl to the cluster of sites along the Escavada Wash. At least one of these is intersected by a road connected to Alto by which some control over roads not in close proximity to Alto could have been maintained. Both the latter roads pass the Poco Site, northeast of Alto, which also may be a point of traffic control.

Nevertheless, not all roads appear to be regionally important. Some that interconnect canyon greathouses or sources for water and areas of potential agricultural use could serve only local functions. The attendant houses around Pueblo Alto all sit astride roads that appear nonregional in context. It is suggested that these (New Alto, Parking Lot Ruin, East Ruin, and Rabbit Ruin) served specific needs associated with use of the roads, although no physical evidence for entries into them has been produced and the relationship to the roads may be fortuitous for some of them. Lekson (Lekson and Judge 1978; Lekson 1984:269) believes that the greathouses built in the early A.D. 1100s, such as New Alto, were primarily storage facilities, and I would include the Parking Lot Ruin and the East Ruin under that use, too. If these facilities were primarily for storage, then a case for them being road related could be strengthened. Rabbit Ruin is a different story and may have been a domicile instead.

Chapter Six

The Architecture of Pueblo Alto and Construction Phases

An understanding of the periods of construction that contributed to the final form of Pueblo Alto is important for understanding other contemporary events at Alto and, possibly, elsewhere. Pueblo Alto, like many greathouses, underwent numerous additions and changes. Fortunately, the project was blessed with a site that did not suffer four centuries of building and renovation like nearby Pueblo Bonito, although the century of occupation at Pueblo Alto did produce some substantial changes. The stages of construction presented here is little changed from the version first published in Lekson (1984).

There is widespread knowledge of how buildings are added to, modified, and otherwise changed, but there is a poor understanding of hiatuses in greathouse construction that affected large parts of the horizontal building. Certainly, unused foundations that appear to underlie every greathouse, including Pueblo Alto, tell of major shifts in planning after the foundations were first set--a hiatus in construction (see Judd 1964:145). In Chaco there are also a number of instances where greathouses went through various stages of construction that followed an overall plan but were never finished. These examples are instructive on how greathouses were built, including Pueblo Alto.

There was some evidence at Pueblo Alto that suggested that it followed similar stages reflected in the unfinished greathouses. At least three of the latter are known. The best known, Judd's Northeast Foundation Complex (Judd 1964:143-153, Plate 45, Figure 11), is much more than a maze of overlapping foundations. The author's examination of the "foundations" in front of the Hillside Ruin revealed that almost 2 m of finished masonry-veneer walls capped by adobe rested on the foundations. Other examples, with shorter finished walls completed to an even height throughout the site, have been noted by Vivian and Mathews (1965:81) for the Headquarters Ruin and by Roberts (n.d.) for 29SJ 2384 below Shabik'eshchee Village (Plate 6.1).

The three unfinished houses also provide us with other insights about intervals that affected the completion of greathouses. These reflect the

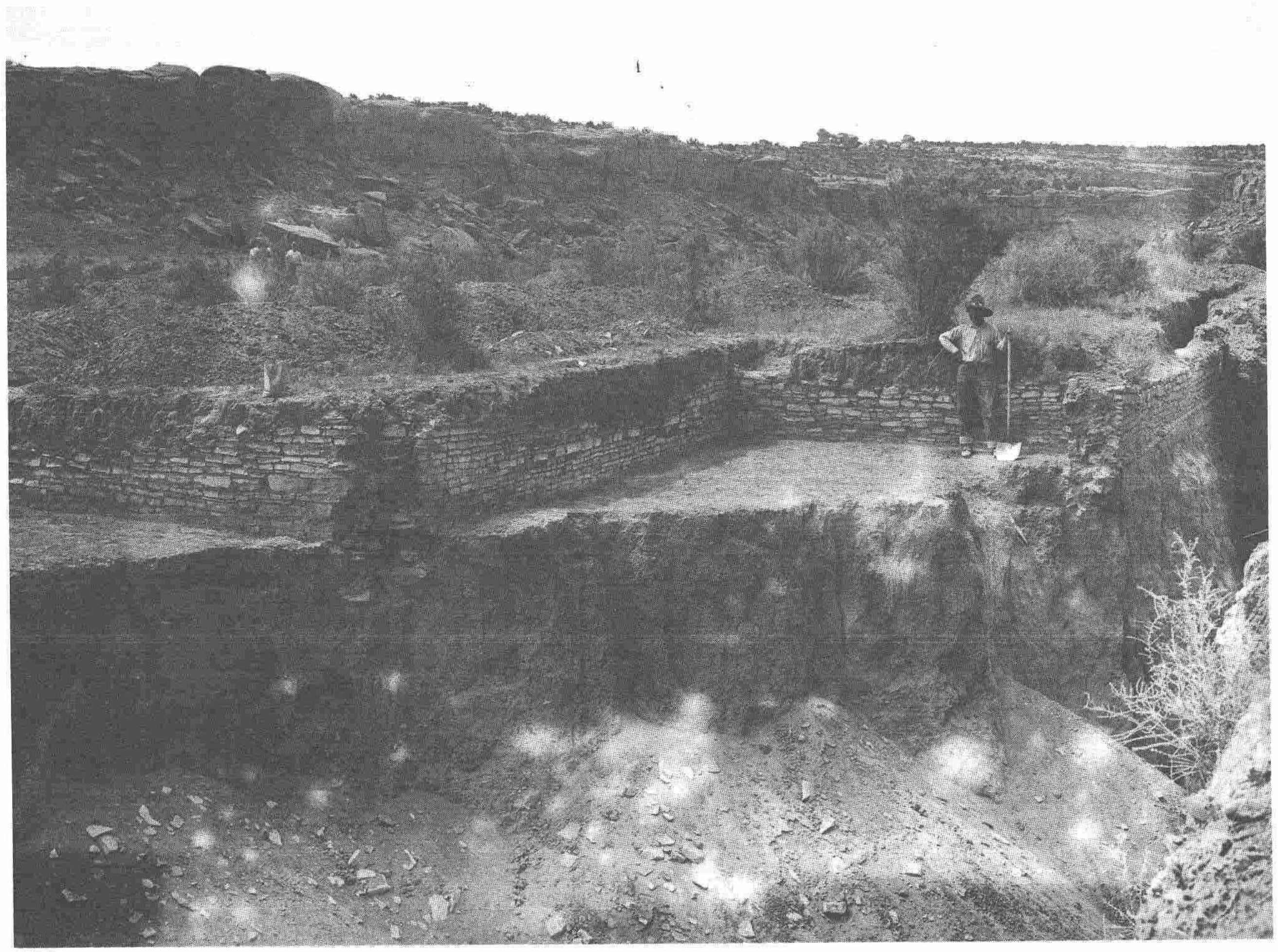


Plate 6.1. 29SJ 2384, an unfinished greathouse below Shabik'eshchee Village in Chaco Canyon. The site was cleared and tested by F. H. H. Roberts, Jr., in 1926. Note that the walls were partly built to the same height when construction ceased. Photo by Neil Judd. (© National Geographic Society.)

strategy of layered construction, that is, large horizontal sections of sites were built that consisted of only a few courses of masonry for individual construction episodes. Monumental architecture in medieval Europe was typical of this type of construction because of economic uncertainties and seasonal building (e.g., see James 1982:49-63, 133-138; Rodwell 1981: 126-127), clearly the basis for a model of Chacoan greathouse construction and economy.

Work at Pueblo Alto also suggested this strategy was operative but carried through to completion. For instance, a suggested break between construction of the foundations in the West Wing and the walls allowed aeolian deposits to occur between the stages of construction. Subtle changes in the shape and coursing of the masonry in Room 112 seemed to indicate another interval that affected continuous wall construction. A number of hiatuses appeared to affect both the horizontal and vertical construction of Alto, intervals that may have spread the primary construction across several years. It is proposed that future research designs need to examine the relationship between greathouse construction and the effects of staged construction on the socioeconomic workings of Chacoan society.

Aside from the possibility of layered, horizontal construction at Pueblo Alto and other greathouses, which was not anticipated and closely examined, a number of relevant observations pertinent to the final interpretation of the construction phases preface the main body of text. However, these do not supersede Lekson's (1984) detailed study of the construction techniques noted for the massive standing architecture found in Chaco Canyon. The interested reader is referred to that fine report for additional information.

Traditionally, wall abutment studies provide much of the evidence for intervals of construction. It was no different at Pueblo Alto, but in addition, the styles of masonry veneers, the types of stone and mortar used in the construction, and the symmetry of the overall construction provided information to guide interpretation of the construction stages. Short reviews of these various observations follow below.

Use Of Stone And Mortar In Construction

Wall Stone

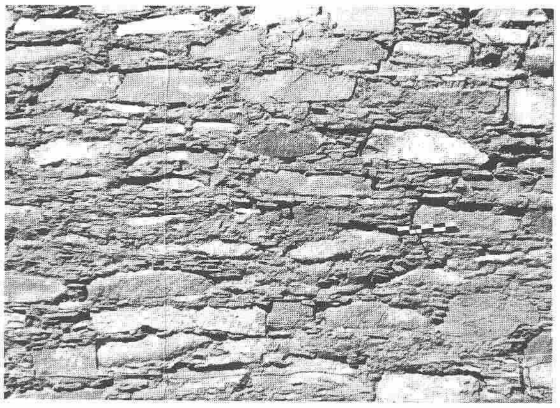
Pueblo Alto walls are thinner than canyon counterparts because of the lighter loads required by its single-story construction. These walls average about 40-60 cm thickness of core-and-veneer style (i.e., the wall core was filled with mortar and horizontal stone between two masonry facings. Masons creating the initial building relied on a well-indurated, light gray sandstone that is found in outcrops along the mesa top. One such quarry area (29SJ 1118) was tested in 1973 west of and adjacent to Cly's Canyon near the route of Road Segment 43 that ties Alto with Peñasco Blanco. This hard material is probably similar to the dark, brown, patinated stone that characterizes the early canyon greathouses and is very resistant to weathering. It occurs in thin sheets that must have been pried loose and then fractured across the bedding planes to form the slabs used for masonry.

Stone used in the initial construction was simply fractured to size and then utilized (Plate 6.2A), whereas by the mid-A.D. 1000s the exposed face of the larger stones was rounded by hammering and then smoothed by grinding (Plates 6.2B-6.2C). Later still, particularly with the use of the classic block-and-spall banding style (Plate 6.2D), the large stones, often of soft sandstone, were typically all ground on the exposed faces. Occasionally, these blocks would exhibit simple incised designs (Plate 6.3). Weathering has often roughened these softer blocks, so that the grinding is less noticeable.

By the late A.D. 1000s or early 1100s, builders preferred using primarily a soft, easily worked sandstone. This material occurs in a variety of brownish hues (brown, tan, yellow, pink, and red) in the Menefee formation along the lower cliffs in the canyon and contrasts with the earlier hard masonry. Large, rectangular blocks were shaped by pecking and then the dimple marks ground off from the face exposed in the wall--a hallmark of "McElmo" style masonry. Often small rooms and kivas, which characterize Stage V construction (this chapter) at Pueblo Alto, were built of the small, friable, tabular pieces of this material, without pecking and grinding of the exposed face, set one stone wide. This style is common at other canyon greathouses, for instance in the rooms added to the south exterior wall of Pueblo del Arroyo and in the small-house sites. The change in stone preference may be due to the exhaustion of earlier, easily obtained supplies that forced reliance upon more economic sources (Lekson 1984:21).

Mortar and Plaster

A variety of mud mixtures, all derived locally (see Appendices MF-H to MF-J), served the needs of the builders at Pueblo Alto for adhesives and finishing surfaces. As in modern construction, these ingredients were chosen for specific structural needs by alternating the ratios of sand, clay, caliche, and water. It appears that mortars as well as stone deteriorated in quality through time. On an intuitive level, two kinds of mortar were used, a hard, gray clay type for the early construction and a soft, tan sandy type in the late construction. Wall and roof mortars with a higher percentage of sand were used in conjunction with the soft sandstone. The hardest mortars, derived from the shales of the Menefee formation, were used in the primary walls and foundations. Some early foundations of soft, reddish, sandy mortar were noted (e.g., in Room 139), however. Unlike the sources of stone, it is difficult to believe that economy and availability were the major causes for varying qualities in mortars used for identical purposes, so other factors must explain the use of inferior materials.



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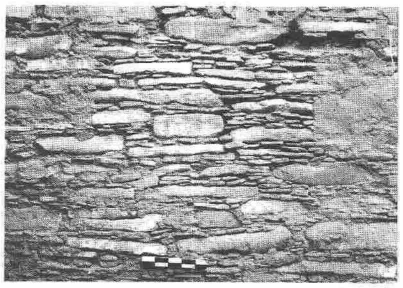

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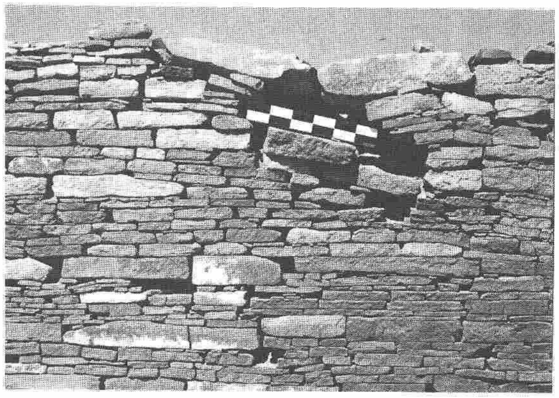

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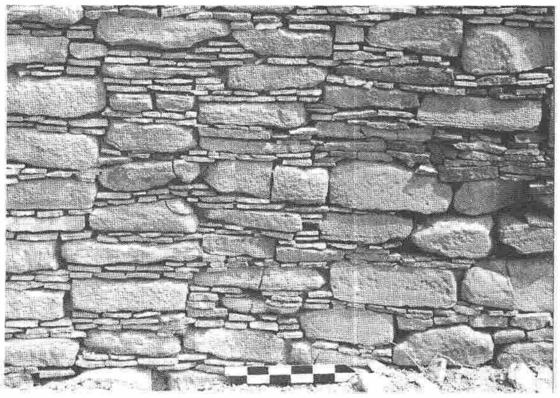

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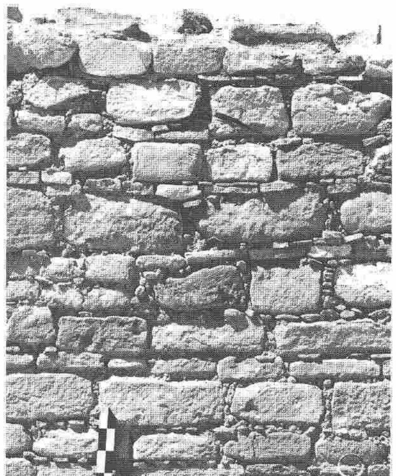

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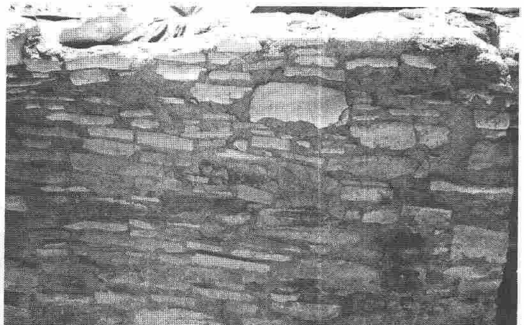

F

Plate 6.2. Changes through time in masonry veneer styles at Pueblo Alto. Note changes in size of large stones and spalls, and in the modification of the exposed stone face. All photos are to the same scale.

A) Room 145, north wall. Stage I construction. (NPS#13710.)
B) Room 110, west wall. Stage II construction. (NPS#17658.)
C) Room 181, east wall. Stage III construction. (NPS#13229.)
D) Room 101, north wall. Stage IV? construction. (NPS#12825.)
E) Kiva 5, outer south wall. Stage IV construction. 30-cm scale. (NPS#15041.)
F) Plaza Feature 1, Room 4, west wall. Stage V construction. 30-cm scale. (NPS#16423.)

Plate 6.3. A rare example of incised blocks incorporated into the wall masonry, Room 172, east wall. 30-cm scale. (NPS#13178.)

Mixtures of adobe with a high-sand, low-clay content were invariably used for plastering walls and floors (see Appendix MF-J). A sandy mixture was probably more economical to apply and smooth over surfaces than was a mucilaginous clay over surfaces, although the former undoubtedly wore out faster. Some plaza surfaces, nevertheless, did exhibit thick beds of hard clay, particularly along the western areas of the interior plaza.

Masonry Veneer Styles

A typology of wall-veneer facings and wall types has long been employed in Chaco (Hawley 1934:Plates 4-5, 12; 1937:Figure 3; 1938; Judd 1954:Plate 5; 1964:Plate 10; Lekson 1984:Table 2.1) to estimate periods of construction. At Pueblo Alto, the types proved useful for defining periods of construction, although the coeval styles used in the A.D. 1000s proved difficult to separate. Generally, Hawley's (1934) typology was used because it reflected greater stylistic variability than Judd's four types.

The sequence of building at Pueblo Alto (see below) indicated that the Central Roomblock was the earliest if Rooms 50 and 51 found beneath the roomblock are discounted. The early roomblock exhibited masonry veneer of rows of small chinks interspersed with rows of medium-sized blocks (Plate 6.2A) that approximates the Type II style of Judd, the Inferior Type III of Hawley (1934), and the Type 5 of Hawley (1937). This style was dated by Hawley (1934, 1937) between A.D. 1030 and A.D. 1070 based on her tree-ring work at Chetro Ketl and fits within the early A.D. 1000s construction interpreted for the roomblock. There was no Type I masonry, of chipped spalls and slabs set in abundant mortar, at Alto, a style clearly associated with A.D. 900s construction at Pueblo Bonito and Una Vida (see Lekson 1984). Other styles were found at Alto (Plate 6.2), but none matched exactly the ideal types illustrated by Judd and Hawley. In some cases, different styles could be found in the same wall facing or on opposite sides of the same wall, which suggests construction by a number of individuals who did not rigidly follow a prescribed pattern. The social correlates of masonry style, however, are presently unknown (see Lekson 1984:17). Unless otherwise stated, masonry styles identified in the chapter refer to those of Hawley (1934).

Abutment Studies

One of the primary goals of the wall clearing was to retrace the construction history of Pueblo Alto. It was important that the abutments be examined soon after wall clearing before they were stabilized. Besides wall masonry styles, considerable faith has often been placed in interpreting the construction sequence from abutment patterns. At Alto, however, we had limited success in utilizing abutment information, because walls were seldom simply butted or tied. Instead, a variety of techniques were used for the joining of walls (Figure 6.1), a problem not unique to Chaco (e.g., the Grasshopper Ruin: see Wilcox 1982:21).

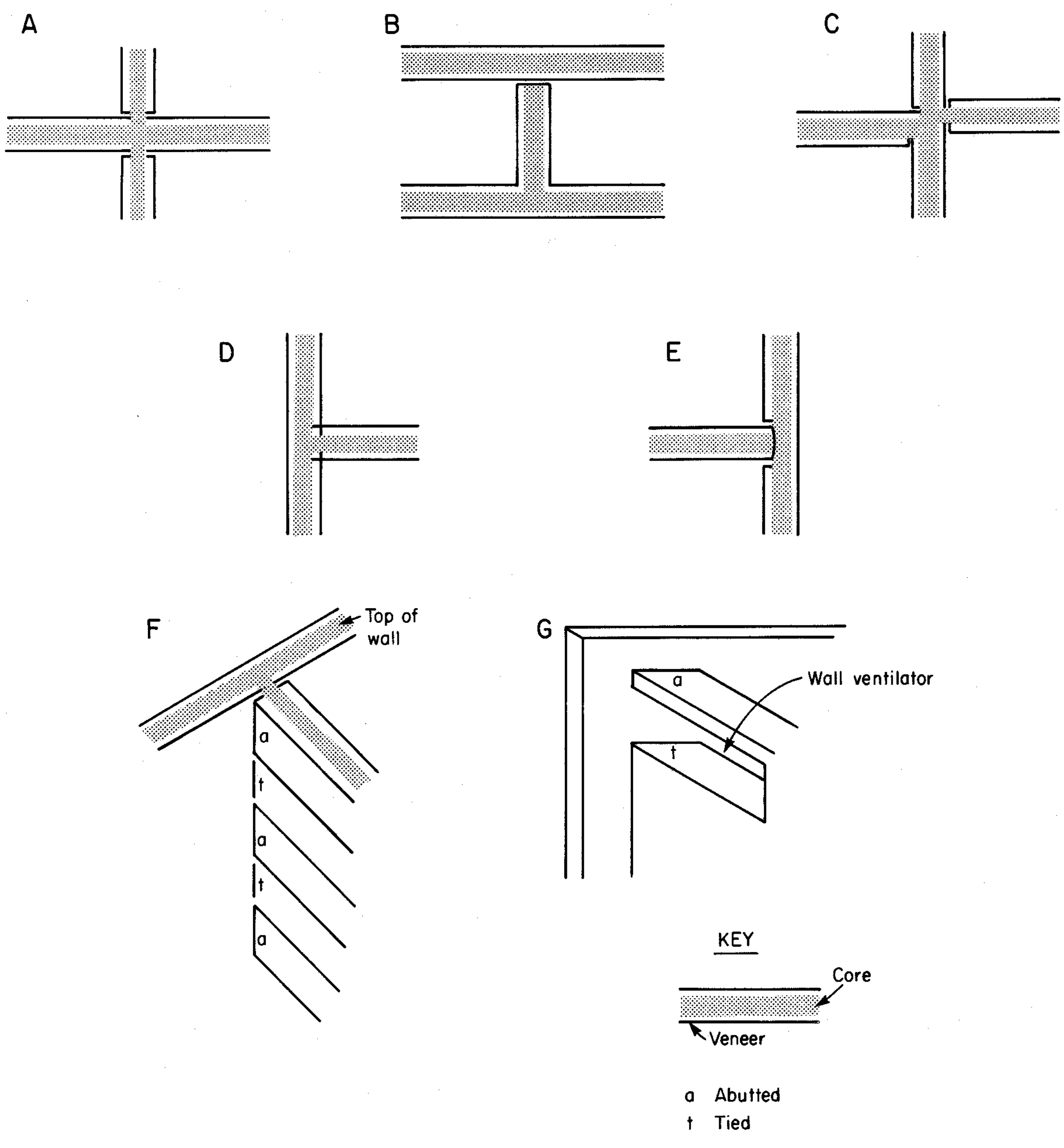

Figure 6.1. A variety of techniques were employed to join the walls of Pueblo Alto.

Commonly, the cores of Pueblo Alto walls were tied but the masonry veneer was not. This may have resulted from a common construction practice best observed at Wijiji that left vertical rows of stones projecting from the wall veneer in anticipation of tying future cross walls. It was not unusual to find a variety of techniques employed for the same junction. Sometimes the veneer on one side would be tied to the adjoining wall, while the opposite side would be butted. Or, a veneer might alternate between butting and tying along the same junction. Ventilators typically occurred at wall junctions, with the veneer or the entire wall above the ventilator butted and that underneath tied. The odd construction illustrated in Figure 6.1E was found just twice, both times in the north wall of Room 102, which was not excavated. Greathouse masons were not averse to partly dismantling a wall veneer in order to tie new cross walls, sometimes by inserting tie logs (e.g., in Room 229). The variation found at Alto made it difficult to verify the method or methods employed at a particular junction without unjustifiably deep, horizontal and vertical testing. Individual wall connections, of course, were generally uninformative. Without more rigorous studies (e.g., of mortar analyses), it is difficult to decipher the building sequence and the related hiatus duration on the basis of abutment studies alone.

Happily, other means used in conjunction with the abutment patterns assisted in determining the construction sequence. When a number of similar changes, such as butted walls or veneer styles, occurred in proximity, then an interlude was suspected. In these locations, wall veneer styles often changed *en masse*, and, along with breaks in the wall alignment symmetry, provided the strongest evidence for construction discontinuity with a hiatus of unspecified time. Independent verification of the length of the hiatus, however, must be derived from other lines of evidence.

Construction Phases

The Earliest Construction (Pre-Greathouse)

The earliest known construction found at Pueblo Alto was a pair of contiguous rooms (Rooms 50 and 51) beneath Rooms 142, 143, and 146 (Plate 9.3; Volume II, Figure 2.2). This pair appeared to represent a typical Pueblo II living room/storage room unit with an associated plaza. Their orientation was due east, that is, the living room area of Room 51, containing three floors and several features including a firepit, was east of Room 50, which was directly behind it and had but a single feature for two floors. A large firepit, an equally large heating pit, and three postholes just east of Room 51 mark the ramada and plaza that were probably associated.

Evidence for additional rooms built prior to the greathouse is lacking. Nearby, in Plaza Grid 8 to the south, is a deep, trash-filled hole in the bedrock. The ashy, soft nature of the trash, dominated by Red Mesa

Black-on-white and plain gray with no Gallup Black-on-white, suggests household refuse generated from Rooms 50 and 51. An abandoned pitstructure is suspected, although the Room 50-51 orientation suggests that another pitstructure may be located to the east.

This early complex should not be dismissed as unrelated to Pueblo Alto. Pueblo II buildings on the mesa top are extremely rare, and, thus, the location of this one may not be fortuitous. Archeomagnetic and carbon-14 dates in the early A.D. 1000s (Tables 8.4 and 8.8) suggested use of the two rooms immediately before the main Pueblo Alto construction during Stage I, so a hiatus may not exist. Furthermore, the wall foundations for the two rooms are 50 cm wide and not unlike those of the Stage I construction. Contemporary foundations exposed in small-house sites are notably less massive (e.g., McKenna 1984; Truell 1986).

It should be noted that earlier, presumably outdoor, surfaces marked by several large, basin-shaped pits extended under Rooms 50 and 51 (Volume II, Figure 2.22). A single archeomagnetic date of A.D. 980 $\pm$ 48 was obtained from one of the pits overlain by the main complex walls of Room 142. This was the earliest date from the site and was not unreasonable considering its stratigraphic position and association with a Red Mesa Black-on-white ceramic assemblage.

Stage I (A.D. 1020-1040): The Earliest Greathouse Construction

Stage IA

The wall abutment study shows a continuous outside wall along the east, north, and west sides of Pueblo Alto (Figures 6.2-6.5). This is also true (with three exceptions) of the next wall parallel to the outside wall(s). The initial impression of the site, later rejected, was of a single constructional event, including East and West Wings and the Central Roomblock.

Discrepancies in this sequence, however, led to alternative interpretations. Foremost was the deposition of trash in the rooms dominated by Red Mesa Black-on-white and plain gray, and without Gallup Black-on-white. In the West Wing, the assemblage lies <u>under</u> the lowest defined floors in excavated Rooms 103, 110, 112, and 229. Constructional debris occurs on the lowest floors or above, not with the underlying material. Conversely, in the Central Roomblock the same ceramic assemblage lies on the lower floors in association with wall construction debris in Rooms 138 and 139.

Second, there is a marked change in the room symmetry near the eastern and western ends of the Central Roomblock. The assumption here is that symmetry is more likely to be maintained during a single planned period of building rather than across construction episodes. Near the eastern end, this architectural change coincides with some discontinuities in the wall construction (e.g., walls are butted and change alignment). The same can be seen at the western end, although it is less clear.

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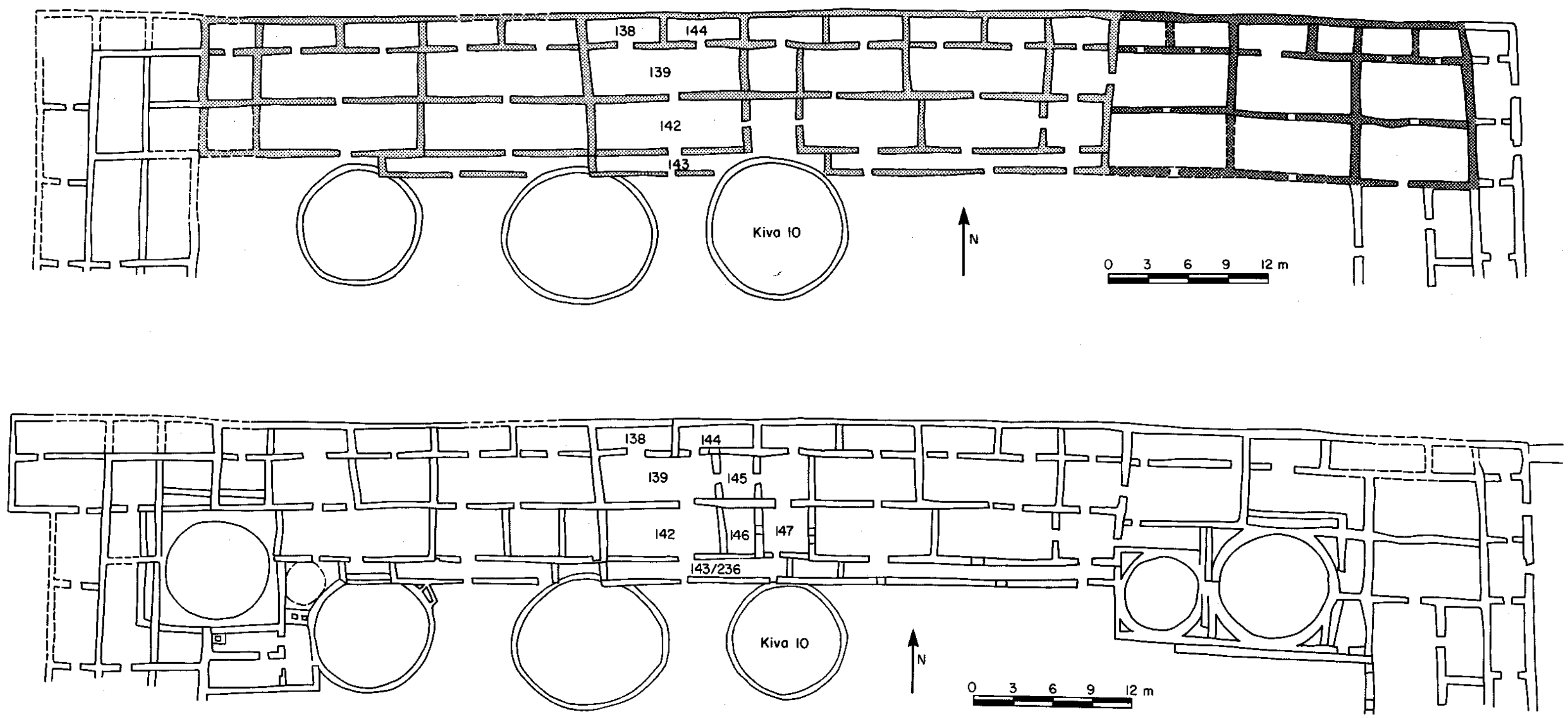


Figure 6.2. Wall plans of the initial (A) and modified (B) Central Roomblock (shaded). Lightly shaded section represents Stage IA and IB construction, and the dark shaded section represents Stage IC construction. Numbered rooms represent excavated suite.

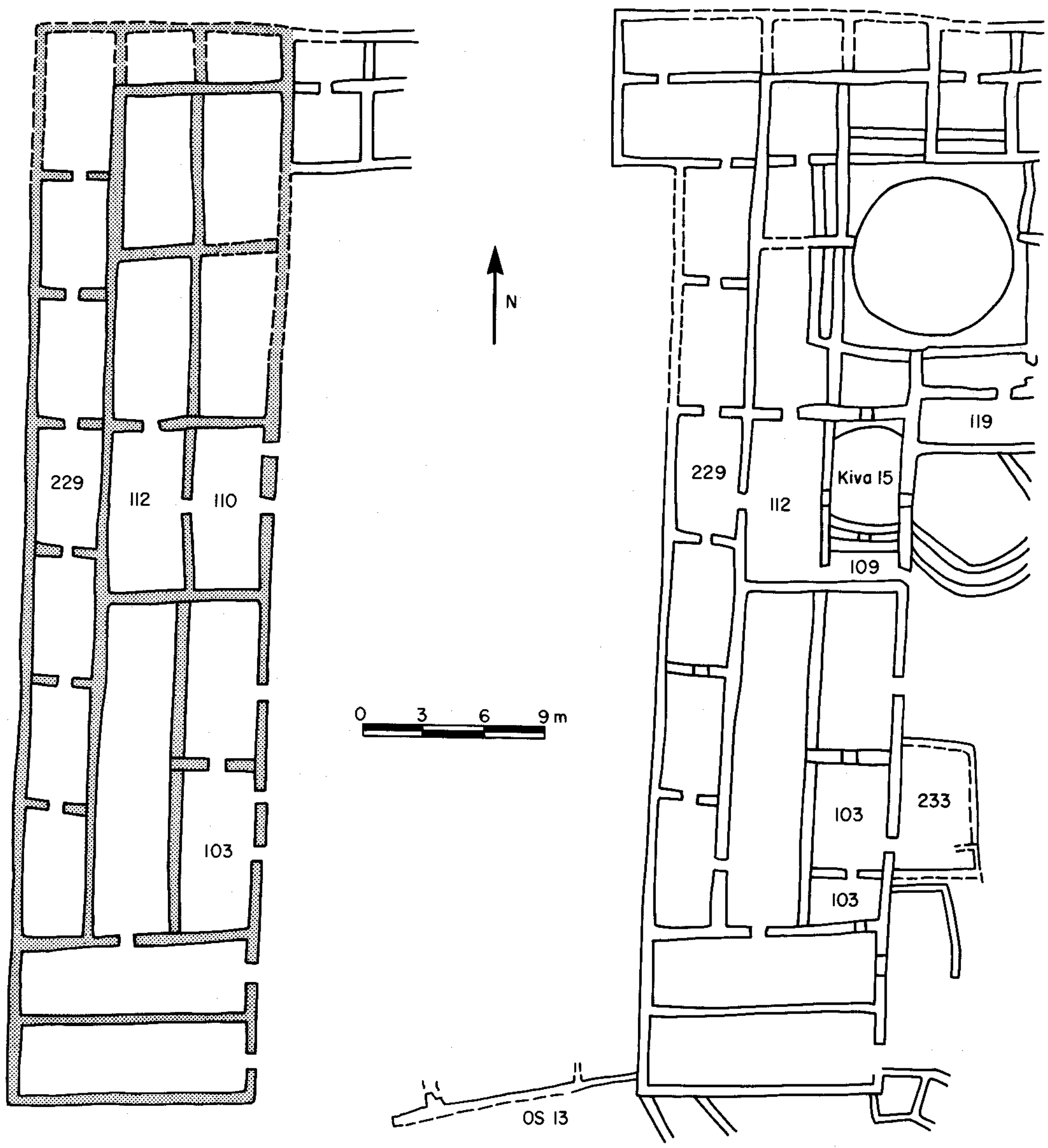


Figure 6.3. Wall plans of the initial and modified West Wing.

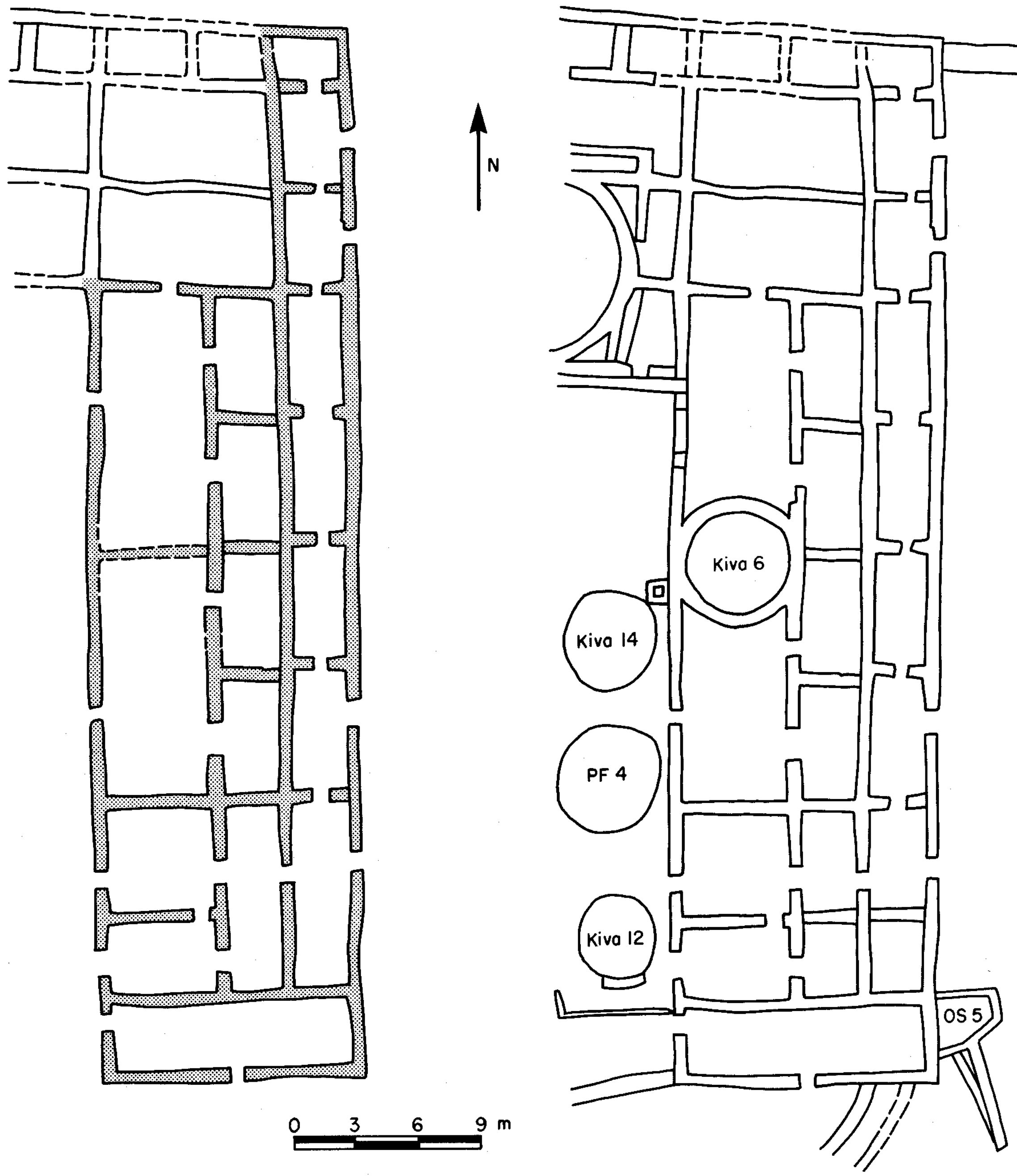


Figure 6.4. Wall plans of the initial and modified East Wing.

From this, it seems likely that the earliest greathouse building at Pueblo Alto consists of the outer two rows of rooms in the Central Roomblock (Figure 6.5), from Rooms 121 and 122 east to Rooms 157 and 158. This plan contains five major suites of rooms, each with a huge room oriented toward the plaza and backed by two smaller rooms. Floor areas for the 5 huge rooms averaged 37.9 m^2 (sd = 2.8 m^2) and for the 10 small rooms 9.8 m^2 (sd = 0.8 m^2).

In addition, at each end of this linear plan of suites was a small two-room unit containing a square, plaza-facing room backed by a smaller rectangular room (mean floor area for two rooms = 7.75 m^2, sd = 0.9 m^2). The two west rooms were destroyed by later building. No lateral movement was possible among any of these seven suites; all initial wall ventilators and doorways were orientated north-south with access to and from the plaza. Doors in excavated rooms all had raised sills; several later had jambs and new lintels added.

The lowest floors in the excavated rooms of Stage I were probably associated with Stage I construction. These floors had numerous shallow and irregular heating pits. The first plastered floors in these rooms, however, were about 50 cm higher and level with the Stage IB floors. These floors were essentially featureless except for postholes.

The size and symmetrical layout of two of the large, plaza-facing, round, pitstructures suggest their association with Stage IA. Kiva 3 and Kiva 10, the largest two at the site (11 m and about 10 m in diameter, respectively), are located just astride the midpoint of the Central Roomblock and the Stage IA rooms. In plan, at least, this creates two equal parts of Stage IA, which may reflect social or political dichotomy of the initial site population. There is still plaza space separating the two pitstructures from the initial suites--an early trait that is later modified as kivas were incorporated into the roomblocks.

Kiva 2 may also be associated with Stage I; if included, it violates the apparent symmetry of Stage IA. Tests in the open space fronting the eastern suites revealed sterile soil without a trace of a companion kiva to mirror Kiva 2's position. Kiva 2 is also smaller (8.6 m in diameter) than Kivas 3 and 10, although its present size could simply reflect remodeling of an earlier, larger structure. Nevertheless, there is insufficient evidence for inclusion or rejection of Kiva 2 in Stage IA.

The masonry style associated with Stage IA is Judd's (1964) Type II or a variation thereof. Essentially, it is composed of thin, lenticular, well-indurated, dark sandstone, chipped along the ends and edges. Larger stones are common, but overall the style is one of masses of long, thin stones with little mortar in between. From the ceramic evidence and some absolute dates, the suggested period of construction is about in the A.D. 1030s or 1040s (see Chapter 8).

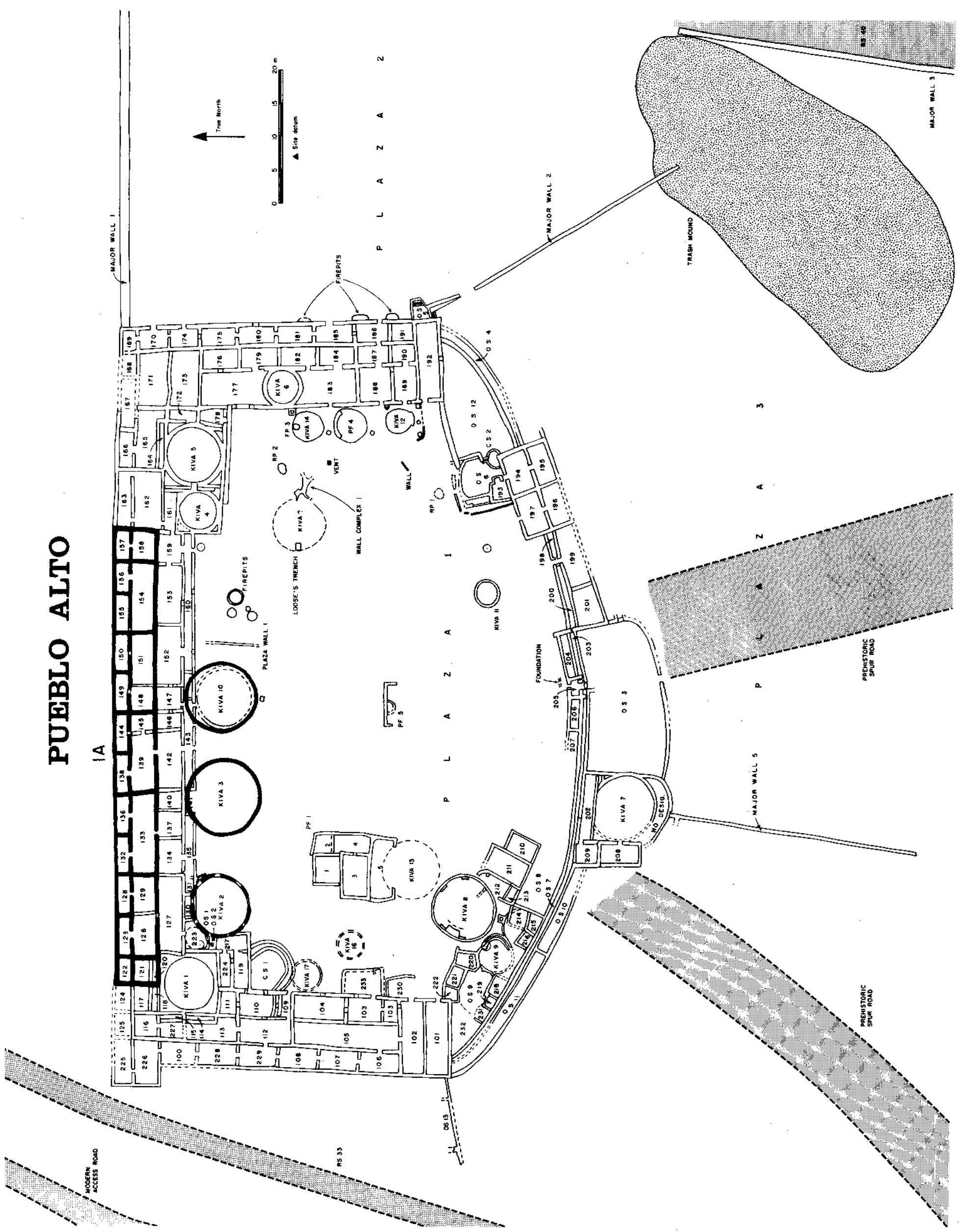


Figure 6.5. Construction phases at Pueblo Alto, Stage IA (A.D. 1020-1040).

Stage IB

A second set of large plaza-facing rooms was apparently added shortly after completion of Stage IA (Figure 6.6). Ten of the 11 cross walls in this unit are butted to the Stage IA section, and several do not follow the alignment of the initial construction. At least in the excavated suite, there is also a sharp rise in the native soil level directly south of Stage IA, which results in higher wall foundations for the new addition. The north-south foundations in Rooms 142 and 146 butt the foundations of Stage IA. It is clear, then, that there is a break in the planning and construction between Stages IA and IB, although probably a very short one.

The new construction nearly mirrors in plan the string of huge rooms in Stage IA. Several cross-wall subdivisions of these huge rooms are clearly later additions and these are not included in this stage. There were five large new rooms added to the five original suites, as well as an additional small square room appended at each end. The average floor area of the Stage IB rooms is 37.6 m^2 (sd = 5.4 m^2). The western three rooms are similar in size to their counterparts in the next row (41.4 m^2, sd = 2.1 m^2), but the eastern two are smaller (31.4 m^2, sd = 0.5 m^2) and do not quite align with those to the back. The latter more closely resembled the large rooms in Stage IC. The single, excavated, large, Stage IB room (Room 142) had room-wide platforms (see Lekson 1984:46), which may be later additions, in both ends of the room.

The irregularity in the size of the eastern and western rooms may reflect space left between the two additions at the expense of the excavated central suite. This left a square area in the plaza, later Room 147, that may have forced a shift in room alignments to maintain similar floor areas for both huge rooms. Doors that led into the plaza from the surrounding rooms would have provided access into or across Kiva 10, a structure that nearly articulates with the new section. A similar room arrangement may account for the subdivisions behind Kiva 3, which allowed access into or across Kiva 3 from Room 140 or an earlier plaza square underneath.

Both Kivas 3 and 10 were still used in this and nearly all succeeding stages. Kiva 2 may have been contemporaneous if not earlier. Sections of plaza-facing corridor rooms were also probably added at this time. Corridor rooms exhibit a distinct masonry style of dark, long, thin, tabular stone, chipped along the edges and ends (Plate 6.4), a style matching that in the south walls of the new huge rooms. The masonry was tightly fitted without the abundant mortar that distinguished masonry of the A.D. 900s. Foundations (at least in Room 143) are bonded to those of the larger rooms.

The corridor rooms may not have been completely enclosed, however. Room 143 was originally left open at the east end, possibly to facilitate easier movement into Kiva 10 or the plaza space directly behind, which later became Room 147. Wall abutments suggest a similar plan behind Kiva

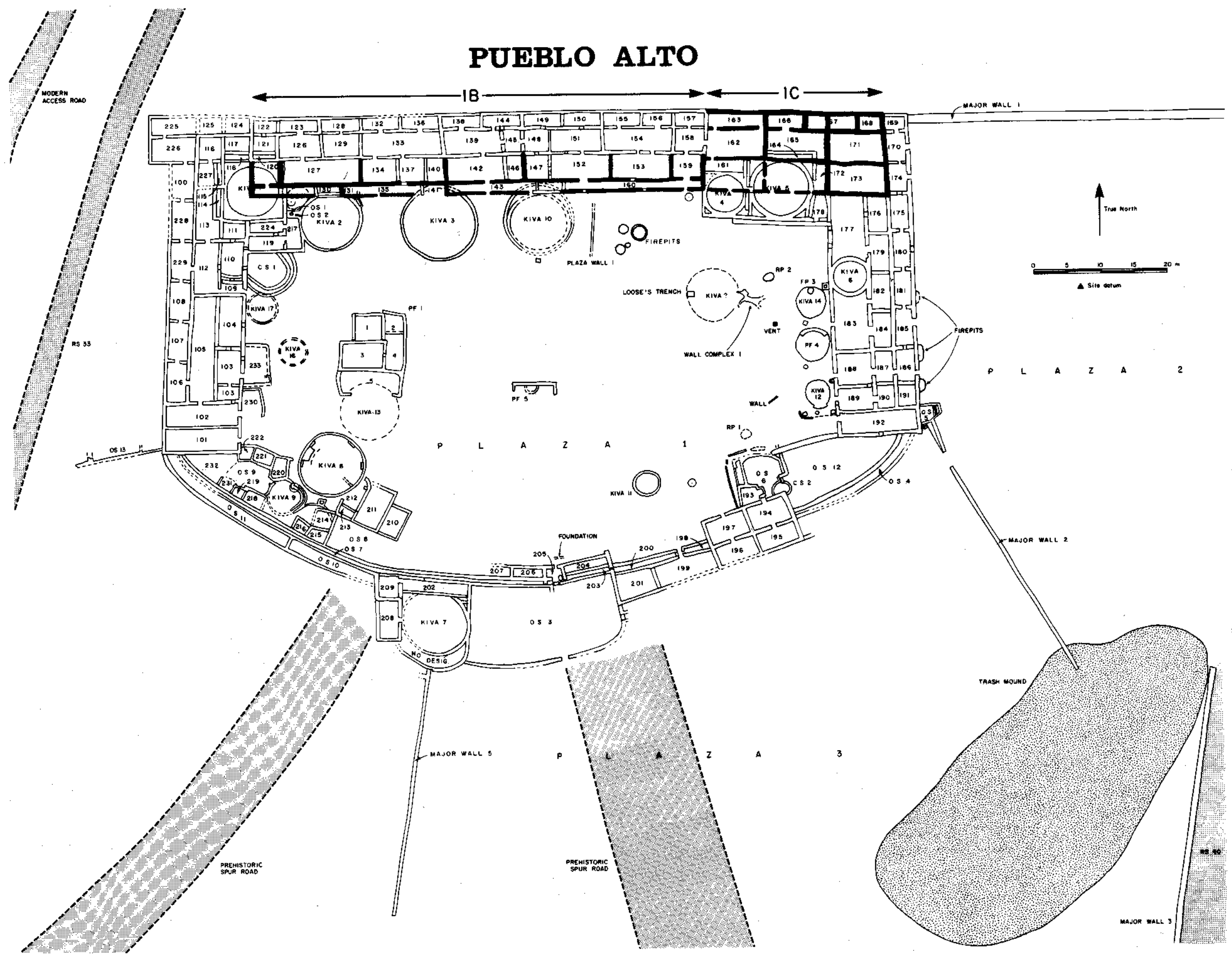


Figure 6.6. Construction phases at Pueblo Alto, Stages IB and IC (A.D. 1020-1040).

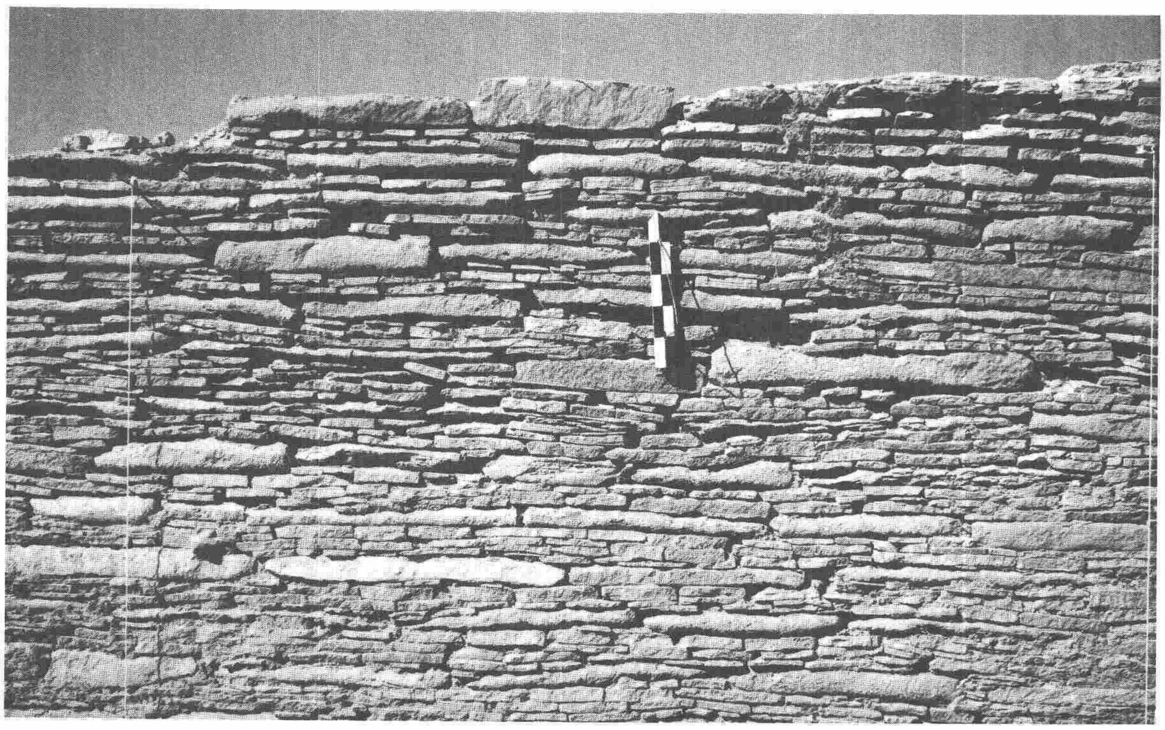


Plate 6.4. Room 143, north wall. Stage I construction of lenticular spalls and slabs. 15-cm scale. (NPS#17893.)

3, where corridor Rooms 131 and 135 might have opened toward the east. The Stage III extension of the corridor room walls over the two kivas would have forced their modification. This was indeed the case with Kiva 10, and we suspect a similar fate for Kiva 3 and perhaps also Kiva 2 by Stage III.

Rooms 208 and 209 in the southern arc enclosing Plaza 1 exhibit a masonry style similar to that in the Stage IB corridor rooms. There once may have been a larger block of rooms associated with a pitstructure in this arc. A prehistoric road, a spur off RS 33, apparently entered Pueblo Alto along the west side of these rooms. Later arc walls have obscured any entrance, but this unit and the associated road are postulated to be of Stage IB or Stage IC construction.

Stage IB, overlying Rooms 50 and 51, was still associated with a Red Mesa ceramic assemblage without Gallup Black-on-white. A roof-support post in Room 142 was tree-ring dated at A.D. 1016vv, and a charcoal fragment, perhaps from the roof, on the upper floor dated at A.D. 1004v. These suggest construction of Stage IB after A.D. 1016 and probably closer to the A.D. 1030s or 1040s. Undoubtedly, Stage IB quickly followed Stage IA, because the Stage IA doors are too high (160 cm) to permit reasonable passage between rooms without raising the floors. The raised floors in the Stage IA section excavated are level with those of the later Stage IIB floors in front, thus providing reasonable access through the units.

Stage IC

A block of rooms at the east end of the Central Roomblock suggests a third stage of construction (Figure 6.6). A few butted walls, smaller rooms, and a shift in east-west wall alignments reveal a discontinuity between Stages IB and IC. Parts of Stage IC exhibit a masonry style identical to that in the Stage IB corridor rooms, although it is disconcerting that not all of Stage IC shares these properties. The six large rooms in Stage IC are similar in form and size to the eastern two rooms of Stage II. The north wall of this Stage IC unit appears continuous with that of Stage IA. Although there are certain characteristics that parallel events in Stage IB, there are enough differences to postulate a separate period of construction. Obviously, if the north wall is continuous, Stages IA and IC, as well as Stages II and III, are contemporary.

Six large rooms (mean area = 33.8 m^2, sd = 1.4 m^2, n = 4 of 6) in two rows of three each are backed by five to six smaller rooms (mean area = 12.0 m^2, sd = 4.0 m^2, n = 4 of 6). There is a north-south wall segment, sandwiched between Kivas 4 and 5, which duplicates the fine masonry of the corridor room. The wall does not follow the projected plan, for it is butted on the north end, which suggests a later subdivision of the western large room in the section. Two of the large rooms have been cut by the construction of Kivas 4 and 5, although enough remains to verify their existence.

Where does Stage IC terminate? The critical outside northeast corner is probably between Rooms 168 and 169, but it could not be located. Nevertheless, Stage IC stands fairly well by itself, although it may have included more than is presented here. There has been no excavation in this section and no dates have been obtained other than a meaningless tree-ring date of A.D. 966vv from the Room 166 wall clearing. The masonry styles, variations of Type II, are similar to Stage II and suggest construction around A.D. 1020 to 1040.

Stage II (A.D. 1020-1050)

Stage II is represented by the West Wing (Figure 6.7). A number of large plaza-facing rooms were built and then backed by rooms of the same size with a single exception (Room 105). A string of six north-south oriented rooms (mean = 17.5 m^2, sd = 0.8 m^2) connected by doors was added to the back of these and, then, two huge rooms (35.8 m^2 and 36.6 m^2) were appended to the south end of the wing. The string of exterior rooms had no door connections to inner rooms until a late door was created between Rooms 112 and 229. The five large plaza-facing rooms average 25.2 m^2 in area (sd = 0.8 m^2); the three behind them (except Room 105) average 26.0 m^2 in area (sd = 1.9 m^2). Overall the eight rooms average 25.5 m^2 (sd = 1.2 m^2). If subdivided, the double-length room (Room 105) behind plaza-facing Rooms 103 and 104 would fit into these categories.

The north end of the wing has been partly obscured by the later addition of Kiva 1 and its buttresses (Rooms 114, 115, 118, 120, and 224), but wall abutments plainly indicate the presence of larger, early rooms extending under Kiva 1. Two room pairs are evident: one directly north of Rooms 110 and 112 that consists of Room 111 (partly under the kiva) and Room 113/114; and a second pair of rooms within the space of Rooms 117 and 118 and the northwest quarter of Kiva 1 and a back room incorporating Rooms 115, 116, and 227.

Examination of the West Wing wall foundations suggests that the inner- and outermost were set first, then the inner two, longitudinal foundations were added along with the cross-wall foundations. All foundations are bonded. Evidently, a hiatus of unknown duration then occurred, allowing a layer of clean sand to accumulate over the floor surface and onto the foundation before wall construction began. The exterior row of rooms may have been added after the plaza-facing rooms despite the conjectured priority of the former's foundation. Cross walls of the outer rooms abut the next row of rooms and generally do not align with the latter. A trace of Gallup Black-on-white under the lower floor of Room 229 and on the lower floor of Room 103 also suggests that the construction of the entire wing was not simultaneous.

The wing terminates in two very large rooms set perpendicularly to the plaza. The wall abutment sequence is unclear; however, I suspect that these were the last major additions to the wing during Stage II. Their

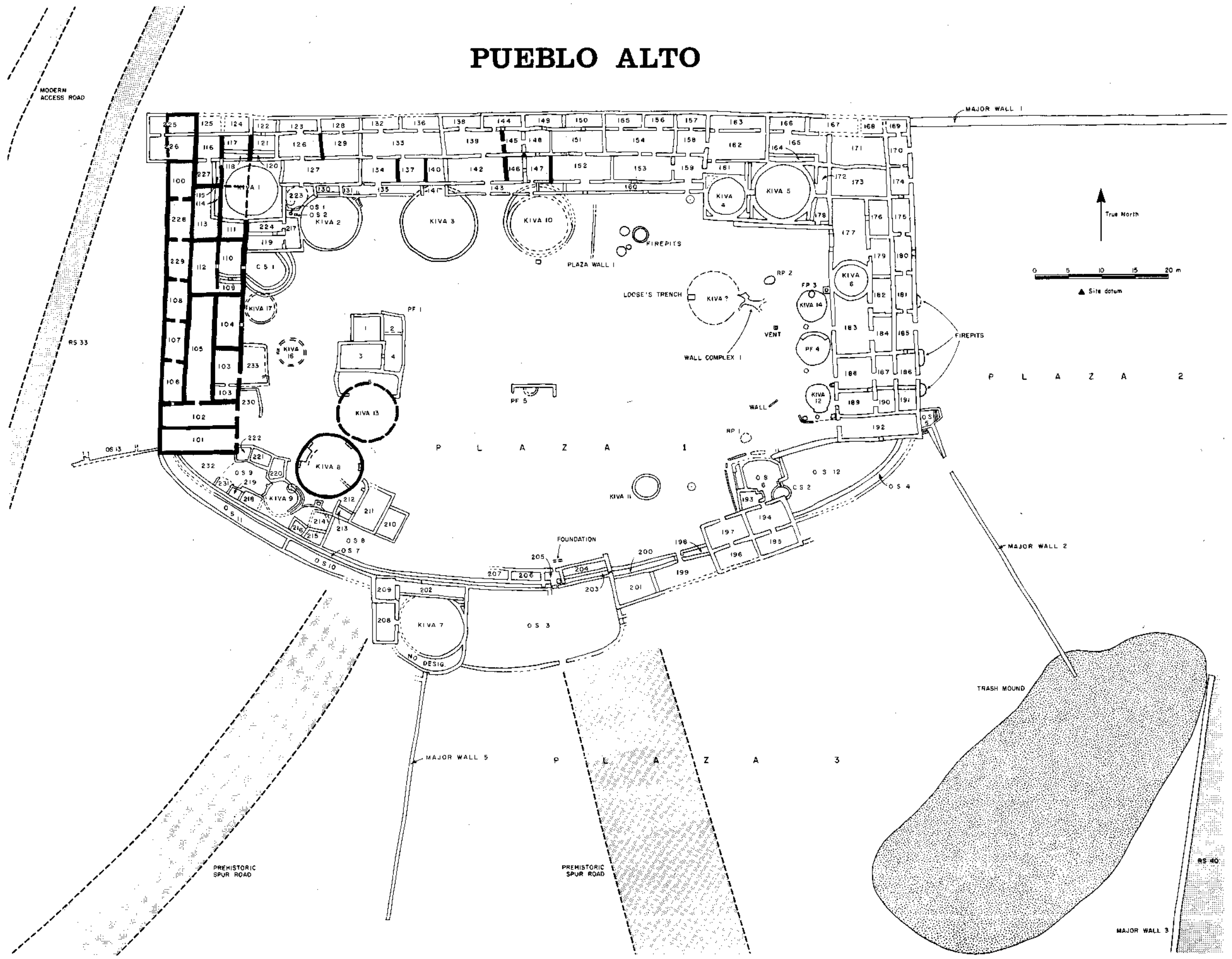


Figure 6.7. Construction phases at Pueblo Alto, Stage II (A.D. 1020-1050).

size is nearly identical to a similarly positioned, very large room in the East Wing (Stage III).

A pair of rooms jutting westward at the northwest corner of the wing mars the apparent symmetry of the building. The critical corners of these rooms (225 and 226) had collapsed, and their temporal relationship is unclear. The size and position of the paired rooms indicate that they are associated with the prehistoric road from Pueblo Bonito that passed a few meters away (see Chapter 5 and Figure 5.4). The rooms are believed to be associated with Stage III.

Identifying the original suites in the West Wing is difficult. Rooms 103 and 104 appeared to be paired. Room 105, directly behind these, might have formed a pair with Rooms 103 and 104 except that no doors provided access. Although its great size (53.6 m^2) would suggest that it was once two rooms of equal size, testing yielded no evidence of a cross wall. Thus, despite its departure from our perceived symmetry of the wing, Room 105 must be accepted as a single large room.

Rooms 110 and 112 were originally paired as a unit front-to-back and not side-by-side like Rooms 103 and 104. The door leading into Room 229 from Room 112 was a late addition. Doors lead north but not south from Rooms 110 and 112. At this point, we were unable to confirm additional doors between the large north rooms because of the Kiva 1 buttresses. Thus, we are left with several possibilities for the initial suite arrangements, although most likely the suites comprised one or two rooms.

On the floors above the surfaces associated with room construction, the two excavated, plaza-facing rooms (103 and 110) had a variety of features indicative of habitation. Numerous heating pits, storage pits, postholes, wall niches, and sets of mealing bins were associated with the occupational floors in Rooms 103 and Room 110. Curiously, formal firepits were used only intermittently, and that was in Room 110. During most or all of its use life, Room 103 did not have an interior firepit.

There are two small, round, pit structures (Kivas 16 and 17) just in front of Rooms 103 and 104, but these are Stage V additions. The spatial proximity of plaza Kiva 8, at the south end of the West Wing, and its size (9.3 m in diameter) suggest that it was built in conjunction with the wing and may have served its inhabitants. Kiva 13, later built over by Plaza Feature 1, may also have been built at this time or earlier. Kiva 8 may have replaced Kiva 13.

The masonry style of the later cross walls (Plate 6.5) in the components of Stages IA and IB (e.g., in Rooms 134/137/140, 139/145, and 142/146) suggests that these were in place by no later than Stage II. The masonry style in the West Wing (Plate 6.2B) is similar to that observed in Stages IA and IC. Basically, it is Type II or a variation of it.

There is a single tree-ring date from the West Wing, despite salvage of numerous logs during wall clearing, all which had complacent rings. A

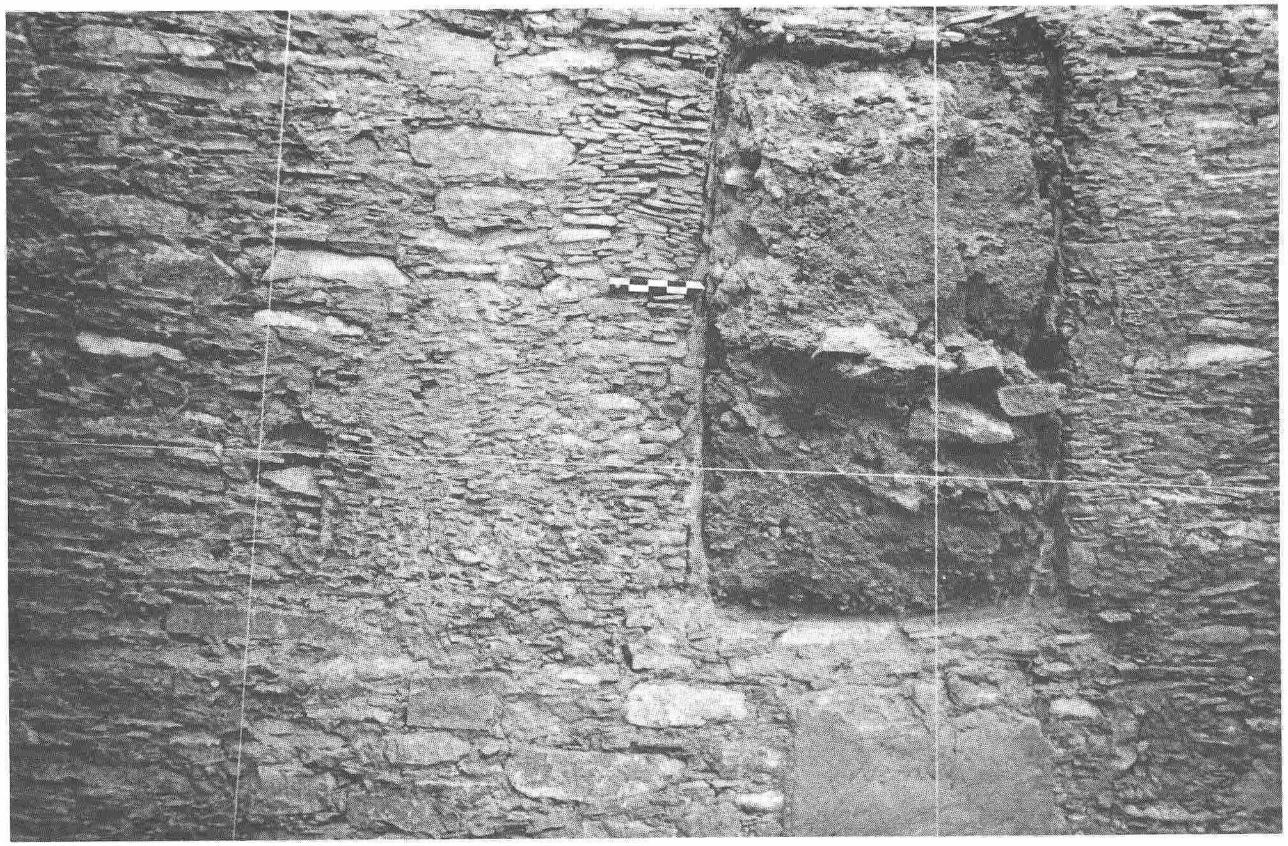


Plate 6.5A. The veneer of secondary cross-walls that subdivide the large rooms in a big-room suite in the Central Roomblock. Note that the masonry veneer style is similar to the initial Stage I construction style. Room 145, west wall and Door 1. 15 cm-scale. (NPS#13723).)

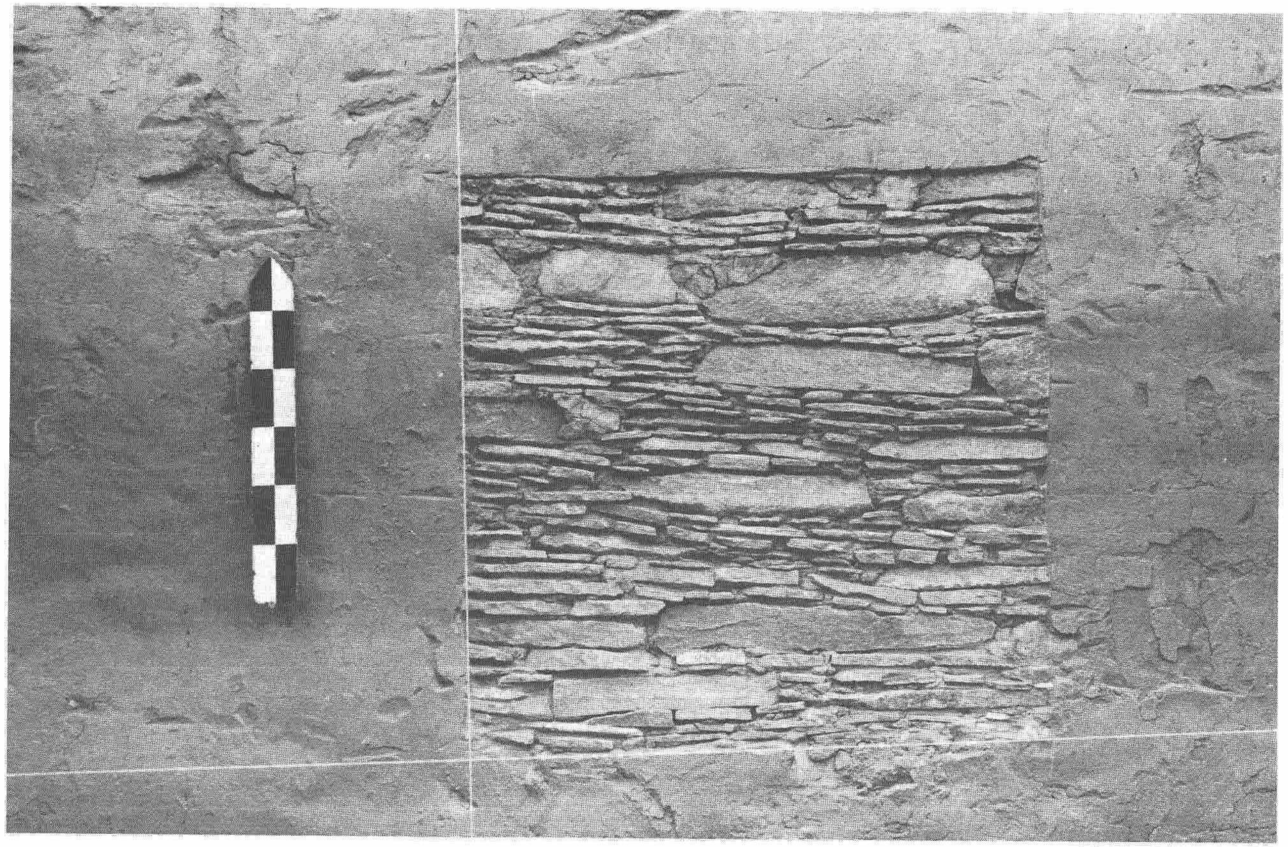


Plate 6.5B. The veneer of secondary cross-walls that subdivide the large rooms in a big-room suite in the Central Roomblock. Note that the masonry veneer style is similar to the initial Stage I construction style. Room 146, west wall with sample of plaster removed. 30-cm scale. (NPS #17014.)

date of A.D. 1021r from a log built into the north wall of Room 110 indicates construction of the north part of the wing by A.D. 1021 or later. The absence of Gallup Black-on-white in the Red Mesa assemblage on some lower floors suggests construction between A.D. 1021 and 1040; however, the trace of Gallup Black-on-white in Rooms 103 and 229 suggests that some construction might be slightly later by a decade or so (e.g., at about A.D. 1050).

The West Wing's eastern orientation, with living rooms facing east onto the plaza, suggests that it is earlier than the East Wing. The West Wing's position relative to the Central Roomblock replicates the L- shaped plan of Una Vida and Pueblo Pintado. There is no precedent for the construction of a greathouse east roomblock in Chaco that was not balanced by a contemporary or earlier west roomblock. If the wings at Pueblo Alto are not, therefore, contemporaneous, then the West (Stage II) probably predates the East (Stage III).

Stage III (A.D. 1040-1060)

The East Wing (Stage III) parallels the West Wing in its positioning, form, and layout (Figure 6.8); however, the former is distinct and exhibits different masonry styles, combining Hawley's (1934) Type III or IV (Plates 6.2C and 6.6-6.7). The most noticeable suites in the East Wing appear to be two three-room suites with a large room (46.1 m^2, sd = 2.8 m^2 for Rooms 177 and 183) backed by two smaller rooms (14.2 m^2, sd = 0.7 m^2)--a pattern common to the Central Roomblock (Stages IA, IB, and IC). These suites are connected by doors leading front to back (or toward the plaza) without allowing lateral movement. It appears that a later kiva separated the two large rooms, although it is difficult to explain the positioning of this round room over the projected cross wall shared by both rooms. Instead, Kiva 6 might be part of the initial wing construction; its walls are bonded with those of Rooms 177 and 183. The suite room doors are offset from the center, and, thus, reflect the spatial presence of Kiva 6, as if the kiva were part of the initial planning. If so, the large rooms would be somewhat diminished in size (42.8 m^2, sd = 4.6 m^2). The small size of Kiva 6 (4.75 m in diameter), its unusual position within the wing, and walls as high as the surrounding rooms suggest it may have been a tower or a tower kiva rather than a kiva. There is no precedence for kivas or towers placed in greathouse roomblocks before the late A.D. 1000s, except for a circular structure built in the early roomblock at Kin Nahasbas (Mathien and Windes 1984).

As in the West Wing, a separate but nearly contemporaneous unit of seven to nine rooms (11.7 m^2, sd = 2.6 m^2, n = 9) was added along the East Wing's exterior with doors running north and south. The variation in size is greatly reduced (12.5 m^2, sd = 1.0 m^2, n = 7) by the elimination of the two end rooms. Communication and access toward the interior plaza (Plaza 1) were limited to a single door in Room 186. There were several outside doors, however, leading to the exterior plaza (Plaza 2) that is crossed by prehistoric roads. One road (RS 37) is aligned direct-

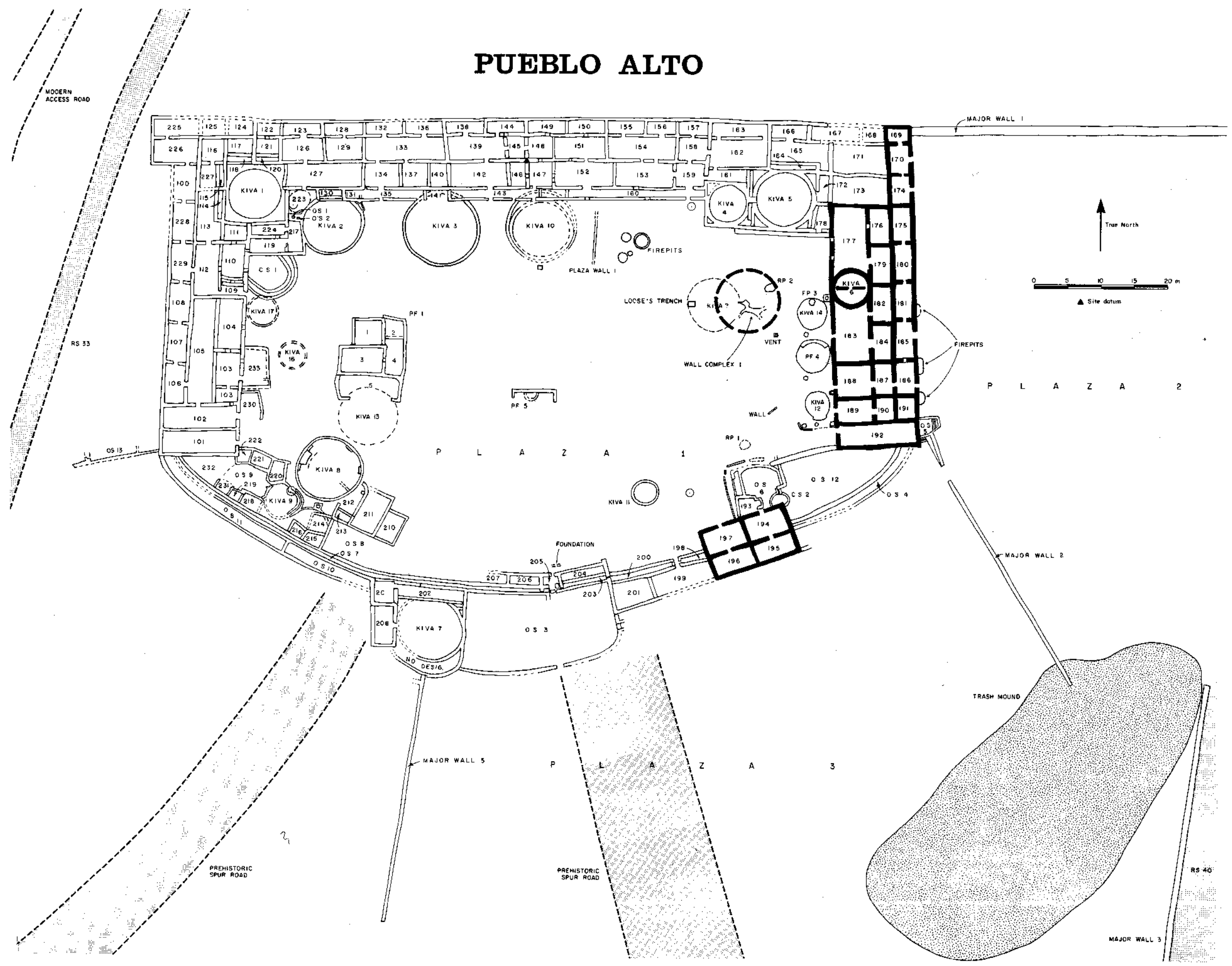


Figure 6.8. Construction phases at Pueblo Alto, Stage III (A.D. 1040-1060).

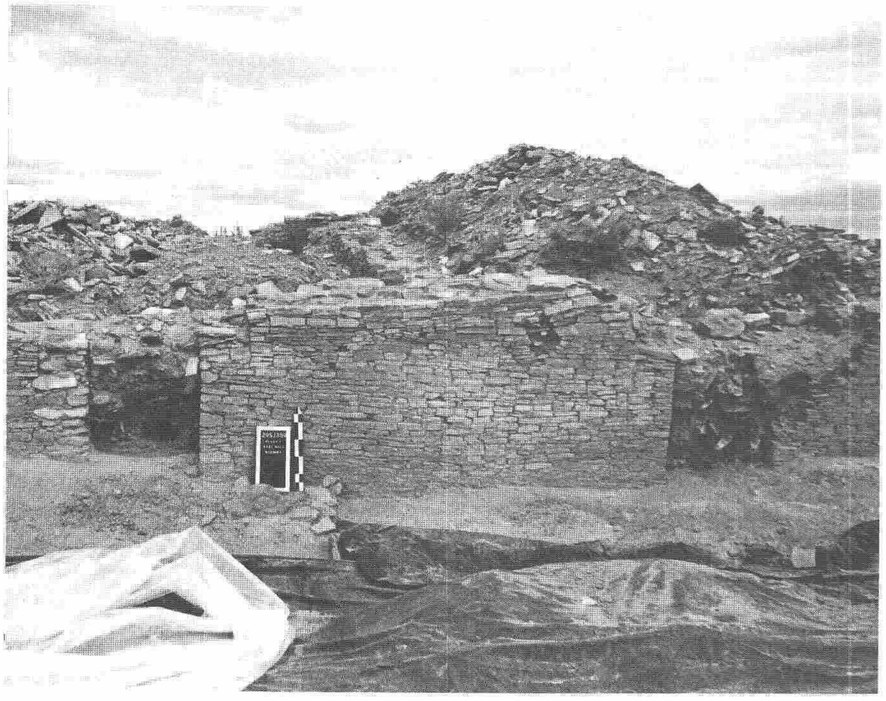


Plate 6.6. Plaza 1 door entries into Rooms 188 (left) and 189 in the East Wing. Note the masonry veneer style of the Stage III construction. 50-cm scale. (NPS#15213.)

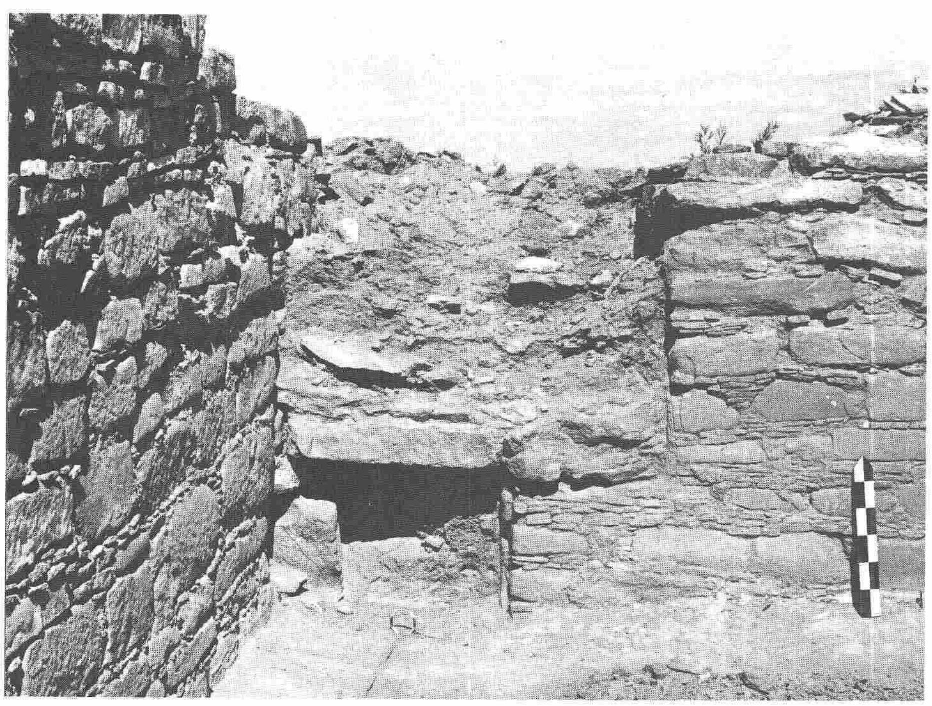


Plate 6.7. Former Plaza 1 door into Room 177 in the East Wing converted into a ventilator. Room is of Stage III construction although the masonry veneer style suggests the wall behind the 30-cm scale was rebuilt (compare with Plate 6.5). Kiva 5 buttress wall to left is of Stage IV construction. (NPS#15068.)

ly with a door and presumably terminated at it. Thus, it is suggested that the exterior row of East Wing rooms are road-associated because of the proximity of the roads, the frequency of doors leading from the rooms to the exterior and their near absence to the site interior, and the alignment of a road and door. A road-related function is also suggested for the exterior row of West Wing rooms because of similarity with the East Wing.

The south end of the East Wing contains several small, rectangular rooms and a large room (Room 192, 35.0 m^2) that mirrors two others in the West Wing. For the sake of symmetry, Rooms 189-191 could have comprised a second large room identical to Room 192, but there is no hint of that in the wall abutments. A single series of doors allows access across the entire wing (Rooms 186-188).

The sequence of construction appears to parallel that in the West Wing. The longitudinal walls were built first and then the cross walls added. The latter are butted to the longitudinal walls or tied only in the core. The style of masonry banding is similar to that of Type III. Three small kivas (Kivas 12 and 14, and Plaza Feature 4) are located in the interior plaza next to the East Wing, but may not be of this stage. Instead, their size and shape indicate possible construction during Stage V.

A block of four rooms (Rooms 194-197), located in the eastern half of the southern wall arc enclosing the interior plaza, stands apart from the surrounding architecture on the basis of wall abutments, door connections, and masonry style. The masonry is similar to that of the East Wing and, therefore, is included in this stage on that criterion alone. The four rooms (two paired suites) are located just east of a prehistoric road from Chetro Ketl that enters the interior plaza from the south. The existence of this road was verified by the presence of a doorway through the arc in the exact position predicted from aerial imagery. The position of the small roomblock suggests an association with an earlier arc not now visible.

There are additional blocks of paired rooms of identical size associated with prehistoric roads on the east and west sides of the site. These, Parking Lot Ruin (west of the main building) and East Ruin, might be contemporaneous with Rooms 194-197 and reflect major expansion or remodeling of the road system around Pueblo Alto (see Chapter 5).

This period or the next might also include the remodeling of Rooms 225 and 226 that now jut west from the northwest corner of the house. Room 225 is slightly smaller than Room 226; nevertheless, both can be considered part of a functional unit by virtue of a connecting doorway. The pairing of these rooms of slightly different size and of their respective areas is nearly identical to that of each of the paired-room units comprising the Room 194-197 block, the East Ruin, and the Parking Lot Ruin. The orientation of the Room 225-226 unit, like the others, is also perpendicular to an adjacent, prehistoric roadway. The masonry style of Rooms 225 and 226 is consistent with the construction of this period.

The masonry style of the eastern addition to Room 143 suggests that it, too, belongs to this stage of construction. Because the addition extends across Kiva 10, the kiva must have been remodeled at the same time. It is likely that the space north of Kiva 10 was then enclosed to form Room 147. Possibly, similar building took place at Kivas 2, 3, and 7, and forced a reduction in their sizes.

Two tree-ring dates were obtained from the East Wing wall clearing: A.D. 949vv from Room 188 and A.D. 935vv from Room 190 (Table 8.2). Neither is useful for interpreting construction events.

Several large firepits were built against the outside wall of the wing. All were covered by wall fall that attests to their use during the terminal site occupation at Pueblo Alto during Stage V. The fuel remains, evidently from roofing material removed from the building, were ponderosa pine, Douglas fir, and spruce/fir. The proximity of the firepits to the East Wing rooms naturally suggests that the source for the wood was close at hand. There is relatively little fir in the assemblage, as opposed to the frequency of its occurrence in the West Wing and Central Roomblock. Based on this tentative data, it is proposed that the firewood was gathered from the East Wing. The many dates from this wood indicate some construction at approximately A.D. 1056. Considering the masonry style and the very tentative dates, the wing's construction can best be assigned to the period of about A.D. 1040-1060. For the next 40 years, there was little apparent construction at Pueblo Alto that was architecturally distinct, except for some kivas in Stage IV.

Stage IV (A.D. 1080-1100)

The last major addition to the main roomblock was the placement of three kivas and their associated buttresses into the northwest and northeast corners of the building (Figure 6.9). By this time, Kiva 13 (south of Plaza Feature 1) had been abandoned and filled with trash dominated by Gallup Black-on-white. Kiva 15 may have been built in Room 110 during this period, if not in the early A.D. 1100s. Kiva 10 also appears to have been abandoned at this time or shortly thereafter and, then, after a short hiatus, used as a trash dump during Stage V. Ceramics from the trash are dominated by Gallup, Chaco-McElmo, McElmo, and Puerco black-on-whites.

There are no chronometric dates for this period. Based on tree-ring dates from other Chacoan ruins associated with masonry similar to that used in the three kivas, this period can be assigned to about A.D. 1080-1100.

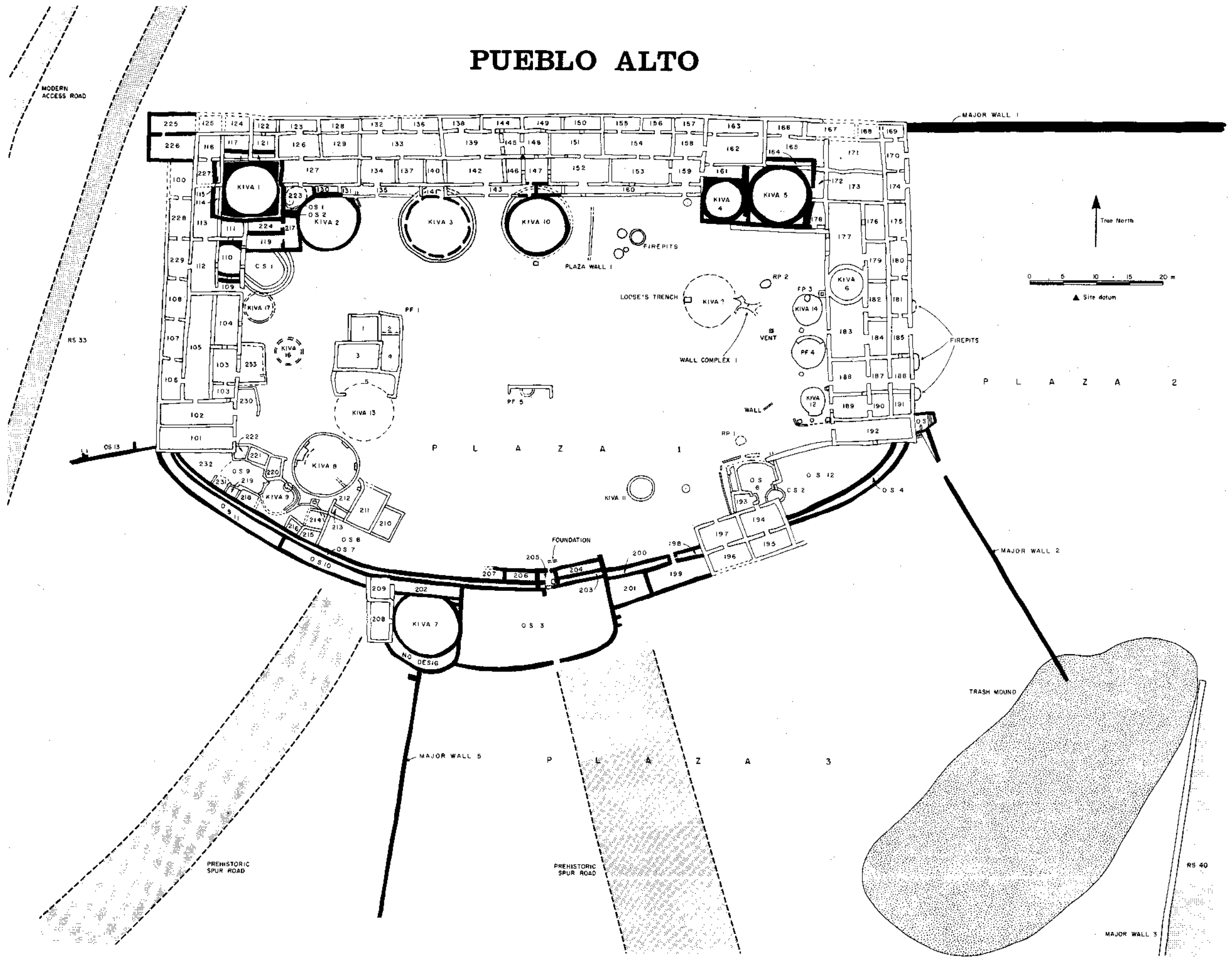


Figure 6.9. Construction phases at Pueblo Alto, Stage IV (A.D. 1080-1100).

Stage V (A.D. 1100-1140)

There are a host of late additions to Pueblo Alto, primarily along the south side of the interior plaza between the two wings (Figure 6.10). Possibly the earliest of the late constructions are Plaza Feature 1 and Room 119. The southern enclosing arc was either modified or constructed for the first time, with additions such as the outer wall (Plate 6.8) completed subsequently. A cluster of small rooms, added along the inside of the arc in the southeast and southwest corners, continued north from the southwest corner to butt against the Stage III rooms in a fashion reminiscent of the late construction at Pueblo del Arroyo. One or more small kivas were built within the maze of small rooms in the plaza corners. Another was built inside Room 223, and possibly the ones in the East Ruin (Rooms 6 and 11) were added as well. Also, the crude, large-block masonry, double-walled structure (Circular Structure 1) of Hawley's (1934) Type IV masonry (Plate 6.9) was built against the plaza-facing rooms in the northwest corner.

Numerous tree-ring dates from huge firepits in Room 3 of Plaza Feature 1 mark the last use of the firepits in A.D. 1132 (Table 8.3). The latest dates were derived solely from pinyon, whereas earlier dates came solely from ponderosa and spruce-fir, presumably scavenged from abandoned room roofs. Pinyon, a common fuel at Chaco, is presumed to have been obtained locally just before its use in the firepits. Numerous archeomagnetic dates from the firepits and from Kiva 15 indicate a late A.D. 1100s use, but these are 70-100 years too late (see Chapter 8). The construction for Stage V most likely took place in the early part of the A.D. 1100-1140 period.

Latest Occupation (A.D. 1300s)

Unlike several other buildings at Chaco, there is no evidence of an occupation at Pueblo Alto utilizing Mesa Verde Black-on-white pottery (only a single sherd was found). The final occupation at Pueblo Alto, then, is assumed to terminate in the twelfth century, probably between A.D. 1132 and 1140. After considerable deterioration had taken place, there appears to have been a brief reoccupation or use of the site. Evidence for this is the discovery of large, crude, slab-lined firepits built high in the postoccupational rubble fill in Room 103 and Kiva 14. Both were sampled for archeomagnetic dating, and the latter yielded a date of A.D. 1365. The sample from Room 103 did not date but its magnetic direction suggested a similar time. The time in question overlaps the mid-1000s on the archeomagnetic curve, but in this instance that time period is improbable given the contexts. Similar large firepits were also found in the postoccupational room deposits at Pueblo Bonito and Kin Kletso (Vivian and Mathews 1965:61, 64), which also must date very late.

The dearth of roofing timbers at Pueblo Alto probably can be attributed to their reuse as firewood by the late occupants at the site. Dis-

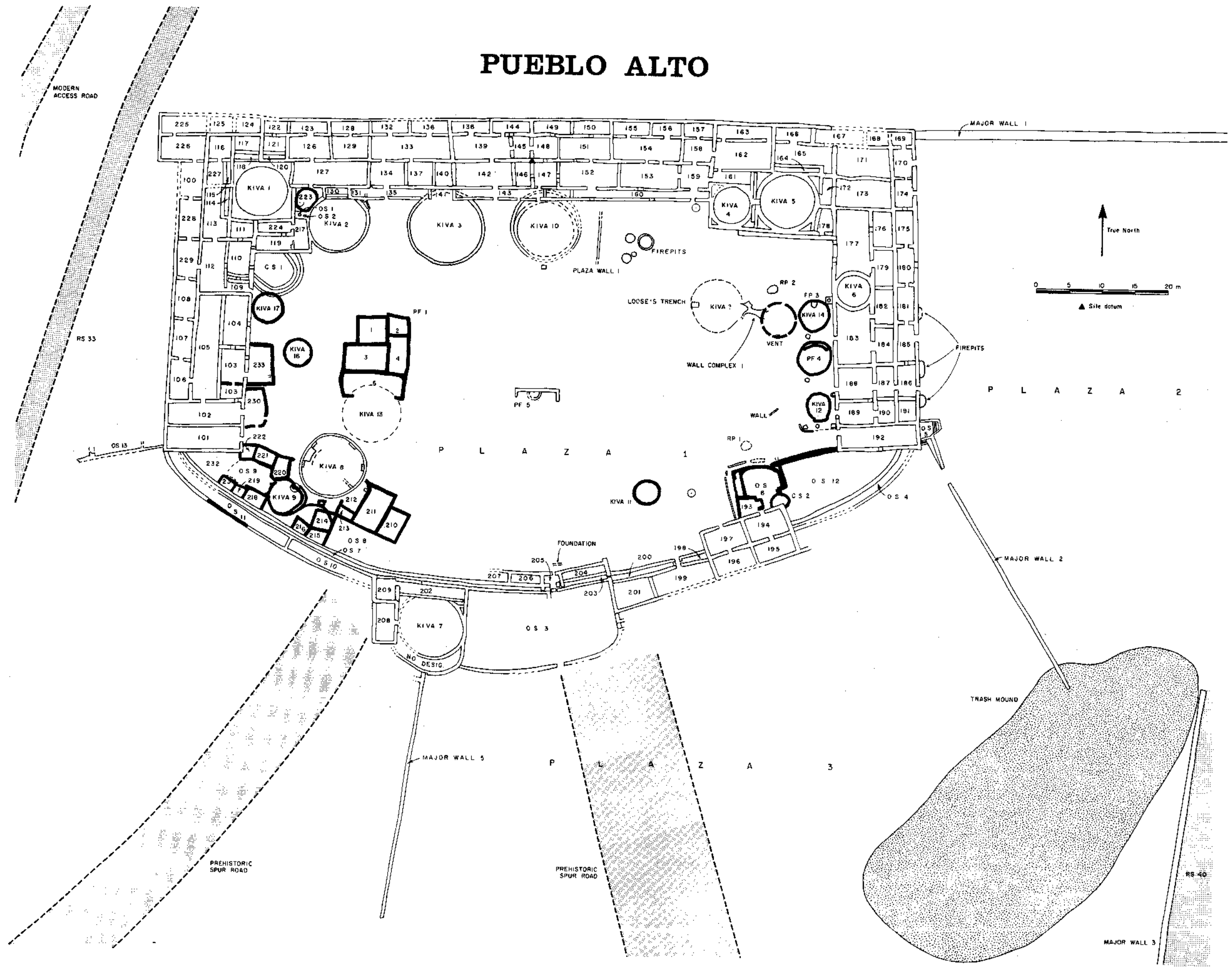


Figure 6.10. Construction phases at Pueblo Alto, Stage V (A.D. 1100-1140).

Plate 6.8. The exterior veneer of soft, blocky masonry forming Other Structure 11, probably added to the enclosing arc of walls in the early A.D. 1100s. The wall is being measured by Suzanne Hunt. 30-cm scale. (NPS#28743.)

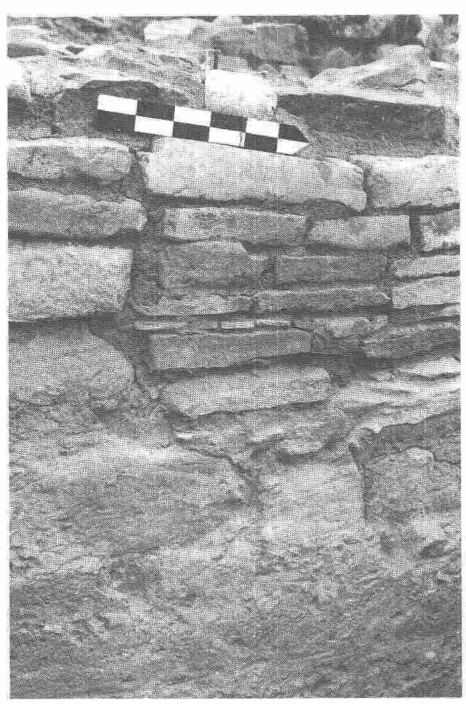


Plate 6.9. The exterior facing of the outer wall of Circular Structure 1, built against the plaza side of Room 110 in the early A.D. 1100s. 30-cm scale. (NPS#15678.)

mantling of the roofs clearly marks the termination of Pueblo Alto's role in the Chacoan system.

Conclusions

Aside from some small, early rooms built in the early A.D. 1000s at the site, Pueblo Alto was constructed in several stages between about A.D. 1020 and 1060. The earliest block of rooms, the Central Roomblock, was built in three stages between A.D. 1020 and 1040. The size and layout of the Central Roomblock rooms followed a plan executed at the earlier Chacoan greathouses (Kin Bineola, Peñasco Blanco, Pueblo Bonito, and Una Vida). After this, the West Wing, which contained a number of residential units, was added between A.D. 1020 and 1050. Finally, an east roomblock was added between A.D. 1040 and 1060. Two other houses associated with Pueblo Alto (the East Ruin and the Parking Lot Ruin) may also have been built coeval with the East Wing; these may have been associated with the prehistoric roads. After A.D. 1060 there appears to have been little construction at the site except for three kivas placed where the east and west roomblocks joined the Central Roomblock. On the basis of masonry style, these three were probably built between about A.D. 1080 and 1100. Their construction destroyed earlier room units in the West Wing and the Central Roomblock.

Between about A.D. 1100 and 1140, a flurry of remodeling and construction took place, but did not match the earlier work in either size or scope. Most of the early A.D. 1100s building was comprised of small rooms and kivas joined to the primary roomblocks, placed along the arc of walls enclosing the interior plaza, and set within the interior plaza. Except for some limited evidence of occupation in the A.D. 1300s, the site appears to have been abandoned between about A.D. 1130 and 1140. A single sherd of Mesa Verde Black-on-white was the only evidence of possible occupation in the A.D. 1200s.

Chapter Seven

The Use of Tree Wood at Pueblo Alto

Prehistoric wood is plentiful in excavated greathouses and can provide information about the site construction (Chapter 6) and chronology (Chapter 8). Pueblo Alto did not yield the hoped-for numbers of timbers, and most of those recovered from the rooms yielded wood with ring series too complacent to date. Nevertheless, dated and undated wood can be informative about other aspects of behavior at the site and beyond, including tree harvesting practices, differential use of wood, source areas, and possible scheduling of construction. These aspects are examined in this chapter with some success, despite limited data and comparative information.

Tree Species and Source Areas

The use of tree wood at Pueblo Alto is represented by 546 specimens identified to 6 species by the Laboratory of Tree-Ring Research (Tables 7.1-3). Half of the wood recovered was ponderosa pine (Pinus ponderosa), followed by 32 percent pinyon (Pinus edulis), 10 percent juniper (Juniperus sp.), 6 percent undifferentiated spruce and fir (formerly white fir, Abies concolor), 1 percent Douglas fir (Pseudotsuga menziesii) and 1 percent Populus sp. The latter could be represented by aspen (P. tremuloides) and/or cottonwood (P. Fremontii and P. acuminata). Cottonwoods favor growth along stream beds, like the Chaco Wash, and could have been procured locally in limited numbers. Given the small numbers of Populus sp. in the sample and its poor qualities for firewood and construction, its presence probably represents expedient local collection of cottonwood rather than selection of high-altitude aspen. Nevertheless, aspen occurs in stands of mixed conifers in forested areas and might have been utilized for Pueblo Alto. The remaining species are generally unavailable locally and undoubtedly were unavailable in the past, barring major environmental changes. Pinyon and juniper grow in the vicinity of the canyon today and probably did in the past until depleted by the Anasazi (see Betancourt and Van Devender 1981; Samuels and Betancourt 1982). Most (398, 73 percent) of the tree specimens recovered from Alto came from just two proveniences

Table 7.1. Wood species from wall clearing, room and kiva excavations and miscellaneous areas.

Provenience	Species[a] DF	SF	PP	Pnn	Jun	Pop	Estimated Diameter (cm)	Cond[b]	Function	FS No.	T-R Lab No.
Room 100, north wall core			1				10	r	intramural beam	511	
Room 100, north wall core				1			7	r	intramural beam	512	
Room 100, north wall core			1				7	r	intramural beam	513	
Room 100, north wall core		1?					4	r	intramural beam	514	
Room 100, north wall core		1?					6	r	intramural beam	515	
Room 100, north wall core			1				6	r	intramural beam	516	
Room 100, north wall core			1				7	r	intramural beam	520	
Room 100, south wall core			1				7.5	r	intramural beam	571	
Room 100, south wall core		1					6	r	intramural beam?	573	
Room 100, southwest corner (fill)		1					9	r	intramural beam?	572	
Room 100, outside southwest corner					1		20	r	viga/tie beam?	271	
Room 103, Layer 1 (TT 5)		1?					6	r	latilla??	505	
Room 103, Layer 2 (TT 2, Level 9)					1		2.5	r	split plank	1000	
Room 103, Layer 2 (TT 2, Level 10)			1				6	c	?	362	
Room 103, Layer 2 (TT 2, 2cm above Fl. 1)		1?					5	c/r	?	1001	
Room 103, Floor 4 (Layer 5 fill, Grid 24)			2							1352	
Room 103, Wall Niche 5			1				9+	w	plank rack?	1466	
Room 103, Floor 1, OP 7 (Layer 1)				1			2.5	c	?	1161	
Room 106, firepit? in surface wall fall					1		7	c	firewood?	502	
Room 109, Floating Floor 1, HP 1				2			2.5,3	c	firewood	5300	
Room 110, Floor 1, WN 9					2		10,11	w	spatulate tools	5301	
Room 110, north wall core			1				?	r	intramural beam	1678	
Room 110, north wall core				1			?	r	intramural beam	1679	
Room 112, Layer 2 (TT 8)			3				12-15	c	?	7046	
Room 112, Layer 2 (TT 2)			1				11	c	?	7013	
Room 112, Layer 3B (TT 5)		1					11	c	?	7031	
Room 112, Door 3 construction				1			7	c/r	?	7159	
Room 112, Floor 1, OP 3				1			5	c	?	7133	
Room 112, Layer 8 (under Surface 2)				1			?	?	?	7239	

[a]See Table 7.4.
[b]Condition: c = charcoal; r = rotted wood; w = unrotted wood.

Table 7.1. (continued)

Provenience	Species[a] DF	SF	PP	Pnn	Jun	Pop	Estimated Diameter (cm)	Cond[b]	Function	FS No.	T-R Lab No.
Room 123, in fill along south wall			1				9	r	intramural beam?	333	
Room 138, south wall core		1					6	r	intramural beam	272	
Room 138, south wall core		1					6	r	intramural beam	273	
Room 142, Layer 4 (TT 7)				1			4	r	?	2735	
Room 142, Layer 6, Level 4 (TT 4)			1				7	r	?	2806	
Room 142, Layer 6, Floor 1 fill (Grid 11)			3				3,4,5	c	?	2807	CNM-385
Room 142, Layer 6, Floor 1 fill (Grid 15)			1				6	r	latilla?	2808	
Room 142, Floor 1, PH 3			1				10	r	roof support	2809	CNM-386
Room 142, Floor 1, PH 4			1				11	r	roof support	2810	
Room 142, Floor 4, HP 3				1			?	c	firewood	7568	CNM-663
Room 143, Layer 2, Floor 1 fill (Grid 11)					1					6780	
Room 143, Floor 2, PH 1 (Grid 13)			1				27	r	post step	6351	CNM-675
Room 143, Layer 7 (Floor 5 construction)				1			3	c	?	6918	
Room 145, Layer 7, Level 5 (NE Quad)		1					?	?	?	574	
Room 146, Layer 9, Floor 6 fill (Grid 8)			1				?	c	?	6136	
Room 146, Floor 3, FP 1 (bottom)				8			4-6	c	firewood	6084	
Room 147, Floor 1, FP 1 (Layer 3)		1					5	c	firewood	6313	
Room 154, north wall core			1				12	r	intramural beam	280	
Room 166, in fill NW-SE 30 cm deep			1				16	r	viga	360	CNM-320
Room 168, outside north wall in rubble			1				9	r	intramural beam?	501	
Room 168, in rubble NW-SE			1				8	r	viga/latilla	510	
Room 168, in rubble NW-SE			1				7	r	viga/latilla	517	
Room 168, in rubble NW-SE			1				6	r	viga/latilla	518	
Room 188, outside west wall (plaza)			1				20-28	r	viga/tie beam	4290	CNM-475
Room 189, west wall			1				17	r	viga?	363	
Room 190, south wall			1				14	r	viga?	365	CNM-338
Room 198, east wall			1				5	r	?	503	
Room 229, west wall core			1				11	r	intramural beam	524	
Room 229, north wall core			1				9	r	intramural beam	523	
Room 229, north wall core			1				13.5	r	intramural beam	570	
Room 229, north wall core			1				11	r	intramural beam	521	
Room 229, north wall core/door sill			1				?	r	intramural beam	5905	

[a]See Table 7.4.
[b]Condition: c = charcoal; r = rotted wood; w = unrotted wood.

Table 7.1 (concluded)

Provenience	DF	SF	PP	Pnn	Jun	Pop	Estimated Diameter (cm)	Cond[b]	Function	FS No.	T-R Lab No.
		Species[a]									
Room 236, Floor 5, rodent hole #1				4			2.7,4,4,?	c	firewood	6854	
Kiva 2, across south wall				1			4.5	r	buttress beam	507	
Kiva 2, across south wall				1			4.5	r	" "	508	
Kiva 2, across south wall			1				4.5	r	" "	509	
Kiva 4, east wall of enclosing room						1	5	r	" "	274	
Kiva 4, east wall of enclosing room			1				6	r	" "	275	
Kiva 4, east wall of enclosing room			1				5.5	r	" "	276	
Kiva 4, east wall of enclosing room		1					3	r	" "	277	
Kiva 4, SE corner of enclosing room					1		2	c	?	278	
Kiva 4, SE corner of enclosing room			1				7	r	buttress beam	279	
Kiva 9, NE arc between walls			1				?	c	?		
Kiva 10, across NW walls				1			?	?	buttress beam	6738	
Kiva 15, vent tunnel construction		1					8	r	lintel	5451	
Kiva 15, south wall construction (#1)		1					6	r	buttress beam	5454	
Kiva 15, south wall construction (#2)			1				6	r	" "	5454	
Kiva 15, south wall construction (#3)			1				6	r	" "	5454	
Kiva 15, south wall construction (#4)		1					6	r	" "	5454	
Kiva 15, south wall construction (#6)			1				16	r	" "	5454	
Plaza Feature 4 (kiva), upright poles				1			5	r	construction	4232	CNM-486
above ventilator tunnel		1					5	r	"	4232	
North Trench, Level 3 (outside Rm 138)				1			?	c	?	6552	
Other Structure 7, north of Rm 209				1			3	r	?	506	
Plaza 1, surface of Grid 76/303				1			15	c	firewood (modern)	332	
Plaza 1, Loose's TT 1 (in kiva fill?)				1				c?	firewood?	30	
Plaza 1, Grid 38, Level 4			1				?	?	?	4208	
Plaza 1, Grid 75, Layer 3 (FP 3?)				1			?	r	firewood?	4315	
Plaza 1, Grid 75, FP 3 (top)			1				5-10	c	firewood	4316	
Subtotal	0	16	50	32	7	1					106
%		15	47	30	7	1					100

[a]See Table 9.20.
[b]Condition: c = charcoal; r = rotted wood; w = unrotted wood.

Table 7.2. Wood species from Plaza 2 and Plaza Feature 1.

Provenience	Species[a]						Diameter (cm)	Cond[b]	Function	FS No.	TR-Lab No.	Total
	DF	SF	PP	Pnn	Jun	Pop						
PLAZA 2:												
SW corner, surface	1						4	r	?	504		
Grid 121, FP (backhoe tr., Layer 2)			4				2.5-7	c	latilla/firewood	3468	CNM-484	
Grid 181, SW 1/4, Layer 2, Level 1			1				4	c	latilla/firewood	3426	CNM-477	
Grid 181, SW 1/4, Layer 2, Level 1			1				2.5	c	latilla/firewood	"	CNM-478	
Grid 181, SW 1/4, Layer 2, Level 1 (next to OP 3)			1				4	?	latilla/firewood	3452		
Grid 181, NW 1/4, Layer 2, Level 1			1				4	c	latilla/firewood	3433	CNM-485	
Grid 181, NW 1/4, Layer 2, Level 1			4				2-3.5	c	latilla/firewood	3431	CNM-481	
Grid 201, NE 1/4, Layer 2, Level 3			1				?	c	latilla/firewood	3507	CNM-640	
Grid 201, NW 1/4, Layer 2, Level 3			1				3	c	latilla/firewood	3508		
Grid 201, SW 1/4, OP 2 (FP) - top			1				4	c	latilla/firewood	3421	CNM-476	
Grid 201, SW 1/4, OP 2 - Layer 4			5				3-6	c	latilla/firewood	3461		
Grid 201, SW 1/4, OP 2 - Layer 4			4				3	c	latilla/firewood	3493	CNM-639	
Grid 201, SW 1/4, OP 2 - Layer 5			2				3-5	c	latilla/firewood	3463		
Grid 201, SW 1/4, OP 2 - Layer 5		1	14				3-6	c	latilla/firewood	3494	CNM-633-638	
Subtotal	1	1	40									42
%	2	2	95									99
PLAZA FEATURE 1:												
Room 3, Layer 3, Fl. 1 fill, G. 6			10				?	c	latilla/firewood	934	CNM-621-628	
Room 3, Layer 4, Fl. 1 fill, G. 7?			1				6+	c	latilla/firewood	935?		
Room 3, Layer 4, Fl. 1 fill, G. 18				4			?	c	firewood	947	CNM-629-632	
Room 3, Floor 1, FP 1 (Layer 3)				9	1		5-8	c	firewood	986	CNM-706-707	
Room 3, Floor 1, FP 1 (Layer 4)		1	11	23			3-13	c	firewood	988	CNM-490-516	
Room 3, Floor 1, FP 1 (Layer 4)			2	2	3		4-7	c	firewood	"	CNM-696-697	
Room 3, Floor 1, FP 1 (Layer 4)		1	6	4	1		?	c	firewood	"	CNM-615-620	
Room 3, Floor 1, FP 2 (Layer 6)			2				6+	c	firewood	998		
Room 3, Floor 1, FP 2 (Layer 8)			1	32	7		4-14	c	firewood	800	CNM-525-538	
Room 3, Floor 1, FP 2 (Layer 9)				19	5		5-11+	c	firewood	801		
Room 3, Floor 1, FP 2 (Layer 9)			1	7	8		6+	c	firewood	"		
Room 3, Floor 1, FP 2 (Layer 9)			4	1	7	2	4-10	c	firewood	"	CNM-699-705	
Room 3, Floor 1, FP 2 (Layer 11)				6	1		4-9+	c	firewood	803	CNM-582-585	
Room 3, Floor 1, FP 3 (Layer 8)			1				6+	c	firewood	814		
Room 3, Floor 1, FP 3 (Layer 9)					2		5-6	c	firewood	816	CNM-698	
Room 3, Layer 24-25, Fl. 5 fill, G. 3				1			5+	c	firewood	793		
Subtotal		2	39	108	35	2						186
%		1	21	58	19	1						100

[a]See Table 7.4.
[b]Condition: c = charcoal; r = rotted wood.

Table 7.3. Wood species from the Trash Mound and the site totals.

Provenience	Species[a] DF	SF	PP	Pnn	Jun	Pop	Diameter (cm)	Cond[b]	Function	FS No.	T-R Lab No.	Total
TRASH MOUND (roofing layer):												
Layer 16, et al., Slump 2			9		4		?	c	roof latillas	4642	CNM 409	
Layer 16, SC 2, Grid 126			1				3,6+	c	roof latillas	4663		
Layer 16, profile collection	1	5	27				3.5-12	c	roof latillas	4684	CNM 446-456	
Layer 16?, Grid 127, Level 9		1	7		1		3.8+	c	roof latillas	4531		
Layer 16, Grid 155, Level 9	1		13				?	c	roof latillas	4535		
Layer 16, Grid 155, Level 10		1					6.2	c	roof latillas	4536		
Layer 16, Grid 155, Level 13			2				2.4,4.7+	c	roof latillas	4645	CNM 394	
Layer 16, Grid 155, Level 14			1				2+	c	roof latillas	4646	CNM 393	
Layer 16?, Grid 155, Level 15			9	1			3.1+	c	roof latillas	4647	CNM 417-420	
Layer 16, Grid 183, Level 15		1	10				2.3-4.2+	c	roof latillas	4625	CNM 392, 400-403	
Layer 16, Grid 183, Level 16	1	4	36	2			1.2-6+	c	roof latillas	4651	CNM 422-444	
Layer 16, Grid 183, Level 17	2	1	21				1.2-4.8+	c	roof latillas	4652	CNM 460-468	
Subtotal	5	13	136	3	5							162
%	3	8	84	2	3							100
TRASH MOUND (trash layers):												
Layer 19, SC 3, Grid 154				1	1		4.5, 6	c	firewood	4747	CNM 649	
Layer 19, Ash lens 2, SC 3, Grid 154				1			4+	c	firewood	4749	CNM 708	
Layer 24-31, SC 3, Grid 154			2	11	3		3.5-7	c	firewood	4737	CNM 650-656	
Layer 31, SC 3, Grid 154				1			5	c	firewood	4741		
Layer 35-41, SC 3, Grid 154				2			4.6,5	c	firewood	4734	CNM 644	
Layer 37, SC 5, Grid 238			1		1		?,6	c	firewood	4803		
Layer 43, SC 3, Grid 154			1	3	1		3-5	c	firewood	4733	CNM 645-648	
Layer 50, SC 4, Grid 210				2			4,6.4	c	firewood	4777	CNM 661-662	
Layer 78, SC 5, Grid 238				1			6	c	firewood	4789		
Layer 92, SC 5, Grid 238				1	1		5,6	c	firewood	4785	CNM 658	
Layer 95, SC 5, Grid 238			1				6	c	firewood	4784		
Layer 98, SC 5, Grid 238			1	1	2		?,4.5,5.5(2)	c	firewood	4782	CNM 657	
Layer 104, SC 5, Grid 238			1				5	c	firewood	4781		
Layer 113, Grid 295			1				3.1+	c	firewood?	4683	CNM 445	
Layer 122, SC 5, Grid 238				1			6	c	firewood	4783		
Layer unk., Grid 183, Level 16			1				3.6+	c	firewood?	4648		
Layer unk., Grid 183, Level 8				4			2.3-3.2+	c	firewood	4618		
Layer unk., Grid 211, Level 8				2			2-3+	c	firewood	4609		
Layer unk., Grid 239, Level 11	1						3+	c	latilla/firewood	4598	CNM 390	
Subtotal	1		9	31	9							50
%	2		18	62	18							100
Totals from Tables 7.1 - 7.3	7	32	274	174	56	3						546
(from Tables 7.1 - 7.3)[c] %	1	6	50	32	10	1						100
Number dating	6	1	87	42	0	0						
% of species dating	86	3	32	24	0	0						

[a]See Table 7.4.
[b]Condition: c = charcoal.
[c]Includes only those sent to Tree-Ring Laboratory.

Table 7.4. Symbols used with the tree-ring data (Tables 7.1-7.3 and 8.2-8.4).

Symbols used with inside date

year	No pith ring present
p	Pith ring present
fp	Curvature of inside ring indicates that it is far from the pith.

Date symbols used with outside date

B	Bark present
r	Less than a full section is present, but the outermost ring is continuous around the available circumference.
v	A subjective judgment that, although there is no direct evidence of the true outside on the specimen, the date is within a very few years of being a cutting date.
vv	There is no way of estimating how far the last ring is from the true outside.
+	One or more rings may be missing near the end of the ring series whose presence or absence cannot be determined because the specimen does not extend far enough to provide an adequate check.
++	A ring count is necessary due to the fact that beyond a point the specimen could not be dated.
c, i, or ?	Subscripts used with cutting dates that indicate the amount of terminal ring growth (c = complete, i = incomplete, ? = indeterminate).

The symbols B and r indicate cutting dates in order of decreasing confidence unless + or ++ is also present.

The symbol B may be used in combination with any other symbol except v and vv. The r symbol is mutually exclusive, but may be used with B, +, and ++. The v and vv are also mutually exclusive, but may be used in combination with all other symbols. Other symbols bearing upon the confidence of the dates are used by the Tree-Ring Lab but were not appropriate with the Pueblo Alto dates.

Tree species symbols

DF	Douglas fir
Jun	Juniper
Pnn	Pinyon pine
Pop	*Populus* sp.
PP	ponderosa pine
SF	*Picea*-*Abies* sp. (spruce or fir)

at the site, the Trash Mound, and Room 3 in Plaza Feature 1, and, thus, the sample cannot be considered representative of the entire site.

Ponderosa pine was the dominant species selected for use at Pueblo Alto, at least for construction, and its high numbers at other canyon greathouses prompted early investigators to assume local sources for it (e.g., Hawley 1934:65-70; Judd 1964:17-18; Vivian and Mathews 1965:7). This view has been substantially modified by more recent studies (Betancourt and Van Devender 1981) that portray inadequate local resources for the thousands of timbers that were cut during construction at the greathouses. In Basketmaker III and Pueblo I sites excavated in Chaco, only three pieces of ponderosa pine and none of the other large conifers have been identified out of 231 pieces used for firewood and construction (Windes 1977a), whereas large conifer species suddenly became prominant in the Pueblo II period at both small and large sites. This must mark a shift to a nonlocal tree procurement strategy rather than an awakened interest in local forest stands. A few scattered large conifers grew in the canyon historically (Judd 1954:3; Vivian 1972:1; Vivian and Mathews 1965:7), and thin stands of ponderosa exist as close as about 32 km to the northeast of Chaco, however these stands are old and in decline. Initially, a few old trees may have been procured locally, but could not have fulfilled the needs for greathouse construction except in specific instances.

Douglas fir may also be found as isolated trees or small stands in the deep rincons of Chacra Mesa bordering Chaco Canyon (Dean and Warren 1983:209; Vivian and Mathews 1965:7), but, again, it is doubtful that more than a very few trees of the requisite size could have been gathered locally. Except for sparse numbers of ponderosa pine and Douglas fir, the vast majority of the conifers utilized at Pueblo Alto for construction must have come from widespread stands of vigorous young trees growing at elevations above the floor of the San Juan Basin. Given the preponderance of ponderosa pine used at Chaco and its presence with other species in proportions found in nearby mountain ranges, probably other species of the desired size were also harvested within ponderosa pine stands after the lower altitude pine stands were depleted.

The variety of large conifer species identified in canyon greathouses and at Pueblo Alto (Table 7.5) exist in the numerous mountain ranges encircling the San Juan Basin, in which Chaco Canyon is located. Distances to the potential sources where sparse numbers of spruces and firs are mixed with large stands of ponderosa pine are approximate, although they give some idea of where sources may lie if distance and energy expenditure were major factors in beam procurement.

Forests are not uniform throughout the mountains encircling the San Juan Basin even though environmental conditions are similar. This seemingly anomalous situation is due to varied Pleistocene climatic changes forcing repeated shuffling of forest components, which do not necessarily migrate in orderly fashion, and resulting in local extinction of some subalpine species (McCallum 1981:40-41; Wright et al. 1973:1156). Modern

Table 7.5. The closest sources of ponderosa pine and mixed conifers in various directions from Pueblo Alto (pinyon and juniper excluded).

Source area	Maximum elevation in general source area	Direction from Alto	Distance from Alto to nearest conifer stand (km)	Species[a] present in nearest stand[b] at lowest elevation	
Ute Mountain	3,041 m - 9,977'	NW	147	2,440 m - 8,000'	BS, DF, PP, QA?
La Plata Mountains (N. of Hesperus, Colo.)	4,033 m - 13,232'	N	143	3,050 m -10,000'	AF, ES, PP, QA, WF?
San Juan Mountains (E. of Bayfield, Colo.)	4,293 m - 14,084'	NNE	127-135	2,260 m - 7,400'	AF, DF, ES, PP, QA, WF?
Mesa Mts. (S. of Durango, Colo.)	2,326 m - 7,630'	NNE	102	2,130 m - 7,000'	BS, DF, PP
Jemez/San Pedro Mountains (E. of Cuba, NM)	3,523 m - 11,560'	E	84	2,260 m - 7,400'	AF, ES, PP, QA
Cuba Mesa (W. of Cuba, NM)	2,256 m - 7,400'	E	80	2,260 m - 7,400'	PP
Mt. Taylor	3,445 m - 11,301'				
(near El Dado Mesa)		SE	76	2,440 m - 8,000'	AF, ES, PP, QA
(near San Mateo, NM)		SSE	86	2,440 m - 8,000'	AF, ES, PP, QA
San Mateo Mesa (near Ambrosia Lake, NM)	2,509 m - 8,230'	S	62	2,380 m - 7,800'	DF, PP
Dutton Plateau (at Hosta Butte)	2,666 m - 8,748'	SSW	58	2,620 m - 8,600'	DF, PP
Zuni Mountains	2,821 m - 9,256'				
(near Ciniza, NM)		SSW	83	2,316 m - 7,600'	BS, DF, PP, QA
(S. of route I-40, between Thoreau and Gallup, NM)		SSW	75	7,000'	PP
Chuska Mountains	2,681 m - 8,795'				
(near Tohatchi, NM)		WSW	75	2,316 m - 7,600'	PP
(at Washington Pass)		W	83	2,590 m - 8,500'	AF, BS, DF, PP, QA
(near Sanostee, NM)		WNW	98	2,260 m - 7,400'	AF, BS, DF, PP, QA

[a]AF = alpine fir, BS = blue spruce, DF = Douglas fir, ES = Engelmann spruce, PP = ponderosa pine, QA = quaking aspen, WF = white fir

[b]After Alexander et al. 1984; DeVelice et al. 1985; Maher 1963; Martin et al. 1978; McCallum 1981; Moir, personal communication 1985; Osborn 1966; Schaafsma 1977; Wright et al. 1973.

vegetation essentially has occupied its present habitat for the past 2,000 years (Betancourt 1984:31-32), although the precise effect of prehistoric human populations on the forests around the San Juan Basin is undetermined. The Chacoan preference for specific sizes of trees may have been beneficial to forest growth (Betancourt et al. 1986), analogous to the effects of tree-thinning practiced in modern silviculture and of uncontrolled forest fires (Foxx 1984). Interestingly, major forest fires that contribute to natural thinning may occur at fairly regular intervals. Robinson's (1978) study of a ponderosa pine stand in the Jemez Mountains found a rough frequency of fires of about every 20 years, whereas other studies have reduced this figure to between 2 and 8 years (William Moir, personal communication 1985). This would promote vigorous growth of younger trees that were not killed by the fire. Oddly, there has not been a single fire scar noted on any of the Chacoan wood (Jeffrey Dean, personal communication 1985). Recent efforts to suppress forest fires have resulted in dense forests of ponderosa pines that grew in more park-like conditions in prehistoric times (Foxx 1984; McCallum 1981).

The key, then, to reducing the number of potential source areas is to match the assemblage of mixed conifer species used for the same functions in Chaco Canyon with those recorded in the adjacent mountain ranges, under the assumption that all were gathered from the same areas during episodes of tree-cutting in the A.D. 1000s. The source of ponderosa pine alone cannot be ascertained because of its tolerance for xerophytic conditions, which allows growth throughout the entire periphery of the San Juan Basin and in reduced numbers within the basin (cf., see Age below). To a lesser extent this is also true of Douglas fir. Different proportions of minerals absorbed by the trees might prove useful in determining specific sources (see Appendix K). Stands of ponderosa pine are present in moderate numbers within 60 km of Pueblo Alto, but not the more mesophytic conifers (e.g., spruce and fir). Dense stands of ponderosa pine occur slightly farther out from Alto (80 km), and pockets of spruce and fir grow just beyond in the mountainous canyons.

The presence of spruce and fir in the Chaco collections points to at least some high-altitude harvesting of timbers, although the classification of white fir in Chaco has been questioned (Betancourt et al. 1986), which leaves the identity of the species uncertain. Those specimens at Chetro Ketl have recently been reclassified to a general spruce/fir class (Dean and Warren 1983) and the Pueblo Alto specimens have followed suit. True fir (_Abies_), however, is present but cannot be identified to species until the Chacoan collections can be re-examined (Jeffrey Dean, personal communication 1985). Re-examination of 20 of the Chetro Ketl specimens in question revealed that 6 (30 percent) exhibited anatomical attributes of alpine (corkbark) fir (_Abies lasiocarpa_) or white fir (_A. concolor_) and 14 (70 percent) of blue or Engelman spruce. Blue spruce (_Picea pungens_) and Engelmann spruce (_Picea engelmannii_), the most likely spruce to be represented, cannot be anatomically separated (Betancourt et al. 1986:372). The former "white fir" category could included any of the four relevant _Abies_ and _Picea_ species (Jeffrey Dean, personal communication 1987).

According to William Moir (personal communication 1985), southwest regional ecologist for the United States Forest Service, blue spruce is the more restricted of the two spruce species but can descend to lower elevations in well-watered canyons with cold air drainage. It favors canyons above 2,000 m (7,874 ft) in the Zuni Mountains (McCallum 1981:7-8, 40) and in the Chuskas (Wright et al. 1973:1163) where cold air drainage creates a favorable micro-environment. Blue spruce is also found on the lower reaches of Mt. Taylor (Alexander et al. 1984; Osborn 1966) and in the Jemez and San Juan mountains (Alexander et al. 1984; DeVelice et al. 1986; Osborn 1966). Thus, the availability of blue spruce closer to the floor of the San Juan Basin and to Chaco makes it the better candidate for use in Chaco Canyon than the higher-altitude Engelmann spruce.

White fir is associated with stands of blue spruce at elevations below those of Engelmann spruce and alpine or corkbark fir (Maher 1963: Figure 2). White fir is absent in the Zuni and Chuska mountains and on Mt. Taylor (McCallum 1981:7-8, 14; Osborn 1966; Wright et al. 1973) but can be found in the Jemez and San Juan mountains (DeVelice et al. 1986; Maher 1963; Osborn 1966; Wright et al. 1973:1163). Alpine (corkbark) fir generally is restricted to elevations above 2,745 m (9,000 ft), often in association with Engelmann spruce (Maher 1963; William Moir, personal communication 1985). The relatively low elevations in the Zuni and Chuska mountains may be responsible for its absence there.

Stringers of alpine (corkbark) fir and Engelmann and blue spruce, however, along with dense stands of ponderosa pine, Douglas fir, and aspen are found on the north sides of many canyons as they extend down from the mountains. These mixed stands occur at Washington Pass and near Sanostee, New Mexico, probable locales for lithics (Cameron 1984) and ceramic tempering material (Toll 1984) used in products imported into Chaco Canyon. It may not be fortuitous, then, that Navajo informants spoke to the Gladwins in 1928 about a clay road at the Chacoan outlier of Skunk Springs, midway between Washington Pass and Sanostee, for transporting pine logs to Pueblo Bonito in Chaco Canyon (Marshall et al. 1979:113; Vivian 1983a:3-3). Prehistoric roads extending out of the Skunk Springs site community toward Chaco have recently been verified (Marshall et al. 1979:113; Obenauf 1980:74).

Other mixed conifer stands are found in the lower and higher elevations of the Zuni and Jemez Mountains and Mt. Taylor, near sources of chert and obsidian that were imported into Chaco (Cameron 1984; Cameron and Sappington 1984). Chacoan roads lead into the Dutton Plateau toward Hosta Butte from Kin Ya'a, a Chacoan outlier, and to a Chacoan site at San Mateo, near the foot of Mt. Taylor (Obenauf 1980:71, Figure 6). The timber sources in the Zuni, Chuska, and Jemez Mountains and Mt. Taylor are equidistant from Pueblo Alto, although topography dictates that the Chuskas are the most economic route to haul trees to Alto, followed by the routes from the Zunis and Mt. Taylor. Precise species identification of the spruce and fir timbers at Chaco will greatly aid identification of the potential sources utilized by the Anasazi.

Differential Use of Tree Species

Contextual information from the tree wood recovered at Pueblo Alto provides some insights into its use. Although tree wood was rarely found in primary contexts, there was evidence that certain species were selected for specific uses, a finding also supported by Dean and Warren (1983) for Chetro Ketl. Because of sampling strategies and excellent preservation, large-diameter (>15 cm) logs, often still emplaced as vigas, were common in the Chetro Ketl sample. Few instances of beams exceeding 15 cm in diameter were found at Alto, but Alto's single-story construction may have permitted use of smaller beams. At Hawikuh on the Zuni Reservation, large, single-story rooms similar in size to Alto's rooms revealed small primary beams (Smith et al. 1966:19, Plate 15b). In one instance at Hawikuh, only two primary beams (14 and 18 cm in diameter) were used to support the upper-room occupants and the massive weight of the roof (Smith et al. 1966:19).

Viga holes, which would have revealed the presence and size of primary beams, were not observed during the Pueblo Alto excavations. All the timbers found in situ during wall clearing were intramural beams placed within the walls. These were often found exposed in the torn crosswall fabric in the exterior Alto rooms (Plate 7.1 and Volume II, Plate 3.46) where the outer walls had collapsed outward. Typically these occurred in groups set side by side. It was the accidental discovery of one of these logs, a pinyon, during excavation of Room 110 that yielded the earliest cutting date at Alto (A.D. 1021r).

Ponderosa pine was the most common species used for intramural beams (Tables 7.1-3), although Cory Breternitz (personal communication 1985) recalled that _Populus sp_. was prevalent. The complacent ring pattern common to the Alto logs and typical of _Populus sp_., however, may have misled field species identification. The Tree-Ring Laboratory identified only a single piece of _Populus sp_. from wall clearing, although seven pieces not sent to the lab may have included others as well. Intramural beams averaged about 8.2 cm (range 6-13.5 cm, n = 19) in diameter and sometimes ran the entire length of a wall to tie adjoining walls as well as to form the door sills and lintels (e.g., in Room 229). At Chetro Ketl, where lower walls were much thicker than Alto's, intramural beams averaged 13.4 cm in diameter (range 6.6-25 cm, n = 24). Overall, the use of intramural logs apparently was a common practice (Lekson 1984:21).

Sometimes, a stray log was recovered in the Pueblo Alto wall fall, which may have been a viga or primary roof beam as suggested by its diameter. Intramural logs with diameters as large as those of primary roof beams, however, were common at Chetro Ketl (Dean and Warren 1983:Table B:1), and one of 20 cm in diameter was recovered from Room 100 at Alto. Otherwise, the size of most of the wood uncovered during wall clearing at Alto, indicates it undoubtedly was once associated with room construction, although its specific function is less clear. The distinction of function between intramural beams and primary and secondary beams is left uncertain

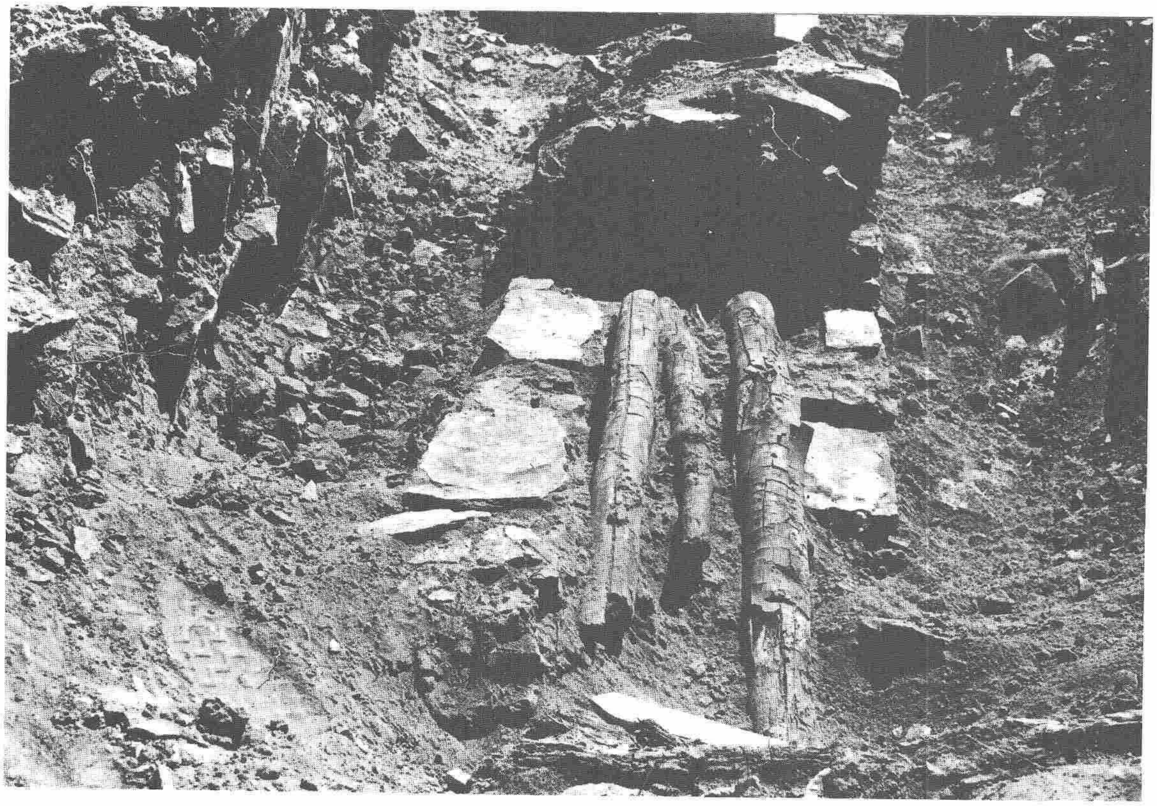


Plate 7.1. Intramural beams placed in the north wall core of Room 100. None of these tree-ring dated. (NPS#13329.)

because of probable overlap in beam diameter (see Dean and Warren 1983: Table B:1).

Wood collected from room and kiva wall clearing reveals species dominated by ponderosa pine (34, 62 percent), spruce/fir (11, 20 percent) and pinyon (8, 15 percent) followed by single instances of juniper and *Populus* (2 percent each). Half of the pinyon and both juniper and *Populus* specimens were associated with kiva construction. At other canyon greathouses, juniper is found in kiva pilasters (Bannister 1965:Tables 31, 45; Dean and Warren 1983:Table B:1).

The primary choices in room construction were ponderosa pine and spruce/fir. Both the latter conifer groups were used for intramural beams at Pueblo Alto, but roofing practices are more difficult to analyze because of lack of data. At the Salmon Ruin (Adams 1979:137) ponderosa pine and spruce/fir were used for all elements of construction as they were at Chetro Ketl. There was nonrandom selection at the latter site, however, that specifically favored spruce/fir for nonprimary beams and lintels (Dean and Warren 1983:211; Tables V:8-10). The branch morphology of Douglas fir, spruce, and fir favors their selection for aperture elements (lintels) because of limb straightness, greater yield per tree, and accessibility from the ground. These species may be under-represented at Alto, because aperture elements were often made of stone.

Despite the number, condition, species, and size of the logs recovered from wall clearing, few could be dated, none with cutting dates. Ring complacency is the primary cause of the poor dating results and is best illustrated by the 11 intact, intramural beams of ponderosa pine and spruce/fir from Room 100 that failed to date. Three of these logs were just 4, 10, and 20 years of age (the others were not aged) and must have grown in moist conditions.

Species use is best differentiated in the Pueblo Alto Trash Mound (Table 7.3). A unit of deposition in the trash (Layer 16) yielded numerous fragments of burned roofing secondaries and adobe and ash. Species from this unit were almost all ponderosa pine (84 percent) and spruce/fir (8 percent) out of 162 specimens. Douglas fir is represented by five pieces (3 percent) in the trash but none from wall clearing. Both areas were dominated by large conifer species in contrast to material recovered from the remainder of the Trash Mound and from site firepits. Excluding the Layer 16 roofing deposition, pinyon (62 percent) is the most prevalent wood, followed by juniper and ponderosa pine (18 percent each). Pinyon and juniper comprise 80 percent of the trash specimens except in the layer of roofing where they are just 5 percent. A Chi-square test of species by provenience rejects the null hypothesis that there is no distinction in species use between the two units (Table 7.6a), although several expected cell values are below recommendations.

The dichotomy in species distribution within the Trash Mound can be explained by differential selection of species for firewood and for construction. If the test combines pinyon and juniper as one category, and

Table 7.6. Chi-square results for comparisons of wood species from samples in the Pueblo Alto Trash Mound.[a]

A. All conifer species (no Populus sp. recorded):

Provenience	Species[b]					Totals
	PP	DF	SF	Pnn	Jun	
Layer 16 roofing	136 (110.8)	5 (4.6)	13 (9.9)	3 (26.0)	5 (10.7)	162
All other layers	9 (34.2)	1 (1.4)	0 (3.1)	31 (8.0)	9 (3.3)	50
Totals	145	6	13	34	14	212

$X^2 = 127.5$
df = 4
p = 0.0000 (Reject H_o)

expected <5 = 4
expected <1 = 0

B. Conifer species condensed:

Provenience	Species[b]		Totals
	PP/DF/SF	Pnn/Jun	
Layer 16 roofing	154 (125.3)	8 (36.7)	162
All other layers	10 (38.7)	40 (11.3)	50
Totals	164	48	212

$X^2 = 118.7$
df = 1
p = 0.0000 (Reject H_o)

expected <5 = 0
expected <1 = 0

[a]Expected frequencies are in parentheses.
[b]see Table 7.4.

the other species of conifers as another to reflect presumed use, then the Chi-square results are the same without violations of low cell frequency (Table 7.6b). Pinyon and juniper have long been favored for fuel among historic puebloans (e.g. Lange 1959; Parsons 1936). They were recovered from Chacoan firepits at the Salmon Ruin (Adams 1979:99) and from Pueblo Alto firepits. The Chetro Ketl East Dump yielded numerous fragments of pinyon (Bannister 1965:Table 9; Hawley 1934:Protocol 2), and it is not surprising that pinyon wood concentrates in middens where it was ultimately deposited when firepits were cleaned out.

The Plaza Feature 1 firepits in Room 3 reveal similar ratios of wood species to the nonroofing specimens in the Trash Mound. A Chi-square test (Table 7.7) was used to examine the null hypothesis that the material came from the same use (i.e., as fuel). Failure to reject the null hypothesis provides additional confirmation that pinyon and juniper were used primarily for firewood. Presumably, the ponderosa pine came from reused structural elements, a strategy noted at other sites near the terminal period of occupation (Dean and Warren 1983:214). Five specimens (of 236) from three other species were excluded from the test to reduce low cell frequencies, but these would not affect the outcome if included.

An apparent contradiction in species use occurred in and around two Plaza 2 firepits, built against the exterior wall of the East Wing, that yielded ponderosa pine (and one spruce/fir) charcoal and no pinyon or juniper. The tight group of dates (see Chapter 8) is much earlier than ceramic, archeomagnetic, and stratigraphic information that places use of the firepit in the early A.D. 1100s. This feature, like those in Plaza Feature 1, was used near termination of the occupation when evidence suggests that social patterns were disrupted. Use of the ponderosa pine in these instances (i.e., late) probably can be attributed to dismantling roofs at the site as an expedient source of firewood.

Tree Harvest and Construction Ties Between Pueblo Alto and Chetro Ketl

Interaction between Pueblo Alto and Chetro Ketl is suggested by the prehistoric roads that link them (see Chapter 5) and the construction timing of both sites in the early A.D. 1000s (Lekson 1984). Timber procurement offers another line of inquiry into the possible ties between the two sites, despite the inadequacies of the comparative samples. The primary premise on which comparison is based is that age and species of the timbers procured for construction at the two sites are meaningful variables for understanding the source or sources of procurement.

Although age and tree size are weakly linked, variability of age and species may reveal aspects of tree harvesting and construction. Variability in age/size and species utilization may covary with the degree of centralized control of the entire tree procurement and construction process. Given the important effects of environmental and geological conditions under which specific species grow, we might expect differences in species composition and presence depending upon whether multiple or singular

Table 7.7. Chi-square analysis of species distribution between the Trash Mound (except Layer 16 roofing) and the Plaza Feature 1, Room 3 firepits at Pueblo Alto.

Provenience	Species[a]		Totals
	PP	Pnn/Jun	
Trash Mound (except Layer 16)	10 (10.9)	40 (39.1)	50
PF 1, Room 3 (3 large firepits)	41 (40.1)	143 (143.9)	184
Totals	51	183	234

$X_c^2 = 0.024$ Fisher's Exact Test = 0.447
df = 1
p = 0.88 (Do not reject H_o)

[a]See Table 7.4.

sources were being utilized, unless fixed ratios of species were maintained by the Chacoans. The latter possibility seems unlikely considering the variety of contexts in which all species were found. If undated tree-ring species are examined, the various greathouses in Chaco appear to yield similar compositions of timber species through time, which suggests use of the same or very similar sources. Of course, without identification of the species in the spruce/fir class, the argument for a few sources must be considered tentative.

Tree Species

The mixed conifer species found at the sites narrows the field of tree sources because of the sensitivity of various montane species to the range of microenvironmental conditions found around the San Juan Basin. It is assumed, of course, that the closest forests are the most probable sources for timber procurement. The closest dense stands of conifers are found in a number of directions and includes a variety of species (Table 7.5). A particular source undoubtedly became depleted after a period of time if we consider the high numbers of trees cut for construction (see Dean and Warren 1983:202-207). At most canyon greathouses species proportions appear consistent during the A.D. 1000s (see Bannister 1965; Dean and Warren 1983; Laboratory of Tree-Ring Research data sent to the Chaco Center), which suggests that the same areas were used for most canyon greathouse construction.

Although Pueblo Bonito, Pueblo del Arroyo, Una Vida, and Peñasco Blanco have yielded only datable ponderosa pine and a few Douglas fir timbers, undated specimens reveal that spruce/fir occur in low proportions as in Pueblo Alto and Chetro Ketl, at least during the eleventh century. Construction of greathouses in the tenth century may have depleted the closest stands of ponderosa pine, as Dean and Warren (1983:217) suggest, and forced higher-elevation procurement in the A.D. 1000s. In contrast, it is expected that Chacoan greathouses located around the periphery of the San Juan Basin would reveal species compositions that mirror conifer types found in the adjacent montane regions and, as a group, would exhibit dissimilarity in species usage. At Salmon Ruin, for instance, ponderosa pine and juniper are the predominant species used for Chacoan roofing, although some undifferentiated spruce and fir were also used. Although Pueblo Alto, Chetro Ketl, and Salmon are connected by the Great North Road, it seems unlikely that the canyon and Salmon timbers were drawn from the same regions because of the disparity in species usage and distances to the closest sources, unless cultural factors influenced different species selection.

The total numbers of conifers recovered from Chetro Ketl (see Dean and Warren 1983) and Pueblo Alto revealed differences in the presence of some species. The null hypothesis that similar species were utilized by both sites was rejected at the 0.001 level by a Chi-square test (the large sample requires a high rejection level). Generally, ponderosa pine was more common at Alto at the expense of spruce and fir where as the opposite occurs at Chetro Ketl (Table 7.8). Eliminating the aperture category, a group that was not represented in the Alto sample, and the firewood category (Dean and Warren 1983:Table V:10) did not change results (Table 7.9). Considering the dissimilarity of sample proveniences at the two sites and the span of time covered, these differences may not be meaningful.

Variability between samples is a better test of comparison when a single functional class based on timber diameter and a short time span is considered. Under these constraints, only the sample of roofing secondaries from the Pueblo Alto Trash Mound could be compared to beams at Chetro Ketl that were cut in the same period (A.D. 1045). In this case, the same null hypothesis of similarity in species use was not rejected at the 0.01 level (Table 7.10), which indicates that the difference observed in the presence and absence of the spruce/fir category was not statistically valid. We must keep in mind, however, that very few roofs out of the hundreds built are involved in the comparison and that a larger data base might well change results. The series of dates from the roof secondaries in the Alto Trash Mound suggested the entire group was cut in two consecutive years, A.D. 1044-1045, or more likely in A.D. 1045.

When the test was expanded to include cutting dates covering A.D. 1044-1045 from both sites, the Chi-square test still did not indicate a statistical difference in species use between the two sites at the 0.01 level of rejection, although it did at the 0.05 level (Table 7.11). The presence and absence of spruce/fir in the two samples remained consistent despite the larger sample, although one spruce/fir existed in the Pueblo Alto sample, a noncutting date. The absence of spruce/fir in the Alto sample was rectified when both dated and undated specimens were compared, revealing that the absence of spruce/fir in the Alto sample was due solely to its being undatable (Table 7.12a). In this case the period compared was expanded because of one A.D. 1043 date in the Alto sample. A final check of the null hypothesis included all of the Alto secondaries in Layer 16 of the Trash Mound. The largest timber in the Alto group was 12 cm in diameter, so only those from the same period (A.D. 1043-1045) and of the same size or smaller comprise the comparable Chetro Ketl sample. Again, the null hypothesis was not rejected (Table 7.12b), which suggests that the two groups share a similar standard in species selection, at least for secondaries, and, therefore, that the wood might have come from the same source in those years.

Tree Age

Trees have different growth rates and responses to their surroundings that should be accentuated in arid habitats. Greater variability in both age and species occurs if trees are from several different stands, particularly in different mountain ranges (see Mauk and Henderson 1984:Appendix E-3). In this regard, the physiology of ponderosa pine is especially instructive. It regenerates sporadically, and to be successful it must rely on a favorable summer rainfall combined with a productive seed crop. In

Table 7.8. Chi-square analysis of total tree species recovered from Pueblo Alto and Chetro Ketl.[a]

Provenience	Species[b] PP	DF	SF	Totals
Pueblo Alto	274 (227.4)	7 (21.6)	32 (64.0)	313
Chetro Ketl	525 (571.6)	69 (54.4)	193 (161.0)	787
Totals	799	76	225	1100

$X^2 = 49.6$ expected <5 = 0
df = 2 expected <1 = 0
p = 0.0000 (Reject H_0)

Table 7.9. Chi-square analysis of tree species recovered from Pueblo Alto and Chetro Ketl excluding the firewood and aperture element categories.[a]

Provenience	Species[b] PP	DF	SF	Totals
Pueblo Alto	274 (249.9)	7 (12.1)	32 (51.0)	313
Chetro Ketl	265 (289.1)	19 (13.9)	78 (59.0)	362
Totals	539	26	110	675

$X^2 = 21.5$ expected <5 = 0
df = 2 expected <1 = 0
p = 0.0000 (Reject H_0)

[a]Expected frequencies are in parentheses.
[b]See Table 7.4.

Table 7.10. Chi-square analysis of beam (<12 cm diameter) species collected in A.D. 1045 for Pueblo Alto and Chetro Ketl.[a]

Provenience	Species[b]			Totals
	PP	DF	SF	
Pueblo Alto	20 (17.7)	3 (3.5)	0 (1.8)	23
Chetro Ketl	10 (12.3)	3 (2.5)	3 (1.2)	16
TOTALS	30	6	3	39

$X^2 = 5.25$ expected <5 = 4
df = 2 expected <1 = 0
p = 0.073 (Do not reject H_0)

Table 7.11. Chi-square analysis of beam (<12 cm diameter) species collected during A.D. 1044-1045 for Pueblo Alto and Chetro Ketl.[a]

Provenience	Species[b]			Totals
	PP	DF	SF	
Pueblo Alto	33 (30.5)	4 (4.1)	0 (2.3)	37
Chetro Ketl	19 (21.5)	3 (2.9)	4 (1.7)	26
Totals	52	7	4	63

$X^2 = 6.18$ expected <5 = 4
df = 2 expected <1 = 0
p = 0.046 (Do not reject H_0)

[a]Expected frequencies are in parentheses.
[b]See Table 7.4.

Table 7.12. Chi-square analysis of species distribution between Pueblo Alto and Chetro Ketl for the period A.D. 1043-1045.[a]

A. All wood with cutting dates between A.D. 1043 and 1045:

Provenience	Species[b]			Totals
	PP	DF	SF	
Pueblo Alto[c]	136 (133.0)	5 (6.7)	13 (14.3)	154
Chetro Ketl	32 (36.0)	3 (1.7)	7 (4.3)	42
Totals	168	8	20	196

$X^2 = 3.98$ expected <5 = 2
df = 2 expected <1 = 0
p = 0.137 (Do not reject H_o)

B. All wood with cutting dates between A.D. 1043 and 1045 with diameters less than 12 cm (the maximum size of the Alto specimens):

Provenience	Species[b]			Totals
	PP	DF	SF	
Pueblo Alto	136 (133.0)	5 (6.7)	13 (14.3)	154
Chetro Ketl	22 (25.0)	3 (1.3)	4 (2.7)	29
Totals	158	8	17	183

$X^2 = 4.00$ expected <5 = 2
df = 2 expected <1 = 0
p = 0.135 (Do not reject H_o)

[a]Expected frequencies are in parentheses.
[b]See Table 7.4.
[c]All specimens in the Alto Trash Mound (Layer 16) assumed to date between A.D. 1043-1045.

the Chuskas, for example, this event occurred just once between 1908 and 1945 (Wright et al. 1973:1158).

It is expected, then, that low variability will occur within the same tree stand, and high variability will occur between stands, considering the difficulty in duplicating proper growing conditions in the San Juan Basin. Unfortunately, the premise may seem logical for the San Juan Basin but requires extensive fieldwork to test. Appraising the age of timber used in construction offers an alternative approach that may provide clues to source variability, although the size-selection process should have decreased age variability. It did not. There was poor correlation between size and age among roofing secondaries of various rooms at Chetro Ketl when subjected to regression analyses, probably because of intrastand variation that was magnified by the initial beam-selection process.

Dated secondaries from the roofs of several sites in Chaco revealed the degree of selectivity of specific sizes of trees used for construction and the widespread, narrow standard of selection for all sites (Table 7.13). The age and standard deviation of all samples were very similar, although some unlisted clusters of fragments from secondaries at Pueblo Alto were nearly twice as old (see Chapter 8).

Overall, the mean ages of secondary beams from well-dated rooms in different greathouses are very similar with consistent moderate standard deviations. This is not unexpected because secondary beams differ from primary beams in the adjustment made for room size and load requirements by varying the <u>number</u> of secondary beams rather than the size (Dean and Warren 1983:223). This illustrates the selective process of harvesting specific sizes of trees, but it may also portray the uniformity of the source(s) being utilized. In contrast, secondary beam ages at Salmon Ruin, and perhaps at Pueblo Alto, differ from those in the main canyon group (see Table 7.13).

Unfortunately a clear-cut pattern of similarity or dissimilarity can not be achieved between the samples from Pueblo Alto and Chetro Ketl. Nevertheless, the trend toward similarity of both beam age and beam species during the only period when the two sites can be directly compared (A.D. 1044-1045) suggests procurement from the same source and uniformity in construction standards (Table 7.14).

Tree-age variance among roofing secondaries (<12 cm in diameter) from Pueblo Alto and Chetro Ketl was tested for differences of sample means by a series of t-tests (Table 7.15). Most of these tests (8 of 10) suggest that the samples could have been drawn from the same age population. In particular, a t-test of tree ages for secondary beams between the Pueblo Alto and Chetro Ketl groups cut in A.D. 1044 and 1045 does not indicate that they came from different populations at the 0.01 level of rejection, although it does for 0.05. The results from Chetro Ketl and Pueblo Alto are intriguing because they reveal the homogeneity of secondary beam selection through time, especially when contrasted with the only other greathouse with comparable data, the Salmon Ruin. Thus, trees cut for

Table 7.13. The mean age of secondary beams (<12 cm diameter) from selected rooms at Chaco Canyon greathouses and from the Salmon Ruins (a northern Chacoan outlier).[a-c]

Site	Room	Cutting Dates (A.D.)	No. of Beams	Mean age in years	sd	Range	Age span in years
Pueblo Bonito	320	919	22	42.7	10.9	24-60	42
Chetro Ketl	106	1032-1034	9	43.6	10.0	36-68	32
Chetro Ketl	57[d]	1036-1039	16	48.4	13.0	28-80	52
Chetro Ketl	93	1050-1052	21	41.9	9.8	21-60	41
Chetro Ketl	39	1051-1052	14	41.0	10.2	23-56	33
Chetro Ketl	92	1053-1054	9	40.6	11.9	26-57	31
Una Vida	21	1055-1056	6	44.0	7.5	32-52	20
Peñasco Blanco	9	1087-1088	10	39.4	9.7	21-57	36
Salmon	36W	1089	9	38.7	13.7	23-73	50
Salmon	51W	1089	9	31.3	46.1	24-125	101
Salmon	62W	1089	8	67.9	30.3	39-133	94
Salmon	67W	1089	10	26.2	7.3	23-32	9
Salmon	84W	1089	15	38.3	9.9	26-61	35
Salmon	129W	1088-1090	36	38.3	31.3	18-85	67

[a]Beams are predominantly ponderosa pine with a few Douglas fir and spruce-fir. Pinyon, juniper, and Populus sp. are not included.

[b]Dates computed only from specimens with both pith and cutting dates.

[c]Beams in Salmon samples are presumed to be secondaries. Beam diameters are unknown.

[d]Intramural beams are of same size range as secondary beams.

Table 7.14. The mean age of beams less than 12cm in diameter (secondaries and intra- mural beams) by selected year span at Pueblo Alto and Chetro Ketl.

Site	Year Range (A.D.)	No. of Beams	Mean age in years	sd	Range	Age span in years
Alto	1044-1045[a]	13	58.7	26.6	24-97	73
Chetro Ketl	1044-1045	21	44.3	20.5	19-97	78
Chetro Ketl	1037-1039	55	43.1	15.5	19-94	65

[a]All samples with pith and non-cutting dates aged to A.D. 1045. One A.D. 1043 cutting date included.

Table 7.15. T-test evaluations of secondary and intramural beam (<12 cm diameter) ages from Pueblo Alto and Chetro Ketl. Null hypothesis that age pairings came from the same age population is rejected at the 0.01 level of significance.

No.	Test pairings	Period (A.D.)	t value	df	score	Result	Conclusion
A.	CK: Rm 39	1051-1052	-0.041	34	0.48	Accept H_o	CK = CK
	CK: Rm 93	1050-1052					
B.	CK: all	1037-1039	0.266	74	0.396	Accept H_o	CK = CK
	CK: all	1043-1045					
C.	CK: all	1043-1045	-0.555	33	0.291	Accept H_o	CK = CK
	CK: Rm 39	1051-1052					
D.	PA: all	1044-1045	2.320	25	0.014	Accept H_o	PA = CK
	CK: Rm 39	1051-1052					
E.	PA: all	1044-1045	-2.827	33	0.004	Reject H_o	PA $\neq$ CK
	CK: Rm 93	1050-1052					
F.	PA: all	1044-1045	1.37	27	0.09	Accept H_o	PA = CK
	CK: Rm 57	1036-1039					
G.	PA: all	1044-1045	-1.91	20	0.035	Accept H_o	PA = CK
	CK: Rm 92	1053-1054					
H.	PA: all	1044-1045	-1.78	32	0.04	Accept H_o	PA = CK
	CK: all	1044-1045					
I.	PA: all	1044-1045	2.80	66	0.0034	Reject H_o	PA $\neq$ CK
	CK: all	1037-1039					
J.	CK: all	1044-1045	0.651	41	0.259	Accept H_o	CK = CK
	CK: Rm 93	1050-1052					
K.	PA: PF 1, Floor	1028++vv	-1.51	21	0.073	Accept H_o	PA = PA
	PA: Plaza 2	1056+					

secondary roofing timbers in some rooms at Pueblo Alto and Chetro Ketl may have been harvested from similar or from the same sources, although the strength of the results is not overwhelming. More importantly, the premise that similarity in tree ages mark similar sources may be flawed if different parts of trees (e.g., saplings and the tops of mature trees) were differentially selected (Jeffrey Dean, personal communication 1987).

Construction Scheduling

The similarity of tree species and age variation for the A.D. 1044-1045 period at both sites suggests the possibility of shared timber resources. If periodic tree harvesting were taking place, as Lekson (1984:261) suggests, then a pooled effort might have been responsible for gathering the timbers and for alternating construction at the two sites. The possibility is made more compelling when one remembers that the prehistoric road system (Chapter 5) closely ties both sites.

Only a single episode of construction can be dated with confidence at Pueblo Alto (see Chapter 8). Despite a much larger dated beam sample at Chetro Ketl, the period between A.D. 1044-1045 yielded more dates at Pueblo Alto. If building intensity is measured by the number of dated timbers (see Dean and Warren 1983), then this period is bracketed by major building efforts at Chetro Ketl (Figure 7.1). Another period of construction at Pueblo Alto, around A.D. 1056, is construed from a small number of dated specimens, yet this, too, is bracketed by clusters of dates from Chetro Ketl. In summary, the age and species of trees used in Chacoan greathouses offer a potential avenue for investigating social and political integration among site inhabitants, or at least among planners and builders. Tentatively, similar or the same timber sources were apparently utilized for some parts of the building at both Pueblo Alto and Chetro Ketl. This factor, along with the possibility of alternate staggered periods of construction between the two sites, suggests cooperative planning and harvesting on the supra-site level. No other greathouses in the canyon have yielded large clusters of dates for the same span of years as have Chetro Ketl and Pueblo Alto, perhaps because of inadequate samples. Projecting intersite planning and cooperation beyond the two sites, therefore, is not now possible.

Summary

Species of timbers used in Chaco Canyon may provide links to tree sources, but an understanding of the forest composition and forest histories in the mountains surrounding the San Juan Basin is necessary before these sources can be identified. In addition, the identification of the relevant species of fir and spruce timbers found in Chaco could assist in identifying sources. Pueblo Alto shares with other greathouses in Chaco a similar proportion of the different large conifer species used for construction in the A.D. 1000s. It is assumed that suitable species of wood were harvested from the closest sources, although many sources may have

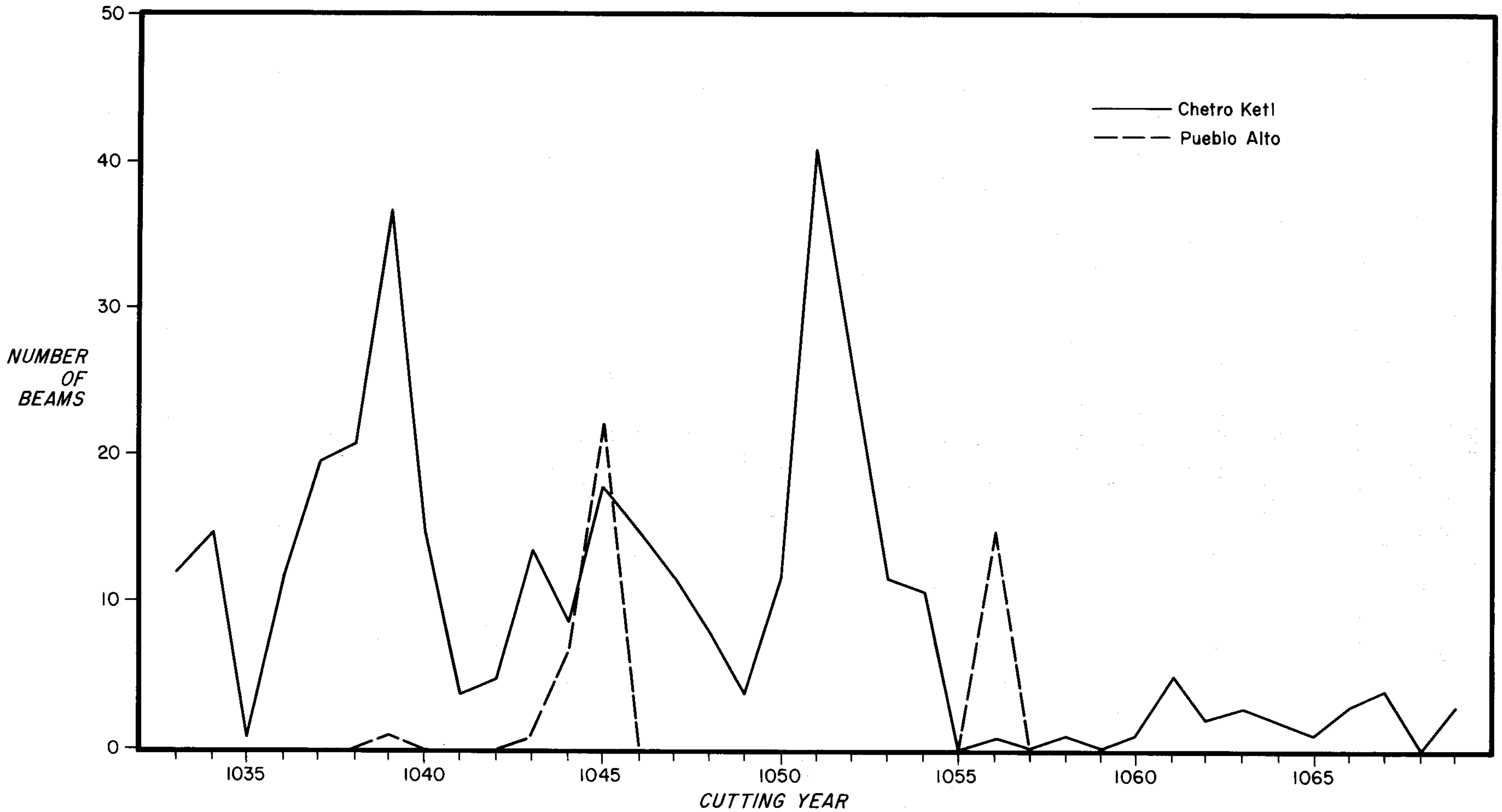


Figure 7.1. Major episodes of building at Chetro Ketl and Pueblo Alto measured by the frequency of tree-ring cutting dates.

become depleted through time which would affect the subsequent species compositions of harvests. Barring past major environmental changes, the closest timber sources to Alto were the Chuska and Zuni mountains and Mt. Taylor.

Tree age and species similarities among greathouses in Chaco Canyon suggest common sources were harvested, although inadequate samples and a poor understanding of specific harvesting techniques make interpretations tenuous. Comparisons of timbers cut for Chetro Ketl and Pueblo Alto in the same years or for the same functions suggested that timber procurement may have come from the same or similar areas. Examination of clusters of tree-ring dates from Pueblo Alto and Chetro Ketl, under the assumption that frequency of the same dates reflects peaks of building (e.g., harvesting), revealed possible alternating construction periods. Thus, cooperative scheduling of construction between builders for the two sites is suggested. Possibly, intersite planning and construction was a canyon-wide activity.

Finally, differential wood use for different functions is clear at Pueblo Alto. Not surprisingly, the large conifer species (ponderosa pine, firs and spruces) were favored for construction, undoubtedly because of their growth pattern and weight-bearing properties. Wood selected for fuel, on the other hand, was predominantly juniper, pinyon, and brush. Near the end of the occupation at Alto in the early A.D. 1100s, the dichotomy in species use became blurred, probably because the wood fabric of the site was scavenged for firewood.

Chapter Eight

Temporal Control at Pueblo Alto

Introduction

A number of chronometric methods were utilized to provide the basis for temporal control at Pueblo Alto (Table 8.1). Along with the excellent horizontal stratigraphy and associated ceramic assemblages, these methods provide confident control of the site's occupational history. In addition to correlating six different dating techniques with the site data, refinement of the dating techniques to improve their usefulness in the Chaco area was also desired. Tree-ring dates provide the most reliable measure of dating but generally are restricted to construction and firepit use. We are aware that the arid Chacoan environment and lack of trees dictates high probability of wood reuse and, therefore, that tree-ring context must be scrutinized. Most of the Alto tree-ring dates came from just two proveniences, yet tree-ring dating provides the most reliable limits for the span of site occupation and the baseline data to assess all other chronometric results for the site.

Table 8.1. Chronometric techniques used at Pueblo Alto.

Dating technique	No. of samples Submitted	No. of dates
Tree-ring	546	136
Archeomagnetic	123	99
Carbon-14	21	27 (includes 6 reruns)
Thermoluminescence	8	1
Obsidian Hydration	22	10
Total	720	273

Archeomagnetic dating of burned adobe yielded the second largest number of dates at Pueblo Alto. This method has frequently been used to date in situ features with confident association and interpretation of the cultural context. The numerous near-duplicate dates from the same proveniences attest to the reliability of the method (see Wolfman 1984). Unfortunately, the accuracy of the dates was often questionable and forced additional laboratory work to revise the archeomagnetic curve for the time period from which the dates were first derived.

Carbon-14 dating was used to cross-check the archeomagnetic results. Carbon-14 results yield high standard errors that normally nullify precise dating in these circumstances where age can be refined by other methods to a decade or two; therefore, samples were clustered to provide multiple dates for the same or similar proveniences and then averaged to provide shorter spans of time. Results were so mixed initially from this strategy that the carbon-14 appeared to do little to rectify the archeomagnetic problems. Instead, much effort was spent in trying to resolve the problems of the carbon-14 dating before resolution of the archeomagnetic problem could be attempted.

A small number of sherds were tested for application of thermoluminescence dating, and one yielded enough quartz for dating. By itself, the date generated was not useful because of a very large standard error, although the date midpoint was in perfect agreement with the predicted age of the room from which it was associated.

Finally, interest in establishing a Chaco dating curve for obsidian from the Jemez Mountains resulted in 34 hydration measurements from 5 sites in Chaco, 22 of them from Pueblo Alto. A curve was never finalized from the initial work, leaving the results unusable for interpreting temporal events at Alto. This was partly rectified later by a second laboratory analysis.

Next to tree-ring dating, ceramic seriation provided the most reliable temporal control for Pueblo Alto. Breternitz's (1966) work has established the basis for most ceramic seriation in the Southwest, although little faith can be placed in the association of tree-ring dates and ceramic types from the early Chaco work because of lengthy site occupations, inadequate field methods, and an inadequate knowledge of the ceramic types. The Alto ceramic assemblages were seriated by a multidimensional scaling program (KYST-2A) and cross-checked against tree-ring-dated assemblages from throughout the San Juan Basin and beyond. This permitted units with sizeable numbers of sherds at Alto to be used for assessing chronometric dating techniques and for dating units without absolute dates.

Tree-Ring Dating

Tree-ring dating can offer the most accurate chronological control, depending on the context and the number of dates. At Pueblo Alto, the 136 dates (25 percent of 546 specimens) provided some temporal certainty of cultural events at the site (Tables 8.2-8.4). Dean and Warren (1983:205) estimate that approximately 15,000 trees may have been used for construction at Alto, although these figures must have been calculated for a multistory pueblo. Using their method of calculation (Dean and Warren 1983:Table V:5) for a single story building yields a more probable figure

Table 8.2. Tree-ring dates from the Pueblo Alto Trash Mound.

Provenience	Tree-Ring Lab. No.	Field FS No.	Species[a]	Function	Date[a]
TRASH MOUND:					
Layer 16, Grid 183, Level 16	CNM-424	4651	PP	latilla	0948p - 0979vv
" Grid 183, Level 16	CNM-428	4651	PP	"	0989p - 1015vv
" Grid 127, Level 9	CNM-399	4531	PP	"	0961fp - 1016vv
" Slump 2	CNM-409	4642	PP	"	0974p - 1016vv
" Grid 183, Level 16	CNM-439	4651	PP	"	0960fp - 1017vv
" Grid 183, Level 16	CNM-425	4651	PP	"	0962p - 1017vv
" Grid 183, Level 17	CNM-467	4652	PP	"	0986fp - 1017vv
" Grid 183, Level 16	CNM-426	4651	DF	"	0986p - 1017vv
" Grid 183, Level 15	CNM-403	4625	PP	"	0990fp - 1022vv
" Grid 183, Level 15	CNM-401	4625	PP	"	0950 - 1024vv
" Grid 183, Level 17	CNM-464	4652	PP	"	0966fp - 1024vv
" Grid 183, Level 15	CNM-400	4625	PP	"	0940fp - 1027++r
" Grid 183, Level 16	CNM-444	4651	S-F	"	0958 - 1028vv
" Grid 183, level 16	CNM-423	4651	PP	"	0949p - 1030++r
" Grid 155, Level 15	CNM-419	4647	PP	"	0984fp - 1031vv
"	CNM-449	4684	PP	"	0979fp - 1034vv
" Grid 183, Level 16	CNM-429	4651	PP	"	0976p - 1038+vv
" Grid 183, Level 16	CNM-437	4651	PP	"	0966fp - 1039vv
" Grid 155, Level 9	CNM-412	4535	PP	"	0966fp - 1039+r
" Grid 183, Level 16	CNM-440	4651	Pnn	"	0998fp - 1040vv
" Grid 155, Level 15	CNM-391	4647	PP	"	0970fp - 1042vv
" Grid 183, Level 17	CNM-460	4652	PP	"	0984p - 1043r_c
" Grid 183, Level 16	CNM-441	4651	PP	"	0991fp - 1044vv
" Grid 127, Level 9	CNM-398	4531	PP	"	0987p - 1044r_c
" Grid 183, Level 16	CNM-436	4651	PP	"	0990fp - 1044r_c
" Grid 183, Level 15	CNM-402	4625	PP	"	0995fp - 1044r_c
"	CNM-451	4684	PP	"	1006fp - 1044r_c
" Grid 155, Level 15	CNM-417	4647	PP	"	1013fp - 1044r_c
" Grid 183, Level 17	CNM-461	4652	PP	"	1015fp - 1044r_c
" Grid 155, Level 14	CNM-393	4646	PP	"	1027fp - 1044r_c
"	CNM-454	4684	PP	"	0973fp - 1045vv
" Grid 183, Level 17	CNM-468	4652	PP	"	1019fp - 1045vv
Slump 2	CNM-407	4642	PP	"	0951fp - 1045$v_?$
" Grid 155, Level 9	CNM-411	4535	PP	"	0969fp - 1045$v_?$
" Grid 155, Level 9	CNM-413	4535	PP	"	0996fp - 1045$v_?$
" Grid 155, Level 9	CNM-410	4535	DF	"	1019p - 1045v_c
" Grid 183, Level 17	CNM-465	4652	PP	"	0957fp - 1045$r_?$
" Grid 127, Level 9	CNM-396	4531	PP	"	0965fp - 1045r_c
" Slump 2	CNM-406	4642	PP	"	0968fp - 1045r_c
" Grid 127, Level 9	CNM-395	4531	PP	"	0970fp - 1045r_c
" Grid 183, Level 16	CNM-438	4651	PP	"	0972fp - 1045r_c
"	CNM-447	4684	PP	"	0974fp - 1045r_c
" Grid 155, Level 13	CNM-394	4645	PP	"	0995fp - 1045r_c
" Grid 155, Level 15	CNM-420	4647	PP	"	0995fp - 1045r_c
" Grid 183, Level 16	CNM-442	4651	PP	"	0987fp - 1045r_c
"	CNM-453	4684	PP	"	0999fp - 1045r_c
" Grid 183, Level 15	CNM-392	4625	PP	"	1000fp - 1045r_c
"	CNM-450	4684	PP	"	1004fp - 1045r_c
"	CNM-455	4684	PP	"	1003fp - 1045r_c
" Grid 155, Level 9	CNM-415	4535	PP	"	1007fp - 1045r_c
" Grid 127, Level 9	CNM-397	4531	PP	"	1013fp - 1045r_c
"	CNM-446	4684	PP	"	1015fp - 1045r_c
"	CNM-448	4684	PP	"	1015fp - 1045r_c
"	CNM-452	4684	PP	"	1016fp - 1045r_c
" Grid 183, Level 17	CNM-462	4652	DF	"	1016p - 1045r_c
" Grid 183, Level 17	CNM-463	4652	DF	"	1018p - 1045r_c
" Grid 183, Level 16	CNM-435	4651	PP	"	1021fp - 1045r_c
"	CNM-456	4684	DF	"	1021p - 1045r_c
" Grid 183, Level 16	CNM-422	4651	PP	"	1022fp - 1045r_c

[a]See Table 7.4 for an explanation of the symbols.

Table 8.3. Tree-ring dates from rooms, plazas, and the Trash Mound at Pueblo Alto.

Provenience	Tree-Ring Lab. No.	Field FS No.	Species[a]	Function[b]	Date[a]
ROOMS:					
Room 110, North wall	CNM-667	1679	Pnn	intra. log	0900p - 1021r$_{1}$
Room 142, Grid 11, Floor 1 fill	CNM-385	2807	PP	unknown	0969fp - 1004v
Room 142, Floor 1, PH 3	CNM-386	2809	PP	roof post	0916p - 1016vv
Room 143, Grid 13, Floor 1, PH 1	CNM-675	6351	PP	post step	0825p - 0911vv
Room 166, wall clear, in fill N-S	CNM-320	360	PP	viga	0930fp - 0966vv
Room 188, wall clear, outside the West wall	CNM-475	4290	PP	intra. log?	0860p - 0949vv
Room 190, wall clear, in fill	CNM-338	365	PP	viga?	0815p - 0935vv
PLAZA 1:					
Plaza Feature 4 (kiva), upright pole above ventilator tunnel	CNM-486	4232	Pnn	construction	0966p - 1044vv
PLAZA 2:					
Grid 121, Layer 2, firepit (in East Backhoe Trench)	CNM-484	3468	PP	latilla/fwd	0970fp - 1021vv
Grid 181, Layer 2, Level 1	CNM-477	3426	PP	latilla/fwd	0933fp - 0977vv
Grid 181, Layer 2, Level 1	CNM-485	3433	PP	latilla/fwd	0935fp - 1014vv
Grid 201, OP 2 [FP] (top)	CNM-476	3421	PP	latilla/fwd	0969fp - 1056vv
Grid 201, OP 2 [FP] (Layer 4)	CNM-639	3493	PP	latilla/fwd	0966fp - 1020vv
Grid 201, OP 2 [FP] (Layer 4)	CNM-479	3461	PP	latilla/fwd	0982fp - 1052vv
Grid 201, OP 2 [FP] (Layer 4)	CNM-480	3461	PP	latilla/fwd	1014fp - 1054vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-637	3494	PP	latilla/fwd	0949fp - 1018vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-638	3494	PP	latilla/fwd	0960fp - 1028+vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-636	3494	PP	latilla/fwd	0971fp - 1034vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-483	3463	PP	latilla/fwd	0982fp - 1047vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-635	3494	PP	latilla/fwd	0984fp - 1049vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-482	3463	PP	latilla/fwd	0982fp - 1055vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-633	3494	PP	latilla/fwd	0987fp - 1056vv
Grid 201, OP 2 [FP] (Layer 5)	CNM-634	3494	PP	latilla/fwd	0994fp - 1056v
TRASH MOUND MISCELLANEOUS:					
Layer 19 (SC 3, Grid 154)	CNM-649	4747	Pnn	firewood	0986p - 1055vv
Layer 24-31 (SC 3, Grid 154)	CNM-653	4737	Pnn	firewood	0780fp - 0855+vv
Layer 24-31 (SC 3, Grid 154)	CNM-656	4737	Pnn	firewood	0828fp - 0927vv
Layer 24-31 (SC 3, Grid 154)	CNM-650	4737	Pnn	firewood	0718 - 0928+vv
Layer 24-31 (SC 3, Grid 154)	CNM-655	4737	Pnn	firewood	0814fp - 0945vv
Layer 58/62 (TT 1, Grid 239, Level 11)	CNM-390	4598	DF	latilla/fwd?	0987fp - 1072+vv
Layer 98 (SC 5, Grid 238)	CNM-657	4782	Pnn	latilla/fwd	0897fp - 0957vv
Layer 113 (TT 1, Grid 295)	CNM-445	4683	PP	latilla/fwd?	0973fp - 1047vv

[a]See Table 7.4 for an explanation of the symbols.
[b]Intra. log = intramural log. Fwd = firewood.

Table 8.4. Tree-ring dates from Plaza Feature 1, Room 3, at Pueblo Alto.

Room 3 Provenience	Tree-Ring Lab No.	Field FS No.	Species[a]	Function[b]	Date[a]
Grid 6, Floor 1 fill:	CNM-622	934	PP	latilla	0912fp - 0965vv
	CNM-625	934	PP	latilla	0938fp - 1010++vv
	CNM-628	934	PP	latilla	0928fp - 1013++vv
	CNM-626	934	PP	latilla	0936fp - 1018+vv
	CNM-623	934	PP	latilla	0953fp - 1023vv
	CNM-621	934	PP	latilla	0942fp - 1024vv
	CNM-627	934	PP	latilla	0960fp - 1026++vv
	CNM-624	934	PP	latilla	0940fp - 1027++vv
Grid 18, Floor 1 fill:	CNM-631	947	Pnn	firewood	0790fp - 0915+vv
Floor 1, Firepit 1 (Layer 4):	CNM-500	988	Pnn	firewood	0722fp - 0851vv
	CNM-617	988	Pnn	firewood	0791fp - 0881vv
	CNM-509	988	Pnn	firewood	0802fp - 0931+vv
	CNM-493	988	PP	latilla/fwd	0879 - 0959vv
	CNM-615	988	PP	latilla/fwd	0873p - 0965vv
	CNM-504	988	Pnn	firewood	0880p - 1004vv
	CNM-491	988	Pnn	firewood	0866fp - 1013vv
	CNM-516	988	PP	latilla/fwd	0993p - 1034vv
	CNM-492	988	PP	latilla/fwd	0965p - 1037vv
	CNM-499	988	Pnn	firewood	0852fp - 1043vv
	CNM-490	988	Pnn	firewood	0921fp - 1049vv
	CNM-503	988	Pnn	firewood	0854p - 1052vv
	CNM-515	988	PP	latilla/fwd	1004p - 1058vv
	CNM-501	988	Pnn	firewood	0989p - 1113++vv
	CNM-506	988	Pnn	firewood	1011p - 1127vv
	CNM-505	988	Pnn	firewood	0990p - 1130r$_c$
Floor 1, Firepit 2 (Layer 8):	CNM-537	800	Pnn	firewood	0719fp - 0837vv
	CNM-488	800	Pnn	firewood	0612fp - 0899+vv
	CNM-536	800	Pnn	firewood	0778p - 0946+vv
	CNM-538	800	Pnn	firewood	0813fp - 0958+vv
	CNM-528	800	Pnn	firewood	0814fp - 1071vv
	CNM-533	800	Pnn	firewood	0925 - 1080vv
	CNM-530	800	Pnn	firewood	1037p - 1093vv
	CNM-532	800	Pnn	firewood	0940p - 1107vv
	CNM-531	800	Pnn	firewood	1042p - 1110vv
	CNM-525	800	Pnn	firewood	1031p - 1132rB$_c$
Floor 1, Firepit 2 (Layer 9):	CNM-563	801	Pnn	firewood	0671p - 0803vv
	CNM-564	801	Pnn	firewood	0760p - 0946++vv
	CNM-522	801	Pnn	firewood	0814 - 1061vv
	CNM-703	801	Pnn	firewood	0938 - 1088vv
	CNM-700	801	Pnn	firewood	1036fp - 1094vv
	CNM-565	801	Pnn	firewood	0939p - 1100vv
	CNM-562	801	Pnn	firewood	1046p - 1130r$_c$
Floor 1, Firepit 2 (Layer 11):	CNM-583	803	Pnn	firewood	0920fp - 1035++vv
	CNM-582	803	Pnn	firewood	0916p - 1105vv
	CNM-585	803	Pnn	firewood	1050p - 1115vv
	CNM-580	803	Pnn	firewood	1063p - 1130rB$_c$

[a]See Table 7.4 for an explanation of the symbols.
[b]Fwd = firewood.

of about 5,000 trees (or fewer) used at Alto. The number of dated timbers at Alto (94), then, represents only a small fraction (perhaps 2 percent or less) of those ultimately consumed for construction. The limitations of a small sample are obvious and, at best, provide us with tentative parameters for the site occupation, in conjunction with tree-ring dates from the other canyon greathouses, in which to assess the other dating methods.

Only seven tree-ring dates, three from wall clearing, were obtained from room excavation at Pueblo Alto. The earliest cutting date, A.D. 1021r, came from an intramural pinyon log placed in the north wall of Room 110 during construction. It occurs in the Stage II construction at the site (see Chapter 6) and substantiates at least some room construction at or after that date. Room 142, part of the initial Phase I construction, yielded a piece of charcoal from the uppermost floor fill that dated at A.D. 1004v, believed to be close to the cutting date. Its association with room construction is dubious, however, because of its context and because it was superseded by a more recently dated specimen (A.D. 1016vv) used as a roof-support post in the same room. The largest timber found at Alto (27 cm in diameter) came from Room 143, which was connected directly by door to Room 142. This timber was reused as a post step in late remodeling of the room and yielded a noncutting date of A.D. 911vv. The latter two specimens and two of the three from wall clearing were some of the largest and oldest ponderosa pine specimens recovered. An unknown number of exterior rings was lost from these old logs, so they have little interpretive value except for, perhaps, the youngest, dating to A.D. 1016vv, which places Stage I construction of the Central Roomblock after that time.

The best dated group of early specimens from Pueblo Alto came from a unit of burned roofing deposited in Layer 16 of the Trash Mound. Numerous fragmented, roofing secondaries were recovered and, with a single exception, dates cluster within a 30-year period (Table 8.2). Of the 59 datable pieces, 8 (14 percent) were cut in A.D. 1044 and 29 (49 percent) in A.D. 1045, indicating a period of tree harvesting, and by inference, construction, during those years. According to Dean (personal communication 1987):

> the terminal ring data indicate that two distinct tree-cutting episodes are represented by the 1044 and 1045 cutting dates. All 1044 cutting dates have complete terminal rings, which means that these ponderosa pine trees were felled between the end of the 1044 growing season and the beginning of the 1045 growing season; that is, between September of 1044 and June of 1045. One of the 1045 cutting dates has an incomplete terminal ring; all the other 1045 cutting dates have complete terminal rings. Most of the one incomplete terminal ring has formed and there is some evidence for the production of late-wood cells. This evidence indicates that the tree that produced this sample had grown through most of the summer and was felled near the end of the growing season. This tree could not have been cut in the spring along with those that produced 1044 complete dates.

Therefore, it is probable that the 1045 cutting dates reflect a single tree cutting event that took place in the early fall of 1045 when all the harvested trees but one had ceased growing for that year.

Following the calculations of Dean and Warren (1983:202, Table V:5) that 30-40 secondary beams were used for each large room roof at Chetro Ketl, at least two roofs must be represented among the 59 dates in Layer 16. The stratigraphy of the Trash Mound suggests that our test trench hit only a small part of the roofing debris that was spread laterally across the buried east slope and that many more roofs should be present. Considering the fragmentary nature of the specimens, however, it is difficult to understand the lack of duplicates recorded during the dating analysis when the identification of matches should not have been difficult (Richard Warren, personal communication 1985). Nevertheless, it seems certain that a number of rooms, probably all built between A.D. 1044 and A.D. 1045, burned, and then the debris was deposited at one time on the Trash Mound.

The burned roofing debris was deposited early in the depositional history of the Trash Mound, shortly after the final discard of a large volume of primary construction debris (see Volume II, Plate 7.1). The interval between the construction and roofing debris corresponds with a shift in ceramic-type dominance. Red Mesa Black-on-white and associated plain gray and neck-decorated culinary ceramics dominated the assemblage associated with the construction material, whereas Gallup Black-on-white and overall indented corrugated culinary ceramics dominated Layer 17 and above. Ceramic seriation of these and similar assemblages (discussed later) suggests that the shift in ceramic types occurred between about A.D. 1040 and A.D. 1050. Based on the above facts and the relative stratigraphic position of the two units in the Trash Mound, it can be presumed that part of Alto burned shortly after the initial greathouse construction, perhaps within five years or at about A.D. 1050.

A few other dates from the Trash Mound, not associated with Layer 16, were scattered in the trash deposits and probably represent firepit charcoal. These add little to our understanding of temporal events at the site. The latest date from the Trash Mound, A.D. 1072+vv, occurred near the end of the midden deposition and correlates closely with the ceramic seriation that was cross-dated with tree-ring dates from other sites, which suggest that deposition ceased at approximately A.D. 1100. Chapter 7 demonstrated the association of pinyon and juniper with firepit fuel and the association of other conifer species with building construction at Pueblo Alto. The A.D. 1072 specimen of Douglas fir, therefore, may represent the latest roofing date recovered from the site, a date preceded by the next latest date of A.D. 1058vv from a ponderosa pine in Room 3 of Plaza Feature 1.

A number of pieces of large-conifer charcoal were found scattered in and around two firepits built against the East Wing wall's exterior in Grids 181 and 201 of Plaza 2 (Tables 7.2-7.3). It is certain that the wood was used for fuel, although the dates belie their association with the late ceramics and the stratigraphic position of the firepits. The species, age, and the range of dates are remarkably similar for firepit fuel. All 37 specimens, including undated ones, were ponderosa pine, except for a single piece of spruce-fir. Despite the loss of both inner and outer rings on the dated specimens, the standard deviation of 14.0 years is low for the mean tree age of 63.9+ years. Fourteen of the 15 dated pieces cover a 42-year period, but even the inside noncutting dates for the 14 cover just 59 years. In general the 15 pieces ranged between A.D. 977vv and 1056v, the latter nearly a cutting date. Eight of the 15 cluster between A.D. 1047vv and A.D. 1056v. The relative homogeneity of the charcoal, therefore, suggests a single group of specimens cut shortly after A.D. 1056 and probably robbed from a roof at Pueblo Alto, perhaps from the adjacent rooms. Except for their older age, the specimens' characteristics are similar to the roofing secondaries recovered from the Trash Mound and in other greathouse roofs. This group offers the only cluster of dates, other than from the Trash Mound group, that tentatively identifies an episode of construction at Alto (Stage III).

The final group of significant dates came from Plaza Feature 1, a small block of late rooms built in the central plaza. A firepit dump of 11 ponderosa-pine charcoal fragments in the northeast corner of Room 3 also exhibited the characteristics of roofing secondaries in species, age, and short time span. Unfortunately, the specimens did not yield any close cutting dates, although 7 of the 8 spanned just 17 years (A.D. 1010++vv to 1027++vv). The ++ symbols associated with half of the 8 dates suggest natural tree death (Jeffrey Dean, personal communication 1987), although both live and dead trees could have been collected simultaneously for roofing beams. The inside rings covered a relatively short span of time, 48 years, considering that none were pith dates. The mean age of the sample was a mature 73.4+ years compared to the younger secondaries from other greathouse roofs (Table 7.12), although the standard deviation of 14.4 years is within the range for roofs with both pith and cutting dates. If the youngest specimen is dropped, than the mean age increases to 77.7 years with a much reduced standard deviation (8.2 years). The variance in age does not statistically separate this group from the Plaza 2 group (Table 7.14). Again, homogeneity of the sample suggests roofing secondaries reused for firewood even though the dates provide little in the way of precise temporal assessment. If from the same roof, the group postdates A.D. 1027 and is thus consistent with the more firmly dated episode of A.D. 1044-1045 and the tentative group of about A.D. 1056.

Two immense firepits in Room 3 yielded the latest tree-ring cutting dates, A.D. 1132, for the Anasazi occupation of Chaco Canyon (Tables 7.2, 8.4). Wood species typical of roof construction were found in the firepits but were mixed with a preponderance of pinyon and juniper charcoal. Only 5 of the 29 ponderosa pine and spruce-fir samples were dated because of short-ring series and ring complacency. The size and age of greathouse secondaries (Table 7.12) make it improbable that the ponderosa pine and spruce-fir group could have been dated as late as the pinyon cutting dates of A.D. 1130 and A.D. 1132 (i.e., made up the 74-year difference) despite the loss of an unknown number of exterior rings in the former group. The size, age, and species composition of the firewood suggests derivation from two sources. Seventy-four years separate the youngest ponderosa pine at A.D. 1058vv from the youngest pinyon at A.D. 1132. The small ponderosa sample of mature trees (mean age = 74.5+ years, sd = 15.9, n = 4), however, is similar to the groups recovered off the floor and from Plaza 2. Thus, the 29 ponderosa pine and spruce-fir specimens likely came from old roofs, whereas the 136 specimens of pinyon and juniper were cut for fuel.

The age variability of pinyon makes it difficult to examine the homogeneity of the group. Of the 33 datable pinyon specimens, there were no cutting dates or near-cutting dates except for the 4 terminal ones at A.D. 1130 and A.D. 1132, which suggests that all were collected in the same 2 years. No matter what the true age of individual specimens was, some very old trees are involved, despite the loss of many interior and exterior rings for most of the specimens (mean age of greater than 140.5 years, sd = 57.4, range 56-287+, n = 33). When one considers the probable effects of the Anasazi upon the local pigmy conifer stands (see Betancourt and Van Devender 1981), one wonders how these old trees could have escaped collection during prior centuries, unless silviculture was practiced or the trees were brought from some distance beyond Chaco Canyon. We know that this fuel was obtained near the end of occupation at the site. Thus, the procurement strategy that yielded some roofing and much possible nonlocal wood for fuel suggests that available roofing at sites was becoming scarce.

Confidence in the tree-ring dates marking the close of occupation at the site was reinforced by the very similar, terminal, tree-ring dates (A.D. 1139) and ceramics derived from Bis sa'ani, a Chacoan site 15 km east-northeast from Alto (Breternitz et al. 1982).

In summary, the Pueblo Alto tree-ring dates attest to a major, perhaps the initial, period of construction in A.D. 1045 for one or more rooms. The earliest date of A.D. 1021 does not rule out earlier construction. Nevertheless, the burned, A.D. 1045 roofing in the Trash Mound deposited just above major deposits of construction debris suggests that the two dates are closely related in time and present the strongest case for the A.D. 1045 period of initial construction unless a major hiatus occurred between construction of the walls and roofs (see Chapter 6).

A second period of construction is more tentatively placed at or shortly after A.D. 1056, on the basis of a small cluster of firepit wood presumably scavenged from roofs. The latest dates from Pueblo Alto thought to represent building timbers were A.D. 1058vv and A.D. 1072+vv, although the small sample is inadequate to represent all construction, repair, and firepit use at the site. Dated firewood places the latest activity at Alto at A.D. 1132 or slightly later, presumably when the socioeconomic organization at the site had disintegrated.

Carbon-14 Dating

As an independent check on the archeomagnetic dates from Pueblo Alto, 27 carbon-14 samples were analyzed or reanalyzed at the Smithsonian Institution Radiocarbon Laboratory and the Dicarb Radioisotope Company (Table 8.5). These labs calibrate their equipment against each other's (Irene Stehli, personal communication 1981), so seemed ideally suited for splitting analysis. Unfortunately, the dates presented new problems that did little to confirm or dispel the accuracy of the archeomagnetic dates. Laboratory variability in radiocarbon results is not unexpected (see Stuiver 1982), but its magnitude was disconcerting.

We know that the magnitude of error for carbon-14 dates results in less precise data than either tree-ring or archeomagnetic dating. One standard deviation confidence limits for a carbon-14 date means that the true date falls within the given time span only 67 percent of the time. This problem was partly reconciled by allotting extra counting time for the analysis, by analyzing clusters of samples considered coeval based on the architectural and stratigraphic associations and by statistical comparisons, and by raising the level of confidence for the dates to 95 percent (i.e., two standard deviations).

Other problems may plague carbon-14 results, however, some that were known beforehand and some that were not. Few samples were explicitly collected for carbon-14 dating at Pueblo Alto, although quantities of charcoal were saved for species identification. Careful, clean, field collection was therefore not in vogue, and we might have expected contamination from oily hands, paper bags, and other means, to produce more recent dates.

On the other hand, old wood can produce older dates than the cultural event dictates. This problem was potentially alleviated by submitting only samples of brush, with one exception, which probably would not have lasted long if fuel was a valuable commodity because of the arid Chacoan environment. From our excavations of small Chacoan sites, it is evident that usable tree wood was almost always salvaged once the site was abandoned, testimony to the value of wood in Chaco, although this may have been less true at the greathouses. Unfortunately, samples of brush may create a new hazard. *Atriplex* and other C_4 plants used by the Chacoans for fuel, including corn, may produce dates 150-200 years too young (Robert Stuckenrath, personal communication 1980; Erving Taylor, personal communication 1981). Unlike the three-stage Calvin cycle that characterizes most plants and trees, C_4 plants go through a four-stage, carbon-development cycle (Slack-Hatch cycle) that discriminates against the carbon-12 and carbon-13 isotopes in favor of disproportionate amounts of the heavier carbon-14 isotope. We attacked this problem by collecting modern brush and tree samples from the canyon and submitting them for carbon-14 dating to the University of California (Appendix MF-L). In this case the samples tested modern, which led us to believe that radiocarbon dating of brush was not the problem.

Table 8.5. Radiocarbon dates from Pueblo Alto.

Provenience	Species	Lab No.[a]	A.D. Date (1 sd)[b]	Date (2 sd)[c]	Associated Dates: Tree-Ring	Ceramics[d]
WEST WING ROOMS:						
ROOM 103						
Floor 1					after	LG
Heating Pit 5	brush	SI-3712	1160 ± 65	1160 ± 144	1021r	
Floor 3					after	G
Hearth 1	brush	SI-3711	405 ± 65	425 ± 138	1021r	
ROOM 110						
Floor 1					after	G
Surface 7 floor fill, Grid 6	brush	Di-1455	1280 ± 50	1265 ± 116	1021r	
Surface 7					after	G
Heating Pit 7	brush	Di-1452	950 ± 45	960 ± 110	1021r	
Surface 8					after	G
Heating Pit 15	brush	Di-1454	1130 ± 50	1130 ± 118	1021r	
Heating Pit 20	brush	Di-1453	1280 ± 50	1265 ± 116	"	
Heating Pit 20	brush	SI-4503	785 ± 65	805 ± 166	"	
Heating Pit 32	brush	Di-1450	1050 ± 50	1055 ± 118	"	
ROOM 229						
North wall intramural beam	ponderosa pine	SI-4594	1100 ± 60[e]	1100 ± 136	after	RM
North wall intramural beam	ponderosa pine	Di-1759	950 ± 55	960 ± 126	1021r	
Floor fill of Floor 1					after	G
Layer 6 (Grid 16)	brush	SI-4505	1400 ± 100[e]	1375 ± 214	1021r	
Layer 6 (Grid 16)	brush	SI-4505	1070 ± 60	1075 ± 136	after	
Layer 6 (Grid 16)	brush	Di-1488	1070 ± 55	1075 ± 126	1021r	
CENTRAL BLOCK ROOMS:						
ROOM 139						
Floor 2						RM
Heating Pit 4	brush	Di-1451	1060 ± 50	1065 ± 118		
Heating Pit 6	brush	Di-1489	1100 ± 45	1100 ± 110		
Heating Pit 6	brush	SI-4009	780 ± 60	800 ± 158		
ROOM 142						
Floor 3					after	RM
Heating Pit 1	brush	SI-4011	960 ± 60[e]	970 ± 136	1016vv	
Heating Pit 1	brush	SI-4011	900 ± 70[e]	915 ± 154	after	
Heating Pit 1	brush	SI-4011	765 ± 60	785 ± 158	1016vv	
ROOM 146						
Floor 3						RM
Firepit 1	brush	SI-4008	970 ± 60	980 ± 136		
Firepit 1	brush	SI-4008	660 ± 70[e]	685 ± 174		
Heating Pit 1	brush	SI-4010	1030 ± 60	1035 ± 136		
UNDER ROOM 142						
ROOM 51						RM
Floor 3						
Heating Pit 1	brush	SI-4007	1345 ± 65	1325 ± 144		
Heating Pit 1	brush	SI-4007	570 ± 60[e]	595 ± 128		
MISCELLANEOUS:						
PLAZA FEATURE 1						
ROOM 3						
Floor fill of Floor 1					at	LM
Layer 4 (Grid 18)	brush	Di-1449	1270 ± 40	1260 ± 100	1132r	
Layer 4 (Grid 18)	brush	SI-4504	1115 ± 60[e]	1115 ± 136	at	
Layer 4 (Grid 18)	brush	SI-4504	945 ± 65	960 ± 144	1132r	

[a]Di = Dicarb Radioisotope Co., Norman, Oklahoma (formerly in Ohio and Florida).
SI = Smithsonian Institution, Radiocarbon Laboratory, Rockville, Maryland.
[b]Based on Libby radiocarbon half-life of 5,568 years.
[c]After Damon et al. 1974.
[d]Assemblages (in sequence from earliest to latest): RM = Red Mesa, G = Gallup, LG = Late Gallup, LM = Mix.
[e]Sample was pretreated by boiling in 6N HCL, followed by the normal 2% NaOH and 2N HClpretreatments in hopes of removing lingering carbonate in the sample.

Another potential problem concerns fluctuations of atmospheric carbon through time. Long-term variation is well known and has insired considerable efforts to calibrate adjustments for carbon-14 dates from tree-ring studies (see Damon et al. 1974; Klein et al. 1982). There may also be short-term variations that are more difficult to pinpoint (e.g., see Blakeslee 1983). Two periods of magnified atmospheric carbon may have existed at about A.D. 1090 and A.D. 1250 (Don Blakeslee, Wichita State University, personal communications 1980, 1985), periods of considerable interest for Pueblo Alto. Blakeslee believes that A.D. 1090 material will yield much younger dates (around A.D. 1500) and that A.D. 1250 samples will produce results in the A.D. 400s and 900s, at least for the Great Plains.

A final source of irritation was discovered by Cynthia Irwin-Williams (personal communication 1981; Baker 1985) from her work on the Rio Puerco (of the East) Project. She discovered that the soil chemistry trapped carbonate in specimens that was not released during the normal carbon-14 pretreatment. The solution to the problem was to boil the specimens in 6N hydrochloric acid followed by 2 percent sodium hydroxide and 2N hydrochloric acid pretreatments in hopes of removing the lingering carbonate fractions (Robert Stuckenrath, personal communication 1980). This was successful for the Puerco specimens but produced mixed results for Pueblo Alto.

A number of carbon-14 dates were much too early to be archeologically credible. Six dated to before A.D. 810, all by the Smithsonian laboratory. Another five dates seemed too late but not unrealistically so. The latest were fourteenth-century dates analyzed by the Smithsonian, whereas three very similar thirteenth-century dates came from Dicarb. A number of the Smithsonian samples were rerun after special pretreatment (mentioned above) but with mixed results that failed to point to a discernible pattern in the problem. In only one case did reruns yield statistical coherence, which indicates irregularities or contamination in the laboratory analysis.

Overall, the two oldest and six youngest dates came from Smithsonian (A.D. 425 to A.D. 1375), and all could be pruned statistically as well as archeologically from chronological use at Pueblo Alto. Those from Dicarb exhibited a far shorter time span (A.D. 960 to A.D. 1265) and, considering the error range, did not greatly exceed the tree-ring span of A.D. 1021 to A.D. 1132 at Alto. To check the suspicion of laboratory contamination, five duplicate samples were analyzed by both labs. Test for coeval sets resulted in only two being statistically confirmed with no clear pattern of accuracy for either laboratory. Thus, the large number of anomalous radiocarbon dates cannot be resolved, although the problem seems to be laboratory rather than field related (cf. Appendix MF-M). The exercise has shown the folly of strict reliance upon individual radiocarbon results without accompanying archeologically coeval dates.

Despite the many disparities among the Pueblo Alto radiocarbon results, sample clustering permits archeological and statistical reduction of the dates to provide the emergence of reliable estimates of time. Initial reliance is placed on the tree-ring dates from Pueblo Alto to provide the approximate occupational span at the site. Confidence that the span is reasonable is bolstered by the ceramic seriation and other lines of evidence.

Radiocarbon results falling centuries beyond the span, therefore, are considered erroneous and can be rejected from further inquiry without recourse to statistical evaluation. These dates clearly do not mark cultural events related to the site occupation. The remaining dates have been subject to analysis of variance tests for equivalence and date averaging (see Long and Rippeteau 1974). T-tests for two samples and F-tests for more than two samples were used to evaluate the null hypothesis that the samples were drawn from the same temporal period. All tests were two-tailed with infinite degrees of freedom and the .01 level used as the criterion for rejection of the null hypothesis. If temporal coherence was not verified by the tests (Table 8.6), then the errant dates were dropped. In addition, the criterion of Chauvenet (Long and Rippeteau 1974) was also used to reject dates that were statistically invalid; that is, those dates that fell beyond the mean standard deviation multiplied by the Chauvenet factor were discarded.

For ease in resolving the dating variation, the radiocarbon results were hierarchically arranged temporally from a combination of tree-ring dates, ceramics, and stratigraphy (Table 8.7). Individual dates are linked to others of assumed coeval age in order of decreasing confidence. Dates drawn from the same sample in reality must have the same age, although this is not always evident from the Pueblo Alto results. Dates from features located on the same floor are assumed to be approximately equivalent in age. Finally, dates derived from different proveniences that share similar architectural, stratigraphic, and ceramic traits at the site are also considered approximately coeval.

The final results of the radiocarbon manipulation are very promising. The matrix-ordering determined from other independent lines of evidence was confirmed by the radiocarbon results and supports the span of occupation suggested by tree-ring and ceramic seriation. The error span for the averaged dates is still too large to refine the chronology, although we must remember that the confidence level is much greater (2 sd) than normally presented and can be reduced by adherence to the minimum and maximum tree-ring dates. Despite the error span for the dates, the mean date appears close to marking the actual cultural event.

The earliest radiocarbon samples were taken from Room 51, and the mean date of A.D. 917 of these is the earliest in the chart matrix. Unfortunately, the two disparate dates force rejection of both as reliable dates.

The most complex block of the matrix is worthy of additional comment. Samples from this block were all taken from features associated with wall-construction activities in Rooms 139, 142, and 146 of the Central Room-

Table 8.6. Test evaluations for coeval radiocarbon dates from Pueblo Alto.

Test	Provenience	Dates Tested (A.D.)	Test Value	Rejection Level	Result	Date Averaging Result (2 sd)
a	Rm 51	595, 1325	t = 3.8	$t_{.01} \geq 2.58$	Reject H_o	N/A[b]
b	Rm 139	1065, 1100	t = 0.2	$t_{.01} \geq 2.58$	Accept H_o	1084 $\pm$ 80
c	Rm 142	915, 970	t = 0.3	$t_{.01} \geq 2.58$	Accept H_o	944 $\pm$ 102
d	Rm 146	980, 1035	t = 0.3	$t_{.01} \geq 2.58$	Accept H_o	1008 $\pm$ 96
e	Rm 229	960, 1100	t = 0.8	$t_{.01} \geq 2.58$	Accept H_o	1024 $\pm$ 92
f	Rm 110	805, 960, 1055, 1130, 1265, 1265[c]	F = 2.0	$F_{.01} \geq 3.02$	Accept H_o	1093 $\pm$ 83
g	Rm 110	1055, 1130	t = 0.4	$t_{.01} \geq 2.58$	Accept H_o	1088 $\pm$ 52
h	Rm 229	1075, 1075	t = 0.0	$t_{.01} \geq 2.58$	Accept H_o	1075 $\pm$ 92
i	Rm 3 (PF 1)	960, 1115, 1260	F = 10.4	$F_{.01} \geq 4.60$	Reject H_o	N/A[d]
j	Rms 142 & 146	915, 970, 980, 1035	F = 0.2	$t_{.01} \geq 3.78$	Accept H_o	979 $\pm$ 70
k	Rms 110 & 229	1055, 1075, 1130	F = 0.1	$F_{.01} \geq 4.60$	Accept H_o	1085 $\pm$ 62
m	Rms 142/146 & 139	915, 970, 980, 1035, 1065, 1100	F = 0.3	$F_{.01} \geq 3.02$	Accept H_o	1023 $\pm$ 53

[a]Dates not listed were rejected on archeological grounds.
[b]Based on Chauvenet's criterion, 595 and 1325 rejected.
[c]Based on Chauvenet's criterion, 805, 960, 1265, and 1265 rejected. Date recalculated (see g).
[d]Based on Chauvenet's criterion, 960 and 1260 rejected.

Table 8.7. Temporal framework for averaging radiocarbon dates (after Long and Rippeteau 1974).[a]

Provenience	Dates	Average	Test j/k	Combined	Test m	Associated Dates: Mean Date	Associated Dates: Ceramics & Tree-Rings
ROOM 51: Floor 3	595 * a 1325 * a	(917 ± 96)				no date	Red Mesa assemblage (A.D. 1000–1050)
ROOM 139: Floor 2	800 * 1065 b 1100 b	1084 ± 80			m	1023 ± 53	
ROOM 142: Floor 3	785 * 915 c 970 c	944 ± 102	j	979 ± 70	m	1023 ± 53	
ROOM 146: Floor 3	685 * 980 d 1035 d	1008 ± 96	j	979 ± 70	m	1023 ± 53	
ROOM 229: wall core	960 e 1100 e	1024 ± 92				1024 ± 92	T-R = after 1021r
ROOM 110: Floor 1	805 f 960 f 1055 f,g 1130 f,g 1265 f 1265 f	1088 ± 52	k			1085 ± 62	Gallup assemblage (A.D. 1050–1100) T-R = after 1021r
ROOM 229: Floor 1	1075 h 1075 h 1375 *	1075 ± 92	k			1085 ± 62	
ROOM 103: Floor 3	425 *					no date	
PF 1, ROOM 3: Floor 1	960 i 1115 i 1260 i	(1158 ± 70)				1115 ± 136	Late Mix assemblage (A.D. 1100–1140) T-R = 1132r
ROOM 103: Floor 1	1160					1160 ± 144	

[a]Temporally ordered from earliest (at top) to latest (at bottom) based on stratigraphy, tree-ring dates and ceramic seriation (see Figures 8.6–8.11). Letters mark tests for contemporaneity (see Table 8.6). Asterisks mark dates rejected on archeological grounds. Error range is at two standard deviations. See Table 8.5 for associated standard deviations of initial corrected dates.

block. Floor 3 features in the latter two rooms are from the same room floor (Room 142), where the space was later subdivided into two rooms. Tree-ring dates place construction of this area after A.D. 1016vv, and the average radiocarbon date was A.D. 1023 ± 53 (2 sd). The period of construction in the West Wing should be marked by a ponderosa beam taken from Room 229. This dated at A.D. 1024 ± 92, and a tree-ring date obtained from another intramural beam in nearby Room 110 was cut at A.D. 1021. Thus, the midpoints of the mean radiocarbon dates are satisfyingly in line with the tree-ring data, although the actual construction may have taken place somewhat later.

The later dates also fall into the proper temporal sequence. One may argue whether the dates from Rooms 110 and 229 should have been merged, but the matter is superfluous, given the closeness of the mean dates for the two rooms at A.D. 1075 and 1088. Finally, the mean date from the latest provenience was A.D. 1158 ± 70, although statistically the three samples were not coeval, with the earliest and latest dates rejected by the criteron of Chauvenet, which left an A.D. 1115 ± 136 date. Either way, the results are credible when associated with the terminal tree-ring date of A.D. 1132 from the same floor.

In summary, despite the initial results obtained from the radiocarbon analyses, judicious pruning of errant samples on archeological and statistical grounds permits confident confirmation of the major periods of Pueblo Alto occupation suggested by the tree-ring dating. Carbon-14 dates lack resolution to discriminate short intervals of time, but groups of them have chronological utility in the absence of more precise dating methods or to help confirm periods suggested by other dating methods and too few tree-ring dates. The strategy of clustering samples from related stratigraphic contexts affords the opportunity to statistically assess the individual results. Despite equal probability that the true dates lay anywhere along the two sigma range for the averaged carbon-14 dates, it is consistently the date midpoints that are closest to the actual cultural events.

Archeomagnetic Dating

Archeomagnetic (AM) specimen collecting of both burned and unburned samples has been intense over the last decade in Chaco Canyon. This method relies upon the principle that clays containing magnetic oxides of iron are susceptible to the earth's magnetic field and tend to acquire its direction and proportionately its density when heated above 500°C. The weak magnetic field of the specimens taken from burned clays (and sometimes unburned clays) can be measured with a magnetometer and the direction matched against a master plot that traces the secular variation of the earth's magnetic field through time. A total of 238 AM samples (almost 3,000 individual specimens or cubes) has been collected over the years by Robert DuBois and his University of Oklahoma students and by the staff of the Chaco Center. Over half, 123 samples, came from Pueblo Alto.

There is much we do not know of local conditions affecting the magnetic field or the chemistry of the samples. This has been quite apparent in Chaco Canyon where significantly different rates of success have been obtained for different sites. For instance, at Pueblo Alto we have collected 123 AM samples with 99 of these yielding dates--a success rate of 80 percent. Actually, four came from unburned features (i.e., wall foundations and posthole liners), and, thus our rate of success with baked clay samples rises to 83 percent. That is not to say that all yielded satisfactory dates, but only that the secular variation for the sets collected was statistically datable. In contrast, at site 29SJ 629 a few kilometers away, only 3 of 19 (one was unburned) samples were dated, a paltry success rate of 16 percent (17 percent for baked clay specimens). Collectors and conditions, as well as the range of burned features, were the same for both sites, so the difference must be attributed to noncollecting factors not yet apparent.

Strover (1906) noted that there were places in Chaco Canyon where a compass needle would not stay still. Similar problems were not noted during the 1972 inventory survey of the canyon and when AM samples were collected, however. Other factors, such as the recent concern over minerals in the San Juan Basin and elsewhere that self-reverse magnetically (Weisburd 1985) may also be of concern. At this point we do not know what critical factors may alter AM results, even from site to site within a small geographical area.

A large body of data was collected from Pueblo Alto, which provided a considerable basis for assessing the accuracy and reliability of AM dating. AM dates were obtained from almost every last-occupied room and kiva floor excavated as well as from many of the others (Table 8.8). Specifically, we were interested in examining the AM dates from Alto to see how well they fit with the known local chronology. More important, we wished to examine the reliability of the method, both in terms of its statistical accuracy (its temporal truth) and its precision or repeatability for coeval events (see Wolfman 1984). Given the data from Alto and elsewhere in Chaco, we have been somewhat successful.

Plotting the Pueblo Alto AM dates by 15-year intervals (Figure 8.1), we find that three clusters emerge: between A.D. 1065 and A.D. 1100 (8 dates), A.D. 1125 and A.D. 1260 (79 dates), and A.D. 1365 and A.D. 1400 (11 dates). The single aberrant date of A.D. 675 is excluded here. If there is no hiatus of dates between A.D. 1100 and A.D. 1125, then the combined early and intermediate groups suggest an almost normal distribution (skewed slightly to the left) of the number of hearths in use through time. This depends, of course, on whether the dated hearths and floor burns represent an unbiased sample of these features used through time.

Clearly, there is little evidence at Pueblo Alto and from elsewhere in the canyon to support the accuracy of the late cluster of dates. In fact, 10 of the 11 came from early floors that also yielded AM and carbon-14 dates in the early and late A.D. 1000s. No dates from the intermediate group came from these floors. Thus, it is obvious that the

Table 8.8. Archeomagnetic results from Pueblo Alto and comparisons with other chronometric results.

Provenience	ESO Lab No.	ESO Date[a] (A.D.)	Other[b] (A.D.)
ROOM 103:			
In wall fall, FP 2	1421	est.1370±	
Floor 1, Heating Pit 1	1428	1205±18	S 1100±30
Floor 1, Heating Pit 5	1447	1210±55	S 1100±30
Floor 1, Heating Pit 7	1427	1215±22	S 1100±30
Floor 2, Heating Pit 2	1452	1180±31	S 1100±30
Floor 2, Heating Pit 3	1451	1185±47	S 1100±30
Floor 2, Heating Pit 4	1453	1180±33	S 1100±30
Floor 2, Heatubg Pit 8	1455	1200±21	S 1100±30
Floor 2/3, Heating Pit 7	1454	est.1200±55	S 1100±30
Floor 3, Hearth 1	1463	est.1175–1180	S 1040–1100
Floor 3, Heating Pits 4 & 5	1460	1175±18	S 1040–1100
Floor 3, Heating Pit 7	1464	est.1175±	S 1040–1100
Floors 1-3, floor burn	1456	1150±23	S 1040–1100
Floor 4, Heating Pit 1	1461	1180±26	post T 1021 C 1024±
ROOM 106:			
Burn amongst wall fall	1420	ND	post S 1140
ROOM 109:			
Floating Floor 1, floor burn	1489	est.1160±50	S 1100±
ROOM 110:			
Floor 1, Firepit 1	1592	1160±26	S 1075–1100
Surface 3, Firepit 2	1599	1160±45	S 1075–1100
Surface 6, Burn 1	1597	1180±20	S 1075–1100
Surface 6, Burn 2	1598	1160±21	S 1075–1100
Surface 7, Burn 4	1606	1175±32	C 1085±
Surface 7, Heating Pit 3	1600	1180±17	C 1085±
Surface 7, Heating Pit 7	1603	1140±41	C 1085±
Surface 7, Heating Pit 8	1604	1185±23	C 1085±
Floor 2, Firepit 1 (last burn)	1660	1195±13	S 1030–1075
Floor 2, FP 1 (earlier burn)	1661	1185±19	S 1030–1075
Floor 2, Firepit 2	1662	1170±16	S 1030–1075 post T 1021
Floor 3, Burn 1	1663	1170±22	C 1024±

[a]ND = No date (too much dispersion).
[b]Other: T = tree-ring; C = carbon-14 mean date midpoint; S = ceramic seriation.

Table 8.8. (continued)

Provenience	ESO Lab No.	ESO Date[a] (A.D.)	Other[b] (A.D.)
ROOM 112:			
Floor 1, Burn 1	1624	1200±29	S 1040-1100
ROOM 138:			
Floor 1, Burn 1	1656	1180±10	S 1100-1140?
Floor 2, Heating Pit 2	1664	1090±23	C 1023±
			S 1000-1040
ROOM 139:			
Floor 1, burn around OP 7	1472	1210±16	S 1100-1140?
Floor 2, Burn 1	1620	1085±06	C 1023± &
Floor 2, Heating Pit 1	1479	1400±18	S 1000-1040
Floor 2, Heating Pit 2	1484	1100±15	S 1000-1040
		(1360±15)	
Floor 2, Heating Pit 3	1487	1380±12	S 1000-1040
Floor 2, Heating Pit 4	1488	1400±15	S 1000-1040
Floor 2, Heating Pit 5	1482	1390±10	S 1000-1040
Floor 2, Heating Pit 8	1481	1085±28	S 1000-1040
		(1310±28)	
Floor 2, Heating Pit 9	1485	1080±22	S 1000-1040
		(1340±22)	
Floor 2, Heating Pit 10	1483	675±29	S 1000-1040
Floor 2, Heating Pit 13	1426	1010±46	S 1000-1040
Floor 2, PH 1 (clay packing)[c]	1478	ND	S 1000-1040
Floor 2, PH 4 (clay packing)[c]	1480	ND	S 1000-1040
ROOM 142:			
Floor 1,			
East wall foundation clay[c]	1448	ND	S 1040-1080?
Floor 1, Burn 1	1493	1195±14	S 1100-1140
Floor 1, Burn 2	1496	1190±22	S 1100-1140
Floor 3, Heating Pit 1	1594	1400±24	C 1023±
Floor 4, Heating Pit 1	1609	1070±38	C 1023±
Floor 4, Heating Pit 2	1621	ND	C 1023±
Floor 9, Heating Pit 1	1623	980±48	pre T 1021
Floating Floor 3, HP 1	1596	ND	C 1023±

[a]ND = No date (too much dispersion).
[b]Other: T = tree-ring; C = carbon-14 mean date midpoint; S = ceramic seriation.
[c]Sample collected from this feature is unburned.

Table 8.8. (continued)

Provenience	ESO Lab No.	ESO Date[a] (A.D.)	Other[b] (A.D.)
ROOM 143:			
Above Floor 1 (Level 11), Burn 1	1593	1240±24	S 1100-1140+
Floor 1, Burn 3	1654	1240±17	S 1100-1140
Floor 1, Heating Pit 1/Burn 1	1650	1195±15	S 1100-1140
Floor 1, Heating Pit 2	1651	1175±12	S 1100-1140
Floor 1, Heating Pit 3	1652	1195±10	S 1100-1140
Floor 1 (main room), HP 3	1677	1100±38	S 1100±
Floor 2 (Grid 13), Burn 1	1682	1215±35	S 1100±
Floor 5, Burn 1	1678	ND	S 1000-1040
ROOM 145:			
Floor 1, Burn directly under floor plaster (Layer 9)	1423	1165±10	S 1100±
Floor 1, west wall found'n clay[c]	1448	ND	C 1140-1080?
ROOM 146:			
Floor 1, Burn 1	1512	1170±20	S 1100-1140
Floor 3, Firepit 1	1590	1390±65	C 1023±
Floor 3, Heating Pit 1	1589		C 1023±
ROOM 147:			
Floor 1, Firepit 1 (Burn 1)	1627	1395±21	S 1100-1140
Floor 1, Firepit 1 (Burn 2)	1628	1200±25	S 1100-1140
Floor 1, Heating Pit 1	1626	1200±10	S 1100-1140
Floor 1, HP 2 (last use)	1625	1190±21	S 1100-1140
Floor 1, HP 2 (early use)	1675	1210±24	S 1100-1140
Floor 1, Heating Pit 4 (burn)	1674	ND	S 1100-1140
ROOM 229:			
South Door sill burn	1673	1165±33	C 1075±
Floor 1, Burns 1 and 2	1658	1210±28	C 1075±
Floor 1, Burn 3	1659	1185±17	C 1075±
ROOM 236:			
Floor 1, see Room 143 (in part)			

[a]ND = No date (too much dispersion).
[b]Other: T = tree-ring; C = carbon-14 mean date midpoint; S = ceramic seriation.
[c]Sample collected from this feature is unburned.

Table 8.8. (continued)

Provenience	ESO Lab No.	ESO Date[a] (A.D.)	Other[b] (A.D.)
ROOM 236 (continued):			
Floor 4, Burn 1	1679	1140±40	S 1050-1100
Floor 4, Burns 2 and 3	1681	1160±23	S 1050-1100
Floor 5, Heating Pit 1	1680	1150±52	S 1050-1100
UNDER ROOM 142:			
ROOM 51:			
Floor 1, Heating Pit 1	1595	1130±34 (1390±34)	S 1000-1040
Floor 2, Firepit 1	1622	1395±15	S 1000-1040
Floor 3, Burn 1	1608	1070±42	S 1000-1040
Floor 3, Heating Pit 1	1610	1385±59	S 1000-1040
Floor 3, Heating Pit 2	1611	1395±43	S 1000-1040
PLAZA FEATURE 1:			
ROOM 3:			
Floor 1, Burn 1 (next to FP 3)	1581	1140±10	S 1100-1140
Floor 1, Burn 2 (next to FP 2)	1582	1180±24	S 1100-1140
Floor 1, Heating Pit 1 (overlies Firepit 1)	1501	1180±21	post T 1132
Floor 1, FP 1 (last plaster)	1508	1220±23	T 1132
Floor 1, FP 1 (earlier plaster)	1509	1215±16	S 1100-1132
Floor 1, FP 2 (last plaster)	1507	1180±15	S 1100-1132
Floor 1, Firepit 3, last remodel (last plaster)	1511	1170±16	T 1132
Floor 1, Firepit 3, (earlier use of FP floor)	1510	1190±19	S 1100-1140
Floor 1, FP 3, (last remodel)	1614	1190±10	S 1100-1140
Floor 1, FP 3, (initial constr)	1615	1190±14	S 1100-1140
ROOM 4:			
Fill above Surface 1 (Layer 3), Heating Pit 2	1586	ND	S 1100-1140?
Surface 1, Burn 1	1588	1130±33	S 1100-1140
Surface 2, Heating Pit 1	1587	ND	late S 1000s?

[a]ND = No date (too much dispersion).
[b]Other: T = tree-ring; C = carbon-14 mean date midpoint; S = ceramic seriation.

Table 8.8. (concluded)

Provenience	Lab No.	ESO Date[a] (A.D.)	Other[b] (A.D.)
EAST RUIN:			
KIVA 14 (ROOM 6):			
Floor 1, Firepit 1 (FP 1 replastered)	1490	1190±18	S 1100-1140
Floor 1, Firepit 2 (FP 1 initial construction)	1499	1205±16	S 1100-1140
KIVA 10:			
Surface 1 (in upper fill), Burn 1	1602	est.1210±	post T 1132
KIVA 15 (built in Room 110):			
Floor 1, Firepit 1 (FP 2 remodeled)	1500	1165±31	S 1080-1140
Floor 1, FP 2 (initial use)	1502	1180±27	S 1080-1140
Floor 1, FP 2 (FP 1-2 use)	1583	1230±20	S 1080-1140
PLAZA 1:			
GRID 75:			
Floor 1, Firepit 3 (on top of fill in Kiva 14)	1491	1365±28	post S 1140
GRID 279 (SW 1/4):			
Floor 1, Burn 1	1457	1250±21	S 1100-1140
PLAZA 2:			
GRID 201:			
Surface 1, Other Pit 2 (top of FP-Layer 1)	1616	NA	post T 1056
Surface 1, Other Pit 2 (bottom of FP)	1505	1190±14	S 1100-1140
Surface 5, Heating Pit 1	1653	1155±55	S 1100±
Suface 5c, Heating Pit 1	1655	est.1160±	S 1100±
Surface 8, Heating Pit 1	1657	NA	S 1050-1100
Surface 9, Heating Pit 1	1671	NA	S 1050-1100
Surface 14, Heating Pit 1	1737	1225±33	S 1050±

[a]NA = Not available. Sample undatable at present time.
[b]Other: T = tree-ring; C = carbon-14 mean date midpoint; S = ceramic seriation.

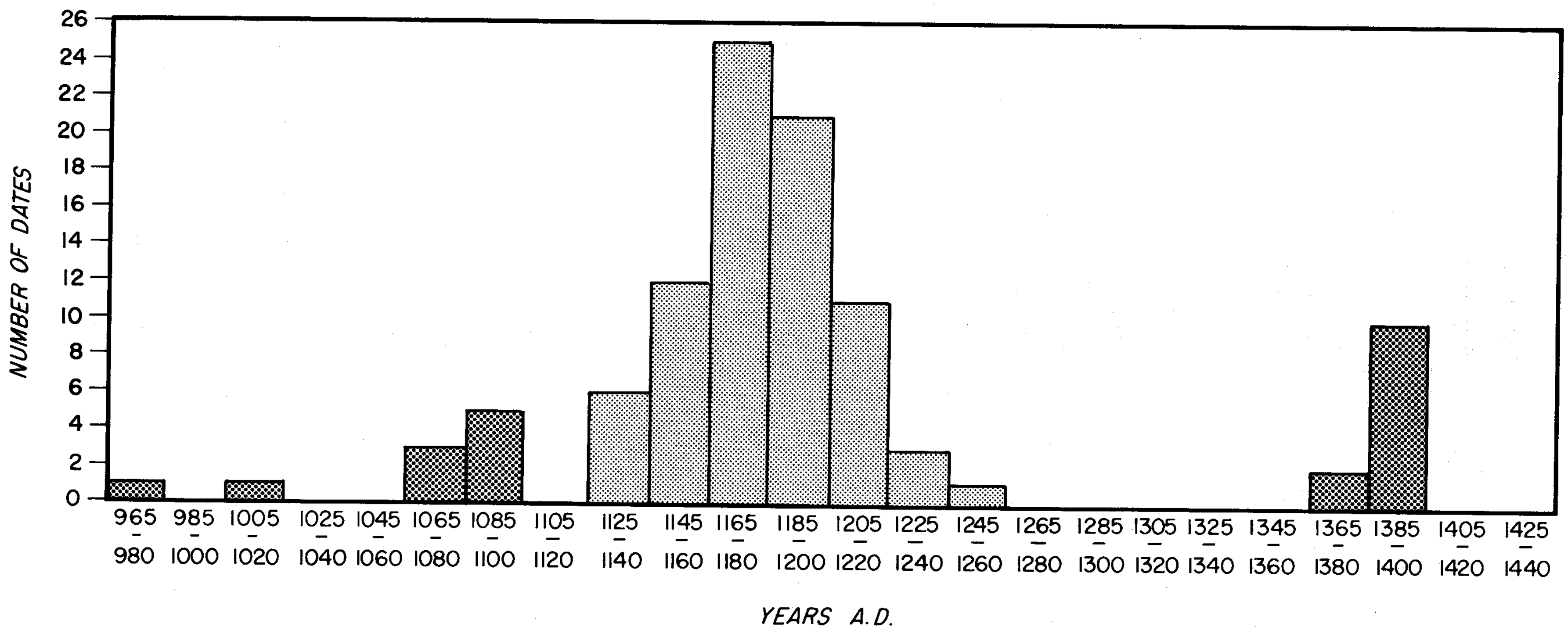


Figure 8.1. Histogram of archeomagnetic dates from Pueblo Alto.

AM curve for the A.D. 1000s includes a direction that is not included presently in the master curve and that overlaps the magnetic direction (path) at approximately A.D. 1390. This problem is duplicated elsewhere in the canyon. More convincing are the few lab results that yield dual dates for both the late A.D. 1000s and the late A.D. 1300s (see Table 8.8), indicating an overlap of the present AM curve for those two periods of time. Radiocarbon dates, cross-dated ceramics, and a few tentative tree-ring dates indicate that this period actually dates in the early A.D. 1000s, most likely between about A.D. 1030 and A.D. 1050. The number of dates (n = 9) between A.D. 1385 and 1400 for the lower floors associated with the same ceramic assemblages attests to the consistency of the AM method for dating coeval events. The remainder of dates from the same floors cluster between A.D. 1070 and AD 1100 (n = 7) but are also too late. Shifting the archeomagnetic dates to earlier periods reveal a histogram of dates that appears more credible (Figure 8.2). A number of researchers are currently revising the curve (Eighmy et al. 1980; McGuire and Sternberg 1982, and Robert DuBois, personal communication 1985).

The earliest date in the 1300s (A.D. 1365) in the late aberrant group appears to be realistic. It came from a firepit (Volume II, Plate 4.6) in the top of an abandoned kiva (Kiva 14) filled with trash and ceramics that match the latest ceramic assemblage at the site (e.g., early A.D. 1100s). A nearly identical firepit built in the wall-fall debris of Room 103 (Volume II, Plate 3.2) yielded a similar but estimated date. Three AM dates from the last occupied floor in the room, nearly a meter below the firepit, averaged A.D. 1209 ± 24 (see Long and Rippeteau 1974 for date averaging), but much too late.

A total of 36 dates from the end of the intermediate group came from 12 of the 14 uppermost floors (Floor 1) in the excavated rooms (including kivas built into rooms). The ceramic assemblages on and above these uppermost floors suggest that the last use was approximately contemporaneous across the site (at least in the excavated sections) in the early A.D. 1100s.

In fact, if we examine the dates from the uppermost floors of all the excavated units, we see remarkable homogeneity of the AM dates (Table 8.9). The date midpoints of clusters of averaged dates from each archeomagnetic provenience range between A.D. 1170 and A.D. 1210, but with 9 of the 12 architectural units in a group between A.D. 1191 and A.D. 1210. This limited span surely marks a very restricted period for the terminal occupation. We know from other data that this actually marks the early A.D. 1100s (i.e., probably around A.D. 1132). An analysis of variance of the mean dates confirms the visual impression that upper-floor dates in the two roomblocks are essentially coeval (Table 8.9).

The relative lateness of the intermediate group of dates (which includes all of the uppermost floor dates), however, is disturbing on two accounts. First, the distribution of the AM dates does not coincide with the known peak of massive building activities in the middle and late A.D. 1000s as indicated by tree-ring dates. Second, logically, an increase in

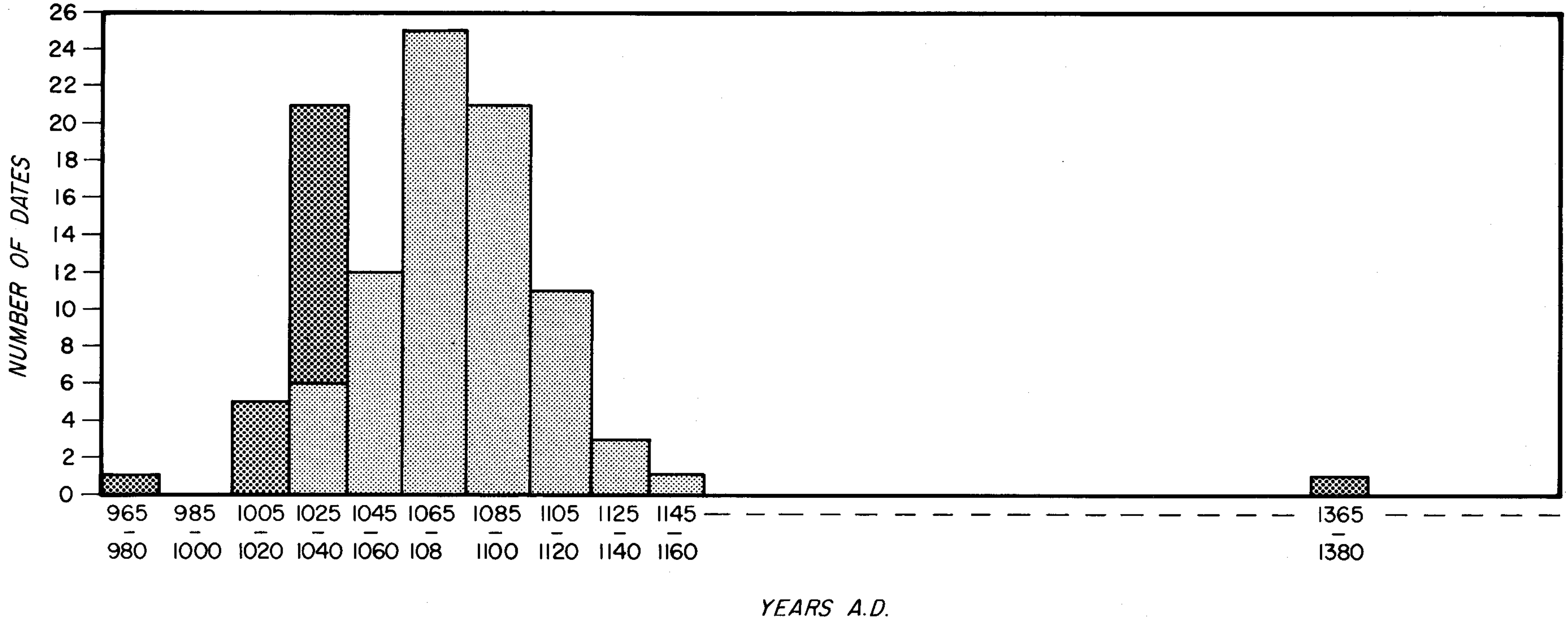


Figure 8.2. Revised histogram of archeomagnetic dates from Pueblo Alto. Dates in the A.D. 1400s moved to the early A.D. 1000s, and those dating between A.D. 1050 to A.D. 1260 shifted 60 years earlier.

Table 8.9. Archeomagnetic dates from the uppermost floors and surfaces at Pueblo Alto.[a]

Provenience	A.D. Date (2 sd)[b]	Range	No. of Samples
MISCELLANEOUS			
East Ruin, Room 6 kiva	1198 ± 12	1186-1210	2
Plaza Feature 1, Room 3	1179 ± 05	1174-1184	10
Plaza 1, Grid 279	1250 ± 21	1229-1271	1
Plaza 2, Grid 201	1190 ± 14	1176-1204	1
CENTRAL ROOMBLOCK ROOMS			
Room 138	1180 ± 10	1170-1190	1
Room 139	1210 ± 16	1194-1226	1
Room 142	1190 ± 08	1182-1198	4
Room 143	1203 ± 06	1197-1209	4
Room 146	1170 ± 20	1150-1190	1
Room 147	1200 ± 08	1192-1208	4
Mean date:	1192.20 ± 15.1[c]	1177-1207	
WEST WING ROOMS			
Room 103	1209 ± 14	1195-1223	3
Room 112	1200 ± 29	1171-1229	1
Room 229	1191 ± 13	1178-1204	3
Kiva 15	1203 ± 14	1189-1217	3
Mean date:	1200.75 ± 7.5[c]	1191-1209	

[a]Uppermost floors and surfaces = Floor 1 or Surface 1.

[b]Mean date for floors with multiple dates after Long and Rippeteau (1974).

[c]T-Test of the two means: $t = 1.04$, $x^2_{.01} = 2.90$, df = 8, $p = 0.16$. Therefore, the two groups can be considered as dating the same period of time, reflecting an approximately coeval abandonment of the two roomblocks. Overall mean for the two roomblocks = A.D. 1195.6 ± 13.

hearth frequency (and thus in AM dates) during occupation should follow the period of massive building construction indicated by tree-ring dates. The interval of 80-100 years between the two chronometric methods and associated activities, however, is much greater than warranted.

Relative to one another, the AM dates appear reasonable from the Central Roomblock rooms. That is, the latest dates came from the upper floors and the earliest dates occur with the lower floors (if we disregard the very late group of dates in Figure 8.1 that were discussed earlier). Also, the dates from the uppermost floors in both roomblocks appear to reflect a contemporaneous abandonment—an event supported by other independent data.

Nevertheless, the AM dates are inaccurate in absolute terms. Ceramics and the few radiocarbon and tree-ring cutting dates from Pueblo Alto suggest that the AM dates are about 50-100 years too late. The problem apparently involves the DuBois curve for the period between A.D. 900 and 1200 (McGuire and Sternberg 1982). For example, parts of a burned roof with numerous cutting dates of A.D. 1045 that were recovered from the Pueblo Alto Trash Mound coincide with a major decade of construction in other Chaco Canyon greathouses and tentatively suggest a similar period of construction at Alto. The earliest group of AM dates associated with construction at Alto, however, came from the lower floor in Room 139 and averaged A.D. 1085 ± 05. Anomalously, a mean of two carbon-14 dates from the same floor features yielded a similar date of A.D. 1084 ± 80. Ceramic seriation results backed by tree-ring dates initially date Room 139 to the early A.D. 1000s, instead.

Ten AM dates (average: A.D. 1179 ± 05) from Floor 1 features in Room 3 in Plaza Feature 1 differ from the latest tree-ring cutting dates of A.D. 1132 at Pueblo Alto, which were obtained from the same features, by approximately 45 years. Finally, two carbon-14 dates from heating pits off Floor 1 in Room 110 averaged A.D. 1093 ± 83, which coincides with the peak period of Chaco greathouse construction dated extensively by tree-rings. Unfortunately, the average AM date from the same floor (Surface 8) was A.D. 1158 ± 10. Again the discrepancy between the two dating methods is large (65 years) if only the mean date midpoints are considered, although the date spans overlap. A similar discrepancy for the same decades has been noted in the archeomagnetic and carbon-14 results processed by other laboratories (e.g., Sebastian 1983a:82, 174).

Obviously, more comparable chronometric data are needed before many of these problems can be detected let alone resolved. It should be noted that the AM curve problem suggested here for the eleventh and twelfth centuries may be specific to Pueblo Alto or Chaco Canyon, perhaps because of local magnetic distortion or even perhaps from the effects of unusual soil chemistry. The results at Alto are duplicated by results at nearby Bis sa'ani, a Chacoan outlier where both AM samples and tree-dates reveal the same discrepancy in dating for the same late period as at Alto (Breternitz 1982a).

In a general way, the AM dates can be extrapolated to more accurate dates. The early A.D. 1000s (A.D. 1030-1050) period is reflected by AM dates in the very late A.D. 1000s (A.D. 1070-1100) and A.D. 1300s (A.D. 1380-1400). The period between A.D. 1050 and 1100 is generally seen as AM dates in the A.D. 1130-1180 range. The early A.D. 1100s (A.D. 1100-1140) are reflected by AM dates in the A.D. 1180 to 1220 range. In all cases, however, there are enough exceptions to prevent rote conversion of the AM dates by subtracting a set number of years. Interestingly, the tree-ring and AM dates from the Salmon Ruin, a Chacoan greathouse probably connected to Pueblo Alto by a prehistoric road, are in close agreement. Dates collected by other projects in the San Juan Basin also suggest that the problem at Alto may not be region-wide.

Although the temporal accuracy of the AM dates has been disappointing, the similarity of many of the dates warrants some inferences regarding the occupation. If we take the dates at face value, then, they may still be relatively informative for aspects of interpretation other than exact dating. AM results apparently confirm the impression (discussed above) that terminal occupations at the site took place throughout the site at approximately the same time. Occupation spans among similar or adjacent rooms may also be usefully scrutinized from the AM results. Let us first look at the two, West-Wing living rooms (Figure 8.3).

Room 103 reflects mean date spans covering 105 years for the lower three floors. Despite overall variation, however, the lowest floor (Floor 4) and Floor 2 above it are statistically identical with dates at about A.D. 1180, except for one A.D. 1200 date. The upper floor (Floor 1) produced three, closely spaced, A.D. 1200s dates. The gap in time between the uppermost floor and Floor 2 was also suspect on archeological grounds. Tentatively, the dates may reflect short, nearly coeval occupation of Floors 2 to 4 (covering a time span so short as to be unidentifiable) on the dating curve, perhaps 20 years, and then a lapse of time before Floor 1 was constructed and used. The one A.D. 1200 date from Floor 2 could be associated with the Floor 1 occupation (use of Floor 2 while Floor 1 was being built?).

We know that Room 110 shares a very similar history with Room 103 through much of its use. Therefore, we would expect a similar AM record. Indeed, the lowest and upper floors reveal almost identical dates, and overall, there is a remarkable consistency. There is a temporal range of 112 years for the 20 AM dates from Room 110. Most (17 of 20) date midpoints cluster impressively between A.D. 1150 and A.D. 1185, which suggests little change in the magnetic field during the occupation of the floors, as in Room 103, and, therefore, little change in time. It is noteworthy that there were no A.D. 1200s dates in the Room 110 batch, although generally the Room 110 dates were slightly earlier than those of Room 103. Kiva 15 was built over Room 110, but its three AM dates show as much variation as the 20 from Room 110. At face value, the Kiva 15 dates overlap the latest in Room 110, although the single A.D. 1200s date may also suggest long-term use of Kiva 15 that is coeval with the Floor 1 occupation of Room 103. On archeological grounds, either long-term or

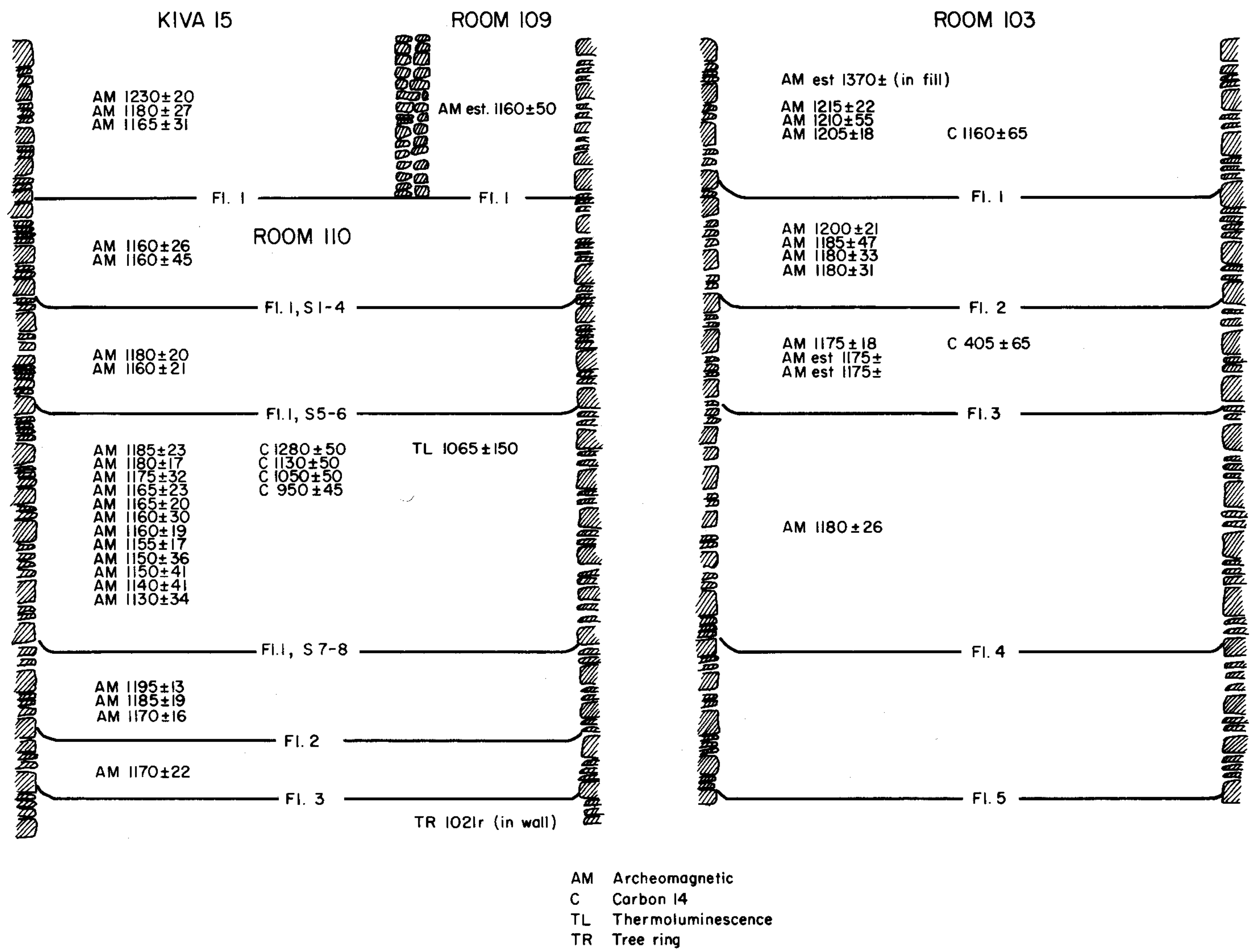


Figure 8.3. Stratigraphic schematic of Room 103 and Kiva 15/Room 109/Room 110 with dates obtained from the various floors.

short-term use is plausible for Kiva 15. Stratigraphy and masonry style suggest the kiva closely followed the abandonment of Room 110, and ceramically the kiva's last use matches Room 103's last use. Thus, as other evidence indicates, Room 103 and Room 110 shared a similar short span of occupation, except that the latest use of Room 103 temporally equates to the last occupation of Kiva 15.

In the Central Roomblock, AM dates from the construction floors were consistently within the same time span (e.g., had nearly identical magnetic direction). Most are either late A.D. 1000s or late A.D. 1300s dates, with some overlap of the latter dates with the late A.D. 1000s archeomagnetic curve. The similar results help to verify inferences made from architecture and stratigraphy that the rooms were built nearly simultaneously. Nearly identical dates came from the small, two-room house (Rooms 50-51) that was razed before the construction, suggesting the two events (razing followed by construction) were closely linked in time. Deposits under Rooms 50 and 51, however, yielded earlier dates, including the earliest AM date from the site at A.D. 980±48.

Likewise, results were extremely similar across the uppermost floors in the suite, as discussed above. In the case of Room 142, where the uppermost two floors may have been nearly coeval (see Volume II, Room 142), the AM results corroborate the stratigraphic interpretation. A two-sample t-test ($t = 0.19$, $df = 4$, $t_{.01} = 4.6$, $p = 0.89$) confirms the impression that the dates from the two floors reflect the same periods of time.

In summary, from this and other data collected at the site and in Chaco Canyon, it appears that AM dating yields consistent results, particularly for probably coeval events, but is inaccurate in absolute terms. It is also clear that the present AM curve needs revising for the eleventh and twelfth centuries and that some local discrepancies remain unexplained. For Pueblo Alto, the dating is generally too late by 50-100 years or more, rather than the approximately 100 years too early suggested by Wolfman (1984:408). Other periods of time may also require refinement, but temporal control by other chronometric methods in Chaco, at least, is too rare to provide adequate checks on these. Once the accuracy of AM dating in Chaco is established, the method promises to be one of the best for dating cultural events.

Thermoluminescence Dating

A pilot program by Washington University, St. Louis, Missouri, to evaluate the suitability of ceramics for thermoluminescence dating involved eight sherds from Pueblo Alto (Appendix MF-N). Several restrictions limited the selection of sherds for the program. Soil matrix from the same or associated contexts yielding test sherds needed to be available for checking background. The sherds also needed to be associated with dated contexts and to be large enough to yield plentiful quartz for testing because the exterior surfaces of the sherds were to be shaved to eliminate contamination. This resulted in a selection primarily of nonindented corrugated sherds, which, in retrospect, was a mistake. The painted sherds contained insufficient quartz, and only a sooted, coarse-sand-tempered, culinary sherd (Coolidge Corrugated) proved suitable for dating.

The culinary sherd (sample W.U. #99f1) was selected because its style indicated manufacture after A.D. 1000 and because it was sooted. Sooting indicated heating over an open flame that might have changed the thermoluminescence age from manufacture to its supposed last use as a cooking vessel in the room in which it was found. The sherd came from Room 110, Surface 9 of Floor 1 in the fill of Other Pit 66 and dated at A.D. 1065 ± 150 (920 ± 150 B.P. at 1 sd). The date range, of course, is temporary insensitive, although the date midpoint corresponds to other dates derived from the room. A tree-ring-dated, intramural beam from the same room indicates that room construction occurred at or after A.D. 1021. Radiocarbon results from pits in the same floor, but associated with slightly later replasterings, yielded a mean date of A.D. 1093 ± 83. Thus, the thermoluminescence mean date seems reasonable for the context in which it was derived. The TL date adds nothing to temporal refinement of Room 110. Nevertheless, the dating method appears promising if large numbers of the dates could be obtained and averaged. Dating sherds from cooking vessels would be particularly useful in dating specific cultural events.

Obsidian Hydration

Research by the University of California at Los Angeles, Obsidian Hydration Laboratory, into hydration rates for Jemez Mountain obsidian prompted delivery of some Chacoan obsidian to Glenn Russell for preliminary analyses. Twenty-two samples from Pueblo Alto were sent, but the majority of these came from early A.D. 1100s deposits. Obsidian from earlier contexts at the site was rare. The samples were first identified by source by Lee Sappington (University of Idaho) who distinguished two types of Jemez obsidian (i.e., that from Polvadera Peak and the remainder from the adjoining Jemez Mountains to the south), with the use of X-ray fluorescence (Cameron and Sappington 1984). Actually, the Jemez Mountain source is a series of several, distinct, obsidian flows in close proximity, which exhibit greater chemical variability than the nearby Polvadera source (see Phagan 1985).

Russell's (1981) initial work with Jemez obsidian revealed very different hydration rates between the two types, the Polvadera material having a much slower rate than the non-Polvadera obsidian. These differences were also noticeable in the Alto sample. Unfortunately, Russell became committed to archeological work in Peru and could not continue his work on Chaco hydration rates, which are faster than the rates of material from the Jemez vicinity. A warmer, drier environment is probably responsible for the faster rates in Chaco. Thus, the hydration rates calculated for samples from sites near the Jemez Mountains (Russell 1981) yield dates in the A.D. 1500s for the Alto specimens, clearly much too late.

What we had was a number of Pueblo Alto hydration measurements, but no dates (Table 8.10). The Alto sample was relatively small but interesting, nevertheless. All the Alto material analyzed for hydration came from just two proveniences: the Trash Mound and Kiva 10. On the basis of ceramics, we know that the two deposits are approximately sequential in time, with Kiva 10 filling with trash shortly after trash was no longer being deposited on the Trash Mound. Obsidian sources differ between the two deposits, although this could be due to sampling error. Both Polvadera and Jemez obsidian came from the Trash Mound, and there is a clear difference in their hydration measurements. The mean Polvadera hydration was 1.83 microns (sd = 0.15, n = 3), whereas the Jemez mean was 2.63 microns (sd = 0.15, n = 3). A t-test of the two samples confirms that the difference is real ($t = 6.41$, $t_{.01} \geq 3.75$, $p = 0.002$, one-tail, therefore H_o is rejected).

The Kiva 10 obsidian was all identified as "Jemez" and may be divided into two groups strictly on stratigraphic criteria. Nine pieces came from the upper units of trash (Levels 17-18), and seven more were submitted from the lower units (Levels 25-27). Although the upper group should be slightly younger than the lower group, there was no significant difference between them ($t = 0.20$, $df = 14$, $t_{.01} = 2.62$, one-tail, $p = 0.422$, therefore accept H_o).

Visual inspection of the data, however, suggests that possibly two different groups of measurements (above and below 3.0 microns) and, therefore, two or more sources may be involved. The lowest four readings are similar to the Jemez obsidian analyzed from the Trash Mound that involved deposition in the last half of the A.D. 1000s. In fact, the three pieces with low readings from the upper fill of Kiva 10 produced exactly the same mean hydration (mean = 2.63 microns, sd = 0.25, n = 3) as those from the Trash Mound. The remainder from the upper fill had a much higher mean hydration (mean = 3.57 microns, sd = 0.19, n = 6), which is statistically from a different population ($t = 6.38$, $df = 7$, $t_{.01} = 3.37$, one-tail, $p = 0.0004$, therefore reject H_o). Those from the lower Kiva 10 group, minus the lowest reading, were similar to the upper group (mean = 3.28 microns, sd = 0.16, n = 6). Despite their similarity, the two groups reveal that they also may have derived from different populations even though a t-test just barely revealed the statistical possibility ($t = 2.83$, $df = 10$, $t_{.01} = 2.76$, $p = 0.009$, one-tail, $n = 12$, reject H_o). The suspected difference cannot be due to differences in age because the rates are reversed for the stratigraphic context in which they were found.

The problems encountered with the analysis may be due simply to the small sample size and the temporal insensitivity of the obsidian for the short time span represented (e.g., perhaps 60-70 years). Some of the Kiva 10 "Jemez" obsidian may also have been redeposited from earlier contexts. Hydration readings from earlier sites in Chaco also revealed problems with reversed temporal rates for "Jemez" material. Clearly more work is needed to rectify the problems with obsidian hydration at Pueblo Alto, specifically with sources and their hydration rates.

Table 8.10. Obsidian hydration measurements from U.C.L.A.

Provenience	FS No.	OHL No.	Source[a]	Hydration[b] (Microns)
Trash Mound, Grid 127, Level 3	4506	7680	J	2.8
Trash Mound, Grid 267, Level 10	4583	7681	P	2.0 (1.8)
Trash Mound, Grid 267, Level 13	4586	7682	P	1.7 (1.6)
Trash Mound, Slump 1	4626-1	7683	J	2.5
Trash Mound, Slump 1	4626-2	7684	P	1.8
Trash Mound, Slump 2	4642	7685	J	2.6/23.7[c]
Kiva 10, Level 17	6502-1	7664	J	3.4 (3.3)
Kiva 10, Level 17	6502-2	7665	J	3.3 (3.0)
Kiva 10, Level 17	6502-3	7666	J	2.6
Kiva 10, Level 17	6502-4	7667	J	3.7
Kiva 10, Level 17	6502-5	7668	J	2.9
Kiva 10, Level 18	6503-1	7669	J	3.8
Kiva 10, Level 18	6503-2	7670	J	2.4
Kiva 10, Level 18	6503-3	7671	J	3.6
Kiva 10, Level 18	6503-4	7672	J	3.6
Kiva 10, Level 25	6517-1	7673	J	3.0
Kiva 10, Level 25	6517-2	7674	J	3.4
Kiva 10, Level 25	6517-3	7675	J	3.2
Kiva 10, Level 26	6518-1	7676	J	3.4
Kiva 10, Level 26	6518-2	7677	J	3.4/42.6[c]
Kiva 10, Level 27	6519-1	7678	J	3.3
Kiva 10, Level 27	6519-2	7679	J	2.8

[a]J = Jemez Mountains (general, non-Polvadera); P = Polvadera Peak, Jemez Mountains.
[b]Samples remeasured in January 1986 by U.C.L.A. (results in parentheses).
[c]Cortex surfaces.

The number of sources comprising "Jemez" obsidian (see Winter 1983c) may have affected the Pueblo Alto results. Work by the Mohlab at Pennsylvania State University has currently revealed the existence of a greater number of Jemez sources than those identified by Sappington and Russell (Joseph W. Michels, personal communication 1985). The two laboratories, however, approach obsidian hydration dating in theoretically different ways with U.C.L.A. relying on empirical data to derive and support their attempt at establishing an accurate hydration rate for each source and area, whereas Mohlab relies more heavily on a pure theoretical approach using "induced" hydration in deriving the dates (Clement Meighan, personal communication 1985; Michels and Tsong 1980).

Four pieces of obsidian analyzed by U.C.L.A. were sent to Mohlab in hopes of rectifying the lack of dating success. The initial results were promising (Table 8.11, samples with the prefix 323-), but flawed by a possible mixup of samples. The mixup seems apparent because the two high readings obtained by U.C.L.A. were the two low readings produced by Mohlab. Clement Meighan kindly re-examined his slides from the specimens in question and found little error in the original U.C.L.A. measurements (Table 8.11). Even if the mixup is taken into account, it was also disconcerting to find that the measurements for the same pieces of obsidian differed greatly between the labs, apparently not a surprise to either lab, however (Joseph Michels and Clement Meighan, personal communications 1986).

The calculated dates also suggest that the samples were switched. The two A.D. 1000s dates fit perfectly with the Trash Mound specimens, whereas the Kiva 10 pieces should date slightly later (in the early A.D. 1100s), but not in the A.D. 1200s and 1300s. It is interesting that the latter Mohlab dates are similar to many others that we have received from radiocarbon and archeomagnetic samples at Pueblo Alto. The similar late dates most likely point to errors that have crept into many chronometric curves derived from a common chronometric source (i.e., carbon-14).

Even if Mohlab's results are correct, as Michels (personal communication 1986) asserts, the two late dates would be even more erroneous if correlated with the Trash Mound specimens. The standard deviations of the two A.D. 1000s dates, however, overlap the temporal span covered by the Kiva 10 deposits, so, no matter which set they are associated with, they are statistically correct. The remaining two dates, of course, are a different matter.

Six pieces from the same two proveniences were later sent to Mohlab to see if the problems could be rectified. These pieces were also selected for the same two sources originally identified by Sappington, but they yielded a split decision: two were confirmed as coming from the Jemez Mountains, as Sappington determined, but the other two came from the Pumice Mountain-Grants Ridge (NM) source that Sappington had analyzed as Polvadera Peak (in the Jemez Mountains) material. The second sample, of course, was expected to yield results similar to the first and did. Thus,

Table 8.11. Obsidian hydration measurements from MOHLAB [duplicate samples analyzed by UCLA (OHL)] and sample mineral composition.

Provenience	Field Specimen Numbers	Laboratory Numbers OHL	Laboratory Numbers MOHLAB	Sources[a] OHL	Sources[a] MOHLAB	Hydration (Microns) OHL[b]	Hydration (Microns) MOHLAB	MOHLAB Dates (1 sd)
Trash Mound, Grid 267, Level 10	4583	7681	323-7681	P	PM	2.0 (1.8) ± 0.2	3.18 ± 0.09	1269 ± 39
Trash Mound, Grid 267, Level 13	4586	7682	323-7682	P	PM	1.7 (1.6) ± 0.2	3.09 ± 0.06	1306 ± 25
Trash Mound, Slump 1	4626-1	7683	347-7683	J	OR	2.5 ± 0.2	2.76 ± 0.09	1106 ± 57
Trash Mound, Slump 1	4626-2	7684	347-7684	P	PM?	1.8 ± 0.2	3.53 ± 0.08	1101 ± 39
Kiva 10, Level 17	6502-1	7664	323-7664	J	OR	3.4 (3.3) ± 0.2	2.82 ± 0.07	1068 ± 47
Kiva 10, Level 17	6502-2	7665	323-7665	J	OR	3.3 (3.0) ± 0.2	2.80 ± 0.06	1076 ± 36
Kiva 10, Level 17	6502-3	7666	347-7666	J	OR	2.6 ± 0.2	2.71 ± 0.06	1138 ± 40
Kiva 10, Level 17	6502-4	7667	347-7667	J	OR	3.7 ± 0.2	2.90 ± 0.07	1012 ± 50
Kiva 10, Level 27	6519-1	7678	347-7678	J	OR	3.3 ± 0.2	2.84 ± 0.04	1053 ± 26
Kiva 10, Level 27	6519-2	7679	347-7679	J	OR	2.8 ± 0.2	2.84 ± 0.04	1053 ± 26

Mineral Composition (source affinity tests):

MOHLAB No.	Na_2O	K_2O	Fe_2O_3	CaO	MgO	Source
323-7664	4.15	4.58	0.89	0.27	0.05	Obsidian Ridge
323-7665	4.25	4.61	1.07	0.37	0.05	Obsidian Ridge
347-7666	4.40	4.40	0.87	0.23	0.05	Obsidian Ridge
347-7667	4.35	4.71	0.94	0.21	0.04	Obsidian Ridge
347-7678	4.32	4.67	0.97	0.20	0.05	Obsidian Ridge
347-7679	4.30	4.72	0.80	0.21	0.04	Obsidian Ridge
323-7681	5.25	4.18	0.95	0.30	0.04	Pumice Mountain
323-7682	5.09	4.14	0.97	0.29	0.03	Pumice Mountain
347-7683	4.54	4.49	0.96	0.21	0.04	Obsidian Ridge
347-7684	5.96	4.15	0.94	0.26	0.04	Pumice Mountain?

[a]J = Jemez Mountains (general, non-Polvadera Peak); P = Polvadera Peak, Jemez Mountains. PM = Pumice Mountain (Grants Ridge near Mt. Taylor); OR = Obsidian Ridge, Jemez Mountains.
[b]Samples remeasured in January 1986 by U.C.L.A. (results in parentheses).

material identified by Sappington as Polvadera Peak obsidian actually appears to have come from Grants Ridge near Mt. Taylor. Both analysts agreed on the identification of Jemez obsidian, however. The key difference between the two sources apparently lies in the sodium and potassium content. Relatively low amounts of sodium oxide and high amounts of potassium oxide occur in the Obsidian Ridge obsidian, with just the opposite for the Pumice Mountain material.

The obsidian dates were tested for contemporaneity (Table 8.12) to derive mean dates for the proveniences sampled (Table 8.13). The dates spanned nearly three centuries, although other evidence narrows the time in question to less than a century. Ideally, the Trash Mound samples should be the earliest, followed closely in time by, if not coeval with, the Kiva 10, Level 27 samples and then by the later deposits from Level 17 in Kiva 10.

Visually and by an analysis of variance (F-test), the four Trash Mound dates can be segregated into two temporal groups: one with a mean of A.D. 1103 and the other at A.D. 1296. If the two late dates (A.D. 1269 and 1306) are switched with the two initial A.D. 1000s dates from Kiva 10 (see above), then the four dates thought to be from the Trash Mound (A.D. 1106, 1101, 1076, and 1068) yield a mean date of A.D. 1086 $\pm$ 43 (2 sd) in close accordance with associated tree-ring and ceramic-seriation dates. Tests for contemporaneity (F-test and Chauvenet's criterion) support the possibility that the latter four dates represent the same period of time. Switching the two late dates to Kiva 10, however, does nothing to refine the Kiva 10 dating. Clearly, the two late dates are aberrant and erroneous.

The lowest deposits in Kiva 10 yielded the earliest obsidian hydration mean date midpoint at A.D. 1053. Happily, the mean date midpoint from these samples preceded the upper deposit sample mean (A.D. 1081) by three decades--a reasonable span of time, although both mean dates from Kiva 10 are earlier than they should be. Statistically, the three mean dates of A.D. 1053, 1081, and 1103 overlap the presumed periods of deposition, if the two late aberrant dates are discarded on archeological and statistical grounds. Microseriation of the period in question is unlikely, given the present precision of obsidian hydration analyses and, thus, the results are chronologically satisfying despite their not following the exact predicted temporal sequence for the proveniences sampled. There were too few obsidian hydration dates to refine the chronology at the site, but the results do not contradict dates derived by other means. Greater emphasis on dating the numerous pieces of obsidian from the early A.D. 1100s at the site would refine the chronology of the final occupation.

Ceramic Seriation

Because of the large role that ceramics play in interpreting chronology at Pueblo Alto, in this chapter they receive more than cursory discus-

Table 8.12. Test evaluations of coeval obsidian hydration dates from Pueblo Alto.

Test	Provenience	Dates Tested	Test Value	Rejection Level	Result	Date Averaging Result (2 sd)
a	Trash Mound	1101, 1106 1269, 1306	F = 7.36	$F_{.01} \geq 3.78$	Reject H_o	N/A[a]
b	Trash Mound	1101, 1106	t = 0.04	$t_{.01} \geq 2.58$	Accept H_o	1103 ± 64
c	Trash Mound	1269, 1306	t = 0.40	$t_{.01} \geq 2.58$	Accept H_o	1296 ± 42
d	Trash Mound	1068, 1076 1101, 1106	F = 0.05	$F_{.01} \geq 3.78$	Accept H_o	1086 ± 43
e	Kiva 10, Lv. 27	1053, 1053	t = 0.00	$t_{.01} \geq 2.58$	Accept H_o	1053 ± 51
f	Kiva 10, Lv. 17	1012, 1068 1076, 1138	F = 0.37	$F_{.01} \geq 3.78$	Accept H_o	1081 ± 42[b]
g	Kiva 10, Lv. 17	1012, 1138 1269, 1306	F = 3.76	$F_{.01} \geq 3.78$	Accept H_o (marginal)	1231 ± 35[c]

[a]Based on Chauvenet's criteron, 1101, 1106, and 1306 rejected.
[b]Based on Chauvenet's criteron, 1012 and 1138 rejected.
[c]Based on Chauvenet's criteron, 1012, 1138, and 1306 rejected.

Table 8.13. Temporal framework for averaging obsidian hydration dates (after Long and Rippeteau 1974).[a]

Provenience		Mean Date	Ceramic and Tree-Ring Dates
TRASH MOUND, Slump			Gallup assemblage (A.D. 1050-1100)
1101	a, b	1103 ± 64	T-R = 1072+vv
1106	a, b		T-R = after 1045r
TRASH MOUND, Grid 267			Gallup assemblage (A.D. 1050-1100)
1269 *	a, c	1296 ± 42	T-R = 1072+vv
1306 *	a, c		T-R = after 1045r
alternative TRASH MOUND			Gallup assemblage (A.D. 1050-1100)
1068	d		T-R = 1072+vv
1076	d	1086 ± 43	T-R = after 1045r
1101	d		
1106	d		
KIVA 10, Level 27			late Gallup assemblage/
1053	e	1053 ± 51	early Chaco-McElmo assemblage
1053	e		(A.D. 1080-1110)
KIVA 10, Level 17			Chaco-McElmo/late Mix assemblage
1012	f		(A.D. 1100-1140)
1068	f	1081 ± 42	T-R = 1132r
1076	f		
1138	f		
alternative KIVA 10, Level 17			Chaco-McElmo/late Mix assemblage
1012	g		(A.D. 1100-1140)
1138	g	1231 ± 35	T-R = 1132r
1269	g		
1306	g		

[a]Temporally ordered from earliest (at top) to latest (at bottom) based on stratigraphy, tree-ring dates, and ceramic seriation (see Figures 8.6-8.9). Letters mark tests for coevality (see Table 8.12). Asterisks mark dates rejected on archeological grounds.

Error range is at two standard deviations. See Table 8.11 for associated standard deviations of initial corrected dates.

sion allotted to some other methods of dating. Unfortunately, as a result of scheduling problems, the temporal refinement for individual units at Alto could not be closely integrated with other analyses. Thus, dates used by some authors for other analyses are now superseded by those provided in the correction list (Table 8.14) if they were not corrected in the Volume III analyses.

For this study, I focused on the ceramic time-depth for the greathouse period, which spans roughly A.D. 900 to 1140. Considerable work has been done in Chacoan sites for this period but almost all sites have revealed lengthy occupation. Often deposits at these sites have been subject to considerable mixing during the occupation and later disturbance by archeologists looking for burials. In addition, there has been a paucity of absolute dates from the small houses, whereas the multitudes from the greathouses are poorly associated, if at all, with specific artifact assemblages. Only Roberts' (1927) study of ceramics from stratified greathouse middens has given some order to the masses of ceramics recovered from Chaco, although this is hampered by the development of different typologies for the canyon ceramics (i.e., Roberts 1927; Hawley 1936; Vivian 1959) that are not compatible. Except for Roberts' tests, the bulk of the ceramics from stratified deposits have not survived curatorial handling so that they can be re-examined in light of more recent work. Thus, previous work has left ceramic time-depth studies in somewhat of a quandry.

Of greatest interest in this case is not specific ceramic types or individual attributes that may be useful at various levels of explanation, but an identification and procedural ordering of ceramic assemblages that mirror the Bonito phase. At this level of investigation, I have been content to employ old-fashioned typology, while leaving more detailed ceramic analyses for others [i.e., Toll and McKenna 1983 (Volume III)]. The limitations of the materials that have been "rough-sorted" without further detailed analyses at this stage are obvious. In particular, it must be recognized that the formation of assemblages from ceramic types that were not precisely defined during the initial sorting may weaken any results. A more detailed and meaningful analysis of the ceramics, however, was designed to follow the initial sorting.

Pueblo Alto might be considered an ideal case for temporal control with its large, unmixed, stratified deposits discarded over a short length of time, which outflanks the utility of an artificial seriation. Nevertheless, the latter study can generate additional confidence in the initial ordering as well as serve as a basis for seriating assemblages at poorly stratified sites in the canyon. One should not accept unequivocally artifact associations from the same stratum, however, because it is always possible that discrete artifact classes became mixed. Although ceramics were used for temporally ordering all other artifact classes (Volume III), generally there were too few items, except for bones and lithic debitage, to illuminate potential discrepancies solely by statistical means. The problem of temporal mixing versus progressive change is an acute one

Table 8.14. Ceramic typological time in Chaco Canyon: A.D. 900-1300.

Ceramic spans For artifact Analyses	Ceramic spans (Revised)	Dominant painted Ceramic type(s)	Dominant culinary Ceramic type(s)
A.D. 920-1020	A.D. 900-1040/1050 (Early Bonito phase)	Red Mesa Black-on-white	Lino Gray Tohatchi Banded neck indented corrugated
A.D. 1020-1040	A.D. 1040/1050	Red Mesa Black-on-white & Gallup Black-on-white	Tohatchi Banded neck indented corrugated PII indented corrugated
A.D. 1020-1120	A.D. 1040/1050-1100 (Classic Bonito phase)	Gallup Black-on-white	Coolidge Corrugated Blue Shale Corrugated Exuberant Corrugated
A.D. 1120-1220	A.D. 1100-1140 (Late Bonito phase)	Gallup Black-on-white Puerco Black-on-white Chaco-McElmo Black-on-white McElmo Black-on-white (local varieties)	Coolidge Corrugated Chaco Corrugated Blue Shale Corrugated Hunter Corrugated
--------------	A.D. 1140-1200?[a]	McElmo Black-on-white (San Juan variety)	PII-III indented corrugated (unknown types, but includes some of the above)
A.D. 1220-1320	A.D. 1200-1300 (Mesa Verde Phase)	Mesa Verde Black-on-white (San Juan and local varieties)	PIII indented corrugated (unknown type)

[a]Span is poorly known.

during periods when ceramic assemblages underwent rapid changes in type quantities, in this case at A.D. 1050 and 1100, particularly for surface collections.

Major shifts in ceramic usage occurred during the Bonito phase that are highly useful as chronological markers. Basically, ceramic assemblages remained fairly stable for a period of time and then were quickly replaced or supplemented by a number of new types that gave form to new assemblages. This contrasts with the view that ceramic style undergoes gradual changes (e.g., Rowe 1961:326). The cultural factors causally related to such change are not ignored (e.g., de Barros 1982) but are dealt with elsewhere in this and other analysts' reports. Because assemblages, defined here as groups of ceramic types that were used together for some specified length of time, are named and used throughout this and other reports as temporal markers, a detailed discussion of them is appropriate.

Fortunately at Pueblo Alto, artifical seriation techniques are not necessary to obtain a chronological sequence because it is enshrined in the successive strata at the site. There are, of course, some situations that militate against the accurate ordering of cultural succession (e.g., Rowe 1961:324), but they are minor annoyances at Alto except where ceramics were scarce.

Bonito Phase Ceramic Assemblages (A.D. 900-1140)(Table 8.15)

Red Mesa Ceramic Assemblage (A.D. 900-1040/1050)

This assemblage corresponds to what we have designated the Early Bonito phase (Toll et al. 1980), although the initial span of A.D. 920 to 1020 has been altered. Of the three assemblages characterizing the Bonito phase, this period lasted the longest but has yielded the poorest chronometric results with a particularly long, undated gap existing for the last half of the A.D. 900s. Ceramic types used during this period under-went relatively little change until the early A.D. 1000s. The entire span, dominated by Red Mesa Black-on-white and neck-decorated, culinary vessels, can be divided into two subperiods. Aside from the primary types, the early one (A.D. 900-975) often exhibits the minor use of several types typical of the preceding century. Lino Black-on-gray, Whitemound, Theodore and LaPlata Black-on-whites, along with Lino Gray and early San Juan Redwares, are typically present. Other trade wares commonly found include early Chuskan (Tunicha and Newcomb Black-on-whites) and Kayentan types (Kana'a Black-on-white). Southern Kiatuthlanna Black-on-white and Sanostee Black-on-red are also found. Culinary vessels are almost exclusively narrow neckbanded forms incorporating sand temper.

The best-dated assemblages from this period came from Una Vida and Kin Nahasbas and carbon-14 dated to the first half of the A.D. 900s.

Table 8.15. Bonito Phase ceramic assemblages in Chaco Canyon: A.D. 900-1140.[a]

Phase/Period	Black-on-whites	Black-on-reds	Culinary
Early Bonito phase A.D. 900-975± (early Red Mesa)	Red Mesa Black-on-white Whitemound Black-on-white Tunicha Black-on-white Kana'a Black-on-white LaPlata Black-on-white	San Juan Redwares (types unidentified) Deadman's Black-on-red LaPlata Black-on-red Bluff Black-on-orange Sanostee Black-on red	Cibola/Tusayan plain gray Cibola narrow neckbanded Tohatchi Banded Kana'a Neckbanded Cibola neck indent. corrugated Chuskan neck indent. corrugated Lino Gray
Early Bonito phase A.D. 975±-1040/1050 (Red Mesa)	Red Mesa Black-on-white Escavada Black-on-white Newcomb Black-on-white Burnham Black-on-white	San Juan Redwares (types unidentified) LaPlata Black-on-red Deadman's Black-on-red	Cibola/Tusayan plain gray Cibola narrow neckbanded Cibola neck indent. corrugated Chuskan neck indent. corrugated Chuskan narrow neckbanded Tohatchi Banded
Classic Bonito phase A.D. 1040/1050-1100 (Gallup)	Gallup Black-on-white Puerco Black-on-white Red Mesa Black-on-white Chuska Black-on-white Toadlena Black-on-white Black Mesa Black-on-white Mancos Black-on-white	Tsegi Orangewares (types unidentified) San Juan Redwares Tusayan Black-on-red	Cibola corrugated (unidentified) Chuskan corrugated (unidentified) indented corrugateds (types unidentified) Exuberant Corrugated Coolidge Corrugated Blue Shale Corrugated Tohatchi Banded
Late Bonito phase A.D. 1100-1140 (Late Mix)	Chaco-McElmo Black-on-white Gallup Black-on-white Puerco Black-on-white McElmo Black-on-white Chuska Black-on-white Toadlena Black-on-white Black Mesa Black-on-white Mancos Black-on-white Sosi Black-on-white Socorro Black-on-white	White Mt. Redwares (types unidentified) Tsegi Orangewares (black-on-reds and polychromes) Puerco Black-on-red Wingate Black-on-red Wingate Polychrome	Chuskan corrugated (unidentified) Cibola corrugated (unidentified) indented corrugateds (types unidentified) Coolidge Corrugated Blue Shale Corrugated Chaco Corrugated Hunter Corrugated Mancos? Corrugated

[a]Types arranged in approximate descending order of frequency. Not all minority types listed.

Other dated samples came from sites in northeastern Arizona. Although several greathouses (e.g., Kin Bineola, Pueblo Bonito, Peñasco Blanco, and Una Vida) yielded numerous tree-ring dates in the A.D. 900s, the dates cannot be directly associated with the contemporary ceramic assemblages at the sites.

The late period (A.D. 975-1040/1050) appears to have a less diverse number of types, with Chuskan trade wares most prominent. Neck indented corrugated and Chuskan neckbanded and clapboard types challenge the popularity of narrow neckbanded vessels. The Chuskan and neck corrugated vessels constitute significant minorities by the early A.D. 1000s. Painted trade wares are dominated by Tunicha and Newcomb Black-on-whites and San Juan Redwares.

Division of the overall period at A.D. 975 is arbitrary and merely represents the midpoint between the better-dated ends of the period. Sites with absolute dates for the subperiod all cluster in the first half of the A.D. 1000s and, with the exception of Pueblo Alto, all are small-house sites.

Gallup Ceramic Assemblage (A.D. 1040/1050-1100)

Formerly dated at between A.D. 1020 and 1120 (e.g., Toll et al. 1980), this period corresponds to the Classic Bonito phase. At about A.D. 1040 or 1050, there was a major shift in ceramic usage highlighted by the rapid demise of Red Mesa Black-on-white and the rise of Gallup Black-on-white. Likewise, there was a shift from the neck-decorated, culinary wares to overall indented corrugated jars. The clear shift in type preference is paralleled by a corresponding realignment in the trade network, with high frequencies of the new types originating in the Chuska Mountains, at times dominated by Chuskan culinary jars [H. Toll 1981, 1984, 1985; Toll and McKenna 1983 (Volume III)]. Important minorities of siliceous stone (Cameron 1984) and perhaps some high-altitude timbers were also collected from the same mountains. At Alto the shift is best visualized in the Trash Mound, where the transition in ceramic assemblages took place shortly after initial greathouse construction. Aside from the overwhelming numbers of Chuskan culinary vessels, Chuska and Toadlena Black-on-whites show up as common but minor types. What few redwares occur in association are usually Tsegi Orangewares and some San Juan Redwares. White Mountain Redware is absent. Toward the end of the period, and perhaps even dominating it for a very short period of time (e.g., 10 years?), were relatively high frequencies of Tusayan Whitewares (Sosi and Black Mesa Black-on-whites). Dated assemblages are again restricted to small house sites and Pueblo Alto.

The shift in ceramic assemblages was rapid and occurred during significant changes in Chaco: the appearance of the prehistoric road system, a renewal in greathouse construction and remodeling, shifts in other resource procurement, etc. Major changes in the socioeconomic-political organization of the Chacoan Phenomenon must have occurred.

Late Mix Ceramic Assemblage (A.D. 1100-1140)

The latest Bonitian assemblage corresponds to the Late Bonito phase, which has been considerably shortened from the A.D. 1120 to 1220 span originally defined. At A.D. 1100, there was another change in the ceramic assemblage compositions. An influx of types marking northern and southern origins co-occurs with the ceramic types of the previous period. There is no overwhelming preference for a particular painted type, and several types were common: Gallup, Puerco, Chaco-McElmo, and varieties of McElmo Black-on-white occur along with Puerco and Wingate Black-on-reds. The new hallmark type was Chaco-McElmo Black-on-white, a type that blends Chacoan, Mesa Verdean, and Tusayan ceramic traditions (Franklin and Ford 1982; Windes 1985). This type, along with McElmo varieties and White Mountain Redware types, appears for the first time in Chaco. Sherd-tempered, indented corrugated vessels also appear for the first time in significant but low frequencies. Chuskan culinary ware appears to suffer a corresponding minor decrease in importation.

Numerous dated sites accurately reflect the Late Mix assemblage (Table 8.16), although many proveniences suffer from mixing of earlier assemblages. Dates in the last half of the century are notoriously absent and may reflect major population withdrawal from the San Juan Basin, which was spurred on by unprecedented drought. Later assemblages marked by Mesa Verde Black-on-white do not occur until the A.D. 1200s in Chaco. Classic San Juan McElmo Black-on-white, a type that might be expected in quantity if much occupation extended into the late A.D. 1100s, is rare in the canyon sites. Where it does occur in Chaco (e.g., mixed with earlier ceramics in Kiva F at Chetro Ketl), it probably derived from an early A.D. 1200s occupation.

The Ceramic Seriation

Cross-dated ceramic types have often provided the most useful method of temporal control in the Southwest in lieu of tree-ring dating. Unfortunately, there has been no attempt to update the pioneering effort of Breternitz (1966) on which most efforts rely. From the Chacoan perspective, it is clear that tighter control of chronometric results and ceramics is required before temporal accuracy of ceramic cross-dating can be refined (see Windes 1984). A relatively new, multidimensional-scaling program (i.e., KYST-2A) developed by Kruskal and Wish (1978) provides an alternative approach to the use of cross-dated ceramic types. The utility of the program for Southwestern ceramic seriation has been successfully tested by Matson and Lipe (1977), Hurst and Durand (1981), and Durand and Hurst (1985).

A short discussion may be useful here to acquaint the reader with the KYST program. The program provides a scattergram, with the proximity of points (ceramic assemblages here) reflecting increasing similarity as the point converge and dissemilarity when far apart, based on the percentage

Table 8.16. Dated proveniences used in the ceramic seriation.

KYST PROV Code	Latest Date[a]	Site	Associated ceramic Assemblage location	General location	Primary Reference
184	895++vv	AZ-P-24-1	Entire site	Blk. Cr. Valley, AZ	Fehr et al. 1982
198	918v	NA 8013	Rooms 2-3, subfloor	Cross Canyon, AZ	Olson 1971
600	928±43	Kin Nahasbas	Trash under great kiva	Chaco Canyon, NM	Mathien & Windes 1984
462	945±40	Una Vida	Room 23, Floor 2	Chaco Canyon, NM	Akins & Gillespie 1979
134	945r	NA 8013	Room 7, Floor 2	Cross Canyon, AZ	Olson 1971
157	960±80	29SJ 629	Pithouse 3, Layer 3	Chaco Canyon, NM	Windes 1978
153	987vv	29SJ 629	Pithouse 2, Floor 1	Chaco Canyon, NM	Windes 1978
133	1006c	NA 8013	Room 7, fill	Cross Canyon, AZ	Olson 1971
135	1005+v	NA 8013	Rooms 9-12, fill	Cross Canyon, AZ	Olson 1971
176	1008r	LA 2701	Room 4, fill	Gallup, NM	Wendorf et al. 1956
177	1008r	LA 2701	Entire site	Gallup, NM	Wendorf et al. 1956
31	1023±27	Pueblo Alto	Room 142, Layer 7	Chaco Canyon, NM	Windes, this volume
29	1023±27	Pueblo Alto	Room 139, Layer 10	Chaco Canyon, NM	Windes, this volume
39	1023±27	Pueblo Alto	Room 146, Layer 12	Chaco Canyon, NM	Windes, this volume
25	1021r	Pueblo Alto	Room 110, Layer 12	Chaco Canyon, NM	Windes, this volume
136	1024B	NA 8013	Kiva 1, fill	Cross Canyon, AZ	Olson 1971
201	1043±40	29SJ 626	Pitstructure 1, floor	Chaco Canyon, NM	Windes 1983
204	1031±20[b]	29SJ 626	Pitstructure 3, floor	Chaco Canyon, NM	Windes 1983
178	1039++vv	LA 2714	Entire site	Ft. Wingate, NM	Smith 1964
182	1042+vv	LA 6383	Entire site	Thoreau, NM	Smith 1964
202	1045±24[b]	29SJ 626	Pitstructure 2, floor	Chaco Canyon, NM	Windes 1983
181	1045+v	LA 6372	Kiva, fill	Thoreau, NM	Smith 1964
69	1045r	Pueblo Alto	Trash Mound, Layer 17	Chaco Canyon, NM	Windes, this volume
466	1045r	Leyit Kin	Trash east of Kiva A	Chaco Canyon, NM	Dutton 1938
175	1047r	LA 2505	Kiva B, fill	Tohatchi, NM	Wendorf et al. 1956
183	1050B	LA 6482	Pithouse, fill	Prewitt, NM	Smith 1964
44	1053±51[c]	Pueblo Alto	Kiva 10, Level 27	Chaco Canyon, NM	Windes, this volume
130	1062r	NA 1355	Entire site	Ganado, AZ	Fuller & Chang 1978
79	1072+vv	Pueblo Alto	Trash Mound, Layer 62	Chaco Canyon, NM	Windes, this volume
24	1088±26	Pueblo Alto	Room 110, Floor 1	Chaco Canyon, NM	Windes, this volume
41	1075±46	Pueblo Alto	Room 229, Layer 6	Chaco Canyon, NM	Windes, this volume
145	1080±110	29SJ 627	Kiva E, Layer 3	Chaco Canyon, NM	Truell 1981
146	1080±110	29SJ 627	Kiva E, Layer 4	Chaco Canyon, NM	Truell 1981
205	1080±126	29SJ 626	Room 5, fill	Chaco Canyon, NM	Windes 1983
42	1081±42[c]	Pueblo Alto	Kiva 10, Level 17	Chaco Canyon, NM	Windes, this volume
138	1087r	NA 8022	Kiva fill below bench	Cross Canyon, AZ	Olson 1971
129	1104vv	Bc 192	Kiva C, fill	Chaco Canyon, NM	Maxon 1963
107	1104r	Bc 59	Kiva 2, fill	Chaco Canyon, NM	McKenna 1981
124	1109r	Bc 362	Kiva 3, fill	Chaco Canyon, NM	Voll 1964
123	1115vv	Bc 362	Kiva 1, fill	Chaco Canyon, NM	Voll 1964
199	1119vv	PM 218	Room 5 (kiva), floor	Gallup, NM	Allen & Nelson 1982
132	1122r	NA 1546b	Pithouse 5, fill	Ganado, AZ	Fuller & Chang 1978
179	1128vv	LA 5596	Room 1, floor	Toadlena, NM	Johnson 1963
194	1128vv	Bis sa'ani	West House, Room 13	Chaco Canyon, NM	Breternitz et al. 1982
193	1131r	Bis sa'ani	West House, Room 7	Chaco Canyon, NM	Breternitz et al. 1982
91	1132r	Pueblo Alto	PF 1, Room 3, Layer 3	Chaco Canyon, NM	Windes, this volume
92	1132r	Pueblo Alto	PF 1, Room 3, Layer 4	Chaco Canyon, NM	Windes, this volume
131	1137r	NA 1546b	Pithouse 5, fill	Ganado, AZ	Fuller & Chang 1978
196	1139vv	LA 17315	Entire site	Chaco Canyon, NM	Breternitz et al. 1982
180	1142r	LA 5596	Room 2, floor	Toadlena, NM	Johnson 1963
20	1160±144	Pueblo Alto	Room 103, Layer 2	Chaco Canyon, NM	Windes, this volume

[a] ± date = carbon-14 date (2 sd, corrected. See Table 8.7). Some of these are averaged from a cluster of dates.
[b]Average of coeval carbon-14 and Eighmy archeomagnetic dates (2 sd).
[c]Obsidian hydration dates (2 sd).

of type sherds within each sample compared to all other samples. The underlying structure is deduced from examination of the plot, and, in this case, thanks to added chronological control from chronometric dates, at least one dimension of the program can be attributed to temporal ordering. Most plots have been subjectively divided into periods of time on the basis of the dated samples to enhance the temporal ordering for the reader. Desirable plots are often in horseshoe form or a related configuration. Some attributes may effect the plot configuration and yet not be strong enough to become visible as separate configurations. Increased program dimensionality may produce more desirable results (and lessen the "stress" factor), although not all dimensions may be interpretable (Kruskal and Wish 1978:57) because it is difficult to discern how the variables were used in the calculations for many of the dimensions.

A measure of the goodness-of-fit of the data (departure from monotonicity) is provided by the "stress" value listed for each plot (Kruskal 1964:3). High values (ie., above .10) may reflect unreliability or the existence of additional structure in the data matrix (Kruskal 1964), which may be illuminated by increasing the number of dimensions in the program. Nevertheless, Shepard (1974:385) has warned against undue emphasis on the stress value to the exclusion of the statistical stability and interpretability of the obtained plot configuration. The large stress values produced by the present plots probably result from the greater amount and variation of data employed compared to the pioneer works of Kruskal and Shepard. The control afforded by the dated samples in the present exercise reveals the accuracy of the ordering, although the stress factor is relatively high (e.g., between .10 and .15). Experience from this analysis has revealed that plots became increasingly difficult to interpret as the stress rose above .15. Trial runs revealed that use of maximum numbers of types reduced the stress, whereas lumping types inexplicably increased it. Increased dimensionality refined results and lessened the stress factor but did not radically alter the scattergram. With our data, the lowest stress occurred in 1-to-5-dimensional space, and that representing dimensions 1 and 2 was always selected for interpretation because only it could be attributed to temporal ordering.

The use of the KYST program for seriation at Pueblo Alto was kept simple. Three variables form the basis of the program: provenience, ceramic type, and the number of sherds per type (converted to percentages in the program). Seventy-nine Alto proveniences were used (Table 8.17) and these (representing 9,427 sherds or about 10 percent of the total Alto sample) were combined with numerous other local samples and dated samples from throughout the San Juan Basin to produce the working file. The Alto samples contained between 8 and 978 usable sherds (mean sample size = 126, sd = 163). All data is stored in file TOMALL10 at the University of New Mexico computer center. Type identification was assigned during initial sorting of the Alto collection by Peter McKenna and the author. Despite whatever sorting biases may have been operative between the two sorters, there is a feeling between the sorters, partly tested by Obenauf (1977),

Table 8.17. Ceramic proveniences used in the KYST-2A multidimensional scaling seriation.

PROV Code	Provenience	Ceramic Period[a]	Dates
1	Kin Ya'a, TM 1 surface	G	
2	Pueblo Pintado, TM 1-2, surface	RM/G	
3	Pueblo Pintado, TM 3, surface	RM/G	
4	Pueblo Pintado, TM 4, surface	G	
5	Tsin Kletzin, TM surface	G/CMc	
6	Pueblo Bonito, Test 2, Layer 2	RM/G	
7	Pueblo Bonito, Test 2, Layer 3	RM/G	
8	Pueblo Bonito, Test 2, Layer 6	RM	
9	Pueblo Bonito, Test 5, Layer 14	eRM	
10	Pueblo Bonito, Test 5, Layer 15	eRM	
11	Pueblo Bonito, Test 5, Layer 16	eRM	
12	Pueblo Bonito, Test 7, Layer 3	G	
13	Pueblo Bonito, Test 7, Layer 14	G	
14	Pueblo Bonito, Test 7, Layer 15	G	
15	Pueblo Bonito, Test 8, Layer 5	G	
16	Pueblo Bonito, Test 8, Layer 8	G	
17	Pueblo Bonito, Test 8, Layer 13	G	
18	Pueblo Bonito, E.Md., surface	G	
19	Pueblo Bonito, W.Md., surface	G	
20	Pueblo Alto, Rm 103, Layer 2	CMc/Mc	
21	Pueblo Alto, Rm 103, Layer 3-5	G	
22	Pueblo Alto, Rm 109, Layer 2	CMc/Mc	
23	Pueblo Alto, Rm 110, Layer 1-2	G	
24	Pueblo Alto, Rm 110, Layer 8	G	1088±52
25	Pueblo Alto, Rm 110, Layer 12	RM	1021r
26	Pueblo Alto, Rm 112, Layer 3-5	G	
27	Pueblo Alto, Rm 112, Layer 8	RM	
28	Pueblo Alto, Rm 139, Layer 3-6	CMc/Mc	
29	Pueblo Alto, Rm 139, Layer 10	RM	1023±53
30	Pueblo Alto, Rm 142, Layer 4-6	CMc/Mc	
31	Pueblo Alto, Rm 142, Layer 7	RM	1023±53
32	Pueblo Alto, Rm 142, Layer 11-13	RM	
33	Pueblo Alto, Rm 142, Layer 14-15	RM	
34	Pueblo Alto, Rm 142, Wall Tr.1	RM	
35	Pueblo Alto, Rm 143, Layer 1-2	CMc/Mc	
36	Pueblo Alto, Rm 143, Layer 14	RM	
37	Pueblo Alto, Rm 145, Layer 7	CMc/Mc	
38	Pueblo Alto, Rm 146, Layer 3	CMc/Mc	
39	Pueblo Alto, Rm 146, Layer 12	RM	1023±53
40	Pueblo Alto, Rm 147, Layer 2	CMc/Mc	
41	Pueblo Alto, Rm 229, Layer 6	CMc/Mc	
42	Pueblo Alto, Kiva 10, Level 15-18	CMc/Mc	1081±42[b]
43	Pueblo Alto, Kiva 10, Level 19-23	CMc/Mc	
44	Pueblo Alto, Kiva 10, Level 24-27	CMc/Mc	1053±51[b]
45	Pueblo Alto, Kiva 10, Level 28	G	
46	Pueblo Alto, Kiva 13, Layer 1	G	
47	Pueblo Alto, Kiva 15, Layer 6-7	CMc/Mc	
48	Pueblo Alto, Kiva 15, bench fill	G	
49	Pueblo Alto, Kiva 16, Layer 1	CMc	
50	Pueblo Alto, Kiva 17, fill	G/CMc/Mc	
51	Pueblo Alto, Loose's Test (kiva)	G	
52	Pueblo Alto, Grid 8, Layer 14/19	eRM	
53	Pueblo Alto, Grid 8, Layer 15	eRM	
54	Pueblo Alto, Grid 30, Layer 6	eRM	
55	Pueblo Alto, Grid 30, OP 1	eRM	
56	Pueblo Alto, Grid 116, Layer 1	CMc/Mc	
57	Pueblo Alto, Grid 116, Layer 9	RM	
58	Pueblo Alto, Grid 117, Layer 9	RM	
59	Pueblo Alto, Grid 203, Layer 2	RM	
60	Pueblo Alto, Grid 203, Layer 4	RM	
61	Pueblo Alto, Grid 302, Layer 3	G	
62	Pueblo Alto, Grid 302, Layer 8	RM	
63	Pueblo Alto, Grid 307, Layer 8	RM	
64	Pueblo Alto, TM, surface	G	
65	Pueblo Alto, TM, backhoe test 1	RM/G	
66	Pueblo Alto, TM, backhoe test 2	RM	
67	Pueblo Alto, TM, backhoe test 3	RM	
68	Pueblo Alto, TM, SC1, Layer 3	RM	
69	Pueblo Alto, TM, SC2, Layer 17	G	1045r
70	Pueblo Alto, TM, SC3, Layer 19	G	
71	Pueblo Alto, TM, SC3, Layer 22	G	
72	Pueblo Alto, TM, SC3, Layer 24-31	G	
73	Pueblo Alto, TM, SC4, Layer 35	G	
74	Pueblo Alto, TM, SC3, Layer 35-41	G	
75	Pueblo Alto, TM, SC3, Layer 43	G	
76	Pueblo Alto, TM SC3-4 Layer 44	G	
77	Pueblo Alto, TM, SC4, Layer 45	G	
78	Pueblo Alto, TM, SC5, Layer 58	G	1072+vv
79	Pueblo Alto, TM, SC5, Layer 62	G	1072+vv
80	Pueblo Alto, TM, SC6, Layer 81	G	
81	Pueblo Alto, TM, SC4, Layer 72	G	
82	Pueblo Alto, TM, SC6, Layer 82	G	
83	Pueblo Alto, TM, SC6, Layer 97	G	
84	Pueblo Alto, TM, SC6, Layer 103	G	
85	Pueblo Alto, TM, SC5, Layer 104	G	
86	Pueblo Alto, TM, SC5, Layer 105	G	
87	Pueblo Alto, TM, SC6, Layer 109	G	
88	Pueblo Alto, TM, SC6, Layer 113	G	
89	Pueblo Alto, East Ruin, Room 14	CMc/Mc	
90	Pueblo Alto, N. Tr., Level 2-4	RM	
91	Pueblo Alto, PF 1, Rm 3, Layer 3	CMc/Mc	1132r
92	Pueblo Alto, PF 1, Rm 3, Layer 4	CMc/Mc	1132r
93	Pueblo Alto, PF 4 (kiva), fil	CMc	
94	Pueblo Alto, Grid 301, Layer 1	CMc/Mc	
95	Pueblo Alto, OS 5, TT 1, Lay 2-7	CMc	
96	Pueblo Alto, Plaza 2, G181/201, S1	CMc	
97	Pueblo Alto, Plaza 2, G181/201, S3	CMc	
98	Pueblo Alto, Plaza 2, G181/201, S6	G	
108	Peñasco Blanco, E.Md., S. surface	RM/G	
109	Peñasco Blanco, E.Md., N. surface	RM/G	
110	Peñasco Blanco, NE Md., surface	CMc	
111	Peñasco Blanco, Test 2, Layer 7	RM	
112	Peñasco Blanco, Test 3, Layer 8	RM/G	
113	Peñasco Blanco, Test 2, Layer 10	RM	
114	Peñasco Blanco, Test 2, Layer 11	RM	
170	Kin Bineola, TM 1 surface	CMc	
171	Kin Bineola, TM 2 surface	RM/G	
172	Kin Bineola, TM 3 surface	RM	
173	Kin Bineola, TM 4 surface	eRM	
174	Kin Bineola, TM 5 surface	RM/G	
185	Chetro Ketl, Kiva F, upper 3' of fill	Mc	
186	Chetro Ketl, Kiva F, Layer 4	Mc	
187	Chetro Ketl, TM surface	G	
188	Pueblo del Arroyo, Parking Lot test	CMc	1100vv
301	RS 8N. Peñasco Blanco, N. Escavada stairs (29SJ 604)	G/MV	
302	RS 8S. Peñasco Blanco, S. Escavada stairs (29SJ 611)	G	
303	RS 1. Peñasco Blanco road east	G	
304	RS 6. Peñasco Blanco road northeast	McE/MV	
305	RS 33. Pueblo Bonito stairs (29SJ 1936)	McE	
306	RS 33. Alto-Bonito road.	CMc/McE	
307	RS 40W. Alto-Talus Unit road	G	
308	RS 40E. Alto-Chetro Ketl road stairs (29SJ 1555)	G	
309	RS 40. Alto-Chetro Ketl road fork	G	
310	RS 31. Alto terrace	G	
311	RS 32. Road east of Chetro Ketl	RM/G	
312	RS 43. Road to Clys Canyon.	G	
313	RS 35. Chetro Ketl to Poco?	G?	
314	RS 50. Kin Ya'a road to southwest	G	
315	RS 28. Terrace northeast of Chetro Ketl	McE?	

[a]See Tables 8.14-8.15 for ceramic periods and temporal spans.
[b]Obsidian hydration date.

of close topological consistency. Sorting was accomplished primarily through design variation and surface characteristics (slip and paint type) without microscopic examination of the temper, except for all redwares, smudged wares, and pottery with carbon paint. Results of the sample detailed analysis of the collection [Toll and McKenna 1983 (Volume III of this report)] were not used for the seriation.

A number of types utilized during the initial ceramic sorting were combined with other types or discarded. Types were combined for two reasons. A few were combined because of inconsistency in identification (i.e., early Red Mesa and Red Mesa, and Escavada and Puerco Black-on-whites). Others were combined into wares if they were consistently represented in trace quantities or were often absent. Redware types, in particular, were combined by ware, without apparent loss of temporal sensitivity.

On the other hand, the work of Hurst and Durand (1981) and trial runs of the Pueblo Alto material indicated a number of types that masked temporal sensitivity, so these were not used. The initial sorting of the Alto culinary ceramics did not distinguish between temper types, thus the vast majority were classified into two groups (unclassified plain gray and unclassifed indented corrugated) that polarized seriation results. Consequently, culinary ceramics were not used for the Pueblo Alto seriation, although better results were later achieved for other studies when temper was included as a typological attribute. Two other categories, unclassified whiteware and unclassified Cibola sherds with mineral paint, were eliminated from the seriation because their large numbers and lack of temporal sensitivity also polarized results.

Pueblo Alto Ceramic Control Samples

Three proveniences of trash at Pueblo Alto provide the full ceramic record for the site occupation. These are not contiguous units but may be linked on the basis of stratigraphy and typological overlap of the assemblages. The earliest occurred in Plaza 1, Grid 8, bordering the Central Roomblock, and yielded (in Layer 15) a Red Mesa assemblage that was overlain by successive strata of ceramic assemblages matching those in the other two units. The age of this unit is uncertain, but we are confident of the dates from slightly later contexts that place this deposit to about A.D. 1020 and perhaps as old as the late A.D. 900s.

The Trash Mound provides the intermediate record of the site occupation, as it encompasses the primary greathouse occupation. Its superb stratigraphic layering provides an unbroken ceramic record from the Pueblo Alto construction through the Classic Bonito phase. The construction material in the midden is tied to a Red Mesa assemblage, which at Alto can be linked to the period between A.D. 1021 and 1045 based on chronometric dates. A monotonously large number of successive strata associated with Gallup ceramics follow the Red Mesa assemblages and construction. The latest tree-ring date from the midden, A.D. 1072+vv, helps place the majority of Gallup units in the last half of the A.D. 1000s but not earlier. Better-dated assemblages, however, define the actual span as between about A.D. 1050 and A.D. 1100 (Figure 8.3).

Finally, Kiva 10, which is located next to Plaza 1, Grid 8, provided the terminal ceramic record at Pueblo Alto. Its lowest deposits were similar to the terminal ones in the Trash Mound and provided a ceramic and presumably a temporal link. Thereafter, the deposits are marked by a Late Mix assemblage that has been cross-dated to a number of assemblages elsewhere at Alto, in Chaco, and in the San Juan Basin. Although the control samples seem to provide a continuous ceramic history at the site, they do not necessarily imply that the site occupation was continual for the temporal span represented by the ceramics.

The accuracy of the KYST program was verified in two ways. The three deep-trash units at Pueblo Alto, described above, were first seriated and the results matched to the known stratigraphic ordering. Despite the internal overall homogeneity of the assemblages in the proveniences tested, the seriation was remarkably successful in arranging the ceramics groups in proper stratigraphic sequence (Figure 8.4). Kiva 10 ceramics came from a Late Mix assemblage except for the lowest units that were similar to the terminal Trash Mound units. The seriation grouped the upper kiva units (Layers 15-27) while plotting the early lowest unit (Layer 28) about midway between the upper units of Kiva 10 and the latest units from the Trash Mound. Not surprisingly, because of their similarity, the Gallup units from the Trash Mound also clustered without too much regard to their stratigraphic placement. But the program did distinguish the latest units of trash from the others by plotting them closest to the Kiva 10 grouping.

This unexpected temporal sensitivity was due to an increase in smudged ware and Puerco and Gallup Black-on-white sherds that paralleled the higher frequencies of the type in the Late Mix assemblages in Kiva 10. A noticeable gap in the plot occurred between the Gallup and Red Mesa assemblages from the Trash Mound, which affirms the major change in ceramic composition at about A.D. 1040 or 1050. This gap is consistently maintained throughout almost all plottings. Finally, the KYST plotting grouped all the Red Mesa assemblages together but left the Trash Mound units slightly more recent than those samples from the plaza deposits, as expected from other kinds of data. Note the change in the ceramic type composition of painted wares tabulated from the groups plotted by the KYST program for the above exercise (Table 8.18). Little change occurred in a modified plot when additional Alto proveniences and a few dated assemblages (see below) were added to the deep-trash control group (Figure 8.5).

This exercise demonstrated the ability of the KYST program to accurately distinguish temporality despite the limitations inherent in subjectively determined, ceramic typology. Of course some problems were minimized by sorting consistency and by the use of large samples.

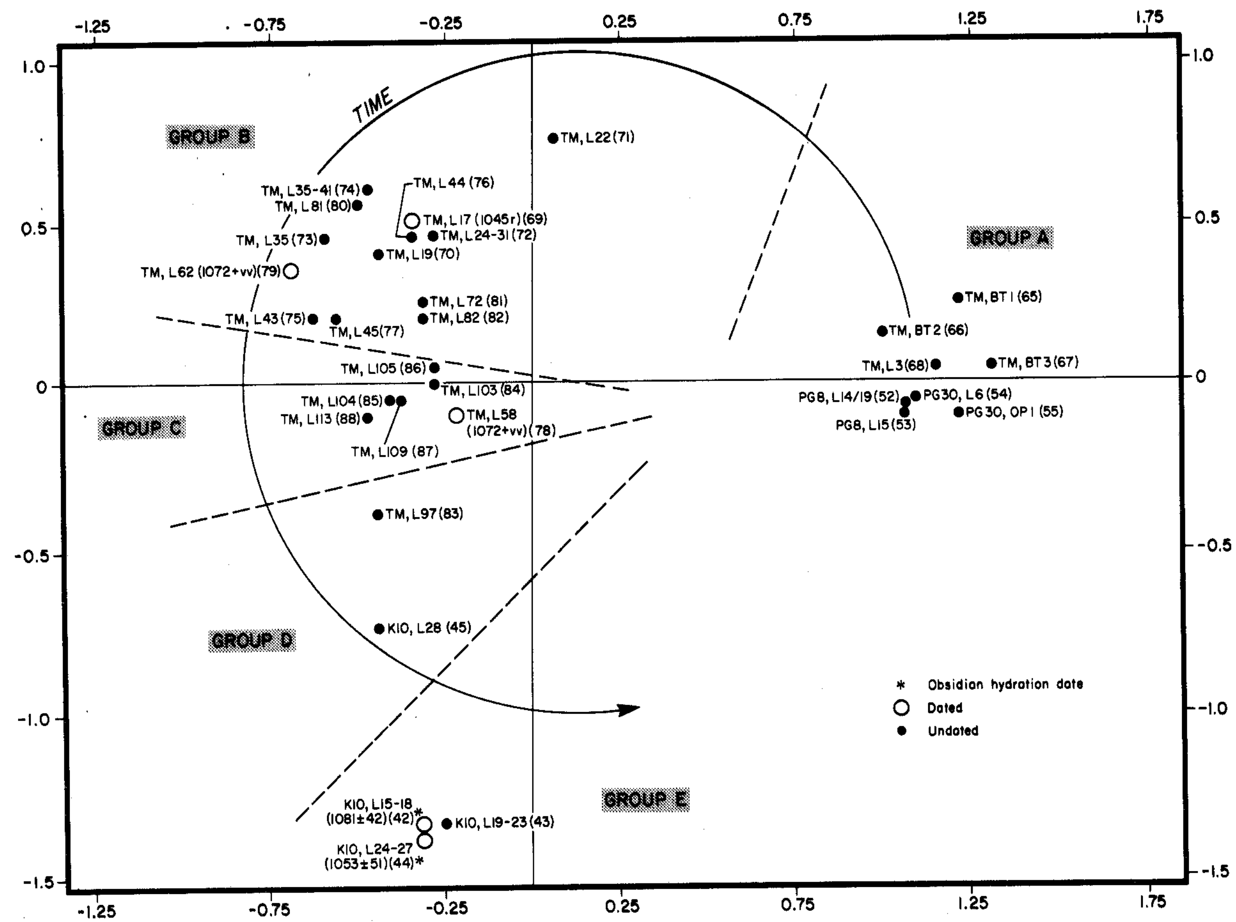


Figure 8.4. Multidimensional scaling plot showing the temporal associations of the ceramic assemblage control groups (n = 32) from Pueblo Alto (early Plaza 1 grids, selected Trash Mound layers, and Kiva 10) using the KYST-2A program in 5-dimensional space. The 2 x 1 dimension is shown. The stress factor is .11. (Compare with Figure 8.5.)

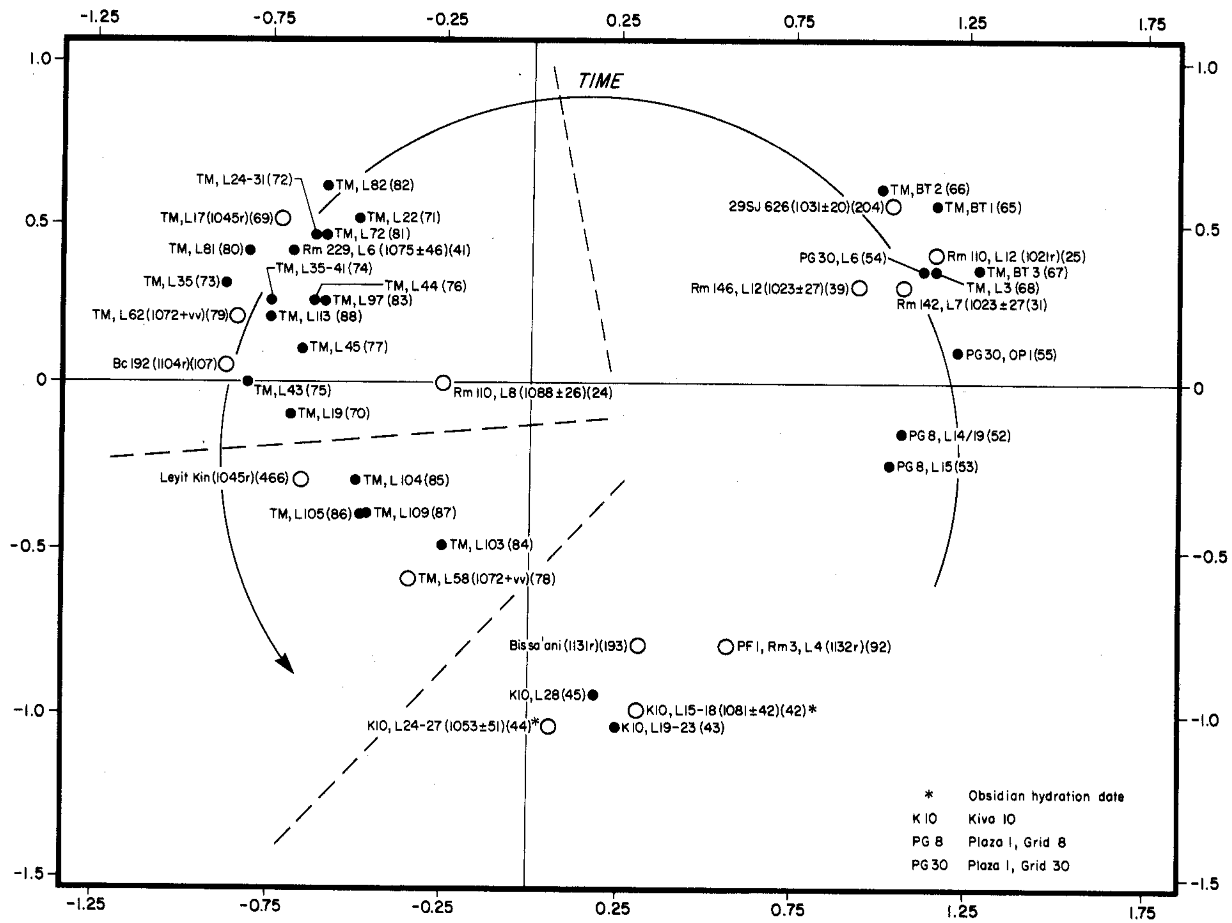


Figure 8.5. Multidimensional scaling plot showing the temporal associations of the ceramic assemblage control groups (n = 32) from Pueblo Alto using the KYST-2A program in 5-dimensional space. Ten dated groups added to reveal the accuracy of the temporal ordering of the undated assemblages. The 2 x 1 dimension is shown. The stress factor is .11. (Compare with Figure 8.4.)

Table 8.18. Ceramic change at Pueblo Alto as seriated using the KYST-2A multidimensional scaling program (from Figure 8.4).

Group	Red Mesa B/w	Escavada B/w and Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	Newcomb B/w and Burnham B/w	Chuska B/w and Toadlena B/w	Nava B/w	Crumbled House B/w	unclass. Chuska carbon	Kana'a B/w	Black Mesa B/w and Sosi B/w	unclass. Tusayan whiteware	Mancos B/w	McElmo B/w	unclass. Mesa Verde whiteware (carbon)	Forestdale Smudged	San Juan redware	Tsegi orangeware	Tusayan Polychrome	St. Johns Polychrome	White Mt. redware	unclass. redware	Total	%
A (n = 8)	553	11	56			37				58	1	1	1		2	3	89	47	15					874	
%[a]	63	1	6			4				7	T	T	T		T	T	10	5	2						98
B (n = 13)	26	78	358	4		11	34			19	3	3	2			1	53	17	15					624	
%[a]	4	13	57	1		2	5			3	T	T	T			T	8	3	2						98
C (n = 6)	21	59	147	3			14	1		10		7	3	4	1		107	16				2		395	
%[a]	5	15	37	1			4	T		3		2	1	1	T		27	4				1			101
D (n = 2)	2	21	22	1		1	29	3		2		3		1	2		6	2				1		96	
%	2	22	23	1		1	30	3		2		3		1	2		6	2				1			99
E (n = 3)	14	294	235	7	269	5	171	27	11	147		39	10	39	332	293	201	4	58	9	7	144	5	2,321	
%[a]	1	13	10	T	12	T	7	1	T	6		2	T	2	14	13	9	T	2	T	T	6	T		98
Total (n = 32)																								4,310	
Ware	Cibola					Chuska					Tusayan			Mesa Verde			smudged	San Juan	Tsegi	White Mt.			unk.		

[a]T = trace (less than 0.5%).

Dated Ceramic Control Samples

A second test for reliability employed tree-ring and radiocarbon dated ceramic assemblages seriated against one another, thus providing excellent control over absolute time and an assessment of the temporal sensitivity of the KYST program. The scarcity of dated assemblages in Chaco spanning the period of Pueblo Alto occupation required that data be gathered from throughout the San Juan Basin and beyond (Table 8.16). Paradoxically, a wealth of tree-ring dates from Chaco covered the period of interest, but very few can be directly associated with specific assemblages because of site complexity, length of site occupation (see de Barros 1982), and field and archival methods. Naturally, this restricted the search to assemblages similar to those in Chaco (i.e., Chacoan assemblages) with tree-ring dates between A.D. 900 and A.D. 1200, including all that could be gleaned from the San Juan Basin. Some of these came from surprising distances. Besides Chaco, the Prewitt, New Mexico, and Ganado and Cross Canyon, Arizona, areas produced the bulk of the dated assemblages.

Using ceramic data from sites not excavated by the Chaco Center required adjustment of prior typology (i.e., terminology) to that used for the present analysis if the ceramics could not be examined and reclassified by the author. For the most part these ceramics were left as classified by the original excavator unless they were incompatible with the Chaco Center typology. The assemblages used in the KYST program were restricted to those in closest physical (i.e., architectural and stratigraphic) association with the tree-ring dates, unless the ceramic samples were so small that the entire site was needed to justify their inclusion in the sample (one case).

Considering the pitfalls of the data base, KYST revealed a remarkable ability to seriate the dated proveniences in temporal order. Unavoidably, some cases exhibited a poor fit, probably as a result of mixed assemblages, abnormally high type counts from restorable vessels, dates that were not approximately contemporary with the assemblages, and ceramic types influenced by socioeconomic factors that contrasted with patterns in the canyon (e.g., trade wares). The poorest ordering came from the small Chacoan sites in the canyon, because their long occupations increased the probability of ceramic mixing (particularly the inclusion of Red Mesa Black-on-white with temporally later assemblages). In addition, Arizona samples were often skewed because of the high frequencies of local (i.e., Tusayan Whiteware) types that typically occurred in lower frequencies as trade wares at the canyon sites.

Despite the problem, errant samples were rarely more than 40 or so years out of the proper temporal order--an acceptable level of error considering the usual control archeologists have over time. More often, the errant sample was plotted in the correct temporal position but conformed poorly to the desired curvilinear arrangement. Sites in the control group that revealed poor ordering were often dropped in favor of those exhibiting the best ordering so as not to exceed the upper parameters of the KYST program; in our case only 42 assemblages could be used during a single plotting. Thus, there was a constant jockeying of dated assemblages into the program to try to reduce stress and to improve temporal interpretation and sample ordering. In theory, some tree-ring-dated samples were dropped if they over-represented a short span of time, in favor of dating other spans that were poorly represented. Also, samples with tree-ring cutting dates were favored over those with noncutting dates or radiocarbon-dated samples.

Some large blocks of time were also poorly represented by the control group. Dates for proveniences falling in these voids had to be extrapolated from surrounding clusters. The lack of tree-ring dates for some periods of time might be related to sampling, although socioeconomic and environmental factors might also have been responsible. There are notable gaps in the late A.D. 900s and A.D. 1000s, with the last half of the 1000s particularly devoid of dates except from the canyon greathouses. Another gap occurs in the last half of the twelfth century (A.D. 1140-1200) when the exceptionally dry period that plagued the San Juan Basin suggests major depopulation of the area. No dates were obtained from sites occupied in the San Juan Basin in the A.D. 1200s, but this was not a major concern of the analysis.

Two of the plotted, dated assemblages reveal how accurate the KYST program is at temporally aligning the ceramics in their proper order (Figures 8.6-8.7). Groups formed by the seriation in Figure 8.6 again reveal the changing type composition (Table 8.19), but this time we have the satisfaction of placing absolute time to these assemblages. Compare these with those in Table 8.18 from the initial Pueblo Alto seriation. As discussed under the Bonito phase ceramic assemblages (above), the table reveals the shift in type composition through time, particularly for Red Mesa, Puerco, Gallup, and Chaco-McElmo Black-on-whites, and the redwares and other tradewares.

Alto Rooms and Kivas

Assemblages from room and kiva fill were seriated to provide another cross-check of the KYST program and to assess the period of occupation or abandonment for excavated rooms and kivas. Expectations for this group were that roof fall and kiva fill (trash) ceramics should comprise the latest samples at the site whereas subfloor deposits should be earlier. Absolute control was maintained by five dated samples from other sites combined with those assemblages at Alto that were associated with absolute dates. The former were selected on the basis of tree-ring cutting dates and their placement within the probable Alto occupation of between about A.D. 1000 and 1150. Thus, non-Alto dates were chosen to represent the approximate beginnings and termination of the span (1 each), whereas others were selected at about 50-year increments. Priority was given first to those dated, unmixed assemblages from local sites and, second, to those from the Prewitt area. The best runs exhibiting the tightest curve and lowest stress are illustrated (Figures 8.8-8.9).

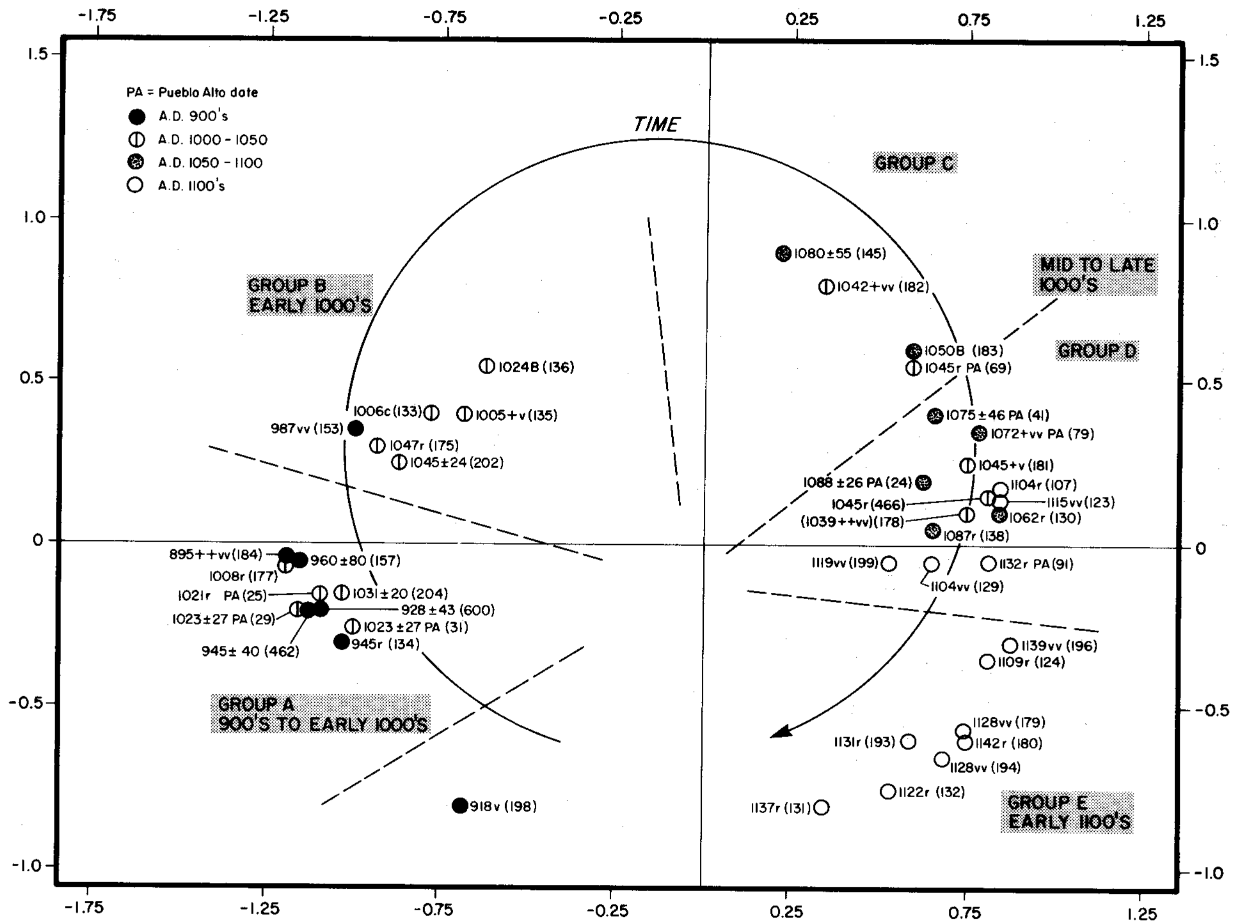


Figure 8.6. Multidimensional scaling plot showing the temporal ordering of ceramic assemblages (n = 42) from dated proveniences using the KYST-2A program in 5-dimensional space. Note the ability of the program to properly seriate the ceramics in the correct temporal sequence, particularly in the A.D. 1000s and the early A.D. 1100s. The 2 x 1 dimension is shown. The stress factor is .12. (Compare with a slightly different version shown in Figure 8.7.)

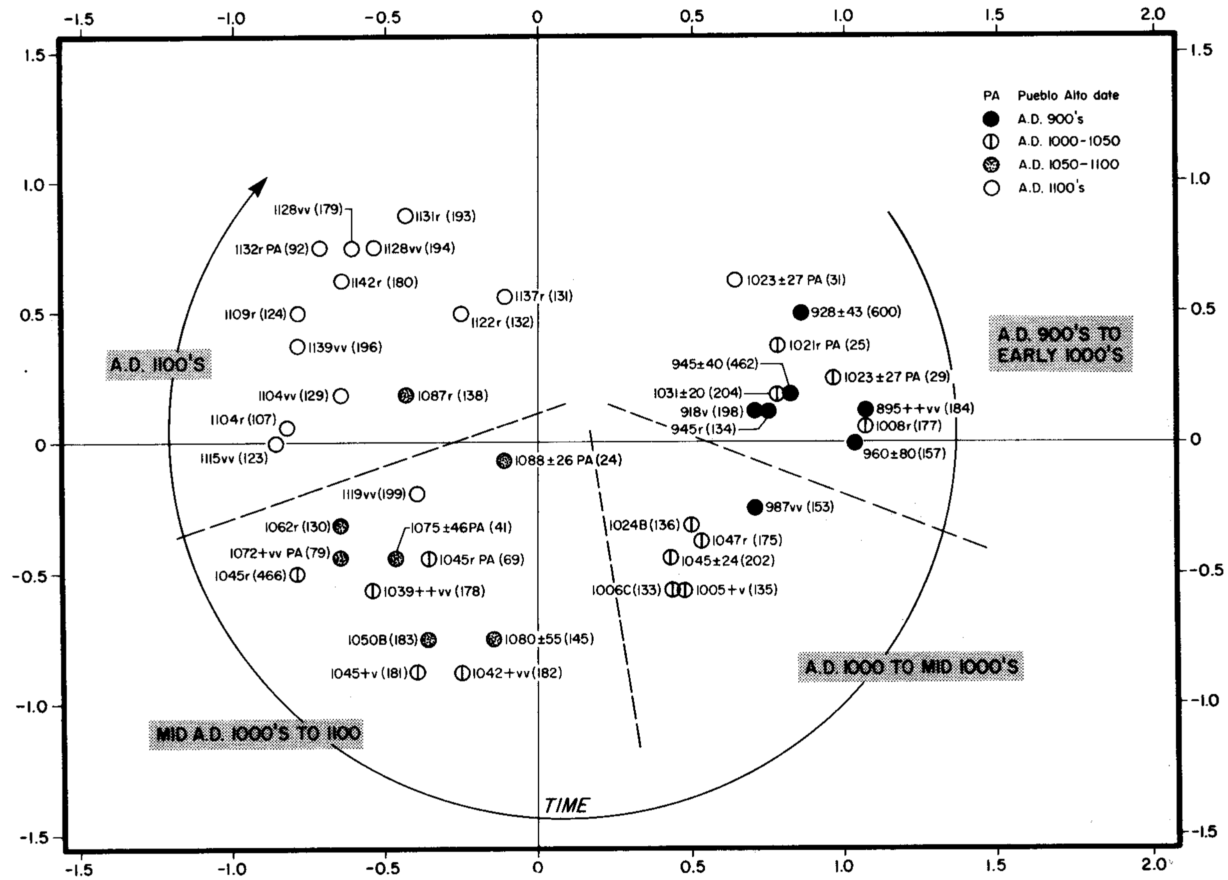


Figure 8.7. Multidimensional scaling plot showing the temporal ordering of ceramic assemblages (n = 42) from dated proveniences using the KYST-2A program in 5-dimensional space. Note the ability of the program to properly seriate the ceramics in the correct temporal sequence, particularly in the A.D. 1000s and the early A.D. 1100s. The 2 x 1 dimension is shown. The stress factor is .12. (Compare with a slightly different version shown in Figure 8.6.)

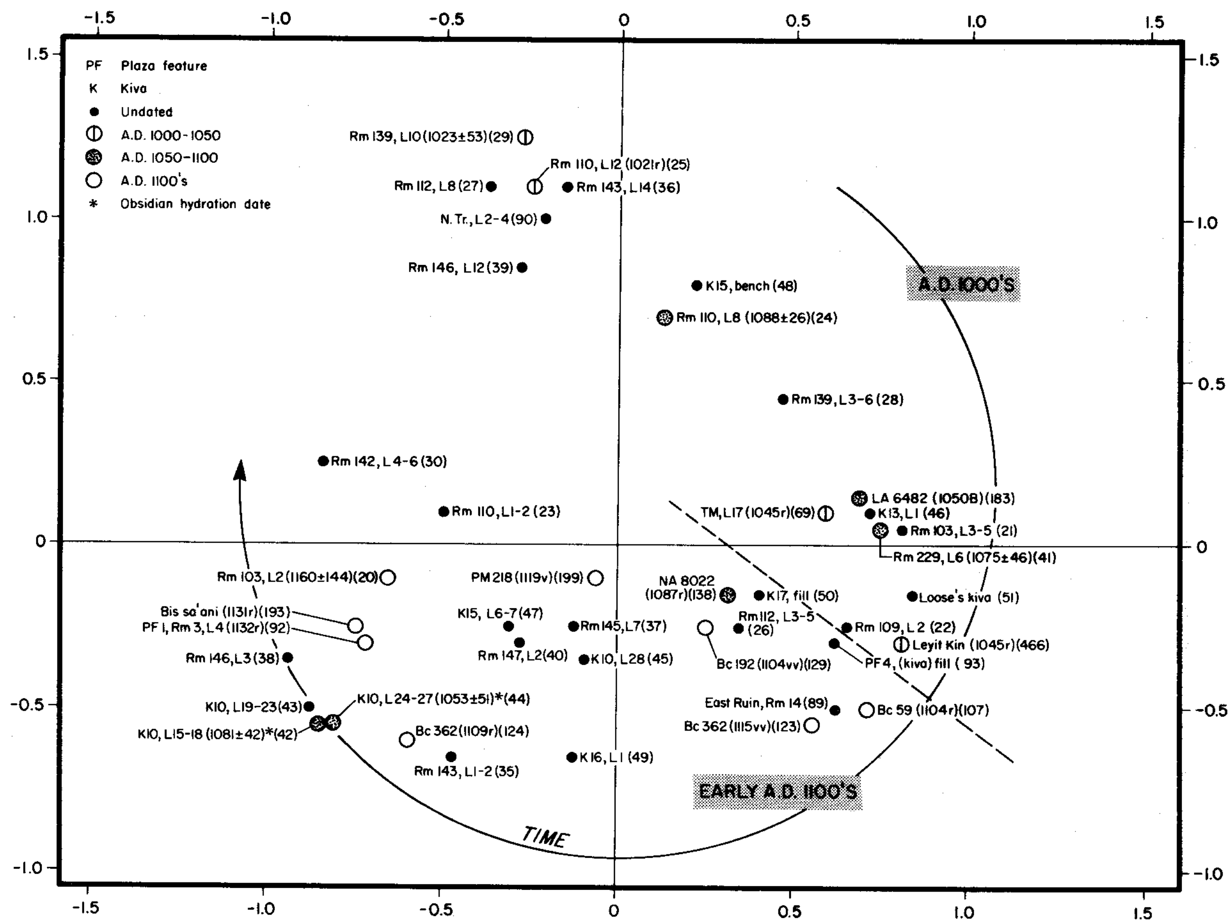


Figure 8.8. Multidimensional scaling plot showing the temporal ordering of ceramic assemblages (n = 42) from Pueblo Alto's excavated and tested rooms and kivas using the KYST-2A program in 5-dimensional space. Nine additional dated assemblages were added as temporal markers. The 2 x 1 dimension is shown. The stress factor is .13. (Compare with Figure 8.9 that employed a slightly different group of dated assemblages.)

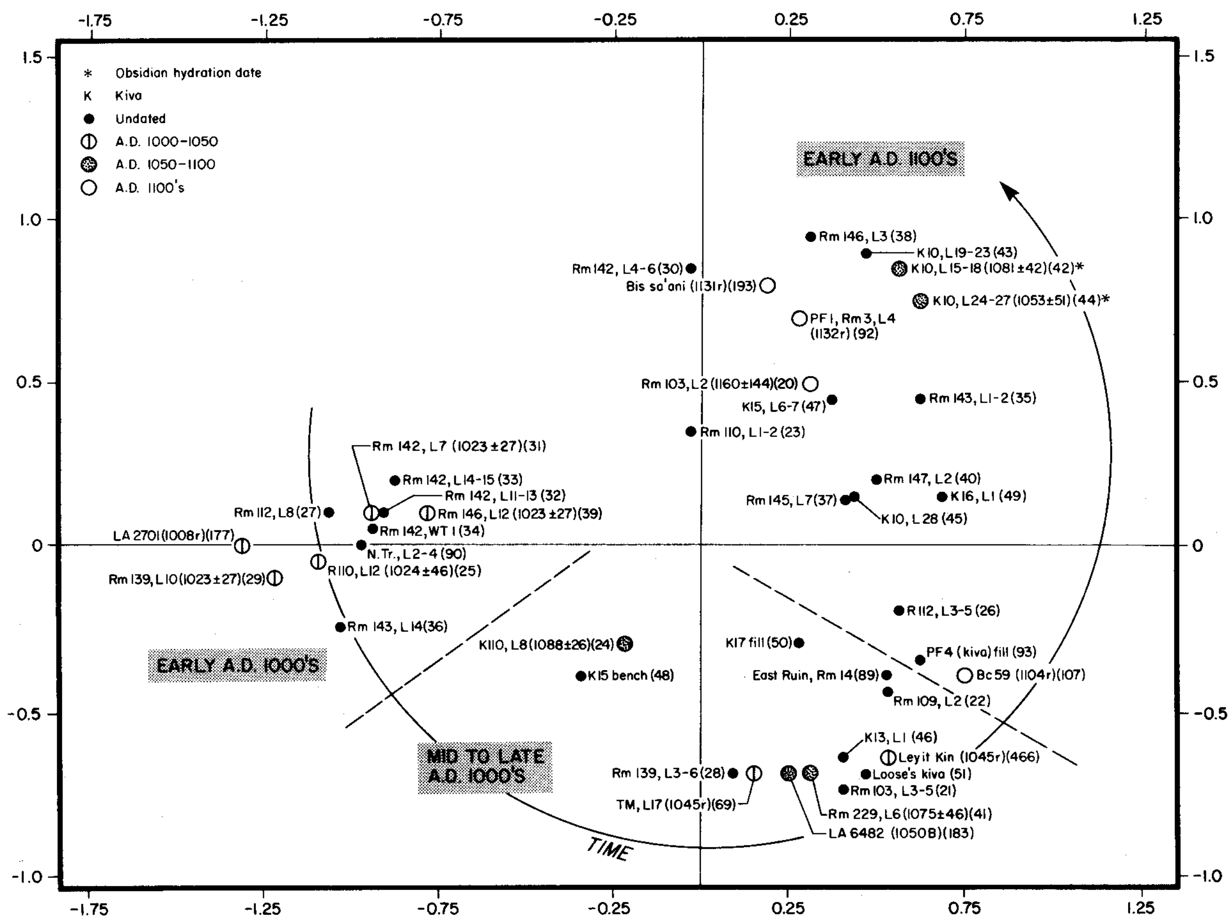


Figure 8.9. Multidimensional scaling plot showing the temporal ordering of ceramic assemblages (n = 42) from Pueblo Alto's excavated and tested rooms and kivas using the KYST-2A program in 5-dimensional space. Five additional dated assemblages then were used in Figure 8.8 added as temporal markers. The 2 x 1 dimension is shown. The stress factor is .12.

Table 8.19. Ceramic change in the San Juan Basin using chronometrically dated assemblages with the KYST-2A multidimensional scaling program (from Figure 8.6).[a]

Group and date	LaPlata B/w	Whitemound B/w	Red Mesa B/w	Escavada B/w and Puerco B/w	Gallup B/w	Chaco B/w	Chaco-McElmo B/w	Socorro B/w	Tularosa B/w	Newcomb B/w and Burnham B/w	Chuska B/w and Toadlena B/w	Nava B/w	unclass. Chuska carbon	Lino B/g	Kana'a B/w	Black Mesa B/w and Sosi B/w	unclass. Tusayan whiteware	Mancos B/w	McElmo B/w	Mesa Verde B/w	unclass. Mesa Verde whiteware (carbon)	Foresdate Smudged	San Juan redware	Tsegi orangeware	Tusayan Polychrome	St. Johns Polychrome	White Mountain redware	Sanostee B/r	unclass. redware	Total
Group A (n = 10) 918v-1031±20 BEST: 945-1024	3 T		1,109 89%	7 1%	13 1%					21 2%			13 1%		19 2%	2 T	1 T				1 T	35 3%	16 1%	1 T					2 T	1,243 100%
Group B (n = 6) 987vv-1047r BEST: 1006-1047		5 1%	317 49%	81 12%	190 29%										25 4%	12 2%						12 2%			1 T	3 T	2 T		1 T	649 99%
Group C (n = 4) 1042+vv-1080±55 BEST: 1045±	9 T	5 T	2,585 32%	1,918 24%	3,175 40%	56 1%	1 T		4 T	6 T	13 T	1 T	1 T			17 T	3 T	10 T				126 2%	24 T	41 1%			36 T	2 T		8,033 100%
Group D (n = 14) 1039++vv-1132r BEST: 1075-1115		10 T	290 11%	732 28%	977 38%	75 3%	43 2%		2 T	4 T	58 2%	4 T	28 1%	3 T	5 T	132 5%	8 T	15 1%	14 1%		25 1%	84 3%	11 T	24 1%			25 1%			2,569 98%
Group E (n = 8) 1109r-1142r BEST: 1120-1142		1 T	9 1%	87 10%	73 8%	5 1%	148 17%		26 3%	1 T	231 27%	7 1%	27 3%			39 5%	3 T	83 10%	24 3%	2 T	4 T	19 2%	2 T	22 3%	5 T		43 5%			861 100%
Total (n = 42)																														13,355
Ware	Cibola									Chuska				Tusayan				Mesa Verde				Smudged	San Juan	Tsegi		Wh.Mt.		unk and Chuska		

[a]T = trace (less than 0.5%).

Note that trash-filled kivas seriated late, as expected, with several appearing to date at or after A.D. 1100 (Kivas 10, 15-17, PF 4, and the East Ruin kiva), but Kiva 10 plotted the latest. Three, however, revealed construction (Kiva 15) or coeval abandonment (Kiva 13 and Loose's kiva) in the middle to late A.D. 1000s. Results for Kiva 15 warrant caution because it appears that the fill used in its bench construction came from earlier contexts (see Volume II, Kiva 15). The seriation matched the Kiva 15 bench-fill ceramics with the lower floor deposits of Room 110 underneath. Conversely, the uppermost deposits overlying Floor 1 in Room 110 (Layers 1-2), directly under Kiva 15, seriated temporally with early A.D. 1100 assemblages, including the postoccupational fill of Kiva 15.

Rooms with roof-fall ceramics also seriated late (after A.D. 1100), as surmised, but some also seriated earlier. Most of the latter were second- and third-tier rooms (112, 139, 229) whereas, generally, first-tier rooms (103, 142, 143, 146, 147) closest to the plaza exhibited the latest roof-fall ceramics. Because kivas around the interior periphery of Plaza 1 were filled with late trash, it may be reasonable to expect that the roof tops would also yield late trash closest to the interior plaza, perhaps from where the trash was thrown. The spatial distribution of the roof trash suggests that the back tiers of rooms were generally unused in the early A.D. 1100s for rooftop activities or as trash receptacles.

The deepest deposits under the room occupations are all satisfyingly grouped temporally earlier. Absolute dates place these ceramics in the early A.D. 1000s. Note that the program correctly placed the deep units in Room 142 in their proper stratigraphic position (earliest to latest) in Figure 8.8, despite the great similarity of the assemblages involved.

Because temporal control was not sharply defined for the decade around A.D. 1100, the second plot (Figure 8.9) utilized additional dated assemblages at the sacrifice of the five earliest samples (Room 142 and site LA 2701). The results were not wholly satisfactory because of the forced use of Arizonan and mixed local samples that skewed results. Nevertheless, the overall ordering differed little from the earlier plot.

The Central Roomblock and Associated Outdoor Areas

All the ceramic assemblages from the Central Roomblock were seriated along with 19 dated assemblages not from the roomblock. The resultant plot yielded the lowest stress for any of the Pueblo Alto seriations because the samples clustered into two arcuate groups (Figure 8.10). Stratigraphically, the earliest samples clustered with assemblages dated in the early A.D. 1000s, whereas all others in the roomblock fell along an arc of time dating between about A.D. 1045 and 1140. The latest assemblage, from the roof fall in Room 142, plotted identically with a sample dating at A.D. 1131. The roof fall included pieces from a restorable Nava/Crumbled House Black-on-white olla (Volume II, Plate 2.43B) that was unique at the site and probably accounted for the late positioning of the assemblage. Ceramics from Plaza 1, Grid 8 (Layer 15), and the Wall Trench in Room 142 seriated the earliest. A remarkably large gap separating the

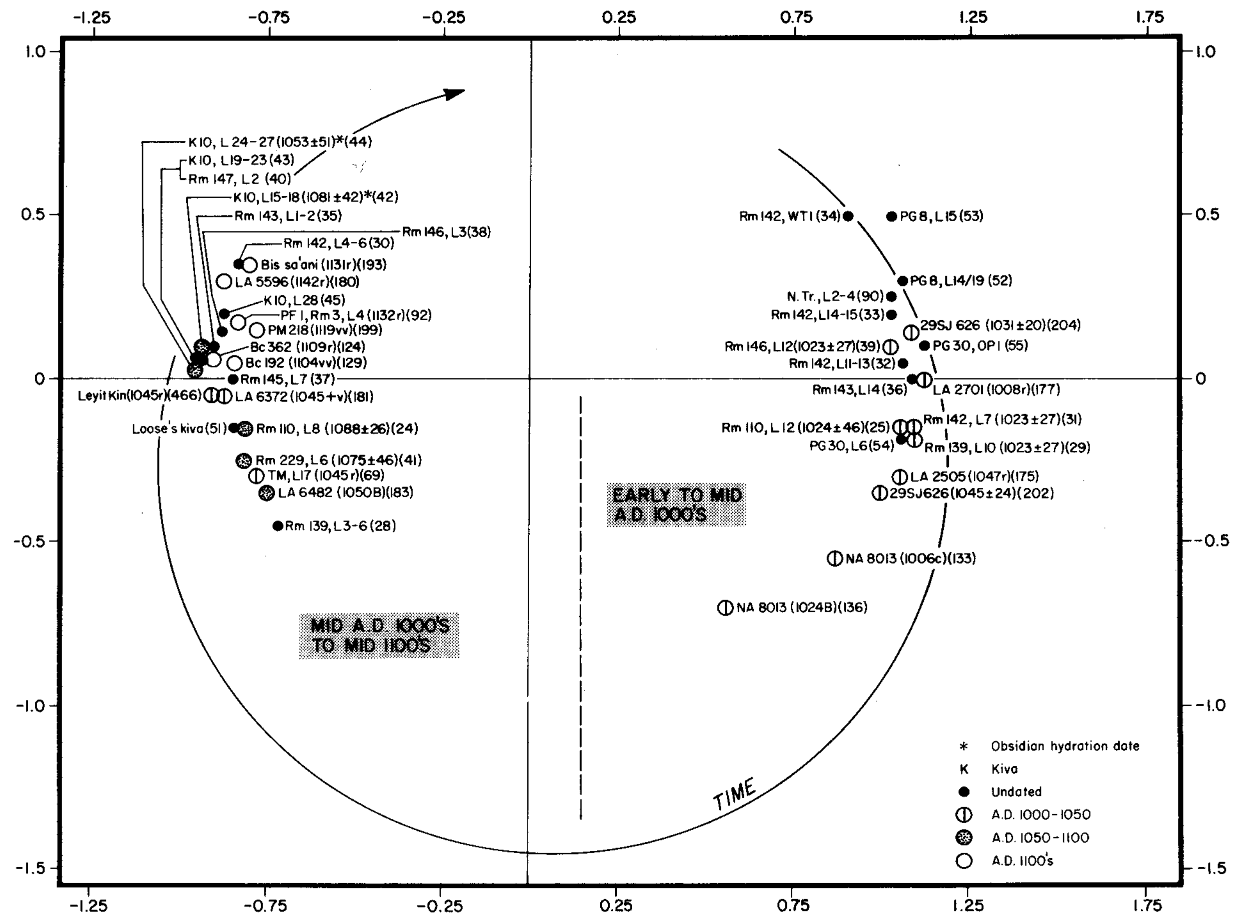


Figure 8.10. Multidimensional scaling plot showing the temporal ordering of selected ceramic assemblages (n = 23) from the Central Roomblock and the associated plaza area, and from Plaza 2 using the KYST-2A program in 5-dimensional space. Nineteen dated assemblages were added as temporal markers. The 2 x 1 dimension is shown. The stress factor is .08.

two clusters marks the break in ceramic continuity noted above. The gap would be even greater if the non-Alto samples were discarded from the plot. The size of the gap can be attributed in part to the near absence of Gallup Black-on-white dominated assemblages from the roomblock.

The West Wing and Associated Outdoor Areas, and Plaza 2

The West Wing follows the pattern revealed for the Central Roomblock, except for a lesser hiatus between the earliest and latest groupings (Figure 8.11). Seventeen dated assemblages were added to induce temporal control and many of these filled the gap between the early and late West Wing assemblages. Note that, again, the deepest deposits in the wing and the adjoining plaza cluster in the early A.D. 1000s, whereas the roof-fall deposits and uppermost plaza assemblages date to the early A.D. 1100s. As discussed above, the postoccupational fill in the back rooms (Rooms 112 and 229), along with the debris in living Room 103 (Layers 3-5), associated with the period of the middle to late A.D. 1000s.

The other living room (110) presents somewhat of an anomaly. Its deepest deposits (Layer 12) seriated early, as expected, but the occupational deposits were aberrant because of unusually high numbers of smudged sherds in Layer 8 and high loadings of Chuskan carbons, San Juan Redwares, and Tsegi Orangewares in Layers 1 and 2, which made the samples temporally later than they should have been. Stratigraphically, the later layers must predate Kiva 15, which seriated anomalously earlier than Room 110. Aside from the Room 110 problem, the remaining sample plots did not deviate from their general stratigraphic position at the site and could be dated with confidence to within a few decades of the associated, dated samples.

There was little change when ceramic lots from Plaza 2, Grids 181/201, and OS 5 were added (Figure 8.12). The program plotted these additions in their proper stratigraphic position, with the latest lot from OS 5 and Plaza 2 (fill above Surface 1) seriating in the early A.D. 1100s, and the deeper deposits (above Surfaces 3 and 6) plotting respectively earlier (in the late A.D. 1000s).

Summary

Despite a number of induced variations to the KYST seriation plots (above), the overall pattern for the Pueblo Alto samples is consistent and clear. The earliest assemblages at Alto cluster together and associate with dated samples from the early A.D. 1000s. These include the assemblages associated with the Alto construction debris, the refuse under the greathouse rooms, and the deepest plaza deposits. We know that the program fails to distinguish early A.D. 1000s material from that associated with the A.D. 900s. Nevertheless, enough chronometric dates have been derived from Alto to suggest that the early A.D. 1000s is the correct era for the majority of the early deposits at Alto.

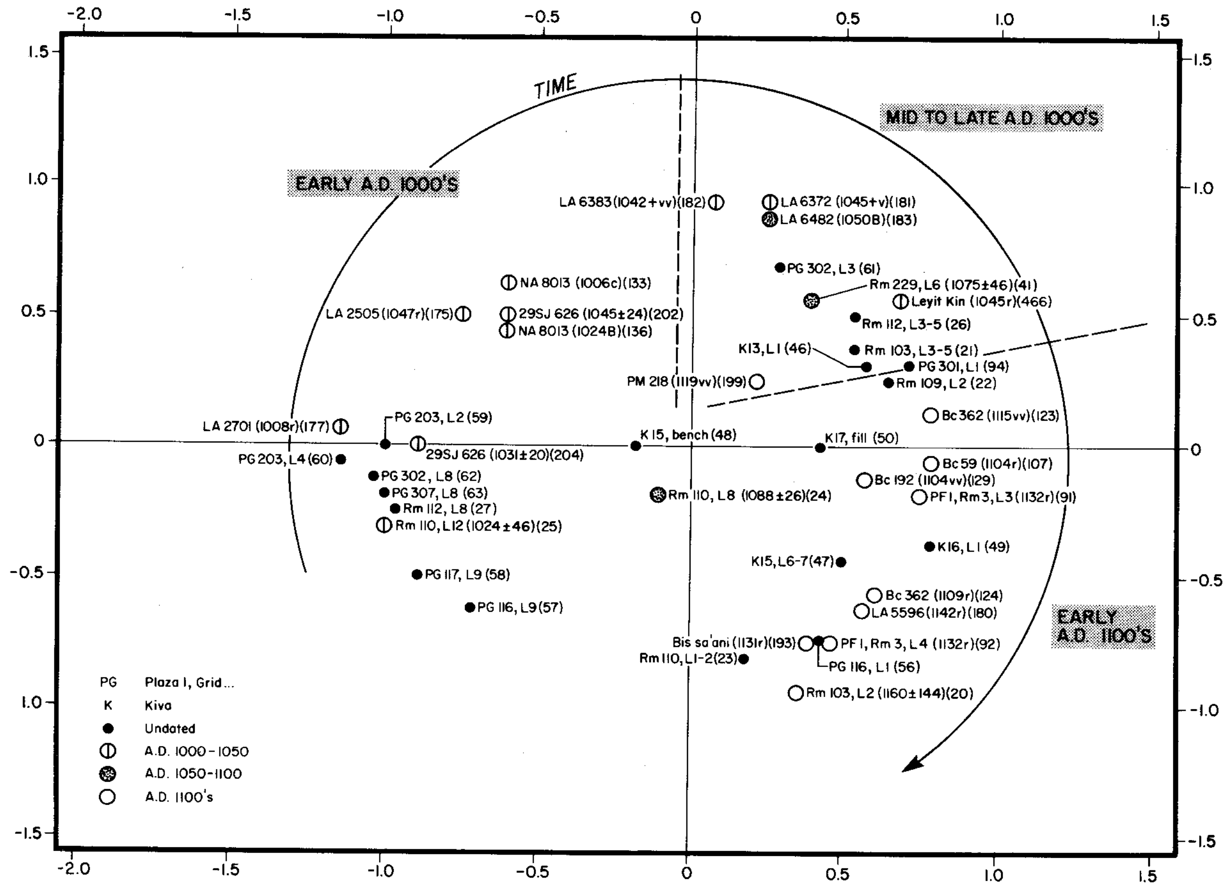


Figure 8.11. Multidimensional scaling plot showing the temporal ordering of selected ceramic assemblages from the West Wing and the associated plaza area of Pueblo Alto (n = 25) using the the KYST-2A program in 5-dimensional space. Seventeen dated assemblages were added as temporal markers. The 2 x 1 dimension is shown. The stress factor is .12.

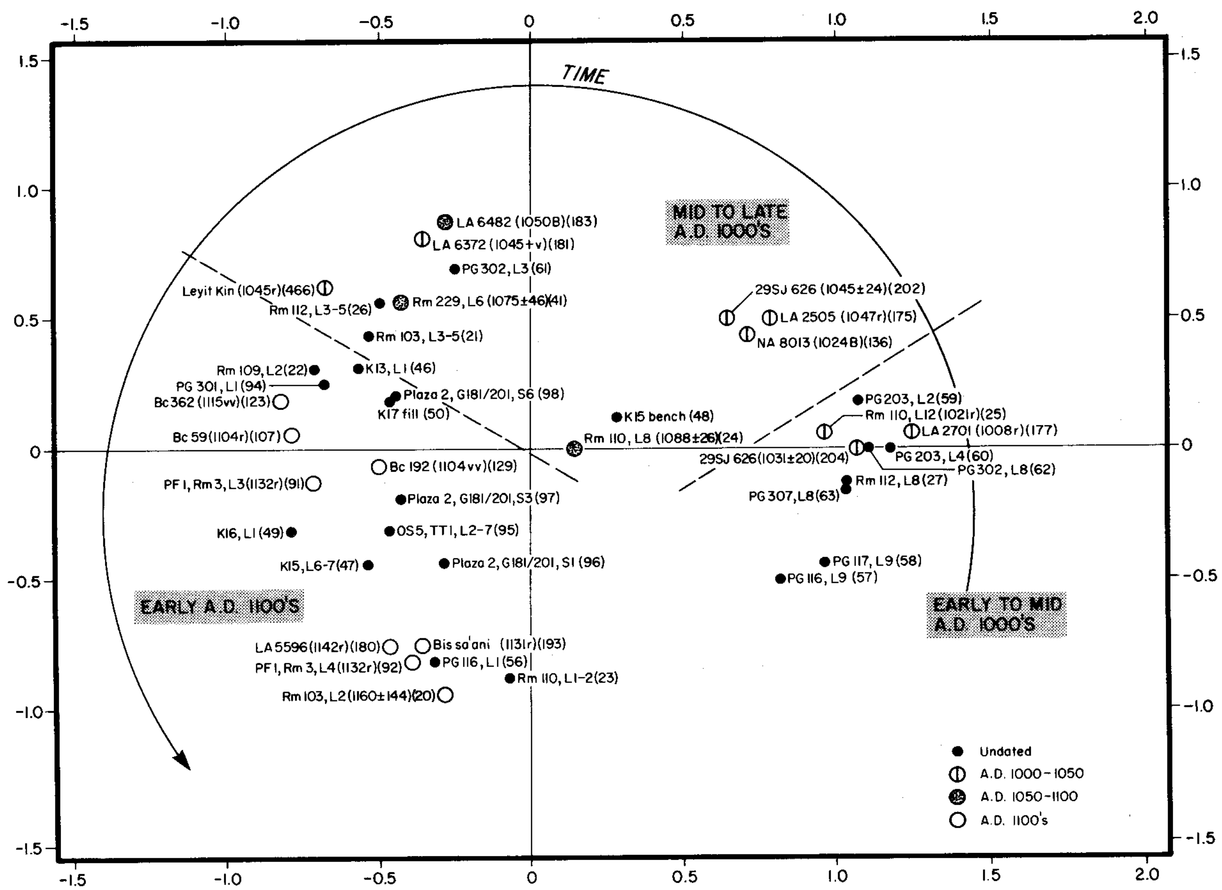


Figure 8.12. Multidimensional scaling plot showing the temporal ordering of selected ceramic assemblages from the West Wing and the associated plaza area, and Plaza 2 of Pueblo Alto (n = 29) using the KYST-2A program in 5-dimensional space. Thirteen dated assemblages were added as temporal markers. The 2 x 1 dimension is shown. The stress factor is .12.

At the opposite side of the temporal scale, assemblages matching the early A.D. 1100s are well represented and occur, naturally enough, in more recent stratigraphic contexts: the roof fall, upper plaza deposits, and in trash-filled court kivas. A myriad of dates from Alto and non-Alto contexts pinpoint the latest occupation at the site between A.D. 1100 and about A.D. 1140. Aside from the Trash Mound, assemblages dating in the last half of the A.D. 1000s, the period for which the Classic Bonito phase is known, were poorly represented. In part, this may simply reflect the selection of the sample or the pertinacity of the inhabitants in keeping occupational surfaces clean, although it would be difficult to claim the latter for the West Wing occupation. The period in question is barely represented by ceramics in the plaza and Central Roomblock. Again, a fastidious cleaning behavior may be responsible, or perhaps the lack can be attributed to activities that generated little refuse or to limited use of those areas.

Summary and Conclusions

Understanding the chronology of a long-occupied site is a difficult task even with numerous chronometric dates. In these circumstances, a single dating method can seldom mark all major cultural episodes at a site. Thus, it is necessary to rely on as many chronometric methods as possible to refine and cross-check the timing of cultural events. Many dating methods fail to provide adequate temporal control because they inherently are imprecise for fine resolution. Nevertheless, when large numbers of dates from these methods (e.g., carbon-14, TL, and obsidian hydration) can be obtained from the same proveniences and checked for contemporaneity, averaged results can yield confident, useful, short periods of time to buttress and expand on inferences made from tree-ring dates, if the latter are present. Statistical confidence can only be achieved from the given temporal span for some dating method results, although, interestingly, there was high agreement among the date midpoints of these results and tree-ring dates at Pueblo Alto that is difficult to accept as entirely fortuitous.

Considerable effort was expended in trying to delineate and refine the temporal ordering at Pueblo Alto. Altogether, 720 samples were submitted for dating by 5 chronometric methods, yielding 273 dates. The high number of dates is considerably reduced after elimination of the many non-cutting tree-ring dates and the numerous aberrant ones generated by other techniques. The end result was one of disappointingly few, absolute dates. Archeomagnetic results were particularly bothersome in that they have the potential for dating almost every excavated room floor at the site but lack accuracy. The efforts were not fruitless, however, and a reliable chronological interpretation can be made for the site but not at the decennial levels for which we had hoped. Seriation and cross-dated ceramic assemblages permitted an overall temporal framework to be applied to the site with some checks provided by chronometric results. The results of the seriation verified the temporal framework derived from the absolute dates and helped decipher some of the internal complexity of the site occupation.

Pueblo Alto was built between A.D. 1021 and A.D. 1045, although some occupation may have preceded A.D. 1021. Completion of the initial house probably did not extend beyond A.D. 1060. Major occupation and use of the site during the Classic Bonito phase falls between A.D. 1050 and A.D. 1100, although we cannot be sure of the intensity and duration of the occupation throughout the entire period (Chapter 11). There is a suspicion, primarily from nonchronometric data, that a major disruption of family habitation and alternation of the primary room suites took place before the end of the century, perhaps as early as about A.D. 1080. Another change is evident by A.D. 1100, when a number of changes took place throughout the canyon that suggest major social reorganization. The early A.D. 1100s occupation at Alto was evident from a number of absolute dates and from the results of the ceramic seriation. After about A.D. 1140, Alto was abandoned with only sporadic use made of the site afterwards, despite an influx of people into Chaco Canyon from the north in the A.D. 1200s (see Chapter 11).

Probably the most important lesson learned from the dating analyses is that reliable, averaged, absolute dates can be obtained if heavy emphasis is placed on cluster dating of architectural and ceramically cohesive units instead of the oft-favored approach of obtaining single, scattered dates for a site. Single dates (e.g., radiocarbon, archeomagnetic, obsidian hydration, and thermoluminescent) cannot be statistically verified without companion results. In the Chacoan context, at least, the KYST seriation demonstrates that, based on the traditional typology, ceramics can provide reliable, short-period, temporal control for much of the Bonito phase when mixed assemblages can be recognized and avoided.

Chapter Nine

Form, Distribution, and Function of Features

Introduction

The recording of features is dealt with in many ways by archeologists. Previous work in Chaco Canyon (i.e., before 1970) generally ignored floor features unless they revealed substantial construction of mortar and stone (i.e., firepits, mealing bins, some postholes, etc.). Unlined or poorly-lined pits have received little attention in Chacoan archeology, so we can have little confidence in reporting of features at other sites, particularly for greathouses (Table 9.1). For instance, there were more floor features (i.e., pits) recorded in each of two living rooms at Pueblo Alto than in all of Pueblo Bonito's approximately 340 ground-floor rooms excavated by Pepper (1920) and Judd (1964), the 110 or so ground-story rooms Hewett cleared at Chetro Ketl (Lekson 1984), or in the 44 ground-floor rooms cleaned out by Judd (1959) in Pueblo del Arroyo, the 47 ground-floor rooms cleared at Kin Kletso by Vivian and Mathews (1965), and the 15 rooms excavated by Gordon Vivian at Una Vida in 1960.

This may cause some readers to feel that a pertinacious staff bent on finding pits, including many that did not exist, explains the wide discrepancy in figures. Yet, there is no question as to the reality of the Alto pits, and the reader need only examine the frequencies of materials found in the pits, their type of construction, and the frequency of burning to dispel lingering doubt. In Una Vida, at least, partial re-excavation the rooms revealed a disparity in record-taking and excavation methods rather than in differences resulting from prehistoric behavior or from the nuances of multistory occupation. The same problem seems also to apply to early small site excavations in Chaco.

Although behavioral patterning derived from the material culture in the archeological record has been emphasized (e.g., Carr 1984; Stevenson 1985), the floor and wall cavities in Chacoan sites have proven the most reliable indicators for interpreting cultural use of space. Primary, in situ, cultural material on floors and surfaces was rare in sites excavated by this project; generally floors were clear of artifacts or were littered with postoccupational trash. Whole artifacts, particularly intact ceramic

Table 9.1. Floor features and wall niches recorded for greathouse rooms in Chaco Canyon.[a]

Site	Excavation period	No. of rooms excavated	FLOOR FEATURES: Fire-pits	Heating pits	Floor burns	Deflec-tors	Floor vents	Other pits	Post-holes	Storage bins	Mealing bins	Wall niches	FLOOR TOTAL	FLOOR FEATURES PER ROOM
FIRST STORY FLOORS:														
Pueblo Alto	1970s	15	7	126	55	0	0	195	141	2	12	60	483	32.20
Pueblo Bonito	1890s/1920s	294	52	25	+	3	13	41	81	22	24	43	261	0.89
Pueblo del Arroyo	1920s	63	11	7	+	1	2	4	9	1	5	7	40	0.63
Chetro Ketl	1920s/1930s	101	21	2	+	1	1	0	13	5	4	±61[b]	47	0.47
Una Vida	1960	20	1	1	0	1	0	1	5	2	0	4	11	0.55
Una Vida[c]	1970s	8	6	11	23	1	9	17	21	3	0	9	91	11.38
Kin Kletso	1934/1950s	55	5	0	5	0	1?	1	2	0	0	0	14	0.25
ALL STORIES:														
Pueblo Alto	1970s	15	7	126	55	0	0	195	141	2	12	60	483	32.20
Pueblo Bonito	1890s/1920s	303	52	29	+	3	16	41	82	22	24	54	269	0.89
Pueblo del Arroyo	1920s	65	12	11	+	1	2	7	10	2	5	8	50	0.77
Chetro Ketl	1920s/1930s	101	21	2	+	1	1	0	13	5	4	±61[b]	47	0.47
Una Vida	1960	20	1	1	0	1	0	1	5	2	0	4	11	0.55
Una Vida[c]	1970s	8	6	11	23	1	9	17	21	3	0	9	91	11.38
Kin Kletso	1934/1950s	55	5	0	5+	0	1?	1	2	0	0	0[d]	14	0.25

[a]May include some features associated with plaza surfaces under rooms.
[b]Rooms recleared by the Chaco Center in 1978-1979. Frequencies include those recorded in 1960 that were not destroyed by weathering.
[c]Walls mapped by the Chaco Center in 1979. Frequency uncertain because many may be blocked wall ventilators.
[d]At least two, however, were noted in stabilization photos.

vessels and metates, were even rarer. Floor features, on the other hand, were nonportable and, thus, avoided the problems of displacement or being dismantled without a trace. Literally, they are the "site furniture" (Binford 1977).

Upper-story, roof and wall features, of course, face different hazards and may disappear from the archeological record, although substantial features can often partially survive architectural collapse (e.g., Ciolek-Torrello 1978:155). There must have been a clear dichotomy of feature types between bottom and upper-story rooms because deep features (i.e., firepits, postholes, storage pits, etc.) were impractical in upper-story floors. Upper-story thermal features, in particular, increased the danger of igniting the roof below. Nevertheless, a few firepits have been noted in upper stories (i.e., Judd 1964), and other functions (i.e., storage) may have been shifted from floor pits to wall cavities.

Feature Recording

The archeologists excavated floor features after the entire floor or excavation surface was cleared, collecting the appropriate samples (pollen and flotation), and mapping and bagging the floor artifacts. Policy dictated that pre-excavation photos be taken of every feature, and this was only ignored near the end of the project when time was at a premium. This policy forced the excavator to identify the feature before its excavation, sometimes incorrectly. Standard procedure for feature excavation was to remove half the fill, profile it, determine the stratigraphy, and then collect pollen and flotation samples from the remaining natural units of fill. The feature fill was removed by natural units when possible. Small or very deep, narrow features could not be handled in this fashion, and the excavator was forced to record natural units and collect samples as fill was being removed. Only a "conservation" sample of fill (from which pollen and flotation could later be pulled) was collected from small-volume features. Several plaza features (i.e., firepits, roasting pits, other pits, and ventilators), mostly along the eastern side of Plaza 1, were outlined but not excavated. Some of these probably were rodent holes.

Approximately 750 features were recorded at Pueblo Alto. Plan views and profiles of each were drawn to scale (Appendix MF-0) and a field form completed. As a rule, at least two profiles perpendicular to one another were drawn for each pit. All features were photographed. Volumes were computed by measuring the plan view and profile areas with a digital planimeter and then computing a mean depth. Mathematically, V (volume) = A_1 (area of plan view) times D (mean depth). D is calculated by dividing the profile area (A_2) by the mouth width (W), or $D = A_2/W$. The mean depth was calculated for each profile and then averaged. This assumes, of course, that features are symmetrical and that the profiles are representative of that symmetry. For the most part that assumption was true, and the calculated volumes should be reliable. After the Alto Project, we discovered it was easier and more accurate to measure feature volumes in the field with the use of graduated cylinders to calculate the fill volume.

Abbreviations and Definitions

The definitions for the features and use surfaces recorded at Pueblo Alto are listed in Table 9.2. Some "features" listed were designated solely for coding purposes and were not analyzed as features because of low frequency or because they were natural (i.e., rodent holes). Others were simply unsuitable for detailed description and analyses (e.g., floors, surfaces, test pits, wall clearing trenches, etc.).

Goals

Analysis of features can, like artifacts, lead to innumerable avenues of investigation and statistical manipulation, often with no end in sight. Thus, the feature analysis was restricted to a few basic goals to reduce costly overruns in time and logistics. Both metric and categorical data were recorded for each feature, which permitted application of discriminant analyses and similarity coefficients to meet some of the goals for the feature analyses. These goals were:

(1) to provide basic metric data and descriptions for each feature and each feature class;

(2) to verify the field classifications of the feature categories;

(3) to discover subclasses of features obscured by the field classifications in order to further refine interpretation of feature function; and

(4) to examine the use of features and feature classes through time and space.

Attributes of Pueblo Alto features

If we extrapolate the approximately 750 floor and wall features recorded for the approximately 10 percent of the site that was excavated, then we can assume that about 7,500 features exist at Pueblo Alto. Over half the features recorded, however, came from just three rooms: Room 103 (140 features, 18 percent of the total), Room 110 (209 features, 26 percent of the total), and Room 142 (74 features, 9 percent of the total). The information for each feature and its contents is listed under Appendix MF-P. The basic data categorizing the various types of features are summarized in Table 9.3. This information characterizes the features primarily as they were identified in the field. It only partly rectifies the small number that may have been misclassified in the field. A discussion of the field verification of various features follows later.

Table 9.2. Definitions for features and use surfaces at Pueblo Alto.[a]

Feature Abbrev.	Feature Category	Definition
--	Bench*	A low flat surface lined with masonry, about 70 cm high, that encircles or partly encircles a round room.
B =	Burn	An oxidation spot on the floor or wall. This was caused by an intentional localized fire probably at or after abandonment. None were caused by architectural (i.e., roof) fires. These have no fill contents, and the materials causing the burn were often dispersed nearby.
--	Ditch*	A clay- and slab-lined trench just above sterile deposits on the west side of Plaza 1. Function unknown. Possibly a wall foundation.
D =	Door*	A large rectangular opening through a wall allowing access and egress. Often blocked with masonry.
--	Door Ramp Step*	Short posts, masonry steps, toeholds in the wall or directly below the door sill, or mortar and stone rises adjacent to door openings, which assisted in ingress and egress to a room.
Fl =	Floor*	A prepared surface of adobe or plaster. This definition was not rigidly adhered to and generally applied to prepared and unprepared surfaces within architectural enclosures (i.e., rooms and kivas). In contrast, such areas were designated as Surfaces when found in a plaza or in unbounded spaces. Numbered from the uppermost surface down.
--	Floating Floor*	A fragment of a compacted use surface that is unconnected with surrounding architecture. Usually found in the postoccupational fill above Floor 1. May be numbered in sequence with the floor/surface series.
FP =	Firepit	A prepared pit that exhibits construction of stone and mortar. Volumes usually exceed 15-20 liters. Typically exhibit extensive oxidation and a fill of ash and charcoal. These often act as trash traps or as pits for floor sweepings.

[a]Those with an asterisk were not analyzed.

Table 9.2 (continued)[a]

Feature Abbrev.	Feature Category	Definition
G/Gr	Grid*	When coded as a feature, this designation refers to a control square for recording the location of floor arti- facts and floor fill, particularly for collecting flotation and pollen samples.
H =	Hearth	A heating pit encircled with an adobe collar. Technically it is closer to a firepit by definition, although it was shallow and only partly lined, without stone construction. Only one was recorded (Room 103).
HP =	Heating Pit	Sometimes labeled a "baking pit." Defined as an oxidized, bowl-shaped, floor feature with little or no preparation other than as a scooped-out pit. The mouth diameter is greater than its depth. Normally, they were unlined and filled with sand and carbonized brush or, rarely, ash. Most appear to have been used for a very short period, perhaps just once. Most have small volumes (<10 liters) and were incapable of producing long-term heat or light.
--	Hematite Stain*	Powdery red material (hematite) spread over a floor. Found only in Room 142 and 146 (two cases).
--	Interstitial Space*	Architectural void left in a room corner after construction of a round kiva within the room.
MB =	Mealing Bin	Slab- and adobe-lined rectangular boxes to enclose the metates and receptacles for catching ground material.
OP =	Other Pit	An ubiquitous floor feature not assignable to another category. May vary greatly in size, shape, and location. Many may have been postholes and storage pits.
P =	Peghole*	A small pencil-shaped and pencil-sized cavity that probably once held a short protruding wooden peg. Present only in Room 110.
PH =	Posthole	A cylindrical floor pit with a depth greater than the mouth diameter. Bits of decayed wood in the fill might be post remains. Larger postholes were commonly lined with adobe and rock, with inset stone shims and a basal stone. Crushed lignite often partially filled the largest pits at Pueblo Alto. Almost all postholes in excavated canyon-bottom sites contained lignite.

[a]Those with an asterisk were not analyzed.

Table 9.2 (continued)[a]

Feature Abbrev.	Feature Category	Definition
PR =	Pot Rest	A slightly raised adobe ring, concave in the center. Added onto an adobe floor or bench surface. Sometimes feature may be a shallow dish-shaped depression in the floor. The form suggests suitability for resting round-bottomed pots. Found in Room 110 and Kiva 15.
RP =	Roasting Pit	A slab- and block-lined firepit of large volume used outdoors. Stone lining was irregular and not mortared and not vertical. Typically postoccupational.
rh =	Rodent Hole*	Tunnels and irregularly shaped pits resulting from rodent activity. Often contrasted with surrounding fill because of infilling with material different from surrounding matrix.
--	Storage Cist or Bin	An unburned rectangular box lined with thin vertical slabs. Not a mealing bin. Found only in Rooms 103 and 110. The slab impressions for one were found in Room 143.
--	Storage Pit	Deep pit, often bell-shaped, with a narrow mouth and a large volume.
S =	Surface*	(a) Generally an unprepared utilized surface, exterior to areas bounded by masonry. In reality, the term was used for both unprepared and prepared surfaces, primarily in the plazas. Many in the plazas are undoubtedly natural. Numbered from the uppermost surface down. (b) A partial replastering of a floor. Sometimes the replastered surface covered the original floor area. (c) The present top of the ground. In the latter case, the word is only spelled out in lower case (i.e., on figures). See also Floor (above).
TP =	Test Pit*	A small trench, usually rectangular, to examine a horizontal area of fill or architecture. Sometimes the term is used interchangeably with Test Trench.
TT =	Test Trench*	A longitudinal trench to examine the fill or architecture. Also used to designate arbitrary subdivisions of deep fill above Floor 1 during the initial excavations of the rooms. Sometimes the term is used interchangeably with Test Pit.
--	Trash Deposit*	A trash concentration of several liters found on a floor or surface or between floors. Limited in extent. May include isolated dumps from cleaning of thermal features.

[a]Those with an asterisk were not analyzed.

Table 9.2 (concluded)[a]

Feat. Abbrev.		Feature Category	Definition
V	=	Ventilator*	(a) A rectangular horizontal opening that goes through the wall. Normally these were found near the ceiling and built during initial wall construction. Many are blocked with masonry (not so indicated on plan views or elevations). Their position and small size indicate that they served for room air circulation. Commonly found in greathouses. (b) An opening that allows air to be drawn by the draft of a fire into an enclosed structure near the floor. This feature is usually comprised of two parts: a horizontal tunnel extending through the wall and connected to a vertical shaft that reached to the surface. At Pueblo Alto, these were all associated with kivas.
VH	=	Viga Hole	A hole high in the wall for supporting roof beams. The only ones listed at Pueblo Alto were holes for in-room shelf poles in Room 142.
WF	=	Wall Foundation	A mass of adobe or clay interspersed with unshaped stones that serves as the footing for masonry walls. Sometimes only the foundation without the overlying walls was evident because the masonry had been dismantled or a wall was never added to the foundation.
N	=	Wall Niche	A wall cavity that might have served as a repository. Few appear to have been built during the initial wall construction. Often they are irregular pockets formed by the removal of wall stones, however, only one or two deliberately penetrate the entire wall (in Rooms 110/112 and 103). Only a few, if any, probably served as beam or pole supports (see Rooms 110, 142, and 143).
WT	=	Wall Trench	(a) A long, narrow trench that appeared to be constructed for a wall foundation, but was never filled. (b) A narrow, often shallow trench bordering the masonry walls or the wall foundations that was filled with construction debris (spalls, clay, and mason's tools). (c) An archeologist's test to delineate wall outlines. Also called wall clearing. Wall tests are not abbreviated on the Pueblo Alto maps and never numbered.
--		Wolky Feature	A triangular wedge of mortar and rocks found under the floor plaster in some corners of North Roomblock rooms. Named after Henry Wolcott Toll, III, the first person to exacavate one at Pueblo Alto.

[a]Those with an asterisk were not analyzed.

Table 9.3. General statistics for Pueblo Alto features.

Feature type	Number	Mean	sd	C.V.	Range
Firepits:					
length	30	103.3 cm	58.2	56.4	35-298
width	30	79.8 cm	41.5	52.0	20-206
mouth	30	7,493.7 cm^2	7,525.0	100.4	850-30,330
depth	20	41.3 cm	33.2	80.4	5-125
volume	20	2,108.2 dl	2,704.6	128.3	18-8,310
burned bone	18	0.3 %	0.3	110.1	0-1
all bone	18	23.2	35.7	154.1	0-128
chipped stone	18	2.6	3.7	142.8	0-13
sherds	18	45.4	105.8	232.9	0-434
Heating Pits:					
length	136	34.2 cm	15.8	46.2	8-88
width	136	29.0 cm	12.7	43.8	6-72
mouth	135	918.1 cm^2	891.1	97.1	40-5,530
depth	135	7.9 cm	4.8	60.7	2-27
volume	135	70.3 dl	117.0	166.4	1-624
burned bone	133	0.1 %	0.2	336.9	0-1
all bone	135	2.0	9.9	508.2	0-110
chipped stone	136	0.4	1.0	263.1	0-6
sherds	136	1.5	5.0	331.7	0-50
Floor Burns:					
length	56	36.6 cm	26.8	73.2	6-180
width	56	27.8 cm	17.9	64.4	10-99
burn area	56	1,093.1 cm^2	1583.0	144.8	80-
Other Pits:					
length	242	31.4 cm	20.7	66.2	7-125
width	241	25.1 cm	16.0	63.5	5-114
depth	241	16.8 cm	14.5	86.0	1-112
volume	240	178.7 dl	597.8	334.4	12-8,727
burned bone	238	0.0 %	0.1	654.8	0-1
all bone	240	8.9	61.2	688.4	0-883
chipped stone	241	1.4	6.5	452.8	0-77
sherds	241	9.3	51.0	550.4	0-707

Table 9.3 (continued)

Feature Type	Number	Mean	sd	C.V.	Range
Postholes:					
length	165	18.3 cm	12.6	68.7	5-94
width	165	15.6 cm	9.5	60.7	5-52
depth	163	24.3 cm	15.9	65.4	5-76
volume	163	87.5 dl	183.9	210.3	1-1,302
burned bone	161	0.0 %	0.0	1,268.9	0-1
all bone	163	1.1	6.7	621.9	0-83
chipped stone	164	0.2	0.6	307.7	0-3
sherds	164	0.4	1.0	262.5	0-6
Post molds:					
length	49	12.6 cm	4.7	37.3	5-26
width	49	11.8 cm	4.4	37.1	5-22
depth	46	26.6 cm	14.6	54.8	5-60
volume	2	40.0 dl	48.1	120.2	6-74
burned bone	49	0.0 %	0.0	-	0-0
all bone	49	1.3	8.1	614.6	0-57
chipped stone	49	0.1	0.2	395.6	0-1
sherds	49	0.2	0.5	289.1	0-2
Wolky Features:					
length	6	59.5 cm	39.9	67.0	15-106
width	6	38.8 cm	22.0	56.7	15-69
depth	6	20.8 cm	11.1	53.4	8-40
volume	6	169.5 dl	244.7	144.4	11-637
burn bone	6	0.0 %	0.0	-	-
all bone	6	0.5	1.2	245.0	0-3
chip stone	6	0.2	0.4	245.0	0-1
sherds	6	0.3	0.8	245.0	0-2
Storage Bins:					
length	2	55.0 cm	17.0	30.9	43-67
width	2	49.5 cm	9.2	18.6	43-56
depth	1	17.0 cm	-	-	-
volume	1	591.0 dl	-	-	-
burn bone	1	0.0 %	-	-	0-0
all bone	1	0.0	-	-	0-0
chip stone	1	0.0	-	-	0-0
sherds	1	3.0	-	-	3-3

Table 9.3 (concluded)

Feature Type	Number	Mean	sd	C.V.	Range
Mealing Bins:					
length	12	64.3 cm	28.7	44.7	29-100
width	12	38.0 cm	7.6	20.0	28-46
depth (basin)	12	16.2 cm	6.3	38.7	6-25
volume (basin)	9	165.3 dl	93.0	56.3	57-309
burned bone	10	0.0 %	0.1	221.8	0-2
all bone	10	13.7	21.7	157.8	0-71
chipped stone	10	1.1	1.7	151.2	0-4
sherds	10	6.9	6.0	87.1	1-17
Pot Rests:					
length	10	20.8 cm	4.7	22.6	15-27
width	10	19.3 cm	4.9	25.5	13-26
depth	8	2.4 cm	1.1	44.7	1-4
volume	10	8.4 dl	9.7	115.2	2-28
burned bone	10	0.0 %	0.0	-	0-0
all bone	10	0.0	0.0	-	0-0
chipped stone	10	0.0	0.0	-	0-0
sherds	10	0.0	0.0	-	0-0
Wall Niches:					
length	64	28.8 cm	20.5	71.1	8-109
width	64	19.2 cm	14.8	77.4	4-73
depth	63	23.1 cm	13.7	59.3	7-79
volume	62	261.6 dl	764.3	292.2	0-5,305
burned bone	61	0.0 %	0.1	692.4	0-1
all bone	64	8.0	25.0	314.0	0-130
chipped stone	64	0.3	1.4	459.2	0-11
sherds	64	1.2	4.0	320.4	0-20
Wall Trenches:					
length	19	275.4 cm	218.1	79.2	65-999
width	19	32.8 cm	26.7	81.5	3-99
depth	19	18.1 cm	15.0	83.0	3-52
volume	15	724.6 dl	1,260.2	173.9	2-473
burned bone	17	0.1 %	0.2	395.2	0-1
all bone	18	5.1	12.7	247.5	0-48
chipped stone	19	2.2	5.4	244.8	0-23
sherds	19	12.7	33.6	263.6	0-1,380

Features may have been misclassified for various reasons, but predominantly errors occurred because the types were not mutually exclusive and because pre-excavation photo records of the features forced their premature identification. The problem of misclassification is not a large one, and some features were later reclassified. Functionally indistinct pits were categorized under the term Other Pits, and these may incorporate the largest variation in pit usage. Typically, Other Pits are assumed to have fulfilled storage functions, although many may have actually been postholes (see below).

Three pit categories produced the vast majority of features. The catch-all Other Pit category yielded the most features (242, 32 percent of the total), followed by postholes (165, 22 percent), heating pits (136, 18 percent), and several other types that were each less than 10 percent of the total (Table 9.4).

Floor Features

Other Pits

Other pits are the feature most conspicuously absent from greathouse excavations predating 1970. Their absence, however, is undoubtedly due to a lack of recognition and different excavation philosophies. Most Pueblo Alto pits contrasted with the surrounding floor surfaces primarily in color and grain size, or by a discontinuity in the floor surfacing material (e.g., Plate 9.1A). Sometimes pits escaped detection until the floor surface was removed. The vast majority of the Other Pits were unlined (Plates 9.1-9.2), which suggests that they were unsuitable for long-term storage of perishables.

Bill Gillespie initially segregated the Other Pits into several morphological classes in Room 110, a system later extended to include Room 103 (see Table 9.5). The large, deep pits (Type 1) may have been used for storage (Plates 9.1-9.2). Type 1 pits were found almost exclusively in the two large, living rooms (Rooms 103 and 110) at Pueblo Alto, where they often contained trash, coprolites, and construction debris that characterized secondary use. These pit types were dominant in the middle stages of the room occupation in the mid-A.D. 1000s and then became obsolete (Table 9.6).

Type 2 pits may have been used in corn processing, because five of the 16 revealed a thin coating of ash that had been applied wet (see Volume II, Room 110 notes). The group of 16 revealed marked clustering, and they may be considered the typical feature for the upper surfaces of Floor 1 in Room 110. All were shallow basins, and the majority cluster south of Firepit 1 on Surfaces 1-4 in Room 110. Type 3 pits bore some resemblance to the slab-lined catchment basins of mealing bins (see OP 5 in Plate 9.10), although there was no evidence they had been used to collect meal. If we ignore possible secondary burning of FP 2 in Room 110, it may be

Table 9.4. Excavated feature frequency by ceramic time (A.D.).[a]

Period:	Red Mesa		Red Mesa-Gallup	Gallup	Gallup-Late Mix	Late Mix	Post-occup.		
	Pre-Alto 980-1030	Alto 1030-1050	1040-1050	1050-1100	1100+	1100-1140	1300-1400	Total	%
Feature Type									
Firepit	1	1	2	4	6	12	5	31	4
%	2	1	6	1	6	12	100		
Heating Pit	21	19	7	73	8	10	0	138	18
%	39	18	22	18	7	10			
Burn	0	3	0	29	22	6	0	60	8
%		3		7	21	6			
Storage Pit/Bin	0	0	0	2	0	1	0	3	T
%				1		1			
Other Pit	32	27	3	137	14	29	0	242	32
%	59	26	9	35	13	28			
Wall Niche	0	0	0	20	23	21	0	64	9
%				5	21	21			
Posthole	0	21	8	98	21	17	0	165	22
%		20	25	25	20	17			
Postmold[b]	0	11	5	19	12	2	0	(49)[b]	
%		11	16	5	11	2			
Pot Rest	0	0	7	0	0	3	0	10	1
%			22			3			
Mealing Bin	0	0	0	12	0	0	0	12	2
%				3					
Wolky Feature	0	5	0	1	0	0	0	6	1
%		5		T					
Wall Trench	0	16	0	1	1	1	0	19	3
%		16		T	1	1			
Totals	54	103	32	396	107	102	5	750	100
%	100	100	100	100	100	101	100		

[a]T = trace (less than 0.5%).
[b]Postmolds are a subclass of postholes. Postmold total not included in overall feature total.

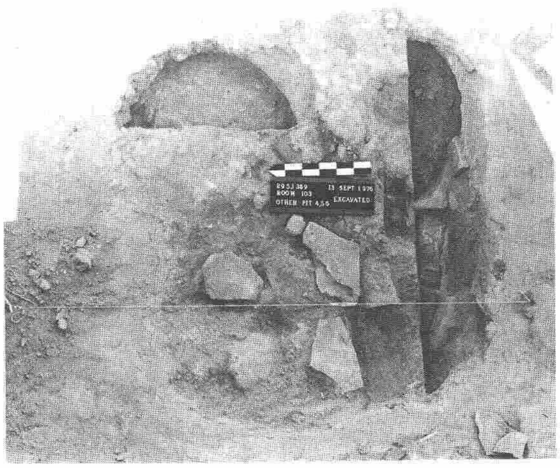
Table 9.5. Pit-form definitions for Other Pits in Rooms 103 and 110.

Pit type	Number
1 = Large, deep pits, generally deeper than 15 cm. Never lined.	
a = circular, bell-shaped (with overhanging walls) with a small mouth.	(5)
b = circular, bell-shaped (with overhanging walls) with a large mouth.	(22)
c = circular/noncircular with steep but nonoverhanging walls.	(16)
2 = Shallow pits, generally less than 6 cm deep. Mouth is longer than depth.	21
3 = Rectangular, slab-lined boxes.	5
4 = Moderate to deep cylindrical pits. Mouth's greatest dimension is less than the depth. Similar to postholes in form.	5
5 = Moderately deep pits, 7-15 cm deep. Mouth's greatest dimension is greater than the depth.	14
6 = Irregularly shaped, 14-20 cm deep. Mouth's greatest dimension is about twice the depth.	14
7 = Small pockets or holes, too small to hold much. Some may not be real features.	12
8 = Slots or grooves. Mouth's greatest dimension several times that of width. May have held boards or stone slabs.	7
Total	119

Table 9.6. Pit types by floor surface in Rooms 103 and 110.

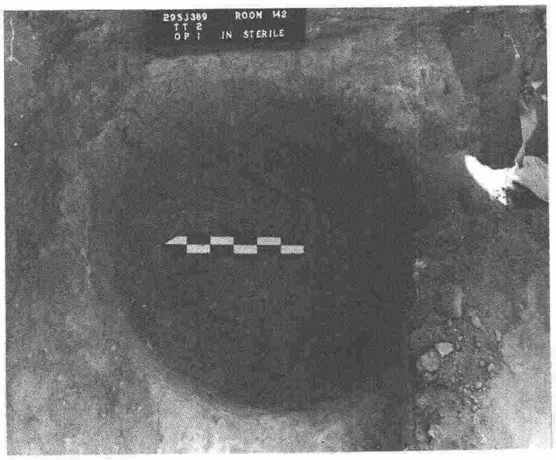
	Other Pit types										Burned features			Misc.			
ROOM 103	1a	1b	1c	2	3	4	5	6	7	8	FP	HP	Burn	PH	MB[a]	Total	%
Floor 1			1				2	3	1			7				14	16
%			7				14	21	7			50				99	
Floor 2					2[b]			1	1	1		9[c]		6	3	23	11
%					9			4	4	4		39		26	13	99	
Floor 3				1			3[c]	2	2		1	8		7	3	27	18
%				4			11	7	7		4	30		26	11	100	
Floor 4		1	7	4		1	3	2	2	4		1		27		52	55
%		2	13	8		2	6	4	4	8		2		52		101	
Floor 5																0	0
Total		1	8	5	2[b]	1	8	8	6	5	1	25		40	6	116	100
%		1	7	4	2	1	7	7	5	4	1	22		34	5	100	
ROOM 110																	
Floor 1																	
Surfaces 1-4				11	1	2	1	2			1			6	6	30	16
%				37	3	7	3	7			3			20	20	100	
Surfaces 5-6	1		1	2			2		1	1	1[c]	1	2	14	6	32	17
%	3		3	6			6		3	3	3	3	6	44	19	99	
Surfaces 7-9	2	21	7	3	2	2	3	4	5	1		39	2	28	4	123	64
%	2	17	6	2	2	2	2	3	4	1		32	2	23	3	101	
Floor 2	2										2			1		5	3
%	40										40			20		100	
Floor 3													1			1	1
%													100			100	
Total	5	21	8	16	3	4	6	6	6	2	4	40	5	49	6[a]	181/191	101
%	3	12	4	9	2	2	3	3	3	1	2	22	3	27	3	101	

[a]Several mealing bins continued in use after many surface replasterings and, therefore, were counted more than once.
[b]Field-classified as a heating pit and a storage pit.
[c]May be a Type 3 Other Pit.



A

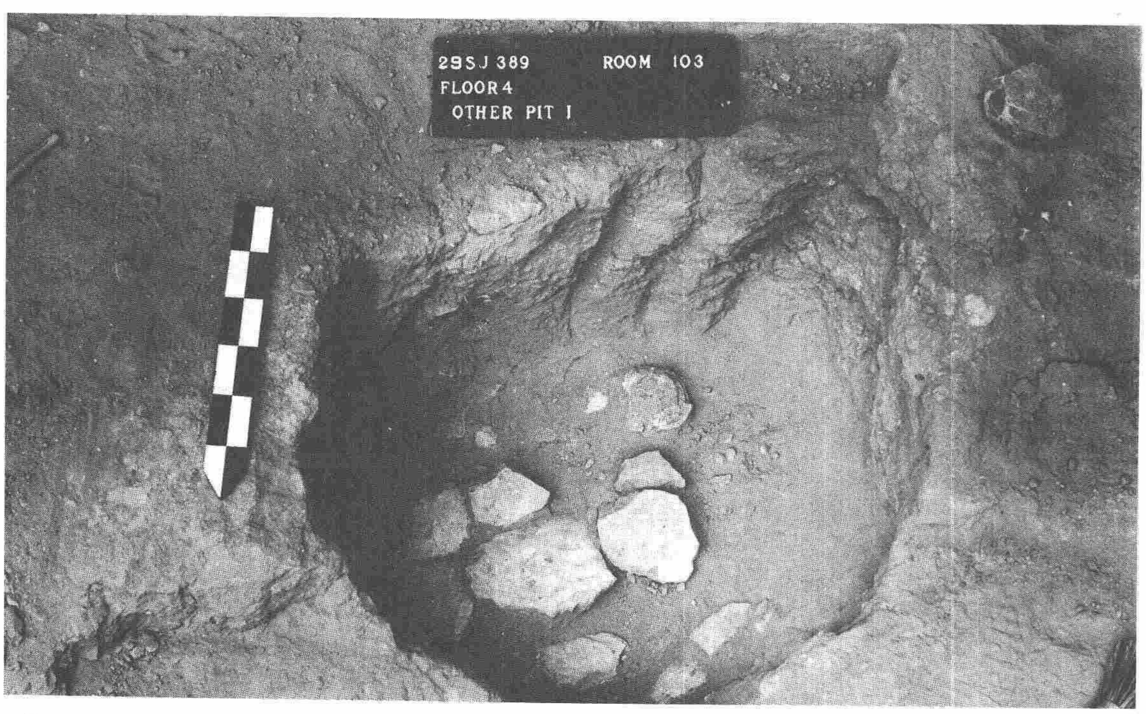
B



C

Plate 9.1. Other Pits in excavated rooms at Pueblo Alto. A) A set of three superimposed Other Pits (4-6) and heating pits (3 and 7) in Room 103, Floor 1 (NSP#13680). B) A bell-shaped pit (OP 38) flanked by three heating pits (23, 24, 30) from Room 110, Floor 1 (NPS#16617). C) Other Pit 1 in Floor 9 of Room 142. Note cracked mud in bottom. A Type 1c pit. (NPS#16763).

A



B

Plate 9.2. Other Pits in Room 103. 30-cm scale. A) Other Pit 8, Floor 4. A Type 1c pit (NPS#14592). B) Other Pit 1 (Type 1c pit), Floor 4, with room-construction spalls in the bottom. Note digging stick marks on the pit sides (NPS#14514).

also classified as a Type 3 pit. Two Type 3 pits (OP 39 and OP 52 in Room 110) were associated with the heating pit and bell-shaped pit (Type 1) complex that characterized early use of Floor 1.

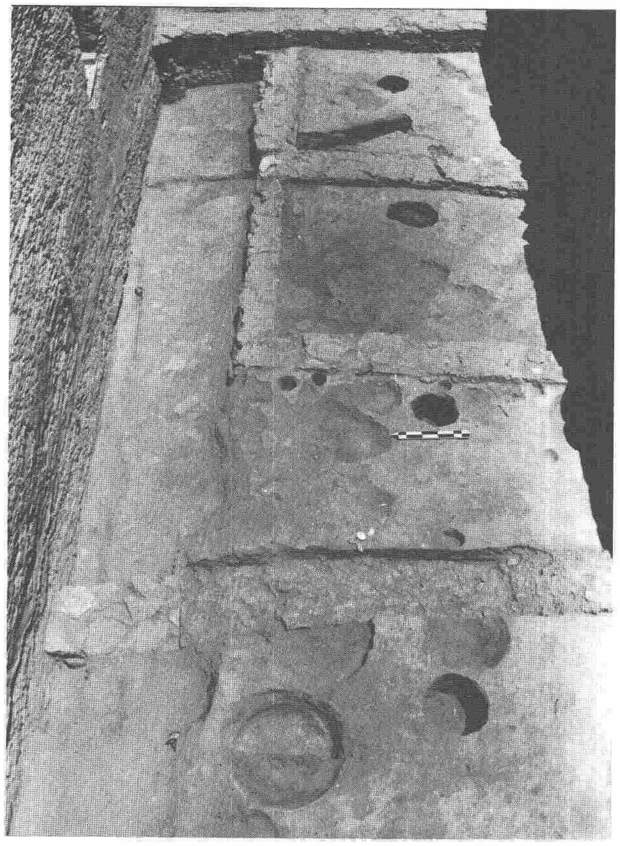
Type 4 pits were morphologically similar to postholes, and may have, in some cases, functioned as post supports. Other attributes, however, suggested different uses to various excavators. OP 6 (Room 110), for instance, contained two clay figurines, and nearby OP 1 contained the impressions of several small rods, perhaps made by pahos. Types 5 and 6 may have served as small storage pits despite their relatively diverse and uninformative fill. Type 7 pits were generally too small for storage, and some may not have been cultural. Finally, Type 8 pits were slots in the floor that appeared to have once held a board or stone slab set on edge.

Occasionally an Other Pit contained a cache of materials that suggested its original storage function. In Room 110, for instance, Other Pit 19 (a Type 7 pit) yielded several large flakes (material type 1080) that fit together to partly form the original core. Other Pit 60 (Type 1b) contained numerous minute flakes (material type 1160) from the manufacture debitage of some finely made tool, along with an antler flaker and quantities of organic material (twigs, seeds, and other plant parts). Other Pit 48 in the same room contained a curious conglomeration of construction debris and an unusual density of 62 bones (mostly rabbit).

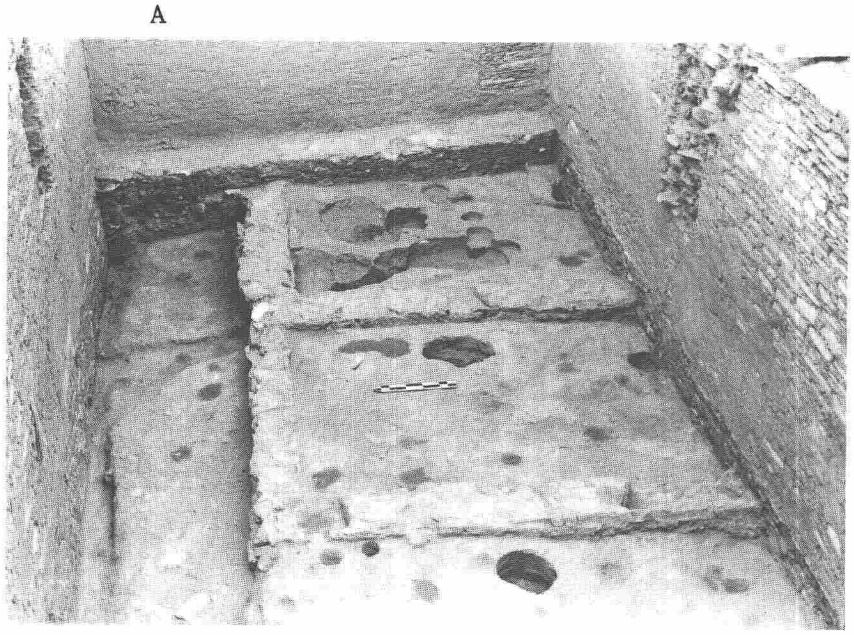
Postholes

Postholes were common features at Pueblo Alto. Large holes for the primary roof supports and post steps characterized the Central Roomblock rooms. Alignment and positioning of the postholes in the central rooms (Plate 9.3), the presence of shims, basal stones, or a collar of clay (Plate 9.4), and sometimes lignite and rotted post remains in the posthole fill assured the proper identification of many of these features. In the plazas and the West Wing, however, these attributes so readily apparent in the central rooms were largely absent. This forced reliance on pit morphology for field identification. Depending on the context, the postholes in the West Wing and plazas may have supported light brush roofs, acted as auxiliary support posts, or supported a light framework for room furniture (e.g., small pens, hanging posts, looms, etc.). The vast majority of postholes recorded in the West Wing rooms and in the plazas were small-diameter pits that were seldom lined.

There were notable exceptions in the two West Wing living rooms, however. In Room 110, all of the 16 pits with even, plastered walls (e.g., Plate 9.5) occurred in the lower surfaces (S7-9) of Floor 1 before the appearance of the mealing bins and firepits--the same surfaces that revealed the majority of the Type 1 Other Pits and the profusion of heating pits. Most of the lined postholes occurred in the west-central part of the room and had apparently been filled with clean sand before later replasterings. Only vague clusters of these pits could be determined that gave hint of the type of framework supported. An obvious pen formed by a series of 12



A



B

Plate 9.3. Room 142 with the foundations of earlier rooms (50 and 51) underneath. Note the line of large, dark pits that mark the roof support holes for Room 142. The dark pit under the rubble-filled door in B was for a post step. The deep trench on the left was filled with wall construction rubble. Most of the remaining pits were other pits and heating pits. 50-cm north arrow. A) NPS#16531. B) NPS#16438.

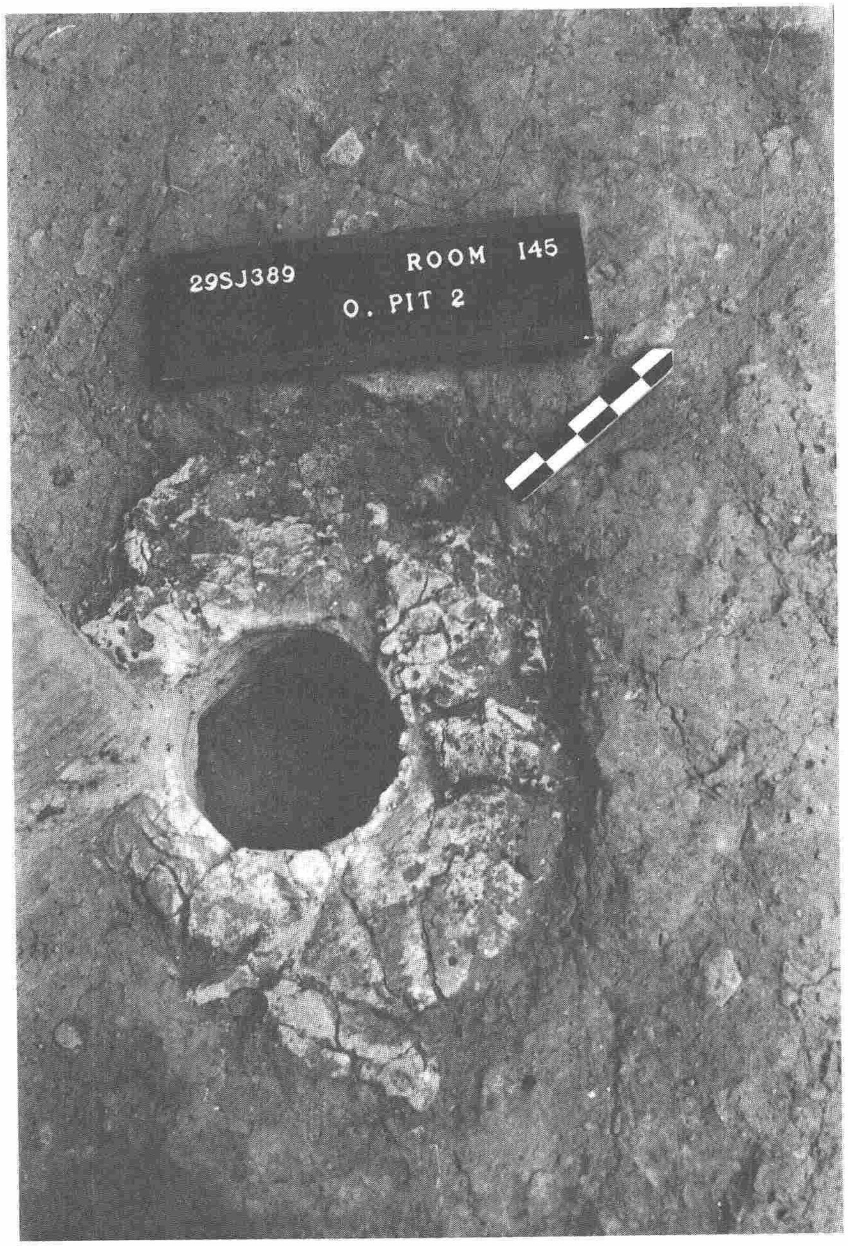
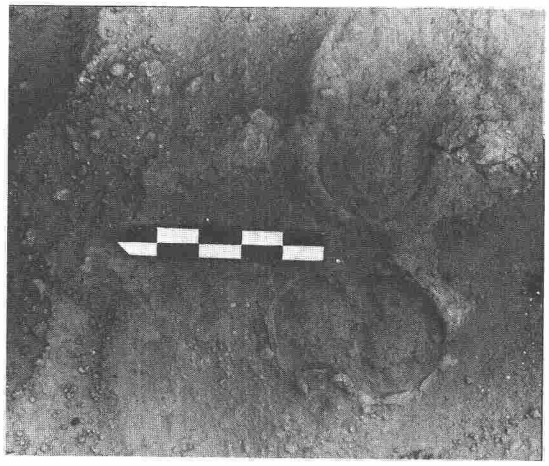
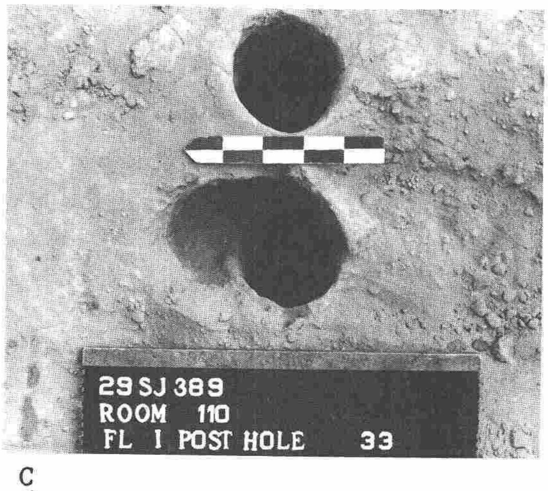


Plate 9.4. Posthole 4 in Room 139, Floor 2. Note adobe packing around the postmold. Signboard is incorrect. 15-cm north arrow. (NPS#14791.)



A

B



C

Plate 9.5. The excavation of three postholes (31-33) in Room 110, Floor 1. Note the ring of adobe marking the perimeter of each pit. 15-cm north arrow. A) Pits are unexcavated (NPS#16614). B) Posthole 31 and postmold of Posthole 32 are excavated (NPS#16627). C) All three postholes are excavated (NPS#16629).

small, irregularly-sided postholes formed a rectangular closure in the northwest corner of Room 110 on Surface 5. A thirteenth hole, Other Pit 20, also fell along the alignment. The pen enclosed an area 300 by 120 cm, but there was no evidence for its type of use.

In Room 103, the majority of postholes occurred on Floor 4, where they comprised 52 percent of the 52 floor features. In contrast to Room 110, however, these postholes were contemporary with the wall construction and may have formed some sort of scaffolding for the masons (see Volume II, Room 103 notes). As in Room 110, the numerous postholes occurred along with the majority of the large-volume pits (Type 1), although activities in the rooms seemed to have differed (construction verses habitation), particularly in the need for heating pits, which were practically absent on Floor 4.

Thermal features

Burned pits comprise one of the largest feature categories. These types fall into several categories (see Chapter 11 and Windes 1984:76-77): burns, firepits, and heating pits. A subcategory of firepits, called ovens, is also important at Pueblo Alto. The primary criterion for identifying thermal features, of course, is the noticeable oxidation of the pit walls and floor. In conjunction with this, thermal features typically contained ash and charcoal. Only in few instances was the identity of thermal features problematic. The only questionable ones are important--Firepit 2 in Room 110 and the burned Type 3 pit in Room 103 that was designated a heating pit. The latter was designated a firepit because it had been burned, although its morphology is that of a Type 3 Other Pit. FP 2, of course, could have been an other pit reused as a firepit. Nevertheless, it is noteworthy because it may reflect less reliance on a traditional firepit during the living room occupation than is assumed in Chapter 11.

<u>Burns</u>. Burns are included under thermal features because it was clear that many resulted from the action of building fires for heating or light on the floors and floor fills in rooms. These features were not formally recorded on feature forms in the field, or at least rarely, so much of the information about them has been gleaned from the room narratives and maps. Burns are two-dimensional features that lack identifiable contents and volume, although often the oxidized fuel rested directly above the feature or was scattered nearby. Until well into the Chaco Project, burns were recognized in the field but did not receive the same attention warranted by three-dimensional features.

Two patterns have emerged from the burn data. Many burns represent impromptu fires built in sheltered areas of the deteriorating site near the end or after the primary abandonment. Burns apparently mark an expedient strategy for a single episode of cooking or heating with little regard for the subsequent refuse generated by the activity. A few were mere extensions of three-dimensional features (e.g., firepits) where flames had overlapped the pit sides onto the floor, but these were not recorded as separate cultural manifestations. Abandonment also seems to have provoked deliberate spot burning throughout the site on the upper floors, walls, and doors. This behavior of building impromptu fires throughout a site at or after abandonment is not well documented in Chaco, although passing reference to it seems commonplace (e.g., at Chetro Ketl: Stubbs in Lekson 1983b:14, 32; Stamm 1929:34). I suspect that these fires date primarily to the early A.D. 1100s, at the end of the Chacoan occupation, and in the A.D. 1200s, during the Mesa Verdean occupation of the canyon.

Firepits. Generally there was little disagreement over firepit morphology. In one of two instances, burned pits resembling heating pits, except in size, defied easy separation between the firepit and heating pit category (Plates 9.6-9.7). In addition, analysis suggested the existence of a number of firepit subcategories based on size. The huge firepits encountered in the plazas (see Volume II, Table 4.1 for the distribution of these in Chaco Canyon) clearly differed from the range of variation exhibited by living room firepits and heating pits. The summary data on firepits (Table 9.3) includes these massive firepits, or ovens, that skew the range of firepit variation. Nevertheless, in volume (Figure 9.1) and mouth area, firepits far exceeded their smaller counterparts, the shallow, unlined heating pits (see below). The impressive amount of cultural material yielded by the firepits, compared to the heating pits, may be due to the differences in size or, more likely, that firepits were preferred as trash receptacles. Compared to small sites, firepits were relatively infrequent in the living rooms and plazas where they are traditionally found.

Heating Pits. The most common thermal feature at Pueblo Alto was the ubiquitous heating pit (Plates 9.8-9.11). Although morphologically similar to their namesakes in small sites, the Alto ones exhibited a use similar to that of firepits. That is, they often contained refuse, suggesting that food-processing activities took place around them (M. Toll 1985b), and were sometimes plastered and hotly burned. Nevertheless, the Alto heating pits typically showed little repeated use and were of small volumes (Figure 9.2). In small sites, these features seemed to be auxiliary to the primary firepit and never were lined or contained cultural material other than fuel. The discrepancy between the small-site and Pueblo Alto heating pits suggest that those at Alto may have replaced firepits.

Roasting Pits. Roasting pits are another phenomenon of the postoccupation activities in Pueblo Alto (Plate 9.12). These slab-lined troughs are widespread in the fill and roof debris of greathouses in Chaco Canyon (e.g., see Vivian and Mathews 1965:62-64) and attest to intermittent use of the sites after considerable time had elapsed since the final abandonment in the A.D. 1100s. Two at Pueblo Alto, in particular, reveal the duration of time that must have elapsed (e.g., Plate 9.12C). Both were high in the fill of abandoned structures (in Room 103 and Kiva 14) and yielded similar magnetic directions of the burned soil that suggested use

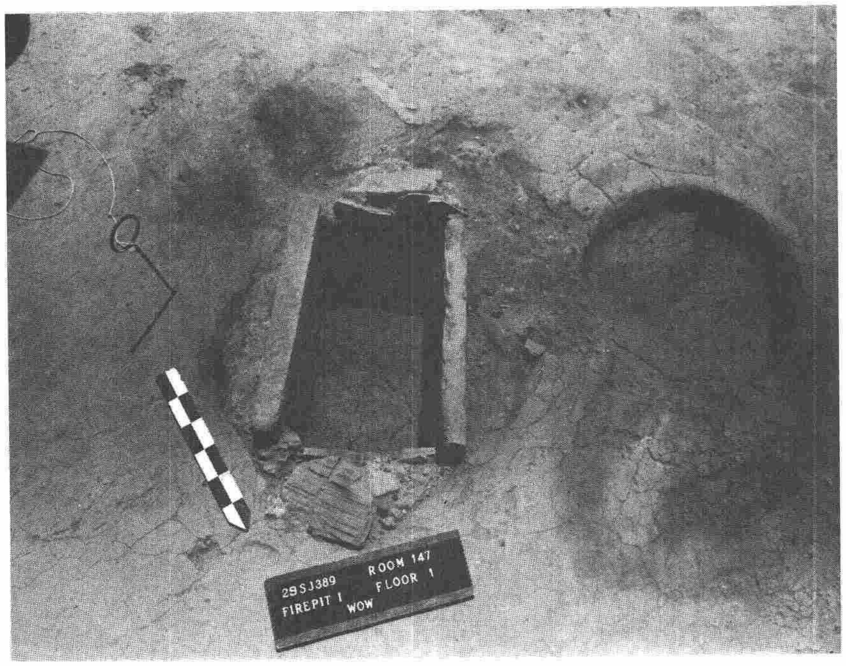


Plate 9.6. Slab-lined Firepit 1 and adobe-lined Heating Pit 1/firepit in Room 147, Floor 1. 30-cm north arrow. (NPS#16656.)

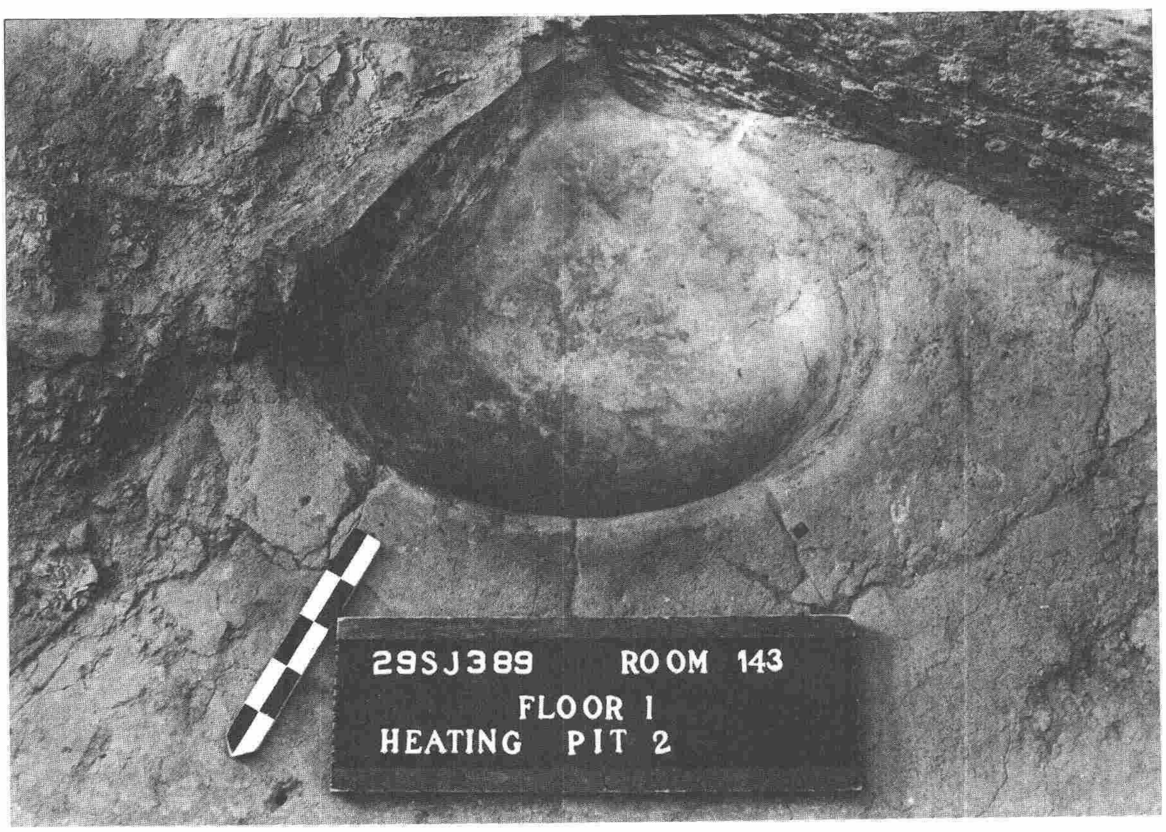


Plate 9.7. An adobe- and slab-lined, modest-volume (6.8 liters) firepit (Heating Pit 2) built in the southeast corner of Room 143/236, Floor 1. 15-cm north arrow. (NPS#16723.)

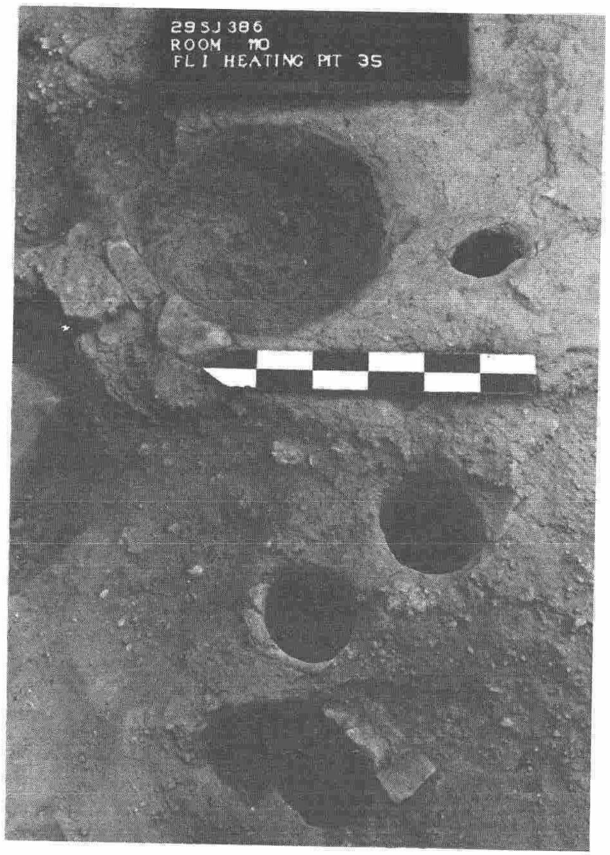


Plate 9.8.

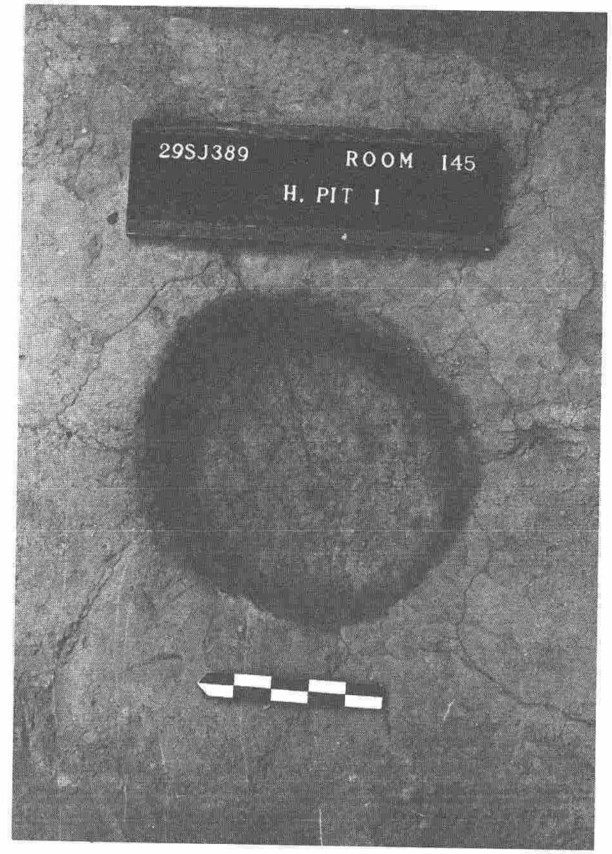


Plate 9.9.

Plate 9.8. Room 110, Floor 1, Surface 8. A plaster-lined heating pit (Heating Pit 35), and Posthole 34 between signboard and 30-cm north arrow. Below arrow are Postholes 37, 31, 33, and 32, respectively. (NPS#16674.)

Plate 9.9. Room 139, Floor 2, Heating Pit 11 (1.6 liters) typical of the many small-volume, unlined, burned pits on Floor 2. Signboard is incorrect. 15-cm north arrow. (NPS#14801.)

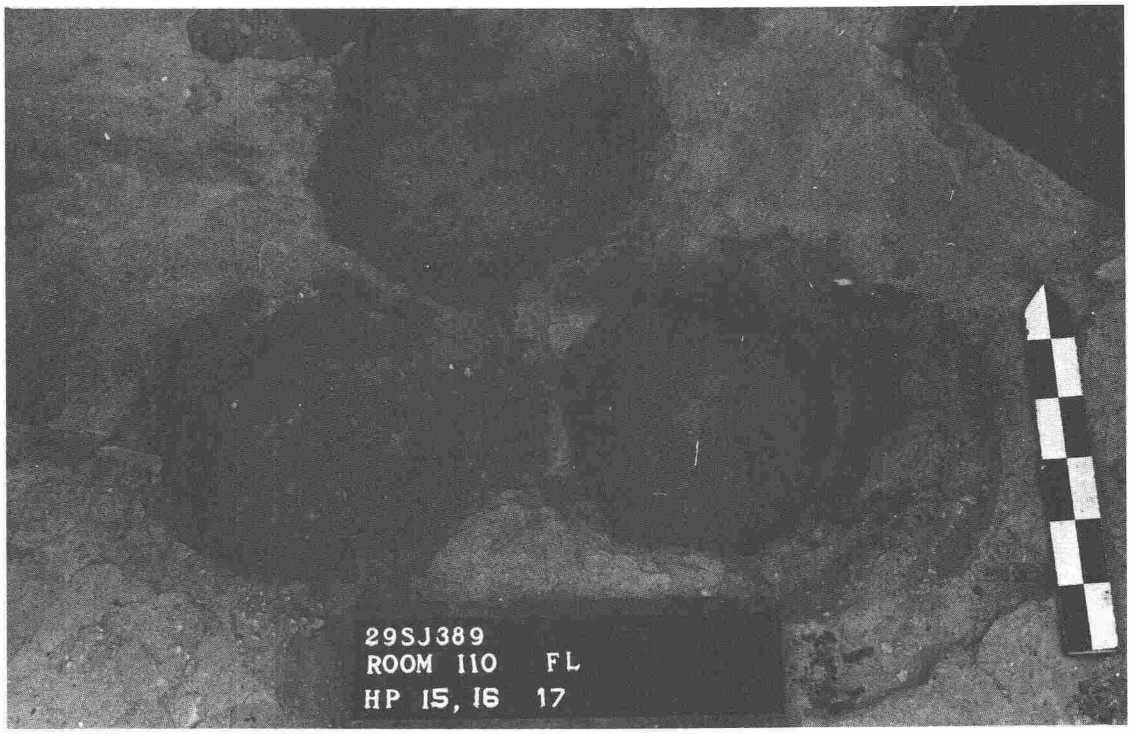
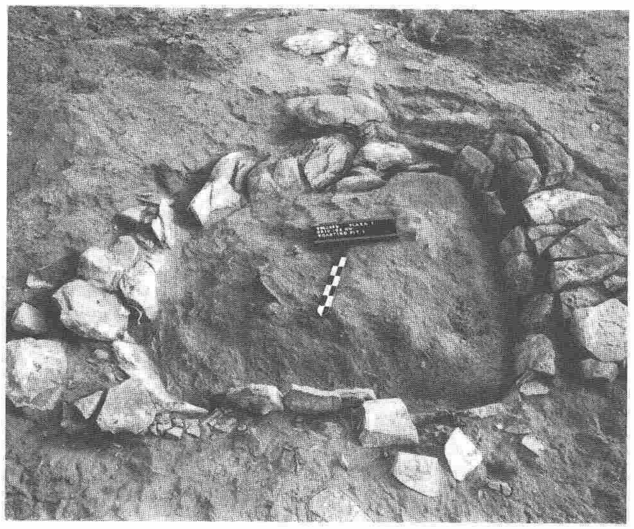
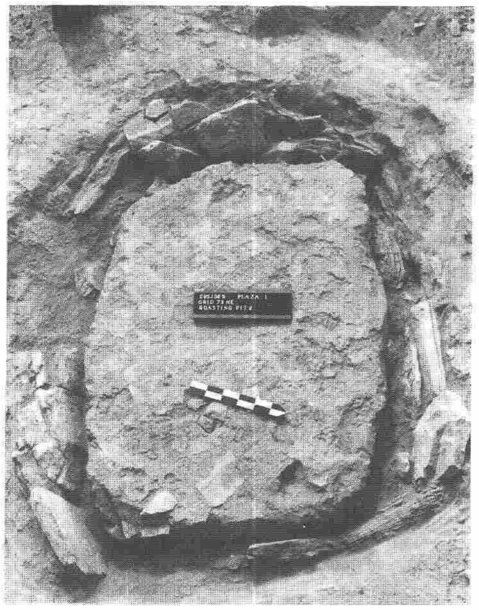


Plate 9.10. Room 110, Floor 1, Surface 8. A cluster of unlined heating pits (Heating Pits 15-17) at the northern end of the room. Slab-lined box (Other Pit 5) is a later (Surface 4) feature. 30-cm north arrow. (NPS#16545.)

Plate 9.11. Room 142, Floor 4, Heating Pit 2. A large-volume (55.9 liters), unlined, heating pit typical of those on the lower floors in Rooms 142 and 146. 30-cm north arrow. (NPS#16447.)



A



B

C

Plate 9.12. Pueblo Alto roasting pits typical of those found in postoccupational greathouse deposits in Chaco Canyon. A) Roasting Pit 1 (unexcavated) in Plaza 1, Grid 193. 30-cm north arrow (NPS#15696). B) Roasting Pit 2 (unexcavated) in Plaza 1, Grids 73-74. 30-cm north arrow (NPS#15695). C) Firepit 2 in Room 103's wall rubble (Layer 1). 15-cm north arrow (NPS#13508).

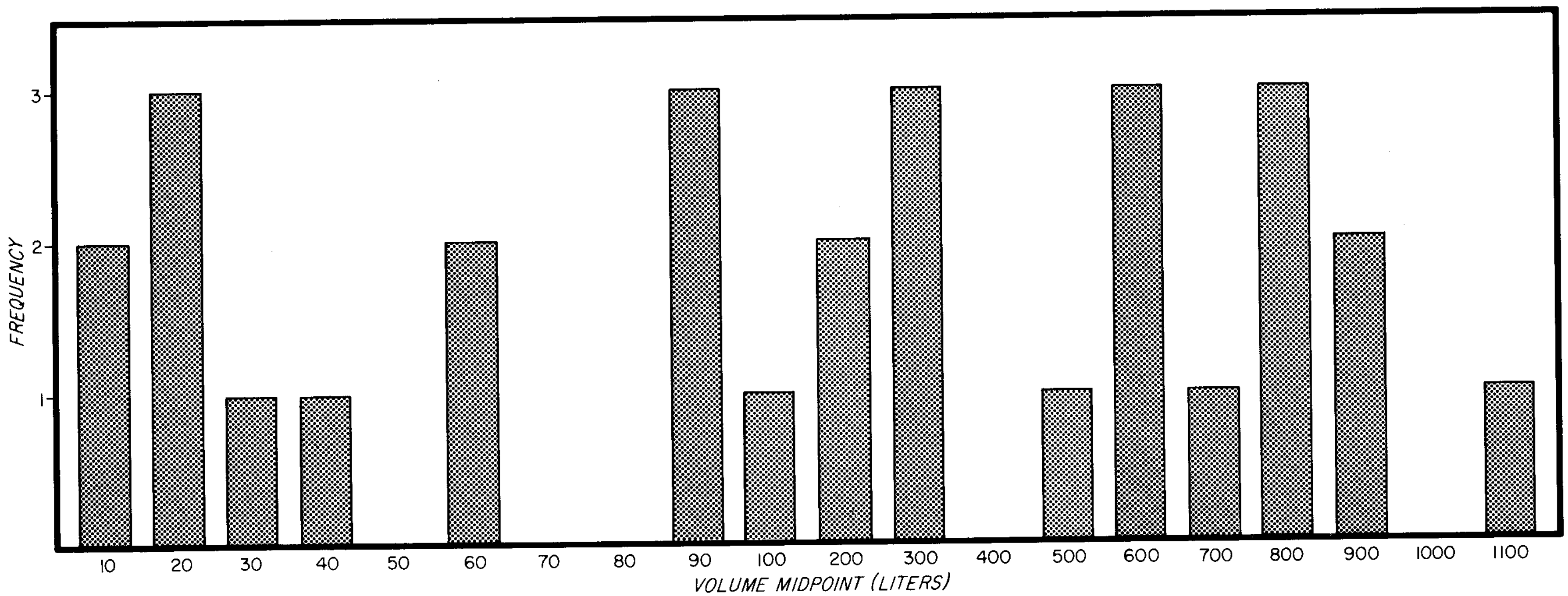


Figure 9.1. Histogram of the Pueblo Alto firepit volumes. Note change in volume intervals after 100 liters.

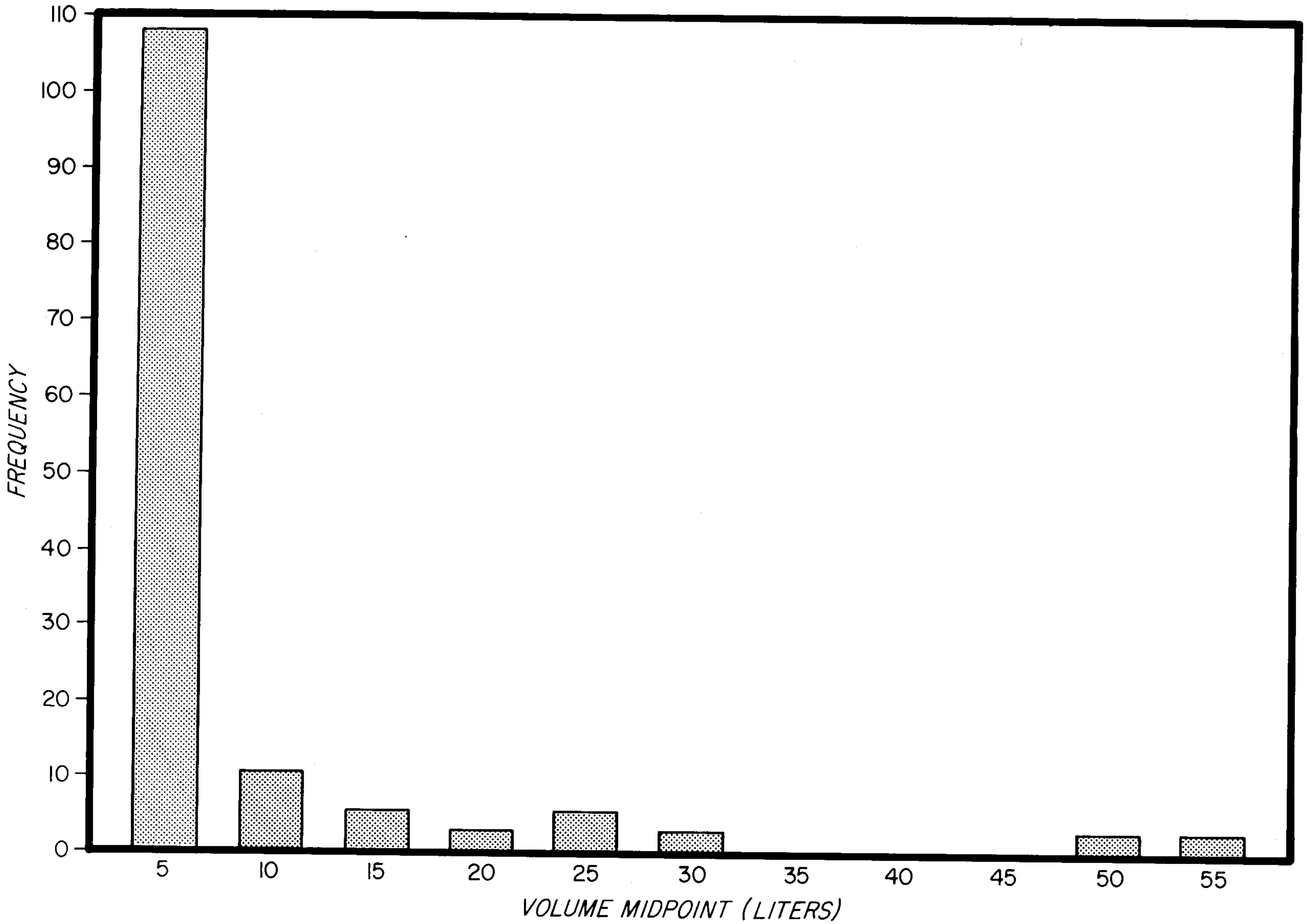


Figure 9.2. Histogram of the Pueblo Alto heating pit volumes.

in the A.D. 1300s. Several others at Alto were located in Plaza 1 but were not excavated, although it is clear that each was of considerable volume (over 100 liters). Plaza 2 yielded at least 3 huge firepits built against the exterior room walls, although they may have been for signalling rather than for some domestic function.

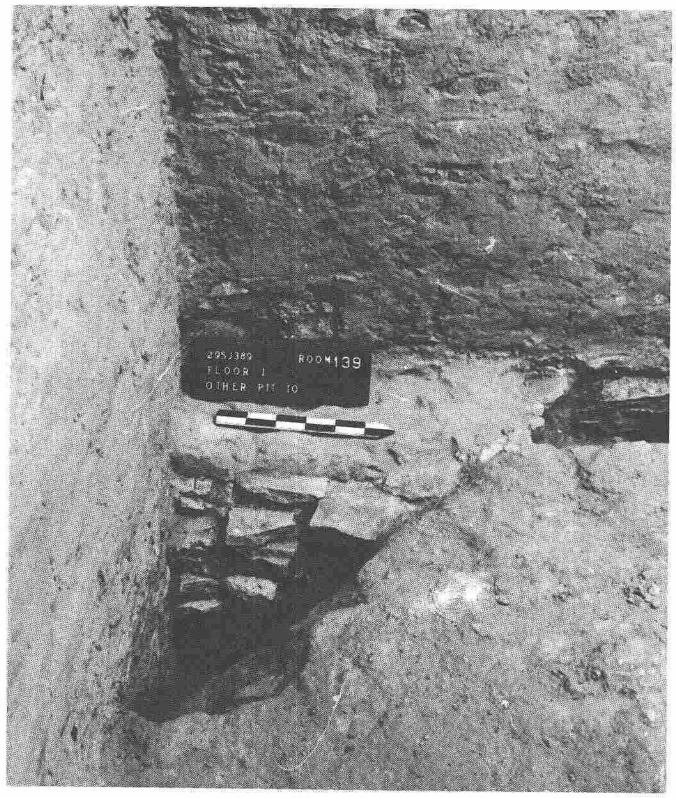
Construction of these huge firepits or roasting pits tended to be haphazard. Little mortar was used in the placement of the poorly aligned, irregularly-sized blocks or multiple rows of upright slabs that form the perimeter. Masses of highly oxidized stone may comprise much of the interior fill, and the fuel often reflects scavenging of site roofing materials.

Wall Trenches

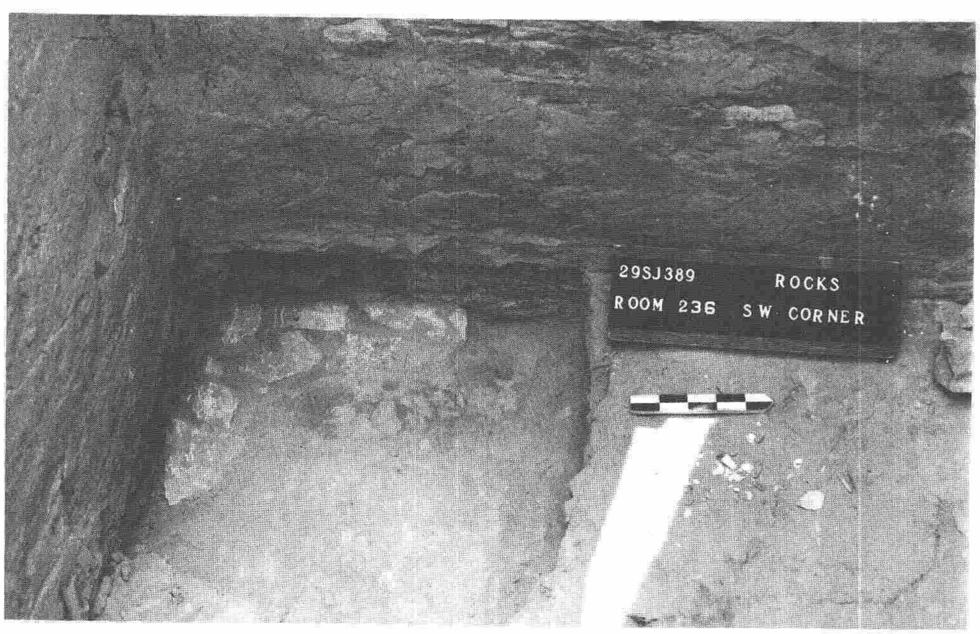
Wall trenches were limited to the Central Roomblock as manifestations of construction behavior. These trenches bordered the bases of walls at the top of sterile deposits and served as catchments for construction debris: globs and balls of mortar, debitage from the shaping of masonry stone, discarded masons' tools, but little other cultural debris. The mean length of these features is not meaningful because the measurements merely reflect their extent within each room being excavated, although often the features extended along walls common to adjacent unexcavated rooms. Most trenches were long, narrow (10-15 cm wide), and shallow (about 10 cm deep). However, a massive trough extending along the north wall of Rooms 142 and 146 and beyond (Plate 9.3) inflated the mean measurements in Table 9.3. Generally, wall trenches bordered longitudinal walls extending east and west in the Central Roomblock, but not along the cross walls. After the Stage I construction at Pueblo Alto (A.D. 1030-1050), this type of feature was no longer built in association with wall construction.

Wolky Features

These unusual features were restricted to the Central Roomblock. Each consisted of horizontally set stones in a triangular block of hard, gray mortar (Plate 9.13) placed in a few room corners (i.e., Rooms 138, 139, 142, and 236). These were not pits, despite their field classification as Other Pits, and contained no artifacts other than a few that probably were accidental inclusions in the materials comprising the mortar. All Wolky Features occurred just under or near the floor's uppermost plaster, and half of the six noted, as well as the smallest, were located in Room 138. All were set in deposits under the floors that dated to the initial construction between A.D. 1030 and 1050. Nevertheless, their placement directly under floor plaster that may have been applied much later suggests that we cannot be sure when the features were built. They were apparently related to construction, either to the initial wall construction or to the late application of floor plaster, but their function remains elusive.



A



B

Plate 9.13. A wedge-shaped block of masonry common under the corner floor plaster in rooms of the Central Roomblock. A) Other Pit 10, under the uppermost floor in Room 139. 30-cm north arrow (NPS#14647). B) Room 236, Floor 3, Other Pit 3. 15-cm north arrow (NPS#17557).

Storage Bins and Storage Pits

Pueblo Alto did not yield any of the huge masonry bins that characterized many of the early rooms at Pueblo Bonito and Una Vida. Instead, only three small, stone-lined boxes were recorded as storage features, and two of these probably were kiva ventilator shafts. Six others were recorded as Other Pits (Type 3), one as a heating pit (it had been dismantled and burned), and one as a storage cist. None were of substantial volume (i.e., over 40 liters) compared to those in the other greathouses.

Pot Rests

Only a few circular rings of adobe (see Volume II, Room 110 and Kiva 15 notes) attached to floor plaster and floor basins were recorded as possible rests for round-bottomed vessels. Their true function, however, is problematic, although six of the ten were located adjacent to firepits where food or water could have been heated by a fire. All ten were located in Kiva 15 and Room 110, and were about 20 cm in diameter and about 1-4 cm deep.

Mealing Bins

Mealing bins were found only in the two West Wing living rooms at Pueblo Alto (Plate 11.1). They occurred in sets of three, with those in Room 110 eventually expanding to a set of six. Temporally, these 12 bins belong to the Classic Bonito phase when Chacoan metates were first enclosed, although there was no corresponding shift to slab metates. Trough metates were propped up in the bins but not permanently affixed, so they could remain portable. All of the metates from Alto were troughed (Schelberg 1987), although none were left in the mealing bins.

Many Pueblo Alto metates were shallow, like their Basketmaker counterparts, which would have allowed greater spillage of ground meal along the sides unless they had been set in bins. The overall size, placement, and number of bins in each set closely mirror those in historic pueblos (Chapter 11). The twelve bins revealed little variation in size. The shift to bins at Alto and in Chaco Canyon, at a time when the environment was poor and major shifts in the population composition took place (Chapter 11), suggests the causality of the events. Perhaps changes in subsistence strategy (e.g., a shift in plant resources) and occupational permanency were directly responsible for the changes in mealing strategy.

Wall Features

A number of features penetrated the room and kiva walls at Pueblo Alto. Wall features were not subjected to some analyses because of sample size, the problem that not all were excavated (by design or by lack of recognition), and the difficulty in associating them with particular floors.

Our ability to predict the presence and position of wall cavities under wall plastering was poor; consequently, many of these features, particularly in Room 103, were probably missed. The difficulty in recording and removing the wall plaster rapidly to look for features, as well as the constraints of conservation, forced only limited investigation of wall surfaces. For the most part, however, wall plaster in the upper half of the rooms had dissolved as a result of natural events before exposure by the spade. Wall cavities added after the initial wall construction and plastering (apparently the most common practice) were noticeable, even when sealed and plastered over. Thus, there was a bias primarily against the discovery of primary cavities built in the lower parts of walls and later covered by wall plaster.

Wall Niches

The most common wall cavities were built after the initial wall construction. In many aspects, wall niches can be equated with Other Pits in the floors. In both categories there were a diverse number of subtypes based on morphology, location, and size. In both groups many probably served for storage of small or bulk items. Small niches appear to have been created by the simple removal of a stone or two from the wall facing and were rarely plastered or finished. These were often so small that their usefulness is suspect for other than a solitary object or two. Nevertheless, such cavities were not common to all rooms and, thus, they are probably behaviorally meaningful. Wall niches, particularly large ones, were always associated with rooms that had firepits. Storage rooms at Pueblo Alto lacked wall niches, so niche use can be associated with living-room or kiva use.

Wall cavity space may have been supplemented by floor cavities for storage. In Room 110, in particular, the large Type 1 Other Pits appeared after many of the large wall cavities were built in the walls to be used with the earlier floors (Floors 2 and 3). This trend may also have taken place in Room 103 because we believe that several large wall cavities remain unexcavated. Both rooms were living rooms, so the shift in storage location may mark a change forced by external conditions common to all site residents (e.g., a need for greater storage).

Doors (Table 9.7)

The majority of doors in the excavated rooms were built as part of the initial wall construction. Most were elevated some distance above the floor, making assistance necessary to gain the door threshold. Assistance was provided in a variety of ways by either post or masonry steps in front of the doors or by small toeholds set into the wall below the door. Post steps appear to have been a holdover from earlier times--they were restricted to the earliest rooms at Pueblo Alto (the Central Roomblock) and were scattered about in the older section of Pueblo Bonito (e.g., Volume

II, Plate 2.17-2.18). Often the post step had been removed, leaving the post hole as the only evidence of its demise. Doors at or nearly at floor level were restricted to the plaza entries into the rooms. In fact, the dual entries between the West Wing living rooms and the interior plaza were so encumbered by rising plaza sands (does this suggest plaza maintenance and, therefore, that occupation was intermittent enough to allow masses of sand to accumulate?) that they were frequently raised to allow access. The northern of the dual entries in each room (Rooms 103 and 110) was built lower than the central opening, but those doors were eventually abandoned because of the rising plaza sands (see Volume II, Room 119 notes).

Pueblo Alto doors were approximately 60-70 cm wide and between 75 and 100 cm high (see Lekson 1984:25-28). Some intramural logs set in the walls provided support as door lintels and sills. A few with door ties and secondary jambs revealed the direction of closure and access. The Central Roomblock suite, in particular, revealed that the entire unit originally was entered and controlled from Room 143. There was no evidence for roof entries except in kivas. Secondary doors were most common in the West Wing, where it was evident that room functions had been altered by the inclusion of new kivas and rooms. Often the original doors in this section had been blocked with chunky, soft masonry (indicative of early A.D. 1100s modification) and new doors added for access to formerly inaccessible rooms. Many of the door-sill slabs had been removed at or after abandonment and fires built on the sill remains.

Ventilators (Table 9.8)

Air circulation was provided through two types of architectural conduits. Kiva ventilator tunnels and shafts are familiar Anasazi traits and need no elaboration here. Small, square openings high in the walls in every room excavated at Pueblo Alto are common in Chacoan greathouses. Because they are too small for physical access and would yield only limited light when located in the exterior roomblock walls, they are thought to have functioned as ventilators. The vents and high-ceiling rooms may have been designed to remove smoke trapped above the "living" level (Lekson 1984:29), although at Alto few rooms contained firepits. A constant flow of smoke fumes through the vents would have caused considerable resin and pitch to build up within the vents, but none of the openings were smoke stained. Weathering might have removed any stains but probably not within the intact vents. Oddly, the vent in Room 147 was sealed while several hearths in the room were being used. Lekson (1984:29) believes the rigidity of architectural placement of vents precluded their use for ventilation (e.g., such as smoke removal) because vents, particularly after A.D. 1050, were built in identical locations regardless of the room orientation, story, or site location. Nevertheless, air circulation would have been greatly enhanced by these wall ducts, if only to bleed off warm air in the summer.

Table 9.7. Door data from excavated rooms in Pueblo Alto. Question marks are missing or unknown data.

NORTH ROOMBLOCK	Primary/ Secondary	Room Location	Width (cm)	Height (cm)	Wall Thickness (cm)	Door Ties	Secondary Door Jambs	Open/ Blocked	Sill Type	Lintel Type	Height Above Floor 1[a] (cm)	Comments
Door 1	P	139/145	58	91	45	Yes	Yes	0	slab	slabs	83/82	
Door 2	S?	145/148	55	105?	unexc	No	?	0	slab?	poles	88/?	
Door 3	S	139/144	61	92	unexc	No	?	0	slab	?	75/?	Replaced Door 8.
Door 4	P	138/139	60	55+	46	No	No	0	masonry		84/85	
Door 5	P	139/142	51 top 60 bot	100	50	No	Yes	0	slab	8 poles	97/100	
Door 6	P	146/147	62	88	50	No	No	0	slab	13 poles	40/34	Formerly Door 8.
Door 7	P	142/143	65	92+	50	No	Yes	0	slab?	?	163/35	
Door 8	P	139/144	?	94±	unexc	No	?	B	slab?	beams	64/?	
Door 9	P?	147/148	55?	90?	unexc	No	No?	0	?	?	45/?	
Door 10	P	147/152	66	100	unexc	No	?	B	?	?	28/?	Pictograph on it.
Door 11	S	147/152	58?	80?	unexc	No	?	0	?	?	5/?	Replaced Door 10.
Door 12	P-S[b]	143/147	50	45+	50	No	No	0	slab?	?	15/20	Plastered with 5+ coats.
Door 13	P-S[b]	143/plaza	57	100+	50	No	No	1/3B	masonry	?	22/27	Assoc. with Step 1.
Door 14	P	143/plaza	75	90+	40	No	No	0	slab?	?	40/?	Assoc. with Step 2.
Door 15	P-S[b]	143/plaza	44±	88±	48?	No	No	0	slab?	?	36/?	Assoc. with steps.
WEST ROOMBLOCK												
Door 1	P	110/plaza	63 top 50 bot	145	unexc	No	No	B	masonry?	4 poles	0-65/?	Raised often; see Figure 8.84.
Door 2	P	110/112	67	134±	unexc	Yes	No	B	?	poles	10/45	
Door 3	S	109/plaza	63 top 58 bot	110±	58	No	No	0	masonry	?	75/?	Cuts the corner; see Figure 8.61.
Door 4	S	109/112	72	75	45	No	No	0	mason+log?	?	61/130	Assoc. with step.
Door 5	P	110/plaza	49 remod.	90 124	46	No	No	B	masonry	?	0/?	Rebuilt as Niche 4; associated with Fl.3; see Figure 8.85.
Door 6	S	110/111	60±	79±	50	No	Yes	B	mason+log	2 poles	40/?	See Figure 8.86.
Door 7	S	112/113	67	86	unexc	No	No	0	masonry	?	29/?	
Door 8	S	112/229	78	90	50	No	No	0	masonry	?	30/22	
Door 9	P	229/108	70	110+	44	No	No	0	mason+log	?	82/?	
Door 10	P	228/229	67	103+	46	No	No	0	mason+log	?	?/75	
Door 1	P	103/plaza	65	95?	unexc	No	?	1/3B	?	?	10-90/?	Raised often.
Door 2	P	103/plaza	47	65?	unexc	No	?	B	?	?	0/?	
Door 3	S	103/104	65?	65+	unexc	No	No?	B	?	?	73/?	
Door 4	S	103/102	50	75?	unexc	No	?	B	?	?	62/?	Covered with wall plaster.
Door 5	P-S[b]	103N/103S	35-45	60±	30	No	No	0	masonry	?	55/56	In wall partition.

[a]Floor 1, Surface 1 in Room 110. Heights measured to Floor 1 in sequence listed under room location.
[b]Primary door in a secondary wall.

Table 9.8. Wall ventilator data for excavated rooms in Pueblo Alto. Question marks are missing or unknown data.[a]

North Roomblock	Room Location	Width (cm)	Height (cm)	Wall Thickness (cm)	Lintel Type	Open/ Blocked	Primary/ Secondary	Height above Floor 1[b] (cm)	Comments
Vent 1	145/146	35	40	?	?	B	P	186/142	
Vent 2	144/145	43	55	?	slab/2 poles	B	P	179	
Vent 3[c]	139/145	26	33	37	slab	B	P-S	167/175	Covered by wall plaster.
Vent 4[c]	139/145	26	31	37	slab	B	P-S	170/179	Covered by wall plaster.
Vent 5	139/144	38	44±	49	?	O	P	181	
Vent 6	139/142	27	33	45	7 poles	B	P	162/166	
Vent 7	138/139	25?	?	?	?	B?	P	?/?	
Vent 8	?	-	-	-	-	-	-	-	See Vent 14.
Vent 9	142/143	28	14+	50	?	O	P	156/135	
Vent 10	138/exterior	38	26+	51	?	O	P	156	
Vent 11	138/exterior	35	32+	55	?	O	P	163	
Vent 12	138/139	38	44+	49	?	O	P	175/178	
Vent 13	143/146	29	44	40	?	O	P	155/134	Formerly Vent 8.
Vent 14	147/148	44	40	?	poles	B	P	125	
West Roomblock									
Vent 1	110/plaza	33	30	50	poles	B	P	165	
Vent 2	110/112	32	36	54	poles	B	P	150/146	
Vent 3	110/104	31	25	50	poles	B	P	145	
Vent 4	110/111	33	25	50	poles	B	P	142	Covered by wall plaster.
Vent 5	110/111	34	28	50	poles	B	P	132	Covered by wall plaster.
Vent 6	112/113	35	36	50	masonry	O	P	160	
Vent 7	112/113	32	22+	50	?	O	P	160	
Vent 8	112/108	28	35+	56	?	O	P	149	
Vent 9	112/104	28	5+	57	?	O	P	175	
Vent 11	112/104	29	35	57	slab	O	P	174	
Vent 1	103/105	30	41	50	masonry?	O	P	155	
Vent 2	103/105	29	30+	49	?	O	P	167	Blocked now (11-18-86).
Vent 3	103/105	30	38	49	masonry?	O	P	155	
Vent 4	103/plaza	27-31	27+	64	?	O	P	157	
Vent 5	103/plaza	35	39	60	masonry?	O	P	152	

[a]All ventilators were built with masonry sills. The tops of many ventilators were stabilized in 1976.
[b]Floor 1, Surface 1 in Room 110. Heights measured to Floor 1 in room sequence listed under room location.
[c]Held a pair of 8-cm-diameter poles to support a shelf. Not air vents. Built in a secondary cross wall.

Vents at Pueblo Alto were generally paired in the longitudinal walls from the plaza to the house exterior across the short axes of the building, like the door pattern. In the Central Roomblock this was particularly true, with the excavated suite being ventilated without lateral ventilation possible from the adjoining suites. This suggests that originally each suite was a separate unit controlled by unrelated groups.

In the West Wing, the living suites contained vents for air flow between the house exterior (the direction of the prevailing winds) and the plaza as well as laterally among adjacent suites. The lateral vents may have provided additional ventilation, however, at the expense of the adjacent living quarters if smoke was allowed to circulate. Does this suggest greater unity or affiliation among the inhabitants of the West Wing rooms in contrast to the Central Roomblock or just a more efficient vent system for getting rid of the firepit smoke? It is not possible to tell from our limited excavation sample. Vents, like doors, may provide clues to the social organization of the site when larger samples of rooms can be investigated. Many of the vents were blocked with chunks of soft sandstone (that suggest early A.D. 1100s handiwork) when the rooms were no longer used for their original purpose (e.g., Room 110).

Peg Holes (see Volume II, Room 110 wall elevations)

Only a few peg holes were discovered at the site, all within Room 110. Others may have existed, particularly in the other living rooms, but escaped the close scrutiny of the walls given to Room 110. Fourteen holes about 10 mm in diameter were found in the Room 110 walls, many only after wall plaster was stripped from scattered 50-cm squares to inspect the masonry. Others undoubtedly exist. The holes were set 10-20 cm horizontally into the wall, usually perpendicular to the wall face, but only four of the holes contained rotted wood. Presumably the majority were used as short pegs for hanging objects, similar to those in historic photographs of Pueblo room interiors (e.g., Mindeleff 1891:Figure 63, Plate 86; Stevenson 1970:Plate 78).

Viga Holes

No viga holes were discovered, presumably because their location near the tops of the walls resulted in their eventual destruction from wall deterioration and roof salvage. A few poles were probably socketed into the walls in Rooms 142 and 143 to support shelves and a room-wide platform.

Problems with the Field Classification of Features

It is important to assess consistency in feature type classification before continuing with feature analysis and broad functional interpretations. Many of the feature categories are not exclusive, although most can be classified into broad functional categories with considerable assurance of exclusiveness (e.g., thermal versus nonthermal, wall versus floor, etc.). Often reports leave it to the reader to define the meaning of particular categories, without commenting on the consistency of the typological application or the variation in its application. Because of widely different perspectives and field experience among the staff, classificatory consistency can be a problem without field guidelines.

Some feature types bore the brunt of classification confusion at Pueblo Alto. The greatest inconsistency was between postholes and the omnipresent Other Pits where cylindrical, unlined pits in both classes may have been classified under either category. For the most part, collaborative evidence from artifacts and fill within the features was not useful for floor feature classification except for thermal features (e.g., firepits and heating pits), some postholes, and mealing bins. Wall niches are similar to Other Pits because of the generic application of the category (e.g., most holes in the walls were labeled wall niches despite a great range of shapes, sizes, and volumes). Undoubtedly, wall niches fulfilled different functions. Clearly, the large-volume wall cavities may have functioned similarly to the large-volume Other Pits.

Besides Other Pits, postholes were the most difficult to identify, although several attributes helped in their identification. Widespread use of multiple posts for structural supports (e.g., for roofs and walls) often created linear pit patterns that eased identification of the proper functional category. These clusters of support posts yield our best range of variation for a subset of functionally discrete posthole types, and served for control in identifying less discrete, solitary types. The solitary posthole was the most difficult to categorize because its characteristics overlapped with Other Pits. Aside from morphology, a number of traits segregated many of these amorphous pits as postholes: the presence of shims (46; 28 percent of the total number of postholes), basal stones (26; 16 percent), lignite packing (5; 3 percent), rotted wood (10; 6 percent), and/or the presence of a post mold (48; 29 percent). Ninety of the 165 postholes (55 percent) shared one or more of these characteristics. The location of pits beneath doorways in some rooms (i.e., in the Central Roomblock), where a post step was commonly placed, marked the presence of a posthole (e.g., Plate 9.3B), although many of these initially were field-classified as Other Pits. Otherwise, a cylindically shaped pit with a mouth diameter half or less than the pit depth was, with rare exceptions, classified as a posthole.

A second area of overlapping feature categories occurs among the thermal features. Although the distinction between them was based primarily on morphological characteristics, we are aware that there was sometimes a gradation among firepits, heating pits, and burns. The degree of separation between burns and heating pits, for instance, often involved a subjective determination of the degree of dimensionality--did the feature exhibit a pit or not? The latter question was made difficult when the feature was located in layers of uneven postoccupational fill or in outdoor contexts. On the other hand, basin-shaped thermal features occasionally were large-volumed and contained a slab or two, making classification a difficult choice between a firepit and a heating pit. From flotation analyses, we also know that the function of heating pits was different at Pueblo Alto than at the small sites (on which the definition for heating pits was proposed). At Alto, heating pit contents often resembled firepit contents despite the difference in morphology (see M. Toll 1985b).

Analyses of Features

Feature Diversity Indices

The distribution and frequency of different kinds of features traditionally are used by archeologists as indices of the functions of enclosed architectural space (e.g., storage, ceremonial, and living; see Hill 1970:37-40; Ciolek-Torrello 1985). Aside from the kinds of features present, their frequency and distribution can also be taken as clues to the use of space. Storage rooms, for instance, are often characterized by a few similar features, whereas living rooms yield a diverse number of features that mark the diversity of activities taking place within them. We might suspect that ceremonial rooms would fall somewhere between storage and living rooms in terms of the number and diversity of features. On this basis, categories are insensitive to finer divisions of room use (i.e., Ciolek-Torrello 1985) but may be useful for broad standardization, particularly with the small sample excavated at Pueblo Alto.

Portable remains can assist in the identity of room function, although few materials were actually found on the Pueblo Alto floors, and even with these, it is difficult to distinguish them with great certainty from floor-related use versus that from collapsed roofs or trash deposits. Because they are nonportable, features, of course, are far more reliable indicators of room use (when present) providing there is adequate temporal control over their period of use.

The Shannon-Weiner diversity index ($\bar{H}$), borrowed from the field of ecology (Pielou 1969, 1974), can be used as a measure of diversity between the types and frequencies of floor features in the rooms and kivas excavated at Pueblo Alto. Low $\bar{H}$ values indicate the presence of few features and/or little variation in the types present, whereas high values indicate many features, a number of different feature types, or both. Use in conjunction with the $\bar{H}$ index, an evenness measure (J), derived from $\bar{H}$, measures how evenly the feature types are distributed in the sample. A maximum J value (1.0) reveals that all feature types occur in even numbers. The lower the J value, the more uneven the distribution of different feature classes in the room. For living rooms we would expect a low J value and a high $\bar{H}$ value. Conversely, storage rooms should exhibit a low $\bar{H}$ value and a high J value.

All floor features were used in generating the indices--wall features, although important, were not included because of inadequate control over the sample excavated. Postholes were included because of their potential regarding room function (i.e., for room furniture), although many clearly held roof-support posts or post steps. Whether roofs or entries vary according to the type of rooms is uncertain. Thus, two lists of indices were generated--one with postholes and one without. Generally there was no radical departure between the groups of indices, so inclusion of postholes in the indices does not appear to affect the interpretation.

The indices reveal some trends (Table 9.9), but they do not indicate room function as well as does interpretation of the kinds of features present or absent. It appears that living-room floors reveal high values of $\overline{H}$ (e.g., above 1.00) and moderate values of J (below 0.9), indicating a high frequency of diverse features--as expected. These values are similar to some of those generated for early (A.D. 600-800) pitstructure floors in the Dolores area, which may also be characterized as multifunctional habitation rooms (Breternitz 1982b:Table 9). A range of values, however, characterize rooms interpreted as storage rooms at Pueblo Alto. As noted in Chapter 10, there may be subclasses of storage rooms (and living rooms) that have caused the range of variation noted in the indices. Note the values from our modal living rooms (Rooms 103 and 110), particularly the low values accorded Floors 1 and 4 in Room 103, which suggest that few multipurpose activities were taking place on them. Several other floors (Room 139, Floor 2; Room 142, Floor 2; Room 143, Floors 1 and 2; and Plaza Feature 1, Room 3, Floor 1) revealed high indices but were dissimilar to the living floors in Rooms 103 and 110 (see Volume II) in the types of features present. The diversity index would be higher and the evenness index lower for the potential living rooms, and not the pretenders, if wall niches had been included in the analysis.

Low values indicate that a few diverse feature types or a few similar feature types were present in the rooms thought to have been used for storage, as expected. The values would have been lower in some cases had they not been inflated by secondary features (e.g., floor burns). Despite numeric assistance, it was clear that many rooms lacked the abundant, diversity of features that marked potential multifunctional habitation rooms. For want of better functional categories, we can only assign these rooms to a storage function without being precise as to the types of goods or materials that they once might have contained.

Only two kiva floors could be compared, and these were dissimilar. The late kiva in the East Ruin revealed little diversity and evenness of features, like many storage rooms. Kiva 15 and Room 147, a possible clan or society room, yielded greater diversity and higher evenness indices than the late kiva. If the indices reveal functional differences between the two kivas in the diversity of activities that took place, then Kiva 15 (and Room 147) housed a greater range of activities than did the East Ruin's late kiva.

In summary, the indices have some utility in marking potential floor use. However, variation may be masked by secondary features and those unnecessary to specific room activities (e.g., some postholes and niches). A greater range of excavated rooms to test might also have yielded less overlap in the indices.

Table 9.9. Shannon-Weiner (H) and evenness (J) values for assemblages of floor features for floors with more than one feature type within rooms and kivas.

Provenience	All features				All features except postholes, steps & wall trenches			
	$\bar{H}$	J	No. of Features	No. of Types	$\bar{H}$	J	No. of Features	No. of Types
Rm. 50, Fl.1			1					
Rm. 51, Fl.1	0.693	1.000	2	2	same			
Rm. 51, Fl.2	0.693	1.000	2	2	same			
Rm. 51, Fl.3	0.474	0.684	11	2	same			
Rm. 103, Fl.1	0.690	0.996	14	2	same			
Rm. 103, Fl.2	1.522	0.849	23	6	1.282	0.797	17	5
Rm. 103, Fl.3	1.437	0.893	27	5	1.167	0.842	20	4
Rm. 103, Fl.4	0.773	0.704	52	3	0.168	0.242	25	2
Rm. 103, Fl.5			0	0				
Rm. 110, Fl.1, S1-4	1.096	0.791	29	4	0.739	0.673	23	3
Rm. 110, Fl.1, S5-6	1.463	0.817	33	6	1.357	0.843	19	5
Rm. 110, Fl.1, S7-9	1.245	0.774	123	5	0.918	0.662	95	4
Rm. 110, Fl.2	1.119	0.807	12	4	0.908	0.826	11	3
Rm. 110, Fl.3			1	1				
Rm. 112, Fl.1	0.540	0.779	13	2	same			
Rm. 112, Fl.2	0.673	0.971	5	2				1
Rm. 138, Fl.1	1.098	1.000	3	3	0.693	1.000	2	2
Rm. 138, Fl.2	1.011	0.921	6	3	0.637	0.918	3	2
Rm. 139, Fl.1	0.377	0.544	8	2				1
Rm. 139, Fl.2	1.438	0.893	45	5	0.830	0.756	25	3
Rm. 142, Fl.1	0.655	0.946	11	2				1
Rm. 142, Fl.2	1.242	0.896	6	4	0.950	0.865	5	4
Rm. 142, Fl.3[a]	1.034	0.746	11	4	0.637	0.918	3	2
Rm. 142/146, Fl.2/2[a]	1.277	0.921	7	4	1.011	0.921	6	3
Rm. 142/146, Fl.3/3[a]	1.215	0.755	14	5	0.950	0.865	5	3
Rm. 142, Fl.4[a]	0.598	0.863	7	2	same			
Rm. 142/146, Fl.6/4[a]	0.537	0.918	3	2	same			
Rm. 142, Fl.7[a]	1.040	0.946	4	3	0.637	0.918	3	2
Rm. 142/146, Fl.8/6[a]	0.271	0.391	13	2	same			
Rm. 146, Fl.8[a]	0.562	0.811	8	2	same			
Rm. 142/146, Fl.9/9[a]	0.530	0.764	9	2	same			
Rm. 143/236, Fl.1	1.548	0.864	16	6	1.215	0.876	9	4
Rm. 143, Fl.2	1.240	0.895	11	4	0.943	0.859	10	3
Rm. 143, Fl.3	0.637	0.918	3	2	same			
Rm. 143, Fl.5	0.693	1.000	2	2	same			
Rm. 143, Fl.6	1.100	1.000	3	3	0.693	1.000	2	2
Rm. 143, Fl.7	-	-	1	1				
Rm. 236, Fl.3	-	-	4	1				
Rm. 236, Fl.4	1.586	0.885	13	6	1.494	0.928	8	5
Rm. 145, Fl.1	-	-	2	1				
Rm. 146, Fl.1	0.693	1.000	2	2				1
Rm. 147, Fl.1	1.277	0.921	7	4	same			
Rm. 229, Fl.1	-	-	16	1				
Rm. 229, Fl.2	0.451	0.650	6	2				1
Kiva 15, Fl.1[a]	1.672	0.934	11	6	1.004	0.914	7	3
East Ruin kiva, Fl.1[a]	1.150	0.829	9	4	0.451	0.650	6	2
PF 1, Rm. 3, Fl.1	1.329	0.826	19	5	1.121	0.809	11	4
PF 1, Rm. 3, Fl.2	0.811	0.562	4	2				1

[a]Plaza surfaces under the rooms. Kiva values in second column include benches and vents.

Exploration for Feature Subgroups

The largest feature classes were subjected to exploratory multivariate analyses to organize the data in a systematic fashion with which to discover underlying patterns and subgroups. Without doubt, considerably more could be done with the data presented in Appendix MF-P. Overall, confidence is high in the field identification of most feature classes (see above) except for the ubiquitious Other Pits. Because it contains the largest number of features and was a catch-all class for a number of different kinds of pits, Other Pits received the closest scrutiny of any feature class. Lack of normal distributions of the metric data recorded for the Pueblo Alto features required the use of nonparametric statistics in some cases to avoid violation of the assumptions involved in classical parametric procedures. Statistical ordering of the data involved box plots, nearest-neighbor discriminate analysis, and cluster analysis using SAS statistical programs (SAS Institute 1982) and the help of computer expert Bill Doleman of the Office of Contract Archeology.

Cluster analysis was used to provide subgroupings of the individual feature classes. This procedure groups entities on the basis of similarity, although there are a wide array of cluster analyses and similar programs that will give different, often conflicting, results for the same data (see Aldenderfer and Blashfield 1984). The strength and weakness of this technique lies in its simplicity, unsupported by an extensive body of statistical reasoning. Results must always be treated with caution and viewed solely as a preliminary exploratory technique needing confirmation. In our case, we have decided against more difficult and complex involvement that would extend analysis and write-up time and impinge our statistical understanding. We have favored the use of the CLUSTER (average linkage method) in the SAS program, to reduce the variation among the attributes, with the cubic clustering criterion (CCC) as the basis for determining the number of meaningful clusters generated by the results (see SAS Institute 1982:417-423).

The CCC is only one of several methods (e.g., the cophenetic correlation, replication, significant tests on variables used to create clusters or on independent variables, and Monte Carlo procedures) used to test the validity of clusters, but the validity and utility of the CCC has not yet been demonstrated (Aldenderfer and Blashfield 1984:76) despite its promised release (SAS Institute 1982:421). Nevertheless, we have used statistics here primarily to organize the data, rather than to go into elaborate probabilistic statements.

The attributes of dimensionality (length, width, and depth) and pit fill (the volumetric density of sherds, chipped stones, and unworked bone, and the percentage of burned bone to unworked bone) were first employed as metric data for the cluster analyses. Typically, many clusters consist of outliers containing only one or two features, often those with the largest dimensions or the highest frequencies of artifacts in the feature class. Because large pit features attracted accumulations of trash, the pit fill attributes often dominated the cluster variables. Using variables based on artifact frequency, we are not convinced, however, that pit fill is indicative of primary pit use. Problems of control over differential effects of the formation processes also suggested the weakness of relying on pit-fill, artifact frequencies. With rare exceptions or in cases of very small numbers, volumetric densities of various cultural materials were always highly unreliable when assessed by the coefficient of variation (see Thomas 1976:82-85). For the most part, therefore, we settled on the use of pit morphology/dimensionality to achieve our groupings, while realizing that major classes had already been discerned on a subjective but probably real level (except for Other Pits).

The amount of variation [coefficient of variation (CV)] among the attributes selected for the cluster analyses revealed that length and width were always the most reliable (CV = <40 percent, and often <20 percent), followed by depth and volume. In all cases, volume was the least reliable of the four attributes, although it was often less than 50 percent. In theory, a large CV is grounds for rejecting the reliability of the attribute (e.g., Thomas 1976), however, a CV less than about 40 percent is indicative of good results when produced from a sample of about 10 or more (Bill Doleman, personal communication 1987). Note that some totals for the same pit classes may vary with different analyses here because features with missing values were culled from some analyses.

Firepits

Firepits were initially clustered on the 7 variables discussed above but only 17 of the 30 firepits could be grouped, because of missing data (several were unexcavated). Twelve clusters were derived for the 17 firepits, averaging a paltry 1.4 firepits per cluster. To broaden the analysis only the variables for length and width were used, resulting in 10 clusters containing 29 of the firepits (Table 9.10). Absence of the depth or volume may not be critical as size indicators because of the uncertainty over the actual usable depth required for a fire.

The largest three firepits formed individual groups. Not unexpectedly, the 10 groups revealed a dichotomy between size and location. Small and medium-sized firepits tended to be found in rooms and kivas, whereas large firepits were located outside. Undoubtedly there was functional utility for this dichotomy because large fires would be safer and more useful outdoors.

Otherwise, individual groups revealed little patterning by individual provenience or time. Two of the four firepits in Room 110 were grouped together (Cluster 1) and two of the four in Plaza 1, Grid 29, were found in Cluster 2. There was some grouping on the basis of provenience type, however. Rooms, rooms and kivas, and plaza areas tended to form clusters. Clusters 3 and 4 contained only small-room or kiva firepits (n = 7, 24 percent of all firepits), whereas Clusters 2, 5, 8-10 contained only large, outdoor firepits (n = 10, 34 percent). Indoor and outdoor firepits intermediate in size (n = 12, 41 percent) were grouped together. On the

Table 9.10. Results of the Pueblo Alto firepit cluster analysis based on length (L) and width (W) in cm.

Cluster	Provenience	Floor	FP
1	Room 110	1	1
1	Room 110	2	2
1	Room 146	3	1
1	Kiva 15	1	2
1	PF 1, Room 3	1	3
1	Plaza 1, G.175	1	2
1	Plaza 1, G.279	1	1
n=7	Mean: L=73.4, W=65.9, D=49.8[a]		
2	Plaza 1, G.29	1	2
2	Plaza 1, G.29	1	4
2	Plaza 1, G.75	1	4
n=3	Mean: L=147.3, W=134.0, D=0.0[a]		
3	Room 103	1	1
3	Room 236	4	1
3	Kiva 15	1	2
3	East Ruin kiva	1	1
n=4	Mean: L=53.8, W=46.3, D=16.8		
4	Room 103	3	1
4	Room 110	1	2
4	Room 147	1	1
n=3	Mean: L=38.7, W=25.0, D=19.0		
5	Plaza 1, G.29	1	5
5	Plaza 1, G.73	1	6
5	Plaza 1, G.193	1	5
5	PF 1, Room 3	1	1
n=4	Mean: L=128.5, W=107.8, D=116.0[a]		
6	Room 110	2	1
6	Plaza 1, G.75	1	3
6	PF 1, Room 3	1	2
n=3	Mean: L=101.7, W=81.0, D=74.0[a]		
7	Room 103	PO fill	2
7	Plaza 2, G.161	1	4
n=2	Mean: L=94.5, W=56.0, D=28.0[a]		
8	Plaza 2, G.201	1	2
n=1	Size: L=203.0, W=133.0, D=55.0		
9	Plaza 1, G.29	1	1
n=1	Size: L=211.0, W=206.0, D=0.0[a]		
10	Plaza 2, G.161	1	3
n=1	Size: L=298.0, W=108.0, D=55.0		

[a]One or more firepits in cluster lack a measurement for depth.

other hand, the three large, similar, contemporary ovens in Room 3 of Plaza Feature 1 were split into three separate groups despite assumed identical functions. In summary, the wide variability of the firepits, as determined by length and width, and the small sample preclude clear-cut patterning by location, room type, or time.

Heating Pits

The large number of heating pits used for analysis (135) was expected to result in more satisfactory results than those achieved from analysis of the firepits. These, too, were initially grouped on the 7 variables for dimensionality and pit fill, which yielded 12 clusters. Examination of the groups, however, revealed that they were often formed as a compromise between fill contents and pit size--as they were supposed to. This led to groups of very dissimilar pits of a wide range of sizes or contents or both. Also, 70 percent of the heating pits were placed in one group (Cluster 1), which made us suspect that heating pits had considerable homogeneity as a class. Only one group of 13 heating pits revealed patterning by location and age. This group consisted of large-volume pits mostly (12 of 13) located on the lower room floors and plaza surfaces under the rooms in the Central Roomblock and dating to the early A.D. 1000s. Some of these may have been reused adobe-mixing pits (see Other Pits below).

Despite the overwhelming size of Cluster 1, a disproportionate number of heating pits in Room 103 (Floor 2) and Room 139 (Floor 2), from the early to middle A.D. 1000s, were distributed among other clusters. Only half of the 8 pits from Floor 3 and 14 pits from Floor 4 in Room 103 were grouped into Cluster 1. It must be remembered that the contribution of Room 110 to the overall heating pit frequency is a large one (30 percent), but it contributed proportionally to the largest group (29 percent of Cluster 1) as might be expected if all heating pits were relatively homogeneous.

When the cluster analysis was limited solely to the three variables of dimension (length, width, and depth), there was no clustering evident. There was so little variation in volume among the pits (Figure 9.2) that it is unlikely that results would have been altered had volume been included. The results of the analysis for heating pits leads us to conclude that the class revealed remarkable homogeneity, although there is some meaningful clustering in the initial grouping that revealed spatial and temporal change of the pits. The large, early heating pits do not appear to be the same as those found in the later greathouse rooms. The large ones may represent temporary, outdoor firepits. However, if we had had metric data on the fuel contents, species of the fuel, and macrobotanical remains, there might have been a more reliable grouping of this class and firepits.

Burns

Because burns are two-dimensional features, only the variables for length and width were used in the clustering analysis. Eleven clusters

(Table 9.11) were formed from the 56 burns, but Clusters 1-3 contained the majority (64 percent). There was some tendency for the medium-to-large burns to be located in the Central Roomblock and small burns in the West Wing rooms, but the meaning of this is unclear. Most of the burns (91 percent) were found in rooms and were split about evenly between the Central Roomblock (41 percent) and the West Wing (50 percent). No kivas yielded floor burns (at least none were recorded) and only five burns were verified on plaza surfaces or from Plaza Feature 1. No patterning within the groups generated could be discerned on the basis of similarity among individual rooms or by time. Most burns appear to have been created in the late A.D. 1000s or the early A.D. 1100s near the end of the site occupation.

Wall Niches

Sixty-three niches were analyzed on the basis of the three dimensional variables. The high incidence of postoccupational deposits found in these eliminated fill contents for consideration as useful variables. Thirteen clusters were formed, with the majority of the niches (65 percent), mostly of small volume, concentrated in 3 groups (Table 9.12). Cluster 1 was comprised primarily of niches from Rooms 103 and 143 (15 of 19, 79 percent) with none from Room 142. Three of the 10 in Cluster 2 came from Room 142, whereas another 5 of the Room 142 niches concentrated in Cluster 4 (42 percent of the cluster). The three late proveniences yielding a solitary niche each (Kiva 15, the East Ruin kiva, and PF 1) were grouped together in Cluster 4, which suggests a common function for the three niches. Two of the latter were the only examples of niches placed in sealed doors, and all three were placed to the east or northeast side of the room.

Although it yielded the largest number of niches (19), Room 110 was under-represented in the largest clusters. Instead, Room 110 niches tended to form unique, low-frequency groups. Clearly this was caused by the large sizes of the Room 110 niches that were seldom found in other rooms. This phenomenon may not be entirely cultural but related to the scrutiny given the Room 110 walls. Room 103 is also expected to have an assemblage of niches like Room 110, which were not discovered and excavated. On the other hand small niches were rare in Room 110 and profuse in Rooms 103 and 143, probably because the Room 110 occupation terminated earlier than the others.

Niches from the latter two rooms (103 and 143) were frequently clustered together in the analysis. In two instances, a niche from Room 103 was paired with one of the 4 niches from Room 147 to form a cluster. The remainder from Room 147 were grouped in Cluster 1 with the majority of the Room 103 and 143 niches. The association of niches from Rooms 103, 143, and 147 in the same groups suggests links between them that are not shared by those in Rooms 110 and 142. What the niches share in common among the three rooms is age and size. All were associated with late occupation of nonstorage rooms and probably denote incidental wall storage of small

Table 9.11. Results of the Pueblo Alto burn cluster analysis based on length (L) and width (W) in cm.

Cluster	Provenience	Floor	Burn
1	Room 110	1	2
1	Room 110	1	4
1	Room 112	1	3
1	Room 112	1	5
1	Room 112	1	6
1	Room 112	1	8
1	Room 142	2	2
1	Room 143	1	4
1	Room 145	1	1
1	Room 147	1	4
1	Room 229	1	1
1	Room 229	1	2
1	Room 229	1	6
1	Room 229	1	10
1	Room 236	4	1
1	Plaza 2, G.221	9	1
n=16	Mean: 23.6, W=19.3		
2	Room 112	1	2
2	Room 112	1	4
2	Room 112	1	9
2	Room 112	1	10
2	Room 142	3	1
2	Room 229	1	4
2	Room 229	1	5
2	Room 229	1	7
2	Room 229	1	8
2	Room 236	4	2
2	Room 236	4	3
n=11	Mean: L=15.2, W=12.2		
3	Room 103	2	1
3	Room 110	1	1
3	Room 110	2	1
3	Room 142	1	1
3	Room 142	1	3
3	Room 142	2	1
3	Room 143	2	1
3	PF 1, Room 4	1	1
3	Plaza 1, G.279	1	1
n=9	Mean: L=35.9, W=26.7		

Cluster	Provenience	Floor	FP
4	Room 112	1	7
4	Room 143	1	3
4	Room 229	1	11
4	Room 229	1	12
4	Room 229	1	13
4	Plaza 2, G.201	8	1
n=6	Mean: L=48.5, W=40.5		
5	Room 143	1	2
5	Room 229	1	3
n=2	Mean: L=61.0, W=25.0		
6	Room 112	1	1
6	Room 142	1	4
n=3	Mean: L=69.0, W=66.5		
7	Room 142	2	3
7	Room 143	5	1
7	Room 229	1	9
n=3	Mean: L=36.0, W=14.3		
8	Room 139	2	1
8	Plaza 2, G.201	9	2
n=2	Mean: L=53.5, W=33.0		
9	Room 138	1	1
9	Room 139	1	1
9	Room 146	1	1
n=3	Mean: L=54.7, W=51.3		
10	Room 142	1	2
n=1	Size: L=99.0, W=73.0		
11	Room 143	1	1
n=1	Size: L=180.0, W=99.0		

Table 9.12. Results of the Pueblo Alto wall-niche cluster analysis based on variables of length (L), width (W), and depth (D) in cm.

Cluster	Provenience	Niche
1	Room 103	9
1	Room 103	10
1	Room 103	13
1	Room 103	14
1	Room 103	15
1	Room 103	18
1	Room 103	19
1	Room 103	20
1	Room 103	22
1	Room 110	13
1	Room 110	14
1	Room 143	2
1	Room 143	3
1	Room 143	5
1	Room 143	6
1	Room 143	8
1	Room 143	9
1	Room 147	2
1	Room 147	2
n=19	Mean: L=13.1, W=9.1, D=11.7	
2	Room 103	5
2	Room 103	8
2	Room 103	12
2	Room 103	17
2	Room 110	3
2	Room 110	18
2	Room 142	3
2	Room 142	7
2	Room 142	8
2	Room 143	1
n=10	Mean: L=19.2, W=11.2, D=20.1	
3	Room 103	11
3	Room 110	12
3	Room 110	15
3	Room 110	20
3	Room 142	2
3	Room 147	7
n=6	Mean: L=31.5, W=23.3, D=28.7	

Cluster	Proveneince	Niche
4	Room 103	1
4	Room 110	11
4	Room 110	17
4	Room 142	1
4	Room 142	4
4	Room 142	5
4	Room 142	6
4	Room 142	9
4	Room 143	4
4	Kiva 15	1
4	East Ruin Kiva	1
4	PF 1, Room 3	1
n=12	Mean: L=30.5, W=17.6, D=18.7	
5	Room 110	1
5	Room 110	5
5	Room 110	19
5	Room 143	10
n=4	Mean: L=42.0, W=37.8, D=27.8	
6	Room 103	6
6	Room 147	1
n=3	Mean: L=18.5, W=16.5, D=31.5	
7	Room 110	2
7	Room 110	7
n=2	Mean: L=17.0, W=10.5, D=51.5	
8	Room 110	16
8	Kiva 12	1
n=2	Mean: L=64.5, W=35.0, D=32.5	
9	Room 103	7
9	Room 147	4
n=2	Mean: L=58.5, W=16.5, D=33.0	
10	Room 110	4
n=1	Size: L=109, W=73, D=72	
11	Room 110	8
n=1	Size: L=88, W=71, D=79	
12	Room 110	6
n=1	Size: L=53, W=53, D=38	
13	Room 110	10
n=1	Size: L=87, W=61, D=41	

items or materials. Unlike the voluminous wall storage capabilites of the mid-A.D. 1000s occupation of Room 110 (and probably Room 103), later occupants maintained a different strategy of storage that did not include large subfloor or wall pits.

Paired niches thought to have held rack or shelf poles revealed similar clustering. Eight of the nine niches in Room 142 formed a large minority of two clusters. No niches opposite one another that may have held the same shelf pole were grouped together in the two clusters. This dichotomy is reasonable given the room width to be spanned by the poles and the presumed difference of the pole-end diameters. In a similar case in Room 143, paired sets of niches (N 2-3 and N 5-6) thought to have held a narrow bed platform were all satisfyingly grouped under Cluster 1.

In summary, patterning revealed by the wall niche cluster analysis was more evident than it had been for the feature classes discussed above. Apparent distinctions among the classes of niches were evident and were consistent with interpretations formed from lines of evidence other than size. Small niches clustered primarily by provenience and time (early A.D. 1100s) and may mark the late special use of the rooms in which they were abundant. Niches related to the primary occupation, however, were variable in size but typically large, reflecting a need for wall storage not evident with their successors. This is in keeping with an inferred multifunctional habitation use of Room 110 unaltered by subsequent occupations.

Postholes and Postmolds

The reliability of posthole identification is considered greater than the Other Pits class but weaker than the features analyzed above. Approximately 55 percent of the postholes had attributes that strengthened their identify beyond mere reliance on morphology, whereas an even higher number could be assigned with certainty on the basis of pit alignments. Analysis of postholes focused on the size of the posts that the holes were intended to support and patterning based on predicted post diameters. The sample used to project predictions of post diameters was derived from those postholes that exhibited postmolds (n = 48). A regression analysis of the 48 mold diameters and their accompanying posthole diameters generated a regression formula of $D_m = .2237 (D_h) + 6.07$ where D_m is the mold diameter and D_h is the posthole diameter ($F = 30$, $p < .0001$).

A histogram of the predicted and actual mold diameters indicates a bimodal distribution of post use at Pueblo Alto (Figure 9.3). The majority of posts were between 6 and 12 cm in diameter and located in the West Wing rooms. A smaller number of posts between 14 and 20 cm in diameter concentrated in the initial site Central Roomblock rooms. The majority of the large posts supported roofs or were used as post steps—a trait common to the Early Bonito phase but that apparently saw terminal use as an architectural trait in the early A.D. 1000s at Pueblo Alto. The West Wing rooms were not much narrower than those in the Central Roomblock but

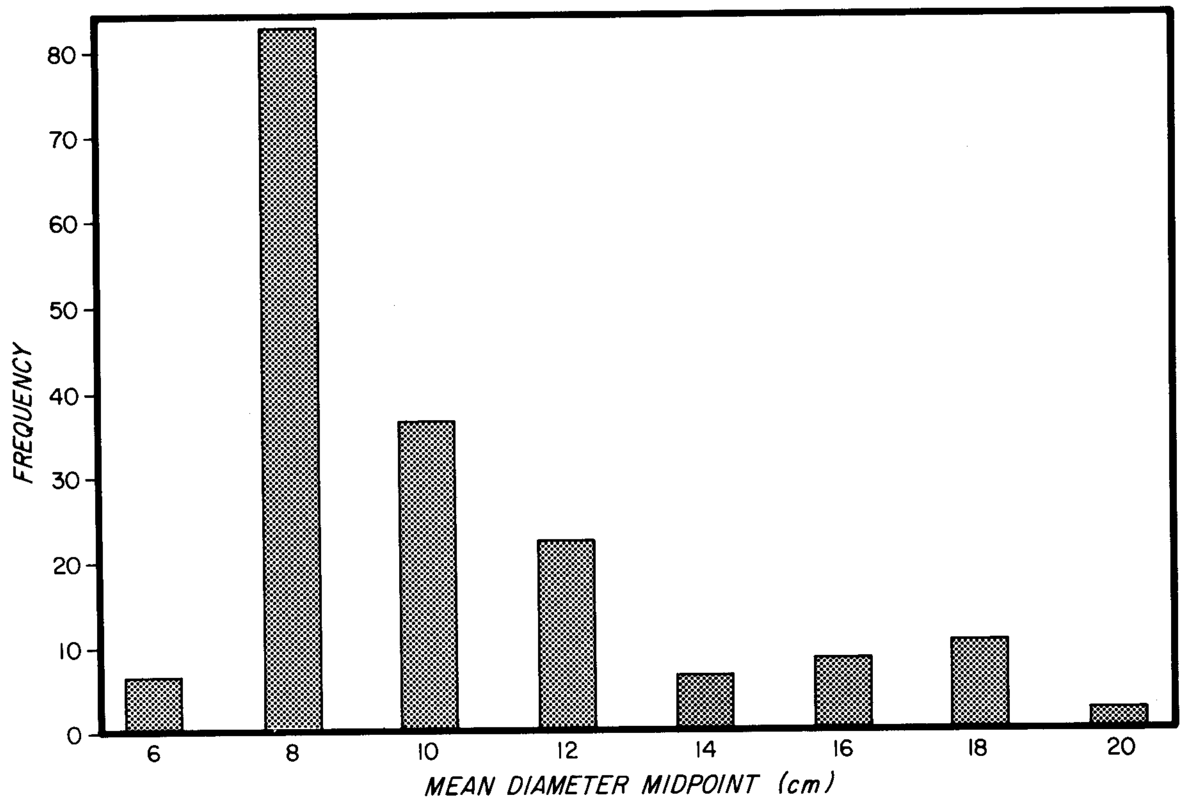


Figure 9.3. Histogram of estimated and known Pueblo Alto post mold diameters.

reflected a haphazard arrangement of small posts (perhaps for scaffolding and room furniture) without recognizable, standardized patterns for roof support. This difference, which seems to be mirrored at Pueblo Bonito, suggests a change in architectural roof design or technology that might have implications for tree procurement.

When predicted post diameters are compared floor-by-floor in different rooms, post size increased through time (Table 9.13), again suggesting shifting tree-procurement strategies or changes in roof design.

Other Pits

We are certain that a substantial number of postholes were misclassified as Other Pits because the two classes share many attributes in common. Conversely, a number of "postholes" may not have held posts. For this analysis we are assuming that the strength of the classification lies with the posthole class, and that postholes were just one of the many potential functions of "Other Pits." Thus, postholes were used as our initial basis for segregating the functions of Other Pits. Factors that might bias the identity of posthole morphology--excavation or postmolds of the exact same size as the posthole in which the post was set--may influence the cluster results, although we think they are minor problems given the large size of the sample.

Posthole data were first used to generate box-plots to identify and remove outlying postholes that fell beyond the expectations for a normal distribution. The remainder were used to reclassify the Other Pits with the use of nearest-neighbor discriminate analysis that identified 50 of the 241 Other Pits (21 percent) as postholes (and 51 of the remaining 151 postholes as "Other Pits") according to the variables of length, width, and depth. This exercise in reclassification left almost the exact same totals (by a difference of one) for Other Pits and postholes as we had initially. The results only confirm our initial impression that there was considerable dimensional overlap between the two classes. Those 191 Other Pits not reclassified as postholes were grouped by cluster analysis to generate potential subtypes on the basis of dimensionality.

This approach, however, suffered problems. First, of the 50 Other Pits reclassified as postholes, a substantial minority (22 percent) included Type 1a and Type 1b bell-shaped pits. Because of a quirk in how these were measured, only the mouth dimensions (and depth) were used in the analysis, resulting in their statistical treatment as cylindrical pits. Their bulging undersides, of course, suggest that these pits were not mere postholes. On the other hand, several Other Pits, noted in the field as possible postholes, were reclassified here, which strengthens the analytical separation. Second, when the cluster analyses were applied to the remaining 191 pits, the results revealed continuous data not applicable to clustering critera.

Table 9.13. Predicted post diameters by room and floor in Pueblo Alto.

Room	Floor	Ceramic time	Number of posts	Predicted post[a] diameter (cm)	Actual posthole[a] diameter (cm)
103	2	Gallup	6	10.5	18.3
103	3	Gallup	8	9.8	22.6
103	4	Gallup	27	9.1	14.1
110	1/1	Gallup	6	8.7	11.8
110	1/2	Gallup	13	8.5	12.1
110	1/3	Gallup	30	8.3	11.1
110	2	Red Mesa/Gallup	1	8.1	9.0
112	2	Gallup	2	10.2	18.5
138	1	Gallup/Late Mix	1	11.8	25.5
139	1	Gallup/Late Mix	7	14.6	33.8
139	2	Red Mesa	8	13.4	41.4
142	1	Gallup/Late Mix	6	14.5	30.3
142	3	Red Mesa	5	8.0	8.7
143	1	Late Mix	6	9.2	13.0
143	2	Gallup	1	12.1	27.0
236	4	Gallup	5	9.3	14.5
143	7	Red Mesa	1	9.0	13.0
229	2	Red Mesa/Gallup	5	11.7	17.4

[a]Mean measurement from total number of postholes for each floor.

To avoid the aforementioned problems, all the Other Pits were re-examined with the addition of the variable for volume. This produced clustering of the data into either 7 or 18 clusters, based on the cubic clustering criterion (SAS Institute 1982:417-421). The reclassified postholes were not culled but left in the analysis and shown under their altered classification (Tables 9.14-9.15).

The two clustering sets of 7 and 18 clusters provide meaningful, non-contradictory results, although the 18-cluster solution is preferred here because of its greater subdivision of the Other Pit variability. Four clusters accounted for 98 percent of the pits in the 7-cluster solution, with the largest cluster comprising 61 percent of the total. In contrast, the 18-cluster solution accounted for 95 percent of the total in the 9 largest clusters, with the largest cluster containing 49 percent of the total pits. Both solutions provided a number of groupings that contained only one to three pits, each of large size, outlying the normal distribution and of little informative use here.

In both solutions, the largest cluster contained a substantial part of the total sample, which demonstrated that considerable homogeneity existed among features field-classified as Other Pits based on morphology. Statistics for both of the largest clusters were similar and revealed that one type of Other Pits (small ones) were ubiquitous across time and space (Table 9.16). Subtle differences did exist in the largest clusters, however. The West Wing rooms were under-represented, despite their dominance of the overall pit sample, and Central Roomblock rooms were over-represented. Greater variability may have existed among the pits in the West Wing rooms that resulted in their analytical dispersal to clusters other than the largest.

The relative absence of pits from Rooms 103 and 110, the West Wing rooms with the greatest number of pits at the site, from the largest cluster in each solution is in keeping with their interpreted use as multi-functional habitation rooms. The greatest discrepancy is in the proportion of pits exhibiting cultural debris in the two largest clusters compared to the overall site sample (20 and 25 percent versus 46 percent), although this difference may be attributed to the small size of the pits comprising the largest clusters. Large pits more often contain trash, but this may not be illustrative of meaningful cultural behavior. Smaller clusters in each solution, however, revealed more noticeable differences in pit morphology by location and through time (Tables 9.14-9.15).

The two, second-largest clusters in the 7-group solution reveal an interesting distribution of large pits between rooms in the West Wing and the Central Roomblock, and in posthole reclassification and pit contents (Table 9.17). In Cluster 2, pits from Room 110, Floor 1, Surfaces 7-9 dominate (52 percent of the 42 pits), although 21 percent were reclassified as postholes (8 of the 9, however, were bell-shaped pits). The vast majority of the cluster pits (90 percent) contained trash, and 50 percent were bell-shaped. Type 1 pits comprised 76 percent of the total, verifying Gillespie's initial impression that these large pits formed a distinct

Table 9.14. Comparison of two groups in the 7-set-group, Other Pit cluster analysis.

CLUSTER 2				CLUSTER 3			
Provenience	Floor[a]	Feature[b]	No.	Provenience	Floor[a]	Feature[b]	No.
Room 103	1	OP	1	Room 51	3	OP	7
Room 103	2	OP	2	Room 51	3	OP	8
Room 103	4	OP	16	Room 103	1	OP	3
Room 103	4	OP	17	Room 103	1	OP	4
Room 103	4	OP	24	Room 103	1	OP	6
Room 110	1/1	OP	1	Room 103	3	OP	8
Room 110	1/1	OP	5	Room 103	4	OP	1
Room 110	1/1	PH	7	Room 103	4	OP	2
Room 110	1/1	PH	11	Room 103	4	OP	8
Room 110	1/2	OP	20	Room 103	4	OP	12
Room 110	1/2	OP	24	Room 103	4	OP	18
Room 110	1/3	PH	22	Room 103	4	OP	20
Room 110	1/3	PH	31	Room 110	1/1	OP	14
Room 110	1/3	OP	32	Room 110	1/3	OP	39
Room 110	1/3	OP	33	Room 110	1/3	OP	46
Room 110	1/3	OP	36	Room 110	1/3	OP	48
Room 110	1/3	OP	38	Room 110	1/3	OP	57
Room 110	1/3	OP	40	Room 110	1/3	OP	66
Room 110	1/3	PH	42	Room 110	1/3	OP	67
Room 110	1/3	PH	49	Room 110	1/3	OP	73
Room 110	1/3	OP	51	Room 112	1	OP	2
Room 110	1/3	PH	54	Room 112	2	OP	2
Room 110	1/3	OP	55	Room 139	2	OP	1
Room 110	1/3	OP	56	Room 139	2	OP	8
Room 110	1/3	OP	58	Room 139	2	OP	11
Room 110	1/3	OP	60	Room 139	2	OP	14
Room 110	1/3	OP	62	Room 142	3	OP	1
Room 110	1/3	OP	63	Room 142	7	OP	1
Room 110	1/3	PH	68	Room 142	9	OP	1
Room 110	1/3	PH	70	Room 142	9	OP	2
Room 110	1/3	PH	71	Room 142	9	OP	3
Room 110	1/3	PH	72	Room 142	9	OP	4
Room 110	1/3	OP	74	Room 146	8	OP	1
Room 110	2	PH	1	Room 146	9	OP	1
Room 112	1	PH	3	Room 146	9	OP	3
Room 112	2	OP	1	Room 146	9	OP	4
Room 112	1	OP	3	PF 1, Room 3	1	OP	2
Room 142	2	OP	3	PF 1, Room 4	3	OP	1
PF 1, Room 3	1	OP	4	Plaza 1, G.55	1	OP	10
PF 1, Room 4	2	OP	1	Plaza 1, G.301	8	OP	2
PF 1, Room 4	4	OP	3	Plaza 2, G.181	?	OP	1
No. Trench	1	OP	3	Plaza 2, G.221	1	OP	1

n=42 Size[c]: L=32.2, W=26.4, D=34.0, V=21.8

n=42 Size[c]: L=58.6, W=46.7, D=16.2, V=30.8

[a]1/1 = Floor 1, Surfaces 1-4; 1/2 = Floor 1, Surfaces 5-6; 1/3 = Floor 1, Surfaces 7-9.
[b]OP = Other Pit; PH = Other Pits reclassified as postholes--the original OP number remains the same despite the reclassification.
[c]L = length (cm), W = width (cm), D = depth (cm), V = volume (liters).

Table 9.15. Results of the 18-set-group, Other Pit cluster analysis based on the variables of length (L), width (W), and depth (D) in cm, and volume in liters.

Provenience	Floor[a]	Feature[b]	No.	Time[c]
CLUSTER 1				
Room 51	2	OP	1	1
Room 51	3	OP	2	1
Room 51	3	OP	3	1
Room 51	3	OP	4	1
Room 51	3	OP	5	1
Room 51	3	OP	6	1
Room 51	3	OP	9	1
Room 103	1	OP	2	4
Room 103	2	OP	1	4
Room 103	2	OP	3	4
Room 103	3	OP	3	4
Room 103	3	PH	5	4
Room 103	3	OP	6	4
Room 103	3	PH	7	4
Room 103	4	OP	3	4
Room 103	4	PH	4	4
Room 103	4	PH	5	4
Room 103	4	PH	6	4
Room 103	4	OP	7	4
Room 103	4	OP	9	4
Room 103	4	OP	10	4
Room 103	4	OP	15	4
Room 103	4	OP	19	4
Room 103	4	PH	21	4
Room 103	4	OP	23	4
Room 110	1/1	OP	2	4
Room 110	1/1	OP	3	4
Room 110	1/1	OP	4	4
Room 110	1/1	PH	6	4
Room 110	1/1	OP	13	4
Room 110	1/2	PH	18	4
Room 110	1/2	OP	19	4
Room 110	1/2	OP	23	4
Room 110	1/3	OP	26	4
Room 110	1/3	PH	27	4
Room 110	1/3	OP	28	4
Room 110	1/3	OP	29	4
Room 110	1/3	OP	30	4
Room 110	1/3	OP	34	4
Room 110	1/3	OP	35	4
Room 110	1/3	PH	41	4
Room 110	1/3	PH	43	4
Room 110	1/3	PH	44	4
Room 110	1/3	OP	47	4
Room 110	1/3	OP	50	4
Room 110	1/3	OP	53	4
Room 110	1/3	OP	59	4
Room 110	1/3	OP	61	4
Room 110	1/3	PH	64	4
Room 110	1/3	OP	65	4
Room 110	2	OP	2	3
Room 112	1	OP	1	5
Room 138	1	OP	1	5
Room 138	1	OP	2	5
Room 138	2	OP	2	2
Room 138	2	PH	4	2
Room 139	2	OP	4	2
Room 139	2	OP	5	2
Room 139	2	OP	6	2
Room 139	2	PH	7	2
Room 139	2	PH	9	2
Room 139	2	OP	10	2
Room 139	2	OP	13	2
Room 139	2	OP	15	2
Room 139	2	OP	16	2
Room 142	1	PH	1	5
Room 142	3	PH	3	2
Room 142	4	OP	1	1
Room 142	4	OP	2	1
Room 142	6	OP	1	1
Room 142	6	OP	2	1
Room 142	8	PH	1	1
Room 143	2	OP	2	4
Room 143	2	OP	3	4
Room 143	2	PH	4	4
Room 143	2	OP	7	4
Room 143	3	OP	1	4
Room 143	3	OP	2	4
Room 143	5	OP	1	4
Room 143	6	OP	1	4
Room 143	6	PH	2	4
Room 146	8	OP	2	1
Room 146	8	PH	3	1
Room 146	8	PH	4	1
Room 146	8	PH	5	1
Room 146	8	OP	6	1
Room 146	9	OP	2	1
Room 147	1	OP	3	5
Room 147	1	OP	4	5

[a] 1/1 = Floor 1, Surfaces 1-4; 1/2 = Floor 1, Surfaces 5-6; 1/3 = Floor 1, Surfaces 7-9.
[b] OP = Other Pit, PH = Other Pits reclassified as postholes--the original OP number remains the same despite pit reclassification.
[c] 1 = A.D. 980-1030 and pregreathouse construction, 2 = A.D. 1030-1050, 3 = A.D. 1030-1060, 4 = A.D. 1050-1100, 5 = A.D. 1080-1120, 6 = A.D. 1100-1140.

Table 9.15 (continued)

Provenience	Floor[a]	Feature[b]	No.	Time[c]
CLUSTER 1 (cont'd)				
Room 236	3	OP	1	4
Room 236	3	OP	2	4
Room 236	4	OP	1	4
Room 236	4	OP	8	4
Kiva 15	1	OP	1	6
Kiva 15	1	PH	2	6
Kiva 15	1	OP	3	6
East Ruin kiva	1	OP	1	6
East Ruin kiva	1	OP	2	6
East Ruin kiva	1	OP	3	6
East Ruin kiva	1	OP	5	6
East Ruin kiva	2	PH	2	6
PF 1, Room 3	1	OP	3	6
PF 1, Room 3	1	PH	5	6
PF 1, Room 3	1	OP	7	6
PF 1, Room 4	3	OP	3	2
PF 1, Room 4	4	OP	1	2
Plaza 1, G.8	2	PH	6	6
Plaza 1, G.8	4	PH	3	2
Plaza 2, G.181	4	OP	1	6
Plaza 2, G.181	4	OP	2	6
Plaza 2, G.182	fill	OP	5	6
Plaza 2, G.201	3	PH	2	6
Plaza 2, G.201	5	OP	1	6
Plaza 2, G.201	6	PH	1	4
Plaza 2, G.201	7	PH	1	4
Plaza 2, G.201	9	OP	2	4
North Trench	1	OP	1	5
North Trench	1	PH	2	5

n=118 Size: L=16.7, W=14.1, D=9.9, V=1.9

Provenience	Floor	Feature	No.	Time
CLUSTER 2				
Room 50	1	OP	1	1
Room 51	3	OP	1	1
Room 103	3	OP	1	4
Room 103	3	PH	2	4
Room 103	3	OP	4	4
Room 110	1/1	OP	8	4
Room 110	1/1	OP	9	4
Room 110	1/1	OP	10	4
Room 110	1/1	OP	12	4
Room 110	1/1	OP	15	4
Room 110	1/1	OP	16	4
Room 110	1/2	OP	17	4
Room 110	1/2	OP	21	4
Room 110	1/2	OP	25	4
Room 110	1/3	OP	37	4
Room 110	1/3	OP	42	4
Room 110	1/3	OP	52	4
Room 142	2	OP	2	5
Room 142	3	OP	5	2
Room 143	1	PH	1	6
Room 236	1	OP	1	4
Plaza 1, G.175	1	OP	3	6
Plaza 1, G.301	6	PH	1	4
Plaza 2, G.155	1	OP	1	6
Plaza 2, G.201	9	OP	1	4
PF 1, Room 3	1	OP	1	6
East Ruin kiva	2	OP	1	6

n=27 Size: L=33.3, W=27.9, D=8.0, V=4.9

Provenience	Floor	Feature	No.	Time
CLUSTER 3				
Room 110	1/1	PH	7	4
Room 110	1/1	PH	11	4
Room 110	1/3	OP	22	4
Room 110	1/3	PH	32	4
Room 110	1/3	OP	38	4
Room 110	1/3	PH	49	4
Room 110	1/3	OP	51	4
Room 110	1/3	OP	55	4
Room 110	1/3	OP	58	4
Room 110	1/3	OP	60	4
Room 110	1/3	OP	62	4
Room 110	1/3	PH	68	4
Room 110	1/3	PH	71	4
Room 110	1/3	PH	72	4
Room 110	1/3	OP	74	4
PF 1, Room 4	2	OP	1	3

n=16 Size: L=32.5, W=29.0, D=42.3, V=30.3

Provenience	Floor	Feature	No.	Time
CLUSTER 4				
Room 110	1	OP	1	4
Room 110	1	OP	3	4
Room 110	1/3	PH	31	4
Room 110	2	PH	1	3
Room 112	1	PH	3	5

n=5 Size: L=13.6, W=12.6, D=34.4, V=6.9

[a]1/1 = Floor 1, Surfaces 1-4; 1/2 = Floor 1, Surfaces 5-6; 1/3 = Floor 1, Surfaces 7-9
[b]OP = Other Pit, PH = Other Pits reclassified as postholes--the original OP number remains the same despite pit reclassification.
[c]1 = A.D. 980-1030 and pregreathouse construction, 2 = A.D. 1030-1050, 3 = A.D. 1030-1060, 4 = A.D. 1050-1100, 5 = A.D. 1080-1120, 6 = A.D. 1100-1140.

Table 9.15 (continued)

Provenience	Floor[a]	Feature[b]	No.	Time[c]
C L U S T E R 5				
Room 103	1	OP	1	4
Room 103	2	OP	2	4
Room 103	4	OP	16	4
Room 103	4	OP	17	4
Room 103	4	OP	24	4
Room 110	1/1	OP	5	4
Room 110	1/2	OP	24	4
Room 110	1/3	OP	30	4
Room 110	1/3	OP	36	4
Room 110	1/3	OP	40	4
Room 110	1/3	PH	42	4
Room 110	1/3	PH	54	4
Room 110	1/3	OP	56	4
Room 110	1/3	PH	70	4
Room 112	2	OP	1	4
Room 112	2	OP	3	4
Room 142	2	OP	3	5
PF 1, Room 3	1	OP	4	6
PF 1, Room 4	4	OP	3	2
North Trench	1	OP	3	5
n=20 Size: L=35.0, W=27.8, D=27.1, V=18.0				
C L U S T E R 6				
Room 51	3	OP	7	1
Room 103	1	OP	4	4
Room 103	1	OP	6	4
Room 103	4	OP	8	4
Room 110	1/1	OP	14	4
Room 110	1/3	OP	48	4
Room 139	2	OP	8	2
Room 139	2	OP	1	2
Room 142	3	OP	1	2
Room 142	7	OP	1	1
Room 142	9	OP	1	1
Room 146	9	OP	3	1
Room 146	9	OP	4	1
n=13 Size: L=50.4, W=46.9, D=12.3, V=19.3				
C L U S T E R 7				
Room 51	3	OP	8	1
Room 103	3	OP	8	4
Room 103	4	OP	2	4
Room 103	4	PH	12	4
Room 110	1/3	OP	46	4
Room 110	1/3	OP	57	4
Room 112	1	OP	2	5
Room 139	2	OP	11	2
Room 139	2	OP	14	2
n=9 Size: L=57.2, W=30.8, D=12.4, V=17.0				

Provenience	Floor	Feature	No.	Time
C L U S T E R 8				
Room 112	2	OP	2	4
Room 142	9	OP	2	1
Room 146	8	OP	1	1
Room 146	9	OP	1	1
PF 1, Room 4	3	OP	1	2
Plaza 1, G.55	1	OP	10	6
Plaza 1, G.301	8	OP	2	1
Plaza 2, G.181	fill	OP	1	6
Plaza 2, G.221	1	OP	1	6
n=9 Size: L=72.3, W=64.0, D=13.9, V=37.1				
C L U S T E R 9				
Room 103	4	OP	1	4
Room 103	4	OP	18	4
Room 103	4	OP	20	4
Room 110	1/3	OP	39	4
Room 110	1/3	OP	66	4
Room 110	1/3	OP	67	4
Room 110	1/3	OP	73	4
Room 142	9	OP	3	1
Room 142	9	OP	4	1
n=9 Size: L=53.1, W=47.6, D=28.3, V=53.7				
C L U S T E R 10				
Room 103	4	OP	11	4
Plaza 1, G.8	6	PH	4	2
East Ruin kiva	1	OP	4	6
n=3 Size: L=49.7, W=42.0, D=52.3, V=82.8				
C L U S T E R 11				
Room 103	1	OP	3	4
PF 1, Room 3	1	OP	2	6
n=2 Size: L=81.5, W=35.0, D=15.5, V=37.0				
C L U S T E R 12				
Room 103	1	OP	7	4
Room 143	2	OP	1	4
n=2 Size: L=81.5, W=37.0, D=50.0, V=47.5				
C L U S T E R 13				
Room 110	1/3	OP	63	4
n=1 Size: L=61.0, W=25.0, D=35.0, V=37.2				

[a] 1/1 = Floor 1, Surfaces 1-4; 1/2 = Floor 1, Surfaces 5-6; 1/3 = Floor 1, Surfaces 7-9.
[b] OP = Other Pit, PH = Other Pits reclassified as postholes--the original OP number remains the same despite pit reclassification.
[c] 1 = A.D. 980-1030 and pregreathouse construction, 2 = A.D. 1030-1050, 3 = A.D. 1030-1060, 4 = A.D. 1050-1100, 5 = A.D. 1080-1120, 6 = A.D. 1100-1140.

Table 9.15 (concluded)

Provenience	Floor[a]	Feature[b]	No.	Time[c]
CLUSTER 14				
Room 146	2	OP	6	2
n=1 Size: L=110.0, W=56.0, D=35.0, V=110.6				
CLUSTER 15				
PF 1, Room 3	2	OP	1	5
n=1 Size: L=77.0, W=64.0, D=40.0, V=139.5				
CLUSTER 16				
Plaza 1, G.8	4	OP	2	2
n=1 Size: L=64.0, W=40.0, D=78.0, V=105.1				
CLUSTER 17				
Room 103	1	OP	5	4
n=1 Size: L=125.0, W=75.0, D=16.0, V=110.1				
CLUSTER 18				
Plaza 1, G.30	2	OP	1	2
n=1 Size: L=114.0, W=114.0, D=112.0, V=872.7				

[a] 1/1 = Floor 1, Surfaces 1-4; 1/2 = Floor 1, Surfaces 5-6; 1/3 = Floor 1, Surfaces 7-9.
[b] OP = Other Pit, PH = Other Pits reclassified as postholes--the original OP number remains the same despite pit reclassification.
[c] 1 = A.D. 980-1030 and pregreathouse construction, 2 = A.D. 1030-1050, 3 = A.D. 1030- 1060, 4 = A.D. 1050-1100, 5 = A.D. 1080-1120, 6 = A.D. 1100-1140.

Table 9.16. Comparison of cluster analyses between the largest cluster in the 7- and 18-set-groups and to the overall site sample of Other Pits.

	7-group set (Cluster 1)		18-group set (Cluster 1)		Total analysis sample	
Sample size	145		118		239	
% of sample size	65		49		100	
Mean length (cm)	19.8		16.7		31.4	
Mean width (cm)	16.7		14.1		25.1	
Mean depth (cm)	9.6		9.9		16.8	
Mean volume (liters)	2.5		1.9		17.9	
	Number	%	Number	%	Number	%
Room 103	21	14	17	14	41	17
Room 110	38	26	26	22	75	31
Room 142	9	6	7	6	16	7
West Wing[a]	57	39	50	42	125	52
Central Roomblock[a]	27	19	16	14	25	10
Other	42	42	52	44	89	37
Reclassified as postholes	35	24	32	27	49[b]	21
Pits with cultural debris	36	25	24	20	109	46

[a]Primary greathouse rooms only.
[b]One posthole not included from previous analysis because of missing values.

Table 9.17. Comparison of the overall distribution of Other Pits with the results of the 18-set-group, cluster analysis by time and area.

Ceramic group:	Red Mesa		Red Mesa /Gallup	Gallup	Gallup/ Late Mix	Late Mix	West Wing[a]	Central Rmbk[a]	Other	Total
Time period:	1	2	3	4	5	6				
Overall Site	32	27	3	135	14	28	125	25	89	239
%	13	11	1	56	6	12	52	10	37	
Cluster 1	18	15	1	59	8	17	50	27	41	118
%	15	13	1	50	7	14	42	23	35	
Cluster 2	2	2		18	1	5	15	4	8	27
%	7	4		67	4	19	56	15	30	
Cluster 3			1	15			15		1	16
%			6	94			94		6	
Cluster 4			1	3	1		5			5
%			20	60	20		100			
Cluster 5		1		16	2	1	16	1	3	20
%		5		80	10	5	80	5	15	
Cluster 6	5	3		5			5	3	5	13
%	38	23		38			38	23	38	
Cluster 7	1	2		5	1		6	2	1	9
%	11	22		56	11		67	22	11	
Cluster 8	4	1		1		3	1		8	9
%	44	11		11		33	11		89	
Cluster 9	2			7			7		2	9
%	22			78			78		22	
Clusters 10-18		4		6	1	2	5	1	7	13
%		31		46	8	15	38	8	54	

[a]Primary greathouse rooms.

class (see Tables 9.5-9.6). The 18-group solution subdivided the Type I pits into three smaller clusters (Clusters 3, 5, and 9; see Table 9.15).

In Cluster 3 of the 7-group solution, the pit distribution was spread more evenly than in Cluster 2. Pits from Room 103 (Floor 4), Room 110 (Surfaces 7-9), Room 139 (Floor 2), and Room 142/146 (Floor 9) formed 58 percent of the cluster. Fewer pits contained trash (60 percent) compared to Cluster 2 (although Cluster 3 pits averaged larger), and none were reclassified as postholes. Cluster 3 was also dominated by Central Roomblock pits (67 percent) and early (early to mid-A.D. 1000s) pits (79 percent). Bell-shaped pits were rare in Cluster 3, and those classified in the Gillespie system were dominated by Types 1c, 5, and 6 (88 percent). In the 18-group solution, Cluster 2 pits were subdivided into Clusters 5, 6, 7, and 9 (Table 9.15).

Clusters 2 and 3, then, suggest that at least two groups of large, storage pits were typical of the occupation at Pueblo Alto in the early to middle A.D. 1000s. The redundancy of the Cluster 2 pits in Rooms 103 and 110 (81 percent of the cluster) suggests reliance on large, floor pits for storage. The similarity of these pits to cache pits used by mobile Archaic groups for seasonal or intermittent storage in rock shelters (Ingbar 1985) may be a clue that these pits were not used on a daily basis. Cluster 3 pits were similar to Cluster 2 pits in age and dimensionality but tended to be straight-sided or bowl-shaped and may have served different purposes.

The 18-group solution provided a broader segregation of pit variability and generally CV results were much lower for the attributes, which is indicative of an improved reliability of the results. Clusters 2-3 and 5-12 yielded results of 21 percent for length and width, whereas the CV for depth was less than 20 percent for Clusters 3, 4, 5, 9, 10, and 12. Volume CVs were under 50 percent in Clusters 4, 5-6, and 8-11. The largest cluster (Cluster 1) was discussed above. Cluster 2 pits were also small but found primarily (56 percent) in the West Wing, multifunctional living rooms (Rooms 103 and 110). Pits from the last half of the A.D. 1000s comprised 67 percent of these 27 pits. The majority came from Floor 1 in Room 110 and Floor 4 in Room 103, and 44 percent contained cultural debris. Few had been reclassified as postholes (11 percent). Their overall distribution and age reflect a type of pit similar to Cluster 1 (e.g., ubiquitous) but slightly larger in size and suitable for the storage of only a few small items.

A small group containing 5 pits (Cluster 4) was also similar to the first two clusters, but the pits were deeper. All were found in the Room 110 suite, and all contained cultural material. None came from the same floor, however, and three were reclassified as postholes (two were bell-shaped). I presume that either this type of pit was needed throughout the occupation by the occupants of Room 110 on a limited basis or that the group was comprised of just a miscellaneous collection of small pits devoid of meaningful interpretation.

The remaining 15 clusters contained large-volume pits (>30 liters) except for Clusters 5-7, which yielded mean volumes between 17 and 19 liters. Of the latter, pit Clusters 6 and 7 exhibited similar dimensions with the length about 3-4 times the depth. Cluster 5 pit mouths were smaller but had twice the depth as those in Clusters 6 and 7. Reclassified postholes were rare among the three clusters (15 percent in Cluster 5 and absent in the rest). Cultural material, however, was common in the fill of all three groups: 80 percent of the pits in Clusters 5 and 7 and 54 percent in Cluster 6. About half of the Cluster 5 pits came from Room 110 with Room 103, Floor 4, yielding another 15 percent. Most were dated between A.D. 1050-1100 (80 percent) and were from the West Wing rooms (80 percent). Those classified under the Gillespie system dominated as bell-shaped Type 1b (35 percent) and Type 1c (40 percent) storage pits.

Although similar to the Cluster 5 pits, those in Cluster 6 came primarily from the pre-A.D. 1050 floors under the Central Roomblock (62 percent), and a few exhibited evidence of adobe-mixing use (Plate 9.1C). Only one of the eight bowl-shaped pits contained cultural material. On the other hand, the remainder were post-A.D. 1050 pits from Rooms 103 and 110 (mostly Types 5 and 6). Given the dichotomy in space and time in Cluster 6, it appears that pits of similar dimensionality here served different functions: storage in the West Wing rooms and construction under the Central Roomblock.

The nine pits in Cluster 7 were dominated by pit Types 5 and 6 from Rooms 103 and 110. Three, however, came from pre-A.D. 1050 contexts under the Central Roomblock. All were broad-mouthed pits of similar dimensions, although depths and volumes formed two distinct subgroupings in time and space. Four were 8 cm or less in depth, whereas the remainder ranged between 14 and 22 cm. In volume, five were less than 10 liters and the remainder between 18 and 46--a curious lumping of a bimodal distribution for 2 of the 4 attributes used in the analysis. Cultural debris was found in 78 percent of the pits.

The only grouping dominated by outdoor pits occurred in Cluster 8 (n = 9). These had mouth dimensions exceeding 55 cm and volumes between 14 and 67 liters but were relatively shallow (<21 cm). The CV revealed that the Cluster 8 attributes were some of the most reliable of any cluster, particularly in length (CV = 12.6 percent) and width (CV = 9.5 percent). The volume CV (43 percent) was also relatively very good. All but one (in Room 112) were outdoor pits, although temporally they grouped early to late in the site occupation. Cultural material occurred in three of the nine pits. One pit was identified as an adobe-mixing pit, and all may have been related to construction activities.

Cluster 9 pits were similar in mouth dimension to the Cluster 8 pits but were about twice as deep and about two-thirds larger in volume. Interestingly, these pits were nearly exclusive to A.D. 1050-1100 floors in Rooms 103 and 110 with two exceptions: early, outdoor, adobe-mixing pits that functionally belong to Cluster 8. Those in Rooms 103 and 110 clustered within the room but differed in location. In Room 110, three of the four were placed next to the plaza entry doors, however, in Room 103 they were found in the southwest part of the room away from any doors. Unlike Cluster 8 pits, cultural debris was found in all of the pits except one and the two outdoor, adobe-mixing pits. Type 1c pits dominated the group, three from Room 110. Except for the two adobe-mixing pits that should be placed in Cluster 8, the Cluster 9 pits can be attributed to large-volume storage.

The remaining clusters (10-18) contained 5 percent of the overall sample and the large, unusual pits. Six of the 13 were located in Plaza 1, Plaza Feature 1, and the East Ruin kiva. Three of the seven pits on the uppermost floor in Room 103 were scattered in three clusters, but otherwise there was little informative patterning in the remaining clusters.

In summary, the cluster analysis of Other Pits provided two alternatives of pit groupings, both of which generated clusters that appeared meaningful on the basis of time and space (Table 9.17). We assume that dimensionality is causally related to pit function (e.g., Ingbar 1985:308) and that time and space patterning reflected by some pit clusters also provide clues to some storage behavior at the site. Interpreting function of the unlined, unburned pits at Pueblo Alto is empirically derived rather than drawn from a solid, substantive basis. Because such pits are rarely reported for many sites excavated in Chaco Canyon, and the remainder rarely yielded pits containing materials indicative of function, pit function must be explained primarily by morphology and spatial patterning. We would expect, however, the spatial distribution of these and other pit types to remain relatively constant through time if there was little functional change of the areas in which they were located--of course, we know that this did not happen.

Some pit clusters did not appear meaningful on the basis of temporal or spatial patterning, although this should not be discouraging because other factors aside from those chosen for dimensionality were probably important functional determinants. In addition, we also recognize that a number of Other Pits may have been used as postholes, and vice versa, and that this problem needs further work to resolve identification of pits used for storage and post support. Aside from the room bell-shaped pits that were reclassified (wrongly) as postholes, most of the reclassified pits (21 of 39, 54 percent) were located in construction floors or in outside surfaces in spatial association with verified postholes. Relative to room pits, more outdoor pits were reclassified as postholes. Thus, most outdoor Other Pits were likely to have been postholes.

Overall, half or more of the Other Pits were small, ubiquitous pockets that must have served a variety of needs through time and location. Small clusters of pits were created primarily from the large-volume pits. Although the large pits were dispersed spatially, primarily they were found during the early and classic occupations at the site but not generally after A.D. 1100. Large, bowl-shaped basins were found under the Central Roomblock, and the few found with gobs of mortar inside suggest that

Clusters 6 and 9, in part, and Cluster 8 pits were associated with construction activities in the 18-group solution. Large, deep pits, many of them bell-shaped cavities with small mouths, comprised separate clusters of pits that we believe were used for storing goods (Clusters 6, 7, and 9, in part, and Cluster 5). The mouth size of the large-volume pits was probably an important factor in the type of goods being stored or their duration of storage. Small-mouthed pits of large volume would be efficient containers to cache foods and equipment over a long period of time (see Ingbar 1985:316).

Storage pit clusters generally were dominated spatially by those from the multifunctional living rooms (103 and 110) in the West Wing. The two other candidates for living-room status, Rooms 143/236 and 147, yielded pits that were lumped primarily with the widespread, small, ubiquitous pits but rarely with those distinct clusters dominated by Rooms 103 and 110. Thus, we can postulate that storage behavior in firepit rooms differed between the Central Roomblock and West Wing.

Conclusions

Features at Pueblo Alto reveal spatial and temporal patterning that provide clues to different functions within the site. In addition, groupings of feature types using cluster analyses provided some meaningful clues to pit function. There is a clear dominance of features of all types in the West Wing living rooms. This is not surprising given the rooms' presumed multifunctional use. Central Roomblock rooms reveal few features and less pit diversity in keeping with an interpreted storage function. Rooms that contain features suggestive of living rooms (e.g., firepits) are dissimilar. The classic living rooms were centered in the West Wing. Early floors at the site, either those in use before Pueblo Alto was built or those used during the Alto construction, however, reveal some living-room features in the Central Roomblock rooms rather than in the West Wing. After A.D. 1100, occupation of some sort returned to the Central Roomblock after the West Wing living rooms had been abandoned for some time. Architectural units built in the A.D. 1100s at the site are expected to provide a more widespread pattern of occupation than those marking the A.D. 1000s, but these were not investigated.

The largest pits among the Other Pits and heating pits occurred in the pre-greathouse, outdoor surfaces under the Central Roomblock. The grouping of these large pits in the heating pit cluster analysis and in the Other Pit Cluster 8 (Table 9.15) suggests a functional relationship among them. A few yielded evidence of adobe-mixing, although for what specific construction is unknown. These pits generally were found in the lowest levels at Pueblo Alto, below all evidence of construction, including Rooms 50 and 51. Nevertheless, we can confidently assign these pits to construction-related activities. Analyses of mortar at Pueblo Alto confirm that the hard, caliche, native soils were like those used in part of the construction (see Appendices MF-H to MF-J). Because of their proximity to the large unburned pits, those that were burned probably were reused adobe-mixing pits.

A relative paucity of firepits at the site made it difficult to obtain clustering results that reflected meaningful patterning. It is obvious that firepits as a class increased in numbers through time, particularly relative to all other feature classes. They also may have shifted, in part, from a small-group facility to a communal one located outdoors. At the same time, heating pits became fewer (Table 9.4). This change, we think, has implications for interpreting occupation duration. Generally, firepits were the only features noted in the post occupational period between A.D. 1300 and 1400. The paucity of other feature types, in this case, may be biased by a lack of morphology distinctive to the post occupational period. Their absence may also reflect brief, transitory occupation(s). Heating pits were often associated with firepits in earlier puebloan sites (usually in pithouses) and in other cultures, where they have been suggested as complementary to firepits (e.g., Binford 1983:158; Jennings et al. 1980:39). This association is rejected for Pueblo Alto simply because heating pits were too often found without a corresponding firepit and, instead, they may have been used as temporary firepits.

Mealing bins, an important piece of domestic room furniture, were only found for a short period between about A.D. 1050 and 1080 at Pueblo Alto. Coincident with their increase were poor and uncertain environmental conditions that may have affected subsistence strategies. Whether bins were abandoned in the early A.D. 1100s during very favorable environmental conditions is uncertain without excavation of a large sample of late living rooms. Understanding of the rise and decline in mealing bins may be important in addressing the changing nature of the greathouse occupation.

Large-volume floor pits and wall cavities dominate the A.D. 1000s occupation at the site, but these fall into disfavor by the late A.D. 1000s. The norm for the early A.D. 1100s, however, are multitudes of small pits and cavities that mark a presumed shift in storage strategy. The total volume of small pits within any room is inadequate for the storage needs evidenced by the earlier occupation. Although he was speaking of Archaic behavior, Ingbar's (1985:330) belief that the degree of residential or logistical mobility determined the utility of seasonal caching may be applicable to the residency at Pueblo Alto. Although there may have been just as many bulk foods or goods to store during the A.D. 1000s and the 1100s, the large, early pits suggest ideal containers for long-term cache behavior that was modified or proved unnecessary later on. The change in storage strategy coincides with changes in the environment and, therefore, it is easy to postulate a causal relationship between storage behavior and the environment.

Chapter Ten

The Identification of Architectural Units (Suites)

This chapter will transcend individual architectural space at the site (e.g., rooms and kivas) to focus on aggregate units and potential suite functions. In order to glimpse the role and function for which Pueblo Alto was built, we must attempt to understand the units or suites comprising it. Webster's dictionary defines suite as "a series or group of things forming a unit or constituting a complement or collection," specifically "a group of rooms designed for occupancy as a unit." Suites are defined here as a group of interconnected rooms thought to be occupied or used as a unit for one purpose or by one group. To paraphrase Rohn (1971), the emphasis is on the mutual accessibility of the component spaces and the relative isolation of those same spaces from other room units. Ideally a suite, therefore, may include surface rooms, pitstructures, and associated outdoor space.

Archeological emphasis is often on household or family units (i.e., Rohn 1971:31), and these may be defined as task-oriented units engaged in some condition of production, distribution, transmission, and reproductive activities (Netting 1982:642-643). More realistically, a household may also be defined as the unit of a domestic group most amenable to identification in the archeological record and represented in the systemic context of a cultural and behavioral system by implements and facilities related to the storage, preparation, and cooking of food (Ciolek-Torrello and Reid 1974:40). Household locations are difficult to predict and identify in Chacoan greathouses, however, because of the large number of suites or room units that cannot be associated with living quarters. Perhaps many of these served communal rather than family purposes or were unrelated to activities associated with the permanent site inhabitants. Secondary doors and walls may further complicate the identification of suites because they mask the original planning intent indicated by the primary architectural layout. The problem is particularly acute for a site such as Pueblo Alto that is mostly unexcavated. For this reason the primary focus here is on the initial occupation because much of the organizational plan is fossilized in the visible architecture.

The use of space may reflect widespread patterning common to many sedentary groups (Oetelaar 1985). Replicability of architectural form is assumed to be the basis for potential replicability in function, particularly if a form is comprised of a number of similarly organized suites. Continuity between historic and prehistoric puebloan architecture suggests that the identity of units related to storage, habitation, ceremonial, and outdoor activities is possible, although there were some major differences at the Chacoan greathouses.

During the Early Bonito phase (A.D. 900-1040/1050) there was an apparent continuation of the small-house room pattern. Large rooms typically were built adjacent to the plaza and had door access to it, whereas smaller rooms were built, often in pairs, behind the large room. In small sites, these rooms can be dichotomized into habitation (large room) and storage (small room) uses. Discouragingly, in the greathouses the same functions are not as easily identified although the room layout can be virtually the same. At greathouses, the front rooms decrease in size through time, the outer tier of (small) rooms remains about the same, and the intermediate tier(s) duplicate both frontal and outer tiers (Lekson 1984:40). Multistory construction complicates identification of interconnectedness and suites. When occupation has been lengthy, it also becomes increasingly difficult to delineate contemporaneous suites because of remodeling changes.

In spite of our relatively small, excavated sample of rooms at Pueblo Alto, wall clearing, an intense search for doors and some comparative information from other greathouses permit the identification of only a few patterns of room use and suite arrangements in the Chacoan greathouses. The room use of Alto can be divided into three major components (see Figures 6.6-6.10):

(1) the primary intended use of the site, which incorporated building Stages I through III;

(2) remodeling of the primary construction, which resulted in major alterations to the form and function of many suites and incorporated Stage IV; and

(3) additional remodeling at the site as well as numerous architectural additions that markedly contrast with the initial patterns of architecture, layout, and use of space (Stage V).

Initial Pueblo Alto Suites (Figure 10.1)

The primary construction at Pueblo Alto is the easiest to decipher because of the rigid adherence to a single type of wall construction and a symmetrical architectural plan. Symmetry allows inference to be carried from excavated to unexcavated units with some degree of confidence, which otherwise would be compromised by extension to dissimilar units. Symmetry also allows insights into the sociopolitical and functional plans that

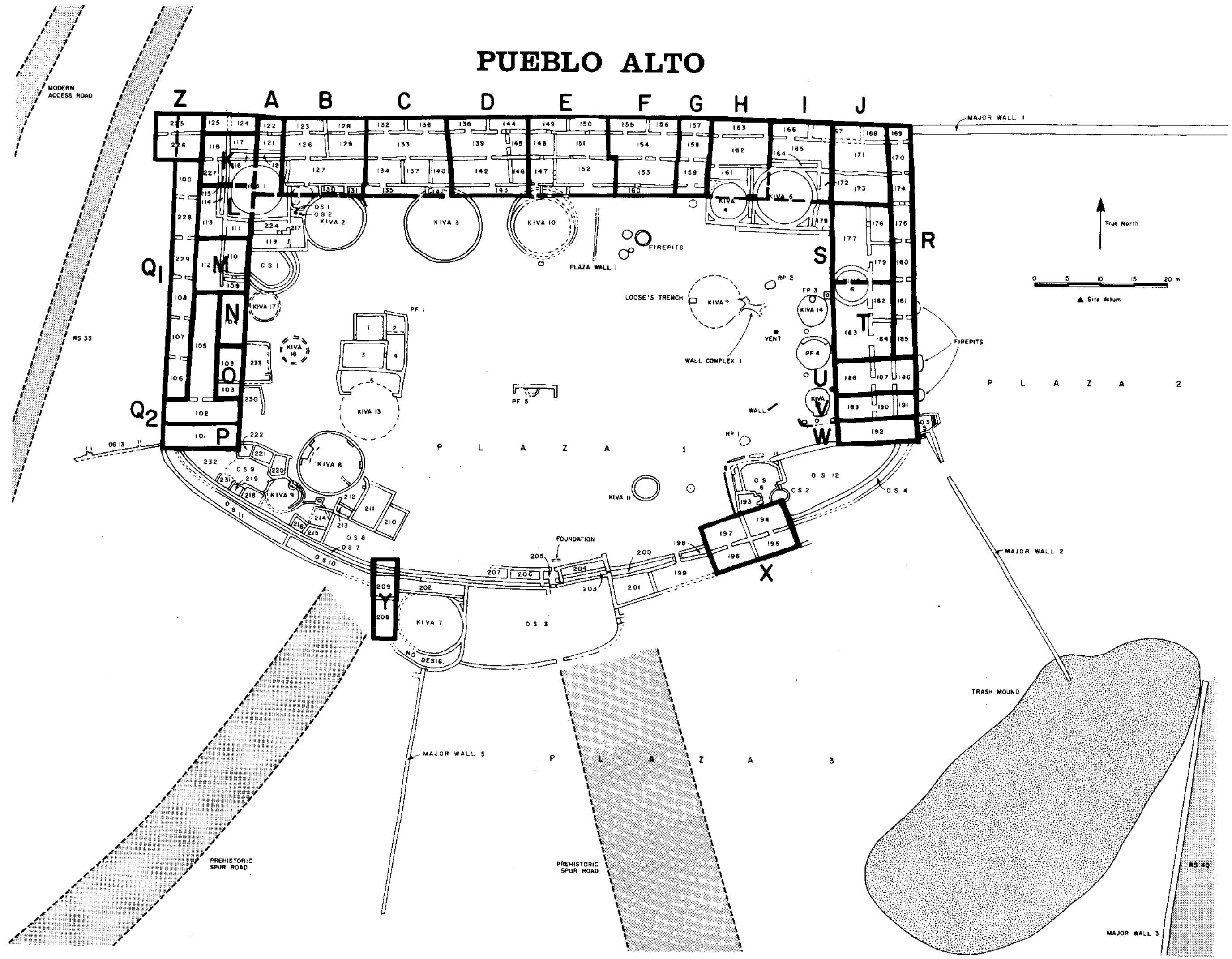


Figure 10.1. Initial room suites at Pueblo Alto.

dictated the ultimate Alto form. Subsequent changes at the site, however, are not always evident from the plan view, which clouds our understanding of later processes.

The initial construction created four major blocks of rooms: the Central Roomblock, an extension to the east of the Central Roomblock, the East Wing and the West Wing. Some time lapse between the various stages of construction is apparent, but the total duration of these lapses is unknown. On chronometric grounds, the maximum span of construction probably ranges between A.D. 1021 and 1060, although it is suspected to be considerably shorter. Temporal ordering of the four blocks, primarily on architectural grounds, permits sequential examination of each from the earliest to the latest. This may lead to a disjointed picture of the four blocks, but the four were undoubtedly related to a complex, integrated plan, foreseen at the beginning of construction.

Initial Central Roomblock Suites

The initial construction of Pueblo Alto (Stage I) consisted of a double row of five huge rectangular rooms backed by an outer tier of paired, small rooms in the classic Pueblo I format (Figure 6.2). In addition, a pair of small, three-room suites was built at the ends of the roomblock, and a third may have been added to its center. Judging from our own excavations and those in other canyon greathouses, we believe door access was solely from front-to-back without possible lateral room access. Each of these blocks of interconnected rooms, therefore, is considered an architectural and functional entity, or suite, consisting of four rooms (i.e., Suites B-F). In addition, narrow corridor rooms extend along the front of the entire Central Roomblock and may at one time have provided access to pairs of suites and the unusual three-room suites (A and G) located at each end of the initial Central Roomblock. Our excavations cleared the central suite of the five big-room suites. In this case the corridor room joined a centrally located (in the roomblock) room of special use (Room 147), at least during later occupation, instead of another big-room suite. We do not know the entire history of Room 147, but it once may have been another three-room suite similar to those at the ends of the roomblock, or it may have been space divided off the big-room suite to the east.

Despite the adherence to architectural symmetry at the site, the five big-room suites were not identical in plan. The three western ones comprised one pattern and the two eastern ones a slightly different one. In the latter, cross walls do not quite align front-to-back, and neither the big-room nor the small-room pairings are mirror images as they are in the western group. In addition, the eastern suites incorporate slightly less total floor area (Table 10.1). Part of the problem may lie in our uncertainty of the history for Rooms 147 and 148 (Suite E_1), units that separate the east and west suites. The big-room pairing immediately east of Rooms 147 and 148 would match its neighbors to the west in size if Rooms 147 and 148 had once been part of big-room Suite E. Room 152, at

Table 10.1. Greathouse big-room suite sizes and areas.[a]

Site/Room number	No. of stories	Length (cm)	Width (cm)	Area (m^2)	Total suite area (m^2)
PEÑASCO BLANCO: Stage I (A.D. 900-915):					
28	2	485	278	13.5	
32	2	455	270	12.5	
33	2	918	mean: 463	42.5	137.0
40	2	473	255	12.5	
43	2	420	256	10.8	
39/97	2	860	445	38.3	123.2
45	2	452	300	13.6	
51	2	466	255	11.9	
46/51	2	913	455	41.5	134.0
56	2	590±	237	14.7	
59	2	534	272	14.5	
55/60	2	1,090	460	50.1	158.6
68	2	563	274	15.4	
71	2	560	285±	16.0	
67/72	2	1,140±	470±	53.6	170.0
76	2	555±	265	14.7	
79	2	554±	265±	14.7	
75	2	1,030	490	50.5	159.0
29	2	477	235	11.2	
98	2	435	233	10.1	
94	2	890±	465	41.4	125.4
PUEBLO BONITO: Stage I (A.D. 920-935, after Lekson 1984):					
102	3	532	269	14.3	
104/107	3	467±	242±	11.3	
108/109	2	941±	381±	35.9	174.2
103	3	507	255	12.9	
113	3	561	274	15.4	
112	2	1,040	429	44.7	176.8
318	3	532	279	14.9	
317	3	531	285	15.1	
323	2	1,069	409	43.7	182.6
319	3	452	264	11.9	
no number	3	504	257	13.0	
325	2	907	391	35.5	148.0
320	3	490	225	11.0	
no number	3	384	252	9.7	
326	2	869	398	34.6	129.3

[a]All measurements are for the ground story unless room unexcavated. Upper story rooms tend to be about 10-20 cm larger in each dimension. Total area calculated from actual dimensions for each story.

Table 10.1 (continued)[a]

Site/Room number	No. of stories	Length (cm)	Width (cm)	Area (m^2)	Total suite area (m^2)
PUEBLO ALTO: Stage I (A.D. 1020-1050):					
123	1			9.4	
128	1	(see Table 3.1		10.5	
126/129	1			38.1	
127	1	for lengths and		43.7	101.7
132	1	widths)		9.5	
136	1			10.5	
133	1			41.1	
134/137/140	1			41.0	102.4
138	1			11.5	
144	1			9.4	
139/145	1			41.8	
142/146	1			40.6	103.3
149	1			10.5	
150	1			10.3	
151	1			24.5	
152	1			31.8	77.1
modified:					
149	1			10.5	
150	1			10.3	
148/151	1			38.1	
147/152	1			45.3	104.2
155	1			10.3	
156	1			8.0	
153	1			32.1	83.4
154	1			33.0	
167 (1/2?)	1			7.5	
168	1			7.0	
171	1			32.0	
173	1			33.6	80.1
166	1			10.5	
167 (1/2?)	1			7.5	
165	1			35.1	
no number	1			35.1?	88.2
163	1			15.6	
162	1			34.6	
no number	1			34.6	84.8

[a]All measurements are for the ground story unless room unexcavated. Upper story rooms tend to be about 10-20 cm larger in each dimension. Total area calculated from actual dimensions for each story.

Table 10.1 (concluded)

Site/Room number	No. of stories	Length (cm)	Width (cm)	Area (m^2)	Total suite area (m^2)
UNA VIDA: Stage II (A.D. 930-950):[b]					
20	2	470	197	9.3	
81	2	477	192	9.2	
21	2	1,045	375	39.2	115.4
KIN BINEOLA: Stage I (A.D. 920-950):[b]					
33	2	515	224	11.5	
44	2	508	228	11.6	
34/45	2	1,122	422	47.3	140.8
47	2	537	234	12.6	
50	2	526	240	12.6	
48/51	2	1,120	408	45.7	141.8

Summary of mean big-room sizes in the big-room suites:

Site	No.	Area (m^2)	sd
Peñasco Blanco	7	45.4 m^2	5.9
Pueblo Bonito	5	38.9 m^2	4.9
Pueblo Alto: original	5	40.7 m^2	4.7
Pueblo Alto: additions	3	34.4 m^2	0.8
Kin Bineola	2	46.5 m^2	1.1
Overall (excluding Pueblo Alto additions)	19	42.4 m^2	5.5

[b]All measurements are for the ground story at Una Vida and the second story at Kin Bineola. Upper story rooms tend to be about 10-20 cm larger in each dimension (this error not adjusted for).

least, was initially connected to Room 147 by a door (later blocked off), which may lend some credence to the possibility that it was part of Suite E_1. Although we partly excavated Room 147, and it seemed that the space had originally been left open, there is no evidence indicating that it was once part of Room 152. Nevertheless, juggling the cross walls does not increase the reduced floor area known for the easternmost big-room suite (F). As it is, the five big-room suites made up the initial greathouse construction at Pueblo Alto and, though not exact duplicates, were similarly planned and arranged.

At the ends of the five big suites were a pair of two, squarish rooms backed by a small, outer-tier room that resembled (in position, size and shape) those attached to the big-room pairings. These three-room suites (A and G) were about one-third the area of the big-room suites. The addition of Kiva 1 removed the surficial evidence of the conjectured, squarish room that matched Room 121 in the western, three-room suite. At the east end, a corridor room connected to the three-room suite as well as the two big-room suites to the west, an arrangement that probably was duplicated at the west end of the Central Roomblock. If so, these may be equated with some sort of multigroup usage. We have no idea as to what use these latter rooms were put, although their small size suggests a storage function. Whatever their function, these small rooms seem to have been added to serve for important group uses not served by the larger suites. At the expense of the room symmetry, the need for additional space outside the big-room suites also may have forced creation of a third, similar, small-room suite (i.e., Rooms 146-148) to which the excavated central suite (D) had access. At least late in the occupation, Room 147 served as a special use or ceremonial room directly linked to the adjacent court kiva, and it may be that Suites A and G were also of similar function instead of for storage.

Another facet of the Central Roomblock organization again appears cooperative. Two large court kivas (Kivas 3 and 10), perhaps three, were so closely attached to the corridor room passageways that there can be little doubt of their association with the suites behind them. Remodeling of the corridor rooms has disguised the original architect's intent, but there may have been originally one court kiva for every two or three big-room suites.

It is clear that the big-room suites were organized quite differently from the habitation suites in the West Wing and from what we have come to expect of contemporary, small-house, Anasazi, habitation suites. The paucity of features attributed to a diverse number of domestic activities leaves the room interpretation strongly oriented toward storage functions. The variety in size and shape of the empty rooms also suggests that storage functions were differentiated, but clues as to specific functions were sparse because of the paucity of artifacts and economic plant remains. In the summary of the Central Roomblock (Volume II), I presented a case for initially unplastered, sand floors in the big-room suites. Certain fruits and vegetables can be kept for long periods of time when set in sandy, cool rooms. Of course, poles could also have been hung from the ceiling rafters for storing dried sundries, hides, etc. Obviously, many kinds of things could have been stored in these rooms, and the rooms' size and placement within the suite may be related to frequency of need of such items and different requirements for storage goods.

The key to understanding the Central Roomblock suites lies with the corridor rooms and kivas. Floor features in the excavated corridor room revealed aspects of domestic use. Although we may attribute habitation of some sort to the corridor rooms, they apparently functioned in a manner contrary to expectations for "typical," multifunctional, living rooms. Although the latter do not abound in greathouses, there are, nevertheless, plenty of examples of contemporary, large, rectangular, plastered rooms filled with floor furniture attributable to habitation (Table 10.2). There are only two excavated in the West Wing of Pueblo Alto, but Pueblo Bonito boasts several others (e.g., Plates 10.1-10.2).

Unfortunately, variation in the size of greathouse living rooms (e.g., those with firepits) is so great that their recognition from wall-top layout alone is not highly predictable. Much of the variation, however, is due to the lack of temporal control, the lack of recognition for different types of habitation rooms, and the use of odd-shaped, enclosed spaces for firepit placement. Many of the latter probably do not mark living rooms per se but rather were an extension of household activities. Living rooms in both small sites and greathouses were commonly afforded similar locations within the roomblock, however, that were directly adjacent to the plaza. They were also typically single-story. Although the corridor room fits these attributes, its direct access to a huge storage facility, to a possible ceremonial or clan/society room, and to a court kiva are aspects not readily identified with other greathouse living rooms. In addition, the extreme narrowness of the corridor room does not seem conducive to everyday habitation by a family or social group (e.g., Volume II, Plates 2.54-2.55). It also lacked the variety of features found in the West Wing rooms, particularly mealing bins and storage pits. Therefore, the corridor room may be ascribed to a specific type of habitation unlike the multifunctional households seen in the West Wing.

Identifying the function of the Central Roomblock suites begs for an examination of the attached court kiva, but, sorrowfully, we were unable to complete our examination of this important link. Certainly Lekson's (1984:50-51) suggestion that kivas served as living quarters is intriguing. But these large court kivas cannot be considered the same as the very small "clan" kivas prolific in small houses throughout the Bonito phase and in greathouses after A.D. 1100 (see <u>Kiva Sample</u> in Chapter 3 for definitions of court and clan kivas and clan rooms). The large court kivas must be considered as integrated within the "supra-domestic" role (Lekson 1984:50) linking multiple families or social groups. Although they may serve to integrate groups, is it realistic to expect that a number of households live in them at the same time? I doubt it, because integrative mechanisms appear in most societies outside the individual family unit and because of the general paucity of material culture and features in both large and small kivas, which suggests that the diverse

Table 10.2. Chaco Canyon greathouse living rooms (A.D. 900-1150).

Site	Room	Age[a]	Story	Size (cm)	Ratio	Area (m^2)	Furnishings[b]
Pueblo Alto	103	a	1	750x340	0.45	25.5	HPs, OPs, WNs, MBs
" "	104	a	1	760x340	0.49	25.8	unexcavated
" "	110	a	1	770x330	0.43	25.4	FPs, HPs, OPs, WNs, MBs
" "	111	a	1	770x330	0.43	25.4	unexcavated
" "	117/118	a	1	750x365	0.45	27.4	unexcavated
" "	147[c]	c	1	350x335	0.96	11.7	FP, HPs, OPs, WNs
Pueblo Bonito	3[c]	c	1	462x364	0.79	16.8	FP, subfloor vent
	34	b/c	1	1,085x399	0.37	43.3	FP, WNs, pot rests
" "	42	b	1	427x293	0.67	12.5	FP, WNs, bins
" "	65	b	1	368x335	0.91	12.3	FPs, OPs, WNs, bins
" "	66	b	1	318x291	0.92	9.3	FP, WN
" "	68	b	1	427x396	0.93	16.9	FP, OPs, WNs, bins
" "	subfl 69	a	1?	?	?	?	FP, bin
" "	71	a	1	527x282	0.51	14.9	FP, WN, subfloor vent
" "	78	a	2	606x260	0.43	15.8	FPs
" "	83	b/c	1	589x340	0.58	20.1	FPs
" "	14/85	b/c	2	682x342	0.50	23.3	FPs, bins (PO)
" "	97[c]	c	1	423x253	0.60	10.7	FPs, bin, bench
" "	159	b/c	1	373x229	0.61	8.5	FP, MBs, OP(?)
" "	290	b/c	1	363x157	0.43	5.7	FP, WN
" "	291	b/c	1	513x214	0.42	11.0	FP, MBs, pot rests
" "	309[c]	b/c	1	531x359	0.68	19.0	FP, OPs, WNs, bins, bench, wall pegs, floor vent, floor vault, deflector
" "	314	b/c	1	248x211	0.85	5.2	FP, WN
" "	315[c]	a/c	1	441x213	0.48	9.4	FPs, subfloor vents
" "	316[c]	a/c	1	443x277	0.63	12.3	FPs, subfloor vent
" "	324	c	1	384x203	0.53	7.8	FP
" "	328[c]	c	1	366x287	0.78	10.5	FP, subfloor vent, deflect
" "	330[c]	c?	1	387x386	1.00	15.0	FP, floor vent
" "	348[c]	c	1	246x187	0.76	4.6	FPs, WN, bench, floor vents
" "	350[c]	c	1	239x234	0.94	5.4	FP, floor vent
" "	351[c]	c	1	230x192	0.83	4.4	FP, floor vent
Pueblo del Arroyo	40	b	1	550x413	0.75	22.7	FPs
" " "	41	b	1	657x375	0.57	24.6	FP, HPs, MBs
" " "	44/47	b	1	744x381	0.51	28.3	FPs, WN, bin
" " "	55	b	1	796x390	0.49	31.0	FP
" " "	9B-III	b?	2	467x208	0.45	9.7	FP, OPs, MBs
Chetro Ketl	38	b?	1	540x490	0.91	26.5	FP, subfloor vent?
" "	39	b?	2	298x288	0.97	8.6	FP
" "	87[c]	b?	1	457x390	0.85	17.8	FP, subfloor vent?
Una Vida	23	a	1	587x345	0.59	20.3	FP, HPs, OPs, subfloor vent
" "	60[c]	a	1	496x357	0.72	17.7	FP, HP, WNs, bin, subfl. ven
" "	63[c]	a	1	360x305	0.85	11.0	FP, WN?, bin, subfloor vent

[a]Age: a = A.D. 900-1050, b = A.D. 1050-1100, c= A.D. 1100-1150.
[b]Possible clan or ceremonial room, often semi-subterranean.
[c]Furnishings: FP = firepit, HP = heating pit, OP = other pit, MB = mealing bin, WN = wall niche, PO = postoccupation.

Plate 10.1. Pueblo Bonito, Room 65, showing firepits and storage bins indicative of a habitation room. (Courtesy of American Museum of Natural History, AMNH#230.)

Plate 10.2. Pueblo Bonito, Room 34. Note the potrests next to the firepit and the wall niches. (Courtesy of the American Museum of Natural History, AMNH#122.)

activities found in living rooms had not been totally relocated. Furthermore, at greathouses contemporary living rooms had not been superseded by the large court kivas. If Lekson is right, then at best we must affirm that possibly two different household patterns existed, one centered in the court kivas and corridor rooms and another centered in the large, rectangular, above-ground rooms.

The physical attachment and access provided between the court kivas and the Central Roomblock suites was not followed in the West Wing, which again indicates a different pattern of habitation. Perhaps some living did take place in the facilities of the Central Roomblock suites, but they may have been more appropriate for intermittent occupation. A scenario of cooperating groups maintaining storage facilities while not in permanent residence is possible if Pueblo Alto was the focus for seasonal gatherings (see H. Toll 1985).

At the east end of the Central Roomblock was an addition of rooms that followed the initial construction. With minor exceptions, suites built in this addition were similar in layout to the earlier ones. Three suites (H-J) were built (Figure 10.1). Again, a pair of huge rooms facing the plaza was backed by a row of small, exterior-tier rooms. The small exterior rooms apparently were not built in pairs behind the big rooms, unlike the initial western suites. The deviation, however, may be due simply to wall collapse that left us unable to correctly identify all the cross walls between the small rooms. The later construction of Kivas 4 and 5 obliterated two of the three big rooms adjacent to the plaza. In any case, the three projected suites each occupy about 80 m^2 of space, about the same as the closest big suite (F) in the earlier section. They are less spacious, however, than their remaining cousins in the western section (Table 10.1). In area, the newer big rooms lie about midway between the size of the initial big rooms in the Central Roomblock and the habitation rooms in the West Wing. No excavations were conducted in this newer addition, so we are unable to specify what function the suites served. They could be living rooms, of course, but their layout and extension east of the initial roomblock suggest a continuity of design and purpose, primarily for storage. We did not get a chance to test for a corridor room or a buried court kiva that might have been associated with these newer suites. The easternmost suite (J), however, revealed no corridor room. For the sake of symmetry and a function similar to the western, big-room suites, a court kiva should have been tucked against the newer rooms, but now may be partly buried under Kivas 4 and 5.

Initial West Wing Suites

Suite identification in the West Wing is hampered to some extent by remodeling, secondary doors, and a greater variety of interconnected units than existed in the Central Roomblock. The advantages of not having to decipher an extra century of urban renewal common to the earlier greathouses, however, was a rare pleasure. The premier units in the wing were composed of five habitation suites (K-O), two of which were excavated.

Three of these comprised two-room units and two were single rooms. All rooms in the suites were nearly identical in size (Table 10.2). Thus, the two-room units were twice the area of the single ones. Two-room suites consisted of a habitation room and a storage room, but the solitary habitation units lacked a companion storage room, or at least one that was contiguous. This dichotomous arrangement suggests differential needs or access to storage among the five habitation groups. The arrangement was planned from the beginning, indicating prior knowledge of the potential groups that were to occupy the suites after construction. A slight change in the building plans could have easily rectified the storage room inequality. We might suspect hierarchial influence or status for the arrangement, or it may simply reflect a more mundane situation such as family size.

Several aspects of the habitation suites contrast with the big-room suites in the Central Roomblock. The habitation suites are about one-fourth or one-half the size of the big-room suites and lack the generous storage accommodations allotted in the Central Roomblock, but they incorporate a much larger area for surface-room domestic activities. The physical ties of corridor rooms and attached court kivas lend an aspect of corporate ownership and participation to the Central suites that was absent from the West Wing. Two court kivas (Kivas 8 and 13) are not far from the West Wing habitation rooms, but their placement dictates a lessened concern for direct or immediate access between the court kiva and the surface rooms. Physical distance can be equated with social distance (Stephens 1985), and in this case might reflect kiva participation that was not invested in a particular habitation or suite group. For at least part of their existence, the two court kivas may not have been contemporaneous, leaving one as the potential candidate for use by all the West Wing inhabitants (i.e., five groups) for a period of time.

What does imply cooperation among the various habitation-suite groups is the care and maintenance of the plaza surfaces adjacent to the West Wing. The plaza in this area was unlike those in most Anasazi sites because of its extensive plastering and upkeep (Volume II, Plates 3.50, 3.53, 3.54) evident during its use in the last half of the A.D. 1000s. Because all the West Wing households had direct access to it, care and maintenance of the plaza was probably a shared responsibility.

In addition to the habitation suites, a series of small, rectangular rooms connected end-to-end were built along the West Wing exterior. Rooms 225 and 226, at the north end of the series, appear to have been later additions that obliterated surface evidence of the initial small ones (see Chapter 5). The other small rooms (Suite Q_1) varied little in size and shape and were linked by a straight-through series of doors. Interestingly, provisions were not made initially for direct access to these small rooms from the habitation suites. As far as we can tell, access was limited to a solitary door at the south end of the suite that linked large Room 105, which opened only to Room 102 that opened only to Plaza 1. The door might be secondary, however. Roof entries are not known for any of the Pueblo Alto rooms, but given the arrangement of doors they seem unlikely. Piles of stone on the floor, indicative of lined, roof entryways were absent from all the room excavations, which suggests the general absence of roof entries at Alto.

Planned, restricted accessibility to the small rooms may portray control, limited to an individual or a small group, that was exercised separately from the domain of the wing inhabitants. The similarity of this suite with one in the East Wing (Suite R), which had better preserved exterior walls and a number of exterior doors, suggests that the function was orientated primarily toward the site exterior and linked to adjacent prehistoric, road activities. The only room excavated in Suite Q_1 (Room 229) was devoid of habitation features and can, therefore, be interpreted as having been built and used for storage. The remainder are also expected to be plain, empty rooms devoted to a like purpose.

Rooms 124 and 125, at the northern end of the West Wing, were placed solely according to projections of adjacent walls. Their presence smooths the exterior outline of Pueblo Alto, and fits the conceived plan of symmetry employed at Alto, but creates an anomaly for the northern habitation suite (K) by adding more potential storage space. Further discussion of these is moot until we can verify their presence. No suite number was assigned to them.

The remaining rooms in the West Wing, huge by any standards, also do not readily yield to explanation. Room 102 remains the key because its doors link it to the series of small exterior rooms (Suite Q_1), the largest room at Pueblo Alto (Room 105), and the interior plaza (Plaza 1). Because of its door connections, it has been considered integrated with the functions of Suite Q_1 and, thus, Rooms 102 and 105 have been designated Suite Q_2. A door connection between Room 102 and Room 103 appeared secondary and does not concern us here. If road-related goods were stored in the exterior small rooms, Room 102 provided the avenue for their transfer into Alto, or vice versa. Room 101 (Suite P), identical in size, shape and position to Room 102, apparently opened only onto the interior plaza and, therefore, does not appear to have been directly associated with the transfer or storage of road goods. Nevertheless, its similarity to 102 and the deterioration of its west exterior wall, where a door could have been located to the outside, make this assertion tenuous.

Initial East Wing Suites

Interpretations of room function are hampered by the lack of excavation in the East Wing. A circular structure, Kiva 6, challenges the perceived, initial, suite arrangement. Kiva 6 appears to be of initial construction, thus separating Suites S and T. Although the nature of the wall attachments could have fooled us, Kiva 6 is unusual enough by itself for us to suspect that it was part of the master plan (see Volume II, the East Wing). If it was late, the builders certainly chose the more difficult placement by positioning it over the presumed, room cross wall instead of typically within an enclosed space. It also, uncommonly, lacks buttress rooms to support its masonry walls. If Kiva 6 was originally part of the plan, perhaps as a tower or a tower kiva, then it may have served to join Suites S and T. With or without Kiva 6, most of the area in the wing was taken up by just two suites (S-T). Both were identically arranged with a huge room facing the plaza backed by a pair of smaller rooms of equal size. In total area (77.4 and 71.4 m^2), each suite was only slightly smaller than those to the north in the Central Roomblock (Suites H-J).

Again, the question is posed on a broad level as to whether the suites are oriented primarily toward habitation or toward storage. An attached court kiva was not discovered, although we suspect that one exists farther out in the plaza (as part of the Unnamed Wall Complex). Overall, the two suites appear to be an architectural variation of the big-room suites located in the Central Roomblock but unlike the West Wing habitation suites. The arrangement of Suites S and T and their position facing west across the plaza, an unusual location for Anasazi habitation rooms, that are normally situated to avoid the prevailing southwesterly winds (Mindeleff 1891:182-183), suggests that the suites may have functioned as large storage units.

A row of small, narrow rooms extend nearly the length of the wing exterior and reflects their counterparts in the West Wing. This suite (Suite R), too, has limited access from rooms within the roomblock and opens primarily toward the outdoors and Plaza 2, an area transversed by prehistoric roads.

Direct access through the East Wing from exterior to interior was provided by Suite U, which also is the place of entry into Suite R. Again, the parallel with the room construction in the West Wing is striking. Suite U is unique at the site for the units it incorporates. The initial configuration is uncertain because the back rooms (Rooms 186 and 187) may have originally been combined with Rooms 190 and 191. A square room (Room 188) opens onto the interior plaza (Plaza 1); similar square rooms at Pueblo Bonito and the Salmon Ruins contained firepits. By extension, it could be a habitation room. The prominent passageway between the interior and exterior plazas, of which it is a part, would have been obstructed, however, by residents living in one of the passageway rooms. The importance of the passageway is enhanced by Road Segment 37, which enters Plaza 2 exactly opposite the exterior door and suggests that road travelers entered Pueblo Alto through Suite U.

Suites V and W are nearly mirror images of the two south-end rooms in the West Wing except that Suite V had been subdivided, possibly after the initial construction. Wall abutments, however, suggest that the subdivision was original, although the similarity of an undivided Suite V to the other long rooms at the end of the wings may mean that the abutments are deceiving. A litter of lithic debris outside Suite W (Room 192), apparently cast from within, marked late activities that were probably unrelated to the original room function. A possible doorway in the south room wall suggests that access to the site exterior was possible before the enclosing arc was built, unless the door was secondary. Suites R through W could all be related to road activities, although the abutments and doors thwart accurate interpretation of the initial plan. Deep testing was not systematically conducted in the area southwest of Room 192, so a large court kiva in an analogous position to Kiva 8 and Room 101 in the West Wing cannot be demonstrated.

Remodeling

As is typical of any site occupied for some length of time, Pueblo Alto yielded changes in the original planning and construction symmetry, which reflects different needs and organization of the inhabitants. This is visually apparent with architectural modifications and, more subtly, from material culture. From the exposed wall tops, at least, extensive remodeling is not apparent, although we are fooling ourselves to think that it was not more widespread than what is now visible. Nevertheless the shorter period of occupation of Alto compared to the older greathouses in Chaco (e.g., Pueblo Bonito, Peñasco Blanco, and Una Vida) argues for substantially less change in the use of space and less subsequent remodeling. We can delineate two periods of remodeling and additions at the site. For the most part, these changes can only be imprecisely dated to within a few decades by ceramics and masonry styles.

A.D. 1050-1100

Central Roomblock

After the initial suites were completed (Stage I) or perhaps even during construction of the later substages of Phase I, a number of the huge rooms were subdivided into two or three smaller rooms each. The masonry veneer of the new cross walls is similar to that of Stages I and II. In our excavated sample, the primary roofs clearly had been placed before the addition of the new cross walls so, at best, the modifications probably postdate the initial construction by enough time for some use of the room, perhaps a decade or two. After subdivision of the old rooms, change in space allocation and the area of some of the original suites had taken place with the addition of new doors. We cannot determine the effect of these changes on adjoining suites without recourse to excavation, although it is noteworthy that the suite excavated (Suite D) apparently was expanded at the expense of Suite E, because the door connecting them (i.e., in Rooms 139 and 145) could be blocked only from the Suite D side. Furthermore, space in the corridor rooms may also have been rearranged when the huge rooms were subdivided. The later change was probably partly coincident with the reduction in size of the adjoining court kivas. We suspect that these changes reflect reorganization at the suprasuite level, because all of the suites in the Central Roomblock were affected. This change is tenuously dated between about A.D. 1060 and 1070 because of the style of masonry used in the remodeling and because Kiva 10 was abandoned by the late A.D. 1000s.

Another change, which destroyed some of the initial Central Roomblock suites, was produced by the introduction of large kivas into the roomblocks. Because our excavated kiva sample was paltry, this shift cannot be correlated with loss or abandonment of the court kivas, although it roughly coincides with a similar kiva relocation in the other canyon greathouses (see Lekson 1984). The kivas moved into the roomblocks are not the tiny chambers associated with the early A.D. 1100s occupation but instead are similar in size and architecture to their courtyard cousins. Two of the large suites (H and I) added to the eastern extension of the Central Roomblock were partially eradicated by this kiva construction, as was the mysterious, small, three-room suite (A) located at the extreme western end of the roomblock. Kiva construction within the houseblock undoubtedly took place in the late A.D. 1000s, perhaps around A.D. 1080 at Pueblo Alto.

West Wing

The West Wing, too, was affected by kiva construction. Kivas destroyed three of the five living rooms, a significant change to the original social arrangement. Probably the remaining living rooms were affected, also. It is not certain if some time elapsed between abandonment of the habitation suites and construction of the kivas at about A.D. 1080. Nevertheless, the kivas document removal of the inhabitants either by force or, more likely, by choice. Suite L might have been destroyed by fire, a plausible reason for abandonment, but reasons for abandonment could not be discerned for Room 110 (Suite M). Suites similar to the ones formerly occupied are not evident at Pueblo Alto, and either their arrangement was modified so that they are not now recognizable from the surface or the former inhabitants abandoned their homes at Alto.

Secondary doors document changes within the habitation-suite organization before kiva emplacement. New doors led laterally into adjoining habitation rooms and, in the case of Room 103, into the postulated road storage facilites (i.e., Room 102). These additions suggest increased cooperation between habitation groups if, of course, the adjoining suites were still functional. If some families had already abandoned their quarters, then the changes may portray an effort by the surviving families to expand their living space.

Except for the kivas built over former rooms, additional (architectural) modifications during the late A.D. 1000s are not apparent from the wall tops in the West Wing, except for the construction of the two rooms (Suite Z) at the northwest corner of the site that jut toward the adjacent, and possibly associated prehistoric road (RS 33).

East Wing

Some possible subdivisions in Suites U and V are the only visible changes in the primary room layout of the East Wing.

A.D. 1100-1140

The terminal occupation at Pueblo Alto is without visible substantial modification of the primary room plan. Considerable widespread additions to the site are evident, however. Construction of enduring, late, high-rise architecture is not characteristic at Alto but marks, indeed, the new house built just west of Alto and known as New Alto. Meddling and superficial changes within the original greathouse rooms were revealed by our work, but the primary changes are evidenced around the southern enclosing arc by small room additions to the existing architecture and by a number of small kivas built in the plaza and in former rooms. We did not explore the newer architectural units except where they were accidently discovered during excavation. Thus, from our limited and selected sample, it is not possible to document the parameters of the latest occupation.

Our best example of reuse of the primary architecture, by no means a clear one, was the use of Room 103, a former West Wing habitation suite, as a member of a larger compound that included Room 233 and the plaza and small clan kiva (Kiva 16) just east of it. All were used at late dates, with Room 233, tacked to the front of Room 103, and Kiva 16 as new additions. Because of its size and location, I suspect that Room 233 served as a living room with some spill-over of activities and storage being reserved for Room 103. Mealing bins were not built with the final flooring in Room 103, as they had been earlier, and it is possible that they were removed from Room 103 and put to use in Room 233.

The living room (Room 104) that is contiguous with Room 103 evidently had been denied direct access to the plaza in the early A.D. 1100s because of the Kiva 17 ventilation system built in front of the door. For this reason, we can assume that its function as a living room had also been terminated. By the early A.D. 1100s, all the former West Wing habitation suites had changed function or had been abandoned. The two, small, clan kivas adjacent to the former suites and three others bordering the East Wing are evidence that major changes had taken place in the use of the adjacent Pueblo Alto rooms. Coevally, care and maintenance of the associated plaza were discontinued and the plaza left to the advances of windblown sands. Other clusters of small rooms and clan kivas are evident along the plaza arc. Without excavation, the identification of individual late suites and the pattern of room arrangement are impossible to decipher. The clusters of new buildings scattered about suggest an opportunistic policy of occupation rather than the master planning evident for the initial Alto construction and use.

Suite Comparisons with Other Greathouses

Amidst the bewildering array of architectural forms at greathouses, there are some striking parallels between some Pueblo Alto suites and those in contemporary and earlier greathouses in Chaco. In this regard, Lekson's (1984) synthesis of greathouse construction units is most useful in identifying suites analogous to Alto's. Three distinct patterns of suites, among many I am sure, are evident at Alto and some other large Chaco sites: big-room, storage suites; lateral rows of small, exterior, storage-room suites; and habitation suites.

Big-Room Suites

Big-room suites among early greathouses are so similar in size, shape, configuration, and position (Figure 10.2; Table 10.1) as to suggest that at least one basic unit of planning and design reflected continuity in function for much of the Bonito phase. These suites, some of the most prominent architectural components in the earliest greathouses, must be of the key units in the development of the initial Chacoan Phenomenon. Indeed, at Kin Bineola, Pueblo Bonito, and Pueblo Alto these were apparently the very first units built. Other functions apparently surpassed the necessity for these suites after the suites were last incorporated into greathouse design and construction at Pueblo Alto. Of course, the function may have been satisfied by a different architectural form, but the change alone must mark a major reorganization at the political or socioeconomic level that required modification of a suite design that had endured for over a century.

Besides the sample at Pueblo Alto (Suite D), the five, big-room, multistoried suites at Pueblo Bonito are the best documented (Judd n.d., 1964; Pepper 1920). The big-room suites at Pueblo Bonito consisted of two-story, large, front rooms backed by smaller, two- and three-story rooms, all largely devoid of habitation features. The presumed continuity of function of these suites is given substantial support by the similar lack of features in the seven units excavated (of the 26 units now recognized) that cover over a century of time (from A.D. 919 to about A.D. 1030 or 1040). Despite Judd's (1964:59) assertions that the big rooms in the suites were used for living (a notion also championed by Judge et al. 1981:84-85), Judd's field notes and the lists of floor features that portray plain empty rooms do not support this assumption. The most prominent feature in all the large rooms in big-room suites was a series of six to eight roof-post supports offset close to one wall (Plates 10.3-10.4). Presumably the posts were not centered in the room because the vigas were too short to span the rooms, at least for some of those pictured at Pueblo Bonito. Furthermore, the floors in two of the large rooms (323 and 325) were unplastered sand, although a third (Room 326, Plate 10.3) was thickly plastered (Judd n.d.). The condition of the others is unknown.

Room 323 contained a firepit, which both Judd (1964:59) and Lekson (1984:31) infer was original equipment and, therefore, a sign of room habitation. The use of a discarded metate in the firepit construction is reason to suspect the pit's secondary placement (See Volume III, Chapter 4). In Chaco, reused ground stone, including metates (Judd 1954:136), is commonly found in secondary construction and in the late sites, presumably because stockpiles of the material had had time to accumulate. Because Room 323, along with Room 320, is the earliest dated and presumably one of

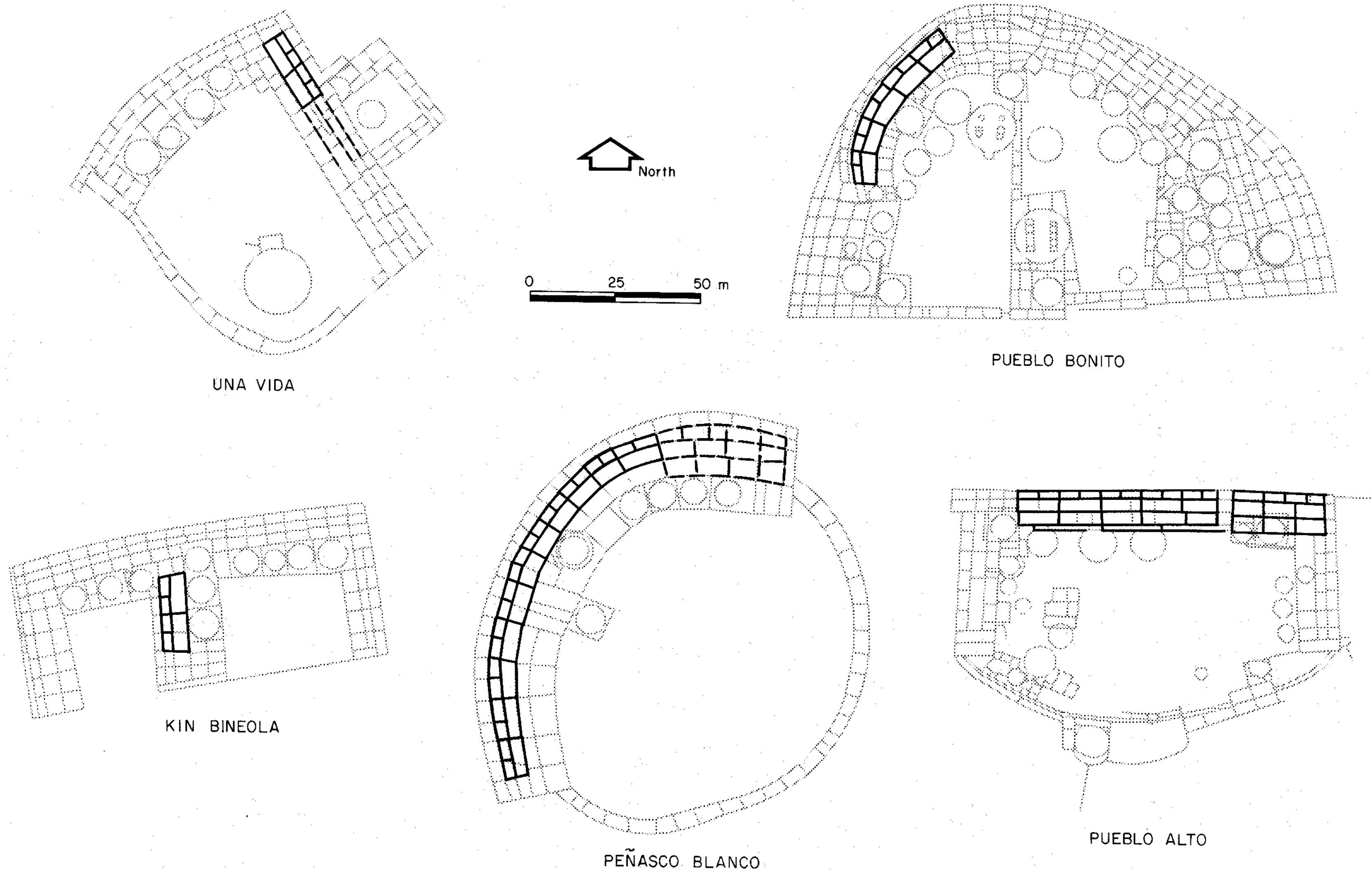


Figure 10.2. Big-room suites built between A.D. 919 and A.D. 1050 in Chacoan greathouses.

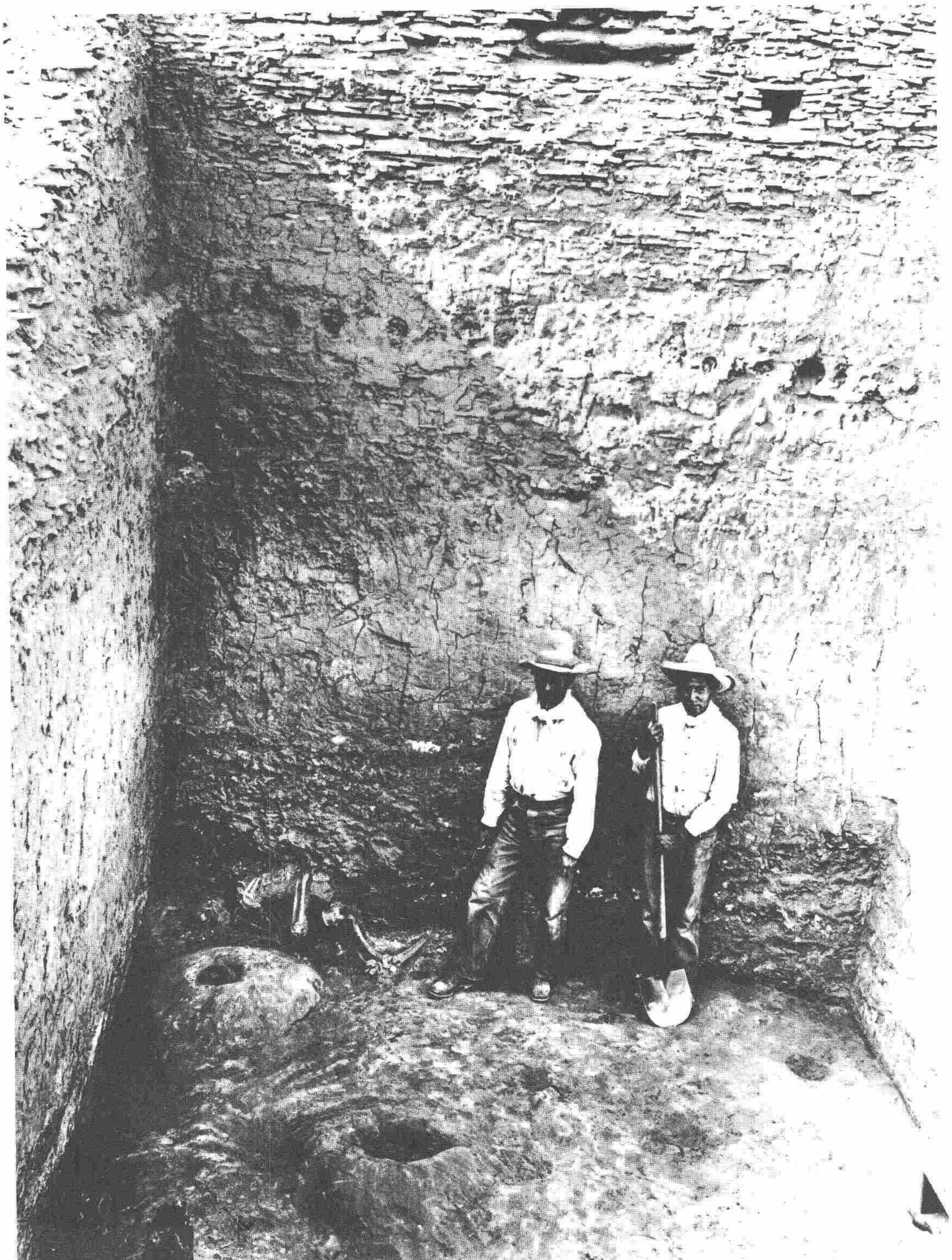


Plate 10.3. Pueblo Bonito, Room 326. The southern end of the large room showing Burial 4 and the adobe caps around three ceiling-post supports. Note alignment of supports close to the wall instead of along the room centerline. (© National Geographic Society.)

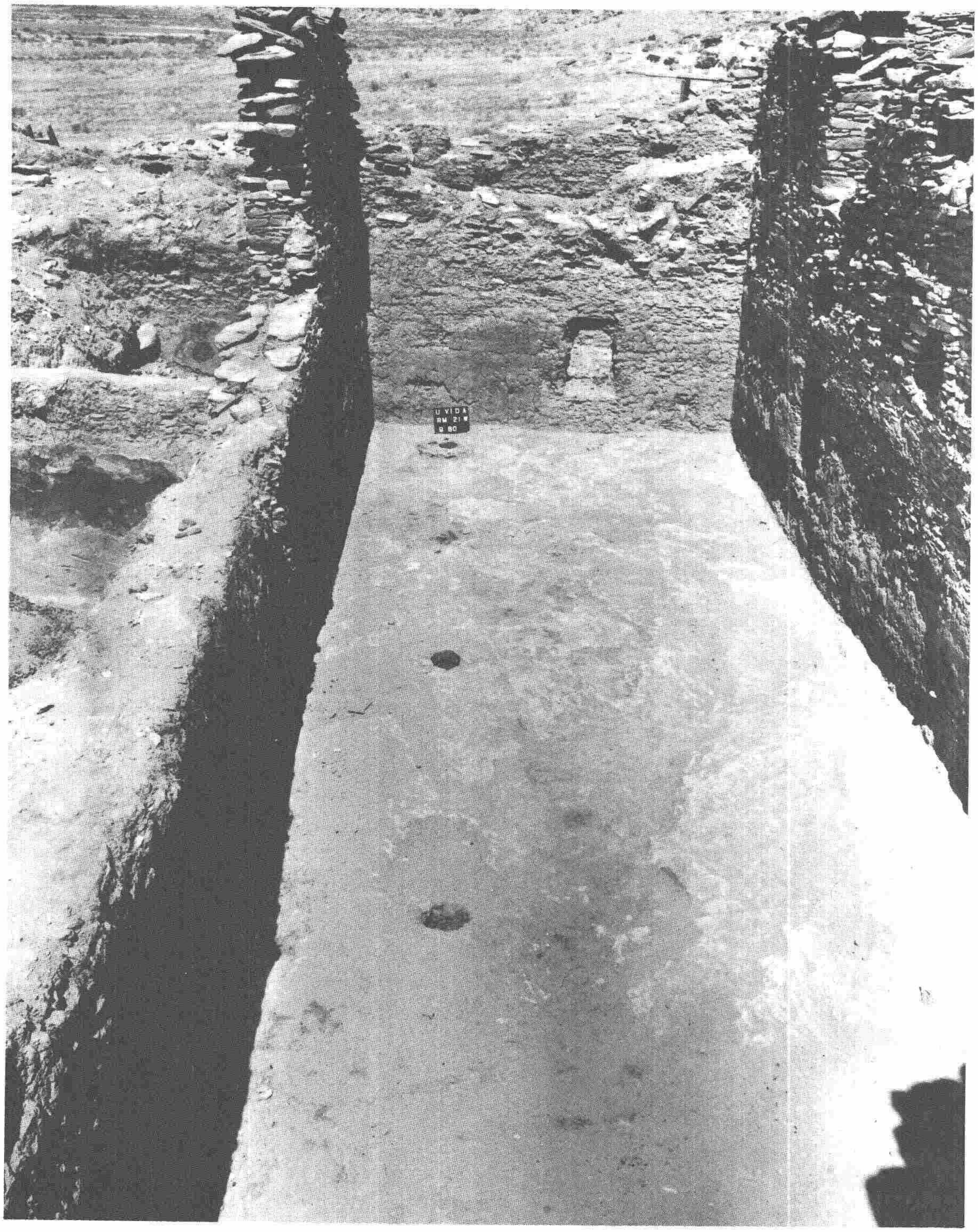


Plate 10.4. A big-room suite at Una Vida. Looking west across Room 21 before stabilization in 1960. Note the row of roof-support holes offset from the center of the room. (NPS#18340.)

the earliest built rooms at Pueblo Bonito, it is unlikely that much recycled stone would have been available for construction purposes. Whatever the circumstances for its construction, this firepit is anomalous among the seven, excavated, Chacoan, big-room suites.

The rooms between the large rooms and the plaza at Pueblo Bonito were mostly additions added a century later, although there was an earlier row of rooms beneath them. Now it is impossible to tell if these were originally corridor rooms, habitation rooms, or another row of large rooms that mirror in shape and size those behind them, although Lekson (1984:Figure 4.20) partly depicts the latter. There is some hint of small living rooms in the row, but features in them are late (Judd 1964:327). Another set of large rooms (35/36/37/61, 38, and 54/84) backed by small rooms existed in the central section of Bonito, although their layout is irregular and unlike other big-room suites. Recent (1987) tree-ring dates suggest that these latter units may date in the mid-A.D. 800s and comprise some of the initial buildings at Pueblo Bonito.

Without knowledge of the earlier rooms adjacent to the plaza, we cannot be sure that the two, large, court kivas beside the Pueblo Bonito big-room suites were connected to the rooms in the manner observed at Pueblo Alto. Their proximity to the rooms and their number suggest a plan and organization that was similar to Alto's. Later on, the small rooms added against the big-room suites were remodeled and used as domiciles.

One of three possibly big-room suites at Una Vida was excavated in 1960 (Plate 10.4) and part of it re-examined by the Chaco Center (Akins and Gillespie 1979). Although it endured almost three centuries of occupation (A.D. 930s through A.D. 1200s), the largest room (Room 21) had little evidence of domestic facilities: a few floor burns and a heating pit. As at Pueblo Alto, two small rooms connected Room 21 to the back. All the suite rooms reached two stories, although Room 21 was, at first, single story (Gillespie 1984b:91). A few smaller rooms were later added to the front of Room 21 at about A.D. 950-960. These had the earmarks of multifunctional, living rooms (large firepits, wall niches, storage bins, subfloor ventilators, and plastered walls) and were analogous to the Alto corridor rooms in function, position, and area. They were also similar to the Alto West Wing living rooms (see Living Rooms below). A court kiva should exist just in front of the three suites, but the area is now covered with the fallen remains of later structures.

At Kin Bineola, two or more of these big units are evident facing east in the central wing (Figure 10.2, Plate 10.5). Tree-ring samples from these units date their construction at A.D. 943 (Bannister et al. 1970:20). Both units consisted of a large room backed by two small rooms, comprising a three-room suite at the ground level and two stories overall (Lekson 1981 field notes). The southern, big room was later subdivided into two rooms (48 and 51). Enclosed, above-ground kivas, built in the early A.D. 1100s, now front the units, so it is impossible to glimpse traces of former, associated rooms and court kivas.

Plate 10.5. An unexcavated big-room suite at Kin Bineola. Todd Windes stands in the doorway of Room 33 and Suzanne Hunt in the doorway to Room 44. Both stand at the back of large Room 34/45. Looking northwest. (NPS#28737.)

Finally, the longest row of big-room suites exists, unexcavated, at Peñasco Blanco. Eleven of these three-room, ground-story units form the primary construction at the site in A.D. 900 to 915. All were multistory. Another row of the large rooms may exist between those visible and the plaza but direct evidence is lacking. Rooms of some sort, but of unknown age, do exist in the area of question, however. Court kivas are impossible to define in association with the suites from the existing surface evidence.

Three suites were added later to the north end of the big-room suites in Stage IIA, dated at A.D. 1050-1065 (Lekson 1984:104-105). In size, configuration, period, and the place of attachment, the addition shows remarkable similarity to Suites H-J at Pueblo Alto, except that the latter were not multistory, and rooms added to the east end of Chetro Ketl during the Stage IVB construction in the A.D. 1050s (Lekson 1984:186-187). Because none of these suites have been excavated, we know nothing about their interior features. The plan of the three suites, however, is similar to the earlier big-room suites. Whatever their function, it is possible that an intersite decision may have been responsible for their coeval construction at the two mesa-top pueblos and Chetro Ketl.

Except at Pueblo Alto, a double row of contiguous, large rooms in the big-room suites has not been positively identified at any greathouse, although its presence cannot be easily dismissed. On the other hand, all the large rooms are two-story with the exception of Alto. What this might mean is that the planners modified the Alto suites from a vertical (two-story) to a horizontal (single-story) layout, thus creating a double row of large rooms. Nevertheless, the shift does not exactly duplicate previous planned spaces because at Alto there were fewer small, exterior, storage rooms. Were practical matters responsible for the shift from vertical to horizontal? Alto's position high above Chaco Canyon exposes it to chilly winds that could affect room temperatures even more had the rooms been stacked. Keeping Alto single story may have maximized energy conservation.

Road-Associated, Storage-Room Suites (Figure 10.3)

At Pueblo Alto, a row of small rooms (Suites Q_1 and R) borders the exterior tiers of each wing. In the West Wing, at least, these rooms may have been added some time after the the initial wing construction, although the eventuality had been prepared for during the setting of the wall foundations (see Volume II, Room 229). The East Wing at Alto has been linked to prehistoric roads and the possible storage of road goods (Chapter 5), and by analogy, so has the West Wing unit. If similar units were common to other greathouses, then they should be evident only in the period after the prehistoric roads made their appearance. Ceramic seriation indicates that the roads appeared in the canyon after A.D. 1000, particularly in the A.D. 1045-1075 period (Chapter 5).

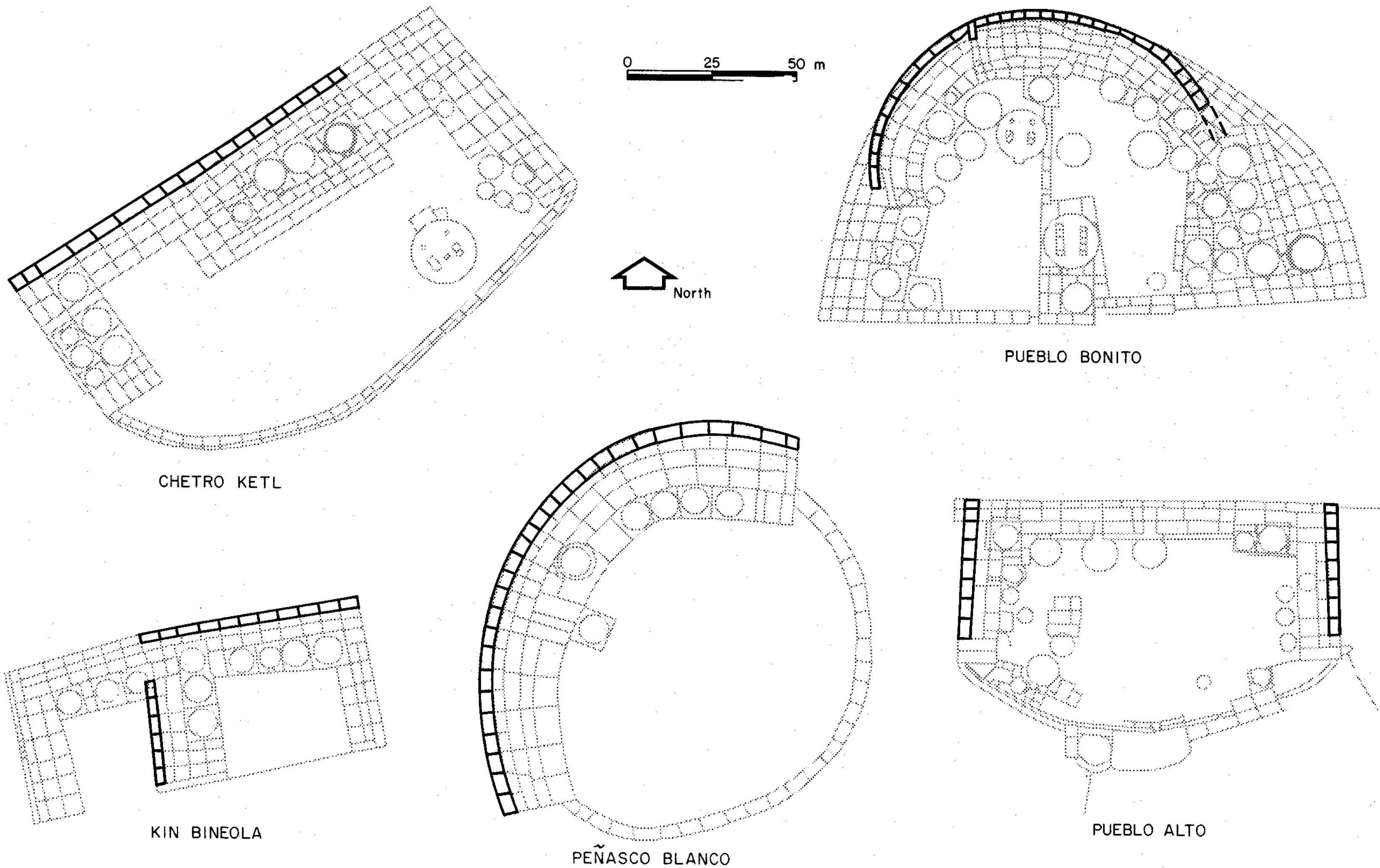


Figure 10.3. Road-associated, storage-room suites built between A.D. 1040 and A.D. 1085 in Chacoan greathouses.

Small rooms in shape and position like those at Pueblo Alto are common to the exterior tiers of every greathouse (Lekson 1984), but similarity alone is unconvincing for their inferred suite function. Additional factors, however, make the inferred relationship to the Alto suites more plausible: the timing of the construction, the type of additions (as lateral rows of rooms), and the door connections. At Pueblo Bonito, a row of small rooms connected end-to-end were added behind the big-room suites and others built in the early A.D. 900s. These averaged 6.5 to 10 m^2 in area (Lekson 1984:133). More important to our case is the lack of doors between the older sections and the new additions that they butt, the lateral door connections throughout the new rooms (Plate 10.6), and, significantly, the door openings in the exterior wall (Plate 10.7), "apparently in every room and on every story" (Lekson 1984:133).

At about the same time those at Pueblo Bonito were added (A.D. 1040-1050), a similar row of small rooms (11.2 m^2) was appended to the exterior of Chetro Ketl (Plate 10.8) during Stage III construction. Lekson (1984:186) prophetically states that "these interconnected rooms form a suite, but clearly do not represent the same kind of suite as the 2-5 room Stage II suites. Stage II (sic, Stage III, TCW) rooms connected laterally, but did not have doors cut through to the older suites." Originally, these new rooms were one story, but later grew to two, and all lower ones had exterior doors (Lekson 1983b:245, Figure I:2). The timing of the new additions exactly matches the period of use of the roads connecting Chetro Ketl with Pueblo Alto.

Directly behind the new room suite was the Talus Unit, which provided a platform (Hayes 1981:57) for direct ascent over the cliff behind Chetro Ketl to prehistoric Road Segment 40W (Chapter 5) and on to the three plazas and Suite R at Pueblo Alto. Again, Lekson's (1985d) research proves opportune; the part of Talus Unit below the staircase to RS 40W, he asserts, is best dated by tree-rings to between A.D. 1065 and 1070, although Room 8, which incorporates the famed, platform-landing staircase (Plate 10.9) probably was built at about A.D. 1032 (Lekson 1985d:48), which was temporally close to the period of building interpreted for the Stage III construction at nearby Chetro Ketl. Happily, tree-ring dates and the stairs at the Talus Unit, Old Building, link the road to Pueblo Alto with the additions at Chetro Ketl.

Lekson (1984:42, 45-48) perceptively remarks that the storage rooms added to the rear of Chetro Ketl and Pueblo Bonito differed in function from earlier back rooms but not for the reasons just mentioned. Steve was intrigued by the presence of roomwide platforms and single-pole racks, features that were absent in the earlier storage rooms. Those at Chetro Ketl also contained unusually large niches centrally located in each room's south wall. Door openings led him to infer a supra-suite, community-wide function for the suites, which served for long-term storage (Lekson 1984:45). Regarding long-term storage, Lekson must be taking the view from the site interior, from where access to the new storage suites was limited. Given the multitude of exterior doors to these, however, storage of goods involving road travelers may have been frequent and

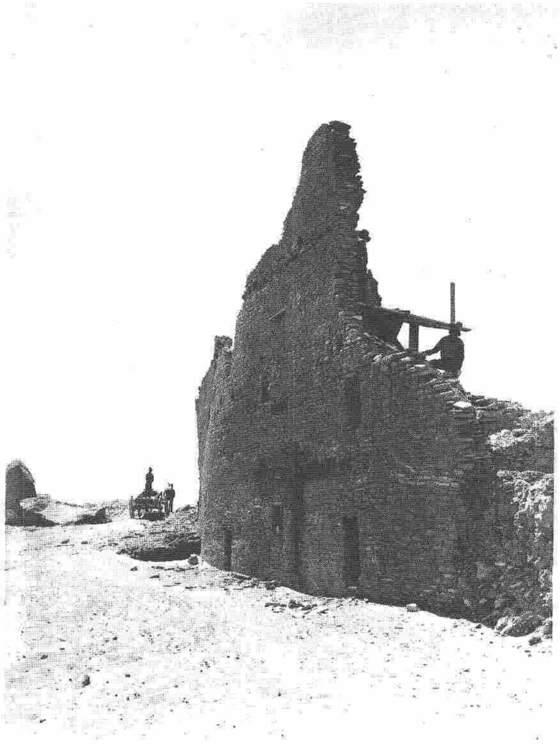


Plate 10.6.

Plate 10.7.

Plate 10.6. Pueblo Bonito, exterior north wall. Note exterior doors that may have provided access to road-related storage facilities. Photo by Neil Judd. (© National Geographic Society.)

Plate 10.7. Pueblo Bonito, looking east-southeast down the exterior rooms added between A.D. 1040 and 1050 (on the right) and believed to be associated with road-related storage activities. Later exterior rooms (on the left) added between A.D. 1075 and 1085. Room 295 in right foreground. Note connecting lateral doorways between rooms. Broken walls are being repaired by workmen. Photo by Neil Judd. (© National Geographic Society.).

Plate 10.8. Chetro Ketl back wall. Note the numerous exterior doors that are probably associated with road-associated storage facilities. Todd Windes and Suzanne Hunt pictured outside one such storage unit. (NPS#28723.)

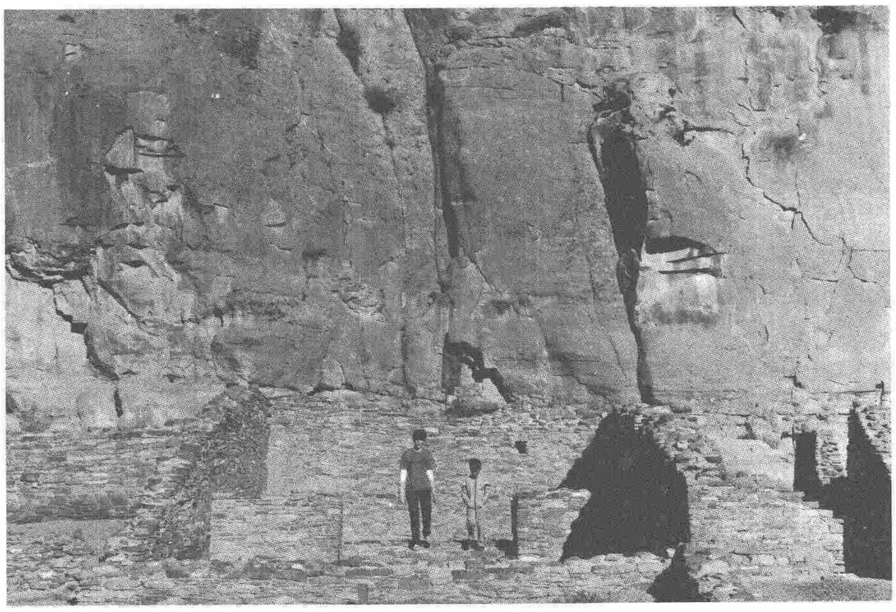


Plate 10.9. Talus Unit 1, Old Building. Looking north at the famed landing platform steps where Suzanne Hunt and Todd Windes stand. Note beam sockets in cleft above figures that probably supported scaffolding stairs to Road Segment 40W directly above leading toward Pueblo Alto. (NPS#28724.)

short-term. Defining the roomwide platforms as possible sleeping racks is not so far-fetched if we suppose that road-weary, nonlocal travelers needed some place to rest during their journeys.

Between A.D. 1085 and 1090, a similar row of rooms was added behind the big-room suites at Peñasco Blanco. Although these were thought to have been added in a single episode (Lekson 1984:105), a change in room size from south to north suggests discontinuity in construction or in function. The cross walls are still visible but the crucial outer wall in all cases is now buried in rubble, which makes the possibility of outer exits speculative. Doors in the visible upper story of the new rooms are absent except for a few entries provided into the older big-room suites. The first story was buried except in Rooms 31 and 95, neither of which revealed lateral doors. Associating these rooms with exterior (i.e., road) activities is, therefore, hampered by the lack of excavation and visible doors but remains a possibility.

Kin Bineola, southwest of Chaco, also revealed numerous exterior doors. In plan (Figure 10.3), it may have existed for a century in a U-shaped form before the western wing was added in the early A.D. 1100s. Most of the first story is buried, so no doors could be discerned for it along the east wing exterior. Along the north side, however, first-story doors apparently open to the exterior from every room, at least for the 11 easternmost rooms (Plate 10.10). Access from these to other rooms could not be determined, although the second-story rooms opened inward to the next tier but not laterally or to the exterior. The size of the 11 exterior rooms was similar to that at the other sites (n = 11, mean = 12.4 m^2, sd = 0.83). Two rows of rooms may have been added to the north exterior, which extended the entire length of the back wall. Unfortunately, the building sequences have not been worked out.

Another row of rooms was added to the exterior of the big-room suites at Kin Bineola along the exterior of the initial west wing rooms. All of these also revealed outer, first-story doors that may have opened to the site exterior before the new west wing was added. Doors leading into the older sections could not be discerned. These exterior rooms were also small (n = 6, mean = 9.6 m^2, sd = 0.48). The masonry style used at Kin Bineola is difficult to date, but the style in both sets of exterior rooms appears to have origins in the A.D. 1000s. Again, these rooms may have been associated with road activities, although there is no present knowledge of roads in direct association with the site.

Three rooms were added behind the excavated big-room suite at Una Vida between A.D. 950 and 960 that were connected laterally with doors. In size (mean = 13 m^2), shape, and position they resembled Suite Q_1 and Suite R at Pueblo Alto, but the Una Vida excavated rooms revealed neither exterior nor interior doors! Although the outer tier of small (presumably) storage rooms along the exterior of the west wing at Una Vida, built in the early A.D. 900s, also seemed analogous to the road-related units described for Alto, Pueblo Bonito, and Chetro Ketl, the two rooms (18 and 65) excavated by Gordon Vivian also did not reveal exterior,

A

B

Plate 10.10. Kin Bineola back wall revealing numerous V-shaped breaks in the masonry from collapsed first-story door lintels. Smaller holes mark former viga rests (to support an exterior balcony?). Connor and Todd Windes pictured in A, and Suzanne Hunt pictured in B. A) Looking west. B) Looking east. (NPS#28745.)

first-story doors. This is fortunate, otherwise it would have suggested the presence of roads in the A.D. 900s, which is contrary to other evidence (Chapter 5).

The addition to greathouse exteriors of rows of rooms with exterior doors is not discernable at other sites (e.g., Hungo Pavi, Pueblo Pintado, and Pueblo del Arroyo), although in some cases this may be because excavation has not uncovered the buried first stories (e.g., Pueblo Pintado and Hungo Pavi). Not all greathouses occupied in the A.D. 1000s, however, may have had such suites appended (e.g., Pueblo del Arroyo).

The row of rooms commonly enclosing greathouse plazas along the south side would seem ideal road-related units except that doors often open toward the interior plaza. Perhaps these are communal storage facilities related to plaza activities. Despite their door orientation, nevertheless, the enclosing arcs sometimes (perhaps always) provide entrance into the greathouse sites from prehistoric roads [e.g., Pueblo Alto and Tsin Kletzin, and perhaps Chetro Ketl (Chapter 5)]. Thus, the arc rooms may also have been associated with the traffic that passed by them from the roads.

Our best evidence, then, for the presumption of road-associated, storage suites derives from the three greathouses most tightly woven into the prehistoric road network: Pueblo Bonito, Chetro Ketl, and Pueblo Alto. It may not be fortuitous that the suites in question were all built at about A.D. 1040 or 1050 in proximity to the roads that link Alto and the other two sites. A number of these rooms were excavated (Judd 1964; Pepper 1920) but nothing remarkable was found in them (or at least reported). Some revealed plastered walls or floors, and none had floor features, although the reporting for them was too inconsistent to say that all were featureless. Two of those at Chetro Ketl were covered with fragments of painted wood thought to have been associated with ceremonial activities, although the wood was deposited in the early A.D. 1100s, long after construction and initial use of the rooms (Vivian et al. 1978:60). Therefore, the wood may not provide clues to the initial use of the road-related, storage rooms. At least one of the pieces of wood was tree-ring dated at A.D. 1110vv, and presumably the entire set was from ceremonies taking place at Chetro Ketl in the early A.D. 1100s (Bannister and Robinson 1978).

Habitation Suites

The most difficult suites to decipher from the architectural plan are those attributed to habitation. Because these suites are often unencumbered by multitudes of appended rooms, they are difficult to distinguish among the phlethora of one- and two-room units scattered throughout the greathouses. In addition, different patterns of household occupation may exist in a single sociocultural tradition (Ammerman et al. 1976:32), which may produce a wide variety of room and suite sizes (Ciolek-Torrello 1985; Reid and Whittlesey 1982). The attributes of single story and location

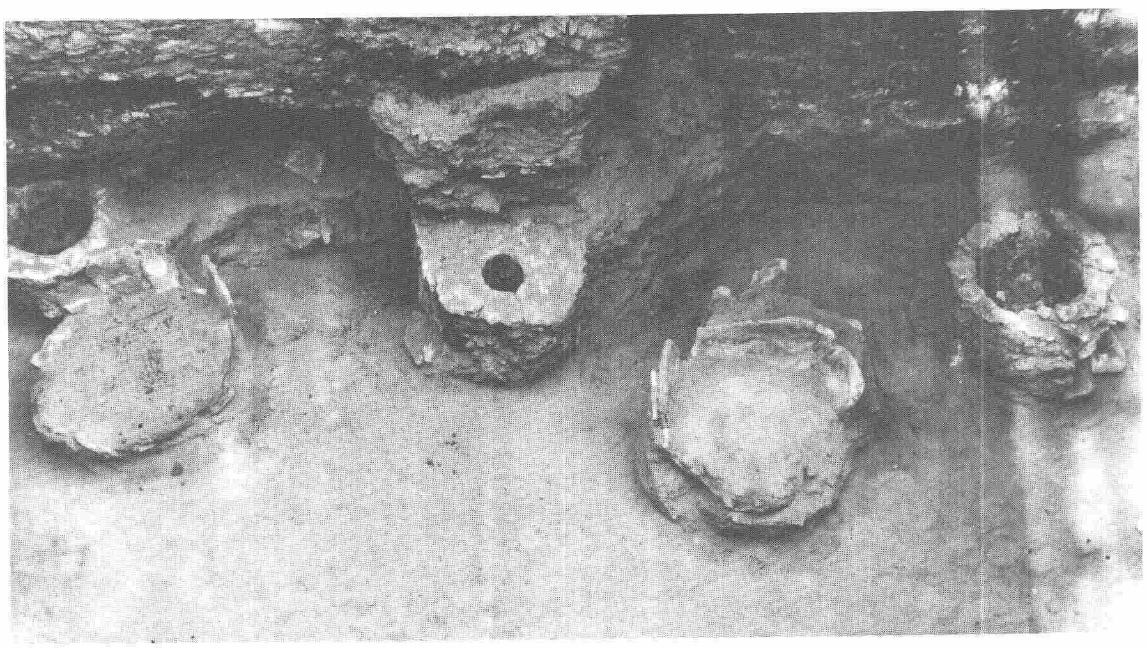


Plate 10.11. Pueblo Bonito, Room 78. A possible former storage room located behind living Room 71 in the northeastern arc of rooms. Photo reveals three posthole seats and two firepits, although the latter may be secondary introductions. (Courtesy of the American Museum of Natural History, AMNH#257.)

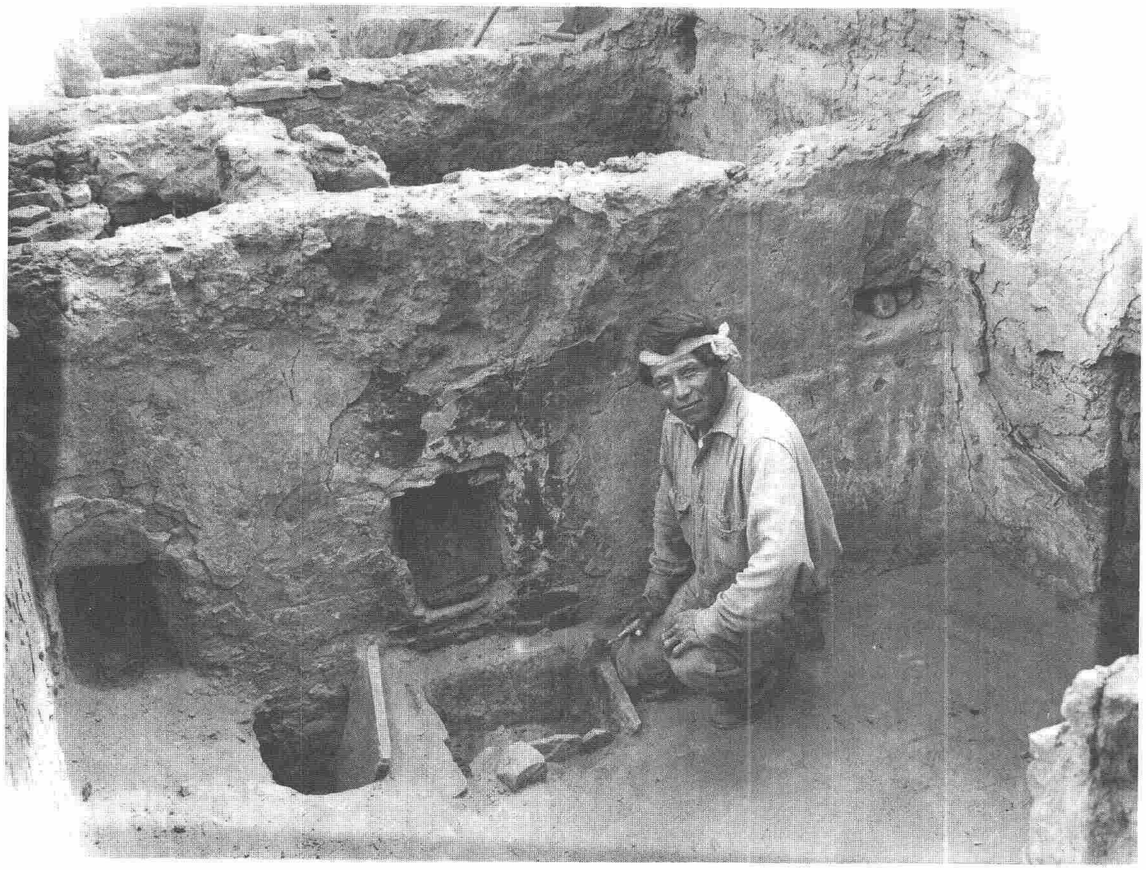


Plate 10.12. Pueblo Bonito, Room 348. A semisubterranean living or clan room added to the front of one of the early big-room suites along the west side, probably in the early A.D. 1100s. This room revealed a few etched figures in the wall plaster. Note the multiple coats of wall plaster, the firepits, ventilators, and wall niches. A narrow bench at one side of the room is not visible. Looking at the south wall. (© National Geographic Society.)

next to the interior plaza help to separate potential Chacoan living rooms from other kinds of rooms. Most important to their identification, however, are the floor features.

Unfortunately, features, or the lack of them, are unreliably reported for the early greathouse excavations (Chapter 9). Firepits generally were the sole features that received nearly universal attention from early investigators. Although firepits are a major requisite for identifying habitation rooms (see Windes 1984), they may also mark activities unassociated with habitation rooms (see Ciolek-Torrello 1985). Furthermore, it is often impossible to associate any of the floor features in greathouse rooms excavated before 1970 with the primary room use, except, perhaps, for some roof supports.

Handicaps aside, there are some patterns evident from ground plans and excavation that make it possible to predict the living quarters in some instances. Again, Pueblo Alto provided the standard for identifying domiciles in earlier greathouses, but after A.D. 1050 or thereabouts, changes in architectural design and remodeling reduced room and suite variability, which makes it difficult to ferret out repetitive, domestic-suite plans. Perhaps there were few domiciles built between A.D. 1050 and A.D. 1100. It is also probable that architects employed multiple designs for different household functions, which were not all discovered at Alto or built there. Those domiciles identified at Alto, nevertheless, comprise one or two of the major suite designs, given their prominent position and allocation of space at the site.

Rooms exhibiting a diversity of floor features (e.g., for cooking, heating, grinding, and storage, etc.) must be considered domiciles. Other criteria help to confirm their status as living rooms: plastered walls and floors, the latter revealing frequent repair or resurfacing, and a diversity of artifacts and ethnobotanical remains. In short, living rooms may be characterized as the loci of multiple activities, which resulted in wear and tear of the room, the discard of large amounts and a variety of cultural materials, and a diversity of ethnobotanical remains. These attributes, observed in some Pueblo Alto rooms, were also common to many of the other, early, greathouse rooms (Table 10.2). Unfortunately, recoverable tool kit remains and debris from specific activities in the rooms were not generally available to us (cf., Ciolek-Torrello 1985).

Some of the best documented living rooms were excavated at Pueblo Bonito (Table 10.2). A series of paired rooms, bordering the plaza of Pueblo Bonito and built in the A.D. 900s, may replicate the domicile pattern discovered at Pueblo Alto. The suites comprise Rooms 71/78/86, 83/85/296/298, and subfloor rooms under Rooms 69/80/87 along with others hidden by later construction under the northeast arc of rooms (Judd 1964: Figure 3). The first room in each pair was a single story, bordered the initial plaza, and contained firepits and other features common to living quarters. Those behind them were two stories, and, in the case of Rooms 78 (Plate 10.11) and 85, also contained firepits (Pepper 1920:256-257, 262-264, 269-272). In none of them, of course, can we be certain of the original intended function, although their complexity suggests intense or long-term habitation. In Room 85, reuse and remodeling were evident from the placement of several storage bins in the postoccupational fill, so the firepit in this room may also be secondary. Plastered walls were evident in Rooms 78 and 83.

Two court kivas suggested by Lekson (1984:Figure 4.20) may have been related to these adjacent domiciles. The arc of living-room suites was partly obliterated by construction in the late A.D. 1000s that produced a number of new living quarters without repetitious layout. Some spatial clustering of households, however, appeared evident (see Chapter 11). Other habitation or clan rooms may have been appended to the front of the big-room suites along the west side of Pueblo Bonito (Plate 10.12), and other rooms with fireplaces are evident throughout the site. In none, however, can the floor features be tied coevally to the room construction with full certainty until the appearance of the terminal habitation/clan rooms in the A.D. 1100s. In their size and association with small kivas, these late-habitation rooms are more similar to small-house architecture than to the preceding greathouse buildings. Many of these newer, rectangular rooms, nevertheless, were semisubterranean, had floor ventilators and small benches, and exhibited painted, wall designs (Plates 10.12-10.14), traits of contemporary, small, circular kivas. These rooms tend toward a square shape (a high width/length ratio) and smaller size in the late A.D. 1000s and early A.D. 1100s, as compared to earlier, greathouse living rooms (Table 10.2). The floor ventilators found in many of these may simply be the result of rising plaza surfaces, particularly after the care and maintenance of the plazas had dissipated in the late A.D. 1000s.

On the other hand, rising plaza deposits at Pueblo Alto did not necessitate a floor ventilator for the firepits in Room 110, and several of the early A.D. 1100 "firepit" rooms were deliberately built to be semisubterranean, which suggests that these rooms with floor ventilators differed functionally from the large, rectangular, "firepit" rooms built in earlier times. The attributes of these late rooms suggest that their function was predominantly ceremonial rather than as multifunctional quarters for living. Similar rooms apparently existed in earlier times; witness Room 309 (Plate 10.15), Room 315, and Room 316 at Pueblo Bonito (Judd 1964:73-74), and those in front of Room 21 at Una Vida (see below). Interestingly, many of these rooms were placed in front of big-room suites, particularly at Pueblo Bonito, long after the initial construction of the suites. Unfortunately, without better temporal control, we cannot be certain when many of these were built (or modified) or adequately understand their relationship to the overall site organization.

A series of contiguous, early, living room suites may also have existed along the west side of Una Vida in the A.D. 900s, reminiscent of the Pueblo Alto plan. Only the northernmost suite has been excavated, and it consisted of a single-story room (Room 23) containing a firepit, a subfloor ventilator, a heating pit and a wall niche and was backed by a two-story room (Room 64) of equal size that was devoid of features (Akins and Gillespie 1979 field notes). From Gillespie's (1984b:Figure 4.4) projec-

Plate 10.13. Pueblo Bonito, Room 350 and Room 351. Semisubterranean living or clan rooms built in the early A.D. 1100s and attached to Kiva 2-D in the West Court as part of a three-room suite. Both rooms exhibited firepits, ventilators, and etched or painted figures on the wall plaster. Photo by O. C. Havens, 1925, looking northwest. (© National Geographic Society.)

Plate 10.14. Pueblo Bonito, Room 328. A living or clan room built in the late A.D. 1000s or early A.D. 1100s. Note firepit and subfloor ventilator. Photo by O. C. Havens. (© National Geographic Society.)

Plate 10.15. Pueblo Bonito, Room 309. A living or clan room built between A.D. 1040 and 1050 in front of earlier rooms in the north-central area. Note the ventilator and deflector system, and the subfloor vault. A narrow bench at the back of the room is not visible. (© National Geographic Society.)

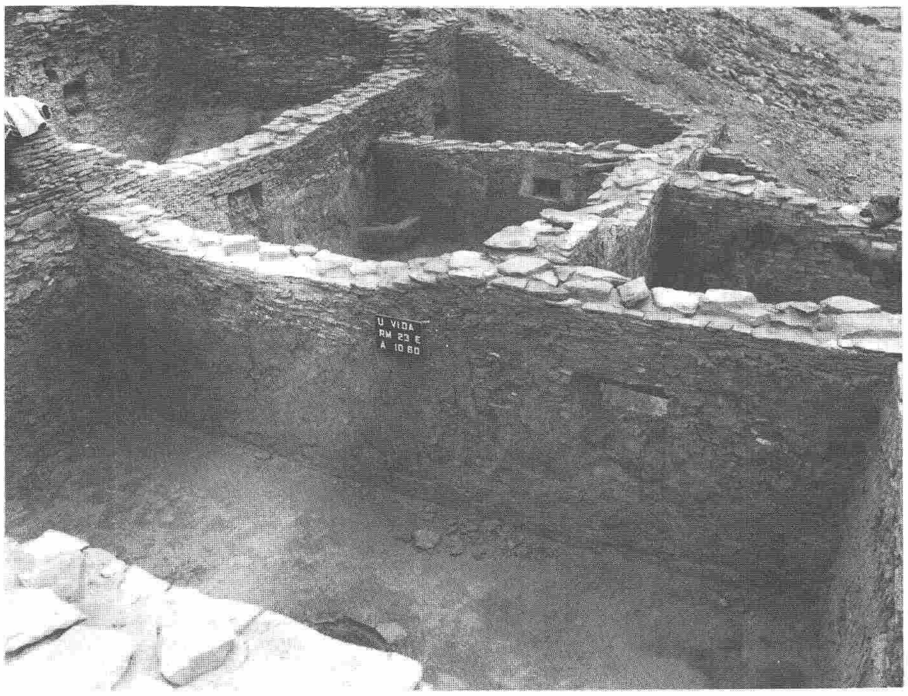


Plate 10.16. Una Vida, 1960 excavations in the northwestern corner of the site. An earlier living room (23) is in foreground, with clan or living rooms behind. Rooms 60 and 63 are in the center of the photo with big Room 21 to the far left. (Courtesy of the Western Archeological Center, NPS#18341.)

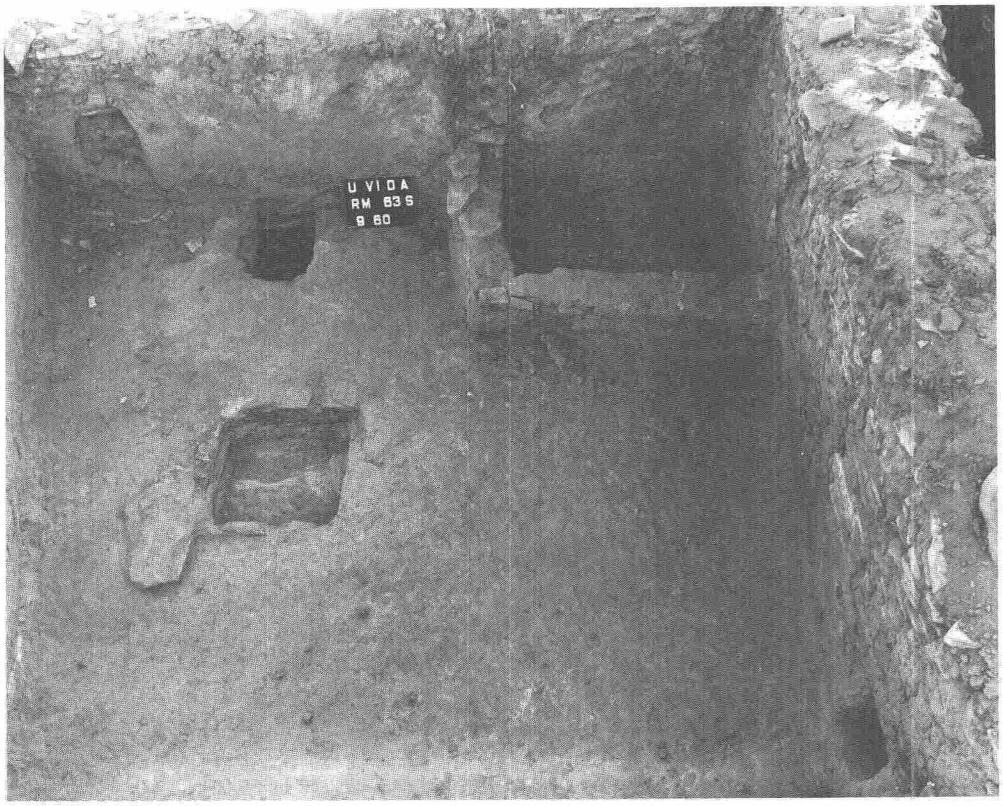
tions, however, it is possible that replicas of the Room 23/64 suites extend south along the entire roomblock, for a total of about 10 habitation suites.

Unfortunately, precise definition of suite perimeters cannot be made at Una Vida because of lateral door openings and door connections between Room 23 and a series of smaller, single-story, living rooms built in front of the big-room suites. Before construction of the latter, Room 23 apparently had double doors opening onto the plaza just like the West Wing habitation rooms at Pueblo Alto. Suite organization was also complicated by the three episodes of construction involved. Room 23 followed construction of the rooms behind it, between A.D. 930 and 960, and then the smaller living rooms were butted against it (Gillespie 1984b:90-92). The complications resulting from the myriad of door connections may be simply a factor of the excavation sample at Una Vida in the corner of abutting roomblocks (Plate 10.16).

The smaller living rooms (Rooms 60 and 63), built in front of the excavated big-room suite (Rooms 20, 21, and 80) at Una Vida (Plate 10.17), had direct door access to Room 21 and the plaza as well as lateral door access to Room 23. They also resemble the excavated corridor room at Pueblo Alto, which was also placed between a big-room suite and the plaza, as was Room 147, a late room. All were of about equal size, although space was arranged differently, and the two Alto rooms lacked subfloor ventilators. Differential access to storage space between the small living rooms and Room 23 also seems similar to Alto's design. From this, I suspect that these two small "living" rooms functioned in a similar fashion to the two associated with the big-room suite at Alto. The two living rooms (60 and 63) initially may have been another large room (30.4 m^2) similar to Room 21. Overall, Una Vida resembles Alto in layout, with the living-room suites arranged along the west (facing east) and the big-room suites butted perpendicularly to them and facing south. Although there are some problems equating Una Vida's design with Alto's because of the lack of data, it seems clear that the two share some surprising parallels in architectural development and function.

Living room suites at Pueblo del Arroyo appear to have comprised the entire initial block of rooms, built between A.D. 1065 and 1075 (Lekson 1984:210, 212). Two of the four potential living rooms were excavated and found to contain firepits (Judd 1959:31-34, 47), and all were adjacent to the initial plaza and facing east before remodeling rearranged the construction plan. Room 44/47 was connected by doors to Rooms 42, 43, and 45 to form one suite, but numerous doors throughout most of the units prevent identification of the initial suite plans. One of the living rooms, Room 55, initially contained a firepit but later was converted into a special-use area containing five mealing bins that postdated the living quarters.

Two other living rooms (40 and 41) were added perpendicularly to the initial roomblock and faced north. Both were two stories and contained a smaller room for storage behind them. Room 40 contained three firepits (Judd n.d.). Besides a firepit and two heating pits, Room 41 also con-



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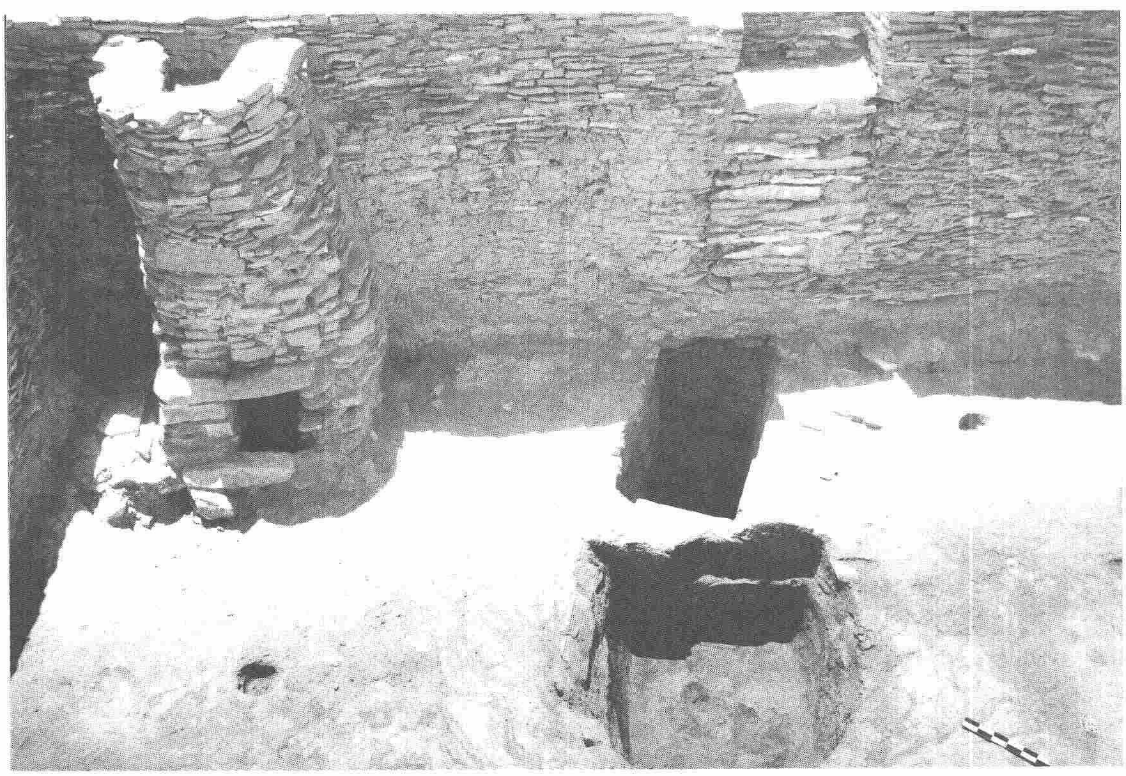


B

Plate 10.17. Una Vida, Room 60 and Room 63, looking southwest. Note the firepit and subfloor ventilator in each. A) Room 60 (NPS#18349). B) Room 63 (NPS#18743).

tained a set of three mealing bins (Judd n.d.; 1959:28, Plate 11) as in the Pueblo Alto domiciles. Except for firepits, Judd mentioned few floor features in the Pueblo del Arroyo living rooms, although I suspect more existed.

No pattern of occupation in the Chetro Ketl rooms could be discerned from the existing field notes. Of the more than 100 rooms excavated, a mere handful (3) contained possible A.D. 1000s firepits (Lekson 1983b). Few suites remain visible at Peñasco Blanco after the big-room, and possibly road-related, storage suites were identified, unless habitation can be attributed to the very large rooms added at the northeast end of the site. More likely, domiciles were represented by the buried row of rooms bordering the plaza. At Kin Bineola, the interior rows of rooms, if any, were covered by secondary kiva construction. It is under these kivas that the initial habitation suites are likely to remain. Otherwise, a pattern of linked domiciles at the latter two sites is not evident.

Other canyon greathouses have not been excavated and defy reliable identification of habitation suites. Rows of moderately sized, single rooms, adjacent to the interior plaza and facing east or south, are good candidates for domiciles (e.g., the large rooms in the west wing at Kin Bineola).

Summary and Conclusions

Using the results of the Pueblo Alto excavations as a standard for identifying some suite patterns and their potential function in other greathouses, we can illuminate three major components of greathouse design. Big-room suites have been no mystery to others (e.g., Judge et al. 1981; Lekson 1984), although it is misleading to portray them as scaled-up habitation suites derived from small-house plans. They both share common components (e.g., storage and living rooms adjacent to the plaza and court pitstructures), but the amount of space allocated to different activities differs significantly.

The amount of surface room space devoted to habitation activities shifts from about 50 percent of the total suite in small sites to miniscule amounts (about 15 percent) in the big-room suites (Volume II, Central Roomblock). If there were no other types of habitation-room suites, then we might project some functional continuity for suites between small and greathouse sites despite their construction arrangement. But the big-room suites exist coevally with habitation suites that mirror the small-site domiciles in terms of placement and proportional allocation of space. Both big-room suites and domiciles are associated with large court kivas, which therefore indicates two suite patterns that apparently functioned quite differently.

There may be historic antecedents for segregated storage units set away from the domiciles. At Zia Pueblo, for instance, small blocks of rooms isolated from others were formally used to store corn and dried deer and rabbit meat for communal and ritual use (Adams 1982; White 1962:49). Other suites of rooms were used by a society or two to perform ceremonies, as well as to store religious paraphernalia (White 1962:142). At Hopi, at least, religious storage rooms are adjacent to religious rooms and kivas (Adams 1982:14), a situation suspiciously like that at Alto. The clumps of fir pollen in some of the rooms in the Alto big-room suite does suggest that the rooms might not have been devoted to food storage. In conclusion, it is proposed that groups not living permanently at the sites used the big-room suites primarily for ceremonial activities and storage, rather than as areas for a multiplicity of domestic activities. The amount of space in big-room suites compared to domicile suites may have benefited large groups or a number of groups rather than just a family or two.

Another type of suite, storage-room units possibly related to prehistoric road traffic, must function with other suites within the same site, although architecturally there was little direct, door communication among them. It is likely that social and economic factors operating within each site did affect the operation of the road-associated suites, however. Were there enough occupants at each site to require the overwhelming disparity of storage and living space allocation? The answer must be no. The ratio of storage space to living space is so unequal as to require alternative models to the one of a scaled-up, small-site organization and function. Furthermore, much of the storage space (e.g., in big-room suites and road-related, storage-room units) was planned and built in a way that deliberately segregated the rows of domicile suites from it. Indeed, if any space in the greathouses gives the appearance of orientation toward nonsite occupants, it is the rows of storage rooms built along some sites' exteriors, with their numerous exterior doors but restricted access to the site interior, which limited social and economic intercourse with the site inhabitants.

Common threads that bound the early greathouses with their small-house contemporaries are reflected in the living units. These units, and the families that lived in them, may be the most informative about the society of which they were a part. Habitation suites apparently were part of the initial planning and design of greathouses for at least the first 150 years. For instance, 5 suites at Pueblo Alto, at least that many or more at Pueblo Bonito, 11 at Una Vida and 4-6 at Pueblo del Arroyo may have served the permanent site inhabitants. Typically, the living rooms in these suites bordered the plaza, were of medium size (15-30 m^2), single-story, and connected to one or more storage rooms. Probably they were also associated with large court kivas. Importantly, the habitation rooms tend to be built in contiguous rows (Figure 10.4) , although other habitation formats may have operated. With the reduction in room size and variability after A.D. 1050 or so in Chaco, a pattern for domicile placement is difficult to discern. At the Salmon Ruin, however, such units are clearly evident in the plan implemented between A.D. 1088 and A.D. 1093. Eleven, single-story, contiguous, habitation rooms resemble those at the canyon greathouses except that they are squarish and larger (<36 m^2) (Adams 1980:276-277, Figures 4.4-4.5). These rooms interconnected into

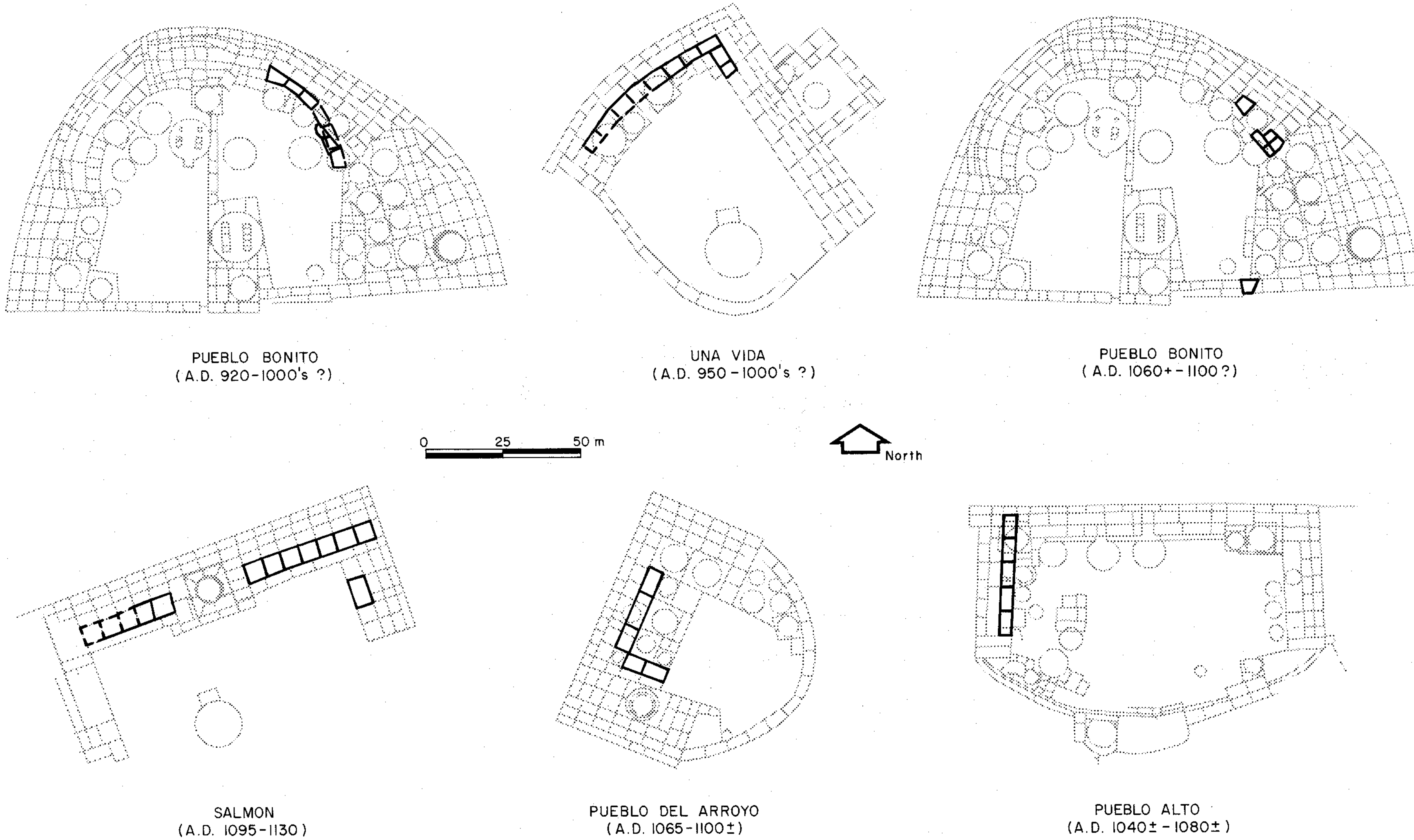


Figure 10.4. Living rooms built between A.D. 919 and A.D. 1095 in Chacoan greathouses.

supra-suites by long, narrow, corridor rooms, which follows the Alto model The largest rooms at Salmon were used for living, but there were no court kivas, in contrast to the canyon examples.

It may be that after A.D. 1050 in Chaco, rows of domiciles were not localized and built in the greathouses. If Kin Kletso is representative of the continuity in greathouse architecture (Lekson 1984), then its complete lack of floor firepits and single-story rooms may mark a shift away from occupation in the greathouses. Simply put, there appear to have been fewer habitation rooms relative to the hordes of storage rooms built after A.D. 1050, and these domiciles lack the patterned placement of earlier times. Numerous fires were built within Kin Kletso (Vivian and Mathews 1965), but all of these were postoccupational. Evidence of upper-story occupation in historic and prehistoric pueblos (e.g., Ciolek-Torrello 1978:155; Mindeleff 1891:103) might seem consistent with the lack of ground-story domiciles in Chacoan greathouses in the late A.D. 1000s and early A.D. 1100s. Indeed, Judd (1959, 1964) noted some upper-story occupation at Pueblo Bonito and Pueblo del Arroyo that lends credence for interpreting widespread upper-story domiciles, but evidence for firepit and mealing bin remains within collapsed upper-story floors is lacking. Upper-story, firepit and mealing bin remains can be easily identified in room fill (e.g., Ciolek-Torrello 1978:155; Windes 1984:77) and, therefore, their absence in reports on Chacoan greathouses is interpreted as a lack of upper-story occupation. There was no evidence of upper-story occupation in Kin Kletso.

The manner in which habitation suites were arranged and furnished harkens to longstanding traditions, including social ties, that transcend the new experiment portrayed by the rise of the greathouses. Other forms of suites, however, may reflect the new order. The big-room suites did not have small-site antecedents, and their configuration suggests functions and needs that transcended those of individual, greathouse households, perhaps as an expression of supra-ceremonial groups that occupied the site on an infrequent basis (see H. Toll 1985). The initial lack of lateral access between big-room suites also marks social-political boundaries perhaps defined by clan or lineage ownership as in the Hopi model (Adams 1982:26).

Certainly the addition of rows of storage rooms oriented toward the site exterior was uncharacteristic of contemporary small houses and earlier sites, and, again, marked not only a community-wide need but architect plans that suggest implementation on the supra-community level. These units must reflect the guiding hand of an authority that transcended decisionmaking at the individual site level or was prompted by intrasite, group consent. Whatever the need and the change that prompted it, the addition of road-related storage rooms at Pueblo Bonito, Chetro Ketl, and Pueblo Alto, and probably at Peñasco Blanco and Kin Bineola, along with an interlocking system of roads, indicates close intersite planning and implementation. The decision to allocate storage space for road-transported goods suggests a need for things that were not locally available. By the early A.D. 1100s, when new greathouses were built, these units disappeared, presumably along with the factors that first caused their creation.

Chapter Eleven

Population Estimates

One of the most difficult problems we face in explaining the Chacoan Phenomenon is the size of the population inhabiting Chaco Canyon and its effects on the dynamics of the system. Population size, of course, can have severe ramifications for models of the system. Clearly, the marginal environment of the canyon makes the population size a major factor in systems explanation. The sheer quantity of small sites and the size of the greathouses have stimulated scholars to conjure images of a canyon teeming with Anasazi. In turn, it was once assumed that the number of sites and the presumably large population could not have been established without increased precipitation (e.g., Fisher 1934). Although some early population estimates suggested that 20,000-30,000 people may have lived in the canyon at one time (Fisher 1934:20; Hewett 1936:159), more recent estimates have amounted to between 4,400 and 6,000 people (Drager 1976; Hayes 1981).

Probably most investigators would accept the lower figures as reasonable for the heyday of the Chacoans in the late A.D. 1000s. The lower estimates have been divided approximately equally between the two basic Anasazi occupational units in Chaco: small houses and greathouses (Hayes 1981). Despite the reasonableness of the lower figures, they are based on analogy with historic puebloan patterns that bears little resemblance to the overall organization of space in the greathouses (Windes 1984). In addition, estimates of the Chaco Canyon population have assumed year-round permanent habitation and have not considered alternative strategies of mobility.

Indices for Predicting the Chacoan Population

Approaches to estimating prehistoric population have varied. Site area (Drager 1976), room area (Naroll 1962), room number (Hayes 1981), kiva number (Lekson 1984:69), meat weight (Akins 1984), the number of pottery vessels (Toll 1984), the amount of charcoal (Windes, Volume II), the amount of arable land (Fisher 1934; Schelberg 1982), and the number of firepits (Windes 1984) have all been used to estimate population in Chaco.

Numbers of burials, an oft-used index employed for large sites throughout the world, has not been useful for population predictions in Chaco because burials are relatively scarce, particularly at the greathouses. This is in contrast to the multitudes of burials that are often found in very large Pueblo IV sites (e.g., see Birkby 1982:36; Kidder 1958:279; Smith et al. 1966:176), which suggest a permanent, large-site population. The burial phenomenon is not particularly anomalous in the general context of Pueblo II sites, however, when there is little patterning. On the other hand, Pueblo III burials from the early A.D. 1100s in Chaco Canyon appear common in site middens. The lack of burials in Chaco has not gone unnoticed but is generally credited to deviant behavior on the part of the Chacoan Anasazi; i.e., people were buried in cemeteries that have yet to be found (e.g., Judd 1954:341). Their lack, however, may be partly an indication of the mobility of the canyon population rather than a shift in burial strategy, notwithstanding the high number of burials that may have been actually found (Akins 1986), mostly in the small late sites.

Examination of greathouse room suites (Chapter 10) does suggest that a number of habitation groups (e.g., families) lived in each greathouse but certainly not in the numbers predicted from room frequency alone (cf. Vivian 1970b:119, 165). Aside from identification of habitation suites as correlates of population size, the question of permanency must be raised. Viable alternative strategies to full-time, year-round occupation include intermittent or seasonal occupation or some combination of both. Recurrent, intermittent use over a period of time may produce substantial cultural material and "permanent" facilities (Anyon et al. 1983:17). In fact, Lekson (1985b) argues that architectural permanence may reflect repeated seasonal use rather than permanent occupation, precisely because well-constructed buildings were needed to withstand the long periods of neglect. A number of aspects of the Pueblo Alto excavations (Volume II), including the Trash Mound stratigraphy and its faunal remains, the record of successive floor occupations and features in the two primary living rooms (Rooms 103 and 110), the ultimate destruction of the group of primary living rooms, and the unusual big-room suites that lack viable living space above ground suggest that the habitation strategy was a complex one that may have utilized both long-term and short-term, intermittent occupation. People may have lived year-round at Alto for periods of time but also exercised transitory occupation. This strategy may have characterized the "permanent" occupation of the West Wing.

A more transitory occupation, however, may have characterized use of the big-room suites, which lacked spacious aboveground domiciles. These suites mirror an emphasis on storage and ceremony rather than space for domestic activities. If so, the size of the user groups in the Central Roomblocks cannot be reliably calculated on the basis of existing information. Perhaps the large sizes of the adjoining court kivas are indicative of the participating group size. If just one court kiva served the five households in the West Wing, then perhaps the kivas associated with the Central Roomblock also may each have served a similarly sized group.

It is possible to measure group size by utilizing the West Wing living rooms. Earlier I have discussed the usefulness of firepits for identifying habitation rooms (Windes 1984), and this is partly covered again here because of its relevance to the discussion. The household is often cited as the smallest residential unit of a population, and this can be identified by the most essential of features, the room firepit (Adams 1982:13; Chang 1958:298; Ciolek-Torrello and Reid 1974:40; Dean 1969:76, 143; Turner and Lofgren 1966:129), along with a number of other features. The use of the firepit as an index of population is not rare (e.g., Ciolek-Torrello 1978:147-151; Hill 1970:76), although its use in several rooms of a single household can, of course, inflate figures. Its presence and location have been used to predict seasonality (Acklen et al. 1982:281; Biella 1979:114-115, Powell 1983), but its absence suggests serious reduction of, or the lack of, heating, lighting, and cooking within a room. Firepit size, and that of the domestic storage facilities, may also covary with household size (Ciolek-Torrello and Reid 1974:40).

In the Pueblo Alto West Wing, Rooms 103 and 110 have nearly all the earmarks of habitation units. Hearths, storage and other kinds of pits, mealing bins and wall niches abound. The floors are badly worn from use. The intense use of the rooms is astounding and unmatched by anything reported for other canyon greathouses, although photos of some rooms at Pueblo Bonito indicate that others did exist. It is surprising, nevertheless, that firepits were relatively rare in the two Alto rooms, although there were numerous heating pits (see below and Chapter 9 for definitions of heating pits and firepits). Room 103, with five floors, had no firepits, whereas Room 110, also with five floors, had just four firepits. The latter room began with a floor devoid of features (probably used during construction) that was replaced by one with dual firepits and little else. This was followed by a floor with almost 100 features and no firepit. There were 29 heating pits, however, but all were of exceedingly small volume except for one of 41 liters, which could have functioned as a temporary firepit. The last two floors revealed a reduction in numbers of all pit types except for the appearance of two firepits.

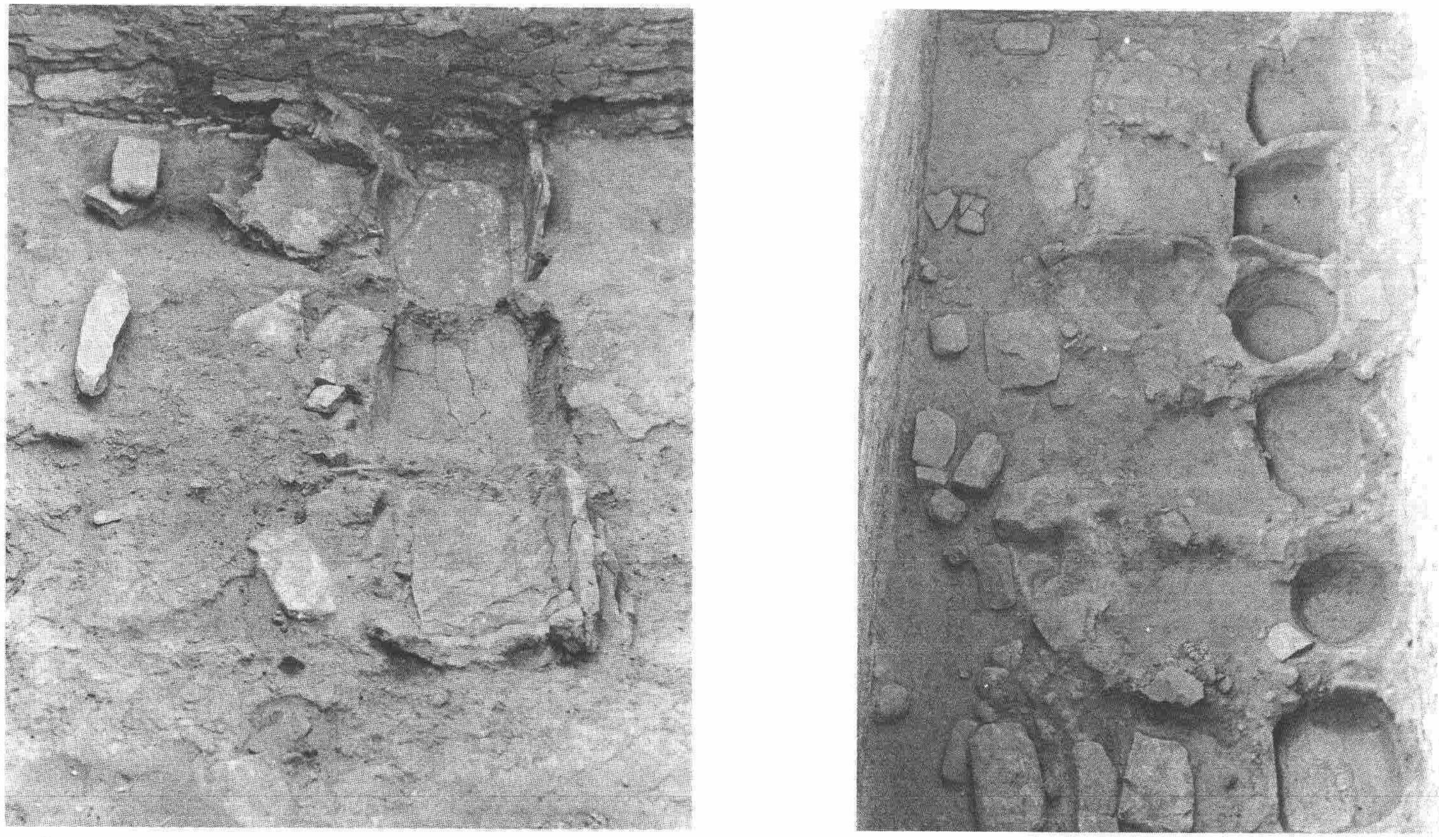
Heating pits at Pueblo Alto do share some attributes with firepits: high oxidation, fuel burned to ash, the presence of economic seeds, and the occasional use of a plaster lining, but generally their size is so small as to be minimally useful for hot fires of long duration attributable to household firepits, which were 5-20 times larger than heating pits. Household firepits in Chaco Canyon greathouses and several small houses ranged between about 20 and 80 liters with an average of about 40 liters (McKenna 1986:Table 1.7; Windes 1984:77). The 24 heating pits in Room 103, however, averaged just 2.8 liters in volume (sd = 2.0 liters) while the 40 in Room 110 were just 3.5 liters (sd = 6.7). For all Alto rooms, heating pits averaged 3.9 liters in volume (n = 100, sd = 5.8). The few large ones could have served as firepits, although their construction and oxidation suggests a short, impermanent use. M. Toll (1985b; Volume III) suggests that the two types of burned pits served similar food preparation activities. Parching Indian ricegrass seeds, however, was found to be a specific function of the Alto heating pits. The expedient nature of the heating pits, exhibiting little labor investment, suggests impermanent use, which would have been unsuitable for long, cold-weather occupancy. An intermittent pattern of occupation, then, is suggested for the West Wing habitation suites.

There was, at times, intense occupation, to be sure, but not a continual one. It is logical to assume that substantial interior firepits would have been present in the living rooms had the inhabitants consistently wintered at the site. Outdoor firepits might have sufficed in lieu of interior ones but few are known in the Alto plaza, and these all date to the following century. Communal cooking facilities, like the ovens in Plaza Feature 1, may have replaced interior, room firepits, but those that are common to the greathouses all postdate A.D. 1100. Finally, although the firepits in kivas could have substituted for those in living rooms, and probably did at times, there is little reason to suspect that they replaced them and other room activities for long periods of time. In the sole kiva analyzed for flotation and pollen remains, Kiva 15, the remains simply did not closely resemble the types and quantities of economic plant species found in the two West Wing living rooms. The same was true of the artifacts recovered from the kiva and the two rooms.

Mealing bin sets may be a more useful index of family size. It is not uncommon to find one, two, or three bins in Anasazi households after A.D. 1000. Historic puebloan households generally had between two and four contiguous mealing bins but most often three, which were always arranged according to the coarseness of the grinding surface (e.g., Bartlett 1933; Hill 1982; Lange 1959; Mindeleff 1891; Parsons 1936; Stevenson 1970). Even in the more distant historic past, a trio of metates was a common household feature. Castaneda remarked on their presence at Zuni in A.D. 1540 (Winship 1896:522) and sets of three or four were noted at Tesuque Pueblo in A.D. 1776 by Dominguez (Adams and Chavez 1956:50).

A set of three mealing bins was maintained throughout much of Room 103's occupation, while an identical set first marked grinding activities in Room 110 (Plate 11.1). Tentatively, then, three bins were minimal requirements for each household. Unfortunately, metates were removed prehistorically from the Pueblo Alto mealing bins, although Schelberg (1987) found little variation in surface coarseness in the Alto metate collection that might suggest metates were arranged by different grades of coarseness. Local availability of material probably was the crucial factor in the selection of fine-grained sandstone for all the manos and metates recovered in Chaco (see Cameron 1985a; Schelberg 1987). If different grades of coarseness were desired, varying the amount of roughening (sharpening) for the metates and manos would have been necessary.

Sometimes mealing bins were relegated to special rooms for communal use. But it would be wrong to assume that this signifies institutionalized craft specialization or work groups organized at the community level (Robertson 1983:34-39). In special-use rooms, where many bins are often found, the numbers may reflect the number of participating households.



A B

Plate 11.1. Mealing bins in living rooms at Pueblo Alto. Note that the metates have been removed, although manos and hammerstones were left behind. A) A set of three mealing bin catchment basins in Room 103, Floor 3 (NPS#14436). B) A set of six mealing bin catchment basins in Room 110, Floor 1 (NPS#15154).

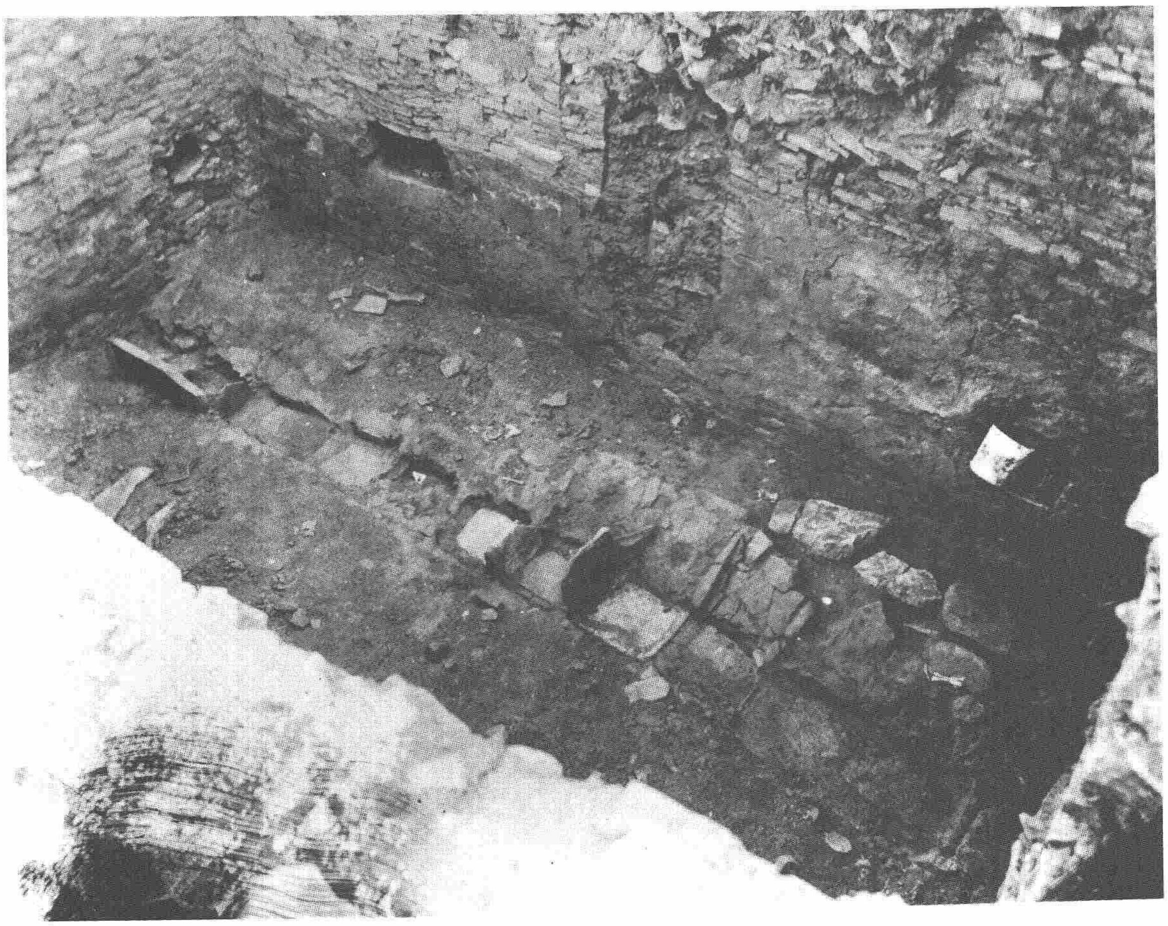


Plate 11.2. Pueblo Bonito, Room 90, exhibiting a row of 10-12 mealing bins with all the metates removed. The residents of three nearby households probably initially utilized this complex for food preparation. (Courtesy of the American Museum of Natural History, AMNH#52-354.)

Room 90 at Pueblo Bonito, with a row of 10-12 bins (Plate 11.2), is a case in point. Room 90 and a number of living rooms clustered around Kiva 75 appear to delineate an interrelated group of people. Firepits, storage bins, and wall niches abound in Rooms 65 (Plate 10.1), 66, 68, 290, and 291 (Pepper 1920), whereas other nearby rooms were devoid of habitation features. Room 291 contained five mealing bins arranged in sets of three and two. The proximity of Room 290, next door, probably allowed its inhabitants to utilize one of the two sets. The other living rooms lacked grinding facilities, and it is logical to assume that Room 90 served the remainder. Handily, a room for storing and manufacturing metates (Room 72) was located between Room 90 and several of the living rooms. No matter how the units are divided among the rooms, the total mealing bins (15-17) divided by the five living rooms in the close vicinity yields three bins per family, or just as predicted from historic analogy.

Few other mealing bins were found at Pueblo Bonito, although the phenomenon of bin construction probably arises in the early A.D. 1000s. The two mealing rooms discussed above, Room 90 and Room 291, were built after A.D. 1060 (Lekson 1984:Figure 4.20), although Judd (1954:135) argues for construction of the bins in Room 90 at about A.D. 1045. In addition, Lekson (1984:49) believed that Room 222 also had mealing bins, possibly four (Judd 1964:282), but Judd (1964:30) fails to mention them under the appropriate discussion.

Another living room at Pueblo Bonito (Room 159) contained a set of three mealing bins that were documented in two unpublished Pepper photos (AMNH #1475, #1476). Rooms 159 and 222 were both built after A.D. 1085, probably in the early A.D. 1100s.

The Chacoan occupation at Salmon Ruin also exemplifies the predicted breakdown of three mealing bins in use per family. The seven large, square, living rooms in the eastern half of the main roomblock were devoid of grinding facilities, but three rooms adjacent to them probably served these needs. These three yielded sets of 3 to 4, 6, and 12 (or more) bins (Shelley 1980:Figure 6.7 and Table 6.22), which averages three per living room. Not only is the mean figure satisfying, but the bins occur in multiples of three, suggesting that the communal rooms were the result of cooperation among small numbers of households. Another room in the east wing contained either 6 or 12 mealing bins, and it was adjacent to two other potential living rooms. No other Chacoan bins were found, although Mesa Verdean bins at the site sometimes occurred in sets of three, but most often as one.

At Pueblo del Arroyo, sets of 1, 3, and 5 bins were found in Rooms 5, 41, and 55, respectively (Judd 1959). The former two contained firepits and are presumed to have been for habitation. Room 55 had been a living room but was converted into a mealing room with access to the roof of an adjacent kiva. Room 5 was a tiny living room of early A.D. 1100s construction, but Room 41 was built and used during the initial Chacoan occupation in the middle A.D. 1000s. Chetro Ketl yielded only a single instance of permanent grinding facilities (four bins in Room 35), but these had direct access only to a nearby kiva roof and not to any known living rooms (Lekson 1983b:18, 263). Single rooms at Bc50 (Kluckhohn 1939:72) and Bc51 (Brand et al. 1937:72) contained sets of three and two bins, respectively, and both were adjacent to late living rooms.

The paucity of mealing bins in Chaco may be due in part to former excavation strategies that failed to strip off the upper room floors. If we had followed this strategy, no mealing bins would have been discovered at Pueblo Alto unless those under Room 109 had come to light. At the time of the latter's discovery, they were thought to have been part of a communal facility in Room 109 rather than equipment for Room 110. On the other hand, the shift to fixed metates may mark a shift in occupational permanency, subsistance or social organization. Metates could be moved outdoors during the warmer months and inside during the colder months, like those documented for Zia Pueblo (Florence Hawley Ellis in Kidder 1958:138). At Pueblo Alto, the appearance of mealing bins may correspond to the use of a new metate type, a thin, shallow-trough metate. Thick, deep-trough metates, which did not need to be enclosed in bins, reappear at Alto in dominant numbers in the early A.D. 1100s when mealing bins apparently were seldom used (see Windes, Volume III). Unfortunately, greathouse living rooms dating in the A.D. 1000s are few and poorly documented, so it is difficult to postulate a pattern of a trio of fixed bins in Chacoan living rooms with a subsequent demise of mealing bins in the early A.D. 1100s, although I suspect that this might have been true.

If three bins are accepted to reflect minimal Chacoan household population, then does an increase in mealing bins mean an increase in household size or the number of people who used them? Possibly. It may also reflect increased functional differentiation of the materials being ground. Note the departure from normal of the new catch basins in Room 110, where two of the three additions contained basket liners (Volume II). From the present information, one option cannot be realized over the other, although the doubling of bins in Room 110 does leave open the possibility that there was an increase in household size (or one that reached a certain threshold of size) not experienced in Room 103.

In summary, at Pueblo Alto, families in the two excavated living rooms may have been proportional in size to the number of mealing bins and firepits present. A set of three mealing bins may suggest that family size was similar to historic puebloan families, whereas twice as many bins may indicate larger families were present, perhaps resulting from the marriage of children and the addition of the new spouses to the household. From historic analogy (e.g., Kidder 1958:133-134), Alto family size may be said to range between approximately five and seven persons per nuclear unit. Nuclear families, therefore, are thought to have inhabited Rooms 103 and 104, whereas larger family units inhabited the remaining three habitation room suites in the West Wing.

Given the vicissitudinous nature of the room occupation as inferred from the many surfaces of use and the features in Room 110, a simple solution identifying permanency and residential group size is not easily forthcoming. At best, a family or two can be said to have occupied Room 110, with a smaller group inhabiting Room 103, but probably not always on a permanent basis. More likely, we are seeing from the archeological record the remains of a highly mobile, residential group able to exercise options other than permanent residency. Permanent residency as used here refers to year-round occupation of several continuous years, whereas a semi-permanent, mobile group is one that shifted residence within a year or two.

Greathouse Populations

My earlier estimates of the Pueblo Alto population (Windes 1984) suggested between 50 and 100 residents. The higher total reflected uncertainty as to whether primary habitation suites existed in the Central Roomblock and East Wing besides those in the West Wing. After examining living rooms found in other greathouses (Chapter 10), I believe that they do not, or, at least, not in numbers that would greatly alter present estimates. Alto, thus, appears to have been planned and built to house five "permanent" or semipermanent families or household units--all located in the West Wing. The size of these families may be related to the number of mealing bin sets found within each habitation room (see above). The widespread use of a trio of such bins, even historically, suggests that at Alto living rooms supported between about 5 to 10 people each, or about 25 to 50 people at the site.

The pattern of building contiguous habitation suites, localized to one part of the site, may have been a long, established tradition in greathouse construction that is first noticeable in the early A.D. 900s. Data are sketchy for this period, but the Pueblo Alto pattern seems duplicated at Pueblo Bonito and Una Vida, two of the earliest greathouses. There are other rooms that fulfill the requisites of "living" rooms if firepits alone are considered the basic common denominator for their identification. But many of these apparently were used for functions other than long-term, family occupation or for different kinds of households. Even the term "permanent" for the five West Wing units is used with misgivings. Permanent in this case means long-term, recurrent occupation, but not necessarily daily, year-in and year-out residence.

The wholesale use of heating pits, in lieu of permanent firepits, in the two Pueblo Alto West Wing rooms excavated, seems to mark an intermittent occupation not committed to permanency. This behavior is not unusual by historic accounts, which state there was frequent movement between the main and subsidiary pueblos (Winter 1983a:425-426). At Zuni, for example, many people spent part of the year away from the ceremonial center to live in large farming communities (e.g., see Kintigh 1985:107). A mobile population has also been suggested for the supposedly sedentary, classic Mimbres (Lekson 1985b). Given the marginal environment in Chaco and the wide seasonal and yearly fluctuations in weather patterns, an option of mobility by the inhabitants seems a sensible tack.

Estimates for Pueblo Alto are about 20 to 50 people for the initial occupation until abandonment of the West Wing living rooms in the late A.D. 1000s. For the same period, use of the Central Roomblock and the East Wing on a temporary basis may have seen an influx of many more people, perhaps between 50 and 100. After about A.D. 1080, the population at Alto is too difficult to estimate because habitation suites are not discernible in the architectural plan and renovations. Between A.D. 1100 and 1140, however, changes at the site and throughout Chaco Canyon suggest departure from the previous social organization. Clearly, some occupation occurred at the site, but probably within the myriad of small-room complexes and modified suites. Kivas at this time show a marked reduction in size and resemble those in small-house sites.

At least 11 of these late kivas were found or are suspected at Pueblo Alto, although many more may exist. One to two habitation suites existed per kiva in the small-house sites, if not more, and there is reason to suspect that this grouping was maintained in the greathouses after A.D. 1100. Thus, between 11 and 22 family units or more may have existed at Alto in this period, if all kivas saw coeval use. More realistically, perhaps about half were coeval at any one time (see Volume II) but, coupled with those that probably remain to be discovered, indicate that a maximum of about 50 people may have inhabited Alto in the early A.D. 1100s.

The size of Pueblo del Arroyo, its suggested number of 4-6 living rooms, the late transfer of kivas into its roomblocks, and its early A.D. 1100s remodeling and occupation suggest a cultural change similar to Pueblo Alto's along with corresponding population numbers. Five to 15 residences were probably maintained throughout the early history of Una Vida, Pueblo Bonito, and Peñasco Blanco until the late A.D. 1000s. Because of its size, Hungo Pavi probably contained no more households than either Pueblo Alto or Pueblo del Arroyo. If the figure of 5 to 10 people per family unit seems reasonable for Alto, then the size of the population before A.D. 1050 at the other three greathouses may have been between 50 and 100 each. By the middle A.D. 1000s, then, the suggested entire greathouse population in Chaco Canyon was between about 300 and 600 people. These estimates are in line with Schelberg's (1982:Table 12) estimates for a self-sufficient population, which were based on available, local, arable land in Chaco. After A.D. 1050 I suspect a drop in population, with a resurgence in the early A.D. 1100s to earlier, if not higher, levels until the near depopulation of the canyon in about the A.D. 1140s.

Small House Populations

Small-site settlement, an integral part of the canyon population and the Chacoan Phenomenon, also is seen as far less populous than previously estimated. A resurvey of a sample of the canyon small houses in Chaco (Windes and Doleman 1985) suggests that earlier site density figures calculated from the 1972 survey (Hayes 1981) were in error because of ceramic sampling procedures used to generate the estimated periods of occupation. These findings are pertinent here for understanding the population density of the canyon during the construction and occupation of Pueblo Alto, as well as the potential effects of the population on the local resources, and the integration of the greathouse and small-house populations. Inferences drawn from the settlement data of the 1970s inventory survey paralleled earlier hypotheses that the Anasazi population grew steadily through time and peaked after a rapid expansion in the eleventh century that corresponded with the florescence of the Bonito phase in the late Pueblo II-early Pueblo III period between A.D. 1050 and A.D. 1100 (Figure 11.1). The number of small houses inventoried, however, steadily decreases from 373 in the Pueblo I period to 172 in the late Pueblo III period (Table 11.1).

Table 11.1. Number of pueblos by period calculated from the 1972 inventory survey (after Hayes 1981:25-32, Figure 10).

Period:	PI	early PII	late PII	early PIII	late PIII
A.D.:	750-950	900-975	975-1050	1050-1175	1175-1300
No. of Pueblos:	373	353	323	282	172

Hayes (1981:60) believed that the reduction in the number of pueblos was alleviated by a huge growth in greathouse occupation that may have been supplemented by population transfer from the small sites. Unfortunately, there are some serious problems with the methods of the survey, which affect the proposed population figures.

The Resurvey Sample

Between 1980 and 1984 a sample of Pueblo II and Pueblo III houses was re-examined in order to refine their occupation span(s). Serious constraints in personnel and time limited the sample to sites within the canyon inventoried during the 1972 survey. The stretch of canyon sampled ran for 17.5 km from Shabik'eshchee Village at the east end to Peñasco Blanco at the western end (Figure 11.2), which included the clusters of sites gathered at the major gaps along the canyon across from Pueblo Bonito and Una Vida. Sites on the mesas above the canyon, a sparse minority of the total, and those in communities not far from the canyon were not included because of the time involved in their re-examination and because the majority of sites were located in Chaco Canyon. The emphasis was on small-site, habitation structures in Chaco Canyon, so buildings with less than three rooms (e.g., possible field houses) were trimmed from the total, which left 201 pueblos in the sample area.

Much has been made of the dense cluster of small sites on the south side of the canyon and their absence on the north side of the canyon (Grebinger 1973; Vivian 1970b). The general view of small-site contemporaneity and spatial separation from greathouses has led to models of a ranked society to explain the discrepancies. In addition, there appears

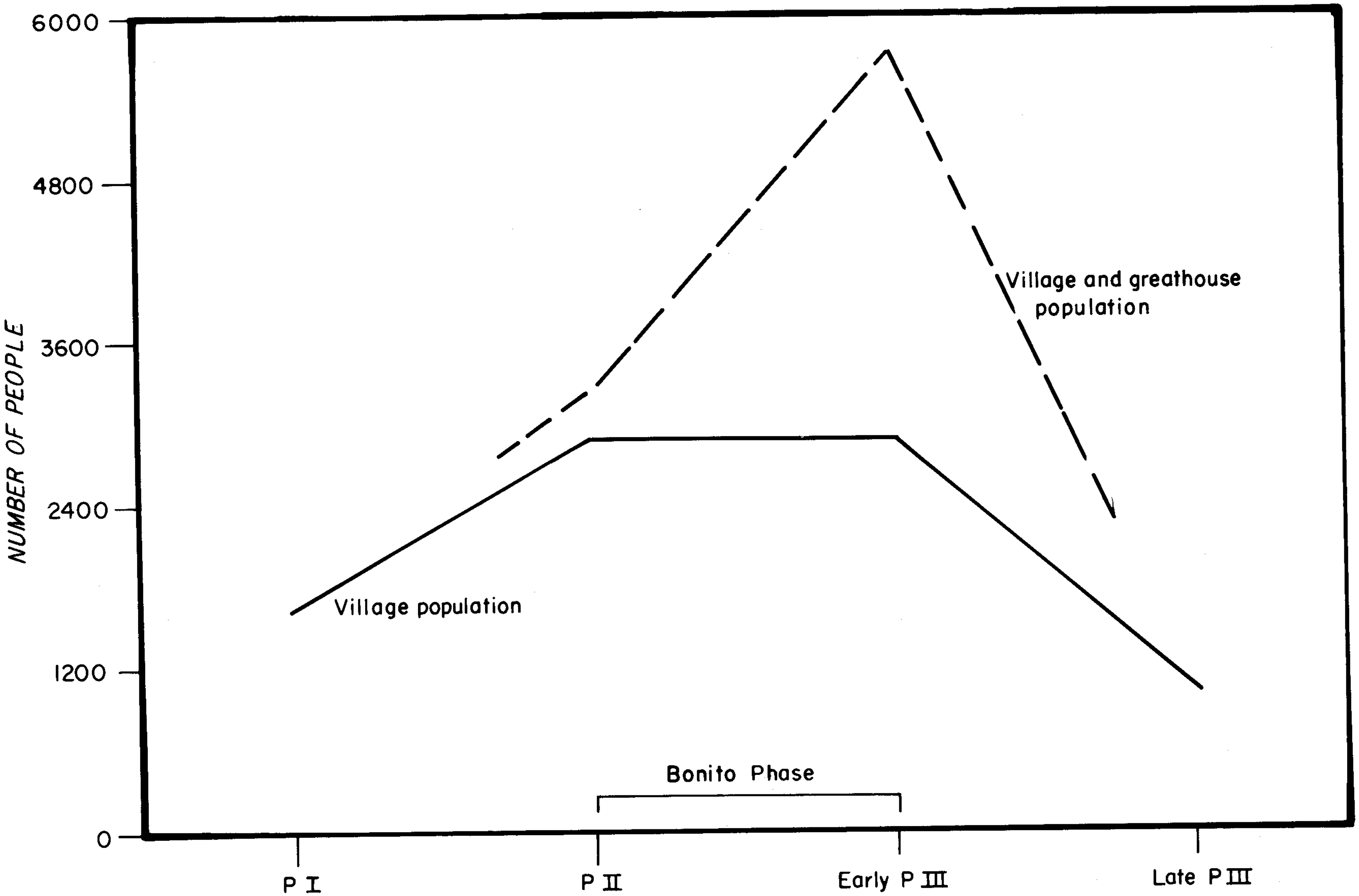


Figure 11.1. Estimated population figures for Chaco Canyon derived from the 1972 inventory survey (after Hayes 1981).

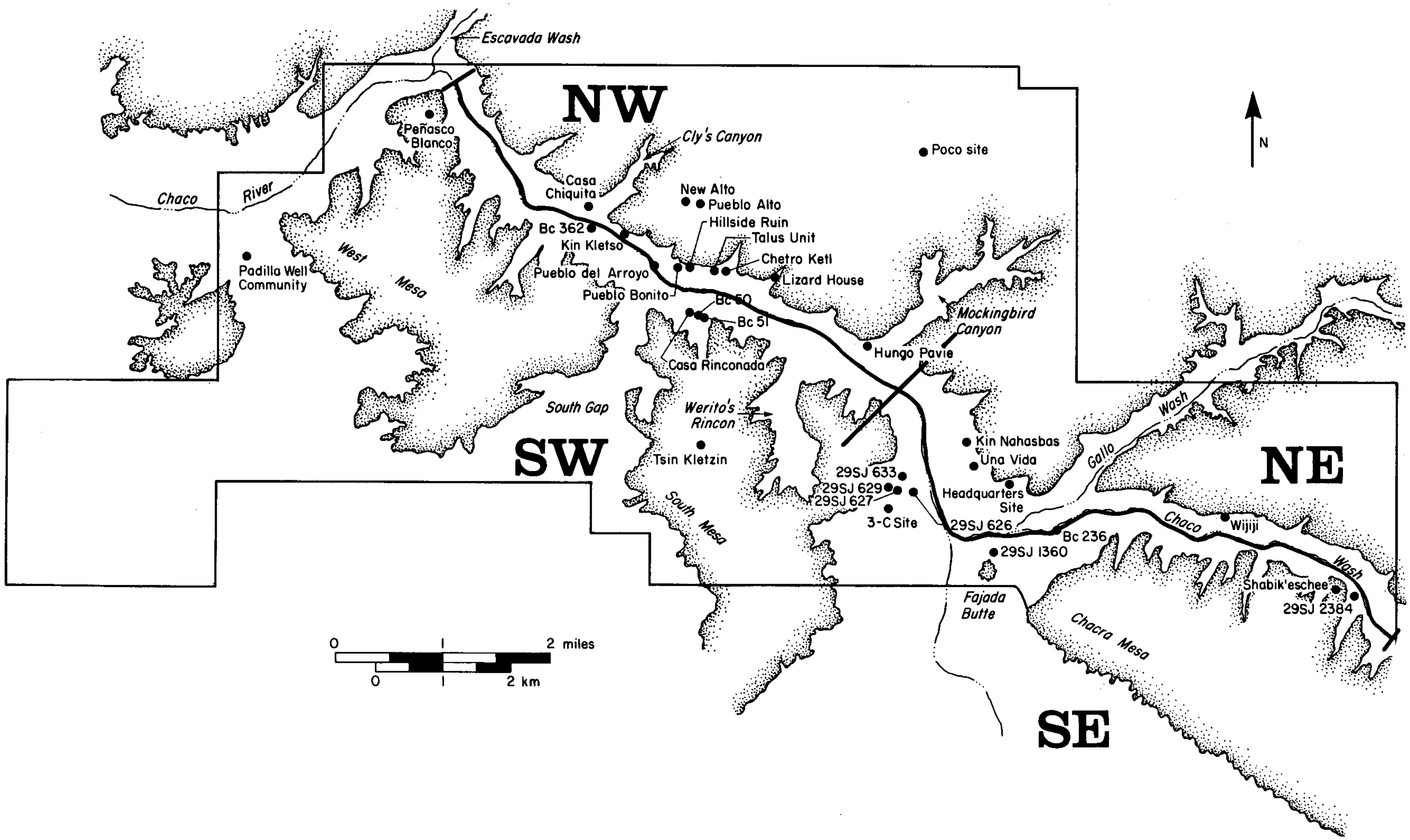


Figure 11.2. Subdivisions of the canyon into the four quadrants employed for the 1980-1984 sample of small Pueblo II and Pueblo III sites in the canyon bottom.

to be an aggregation of sites through time at the major gaps along the canyon, particularly around South Gap and Pueblo Bonito. Thus, the sampling design incorporated subdivisions of the canyon to reflect the potential dichotomy of north-south (opposite sides of the canyon) and east-west differences (Figure 11.2). The Chaco Wash served to divide the two sides of the canyon into north and south. Although the wash has changed its course over the past several millennia, few sites are located in the flood plain and none were included in the sample.

A break in site distribution between the two major, site clusters (at South Gap and Fajada Gap) determined the boundary between the east and west parts of the canyon. There is a fairly even scatter of small sites along the two sides of the canyon until a 720-m strip on both sides is reached just east of Hungo Pavi. The canyon topography may have caused the break in settlement or perhaps it reflects some social-political boundary between the two site clusters. The boundary is about midway between the east and west limits of the survey area (8.5 km from the west end). Nevertheless, although the boundary was chosen as an excellent place to divide the two major site clusters, it also fortuitously split the number of houses into roughly equal lots.

Every fourth site along both sides was initially chosen to represent a 25 percent sample of the 201 Pueblo II and Pueblo III houses in the canyon bottom. Several factors mitigated against strict application of this approach, however. Several sites, particularly along the northern side of the canyon, did not yield enough, if any, ceramics to justify analysis (15 sites). In addition, two sites could not be relocated, and all excavated sites (23) were excluded from the sample. More than the 40 unusable sites would have been discarded if all 201 pueblos had been revisited. In cases where undesirable sites were discovered in the sample, the next suitable site became the sample target. In one case, however, a series of four sites initially examined for another project were included in the sample. Eventually 21 percent of the 201 houses were studied. The sample included sites under study throughout the length of the canyon, although sampling inequalities among the four quadrants (between 19 and 30 percent) produced an unproportional, stratified sample. Twenty percent of the small houses were sampled in the two southern quadrants of the canyon, where 71 percent of all the small Pueblo II and Pueblo III sites are located.

To monitor the site ceramics, the entire site surface was first closely examined by the author and changes in ceramic assemblages noted. This permitted recognition and sampling of the various multicomponent assemblages on a site. Transects covered each trash concentration and house mound for every site sampled (unless there was nothing to sample), but heterogeneous middens received multiple, separate transects. Typically, all the ceramics on the house mound were recorded while multiples of meter-wide transects ran along the central, longitudinal axis of each midden. For middens, ceramics were examined until a mimimum of about 250 or 300 sherds was recorded for each area sampled. A total of 18,450 sherds were tabulated for the 77 transects examined (a mean of 240 sherds per transect).

Ceramics, then, provide the chronological control for the sampling. The basis for the ceramic assemblage seriation was provided by a multidimensional scaling program called KYST-2A (see Chapter 8). For this analysis we found that identifiable, painted ceramics worked best, followed by culinary types, but that unclassified whitewares and unclassified sherds with mineral paint caused results to polarize. The latter two categories were, therefore, excluded from the seriation. Culinary types provided an independent seriation of the assemblages that closely matched that produced by the painted types.

The Findings

Despite a more rigorous approach to collecting ceramic data than was used for the 1972 inventory survey, the possibility of mixed assemblages continues to plague temporal distinctions. Nevertheless, the resurvey, combined with multidimensional scaling and a number of tree-ring-dated ceramic assemblages, permitted assignments of relatively tight temporal control to the calculated, small-site occupations (Figure 11.3 and Table 11.2). We believe that alternative, more reliable results are possible by making some adjustments (discussed below) in the temporal placements (Figure 11.4 and Table 11.3).

Although the KYST-2A seriation easily distinguished major ceramic components, it could not adequately subdivide the 150-year period between A.D. 900 and 1050 that is dominated by Red Mesa Black-on-white (and neck-decorated culinary). Thus, we were unable to grasp at house figures for shorter more meaningful periods of time solely from the seriation. All excavated small sites (five) in the canyon that were dominated by Red Mesa Black-on-white on the surface revealed occupation in the early A.D. 1000s and abandonment (for at least four of the five) at about A.D. 1050. Therefore, for Table 11.3, all sites dominated by Red Mesa were placed in the early A.D. 1000s period, although many, if not most, were undoubtedly also occupied in the A.D. 900s.

Between A.D. 1040 and 1060, ceramic preference switched rapidly to assemblages dominated by Gallup Black-on-white (and indented corrugated). We suspect that sites revealing assemblages with high frequencies of both Red Mesa and Gallup Black-on-whites were occupied during this "transition" period but not later. Nevertheless, it seems more realistic to err on the conservative side by placing the occupation of these sites in both the early and late periods of the A.D. 1000s, given the difficulty of precise ceramic dating.

Sites placed in the A.D. 1050-1100 period for Table 11.3 include those dominated by Gallup Black-on-white (i.e., in Table 11.2), those with a mix of "transition" ceramics, and sites yielding ceramic components bracketing the period, which suggests continuous occupation throughout the A.D. 1000s. Houses initially assigned to the early A.D. 1100s and the A.D. 1200s periods in Table 11.2 were not adjusted in Table 11.3. The adjustments, then, may have inflated figures for the A.D. 1000s but left later temporal placements intact.

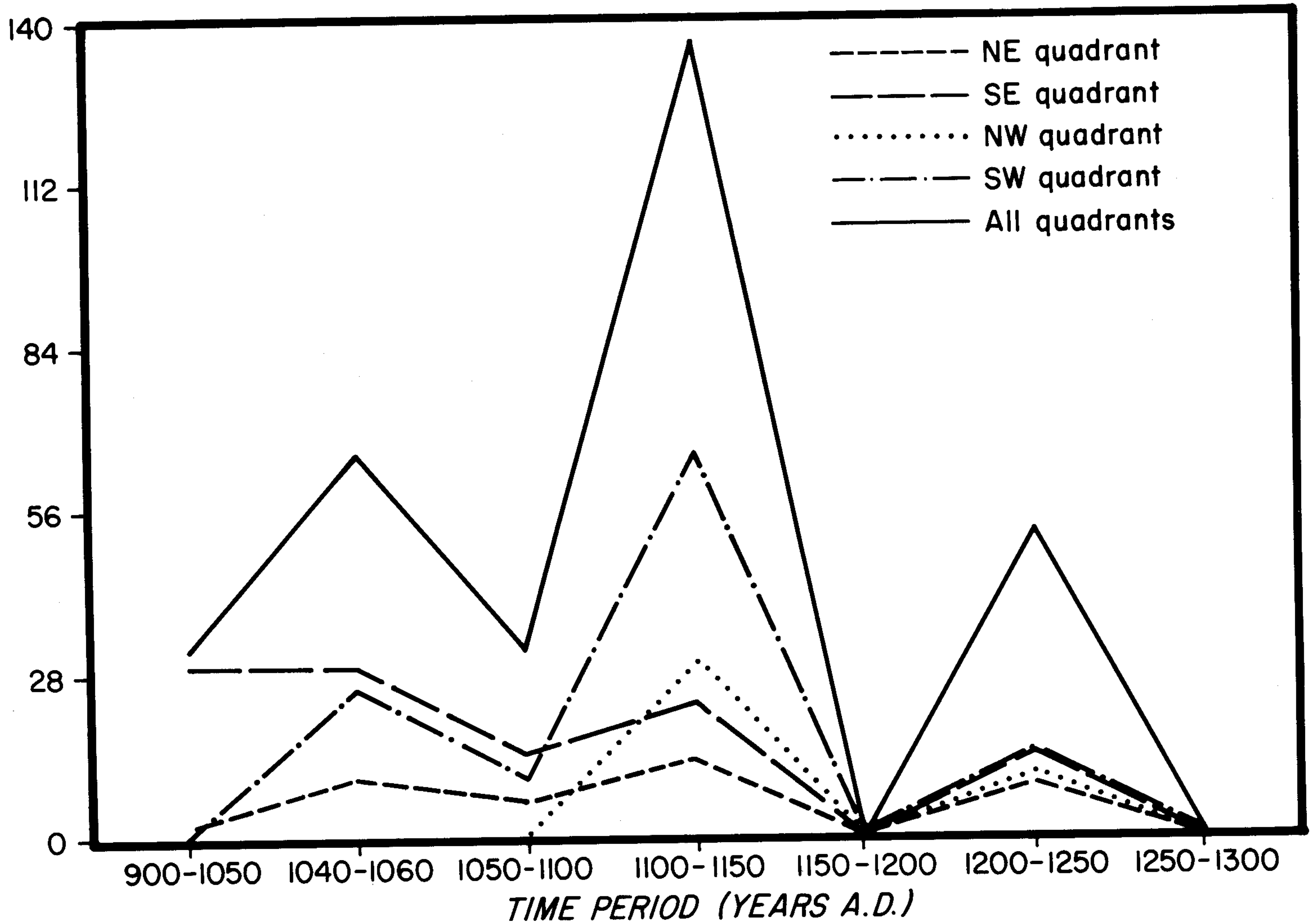


Figure 11.3. Small-house frequency in Chaco Canyon by quadrant through time (A.D. 900-1300).

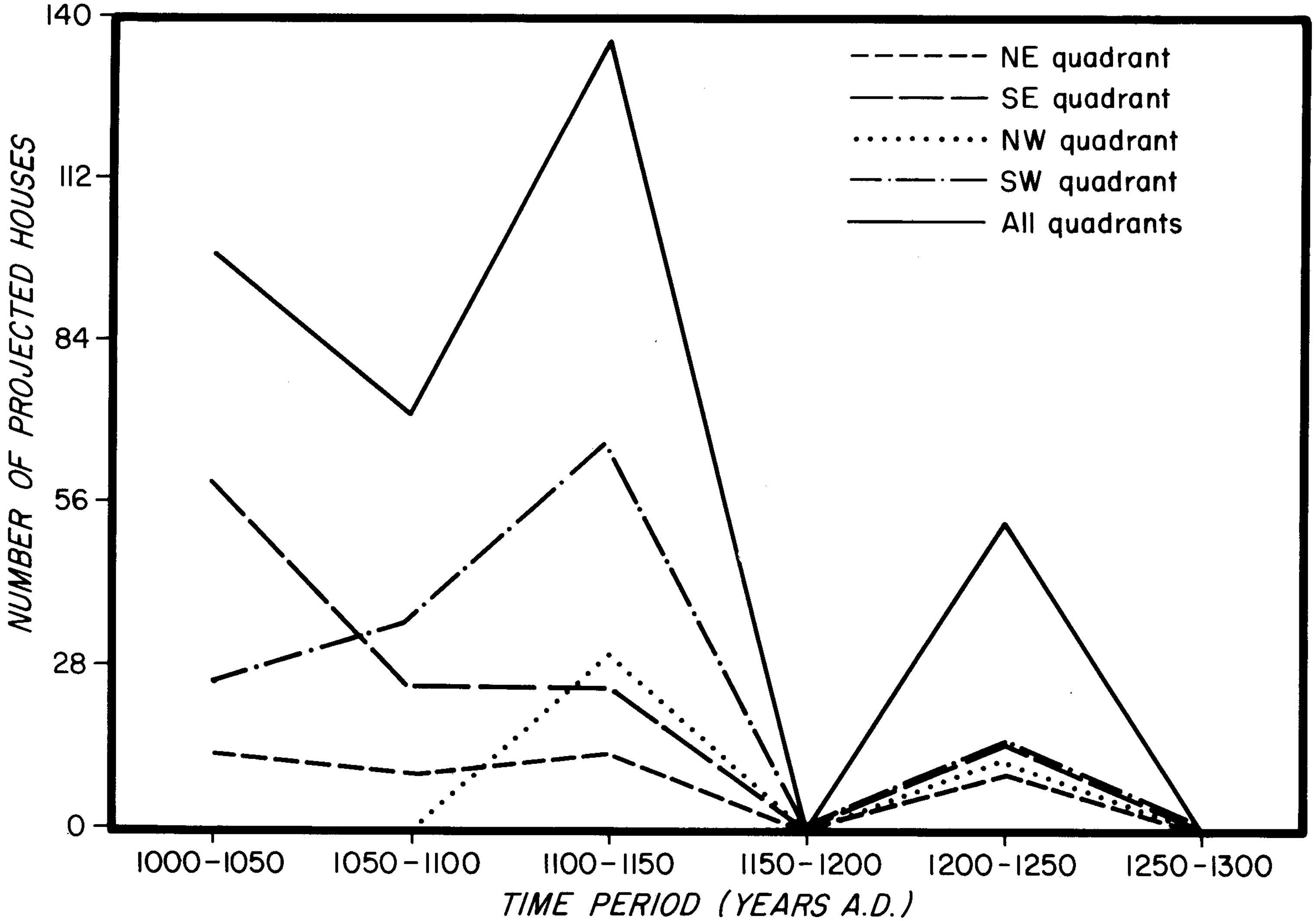


Figure 11.4. Adjusted small house frequency in Chaco Canyon by quadrant through time (A.D. 1000-1300).

Table 11.2. Sample and projected frequencies of occupied small houses in Chaco Canyon from about A.D. 900 through 1300.

AREA OF CHACO	PERIOD OF TIME				
Ceramic Time:	Red Mesa	Red Mesa/Gallup	Gallup	Chaco-McElmo	Mesa Verde
A.D.:	900-1050	1040-1060	1050-1100	1100-1150	1200-1300
NE Quadrant					
Sample total	1	3	2	4	3
Projected total	(3.4)	(10.1)	(6.8)	(13.5)	(10.1)
%	10	15	21	10	19
SE Quadrant					
Sample total	6	6	3	5	3
Projected total	(30.0)	(30.0)	(15.0)	(25.0)	(15.0)
%	90	45	47	18	28
SW Quadrant					
Sample total	0	5	2	13	3
Projected total		(26.0)	(10.4)	(67.6)	(15.6)
%		39	32	49	29
NW Quadrant					
Sample total	0	0	0	6	2
Projected total				(31.0)	(12.4)
%				23	23
Totals					
Sample total	7	14	7	28	11
Projected total	(33.4)	(66.1)	(32.2)	(137.1)	(53.1)
%	100	99	100	100	99

Quadrant site and sample totals:

Quadrant		Total PII-III sites	No. and % Sampled	
NE	=	27	8	29.6%
SE	=	65	13	20.0%
SW	=	78	15	19.5%
NW	=	31	6	19.4%
Total		201	42	
Mean				20.9%

Table 11.3 Adjusted sample and projected frequencies of occupied small houses in Chaco Canyon from about A.D. 1000 through A.D. 1300.

AREA OF CHACO	PERIOD OF TIME (A.D.)			
	1000-1050	1050-1100	1100-1150	1200-1300
NE Quadrant				
Sample total	4	3	4	3
Projected total	(13.5)	(10.1)	(13.5)	(10.1)
%	14	14	10	19
SE Quadrant				
Sample total	12	5	5	3
Projected total	(60.0)	(25.0)	(25.0)	(15.0)
%	60	35	18	28
SW Quadrant				
Sample total	5	7	13	3
Projected total	(26.0)	(36.4)	(67.7)	(15.6)
%	26	51	49	29
NW Quadrant				
Sample total	0	0	6	2
Projected total			(31.0)	(12.4)
%			23	23
Totals				
Sample total	21	15	28	11
Projected total	(99.5)	(71.5)	(137.1)	(53.1)
%	100	100	100	99

Quadrant site and sample totals:

Quadrant		Total PII-III sites	No. and % Sampled	
NE	=	27	8	29.6%
SE	=	65	13	20.0%
SW	=	78	15	19.5%
NW	=	31	6	19.4%
Total		201	42	
Mean				20.9%

No matter which alternative is preferred (I prefer Table 11.3), similar trends are evident for the small-site occupations. Pueblo II sites occupied before A.D. 1050 and dominated by Red Mesa Black-on-white were found only in the east canyon sample. Probably they are also well represented in the west end of the canyon but are masked by later occupations. The least common house was one exhibiting the ceramics of the Classic Bonito phase (i.e., dominated by Gallup Black-on-white), dating between A.D. 1050 and 1100, for which Chaco is best known. We know from greathouse ceramics that Gallup Black-on-white is the most numerous decorated type in ceramic assemblages during this period and that Red Mesa Black-on-white usage and discard diminished rapidly by A.D. 1050 or 1060. Some would argue that this may not be true at small houses and that differential access to production goods favors greathouse inhabitants. Assemblages dominated by Gallup Black-on-white, however, are also found at small houses in Chaco as well as those beyond the canyon as far west as the Chuska Mountain foothills and Ganado, Arizona. The majority of the projected Classic period, small houses (68 percent), dominated by Gallup Black-on-white ceramics, are located in the east half of Chaco Canyon, perhaps, again, because of the problem of recognition in the west area where later occupations in the early A.D. 1100s may mask the earlier deposits.

Gallup Black-on-white is also frequent on Chaco small sites dating in the early A.D. 1100s when it is associated with a new ceramic type, Chaco-McElmo Black-on-white, that is confidently dated after A.D. 1100 (Windes 1985). The question is whether the Classic period, small sites cannot be distinguished because Gallup Black-on-white continues as a very popular type into the early A.D. 1100s, or whether the small sites are simply rare. Probably there is some truth to both answers.

Because of the concentration of the huge greathouse middens in the A.D. 1050-1100 era in the Pueblo Bonito area, it is possible that the small-site population moved into the greathouses, an issue raised by Hayes (1981:60). The low numbers of greathouse habitation rooms believed to have been occupied during this period (see above), however, suggest otherwise.

Despite the problems of deciphering small-house occupation during the Classic period, it is clear from the sample that the small-house occupation in the early A.D. 1100s in Chaco was overwhelming (Figures 11.3 or 11.4 and Tables 11.2 or 11.3). Twenty-eight (67 percent) of the 42 sites in the sample exhibited ceramics of this occupation, not including those with trace amounts. Five times as many houses contained early A.D. 1100s occupation as the prior Classic period in Table 11.2 but only twice as many in Table 11.3. Thus, even if the figures in Table 11.3 were inflated, eleventh-century, small sites do not appear to be nearly as widespread as those in the early A.D. 1100s. The sample revealed that most sites with earlier occupations in the transition and Classic periods were occupied during this early A.D. 1100s period, but a host of new sites was also built. It was during the early A.D. 1100s that formal, extramural middens common to the Red Mesa and Gallup period sites in the A.D. 1000s were no longer in vogue, which suggests social-economic changes in the Chacoan system.

Some caution must be attached to the trash dispersal pattern, however. Our knowledge of small-site middens derives primarily from the eastern half of the canyon where most of the Chaco Center excavations were conducted. A relatively flat topography in the east favored the settlement of low ridges and gentle alluvial slopes where middens may retain their spatial integrity. In the western half of the canyon, however, small, steep knolls are common site locations. Middens at these features are scattered on the slopes. Whether the pattern at these western sites (all of which appear to have been occupied at least into the early A.D. 1100s) was determined by cultural restraints or topographic conditions is unknown.

A major shift in site location for the early A.D. 1100 sites was also evident from the resurvey, with house frequency declining in the east and rising in the west quadrants (Figure 11.4). House location was now heavily aggregated in the west half of Chaco Canyon around the greathouse center of Pueblo Bonito, Chetro Ketl, and Pueblo del Arroyo, apparently at the expense of the earlier population center around Fajada Butte Gap and Una Vida. Only 28 percent of the late sites occur in the eastern half of the canyon. The sample also suggests that sites were now occupied for the first time along the northern side of the canyon in the western half.

Although the number of houses occupied is used here as an index of population, the size of the sites is also an important factor assuming, of course, that there is a fixed ratio between room numbers and population size (see Plog 1974). Excavation revealed that information on house size in the 1970s survey was unreliable and typically underestimated. No small houses in the Classic period have been excavated, so there are no criteria on which to base size projections. If anything, Red Mesa sites were predominantly smaller than their excavated counterparts in the early A.D. 1100s, so the latter population may be even greater than projected from simple house counts. Of the 201 small houses from the Pueblo II and Pueblo III periods in the canyon bottom, 137 (68 percent) are projected to have been occupied in the early A.D. 1100s. According to room and kiva numbers from excavated sites, the majority of these sites appear to have contained at least two to three family units. If 10 to 15 people lived in a small house, then we might expect approximately 1,370 to 2,055 people in the early A.D. 1100s <u>if year-round occupation is assumed</u> and all sites were coeval. More likely, figures were much lower, perhaps a third to a half of the above estimates (e.g., about 450-1,000 people). Occupation during the late A.D. 1000s, then, is presumed to have been far less for the small sites. Combined with the estimated greathouse population, there may have been fewer than 1,000 people in Chaco Canyon in the middle A.D. 1000s and probably even fewer in the four or five decades that followed.

Even 1,000 people may seem high when one considers the estimates of the rapidity and effects of deforestation for a population that needed wood for fuel and building over the previous 500 years (see Plog 1981;

Samuels and Betancourt 1982). Compared to the Navajos, who had a similar subsistence strategy utilizing runoff irrigation for the same area (see Appendix MF-C), but had access to bulk, wheeled transportation (wagons), these estimates are staggeringly high. Brugge (1986:137) estimates a maximum of only 20 Navajos for the area around Wijiji, whereas his survey of Navajo structures in the park suggests a population of no more than 150 (Brugge, personal communication 1986). Others estimate that the most ecologically diverse area of Chacra Mesa, bordering the eastern end of Chaco Canyon, supported less than 40 Navajos at any one time (e.g., Gleichman 1987:167-176). Of course, differences between the Navajo and Anasazi social organization and involvement with regional networks could account for the higher projected Anasazi figures but probably not to the extent for thousands of people. Thus, an Anasazi population numbering in the hundreds seems far more reasonable for Chaco Canyon than previous estimates in the thousands.

Many of the sites with the early A.D. 1100s occupation have been reoccupied and remodeled, so the true number of rooms occupied cannot be calculated from present information, even from excavation. By any method of calculation, the early A.D. 1100s occupation is the most widespread in the canyon and I conclude, therefore, that it was the most populous. The latter occupation may have totalled as many as 1,000 people if we combine both the greathouse and small-house populations. In contrast, most archeologists have assumed that the maximum population occurred in the late A.D. 1000s when there was a flurry of greathouse construction. Lekson (1984:272; 1985e) believes that the population hovered at about 2,500 people in the late A.D. 1000s-early A.D. 1100s. This size would have been the lowest limit, based on cross-cultural comparisons, that would have forced development of a complex social and political system such as a chiefdom or state (Lekson 1985e).

At least a 50-year period of abandonment or near-abandonment of Chaco Canyon apparently spans about A.D. 1150 and 1200. A flurry of new occupation is indicated for the A.D. 1200s by the appearance of numerous, small houses built against the cliffs and exhibiting Mesa Verde Black-on-white pottery. These sites are particularly evident east of the park, but they also are widespread within the sample area. Ceramics on many of the talus ruins include a variety of earlier (Chacoan) ceramics that I suspect were collected for tempering material by the Mesa Verdean inhabitants rather than being indicative of earlier occupations (cf. Truell 1986). These types distort the ceramic assemblage and had to be culled for a more effective KYST-2A seriation. The span of the Mesa Verdean occupation is unknown but probably peaked in the A.D. 1220s to 1240s period when precipitation regimes were above normal on the whole (Rose et al. 1982). Final abandonment was by the late A.D. 1200s. Although the latest Anasazi sites are easily distinguished along the northern side of the canyon where the favored house habitat is next to vertical cliffs, they also are widely scattered along the southern side of the canyon, commonly within earlier Chacoan houses. Their projected numbers (53 of 201 or 26 percent of the total) reveal a drastic dropoff from house occupation in the early A.D. 1100s (Figure 11.4 and Table 11.3). In contrast to earlier occupations, the Mesa Verdean occupation appears to be evenly distributed in the four quadrants of the canyon.

The Mesa Verdean occupation, however, is difficult to discern in the open, previously occupied sites. An example of this problem is provided from the testing of 29SJ 633 (Truell 1979). Intensive transect sampling of the midden surface yielded 2,725 sherds. Seven (0.25 percent) of these were Mesa Verde Black-on-white and might normally be considered intrusive. When two rooms were excavated, however, a Mesa Verdean reoccupation of the site was manifest in both ceramics, burials, and grave goods. I believe that this pattern was widespread and masks a larger occupation in the A.D. 1200s than has been previously suggested.

Conclusions

The population figures postulated for both greathouse and small-house occupation may be startling in their decrease from previous estimates, but there is now enough data to suggest that the figures have some reality. There is a close correspondence between major fluctuations in precipitation (see Chapter 2) and population that must be causally related in an environment as marginal as Chaco's. Thus, previous predictions of a steadily increasing population through the A.D. 1000s that ignored periods of drought must be considered in error.

Models that explain how a large population survived during the late A.D. 1000s can easily adjust for a smaller population, if the logical responses, out-migration (Vivian 1981) or increased mobility (perhaps seasonal or periodic), took place long before the peak of the canyon florescence. Some evidence of periodic occupation is, in fact, interpreted for small Chacoan sites (Truell 1981; Windes 1978, 1982a) as well as the large ones. If Chaco was a regional center during the eleventh century, the requisite of a large population does not have to go with it. Its central status could be maintained by a lower permanent population of specialists and ranked members periodically responsible to a larger population drawn to Chaco by its role as a social-political-religious center (Doyel et al. 1984:49, 51; Judge 1979:903; 1983).

Alternatively, if the population was smaller, then the immediate region around Chaco may always have been adequate to support the canyon population, and would make it unnecessary to extend an increasingly formalized, reciprocity network throughout the San Juan Basin (William Gillespie, personal communication 1982). The addition of road-related, storage rooms and other large, empty suites, presumably for storage, during the period when precipitation was poor suggests, nevertheless, that increased exchange and formalization of the system was necessary to support whatever population was left in the canyon.

The large number of early A.D. 1100s sites may mark the largest population to reside in the canyon during the Anasazi occupation. New centers along the periphery of the canyon (in the Escavada Wash, Bis sa'ani, and

Pueblo Pintado areas) arose. Although this early Pueblo III period is often seen as one of Chacoan disintegration and collapse, it may simply herald the return of the canyon as a more local center, with the ascent of the San Juan area to the north as the new regional center (Toll et al. 1980). The critical factors in this increase may have been unprecedented, favorable, climatic conditions for horticulture that were unknown during the previous two centuries. This seems to have spurred an influx of new people into the canyon from the north.

In summary, previous estimates of Chacoan population growth and decline are misleading and insensitive to major shifts that occur during the 270-year Bonito phase in the Pueblo II and Pueblo III periods. Relatively large greathouse and small-site populations are suggested for the early A.D. 1000s and the early A.D. 1100s, with the population stabilizing or even declining during the intervening period in response to environmental conditions. Although this may not drastically alter models of the Chacoan system, it may shift the timing and concern over the causality of a rising population trajectory postulated for the Classic Bonito phase between A.D. 1050 and 1100.

Chapter Twelve

Mesoamerican Influence

Closely examining the Mesoamerican impact on Chaco is not a prime goal of the Pueblo Alto site report and is more appropriately reserved for the final Chaco project synthesis report. Nevertheless, the Mesoamerican traits that did occur at Alto warrant some brief commentary. Much ado has been made of the Mesoamerican traits in Chaco Canyon and the possible impact of Mesoamerican long-distance traders on the development of the Chacoan culture (DiPeso 1974; Ferdon 1955; Frisbie 1978, 1985; Kelley and Kelley 1975; Lister 1978). Ferdon's (1955) initial treatise on the subject introduced the possibility that some (rare) architectural forms at Chaco are Mesoamerican derived, specifically colonnades, towers, multi-walled circular structures, and platforms. This was followed by revived interest in other aspects of Mesoamerican influence at Chaco, mainly in cultural material and burials (e.g., Frisbie 1978; Reyman 1979).

Undeniable items of Mesoamerican origin do exist in Chaco, probably derived from northwest Mexico and channeled to the Anasazi through the Hohokam (Ferdon 1955; Kelley 1966, 1986; Schroeder 1981) and the Mimbres (LeBlanc 1983). Copper bells, cloisonné, macaws, shell, and a few pieces of pottery are often touted as the prime examples of such trade to the south (e.g., DiPeso 1974; Lister 1978; Lister and Lister 1981, Mathien 1983). Most of the material recovered from Chaco and Pueblo Alto, however, was indigenous to the Colorado Plateau. Frisbie's (1978, 1985) contention that a Mesoamerican entrada might have left little in the Chacoan archeological record does not demonstrate the reality of southern dominance, only its possibility. Others (e.g., Lekson 1983a; Mathien 1985; McGuire 1980) have refuted these claims of Mesoamerican dominance of the Chacoan system. Instead, they believe the presence of such traits are due to local trade and economic networks rather than to foreign domination (see also Foster 1986:61-62). Before Chaco Canyon and the Southwest can be considered parts of a Mesoamerican World Economy (Pailes and Whitecotton 1979), we need a far better understanding of the working of these parts and the degree of interaction. Nevertheless, interaction between Mesoamerica and the Southwest may have been complex and regular as Pailes and Whitecotton emphasize.

Some have stressed the coeval occurrence of the rise of the Chaco Phenomenon and the appearance of Mesoamerican traits as proof of the arrival and dominant control of Chaco by the foreigners. This coincidence, however, is based on faulty interpretation that places the rise of the Chaco Phenomenon at around the late A.D. 900s or early A.D. 1000s (e.g., Ferdon 1955:3-4; Frisbie 1983; Hayes 1981:55; Lister 1978:233; Pailes and Whitecotton 1979:117; Riley 1980:16; Vivian and Mathews 1965:108-109). Contrary to the "meteoritic" rise of Chaco seen by Frisbie (1978:210), it is quite clear that the departure of Chaco from the standard San Juan-Anasazi pattern (Lister 1978:233) occurred much earlier, by at least the early A.D. 900s. Kelley and Kelley (1975:200-201), the chief proponents of the theory of Mesoamerican control of the Chaco system, believe that Mesoamerican influence was "conspicuously" absent during the A.D. 900s. Thus, based on present data, there is no reason to suspect that Mesoamerican influence for being responsible for the rise of the Chacoan Phenomenon, although there may have been later impact that altered the Chacoan course. The size of multistory construction of the earliest Chacoan greathouses was a departure from the contemporary norms (Hayes 1981:55). But nothing in the archeological record thus far for this early period suggests nonindigenous influence, although the period's cultural material (except for sherds) has been poorly documented.

So, what of Mesoamerican influence at Pueblo Alto? Alto, of course, was built and occupied during the height of the Chaco Phenomenon, so it should be a prime candidate for evidence of Mesoamerican influence. Lister (1978:233) expected Alto to yield such evidence and, perhaps, this expectation influenced the decision to dig there. Lister was particularly intrigued by the mounded projections along the southern side of the plaza, which suggested the remains of a colonnade similar to that at Chetro Ketl. In addition, a small, flattish mound in Alto's interior plaza provoked images of a possible platform mound, a common Mexican feature.

As we now know, neither of these hopefuls bore Mesoamerican fruit. The projections along the southern side were simply part of the remains of the enclosing walls and small rooms attached to the arc. Testing of the mound in the plaza revealed a small, four-room structure, designated Plaza Feature 1, in which special cooking facilities were located. Like the colonnade at Chetro Ketl and the odd biwall at Pueblo Alto, Plaza Feature 1 was built after A.D. 1100, in the closing Chacoan era, when widespread changes took place.

A great kiva, which Kelley and Kelley (1975:205) regard as critical to the long-distance trader model, was absent at Pueblo Alto (and at several other Chacoan greathouses), perhaps because the resident population was not large enough. Roads, of course, appear to be a major aspect of Alto's existence, and these do have parallels with Mesoamerica (and South America) but seem absent on the same scale elsewhere in the Southwest.

Ties to Mesomerica in the form of material culture were scant. Two copper bells were found at Pueblo Alto, but neither came from an occupational context. One came from the wall fall in Room 103 and the other from trash deposits filling the hypothesized (Loose's) kiva in the plaza. Based on DiPeso's (1974, Vol.7:510) typology, one bell is a type IAla and the other a IIAla (see Mathien, Volume III). Ceramics from the latter place deposition in the late A.D. 1000s, although we cannot be certain when either bell was brought into the site. Macaw and parrot remains were not found. Although cylindrical vessel shapes may derive from Mesoamerican influence (Judd 1954:210; Washburn 1980:78-82), only a single sherd from a possible cylindrical vessel (in the Trash Mound) was recovered from Alto. Cylindrical vessels apparently were made over a wide area and were not the single domain of a specialist-task group (Toll 1986). Some jars clearly reveal Chuskan orgins, and at least one fragment came from a small house in Chaco (McKenna 1984:187, 389).

Shell artifacts from west Mexico were common at the site (Mathien 1981, 1983), an area that might have supplied many of the Mesoamerican products and influences to Chaco (Kelley 1986:93). Otherwise, cultural material recovered from Pueblo Alto was primarily indigenous. Turquoise, proposed as the prime medium of Chacoan exchange with Mexico (e.g., Kelley and Kelley 1975:202; Lister and Lister 1981:202; Pailes and Whitecotton 1979:118), was not abundant at Alto and, indeed, was probably not needed in Mexico during the period of its greatest abundance in Chaco (Mathien 1986). That is not to say Mesoamerican influence was sparse at Alto, but it was certainly intangible.

Thus, there is little physical evidence to suggest Mesoamerican dominance at Pueblo Alto or any other Chacoan site. Whatever Chaco's role within an interregional system, it is clear that Alto's role was one linked to the local and the regional network. Could Alto have risen as a result of the effects of external stimuli? It is possible, although the extraordinary coincidence of its founding with a severe drought that resulted in abandonment of the majority of small-house sites in Chaco (Chapter 11) and with the spread of a network of prehistoric roads (Chapter 5) suggests that local or regional factors were dominant in the creation of Pueblo Alto.

The origins of the Chacoan Phenomenon in the early A.D. 900s revealed little or no correlates with Mesoamerican influence, but can be seen, instead, as a response to environmental variability (see Dean et al. 1985:548). The demise of Pueblo Alto and of the Chacoan system can be attributed to major adverse effects of drought rather than of shudders from the fall of Tula and the Toltec Empire so far away. In addition, the closing chapter of the Chacoan system is closely linked with influences from the San Juan Region to the north (e.g., Toll et al. 1980) rather than the south. True, there was a definite influx of Mesoamerican traits into Chaco Canyon by the mid-A.D. 1000s, which was perhaps associated with aspects of economic and political power. Southern support, even control, may have directed the Chacoan system in the late A.D. 1000s, but this, too, was undoubtedly heavily influenced by local conditions. In summary, whatever the impact and form of the Mesoamerican influence on Chaco and Alto, we believe the rise and fall of the Chacoan Phenomenon was primarily influenced by indigenous factors.

Chapter Thirteen

Conclusions

Like any large puebloan complex, Pueblo Alto may have been used for a variety of tasks. Its initial founding, however, may have been limited to a few specific functions with an emphasis on road control, regional communications, ritual, and storage. Seen from afar, the most vivid visual impression of Pueblo Alto is the contrast of its surroundings compared to those of the sites in the canyon below. Unlike the initial greathouses of the Bonito phase that may have been placed in strategic environmental locales (Judge et al. 1981), Alto achieved no such apparent advantage. Alto's placement high on the grassy plains/mesa above Chaco Canyon along the southern crest of the Escavada Valley subjected its inhabitants to some of the driest and poorest terrain for horticultural pursuits in Chaco. This fact was recognized by later-arriving Navajo and white settlers, who avoided the land on which Alto was built, as well as similar lands stretching far to the east and west. The terrain and microenvironment may also explain why there was a distinct lack of Mesa Verdean occupation in and around Alto in the A.D. 1200s, an occupation common to the canyon below. Given the assumed Anasazi emphasis on house location near areas favorable for horticulture, Alto's placement should be viewed as not dependent upon overriding investment in horticulture. That is not to say that horticulture was unimportant--the nearby farming terraces suggest otherwise--only that Alto was knowingly planned and built in a spot that sacrificed horticultural advantages. Indeed, Alto's construction undoubtedly overlapped a period of drought that would have made the surrounding area even less favorable than previously.

Pueblo Alto's prime advantage is its view of the surrounding Chacoan world. It is situated to observe the splendid mountain ranges surrounding the San Juan Basin, shrines, probably sacred peaks near and far from Chaco, and several of the outlier communities to the north and east. We know that a view toward other sites was important to the Chacoan Anasazi (e.g., Mathien and Windes 1984), and it was particularly manifest in the placement of the esoteric architecture, such as the nearby shrines and stone circles in Chaco (Hayes and Windes 1975; Windes 1978), during the period in which Pueblo Alto was built. Possibly, one of Alto's initial roles was to interface with the shrine communications system (Hayes and Windes 1975; Toll and McKenna 1983), because of the visibility afforded Alto's location, and to symbolically represent part of Chacoan cosmology in a spatial relationship with other greathouses (Fritz 1986). This duty may have been eclipsed in the early A.D. 1100s when Tsin Kletzin was built on a higher mesa directly south of Pueblo Alto in a like setting of widespread visibility (W. James Judge, personal communication 1983).

Also important is Pueblo Alto's connection with the prehistoric roads that converge on it and the visibility of the roads from Alto as they approach from far across the landscape. Not fortuitously do the rise of Alto and the prehistoric roads coincide with the period of drought between A.D. 1030-1048. To what extent long-range planning influenced the construction of Alto is unknown, but it seems certain that Alto was an important first stage in establishing the formal Chacoan network to the northern periphery of the San Juan Basin. Environmental stress, and, perhaps, a rising population, induced migration from the canyon to alleviate worsening conditions a century before the disappearance of the Bonito phase. Nevertheless, regional abandonment, theoretically favored by Berry (1982) as a response to drought, was not utilized as the Chacoan final resort in the A.D. 1000s. Instead, increased mobility of the Chacoan population ameliorated the effects of dry periods. The roads were not solely to allow people to leave Chaco, but also to allow them to return. In addition, roads probably helped to facilitate the movement of goods and resources into the canyon and strenghtened regional ties. Because of the lack of a local, small-house community, Alto can be seen as important in a regional system that was linked to it by the many prehistoric roads.

In the A.D. 1000s, few people lived "permanently" at Pueblo Alto, perhaps only about 25 to 50 people. Compared to the small habitation sites, the interior plaza at Alto reflected little domestic use given the paucity of firepits and other features on it. The unusual recurrent preparation of the plaza surfaces, however, suggested the importance of outside activities at the site. Material consumption far exceeded normal for the predicted number of site inhabitants. If these facts are coupled with the intermittent deposits that formed the Trash Mound, the few living rooms, and the lack of permanent residency suggested for the big-room suites, Alto's importance as an intermittent or seasonal meeting place for nonresident groups seems paramount, perhaps motivated by ritual activities (see Judge 1983).

Speculation of the role of the "permanent" residents of Pueblo Alto and of other greathouses has varied. It is believed by some that the residents were powerful elites of a stratified society (e.g., Powers et al. 1983; Schelberg 1982). Large living rooms, typical of Alto, have been suggested as indicators of power (Netting 1982:42-43; Schelberg 1982:115), although this has been disputed by Wilk (1983), who believes that they simply reflect more people. Schelberg (1982:115) also portrays elites as having more rooms per residential unit, compared to other members of the society, and more firepits--neither trait was true at Alto. The few firepits and mealing bins found in the Alto living rooms suggest that the number of people using them was not atypically large when compared with small habitation and historic sites.

Taking a more cautious approach, H. Toll (1985:498, 503) believes that the residents were important and integral members of the Chacoan organization but not overwhelmingly powerful or causal to its operation. Others (Judge 1979; Judge et al. 1981) have suggested the possibility of a managerial or administrative, caretaker population at the sites or, at least, some part-time residence (Doyel et al. 1984:51). If residence at Pueblo Alto was not long-term and full-time, then it is possible that the residents did not command the power and resources to establish permanent occupancy. For instance, Lekson (1985c:167) believes that the greathouse residents at Bis sa'ani also may have been the part-time residents of the nearby small houses. This does not point to an elite group. On the other hand, Lekson (1984:265) does feel that there were emerging elites in the very early greathouses.

The discrepancy may be resolved by not viewing all greathouses in the same way. Perhaps some held elites--it seems that everyone thinks Pueblo Bonito is the prime candidate--and others did not. The power of an elite class lies in their ability to act in unison and to have decisive social influence, as well as to perpetuate their capacity through different generations (Esteva-Fabregat 1987)--admittedly difficult to discern archeologically. At Pueblo Alto, at least, the evidence does not suggest that the residents were powerful beings insulated from a harsh environment and who exercised control over the canyon and the surrounding residents. There seemed to be little differential access to goods [e.g., in lithics (Cameron and Young 1986:64-65)], in contrast to that expected for elites, although the quantity of consumption [e.g., in lithics (Cameron 1984:146), manos (Cameron 1985a:20), and ceramics (Toll 1984)] was higher compared to that at the small sites. The latter discrepancy, however, may be reconciled if intermittent gatherings at the greathouses took place, which temporarily swelled population figures and, thus, increased consumption rates based only on the permanent site inhabitants. Instead of being powerful elites at Alto, the inhabitants may have been entrusted with managerial roles more suited for maintaining the site and with supervision over road traffic, regional communications, and periodic gatherings at the site, perhaps involving some important ideological influence.

Pueblo Alto's involvement in a regional system may have been sharply reduced or altered in the late A.D. 1000s, when the initial residences at the site were abandoned, possibly during a major drought in the A.D. 1080s and 1090s. Because of poor microchronological control and the subtle changes in an archeological record spanning a mere decade or two, I hesitate to postulate a short abandonment of the site in the late A.D. 1000s, although there are bits of evidence that suggest it.

What is clear, however, is that the dawn of the A.D. 1100s at Pueblo Alto brought with it a myriad of changes in the character of the site's occupation. There are many things, however, that establish continuity of the Chacoan system into the new century--among them were the continued use of some of the roads and material goods and some sources of the preceding century, and the establishment of new greathouses, many in the area north of the San Juan River. Yet, the A.D. 1100s occupation was substantially different in many other ways, although, perhaps, no more so than the changes seen in the Chacoan system in the early A.D. 1000s (Stephen Lekson, personal communication 1986). These changes are legion throughout the review of the excavations at the site (see Volumes II and III), including changes in the use of space, trash deposition, plaza maintenance, road use, subsistence, resources, ceramics, and others, which mirror developments in Chacoan sites reoccupied by Mesa Verdeans in the A.D. 1200s. The early A.D. 1100s occupation at Alto and other canyon sites reflected a northern influence in the style of construction, the type of architecture, and ceramics, if not an outright migration from the northern regions.

Corresponding with these changes was the wettest period during the entire Bonito phase, and, indeed, for the past 1,000 years in the region. Migration into Chaco as a consequence of this unique period was a logical, and typical, response. Some idea of the relationship of the occupation during this period can be gleaned from a new community of small sites and a greathouse, unencumbered by earlier occupations, at nearby Bis sa'ani (Breternitz et al. 1982; Lekson 1985c). Here, the greathouse apparently served as a part-time residence for the inhabitants of the associated small-house sites (Breternitz 1982c:1247; Lekson 1985c), a situation not unlike that proposed for Alto where, intermittently, groups may have gathered. Initial Anasazi occupation in the Bis sa'ani area may have been possible by an unprecedented increase in precipitation in the early A.D. 1100s. Increased moisture may also have increased the horticultural potential around Pueblo Alto at the same time, which led to an influx of new population at Alto and in the several new sites in the near vicinity.

Shifts in directionality of influences impacting the Chacoan Phenomenon are a hallmark of the Bonito phase, but the latest, in the early A.D. 1100s, is the most tantalizing because of its involvement with a people whom archeologists have traditionally considered a distinct cultural entity--Mesa Verdean. There is little doubt that the two groups, Chacoan and Mesa Verdean, are tightly interwoven in the final act of the "Chacoan" Phenomenon, if they were not previously. The relationships between Chaco and the northern San Juan regions remain as important, critical gaps in an integrated understanding of cultural dynamics in the late A.D. 1000s and early A.D. 1100s for the San Juan Basin and beyond.

The Pueblo Alto Community

Sites in the Pueblo Alto community mirror organizational changes within Alto during its life. Only two houses may have been built coeval with or slightly later than Alto: the Parking Lot Ruin and East Ruin, both probably road-related structures. It is clear that Major Wall 1, connecting the East Ruin and Alto, was built after Alto was constructed, although the lapse of time is unknown. The wall was tied to the East Ruin, suggesting contemporaneity, but it may actually postdate both ruins.

Although a symmetrical arrangement of walls and houses extending out from the sides of Pueblo Alto is created by the presence of the East Ruin and New Alto, the latter was built much later than the East Ruin. An earlier, contemporary house mirroring the East Ruin (i.e., a "West Ruin") might exist under New Alto, but this cannot be verified from present data. The Rabbit Ruin houseblocks were also quite late, postdating initial Alto by nearly 60 years or more. When the Rabbit Ruin and New Alto were built, the others (East Ruin and Parking Lot Ruin) apparently had been long dismantled. Thus, the Alto community in the A.D. 1000s is merely a figment of spatial context, not one in a temporal sense in which all houses share coeval occupation. Except for the Parking Lot Ruin, however, all revealed occupation in the early A.D. 1100s.

It is uncertain, then, if any buildings were built coevally with Pueblo Alto, but certainly the East Ruin and the Parking Lot Ruin arose shortly afterward. The proximity of the latter ruins to Alto implies strong cultural integration among the three sites. The similarity in plan and size of the two-room suites comprising the numerous units of the East Ruin, the Parking Lot Ruin, and the two units within Alto, as well as their placement next to prehistoric roads is tantalizing evidence that all were functionally associated with the use of roads. These elements were all in place by the middle A.D. 1000s and reflect part of Alto's reason-to-be.

Rabbit Ruin and New Alto were built in the early A.D. 1100s, long after the expansion of the canyon's road system. Their proximity to prehistoric roads is significant and indicates continuity of the system from earlier times. With the termination of use of the East Ruin and the Parking Lot Ruin, however, there was a shift in emphasis of the road traffic along the west side of Alto, which may have taken precedence over the eastern road where ceramics and dismantled walls suggest that the eastern road fell into disuse first.

Despite similar ground plans, Rabbit Ruin and New Alto suggest contrasting functions. New Alto followed an architectural plan based on a modular unit of small rooms surrounding a large, Chacoan-style kiva and seen at a handful of other greathouse sites in Chaco Canyon. Kin Kletso, the only excavated example, provides us with clues to interpret New Alto as a large storage facility with little or no habitation (Lekson 1984: 269). Lekson believes that the storage functions of the older greathouses were transferred to these new, specially-designed, "McElmo" buildings--in this case, from Pueblo Alto to New Alto. But were all storage functions relocated or just specific ones?

Only one type of suite at Pueblo Alto reflects a suite of storage rooms connected to a large Chacoan-style kiva and that is the big-room suites. Kiva sizes in both the older greathouses and the newer "McElmo" greathouses are similar, and, presumably, their features were of similar function. Arrangement of the storage rooms in the two greathouse types does differ--attributed by Lekson (1984:272) to increased institutionalization of the social system--but the storage area of New Alto approximates that of the five, original, big-room suites at Pueblo Alto (450 m^2), despite the reduction in kiva numbers. Perhaps the similarity of the two greathouse units is only fortuitous, but the spatial relationship of the large kivas to the storage rooms and the timing of the shift are remarkably congruent. Our investigation of a big-room suite at Alto did reveal signs of a change in occupation, remodeling, and the abandonment of the associated court kiva at about A.D. 1100, when New Alto appeared. If big-room suites were centers for ritual or seasonal gatherings and the functions transferred to New Alto, they no longer generated voluminous trash, however.

H. Toll (1985:487) believes that, alternatively, the new storage facilities represented at New Alto were a consequence of increased habitation and increased crop yield resulting from above-normal precipitation. The proximity of New Alto, Kin Kletso, and Casa Chiquita, all "McElmo" greathouses, to the highest density of massive, water-control works and gardening terraces in the canyon lends some weight to Toll's argument, as does the coeval timing for the most prolific settlement of small houses in Chaco Canyon in the early A.D. 1100s.

Rabbit Ruin presents a different picture. It, too, has sets of small roomblocks, each surrounding a kiva. But the scale of architecture was reduced compared to New Alto, and it had a greatly reduced, room-to-kiva ratio. Furthermore, room size varies more at Rabbit Ruin than at New Alto, and the kivas at Rabbit Ruin are small compared to those at the "McElmo" greathouses. Rabbit Ruin does not appear to be strictly a storage facility, but rather one for occupation. Interestingly, our Navajo workers felt that the legendary "Gambler" lived in Rabbit Ruin (or New Alto) rather than in Pueblo Alto; perhaps Alto also seemed an unlikely place of residence to them. To one side of the main Rabbit Ruin houseblocks there is an earlier structure that resembles the latest adjacent structures and probably is also early A.D. 1100s in age. There is presently no evidence for structures at Rabbit Ruin coeval with the beginnings of Pueblo Alto.

The majority of sites near Pueblo Alto were occupied in the early A.D. 1100s and, thus, this period reveals the maximum extent of the Alto "community." Whether Alto socially integrated the site community is questionable. Certain architectural modifications coeval with this period suggest that both indoor and outdoor access to space became more restricted (e.g., H. Toll 1985:485-486). For example, at Alto the interior plaza was enclosed by the southern arc walls (although earlier ones might have existed), and the exterior doors along the West Wing were blocked. The plan of New Alto (and other "McElmo" houses) also revealed a different concept of space that was far less open than in the previous greathouses. Habitation no longer appeared confined to Alto but had been dispersed to some of the other nearby sites. New buildings, remodeling, and rebuilding in the early A.D. 1100s suggest a reorganization of space and society that parallels events throughout the Chacoan system, particularly in the areas around Pueblo Bonito, Chetro Ketl, and many of the outliers (e.g., Pueblo Pintado and Kin Ya'a).

Despite the problem of surmising Pueblo Alto's initial function, its role as a local, administrative, and community religious center (Powers et al. 1983) or as a community public structure (Marshall et al. 1979) is weakened by the notable lack of a contemporary, surrounding, small-site community and the absence of a great kiva. These functions may be relegated to Pueblo Bonito and Chetro Ketl, which contained several great kivas and were situated among dozens of small habitation sites.

The Canyon Community and Beyond

At Pueblo Alto the roads constitute tangible evidence of the formalized expansion of the Chacoan system to the north--how far north initially is presently unknown. Similarly placed greathouses high above the canyon to the west (Peñasco Blanco) and east (Pueblo Pintado) also revealed roads extending away from the canyon that may coincide in time with those at Alto. These changes constitute signs of systemic reorganization at about A.D. 1050.

Pueblo Alto was built at about A.D. 1040 or a little earlier. No outliers along the Great North Road and north of the San Juan River are known to definitely predate the construction of Pueblo Alto. Thus, one is tempted to believe that Alto represents the initial planning and thrust of a northward, Chacoan expansion and influence. It is difficult to explain, however, Alto's presence 40 years before the emergence of the first tree-ring-dated outliers north of the San Juan River. This problem is especially acute when we consider how rapidly construction transpired in Chaco during this period without corresponding activity to the north except for the emergence of Alto and, importantly, the small sites along the Escavada Wash. Actually, the absence of northern outliers is not quite as profound as the cutting dates would have us believe. On the basis of ceramics, architectural veneer style, and some noncutting tree- ring dates, at least, two outliers could have been coeval with Alto: the Sterling Ruin (Bice 1983) and Morris 41 (Powers et al. 1983:147-149). If there was a gap between Alto's construction and construction of the northern outliers, then considerable long-range planning for expansion must have operated, or Alto was built initially for purposes other than monitoring far-flung road activities.

Chacoan sites were concentrated to the south and west by the mid-A.D. 1000s in the San Juan Basin (Marshall et al. 1979; Powers et al. 1983; H. Toll 1985), and there is reason to believe that these would have been linked during the formalization of the road system. Little Chacoan settlement is known north and east of the canyon at this time, so the construction of Pueblo Alto and Pueblo Pintado seems to mark formal attempts at expansion in the latter two directions. Both the peripheries of the Escavada Wash, north of Alto, and the headwaters of the Chaco Wash, in the vicinity of Pueblo Pintado, were potential areas for horticulture that could have supplemented the food resources in the canyon (see Marshall et al. 1982; Winter 1983a). Thus, both sites might have initially served as administrative centers and store houses for the adjacent horticultural areas. Little is known of the small sites around Pueblo Pintado except that the vast majority appear architecturally and ceramically late (early A.D. 1100s), although perhaps masking earlier occupations contemporary with the beginnings of Pueblo Pintado in the early A.D. 1000s.

The small sites along the Escavada also reveal occupation in the A.D. 1100s, but their construction appeared to be approximately contemporary with Pueblo Alto's, which would have provided the impetus for their linkage to the Alto road system. On the other hand, routes to the Escavada Wash would also have been invaluable for the ease of access to its potential water there because supplies would have been inadequate in Chaco for any sizable population. Road Segment 33, along the west side of Alto, extended north across the Escavada and beyond and may have linked early with Pierre's community 15 km north of Alto (see Powers et al. 1983), another area of horticultural potential and a possible rest stop for road travelers. There are few sites along this route (Obenauf 1983:Figure 4-13), and the one closest to Alto is located on the crest of the Escavada valley 1.6 km north of the Escavada Wash in a position analogous to Alto's on the southern crest. This road extended as far north as the San Juan River, at least, although it cannot be demonstrated to have reached its fullest extent all at once.

In short, the Pueblo Alto road system probably initially ran to the Escavada Wash to link Alto with the small-site community there, as well as to provide routes for water transport and exchange, but it also may have extended much farther north. If the size of the road-related structures is indicative of their importance or amount of use, then initial emphasis was on the routes passing east of Alto. The East Ruin dwarfs the west side Parking Lot Ruin by having three times as many paired room units. This suggests that the flow of traffic and goods to and from the Escavada communities was more important or more frequent than that passing by the west side of Alto (e.g., from Pueblo Bonito and Pueblo del Arroyo) in the A.D. 1000s. By A.D. 1100, however, the East Ruin and Major Wall 3, bordering Road Segment 40 that led to Chetro Ketl, were apparently dismantled, which suggests a cessation in traffic and importance along the Alto-to-Escavada community route.

Powers et al. (1983:275) have argued that all canyon greathouses were administrative, economic, and ceremonial centers to varying degrees depending on their hierarchical position within the system. Pueblo Bonito and Chetro Ketl, they argue, represent the premier greathouses based on their size, long development, and location in Chaco Canyon, while Pueblo Alto was subordinate to them. Alto's position, however, suggests dominance over traffic and commerce on the Great North Road, among other roads and their associated communities (Powers et al. 1983:274). In this sense Alto would fit Loose's (1979:361) concept of a "transportation outlier" for facilitating the movement, not production, of goods, although technically Alto is not an "outlier."

Pueblo Alto could have been subordinate to Pueblo Bonito and Chetro Ketl as Powers suggests. Pueblo Bonito, at least, is the older and larger of the three houses and must have achieved some measure of influence and prestige by the time Alto was built in the middle A.D. 1000s. If Pueblo Bonito and Chetro Ketl were major centers within a hierarchically organized system for the redistribution of goods, as Judge et al. (1981) and Powers et al. (1983:274) believe, then Alto is unlikely to have been built astride the multitude of northern roads without influence and direction from the residents of those two greathouses nearby, to which the roads ultimately ran. In other words, it is unlikely that the inhabitants of Pueblo Bonito and Chetro Ketl would have allowed Alto to have been built if it threatened direct or indirect economic competition.

Nevertheless, size may not be determined primarily by power and status, but may relate to other more important factors, such as function. It is true that Pueblo Bonito stands alone in yielding exceptional numbers and quality of cultural material (e.g., H. Toll 1985:503-504), but there is little difference from the other greathouses to suggest social differentiation. Indeed, the inventory of cultural material from among the other greathouses and from small houses is very similar and differs primarily in quantity, if Pueblo Bonito is not considered. Perhaps our perception of the Chacoan system has been obscured by equating all greathouses with similar functions, e.g., as elite residences (Schelberg 1982) or public structures (Marshall et al. 1979). There are great similarities, although this is primarily biased by their impressive architecture. Several functional classes of greathouses may have existed but are not yet perceptible to us, or the functions of greathouses may have changed over time (e.g., Lekson 1984:266, 271)--clearly, however, Pueblo Alto was no Pueblo Bonito.

One road (RS 43 and RS 6) leading north out of Pueblo Alto swings west to connect with Peñasco Blanco. This important link to the west was not previously recognized and provides a new dimension to the "northern" emphasis of the Alto road system. This link would have allowed goods and people to bypass Pueblo Bonito and Chetro Ketl and to be brought directly into Alto from the west, past Peñasco Blanco. Chuskan goods, in the form of ceramics and lithics (Cameron 1984, 1985b; Toll 1984, 1985; Toll and McKenna 1983), abound at Alto, although it was difficult to reconcile the heavy Chuskan orientation of trade materials at Alto, given its northern road emphasis (e.g., H. Toll 1985:437). Now it is clear that the western roads also were part of the Alto system, which lessens the perceived dominance of Chetro Ketl and Pueblo Bonito over Alto. Instead, the road system at Alto seems to reflect less emphasis on hierarchial power and control of the system, and more on equality among its various units. Remember also that Peñasco Blanco and Pueblo Alto (and perhaps Chetro Ketl) both exhibited major, big-room-like additions to the primary row of big-room suites (Chapter 10), which were not evident at other sites. Evidently, some decision-making policy was implemented at these two or three sites but was not at the others. Again this might suggest supra-site, decision-making processes that crisscrossed individual sites but was not beholden to all of them, another possible example of widespread interaction among sites of the Chacoan system.

In addition, the conspicuous road links between Pueblo Alto and Chetro Ketl suggest political and economic ties, which ceramics and site construction place in the last half of the A.D. 1000s. Tentatively, cooperation has been suggested among the two sites in other spheres, e.g., in construction scheduling and in harvesting construction timbers (Chapter 7). Road-associated ceramics and the deterioration of road-associated architecture at Pueblo Alto imply that ties between Pueblo Alto and Chetro Ketl were weakened or severed by A.D. 1100, although both sites continued to flourish. When the East Ruin was dismantled around A.D. 1100, Pueblo Alto appears to have relinquished control or influence over traffic to the east and northeast to Chetro Ketl. In the early A.D. 1100s, however, continued or new ties appear to have developed between Pueblo Alto and Pueblo Bonito, and Chetro Ketl and the Escavada community. Shifts in road use and artifact discard parallel other lines of evidence documenting changes in the Chacoan social and political organization at about A.D. 1100 (cf. Toll et al. 1980; Toll and McKenna 1983).

Pueblo Alto as Part of the Chaco Phenomenon

The A.D. 1000s are critical to an understanding of the flexibility of the Chacoan Phenomenon to the stresses and strains that must have burdened it after the first century of its existence. It was in the A.D. 1000s, of course, that Alto and many other greathouses appeared, but traditional views of this period have usually espoused a growing population and increasing social complexity that reached a climax near the end of the century, which forced a decline and eventual demise of the system. Although environmental fluctuations were recognized, these were thought to be inadequate to cause major, cultural, systemic change (e.g., Lipe 1978:378). Some (e.g., Judge 1983:39), in contrast, have thought that the period was blessed by favorable environmental conditions.

Increasing formalization of exchange networks to counter population pressures and dry conditions, as Judge and others (1981) have suggested, might well have marked the shift of Chaco from a local center to a more regional one and set the stage for a stratified society. According to Hassan (1978, 1981), however, complexity need not be correlated with population size as Carneiro (1970), Adams (1972), and Sanders (1974) have stressed, although its initial rise may have spurred development. Lekson (1985e) believes that the maximum Chacoan population (between 2,100 and 2,700 people) was only at a marginal level to have forced development of a complex social and political society, although complexity could be obtained along other levels of achievement (e.g., architectural and economic). A much smaller population than Lekson's figures might lessen the necessity for explaining the Chacoan Phenomenon in terms of increased social and political complexity. A large population brings with it stresses detrimental to the development of complexity (e.g., factionalism) and we may expect mechanisms other than social and political complexity to have alleviated these problems long before they precipitated a "collapse" (Hassan 1978).

One of the major dilemmas in explaining the Chacoan Phenomenon concerns the systemic reponse to a growing population in Chaco Canyon. An increasing population would have strained local subsistence resources, if not exceeded them, unless shifts in reciprocity, mobility, or out-migration were made. In addition to the calamity of over-population and increasing exploitation of an always marginal, resource base in Chaco, with increased numbers of small-land holders and landless laborers (Netting 1982:656), the environmental variability always must have cast a pall of uncertainty and stress on the inhabitants. For instance, Schelberg (1982) has characterized Chaco as a poor area for agriculture, at best, with the shortest duration of frost-free days in the San Juan Basin. According to climatic reconstructions (Chapter 2), climatic disaster, after more than a century of average or slightly above-average precipitation, loomed in A.D. 1030 and lasted for 18 years. Unquestionably, the length of the A.D. 1030s and 1040s drought would have prompted major systemic response rather than a policy of simply "sitting it out."

Deteriorating growing conditions for this period are evident in the reduction of corncob size from sites in Chaco (M. Toll 1985a:261), a critical effect on one of the major Chacoan food staples. A drought of this magnitude should have had a psychological effect upon the inhabitants of the San Juan Basin, with a growing awareness over the generations that the drier conditions were normal. This could have influenced future systemic response, and the requisites for coping with the drier-than-normal conditions could have been eventually accepted as normal. A second, major, dry period in the A.D. 1080s and 1090s should have reinforced this attitude.

Some believe that redistribution of the population was a remote possibility because suitable land was already occupied by other groups (e.g., Cordell 1979:102; Dean et al. 1985:547; Judge et al. 1981:78; Plog 1979:150). Although it is true that Anasazi sites seem to be most widespread and prolific during the A.D. 900s and 1000s on the Colorado Plateau, this does not mean that each site represented a distinct social entity. On the contrary, multiple-site residency is a viable option in the arid Southwest (e.g., Nichols and Powell 1987), one practiced widely during the historic puebloan period (e.g., Adams 1981; Winter 1983a:425).

Alternatively, others have suggested that migration out of Chaco Canyon was a logical response to increased population pressures, and that this created the new outlier communities in the A.D. 1000s and 1100s (e.g., Irwin-Williams 1983; Vivian 1981, 1983c). Conversely, opponents would argue that at least some of the outliers were established to facilitate resource procurement for other areas of the Chacoan system (Kane

1986; Powers et al. 1983). Our work at Pueblo Alto, and the resurvey of a sample of small houses in Chaco, have brought into clearer focus the possibility that out-migration and general mobility were practiced options long before the eventual demise of the Chacoan system in the middle A.D. 1100s. Nevertheless, this does not detract from the possibility that procurement centers were set up to transfer scarce goods, paricularly those goods affected by environmental perturbations.

Many of the responses seen in the archeological record are expected reactions to the problems of population growth and environmental stress [see Dean et al. (1985) for a listing], and we might expect that the behavioral response would be a complex one, defying simple solutions. Pueblo Alto, more than any other site at Chaco, reflects the events dictated by the new cultural response to the conditions of the early A.D. 1000s. It may seem surprising that part of the Chacoan response was to build new houses, of which Pueblo Alto, Chetro Ketl, and, perhaps, Pueblo Pintado were the first in a new series. This seemingly preposterous solution can be understood in terms of Alto's role in the new scheme. Whether Alto preceded the drought of A.D. 1030-1048 or followed it cannot be determined with certainty, although I suspect Alto was planned and the foundations set in anticipation of future use. Partial construction of some greathouses in Chaco Canyon that remained uncompleted may be testimony to the advance planning of greathouses before their need and use was desired.

Pueblo Alto's primary role was to interface with areas outside Chaco Canyon through its connections with the prehistoric road and communications systems. H. Toll (1985:425) believes that this period, in which Alto was built, marked a shift from local community to regional interaction. Roads would have ameliorated part of the problem of resource depletion and population pressures by allowing rapid transportation of goods into Chaco and rapid dispersion of people out of it. In addition, if Chaco became an important ritual center (e.g., Breternitz 1982c; Judge 1983), then the roads would have facilitated widespread participation in the ceremonies. Roads may not have been necessary to effect these changes, but they did allow greater flexibility and speed for the events to happen. The care that went into road construction suggests that roads were not designed to be short-term solutions. We suspect that roads and the sites associated with them, such as Alto, were seen as a partial solution to a rising population and an unpredictable environment, a solution that resulted in reorganization of a system that had been sustained for over a century without major disruptions. Until more refined dating can be achieved for events, however, the determination of which came first, the stress from a rising population and resource depletion or from a deteriorating environment, cannot be made satisfactorily.

By the early A.D. 1100s, a relatively large population probably existed in Chaco Canyon, which, even then, may have neared its carrying capacity. An increasing population, and the effects on it from normal environmental fluctuations and diminishing local resources, were probably predictable events that must have been noticed by the local inhabitants.

In conjunction with this, however, the most severe environmental change since the beginning of the Bonito phase struck between A.D. 1030 and 1048 (Figure 2.3) and again between A.D. 1081 and 1099. From these events, a multitudinal societal response (see Dean et al. 1985), resulting in systemic change, can be observed in the archeological record. It cannot be determined which levels or combinations of stress created by the conditions were responsible for the manifestations observed in the record, only that such problems would have caused stress to the system and that the systemic change was synchronously and causally related to it.

The specific ties between greathouses and roads that seem part of the solution to deteriorating resources may be found archeologically in the form of the road-related, storage suites built between A.D. 1040 and 1050, specifically those at Pueblo Alto, Pueblo Bonito, and Chetro Ketl. Additional greathouses at the periphery of Chaco Canyon (Peñasco Blanco and Pueblo Pintado) and those situated in horticulturally favorable areas (compared to Chaco, e.g., Kin Bineola) were probably also built or modified at this time to accommodate goods transferred into Chaco. These suites, along with the big-room suites, mark a departure in the use of space seen in previous Anasazi sites.

Pueblo Alto is a part of the Chacoan response to conditions of the early A.D. 1000s. In addition to facilitating road traffic in and out of Chaco Canyon, Alto revealed technological and economic shifts that coincide with the early to mid-A.D. 1000s period. Supplemental areas were incorporated for horticulture in the form of gardening terraces built at the base of the cliffs between Pueblo Alto and Chetro Ketl. Although irrigation devices appeared in the canyon (Vivian 1970a), control of the Cly's Canyon drainage and dam may have also been an investment of the Alto inhabitants because of the proximity of Alto to the associated upper drainage basin. The water control system in Chaco probably became more widespread and complex in the A.D. 1000s because of dry conditions. In addition, dietary shifts are noticeable in faunal procurement (Akins 1984, 1985a, 1985b) and an increase in wild foods (M. Toll 1985b). Sharp increases in the importation of ceramics (Toll 1981, 1984) and lithics (Cameron 1984) are also noticeable, as well as a shift in resource areas. There is, of course, the rapid change in ceramic assemblages from the Red Mesa Black-on-white and neck-banded-dominated assemblages to those dominated by Gallup Black-on-white and overall indented corrugated vessels. These shifts are suggested indicators of societal response to stress (Hanson 1975).

In addition, much of what was found at Pueblo Alto suggested behavior not rooted in long-term, permanent residence. The three types of suites identified at Alto, which minimally comprise 74 percent of the initial, total, room space, reflected user mobility rather than permanence. The small, resident population estimated for the site in the A.D. 1000s is more in accordance with available local resources than a site (and a canyon) crammed with Anasazi residents. The discrepancy between the small population size and the large volume of refuse in the Alto Trash Mound, along with the cultural material and the mound stratigraphy, can be explained as a result of intermittent activities, probably in the form of large, periodic influxes of people not in "permanent" residence at the site (see Breternitz 1982c; Judge 1983; H. Toll 1985). The proposed reduction of small-house sites and greathouse households during the classic period may, then, reflect the positive response to deteriorating local resources brought on by population pressures and periods of severe drought.

Ceremonialism also seems to have coalesced and become more formalized at the same time, with an increase in religious structures (shrines, great kivas, and kivas) and artifacts associated with the classic period. Cosmological and mathematical knowledge may also be symbolically formalized in the placement of new or remodeled greathouse architecture (Fritz 1986; Bart Jordan and Anna Sofar, personal communications 1987). Chaco became an important "special place" to the population that left it. Because Chaco had few tangible resources to exchange for goods, ritual may have been the prime mechanism in the A.D. 1000s for drawing resources to Chaco.

As an adaptive strategy, mobility by the Anasazi is becoming increasingly recognized as a common response for occupation in the marginal environment that characterizes most of the Colorado Plateau (e.g., Adams 1981: 327-328; Benson 1984:131; Berry 1982; Davis 1965:353; Dean 1969:199; Lekson 1985b; Nichols and Powell 1987:203-204; Powell 1983:134-138; Sebastian 1983b:447; H. Toll 1985:490). Even in areas of permanent stream flow, for example along the Rio Grande, seasonal mobility was practiced (Biella 1979:144). Although Chaco Canyon sometimes has been perceived as an oasis of sorts (Vivian 1970a:61), we now know of its extremely marginal suitability for sedentary, horticultural groups (e.g., Gillespie 1984a, 1985; Rose et al. 1982), particularly during dry periods despite elaborate water control systems.

Not illogically, Slatter (1973) proposes that mobility was a common human response to changing climate, with increased use of marginal lands during wetter periods and a retreat from them to better areas during drier periods (see also Colson 1979). This strategy is also proposed for the contemporary Anasazi occupation of the Chuska Valley (Wiseman 1982), an area that figures prominently in the Chacoan Phenomenon during the Classic period, and in the areas adjacent to Chaco Canyon (Sebastian and Altschul 1986). During the dry A.D. 1000s in Chaco, the population fell, and when an above-normal precipitation period arrived in the early A.D. 1100s, the population greatly increased. Expansion into the marginal, lower, Chaco River region, because of increased rainfall during approximately the same period (Sebastian 1983b:448), may be another sign of a common strategy of mobility in the San Juan Basin.

I suggest, then, that Chaco Canyon was only part of a very large region of subsistence used by the Chaco Anasazi and that mobility was an important coping strategy, even for those with housing investments in the canyon (see Doyel et al. 1984). The position of Pueblo Alto at the terminus or junction of major north and west roads was a key part in this Chacoan strategy. It is a narrow view of the Chacoan society, however, if we continue to see Chaco Canyon as the sole center for an enterprise that incorporated the San Juan region and beyond, although Chaco may have contained important aspects of Chacoan society (e.g., ceremonial and administrative).

The Bonito phase is seen as a system closely affected by regional fluctuations in moisture and temperatures. Instead of a system seemingly sky rocketing in population and complexity, I believe that the system closely responded to the ebb and flow of local and regional drought cycles. Sometimes the system remained relatively static, as in the A.D. 900s, and in other times it responded in innovative fashion with technological and societal changes forced on it by environmental constraints. It was an integrated system of small and large sites spread throughout the San Juan Basin and based on mobility to cope with the uncertainties of the environment. The accomplishments of the Chacoan Anasazi are admirable, yet the environmental checks on the system were real ones and cannot be underestimated when we assess the complexity of their achievements. But why did Chaco Canyon become a center instead of more favorable areas is still difficult to answer. There are no resources that make Chaco unique, unless the canyon physiography and tradition of a long Anasazi occupation imparted certain important qualities to the Anasazi of the San Juan Basin.

Appendix A

PROJECT PERSONNEL

by

Thomas C. Windes

PROJECT PERSONNEL

Chaco Center Staff for the 1976-1979 field seasons[a]

Chief, Chaco Center
Robert H. Lister - 76
W. James Judge - 77-79

Project Supervisor
W. James Judge - 76-79

Field Supervisor
Thomas C. Windes - 76-79

Field Lab Directors
L. Jean Hooten - 76
Marcia L. Truell - 77
Cathy M. Cameron - 78

Project Lab Director
Tom W. Mathews - 76-79

Lab/Assistant Archeologist
Marcia Donaldson - 77
Lou Ann Jacobson - 77
Bruce Moore - 77
Wirt H. Wills - 77

Special Equipment Technician
Robert Greenlee - 76-78

Volunteers - Long Term
Victoria Atkins - 76
Fred Burt - 76
John Shaffer - 78
Robert Sounart - 76
Adrian White - 78
Wirt H. Wills - 76

Remote Sensing Volunteers
Art K. Ireland
F. Joan Mathien
Gretchan S. Obenauf

Archivist
Catherine C. Ross - 76-79

Staff Archeologists
Nancy J. Akins - 76-78
Cory D. Breternitz - 76-78
William B. Gillespie - 76-78
Lou Ann Jacobson - 78
Stephen H. Lekson - 76-78
Peter J. McKenna - 76-78
Earl Neller - 76
Robert P. Powers - 76-79
John D. Schelberg - 76-78
H. Wolcott Toll - 76-79
Marcia L. Truell - 76-78
Wirt H. Wills - 78
Michael Windham - 76

Laborers[b]
Gene Begay - 76
Martin Britt - 77
Wayne Castiano - 76-78
Wallace Castillo - 76-78
Susan Cly (NYC) - 77
Ben Etcitty - 76
Herman Etcitty - 76
Eddy Garcia - 76-77
Gerald Harrison (CETA) - 77
Amos Hasuse - 76-77
Victor Kee (NYC) - 76-77[c]
Daniel Lopez (CETA) - 77
Jimmy Lopez - 76
Lewis Lopez - 76
Johnny Martinez - 76-77
Brett Ratti - 77-78
Steve Roll - 77
Paul Tso - 76-78
John Wero - 76

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[a]The 1979 field season was a short one to finish Plaza 2 and to examine some prehistoric road features.
[b]NYC = Navajo Youth Corps employee; CETA = Comprehensive Employment Training Act employee.
[c]Victor Kee was a NYC employee only in 1977.

SHORT-TERM PROJECT VOLUNTEERS

For the 1976-1979 field seasons

Lynne Arany - 77
Mary F. Benson - 78
Alicia Billings - 78
Nancy Billings - 78
Bruce Burns - 77
Donna Burns - 78
Jim Cassidy - 76
Tom Chadderdon - 78
Joe Cisneros - 78
Michelle Combellick - 77
Terry Czech(?) - 76
Sondra Diepen - 77
Terry Fifer - 77
Diane Gelburd - 78
David Greenberg - 76
Kay Greenlee - 78
Sarah Gurewitz - 76
John Hildebrand - 76
Buc Holliman - 76
Andrea Josephs - 78
Jay Judge - 76
John J. Lavino Jr. - 78
Charles Mobley - 78
Megan Monson - 78
James Moore - 76
Ellen Reed - 76
James Snead - 78
Kathleen Sullivan - 78
Bradley Vierra - 77
Emily Werito - 78
Lolita Wilson - 78
Lorraine Wilson - 78
B. Todd Windes - 79
Mary Jo Windes - 77
Karen E. Wise - 78

For related field and laboratory work 1980-1987

Julian Anastasio - 84-87
Kaydean Baker[a] - 82
Cathy Cameron - 80, 83
Marianito Carbo[a] - 85
Barry Cowan[b] - 82
Kelly Cooper[b] - 81-83
Kim Cooper[b] - 82
Kristan Cooper[b] - 84-85
Matt Hulett[b,d] - 84-85, 87
Suzanne Hunt[b,c] - 85-87
F. Joan Mathien - 83
Christie McGee[b] - 84
Kathy Neaman[b] - 82
Natalie Pattison - 83
Laura Smith[a] - 82
Cindy Terry[a] - 84
Francis Vogel - 85-87
B. Todd Windes[b] - 86
Connor Windes[b] - 86-87

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[a]Bennington College
[b]Albuquerque Public Schools
[c]University of New Mexico
[d]New Mexico State University

Plate A.1. The 1977 Pueblo Alto field crew. Front row (L-R): P. McKenna, T. Windes, M. Truell, J. Judge. Middle row: J. Schelberg, N. Akins, L. Jacobson, C. Breternitz, R. Powers, W. Toll, M. Donaldson. Back row: S. Lekson, B. Gillespie, C. Wills, B. Ratti, S. Roll, J. Martinez, M. Britt, E. Garcia, D. Lopez, G. Harrison, A. Hasuse. (Courtesy of Dick Meleski, University of New Mexico Photo Services.)

Plate A.2. Archeologists take a break during a cold, rainy day near the end of the 1977 Pueblo Alto field season. T. Windes, M. Truell (Newren), N. Akins, R. Powers, and C. Breternitz. (NPS#13696.)

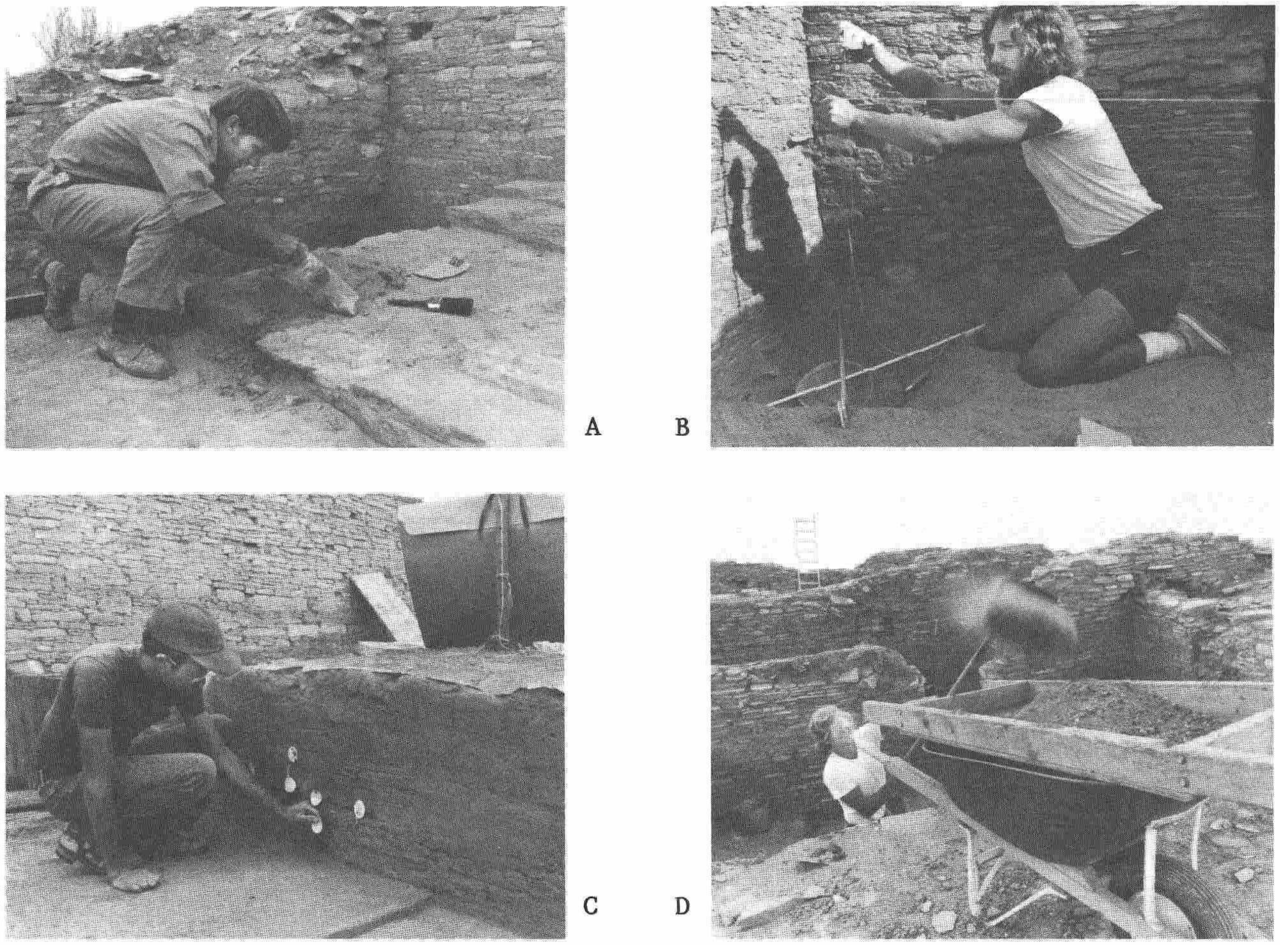


Plate A.3. The staff archeologists at work at Pueblo Alto. A) Wolky Toll clearing surfaces in Plaza 2. B) John Schelberg triangulating a bowl found in Room 229. C) Robert Powers marking stratigraphy in Plaza 2. D) William Gillespie removes fill from Room 229. (Courtesy of Dick Meleski, University of New Mexico Photo Services.)

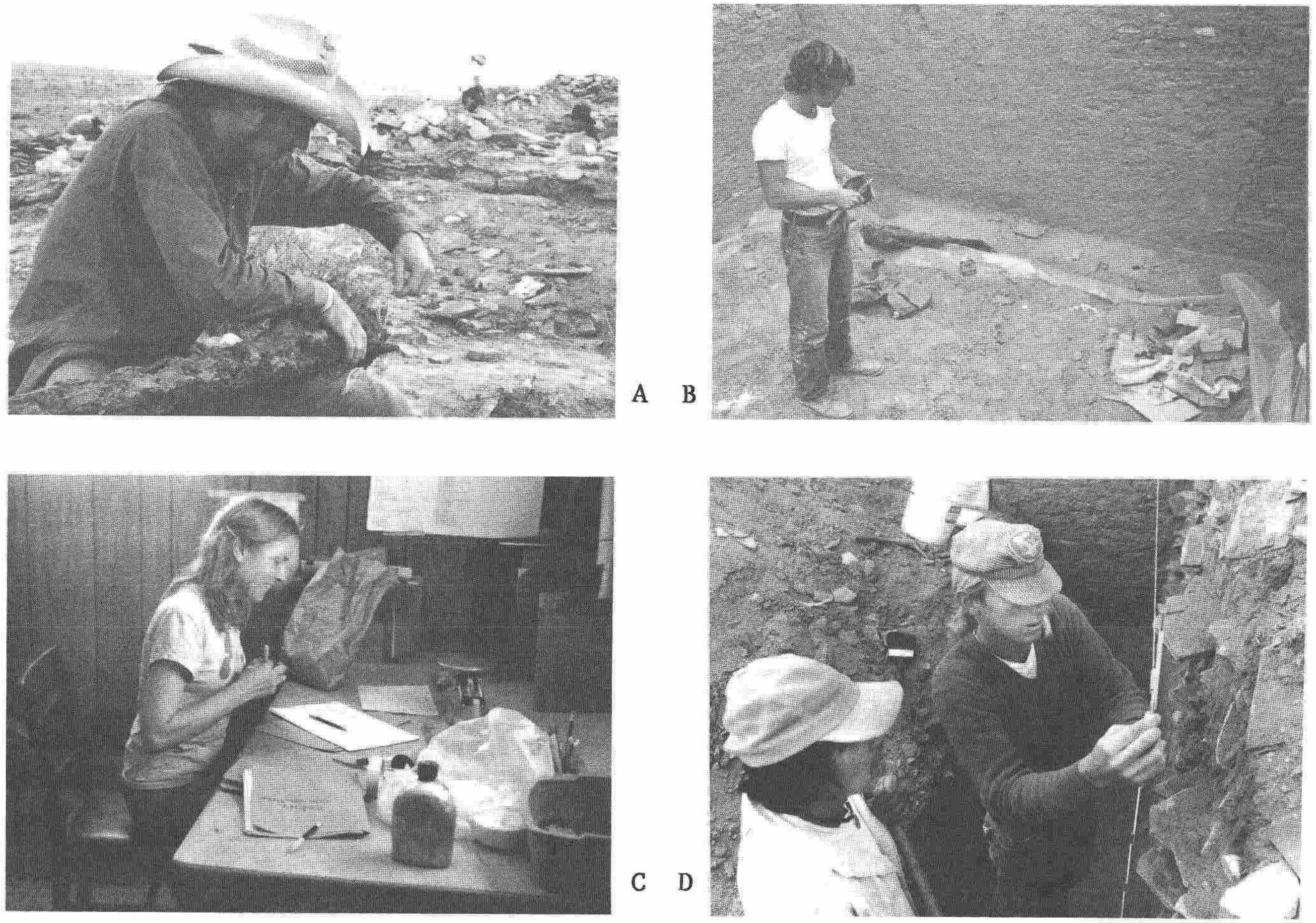
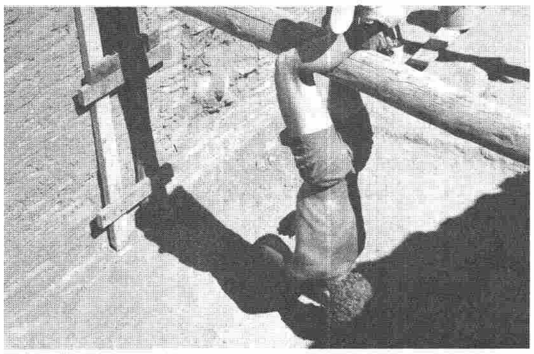


Plate A.4. The staff archeologists at work at Pueblo Alto. A) Cory Breternitz wraps an old roof beam during wall clearing (NPS#13080). B) Chip Wills removes archeomagnetic samples from the wall foundation in Room 142 (NPS#15821). C) Cathy Cameron tabulates artifacts in the site laboratory trailer (NPS#17703). D) Steve Lekson and Paul Tso profile the North Trench (NPS#15820).

Plate A.5. The staff archeologists and laborers at work at Pueblo Alto. A) Nancy Akins profiles the door ramp in Room 3 of Plaza Feature 1 (NPS#15817). B) Marcia Truell and Chip Wills record wall abutments (NPS#13435). C) Paul Tso screens for artifacts (NPS#15816). D) Amos Hasuse clears Room 103 (NPS#15820).

A B



C D

E F

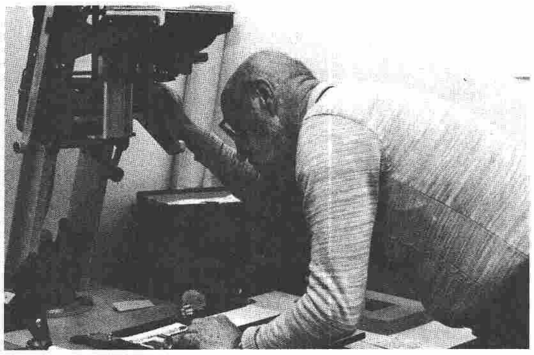


Plate A.6. The staff archeologists and volunteers at work at Pueblo Alto. A) Marci Donaldson and LouAnn Jacobson take notes on the Parking Lot Ruin (NPS#14721). B) John Shaffer from George Washington University demonstrates the fine art of clearing a delicate floor in Room 112 (NPS#16898). C) Robert Powers, Todd Windes, Tom Windes, and Wolky Toll backfill a trench across a prehistoric road (NPS#24596). D) Marci Donaldson and Nancy Akins working in Room 103 (NPS#14517). E) Anne Cully and Mollie Struever (Toll) meet an old friend (Howard Anderson) (NPS#12845). F) Francis Vogel enlarges photos for the Alto report.

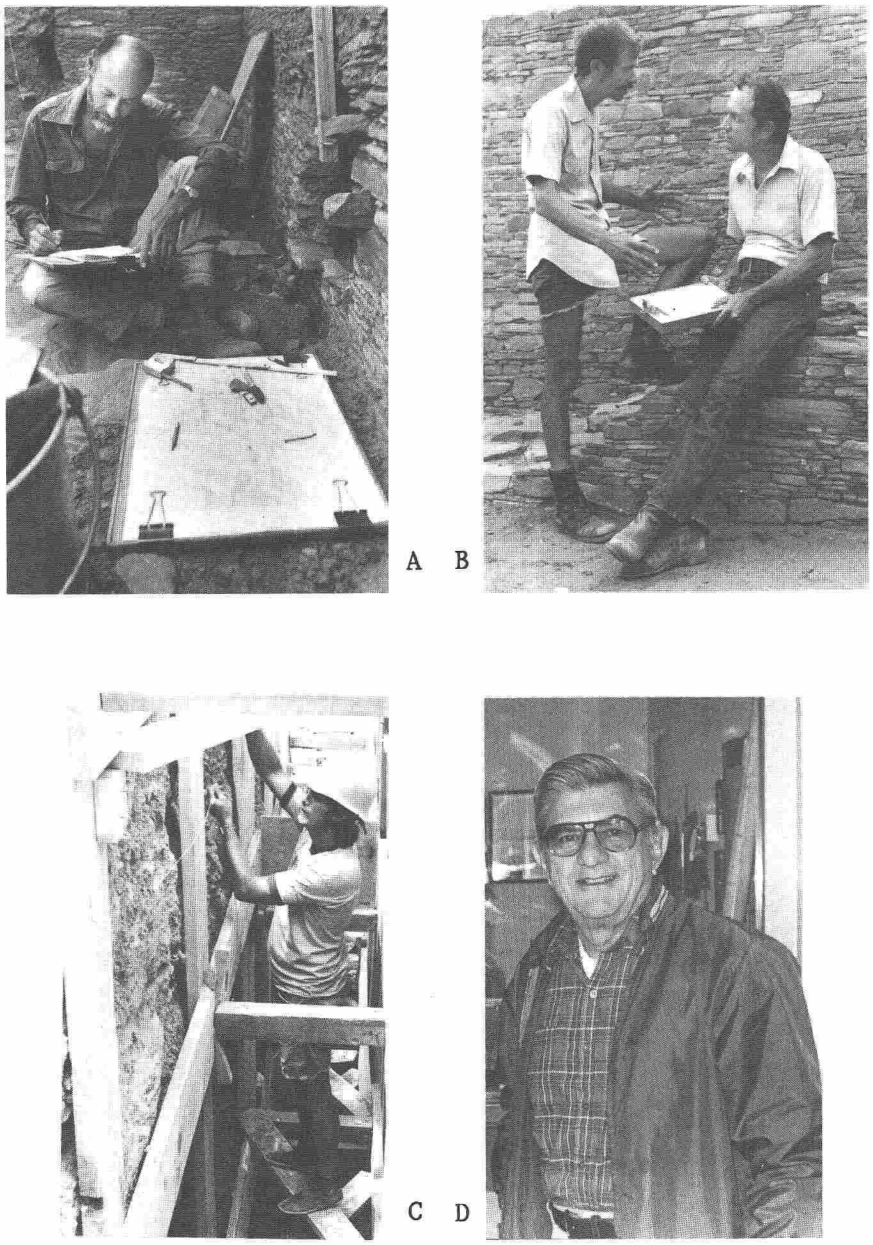


Plate A.7. The staff and volunteers. A) Robert Greenlee makes maps of wall features in Room 110. B) Tom Windes and Jim Judge discuss strategy. C) Peter McKenna maps the stratigraphy in the Trash Mound (NPS#14862). D) Julian Anastasio works in the archives. (Courtesy of Dick Meleski of UNM Photo Services for A-B and Jerry Livingston of the NPS for C-D.)

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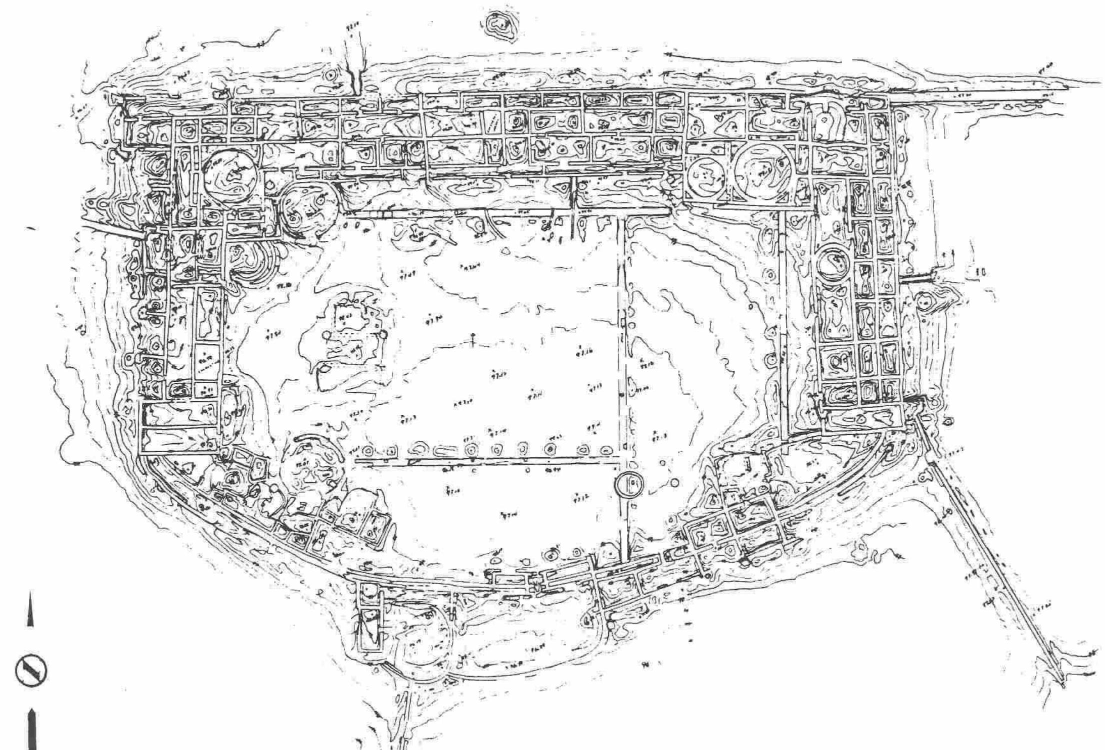

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OLD ALTO
AFTER STRIPPING OF WALLS