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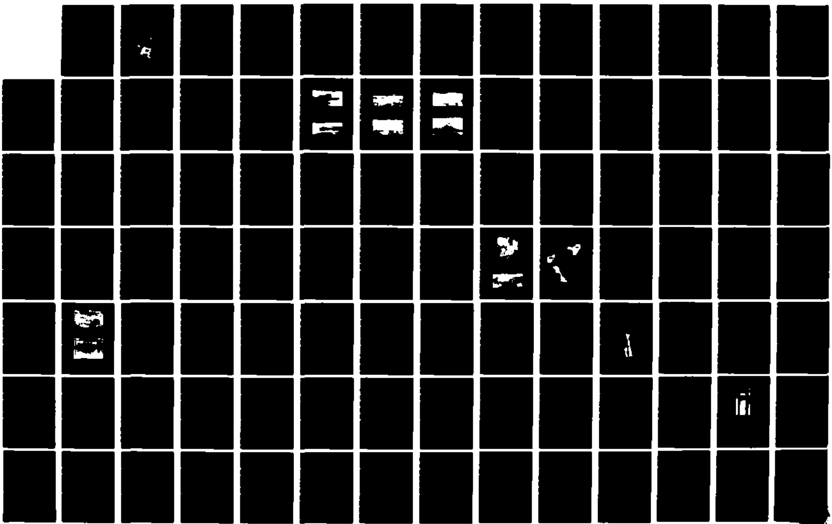

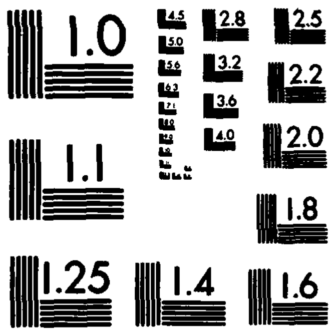

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THE KEYSTONE DAM SITE
AND OTHER ARCHAIC AND FORMATIVE SITES IN NORTHWEST EL PASO, TEXAS

by

Thomas C. O'Laughlin
Project Archeologist

with a contribution by
Anne C. Cully and Karen H. Clary

Rex E. Gerald, Ph.D.
Editor and Principal Investigator

Publications in Anthropology No. 8
El Paso Centennial Museum
The University of Texas at El Paso

October 1980

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	A127405	3. Recipient's Accession No.

4. Title and Subtitle	The Keystone Dam Site and other Archaic and Formative Sites in Northwest El Paso, Texas
5. Report Date	Oct. 1980
6.	
7. Author(s)	O'Laughlin, Thomas C.
8. Performing Organization Rept. No.	No. 8
9. Performing Organization Name and Address	El Paso Centennial Museum The University of Texas At El Paso
10. Project/Task/Work Unit No.	
11. Contract(C) or Grant(G) No.	(C) DACW47-79-C-0004 (G)
12. Sponsoring Organization Name and Address	U.S. Army COE Albu. District Albu., NM
13. Type of Report & Period Covered	Final 1978
14.	
15. Supplementary Notes	

16. Abstract (Limit: 200 words)

The most important result of the study is the identification of a Large Archaic (4450-3750 BC) component of Site 33 in which there are 23 to 41 burned, mud-plastered, domed, brush structures erected over shallow depressions of ca. 3 m diameter. Utilization of the site, at least sporatically, throughout the year by a central-based wandering group is indicated by the mud plastered dwellings (winter), rare fire-cracked rock hearths for baking leaf succulents (spring), and fruits and seeds that were collected within the foraging range (summer and fall) and presumably stored for later use. No other ~~xxx~~ site is known in the Southwest that holds such potential for informing on the subsistence strategies and social organization of Archaic period society.

17. Document Analysis a. Descriptors

Prehistoric Archeology, Cutlrual Resource MAnagement

b. Identifiers/Open-Ended Terms

Western Texas, Archaic, Formative, lithics, pottery, architecture

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unrestricted	Unclassified	293
	20. Security Class (This Page)	22. Price
	Unclassified	

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Prepared for the U.S. Army
Corps of Engineers
Albuquerque District
Contract No. DACW47-79-C-0004

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ABSTRACT

Eight potential National Register sites of the Archaic and Formative periods that will be affected by the Northwest El Paso Local Protection Project of the U.S. Army Corps of Engineers, Albuquerque District, were examined for the purposes of their further evaluation and the determination of appropriate mitigative measures. One site was examined sufficiently to mitigate its loss and two others were tested extensively. The latter two, the Keystone Dam Site (EPCM 31:106:2:33) and EPCM 31:106:2:34, are adjacent and together cover some 4.4 ha of an alluvial fan at the edge of the Rio Grande flood plain. Both sites bear abundant evidence of the baking of leaf succulents in small and large fire-cracked rock hearths during the Formative period but there is little evidence of other types of activities. Pottery is rare and is associated with the hearths; lithic artifacts are expediently manufactured and little used. The most important result of the study is the identification of a large Archaic (4450-3750 B.P.) component of Site 33 in which there are 23 to 41 burned, mud-plastered, domed, brush structures erected over shallow depressions of ca. 3 m diameter. Utilization of the site, at least sporatically, throughout the year by a central-based wandering group is indicated by the mud plastered dwellings (winter), rare fire-cracked rock hearths for baking leaf succulents (spring), and fruits and seeds that were collected within the foraging range (summer and fall) and presumably stored for later use. No other site is known in the Southwest that holds such potential for informing on the subsistence strategies and social organization of Archaic period society.

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PREFACE

The Keystone Dam Site, the 4500-year-old cultural resource that is the principal focus of this report, must be recognized as one of the most important archeological sites yet to have been reported in the Southwest because of the tremendous potential it holds for the reconstruction of Archaic period environment, adaptive strategies, and social organiztion. Other sites that will be affected by this flood control project are also discussed. Mr. O'Laughlin's test excavations, carried out for the purpose of delimiting and evaluating the subsurface deposits, admit of no doubt as to the occurrence at the Keystone Dam Site of a number of well-preserved, burned, Archaic houses surrounded by outdoor activity areas and storage facilities within which evidence relative to past lifeways is to be found in abundance. Fortunately, the owners of the property, Messrs. Paul Harvey, Sr., and Paul Harvey, Jr., of the Boykin-Harvey Trust, recognize the importance of this site and have expressed an interest in facilitating its preservation.

A number of additions to our knowledge of the prehistory of the El Paso del Norte area is presented in the following pages. Among them is the observation that late Archaic period dwellings are small, circular, mud-plastered brush structures erected over shallow depressions that are apparently quite similar to structures of the early to middle Formative period that date as much as 3000 years later. This observation is paralleled by the growing suspicion that subsistence strategies evolved slowly from the late Archaic through most of the Mesilla phase of the early and middle Formative with few or no dramatic changes. The addition of ceramics, which in practice distinguishes the Archaic from the Formative during the first centuries of the Christian era, must have permitted the utilization of a greater variety of plant foods and the realization of greater nutritional values from most foods, but our measuring devices are too crude at present to permit the recognition of the effect of this innovation on health or population density.

The reconstruction of past climatic conditions is of overwhelming importance to the understanding of past human adaptive systems in the aboriginal Southwest where most, if not all, subsistence strategies were dependent upon the extraction of resources from the local environment by societies whose economies were based upon hunting and gathering or horticultural activities. In view of this, Mr. O'Laughlin has reviewed evidence from geological, macrofloral, and palynological studies in an attempt to construct a chronology of climatic conditions in the El Paso area. His review brings into focus inconsistencies in the data or in their interpretation and draws attention to those areas requiring additional consideration before even a preliminary chronology can be formulated. One problem that arises, particularly in the discussion of palynological data, is the distinction between climatic change and environmental shift and the significance of each relative to human activities. Climatic change apparently refers to a change in the natural environment that is long-enduring and of major magnitude while environmental shift presumably refers to a change in the natural environment that is of seasonal or at most of a few years duration and of minor magnitude. Such relatively straightforward definitions seem adequate in the abstract but their inadequacies become apparent when attempts are made to put them to use. The significance, for the student of human adaptation systems, of the continuous variation in climate must be relevant to specific systems. Horticultural systems and others that are anchored to specific localities, for example, are apparently strongly affected by minor local variations in critical seasonal precipitation and temperature while hunting and gathering and other more mobile systems are affected in significant ways only by variations of greater magnitude manifest over larger geographical areas.

Since climatic conditions may vary along a continuum of lesser to greater magnitude relative to a number of variables, the most critical of which in the Southwest may be precipitation, temperature, and seasonality, it is necessary to determine empirically the critical range and combination of variables relative to the plants and animals important in human subsistence strategies. The other unknown, to a large extent, at least, is the subsistence strategies employed in the past, and Mr. O'Laughlin has done much with the limited data from his test excavations to identify the food resources and extractive technologies that were utilized by the Archaic and Formative occupants of the Keystone Dam Site.

A variety of charred seeds was identified from the numerous deposits of burned materials but it is noteworthy that a majority of them was probably intruded into the deposits naturally rather than as a result of human action. Further work in burned dwellings will undoubtedly permit a fuller understanding of food utilization and storage practices, but it appears that the seeds and fruits of prickly pear, smartweed, dock, goosefoot or pigweed, bulrush, and tornillo were important foodstuffs utilized during the Archaic period occupation.

A comparison of the Archaic and Formative period occupations suggests that the Archaic dwellings may have been used for the storage of foodstuffs during much of the year but were actually occupied primarily during the winter season while the Formative occupants apparently utilized the site almost exclusively for brief periods during which they baked leaf succulents. Archaic lithic artifacts are smaller and of finer-grained materials than are those of the Formative and were apparently curated rather carefully and utilized for a variety of purposes as would characterize the activities in a base camp. The Formative artifacts are large tools, made expediently of materials immediately available on the site, that were utilized briefly, probably in the processing of leaf succulents, and abandoned. The full range of subsistence strategies is not represented in either the Archaic or the Formative occupations and that of the latter appears to be typical of a highly specialized segment of the total subsistence pattern. Additional work is needed in other resource zones before relatively complete pictures can be obtained on the adaptive strategies employed throughout the year by the prehistoric occupants of this site.

An important portion of this report is the recommendation of a research plan whereby the important data contained in this site and the others discussed in the following pages may be recovered. This is presented in Appendix A and is based on the information available at the time of its writing, that is, that a major portion of the Keystone Dam Site, and a minor portion of the adjoining Site 34 would be destroyed as a result of the construction of Keystone Dam. It is with pleasure that I report now that the Corps of Engineers acknowledged the significance of these sites and expended considerable effort in redesigning the dam so that the Keystone Dam Site and Site 34 would be minimally affected. It would be untruthful, however, to fail to acknowledge that we had hoped to have the opportunity to engage in a well-funded project to recover the important information the Keystone Dam is known to contain. Also, there is still grave concern over the method the owners will choose to assure the preservation of the site. I hope that it may be brought into the public domain and thus protected and preserved by State and Federal antiquities laws for study by the archeologists from time to time in the future as new and more comprehensive sets of important questions evolve and as more sophisticated archeological techniques are developed for recovering data.

Rex E. Gerald, Ph.D.
Principal Investigator

ACKNOWLEDGMENTS

This report details the examination of eight sites in northwest El Paso, Texas, for the purpose of delineating sufficient measures for the mitigation of potential adverse effects to these sites with the construction of two earthen retention dams. The successful completion of this report would not have been possible without the cooperation and, at times, the encouragement of many individuals and institutions.

Funding for this project was largely provided by the U.S. Army Corps of Engineers, Albuquerque District, and the assistance and understanding of Donna M. Roxey, Corps of Engineers archeologist, is most gratefully acknowledged. Ms. Roxey not only admirably oversaw the interests of the Corps of Engineers and exhorted the completion of this project, but was instrumental in the securing of some financial assistance from the Public Service Board of El Paso for the subsurface investigation of a small area in one of the sites which was to be disturbed with the construction of a large waterline. Robert A. Parsons, Jr. and John T. Hickerson of the Public Service Board are also commended for their support of this latter activity, the results of which are included in this report.

This project focused on the surface mapping and collection and the subsurface excavation of two sites on land owned by Boykin-Harvey Trust of El Paso. The courtesies extended by this trust and its representative, William C. Geyer, Jr. of the El Paso National Bank, are greatly appreciated. In particular, Paul Harvey and Paul Harvey, Jr. are complimented for their generous support, repeated visits, and interest shown in the project.

This research was conducted under the auspices of the El Paso Centennial Museum and The University of Texas at El Paso. Dr. Rudolph Gomez, Director of Research at the onset of this project, Dr. Michael Austin, Acting Director of Research at the completion of this project, and Dr. Joseph D. Olander, Vice President for Academic Affairs, were very helpful in obtaining, administering, and encouraging the completion of this project. A special note of appreciation is given to Dr. Rex E. Gerald for his efforts as Principal Investigator of the project and editor of this report.

Field work was accomplished under the supervision of the writer with the assistance of Ray Mauldin and a field crew which consisted at various times of Gwen Pickard-McLendon, Christine Orrall, Margaret Wellborn, James Dott, Rebecca Kruger, Albert Ortiz, Michael Quinlivan, David Carmichael, Lorraine Matteson, Manuel Rubio, and Robert Hard. In addition, the surface collection of a portion of one of the sites was undertaken by students participating in a course of archeological techniques taught by Dr. Rex E. Gerald.

The cleaning, sorting, and cataloging of artifacts and other materials, the analysis of artifacts, and the reduction of much of the data for this report was performed by Ray Mauldin and Gwen Pickard-McLendon with the supervision of the writer. Both of these individuals processed soil samples for the recovery of charred remains of identifiable plant parts, spent many hours extracting small seeds from the processed soil samples, and provided summary descriptions of the investigated features. Mr. Mauldin undertook the analysis of chipped stone artifacts, and Ms. Pickard-McLendon furnished descriptions of ceramics, ground stone implements, and hammerstones. The writer is indebted to Mr. Mauldin and Ms. Pickard-McLendon for their perseverance, excellent work, and companionship throughout this project.

Specialized analyses were performed by a number of consulting individuals and institutions. Charles Tucek of Radiocarbon, Ltd., provided radiocarbon dates of charcoal samples, and Mathew Hall of the Radiocarbon Laboratory of the University of California at Riverside supplied obsidian hydration measurements. Donna R. Chapman, Anthropological Research Laboratories of Texas A & M University, furnished species identification for much of the wood charcoal, and Paul Minnis of the Mimbres Foundation at the University of New Mexico studied some of the more difficult to identify seeds and other plant parts. The extraction and identification of pollen from soils was undertaken by Anne C. Cully and Karen H. Clary of Albuquerque, New Mexico. Physical and chemical descriptions of soils were supplied by the Soil, Plant, and Water Testing Laboratory of New Mexico State University.

Portions of the draft manuscript were typed by Gwen Pickard-McLendon, and Dora S. Visconti was responsible for the typing of much of the draft manuscript and all of the final report. The published tables were also composed by Mrs. Visconti. Text figures were drafted by Clay Martin, and the cover drawing was done by the writer and represents one of a number of possible reconstructions of houses found at one of the sites. The typesetting and printing of this report were accomplished by the Print Shop of The University of Texas at El Paso, and a special thank you is extended to F. Joe Hill, Print Shop Director, and Lee Locke, typesetter, for their cooperation and hard work.

Above all others, the friendship and constant reassurance of Gwen Pickard-McLendon and Dora Visconti fostered the determination to carry through this project. I thank both of them.

Thomas C. O'Laughlin
Project Archeologist

CHAPTER I

INTRODUCTION

This report presents the outcome of studies undertaken by the El Paso Centennial Museum of The University of Texas at El Paso for the U.S. Army Corps of Engineers as part of Phase II Archeological Investigations of the El Paso Flood Control Project, Northwest Area, El Paso, Texas. Specifically, details are given of the results of surface mapping and collection and subsurface testing of three sites (EPCM:31:106:2:29, 33, and 34) and on the evaluation and recommendation for the mitigation of potential adverse effects on these three sites and five others (EPCM:31:106:2:31, 32, 35, 36, and 37) due to the proposed construction of Keystone and Mesa Dams in the northwest portion of the city of El Paso, Texas (Figure 1).

Site 33, the Keystone Dam Site, was first described by the writer in 1974 in a letter to Calvin R. Cummings of the Division of Archeology of the Southwest Region of the National Park Service following a cursory examination of proposed drilling locations for obtaining substrate information to be used in design of the earthen retention dams. Rex E. Gerald (n.d.) of The University of Texas at El Paso further described Site 33 and 17 other sites in the project area in 1976 in a report to the U.S. Army Corps of Engineers. Aside from possible temporal differences, occupations at the eight sites which might be adversely affected by construction appeared to vary principally in areal extent and quantity of cultural debris and numbers of fire-cracked rock hearths. These variables allowed the division of the eight sites into three general groups from which one site of each group was chosen by the Corps of Engineers for limited examination as Part of Phase II Archeological Investigations in the project area.

Of the three groups of sites, the first included those sites with the smallest site areas (10 to 600 square meters), one or two hearths, and very little and widely scattered cultural debris. Sites 29, 31, 35, 36, and 37 were included in this group. Site 31 had few sherds of brownware pottery suggesting a Mesilla phase (ca. A.D. 600-1000) occupation, but the remaining sites lacked diagnostic artifacts which would allow accurate temporal placement. Site 29 was considered representative of the small sites and was selected for study by the Corps of Engineers.

Sites 32 and 34 comprised the second group with site areas (14,500 and 4,200 square meters) considerably larger than the first group. Each site had two hearths visible on the surface and a greater density of surface artifacts than the first group of sites. Brownware sherds on the surface of Site 34 suggested a Mesilla phase occupation, and Site 32 was noted as being aceramic and possibly dating before the time of Christ (Gerald n.d. d). Surface mapping and collection and subsurface testing were performed at Site 34.

The third group of sites included only Site 33, which was by far the largest site with an area of 40,000 square meters. Surface artifact density was suggested to be fairly high, numerous hearths were observed, and the presence of buried pithouses was also suggested (Gerald n.d. d). Brownware sherds on the surface of Site 33 implied a Mesilla phase occupation. Limited subsurface testing and surface collection and mapping of Site 33 were to become the focus of this project.

In addition to the limited investigations of Sites 29, 33, and 34, the remaining five sites were to be visited to gather additional information pertinent to discussions of possible adverse effects of construction activities and necessary measures for the mitigation of the loss of information contained by these resources.

The general objectives of Phase II Archeological Investigations reflect the interplay of resource management and research concerns and are: (1) the characterization of cultural remains in the project area, (2) the elucidation of the cultural context in which these remains were deposited, and (3) the evaluation of indirect and direct impacts on cultural resources for the purpose of designing an efficient program of mitigation. Information derived from the testing of Sites 29, 33, and 34 should serve as a foundation for the development of necessary and sufficient measures for addressing possible unavoidable adverse impacts to the cultural resources resulting from the construction of the earthen dams. The applicability of various techniques for the later and more intensive investigation of these and other sites and the potential for recovery of important information with respect to past human systems in the area should also be evident from the research efforts presented herein.

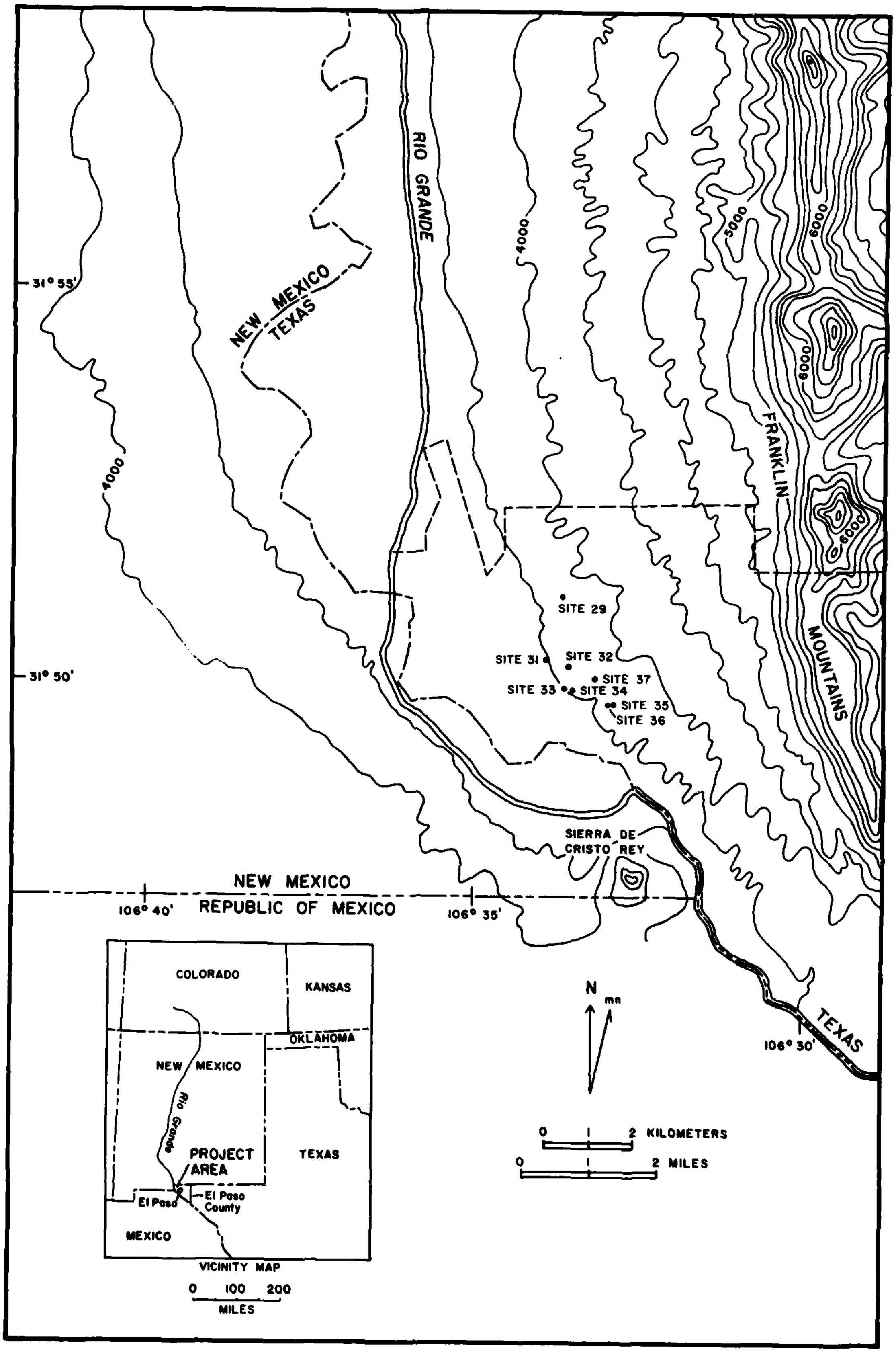

Figure 1. Locational plan of the project area. Complete site numbers are EPCM:31:106:2:29, etc.

Phase II Archeological Investigations are conditioned, in part, by the particular constraints of time, money, and cultural resources presented by this project. These constraints certainly limit the scope of research endeavors, but they do not restrain the imagination of the investigator. That is, the kinds of information sought in the investigation of questions about human behavior as reflected in the archeological record are largely independent of, though necessary for, cultural resource management considerations. In attempting to characterize the cultural remains of the project area and the behavioral contexts for their deposition, the kinds of data collected and the methodology of data collection, analysis, and interpretation are influenced primarily by the orientation and interest of the investigator. The link between the problem-oriented research interests of the investigator must be made explicit, especially since it will be shown to extend beyond the simple enumeration of sites and the elaboration of culture history into a discussion of culture as a dynamic system.

Research Perspective

For the purpose of this study, a cultural system is conceptualized as a "complex adaptive system" operating within the broader ecosystem and composed of internally differentiated and organized arrangements of formally differentiated elements (Binford 1962; 1965; 1980). Cultures may be viewed as being systemic in that the exchange of matter, energy, and information within their social environment and with their physical environment leads to a clearly defined structure with integrated parts. The use of a systems approach allows for the efficient organization and explication of complex archeological data but does not necessarily imply a body of theory from which explanatory statements may be drawn (Athens 1977; Hill 1977). Cultural systems are also adaptive in the sense that they are capable of altering structural poses with changes in the physical and/or social environment such that changes in any one of the structural elements requires adjustments in others.

The explanation of variability in human behavior and the stability or change in human systems of adaptation is a primary goal of anthropology and archeology (Binford 1962). Although a number of variables have been advanced as causal factors in cultrual evolution, there is no single coherent paradigm which can claim to explain the maintenance or modification of any given society in that no single factor has universal applicability (Athens 1977; Wright 1977). Thus, processes important in a discussion of cultural change are most likely multivariate in nature and, therefore, difficult to identify. Environmental change, population growth, social circumscription, and technological improvement are a few of the causal factors put forth for the evolution of complex societies (see Athens 1977 for others). The identification of causal factors and processes important to the study of cultural change compels the archeologist to focus on the constant or cyclically repetitive articulations of the component parts of the cultural system under study and the environment in which it is operative (Binford 1964; 1965). This may perhaps best be understood in the following statement by Binford (1980:13).

> ...since systems of adaptation are energy-capturing systems, the strategies that they employ must bear some relationship to the energy or, more important, the entrophy structure of the environments is which they seek energy. We may expect some redundancy in the technology or means, as well as the organization (labor organization), of production to rise as a result of "natural selection." That is the historical movement toward an "optima" for the setting.

The above statement implies that the technological and social characteristics of human adaptive systems (especially those with subsistence economies) are referable, in part, to environmental conditions The emphasis placed on characterizing the present and past environments of the El Paso area in this respect should not be surprising, and much of this information is summarized in Chapter II. With respect to past environments, considerable effort was expended in elucidating soil formation processes evidenced at Sites 33 and 34 (Chapter V), factors effecting variability in pollen spectra from Site 33 (Chapter VI), and immediate site environs via the analysis of macrofloral remains (Chapter VII).

It is assumed that human behavior is patterned and that the patterned behavior of the members of an extinct human adaptive system results in a structured set of spatial-formal relationships in the archeological record (Binford 1962; 1964; 1965). Changes in the environment or in components of the cultural system should be reflected by temporal or spatial changes in the tools, facilities, or locations used in or created by social, economic, and ideoreligious activities. This view is well summarized by Binford (1972:132):

> The behavioral model recognizes that behavior is the dynamics of adaptation. People draw upon a repertoire of cultural backgrounds and experience to meet changing or variable conditions in their environment, both social and physical. Our expectations, then, are for variability in the archeological

record to reflect a variety of different kinds of coping situations. Activities will vary with the particular adaptive situation of the group and the character of tasks being performed. We would therefore expect variability in the archeological record to reflect these different situations.

The assumption that past behavioral patterns are discernible directly through investigation of the archeological record has recently drawn criticism (Collins 1975; Schiffer 1976; Yellen 1977). Certainly a number of natural and cultural processes can intervene and affect the relationships between observational units or even their visibility. However, these biases in the archeological record can often be anticipated or detected, and the assumption still has great utility (Binford 1978a; 1978b; 1980; Schiffer 1976).

In order to document changes in behavioral patterns of cultural systems evidenced in the project area, the temporal and spatial distributions of cultural remains need to be known. A summary of the present knowledge of cultural developments in the El Paso area is presented in Chapter III. Chapter IV outlines the techniques utilized to gain temporal and spatial control over materials and information recovered from Sites 29, 33, an 34, and Chapter V reports the results of stratigraphic studies, radiocarbon dating, and measurements of obsidian hydration layers. In Chapter IX attempts to refine the local ceramic chronology are discussed, and the spatial and temporal distributions of tools, facilities, and locations are treated in Chapter X.

Although it may be anticipated that patterned variability exists in the archeological record, "The archeological record is at best a static pattern of associations and covariations among things distributed in space" (Binford 1980:1). Giving meaning to these static and contemporary patterns necessitates an accurate understanding of the dynamics which brought such patterning into existence and a well-developed methodology. The perspective of the investigator delimits those processes important to the study of cultural variability and change, as well as the relevant classes of archeological data needed to approach such studies. In turn, a well-founded methodology insures the accuracy or unambiguity of meanings ascribed to the archeological record. However, the development of reliable instruments of measurement and the identification and operational definition of relevant classes of archeological data poses one of the more severe limitations to processual studies (Binfor 1977; 1978a; 1980; Schiffer 1976).

The above is best illustrated through a brief contrast of the uses of site size (horizontal distribution of artifacts) and site content (density of artifact classes and number of facilities) by Whalen (1977; 1978) and O'Laughlin (1979) in the description of Formative period settlement patterns near El Paso. The orientation of both of these archeologists is similar in that both view cultures as adaptive systems. However, Whalen tends to emphasize craft and exchange activities and levels of socio-cultural development as reflected by social differentiation and integration, while O'Laughlin views the geography of environmental parameters and concomitant means and organization of production to be of greater import. Site size and content are seen as variables relevant to their respective orientations, but the meanings given to these variables differ. For Whalen, site size and content can be used to define residential and special purpose sites, and site size and content are seen as varying directly with the number of occupants of residential sites. Whalen views variability in site size as indicative of variability in social group size and greater variety in site size as evidence of greater social defferentiation and, therefore, social integration. O'Laughlin suggests that sites are not equal and can be expected to vary with respect to their organizational roles in a system. Site size and content are viewed as varying not only with the size of social groups and nature of activities performed at sites but more importantly with the mobility patterns of Formative period populations. Some sites which Whalen would define as residential sites on the basis of site size and content are described as intermittently, but relatively frequently, occupied sites for specialized economic activities according to O'Laughlin. The different meanings assigned by Whalen and O'Laughlin to site size and content obviously reflect different understandings of the dynamics responsible for the formation of the archeological record.

The specific goal of this project is to develop an understanding of the roles Sites 29, 33, and 34 played in the adaptive strategies of the social groups that once occupied them. To this end, it is a tacit assumption that these sites do not represent all of the organizational components of the past adaptive systems to which they pertain, but that they do contain material evidence of the organizational principles of past adaptive systems. The concern here is with those organizational principles that relate most directly to the technology of production (i.e., the means and social organization of production). In this respect, it is envisioned that the adaptations of prehistoric social groups in the El Paso area may be characterized by two complementary organizational principles or strategies: one involving high residential mobility with consumers moving to resources, and the other involving relative sedentism in which resources are moved to consumers logistically. These two principles are not necessarily in direct opposition to one another, and a particular adaptation may include a mixture of both in its strategy.

A summary of the environmental setting of the El Paso area in Chapter II points out two conditions which undoubtedly affected the particular mix of the above organizational strategies for past adaptive systems:

1) the combined effects of temperature and rainfall produce a relatively long, but marked, season of biotic productivity and make for a less productive winter season in which plant foods are either unavailable or not in their most desirable state, and
2) spatial and temporal heterogeneity in potentially useful resources in this semiarid environment insures that all of the requisites for survival of subsistenc economies will not be found at all times at any given locale.

Seasonal biotic productivity suggests that prehistoric hunter-gatherers and farmers with subsistence economies must have practiced some storage of foodstuffs to compensate for the "leaner" winter months. The degree to which the storage of food items (including crops) was practiced is seen as having a direct relationship to the mobility of populations and the importance of a logistically oriented strategy. That is, a decrease in residential mobility and an increase in the logistic component of resource procurement activities is envisioned with an increase in the dependence on and bulk of stored foodstuffs. Conversely, it can be inferred that the storage of little or no foodstuffs would promote high residential mobility in response to the seasonal and spatial availability of resources. Spatial and temporal heterogeneity in the availability of resources also implies that sites of resource procurement and processing for both hunter-gatherers and farmers may demonstrate variability in their spatial distribution and assemblages which correlate with the variability in the natural environment, and that logistically provisioned sites of relatively permanent residence will exhibit less specialized or more varied artifact assemblages which show little congruence with temporal or spatial variability in resources. These ideas and expectations for the archeological record are developed with the introduction of environmental data in Chapter II and are elaborated further with an overview of the culture history of the El Paso area and settlement patterns of the project area in Chapter III.

Chapters VII through X deal specifically with the archeological materials and other kinds of information recovered from the limited investigation of Sites 29, 33, and 34. Among other things these chapters are aimed at the definition and delineation of activities performed at these sites, the seasons of occupation, and the permanency of occupation. Considerable effort is expended in these chapters to insure the unambiguity and significance of meanings given to the archeological record, and the rationale for seeking various kinds of information is provided. Chapter X is particularly important with respect to the information and interpretations gleaned from the study of chipped stone which has been sorely neglected in most archeological studies of the El Paso area. This chapter also demonstrates the concern herein with the definition of classes of archeological data and the devising of measurements used to study cultural processes. Chapter XI gives a summary of the contributions made by this project and incorporates the new information into perspectives on Archaic and Formative period adaptations in the El Paso area.

CHAPTER II

ENVIRONMENTAL SETTING

The major concern of this chapter is with those environmental parameters which may have a direct bearing on the interpretation of archeological materials recovered from the prehistoric sites of the study area. Viewing culture as man's adaptive system necessitates an accurate understanding of the variability in the natural environment within which the adaptive system operates. Thus, the explication of subsistence-settlement patterns begins with an appreciation of the spatial and temporal variability in the natural environment. The significance of the environmental parameters to be mentioned will be discussed briefly in this chapter and their importance will be made more apparent in later discussions of archeologial materials and information from the investigated sites.

Physical Geography

The study area (Figure 1) is within the Mexican Highland Section of the Basin and Range Physiographic Province with north-south trending fault block ranges which were uplifted in the late Tertiary period and intermontane basins which were filled with detritus principally from the erosion of uplands in the Pleistocene epoch (Kottlowski 1958; Strain 1966). Specifically, the project area is located on the eastern edge of one such intermontane lowland known as the Mesilla Bolson which is bound by the Sierra de Las Uvas and Potrillo Mountains on the west and the Organ and Franklin Mountains on the east. The Franklin Mountains (Figure 2a), which are within 6 km of all of the prehistoric sites of this project, are some 37 km long (north to south) and 3 to 8 km wide (east to west) with prominent peaks ranging in altitude from 1640 to 2000 m above mean sea level. Runoff from the east slope of the Franklin Mountains empties into the Hueco Bolson, and drainage of the west slope was into the Mesilla Bolson until mid-Pleistocene times when the ancestral Rio Grande began to cut its present valley into the basin sediments (Strain 1966). Today, runoff from the west slope of the Franklin Mountains empties directly into the Rio Grande at an elevation of 1125 m in the project area.

Between the Rio Grande floodplain and the Franklin Mountains is an alluvial slope or piedmont composed of Late Tertiary and Quaternary sediments which are eroded and dissected by numerous drainages originating in the Franklin Mountains (Figure 2a and b). Some terracing is also evident in areas adjacent to the floodplain, and these terraces have been correlated with major glacial-pluvial cycles of the late Pleistocene which resulted in the Rio Grande aggrading or degrading its bed (Metcalf 1967). The sites investigated as part of this study are located on alluvial fans at the mouths of major drainages and immediately adjacent to the Rio Grande floodplain (Sites 31, 33, and 34) or on ridge tops near the western terminus of the dissected alluvial slope and within 1 km of the Rio Grande floodplain (Sites 32, 35, 36, and 37) (Figures 2 and 3). The only exception is Site 29 which is some 1.5 km from the floodplain and near the base of a small hill (Figure 4a).

To the west of the Rio Grande and near the project area, the basin sediments are nearly level and uninterrupted for many miles to the west and north on what was once the bed of Pleistocene Lake Cabeza de Vaca (Strain 1966). This nearly level surface is referred to as the La Mesa surface (Hawley and Kottlowski 1969). Along the western edge of the Rio Grande floodplain, basin sediments are eroded into rounded ridges with shallow drainages and slope gently from the La Mesa surface toward the Rio Grande. This western slope is covered in most areas with substantial accumulations of eolian sands which have been deposited by southerly to westerly winds blowing off the La Mesa surface. In some places the La Mesa surface ends abruptly in an escarpment of exposed Cenozoic sedimentary deposits of the Santa Fe formation and gives the appearance of a mesa or table-land as viewed from the Rio Grande (Hawley, et al. 1969; Strain 1966) (Figure 3b).

Rocks of Precambrian, Paleozoic, Cretaceous, and Tertiary age are exposed in the Franklin Mountains and are mostly sandstone, limestone, quartzite, and rhyolite with granite and andesite intrusions (McAnulty 1967). All of these materials are represented in unconsolidated alluvial deposits which lap up on the flanks of the mountains. However, the distribution of these and other materials varies between the east and west alluvial slopes of the Franklin Mountains because of the ex-

a.

b.

Figure 2. General Views of Site 33 North. a, view to the east across mesquite, creosotebush, soap-tree yucca vegetation toward the Franklin Mountains; b, view to the northwest across dissected alluvial slope with the 1978 arroyo in the foreground and salt cedar and tornillo trees of the floodplain at the left edge center.

a.

b.

Figure 3. General views of Sites 33 and 34. a, view to the southeast across the sites (center) and the juncture of the alluvial fan and the floodplain (right center) to Mount Cristo Rey; b, view to the southwest across Sites 34 North and 33 South. Note the sparce vegetation of the gravelly terraces (foreground), the juncture of the alluvial fan and the floodplain (center) and the escarpment west of the Rio Grande (background).

a.

b.

Figure 4. Views of Sites 29 and 33. a, general view to the northeast across Site 29 showing creosotebush and herbaceous annual vegetation and the Franklin Mountains in the background; b, runoff from summer thunderstorm rushes down 1978 arroyo into dense salt cedar and tornillo tree thicket west of Site 33 North.

posure with faulting of older Precambrian, Cambrian, and Ordovician rocks along with Silurian, Devonian, Mississippian, and Pennsylvanian strata on the east slope and of the dominance of Silurian, Devonian, Mississippian, and Pennsylvanian strata along with substantial Cretaceous deposits on the west slope. Quaternary deposits on the east alluvial slope are dominated by rhyolite and quartzite rocks. Limestone occurs in lesser amounts, and granite, diabase, sandstone, and cherts can be found but are not common. The deposits of the west alluvial slope consist mostly of limestone rocks, but rhyolite is abundant immediately to the north of the project area. Quartzite can be found but is not common. Cherts are more common than quartzite and occur in amounts much greater than are found on the east alluvial slope. Granite, dolomite, shale, and sandstone occur infrequently. Some small nodules of obsidian of fluvial origin have been noted in the project area. To the west of the Rio Grande, basin sediments are largely covered by eolian sands but are exposed or redeposited in some of the drainages. These deposits are generally made up of rocks that are similar in types but smaller in size than those of the west alluvial slope of the Franklin Mountains. All of the above mentioned materials are suitable for chipped and ground stone tools, and the limestone, rhyolite, and quartzite have been noted in the prehistoric burned rock features of the area.

Soils

A number of soil associations can be found in or close to the project area. Their distribution and potential for agriculture will be discussed following the soil descriptions and land classification schemes presented by Maker, et al. (1971) for Dona Ana County, New Mexico, and by Jaco (1971) for El Paso County, Texas.

Soils of the west alluvial slope or bajada of the Franklin Mountains and above the floodplain belong to the Delnorte-Canutio association, have developed in recent times, and are shallow over calcium carbonate deposits or are deep and gravelly throughout. Slopes range from 2 to 8% on ridgetops and down arroyos, and they may be as much as 30% on hillsides and flanks of arroyos. In addition, these soils have a low water-holding capacity and are moderately permeable. They are viewed as having little, if any, potential for irrigation or dry-land farming.

Bordering both sides of the Rio Grande floodplain are limited areas of the Bluepoint soil association. These soils are generally found on alluvial fans at the mouths of larger arroyos and are composed of deep sands and loamy sands that contain little gravel. Slopes are usually within 1 to 3%, and soil surfaces are susceptible to wind erosion and dune formation. These soils are suitable for irrigation farming but are rarely used today because of their low water-holding capacity and rapid permeability. Nevertheless, alluvial fans with those soils, such as at Sites 33 and 34, are possible loci for prehistoric dry-land farming and/or farming with slope runoff.

The level to gently sloping floodplain of the Rio Grande has deep, loamy, very fine sand to silty clay loam of the Gila-Glendale-Vinton association. These soils have moderate to high water-holding capacities, slow to moderate permeability, and are well suited for irrigation farming today. However, river flooding, flooding by runoff from adjacent higher lying lands, changes in the course of the river, and, periodically, years of diminished flow and river channelization may have made irrigation farming a risky proposition for the prehistoric inhabitants of the area. In all likelyhood a number of strategies were employed in farming the floodplain. These would include multiple plots in different settings and combinations of dry-land and flood water farming in order to minimize the risk of crop failure attendant upon the use of only one strategy.

The narrow strip of land between the La Mesa surface and the Rio Grande floodplain has a variety of soil types which include Pajarito, Bluepoint, Yturbide, and Caliza soils, as well as eolian deposits derived from the La Mesa surface to the west. In general, this area has a moderately to steeply sloping landscape with rounded ridgetops and shallow drainages. Soils are largely eolian in origin and consist of shallow to deep sands or loamy sands which are susceptible to wind erosion and that form large dunes or ridge-lines in much of the area. Some ridgetops and hill slopes have calcareous, gravelly, sandy loams but these are of limited extent. A low water-holding capacity and moderate to rapid permeability characterize these soils. Topographic conditions and soil properties suggest that there was little potential for farming this area prehistorically, but small and dispersed areas could have been farmed using dry-land techniques or a combination of rainfall and runoff techniques in some of the shallow drainages.

The La Mesa surface west of the Rio Grande has soils of the Pintura-Berino-Simona and Cacique-Pintura associations. These soils consist of sands or loamy sands in nearly level areas to sandy clay loams in slight depressional areas. These soils are often underlain by calcium carbonate deposits (caliche) at depths of 50 to 100 cm, have a low water-holding capacity and moderate to high permeability, and are susceptible to wind erosion and duning. The availability of water is the principal factor limiting the farming of these soils. Given adequate rainfall, these soils could have been farmed using dry-land techniques, particularly the soils in the slight depressions with better water-holding capacities.

From the above description of soils, it is implied that slope and availability of water would be variables important in delimiting those areas which could be farmed with dry-land, flood water, and rainfall and runoff techniques. Particular soil characteristics, topography, catchment areas, rainfall, and peak and annual flows of the Rio Grande are viewed as variables which modify available soil moisture and further delimit appropriate farming strategies. Three general farming areas and strategies can be inferred: floodplain, alluvial fan and shallow drainage, and upland plain.

Floodplain farming is suggested to involve flood water and dry-land farming of the relatively wide Rio Grande valley with multiple fields due to the risks of uncertain magnitude of river flow and river course. Farming of the floodplain was probably the more important of the three strategies for adaptive systems relying on the products of farming activities. Alluvial fan and shallow drainage farming probably involved combinations of dry-land or rainfall and sheetwash or runoff farming techniques. Local areas which could be farmed under this strategy include the few larger, sandy alluvial fans at the mouths of arroyos which drain the Franklin Mountains and some of the shallow drainages and alluvial fans of the slope bordering the Rio Grande on the west. These areas are relatively small and separated by some distance from other such areas, and the farming of these loci would certainly have to be coupled with other strategies under conditions of relatively high population density. The upland plain strategy involves dry-land or rainfall dependent farming techniques on the large La Mesa surface west of the Rio Grande. Although the upland plain is quite large, it appears that farming would only have been possible under conditions of greater rainfall than the area now receives. The particular mix of these three farming strategies (see Whalen 1977; 1978 for others) for prehistoric adaptive systems is uncertain, and no attempt will be made here to approach the subject.

Soil surfaces and terraces of late Pleistocene age have been described for the west alluvial slope of the Franklin Mountains by Kottlowski (1958) and correlated with glacial-pluvial cycles and entrenchment of the Rio Grande by Metcalf (1967). The development of soil surfaces during the Holocene and on the west alluvial slope of the Franklin Mountains has not been investigated, but studies of Holocene geomorphic surfaces between the Rio Grande and the Organ and San Andres Mountains some 70 km north of the project area have been reported by Hawley and Kottlowski (1969). These studies indicate cycles of landscape instability and concurrent erosion and sedimentation alternating with long periods of surface stability and soil formation. Along inner valley borders, there is noted a major cycle of arroyo cutting from late Pleistocene to early Holocene times and subsequent aggradation and build-up of alluvial fans from before 5000 B.P. to sometime after 2600 B.P. On alluvial slopes below mountain ranges, three deposition units of middle to late Holocene age are recorded. Deposition of the oldest unit began about 5000 B.P., and this unit is separated by a disconformity from a more recent period of deposition which began about 2200 B.P. It is also separated from the next older unit by a disconformity. The duration of each of these depositional events is unknown, but Hawley and Kottlowski (1969) suggest that each of these and their surfaces correlate fairly well with the general alluvial chronology of the Southwest, as summarized by Haynes (1968).

Haynes (1968) suggests that the inner valley border aggradation of 5000 B.P. or more to less than 2600 B.P. is correlated with the two older depositional units of the alluvial slope (roughly 5000 B.P to 1100 B.P. or more) and that the hiatus between the two older alluvial slope units is of little regional importance. These units would be subsumed under Haynes' depositional D unit, and the most recent alluvial slope deposition unit would be included in his depositional E unit. Both the D and E deposition units are considered to be Medithermal soils, and earlier arroyo cutting along the inner valley border may be attributable to the Altithermal. Antevs (1948; 1955) infers a relatively warm and dry climate for the Altithermal and a cooler and moister climate for the Medithermal which is still in progress. Haynes (1968) is more cautious but appears to agree generally with Antevs. Climatic inferences from soil formation processes and other kinds of information will be considered in more detail in the section describing temporal changes in vegetation.

As one final note on soils, recent studies by O'Laughlin (1979) and Hard (ms) on the east alluvial slope of the Franklin Mountains indicate that widespread alluviation had ended by about A.D. 1000 and that arroyo cutting and alluviation only began again in the late 1800's with overgrazing of vegetation by cattle and a series of droughts.

Climate

The modern climate for the El Paso area is semiarid mesothermal with hot days, cool nights, and a low relative humidity. Average annual precipitation is 20.1 cm with about half of that falling during July, August, and September (U.S. Dept. Commerce 1969). Summer precipitation usually takes the form of violent monsoonal thunderstorms of short duration while winter precipitation tends to be slow and penetrating. The driest year of record was 1891 when only 5.6 cm of precipitation fell, and the wettest year was 1884 when 46.5 cm fell. Daytime and nighttime temperatures often differ considerably (ca. 15 degrees centigrade). Average maximum temperatures range from 35.2 degrees centigrade in June to 13.5 degrees in January. The average number of consecutive freeze-free days is 248.

The combination of temperature and rainfall make for marked seasonality and one long growing season in which the productivity of plants and animals is subject to a wide range of variability correlated generally with spatial and temporal distribution of rainfall and temperature. In addition to these factors, rapid changes in relief and substrate within the study area result in clearly visible and different ecological settings within relatively short distances. These ecological zones will be considered shortly.

Surface Water

The Rio Grande is the only permanent source of water in the area, except for a few small springs in the Franklin Mountains. However, the river's flow may vary considerably from year to year and with the seasons. Much of this variability has been dampened by the construction of Elephant Butte Dam in 1916, but some comments on earlier stream flow can be made with the aid of historic accounts. Peak flow would have been in the spring when periodic floodings and changes in the river's course were likely (Nelson, Holmes and Eckman 1914). Thus, the river may have been on one side of the valley in one year and on the other side of the valley and several kilometers more distant the next year. In addition, Baldwin (1939) reports that the river in the Mesilla valley above El Paso became dry after June in the years of 1879, 1891, 1894, and 1896. These factors certainly would have influenced the placement of settlements and farming strategies.

Besides the river and the springs in the Franklin Mountains, the only other source of surface water is of a more temporary nature due to the porosity of the land surface and the high evaporation rate. Water flows through drainages of the alluvial slopes of the Franklin Mountains only after heavy rains, and then for only short periods of time in the form of flash floods (Figure 4b). On the east side of the Franklin Mountains, runoff from summer thunderstorms accumulates for a time prior to evaporation in small playas or depressions on the floor of the Hueco Bolson. On the west side of the Franklin Mountains runoff is discharged directly onto the floodplain and may cause localized flooding. On the La Mesa surface west of the Rio Grande the occurrence of standing water would have depended directly on rainfall and some playas may have contained water temporarily following summer thunderstorms. The distribution of prehistoric sites in the interior of the Hueco Bolson follows closely the distribution of such playas (Whalen 1977; 1978; n.d.).

Changes in Vegetation and Climate

The modern vegetation of the El Paso area is similar to that of much of western Texas, southern New Mexico, and northeastern Mexico, and is within the boundary of the Chihuahuan Desert described by Shreve (1942). It is characterized by lechuguilla *(Agave lecheguilla)*, sotol *(Dasylirion wheeleri)*, and skeleton leaf goldeneye *(Viguiera stenoloba)* in the uplands and tarbush *(Flourensia cernua)* in the lowlands. In recent years evidence has been accumulated that is indicative of substantial changes in the vegetation from late Pleistocene to historic times. O'Laughlin (1979) has summarized much of this data, and the following discussion draws heavily upon O'Laughlin's synthesis and provides additional information or elaboration where necessary.

Vegetation changes in the smaller mountain masses (Hueco Mountains and Bishop's Cap) near El Paso are best known from the studies of plant materials incorporated into the nests of woodrats (Van Devender 1977; Van Devender and Everitt 1977; Van Devender and Wiseman 1977; Van Devender and Riskind 1979; Van Devender and Spaulding 1979). Plant materials in the nests show that a late Pleistocene pinyon-juniper woodland was present until about 11,000 years ago and that it was replaced by an early Holocene juniper-oak woodland. With the onset of the middle Holocene climate about 8,000 years ago the juniper-oak woodland disappeared, and it is suggested that the juniper-oak woodland was followed by grassland with some desert species and rare juniper and oak (Van Devender and Wiseman 1977). Unfortunately, the composition and ages of middle Holocene woodrat nests have not been reported. By late Holocene times xerophytic upland species of the Chihuahuan Desert came to dominate the landscape as is noted by the presence of lechuguilla *(Agave lecheguilla)*, sotol *(Dasylirion wheeleri)*, ocotillo *(Fouquieria splendens)*, and creosotebush *(Larrea tridentata)* in two nests dated at 1700 and 1530 years ago (Van Devender and Riskind 1979). There is also some evidence that some of the mesophytic species have disappeared or diminished in numbers in the Hueco Mountains east of El Paso within the last 2,000 years (O'Laughlin 1977a; Van Devender and Riskind 1979). These species include juniper *(Juniperus monosperma)*, evergreen sumac *(Rhus virens)*, oak *(Quercus pungens)*, and perhaps netleaf hackberry *(Celtis reticulata)*.

Van Devender and Spaulding (1979) suggest from their studies of woodrat nests that late Pleistocene (actually late Wisconsin) climate in the Southwest was characterized by mild winters, cool summers, and greater-than-present winter precipitation. Evidence of equable late Wisconsin climates is supported by cave faunas from near El Paso and elsewhere which exhibit mixtures of forest, woodland, and grassland animals, as well as species which now have extra-areal distributions to the north and south (Harris 1977).

The climate of the early Holocene in the Southwest was one of transition (Van Devender and Spaulding 1979). As the Cordilleran ice sheet dissipated the winter storm track assumed its present position, and the later retreat of the Laurentian ice sheet resulted in the development of the present summer monsoonal rain. In addition, colder winters may have prevailed in the El Paso area after about 11,500 B.P. as an ice-free corridor opened between the two ice sheets and allowed northers to penetrate farther south in the winter. Through the early Holocene, winters became colder, summers became warmer, winter precipitation decreased, and the summer monsoon became more important. These developments brought about range changes in many plants and animals and the extinction of some animal species at about 11,000 B.P. Of 98 late Pleistocene species represented in cave faunas near El Paso, 12% are now extinct, 9% now have extra-areal distributions, and 81% are found in the modern fauna (Harris 1977). Notable among the extinctions are sloth *(Nothrotherium shastense)*, horse *(Equus fraternus)*, camelids *(Camelops* sp. and *Tanupolama* sp.), four-pronged antelope *(Tetrameryx onusrosagris)*, and dire wolf *(Canis dirus)*.

By the middle Holocene or 8,000 years ago, Van Devender and Spaulding (1979) suggest that a climate comparable to today's was established in the Southwest. Hot summers with monsoonal rains and cold and relatively dry winters have been inferred, and it is suggested that summer rainfall was greater than at present. Van Devender and Spaulding (1979) imply that middle Holocene wet climates favored the development of grassland in intermontane basins and the lower elevations of mountains in the area. These inferences are supported by the pollen studies of Martin (1963) and Mehringer, et. al. (1967) in southeastern Arizona and those of Johnson (1963) near the confluence of the Pecos and Rio Grande Rivers in southwestern Texas. However, Bryant (1977) infers that the climate was hot and dry during much of the middle Holocene from his pollen studies in the same area as those of Johnson. Bryant's interpretations also follow those of Antevs (1948; 1955) and Haynes (1968) who base their conclusions on cycles of erosion and deposition in the pedologic record. Antevs and Haynes refer to this hot and dry period in the Southwest as the Altithermal. Van Devender and Spaulding (1979) suggest that the term Altithermal be applied only to the Great Basin where evidence for a hot and dry interval does exist. They argue that a hot and dry climate for the Southwest at this time is untenable because of the development of the summer monsoonal rain pattern.

A pollen study by Freeman (1972) of alluvial deposits of the Jornada del Muerto Bolson in southern New Mexico but some 70 km north of the study area indicates several episodes of increased or decreased effective precipitation and changes in the relative abundance of grasses or desert shrubs. These same deposits have been correlated by Hawley and Kottlowski (1969) with Antevs' (1948; 1955) Altithermal and Medithermal (late Holocene) climatic periods, but Haynes (1968) infers that all of the deposits may be more accurately referrable to only the late Holocene. Freeman (1972) interprets changes in the frequency of grass pollen relative to Chenopodiacae and Amaranthaceae pollen as suggestive of a desert shrub to gassland transition between 5,000 and 4,000 years ago, a drying trend in deposits less than 2,300 years old, and a return to conditions similar to those of 4,000 years ago in deposits less than 1,100 years old. Freeman suggests that a hot, dry Altithermal period in the Southwest is supported by his pollen study, but some questions can be raised concerning the time at which his inferred transition from desert shrub to grassland took place and whether the vegetation changes may have been one of degree rather than magnitude. These and other subjects will be treated more fully in a reappraisal of Freeman's data in Chapter VI.

One other study may have some bearing on the nature of Holocene climates in the El Paso area, and this is a report of the herpetofauna from Howell's Ridge Cave in southwestern New Mexico by Van Devender and Worthington (1977). From changes in the number of species and number of individuals of mesic forms compared to xeric forms through time, a gradual change in biotic communities from late Pleistocene to modern times is indicated. Late Pleistocene climates are suggested to be cool and moist with little seasonal variability. From 10,000 to 4,000 or 5,000 years ago a transition to a warm and moist climate with seasonality is inferred, but a hot and dry Altithermal climate is not supported.

At about 4,000 to 5,000 years ago a dramatic change in the fauna occurs and appears to indicate a decrease in effective precipitation and the drying-up of playas that held water perennially in early and middle Holocene times. The drying trend seems to have continued to the present with only minor fluctuations in precipitation noted in the last 4,000 to 5,000 years. At about 3,300 years ago the climate appears to have been hotter and drier than the present, and two wet periods are suggested at about 3,000 and less than 1,000 years ago.

Extended periods of time during which grasses and desert shrubs varied in their relative importance in intermontane basins during the last Holocene are quite probable given the modern climate of the region. The present average annual precipitation is on the xeric side of that needed to support a desert grassland complex, and slight changes in annual precipitation could easily have resulted in noticeable changes in grass or desert shrub cover. Indeed, the combined effects of drought and the overgrazing by cattle in the late 19th centuries have culminated in a drastic reduction of grass cover, the loss of soil surfaces, and the firm entrenchment of desert shrubs in the northern Chihuahuan Desert (for detailed discussions see Gardner 1951; Buffington and Herbel 1965; York and Dick-Peddie 1969; O'Laughlin and Crawford 1977; Kenmotsu 1977).

Environmental Zones

In the following discussion six environmental zones are delimited for the project area. These environmental zones are defined on the basis of land form, substrate, and clearly visible patterns in the distribution of plant species. It is not implied, however, that these zones represent distinct ecological communities. Information on the physiography, geology, and pedology of the project area has been given in previous sections, and the concern here is primarily with the spatial distribution of plant species. The information gained from the present distribution of plant species should be useful in assessing the variability in the natural environment within which a human adaptive system operated. The reconstruction of the subsistence-settlement system is facilitated through the recognition of grouping or stratification of the plant components of the present natural environment and by assuming some correspondence between the modern flora and that of prehistoric times. Certain qualifications will be made with respect to charges noted in the vegetation in recent historic times, but it is thought that the modern distribution and density of vegetation is roughly comparable to that of the last 8,000 years. That is, inferences from the previous section on climate and vegetation changes during this period are: (1) that the climate has remained much the same with a possible drying trend noted for the middle Holocene and with minor fluctuations in precipitation in the late Holocene and (2) that desert species became established and increased in importance during the middle Holocene and fluctuated in relative importance with more mesophytic species during the late Holocene. Thus, present species distributions are considered to approximate those of the past, though their representation in the environment may not be the same because of the effects of recent droughts and overgrazing by cattle.

The potential usefulness to prehistoric populations of some of the more important species will be indicated for each environmental zone, but no attempt will be made to outline all potentially useful plants nor all uses. Rather, attention will be focused on the availability of what are considered to be the more important food items for each zone. Summaries of ethnographically recorded uses of native plants found in the area can be found in Bohrer (1972), Kenmotsu (1977), and Smith (1977), and Basehart (1974) has excellent descriptions of the historic use of many economically important plants by the Mescalero Apache in the vicinity of El Paso and just to the north in southern New Mexico. In addition, Cosgrove (1947) and O'Laughlin (1977a) document the use of plants in perishable artifacts and possible food remains from caves in the area; and Ford (1977), O'Laughlin (1979) and Wetterstrom (1978) describe burned plant remains that have been recovered from open archeological sites.

The location of the six environmental zones is shown in Figure 5. They will be referred to as the Mountain, Upper Bajada, Lower Bajada, Riverine, Leeward Slope, and West Mesa zones. All of these zones are within 6 km of the archeological sites that were investigated as part of this project; they will be described in order of occurrence from east to west across the project area.

Mountain Zone

The Mountain zone includes those rockland areas above about 1460 m in elevation in the Franklin Mountains. The west slopes of the Franklins are quite steep and have considerable exposures of bedrock and few large, protected canyons. The drier slopes of the Franklin Mountains are sparsely

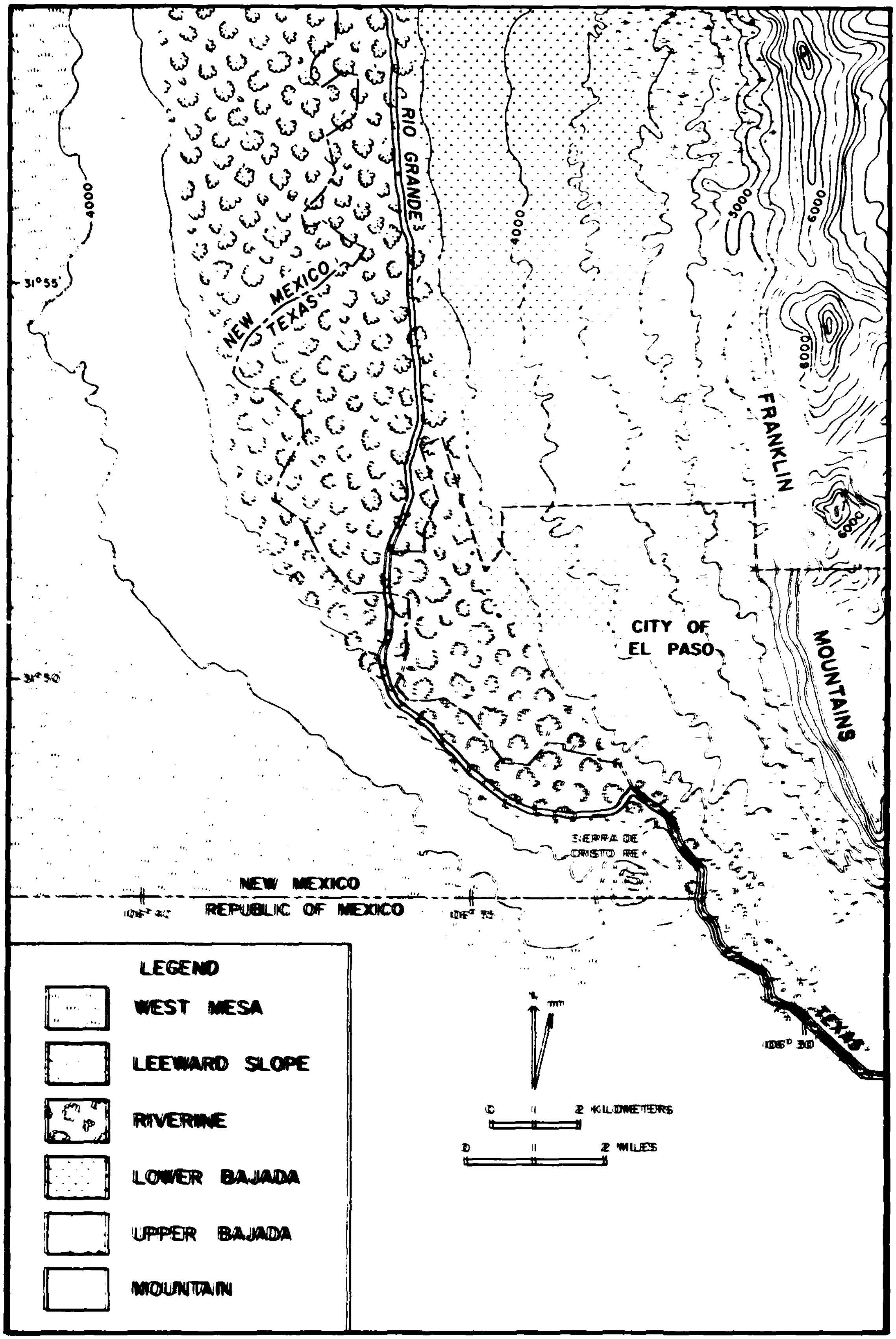

Figure 5. Environmental Zones of the Project Area.

covered with lechuguilla *(Agave lecheguilla)*, prickly pear cactus *(Opuntia* spp.), ocotillo *(Fouquieria splendens)*, sotol *(Dasylirion wheeleri)*, and creosotebush *(Larrea tridentata)*. The higher portions and few protected canyons of the Franklin Mountains are heavily vegetated with wait-a-minute *(Mimosa biuncifera)*, desert willow *(Chilopsis linearis)*, hackberry *(Celtis reticulata)*, algerita *(Berberis trifoliata)*, beargrass *(Nolina texana)*, and some oak *(Quercus spp.)* and rarely juniper *(Juniperus monosperma)*. Wait-a-minute, mesquite *(Prosopis glandulosa)*, desert willow, whitethorn *(Acacia constricta)*, and small-leaved sumac *(Rhus microphylla)* are common in the bottom of canyons where they emerge from the mountains.

Harris (n.d.) suggests that the Franklin Mountains have been heavily impacted in historic times. Junipers and other large trees were apparently more common in the historic past and were reduced considerably in numbers as a result of being cut for use as fuel and timbers by residents of El Paso, Texas, and Cd. Juarez, Mexico. A reduction in grass cover as a result of overgrazing by sheep and goats is also probable and has been exacerbated by droughts and the erosion of the shallow soils from steep slopes. Important grass species would have included black grama *(Bouteloua eriopoda)*, bush muhly *(Muhlenbergia porteri)*, and sideoats grama *(Bouteloua curtipendula)*. Reduction in grass cover and erosion of soils has undoubtedly permitted the increase of more xerophytic species such as lechugilla.

There are a number of important food items found in the Mountain zone, but only one—acorns—is restricted to the Mountain zone. The best time for procuring these resources is either in the spring or late summer and fall. The more important economic species are discussed briefly below.

Sotol (Dasylirion wheeleri). The green stalks of sotol are edible, but the head and trunk of this leaf succulent are more often utilized for food according to ethnographic accounts. The preparation of sotol would have been by pit baking, and the baked product has excellent storage properties. These plants would have been in their best condition in the spring but can be harvested throughout the year. Sotol figures prominently in Mescalero Apache subsistence (Basehart 1974) and was probably of some importance to prehistoric populations of the area.

Datil (Yucca bacatta and *Y. Torreyi).* The large fruits of datil ripen in late spring and summer. The plant is common but widely dispersed on the slopes. The initial preparation of datil is carried out by splitting and drying the fruit, by roasting and then splitting and drying, or by mashing the fruit into cakes and drying. These fruits have good storage characteristics and were also an important element in Mescalero Apache subsistence (Basehart 1974).

Lechuguilla (Agave lecheguilla and *A. neomexicana).* This plant was widely used in the Trans-Pecos area of west Texas by prehistoric populations (Marmaduke 1978), but Basehart (1974) makes no mention of its use by the Mescalero Apache. Lechuguilla would be in its best condition in the spring and could have been used throughout the year. Preparation of lechuguilla was by pit baking the crowns which could have been stored. This plant is probably similar to sotol as a subsistence item, but its smaller size and the uncertainty as to its palatability compared to other leaf succulents, such as sotol, mescal, and soap-tree yucca, may have relegated it to use only in times of relative food-scarcity in the El Paso area.

Prickly Pear (Opuntia spp.). The fruits or tunas of these cacti and certain others ripen in late summer or early fall. They can be eaten raw or split and dried for future use. Today, prickly pear form dense patches in some areas of the Mountain zone. Their abundance prehistorically is not documented and the distribution was probably patchy then also. Tunas are recognized as of some importance to the Mescalero Apache, but no dependence on this foodstuff is claimed by Basehart (1974). The fleshy stems of prickly pear are edible and were probably used to a minor degree by prehistoric populations in the area.

Oak (Quercus spp.). Several varieties of acorns were utilized occasionally as a food item by the Mescalero Apache. However, the Mescalero considered their storage properties inferior, and the taste was not appreciated (Basehart 1974). The preparation of the local variety of acorns probably involved some labor to crush the nuts and leach out with water the bitter tannin before cooking as mush or cakes. Although acorns have been found in one prehistoric site where their use might be inferred (Brook 1966), they are assumed to be of little importance to prehistoric occupations in the El Paso area.

Mesquite (Prosopis glandulosa). The flowers and green beans of mesquite can be eaten raw but the common practice is to gather them for use when they are fully ripe. The peak time for the procurement of mesquite beans is in the fall; they can be stored without further preparation. Mesquite beans constituted a significant portion of the Mescalero Apache diet (Basehart 1974) and were probably of some importance to prehistoric populations as well. Mesquite is found to some extent in all of the environmental zones, therefore, the beans may have been collected at those loci where other resources were available at the same time, such as in the

Riverine zone where tornillo *(Prosopis pubescens)* was also available.

Grass (Gramineae). Grass seeds of the genera *Bouteloua*, *Muhlenbergia*, *Panicum*, and *Sporobolus* were probably of only minor importance prehistorically if their role in the Mescalero Apache subsistence pattern can be taken as exemplary (Basehart 1974). The distribution of small sites around playas in the interior of the Hueco Bolson east of the Franklin Mountains may be indicative of some collecting of grass seeds, but the role of grass seeds in the subsistence patterns of prehistoric populations is unknown (O'Laughlin 1978). Although grasses were once more abundant in the Mountain zone than they are today, they were equally or better represented in some of the other environmental zones.

From the above descriptions of potentially useful food plants, it can be suggested that prehistoric foraging or collecting activities in the Mountain zone may have been restricted to two times of the year. In the spring sotol and lechuguilla crowns may have been gathered, and there may have been limited collecting of datil. This later activity may have continued into the summer. The second period may have been in late summer and fall when prickly pear and, perhaps, mesquite were obtained.

Upper Bajada Zone

The west alluvial slope of the Franklin Mountains is divided into two zones, the Upper Bajada and the Lower Bajada. The Upper Bajada is at the foot of the Franklin Mountains, has a moderate slope, and gravelly to rocky limestone soils. The ridges and slopes are dominated by creosotebush, lechuguilla, and ocotillo, and prickly pear, datil, and sotol are common in the upper portions of this zone. Arroyos have a vegetation comparable to that of the lower portions of canyons in the Mountain zone, and wait-a-minute, mesquite, desert willow, whitethorn, small-leafed sumac, apache plume *(Fallugia paradoxa)*, and brickellbush *(Brickellia laciniata)* constitute some of the more common plants. Grasses are not common today but probably were of some importance in the past. The prehistoric vegetation was probably a mixed desert shrub/succulent and grass complex.

Although there are considerable physiograhic, substrate, and vegetation differences between the Mountain zone and the Upper Bajada, there is considerable comparability in terms of important potential food plants. Lechuguilla is found in both zones, as is some mesquite. Sotol, datal, and prickly pear are common in the upper portions of the Upper Bajada but are better represented in the Mountain zone. In all likelihood procurement activities would have been the same as in the previously described Mountain zone. That is, sotol and lechuguilla would have been procured in spring, datil in late spring and summer, and prickly pear and some mesquite in late summer and fall. However, procurement strategies were probably oriented towards particular resources rather than toward the environmental zones identified here.

Lower Bajada Zone

The Lower Bajada zone is located between the Upper Bajada and the Riverine zones. It includes the lower elevations of the west alluvial slope of the Franklin Mountains and has a rather gentle slope and somewhat thicker and less gravelly surface soils than the Upper Bajada. The western terminus of this zone is dissected by deep drainages and exhibits some terracing as a result of cyclic valley entrenchment and aggradation. Ridgetops and slopes are characterized by creosotebush and ocotillo, and range ratany *(Krameria parvifolia)* can be found in small amounts. Grasses are rare and include threeawn *(Aristida* sp.), fluffgrass *(Tridens pulchellus)*, bush muhly, sand dropseed *(Sporobolus cryptandrus)*, and mesa dropseed *(Sporobolus flexuosus)*. In the past black grama was probably the dominant grass and vegetation cover on the slopes and ridges. This is suggested by the historic accounts of grassland on the west alluvial slopes of the Organ Mountains just to the north of the study area (York and Dick-Peddie 1969).

Many of the ridgetops and terraces overlooking the Rio Grande have some duning of eolian sands which appear to have developed in the late Holocene times. Mesquite, soap-tree yucca *(Yucca elata)*, and some broom dalea *(Dalea scoparium)* are found in these dune areas most of which also have evidence of prehistoric occupation.

Drainages contain a variety of plants which include desert willow, little-leafed sumac, apache plume, brickellbush, mesquite, whitethorn, fourwing saltbush *(Atriplex canescens)*, mariola *(Parthenium incanum)*, and *Porophyllum scoparium*. Datil and prickly pear occur infrequently on the slopes of drainages and sides of a few small hills. Tornillo occasionally occurs in drainage bottoms near the floodplain.

The Lower Bajada would seem to have little of offer prehistoric populations under grassland conditions or under the present desert shrubs condition. Datil and prickly pear occur too infrequently to be considered seriously, but they may have been gathered on an encounter basis by parties crossing this zone or as part of daily foraging activities from camps or more permanent settlements along the Rio Grande. The gathering of pods of whitethorn may possibly have assumed a relatively greater role in this zone than elsewhere because of the dearth of other food resources. These pods have edible seeds which require no processing for storage, but the low frequency of occurrence of this species in drainage suggests that it would have been a minor resource that was available in the fall. The same may also be said of mesquite. The gathering of grass seeds in late summer and fall may have been another minor collecting activity, but the role of grasses in the subsistence-settlement pattern is unclear.

The dune areas at the western terminus of this zone are occupied by mesquite and soap-tree yucca, and soap-tree yucca was a food resource that was utilized to some extent by the Mescalero Apache (Basehart 1974). The flowers of this plant may be eaten raw, and the young flower stalk can be eaten raw or after cooking on coals. The crown and trunk of soap-tree yucca are in prime condition in the spring and could be pit-baked and prepared for storage much like sotol. Soap-tree yucca could be harvested and processed throughout the year; however, Basehart (1974) notes a preference by the Mescalero for sotol over soap-tree yucca. In addition to the patchy distribution of soap-tree yucca on ridgetops and terraces bordering the Rio Grande, this species can also be found in the bottoms of some of the drainages and on sandy alluvial fans at the mouths of drainages. Soap-tree yucca was probably the most important food resource of this zone.

The food resources of the Lower Bajada are meager compared to those of the Upper Bajada and Mountain zones. Small quantities of datil fruits in the spring and early summer, prickly pear fruits in the late summer, grass seeds in the summer and fall, and mesquite and whitethorn in the fall constitute the minor food resources of the Lower Bajada. The major important food source available on the Lower Bajada is the crown of soap-tree yucca which was best in the spring. However, soap-tree yucca is more abundant west of the Rio Grande in the study area, and the peak time for the procurement of soap-tree yucca coincides with that of lechuguilla and sotol. An evaluation of the relative importance of soap-tree yucca in the Lower Bajada as compared to other zones and species requires more data than is currently available.

Riverine Zone

The Riverine zone includes the floodplain of the Rio Grande and floodplain border surfaces. The Rio Grande determines much of the character of this lowland area, and it undoubtedly meandered across the valley forming oxbows and braided streams and cutting and filling channels. The flooding of the valley with peak spring flow and with summer runoff from local uplands has been noted as have periodic decreases and even failure in the flow of the river (Baldwin 1939). Some localized swampy areas probably existed in the past also, but these are restricted in occurrence today because of the construction of river levies in the study area and of Elephant Butte Dam upstream.

The present vegetation of the valley is greatly altered as a result of cultivation, house construction, and flood control activities and is undoubtedly very different from what it was before non-Indian settlers arrived in this area (Campbell and Dick-Peddie 1964). Today, salt cedar *(Tamarix pentandra)* forms dense stands in some areas bordering the floodplain, but this species was introduced from Europe in the recent past and has replaced native vegetation. Valley borders undoubtedly were vegetated in the past with a mixture of tree and shrub forms. As the slope became greater and the water table deeper at valley edges, cottonwood *(Populus fremontii)* would have given way to thickets of tornillo with some mesquite and that to mixed shrubs and small trees, including wolfberry *(Lycium pallidum)*, four-wing saltbush, and seepweed *(Suaeda suffrutescens)*. The interior of the valley was probably very open with saltgrass *(Distichlis stricta)* covering areas of alkaline soil and scattered cottonwoods. The river's course was probably lined with some cottonwood, willows *(Salix goddingii* and *S. exigua)*, and seep-willow *(Baccharis glutinosa)*. The few swampy areas and shallow streams would have had fairly dense stands of cattail *(Typha latifolia)* and reed *(Phragmites communis)*.

The plant food resources of the Riverine zone are numerous but the more important items are probably tornillo, mesquite, wolfberry, and cattail. Of less obvious importance are the greens and seeds of such plants as amaranth *(Amaranthus* supp.), goosefoot *(Chenopodium* spp.), purslane *(Portulaca oleracea)*, and dock *(Rumex* sp.). These latter resources are available from spring to summer.

Tornillo and some mesquite beans are available in the fall and require no processing for storage as was noted above. Tornillo has a high sugar content and would probably have been preferred over mesquite in the Riverine zone. Wolfberry has small, juicy berries that are available in the spring and early summer. These berries may be eaten raw or dried for storage. Cattail may well have been the most important plant food of this zone because it can be utilized throughout the year. The young shoots and flower stalks which are available in the spring can be boiled or eaten raw. The flowers and pollen can be gathered to some extent in the summer and can be dried and stored. Rootstalks can be collected throughout the year but are best in the spring. The rootstalks of cattail can be boiled and baked for consumption or dried for storage. Basehar (1974) reports that cattail and tornillo were minor resources for the Mescalero Apache, but this may be more of a reflection of the restricted range of Mescalero Apache in historic times than of the potential importance of these food items to prehistoric populations of the El Paso area.

Leeward Slope Zone

The Leeward Slope lies between the Riverine and West Mesa zones and includes the ridges and shallow drainages of slopes just west of the Rio Grande. Eolian sands brought in from the West Mesa zone by the prevailing west winds dominate the soils of these slopes and are subject to surface erosion and duning. Gravelly soils occur in this zone but are limited in extent. Shallow, gravelly soils of some of the terrace remnants, ridgetops, and alluvial fans are covered with creosotebush and broom snakeweed *(Xanthocephalum sarothrae)* with some mesquite. The vegetation of the deeper soils and dune areas consists of mesquite, four-wing saltbush, broom dalea *(Dalea scoparia)*, joint fir *(Ephedra trifurca)*, and soap-tree yucca. Grass cover is low in the area and is mostly of dropseed *(Sporobolus* spp.). Grass cover was probably greater in the past in this zone with more dropseed in sandier areas and some black grama on shallow and gravelly soils. However, desert shrubs were probably well represented because of the relatively unstable sandy soil surfaces.

The important food plants for the Leeward Slope are mesquite and soap-tree yucca. Mesquite beans could have been gathered in the late summer or fall, and mesquite is better represented in this zone and in the West Mesa zone than in any of the other environmental zones. Soap-tree yucca is in its best condition in the spring, but the crowns may be harvested throughout the year. Soap-tree yucca occurs regularly throughout the Leeward Slope and West Mesa zones and appears to be somewhat more abundant than in the Lower Bajada zone. Grass seeds might have been of minor importance in the summer and fall, but grasses would have been more abundant in the Lower Bajada and West Mesa zones.

West Mesa Zone

The West Mesa includes the large, level upland plain west of the Leeward Slope zone. Erosional escarpments at the east end of this zone give a mesa-like appearance to the plain when viewed from the valley—thus the name. Today, the West Mesa is characterized by sandy soils which form coppice dunes. These dunes usually develop around mesquite, and interdunal areas are generally barren. Four-wing saltbush and soap-tree yucca are also common on these duning soils. There are a few slghtly depressed "playa" areas with heavier soils which may contain some water for short periods of time after summer thunderstorms. Generally, mesquite decreases in abundance in these playas, and four-wing saltbush and soap-tree yucca may be somewhat more abundant. Summer annuals may also be well represented in some of these playas. Historic descriptions of this plain just to the north of the study area indicate that grasses were relatively abundant in the West Mesa zone in the 19th century and that black grama and dropseed were the principal kinds of grass (York and Dick-Peddie 1969). Mesquite is expected to have occurred more frequently around playa fringes and in areas susceptible to wind erosion and duning of soils. Soap-tree yucca is likely to have had a distribution comparable to that of today.

Mesquite and soap-tree yucca are believed to have been the important food plants of the West Mesa and would have had a distribution and relative abundance comparable to that of the Leeward Slope zone. Principal times of procurement would have been the spring for crowns of soap-tree yucca and late summer or fall for mesquite beans. Grass seeds could have been harvested in the summer or fall, but their importance to prehistoric populations is not clear. As a food resource, grass seeds would also have been available to almost an equal extent in the Lower Bajada zone. Greens and seeds of herbaceous plants, including amaranth, purslane, and plains sunflower *(Helianthus petiolaris)*, may have been of minor importance in the spring and summer. These would be available in small amounts in slightly depressed areas or playas which are occasionally found near the east edge of the West Mesa.

Summary

The demarcation of environmental zones has hopefully provided the reader with a better conceptualiztion of what the landscape looks like in the project area, as well as the spatial variability in land form, soils, and recent and past vegetation. Spatial variability in the environment undoubtedly had an influence on the subsistence and settlement patterns of prehistoric populations, especially when it is remembered that the project area is only a small portion of a larger basin and range province with locally different mixes of these and other potentially definable environmental zones. If the environmental variability of the project area can be considered representative of the kinds of situations to which prehistoric populatons had to adapt in the wider El Paso area, then it should be possible to extract some of the environmental correlates to subsistence-settlement strategies from the spatial and temporal variability in the plant food resources presented herein.

The environmental zone distribution and peak procurement times for suggested major and minor plant food resources are shown in Table 1. Although some resources have a wider environmental zone distribution than others, all plant food resources are not found in all zones, and some zones have more resources than others. In addition, although some plant food resources are available in most environmental zones during spring, summer, and fall, some zones have a greater variety of plant food resources in some seasons than other zones. From these seasonal and spatial patterns in plant food resources, it could be suggested that sites of hunters and gathers might also be expected to exhibit similar patterns. That is, hunters and gatherers are likely to have moved about the landscape in response to the seasonal and spatial availability of resources, and the material remains of hunters and gatherers may have spatial distributions and variability in site assemblages that correlate with the variability observed in the natural environment. This is supported somewhat by the studies of O'Laughlin (1977a; 1978; 1979) and Whalen (1977; 1978) in the Hueco Bolson east of the Franklin Mountains. However, the archeological sites of this project are within 6 km of all of the described environmental zones, and this distance is within daily foraging radii noted in similar seasonal environments for modern hunters and gatherers such as the Bushmen of south Africa (Lee 1969; Silberbauer (1972). Thus, archeological sites in the project area may be expected to demonstrate evidence of a wide range of subsistence activities and to occur in places that have a spatial congruence of some resources and/or that minimize travel distances to a variety of resources.

From Table 1 it is also noted that no plant food resources have the winter months as their peak time of availability. The winter months are envisioned, therefore, as "lean times" when the majority of plant foods are neither available nor in their most desirable state. Mesquite, tornillo, and whitethorn beans could be gathered in the winter months, and the crowns of sotol, lechuguilla, and soap-tree yucca, the rootstalks of cattail, and the fleshy pads of prickly pear could also be harvested and utilized during the winter season. It is thought that some storage of plant foods would be necessary, however, to compensate for the less productive winter months and that the storage of foodstuffs would reduce the mobility of hunters and gatherers. The archeological sites of hunters and gatherers who practice some storage of foodstuffs might then be divisible into winter residences in which the assemblages might reflect a greater range of activities and the longer occupation might produce a greater quantity of archeological material than the summer counterpart.

Finally, it should be noted that the peak period of availability of most natural plant food resources overlaps the growing season for corn and other cultigens. As prehistoric populations became more dependent upon crops, greater difficulty was experienced in coordinating plant gathering activities with those of crop raising and harvesting. With increased dependence on crops, a reduction in the importance of plant gathering can be expected. In addition, a dependence on crops is likely to result in an increase in the amount of stored foodstuffs and a marked reduction in the mobility of the group. The location of sites inhabited by farmers is expected to be strongly conditioned by the distribution of arable lands and especially of water in this semiarid environment. With a reduction in residential mobility, it is probable that the acquisition of natural resources will reflect logistic strategies (i.e., transporting bulk goods to consumers) and that extractive locations utilized by farmers will have assemblages that are more highly specialized than sites of hunters and gatherers from which the same resources were sought.

Fauna

Common mammals recorded for the area include desert cottontail *(Sylvilagus auduboni)*, black-tailed jack rabbit *(Lepus californicus)*, ground and rock squirrels *(Spermophilus* spp.), pocket mouse *(Perognathus* spp.), kangaroo rat *(Dipodomys* spp.), white throated woodrat *(Neotoma albigula)*, coyote *(Canis latrans)*, striped skunk *(Mephitis mephitis)*, pronghorn *(Antilocapra americana)*, and mule deer *(Odocoileus hemionus)* (Ederhoff 1971). Blair (1950) reviews other common faunal elements of the Chihuahuan Desert.

Although there are numerous animals which could have been utilized by prehistoric man in the El Paso area, probable hunting patterns described by O'Laughlin (1977b) suggest that relatively few are of any great importance. On the basis of faunal remains from archeological sites, O'Laughlin details three broad hunting patterns which may be applicable to the study area: highland, lowland, and riverine.

The highland hunting pattern is found in the larger mountain masses of the El Paso area and is

TABLE 1

PEAK PROCUREMENT TIMES AND ENVIRONMENTAL ZONE DISTRIBUTION
OF MAJOR AND MINOR PLANT FOOD RESOURCES

			Zones					
Common Name	Plant Part Used	Time	Mountain	Upper Bajada	Lower Bajada	Riverine	Leeward Slope	West Mesa
Sotol	leaf bases, hearts, young stalks	spring	X	X	-	-	-	-
Lechuguilla	leaf bases, hearts, young stalks	spring	X	X	-	-	-	-
Soap-tree yucca	leaf bases, hearts, young stalks	spring	-	-	X	-	X	X
Cattail	rootstalk, young shoot and flower stalk	spring	-	-	-	X	-	-
Wolfberry	fruits	spring to early summer	-	-	-	X	-	-
Datil	fruits	late spring to summer	X	X	?	-	-	-
Herbs	greens and seeds (minor resource)	spring to summer	-	-	-	X	-	X
Grasses	seeds (minor resource)	summer to fall	-	-	X	-	?	X
Prickly pear	fruits	late summer to fall	X	X	?	-	-	-
Tornillo	beans	fall	-	-	-	X	-	-
Mesquite	beans	fall	?	?	?	X	X	X
Whitethorn	beans (minor resource)	fall	X	X	X	-	-	-
Oak	acorns (minor resource)	fall	X	-	-	-	-	-

characterized by the hunting of deer (O'Laughlin 1977b). Although deer range through all elevations, they are more commonly found in the larger mountains where there is sufficient browse for larger deer populations. Deer aggregate into herds in the winter while they are more often solitary during other times of the year. In the foothills of larger mountains and in some of the smaller and drier mountains cottontail may also have been of some importance. The Mountain zone of this study is considered to be an area where highland hunting would have occurred, and where cottontail would have been taken throughout the year and deer primarily in the winter.

The Upper Bajada, Lower Bajada, Leeward Slope, and West Mesa zones would be included in those environments where the lowland hunting pattern has been documented (O'Laughlin 1977b). The lowland hunting pattern is characterized by the hunting of jack rabbit along with some cottontail and pronghorn in low elevation grasslands and deserts. Pronghorn may have occurred more frequently in open grassy areas such as the West Mesa and in northern extensions of the Lower Bajada zones, and cottontail may have been restricted mostly to the Upper Bajada and to lower portions of the Lower Bajada and Leeward Slope environmental zones. Jack rabbit would have been found in all four of the above mentioned zones and was likely to have been of greater importance to prehistoric populations than either cottontail or pronghorn. Some deer could also have been taken opportunistically in these zones.

The riverine hunting pattern is known from sites excavated along the Rio Grande and is similar to the lowland hunting pattern but it also includes a number of animals less common or not found in the lowland areas away from the river (O'Laughlin 1977b). The Riverine zone is that environment in which this hunting pattern would be expected, and the important animals would include cottontail, jack rabbit, fish, spiny soft-shell turtle, and migratory water fowl such as duck. Cottontail would have been common in the Riverine zone because of the dense shrubbery that often borders the floodplain, and jack rabbit would not have been as abundant in this zone as they would be in more open areas away from the river. Deer may also have been found on occasion in the Riverine zone. A minor fllyway for migratory water fowl follows the Rio Grande (Peterson 1963), and some hunting of water fowl such as mallards, pintail, and teal may be suggested. Muskrat and perhaps beaver would also have been available along the river (Findley, et al. 1975), and fish and spiny soft-shell turtle were probably important aquatic resources from summer through the winter when river flow would have been slow and shallow.

The seasonal and spatial distributions of economically important animal resources are not as pronounced as those of plant foods but do exhibit some patterning. Pronghorn, fish, spiny soft-shell turtle, other water fowl and mammals, and perhaps deer, all have rather well-defined distributions with respect to environmental zones in the project area, and jack rabbit and cottontail vary inversely with one another in relative abundance as the vegetation varies from open grassland and desert shrubs to denser shrubbery along the Rio Grande and in the Franklin Mountains. The numbers of deer, jack rabbits, and cottontails are greatest in the spring and summer, but deer hides and meat are in their best condition in the winter when deer are more readily taken because of aggregation although their overall density is somewhat reduced. In addition, the character of the river's flow and the presence of a minor flyway of migratory fowl suggest some seasonal patterning in the availability of fish, spiny soft-shell turtle, and water fowl. The relationships between seasonal and spatial distributions in the availability of animal resources and subsistence and settlement patterns of prehistoric populations follow those presented in the previous section on plant food resources. It can also be suggested that deer and fish may have played important roles in the winter subsistence strategies of both farmers and hunters and gatherers when natural plant foods were not generally available or were in less than prime condition.

CHAPTER III

CULTURE HISTORY OVERVIEW

The culture history of the area is summarized by the following developmental periods: Paleoindian, Archaic, and Formative. Because the sites investigated as part of this project appear to be largely prehistoric, with small amounts of 20th century trash scattered about the surface, there will be little discussion of the historic era. Discussions will also be restricted in scope with the intent of providing a general overview of cultural developments in the El Paso area and not lengthy presentations of material culture and previous archeological research. These latter interests are well documented by Brethauer (1977), Eck (1979), Hammerson (1972), and Marshall (1973).

Paleoindian Period

The presence of Early Man in the El Paso area is known principally from surface finds of distinctive projectile point styles and shaped tools such as knives, scrapers, and gravers (Beckes 1977a; Everitt and Davis 1974; Russell 1968). These artifacts are attributed to occupations of Folsom and later Plano traditions of the Paleoindian period and date roughly between 10,000 and 8,000 years ago. In addition, these stone tool assemblages are indicative of some reliance on the hunting of large mammals and the processing of meat, skin, and bone. Notably absent are ground stone implements for processing seeds and other plant parts.

Although no sites of this period have been intensively investigated in the El Paso area, chipped stone assemblages from scattered surface finds are interpreted in the light of more extensive investigations of this period in central and eastern New Mexico and in the mid-continental grasslands of North America (see Judge 1973). These studies and knowledge of contemporary hunters and gatherers suggest that Paleoindian adaptations of the late Pleistocene and early Holocene were oriented toward the hunting of large mammals (principally bison), that plant foods were probably collected, that social groups were small (family to band in size), that group membership was probably very flexible, and that social groups were highly mobile and traversed great distances in pursuit of game animals. Mobility and extensive kin and information networks are reflected in the high uniformity of projectile point styles and other chipped stone tools over very large areas and across major ecological biomes.

During the late Pleistocene, the El Paso area appears to have had expanses of savanna or open woodlands with small lakes and well-forested hills and mountains with perennial streams. Horses, camels, a four-horned antelope, pronghorn, deer, and perhaps bison were apparently common, if not numerous. With a change in climate regime, the extinction of many large mammals, and the establishment of ecological communities comparable to today's by the middle Holocene, Paleoindian adaptations based on large mammal hunting ceased to exist and an era of wide-spectrum foraging for both plants and animals emerged — the Archaic period.

Archaic Period

The Archaic period encompasses a considerable length of time from about 7,000 or 8,000 years ago to about the time of Christ. As with the Paleoindian period, evidence of Archaic populations in the El Paso area comes largely from surface finds of diagnostic projectile point forms because only a handful of sites have been securely identified and fewer have been excavated to date. There is a wide range of variability exhibited in these projectile points, some of which is a reflection of the length of this period (see Beckes 1977a). In addition, the variability in projectile point styles tends to increase in the middle to late Archaic, there being more uniformity in the early Archaic. In turn, there are fewer parallels in projectile point styles from area to area from early to late Archaic. This situation is duplicated in many other areas throughout western North America during this period and is interpreted as evidence for increasing population density, decreasing size of the area exploited by a social group, and the development of more specialized or area-specific adaptations (Jennings 1964; MacNeish, et al. 1967; Taylor 1966). During this period, social groups are envisioned as being relatively small (family to band), fairly flexible in composition and group membership, highly mobile with respect to residence but not range, and loosely integrated with effective kin and communication networks smaller than during the Paleoindian period and decreasing in size from early to late Archaic.

Although the Archaic period of the El Paso area is thought to have lasted some 5,000 to 6,000 years, the recognition of shorter intervals of time which may be characterized by different assemblages or adaptive strategies has not been possible yet. Assemblages of the Archaic period and the early Formative are similar with differences restricted largely to projectile point forms and the addition of ceramics to the early Formative material culture (Becket 1979; O'Laughlin 1977a; Whalen n.d.). Added to the difficulty in distinguishing Archaic and early Formative remains in the absence of projectile points and ceramics is the wide range of variability exhibited in Archaic projectile point styles which have tentatively been dated by reference to similar forms in other areas. However, Archaic projectile point styles do not reveal sufficient temporal patterning to allow development, at present, of a local chronology.

Affinities of Archaic materials in the El Paso area to those of southwestern New Mexico and southeastern Arizona are inferred by Lehmer (1948) and Irwin-Williams (1967), and assemblages similar to those of Trans-Pecos Texas are noted by Sayles (1935) and Setzler (1935). Kelley (1959) implies that Archaic materials of the El Paso area are similar to those of Trans-Pecos Texas as well as the Edwards Plateau of Texas, and Beckes (1977b:202ff.) follows Setzler (1935) and Taylor (1966) in suggesting that the assemblages of the El Paso area and Trans-Pecos Texas are comparable to those of northern Mexico, especially those of the state of Coahuila. In addition, the writer has noted the occurrence of projectile points in local collections that bear strong resemblances to those of northwestern New Mexico (Irwin-Williams 1973). Each of the above mentioned areas has a reasonably well-developed Archaic chronology and a distinctive material culture. The occurrence of projectile points and other elements of material culture in the El Paso area which are referrable to so many separate and distinct culture histories may suggest that all are interrelated and perhaps represent a single population with similar geophysically related adaptive strategies (Wimberly 1979). The intermediacy of the El Paso area in terms of environment and Archaic material culture to surrounding areas is a possibility, but the absence of a well-developed chronology to deal with such questions is a fact.

In addition to projectile points, stone artifact assemblages are characterized by grinding implements and expediently manufactured flake and core tools. Excavations of caves and shelters occupied during the middle and late Archaic have also revealed a considerable inventory of perishable artifacts which include cordage, basketry, matting, sandals, throwing sticks, and spear throwers (Cosgrove 1947); Human Systems Research 1972; O'Laughlin 1977a). In general, subsistence activities suggested by stone tools and more perishable artifacts appear to be based on the gathering of wild plant foods with some hunting. Some of the more important edible plant foods were probably mesquite and tornillo beans, agave hearts and stalks, sotol hearts, yucca hearts and stalks, cacti fruit and pads, pinyon and oak nuts, and possibly grass seeds and the seeds of small herbaceous plants (O'Laughlin 1977a). Faunal remains from excavated sites include a variety of reptile, birds, amphibians, and mammals. However, rabbits, deer, and antelope seem to provide the bulk of the meat diet (O'Laughlin 1977b). Corn, gourds, and perhaps beans were known in the area from at least 1600 B.C. (Humans Systems Research 1972), but dependence on cultigens is not apparent until late in the Formative period (O'Laughlin 1979, Whalen 1977; 1978).

Although only a few Archaic sites have been excavated, they do reveal some interesting patterns with respect to site size and location, length and time of occupation, and variability in subsistence activities. Small, seasonal occupations of playa edges and caves for the procurement and processing of plants and the opportunistic hunting of animals from spring to fall are known (O'Laughlin 1977a: Whalen 1975). More sizable and repeated occupations of mountain shelters for the hunting of large mammals and the gathering of upland plants primarily during the fall and winter are also in evidence (Human Systems Research 1972; O'Laughlin n.d. a). A few small camps that were occupied in the spring for the purpose of processing leaf succulents and that were located at the base of mountainous areas have been documented (O'Laughlin 1979). One site located on the edge of the Rio Grande has been investigated and appears to be composed of a series of small encampments that were occupied from time to time throughout the year for the purpose of processing lithic materials, collecting plants, and some hunting (Greiser 1973). Taken together, these sites reflect a general tendency for the movement of social groups to correspond to the seasonal availability and spatial distribution of economically useful plant and animal resources. Some locales are repeatedly occupied due partially to the distribution of natural resources but more importantly to conditions that make the site more amenable to habitation. Variability in site size also suggests that small social groups may gather at favored locales for short periods of time to carry out cooperative activities, to reaffirm group solidarity, to exchange information, and to build economic, social, and kin networks. Residential mobility and the lack of permanent storage facilities suggest low population densities and the sufficiency of natural resources for subsistence needs.

Formative Period

Following the Archaic, there is a long period (from about the time of Christ to A.D. 1400 or 1500) which is referred to as the Formative. The usage of the period names Archaic and Formative follows that of Willey and Phillips (1958) only insofar as the Archaic is used to refer to post-Pleistocene hunter and gatherer adaptations, and the Formative to the beginnings of non-urban village life based on agricultural pursuits. It is not suggested that these periods represent portions of a general developmental or evolutionary model or that similar developments may occur synchronically in other areas.

Although a great deal of archeological work has been done on this period, much confusion exists with the chronology and the nature of past adaptive systems. In recent years the beginning date for this period has been pushed back from A.D. 900 to at least A.D. 250 ± 110 (Whalen n.d.), and the existing divisions which break this period into phases defined by "traits" have become increasingly more difficult and burdensome to use. Differences in traits between the Archaic and Formative periods have suggested to those archeologists pursuing culture history via a normative framework, that drastic changes took place in social organization, technology, and subsistence. More recently, variability in the archeological record has become the focus of attention, and the interpretations of this variability have differed with some archeologists showing concern for the study of culture process and change and some still trying to push the variability into the mental constructs of the traditional culture center-age area paradigm.

Differences between the Archaic and Formative periods have been viewed in the following ways:

1. The Formative differs from the Archaic in the addition of new traits such as pottery, houses, and the bow-and arrow through diffusion.
2. The Archaic and Formative periods represent differences in lifeways with the former representing hunters and gatherers and the latter referring to sedentary farmers.
3. The distinction between Archaic and Formative is largely a matter of time with the Archaic older than the Formative.
4. The differences between the Archaic and Formative reflect the degree of social integration through religion.

Other examples of conflicting viewpoints could be given but would lead to little additional understanding of the Formative period.

The chronology of the Formative is not well worked out. The first attempt to deal with temporal and spatial variability in traits ended in a three-phase chronology (Lehmer 1948): Mesilla (A.D. 900-1000), Dona Ana (A.D. 1100-1200), and El Paso (A.D. 1200-1400). The Mesilla phase has since been found to begin by at least A.D. 250 ± 110 (Whalen n.d.), and terms such as early Mesilla phase and late Mesilla phase or early and late Pithouse periods have been used with increased frequency (Thompson 1979; Whalen 1978; n.d.). The Dona Ana phase has also been referred to as the Transitional period, and the El Paso phase has been called the Pueblo period (Thompson 1979; Whalen 1978; n.d.). At present, chronological divisions of the area's prehistory reflect assumptions relative to cultural development or the temporal distributions of traits.

For the remainder of this section, a very brief overview of the Formative will be given using the Mesilla, Dona Ana, and El Paso phases as the foci of discussion. The Formative ends about A.D. 1400 or 1500 with the apparent depopulation of the area until historic times.

Mesilla Phase

The Mesilla phase (from about the time of Christ to A.D. 1100) evidences the first known occurrence of ceramics and the bow-and-arrow in the El Paso area (Lehmer 1948). Small huts or pithouses have also been included in the list of traits which distinguish the Formative from the Archaic, but this is no longer possible with the finding of Archaic houses at one of the sites of this project.

Settlement patterns for most of this phase are similar to those of the Archaic period and suggest high residential mobility of loosely integrated and small social groups depending principally on hunting and gathering with some growing of domesticated plants (Beckes 1977b; Whalen n.d.). The addition of ceramics and the bow-and-arrow imply new technologies for processing or acquiring the requisite subsistence needs and may also indicate the use of new resources or changes in the relative contributions of previously used foodstuffs. Population density seems greater than for the Archaic period and appears to increase through this phase.

At about A.D. 900 to 1100 some changes in settlement patterns are noted. A few communities seem larger than before and exhibit patterning of houses which implies a greater degree of integration of social groups and more permanent occupations than during the early part of this phase (Lehmer 1948; Whalen 1979; n.d.). Some communities are also located along the Rio Grande or near the areas of temporarily impounded water from mountain runoff. The location of these communities suggests some dependence on the growing of domesticated plants (O'Laughlin 1979; Whalen 1978; n.d.). Specialized sites for the processing of large amounts of leaf succulents appear to become more common at this time or somewhat earlier (Greer 1868a; 1968b). Population pressure near the end of this phase may have reduced the areas from which local populations could procure native plant and animal resources. Reduction in effective environments or territories for social groups may then have stimulated changes in the contribution of various food items to the diet and concomitant changes in site locations and permanency of occupation. Greater variability in site types indicates a change in the organization of activities with a slight decrease in residential mobility, an increase in the storage of subsistence goods, a differentiation of sites into habitation and special activity occupations, and a greater size of the social groups which were somewhat better integrated than during the early part of this phase (O'Laughlin 1979; Whalen 1978).

Dona Ana Phase

Relatively little is known of the Dona Ana phase (A.D. 1100-1200) because only three excavations of this phase are known (Kegley 1979; Marshall 1973; Schaafsma n.d.). Sites of this time are also difficult to distinguish from earlier or later phases with surface ceramics (Beckes 1977b; Whalen 1977; 1978). During this phase small pueblos were built, the painting of ceramics begins, and settlements tend to concentrate in those areas most suitable for agriculture. There is also evidence of a major shift in populations from the southern portion to the northern portion of the area previously occupied during the Mesilla phase (Way 1979; Yeo n.d.). This movement of populations may be in response to a decrease in effective precipitation during this phase.

El Paso Phase

Much excavation has been done in sites of the El Paso phase (A.D. 1200-1400) (see Marshall 1973), and large area surveys have documented variability in site kind and placement (Beckes 1977b; Whalen 1977; 1978). Small to large pueblos were being built during this phase, and there is some evidence for community planning and the integration of social groups through ceremonial activities (Whalen 1977; 1978). Communities vary in size, and this may imply a hierarchy of settlements with differentiated activities and importance. Social organization is still largely egalitarian with kinship probably providing the basis for residence patterns, task group, and religious society composition, and exchange and information networks.

The El Paso phase demonstrates a greater variety and quantity of non-local ceramics and shell objects than the earlier Mesilla phase, and this is seen as an increase in the extent and complexity of interregional relations according to Whalen (1977; 1978). Whalen also views the increase of imported items as indicative of a relatively greater differentiation in status between communities and societal members during the El Paso phase than during the Mesilla phase. Wimberly (1979) also suggests that the volume of imported items reached substantial proportions during the El Paso phase and that the growth of particular population centers may be due to their positioning with respect to long established routes of travel and the flourescence during this phase of the major trading center of Casas Grandes to the southwest in Chihuahua, Mexico.

Sites of the El Paso phase are easily divided into habitation sites and special activity sites (Whalen 1977; 1978). Habitation sites generally occur along the Rio Grande or where runoff from mountains accumulates temporarily. The growing of corn, beans, and squash is the most evident activity at these sites (Brook 1966; Ford 1977), and most habitation sites appear to have been occupied on a fairly permanent basis for varying lengths of time. Special activity sites include hunting camps and plant gathering and processing camps. Special activity sites are often larger than those of previous phases and evidence a more restricted range of activities by larger task groups.

Populations apparently increased during the El Paso phase (Whalen 1977; 1978), and those areas not used during the Dona Ana phase were once again inhabited. This may reflect a return to more amenable conditions for agricultural activities. At about A.D. 1400 or perhaps A.D. 1500, the area was apparently abandoned, as were many other areas of the Southwest. Marked changes in the environment may have occurred at that time or the collapse of the adaptive system may have been the result of too heavy a reliance on agriculture which is a tenuous adaptation for this area and for the technology and social organization of the El Paso phase. It may also be possible that the dispersal or reduction in population noted at the end of the El Paso phase may be related to the decline at about this same time of the trading center of Casas Grandes (Wimberly 1979).

Archeological evidence for the presence of peoples in the El Paso area after the El Paso phase and before the establishment of Spanish mission communities does not exist. However, evidence of the presence of hunters and gatherers for this time may eventually be found in the El Paso area. Early Spanish accounts mention the presence of Suma hunters and gatherers along the Rio Grande below El Paso and to the southwest and southeast in Chihuahua, Mexico, and Trans-Pecos Texas, as well as Manso hunters and gatherers above El Paso and along the Rio Grande (Gerald 1974a; 1974b). Both of these groups are noted as having flimsy brush shelters or huts arranged in settlements of variable size. Subsistence items are described as including mescal, mesquite beans, prickly pear, roots, seeds, fish, and animals. Everitt (1977) also points out the regularity with which populations were observed in winter months along the Rio Grande, while travelers in the summer months either saw no one or only the abandoned dwellings. Undoubtedly the seasonal patterns in available plant and animal resources and rainfall which are suggested in Chapter II to have conditioned settlement patterns for prehistoric hunter-gatherer adaptations are related to the apparent seasonal aggregation and dispersion of these historic hunters and gatherers.

Settlement Patterns in the Project Area

A rather sketchy description of prehistoric settlement patterns in the project area will be presented in this section to provide a basis for later interpretations of those sites specifically investigated as part of this project. This data is considered important because no large scale archeological surveys have been reported for areas bordering the Rio Grande in the El Paso area. At the same time, discussions of settlement patterns will be brief and sketchy because they are based on incomplete coverage of the area and the employment of a wide variety of archeological survey techniques. Sources for the information presented herein include Gerald (n.d. d), Hunter-Anderson (1979), Way (n.d.), and Yeo (n.d.), as well as survey records of the El Paso Centennial Museum. In addition, O'Laughlin (1977b) and Rex E. Gerald (personal communication) have excavated Mesilla phase residential sites on the west bank of the Rio Grande.

The distribution of sites for each period and phase is shown in Figure 6. Numbered sites are those recorded by Gerald (n.d. d) in areas where the construction of new retention dams or modification of existing dams has been proposed. These sites include Site 29 and Sites 31 to 37 whose limited examination was the focal point of the project.

The large number of sites along the Rio Grande is a reflection of the more extensive examination of easily accessible areas adjacent to the floodplain, and those areas away from the floodplain with no sites have been subjected to little investigation to date. It is thought that about 10% of the area above the floodplain shown in Figure 6 has been surveyed to some extent, and the distribution of the coverage is roughly 2% for the Mountain and Upper Bajada environmental zones, 2½% for the Lower Bajada zone, 2½% for the lower portions of the Leeward Slope zone, and 3% each for the upper portions of the Leeward Slope and West Mesa zones. Few sites would be expected on the floodplain, and the Riverine zone is now largely under cultivation or developed for residential housing. Thus, all environmental zones above the floodplain are represented in the archeological surveys, and it is believed that the distributions of the various kinds of sites among the environmental zones exemplify past settlement patterns.

For this discussion, camps will be defined as those sites with small areas suggestive of temporary occupation or tools and facilities reflecting a limited range of activities. They are generally less than 0.1 hectare in size, evidence thin occupational deposits or very low densities of artifacts, and appear to have more variable assemblages than other site types. A camp with many hearths is one which has four or more fire-cracked rock hearths. It is often larger than a small camp, ranges up to a hectare in size, and has a higher density of artifacts which include large chipped stone tools and some ceramics. Residential sites are noted as generally being large and exhibiting a wide range of activities in terms of tools and facilities. Two of these sites are only about 0.1 hectare in size, but most are much larger and range up to 1.5 hectares in size. Occupational deposits of residential sites are often substantial, and artifact densities are higher than for the other site types. Processing and manufacturing debris at these sites is common, and artifact assemblages are general in nature and include most easily recognizable artifact classes (though ceramics are absent in the earlier residential sites). Structures have been noted on all of the El Paso phase residential sites and two pithouses have been excavated in one of the Mesilla phase residential sites. However, the presence of observed or inferred structures is not taken as definitive evidence of a residential site.

The Paleoindian period is represented by two projectile points (a Folsom and a later Plano form) which occurred as isolated finds. Other than noting the past presence of Paleoindian populations in the project area, little can be added to the material given in the section on this period.

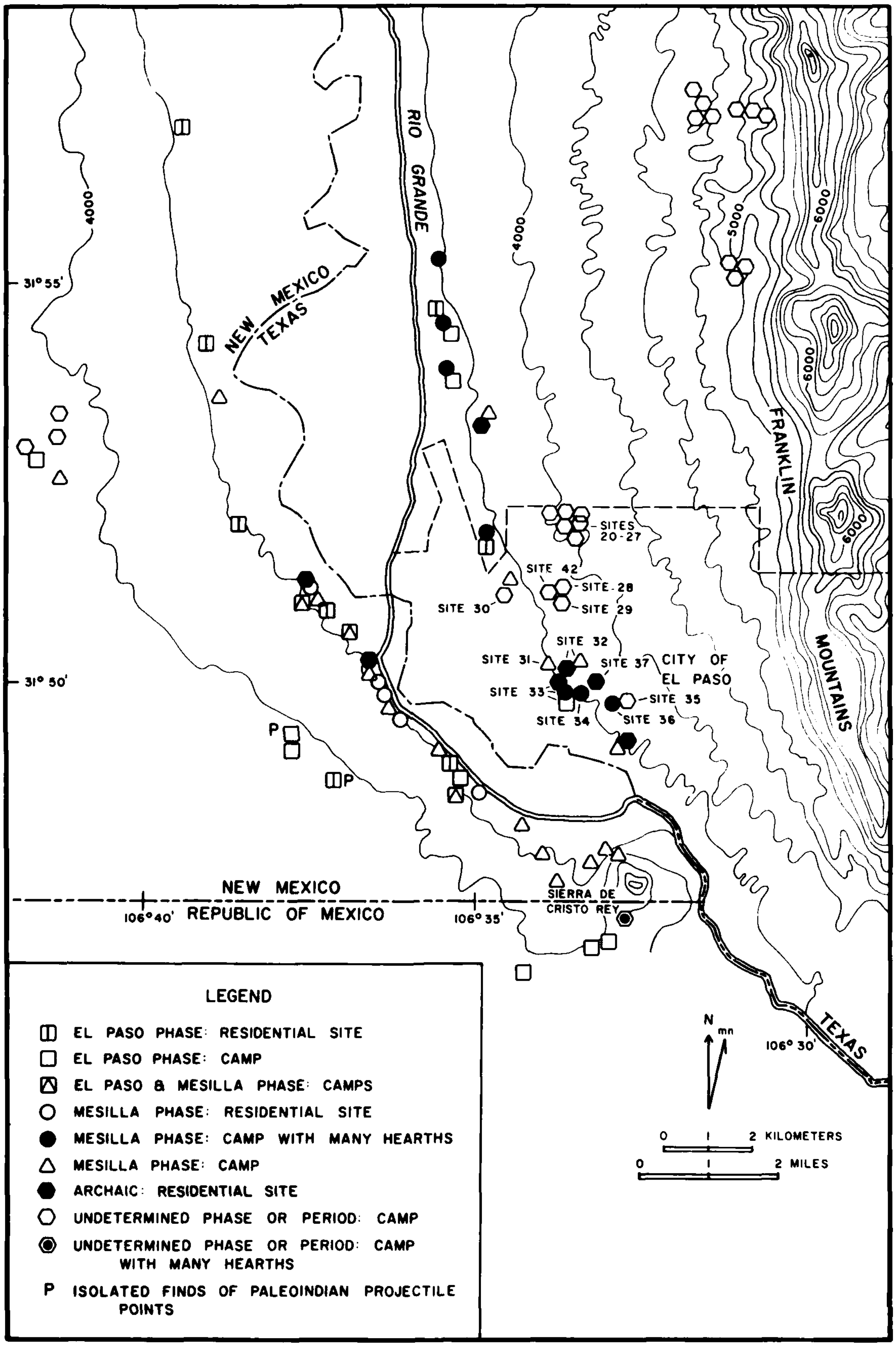

Figure 6. Settlement patterns for the project area. Complete site numbers are EPCM 31:106:2:30, etc.

Residential sites of the Archiac and Formative periods (Figure 6) are located primarily along both sides of the Rio Grande on alluvial fans and ridge tops near the juncture of the Lower Bajada and Leeward Slope zones with the Riverine zone (refer to Figure 5). The near absence of reported residential sites away from the river is believed to be an accurate reflection of their distribution in this area, given the greater size and visibility of residential sites as compared to small camps. The overlapping patterns in residential site locations in spite of suggested changes in subsistence and technology for these periods is also viewed as being conditioned by the availability of water for human consumption. The Rio Grande is the only secure source of surface water in the project area, and the linear distributions of residential sites along the river is obvious. In basin lowlands away from the river the geometry of residential site locations is much different but is also based to a large degree on the availability of water. Away from the river water either accumulates from rainfall in playa areas in the central portions of bolsons, or from rainfall and runoff at the juncture of mountain alluvial slopes and basin floors. Although Archaic sites are not well documented for these non-river and lowland areas, Formative period residential sites have spatial patterns which covary with the distribution of surface water (O'Laughlin 1978; Whalen 1977; 1978). Differences between Mesilla and El Paso phase settlement patterns in these same lowland areas away from the river are attributable to an increasing reliance on domesticated food plants in the later phase. Mesilla phase residential sites have a wide distribution whereas El Paso phase sites are virtually confined to the runoff zone at the base of mountains (Whalen 1977; 1978). Seasonal and annual variability in the availability of water derived from rainfall suggests that many of the residential sites away from the river were occupied only seasonally or coincidentally with periods of regular or above average precipitation. This point is observed by Wimberly (1979) when he notes that most sites which bear evidence of sizable investment in structures were occupied for only short periods of time. The Rio Grande with its reliable water supply that is not dependent on local rainfall would, therefore, be one area where longer occupations might be expected and certainly where some seasonal occupation by both hunters and gatherers and farmers could be predicted during the winter months.

Although residential sites in the project area exhibit little variability in location with respect to distance from the Rio Grande, the number of sites does vary from one side of the river to the other. Differences in the number of residential sites for each side of the river may be referable to differences in subsistence patterns. Residential sites of the Archaic period are more often noted on the east side of the river where resources of the Mountain, Upper Bajada, Lower Bajada, and Riverine environmental zones would be available within foraging distance. The number of important native food plants and their seasonal availability is greater for the east side of the river than the west side (see Table 1), even though resources of the Riverine zone would be accessible from both sides of the river. Animal resources have a wider distribution than food plants, but deer may have been more common on the east side of the river in the Mountain zone. Thus, Archaic residential sites seem to be positioned with respect to variety, and perhaps abundance, of naturally occurring food items. This pattern is not apparent for the Formative period residential sites. All reported residential sites of the Mesilla phase are located on the west side of the Rio Grande, and most El Paso phase residential sites are also located primarily on the west side of the river with only two having one or two room structures each known on the east side of the river. El Paso phase residential sites on the west side of the river are generally large and range from a few rooms to structures that may have as many as 30 rooms. The greater numbers of Formative period residential sites along the west side of the river contrasts with the greater number of Archaic residential sites on the east side of the river and is viewed as indicative of an increasing dependence on domesticated plants in the Formative period. The prevalence of residential sites on the west side of the river during the Formative period suggests that floolplain farming was not conditioning the placement of settlements and that runoff from the mountains may have been too large and the velocity of the water too great to handle in the narrow drainages of the Lower Bajada zone. It is inferred that the Leeward Slope zone was more amenable to farming with its smaller catchments and shallower drainages than the Lower Bajada zone, though some farming of the floodplain may also have been practiced. This pattern of Formative period residential sites located on one side of the river or the other appears to be conditioned by local physiographic factors such as drainage size, slope, and the presence of mountains. It has been noted by the writer as far up the river as Radium Springs, New Mexico. The single El Paso phase residential site located in the West Mesa zone may also be indicative of farming strategies involving the Leeward Slope zone, but it is more likely to be associated with dry land or playa farming strategies which become more important farther to the west or in other basin lowlands (Sudar-Murphy and Laumbach 1976; Whalen 1977; 1978).

Complementing the distribution of Mesilla phase residential sites on the west side of the river are an even greater number of camps with many fire-cracked rock hearths on the east side of the river (Figure 6). Some of these camps are as large as residential sites but generally have only moderate to light scatters of ceramics and extensive deposits of fire-cracked rock or numerous identifiable hearths. These hearths could have served many purposes, but their distribution closely follows that of the leaf succulents such as mescal or agave, sotol, and particularly lechuguilla (O'Laughlin 1979). The widespread occurrence of these hearths in sites east of the river may be related to the presence of lechuguilla and sotol in the Upper Bajada and Mountain environmental zones which are east of the river (see Figure 5). The only camp with many hearths west of the river is one of undetermined phase or period (lacking ceramics or other temporally diagnostic artifacts) located on the south slope of Sierra del Cristo Rey. The south and east slopes of Sierra del Cristo Rey are the only locales near the project area in which lechuguilla can be found west of the Rio Grande and then they are found only in a small area and in small numbers (see the area of the Upper Bajada zone west of the river in Figure 5). In addition, it has been observed by the writer that fire-cracked rock hearths decrease in frequency along the river just south of the Franklin Mountains and also north of the project area where the limestone rocks of the Franklin Mountains give way to alluvial deposits to the south and to the predominantly igneous and metamorphic rocks of the Organ Mountains to the north where lechuguilla disappears altogether. Although rocky soils are predominant east of the river in the project area, the few fire-cracked rock hearths in sites west of the Rio Grande are certainly not a reflection of the distribution of rock for there are several areas in which rocky soils are exposed.

The numerous camps with many hearths of the Mesilla phase suggest that domesticated plants were not as important as they appear to be in the later El Paso phase when the use of leaf succulents (as inferred from the presence of camps with fire-cracked rock hearths) seems to decrease. Whalen (1977; 1978) is not in total agreement with this statement, but Hard (n.d.) has suggested that some of the large camps with many hearths were incorrectly dated to the El Paso phase by Whalen and that some of the Mesilla phase residential sites near mountains have many more of these hearths than Whalen implies. The inferences are that subsistence was based to a larger degree on the contribution of native plant foods during the Mesilla phase than it was during the later El Paso phase, that activities relating to the procurement and processing of upland leaf succulents were probably just as specialized, if not more so, during the Mesilla phase as they were during the El Paso phase (Whalen 1977; 1978), and that the apparent increase in the use of upland leaf succulents in the Mesilla phase as compared to earlier and later times may be related to insecurity in the subsistence base caused by such things as environmental perturbations, population pressure, and relations with surrounding populations. This latter point may be subject to debate, but it is noted that lechuguilla was not a preferred food of the Mescalero Apache who also ranged through similar environments (Basehart 1974) and that population movements at the end of this phase and dramatic changes in subsistence and settlement patterns for the El Paso phase are indicative of less than stable relations between populations and resources.

The last category of sites includes the small camps. No Archaic camps are known in the project area, but it is probable that some of the camps of undetermined phase or period are from the Archaic period. Small camps of the Mesilla and El Paso phases are found mostly along the river and exhibit distributions with respect to east and west sides of the river comparable to those of residential sites (Figure 6). Many of these small camps undoubtedly represent procurement and processing activities directed toward natural resources that were carried out in conjunction with the synchronic occupation of the residential sites. That is, many of these small camps may be locations for the extraction of natural resources to be transported to nearby sites of residence. Small camps of all phases and periods along the river and elsewhere have very little archeological debris on them, which implies a temporary occupation of these sites, and variable assemblages, which hint at the specificity of the resource procurement and processing activities at these sites. The specialized activities at small camps are suggested by the presence or absence and various combinations of ceramics, ground stone, and different kinds of chipped stone tools. Data is not at hand for a detailed discussion of variability in the assemblages of small camps, but ceramics and ground stone are more frequently encountered in small camps in the West Mesa zone and lower portions of the Leeward Slope and Lower Bajada zones while small camps of the Upper Bajada and Mountain zones rarely have ground stone or ceramics but they frequently have large core or flake tools. These particular distributions of ceramics, ground stone, and chipped stone tools are taken to indicate specialized activities directed toward the procurement of tornillo, mesquite, grass, and other seed plants along the river and to the west, and of leaf succulents in the upland areas. This, however, is only a suggestion that is not supported by adequate data. The temporal distribution of small camps is uncertain because of the small coverage by archeological surveys of areas away from the river and the lower archeological visibility of small camps as compared to residential sites or camps with many hearths. It is noted however, that the number of small camps of the Mesilla phase is nearly twice that of small camps of the El Paso phase while residential sites of the two phases are more nearly equal in number.

If the number of residential sites for each phase and period can be correlated directly with population and if the number of residential sites observed is representative of the total for each phase and period, then an increase in population through time may be noted for the project area until about A.D. 1400 when the area seems to have been abandoned. The number of residential sites for each phase or period is as follows: Archaic period 7, Mesilla phase 5, Dona Ana phase 0, and El Paso phase 8. With the exception of the Dona Ana phase, the amount of time that each phase or period lasted decreases rapidly from as much as 5,000 or 6,000 years for the Archaic period to as little as 200 years for the El Paso phase. Thus, the similar number of residential sites for the Archaic period, Mesilla phase, and El Paso phase can be translated into a trend of population increase when the length of each period or phase is considered.

There are no known sites of the Dona Ana phase in or just to the north of the project area, and few are noted in adjacent areas to the west or east (Sudar-Murphy and Laumbach 1976; Whalen n.d.). However, sites for the Dona Ana phase are common along the Rio Grande near Hatch, New Mexico (Yeo n.d.; and observations of the writer), and in the southern portion of the Tularosa Bolson which is just northwest of the project area (David Carmichael, personal communication; Way 1979). Considerable population movement has been suggested for this time by the writer, but it is also possible that the transition from the Mesilla phase to the El Paso phase was very rapid in many areas and that archeological evidence for the Dona Ana phase may be of limited extent. The development of the large trading center of Casas Grandes to the southwest in Chihuahua, Mexico, may also have had a greater influence on the quickness of cultural developments in the El Paso area than the writer currently believes.

CHAPTER IV

FIELD METHODS AND SITE DESCRIPTIONS

The field methods used in surface mapping and collection and in the limited subsurface testing are described below for Sites 29, 33, and 34 along with brief statements on site settings. The rationale for the various field techniques is provided but the discussions relative to special samples and laboratory analyses are left to the appropriate, later chapters.

Site 29

Site 29 is located in a gently sloping area on the alluvial slope below the west flank of the Franklin Mountains and some 1.5 km from the floodplain of the Rio Grande (Figure 1). Surface soils are generally gravelly, and a small hill of limestone rock rises 40 m to the north. Along the south and west sides of the hill shallow sands have been deposited by winds, and the vegetation or the area is dominated by creosotebush with some range ratany, ocotillo, and soap-tree yucca (Figure 4a). Grasses are rare, and summer annuals are common. Prickly pear and datil occur infrequently in the area. This site is within the Lower Bajada environmental zone.

Evidence of prehistoric occupation at Site 29 consisted of a very light scatter of fire-cracked rock over an area of approximately 125 square meters. This area was subdivided into 4 m grids, and the locations of fire-cracked rock were mapped for each grid to give an estimate of the extent of the site and the number of fire-cracked rock features. This was followed by a diligent search of the site area and outwards for an additional 30 m for artifacts, but none were found. One chert flake was reported to have been present on this site by Gerald (n.d. d).

One partially eroded fire-cracked rock hearth was observed on the surface of Site 29 (Figure 26 upper left) and one or two others were suggested by small concentrations of the otherwise widely scattered fire-cracked rock. The concentrated scatters of fire-cracked rock were tested by the excavation of a 1 m square in one area and a 4 m square in another, and the remaining portion of this site was tested at 2 m to 4 m intervals with a 10 cm soil auger. These tests and observations of small arroyo cuts did not reveal the presence of buried deposits or features other than the single partially eroded fire-cracked rock hearth.

The one, mostly-intact, fire-cracked rock hearth was exposed by brushing the loose sand away, and the fire-cracked rock was mapped to location and then removed for counts and weights of the various rock materials represented. Soil flotation samples were taken from the few slightly ashy areas at the bottom of the hearth but there was insufficient charcoal for a radiocarbon sample. Pollen samples were not taken because of the absence of occupational deposits, the probability that recent pollen had been mixed with that of the older hearth contents, and the difficulty of placing the site in any specific time interval because of the absence of temporally diagnostic artifacts.

Sites 33 and 34

Sites 33 and 34 are considered together because they are located near one another on the same alluvial fan and the field techniques used to investigate them were identical.

These sites are situated just above the floodplain of the Rio Grande and on a large alluvial fan which has developed at the mouth of one of the bigger arroyos that drain the west slopes of the Franklin Mountains (Figure 1). The topography of Sites 33 and 34 and adjacent areas is shown in Figure 7. Nearly level, loamy or clay soils of the floodplain are found just to the west of Site 33, and strongly sloping terraces and ridges are located immediately east of Site 34 and northeast of Site 33 (Figure 3b). These terraces and ridges have gravelly soils which are littered with larger limestone rocks and some rhyolite. Site 33 is divided by an arroyo system into two portions which will be referred to as Site 33 North and Site 33 South henceforth. A small gravelly rise separates Site 33 South from Site 34, and a small drainage divides Site 34 into two segments which will also be referred to as Site 34 North and Site 34 South. The soils of Site 33 are of mixed alluvial and eolian origin, slope somewhat to the southwest, and have undergone considerable wind erosion in recent times with the resulting formation of numerous small to large sand dunes (Figure 2). Site 34 appears to be situated either on a low gravelly terrace or on redeposited alluvial gravel. Gravelly soils are found on a rise in the western portion of Site 34 North and on the higher terrace slopes of the

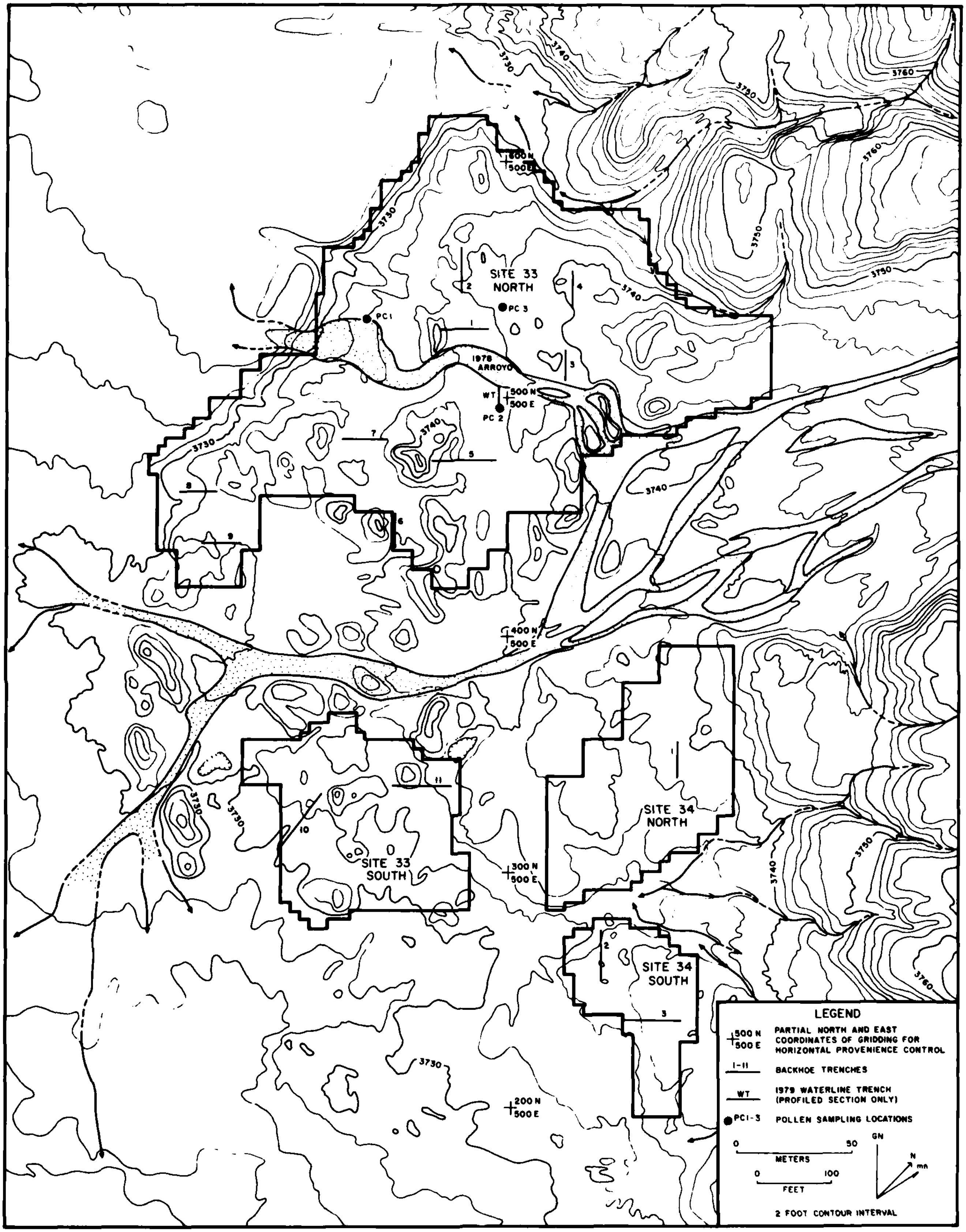

Figure 7. Topography and boundaries of Sites 33 and 34.

eastern portions of both Site 34 North and Site 34 South. Shallow eolian sands and small dunes are located in the central portion of Site 34 North and the western half of Site 34 South.

The distribution of the vegetation of Sites 33 and 34 and adjacent areas is quite varied but can be subsumed under four general headings: ridges and terraces, arroyos, alluvial fan, and floodplain. The ridges and terraces, arroyos, and alluvial fan would be included in the Lower Bajada environmental zone, and the floodplain is equated with the Riverine zone. Each of these areas has a different vegetation, and 93 different species were observed in these areas during the months of June and July, 1979. The distribution of all 93 species will not be specified here. Only the major constituents of each area will be given.

The gravelly soils of the ridges and terraces east of Sites 33 and 34 are sparsely covered with creosotebush and ocotillo and some soap-tree yucca, mesquite, and broom snakeweed (Figure 3). Grasses are rare and represented mostly by fluffgrass. Common spring and summer annuals include hairyseed bahia *(Gahia absinthifolia)*, tansy mustard *(Descurainia pinnata)*, hairypod pepperweed *(Lepidium lasiocarpum)*, globe mallow *(Sphaeralcea angustifolia)*, and scorpion weed *(Phacelia coerulea)*. Prickly pear occurs on ridges and terraces near Sites 33 and 34 but is rare.

Arroyo vegetation is diverse and includes elements from higher elevations as well as some floodplain species. The more important woody species include desert willow, mesquite, four-wing saltbush, mariola, and broom snakeweed. Whitethorn and datil occur infrequently in some of the washes, and grasses can be found occasionally and include dropseed, sideoats grama, and bush muhly. Herbaceous plants are comprised of such species as mountain pepperweed *(Lepidium montanum)*, skeleton-leaf goldeneye *(Viguiera stenoloba)*, and Jimson weed *(Datura meteloides)*.

The vegetation of the alluvial fan varies from the gravelly soils of Site 34 to the sandy dune areas of Site 33. The vegetation of the gravelly soils in Site 34 and in restricted areas of Site 33 is much like that of the nearby terraces and ridges, while most of Site 33 and the sandy areas of Site 34 are vegetated with mesquite and four-wing saltbush with some creosotebush, soap-tree yucca, joint fir, and Jimmyweed *(Isocoma wrightii)* (Figure 2). Grass is rare on the alluvial fan. Some of the spring and summer annuals found on sandy soils include desert marigold *(Baileya multiradiata)*, hairypod pepperweed, sand verbena *(Abronia angustifolia)*, and stick leaf *(Mentzelia multiflora)*.

The lowland area west of Site 33 is considered to be part of the floodplain of the Rio Grande, but the area is effectively sealed off today from the floodplain proper by highway and railroad construction just to the west. Runoff from the Franklin Mountains accumulates for a time in the summer in this lowland where the vegetation adjacent to the site includes a number of phreatophytic or riparian species characteristic of other areas bordering the floodplain. The most important tree is salt cedar which has been introduced into the area in historic times and now forms a dense thicket just below and to the west and north of Site 33 (Figures 2b, 3, and 4b). Other common tree and shrub forms are tornillo, mesquite, wolfberry, and four-wing saltbush. Grasses develop a fair cover in some areas and include dropseed, bluegrass *(Poa* sp.), and vine-mesquite grass *(Panicum obtusum)*. Spring and summer annuals produce a dense cover, are quite diverse, and are composed of such species as cowpen daisy *(Verbesina encelioides)*, silverleaf nightshade *(Solanum eleagnifolium)*, London rocket *(Sisymbrium irio)*, devilweed aster *(Aster spinosus)*, amaranth, goosefoot, and spurge.

Animals observed on or near Sites 33 and 34 include numerous cottontails and toads, occasional whiptail and horned lizards, two rat snakes, a few jack rabbits, and one mule deer. Quail and dove were commonly seen and nest in the area, and wrens and yellow-breasted chats were also recorded as well as a pair of bald eagles. This list does not exhaust the potential number of animal forms in the vicinity of Sites 33 and 34 but does suggest the variety of fauna in the area.

As previously mentioned, an arroyo system divides Site 33 North from Site 33 South. Runoff from the Franklin Mountains leaves the large drainage east of Site 33 and braids out into a number of smaller streams which cross the area between Sites 33 North and Site 33 South and either cut the alluvial deposits of the fan or spread out and aggrade surfaces with additional sediments. Runoff can be substantial in the summer months, and large stream flows in the summer of 1978 changed courses several times and began the cutting of deposits in Site 33 South and Site 33 North. In the latter, a deep arroyo was excavated across the central portion of this area the channel of which has since been minimally refilled (Figures 2b and 4b). As a point of reference, this arroyo has been named "the 1978 arroyo" (Figure 7).

Gerald (n.d. d) described Site 33 as having numerous fire-cracked rock hearths and artifacts visible in level places and between sand dunes over an area of approximately 40,000 square meters. One possible buried pithouse was observed in an arroyo cut, and deposits of cultural materials were suggested to be fairly shallow. Brownware sherds on the surface of this site implied that the occupations dated to the Mesilla phase. Site 34 was similarly described by Gerald (n.d. d) although fewer hearths and artifacts were seen. Substantial deposits of archeological materials were not suggested by Gerald, and no buried pithouses were observed in an area of about 4,200 square meters. A Mesilla phase occupation was also suggested for Site 34 on the basis of brownware sherds on the surface.

With the onset of field work at Sites 33 and 34, it soon became apparent that features and artifacts were much more common than had been expected by Gerald (n.d. d) or the writer and that Site 33 was very complex with a long history of use and considerable thickness and depth of desposts. Similar difficulties in anticipating the extent, depth, and nature of archeological remains on alluvial fans had also been encountered previously by Hard (n.d.) and O'Laughlin (1979) on the east alluvial slope of the Franklin Mountains. Fortunately, the field techniques of this project were well suited to the investigation of Sites 33 and 34 and have provided a base from which possible mitigative measures can be developed and from which the cultural remains can be described and interpreted.

Field work at Sites 33 and 34 was accomplished during the period of 15 Febraury to 4 May 1979, and a total of 220 field man-days was expended during this period under the sponsorship of the U.S. Army, Corps of Engineers, Albuquerque District. In addition, another 42 man-days were spent during this period in the investigation of archeological remains in Site 33 North which were to be disturbed by the construction of a 54-inch water line across Site 33 North from north to south and between Site 33 South and Site 34. The construction of this water line involved the excavation of a trench that was to be 3 m wide and up to 4 m deep and the disturbance of the surface by grading and equipment movement over an area that proved to be some 16 m wide along the pipeline. The examination of cultural remains in the area to be impacted by the construction of the water line was sponsored by the Public Service Board of the City of El Paso. The results of these studies are included with those for the Corps of Engineers in this report. The various field techniques utilized in the investigation of Sites 33 and 34 are described in the following sequence of field activities.

Surface Collection and Mapping

Sites 33 and 34 were staked at 16 m intervals to provide a basic grid system for surface collection and mapping and subsurface excavation. This grid system permitted the designation of points or of the southwest corners of square units in terms of distances in meters north and east of the point of origin. Thus, notations in figures and tables occurring in the form of "500N/500E" indicate locations which may be determined by reference to Figure 7.

The deviation of this grid system from true north—it is actually oriented northwest-southeast—is noted in the legends of the figures in which "GN" indicates grid north.

The 16 m grid units were subdivided into 4 m grid units from which collections were made and surface features and artifacts mapped (see Figure 8). The various classes of artifacts were piece-plotted before their collection, and well-defined features were mapped in detail. Observations on scattered fire-cracked rock were recorded as the number of rocks, their size, and their material in each 1 m square. In addition, notes on vegetation, soils, and the occurrence of natural and man-made distrubances were recorded for inclusion in site descriptions and in consideration relative to possible mitigative efforts.

The collection of surface artifacts and the mapping of surface features by 4 m grids provided information on the areal extent of sites, data for temporal and spatial analyses, and descriptive and quantitative information on artifacts and features. Grid units of similar size had been found to give interesting spatial patterns of artifacts and features at comparable sites in the area (Gerald n.d. b; O'Laughlin 1979; O'Laughiin and Greiser 1973).

Artifacts were collected and features mapped by 4 m grid units over a total of 32,752 square meters at Site 33 and 8,736 square meters at Site 34. These areas which are believed to encompass the maximum areal distributions of surface and subsurface cultural materials are shown in Figure 7.

Wide Interval Soil Augering

All of Sites 33 and 34 and some adjacent areas were examined at 8 m intervals with 5 and 10 cm diameter cores that were obtained with soil augers. Information was thus collected on the depths of deposits, stratigraphy, buried features, and the areal extent of deposits. Soil coring at 8 m intervals was performed at the same time that surface maps and collections were made. At each location soil cores were removed in 25 cm units or levels to a depth of 1.5 m or less when large gravel was encountered (Figure 9a). Each level was screened through 1/4-inch mesh for the recovery of artifacts and charcoal, and one soil flotation sample was taken at least every 16 m from the level with the greatest discoloration from ash and charcoal. Artifacts were too few in number to be of much use in

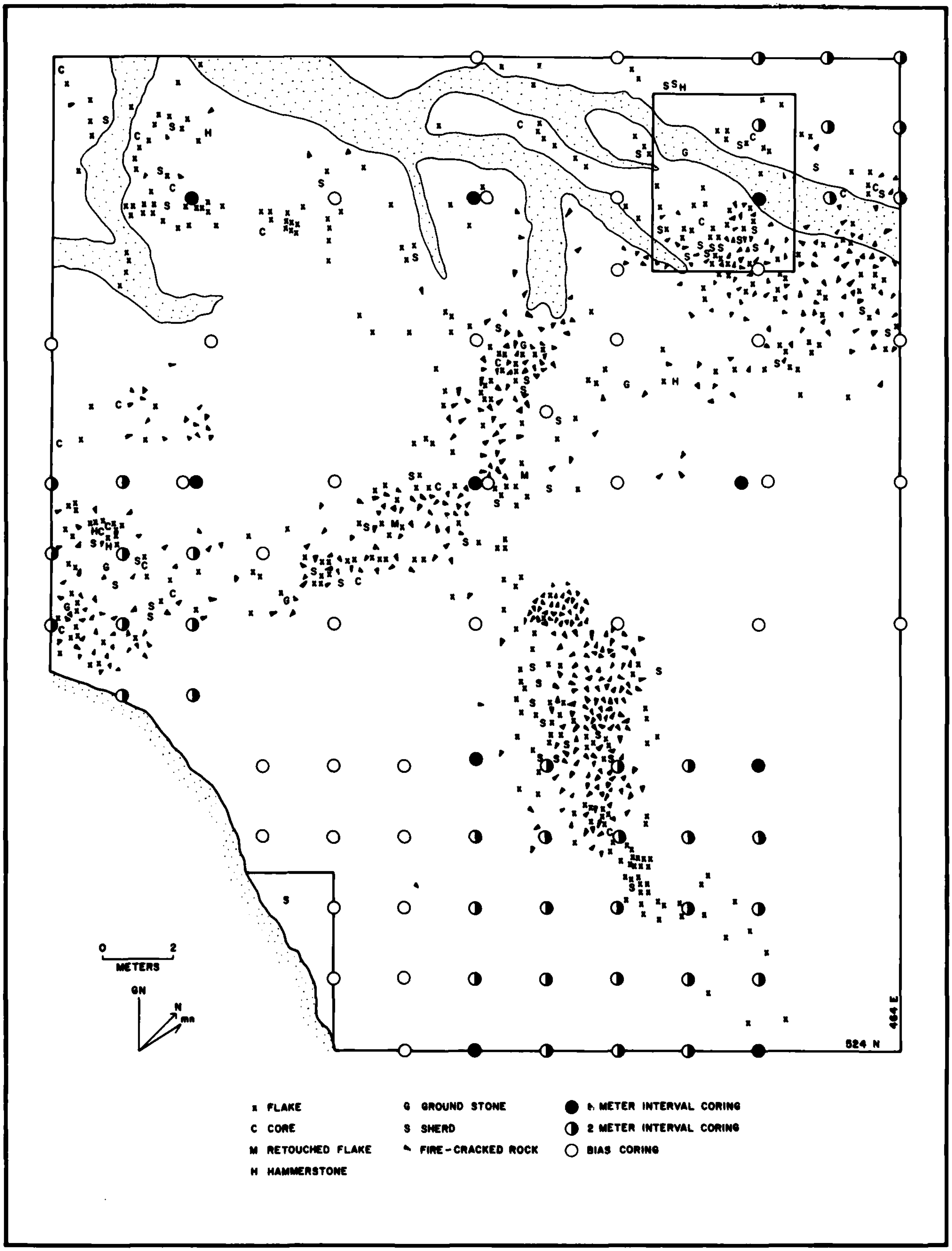

Figure 8. Results of surface mapping in a western portion of Site 33 North.

distributional studies, but many of the flotation samples were analyzed and provided useful informtaion on the distribution of macrofloral remains. At each soil core location the number, size, and materials of fire-cracked rock for each level were recorded, and this information aided in ascertaining the location and distribution of buried fire-cracked rock features. Soil texture and color were also recorded for each level and gave the first real indication of the depths and thicknesses of the deposits, the areal extent of the deposits, and the presence of buried features other than those with fire-cracked rock at Site 33. As previously mentioned, the maximum areal extent of subsurface deposits was found to closely follow the distribution of surface artifacts and features as shown in Figure 7, but some deposits were of more limited distribution.

Soil coring was carried out because of the location of Sites 33 and 34 on an alluvial fan where subsurface deposits may have been undetectable by surface reconnaissance alone. In addition, a knowledge of the distribution of surface artifacts and features and of subsurface deposits was desired for use in studies of spatial patterns in the archeological materials and of the uses of the sites. Information on the extent and depth of deposits was also viewed as necessary in order to develop a program of mitigation. Data from the 8 m interval soil cores were collected in order to provide information for the placement of many of the subsurface tests and of the additional soil cores at 2 m intervlas.

Close Interval Soil Augering

Sites 33 and 34 were cored at 2 m intervals with soil augers at locations selected on the basis of data obtained from the cores at 8 m intervals and from surface mapping and collections (Figure 9b). Soil coring at 2 m intervals was performed in grids that were 8 m on a side except for the occasions when supplemental cores (referred to as bias cores in Figure 8) were taken in order to clarify conditions revealed by the 2 m cores. One area of 300 square meters was cored at 2 m and 3 m intervals in order to obtain more information on subsurface features in the area that was to be disturbed by the construction of the 54-inch water line. As with the 8 m interval soil cores, the texture and color of the soil and amount, size, and materials of fire-cracked rocks were recorded for each 25 cm level of each soil core. Because of the large number of soil cores that were taken and the low frequency with which artifacts were encountered in the 8 m interval core samples, soil cores from the closer interval soil augering generally were not screened with 1/4-inch mesh. Artifacts and charcoal were collected when encountered, and soil flotation samples were taken only from obvious features and from the darker ash and charcoal discolored soils. Approximately 7% of Site 33 and 3% of Site 34 were tested by coring at 2 m intervals within 8 m grid units. Another 1% of Site 33 was tested at 2 m and 3 m intervals in Site 33 North where surface and subsurface disturbance was anticipated as a result of the construction of the water line.

The soil coring at 2 m intervals was especially effective in locating and defining the size of subsurface features of 2.8 m diameter or larger, although features of smaller size were also detected (Figure 10). Many suspected houses were located in this manner, as well as fire-cracked rock features and pits without rock. This technique had previously been used by Whalen (n.d.) in the investigation of a Mesilla phase site east of the Franklin Mountains and proved reliable in locating buried pithouses and other features.

Backhoe Trenching

Site 33 was tested with 11 backhoe trenches, and three backhoe trenches were dug on Site 34 (Figure 7). The excavation of these trenches was carried out in order to get a better picture of the stratigraphy of these sites. Information gained from profiles of trenches provided insights into the vertical relationships between various strata and yielded information on natural and cultural processes which produced the deposits.

The backhoe trenches also revealed the presence of additional houses and small features in areas which had not been tested by soil coring at 2 m intervals. In several of the trenches where strata were easily recognized and profiled, pollen samples were taken every 10 cm in vertical suites through all strata for possible use in palynological studies. Finally, the excavation of the large trench for the water line provided additional observations and profiles of the stratigraphy of Site 33 North.

Hand Excavation

With the information from surface mapping and collecting, soil coring, and backhoe trenching, 1 m square tests of the subsurface of Sites 33 and 34 were excavated. Excavations proceeded by natural or arbitrary 10 cm levels with elevations noted from a central datum at 1139.9 m above mean sea level. In tables and figures elevations will occur in the form "4.5 MBD" which may be read "4.5 meters below datum." All excavated soils were screened with 1/4-inch mesh or smaller, and pollen and soil flotation samples were taken from nearly every level of every square. Charcoal was also collected, whenever encountered, for possible use in radiocarbon dating or

a.

b.

Figure 9. Soil augering at Site 33. a, screening soil by levels during wide interval coring; b, augering an 8 m grid at close intervals.

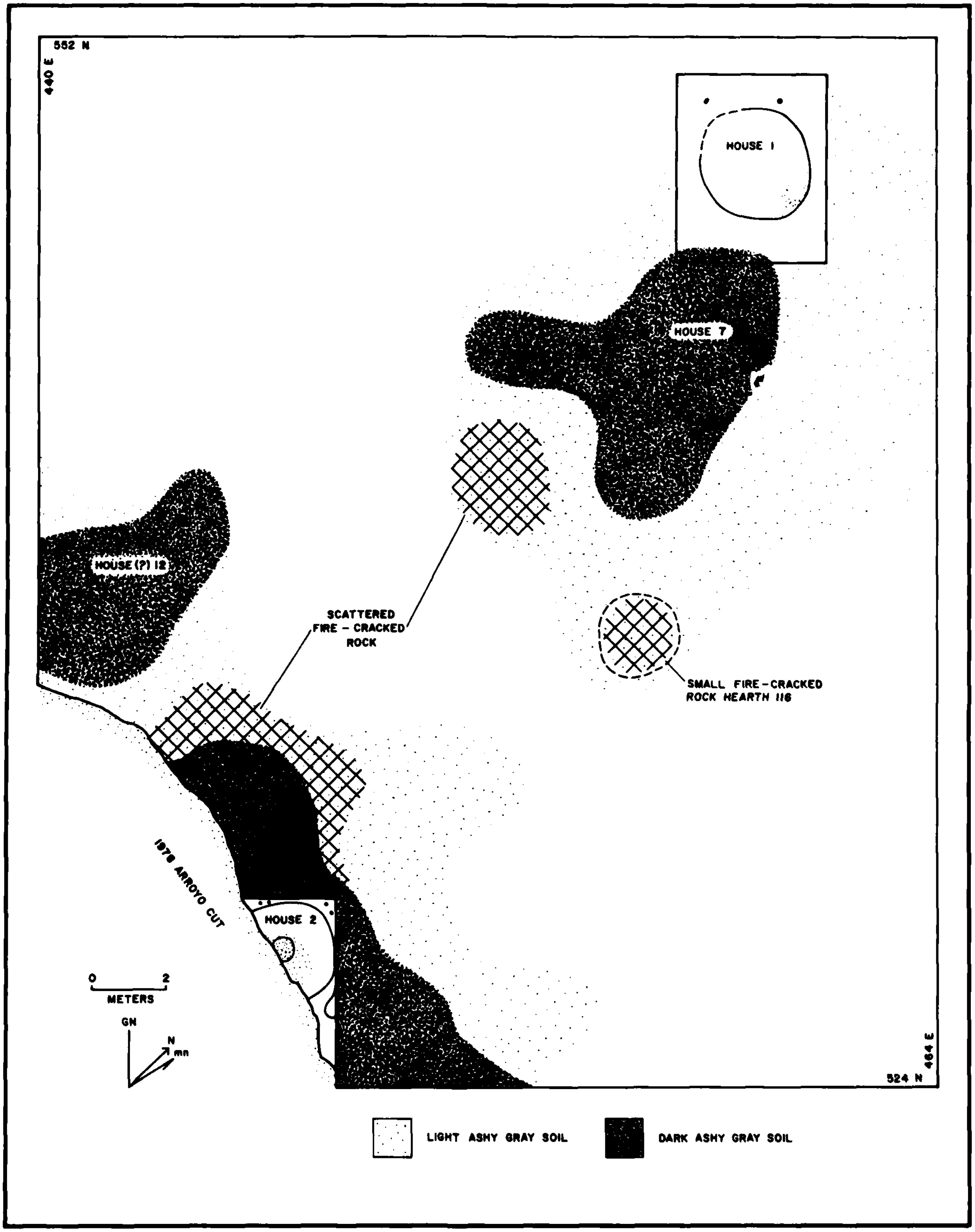

Figure 10. Subsurface houses (dark areas) and hearths (hatchering) suggested by soil coring and detailed by excavation in a western portion of Site 33 North.

in the identification of species. Number, size, weight, and material of fire-cracked rock was also recorded for each level of each square, and soil texture and color was described. A total of 14 square meters or 0.16% of Site 34 was tested in this fashion, and 82 square meters or 0.25% of Site 33 was excavated by 1 m squares. Of these latter squares, 17 were excavated in areas to be disturbed by construction of the water line.

All subsurface features which were tested or dug in their entirety were excavated by the above mentioned techniques. In addition, seven small fire-cracked rock hearths that were visible on the surface of Site 33 were excavated as archeological feature units with pollen, radiocarbon, and macrofloral samples taken. Attributes of fire-cracked rocks, as described above, were also noted.

These tests provided detailed information on the depth and nature of subsurface and surface deposits and features, quantities of archeological materials, provenience of special samples, and clues to the processes that produced the deposits. These data also allowed the pursuit of questions with respect to the temporal and spatial distribution of artifacts and features. Once more, information from these subsurface tests was essential to the development of a program of mitigation.

CHAPTER V

STRATIGRAPHY AND DATING

A knowledge of the stratigraphy and the ages of the various strata at Sites 33 and 34 is crucial to many of the discussions in later chapters. The dated strata provide a foundation for temporal and spatial analyses of cultural materials. An understanding of the stratigraphy also allows the recognition of natural and cultural processes which have resulted in the deposits and are referable to past environmental conditions and prehistoric patterns in the use of space. Site 29 is not considered here because it has been subjected to slope and wind erosion and apparently does not have deep deposits of cultural materials (see Chapter IV).

Site 33 Stratigraphy

Gerald (n.d. d) assumed that only one relatively shallow deposit of cultural materials dating to the Mesilla phase was present at Site 33, and the inspection of exposed surfaces and arroyo cuts during the surface mapping and collection of Site 33 early in this study also suggested that only a single stratum of cultural materials was present. However, soil augering at Site 33 soon hinted at the presence of more than one strata of cultural deposits, and backhoe trenching and hand excavation revealed the occurrence of several identifiable geological (soil) strata.

The soil strata of Site 33 vary in thickness and extent and grade laterally or vertically into one another in many places. Some of these strata are quite distinct and easily recognized throughout their horizontal distribution, while others are difficult to distinguish because they merge conformably with those above or below them. The soils of Site 33 are mostly permeable sands or loamy sands, and the drainage of water downward through these soils or upward as a result of capillary action has tended to obscure the junctures of strata with the vertical movement of soil particles, ash, and charcoal.

Site 33 is located on the toe of an alluvial fan at the mouth of a large arroyo which drains the Franklin Mountains (Figure 7). The northern portion of Site 33 and much of Site 34 are slightly elevated and above adjacent areas which have seen a considerable build up of sediments to form the present alluvial fan. These slightly elevated areas on either side of the large arroyo and immediately adjacent to higher terraces and ridges have gravelly soils and appear to be remnants of a low valley terrace or alluvial fan which was divided by the large arroyo and truncated by river entrenchment and lateral cutting. Along the northern boundary of Site 33 North is a westerly trending ridge which drops abruptly to a small arroyo on the north and slopes gently to the south to areas that are currently being aggraded by alluvium. It is suggested that this ridge line is the product of deposition before arroyo cutting and channel filling on the older terrace or alluvial fan shifted to the south and began aggrading surfaces. Today arroyo cutting and the aggrading of surfaces with alluvial sediments continues in low areas, and wind action on the sandy soil surfaces has produced numerous dunes. Slope erosion is also important on the ridge line in the northern portion and along the western edge of Site 33 North and over much of Site 34. These factors of deposition and erosion are also represented by buried strata in the same areas.

A total of five zones or strata have been identified at Site 33. The designation of strata as zones is not intended to suggest any correspondence with the distinctive soil layering of geologic zonal soils which reflect the influence of such factors as climate and vegetation. Rather, the referencing of strata by zones is simply a matter of labeling for ease of discussion. The stratigraphy of Site 33 is illustrated by the selected profiles of trenches that are shown in Figures 11 and 12, and the locations of these trenches are indicated in Figure 7. With the exception of minor subdivisions of two zones, all recognized strata are shown in Figures 11 and 12, and profiles of other areas of Site 33 will be found in later chapters. The five zones will be described in order from the most recent and uppermost zone to the lowest zone.

Zone 1

Zone 1 includes all soils of recent origin; it does not bear evidence of prehistoric occupation, but modern trash does occur sporadically. Soils are sandy and range in color from buff or tan to brown. Stratified alluvial deposits of Zone 1 are generally shallow and are of limited occurrence within the boundaries of Site 33. They are more extensive and

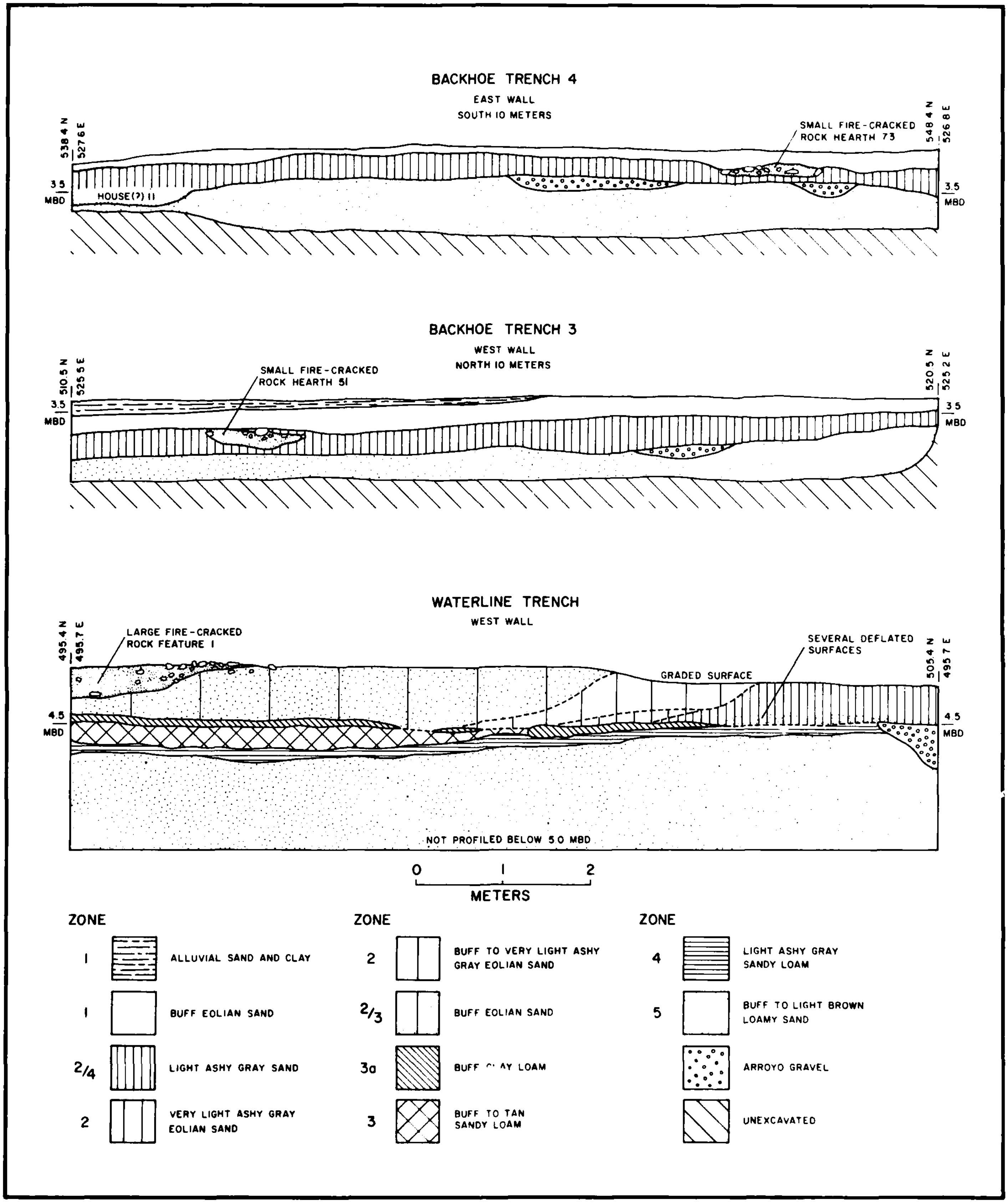

Figure 11. Stratigraphic profiles of trenches in Site 33 North.

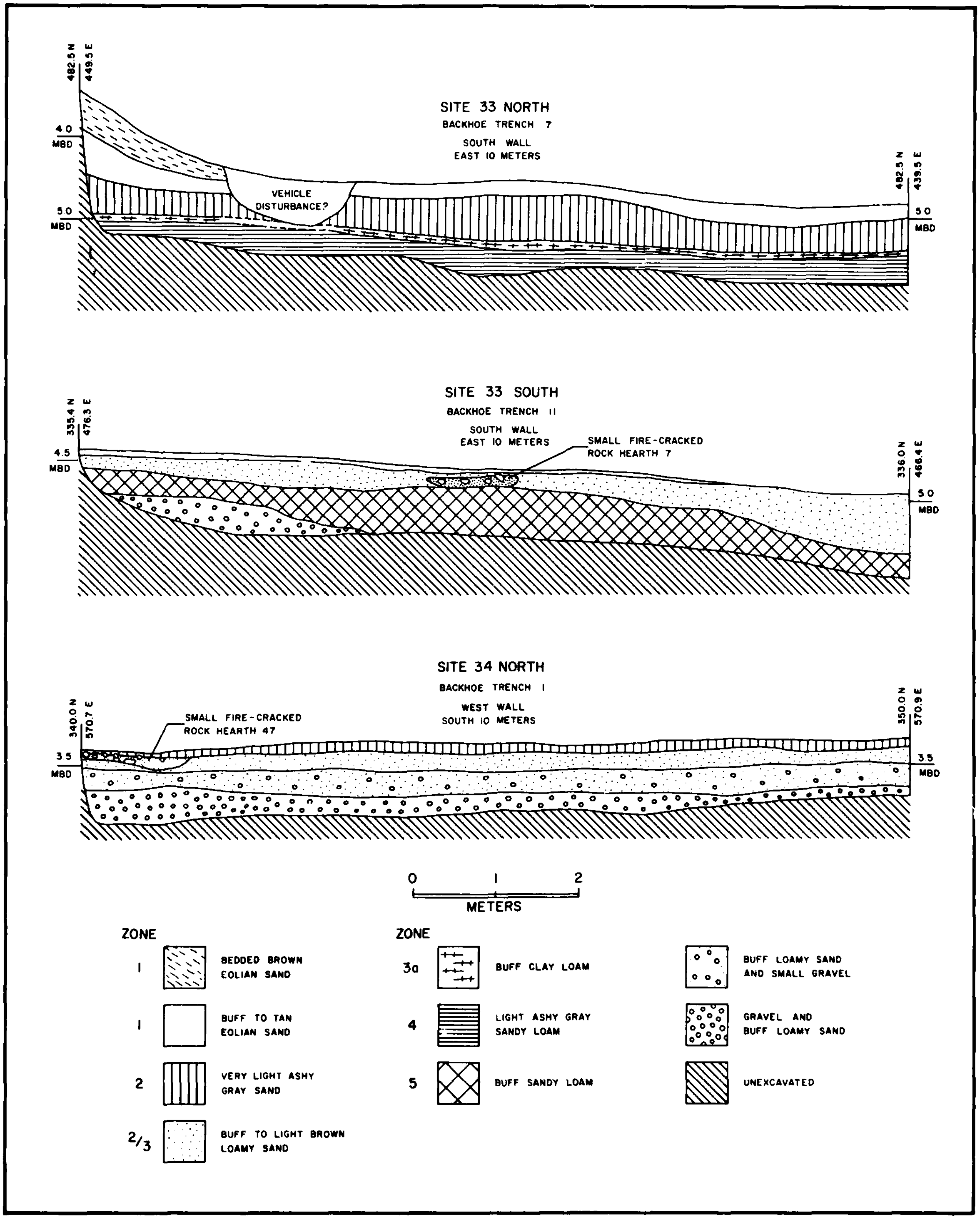

Figure 12. Stratigraphic profiles of backhoe trenches in Sites 33 and 34.

deeper in the lower areas to the west of Site 33 and between Site 33 North and Site 33 South. The sandy soils of the alluvial fan are susceptible to wind erosion and dunes of cross-bedded sands are common with some reaching over 1.5 m in height (Figure 12 top). Interdunal areas are often deflated with materials of lower zones exposed (Figure 25), and slope erosion along the ridge line and western portions of Site 33 North has also uncovered older soils and materials where shallow eolian sands of Zone 1 are not present. Recent arroyo cutting has begun in Site 33 South and a large arroyo cut through all five zones in Site 33 North in 1978 (Figures 4b, 7). Channel sediments in these recent arroyos are light-colored and contain large and small gravels.

Zone 2

Soils of Zone 2 lie beneath those of Zone 1 or are exposed on the surface of Site 33 by wind or slope erosion. These soils are noticeably darker than those of Zone 1 above or Zone 3 which lies below Zone 2 (Figure 13). Soil color ranges from brown to ashy gray, and charcoal and prehistoric artifacts are distributed throughout. In many areas the upper portion of this zone is much darker than the lower half or vice versa. This suggests that a number of different prehistoric occupations may be represented by Zone 2 or that the locations of activities varied through time. In addition, the south slope of the ridge line in the northern portion of Site 33 North exhibits one or two deflated surfaces (manifested as thin layers of gravel) in restricted areas in the lower portions of Zone 2, which may indicate periods of non-occupation and/or slope erosion (Figure 11 bottom). This zone is as much as 80 cm thick in some places but usually is no more than 30 or 40 cm thick.

Zone 2 soils of Site 33 are sands or loamy sands which seem to be mostly eolian in origin but bedding is rarely observable in these deposits because of percolating water. Well-sorted alluvial sands are difficult to distinguish from eolian sands but seem to be present in the Southern portions of Site 33 North. The alluvial sands and gravels of Zone 1, between Site 33 North and Site 33 South, grade imperceptibly into those of Zones 3 and 5. Zone 2 is either missing in this area or the eolian and alluvial deposits of Zone 2 are lighter color and indistinguishable from those of Zone 1 presumably because there was little prehistoric activity. Although Zone 2 does not continue uninterrupted from Site 33 North into Site 33 South or into Site 34, the separate strata of these areas can be assigned to Zone 2 on the basis of archeological materials and radiocarbon dates. Radiocarbon dates will be considered shortly.

There is no evidence of arroyo cutting during the deposition of Zone 2 but wind erosion of the sandy surface is indicated by the presence of a number of dunes that are over a meter in height and that became even larger with additional Zone 1 deposits (Figure 12 top). The general impression gained from the study of Zone 1 and Zone 2 deposits is that the aggradation of the alluvial fan with alluvium was minimal during the periods represented by these deposits and that the sandy soil surfaces were prone to wind erosion and duning and were probably poorly vegetated, dry, and loose.

Zone 3

The soils of Zone 3 are up to 60 or 70 cm in thickness and of mixed eolian and alluvial origin. Zone 3 soils are also loamy sands or sandy loams which are most often buff or tan in color. Generally, the soils in the lower areas between Site 33 North and Site 33 South are alluvial in character, while those of the higher northern portion of Site 33 North and parts of Site 33 South tend to be eolian deposits with bedding obscured by percolating waters. Along the ridge line in the northern portion of Site 33 North Zone 3 is missing and Zone 2 lies conformably above Zone 4 (Figure 11). Much of the western portion of Site 33 North and some of Site 33 South also lack evidence of Zone 3 deposits. Zone 3 soils occur most commonly in the southern and southeastern portions of Site 33 North and over most of Site 33 South. As previously mentioned, Zone 3 soils are not distinguishable from those of Zone 1 and Zone 5 in the area between Site 33 North and Site 33 South. In addition, there is no evidence of prehistoric occupation at Site 33 during the deposition of Zone 3.

Sand dunes are noted for the first time during the period represented by Zone 3, and dunes of 0.5 to 1.0 m in height are in evidence in both Site 33 North and Site 33 South. Some arroyo cutting is observed for the period of Zone 3 deposition in Site 33 North and Site 33 South, and a number of small arroyos and one large arroyo cut through Zones 3 and 4 in an area to the south of and paralleling the eastern half of the 1978 arroyo and also in the same area as the western half of the 1978 arroyo (Figure 7, 13b). Thus, the period of the Zone 3 deposition seems to be one of some alluvial deposition primarily in the lower areas between Site 33 North and Site 33 South accompanied by wind erosion and duning in the central portions of Site 33 North and over much of Site 33 South.

Shortly after the beginning of Zone 3 deposition, apparent backwaters from the Rio Grande covered the west central portion of Site 33 North and left a 5 to 10 cm stratum of buff colored clay loam. This

a.

b.

Figure 13. Stratigraphy in 1978 arroyo wall at Site 33 North. a, profile showing light colored eolian sands of Zone 1 (above 80 cm on the rod), dark soils of Zone 2 grading into the darker soils of House 4 in Zone 4 (between ca. 52 and 66 cm), and the light colored sand and clay loams of Zones 5 and 5A (below 52 cm). Zone 3 soils are missing from this profile; b, profile showing arroyo gravels and lighter colored soils of Zone 3 between the Zone 2 soils (above ca. 102 cm on the rod) and Zone 4 soils (below ca. 50 cm). Soils of Zones 1 and 5 are not visible in this profile.

layer is referred to as Zone 3A and is found just above the juncture of Zone 3 with Zone 4 or sandwiched between Zone 2 and Zone 4 (Figure 11 bottom, 12 top). Zone 3A is level in its distribution and quite distinct insofar as it has a higher clay content and does not grade into other sediments. A similar layer also occurs in Zone 5.

Zone 4

Zone 4 is usually manifest as a 5 to 15 cm thick stratum of compacted calcareous sandy loam with occasional carbonate-coated pebbles. These soils are dark ashy-gray in color, and archeological materials and charcoal are found throughout Zone 4 deposits. Zone 4 lies beneath Zone 3 or Zone 3A in many areas (Figure 11 bottom, 12 top, 13b), however, in some parts of Site 33 South and the northern portion of Site 33 North, Zone 4 grades into Zone 2 with no intervening Zone 3 and with no perceptible change in soil color or texture (Figure 11, 13a). The soils of Zone 4 in these latter areas are less calcareous, softer, and not so dark. The transition from Zone 4 to Zone 2 is sometimes indicated on the southern slopes of the ridge line in the northern portion of Site 33 North by an erosional unconformity that is recognizable as a deflated surface at the top of Zone 4 (Figure 11 bottom, 16). Zone 4 soils are rarely visible on the surface and are not often found directly beneath Zone 1 soils on Site 33.

Zone 4 slopes to the south and shows very few elevated areas. These slight rises are generally in those areas in which large sand dunes are found in Zones 1, 2, and 3. The soils of Zone 4 appear to have been more stable and less subject to wind erosion than those of the overlying three zones, and there is no evidence of either arroyo cutting or of the deposition of alluvium during the period represented by Zone 4. While Zone 2 is found throughout almost all of Site 33, Zone 4 is limited to the central portion of Site 33 South and is not found on the eastern and southeastern peripheral areas of Site 33 North. The total area covered by Zone 4 is approximately 25,600 square meters. The discontinuity of Zone 4 between Site 33 North and Site 33 South is similar to that of Zone 2, and the spatially separated strata are correlated by radiocarbon dates and archeological evidence which will be presented later.

Zone 4 also has a minor unit which is called Zone 4A. Zone 4A is known from only one very small area in Site 33 North where wind erosion has evidently redeposited Zone 4 soils on top of other surface-eroded but otherwise intact portions of Zone 4 (see Figure 16 top). This deposit will be discussed further in Chapter VI.

Zone 5

Zone 5 includes all of the deeper alluvial sands, gravels, and clays of the alluvial fan which slope to the south and southwest from the older gravelly terrace or alluvial surfaces on either side of the large arroyo east of Site 33 (Figure 12 middle). These sediments are buff to tan in color and overlie loamy clays and sandy loams of the Rio Grande floodplain. Zone 5 sediments are as much as 5 m thick in the northern portion of Site 33 North and feather-out as they merge with the floodplain.

Archeological investigations at Site 33 were almost always restricted to the upper 1.5 m of deposits on the alluvial fan and little is known of the deeper portions of Zone 5. The trenching from north to south across the central area of Site 33 North during the construction of the waterline revealed several meters of coarse and fine-textured alluvial loamy sands, with a number of small, gravel-filled arroyos near the top of Zone 5, but no major subdivisions of this otherwise massive unit were noted (Figure 11 bottom). Unfortunately, most of the waterline trench was backfilled soon after excavation and detailed examinations of exposed sections of Zone 5 were not possible. Trenching for the waterline did uncover a basin-shape pit (Pit 9) and a thin layer of charcoal-stained soil which was 1.5 m long on one side of the trench. The pit and the thin layer of charcoal-stained soil were the only evidence of prehistoric occupation at Site 33 North during the deposition of Zone 5. They occurred close together and 1.0 to 1.1 m below Zone 4. This pit (Pit 9) was described quickly and excavated before the trench was back-filled; no artifacts were found.

In the extreme northwest portion of Site 33 North, a 20 to 30 cm thick stratum of tan to yellow clay loam occurs below Zone 4 or is exposed on the surface in an area of recent slope erosion which removed the soils of the upper zones and left numerous artifacts of Zone 2 and 4 scattered about (Figure 13a, 16 top). There is some indication that loamy sands of Zone 5 may be found between Zone 4 and the underlying layer of yellow clay loam, but this is uncertain. This layer will be knows as Zone 5A and is similar to Zone 3A in its higher clay content and its probable depostion by backwaters from the Rio Grande.

Site 34 Stratigraphy

The stratigraphy of Site 34 is relatively simple compared to that of Site 33, and only three zones are recognizable. These zones are superimposed on older gravelly terrace or alluvial fan sediments which generally slope to the west and south from the higher terraces to the east (Figure 7). Arroyo cutting and slope erosion are responsible for the development of a low ridge line of exposed gravels along the western and northern edges of Site 34 North which is separated from the southern part of the site (Site 34 South) by an arroyo, as was Site 33. These features break the continuity of strata from Site 34 North to Site 34 South and from Site 34 North to Site 33 South. However, the relationships between strata in Sites 33 and 34 will be demonstrated later with the aid of radiocarbon dates and archeological materials.

Zone 1

The soils of Zone 1 are bedded eolian sands of recent origin which are generally very shallow and may be absent in areas of slope erosion or arroyo cutting. Some duning of these sands is found in the western and north central portions of Site 34 North and in the northern half of Site 34 South, but these dunes are rarely over 50 cm in height. Soil color is usually tan or brown. No archeological materials have been found in Zone 1 soils.

Zone 2

Zone 2 soils are of limited extent at Site 34 and are most often found in areas where Zone 1 deposits protect them. They occur in the south central portion of Site 34 North and the north central part of Site 34 South, and there is evidence of prehistoric occupation for Zone 2 soils in both of these areas. These soils are light gray to brown eolian sands which range in thickness from 5 to 15 cm (Figure 12 bottom).

Zone 3

The soils of Zone 3 are buff-colored sands or loamy sands with some small gravel in localized areas (Figure 12 bottom). These soils appear to be alluvial deposits eroded from the terraces to the east of Site 34 and commonly do not exceed 40 cm in thickness. Shallow deposits of Zone 3 are found in the south central portion of Site 34 North and become thicker as they extend to the south across Site 34 South. Some small dunes had developed on the surface of Zone 3 soils before the deposition of Zone 2. No archeological materials were found in Zone 3.

Zone 3 soils either rest on the gravels of the older terrace/alluvial fan sediments or on mixed alluvial deposits of buff-colored loamy sands and small gravels. These latter materials are also viewed as the products of the erosion of slopes to the east of Site 34.

Radiocarbon Dating

The previous discussion of the stratigraphy at Sites 33 and 34 implied that prehistoric occupations at these sites occurred primarily during the deposition of Zones 2 and 4 which were often separated by the archeologically sterile Zone 3. Zones 2 and 4 soils were also noted as being discontinuous in their distributions between Sites 33 and 34, as well as between the northern and southern segments of each of these sites. Because of this, radiocarbon dating was used to provide a means for correlating the spatially discrete portions of these strata. In this respect the objective of radiocarbon dating was to ascertain the period of time involved in the deposition of these strata and not necessarily the age of particular features. However, sufficient charcoal for radiocarbon dating was almost always found in houses, pits, and fire-cracked rock features rather than in non-feature areas. In addition, Pit 9 in Zone 5 of 33 North and the one intact small fire-cracked rock hearth at Site 29 were not radiocarbon dated because they contained too little charcoal.

The 15 radiocarbon dates from Sites 33 and 34 are listed in Table 2 and graphed in Figure 14, where the dates and one standard deviation are shown. These dates were obtained from samples submitted to Charles S. Tucek of Radiocarbon, Ltd., who also calculated the corrected BC/AD dates. The radiocarbon age of each sample is based on a half-life of radiocarbon of 5,568 years, and the corrected BC/AD dates follow the suggested conversions of radiocarbon years to solar years by Ralph, Michael, and Han (1973). These conversions are necessary because of fluctuations in atmospheric radiocarbon through time which can give radiocarbon dates much different from those based on tree-ring counts. For example, the radiocarbon dates for Zone 4 are found to be 200 to 500 years younger than the corrected BC/AD dates, while the radiocarbon and BC/AD dates corrected for Zone 2 are much closer together (Table 2). The differences between the radiocarbon and corrected BC/AD dates do not alter the interpretation of archeological materials from these strata, however, and there is sound reason to believe that the corrected BC/AD set of dates is the more accurate of the two sets (Damon et al. 1974). Only the corrected BC/AD dates are shown in Figure 14.

Zone 2

There are nine corrected BC/AD dates for Zone 2, and they range from 160 BC to AD 1500. Site 34 North has one date of AD 820 ± 130, and the single date from Site 34 South is AD 250 ± 140. These dates suggest that Zone 2 of Site 34 dates to the first

TABLE 2

RADIOCARBON DATES FROM SITES 33 AND 34

Radiocarbon, Ltd. Number	Radiocarbon Age Years BP	MASCA Corrected BC/AD Date	Site	Zone	Provenience	Feature Association
RL-1157	3300±140	1590BC±210	33	4	450N/380E* 5.7-5.83MBD**	House 4, Floor
RL-1158	3640±130	2090BC±90	33	4	336-337N/454E 5.7-5.95MBD	House 3, Floor
RL-1159	4100±200	2790BC±310	33	4	527-528N/446E 5.25-5.38MBD	House 2, Floor
RL-1160	2010±120	130BC±230	33	2	504N/570E 2.95-3.05MBD	Large Fire-cracked Rock Feature 3, Bottom
RL-1161	1600±120	AD380±150	33	2	494N/495E 3.9-4.0MBD	Large Fire-cracked Rock Feature 2, Bottom
RL-1162	1730±120	AD250±140	34	2	202N/554E 4.67MBD	Pit 1, Fill
RL-1163	3480±140	1910BC±220	33	4	497N/517E 4.15-4.40MBD	Small Fire-cracked Rock Hearth 5
RL-1164	3800±140	2350BC±210	33	4	497N/438E 5.3-5.44MBD	House 5, Floor
RL-1165	400±110	AD1500±110	33	2	559N/506E 3.9-4.0MBD	Pit 7, Fill
RL-1166	1140±100	AD820±130	34	2	315N/551E 4.25-4.4MBD	Small Fire-cracked Rock Hearth 21
RL-1167	1120±110	AD860±120	33	2	461N/469E 4.07-4.35MBD	Small Fire-cracked Rock Hearth 4
RL-1208	1450±120	AD520±120	33	4?	535N/442E 5.37-5.5MBD	Non-feature Area
RL-1209	2050±110	160BC±220	33	2	348N/412E 5.37-5.5MBD	Large Fire-cracked Rock Feature 1, Bottom
RL-1210	750±110	AD1200±110	33	2	539N/498-499E 3.82-3.95MBD	Small Fire-cracked Rock Hearth 94
RL-1211	1430±120	AD550±120	33	2	335N/472E 4.68-4.78MBD	Small Fire-cracked Rock Hearth 7

* North and east grid coordinates for southwest corner of 1x1 m square.
** MBD = meters below datum.

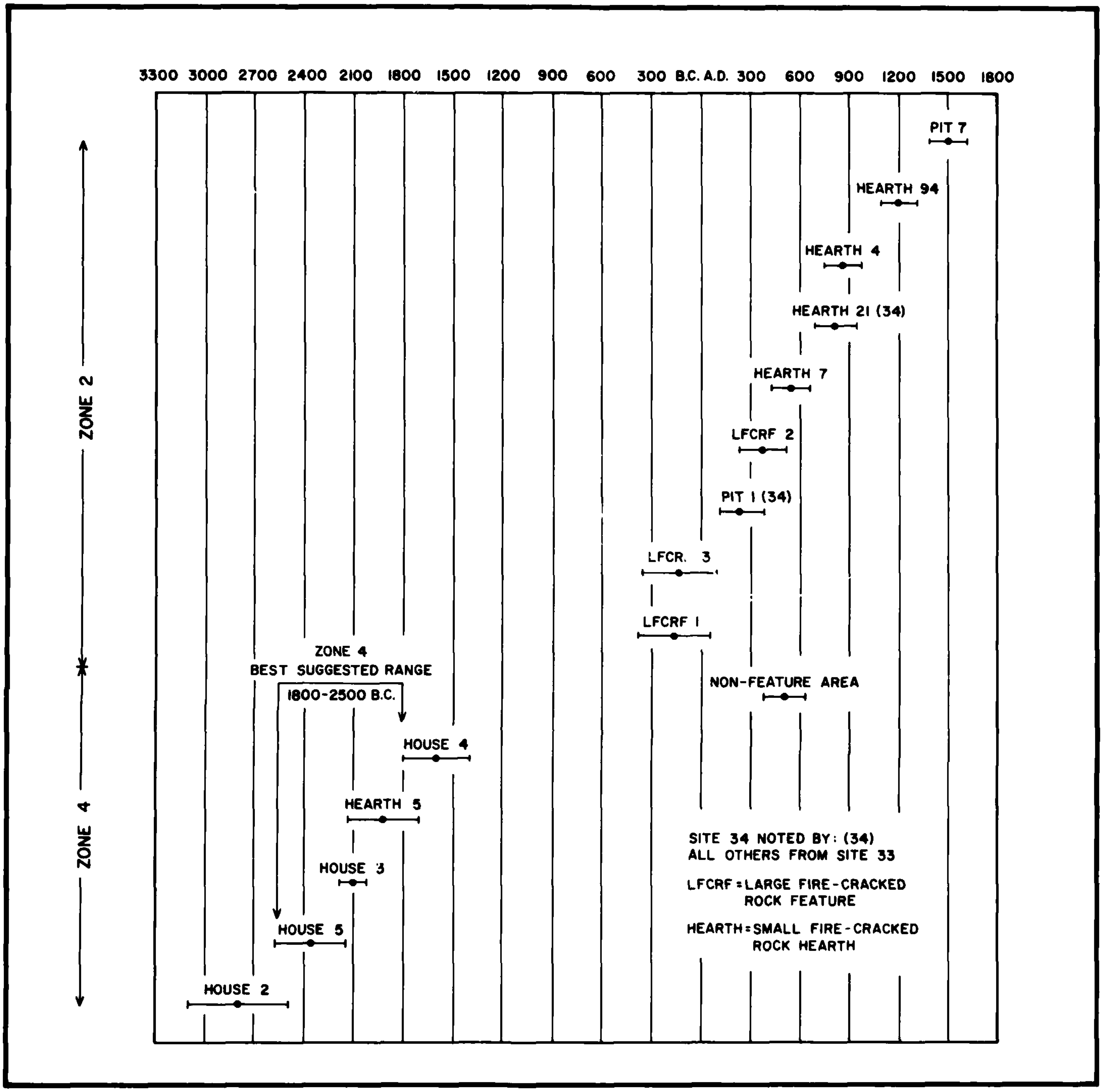

Figure 14. Corrected BC/AD dates for Sites 33 and 34.

millenium AD, and ceramic material from this site agrees with such a contention (see Chapter IX). However, it is possible that earlier or later archeological materials may be present on Site 34 but unrecognized because of the mixing of temporally different artifacts as a result of erosion and the limited investigation of the few remaining areas with Zone 2 deposits.

Site 33 South has two dates for Zone 2, and the presence of Zone 3 deposits between Zone 2 and Zone 4 in Site 33 South permits a more definitive statement as to the beginning of the deposition of Zone 2 than is possible for Site 34. The bottom of Large Fire-cracked Rock Feature 1, which dates at 160 BC ± 220, rests on Zone 3 deposits. No ceramics were found in direct association with the charcoal in the bottom of this feature, but ceramics were present on the surface and in the upper level of the 1 m square in this feature that was excavated. The earliest ceramics for the El Paso area are dated by radiocarbon at AD 250 ± 110 (Whalen n.d.), which is considerably later than the date of Large Fire-cracked Rock Feature 1. Thus, the corrected BC/AD date may be too early for this feature or indicative of a late Archaic and non-ceramic occupation at the beginning of the deposition of Zone 2. The second corrected BC/AD date from Zone 2 of Site 33 South comes from Small Fire-Cracked Rock Hearth 7 and is AD 550 ± 120. This date is within the range of corrected BC/AD dates for Site 34 and the suggested times of occupation for Site 33 South based on ceramics (Chapter IX). Ceramic materials from Site 33 South are mostly attributable to Mesilla phase occupations and probably date from early in the first millenium AD to about AD 1100. A later, brief occupation between AD 1200 and AD 1400 is suggested by the ceramics from Site 33 South. Therefore, Zone 2 deposits at Site 33 South are viewed as having accumulated over a period of time from shortly before the time of Christ to about AD 1100. The later occupation between AD 1200 and AD 1400 appears to have added little material to the Zone 2 deposits.

There are five corrected BC/AD dates for Zone 2 of Site 33 North, and these range from 130 BC to AD 1500. The earliest date (130 BC ± 230) comes from the bottom of Large Fire-cracked Rock Feature 3 which lies on Zone 3 deposits. This date is comparable to that of Large Fire-cracked Rock Feature 1 in Site 33 South, and no ceramics were found in the level from which the charcoal for the date was obtained. Together the two dates for these large, fire-cracked rock features – 160 BC and 130 BC – suggest that the beginning of the deposition of Zone 2 is shortly before the time of Christ and that the earliest occupation of Zone 2 in Site 33 may possibly have been by late Archaic peoples. In many of the excavated 1 m squares of Site 33 ceramics are absent in the lower levels of Zone 2, and this may lend credence to a late Archaic occupation. However, ceramic materials are not common in or on the Zone 2 deposits and decrease rapidly in numbers from eroded surfaces to subsurface deposits. Thus, the absence of ceramics in lower levels of Zone 2 should not be taken as conclusive evidence of its absence at the time in view of this project's limited subsurface testing of Site 33. This is also reflected in the few direct associations of ceramics with radiocarbon samples. The only corrected BC/AD dates for associated ceramics are AD 820 ± 130 from Site 34 North and AD 1200 ± 110 from Site 33 North, and these dates are much younger than the AD 250 ± 110 date for ceramics reported by Whalen (n.d.). There is, however, a potential for dating early ceramics and refining the ceramic chronology in the El Paso area with the long period of time represented by the Zone 2 deposits of Site 33.

Ceramic materials from Zone 2 of Site 33 North are much like those of Site 33 South and indicate Mesilla phase occupations to about AD 1100 and later ephemeral occupations from about AD 1200 to 1400 or perhaps AD 1500 (Chapter IX). The three corrected BC/AD dates of AD 380 ± 150, AD 860 ± 120, and AD 1200 ± 110 from Site 33 North are well within the range of expectable dates suggested by the ceramic materials. However, the AD 1500 ± 110 date from Pit 7 is at the upper limit of the time span of Zone 2 occupations based on indigenous or intrusive wares of the El Paso phase.

Tree-ring, archeomagnetic, and radiocarbon dates from El Paso phase sites in the area all fall between AD 1200 and AD 1400 (Beckes 1977c; Brooks 1975; Greer 1968a). Breternitz (1966) reports that El Paso phase ceramics can be found in other areas at somewhat later dates as trade wares, and Greer (1968a) gives dates of AD 1440 ± 80 and AD 1490 ± 90 for a site in Eddy County, New Mexico, with ceramics of the El Paso phase. The AD 1500 ± 110 date from Pit 7 is more recent than the AD 1200 to 1400 range normally assigned to the El Paso phase and suggests that the date is in error and too late, that the El Paso phase may have persisted past AD 1400 in the El Paso area, or that the date may be indicative of a post-El Paso phase occupation at Site 33 North. Ceramics of the El Paso phase were not found in association with Pit 7 or anywhere nearby. In addition, the three sherds questionably associated with Pit 7, two other nearby pits, and two postholes are not diagnostic of any particular period of time and do not differ visually from sherds of Mesilla phase occupations at Site 33 North. Thus, the ceramics found near Pit 7 do not affirm or contradict the date of this feature. It is also possible that Pit 7 and the other nearby pits and postholes may be from a post-El Paso phase occupation predating the entrance of the Spaniards into the El Paso area. The presence of hunter-gatherers in the El Paso area is noted by 16th Century Spanish explorers, but their lifeways and material cultures are poorly known from these early accounts (Gerald 1974a; 1974b). Aboriginal archeological materials of the period of time from the end of the El Paso phase up to the later part of the 17th Century have not been investigated in the El Paso area, and the absence of comparative materials of this time leaves questionable any implication of a post-El Paso phase occupation at Site 33 North. The AD 1500 ± 110 date of Pit 7 is assumed to be correct and indicative of a late occupation at Site 33 North which most likely was during the El Paso phase. The accuracy of this late date for Site 33 North is also suggested by the charcoal of Pit 7 and other nearby pits which was larger and better preserved than charcoal yielding earlier dates from Site 33 or Site 34.

The Zone 2 deposits at Site 33 North are believed to have accumulated slowly over a period of time from about the time of Christ to AD 1500. Later discussions of artifacts and features from Zone 2 and on the surface of Site 33 North are interpreted to suggest that occupations were of short duration and intermittent throughout the deposition of Zone 2. This is reflected in the overall uniformity of the soils of Zone 2 and the nondiscriminate nature of stratigraphic subunits which may be referrable to specific time intervals. This situation is also duplicated at Site 33 South and Site 34, although occupations in these areas are not believed to be as late as those of Site 33 North

The corrected BC/AD dates for Zone 2 in Sites 33 and 34, as well as the ceramic materials described in Chapter IX, do support the contention that the discontinuous deposits of this zone are coeval. There is, however, some question as to when the deposition of Zone 2 began and whether a late Archaic component is represented at Site 33.

Zone 4

The corrected BC/AD dates for Zone 4 (Table 2) are fairly close to one another and make Site 33 the best dated large Archaic site in the El Paso area. With the exception of a single earlier date to be discussed shortly the range of five other dates is 2790 BC to 1590 BC. Whalen (n.d.) given dates of 2370 BC to 160 BC for individual hearths in the Hueco Bolson east of El Paso, and Hard (n.d.) and O Laughlin (1979) report dates in the first millenium BC for scattered hearths on an alluvial fan on the east side of the Franklin Mountains. Beckett (1973) describes a metate northeast of Las Cruces, New Mexico, which dated at 4400 BC ± 110, and a single date of 1665 BC ± 120 is reported for Fresnal Shelter in the Sacramento Mountains northeast of El Paso (Human Systems Research 1972). These dates reflect the length of the Archaic period but are from sites considerably smaller than Site 33. A large Archaic site has been excavated near Las Cruces, New Mexico, by Greiser (1973); however, no radiocarbon dates are reported for this site. The importance of Site 33 as a large and well-dated Archaic site for a region where a well-founded chronology of the period does not exist is further emplified by the finding of numerous houses in the Zone 4 Archaic occupation. Archaic houses have not been reported in the El Paso area, and few houses of the age of those at Site 33 are known for the Southwest.

The houses of Zone 4 at Site 33 are found in a combined area of approximately 25,560 square meters. House 3 in Site 33 South has a corrected BC/AD date of 2090 BC ± 90, and three houses in Site 33 North are dated at 1590 BC ± 210, 2350 ± 210, and 2790 BC ± 310. These dates imply that the deposits of Zone 4 in Site 33 North and Site 33 South were laid down at the same time. These dates are also shown in Figure 14 along with the 1910 BC ± 220 date of Small Fire-cracked Rock Hearth 5, and it is suggested from the overlapping of dates at one standard deviation that the best range of dates for Zone 4 is 1800 BC to 2500 BC.

Although the best suggested range of dates is 1800 to 2500 BC, the Zone 4 Archaic occupation appears to have endured for a period of time less than the 700 years indicated by the corrected BC/AD dates. This is suggested by the relatively thin deposits of Zone 4 as compared to those of Zone 2. In addition, Zone 4 deposits are much darker than those of Zone 2, and the houses and other features exhibit spatial patterns which imply an internal community organization and a relatively more permanent occupation than do the features of Zone 2. Also there is no known superimpositioning of features in Zone 4, but this is a common occurrence in Zone 2. It is not certain whether the deposits of Zone 4 represent one or several occupations somewhere between 1800 and 2500 BC. However, the non-overlapping spatial distributions of features in Zone 4 do suggest that, if there were several periods of occupation, they were not separated by long intervals of time.

In addition to the five corrected BC/AD dates which give the best suggested time range of 1800 to 2500 BC for Zone 4 deposits, there is one younger date of AD 520 ± 120 from charcoal found in a non-feature area of Zone 4. This date is not considered to be in error, but it is suggested that the charcoal recovered in Zone 4 is intrusive from Zone 2 deposits. The large difference in age between this later date and the earlier ones should be apparent in Figure 14 and justifies the exclusion of the AD 520 date as a valid measure of the time of Zone 4 deposition. There are also four corrected BC/AD dates from Zone 2 that are older than the AD 520 date from Zone 4.

Very little charcoal was found in Zone 4, and most peices of charcoal were of very small size. The charcoal from the AD 520 ± 120 sample was much larger than other pieces in Zone 4, and other large pieces of charcoal were found scattered above this sample and near a small fire-cracked rock feature in Zone 2. Although it was suspected that this sample may have included charcoal carried into Zone 4 from Zone 2 by rodent activity, the importance of dating the Zone 4 deposits necessitated the consideration of all radiocarbon samples taken from Zone 4. Thus, the six radiocarbon dates from Zone 4 represented the total number of radiocarbon samples weighing 2 grams or more obtained in the limited investigation of this zone. Unfortunately, a sample of questionable origin was included with those of more certain provenience.

Obsidian Hydration Measurements

Freshly exposed surfaces of obsidian take up water to form hydrated surfaces whose thicknesses can be measured by microscopically examining thin-sections of the material. The thickness of a hydrated layer of obsidian is a function of how long the surface has been exposed, and dated measurements of hydrated layers of obsidian specimens can be used to derive equations which will give approximate dates for other specimens. However, factors such as temperature and relative humidity of the environment and chemical composition of the obsidian cause the rates of hydration to vary for different environments and different kinds of obsidian (Friedman and Smith 1960). At present the rate of obsidian hydration in the El Paso area is not known, but the results of this study do indicate some possibility of utilizing this technique for dating.

A total of 27 specimens of obsidian was submitted to Mathew Hall of the Radiocarbon Laboratory of the University of California at Riverside for thin-sectioning and measurement of hydration layers. Seven of these specimens were too small for thin-sectioning. Seven of the remaining 20 species either had no visible hydration layer or were devitrified and without hydration layers, and the other 13 specimens exhibited only a single measurable hydration layer (Table 3). All of the obsidian was from Site 33 North because no obsidian was found in Site 33 South or Site 34. Many of the specimens were from surface collections and subsurface excavations of mixed or uncertain phase or period deposits. Very little obsidian was found at Site 33 North, therefore, all of the larger specimens were submitted for analysis in spite of a lack of good temporal control for many of them or possible biases from surface exposure.

Hydration measurements are given in Table 3 and shown in Figure 15 along with inferred phase or period of occurrences. Phase or period designations follow those used throughout the remainder of this report. The Archaic period refers only to the materials of Zone 4. The Mesilla phase includes all materials of Zone 2 except those associated with later ceramics of the El Paso phase or possibly the Dona Ana phase. The designation of mixed Mesilla, Dona Ana, and El Paso phase materials is for those areas where later ceramics are found with those of the Mesilla phase. The lowest levels of Zone 2 are also subsumed under the Mesilla phase along with the upper levels of Zone 2, even though they may represent a late Archaic or transitional occupation at Site 33. The absence of stratigraphic subdivisions and the infrequent occurrence of ceramics in lower levels of Zone 2 make any finer chronological dissection of these materials impossible at this time. Reference to mixed Archaic period and Mesilla phase materials is necessary for those areas where the lower levels of Zone 2 cannot be stratigraphically differentiated from Zone 4 or where slope erosion of Zones 2 and 4 has placed materials of these horizons together on the surface.

From Figure 15 it can be seen that the measurements of obsidian hydration layers are smaller for the Mesilla phase than they are for the Archaic period and that hydration measurements for the mixed Archaic period and Mesilla phase specimens overlap those of the Mesilla phase and the Archaic period. It would, therefore, seem possible to distinguish between Mesilla phase and Archaic materials at Site 33 on the basis of obsidian hydration measurements. This would be very important in those areas where Zones 2 and 4 grade into one another without any indication of where one zone ends and the other begins.

The two obsidian hydration measurements with associated corrected BC/AD radiocarbon dates are not sufficient for ascertaining the rate of hydration in the El Paso area, and few other radiocarbon dated obsidian hydration measurements are available which cannot be questioned due to surface exposure (Hard n.d.; Whalen n.d.). Together these hydration measurements suggest that it may

TABLE 3

MEASUREMENTS OF THICKNESS OF HYDRATION FOR OBSIDIAN FROM SITE 33 NORTH

Univ. Calif. Riverside No.	Measurement (Microns)	Zone	Provenience	Feature Association	Period or Phase
OHL-879	4.96±.20	2/4	528N/447E* 5.05-5.13MBD**	-	AME
OHL-880	Devitrified	2/4	"	-	AME
OHL-881	2.77±.20	2	472N/358E 5.18-5.29MBD	-	ME
OHL-882	8.12±.20	2/4	528N/447E 4.87-5.05MBD	-	AME
OHL-883	5.51±.20	2/4	550N/460E 4.85-4.92MBD	-	AME
OHL-884	4.55±.20	-	496N/388E Surface	-	AMS
OHL-885	Devitrified	-	528N/596E Surface	-	MS
OHL-886	No band	-	452N/372E Surface	-	MPS
OHL-887	Devitrified	-	548N/551E Surface	-	MS
OHL-888	8.11±.25	4	526N/497E 4.0-4.1MBD	-	AE
OHL-889	No band	2	559N/506E 3.7-3.8MBD	Pit 7, Fill	ME
OHL-890	No band	2/4	548N/458E 5.04-5.06MBD	-	AME
OHL-891	6.86±.36	4	528N/447E 5.2-5.25MBD	House 2, Floor Radiocarbon dated 2790 BC±310	AE
OHL-892	No band	-	496N/440E Surface	-	MS
OHL-893	4.34±.20	-	460N/470E Surface	Small Fire-cracked Rock Hearth 4 Radiocarbon dated AD 860±120	MS
OHL-894	5.93±.20	-	528N/528E Surface	-	MS
OHL-895	5.44±.34	-	532N/580E Surface	-	MS
OHL-896	10.40±.56	4	496N/388E Partially exposed	-	AE
OHL-897	6.49±.20	-	560N/436E Surface	-	AMS
OHL-898	4.79±.20	-	496N/396E Surface	-	AMS

*North and east grid coordinates for southwest corner of excavated 1x1 m square or surface collected 4x4 m square

** MBD = Meters below datum

E = Excavation

S = Surface

A = Archaic period

AM = Mixed Archaic period and Mexilla phase

M = Mesilla phase

MP = Mixed Mesilla, Dona Ana, and El Paso phases

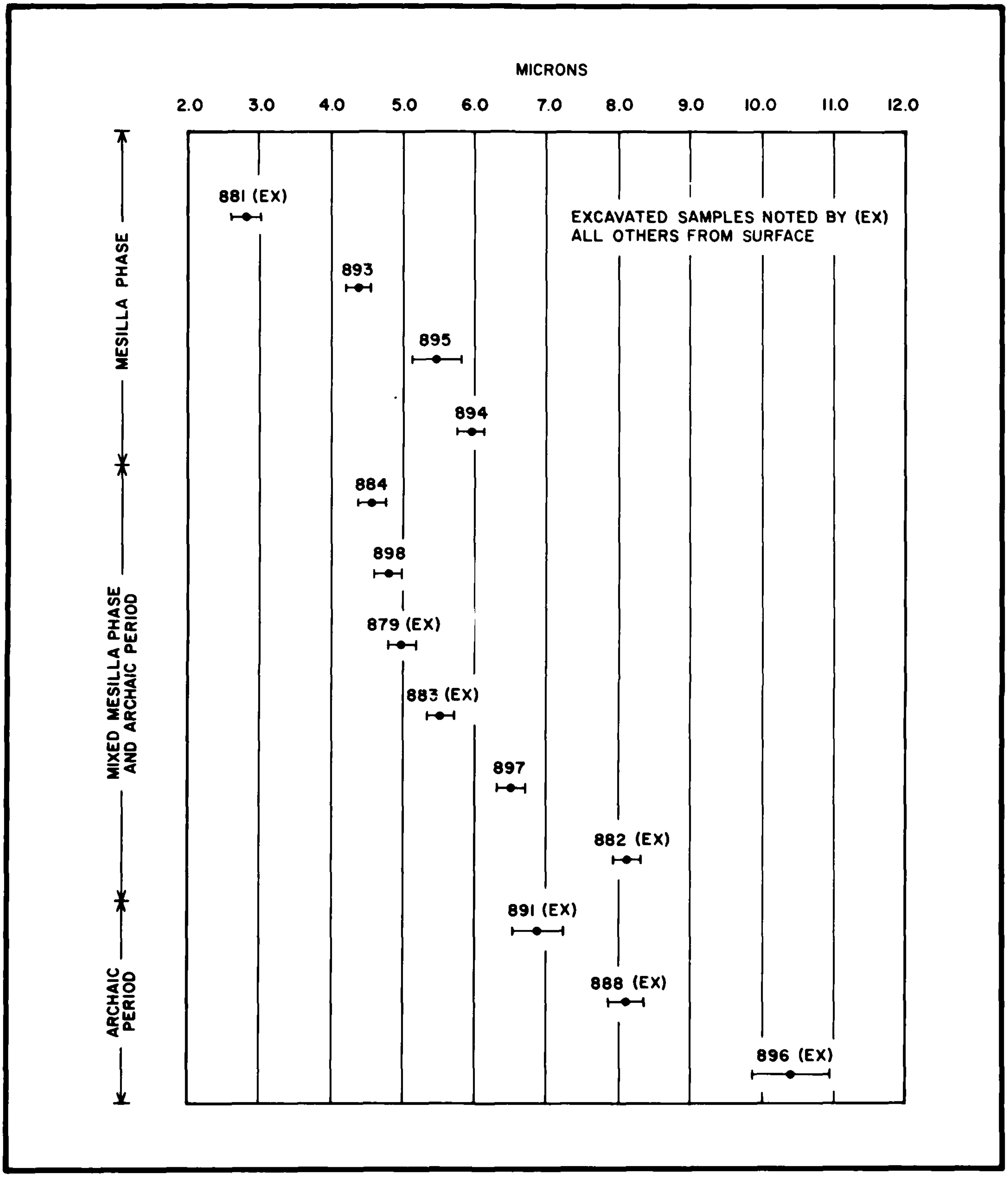

Figure 15. Obsidian hydration measurements from Site 33 North.

be possible to develop an equation which will yield approximate dates for other specimens in the El Paso area. This would be important for sites lacking charcoal for radiocarbon dating and temporally diagnostic materials, especially the small sites with little artifactual material and sites of the Archaic period. This becomes even more important when it is realized that the cost of radiocarbon dating is currently about twenty times that of obtaining an obsidian hydration measurement. The long period of time represented by the occupations of Zones 2 and 4 at Site 33 offers an excellent opportunity for continued obsidian hydration studies.

The exposure of obsidian on the surfaces of sites can greatly increase the rate of hydration and give measurements comparable to much older, buried specimens (Friedman and Smith 1960). This is certainly the case of obsidian hydration measurements reported by Whalen (n.d.) for sites in the Hueco Bolson east of El Paso where surface exposure gave random and unpredictable hydration measurements of obsidian dated by ceramics or radiocarbon. Mesilla phase surface samples at Site 33 North do have thicker hydration layers than the single buried specimen, but the uncertain dating of the majority of these specimens does not permit an evaluation as to whether this may be a result of surface exposure. Even if surface specimens from the Mesilla phase occupations have thicker hydration layers due to exposure than those that were excavated, they still do not overlap the measured hydration layers for the buried pieces of obsidian from the Archaic period. This makes it possible to suggest that not only may buried or exposed obsidian of the Archaic period or Mesilla phase be recognized by obsidian hydration measurements, but that it may also be possible to infer, with the aid of these measurements, past episodes of slope and wind erosion which are sometimes evidenced as buried layers of gravels and archeological materials at Site 33 North.

Obsidian occurs as small nodules in the El Paso area and frequently in the gravels of river terraces in the project area. Various forms of obsidian have been noted in the materials from Site 33 North and include a black opaque obsidian, a transparent to translucent gray obsidian, and a translucent obsidian with bands of light and dark gray. This suggest that the chemical composition of the obsidian varies. The hydration measurements from the Archaic occupation of Zone 4 exhibit a range of about 3.5 microns which is close to that for the four Mesilla phase specimens. It has been suggested from other data that the deposition of Zone 4 occurred over a period of time considerably shorter than that of Zone 2. Thus, the wide range of hydration measurements for Zone 4 may reflect variability in the chemical composition of obsidian which may complicate future efforts aimed at delimiting the rate(s) of obsidian hydration in the El Paso area.

Although it has not been possible to assign dates to obsidian specimens on the basis of hydration measurements, it has been demonstrated that the Zone 4 specimens have thicker hydration layers than those of Mesilla phase specimens and all but one of the mixed Archaic period and Mesilla phase specimens. This adds to the evidence from stratigraphy and radiocarbon dating that Zone 4 deposits are older than those of Zone 2 and provides a means of distinguishing Zone 4 deposits on materials from those of Zone 2.

Summary and Discussion

Having described the stratigraphy and the corrected BC/AD radiocarbon dates for two of the strata of Sites 33 and 34, a summary of this material can be attempted which will incorporate other paleoenvironmental studies. Discussions will begin with the older strata and proceed to the younger deposits.

Beneath Site 34 and the eastern portion of Site 33 North and on either side of the large arroyo just east of Site 33 are gravelly soils of an alluvial fan or perhaps of a low valley terrace some 6 m above the present floodplain. These sediments are believed to be late Pleistocene in age and have been subjected to entrenchment by the large arroyo and possibly to lateral cutting by the river. Partially overlying these gravelly soils, above the soils of the floodplain, and inset in the .arge arroyo are sands and gravels of Zone 5 in Site 33. These alluvial deposits make up most of the sediments of the extant and still pedologically active fan at the mouth of the large arroyo. Zone 5 alluvial deposits at Site 33 are as much as 5 m in thickness, but it is not certain from the limited examination of this zone whether the deposits represent one or several episodes of aggradation. In and to the west and south of Site 34 are gravelly sands beneath Zone 3 which were apparently eroded from higher elevations of Site 34 and from the terraces to the east and were deposited on this site while Zone 5 was being deposited in Site 33. These gravelly sands merge with Zone 5 soils to form a large coalescent alluvial fan.

The deposition of Zone 5 probably began during the middle Holocene when alluvial fans and inset terraces along arroyos were being formed along the Rio Grande valley just to the north in southern New Mexico (Hawley and Kottlowski 1969). Sometime prior to 4450-3750 BP the aggradation of Zone 5 surfaces ceased and this was followed by a period of relative surface stability evidenced by the thin occupational deposits of Zone 4 on the alluvial fan at Site 33. Succeeding the deposition of Zone 4 at Site 33 between 4450 and 3750 BP, more alluvium was added to the coalescent fan of Sites 33 and 34 and surfaces were aggraded by as much as 70 cm before 2000 BP.

The sequence of alluvial aggradation, relative surface stability, and aggradation again as seen in the deposits of Zones 5, 4, and 3 appears to parallel similar events in south central New Mexico. Hawley and Kottlowski (1969) note an episode of alluvial fan aggradation along the Rio Grande beginning before 5000 BP and ending after 2600 BP. They also describe two units of deposition with an erosional hiatus of unknown duration between them on alluvial slopes below mountain ranges but away from the Rio Grande valley, which indicate a period of alluviation from sometime before 5000 BP to sometime after 2200 BP. Haynes (1968) considers the erosional hiatus between the two alluvial deposits on slopes below mountains to be of little regional importance and sees a coincidence in the alluviation of valley borders and slopes below mountains between about 5000 BP and sometime after 2200 BP. The deposition of alluvium at Sites 33 and 34 is known to have begun before 4450-3750 BP and appears to have been minimal after 2000 BP. Zone 5 is some 5 m thick in some areas, but this does not necessarily reflect a great age for these deposits because Hawley and Kottlowski report alluvial fan deposits as much as 12 m thick along the river which were laid down from sometin.e before 5000 BP. Thus, the alluvial deposits of Zones 3 and 5 correlate fairly well with those detailed by Hawley and Kottlowski along the Rio Grande and on slopes below mountains in south central New Mexico. The period of relative surface stability and non-alluvial deposition noted for Zone 4 deposits might remotely correspond to the erosional hiatus seen in alluvial deposits on slopes below mountains. It is also possible that a short period of surface stability or erosion may have gone unrecognized by Hawley and Kottlowski in valley border alluvial fans. Indeed, Zone 3 could not be distinguished from Zone 5 in those areas where the darker Zone 4 soils are not present.

Hawley and Kottlowski (1969) and Haynes (1968) suggest that the period of alluvial deposition from sometime prior to 5000 BP to sometime after 2200 BP in southern New Mexico can be correlated with the general alluvial chronology of the Southwest described by Antevs (1955). However, Haynes refers to this entire period of alluviation and to another later period of channel filling after 1100 BP as attributable to Antevs' Medithermal period, while Hawley and Kottlowski follow Freeman (1972) in suggesting that the soils deposited from 4000 BP to sometime before 5000 BP are of Altithermal age. Freeman bases his interpretation on pollen from the alluvial sediments which suggests a transition from a desert shrub to grassland vegetation between 4000 and 5000 BP that can be likened to Antevs' suggested change in climate at this time from the warm and dry Altithermal to a cooler and moister Medithermal. Haynes prefers to emphasize the correspondence of the alluvial stratigraphy reported for south central New Mexico with that of other areas in the Southwest and sees the long period of alluviation from before 5000 BP to after 1100 BP as evidence of deposition under Antevs' Medithermal climate, and a previous episode of arroyo cutting as indicative of Antevs' Altithermal climate. Questions can be raised concerning the origin of pollen in alluvial sediments and whether the trend in climate noted by Freeman is an accurate reflection of the environment at about 4000 to 5000 BP. At the same time, climatic reconstructions from alluvial stratigraphy are based on some rather tenuous assumptions concerning the conditions which lead to arroyo cutting or alluvial aggradation. Climatic inferences derived from pollen data will be taken up in the next chapter, while the balance of this chapter will be focused on factors which condition arroyo cutting or filling and that may be pertinent to the interpretation of deposits at Site 33 and 34.

The alluvial chronology detailed by Antevs (1955) and initially developed by Bryan (1941; 1954) is founded on observations of synchronous episodes of deposition and erosion in Southwestern floodplains. According to Bryan (1954), deposition is thought to occur when a stream has a greater load that it can carry on a given grade, and erosion takes place when a stream can carry more material than it is furnished. Bryan (1941; 1954) and Antevs (1948; 1955) infer that long periods of arroyo cutting during the Holocene were related to increased runoff following droughts or arid periods during which plant cover was reduced. This inference is built upon historic documentation of down-cutting that was preceeded by drought and overgrazing by livestock which reduced the vegetation cover and led to increased runoff from barren ground. Antevs (1955) also suggests that deposition is characteristic of changing environments where increasing precipitation stimulates vegetative growth and reduces runoff and decreasing precipitation results in less runoff. Bryan (1954), however, implies that sedimentation is only associated with moist periods. Both Antevs and Bryan view widespread arroyo cutting in the Southwest between 4000 BP and 7500 BP as a result of a warm and dry climate which

Antevs calls the Altithermal. Alluvial aggradation after 4000 BP is viewed as the product of a change in climate to a moister and cooler period which Antevs calls the Medithermal. Haynes (1968) follows both Antevs and Bryan in their climatic reconstructions of the Altithermal and Medithermal periods but he also notes that erosion in the late Altithermal may have been in response to an increase in precipitation rather than continued aridity. Martin (1963) disagrees with the Bryan-Antevs climatic model and correlates erosion with intense summer rainfall and alluviation with light summer rainfall or winter dominant precipitation. Martin also suggests that the Altithermal of Antevs was not warm and dry in the Southwest but that it was moister than the present and was characterized by well-developed summer monsoonal rains. Three differing viewpoints have been given on events which can promote erosion (or inversely, alluviation): (1) a relatively long period of aridity with a decrease in vegetation cover followed by a wet phase; (2) a definite increase in annual precipitation and, therefore, runoff; and (3) intense summer rains with violent runoff. Other opinions concerning the cause of erosion and sedimentation could be offered but little more would be gained without a better understanding of Southwestern climates during the time period encompassed by Antevs' Altithermal and Medithermal. That is, erosion and alluviation are probably conditioned by many factors and additional kinds of information should be sought to evaluate alluvial stratigraphy.

Perhaps the best summary of Holocene climates for the Southwest is that by Van Devender and Spaulding (1979) which is based on their and others' study of plant materials incorporated into woodrat nests, faunal remains from caves, tree-rings, and pollen from alluvial and lacustrine deposits. This information is presented in the section on Changes in Vegetation and Climate in Chapter II, and only an abridged discussion of post-Holocene climates will be given here. Van Devender and Spaulding divide the Holocene into three periods: early, middle, and late. Of interest here is the middle Holocene 8000-4000 or 5000 BP, which corresponds in time to Antevs' Altithermal, and the late Holocene (4000 or 5000 BP to the present) which is temporally equivalent to Antevs' Medithermal. Van Devender and Spaulding suggest that a climate comparable to that of today was established in the Southwest by the middle Holocene. They infer warm summers with heavy monsoonal rains and cold and relatively dry winters, and summer precipitation is thought to have been greater than it is at present. At the beginning of the middle Holocene, juniper-oak woodlands were apparently replaced by grassland in the lower elevations of the mountains and in the intermontane basins of the El Paso area. The warm and dry Altithermal of Antevs is not recorded for the Southwest, and Van Devender and Spaulding suggest that the term be restricted to use in the Great Basin where dendroclimatologic evidence for it exists (La Marche 1973). Van Devender and Spaulding note a drying trend through the middle Holocene and into the late Holocene. At about 4000-5000 BP a marked decrease in effective precipitation is noted, runoff does not appear to be sufficient to fill some playas regularly, and desert shrubs and succulents begin to dominate the lower elevations of mountains in the El Paso area. This drying trend seems to have continued to the present with minor fluctuations in precipitation noted for the last 4,000 or 5,000 years.

If the climatic reconstruction of Van Devender and Spaulding can be assumed to be largely correct, then it sould be possible to interpret the deposits of Sites 33 and 34 and similar sediments in south central New Mexico in this light. The correlation of these deposits with other Quaternary deposits in the Southwest has already been approximated, and the intent now is to judge how well the reconstructed climates of middle and late Holocene times for the Southwest fit the local alluvial stratigraphy. Hawley and Kottlowski (1969) note arroyo cutting of valley border sediments in south central New Mexico which is followed by aggrading alluvial fans along the Rio Grande and on slopes at the skirts of mountains from sometime prior to 5000 BP to sometime after 2200 BP. The dissection of valley border deposits appears to occur during the middle Holocene when it is thought that down-cutting was initiated by increased runoff from precipitation in the form of intense summer monsoonal rains as envisioned by Martin (1963). The aggradation of alluvial fans in south central New Mexico from sometime before 5000 BP to sometime after 2200 BP and the deposition of Zones 3 and 5 at Sites 33 and 34 during the interval from sometime before 4450-3750 BP to sometime prior to 2000 BP are seen as having occurred under similar environmental conditions. This occurred during the late Holocene and should have begun in the El Paso area by about 5000 BP. The aggradation of alluvial fans during this time period suggests that stream runoff was not torrential but was sufficient to erode uplands and redeposit sediments where the slope decreased and stream velocity slowed. Summer monsoonal rains are envisioned as not having been as intense as they were during the middle Holocene, and annual precipitation appears to have decreased. Vegetation cover is also believed to have been good but xerophytic species are certainly present by late

Holocene times. Thus, aggradation of alluvial fans during the early half of late Holocene times can be attributed to a good vegetation cover, a somewhat decreased annual precipitation, and relatively light summer rains which reduce the volume and velocity of runoff and made more probable the deposition of sediments. These views correspond fairly well to those of Van Devender and Spaulding (1979) and Martin (1963). However, annual precipitation is seen as being more effective, though of reduced quantity, for the early half of the late Holocene than Van Devender and Spaulding imply. These views are not markedly different from those of Antevs (1955), Bryan (1954), and Haynes (1968).

Although the late Holocene has been treated thus far as evidencing only one type of climate, this is very far from the variability in precipitation inferred from paleoenvironmental studies. Van Devender and Worthington (1977) deduce from faunal evidence a general drying trend through the late Holocene for southwestern New Mexico, suggest that a hotter and drier climate than the present prevailed about 3300 BP, and indicate that there were two wet periods, one at about 3000 BP, and indicate that there were two wet periods, one at about 3000 BP and the other at less than 1000 BP. Hawley and Kottlowski (1969) record a period of channel cutting and filling which occurred less than 1100 BP in south and central New Mexico, and Freeman (1972) interprets pollen from the channel deposits as indicative of increasingly effective precipitation as compared to pollen characteristic of a drying trend that is noted in alluvial deposits which are dated at less than 2200 BP. Antevs (1955) and Bryan (1954) describe four possible drought associated episodes of arroyo cutting for northern New Mexico at about 2500 BP, 1625 BP, 675 BP, and 370 BP. They also take note of recent historic arroyo cutting associated with droughts and livestock overgrazing. These episodes of arroyo cutting with mesic interludes have also been correlated with pollen sequences from Northern New Mexico (Schoenwetter 1970). Powers (1939) sees a dry period in the San Agustin Basin of west central New Mexico around 2500 BP, and Lake Meinzer in the Estancia Valley of east central New Mexico appears to have been filled for a period of time near 4000 BP and to have dried up by 3000 BP (Bachuber 1971). Bryant (1977) infers from pollen sequences a mesic period at about 2500 BP followed by increasing aridity in Transpecos Texas and correlates this with a mesic interval noted by Hafsten (1961) for the west Texas plains. Bryson and Wendland (1967) have modeled atmospheric circulation patterns for the central United States which suggest arid periods for the Southwest at 2500 BP, 1600 BP, 750 to 450 BP, and from 100 BP to the present, and more mesic periods for 1050 to 750 BP and 400 to 100 BP. Finally, Fritts (1965), Jorde (1977), La Marche (1974), and Robinson and Dean (1969) have noted regional and temporal variations in precipitation evidenced in tree-ring indices. There are few correspondences in these data, but it can be suggested that the earlier part of the late Holocene in the Southwest may have seen a trend toward increasing aridity that continued up to sometime after 2500 BP and that at least four cycles of wetter and drier environments occurring after 2500 BP are supported for some areas by the studies of Bryson and Wendland and by the alluvial chronology of Bryan and Antevs. Regional variations in the temporal placement and intensity of the more arid or more mesic periods is to be expected, and the deposits of the coalescent alluvial fan of Sites 33 and 34 simply add another example of variability in the late Holocene record.

The stratigraphy of the coalescent alluvial fan at Sites 33 and 34 is interpreted as evidencing a trend toward increasing relative aridity through the late Holocene. Zone 5 alluvial sediments are quite thick compared to those of Zone 3 and may be taken to indicate a decrease in runoff from the period before 3750-4450 BP to the period after that interval and extending up to sometime prior to 2000 BP. Although a decrease in runoff between these two periods could be viewed as suggesting a lessening in the intensity of summer rain storms or a shift to winter dominant precipitation, the establishment of xerophytic species in lower elevations of mountains in the El Paso area during these times suggests that a decrease in effective precipitation, or increasing aridity, was occurring (Van Devender and Riskind 1979). Vegetation cover is inferred to have been good through most of the early part of the late Holocene, and precipitation is thought to have been greater than that of the present at the start of the late Holocene with perhaps 28 to 35 cm falling annually and mostly during summer months. This rainfall pattern would have promoted a good vegetation mat of grasses in intermontane basins. Sometime between 3750 BP and 4450 PB, a period of relative surface stability and soil formation is noted in Zone 4 deposits at Site 33. Zone 4 soils are fairly compact, calcareous sandy loams that evidence more structure than the massive sands above or below them. This implies stability of soil surfaces and soil formation rather than erosion or alluviation. Neither alluvial aggradation nor arroyo cutting is noted during this period, and the extensive Archaic occupation with numerous houses on the alluvial fan would not have been possible if alluviation or arroyo cutting had occurred during this period. It is inferred that runoff was minimal during this period, that summer rain storms were not as energetic as they were during the preceeding or following periods, and that a shift to winter dominant precipitation or a decrease in total annual precipitation had taken place. The radiocarbon dates from Zone 4 only approximate the length of time involved in the deposition of Zone 4 soils, and the thin deposits and non-overlapping distribution of Archaic houses and other features suggest that Zone 4 soils were formed during a period of time much less than the 700 years implied by the radiocarbon dates. In addition, the briefness of the Zone 4 soil formation as compared to longer episodes of alluviation during the earlier half of the late Holocene may be attested by the absence of similar findings in other studies of Southwestern alluvial stratigraphy.

Eolian deposition and dune formation are noted first in Zone 3 deposits and are characteristic of Zones 1 and 2. This is interpreted as evidence for the continuation of a drying trend into the second half of the late Holocene. Slope erosion of the terraces east of Site 34 and of the higher parts of that site and the ensuing alluvial aggradation of the lower parts of the site ceases and small dunes form on the Zone 3 deposits sometime prior to the deposition of Zone 2. In Site 33 the alluvial aggradation of the fan slows considerably toward the end of the period of Zone 3 deposition, or sometime prior to 2000 BP, and is minimal for later times. Some slope erosion on the ridgeline in the northern part of Site 33 North appears to have occurred during the later half of the deposition of Zone 3, and wind erosion of the sandy soil surfaces and duning is substantial by the end of the deposition of Zone 3. As the alluvial aggradation of the fan declined through the period of the deposition of Zone 3, runoff must have declined also. This is thought to be related to a decrease in annual precipitation and not to a shift to winter dominant precipitation, to an increase in the vegetation cover, or necessarily to a lessening of the intensity of summer thunderstorms, although summer precipitation probably decreased. If there had been a shift to winter dominant precipitation or a lessening in the intensity of summer monsoonal rains, then precipitation may have been more effective, plant cover improved, and runoff reduced. However, wind erosion and the duning of Zone 3 deposits suggest that the sandy soil surfaces of the alluvial fan were dry, loose, and poorly covered by vegetation, and that wind erosion was probably made possible by a decrease in soil moisture. This alone does not imply a decrease in precipitation. However, the suggestion of an arid period in the Southwest at about 2500 BP by Antevs (1955), Bryan (1954), and Bryson and Wendland (1967) and of a possible drying trend beginning before 2200 BP in south central New Mexico by Freeman (1972) seems to substantiate the inference from the wind erosion of the upper deposits of Zone 3 of a decrease in precipitation before 2000 BP. In addition, numerous small arroyos in the upper portion of the Zone 3 deposits, slope erosion of the ridgeline in Site 33 North possibly during the later part of Zone 3 deposition, and the cutting of a large arroyo from near the top of Zone 3 deposits through Zone 4 and into Zone 5 in Site 33 North suggest that runoff was more substantial just prior to 2000 BP or perhaps 2200 BP with channel cutting possibly following a dry period which reduced vegetation cover in the water catchment area. Dissection of the alluvial fan is suggested to have occurred sometime between 2500 BP and 2000 BP by correlation with the Bryan-Antevs alluvial chronology for the Southwest. Arroyo cutting is believed to have lowered the water table of the alluvial fan and to have caused an increase in the intensity of duning by the end of the deposition of Zone 3 soils. Duning, however, was well underway before arroyo cutting commenced.

Wind erosion and duning of the alluvial fan continue during the deposition of Zones 2 and 1 at Sites 33 and 34 or from about 2200-2000 BP to the present. Very little aggradation of the alluvial fan is suggested by the Zone 2 deposits at Site 33 and evidence of arroyo cutting is not apparent. Some deposition of alluvium and arroyo cutting is indicated in the upper portions of Zone 1 of both Sites 33 and 34, and this is associated with a reduction in vegetation cover from droughts, possible livestock overgrazing, and modern construction in the catchment area with the resulting torrential runoff within the last 100 years or so. Prehistoric occupation of the alluvial fan during the deposition of Zone 2 and between 2200-2000 BP and 450-550 BP may have contributed to the wind erosion of soil surfaces. There is no evidence of arid-mesic environmental fluctuations from Zone 2 or Zone 1 deposits with the exception of modern arroyo cutting. Stabilized dune surfaces are not noted, and Zone 2 soils grade conformally into the soils of Zone 1. This is not to suggest that intervals of increased or decreased precipitation did not occur during the last 2000 years prior to modern arroyo cutting but rather that evidence for increased or decreased precipitation during this period is not recognized and is best sought from other sources where prehistoric human activities are not such an important consideration. However, Hawley and Kottlowski (1969) note only one or two minor cycles of erosion and sedimentation during this period in south central New Mexico. Minimal alluvial aggradation and arroyo cutting and the absence of any evidence for stabilized dune surfaces during the last 2,000 years prior to modern arroyo cutting suggests that the climate was somewhat arid and that annual precipitation probably averaged less than during the early half of the late Holocene and was on the order of 25 to 30 cm, or barely adequate for the maintenance of desert grasslands in intermontane basins.

There are two deposits in restricted areas of Site 33 North which suggest flooding by the Rio Grande. One occurs in Zone 5, and the other is in Zone 3. Climatic inferences from these deposits are not possble because of non-local contributions to stream ffow. Periodic floodings by the Rio Grande have been recorded for the project area in historic times (Nelson, Holmes, and Eckman 1914).

The stratigraphy of Sites 33 and 34 is very complex, and environmental reconstructions are suggested from only a limited examination of the stratigraphy at these sites. The various strata at Sites 33 and 34 have not been studied in detail by a soils geologist, and the results of this study should be viewed and applied with caution. However, there are many correlations with other episodes of erosion and sedimentation in the Southwest and the implication of increasing aridity through the late Holocene with cycles of increased or decreased effective precipitation follows that of many other investigators. Decreasing precipitation through the late Holocene is certainly indicated by substantial alluvial aggradation during the first half of the late Holocene as opposed to wind erosion and duning during the second half of the late Holocene. A possible arid period at about 2500 BP followed by arroyo cutting before 2200-2000 BP and modern arroyo cutting are correlated with similar events noted elsewhere in the Southwest. The suggested period of surface stability and soil formation sometime between 4450 and 3750 BP is not noted elsewhere in the Southwest, may have been of relatively short duration, and can be questioned in terms of the proposed environmental reconstruction. It has also been suggested that cycles of increased or decreased effective precipitation during the last 2,000 years and before modern arroyo cutting would not necessarily be recognizable in deposits of this time.

CHAPTER VI

PALYNOLOGY

The intent of the analysis of pollen from Site 33 is to provide information which may be referable to past environments of the El Paso area from sometime prior to 4450-3750 BP to the present. Pollen samples were chosen for analysis only from Site 33 North where all soil zones are represented and where radiocarbon dates or archeological materials allow better definition of the times involved in the deposition of soil zones. Samples were also selected to give pollen counts from all of the soil zones for correlation with the interpretations of stratigraphy in Chapter V. With the limited number of samples which could be processed and analyzed as part of this project, archeological features which might yield economic pollen for possible discussions of feature use were specifically excluded from consideration in favor of acquiring a long pollen sequence for the area. However, some comments can be made concerning the apparent presence of economic pollen in the samples which were analyzed.

The soil samples collected at Site 33 were processed and the pollen extracted by Anne C. Cully and Karen H. Clary, Botanical Consultants, of Albuquerque, New Mexico, and their findings and interpretations are presented in Appendix B. They report temporal changes in the composition of pollen from these samples but suggest that trends in the pollen spectra do not necessarily imply climatic change and that a shrub-grassland predominated throughout the represented time periods. Differences between samples in the relative contribution of pollen types are attributed by Cully and Clary primarily to the differential preservation of pollen grains and the influence of prehistoric man's activities on the pollen rain of Site 33. However, Cully and Clary recognize that they do not understand the effects of these two factors on the representation of pollen types. Factors which might alter the composition of pollen samples are elaborated by the writer in this chapter, and certain misunderstandings by Cully and Clary in the nature of soil zones, ages of some of the samples, and variability in the intensity or presence of human activity at Site 33 are corrected here. The contribution of Cully and Clary to the understanding of past environmental conditions at this site is acknowledged although they are not responsible for the uncited opinions expressed in this chapter, of course.

Site Setting

The environment of the project area and the particular setting of Site 33 have already been described in detail in Chapters II and IV. Therefore, only a brief inventory of the modern flora of the area will be given here as an indication of the diversity of habitats in close proximity to Site 33.

Site 33 is situated on an alluvial fan at the mouth of a large arroyo which flows from the Franklin Mountains some 5 km to the east (Figure 1). More specifically, this site is located on the east side of the Rio Grande and just above the floodplain. The vegetation of the alluvial fan is predominantly mesquite *(Prosopis glandulosa)* and four-wing saltbush *(Atriplex canascens)* with some creosotebush *(Larrea tridentata)*, soap-tree yucca *(Yucca elata)*, and joint fir *(Ephedra trifurca)*. Arroyos draining into the floodplain have a diverse shrubby flora which is characterized by little-leafed sumac *(Rhus microphylla)*, datil *(Yucca torreyi)*, mariola *(Parthenium incanum)*, and whitehorn *(Acacia constricta)* (Williams 1969). The vegetation of the floodplain includes cottonwood *(Populus fremontii)*, willow *(Salix* spp.), seep willow *(Baccharis glutinosa)*, and saltgrass *(Distichlis stricta)*. The floodplain has also been invaded in the recent past by salt cedar *(Tamarix pentandra)*, and tornillo *(Prosopis pubescens)* and wolfberry *(Lycium pallidum)* are common along the edges of the floodplain (Campbell and Dick-Peddie 1964). Terraces and alluvial fans between the Rio Grande and the Franklin Mountains are vegetated with sparse desert shrubs which include creosotebush, range ratany *(Krameria parvifolia)*, ocotillo *(Fouqueria splendens)*, lechuguilla *(Agave lecheguilla)*, prickly pear *(Opuntia* spp.), and datil (Ederhoff 1971). West of the Rio Grande, slopes and sandy plains have a meager cover of mesquite, four-wing saltbush, and soap-tree yucca. The Franklin Mountains furnish a diverse habitat for various species such as oak *(Quercus* spp.), sotol *(Dasylirion wheeleri)*, lechuguilla, wait-a-minute *(Mimosa biuncifera)*, algerita *(Berberis trifoliata)*, and rarely juniper *(Juniperus monosperma)* (Harris n.d.).

The vegetation of the project area today is typical of intermontane lowlands in west Texas, southern New Mexico, and northeastern Mexico and is described by Shreve (1942) as the Chihuahuan Desert. Desert shrubs dominate the landscape in all but the best watered areas, and grass cover is generally sparse or non-existant. However, extensive desert grasslands are noted for the area until late in the 19th century when the effects of overgrazing by livestock and droughts culminated in reduced grass cover, soil loss, and the establishment of desert shrub communities (Gardner 1951; York and Dick-Peddie 1969).

Sampling Methods and Stratigraphy

This palynological study is based on 30 samples from Site 33 North. Twenty-two samples are from Pollen Sampling Location One; five samples are from Pollen Sampling Location Two; and two samples are from Pollen Sampling Location Three (see Figure 7 for sampling locations). The last sample is a composite pinch sample taken throughout the area of Site 33 North from the upper 1 or 2 cm of surface soils of Zone 1. The surface sample was acquired in the spring when numerous annuals were in flower, particularly those of the family Compositae. The stratigraphy of Site 33 North has been described in Chapter V. Observations of the stratigraphy at the pollen sampling locations are presented here to help delimit the ages of the pollen samples and to describe slight variations in the soils from the general patterns previously detailed.

Pollen Sampling Location One is near the western edge of Site 33 North and includes a vertical suite of samples taken at 5 cm intervals from the north wall of the 1978 arroyo. Each pollen sample was taken from an area approximately 25 x 25 cm in size and with a maximum vertical thickness of 2 cm. The 22 samples from Pollen Sampling Location One represent all five soil zones. The stratigraphy at Pollen Sampling Location One is shown in Figure 16. Sample No. 1 is from the bottom of bedded eolian sands in Zone 1 which were deposited sometime between 550-450 BP and the present. Samples Nos. 2 through 13 are from Zone 2 eolian deposits which give evidence of prehistoric occupation. The top of Zone 2 may date to 550-450 BP on the basis of radiocarbon dates and ceramic materials from Site 33 North, and the lowest deposits of Zone 2 may be as early as 2150-2050 BP if the two earliest radiocarbon dates from this zone can be accepted as indicative of the age of the lowest portions of Zone 2 at Pollen Sampling Location One. A 1 m square was excavated 2 m north of Pollen Sampling Location One, and Mimbres Bold Face Black-on-white sherds were found at the level of sample Nos. 4 and 5 which suggest that these samples may date to between 1050 BP and 850 BP. Zone 2 deposits are 60 cm thick at Pollen Sampling Location One and 20 to 30 cm thicker than other Zone 2 deposits of Site 33. The selection of Pollen Sampling Location One for pollen analysis over many others is largely attributable of lower Zone 4 soils.

Samples Nos. 14 and 15 of Pollen Sampling Location One come from Zone 3 soils which are weathered eolian sands that are much thinner than Zone 3 soils in other areas of Site 33. The age of Zone 3 soils at Pollen Sampling Location One is uncertain but falls between 4450-3750 BP and 2150-2050 BP. Sample Nos. 16 through 18 are from Zone 4A which appears to be soils of Zone 4 that have been redeposited by wind action. This is suggested by the darker color of Zone 4A soils than Zone 3 soils and the presence of a deflated surface at the juncture of Zones 4A and 4. Zone 4A soils were probably redeposited shortly after the Zone 4 soils were laid down, and Zone 4 is radiocarbon dated to sometime between 4450 BP and 3750 BP. Zone 4 is 15 to 30 cm thick at Pollen Sampling Location One and is represented by sample Nos. 19 through 21. Zone 4 shows evidence of an extensive Archaic period occupation and rests on Zone 5A clay loams. Zone 5A is separated from Zone 4 by Zone 5 sediments in other areas and is of uncertain age, although it probably dates to a period that begins after 5000 BP and ends before 4450-3750 BP. It is assumed (Chapter V) that Zone 5A soils are indicative of an episode of flooding by the Rio Grande. Sample No. 22 comes from Zone 5A.

Pollen Sampling Location Two is an excavated 1 m square that is located near the center of Site 33 North. It was chosen because of the well-defined stratigraphy of Zones 3, 3A, 4, and 5 (Figure 16). Zones 5 and 3A are not represented in the samples from Pollen Sampling Location One, and Zone 3 is thin and weathered at that location. Thus, Pollen Sampling Location Two complements the lower portions of Pollen Sampling Location One and provides duplicate samples of Zones 3 and 4. Sample No. 1 is from the upper portion of Zone 3 and from below Large Fire-cracked Rock Feature 2 which was excavated into Zone 3. Charcoal from near the bottom of this feature was radiocarbon dated at 1570 BP ± 150. Sample No. 3 comes from the lower portion of Zone 3 and is above Zone 4 soils that are radiocarbon dated to the period between 4450 BP and 3750 BP. Sample Nos. 1 and 3 are suggested to date to the later and earlier times respectively of the period after 4450-3750 BP and sometime before 2150-2050 BP. Sample No. 1 was taken from eolian

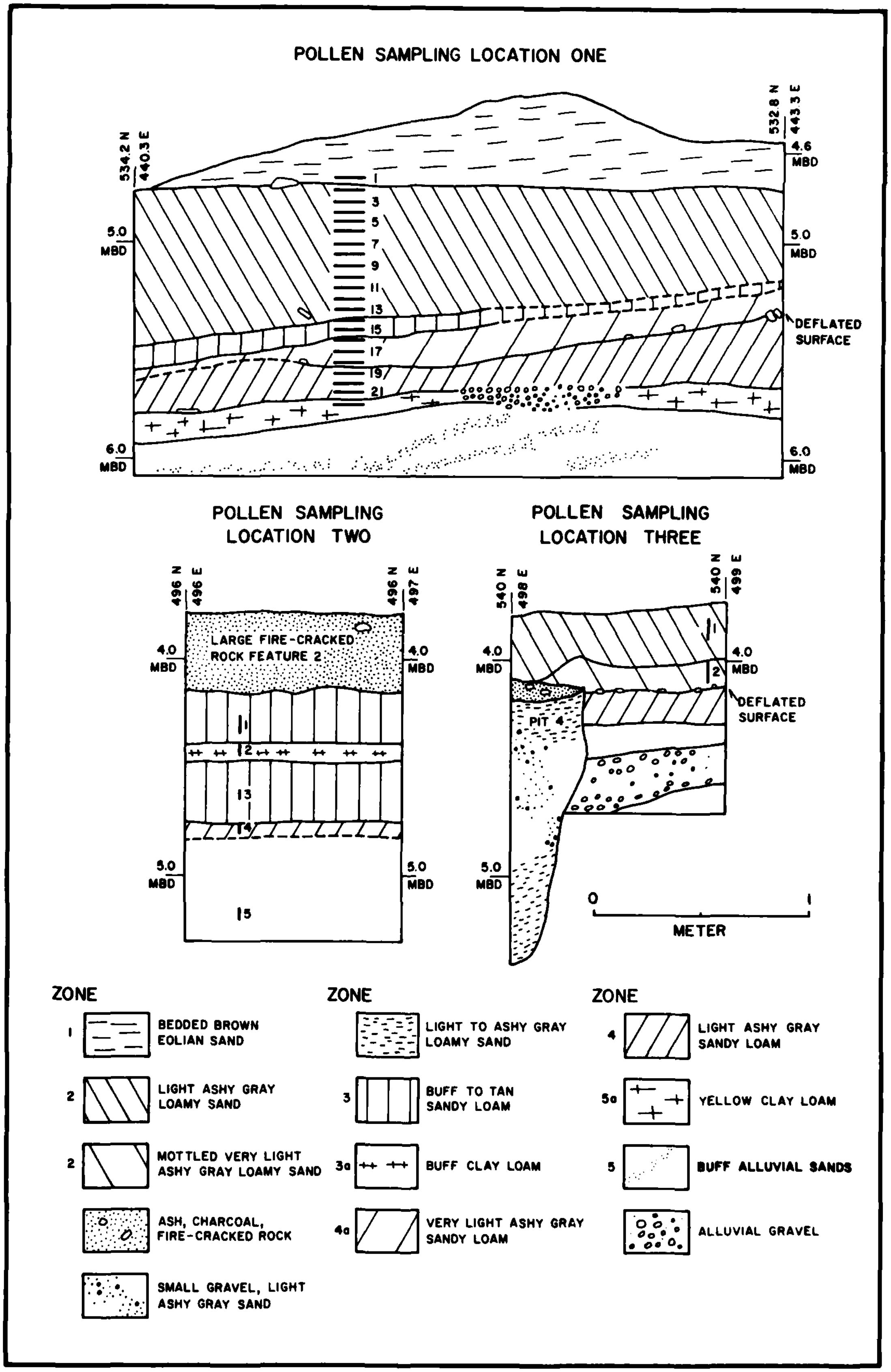

Figure 16. Stratigraphy of pollen sampling locations in Site 33 North.

sands, and the soils of sample No. 3 are of mixed alluvial and eolian origin. Between sample Nos. 1 and 3, sample No. 2 was taken from Zone 3A sediments which are believed to be back-water deposits that resulted from a flooding of Site 33 North by the Rio Grande. From stratigraphic evidence, sample No. 2 is believed to date to the middle of the period of Zone 3 deposition. Sample No. 4 is from Zone 4, and sample No. 5 comes from well within Zone 5. Sample No. 5 dates sometime before the deposition of Zone 4 between 4450 and 3750 BP, and Zone 4 soils are alluvial sands. The vertical extent of sample No. 1 is 4 cm, and the other four samples were removed from layers that were no more than 2 cm thick.

Pollen Sampling Location Three is near the center of Site 33 North and north of Pollen Sampling Location Two. The two samples from Pollen Sampling Location Three are from Zone 2 deposits which overlie Zone 4 (Figure 16). These samples were chosen to provide additional samples of Zone 2 deposits from another aea of Site 33 North for comparison with those of Pollen Sampling Location One. In addition, Zone 2 deposits at Pollen Sampling Location Three are divisable into two subunits by soil color, and a nearby radiocarbon dated feature provides some temporal control over sample No. 1. The differences in soil color between sample Nos. 1 and 2 may be attributable to separate prehistoric occupations of Site 33 North, and the soils of Zone 2 are eolian sands. Sample No. 1 is believed to date to about the same time as Small Fire-Cracked Rock Hearth 94 which is radiocarbon dated to AD 1200 ± 110 (750 BP) and is 1 m to the east and at the same level as sample No. 1. Sample No. 2 lies above the deflated surface of Zone 4; ceramics were found at this same level and in Pit 4 (Figure 16). The suggested age of sample No. 2 is sometime after 1950 BP and probably before 1150 BP. These two samples were taken from the four corners of an excavated 1 m square and had a vertical extent of no more than 4 cm.

In Chapter VIII there was noted the vertical movement with percolating waters of ash and charcoal in the occupatonal deposits of Zones 2 and 4 by as much as 25 cm, and it is quite probable that pollen moved vertically a similar distance in the sandy soils of Site 33 North. Thus, the interpretation of pollen from Site 33 North must necessarily be approached with caution and skepticism particularly with regard to any anomalous samples which might otherwise suggest short term environmental fluctuations.

Inherent in any palynological study of archeological sites is the problem of biases in pollen spectra from human activities which disturb soils and vegetation and introduce pollen from economically useful plants. Fortunately, the five major soil zones and two possible episodes of river flooding include alternating non-occupational and occupational deposits such that an evaluation of the impact of human activities on the pollen spectra can be attempted. In addition, the occupations of Zones 2 and 4 differ in intensity with a more permanent occupation suggested from Zone 4 and intermittent and short-term occupations inferred for Zone 2 (See Chapters VIII and X). These differences in the nature of prehistoric occupations also allow comment on the biases in pollen spectra introduced from human activities.

Sample Treatment

Attempts to recover pollen from soils of the El Paso area have had variable success. Freeman (1972) was able to extract pollen from deep alluvial sediments in south central New Mexico; Spaulding (n.d.) had good recovery of pollen from a shallow archeological site near Las Cruces, New Mexico; and Horowitz, Gerald, and Chaiffetz (n.d.) have reported on pollen from four shallow archeological sites near El Paso. However, Whalen (1977) and Holloway (n.d.) were unable to recover pollen in sufficient amounts for analysis from archeological sites on the alluvial slopes east of the Franklin Mountains and in the Hueco Bolson east of El Paso. Some concern, therefore, existed as to whether pollen was preserved in the various strata of Site 33 North, and considerable effort was expended by Cully and Clary (Appendix B) in attempts to extract pollen in sufficient quantities for analysis. Howowitz, Gerald, and Chaiffetz (n.d.) had previously shown that pollen could be obtained from Zones 1 and 4 of Site 33 North, but some questions still remained with respect to pollen preservation in the other soil zones and other areas of Site 33 North.

Pollen grains in Southwestern soils are often poorly preserved and are usually found to be in an eroded and crumpled condition, and relatively large soil samples are generally required to obtain sufficient pollen for reliable counts of the represented taxa (Martin 1963; Mehringer 1967). Horowitz, Gerald, and Chaiffetz (n.d.) recognized this problem and used very large samples weighing 500-1000 grams from Zones 1 and 4. These samples were treated with hydrochloric acid to remove carbonates and then "swirled" to get rid of the coarse mineral fraction. After settling for 24 hours, organic material was separated from the finer mineral fraction with a zinc bromide solution. Pollen was then concentrated by mechanical sieving, and the residue collected between 120 and 20 micron sieves, saved, and mounted on microscope slides for study. Their technique differs from that employed by Cully and Clary (Appendix B) in the use of very large soil samples and the avoidance of chemical treatments in preference of physical separation of the pollen from the mineral material.

Two techniques of pollen extraction from soil samples were utilized by Cully and Clary (Appendix B). The first method made use of a technique developed by Dr. Roger Y. Anderson of the Department of Geology of the University of New Mexico which concentrates pollen-laden sediment in settling tubes. Soil samples weighing 15-20 grams were processed with this technique which involves the following steps:

> Step 1. A soil sample of 15-20 grams was ground with a mortar and pestle and washed through a 180 micron screen into a beaker.
>
> Step 2. Carbonates were removed by the addition of 5-10 milliliters of hydrochloric acid to the beaker and this was followed by the centrifugation and washing of the samples several times.
>
> Step 3. A dispersing solution of 3.3% sodium hexametaphosphate was added to the beaker, and the sample was thoroughly mixed and poured into a settling tube filled with the dispersing solution. After 2 minutes, a clamp was placed on the tube above the heavy sand grains which had settled in the bottom of the tube.
>
> Step. 4. The flexible tubing was removed after 19 hours, and the sediment above the clamp with soil grain sizes associted with pollen was transferred to a test tube. Spot checks were made to insure that pollen was not present in the sand, silt, and clay fraction left in the tubing and above the clamp.
>
> Step 5. The pollen bearing portion of the sediment from the settling tube was treated with 40% hydrofluoric acid in a hot water bath to remove silicates. This was followed by the washing of the remaining portion of the sample and the preparation of microscope slides.

The processing of soil samples by the above described technique reduced the original 15-20 gram soil sample to 1-3 milliliters of sediment with pollen. This technique had proven successful for obtaining sufficient amounts of pollen for analysis of small soil samples from northwestern New Mexico (Clary and Cully n.d.). However, this technique yielded unsatisfactory results with the poor pollen producing sediments of Site 33 North and was soon discontinued in favor of a second technique which concentrated more pollen from a larger soil sample and, therefore, had a greater likelihood of providing sufficient pollen for a minimum of 300 pollen grain counts (Cully and Clary, Appendix B).

The second technique utilized chemical treatments to remove carbonates, silicates, and organic debris from soil samples weighing 50 grams. This technique will not be described here but follows that developed by Mehringer (1967) and widely used in Southwestern palynological studies. The only important difference between the technique used in this study and the Mehringer method was the way in which the heavy sand fraction was separated from the rest of the sample. The Mehringer method utilized a "swirl" technique to remove the coarse sand fraction, while the technique used in this study employed a 180 micron sieve and washing to separate the larger sand grains. Chemical treatments reduced the 50 gram soil samples to 5-6 milliliters of sediment containing pollen. Although this technique proved more successful than the technique using settling tubes, only 19 of the 30 soil samples produced enough pollen for minimum 300 pollen grain counts (Cully and Clary, Appendix B).

Pollen Types

Designations standard to Southwestern palynology have been given to the identified pollen. Most pollen grains have been identified to either family or generic levels. Explanations of some of the pollen classifications are presented below (Cully and Clary, Appendix B).

> Cheno-Am. This category is made up of pollen type from members of the families Chenopodiaceae and Amaranthaceae that are morphologically indistinguishable with the light microscope. Examples of the genera included in this group are *Atriplex*, *Chenopodium*, and *Amaranthus*.
>
> Low Spine Compositae. Included in this group are pollen grains of the sunflower family which have spines less than 1.5 microns in length. Species of this group are primarily wind pollinated and include those of the genera *Ambrosia* and *Xanthium*.
>
> High Spine Compositae. This group takes in pollen grains of the sunflower family which have spines greater than 1.5 microns in length. Many annual and perennial sunflowers of such genera as *Baileya*, *Helianthus*, and *Senecio* belong to this category. High Spine Compositae are usually insect pollinated.
>
> *Canotia* type. This category includes pollen resembling that of the genus *Canotia* but possibly produced by other genera.

Type A. Pollen of this category appears to be of the Gramineae or grass family. The grains are large and between 90 and 120 microns in diameter which is the same size as corn (*Zea mays*). However, it is not certain that these pollen grains are of corn. Annuli usually are not obvious because of the crumpled and corroded condition of most grains. In addition, they bear some similarity to a fungal spore recognized in the samples.

Ephedra spp. Most of the Ephedra pollen grains in the samples compare favorably with those of *Ephedra trifurca* but they are not readily distinguished from *E. torreyana* or *E. antisyphylitica*.

Pollen Profiles

The total pollen count and percentages of the identified taxa for each soil zone of each pollen sampling location are given in Table 4, and the percentages of major pollen types from Pollen Sampling Location One are shown in Figure 17. The pollen spectra from each location are briefly described below, and considerations of economic pollen and climatic inferences are taken up in the following sections.

Surface Sample

The surface sample is dominated by Cheno Ams which comprise 38.5% of the identified pollen grains and an additional 24.4% are of grasses (Gramineae). High and low spine composites have a combined percentage of 10.7%, and pine (*Pinus* spp.) contributes 5.6% to the surface pollen spectrum. Small amounts of juniper (*Juniperus* spp.), willow (*Salix* spp.). maple (*Acer* cf. *negundo*), oak (*Quercus* spp.), joint fir (*Ephedra* spp.), and creosotebush (*Larrea tridentata*) are also noted for the surface sample. In addition, salt cedar (*Tamarix* sp.), a historically introduced tree on the floodplain, also occurs in the surface sample.

The surface sample is comparable to subsurface samples in the high percentage of Cheno-Ams, moderate percentage of grasses, and low percentages of composites and pines. However, Cheno-Ams are noticeably less abundant in the surface sample than in subsurface samples, and grasses have their highest percentage in the surface sample. Differences in the pollen composition between surface and subsurface samples do not necessarily imply a difference in climate. As suggested by Cully and Clary (Appendix B), subsurface pollen grains have probably undergone differential destruction and preservation in the alkaline soils of Site 33 North. The soils of this site have a hydrogen ion activity of 8.15 to 8.96, and the possible oxidation of pollen grains is inferred by the low (0.4% or less) organic matter content of these same soils (measurements by the Soil, Plant, and Water Testing Laboratory of New Mexico State University). Potter (1967) has documented the differential oxidation of pollen grains in modern Southwestern alkaline soils, and the differential preservation of pollen in subsurface samples at Site 33 North is suggested by the greater variety of pollen types in the surface sample than in the soils of Zone 2 at Pollen Sampling Location One. This is also indicated by the better representation in the surface sample of willow which is a prolific producer of fragile pollen grains that do not preserve well.

The similarity of the pollen spectrum of the surface sample to those of subsurface samples is noted in the poor representation of the floodplain species cottonwood (*Populus* sp.), willow, and tornillo (*Prosopis* spp.) and of the desert shrubs such as mesquite (*Prosopis spp.*), *acacias* (*Acacia* spp.), and yuccas (*Yucca* spp.). Cottonwood, like willow, produces large quantities of pollen that does not preserve well. The presence of cottonwood and willow in the pollen samples of Site 33 North does reflect proximity to the Rio Grande but should not be expected to carry much information with respect to past environments. Tornillo, mesquite, acacias, and yuccas are all insect pollinated and shed very small amounts of pollen. The occurrence of these species throughout the pollen samples is indicative of their presence in the past on Site 33 North or nearby, but no trends are readily apparent from the small percentages of these species.

Horowitz, Gerald, and Chaiffetz (n.d.) report pollen percentages from the top of Zone 1 and some 6 m east of Pollen Sampling Location One. These percentages compare very well with those reported herein from the surface of Site 33 North and include slightly higher percentages of composites and pine and a somewhat lower percentage of Cheno-Ams. Salt cedar, a recently introduced tree of the floodplain, is noticeably absent, and this seems to suggest that their sample is from deposits of the last century or perhaps earlier.

Pollen Sampling Location One

The pollen profile of Pollen Sampling Location One includes many more samples and soil zones than do those of other pollen sampling locations and provides the basis for later discussions of climatic inferences. Therefore, some attention will be devoted to differences in the pollen composition of each soil zone and within the well-represented Zone 2 deposits. From Figure 17 it can be seen that the samples from Pollen Sampling Location One are similar in pollen composition but that trends or pat-

TABLE 4

POLLEN PERCENTAGES FOR SITE 33*

Pollen Sampling Location	Sample Number	Meters Below Datum	Zone	PINACEAE	Pinus spp.	Pinus ponderosa	Pinus edulis	Juniperus spp.	Quercus spp.	Juglans sp.	Celtis spp.	Populus sp.	Salix spp.	Salix cf. gooddingii	Acer cf. negundo	Ulmus spp.	CARYOPHYLLACEAE	Liquidambar sp.	Tilia sp.	BETULACEAE	Tamarix sp.	CHENO-AM	Sarcobatus spp.	GRAMINEAE	Ephedra spp.	High Spine COMPOSITAE	Low Spine COMPOSITAE	Artemisa spp.
Surface	-	-	1	-	5.6	-	-	1.4	1.4	-	-	-	1.1	1.7	2.8	-	-	-	-	-	2.2	38.5	-	24.4	2.2	4.8	5.9	-
Location One	1	4.70	1		insufficient pollen																							
	2	4.75	2	-	3.5	-	-	.3	-	-	-	-	-	-	-	-	-	-	-	-	-	91.5	-	.9	-	2.2	-	
	3	4.80	2	-	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	97.4	-	.3	.3	-	.3	-
	4	4.85	2	-	3.0	-	-	-	-	-	-	-	.2	-	-	-	.2	-	-	-	-	83.1	-	9.0	-	.8	.8	-
	5	4.90	2		insufficient pollen																							
	6	4.95	2	-	5.7	-	-	-	-	-	-	.2	-	-	-	-	-	-	-	-	-	43.8	-	19.3	2.4	.2	-	-
	7	5.00	2	-	1.3	-	-	-	-	-	-	-	.3	-	-	-	-	-	-	-	-	86.3	-	10.1	.6	.3	.3	-
	8	5.05	2	-	-	-	-	-	.6	-	1.3	-	-	-	-	.3	-	-	-	-	-	67.7	1.0	12.9	.9	4.5	1.6	-
	9	5.10	2	-	4.2	-	-	-	-	-	-	.3	-	-	-	-	-	-	-	-	-	80.1	-	12.0	1.2	.3	-	-
	10	5.15	2	-	3.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78.1	-	11.9	2.0	1.5	1.2	-
	11	5.20	2	-	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	77.6	-	15.8	.9	.9	-	-
	12	5.25	2	-	3.0	-	-	-	-	-	-	-	-	-	-	-	.6	-	-	-	-	83.0	-	8.8	.9	2.1	.3	-
	13	5.30	2		insufficient pollen																							
	14	5.35	3		insufficient pollen																							
	15	5.40	3	-	.3	-	.3	.3	1.3	.3	.6	.3	-	-	-	1.0	-	-	-	-	-	59.5	.3	19.7	.3	4.5	1.3	.3
	16	5.45	4A	-	.6	-	.3	-	1.0	1.0	-	-	-	-	-	-	-	.6	-	-	-	59.9		18.0	2.2	9.9	2.2	-
	17	5.50	4A	.3	.3	-	-	-	1.6	.6	.3	-	-	-	-	-	-	.3	-	-	-	68.4	-	15.1	2.3	1.9	.6	.3
	18	5.55	4A		insufficient pollen																							
	19	5.60	4	-	-	-	-	-	2.7	-	.7	-	.7	-	-	-	-	-	-	-	-	53.7	-	13.4	2.0	9.4	8.7	-
	20	5.65	4	-	-	-	-	-	1.3	-	.3	-	-	-	-	-	-	-	-	-	-	53.4	-	16.3	1.0	8.6	6.4	-
	21	5.70	4		insufficient pollen																							
	22	5.75	5A	-	2.9	-	-	.3	3.8	-	2.2	-	.3	-	-	1.3	-	-	.3	-	-	52.2	-	18.4	-	3.5	3.5	.3
Location Two	1	4.30	3		insufficient pollen																							
	2	4.42	3A	-	1.2	-	-	-	2.5	-	.3	-	-	-	-	.3	-	-	-	-	-	60.0	.6	12.0	.3	6.7	4.0	-
	3	4.62	3		insufficient pollen																							
	4	4.77	4		insufficient pollen																							
	5	5.17	5		insufficient pollen																							
Location Three	1	3.85	2	-	.6	.2	-	-	.4	-	-	-	-	.2	-	-	-	-	-	.2	-	75.3	7.0	5.8	2.4	1.4	.4	-
	2	4.05	2	-	.9	-	-	.6	-	-	.9	-	.6	-	-	.3	-	-	-	-	-	65.5	1.6	11.4	3.2	2.5	1.9	-

TABLE 4—Continued

Pollen Sampling Location	Sample Number	Zone	LEGUMINOSEAE	Prosopis spp.	Acacia spp.	LILIACEAE	Yucca spp.	Larrea tridentata	Fouquieria splendens	Lycium cf. pallidum	ROSACEAE	Cercocarpus sp.	CACTACEAE	Opuntia spp.	SOLANACEAE	Solanum cf. eleagnifolium	MALVACEAE	Sphaeralcea spp.	Croton spp.	EUPHORBIACEAE	cf. Dythyrea wislezenii	Abronia cf. angustifolia	Allionia sp.	CISTACEAE	Vitis sp.	Cleome sp.	Convolvulus spp.	Ilex sp.	Canotia Type	Type A	Total Number of Grains
Surface	-	1	1.1	-	-	-	-	4.2	.8	-	.3	-	-	-	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	356
Location One	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	2	-	.3	-	-	.3	-	-	.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	316
	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	315
	4	2	-	1.4	-	-	.8	-	-	-	.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	356
	5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	2	-	-	-	.2	-	-	-	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	425
	7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.3	-	.3	-	-	-	-	-	-	-	-	-	307
	8	2	-	-	1.3	-	-	.3	-	-	-	.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	310
	9	2	-	-	.9	-	-	-	-	-	-	-	-	-	-	-	.6	-	-	-	-	.3	-	-	-	-	-	-	-	-	332
	10	2	.3	.3	.6	-	-	.3	-	-	.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	337
	11	2	-	.3	.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	303
	12	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.3	.9	-	-	-	-	-	-	-	-	-	-	-	330
	13	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	3	.3	.6	1.3	-	.3	.3	-	-	-	-	.3	.3	-	-	-	.3	.3	-	-	-	-	.3	-	-	-	-	-	5.2	309
	16	4A	.3	.3	.6	-	-	-	-	-	-	-	.3	.3	-	-	-	-	-	-	-	-	-	-	.3	-	-	-	-	1.9	312
	17	4A	1.6	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.3	-	-	-	-	-	-	4.5	310
	18	4A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	19	4	-	-	-	-	-	-	-	-	.7	-	4.0	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	149
	20	4	1.3	.6	.6	-	.3	-	-	-	-	-	-	7.8	-	-	.3	-	-	-	-	.3	-	-	-	-	.6	-	-	.6	313
	21	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	22	5A	1.0	.3	4.4	-	-	.6	-	-	-	-	.3	-	-	-	-	.3	-	-	-	-	-	-	-	.3	-	-	.3	3.8	316
Location Two	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	3A	1.2	.3	-	-	.3	-	-	-	-	-	-	8.7	.3	-	-	-	-	.6	-	-	-	-	-	-	.9	-	-	.3	327
	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Location Three	1	2	.2	.2	-	-	.6	-	-	-	-	-	.2	-	-	-	-	.6	.2	.4	-	-	-	-	-	-	-	-	-	2.8	503
	2	2	.6	.9	-	-	.9	.3	-	-	-	-	-	-	-	-	-	-	.3	1.3	-	-	-	-	-	-	-	.9	-	5.7	316

*Adapted from Cully and Clary (Appendix B).

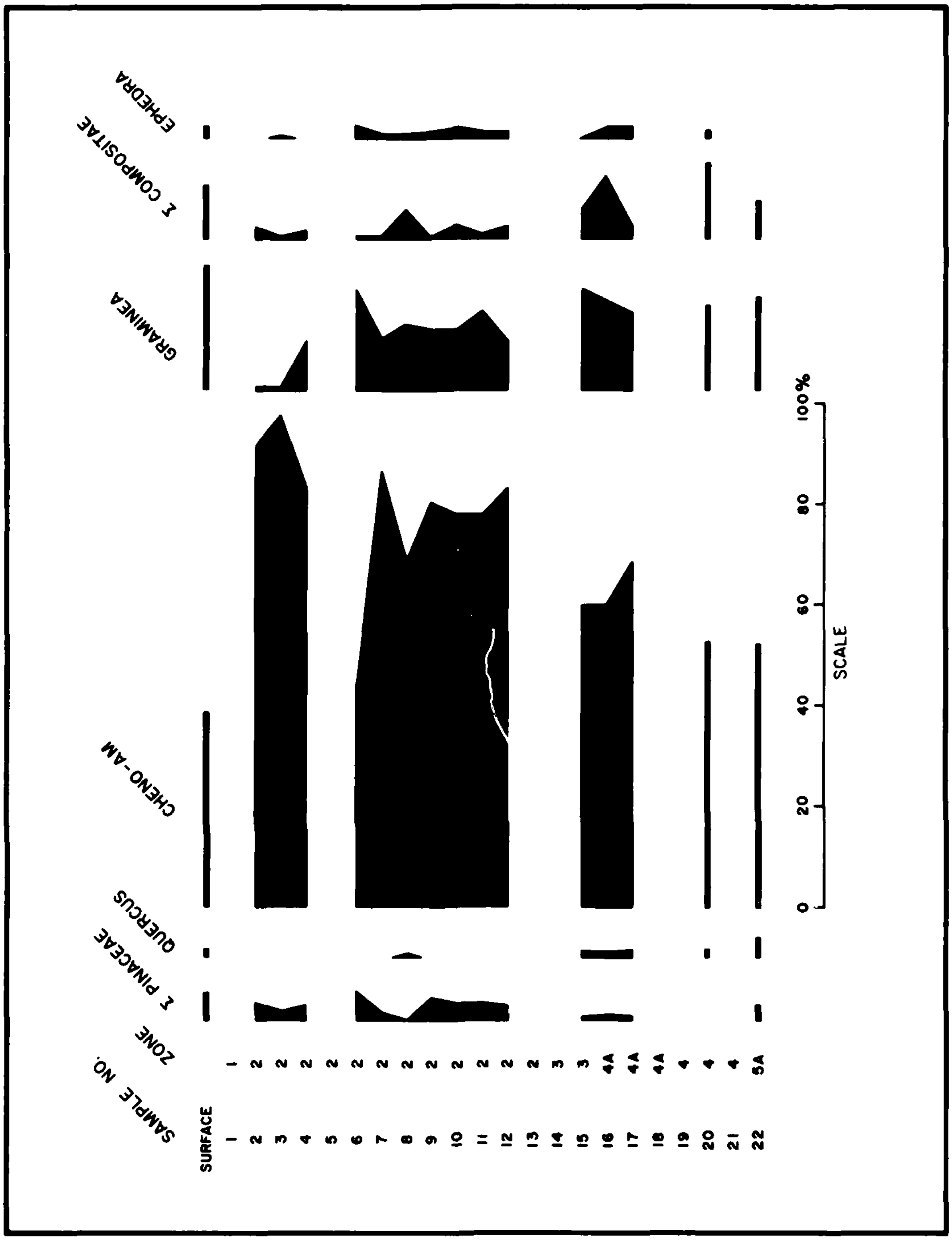

Figure 17. Major pollen types from the surface and Pollen Sampling Location One of Site 33 North (adapted from Cully and Clary, Appendix B).

terns in the major pollen types are apparent. The factors responsible for these patterns, however, are not so easily delimited and may include cultural as well as environmental variables. Discussions will center here on cultural factors and differences in depositional units which may bias pollen composition or affect preservation.

Pollen preservation is very poor in seven of the 22 samples, and insufficient pollen was recovered for counts of pollen grains which would reliably reflect the pollen composition of these samples. Six of these samples occur at the juncture of two soil zones, and this suggests that the surface of the lower zone at these junctures have been subjected to exposure with weathering. Poor pollen preservation at the surface of exposed sediments has also been noted by Freeman (1972) in south central New Mexico. The small amount of pollen found in samples just above the contact of two soil zones may also indicate the dilution of pollen with the vertical movement of soil water. The seventh sample with poor pollen preservation is located within Zone 2 deposits but no obvious change in soils is noted at the level of this sample. However, scattered stones and charcoal from small fire-cracked rock hearths to the north and east are noted at the level of this sample and suggest a past episode of surface deflation by wind action. The only contact between two soil zones which does not exhibit poor pollen preservation is that between Zones 4A and 3. Zone 4A soils are suggested to be Zone 4 soils redeposited by wind action, and the deposition of Zone 3 is thought to have taken place shortly after the deposition of Zone 4A or it is a continuation of an episode of eolian deposition that began with the deposition of Zone 4A and continued during the deposition of Zone 3 soils. In either case a prolonged period of surface exposure is not suggested.

Cheno-Am pollen dominates all of the samples from Pollen Sampling Location One and increases from slightly over 50% in the lower soil zones to over 90% in the highest samples of Zone 2 (Figure 17). High percentages of Cheno-Am pollen may be attributable to soil distrubances from human activity which encourages weedy species such as *Chenopodium* and *Amaranthus*. However, Cheno-Am pollen does not appear to vary with prehistoric occupation of the alluvial fan. Zones 3 and 5A which bear no evidence of prehistoric occupation do not have markedly lower percentages of Cheno-Ams, and Zone 2 samples have greater percentages of Cheno-Ams than do those from Zone 4 although the intensity of prehistoric occupation appears to have been greater during the occupation of Zone 4. The surface sample has a low percentage of Cheno-Ams, but this appears to be a reflection of the temporarily greater variety of pollen types in recent soils. The low Cheno-Am percentage for the surface sample certainly does not reflect the current soil distrubance of the alluvial fan noted in Appendix A. Today the alluvial fan and higher terraces and ridges are characterized by annuals of such families as the Compositae, Cruciferae, and Nyctaginaceae. Herbaceous species of the families Chenopodiaceae and Amaranthaceae are not to be found on the alluvial fan but are noted on soils of the floodplain just west of Site 33 and at the mouths of nearby arroyos where runoff is currently aggrading or degrading sediments. High percentages of Cheno-Am pollen in Zones 3 and 5A may reflect similar disturbances when the alluvial fan was actively being aggraded with sediments, but the higher percentages of Cheno-Ams in Zone 2 soils are not explicable in these terms. The presence of sand dunes during the deposition of Zone 2 suggests that the vegetation of the alluvial fan should have been comparable to that of today and that the contribution of weedy Cheno-Am species on the alluvial fan to the pollen spectra of Zone 2 should have been minimal. The implication is that the relative percentages of Cheno-Ams for the various soil zones do not necessarily monitor natural or human disturbances of the alluvial fan but may provide a measure of the local environment.

Differential preservation of pollen grains may also be responsible for the higher percentages of Cheno-Ams in Zone 2 samples than in those of the lower soil zones or of the surface sample as is noted by Cully and Clary (Appendix B). The differences in pollen profile composition between the surface sample and subsurface samples because of likely differential preservation of pollen types has already been discussed, and the concern here is with any possible bias in subsurface pollen spectra resulting from differential preservation. From Figure 17 it is seen that there is greater similarity in the composition of the pollen samples from Zones 3, 4A, 4, and 5A than there is between any of these and those from Zone 2. This distinction between pollen spectra at Pollen Sampling Location One parallels that for the deposition of soils at Site 33 where alluvial deposition characterizes earlier deposits and eolian deposition is noted for Zone 2 and the upper part of Zone 3. Thus, differences in the modes of deposition approximate differences in pollen composition and can be taken as indicative of differences in pollen preservation. In this respect, it is observed that the number of taxa represented in 300 or more grain counts ranges from 5 to 12 for Zone 2 samples and from 15 to 26 for the lower soil zones. It is noted also that Cheno-Ams occur in a lower percentage in Zone 2 samples at Pollen Sampling Location Three where pollen preservation appears to be better and where a large number of taxa (19) are represented in each sample. It seems that wind erosion and deposition of soils have inflated the percentages of Cheno-Ams (and perhaps pines) in Zone 2 samples at Pollen Sampling Location One. Later descriptions of the pollen spectra at Pollen Sampling Location Three will indicate that the percentage of Cheno-Am pollen are also higher for Zone 2 than for the lower soil zones at Pollen Sampling Location One.

The poor preservation of pollen at the juncture of soil zones has been interpreted as a result of exposure and weathering of the deposits in the lower zone; however, samples above or below these levels of poor pollen preservation do not manifest a recognizable pattern of differential pollen preservation. In addition, the presence of these poor pollen bearing levels does suggest that movement of pollen with percolating waters has been restricted to rather narrow vertical limits. This seems particularly likely in the lower soil zones where the silt and clay fraction of the soil is much higher than for the more permeable and sandier Zone 2 soils. The differences in pollen composition between soil zones are suggested, therefore, to be sensitive to differences in local pollen rain although differential preservation and soil water movement have probably altered the percentage of some pollen types and obscured somewhat the temporal variation in the composition of the pollen spectra for Zone 2.

The sample from the lower portion of Zone 1 did not yield adequate amounts of pollen for reliable counts of pollen grains. This is unfortunate because the sample from Zone 1 may have helped clarify questions concerning the high percentages of Cheno-Ams in Zone 2 by providing a pollen spectrum from more recent, non-occupational eolian deposits. However, at least one sample from each of the other soil zones at Pollen Sampling Location One did have sufficient pollen for 300 or more grain counts. The pollen composition of Zones 2, 3, 4A, 4, and 5A are briefly described in the remainder of this section.

Zone 2. The pollen spectra of Zone 2 are dominated by Cheno-Am pollen which accounts for more than 75% of the grains in all but two of the samples and for more than 90% in the two uppermost samples. The percentages of grasses vary between 0.3% and 19.3%, are generally less than the percentages in the lower soil zones, and decrease dramatically in the latest two samples. Together, Cheno-Ams and grasses account for over 90% of the pollen in all but two of the samples; therefore, it is not surprising that these two taxa show a pattern of inverse variability. Relatively few pollen types are represented in each sample from this zone (5-12) and the more important taxa include pines, composites, and joint fir (*Ephedra* spp.). Pines generally occur in percentages of less than 5% but are better represented than in most of the lower soil zones. High and low spine composites appear to vary directly with one another and generally have percentages of less than 5%. Composite pollen comprises larger percentages of the pollen spectra from lower soil zones. The pollen of joint fir occurs throughout Zone 2 in small amounts that never exceed 2.5% of the total pollen count for any single sample. Joint fir pollen shows a noticeable decrease in the three highest samples of this zone.

There are three portions of the pollen profile of Zone 2 which show substantial increases or decreases in pollen types compared to the other portions of the profile of Zone 2. The two uppermost pollen samples of this zone (Sample Nos. 2 and 3) exhibit the highest percentages of Cheno-Ams and the lowest percentages of grasses of the samples from this or other soil zones. The percentages of pines and composites are comparable to the rest of Zone 2, but joint fir is not as well represented as it is in the remainder of Zone 2 samples. These samples probably date from sometime after 1050-850 BP and sometime before 550-450 BP. The location of these samples at the top of Zone 2 soils makes the differential preservation of pollen a strong possibility; however, the temporal coincidence of these samples which date from after 1050-850 BP until before 550-450 PB, with inferred changes in Southwestern precipitation at about this time cannot be ignored. Climatic inferences from these and the other samples will be deferred for consideration in the final section of this chapter.

Sample No. 6 has the highest percentage of grasses and the lowest percentage of Cheno-Ams of any of the samples from Zone 2. The low percentage of Cheno-Ams is due, in part, to the presence of a high percentage of wolfberry *(Lycium* cf. *pallidum)* pollen. If the wolfberry grains are subtracted from the total pollen count, then the percentages of Cheno-Ams and grasses would become 60.8% and 26.8%. This would bring the percentage of Cheno-Ams more into alignment with that of other samples from Zone 2, but grasses would still have a high percentage. Pine and joint fir pollen also peak in this sample, and composite pollen is poorly represented. This sample is somewhat anomalous in the percentages of major pollen types as compared to patterns exhibited in these pollen types over the entire profile of Pollen Sampling Location One (Figure 17). That is, a higher percentage of composite pollen and a decrease rather than an increase in pine pollen would be expected to correlate with a decrease in Cheno-Ams and an increase in grasses. The presence of wolfberry in this sample and evidence of nearby disturbed or eroded small fire-cracked rock hearths just above this sample locus may indicate a modification of the pollen composition of Sample No. 6 as a result of human activity. This sample should date to a period just before 1050-850 BP.

Sample No. 8 of Zone 2 is of uncertain age though it may date to the period between 1600 BP and 1300 BP on the basis of its vertical position in Zone 2. This sample is noteworthy because of the low percentages of pines and Cheno-Ams and a high percentage of composite pollen compared to other samples of Zone 2. Grasses show only a slight increase over adjacent samples, and there are small percentages of oak and hackberry *(Celtis* spp.). This sample has a pollen composition similar to that of the lower soil zones.

Zone 3. Only one sample from the weathered eolian deposits of Zone 3 has enough pollen for a 300 grain count. There are a large number of pollen types (26) represented in this sample, and the pollen composition differs from those of Zone 2 samples insofar as it has lower percentages of Cheno-Ams (59.5%) and pines (0.6%) and somewhat higher percentages of grasses (19.7%) and composites (5.8%). In addition, arboreal pollen from species associated with riparian environments and with the lower elevations of mountains in this area and to the north are present in this sample which also includes small percentages of oak, hackberry, and walnut *(Juglans* sp.). The sample from this zone compares favorably with those from Zone 4A.

Zone 4A. The soils of Zone 4A appear to be Zone 4 soils which have been redeposited by wind action. The pollen composition of the two samples from Zone 4A with 300 or more grain counts is very similar to that of Zone 3 with the only notable difference being the somewhat higher percentages of joint fir pollen. The two samples from Zone 4A are also similar to the single sample from Zone 4 with a 300 grain count. Pine and walnut pollen types are missing from the Zone 4 sample, and the Zone 4A samples have somewhat higher percentages of Cheno-Ams and lower percentages of composites than the sample from Zone 4. There are 15 and 17 pollen types represented in the two Zone 4A samples.

Zone 4. Only one sample (No. 20) from Zone 4 yielded adequate pollen for a 300 grain pollen count. However, another sample (No. 19) with a total pollen grain count of only 149 has been included in Table 4 to support the suggestion that the percentages of major pollen types from the larger sample do reflect the pollen composition of Zone 4. As previously mentioned, the pollen composition of Zone 4 does not differ markedly from that of Zone 4A. The pollen composition of Zone 4 is also quite similar to that of Zone 5A while pines, oak, and hackberry pollen types are somewhat better represented in Zone 5A and composites and joint fir types occur in lower percentages. It was suggested earlier (Chapter V) that Zone 4 deposition occurred during a period of relative stability of the surface of the alluvial fan, but this is not substantiated by the change in the pollen spectrum of this zone relative to those above or below it.

Horowitz, Gerald, and Chaiffetz (n.d.) give percentages of pollen types recovered from the fill of House 2 which is located in Zone 4 some 6 m east of Pollen Sampling Location One. Hydrophilous trees such as cottonwood, willow, maple *(Acer* sp.), and ash *(Fraxinus* sp.) are well represented in their sample, and small percentages of smartweek *(Polygonum* sp.) and cattail *(Typha angustata)* are reported and suggest the presence of water not far from Site 33. This is also supported by the finding of burned seeds of smartweed and bulrush *(Scirpus* sp.) in Zone 4 deposits (Chapter VII)..

Horowitz, Gerald, and Chaiffetz (n.d.) give a high percentage for grasses (56.5%) and small percentages for Cheno-Ams (12%) and composites (6%). These percentages contrast sharply with those for grasses (16.3%), Cheno-Ams (53.4%), and composites (15.0%) from Sample No. 20 of Pollen Sampling Location One. These differences may be attributable to prehistoric human activities with larger amounts of grass pollen and perhaps hydrophilous tree pollen accumulating as a result of house construction or of other activities within houses. However, it is just as likely that the differences between these samples may reflect the dissimilarity in pollen extraction techniques (see the section on sample treatment). In this respect, it is noted that similar percentages of grasses, Cheno-Ams, and composites have been noted for deposits of comparable age to those of Pollen Sampling Location One from south central New Mexico, which is just to the north of the project area, by Freeman (1972) and Spaulding (n.d.) who used pollen extraction techniques following the preferred technique of this study.

Zone 5A. The soil of Zone 5A is a clay loam with a much higher clay content than the overlying soil zones. It was suggested (Chapter V) that the restricted occurrence of this thin zone in the northwestern portion of Site 33 North may indicated flooding of the site by the Rio Grande. Slightly higher percentages of pine, oak, and hackberry pollen are noted for Zone 5A than for Zones 3, 4A, and 4, but the pollen composition is, otherwise, not dissimilar from that of Zones 3, 4A, and 4. The pollen spectrum of Zone 5A implies that alluvial deposition with runoff from the Franklin Mountains could also be responsible for the Zone 5A sediments.

Pollen Sampling Location Two

The five samples from Pollen Sampling Location Two were intended to provide information from the alluvial deposits of Zones 3 and 5, the possible river sediments of Zone 3A, and from another location of Zone 4 soils. However, only the sample from Zone 3A was found to contain adequate amounts of pollen. The pollen composition and diversity of pollen types of this sample are comparable to those of Zones 3, 4A, 4, and 5A at Pollen Sampling Location One. The percentages of pine (1.2%) and oak (2.5%) pollen are similar to those of Zone 5A and are relatively high compared to those of Zones 3, 4A, and 4. Zone 3A, like Zone 5A, is a thin layer of clay loam with a limited occurrence in Site 33 North; it was suggested earlier (Chapter V) that both Zones 3A and 5A may represent sedimentation as a result of river flooding of Site 33 North. Nevertheless, the pollen spectra of Zones 3A and 5A are so similar to those of Zones 3, 4A, and 4 that it is not possible to determine whether these deposits are the result of river flooding or of arroyo alluviation.

Pollen Sampling Location Three

The two samples from Pollen Sampling Location Three are from Zone 2 deposits. Nineteen different pollen types are represented in each of these samples. The greater number of pollen types found in Zone 2 samples at Pollen Sampling Location Three as compared to Zone 2 samples at Pollen Sampling Location One suggest that the preservation of pollen is better at the former locus. This permits a comparison of Zone 2 samples from these two locations with respect to the differential preservation of major pollen types and an evaluation of the possible exaggerated importance of Cheno-Ams at Pollen Sampling Location One.

Sample No. 1 from Pollen Sampling Location Three is about the same age as Sample Nos. 2-4 of Pollen Sampling Location One, and all of these samples date to sometime after 1050-850 BP and before 550-450 BP. The sample from Pollen Sampling Location Three has smaller percentages of Cheno-Ams (75.3%) and pine (0.8%), similar percentages of grass (5.8%) and composites (1.8%), and a higher percentage of joint fir (2.4%) than Sample Nos. 2-4 at Pollen Sampling Location One. A small percentage of oak pollen also occurs in the sample from Pollen Sampling Location One. The differences in pollen composition between these samples does seem to suggest the differential preservation of pollen. However, the percentage of Cheno-Ams from Sample No. 1 at Pollen Sampling Location Three is still much higher than those for Cheno-Ams in Zones 3, 3A, 4A, and 5, and grasses and composites have much lower percentages. In addition, a substantial number of greasewood (*Sarcobatus* spp.) (7.9%) grains, mostly from a single clump of pollen grains, has lowered somewhat the percentages of other pollen types for Sample No. 1 of Pollen Sampling Location Three. The pollen composition of this sample comes closer to approximately those of Sample Nos. 2-4 at Pollen Sampling Location One, if this pollen type is subtracted from the total pollen count.

Sample No. 2 from Pollen Sampling Location Three is noted as having a lower percentage of Cheno-Ams (65.5%) and higher percentages of grasses (11.4%) and composites (4.4%) than Sample No. 1 from the same location. The percentages of joint fir and pine are similar and small for both of these samples. The differences between the two samples of Zone 2 at Pollen Sampling Location Three parallel the differences between the upper three samples and the lower samples of Zone 2 at Pollen Sampling Location One which have previously been described. Sample No. 2 at Pollen Sampling Location Three exhibits lower percentages of Cheno-Ams and pine than the lower samples of Zone 2 at Pollen Sampling Location One, and this would indicate differences in the preservation of pollen types between the two locations similar to that described for Sample No. 1 of Pollen Sampling Location Three and Sample Nos. 2-4 of Pollen Sampling Location One. The percentage of grass pollen in Sample No. 2 at Pollen Sampling Location Three is less than the percentages of grass pollen in soil zones below Zone 2, and the percentage of Cheno-Am pollen is higher and the percentage of composites pollen lower than in all but one of the pollen samples from soil zones below Zone 2.

The comparison of pollen spectra from Zone 2 at Pollen Sampling Locations One and Three does suggest that the preservation of pollen varies between these two locations and that Cheno-Ams and perhaps pines have magnified percentages at Pollen Sampling Location One. However, increases or decreases in major pollen types from the lower soil zones to Zone 2 which are magnified at Pollen Sampling Location One are also evidenced at Pollen Sampling Location Three. The high number of pollen types identified in single samples of Zone 2 at Pollen Sampling Location Three and the lower soil zones of Pollen Sampling Location One suggest that the preservation of pollen is comparable for these samples; and that, contrary to the findings of Cully and Clary (Appendix B), the trend in major pollen types are probably attributable to factors other than human activity or differential preservation of pollen types.

Economic Pollen

Many of the taxa found in the pollen samples at Site 33 North have ethnographically or archeologically recorded uses. However, there are few of these taxa whose representation in the pollen spectra is suggestive of past human activity. These taxa include wolfberry, prickly pear and other cacti, and the Type A category. Other pollen types occur consistently as components of the modern and fossil pollen spectra or infrequently with percentages so small as to make questionable any inference of human introduction.

Wolfberry *(Lycium* cf. *pallidum)* accounts for 0.9% of the pollen in Sample No. 2 and 28.0% of the pollen in Sample No. 6 from Zone 2 deposits of Pollen Sampling Location One. This species does not grow today on Site 33 North and is generally associated with shrubby vegetation of the valley border. Wolfberry is also an insect pollinated plant, and the finding of such a large percentage in Sample No. 6 of Pollen Sampling Location One suggests the introduction of flower parts to Site 33 North rather than the chance occurrence of pollen grains as part of the normal pollen rain. The presence of wolfberry was noted (Chapter VII) in the wood charcoal of Zones 2 and 4 of Site 33, and Harrington and Matsumura (1967) report that the berries of this species are edible and were gathered by Southwestern Indians. Basehart (1974), however, makes no mention of the use of wolfberry by the Mescalero Apac' ; whose historic range included the Rio Grande in the vicinity of El Paso.

Prickly pear *(Opuntia* spp.) and other cacti are also insect pollinated taxa whose presence in other than small percentages in pollen spectra may be attributed to human activity. Cacti occur infrequently near Sites 33 and 34 and are more common in the Upper Bajada and Mountain environmental zones (Chapter II). The fruits of prickly pear and other cacti are edible and were widely used by the Mescalero Apache (Basehart 1974). Numerous prickly pear seeds were found in House 4 of Zone 4 at Site 33 (Chapter VII).

Prickly pear and other cacti pollen were found in samples from all soil zones except Zone 2 at Site 33 North. The percentages of prickly pear and other cacti pollen range from 4.0% to 7.8% for Zone 4 samples and imply the use of cacti fruits during the Archaic occupation of Site 33. Very small percentages of these pollen types (a total of 5 grains) occur in the samples from Zones 3, 4A, and 5A. This may be taken as the chance occurrence of these pollen types in the samples or the results of the possible movement of pollen grains between Zones 4 and 5A with percolating soil water and of the mixing of Zone 4 deposits with the later eolian deposits of Zones 3 and 4A. The large percentage of prickly pear (8.7%) in the sample from Zone 3A is not understood. There is no known prehistoric occupation of Site 33 during the deposition of Zone 3A, but the river flooding or arroyo runoff which resulted in the deposition of Zone 3A may have eroded portions of Zone 4 and incorporated pollen from Zone 4 with that from Zone 3A sediments.

The type A pollen category includes palynomorphs which appear to be of the grass family and strongly resemble corn *(Zea mays)*. However, the poor condition of these pollen grains does not allow positive identification (Cully and Clary, Appendix B). Small percentages of Type A pollen were found in all soil zones including the non-occupational deposits of Zones 3, 3A, and 5A and the secondary eolian deposits of Zone 4 in Zone 4A. The presence of Type A pollen in the non-occupational deposits could be the product of water movement and pollen transport through soil profiles or the result of secondary deposition of soils with wind or water erosion of occupational deposits, but this is uncertain. Macrofloral evidence of burned corn was not found in the deposits of Sites 33 and 34 (Chapter VII).

If Type A pollen is corn pollen, then its occurrence in Zones 4 and 5A would be dated to 4450-3750 BP or possibly somewhat earlier. Very few archeological sites in the Southwest bear evidence of corn at such an early date. Macrofloral remains of corn which date between 5000 BP and 4000 BP have been reported from Bat Cave in a mountainous area of west central New Mexico (Dick 1965) as well as at about 3600 BP from Fresnal Shelter in the Sacramento Mountains northeast of the project area (Human Systems Research 1972). Irwin-Williams and Tompkins (1968) note the presence of corn pollen in deposits dating to about 3500 BP at En Medio Shelter which is in a plateau area of north central New Mexico. Corn pollen was also found in deposits dating to 4000 BP or somewhat earlier at Cienega Creek in the mountains of east central Arizona (Martin and Schoenwetter 1960). Additional archeological and palynological studies are needed to clarify the question of the possible occurrence of corn at Site 33. It is not unreasonable to expect evidence of corn as early as the suggested date of 4450-3750 BP for Zone 4 or the somewhat earlier Zone 5A. Corn has not been reported, as yet, from other low elevation and semiarid environments of the Southwest at this date, and the documentation of the presence or absence of corn pollen or macrofloral remains of corn in the earlier deposits of Site 33 would provide important new information on the temporal and spatial distribution, and perhaps the varieties, of corn.

Climatic Inferences

The previous detailed description of the pollen composition of samples from Site 33 North has implied that differences in the percentages of major pollen types between soil zones is not explicable solely in terms of past human activity nor of the differential preservation of pollen. In addition, it has also been suggested that the pollen spectra are responsive to the pollen rain of the local environment and not just to that produced by the vegetation of the alluvial fan of Site 33 North (see Cully and Clary, Appendix B, for contrary opinion). The trends in major pollen types at Pollen Sampling Location One (Table 4, Figure 17) may, therefore, be taken as suggestive of variations in the environment of the area. The samples from Zone 2 at Pollen Sampling Location Three indicate that the trend are probably real rather than sampling error, although some pollen types have exaggerated percentages in Zone 2 deposits at Pollen Sampling Location One probably because of poor pollen preservation. The sample from Zone 3A at Pollen Sampling Location Two is also very similar to that of Zone 3 at Pollen Sampling Location One.

Discussions are best focused on variability in the pollen spectra of Pollen Sampling Location One, for the pollen spectra bespeak variation in the environment and not climatic change for the last 4,000 or perhaps 5,000 years. All of the pollen spectra from Site 33 North are dominated by high percentages of Cheno-Ams with smaller amounts of grasses and composites. An increase in Cheno-Ams and a decrease in grasses and composites for Zone 2 deposits are indicated but are viewed as reflecting a relatively small modification in the inferred shrub-grassland vegetation of the area (Chapter VII and Cully and Clary, Appendix B).

Desert shrubs such as mesquite, acacia, creosotebush, and yucca are represented in the oldest pollen samples from Zones 4 and 5A and are well represented in Zones 2 and 3. The presence of these species and other shrubs which characterize the local arroyo vegetation has been noted in the wood charcoal of Zones 2 and 4 (Chapter VII). The distribution of desert shrubs was probably more restricted and different from that of today, but this cannot be substantiated by the pollen spectra of Site 33 North. Many desert shrubs are insect pollinated and shed very small amounts of pollen. Therefore, the small percentages of mesquite, acacia, creosotebush, and yucca pollen only imply that these species were components of the vegetation of the alluvial fan and perhaps of the nearby hillsides and arroyos at 5000-4000 BP.

Cottonwood, willow, and wolfberry are the only pollen types which are directly referrable to the vegetation of the floodplain, but they occur infrequently or in percentages too small to suggest anything more than the proximity of Site 33 to the Rio Grande. The valley species, of cottonwood, wolfberry, and perhaps tornillo are recorded in wood charcoal samples from Zones 2 and 4 (Chapter VII).

Joint fir is found in small amounts in all soil zones except Zone 5A where its absence may only reflect a bias in sampling. Freeman (1972) suggests that joint fir is a component of desert grasslands in the area, and it is noted that percentages of joint fir generally follow those of grasses and decrease substantially along with grasses in the upper portion of Zone 2. The joint fir pollen from Site 33 North appears to be of the *Ephedra torreyana* type (Cully and Clary, Appendix B) which Martin (1963) associates with environments characterized by summer precipitation. Summer precipitation can also be inferred from the presence of small percentages of herbaceous species such as mallows *(Malvaceae* and *Sphaeralcea* spp.), spectacle pod (cf. *Dithyrea wislezeni)*, sand verbena *(Abronia* cf. *angustifolia)*, and umbrella-wort *(Allionia* sp.).

The percentages of Cheno-Ams, grasses, and composites in the pollen spectra of Site 33 North are comparable to those recorded for these pollen categories by Spaulding (n.d.) for deposits of similar age on a ridge overlooking the Rio Grande Valley near Las Cruces, New Mexico. However, the percentages of grasses and composites are about half and the percentages of Cheno-Ams are about twice those of these same pollen types described by Freeman (1972) for deposits of comparable age in an area of desert grassland away from the river in south central New Mexico and north of the project area. These data suggest that the pollen spectra of Site 33 North include higher percentages of Cheno-Ams than Freeman's samples because of the greater natural disturbance of soil surfaces associated with the lower reaches of arroyos and the floodplain at Site 33 North. In addition, the difference in the relative importance of these three pollen types between valley border deposits and the desert grassland area away from the river may also be useful in ascertaining the nature of environmental variability from change in the composition of the pollen profile at Pollen Sampling Location One.

That is, increases in grasses and composites may be referrable to periods of increased effective precipitation and less soil disturbance, while increases in Cheno-Ams may indicate periods of less effective precipitation, increased runoff, erosion with dissection of soils, and a lower water table. These patterns are also noted by Martin (1963), Schoenwetter (1970), and others along with the preference of Cheno-Ams for more alkaline soils and the association of Cheno-Ams with heavy summer rains and composites with light summer rains in the Southwest.

The pollen composition of samples from Zones 3, 4A, 4, and 5A at Pollen Sampling Location One and Zone 3A at Pollen Sampling Location Two are too similar to one another to suggest anything other than that they were probably the products of similar environments. However, the pollen spectra from Zone 2 samples are much different from those of lower soil zones. At Pollen Sampling Location Three where the preservation of pollen in Zone 2 soils appears to be better than at Pollen Sampling Location One, the percentages of Cheno-Ams are about 5% to 15% higher, composites are roughly 5% lower, and grasses are somewhat lower than the percentages for these pollen types in the lower soil zones. The pollen spectra from Zone 2 at Pollen Sampling Location One also reflects these changes in the contribution of Cheno-Am, grass, and composite pollen, but the differences are more marked because of the suspected differential preservation of pollen.

The increase of Cheno-Am pollen and the decrease of composite and grass pollen for the period between 2150-2050 BP and 550-450 BP may be taken to indicate less effective precipitation and perhaps heavier summer thunderstorms with more runoff leading to arroyo cutting and dissection of valley border sediments than during the earlier period represented by the samples from Zones 3, 3A, 4A, 4, and 5A. This interpretation generally follows that derived from the analysis of the stratigraphy of Site 33 (Chapter V). The aggradation of the alluvial fan from sometime prior to 4450-3750 BP to sometime before 2150-2050 BP is followed by dissection of the alluvial fan with arroyo cutting and the establishment of sand dunes. The stratigraphy of Site 33 is correlated with that of other areas of the Southwest and suggests that there was a decrease in effective precipitation or an increase in aridity and that there were more energetic summer rain storms during the period of Zone 2 deposition than during the deposition of the earlier soil zones.

The relative increase in Cheno-Am pollen and the decrease in composite pollen from the lower soil zones up to Zone 2 of Site 33 North also follows similar changes of these pollen types in late Holocene or post-Altithermal deposits as given by Martin (1963) for southeastern Arizona and by Hafsten (1961) for the plains of west Texas Although the increase in Cheno-Ams and decrease in composites at Site 33 North is not as conspicuous as those between Martin's Pollen Zones II and I and between Hafsten's Zones A2 and A1, the correspondence of the change in the relative proportions in these three areas does lend credence to the reality of the observed increase in Cheno-Am pollen and decrease in grass and composite pollen in Zone 2 of Site 33 North.

Although the ecological preferences of Cheno-Ams and composites may be useful in the interpretation of stratigraphy, Martin (1963) warns that the Cheno-Am and composite pollen content of sediments may not by itself provide information on the regional climate. This is perhaps most evident from the suggestion that the period of Zone 2 deposition may be characterized by less effective precipitation or perhaps by increased aridity and more energetic summer thunderstorms with increased runoff. Increased aridity and runoff do not intuitively go together without some auxiliary information which is not provided by the relative contribution of Cheno-Ams and composites. To this end, the contribution of pine, oak, walnut, and hackberry to the pollen spectra of Pollen Sampling Location One will be considered.

Pine pollen is not well represented in the lower soil zones of Site 33 North, but it increases noticeably in Zone 2 deposits. High percentages of Pine pollen in desert areas far from coniferous forests can be attributed to long distance transport and to relative enhancement by poor local pollen production (Hevly, et al. 1965; Martin and Mehringer 1965). Thus, the higher percentages of pine in Zone 2 samples may be indicative of a decrease in local pollen production corresponding to a period of less effective precipitation or of greater aridity. These conditions could also be responsible for reduced vegetation cover which can, in turn, result in greater runoff during heavier summer rain storms.

The percentages of oak, walnut, and hackberry are much larger for the lower soil zones than they are for Zone 2 of Site 33 North. These three pollen types also occur consistently in the lower soil zones but infrequently in the samples from Zone 2. The decrease in the pollen of these species, which are not found near Site 33 today, suggests a period of increased aridity or of less effective precipitation during the deposition of Zone 2 that also had its effect on the pollen production of these species. The closest walnut is found in mountains north of the study area in New Mexico, and hackberry and oak occur in the Franklin Mountains east of Site 33 and in the lower elevations of other nearby mountains. O'Laughlin (1977a) and Van Devender and Riskind (1979) note the probable diminution in the numbers of oak, hackberry, and other mesophytic species as a result of increasing aridity within the last 2,000 years in the Hueco Mountains east of El Paso.

The discussion above has been oriented towards contrasting the pollen composition of samples from Zone 2 with that of the lower soil zones of Site 33 North. However, it should be emphasized that the differences between Zone 2 and the lower soil zones in pollen composition are viewed as being relatively small and not indicative of a change in climate. Allowing for the effects of differential preservation of pollen in subsurface samples and the particularly poor preservation of pollen in Zone 2 samples at Pollen Sampling Location One, all of the pollen spectra from Site 33 North appear to be very similar and indicative of a single climate. Large changes in vegetation are not suggested for the last 4,000 or perhaps 5,000 years by the pollen spectra of Site 33 North, although a slight reduction in vegetation cover and a probable increase in desert shrubs for the period between 2150-2050 BP and 550-450 BP could be argued from the pollen data.

The pollen sample from Zone 4 dates to 4450-3750 BP, and the sample from Zone 5A is older but of uncertain age. At about 5000-4000 BP changes in Southwestern climate have been proposed which generally follow two opposing views. On the basis of alluvial stratigraphy, Antevs (1955) infers a hot and dry climate for the period before 5000-4000 BP which he calls the Altithermal and a moister and cooler climate comparable to that of today for the period after 5000-4000 BP which he calls the Medithermal. Martin (1963) suggests from palynological studies that the period before 5000-4000 BP was probably characterized by heavy summer monsoonal rains with greater precipitation than occurred afterwards.

The pollen samples from Zones 4 and 5A do not differ appreciably from one another or from the samples from Zones 3, 3A, and 4A. This suggests that the samples from Zones 4 and 5A are too recent to contain evidence of changes in climate and vegetation which may have occurred at about 5000-4000 BP. Freeman (1972) notes changes in pollen spectra dated to this time just north of the project area in southern New Mexico which he interprets as supporting Antevs' hot and dry Altithermal. However, changes in pollen composition similar to that documented by Freeman have been taken by Martin as evidence for heavy, summer monsoonal rains before 5000-4000 BP. It is unfortunate that the sample from Zone 5 at Pollen Sampling Location Two did not have adequate amounts of pollen to allow additional comments on the older sediments at Site 33 North. palynological studies will hopefully continue at Site 33 with the analysis of more samples from the deeper portions of Zone 5 which may provide information on suggested changes in vegetation and climate at 5000-4000 BP.

The pollen samples from Zones 3, 3A, 4A, 4, and 5A date from sometime prior to 4450-3750 BP to sometime before 2150-2050 BP. The pollen spectra of these soil zones are similar to one another and not greatly dissimilar to that of the surface sample. The climate is suggested to have been much like that of today with most of the precipitation falling during the summer months. Differences in pollen composition between these soil zones and Zone 2 imply, however, that precipitation was more effective, perhaps somewhat greater annually, and that runoff was less energetic during the deposition of the lower soil zones than it was during the deposition of Zone 2. These views conform to those developed as a result of the study of the stratigraphy of Site 33 (Chapter V) where evidence of alluvial aggradation is recognized sometime before 2150-2050 BP and arroyo cutting and duning thereafter. Numerous studies are reviewed in Chapter V that suggest more mesic or more arid intervals during the period covered by the deposition of Zones 3, 4, and 5; however, such variations in the environment are not evident in the few pollen samples from these soil zones from Site 33 North. Evidence of arroyo cutting is noted in the upper portions of Zone 3 which is correlated with an arid interval and arroyo cutting reported elsewhere in the Southwest at about 2500 BP (Antevs 1955). The pollen spectrum from Zone 3 does not reflect a more arid interval and does not differ from the spectra from either Zone 3A or the lower soil zones. It is quite possible that the pollen samples from Zones 3 and 3A date to somewhat before 2500 BP and therefore should not be expected to provide information on this later incident of arroyo cutting.

Freeman (1972) infers a drying trend beginning sometime between 2200 and 1100 BP from his pollen record of deposits in southern New Mexico. This drying trend could be temporally correlated with the episode of arroyo cutting in the later deposits of Zone 3 or with the intensification of duning recorded in Zone 2 sands. However, changes in the frequencies of pollen types that occur in Freeman's data in a uniform fashion across a depositional disconformity representing a hiatus of as much of 2,300 years may not be reliable. If the pollen samples which Freeman takes to indicate a drying trend after 2200 BP and before 1100 BP are discounted because of possible bias in pollen composition, then the pollen record from Freeman's study would show no obvious change in vegetation for the last 4,000 years. This would certainly be more in line with the inference drawn from the pollen record of Site 33 North. In this case Freeman's suggested return to more mesic conditions just prior to 1100 BP based on the presumed previous drying trend would also lose its significance. This will have some bearing on the discussion of variability in samples from Zone 2.

The pollen composition of samples from Zone 2 has been taken to reflect a period of somewhat less effective precipitation than during the deposition of the lower soil zones. It has also been implied that runoff may have been more energetic with a possible increase in the intensity of summer thunderstorms or a decrease in vegetation cover. Slope erosion, arroyo cutting, and the dissection of alluvial fans bordering the valley would all tend to decrease available soil moisture to plants and would remove or disturb soils and vegetation. All of these effects could be argued from the apparent increase in Cheno-Ams seen in the samples from Zone 2. The pollen spectra from Zone 2 are not totally like one another, and intervals of more, or less, effective precipitation could be suggested from lower or higher percentages of Cheno-Ams or other pollen types. However, the poor preservation of pollen at Pollen Sampling Location One and possible alterations in pollen composition as a result of human activity do not permit firm statements relative to environmental variability during the deposition of Zone 2.

Of the 11 pollen samples from Zone 2 at Pollen Sampling Location One, four samples stand out as having higher or lower percentages of Cheno-Ams and other pollen types (Figure 17). The pollen compositions of Sample Nos. 2 and 3 are noted as having the highest percentages of Cheno-Ams and the lowest percentages of grasses for any of the samples from Site 33 North and can be taken as indicative of an interval of effective annual precipitation that was less than that of any other time represented by the samples from Site 33 North. These samples date between 1050-850 and 550-450- BP, and an interval of decreased annual effective moisture or increased aridity has also been suggested for the Southwest during this time span by Antevs (1955), Bryan (1954), Bryson and Wendland (1967), Hill and Hevly (1968), Schoenwetter (1970), and many others. Sample No. 6 exhibits a very low percentage of Cheno-Ams and a high percentage of grasses which suggests a more mesic period just prior to 1050-850 BP. However, the possible alteration of the pollen composition as a result of human activity and wind erosion of surfaces at the level of this sample and just above make questionable any environmental inference from Sample No. 6. Sample No. 8 has the lowest percentage of Cheno-Am and pine pollen and the highest percentage of composite pollen of any sample from Zone 2, and the similarity of the pollen spectrum of Sample No. 8 to those of the soil zones below Zone 2 suggests an interval of increased effective precipitation which may date after 1300 BP and certainly before 1050-850 BP. Bryson and Wendland (1967), Hill and Hevly (1968), and Schoenwetter (1970) are among those who infer a more mesic environment for portions of the Southwest for times approximating those for Sample Nos. 6 and 8. Closer to El Paso, Freeman (1972) suggests a more mesic interval beginning about 1100 BP in southern New Mexico, but the evidence for the implied increase in effective precipitation has been questioned above. Van Devender and Worthington (1977), however, do note a wet period just prior to 1000 BP in southwestern New Mexico. Once again, it should be emphasized that variation in the pollen composition of samples from Zone 2 may be attributable to factors other than climate and vegetation and that implications of more moist or arid intervals within the time span covered by the deposition of Zone 2 are based on a limited investigation of these soils and should be viewed with skepticism.

The goal of the discussion of this palynological study has been to ascertain whether or not pollen is present at Site 33 North which might provide evidence relevant to past environmental conditions. In many respects this goal has been achieved but there remains debatable opinions concerning factors that may have affected the relative importance of pollen types. The more important of these factors are the movement of pollen within soil profiles, differential preservation of pollen with differences in the nature of depositional units, and alteration of the pollen composition as a result of human activity. These factors have been accounted for in some detail, and it has been possible to suggest some trends in the pollen record at Site 33 North. However, the evident poor preservation of pollen in most of the samples from Zone 2 and the representation of all other zones by only one or two samples does not make a strong case in favor of some of the interpretations of the pollen record. The correspondence of changes in the percentages of major pollen types with inferences drawn from the stratigraphy of Site 33. (Chapter V) is of some comfort and adds credence to observed trends in the pollen spectra from Site 33 North. Still, implications from the pollen record are best left to considerations of overall changes in the pollen spectra for long periods of time and not to short time intervals such as those for Zone 2. In this respect, the overall similarity of the pollen composition of samples from Site 33 North indicates that there has been no large change in vegetation or climate in the project area for the last 4,000 or perhaps 5,000 years. Periods of relatively more or less effective precipitation are, nonetheless, perceptible in the pollen records. The samples dating from shortly before 4450-3750 BP to sometime prior to 2150-2050 BP, the modern surface sample, and the sample from the upper portion of Zone 1 reported by Horowitz, Gerald, and Chaiffetz (n.d.) have similar pollen compositions which suggest comparability in vegetation and climate. The pollen spectra of these samples differ from those of Zone 2 which implies a period of somewhat decreased annual effective moisture (and perhaps considerable temporal variation in precipitation patterns) from 2150-2050 BP to 550-450 BP. Although a reduction in grass cover and an increase in desert shrub communities within the last 100 years or so have been noted by others with the aid of historic documents (see Gardner 1951; York and Dick-Peddie 1969), there are no pollen samples from Site 33 North for the period from 550-450 BP to about 100 BP which would allow comment on this period or on more recent changes in vegetation.

CHAPTER VII

MACROFLORAL AND FAUNAL REMAINS

The results of macrofloral and faunal studies at Sites 29, 33, and 34 are presented in this chapter. These studies were designed to provide information on past vegetational environments and possible prehistoric uses of plant and animal species. Macrofloral remains are considered under the two analytic categories of charcoal and seeds; comments on the faunal material follow those on the macrofloral remains.

Charcoal

All pieces of charcoal from woody perennial plants with any dimension of 0.5 cm or larger were segregated for species identification from smaller pieces of charcoal or recognizable plant parts (spines, leaves, etc.) during the field excavation of features and 1 m squares and during the laboratory preparation of soil samples to be processed for the recovery of seeds and other small plant and animal remains. A minimum dimension of 0.5 cm was the lower size limit for which charcoal specimens could be easily snapped and manipulated so as to allow microscopic inspection of the structure of the wood. Some charcoal was also separately packaged in aluminum foil for possible radiocarbon dating from many features and levels of the excavated 1 m squares, but the taking of radiocarbon samples did not pose a problem with the respect to diminishing the size or representation of samples for plant identification. Those locations from which charcoal was taken for radiocarbon samples either had charcoal of insufficient size for identification purposes or adequate amounts of charcoal which would permit the partitioning of charcoal into the two types of samples on the basis of the diameters of specimens and the suspected differences in the kinds of wood.

The identification of charcoal from woody perennial plants, as well as that from some of the leaf succulents, was provided by Donna R. Chapman of the Anthropological Research Laboratories of Texas A&M University and is summarized in Tables 5 and 6. Paul Minnis, who is currently associated with the Mimbres Foundation at the University of New Mexico, recognized the leaf fibers from Pit 5 of Zone 2 at Site 33 as being from a species of *Yucca*, and the writer also furnished identifications of the grasses, stem succulents, and some of the leaf succulents and added the miscellaneous and unidentifiable plant parts such as barks, leaves, and spines to Tables 5 and 6.

There are 777 charcoal specimens enumerated in Tables 5 and 6, and these specimens represent all of the leaf and stem succulents, grasses, and unidentifiable plant parts and nearly all of the charcoal from woody perennial plants. The specimens of woody perennials which were not analyzed are from Pits 6 and 7, Small Fire-cracked Rock Hearths 1, 2, 7, and 94, and Large Fire-cracked Rock Features 1, 2, and 3 from Zone 2 at Site 33. The abundance of charcoal in these features made it necessary to sample the charcoal from these features based on stem diameter and possible kinds of wood The features from which charcoal was identified are clearly noted in Tables 5 and 6, and the non-feature category in these tables includes pooled samples from 1 m square excavation units where no feature was evidenced or recognized. The non-feature area of Site 34 comprises only one sample, while 29 (7 from soil cores) and six samples are incorporated into the non-feature areas of Zone 2 and Zone 4 respectively of Site 33. The number of specimens for each site and zone reflects the differential preservation of charcoal. There are 15 specimens for Site 34, 92 for Zone 4 at Site 33, and 670 for Zone 2 at Site 33. Very little charcoal was found in the exposed features and shallow deposits of Site 34, and most of the charcoal from Zone 4 at Site 33 was preserved as very small fragments. Preservation of charcoal was best in the more recent deposits of Zone 2 at Site 33. In addition, no charcoal of sufficient size for identification was recovered from Small Fire-cracked Rock Hearth 1 at Site 29 or from Pit 9 in Zone 5 at Site 33 North.

The representation of species in the charcoal from Sites 33 and 34 is probably biased as a result of the preference of certain plants for particular uses by the prehistoric inhabitants of these two sites and should not be taken as a direct measure of the composition of the vegetation on or near these sites. However, the species identified in the charcoal from Sites 33 and 34 may well suggest the occurrence of at least these species in the vicinity of these sites. This is supported by the studies of Ford (1977),

TABLE 5

CHARCOAL IDENTIFICATIONS FROM ZONE 2 OF SITES 33 AND 34

Site	Zone Association	Acacia sp. (acacia)	Artemesia sp. (sagebrush)	Atriplex canescens (four-wing saltbush)	CACTACEAE (cactus family) (spine)	Chilopsis linearis (desert willow)	Ephedra sp. (Mormon tea)	Fallugia paradoxa (Apache plume)	GRAMINEAE (Grass family) (stem)	Larrea tridentata (creosotebush)	Lycium sp. (wolfberry)	Populus fremontii (cottonweed)	Prosopis sp. (mesquite or tornillo)	Prosopis glandulosa (mesquite)	Prosopis pubescens (tornillo)	Prosopis/Acacia
34	2															
	Non-feature Area	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
	Pit 1	-	1(1)	-	-	-	-	-	-	-	-	-	2(2)	-	-	-
	Pit 2	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
	Large Fire-cracked Rock Feature 1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
	Total for Zone 2	-	1	-	-	-	-	-	-	-	-	-	11	-	-	-
	Percent of Total	-	6.7	-	-	-	-	-	-	-	-	-	73.3	-	-	-
	Percent of Samples	-	25.0	-	-	-	-	-	-	-	-	-	100.0	-	-	-
33	2															
	Non-feature Areas	-	1(1)	-	-	-	-	-	2(1)	2	-	7	29(4)	-	3	8
	Pit 4	-	2(2)	-	-	-	-	-	1	-	-	-	-	-	-	-
	Pit 5	-	-	-	-	-	-	-	1	-	-	1	-	4	-	1
	Pit 6	5(5)	-	-	-	-	-	-	-	-	-	5	4	-	-	6
	Pit 7	-	-	-	-	-	-	-	-	-	-	31	40	12	-	6
	Small Fire-cracked Rock Hearths:															
	Hearth 1	-	-	-	-	-	-	-	-	-	2	-	-	4	11(8)	-
	Hearth 2	-	-	-	-	-	-	2(2)	-	2	-	-	17	-	-	-
	Hearth 3	-	-	-	-	-	-	-	-	-	-	-	5(5)	-	-	-
	Hearth 7	-	-	-	-	-	-	-	-	-	-	1	52	-	2	-
	Hearth 21						1(1)	-	-	-	-	-	2	-	-	-
	Hearth 32	-	-	8	-	-		-	-	-	1	-	1	-	-	-
	Hearth 94	-	-	-	-	-	-	-	-	1	-	1	15	-	-	-
	Hearth 83	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
	Hearth 109	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
	Large Fire-cracked Rock Feature 1	-	-	-	-	15(15)	-	-	-	-	-	-	24	-	2	8
	Large Fire-cracked Rock Feature 2	-	-	-	1(1)	-	-	-	18	1	1(1)	-	26	28(8)	15	-
	Large Fire-cracked Rock Feature 3	-	-	-	-	-	-	-	-	-	-	-	55(5)	-	-	-
	Total for Zone 2	5	3	8	1	15	1	2	25	6	4	47	271	48	33	29
	Percent of Total	0.7	0.4	1.2	0.1	2.2	0.1	0.3	3.7	0.9	0.6	7.0	40.4	7.2	4.9	4.3
	Percent of Samples	2.2	4.4	2.2	2.2	2.2	2.2	2.2	13.3	8.9	6.7	24.4	53.3	8.9	11.1	13.3

Parentheses indicate questionable identifications.

TABLE 5--Continued

Site	Zone Association	*Rhus microphylla* (little-leaf sumac)	*Yucca* sp. (yucca) (leaf base)	*Yucca* sp. (yucca) (leaf fiber)	Yucca/Agave: Leaf Base	Yucca/Agave: Leaf Fiber	Yucca/Agave: Matted Fiber	Yucca/Agave: Caudex	Yucca/Agave: Carpel (?)	Branch Fragment No ID	Burned Green Wood No ID	Bark/No ID	Bark or Leaf No ID	Leaf/No ID	Woody Spine No ID	Total
34	2															
	Non-feature Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Pit 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Pit 2	-	-	-	-	-	-	-	-	-	-	-	1	-	1	5
	Large Fire-cracked Rock Feature 1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4
	Total for Zone 2	-	-	-	-	-	-	-	-	-	1	-	1	-	1	15
	Percent of Total	-	-	-	-	-	-	-	-	-	6.7	-	6.7	-	6.7	100.1
	Percent of Samples	-	-	-	-	-	-	-	-	-	25	-	25	-	25	-
33	2															
	Non-feature Areas	-	2(1)	-	-	-	-	4	-	9	-	-	7	2	1	77
	Pit 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Pit 5	-	-	35	-	-	-	-	-	-	-	-	-	-	-	42
	Pit 6	-	-	-	-	2	-	-	-	-	2	-	-	-	1	25
	Pit 7	-	-	-	-	-	-	-	-	1	7	-	1	-	-	98
	Small Fire-cracked Rock Hearths:															
	Hearth 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
	Hearth 2	-	-	-	-	-	-	-	-	3	8	-	-	-	-	32
	Hearth 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
	Hearth 7	-	-	-	1(1)	-	-	-	3(3)	3	9	-	-	-	-	71
	Hearth 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Hearth 32	-	-	-	-	-	-	-	-	2	-	-	-	-	-	12
	Hearth 94	-	-	-	-	-	-	-	-	-	-	-	-	-	2	19
	Hearth 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
	Hearth 109	-	-	1(1)	-	-	-	-	-	-	-	-	-	-	-	4
	Large Fire-cracked Rock Feature 1	2	-	-	-	-	-	-	-	-	3	3	-	1(1)	2	60
	Large Fire-cracked Rock Feature 2	-	-	-	-	-	-	5(1)	-	-	31	-	2	1	-	129
	Large Fire-cracked Rock Feature 3	1	-	1(1)	-	-	1	1	-	1	8	-	1	1	1	71
	Total for Zone 2	3	2	37	1	2	1	10	3	19	68	3	11	5	7	670
	Percent of Total	0.4	0.3	5.5	0.1	0.3	0.1	1.5	0.4	2.8	10.1	0.4	1.6	0.7	1.0	99.2
	Percent of Samples	4.4	4.4	6.7	2.2	2.2	2.2	6.7	2.2	15.6	15.6	2.2	11.1	11.1	11.1	-

Parentheses indicate questionable identifications.

TABLE 6

CHARCOAL IDENTIFICATIONS FOR ZONE 4 OF SITE 33

Site	Zone Association	Chilopsis linearis (desert willow)	Echinocactus sp. (Turk's cap) (stem)	Fallugia paradoxa (Apache plume)	GRAMINEAE (Grass family) (stem)	Larrea tridentata (creosotebush)	Lycium sp. (wolfberry)	Phragmites communis (reed) (stem)	Populus fremontii (cottonwood)	Prosopis sp. (mesquite or tornillo)	Prosopis glandulosa (mesquite)	Yucca/Agave (Carpel ?)	Branch Fragment No ID	Burned Green Wood No ID	Leaf/No ID	Woody Spine No ID	TOTAL
33	4																
	Non-feature areas	1(1)	-	-	-	-	-	-	1(1)	9	-	1(1)	1	-	-	-	13
	Pit 1	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	3
	Small Fire-cracked Rock Hearth 5	-	-	.	-	-	-	-	-	-	-	-	-	-	-	1	1
	House 1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
	House 3	-	-	-	-	-	-	4	-	18(1)	-	-	-	1	1	-	24
	House 4	-	-	-	1	3	3	-	1	10	-	-	-	-	1	-	19
	House 6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
	House (?) 7	-	2(2)	-	-	-	-	-	-	-	20(20)	-	-	1	-	-	23
	House (?) 12	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	3
	House (?) 16	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
	House (?) 22	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	2
	Total for Zone 4	1	2	1	1	5	3	4	2	46	20	1	1	2	2	1	92
	Percent of Total	1.1	2.2	1.1	1.1	5.4	3.3	4.3	2.2	50.0	21.7	1.1	1.1	2.2	2.2	1.1	100.1
	Percent of Samples	6.2	6.2	6.2	6.2	18.7	6.2	6.2	12.5	62.5	6.2	6.2	6.2	12.5	12.5	6.2	-

Parentheses indicate questionable identifications.

Holloway (n.d.), and O'Laughlin (1979) where the woods recorded by them in archeological sites near El Paso generally follow the contemporary ecological distribution of these same plants. In this respect many of the species presently found on or near Sites 33 and 34 and described in Chapter VI also occur in the charcoal samples from these sites. These species include mesquite, four-wing saltbush, and creosotebush which are the principal species present today on the alluvial fan of Sites 33 and 34; desert willow, Apache plume, little-leaf sumac, acacia, sagebrush, mesquite, and Mormon tea, or joint fir, which are found in the arroyo east of Sites 33 and 34 or in other nearby arroyos; cottonwood, tornillo, wolfberry, mesquite, and four-wing saltbush which are important species of the floodplain and valley border; and creosotebush which currently is the major species of gravelly terraces and ridges above the valley floor.

Besides the presence of species in the charcoal samples which are major components of the modern vegetation on or near Sites 33 and 34, it is also noted that the representation of woody perennial species in the charcoal samples is comparable in Zone 2 of Site 33, Zone 2 of Site 34, and Zone 4 of Site 33. There are obvious differences between the occupational zones of Sites 33 and 34 in terms of the number of identified taxa, but these differences are largely attributable to variation in sample size. Only two taxa are recognizable in the 12 identifiable specimens from Site 34, whereas 12 different woody perennial types are recorded for the 475 identifications of charcoal from Zone 2 at Site 33. Seven taxa are also noted for the 78 identifiable pieces of charcoal from Zone 4 at Site 33, and the differences between Zones 2 and 4 of Site 33 are in five species which occurred in samples from only one or two locations of Zone 2. Dissimilarity between the occupational zones of Sites 33 and 34 in the number of represented woody perennials corresponds to variation in the number of identified charcoal specimens (and the number of locations sampled) and does not necessarily imply temporal dissimilarity in plant communities near these sites or differences in human activities. In addition, most species account for a small percentage of the total number of specimens or occur infrequently in samples [illegible] of the occupational zones. Although these [illegible] represented species are more subject [illegible] sample size, there does not appear [illegible] disparity in the composition [illegible] (arroyo, floodplain, etc. [illegible] larger samples of Zones [illegible] similarity of samples [illegible] Sites 33 and 34 is [illegible] contribution [illegible]

species make-up of each of the occupational zones. These better represented species will be considered below along with some preliminary comments on the kinds of features manifest in the occupational zones.

Species of the genus *Prosopis* dominate the identified, perennial woods at Sites 33 and 34. These species include mesquite and tornillo which were not distinguished from one another in most of the charcoal specimens, although mesquite specifically was identified somewhat more often than tornillo. Mesquite and tornillo make up over 80% of the identified woody perennials and occur in over 50% of the samples from each of the occupational zones. Mesquite wood makes an excellent fuel by yielding a bed of hot, slow burning coals, and the same may be true of tornillo. Mesquite was the most common firewood noted for sites in the Hueco Bolson east of El Paso and was apparently selected over other woods at those sites where it is not particularly abundant today (Ford 1977; Holloway n.d.; O'Laughlin 1979).

The deposits that compose Zone 2 of Sites 33 and 34 are thought to be the result of short term and intermittent occupations of the alluvial fan for a limited range of activities centering on the use of small and large fire-cracked rock features and various pits in which fires were built. With the exception of F[illegible] 4, mesquite or tornillo was recovered from all [illegible] samples with identifiable charcoal from [illegible] Zone 2. This finding attests to the [illegible] mesquite and perhaps tornillo [illegible] ever, the use of mesquite and [illegible] cupations which produced [illegible] Site 33 is not so clear [illegible] pear to be longer [illegible] evidence relative [illegible] are indicated [illegible] Zone 4 wh[illegible] [illegible]

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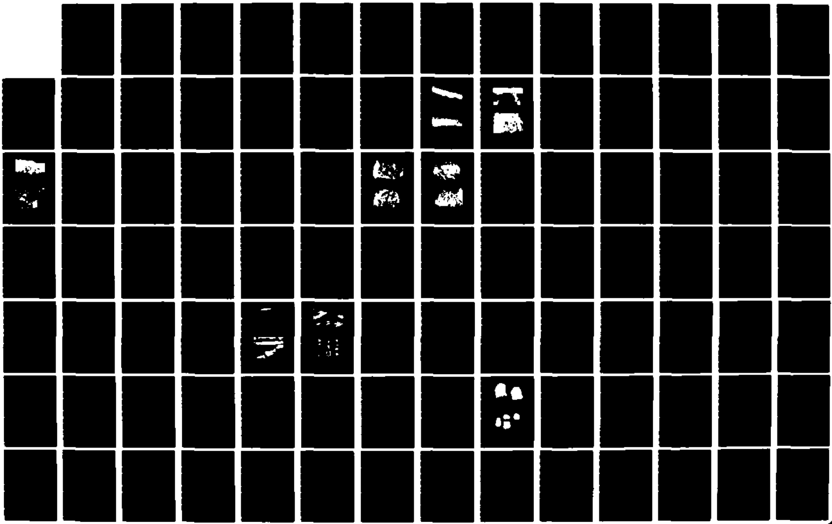
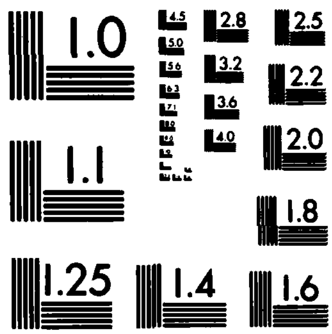




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Creosotebush and cottonwood occur less frequently in samples and account for a much smaller percentage of the identified charcoal of woody perennials from Site 33 than mesquite or tornillo, but they are somewhat better represented than any of the other species. Creosotebush is the third most important woody perennial for Zone 4 and was found in more samples from Zone 2 than any of the other species except mesquite or tornillo and cottonwood. Even though creosotebush is of minor importance when compared to mesquite or tornillo, the frequency of occurrence of creosotebush in samples suggests that it was an important species of the vegetation on the alluvial fan and probably on the nearby hillsides during the times of occupation of Zones 2 and 4 at Site 33.

Cottonwood represents only a small percentage of the identified wood from Zone 4 and was recovered from only one more sample than the least frequently occurring species for this zone. However, cottonwood ranks just below mesquite or tornillo in importance of woody perennials from Zone 2 in terms of its percentage of the identified charcoal and frequency of occurrence. Much of the charcoal of cottonwood is from Pits 5, 6, and 7 which are located next to one another and were probably in use at the same time. A radiocarbon sample from Pit 7 yielded a BC/AD corrected date of AD 1500 ± 110 which is the latest radiocarbon date for Zone 2 at Site 33. The percentage of identified charcoal and the frequency of occurrence of cottonwood for Zone 2 would be comparable to that for cottonwood in Zone 4 and closer to that of other woody perennials of minor importance in Zones 2 and 4 if it were not for the counts of cottonwood charcoal from Pits 5, 6, and 7. The reason for finding so much cottonwood in pits near one another and dating to the later part of the Zone 2 occupation is not known. Speculation on the importance of cottonwood in Pits 5, 6, and 7 could include the depletion of mesquite and perhaps tornillo fuels on or near Site 33 by previous occupations, the existence of stands of cottonwood closer to Site 33 than they had been before, or the distortion of averages with small samples. No matter what the explanation for the cottonwood in Pits 5, 6, and 7 might be, the notation of cottonwood in both Zones 2 and 4 of Site 33 would certainly seem to indicate the proximity of cottonwood in the past although it does not occur today on the floodplain adjacent to Site 33.

Unidentifiable pieces of charcoal from Sites 33 and 34 include small fragments of branches, bark, and leaves, which could not be accurately assigned to particular woody taxa, and a number of woody spines which are probably from mesquite, tornillo, or acacia. The largest number of unidentifiable pieces of charcoal are subsumed under the category of burned green wood. This category contains those pieces of charcoal whose cellular structure has been expanded or exploded to give a netted appearance to transverse sections of stems. Although these specimens are thought to be from wood which was burned when green, this is not a certainty. These specimens are uncommon in the materials from Zone 4 of Site 33 and occur in some of the pits and small fire-cracked rock hearths from Zone 2 of Site 33. However, all of the large fire-cracked rock features of Zone 2 at Sites 33 and 34 were found to have some charcoal which is presumed to be from burned green wood. Differences between small fire-cracked rock hearths and large fire-cracked rock features will be elaborated in Chapter VIII, but it can be noted here that the large fire-cracked rock features are very much larger than the small fire-cracked rock hearths and that the provisioning of the larger features with fire-wood gathered on or near these sites may have necessitated at times the use of some green wood.

Grass stems were recovered from some of the pits, small fire-cracked rock hearths, and large fire-cracked rock features of Zone 2 at Site 33 where they were used conceivably as tinder or possibly to cover food stuffs being baked in these features. Basehart (1974) records the use of grass by the Mescalero Apache as both a tinder and a covering material for the leaf succulents baked in pits with heated stones. One unidentifiable grass stem was found in a house from Zone 4 of Site 33 and impressions in roofing clay from houses of Zone 4 certainly indicate the use of grass in the superstructures of these dwellings (Chapter VIII). Reed fragments were also retrieved from one house of Zone 4, where they may have been used in roof construction or household furnishings.

Stem succulents are not well documented in the charcoal specimens from the occupational zones of Site 33; they are questionably noted for one sample from each of Zones 2 and 4. Two fragments of what might be part of the stem of Turk's cap were found in a possible house of Zone 4. There is no known ethnographic record for use of the stems of Turk's cap, but the green fruits of this cactus are reported to be edible (Benson 1969). Turk's cap does not occur in close proximity to Site 33 but it is a common cactus of the Upper Bajada and Mountain environmental zones. A possible cactus spine was recovered from one of the large fire-cracked rock features of Zone 2. This questionable spine compares favorably with those of the genus *Opuntia* (prickly pear and cholla) whose green stems are edible. The stems of some species of *Opuntia* may be eaten raw or after boiling, and the pit baking of *Opuntia* stems is noted for the Pima and Papago of Arizona (Castetter and Bell 1942). Some pit baking of cacti may have been done in the pits, small fire-cracked rock hearths, and large fire-cracked rock features of Sites 33 and 34 or even Site 29, but there is little evidence to suggest that this was the case.

The utilization of leaf succulents as a food resource by various historic Indian groups over much of Mexico and adjacent arid areas of the American Southwest has been noted by many (Basehart 1974; Bell and Castetter 1941; Castetter, Bell and Grove 1938; Pennington 1963; and others). The parts of these plants which were eaten varies somewhat with the species concerned and include the young flower stalk, flowers, fruits, seeds, and the leaf bases and heart or central stem or caudex. Flower stalks, flowers, fruits, and seeds are described as being eaten raw or needing little processing prior to storage or consumption. However, the leaf bases and hearts of leaf succulents are most often recorded as requiring pit baking with heated stones from one to several days prior to consumption or further processing for consumption or storage.

Soap-tree yucca *(Yucca elata)* which occurs in small numbers on Sites 33 and 34 and in nearby arroyos and on a few nearby sandy ridge-tops, and sotol *(Dasylirion wheeleri)* which occurs in the Upper Bajada and Mountain environmental zones, are two species whose use by the Mescalero Apache in southern New Mexico and extreme western Texas is detailed by Basehart (1974). Lechuguilla *(Agave lecheguilla)* which is common in the Upper Bajada and Mountain environmental zones is also suggested to have been used by the Mescalero Apache (Matson and Schroeder 1961), and *Agave neomexicana* which is very similar to lechuguilla but found in fewer numbers and gerenally at higher elevations than lechuguilla is reported by Castetter, Bell, and Grove (1938) to have been used by the Mescalero Apache. The Mescalero Apache prepared the hearts of all of these leaf succulents by pit baking with heated stones, and it is likely that the heart of datil *(Yucca torreyi)*, which occurs principally in the Upper Bajada environmental zone and occasionally in drainages of the Lower Bajada environmental zone, was prepared in a similar fashion though the use of the heart of datil is not reported for the Mescalero Apache.

Leaf succulents are relatively well represented in the charcoal material from Zone 2 at Site 33 while only one questionable piece of a carpel of yucca or agave was found in a non-feature area of Zone 4. The apportionment of remains of leaf succulents in Zones 2 and 4 of Site 33 parallels the temporal distribution of small and large fire-cracked rock features at Site 33 where fire-cracked rock features are numerous in Zone 2 occupations but sparse and small in Zone 4. The covariance of remains of leaf succulents and fire-cracked rock features in the occupational deposits of Site 33 and the actual finding of specimens of leaf succulents in some of the fire-cracked rock features would suggest that fire-cracked rock features of Site 33 and Sites 29 and 34 were used in the processing of the hearts and leaf bases of leaf succulents. Some pits have burned pieces of leaf succulents in them and may also have been utilized in baking leaf succulents.

The inference that small and large fire-cracked rock features and some pits at the archeological sites of this project were used to process leaf succulents is a tenuous argument when based solely on carbonized plant remains found in these features or occupational deposits. Inasmuch as the intended use of these features was likely to convert plant materials into more usable forms, it should not be expected that large quantities of burned vegetal foods would be found in them except possibly as byproducts of consumption or further processing. Although a number of carbonized pieces of leaf succulents was found in the fire-cracked rock features and some of the pits of Site 33, other plant materials recovered from these features include the previously mentioned cactus spine and numerous seeds described in the next section. Thus, it would be possible to infer a wide range of activities such as the boiling, parching, roasting, and baking of plant materials from the carbonized plant remains found in the fire-cracked rock features and pits. Similar problems in ascertaining from carbonized plant materials the uses of similar features in open archeological sites of the Hueco Bolson east of El Paso have been encountered recently by Ford (1977), Gasser (n.d.), Holloway (n.d.), O'Laughlin (1979), and Wetterstrom (1978; n.d.) whose studies yielded identifications of small numbers of leaf succulents, native seeds, and introduced cultigens but little assurance as to use of features containing fire-cracked rock or burned caliche. Fire-cracked rock features and pits of the archeological sites of this project may well have served many functions, but it will be suggested from descriptions of these features and considerations of the regional distributions of these features and leaf succulents in Chapter VIII that the most important activity centering particularly on the use of fire-cracked rock features was the processing of leaf succulents. This implication has already been alluded to in Chapter III from the distribution of fire-cracked rock features and leaf succulents in the project area.

The presentation of identified leaf succulents from Site 33 in Tables 5 and 6 requires some clarification because the species which may be represented are not necessarily indicated by the taxonomic headings. The leaf bases and fibers identified as being of the genus *Yucca* are most likely from soap-tree yucca which can be found today on Site 33 but may include some datil which occurs infrequently near Site 33. Questionable identifications of a leaf base and two leaf fibers to the genus *Yucca* are based on morphological grounds. However, these specimens were too small to insure accuracy of identification, and they may also be charred remains of sotol or of agave. The leaf base, leaf fibers, and pieces of caudex under the category of *Yucca/Agave* may be from any of five leaf succulents which include the two above mentioned yucca, sotol, lechuguilla, and *Agave neomexicana*. Questionable identifications are based on morphological resemblance to parts of these leaf succulents, and it is possible that some questionable specimens are not even of leaf succulents. Those parts suggested to be fragments of carpels of a yucca or agave and certainly not sotol are the least reliable of any of the identifications.

Most of the identifications of leaf succulents from Zone 2 of Site 33 are leaf bases or fibers of leaves or portions of the caudex. This could be taken to indicate the pounding or chewing of leaf succulents after pit baking and the discard of fibers and portions of leaves in the open pits. The specimen of matter fiber from Large Fire-cracked Rock Feature 3 bears some resemblance to a "quid" which generally results with the chewing of the fibrous portions of leaf succulents to separate the fleshy portion for immediate consumption.

Leaf succulents are reported to be in prime condition, or sweetest, in the spring shortly before to sometime just after the emergence of the inflourescence, although all of the species in the project area could have been collected throughout the year (Basehart 1974; Bell and Castetter 1941; Castetter, Bell, and Grove 1938). As more information is provided on the features and artifacts of Zone 2 at Sites 33 and 34 in the following chapters, it will become increasingly more evident that occupations of Site 29 and Zone 2 at Sites 33 and 34 were intermittent, short, and directed principally towards the processing of leaf succulents which probably was a spring activity. Any of five leaf succulents could have been processed at these sites, and all five leaf succulents can be found today within 3 to 6 km. However, the discussions of Chapters II and III suggest that some of these leaf succulents would have been more important than others, and the description of features in Chapter VIII will include a summary of information from which it can be suggested that the more important leaf succulents would have been those found in the Upper Bajada and Mountain environmental zones.

The analysis of charcoal material from Sites 33 and 34 has made possible some initial statements about the preference of woods for fuel and house construction, the occurrence of woody perennial species on or near these sites, and the presence of possible subsistence items. Mesquite and perhaps tornillo were found to be by far the most abundant species represented in the materials from these sites and are noted as having been used for firewood in Zone 2 of Sites 33 and 34 and Zone 4 of Site 33. In addition, mesquite or tornillo and a number of other small trees and shrubs found today on or near Site 33 are suggested to have been used in the construction of the houses of Zone 4 of Site 33. Reeds may also have been incorporated in the roof of one house of Zone 4 at Site 33. Mesquite, tornillo, and the other less well-represented shrubs and trees that were utilized as firewood or in house construction occur on or near Sites 33 and 34 today. The similarity of the composition of the samples of perennial woods from the occupational deposits of Zone 2 at Site 33, which date between 2150-2050 BP and 550-450 BP, and those from Zone 4 at Site 33, which date to 4450-3750 BP, may indicate that there has been little change in the presence or composition of perennial, woody, plant species on or near Site 33 for the last 4,000 years. This is generally supported by the comparability of the less frequently occurring species in Zones 2 and 4 of Site 33 which are probably less subject to the selective preferences of the prehistoric inhabitants of this site and thus are more reliable indicators of the past vegetation. Relative stability in vegetation and climate in the project area for the last 4,000 or perhaps 5,000 years has also been inferred from the palynological study of soils from Site 33 that was presented in Chapter VI. Subsistence items recorded in the charcoal from Site 33 include stem and leaf succulents. Stem succulents (cacti) are questionably noted in one sample from each of Zones 2 and 4, but the importance of these plants cannot be definitely stated from the meager remains recovered. However, leaf succulents (yucca, sotol, and/or agave) were found in the deposits and features of Zone 2 in sufficient numbers to permit the suggestion that the processing of these plants may have been an important spring activity during the occupations of Zone 2 at Site 33, as well as during the occupations of Site 29 and Zone 2 at Site 34.

Seeds

This section details the analysis of soil samples from Sites 29, 33, and 34 which were examined utilizing flotation techniques for the recovery of seeds and other small floral remains. A total of 472 soil samples was taken at these sites for the flotation recovery of carbonized plant remains. These include soil samples from soil cores, hand excavated features, and arbitrary levels of 1 m square excavations. The soil core samples are comprised of 231 samples from Site 33 and 45 samples from Site 34. These samples were taken at least every 16 m across Sites 33 and 34 from the level of greatest discoloration with ash and charcoal (see the section on wide interval soil augering in Chapter IV). Soil samples from hand excavation are made up of one sample from the single, excavated, small fire-cracked rock hearth at Site 29, 187 samples from the excavated features and 1 m squares of Site 33, and 8 samples from excavated 1 m squares and features of Site 34. Soil samples from the soil cores generally weighed between 2 and 4 kilograms, while the hand excavated soil samples often weighed between 4 and 6 kilograms.

All of the above mentioned soil samples were prepared for analysis in the following manner. The soil from each sample was first screened through one quarter inch mesh into 2 gallon containers, and artifacts, pieces of wood charcoal, and rarely small pieces of bone were removed from the screen when present. Water was then added to the soil, and the mixture stirred to release the small carbonized plant materials. After the silt and clay fraction of the soil began settling in the container, the water and floating plant materials were poured from the container through polyester fabric with a mesh of approximately 0.3 m. Water was once more added to the soil samples and poured through the same cloth after stirring. This process was repeated until carbonized plant materials were no longer evident in the soil sample, and the flotation sample was then cleaned of any soil by dipping the folded cloth into containers of fresh water. The flotation samples were allowed to air dry and were visually inspected for larger pieces of wood charcoal or other plant parts before repackaging. The dry weight of flotation samples was often less than 0.1 grams but ranged as high as 265 grams.

Given the large number of flotation samples from Sites 29, 33, and 34, it was not possible under the fiscal constraints and research directives of this project to separate recognizable plant parts from all of the samples. Therefore, samples were selected from these sites which would provide information on manifest deposits and kinds of features. Twenty-eight percent of the flotation samples were chosen for further processing from each of the two kinds of soil samples (e.g. soil core or hand excavation) for a total of 134 samples. These flotation samples included the sample from the small fire-cracked rock hearth at Site 29 and the sample from Pit 9 of Zone 5 at Site 33. At Sites 33 and 34 flotation samples from features of Zones 2 and 4 were mostly those derived from hand excavation, while non-feature areas were represented primarily by flotation samples taken by soil augering. Flotation samples from non-feature areas were selected to give as wide as possible an areal coverage of the occupational deposits of Sites 33 and 34 and in numbers substantial enough to not only provide information on non-feature areas but to yield sufficient quantities of seeds for comparison with those from features. In general, carbonized plant materials in flotation samples from non-feature areas were minimal with most samples weighing less than 0.1 gram and having no seeds. The combined flotation samples from Zones 2 and 4 from Sites 33 and 34 included 77 samples from non-feature areas, 17 samples from small fire-cracked rock hearths, 10 samples from large fire-cracked rock features, 10 samples from various pits, and 18 samples from houses.

The 134 flotation samples selected for further processing were thoroughly mixed, and a small portion of each sample was then scanned under a binocular microscope at 20 to 40 power for recognizable seeds and other plant parts. These specimens were separated from the rest of the flotation sample, and additional material from each sample was inspected microscopically until one hour had been spent on each sample. Approximately 50% to 100% of most of the flotation samples from non-feature areas and those samples weighing 0.1 grams or less were inspected in this manner, while only 2% to 25% of the flotation samples from most of the features and those samples weighing over 0.1 grams could generally be viewed in an hour's time. Miscellaneous plant parts recovered from the flotation samples were few in number, often unidentifiable, and composed principally of leaf fragments and fibers, bark, and spines. These materials have been included with the charcoal specimens of the previous section. Seeds and fruits found in the flotation samples were categorized to type, and the writer provided identifications of most seeds and fruits. Paul Minnis, who furnished identifications for some of the material in the previous section, aided in the identification of some of the more difficult specimens. The identified seeds and fruits from Sites 29, 33, and 34 are presented in Table 7.

The identified seeds and fruits enumerated in Table 7 are all carbonized with the possible exception of the seeds of Turk's cap which may only be blackened from oxidation. Seeds which were too fragmentary for species determination are included in the category of unidentifiable seeds, and those

TABLE 7

BURNED SEEDS FROM FLOTATION SAMPLES
FROM SITES 29, 33, AND 34

SITE	ZONE	ASSOCIATION	Atriplex canescens (seed) (four-wing saltbush)	Atriplex canescens (fruit) (four-wing saltbush)	Chenopodium/Amaranthus (goosefoot/pigweed)	Chenopodium/Suaeda (goosefoot/seep-weed)	Descurainia sp. (tansy mustard)	Echinocactus horizonthalonius (Turk's cap) (burned?)	Eragrostis sp. (love grass)	Gramineae (grass family)	Kallstroemia sp.	Larrea tridentata (creosotebush)	Opuntia sp. (prickly pear)	Papaveraceae (poppy family)	Portulaca sp. (purslane)	Polygonum sp. (smartweed)	Prosopis sp. (mesquite or tornillo)	Prosopis pubescens (fruit) (tornillo)	Prosopis/Acacia	Rumex sp. (dock)	Scirpus sp. (bulrush)	Unknown Seeds	Unidentifiable Seeds	TOTAL
29	-	Small Fire-cracked Rock Hearth 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
34	2																							
		Non-Feature Areas	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
		Pit 2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Total for Zone 2	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
33	2																							
		Non-Feature Areas	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	2	9
		Small Fire-Cracked Rock Hearths	2	-	-	-	-	-	-	1	-	1	-	1	-	-	1	-	-	-	-	1	3	10
		Pit 4	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2
		Pit 5	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
		Large Fire-Cracked Rock Feature 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	3
		Large Fire-Cracked Rock Feature 2	-	-	-	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1	-	-	1	6
		Large Fire-Cracked Rock Feature 3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	3
		Total for Zone 2	2	1	1	1	2	1	-	3	1	1	-	2	1	-	1	-	1	1	-	7	8	34
33	4																							
		Non-Feature Areas	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	5
		Small Fire-Cracked Rock Hearth 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4
		House 2	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	3
		House 3	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2
		House 4	-	-	2	-	-	-	-	-	-	-	16	-	-	25	-	3	-	4	1	4	37	92
		House 6	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2
		House(?) 13	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2
		Total for Zone 4	1	-	2	-	-	1	1	2	-	-	16	1	1	25	-	3	1	7	1	4	44	110
33	5																							
		Pit 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Total for All Sites			3	2	3	1	2	4	1	5	1	1	16	3	2	25	1	3	2	8	1	11	52	147
No. of Samples in which Seeds Occurred			3	2	3	1	2	4	1	5	1	1	4	3	2	3	1	1	2	3	1	7	14	35

seeds which were complete enough for species recognition but could not be identified are subsumed under the heading of unknown seeds. In addition to the few burned seeds and fruits in some of the flotation samples, unburned seeds and fruits were also recovered from nearly all of the flotation samples. Non-carbonized seeds and fruits were most common in the soil samples obtained from near the surface of Sites 29, 33, and 34 but were found in soil samples taken from over 1 m below the surface at Site 33.

An appreciable degree of similarity was observed between the taxa represented in the unburned and burned seeds and fruits from Sites 33 and 34. A large number of species, particularly herbaceous annuals, was noted among the unburned seeds and fruits of flotation samples, and species occuring today in floodplain environments were recorded only in the burned seeds and fruits of flotation samples from House 4 of Zone 4 at Site 33. These latter species include tornillo, smartweed, and bulrush. Charred prickly pear seeds were also found in House 4, and this species is found infrequently near Sites 33 and 34 and is more important in the Upper Bajada and Mountain environmental zones. A few questionably burned seeds of Turk's cap were present in flotation samples from Site 33 and 34, and additional unburned seeds of this species were obtained from other samples at these sites. Turk's cap has a distribution comparable to that of prickly pear and is a rare species near Sites 33 and 34. The charred remains of prickly pear, tornillo, smartweed, and bulrush in flotation samples from House 4 of Zone 4 at Site 33 suggest that these items were accumulated as a result of human activities since they are not found on Site 33 today; it is not expectable for them to have been present on Site 33 during the Zone 4 occupation. However, all other species occur naturally in the soils of Sites 33 and 34, and the finding of so few burned seeds and fruits of these species does not provide unquestionable evidence for their use by the inhabitants of these sites. The following discussion of plant species present or absent in the flotation samples and the distribution of carbonized seeds and fruits in the deposits and features of Sites 33 and 34 should provide a basis for evaluating the significance of these floral remains.

All of the plants represented by burned seeds and fruits in the flotation samples from Sites 33 and 34 have ethnographically recorded uses such as food, medicine, emetics, firewood, and manufactured articles (Basehart 1974; Kenmotsu 1977; Harrington and Matsumura 1967; Smith 1977). The concern here, however, is with the possible role these plants may have played in subsistence activities at these sites. That is, since subsistence was a daily concern involving food procurement, storage, preparation, and consumption, food plant remains should be relatively common whereas plants used for such things as medicine or emetics and in the manufacture of tools, containers, etc., should occur infrequently in the carbonized floral remains from these sites. The use of perennial woods and grass as firewood and tinder has been detailed in the previous section; the possible utilization as firewood and tinder of the species represented by burned seeds and fruits will be taken up later in this section.

Food items indicated by the burned seeds and fruits from Sites 33 and 34 can be divided into two groups on the basis of season of peak availability. The first group is composed of goosefoot or lambsquarter, pigweed or amaranth, purslane, dock, tansy mustard, smartweed, and bulrush which have edible seeds and greens that are best gathered from late spring into the summer. Smartweed and bulrush also have edible rootstocks that could be gathered at the same time. The second group is comprised of the fruits of prickly pear, Turk's cap, mesquite, tornillo, and acacia (probably *Acacia constricta*, or whitethorn) and the seeds of grasses which become available in late summer and can be gathered well into the fall. There are too few seeds from Site 34 for a firm statement regarding the importance of these possible subsistence items, but both groups of food items are represented in both Zones 2 and 4 of Site 33. The burned seeds and fruits of Zones 2 and 4 at Site 33 could be taken as indicative of occupations at least from late spring into fall and the use of a wide variety of plant foods. In addition, the burned floral remains from Zone 4 at Site 33 suggest the collecting of plant foods from a number of environmental zones as distant as 3 to 6 km from the site. However, the evidence for these suppositions is equivocal because of the few burned seeds and fruits recovered from the flotation samples and the poor representation or noticeable absence of species which were probably important subsistence items.

The number of burned seeds and fruits found in flotation samples is not impressive in view of the number of samples which were processed and inspected microscopically. Excluding the four samples from House 4 of Zone 4 at Site 33, burned seeds and fruits were encountered in only 23% of the flotation samples from Sites 29, 33, and 34 for an average of one burned seed or fruit for every 2.5 samples. Charred seeds and fruits did not occur in sufficient numbers in samples from non-feature areas or samples from features other than House 4 to allow the direct inference of subsistence activities. Once more, with the exception of the materials from House 4, all of the burned seeds and fruits from Sites 33 and 34 have unburned counterparts in the soils of these sites. This suggests that many of the seeds and fruits may have been burned accidentally or incidentally to other activities at these sites.

None of the recorded plant species from Sites 33 and 34 appears to be better represented than any of the others if the occurrence of seeds and fruits of prickly pear, tornillo, smartweed, and dock in House 4 of Zone 4 at Site 33 is ignored. One could also infer from these data that subsistence activities were directed equally toward the various species in accordance with their season of availability. However, the poor representation of mesquite and tornillo also indicate that the occurrence of burned seeds and fruits in the soils of Sites 33 and 34 may be explained in ways that do not include their possible contribution to prehistoric diets. Mesquite and tornillo were widely used by historic Indian groups of the Southwest (Bell and Castetter 1937) and have been found with some consistency in Formative period residential sites of the El Paso area (Brook 1966; 1980; Ford 1977; Wetterstrom 1978). The fruits of mesquite and tornillo are fairly large and easily gathered in the fall, and both species occur on or near Sites 33 and 34. Given the large size of the fruits of mesquite and tornillo and the probable importance of these species to prehistoric populations of the El Paso area, it is thought that the fruits of these species should have been well represented in the burned floral remains from Sites 33 and 34. Therefore, the recovery of so few seeds and fruits of these species lends little credence to any implication of subsistence activities from the burned seeds and fruits at Sites 33 and 34 other than those which have been suggested from the materials in House 4. This is particularly evident when it is realized that the fruits of tornillo and mesquite are of a large enough size and of forms distinctive enough to have been recognized during excavation and the preparation of the 472 soil samples and not just during the microscopic examination of the 134 flotation samples which yielded small seeds of these and other species.

Some questions have been raised above concerning the representativeness of plant species in the burned seed and fruits from Site 33 and 34 because of the infrequent occurrence of burned seeds and fruits in the flotation samples from these sites. Further consideration below of plant species poorly represented or absent in the flotation samples from these sites will also question the reliability of burned seeds and fruits as indicators of subsistence activities generally.

Although prickly pear seeds were recovered from House 4 of Zone 4 at Site 33, soil samples from Zone 4 at Site 33 also yielded substantial percentages of pollen from the genus *Opuntia* which includes prickly pear (Chapter VI). The high percentages of *Opuntia* pollen in Zone 4 at Site 33 suggest that prickly pear may be underrepresented, in terms of its dietary importance, in the flotation samples from Zone 4 at Site 33.

Wolfberry (*Lycium* df. *pallidum*) is noted as occurring as a high percentage in the pollen from one soil sample of Zone 2 at Site 33 (Chapter VI). This species, which produces an edible berry, occurs on the floodplain near Sites 33 and 34 (Harrington and Matsumura 1967). Wolfberry also appears to be underrepresented in the carbonized seeds from Sites 33 and 34.

Cattail (*Typha latifolia*) pollen is reported from the fill of House 2 of Zone 4 at Site 33 by Horowitz, Gerald, and Chaiffetz (n.d.), but cattail was not found in the carbonized floral remains of Sites 33 and 34 although it may have occurred on the floodplain near these sites. The rootstocks, young stems, and flowering stalks of cattail are all edible (Harrington and Matsumura 1967).

Finally, the uncertain occurrence of corn pollen in soil samples from Zones 2 and 4 at Site 33 was not substantiated by the finding of macrofloral remains of corn at Site 33 or Sites 29 and 34 (Chapter VI). Carbonized remains of corn are easily identified, and the absence of corn in the flotation samples from these sites provides yet another example of expectable subsistence items that were not found in the carbonized materials from these sites. Unlike some of the naturally occuring plant species which are potential food items near Sites 29, 33, and 34, corn would not be expected to occur with great frequency at any of these sites. Corn may well have been of only minor or of no importance during the Archaic period occupation(s) of Zone 4 at Site 33, and the Formative period occupations at Site 29 and of Zone 2 at Sites 33 and 34 are visualized as having been short, intermittent, and aimed at the processing of native plants.

The value of burned seeds and fruits for delineating subsistence activities and seasons of resource procurement for the occupations evidenced at Sites 33 and 34 is dubious because of the small number of burned seeds and fruits and the poor representation or absence of potentially important subsistence items in the flotation samples from Sites 29, 33, and 34. With the exception of some of the species recorded in the materials from House 4 of Zone 4 at Site 33, it has been noted that species documented by burned seeds and fruits were also observed in flotation samples from Sites 33 and 34 as unburned seeds and fruits. This has prompted the suggestion that many of the burned seeds and fruits may have become part of the archeological record for causes other than their possible utilization as food resources. That is, the burning of seeds and fruits was probably not the result of human activity. The context under which many of these plant materials were burned is not clear and may be related to the natural occurrence of seeds and fruits in the soils of these sites. The following description of the distribution of burned seeds and fruits among the various features and non-feature areas of Sites 29, 33, and 34 sheds some light on the contexts under which seeds and fruits may have been burned.

The number of flotation samples examined microscopically for Sites 29, 33, and 34 has been given previously in this section, but the distribution of these samples among the various features and non-feature areas of these sites has not been itemized in the text or in Table 7. Therefore, a brief description of the flotation samples from these sites and the occurrence of burned seeds and fruits in these samples will be given as a preface to a more general discussion of the distribution of burned seeds and fruits at these sites.

One flotation sample was examined microscopically from Small Fire-cracked Rock Hearth 1 at Site 29 and was found to contain no burned seeds or fruits, and the single sample from Pit 9 of Zone 5 at Site 33 produced similar results. There were 15 samples examined from Zone 2 of Site 34. The flotation samples from Site 34 included 11 samples from non-feature areas, one sample from each of Pits 1 and 2, and two samples from the large fire-cracked rock feature. Two of the samples from non-feature areas and the sample from Pit 2 yielded burned seeds and fruits, and flotation samples from the largely eroded or deflated small fire-cracked rock hearths at Site 34 were not examined because of the lack of carbonized plant materials in them. Zone 2 of Site 33 was represented by 88 flotation samples which were made up of 56 samples from non-feature areas, 16 samples from small fire-cracked rock hearths, 8 samples from the three large fire-cracked rock features, and 8 samples from Pits 4, 5, 6, and 7. Burned seeds and fruits were recovered from 8 of the samples from non-feature areas, 7 of the samples from small fire-cracked rock hearths, 5 of the samples from the large fire-cracked rock features, and one of the samples from each of Pits 4 and 5. A total of 29 flotation samples from Zone 4 of Site 33 was examined microscopically, and these samples included 18 samples from Houses 1, 2, 3, 4, 6, 13, and 16, 10 samples from non-feature areas, and one sample from Small Fire-cracked Rock Hearth 5. Nine of the samples from houses, two of the samples from non-feature areas, and the single sample from the small fire-cracked rock hearth produced burned seeds and fruits. Flotation samples from the three excavated pits of Zone 4 at Site 33 were, unfortunately, not among the samples examined microscopically.

Burned seeds and fruits in the combined flotation samples from Sites 29, 33, and 34 were recovered from 16% of the samples from non-feature areas, 27% of the samples from pits, 44% of the samples from small fire-cracked rock hearths, 50% of the samples from large fire-cracked rock features, and 50% of the samples from houses. The lowest frequency of occurrence of burned seeds and fruits is in the flotation samples from non-feature areas, and the percentage of samples with burned seeds and fruits is somewhat higher for pits. The proportion of samples containing burned seeds and fruits is much larger in those from small fire-cracked rock hearths and large fire-cracked rock features than it is in samples from pits or non-feature areas. The increase in the percentage of flotation samples with burned seeds and fruits that is observed as one goes from non-feature areas and pits to the small and large fire-cracked rock features corresponds well with the distribution of wood charcoal. This supports the suggestion that fires were built in these features. The high frequency of flotation samples from houses with charred seeds and fruits also appears to be related to the past existence of fires. Hearth areas were defined in the two most extensively excavated houses and three of the tested houses, and many of the houses seem to have been razed by fire. Thus, it may be concluded that the frequency of occurrence of burned seeds and fruits is correlated with the incidence of fires at these sites.

Although it could have been intuitively surmised that fires are necessary to produce burned seeds and fruits, the simple notation of burned seeds and fruits at these sites would not have provided the contextual information needed to evaluate these charred materials. In this respect, there are three contexts under which seeds and fruits could have been burned. First, seeds and fruits may have been burned accidentally while being processed and prepared for meals or charred accidentally when stored in houses. The latter case may be true of the seeds and fruits in House 4 of Zone 4 at Site 33, but the previous discussion of the representation of various species in the flotation samples from Sites 33 and 34 and the initial consideration of features at these sites which will be described in more detail in the next chapter suggest that many of the seeds and fruits may have been burned in contexts other than those involving the use of these species as food items. Second, the burning of seeds and fruits may have been incidental to their possible use as subsistence items when they were included with other plant materials used for tinder, as firewood, and in the superstructures of houses. A number of the species represented by burned seeds and fruits at Sites 33 and 34 was also recorded in the charcoal from features at these sites, and the possibility of the chance inclusion of seeds and fruits with other plant materials used for fuel or in house construction seems real and does not make for unequivocal statements regarding the utilization of species represented by burned seeds and fruits as foods. Third and finally, unburned seeds and fruits occur naturally in the soils of Sites 33 and 34, and some of these naturally occurring seeds and fruits may have been burned because of the close proximity of fires to soils containing these seeds. The comparability of unburned and burned seeds and fruits of plant species found today on Sites 33 and 34 has previously been detailed, and it is noted in addition that unburned and burned feces of small rodents and rabbits occurred in the flotation samples from Site 33. Inasmuch as the burning of animal feces was probably only casually related to subsistence activities at Site 33, it can also be argued that many of the seeds and fruits were burned in a context which would not lend itself to the definition of subsistence activities.

The lengthy consideration of burned seeds and fruits in this section has not been to suggest that many of the plant species were not used as food items at Sites 29, 33, and 34. Rather, the intent of the discussion has been to point out the ambiguity of the evidence from burned seeds and fruits found at Sites 33 and 34 for ascertaining the roles of various plant species in subsistence activities at these sites. It has also been emphasized that the mere presence of burned seeds and fruits in archeological contexts at Sites 33 and 34 is not sufficient justification for implying subsistence activities and seasons of occupation. This is not to say that the burned seeds and fruits from Sites 33 and 34, as well as the other carbonized plant materials from these sites described in the previous section, and the pollen from Site 33 detailed in Chapter VI, do not hint at the nature of subsistence activities and seasons of occupation at Sites 29, 33, and 34. Inferences that can be drawn from these data with respect to subsistence activities and seasons of occupation at these sites are summarized below and rely, in part, on the kinds of features found at these sites. Many of the ideas concerning subsistence activities and seasons of occupation will be expanded in following chapters when the features and artifacts from these sites are considered in greater detail.

The Archaic period occupation of Zone 4 at Site 33 differs from later occupations at this site and at Sites 29 and 34 by the presence of a substantial number of houses and very few small fire-cracked rock hearths. The construction of the houses and the spatial arrangement of houses and other features suggest that this was more than a short encampment and that the occupation probably occurred during winter months. The carbonized macrofloral remains and the pollen spectra from the deposits of this occupation do not document the possibility of winter residence but do provide some information on other seasons and subsistence activities.

The flotation samples from House 4 of the Zone 4 Archaic period occupation of Site 33 were found to contain numerous burned seeds and fruits (62% of all burned seeds and fruits from Sites 33 and 34) which undoubtedly were accumulated as a result of human activities. These seeds and fruits were recovered from a 1 m square test excavation of the floor of this house. Many chipped stone tools and numerous prepared cores and flakes struck from the same nodules of stone were obtained from the same excavation unit. Although many of the houses of the Zone 4 occupation appear to have been razed by fire, House 4 is the only tested or completely excavated house which seems to have burned when it was occupied. This may account for the large number of burned seeds and fruits on the floor of House 4 and the infrequent occurrence of burned seeds and fruits in other houses of this occupation.

Tornillo, bulrush, smartweed, prickly pear, dock, and goosefoot or pigweed are the species represented in the burned seeds and fruits from House 4. It is assumed that inferences arising from the presence of these species in House 4 are generally applicable to the Archaic period occupation of Zone 4 at Site 33. Accordingly, it can be reasoned from the numerous burned seeds and fruits represented on the floor of House 4 that some foodstuffs were stored during the Archaic period occupation and that plant foods were gathered from the Riverine, Lower Bajada, and Upper Bajada environmental zones within 3 to 6 km of Site 33. In addition, the seasons of peak availability for the plant species recorded in the burned materials from House 4 span the time from late spring to fall and may be taken to indicate the occupation of Site 33 during these portions of the year. Together, the presence in House 4 of seeds and fruits which are most commonly available between late spring and fall and the construction of houses in Zone 4 for occupation probably during the colder portion of the annual cycle could be viewed as illustrative of a year-long occupation of Site 33. However, it is also possible to infer from the data presented thus far that the occupation of Zone 4 at Site 33 was principally during the winter months and that the inhabitants of this site were subsisting, in part, on stores gathered from other areas and during other times of the year.

Additional information bearing on the seasons of occupation and subsistence activities comes from the small fire-cracked rock hearths and pollen record of Zone 4 at Site 33. Although small fire-cracked rock hearths could have been used to bake or perhaps roast such items as prickly pear pads, green corn, and the rootstocks of cattail, it is thought that the primary function of these features was to bake leaf succulents such as soap-tree yucca, lechuguilla, and sotol. There are few of these small fire-cracked rock hearths noted for Zone 4 at Site 33, and this may indicate that there was little reliance on leaf succulents which are best processed in the spring and are available in small numbers on or near Site 33. Larger quantities are available in the Upper Bajada and Mountain environmental zones. The occurrence of these facilities in Zone 4 at Site 33 is, however, one of the stronger indicators for the occupation of Zone 4 during seasons of the year other than winter. High percentages of *Opuntia* pollen, which is probably from prickly pear, were recorded for soil samples of Zone 4 at Site 33. This implies a possible occupation during the late summer and fall when these fruits ripen and become available in the Upper Bajada and Mountain environmental zones.

The finding of pollen grains in the soils of Zone 4 at Site 33 which resemble those of corn may also give additional evidence of possible occupation during the warmer seasons of the year. No carbonized remains of corn were recovered from Zone 4 at Site 33, but it is not unwarranted to suggest that the occupants of Zone 4 at Site 33 knew of corn and utilized it as a food item. Alluvial fans such as that of Sites 33 and 34 and the adjacent Rio Grande floodplain are among those areas considered in Chapter II where cultigens could have been raised.

The carbonized plant materials, pollen, and small fire-cracked rock hearths from the Archaic period occupation of Zone 4 at Site 33 certainly suggest that a variety of plants was collected from a number of environmental zones within 3 to 6 km of Site 33, that they were collected during the warm growing season, and that plant foods were probably stored and processed at Site 33. In turn, the possible storage of foodstuffs and the construction of what appear to be relatively well-insulated houses does imply overwintering at Site 33 during the season of non-biotic productivity. Some questions still exist, however, as to whether the Archaic period oc upation of Zone 4 at Site 33 was year-long or prin ly during the winter, and perhaps the spring, v periods of non-occupation during the growing season when the site's inhabitants may have been involved in subsistence or other activities at some distance from Site 33. The inclusion of corn in the diet of the inhabitants of Zone 4 at Site 33 would strengthen the possibility of yearly occupation, but more concrete evidence of its presence in the Archaic level is needed before the implications of corn use can be given serious consideration.

The Formative period occupations of Zone 2 at Sites 33 and 34 and the probable Formative period occupation of Site 29 have been described as short, intermittent, and principally for the purpose of processing leaf su culents in the spring. This was alluded to in the previous section where it was inferred from the presence of numerous small fire-cracked rock hearths at these sites, the occurrence of a few large fire-cracked rock features at Sites 33 and 34, and the finding of some carbonized remains of leaf succulents in the deposits and features of Zone 2 at Site 33. However, the best evidence in support of these inferences is still to be given in following chapters where the descriptions of fire-cracked rock features and the types and spatial distributions of artifacts leave little room to doubt the above characterizations of the occupations during the Formative period at these sites.

The burned seeds and fruits from Zone 2 occupations at Sites 33 and 34 and the pollen record for Zone 2 at Site 33 are of little use in determining which additional plants may have been utilized as foods during the Formative period occupations of these sites, although it is probable that the seeds and greens of herbaceous plants, the fruits of wolfberry, and the young shoots of cattail, and perhaps bulrush, were of at least minor importance during the suggested spring occupations of these sites. Mesquite and tornillo beans may also have been gathered and processed at Sites 33 and 34 during infrequent visits to these sites in the late summer and fall, and corn pollen is questionably recorded in a few of the soil samples from Zone 2 at Site 33.

Faunal Remains

Faunal remains were not expected to occur in large numbers at Sites 29, 33, and 34 where conditions were thought not to be good for bone preservation. In addition, little faunal material was anticipated for the Formative period occupations of these sites where the primary activity is believed to have been the processing of leaf succulents and where hunting, trapping, and fishing were probably minor concerns. It was also thought that faunal remains generally would exhibit the riverine hunting pattern described by O'Laughlin (1977b) and would consist principally of cottontail and jack rabbit with some fish, spiny soft-shell turtle, and migratory water fowl. In many ways, these anticipated findings were borne out by the faunal materials recovered from Site 33 and reported in Table 8. No faunal remains were found at Sites 29 and 34.

A number of burned and fragmented bones of a large mammal was found eroding from recent eolian sands of Site 33 South, and a 7 square meter area was eventually cleared of loose sand to expose many additional bone fragments. This investigation was prompted by the hope of recovering faunal material which could help describe prehistoric subsistence activities for Site 33 and which had been encountered infrequently in other areas of Site 33. However, these bone fragments proved to be the burned and badly broken remains of a single cow which apparently had been dumped on Site 33 South in historic times. Several pieces of manganese or purple glass were associated with these bones which suggest that this trash deposit dates to the first quarter of this century. The dumping of modern trash has been and continues to be a frequent activity at Sites 33 and 34.

Recent, intrusive bone was recovered from non-feature areas of Zones 1 and 2 at Site 33 North. A spadefoot toad, a kangaroo rat, a small mammal, and a medium to large-sized mammal are represented by these bones of recent origin.

Three long bone fragments from small to medium-sized mammals were found on the surface of Site 33 North and were probably from Zone 2 deposits. A few additional bones of small to medium-sized mammals were also recovered from three of the small fire-cracked rock hearths of Zone 2 at Site 33 North. All of these bones are the size of similar bones from cottontail or of the larger-bodied jack rabbit; positive species identification was not possible for the small bone fragments or the non-diagnostic caudal vertebra. These few bones (10) from the Formative period occupation at Site 33 North suggest little more than the probability that rabbits were hunted occasionally and that the animals were cooked and/or their bones were disposed of in small fire-cracked rock hearths.

The faunal remains from the Archaic period occupation of Zone 4 at Site 33 North include two elements of cottontail, one element from a jack rabbit, and 17 bones from animals the size of cottontail or jack rabbit. These bones were found in three houses and non-feature areas and indicate the hunting or trapping of rabbits and the possible processing and consumption of these animal foods in the Archaic period houses. Besides the few mammal bones retrieved from the deposits and features of Zone 4 at Site 33 North, bird eggshell fragments are recorded for the floors of two houses. These eggshell fragments are too small to suggest the size of the eggs or the species represented, and it is assumed that they may be from any of a number of birds that nest in the area during the spring and summer. The identification of the species represented by the eggshell fragments matters little; however, the presence of bird eggshells on house floors does furnish additional information in support of a spring or summer Archaic period occupation for Zone 4 at Site 33, if man brought them there.

The sparceness of faunal remains from Zones 2 and 4 at Site 33 North and their absence at Sites 29 and 34 were anticipated. The finding of rabbit bones or bones the size of those of rabbits at Site 33 North was also expected, but noticeably absent are remains of fish, spiny soft-shell turtle, or migratory water fowl that were anticipated for Sites 33 and 34 because of their proximity to the floodplain. Poor bone preservation is probably responsible for the small number of bones recovered, for the bias towards rabbits at Site 33, and for the absence of faunal materials at Sites 34 and Site 39. The relative importance of animal foods for either the Archaic period occupation at Site 33 or the Formative period occupations at Sites 29, 33, and 34 cannot be inferred from the paucity of animal remains, however. The bird eggshell fragments from Zone 4 at Site 33 complement the evidence from burned seeds in support of a spring or summer period of occupation at least, during the Archaic period.

TABLE 8

FAUNAL REMAINS FROM SITE 33

	Site 33 North										Site 33 South	
	Surface	Zone 1 Non-Feature Area	Zone 2				Zone 4				Surface	Zone 1 Historic Trash Dump
			Non-Feature	Hearth 4	Hearth 94	Hearth 99	Non-Feature	House 2	House 4	House 5		
AVES (bird)												
Eggshell Fragment	-	-	-	-	-	-	-	1	22	-	-	-
Scaphiopus sp. (Spadefoot Toad)												
R Radio-ulna	-	-	1*	-	-	-	-	-	-	-	-	-
L Radio-ulna	-	-	1*	-	-	-	-	-	-	-	-	-
L Humerus	-	-	1*	-	-	-	-	-	-	-	-	-
L Scapula	-	-	1*	-	-	-	-	-	-	-	-	-
R Pelvis	-	-	1*	-	-	-	-	-	-	-	-	-
R Femur	-	-	1*	-	-	-	-	-	-	-	-	-
cf. Dipodomys sp. (Kangaroo Rat)												
R Dentary	-	-	1*	-	-	-	-	-	-	-	-	-
Sylvilagus sp. (Cottontail)												
L Scapula	-	-	-	-	-	-	-	1	-	-	-	-
R Calcaneum	-	-	-	-	-	-	1	-	-	-	-	-
Sylvilagus/Lepus (Cottontail/Jackrabbit)												
Phalange	-	-	-	-	-	-	1	-	-	-	-	-
Small Mammal												
Cervical Vertebra		1*	-	-	-	-	-	-	-	-	-	-
Caudal Vertebra	-	-	-	-	-	1	-	-	-	-	-	-
Long Bone Fragments	2	-	-	-	-	-	-	6	-	-	-	-
Small to Medium Mammal												
Skull Fragment	-	-	-	-	-	-	-	-	5	1	-	-
Vertebra Epiphysis	-	-	-	-	-	-	-	-	2	-	-	-
Pelvis Fragment	-	-	-	-	2	-	-	-	-	-	-	-
Long Bone Fragment	1	-	-	1	3	-	2	1	-	-	-	-
Medium to Large Mammal												
Cancelleous Tissue	-	-	1*	-	-	-	-	-	-	-	-	-
Bos cf. taurus (Domestic Cow)												
Skull & Tooth Fragment	-	-	-	-	-	-	-	-	-	-	6	128
Mandible Fragment	-	-	-	-	-	-	-	-	-	-	-	115
Rib Fragment	-	-	-	-	-	-	-	-	-	-	-	14
Flat Bone Fragment	-	-	-	-	-	-	-	-	-	-	26	506
Long Bone Fragment	-	-	-	-	-	-	-	-	-	-	-	114

*Recent Intrusive Bone.

CHAPTER VIII

HEARTHS, PITS, AND HOUSES

Numerous and varied kinds of features were located and identified at Sites 29, 33, and 34 through surface survey, soil augering, backhoe trenching, and hand excavation. Accounts of these features are given in this chapter under the categorical headings of large fire-cracked rock features, small fire-cracked rock hearths, pits, postholes, hearths of ash and charcoal, and houses. In general, discussions begin with the later Formative period features and conclude with the earlier Archaic period houses. Although the primary intent of this chapter is to furnish the descriptive details of features, some attention is also devoted to the functional interpretation of features, their spatial distribution, the associations between features, and the characterization of the Formative and Archaic period occupations as inferred from features at these sites.

Site 29 is a small (125 square meters) and largely eroded or deflated site with two loci of fire-cracked rock which apparently represent three small fire-cracked rock hearths. Archeological testing of Site 29 failed to disclose the presence of buried deposits or of features other than the two loci of fire-cracked rock.

The total area of Site 33 is 32,752 square meters which is divided into northern and southern segments by a modern arroyo system (Figure 7). Two primary stratigraphic zones of occupation (Zones 2 and 4) are discernible at Site 33, and a limited area of occupation in soil Zone 5 at Site 33 North is manifest by a single pit and a thin layer of charcoal-stained soil. The spatial distributions of surface and subsurface features of the Formative period in Zone 2 at Site 33 North and Site 33 South are shown in Figures 18 and 19. The subsurface features of the Zone 4 Archaic period occupation at Site 33 are located in Figure 20. There are many recorded features for the Zone 2 and Zone 4 occupational deposits of Site 33, and additional archeological investigations at Site 33 would undoubtedly reveal the presence of other features. The liklihood that additional features exist at Site 33 will be considered under the description of each feature type.

Site 34 is also a fairly large site (8,736 square meters) which is divided into northern and southern parts by a small modern arroyo (Figure 7). Figure 21 provides the spatial distribution of surface features of the Zone 2 Formative period occupation at Site 34, and archeological survey and subsurface testing suggest that few, if any, features have gone unrecognized at Site 34.

Large Fire-Cracked Rock Features

There are four large fire-cracked rock features at Site 33 and 34. These features are easily distinguished from small fire-cracked rock hearths by their much larger horizontal dimensions and the greater quantities of associated fire-cracked rock. All of the large fire-cracked rock features were partially exposed on the surfaces of Sites 33 and 34. It is thought unlikely that additional, large fire-cracked rock features are buried and unrecognized at Sites 33 and 34 because of the large size of these features and the extensive subsurface testing of these sites by soil augering, backhoe trenching, and hand excavation. This is especially true for Site 34 where much of the surface is eroded or deflated and occupational deposits are very thin. Each of these large fire-cracked rock features is reported separately below and an interpretation follows.

Site 33

Large Fire-cracked Rock Feature 1. This feature consists of a dense, roughly ovoid scatter of fire-cracked rock that extends over an area of approximately 96 square meters. It is located in a sandy area on the western periphery of a large dune of Zone 3 deposits in Site 33 South (Figure 19). A single 1 m square was excavated near the center of the concentration of fire-cracked rock which revealed dark, ashy-gray soil with considerable charcoal to a depth of 45 cm below the surface. Fire-cracked rock was encountered in the upper and lower 10 cm of the excavation and consisted principally of limestone with some rhyolite and quartzite. Fire-cracked rocks range in size from 5 to 15 cm in maximum dimension and the total weight of this rock from the excavation is 13.1 kg. The reconstructed total weight of fire-cracked rock for this feature based on the areal extent of this feature on the surface and the weight of fire-cracked rock from the excavated 1 m square is 1,179 kg.

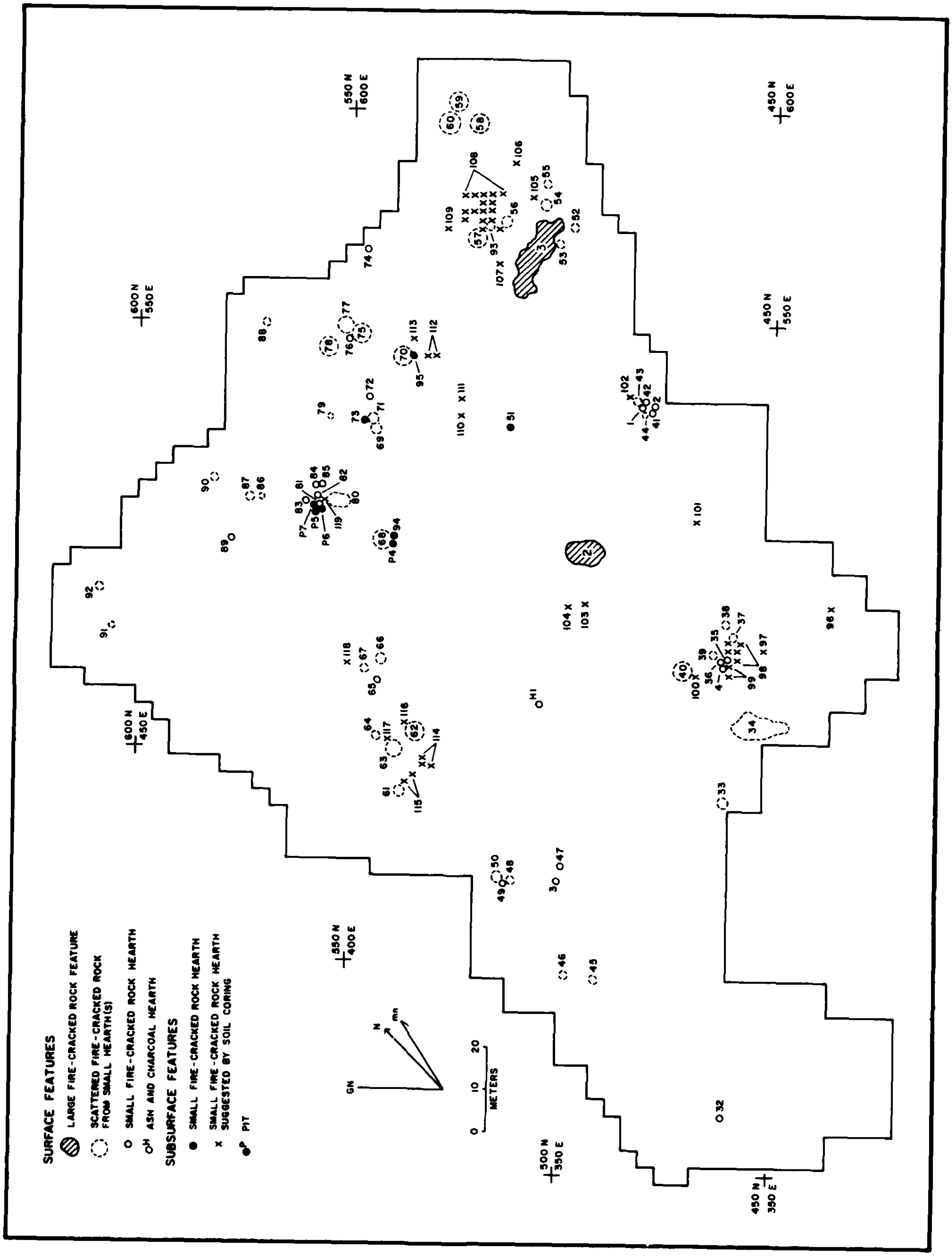


Figure 18. Features of the Zone 2 Formative period occupation at Site 33 North.

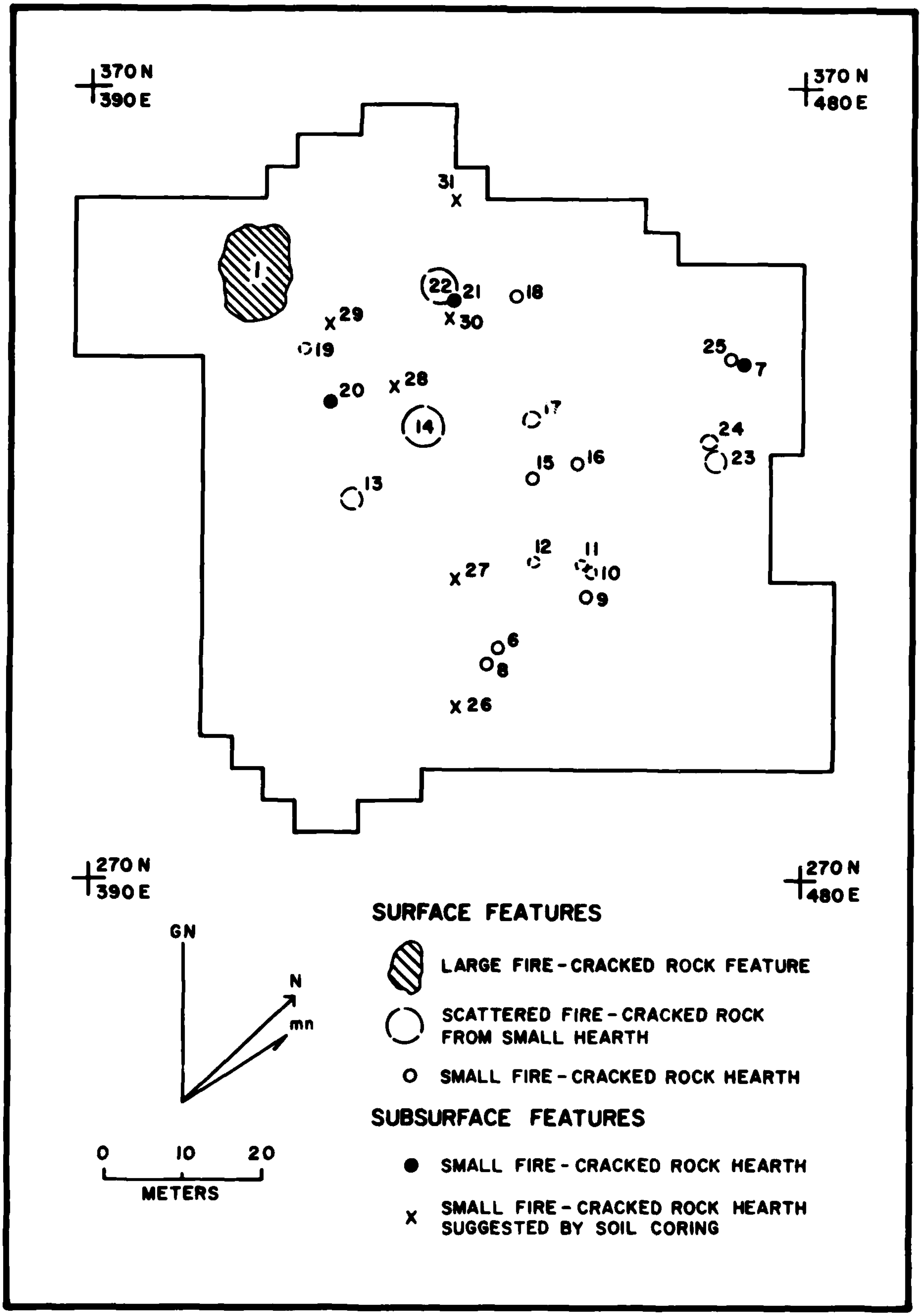


Figure 19. Features of the Zone 2 Formative period occupation at Site 33 South.

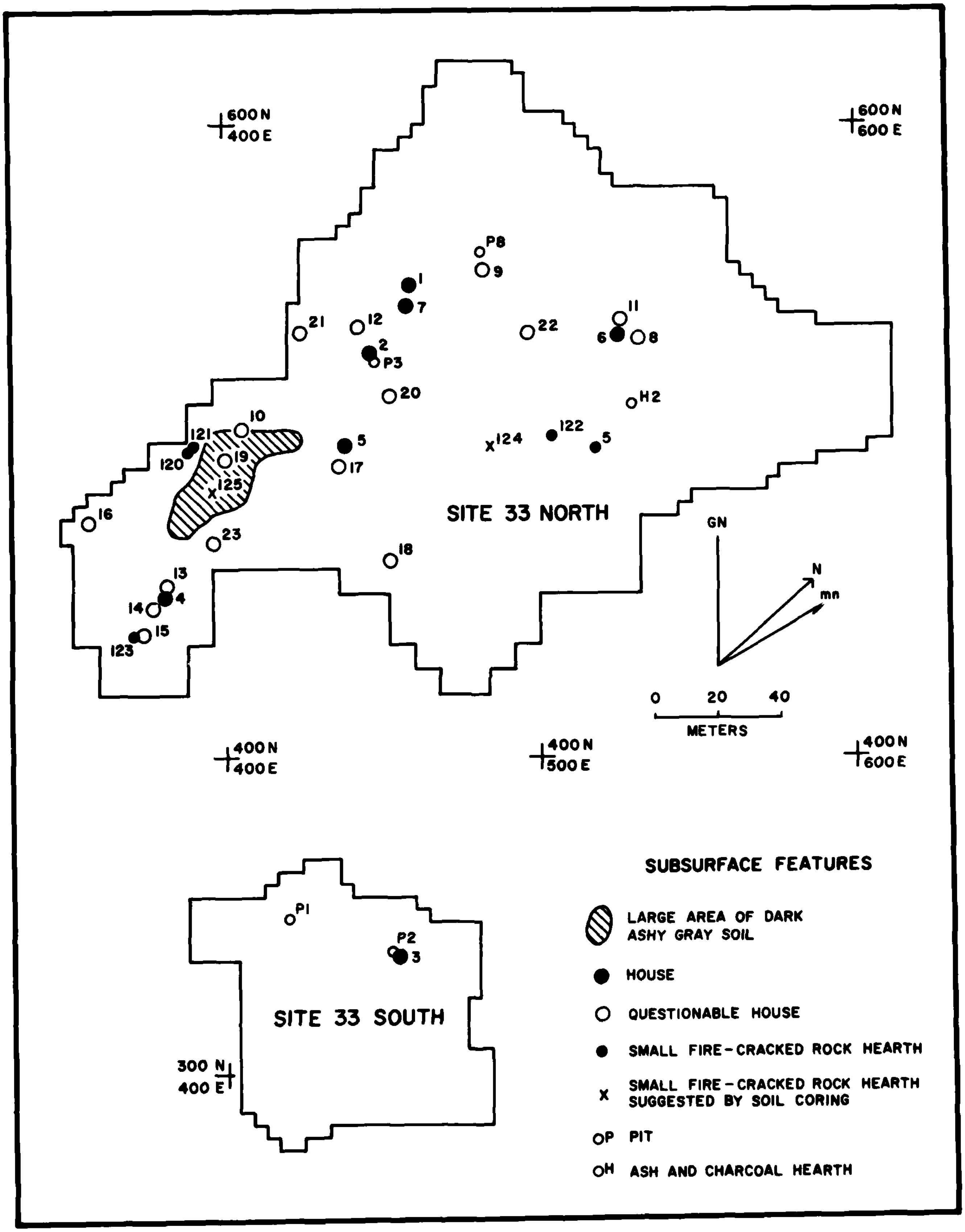


Figure 20. Features of the Zone 4 Archaic period occupation at Site 33.

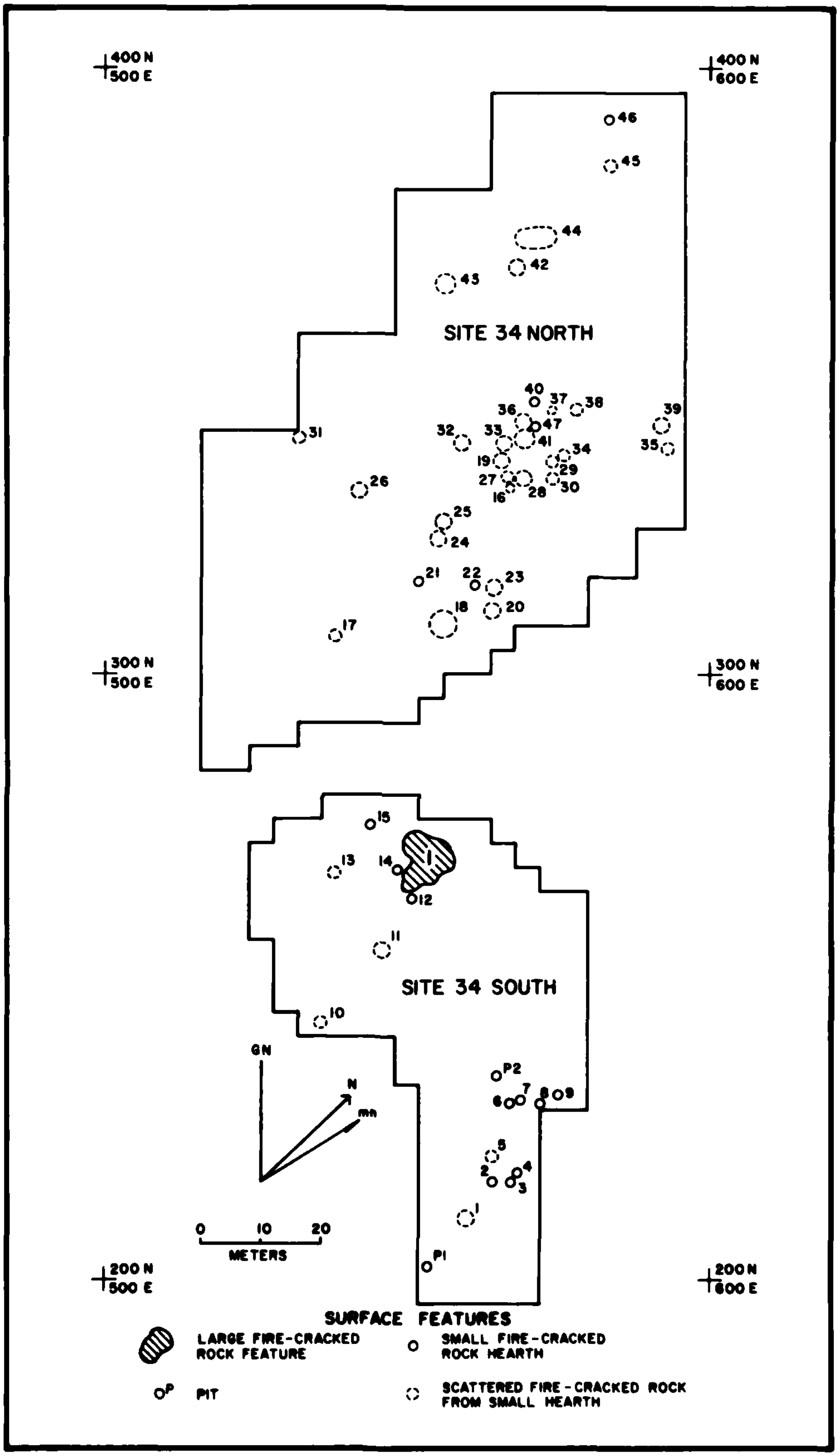


Figure 21. Features of the Zone 2 Formative period occupation at Site 34.

Large Fire-cracked Rock Feature 2. This feature was the most extensively studied of the large fire-cracked rock features. Its investigation was prompted by its imminent destruction during the construction of a Public Service Board waterline across Site 33 in the summer of 1979. Large Fire-cracked Rock Feature 2 is situated on the western edge of a low sand dune of Zone 3 desposits in Site 33 North (Figure 18). The construction of an earlier waterline across Site 33 in 1953 had disturbed the surface and removed the eastern one-third of this feature (Figure 22). On the surface, this featue was perceived as an arcing concentration of fire-cracked rock that probably once formed a circular ring of rock before it was disturbed by the construction of the 1953 waterline. The ring of concentrated fire-cracked rock ranges from 2.8 to 3.0 m in width and has a maximum outer diameter of 9.5 m. Smaller amounts of fire-cracked rock were observed inside the concentrated ring of fire-cracked rock and around the periphery of this feature. It is suggested that the ring of concentrated fire-cracked rock may have been mounded and higher than the center of this feature or surrounding areas prior to surface disturbance with the laying of the 1953 waterline.

The excavation of 13 square meters of Large Fire-cracked Rock Feature 2 revealed a layer of concentrated fire-cracked rock that was 10 to 20 cm thick and some 0.7 to 1.4 m wide and which curved beneath the surface scatter of dense fire-cracked rock for a maximum outer diameter of about 7.5 m (Figure 22). The subsurface ring of fire-cracked rock rested partially upon archeologically sterile sands of Zone 2 and dipped slightly into a central depression filled with a dark ashy-gray soil and numerous pieces of charcoal (Figures 22 and 23). The central depression was approximately 6.5 m in maximum diameter and had sloping pit walls and a nearly level but undulating bottom (Figures 22 and 24a). The dark ashy-gray soil of the central depression was 35 to 40 cm thick, and fire-cracked rock was only occasionally encountered in the fill of this depression or beneath the surdace and more than 1 m away from the subsurface ring of dense fire-cracked rock. Fire-cracked rock from this feature generally ranged from 5 to 15 cm in diameter and was made up primarily of limestone with some rhyolite, quartzite, and sandstone. The average weight of fire-cracked rock per excavated 1 m square was 38.8 kg, and the projected total weight of rock for this featue was 2,755 kg.

Large Fire-cracked Rock Feature 3. This feature is an elongated and irregular area of dense fire-cracked rock on the south side of a large dune of Zone 3 deposits in Site 33 North (Figure 18). The surface scatter of fire-cracked rock encompasses an area of 93 square meters. However, sizable portions of this feature are buried by eolian sands to the north and south of the exposed fire-cracked rock, and the total area of this feature may approach 150 square meters. Large Fire-cracked Rock Feature 3 was tested by a single 1 m square excavation near the center of the exposed scatter of fire-cracked rock. This excavation produced ashy-gray sand and charcoal to a depth of 55 cm below the surface and two layers of fire-cracked rock which were 15 and 10 cm thick (Figure 24b). Fire-cracked rock was usually between 5 and 15 cm in diameter but ranged in size up to 20 cm. Limestone was the predominant rock type, and rhyolite was also common. The weight of fire-cracked rock from the evacuated 1 m square was 88.1 kg, and the projected weight of rock for this feature was 13,215 kg.

Site 34

Large Fire-cracked Rock Feature 1. This feature sits atop a low sand dune in Site 34 South and comprises an amorphous area of fire-cracked rock eroding from the lower slopes of the dune (Figure 21). Eolian sands cover much of the fire-cracked rock towards the center of this feature where soil coring revealed a 30 to 40 cm thick deposit of dark, ashy sand with little fire-cracked rock. The margin of this feature was tested with two 1 m square excavations and a large quantity of fire-cracked rock was found as deep as 30 cm below the surface and following the incline of the dune. Only a few pieces of charcoal were recovered from the two excavated 1 m squares where the soil varied from a buff sand to a light ashy-gray sand. The average weight of fire-cracked rock from the two 1 m square tests is 36.6 kg, and extrapolation from the average weight of rock per square meter from tests gives 2,013 kg for the entire feature area of 55 square meters. Fire-cracked rock ranges in size from somewhat under 5 cm to 15 cm in maximum dimension and is made up mostly of limestone with some rhyolite.

Interpretive Summary of Large Fire-Cracked Rock Features

The large fire-cracked rock features of Sites 33 and 34 are similar to one another in that each encompasses a large area (55 to 125 square meters), contains large amounts of fire-cracked rock (estimated total rock weight 1,179 to 13,215 kg), and has dark carbonaceous soil lenses some 30 to 55 cm thick. The fire-cracked rock of these features is made up mostly of limestone with some rhyolite and rarely quartzite or sandstone, and the relative abundance of rock types in large fire-cracked rock features is comparable to their representation in rocks with 10 to 30 cm diameter on the gravelly

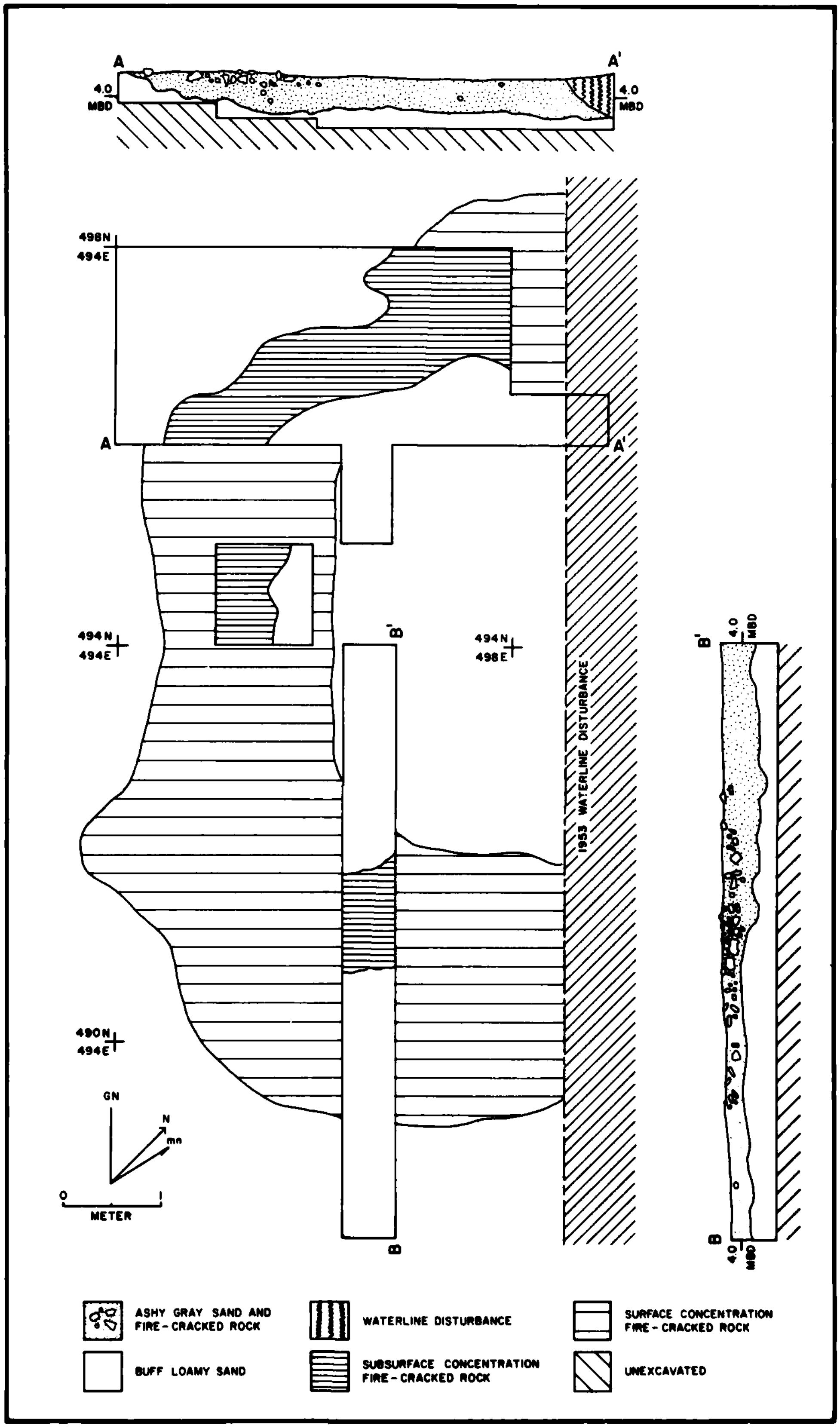


Figure 22. Plan and sectional views of Large Fire-cracked Rock Feature 2 at Site 33 North.

a.

b.

Figure 23. Stratigraphic profiles of Large Fire-cracked Rock Feature 2 of Site 33 North. a. Section A in Figure 22. Note concentrated fire-cracked rock (right) overlying darker soil of central depression (left). North arrow is 50 cm long. b. Fire-cracked rock and edge of central depression (center left) detailed in section B of Figure 22.

a.

b.

Figure 24. Stratigraphic profiles of Large Fire-cracked Rock Features 2 and 3 of Site 33 North. North arrows are 50 cm long. a. Profile of dark soil and undulating bottom of central depression of Large Fire-cracked Rock Feature 2. b. Excavated 1 m square in Large Fire-cracked Rock Feature 3 showing the lower layer of fire-cracked rock. Note the upper layer of rocks protruding from test pit walls.

ridges and terraces above Sites 33 and 34. All of the large fire-cracked rock features are also located either on or near sand dunes which predate the Zone 2 occupation of Sites 33 and 34, and it will be suggested in the section on small fire-cracked rock hearths that sites with fire-cracked rock features in the project area occur predominantly on sandy soils where subsurface excavation of pits would have been much easier than on other more compact or gravelly soils of the project area.

The limited subsurface examination of three of the large fire-cracked rock features did not provide sufficient information to define with certainty the form of these features and their likeness in form to the more extensively investigated Large Fire-cracked Rock Feature 2 of Site 33 North. However, the central area of dark carbonaceious soil and the outer dense scatter of fire-cracked rock of Large Fire-cracked Rock Feature 1 at Site 34 South would seem to resemble the better defined central pit and ring of concentrated fire-cracked rock of Large Fire-cracked Feature 2 at Site 33 North. It is also felt that Large Fire-cracked Rock Feature 1 of Site 33 South may have a form similar to that of the two above mentioned features although this was not revealed by the surface scatter of fire-cracked rock or the profiles of the single excavated 1 m square of this feature. Large Fire-cracked Rock Feature 3 of Site 33 North differs from the other large fire-cracked rock features in its larger size and surface configuration of fire-cracked rock and does not bear evidence of a central area with little fire-cracked rock or of a central pit.

Circular or semicircular accumulations of unexcavated fire-cracked rock which may or may not have a pit in their center have been recorded for desert environments of northern Mexico, southern New Mexico, and Transpecos Texas by Greer (1968a), Mera (1938), Sayles (1935; 1936), and Wilson (1930). These features are referred to as ring middens, midden circles, mescal pits, and sotol pits. Sayles (1935) and Wilson (1930) note that the distribution of these features follows that of the leaf succulent sotol *(Dasylirion* spp.) and conclude that these features were roasting pits used in the pit-baking of sotol. Mera (1938) also infers the roasting of agave *(Agave* spp.) in these features.

Close to El Paso, four circles of fire-cracked rock have been excavated and have suggested central pits with diameters (2.2 to ca.5m; ca. 4.3 m mean) and depth (30 to 60 cm) much like that of Large Fire-cracked Rock Feature 2 at Site 33 North. These four excavated circles of fire-cracked rock include examples from the following areas: one from near Campo Grande Mountain southeast of El Paso (Gerald n.d. a); one from near Sierra Blanca Mountain southeast of El Paso (Skinner, Steed, and Bearden 1974); and two from slopes bordering the Hueco Mountains east of El Paso (Greer 1968b; Whalen 1977:160-161). Additional large circles of fire-cracked rock are also documented by Aten (1972) on an alluvial slope below the east flank of the Franklin Mountains, by Greer (1968b) and Whalen (1977) for alluvial slopes just west of the Hueco Mountains, and by Skinner, Steed, and Bearden (1974) near Sierra Blanca Mountain.

With the exception of Large Fire-cracked Rock Feature 2 at Site 33 North and the other large fire-cracked rock features of Sites 33 and 34, all of the above cited circles of fire-cracked rock are located in or very near plant communities in which the leaf succulents lechuguilla *(Agave lecheguilla)* and sotol *(Dasylirion wheeleri* or *texanum)* are important constituents. The large fire-cracked rock features of Sites 33 and 34 are, however, situated only 3 km from the Upper Bajada environmental zone where lechuguilla is common and where sotol can be found but is not as frequently encountered as it is in the Mountain environmental zone. The presence of the Rio Grande may well have influenced the placing of the large fire-cracked rock features at Sites 33 and 34 at a somewhat greater distance from source areas of leaf succulents such as lechuguilla and sotol than fire-cracked rock circles occurring away from the river. Thus, a correlation between the spatial distributions of lechuguilla-sotol and large circles of fire-cracked rock can be only tentatively advanced. More information on the geographical distribution of leaf succulents and fire-cracked rock features will be given in the following section on small fire-cracked rock hearths and in support of the covariation of leaf succulents and fire-cracked rock features.

Ethnographic accounts of the processing of roots, hearts, and leaf bases of leaf succulents by Indian groups of northern Mexico and adjacent arid areas of the United States most often describe the pit baking of species of *Agave*, *Dasylirion*, and *Yucca* in features which seem to be similar to the large fire-cracked rock features of the El Paso area (Basehart 1974; Bell and Castetter 1941; Bye, Burgess, and Trias 1975; Castetter, Bell, and Grove 1938; Pennington 1963; 1969). The pit baking of leaf succulents is commonly said to involve the building of a fire on rocks which have been placed in a pit some 1 to 4 m in diameter and approximately 1 m deep, the placing of leaf succulents on the rocks after the fire has burned out and between other plant materials, and the covering of the pit contents with a layer of earth. Some groups are also known to have built fires on top of the earth covering or to have layed additional hot stones on top of the leaf succulents.

The leaf succulents were left in a pit oven for one or more days and then removed for consumption or further processing.

The archeologically noted circular accumulations of fire-cracked rock with large central depressions filled with carbonaceous soil of the El Paso area agree with the ethnographically reported pit ovens used to bake leaf succulents insofar as there is an association of quantities of fire-cracked rock with pits in which fires were built. However, there is a greater tendency for the fire-cracked rock to be found outside of the pit and for the pit excavation to be wider and shallower in the archeological features than in the ethnographically detailed pit ovens. These differences are thought to be related to the reuse of the archeological features through time, whereas most ethnographically described pit ovens appear to be ones which were being used for the first time. Castetter, Bell, and Grove (1938) give an excellent description of the reuse of pit ovens by the Diegueño of California who used the same ovens again and again and raked fire-cracked rock away from the pits to form circular mounds. Mera (1938) and Greer (1968a), in interpreting archeological features, envisage a similar process that resulted in the production of circular accumulations of fire-cracked rock from the reuse of central pit or surface ovens. The tendency toward a larger diameter of the central pit or pit area in the archeological features of the El Paso area as compared to the diameter of the ethnographically characterized pit ovens is seen as an outcome of the repeated use of the same pit area with the later pits not necessarily located in the exact position of earlier pits. As a result of the reuse of the same area, the central pit is enlarged. The circular accumulation of fire-cracked rock and the large central depression filled with carbonaceous soil of the archeological features may, therefore, give an impression of pit ovens larger than any or most that were actually used. The central depressions of the large fire-cracked rock features of the El Paso area are also shallower than the ethnographic examples of pit ovens, and this may have to do with the erosion of surface soils which is treated in the next section.

The limited investigation of the large fire-cracked rock features at Sites 33 and 34 has provided several pieces of information on the probable repeated use of these features in addition to that of the circular accumulation of fire-cracked rock and large central and mostly rock-free depression of Large Fire-cracked Rock Feature 2 at Site 33 North and presumably Large Fire-cracked Rock Feature 1 at Site 34 South. First, Large Fire-cracked Rock Feature 2 at Site 33 North has a central depression with an irregular or undulating bottom which suggests multiple pits resulting from the reuse of this feature (Figures 22 and 24a). Second, the excavated 1 m squares of Large Fire-cracked Rock Features 1 and 3 of Site 33 have two recognizable layers of fire-cracked rock that indicates at least two episodes of activity (Figure 24b). Although the form of Large Fire-cracked Rock Feature 1 at Site 33 South is uncertain, the unpatterned and extensive scatter of the fire-cracked rock of Large Fire-cracked Rock Feature 3 at Site 33 North would imply that the repeated use of this feature was not centered on any one particular pit area and that the noncongruent placement of pits in the area of this feature produced overlapping distributions of fire-cracked rock. Finally, the BC/AD corrected radiocarbon dates and ceramics from three of these features may be taken as indicative of long or repeated use of these features. Large Fire-cracked Rock Features 1 and 3 of Site 33 have on their surfaces Mimbres Black-on-white sherds which date between AD 900 and 1100 and have radiocarbon samples taken at the bottom of these features that date 160 BC ± 220 and 130 BC ± 230 respectively. A single sherd of a brownware with a black-painted line which probably dates somewhere between AD 1050 and 1250 was found on the surface of Large Fire-cracked Rock Feature 2 at Site 33 North, and a radiocarbon sample from the bottom of this feature was dated at AD 380 ± 150. Ceramic materials were generally found on the peripheral surfaces and only in the upper 10 cm of the excavations of the above three large fire-cracked rock features and the considerable differences between radiocarbon dates and dates suggested from ceramics may indicate a long history of activities involving the use of the localities in the vicinity of these features.

There are no radiocarbon dates or associated ceramics for Large Fire-cracked Rock Feature 1 at Site 34 South, but this feature is believed to be of an age comparable to that of the other large fire-cracked rock features on the basis of ceramics and radiocarbon dates from other areas of Site 34.

The previous exposition of the likeness in spatial distribution of leaf succulents and large circular accumulations of fire-cracked rock such as Large Fire-cracked Rock Feature 2 at Site 33 and the similarity, with qualifications of reuse, of the excavated large accumulations of fire-cracked rock with central depressions to ethnographic examples of pit ovens used to bake leaf succulents has led to the tacit assumption that the archeological features were used to pit-bake upland leaf succulents such as lechuguilla and sotol. A consideration of the spatial distribution of large scatters or middens of fire-cracked rock such as Large Fire-cracked Rock Feature 3 at Site 33 was not attempted, but it is believed that the spatial distribution of these features would also have shown a correspondence with that of upland leaf succulents. Direct archeological evidence of the baking of leaf succulents in large fire-cracked rock features like those of Sites 33 and 34 is lacking from other sites of the El Paso area, but it is noted that small amounts of carbonized leaf succulents were recovered from Large Fire-cracked Rock Features 2 and 3 of Site 33. These data support the proposition advanced by this writer and others working in the El Paso area (Greer 1968b; Hard n.d.; O'Laughlin 1977a; 1979; O'Laughlin and Greiser 1973; Whalen 1977; 1978) that these features were used to pit-bake leaf succulents.

Strong support for this proposition also comes from the studies of Castetter, Bell and Grove (1938) and Sayles (1935) who not only note the correlation of the spatial distribution of archeological features similar to the large fire-cracked rock features of this project with that of agave and sotol, but also the correlation of the spatial distribution of agave and sotol with the pit baking of these plants by historic Indian groups.

Very little can be said of the temporal distribution in the El Paso area of large fire-cracked rock features similar to those of Sites 33 and 34 other than observing their occurrences in sites of both the Archaic and Formative periods. Large scatters or middens of fire-cracked rock like that of Large Fire-cracked Rock Feature 3 at Site 33 are known from shelter sites such as La Cueva in the Organ Mountains (O'Laughlin n.d. a) and White Rock Shelter in the Franklin Mountains (Green 1971) where excavations have revealed long histories of repeated and probably seasonal occupation and use of fire-cracked rock features. Formative period occupations of the Mesilla and El Paso phases are represented at both La Cueva and White Rock Shelter, and an Archaic period occupation is also evidenced at La Cueva. Large circular accumulations of fire-cracked rock or ring middens similar to Large Fire-cracked Rock Feature 2 at Site 33 are not well dated and many have been assigned only to the Formative period without phase designation or have been included with other sites of unknown phase and period of occupation (Skinner, Steed, and Bearden 1974). The few ring middens (12) which have been dated by associated ceramics or radiocarbon dates to either the Mesilla or El Paso phase of the Formative period are equally distributed between these two phases (Aten 1972; Gerald n.d. a; Greer 1968b; Skinner, Steed, and Bearden 1974; Whalen 1977; and this project). Only one ring midden is reported which may date to the Archaic period on the basis of projectile point forms from the same site (Skinner, Steed, and Bearden 1974). The greater number of documented large fire-cracked rock features of the Formative period as compared to the Archaic period is a reflection of the greater archeological visibility of the later Formative period sites and an apparent increase in population during the Formative period and is not necessarily an indication of the importance of subsistence activities involving the leaf succulents of mountains or slopes below mountains in the El Paso area. In addition, archeological surveys of lower mountain slopes and alluvial slopes below mountains where these large fire-cracked rock features occur most commonly have been of very limited extent and the representativeness of the temporal distribution of these features is not known.

Use in the baking of leaf succulents has been proposed as the probable function of large fire-cracked rock features comparable to those of Sites 33 and 34 in the El Paso area, and as previously noted, other archeologists working in the El Paso area have advanced parallel views. However, there are differing opinions concerning the part that Formative period sites with large fire-cracked rock features played in the adaptive strategies of the social groups that once occupied them. Whalen (1977; 1978) sees sites with large fire-cracked rock features of the El Paso phase as special purpose, temporarily occupied camps in which leaf succulents were processed for transport to permanently occupied residential sites and contends that sites with large fire-cracked rock features of the Mesilla phase have domestic refuse which is typical of residential communities of at least semipermanent occupation. O'Laughlin (1979) and Hard (n.d.) agree with Whalen's characterization of the El Paso phase sites with large fire-cracked rock features and with his observation that Mesilla phase sites with large fire-cracked rock features tend to have a wider variety and greater density of artifacts than El Paso phase sites with large fire-cracked rock features. Nevertheless, O'Laughlin and Hard suggest that Mesilla phase sites with large fire-cracked rock features were occupied only intermittently for short periods of time and that these sites were as specialized as the El Paso phase sites in the sense of the major activity being the processing of leaf succulents. Repeated occupation over a period of time of the Mesilla phase sites is seen by O'Laughlin and Hard as increasing the density and variety of artifacts, while most El Paso phase sites were thought to have been revisited a fewer number of times. While Whalen implies that Mesilla phase sites with large fire-cracked rock features are residential sites exhibiting some permanance of occupation and diversity of subsistence activities, O'Laughlin and Hard argue that these sites are only one of a number of types of Mesilla phase sites that were generally occupied for relatively short periods of time and for a limited range of subsistence activities. That is, O'Laughlin and Hard envision populations throughout most of the Mesilla phase changing residence frequently and in accordance with seasonal and spatial variability in the availability of natural food resources or with conditions amenable to the raising of cultigens.

The large fire-cracked rock features of the Formative period occupations at Sites 33 and 34 are believed to have been in use during the Mesilla phase. Large Fire-cracked Rock Features 1, 2, and 3 of Site 33 have ceramics on their surfaces which date to the later part of the Mesilla phase, and the radiocarbon date from Large Fire-cracked Rock Feature 2 at Site 33 is well within the time span of the Mesilla phase. Radiocarbon dates from the bottoms of Large Fire-cracked Rock Features 1 and 3 at Site 33 have mean BC/AD corrected dates which are somewhat earlier than the earliest radiocarbon dated ceramics of this phase at AD 250 ± 110 (Whalen n.d.). However, the beginning date of the Mesilla phase is not known, and the standard deviation of the radiocarbon dates from Large Fire-cracked Rock Features 1 and 3 at Site 33 does not rule out the possibility that these features may actually have been first used between the first and fourth centuries AD (see Chapter V for a more complete discussion of these radiocarbon dates). Ceramics and radiocarbon dates from Site 34 indicate that Large Fire-cracked Rock Feature 1 at Site 34 South is of Mesilla phase age.

The presence of large fire-cracked rock features at Sites 33 and 34 which are thought to have been utilized for the processing of leaf succulents and which were apparently reused over a period of time does not, by itself, provide adequate information for ascertaining whether the occupations during the Mesilla phase at these sites were temporary or relatively permanent and of a specialized or more general economic nature. Although the large fire-cracked rock features of Sites 33 and 34 do seem to be specialized facilities which were utilized repeatedly over a considerable length of time, additional data on the other kinds of features and artifacts of the Zone 2 occupations at Sites 33 and 34 are necessary to document the writer's contention that these features are but one line of evidence suggesting ephemeral occupation for which the processing of leaf succulents is the most obvious activity.

Small Fire-cracked Rock Hearths

Small fire-cracked rock hearths are by far the most numerous kind of feature found at Sites 29, 33, and 34. These features are easily distinguished from the large fire-cracked rock features of Sites 33 and 34 by their smaller size, shallower depths, and smaller weights of fire-cracked rock. Each of these attributes of small fire-cracked rock hearths will be considered shortly after first describing the representation of these features at Sites 29, 33, and 34 and the methods employed in investigating them. The number of suggested small fire-cracked rock hearths at Sites 29, 33, and 34 and their important attributes are summarized in Table 9.

Small fire-cracked rock hearths are the only features disclosed by the examination of Site 29 where it is thought that three of these hearths are represented by light surface scatters of fire-cracked rock in two areas of this small site. The investigation of Site 29 and the exposed condition of this Site indicate that other small fire-cracked rock hearths or other kinds of features did not go unrecognized. Two of the small fire-cracked rock hearths were too eroded to obtain estimates of their original size, form, and the weight of fire-cracked rock. The third hearth was found to be relatively intact although the upper portion of this feature had eroded away. The size distribution, weight, material, and position of the fire-cracked rock of this hearth was recorded, and the soil was saved after screening for the possible recovery of carbonized floral remains through water flotation. A radiocarbon sample was not taken from this hearth because of the paucity and very small size of charcoal.

Site 33 has 125 identified localities of fire-cracked rock which appear to represent 145 small fire-cracked rock hearths (Table 9). As many as 63 small fire-cracked rock hearths of the Zone 2 Formative period occupation are indicated by 53 separate and light surface scatters of fire-cracked rock from either partially weathered and mostly buried hearths or completely deflated and eroded hearths (Figures 18, 19, 25a). There are also 28 intact or partially eroded small fire-cracked rock hearths attributable to the Zone 2 Formative period occupation and visible on the surface of Site 33 (Figures 18, 19, 25b). Seven small fire-cracked rock hearths of the Zone 2 Formative period occupation and five small fire-cracked rock hearths of the Zone 4 Archaic period occupation were discovered in backhoe trenches and 1 m square excavations or in the vertical faces of arroyo cuts, and two Zone 4 Archaic period hearths and as many as 40 Zone 2 Formative period hearths are suggested by subsurface fire-cracked rock and charcoal from 32 locations of soil augering (Figures 18, 19, 20).

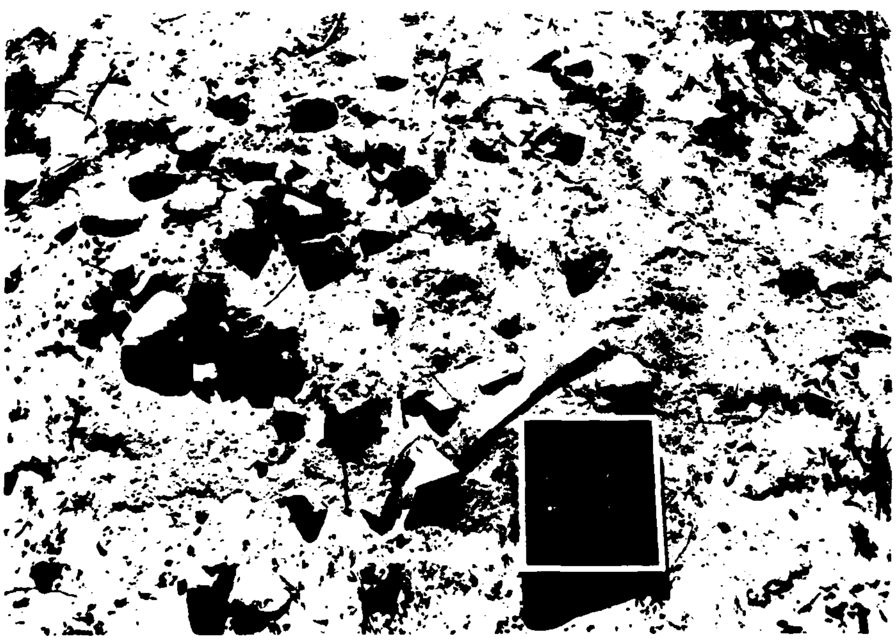
Although 145 small fire-cracked rock hearths have been recorded for the occupations of Zones 2 and 4 at Site 33, other subsurface hearths have

TABLE 9

ATTRIBUTES OF SMALL FIRE-CRACKED ROCK HEARTHS

Site	Zone	No. Loci	No.Hearths Suggested	Diameter(cm) n	Diameter(cm) Range	Diameter(cm) Mean	Depth(cm) n	Depth(cm) Range	Depth(cm) Mean	Rock Weight(kg) n	Rock Weight(kg) Range	Rock Weight(kg) Mean	Shape of Bottom Shallow Basin	Shape of Bottom Flat	Placement of Rock Dispersed	Placement of Rock Lined	Placement of Rock Ringed	Emptied?
34	2	47	48	10	65-140	106.5	2	15-20	17.5	6	16.7-44.2	26.0	1	1	3	-	1	-
33 North	2	92	111	14	90-180	113.9	10	10-16	12.9	19	6.9-110.8	39.7	4	3	5	2	3	1
33 South	2	26	27	7	70-150	102.1	4	10-20	12.5	3	24.8-33.5	29.5	3	-	2	-	2	1
33	4	7	7	2	80-85	82.5	2	10	10.0	1	54.6	54.6	1	1	3	-	1	-
29	-	2	3	1	110	110.0	1	10	10.0	1	43.1	43.1	1	-	1	-	-	-

a.



b.

Figure 25. Surface evidence of small fire-cracked rock hearths at Site 33 North. a. View looking east toward the Franklin Mountains and across a large surface scatter of fire-cracked rock (Number 34) representing 4 to 6 hearths in a wind deflated interdunal area. b. Small Fire-cracked Rock Hearth 4 eroding from a slope. Arrow points north and is 50 cm long.

certainly gone unnoticed because of the field sampling techniques used in this limited examination of Site 33. Only 0.65% of Site 33 was tested with backhoe trenches and 1 m square excavations, and the placement of backhoe trenches and 1 m square excavations involved considerations other than those pertinent to the random sampling of deposits for probabilistic statements on the number of small fire-cracked rock hearths for the Zone 2 and Zone 4 occupations at Site 33. In general, backhoe trenches and 1 m square excavations were situated to provide information on the stratigraphy of Site 33 and details of the various kinds of identified surface and subsurface features. Three small fire-cracked rock hearths which were not manifest by surface scatters of fire-cracked rock or fire-cracked rock in soil cores were disclosed by backhoe trenching, but the biased sampling scheme does not justify the extrapolation from the subsurface excavation of less than 1% of the area of Site 33 to a statement that hundreds of these hearths lie buried at Site 33 and undocumented by this study. The subsurface testing of Site 33 by interval soil augering was more extensive than that by backhoe trenching and excavated 1 m squares. All of Site 33 was tested at 8 m intervals with soil augers, and 7% of Site 33 was cored at intervals of 2 m. However, the distance between soil cores (either 8 m or 2 m) was not short enough to give a probabilistic measure of the number of buried small fire-cracked rock hearths which range in size from 0.7 to 1.8 m in diameter at Site 33 (Table 9). That is, the intervals of soil augering are larger than the largest noted diameter of a small fire-cracked rock hearth and cannot be expected to give reliable estimates of the number of small fire-cracked rock hearths for the occupations of Zones 2 and 4 at Site 33. Even though the subsurface testing of Site 33 was not designed to give a statistically reliable estimate of the number of small fire-cracked rock hearths at Site 33, it is believed from the few hearths found in the subsurface tests, the often weathered and relatively shallow deposits of Zone 2 in which most of the hearths occur, the rare occurrence of fire-cracked rock in Zone 4 deposits, and the infrequent finding of buried hearths or scatters of fire-cracked rock away from clusters of small fire-cracked rock hearths in Zone 2 deposits that a major portion of the small fire-cracked rock hearths have been located at Site 33. The total number of hearths is envisioned, therefore, as being between 200 and 300. In addition, it is also believed that the extensive subsurface testing of Site 33 has furnished a good measure of the relative importance of these features and their spatial distributions for the occupations of Zones 2 and 4 at Site 33. These factors will be dealt with later in this section.

There are 32 light surface scatters of fire-cracked rock which indicate the presence of 33 small fire-cracked rock hearths at Site 34, and another 15 intact or partially eroded small fire-cracked rock hearths are evident on the surface of Site 34. Most of the surface scatters are from badly eroded hearths, and only 10 to 15 of the surface scatters appear to have subsurface fire-cracked rock below them. Many of the more intact small fire-cracked rock hearths have recently been exposed by slope erosion (particularly in Site 34 South), and even the best preserved hearths seem to have been subjected to some weathering such that charcoal was rarely encountered and only a circular concentration of fire-cracked rock was discernible in tests of these features. Extensive subsurface tests of Site 34 with backhoe trenches, 1 m square excavations, and soil cores at 8 m and 2 m intervals did not reveal the presence of additional small fire-cracked rock hearths. The weathered surfaces, the limited occurrence of very thin occupational deposits, the eroded condition of most hearths, and the extensive subsurface testing at Site 34 suggest that most, if not all, hearths have been located. Radiocarbon dates (Chapter V) and ceramic materials (Chapter IX) from Site 34 imply primary occupation of this site during the Mesilla phase of the Formative period. Because of the eroded condition of Site 34 and the few direct associations of hearths with ceramic materials, it is not possible to state with certainty that all small fire-cracked rock hearths at this site date to the Mesilla phase. However, the relatively infrequent occurrence of small fire-cracked rock hearths in the Zone 4 Archaic period deposits of adjacent Site 33 does strengthen the inference that the hearths at Site 34 probably date to the later Formative period.

The field methods utilized in investigating the surface and subsurface remains of small fire-cracked rock hearths at Sites 33 and 34 that were partially described in Chapter IV are further detailed here. The number of fire-cracked rocks, their size, and their materials were recorded for the surface of each 4 m square of the grid system used to locate features and artifacts at these sites, and the number of fire-cracked rocks were noted for each 1 m square. When encountered, well-defined, small fire-cracked rock hearths were drawn to provide information on the dimensions of these features and the positioning of rocks in them. The number, size range, and material of fire-cracked rock in well-defined hearths was also recorded, and observations were made on the condition of surface hearths and the probability of their continuation beneath surface soils. The weight of fire-cracked rock for each 4 m grid square was calculated from a graphic display of measured weights of fire-cracked rock from excavated samples against their size and for each of the represented materials. These estimates of the weight of fire-cracked rock per 4 m grid square are included in a factor analysis of surface materials from Sites 33 and 34 which is outlined in Chapter X.

The number, size, and material of fire-cracked rock were described for each 25 cm level of soil cores taken at 8 m and 2 m intervals at Sites 33 and 34. The presence of two or more fire-cracked rocks in a 25 cm level, the co-occurrence of dark carbonaceous soils and charcoal, and the lack of fire-cracked rock at the same level in other nearby soil cores were taken as evidence for a buried small fire-cracked rock hearth. The level at which a hearth was noted and stratigraphic information from soil cores or other subsurface tests made possible the assignment of hearths disclosed by soil augering to either the Zone 4 Archaic period occupation or the Zone 2 Formative period occupation at Site 33. There were no buried hearths indicated by soil augering at Site 34. Charcoal from small fire-cracked rock hearths found in soil augering was saved for species identification, and soil samples were taken from hearths located by soil augering for laboratory processing to recover carbonized floral remains.

Nine small fire-cracked rock hearths discovered by backhoe trenching or observed in the walls of arroyos at Site 33 were drawn in cross-section, measurements were taken of the widths and thicknesses of these features, the position of rocks was recorded, and the extent of dark carbonaceous soil below the fire-cracked rock was noted (see Chapter V, Figures 11, 12). Three of these hearths were investigated in greater detail as described below.

Seventeen small fire-cracked rock hearths at Site 33 and 34 were either excavated as feature units (9) or as part of the subsurface testing of these sites by 1 m squares (8). In most cases excavation proceeded until a large enough area (50%-70%) of a hearth was revealed to give information on its form, size, and contents. This left intact a portion of most excavated hearths for possible re-examination in future studies. Four surface hearths and one buried hearth which either were disturbed by backhoe trenching, would have been destroyed by the construction of the waterline across Site 33 North in the summer of 1979, or were entirely exposed in small arroyos, were completely excavated. Plans and cross-sections were drawn of all excavated hearths. Weight, number, size range, and material of fire-cracked rock were tabulated for each hearth, and the total weight of fire-cracked rock for partially excavated hearths was estimated from the excavated portion. Pollen and soil flotation samples were taken from all hearths, and charcoal, when present, was collected for radiocarbon dating and species identification. All of the excavated soil from each hearth was screened for the recovery of artifacts which were generally few in number and of infrequent occurrence.

Small fire-cracked rock hearths were chosen for excavation in an effort to obtain a representative sample of both surface and buried hearths and of all of the various occupations of Sites 33 and 34. Although the sample of excavated small fire-cracked rock hearths is small (8.8%), the amount of redundancy in the attributes of these features (both excavated and non-excavated) did not warrant the excavation of additional hearths as part of the limited investigation of these sites. The excavated hearths included two buried and seven surface hearths of the Zone 2 Formative period occupation at Site 33 North, two buried and one surface hearth of the Zone 2 Formative period occupation at Site 33 South, three surface hearths of the Zone 2 Formative period occupation at Site 34, and two buried hearths of the Zone 4 Archaic perioc occupation at Site 33 North.

Attributes of Small Fire-Cracked Rock Hearths

The attributes of small fire-cracked rock hearths are detailed below and are followed by a discussion of the possible uses of these features and consideration of their temporal and spatial distribution at Sites 29, 33, and 34. Many of the attributes of small fire-cracked rock hearths are summarized in Table 9.

The maximum diameter of measurable, small fire-cracked rock hearths ranges from 65 to 180 cm at Sites 29, 33, and 34, and the mean diameters of the hearths at these sites varies from 82.5 to 113.9 cm (Table 9). Most hearths ranged in diameter from 90 to 130 cm, and there appeared to be unimodal distribution. Hearth diameters were measured by the horizontal extent of fire-cracked rock or, less often, by the extent of charcoal and dark carbonaceous soil. None of the excavated hearths or hearths visible in arroyo walls and backhoe trenches had definable pit walls.

The diameters of small fire-cracked rock hearths at Sites 29, 33, and 34 contrast sharply with the large surface scatters of fire-cracked rock and circular accumulations of fire-cracked rock with large central depressions noted in the previous section, but they are comparable in size to the many smaller fire-cracked rock features excavated on an alluvial fan below the east flank of the Franklin Mountains

(Aten 1972; Hard n.d.; O'Laughlin 1979; O'Laughlin and Greiser 1973; Thompson 1979). These latter features range in diameter from 56 to 270 cm.

The depth of small fire-cracked rock hearths at Sites 29, 33, and 34 ranges from 10 to 20 cm (Table 9). As noted above, pit walls could not be defined for hearths, and this is also true of pit bottoms. The depth of hearths is in actuality the thickness of fire-cracked rock and/or charcoal in these features. In many cases the upper pit walls seem to have eroded away (Figures 11, 12, 26). However, even the more deeply buried hearths furnish no evidence of pit walls. This is, in part, because of the sandy texture of soils at Sites 29, 33, and 34, and the probable obscuring of pit walls with percolating waters in these permeable soils. In addition, these features were probably filled with soils similar to those in which they were dug and following their use which involved the layering of rock and fuel for a fire in the bottoms of these features. Charcoal and dark carbonaceous soil which would help delimit pit walls was not found more than a few centimeters above the fire-cracked rock of these features. Fire-cracked rock, charcoal, and dark carbonaceous soils did aid in demarcating the shape of a number of pit bottoms which were either very shallow basins or were flat-bottomed (Table 9). In six cases the downward movement of water has carried very small pieces of charcoal with it and produced basin-shaped and slightly discolored soils as much as 25 cm below the level of fire-cracked rock and larger pieces of charcoal (Figure 11, Hearth 51; Figure 26, Hearths 5 and 7).

The depths of small fire-cracked rock hearths at Sites 29, 33, and 34 given in Table 9 do not approximate the original depths of these features and only provide a measure of the thickness of fire-cracked rock and charcoal. The erosion of occupational surfaces, the probable filling of these features with soils similar to those in which they were excavated, and the obscuring of pit outlines with percolating water have made it impossible to define pit walls and estimate with certainty the original depths of these features. A similar problem exists with the small fire-cracked rock features excavated on an alluvial fan below the east slope of the Franklin Mountains where slope erosion has apparently removed the upper portions of many of these features (Aten 1972; Hard n.d.; O'Laughlin 1979; O'Laughlin and Greiser 1973; Thompson 1979). Measured pit depths of these small fire-cracked rock features generally range from 10 to 25 cm and occasionally reach 30 to 55 cm. In the Hueco Bolson east of the Franklin Mountains, numerous small hearths containing burned lumps of caliche are also noted as being very shallow and evidently deflated by the wind erosion of the surfaces (Whalen 1977; 1978; n.d.). The apparent susceptibility of soil surfaces in the El Paso area to wind and slope erosion makes difficult and open to question most conjectures concerning the original depth of pits containing fire-cracked rock. However, it is felt that the pits of small fire-cracked rock hearths at Sites 29, 33, and 34 may have been relatively shallow and that they were rarely deeper than half a meter. This is somewhat supported by the 30 to 55 cm range in depth of dark carbonaceous soil and fire-cracked rock for the large fire-cracked rock features of Sites 33 and 34 described in the previous section. Although the surfaces of these large fire-cracked rock features have probably undergone some erosion, the substantial quantities of fire-cracked rock in these features have probably helped stabilize their surfaces. Shortly, it will be suggested that the small fire-cracked rock hearths and large fire-cracked rock features were functionally equivalent with differences between these features relating to feature reuse and quantity of plant material being processed. Thus, it is believed that the depth of the large fire-cracked rock features is also a close approximation of the original depth of pits of the small fire-cracked rock hearths.

All of the small fire-cracked rock hearths at Sites 29, 33, and 34 contain some fire-cracked rock (Table 9) and in this respect these features differ from Large Fire-cracked Rock Feature 2 at Site 33 North and possibly Large Fire-cracked Rock Feature 1 at Site 34 South which have very little rock in their centers and large amounts of rock on their peripheries. However, the weight of fire-cracked rock in small fire-cracked rock hearths (6.9 to 110.8 kg) is considerably less than that estimated for the four large fire-cracked rock features of Sites 33 and 34 (1,179 to 2,755 kg). Differences in weight and positioning of fire-cracked rock between the small fire-cracked rock hearths and the large fire-cracked rock features is thought to be related to the reuse of the larger features, while the small fire-cracked rock hearths are believed to have been used once or only a few times. This inference will be dealt with specifically when the spatial distribution of fire-cracked rock features at Sites 33 and 34 is discussed later in this section.

There is a slight tendency for the weight of fire-cracked rock to covary with the maximum diameter of small fire-cracked rock hearths. This follows from the definition of most hearth diameters by the horizontal extent of fire-cracked rock and the rather narrow range of observed depths of fire-cracked rock in hearths. Hard (n.d.) has also noted a direct and positive relationship between the maximum

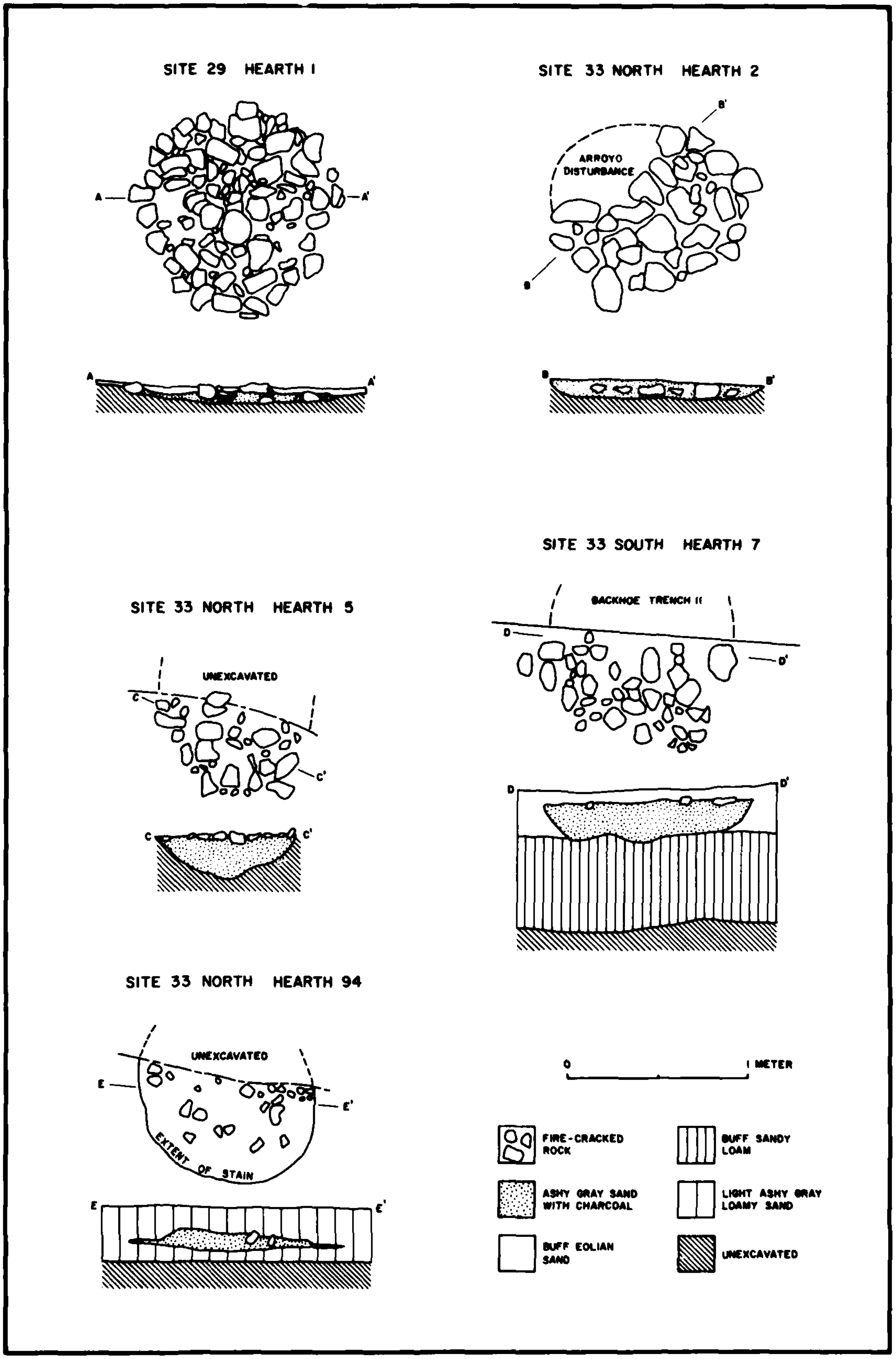


Figure 26. Plan and sectional views of some of the excavated small fire-cracked rock hearths.

diameter and weight of fire-cracked rock for 16 excavated small fire-cracked rock hearths on an alluvial slope on the east flank of the Franklin Mountains and finds hearth diameters and the weights of fire-cracked rock comparable to those for the hearths of this project. Observed variation from the pattern in which fire-cracked rock weight increases with the enlargement in hearth diameter at the sites of this project is partially attributable to the apparent erosion of many hearths and the scattering of hearth stones such that some stones were not necessarily included in the measured weights of fire-cracked rock. Other factors that have contributed to variability in weight of fire-cracked rock for recorded hearth diameters include the density or packing of fire-cracked rock in hearths and the possible intentional removal of rock from some hearths which will be considered momentarily.

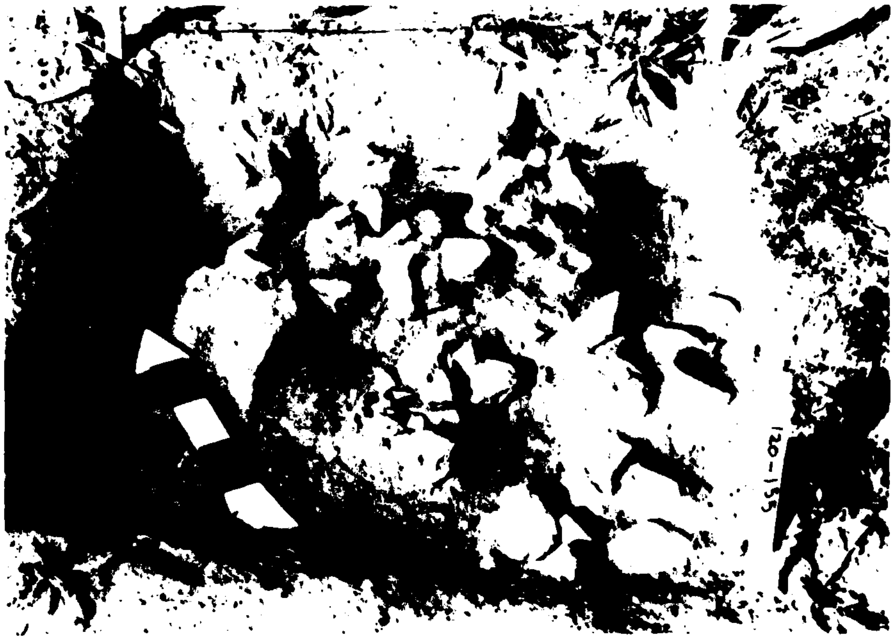
The materials and size range of rock for small fire-cracked rock hearths parallels that of the large fire-cracked rock features. Limestone is the predominant rock type found in the small fire-cracked rock hearths although small amounts of rhyolite occur in most hearths. Quartzite and sandstone are comparatively rare and are found infrequently in the small fire-cracked rock hearths. The size range of the fire-cracked rock in hearths generally varied in largest dimension from 5 to 15 cm, but smaller rocks or larger rocks of up to 30 cm in maximum dimension were recorded for some hearths. As with large fire-cracked rock features, the relative abundance of rock types in small fire-cracked rock hearths parallels the relative abundance of rocks of 10 to 30 cm diameters on the gravelly ridges and terrances above Sites 29, 33, and 34.

Diversity in the weight, size, and positioning of rock in the small fire-cracked rock hearths of Sites 29, 33, and 34 is subsumed in Table 9 under the categorical heading of "placement of rock" which has four descriptive classes of hearths: dispersed, lined, ringed, and emptied. The *dispersed* class of hearths includes those hearths which contain numerous fire-cracked rocks and which exhibit no particular arrangement of the various sized rocks; this does not include hearths whose stones have been dispersed by erosion. The class of hearths described as being *Lined* are those with large and mostly unfractured rock on their bottoms, and the *ringed* class of hearths encompasses those that have large rocks on the outer edges and small fire-cracked rock in the centers. The *emptied* class of hearths comprises those in which very little fire-cracked rock was found. All of these classes of hearths will be described in more detail later. A total of 25 surface-mapped or excavated small fire-cracked rock hearths from these sites was sufficiently intact to ascertain the original placement of rock in these features. However, it is not certain whether these few hearths accurately reflect the distribution of hearth types at Sites 33 and 34, and it is suspected that hearths of the dispersed rock type are under-represented and that hearths ringed with larger rock are over-represented in the small sample of 25 hearths. This is suggested by the numerous surface hearths and a few of the subsurface or partially eroded hearths which have weights and sizes of fire-cracked rock comparable to hearths of the dispersed rock type but whose diameters and original placement of rock could not be precisely defined (Figure 27a).

Small fire-cracked rock hearths of the dispersed rock type are those hearths with a dispersed or random placement of rock in them and are the more common type of hearth encountered at Sites 29, 33, and 34 (Figure 26, Hearth 1; Figure 27b). These hearths usually have a mixture of hearth stones ranging in size from 5 to 15 cm in largest dimension, but a few hearths were noted in which the hearth stones were all of a similar size with modes approaching either 5 cm or 15 cm. Most of the rock in these hearths is fire-fractured, and the rock is generally closely spaced without noticeable arrangements of differently sized rocks. In some cases the outermost rocks show some alignment which followed the presumed curvature of pit walls (Figure 26, Hearth 1).

There are two examples of the lined class of small fire-cracked rock hearths which have a layer of large rock in them (Figure 26, Hearth 2; Figure 28a). The bottoms of these hearths have stones which range in size from 15 to 30 cm in largest dimension and manifest little evidence of fracture by heat. On top of and between these larger stones were found some smaller and more frequently fire-fractured stones. The total weight of rock in each of these two hearths was somewhat higher than the weight of rock for hearths of the dispersed rock class with comparable diameters. As with hearths with dispersed rock, there was no discernible pattern relative to the arrangement of rocks in the bottoms of these hearths.

Small fire-cracked rock hearths of the ringed class of hearths are similar to hearths of the dispersed rock class in the weight, size distribution, and fire-fracturing of hearth stones. However, there is a tendency for the larger rocks to be found on the outer edge of the ringed class of hearths (Figure 26, Hearths 5 and 7, Figure 28b). The outer ring of rock generally includes hearth stones of 10 to 15 cm in largest dimension, though occasional rocks of greater size were also recorded. Smaller and more



a.

b.

Figure 27. Excavated small fire-cracked rock hearths at Site 34. Arrow points north and is 50 cm long. a. Partially eroded Hearth 21. b. Undisturbed rocks of Hearth 4. Note the random arrangement and 5-15 cm size of rocks.

a.

b.

Figure 28. Excavated small fire-cracked rock hearths at Site 33. Arrow points north and is 50 cm long. a. Large and mostly unfractured rock lining the bottom of Hearth 2. b. 10-15 cm sized rock in Hearth 7 which was bisected by a backhoe trench. Note carbonaceous soil below hearth stones.

fire-fractured hearth stones were most common in the center of this class of hearths.

The last, emptied, class of small fire-cracked rock hearths includes two hearths which are very different from the above mentioned kinds of hearths. These hearths contain only very small amounts of highly fire-fractured rock (Figure 26, Hearth 94). The hearth stones are scattered throughout the fill of these hearths and are less than 10 cm in largest dimension. In addition, significant amounts of fire-cracked rock which ranged in size up to 15 cm in maximum dimension were found adjacent to and at the same level as these buried hearths. This suggests that the stones of these hearths may have been intentionally removed and disposed nearby. Thus, the heading for this class of hearths in Table 9 is "emptied."

Reasons for the differences between the four classes of small fire-cracked rock hearths in the size, amount, and placement of hearth stones are not completely understood but appear to relate to the reuse of these features or hearth stones and perhaps to the intensity of the heat from fires in the features. The hearths with linings of large and mostly unfractured stones are visualized as having been used once, and either the temperature from fires in these hearths was not high enough to fracture most of the rock or the lowermost rock in these hearths was not subjected to a wide enough range of temperatures in a short period of time to cause fracturing of the rock. Hearths with a dispersed or random arrangement of rock generally contain numerous and highly fractured rocks. Temperatures from fires in these hearths were apparently of sufficient magnitude or variable enough to fracture the rock but is is not clear whether the numerous fire-fractured rocks in these hearths are a result of one or more episodes of use or whether fire-fractured stones from other hearths may have been incorporated in these hearths. In some cases the stones were fractured but remained largely intact such that the size of the original stones was readily determined (Figure 27b). In most cases, however, the fire-fractured rock was not articulated with other pieces from the same stone. This may be indicative of the use of fractured stones from other hearths or the movement of hearth stones while retrieving the items that were processed in the hearths.

Hearths with outer rings of large stones and highly fractured rock in their centers appear to be intermediate between the two above mentioned hearth types in the possible incorporation of fractured and unfractured stones, the fracturing of some of the rock with heat from fires, or perhaps the use of these hearths more than once but not many times. The two hearths which contained little rock and had fire-cracked rock outside of them appear to be hearths for which the stones were removed either for use in other hearths or in the process of retrieving items that had been baked in them. It is also possible that the fire-cracked rock around these hearths may be diagnostic of repeated use and maintenance. In this respect, it is noted that none of the other classes of small fire-cracked rock hearths had much fire-cracked rock scattered outside and around them (except in the cases of partially deflated or eroded hearths); this may reflect the one-time use or limited reuse of these hearths. Obviously, much work still needs to be done in order to clarify the conditions necessary to produce heat-fractured rock and the results observable as a consequence of the reuse of these features or the hearth stones.

Possible Uses of Small Fire-cracked Rock Hearths

It is the writer's contention that small fire-cracked rock hearths are functionally equivalent to the previously described large fire-cracked rock features and that the principal use of both was for the pit-baking of leaf succulents. In the following discussion, small fire-cracked rock hearths will be compared with ethnographically recorded examples of pit ovens and with the large fire-cracked rock features of Sites 33 and 34. The geograhical distribution of small fire-cracked rock hearths and leaf succulents will also be considered.

Ethnographic accounts of the processing of roots, hearts, and leaf bases of leaf succulents such as agave, sotol, and yucca by Indian groups of northern Mexico and adjacent arid areas of the United States have been presented in the previous section on large fire-cracked rock features. The most commonly described method employed in baking leaf succulents entails the building of a fire on and among rocks that have been placed in a pit some 1 to 4 m in diameter and approximately 1 m deep, the placing of leaf succulents on the rocks after the fire has burned out and between other plant materials, the covering of the pit contents with a layer of earth, and finally the removing of the leaf succulents after one or more days of baking for consumption or further processing.

The small fire-cracked rock hearths of Sites 29, 33, and 34 have diameters generally within the range of the ethnographically reported pit ovens, though some hearths were measured at less than 1 m in diameter. Most small fire-cracked rock hearths also have considerable fire-cracked rock in them, and charcoal and carbonaceous soil from fires occur in all hearths with the exception of the exposed and more weathered ones. The major discrepancy in attributes between the small fire-cracked rock hearths at Sites 29, 33, and 34 and the ethnographically described pit ovens is the much shallower depth of the small fire-cracked rock hearths. The hearths at Sites 29, 33, and 34 had recorded depths of only 10 to 20 cm, and other small fire-cracked rock hearths in the El Paso area were previously noted as rarely reaching depths of 55 cm. The erosion of soil surfaces and the difficulty encountered in defining pit walls at Sites 29, 33, and 34 have been suggested as factors affecting the preservation and measurement of pit depths. However, it has also been inferred that pit depths of the small fire-cracked rock hearths only occasionally exceeded 50 cm. The small fire-cracked rock hearths, therefore, do not match exactly the ethnographic accounts of pit ovens used to bake leaf succulents. The disagreement in formal attributes between these features leaves open to question an argument from ethnolographic analogy that leaf succulents were baked in the small fire-cracked rock hearths. Clearly, other kinds of information must be presented to support the supposition that the most important activity involving the use of small fire-cracked rock hearths was the processing of leaf succulents.

Differences in formal attributes between the large fire-cracked rock features at Sites 33 and 34 and the ethnographic examples of pit ovens have been attributed to the apparent more frequent ethnographic observation of pit ovens being used for the first time and the probable repeated use of the archeological features or feature areas. The large fire-cracked rock features seem to be of two types, neither of which bears much resemblance to the more frequently recorded ethnographic pit oven of 1 to 4 m in diameter and with a layer of stones in its bottom. The first type of large fire-cracked rock feature shows repeated use of the same pit which created a large and generally rock-free central depression surrounded by substantial accumulations of fire-cracked rock. The second type of large fire-cracked rock feature bears evidence of the repeated use of an area such that the noncongruent placement of pits produced a very large and overlapping distribution of fire-cracked rock. The former type of large fire-cracked rock feature is represented by Large Fire-cracked Rock Feature 2 at Site 33 North and possibly Large Fire-cracked Rock Feature 1 at Site 34 South, and the latter type of large fire-cracked rock feature is represented by Large Fire-cracked Rock Feature 3 at Site 33 North and possibly by Large Fire-cracked Rock Feature 1 at Site 33 South.

Whereas the large fire-cracked rock features are suggested to have resulted from the recurrent utilization of the same pit or pit area, the small fire-cracked rock hearths of Sites 29, 33, and 34 appear to be comparable to the ethnographic examples of pit ovens being used for the first time. That is, the small fire-cracked rock hearths seem to be small and spatially discrete features which were used once or only a few times. This has been inferred principally from the interior layer of rock and the small size of small fire-cracked rock hearths and partially from the infrequent occurrence of hearths which appear to have been emptied of stone and which provide the only evidence of the possible reuse of these features. Although dissimilarity in formal attributes between the large fire-cracked rock features and the small fire-cracked rock hearths is thought to be referrable to the reuse of the larger features (and perhaps to the bulk processing of materials), interpretations of these features have varied. Those archeologists working in the El Paso area who have advanced propositions on the use of the large fire-cracked rock features infer the baking or roasting of leaf succulents in these features (Greer 1968b; Hard n.d.; Whalen 1977; 1978; this report). However, implied functions of the small fire-cracked rock hearths include the roasting or baking of leaf succulents and/or a more general usage relating to meal preparation and body warmth (Hard n.d.; O'Laughlin 1979; O'Laughlin and Greiser 1973; Wetterstrom 1978; n.d.; Whalen 1977; 1978; n.d.). These alternative propositions for the function of small fire-cracked rock hearths are considered in some detail in the ensuing discussion.

Small fire-cracked rock hearths like those of Sites 29, 33, and 34 and other sites on the east side of the Rio Grande in the project area (Chapter III) are also found on the lower alluvial slopes of the east flank of the Franklin Mountains (Aten 1972; Gerald n.d. c; Hard n.d.; O'Laughlin 1979; O'Laughlin and Greiser 1973; Thompson 1979) and on alluvial slopes below the western escarpment of the Hueco Mountains (Whalen 1977). In addition, small hearths which average near 1 m in diameter and contained burned lumps of caliche (calcium carbonate) rather than fire-cracked rock are scattered throughout lowland areas of the Hueco Bolson between the Franklin and Hueco Mountains and on the La Mesa surface west of the project area (Lynn, Baskin, and Hudson 1975; Sudar-Murphy and Laumback 1976; Whalen 1977; 1978).

Whalen (1977:164) combines the hearths with burned caliche and the smaller of the small fire-cracked rock hearths and calls them "small campfire-sized hearths." He (Whalen 1977; 1978) suggests from the wide spatial distribution of this class of small hearths in various environmental zones of the El Paso area that these features are general purpose facilities used in the performance of daily activities. Whalen (1978:24) also recognizes a second and less numerous class of hearths which are larger than the first class of small hearths, but apparently smaller than large fire-cracked rock features which have large central depressions ringed with fire-cracked rock and are located on or near the lower slopes of mountains in the El Paso area. The class of larger hearths is thought by Whalen (1978:24) to be outdoor hearths associated with the performance of more particular tasks than the small class of hearths. He (Whalen 1977; 1978) interprets the large fire-cracked rock features as task-specific facilities used in the processing of leaf succulents. Whalen's definitions of general purpose and more functionally-specific facilities are based principally on the size of the fire-cracked rock and burned caliche features although some consideration is given to the spatial distribution of large fire-cracked rock features in an effort to further delimit their use. He (Whalen 1977; 1978) also notes that the small class of hearths occurs on different kinds of sites including those he describes as special activity sites and residential sites, and this is taken by Whalen as evidence of the general uses to which the small class of hearths were put.

Hard (n.d.), in a study of small fire-cracked rock features located on an alluvial fan on the east side of the Franklin Mountains and adjacent to slopes with lechuguilla and sotol, concludes from an in-depth comparison of these features with ethnographically described pit ovens that small fire-cracked rock hearths with rock weights of approximately 13 kg or more and diameters of approximately 1 m or more were used to bake or roast leaf succulents. Thus, Hard suggests that some of the small fire-cracked rock hearths which would be included in Whalen's class of small hearths on the basis of their size are not general purpose facilities but, rather, functionally-specific features. However, Hard places small fire-cracked rock hearths with diameters of less than 1 m and rock weights of less than 13 kg in the same category as small hearths with burned caliche because of their comparability in size and weight of rock or caliche and their inferred dissimilarity to ethnographically reported pit ovens. As with Whalen, Hard proposes that these smaller fire-cracked rock or burned caliche hearths were used for more general purposes such as for body warmth and meal preparation.

Ford (1977) and Wetterstrom (1978; n.d.) have analyzed carbonized plant materials from numerous small fire-cracked rock hearths and hearths with burned caliche in the Hueco Bolson east of the Franklin Mountains. Other than wood charcoal, carbonized plant parts which might help define the nature of activities conducted with these facilities have been exceedingly sparse and infrequently encountered. Wetterstrom (n.d.) implies from the few carbonized seeds found in these features that the processing of foods was not an important activity involving the use of these features and that small fire-cracked rock hearths and hearths with burned caliche were primarily utilized for warmth.

The above simplified rendering of alternative interpretations of small fire-cracked rock hearths and similar hearths with burned caliche illustrates the difficulty of ascertaining the functions of these features, as well as the ambiguity of meanings assigned definitionally to these features. The different approaches taken by Wetterstrom, Hard, and Whalen in the study of these features are commented on below, and this is followed by a discussion of the spatial distribution of these features and particular plant resources which provide the foundation for the writer's interpretation of these features.

Attempts at recovering carbonized plant materials from small fire-cracked rock hearths and hearths with burned caliche have been successful in the sense of demonstrating that little, if anything, will be found in these hearths which would provide information on the uses of these features (Aten 1972; Ford 1977; Gasser n.d.; Holloway n.d.; Lynn 1976; O'Laughlin 1979; O'Laughlin and Greiser 1973; Thompson 1979; Wetterstrom 1978; n.d.). Gasser (n.d.) and O'Laughlin (1979) suggest that the burning of plant foods being processed in these features would be unintentional and should not be expected to have been a frequent happening. In addition, it can also be suggested that the probability of accidental burning of plant foods would be inversely related to the size of the plant part being processed. Thus, features utilized in the parching or roasting of seeds and the cooking of porridges or breads made from seeds would be more likely to contain evidence of these activities than would features used in baking the much larger hearts of leaf succulents. It has also been suggested in Chapter VII that the presence of burned seeds in small fire-cracked rock hearths and hearths with burned caliche may often be an outcome of their natural occurrence in soils and their close proximity to fires in these features or their incidental placement in hearths along with fuel or tinder. The few burned seeds found may indicate that the processing of seeds was not routinely performed with these features, as Wetterstrom (n.d.) implies. This, however, does not negate the possibility that these features were used to process other plant foods, and it is important to note the finding of some charred remains of leaf succulents in small fire-cracked rock hearths which include two hearths on the lower alluvial slope of the west side of the Hueco Mountains (Ford 1977), two hearths on the lower alluvial slopes of the east side of the Franklin Mountains (Holloway n.d.), and two hearths of the Zone 2 occupation at Site 33 (Chapter VII). Carbonized remains of leaf succulents were also recovered from two of the large fire-cracked rock features at Site 33 (Chapter VII). These few fire-cracked rock features with carbonized remains of leaf succulents are situated in or near areas with relatively abundant leaf succulents such as sotol and lechuguilla, and this adds some credence to the supposition that at least some of the fire-cracked rock features were used to process these plants. Nevertheless, the paucity of carbonized plant parts in small fire-cracked rock hearths and hearths with burned caliche does not allow for firm statements on the uses of these features at this time from these kinds of data. In general, quantities of burned remains of potentially edible parts of native plants or cultigens have been retrieved only from the occupational refuse of sites with architectural remnants where plant processing and consumption was apparently more routinely performed (Brook 1966; 1980; Ford 1977; Wetterstrom 1978) or from deposits in caves where preservation of plant materials is much better than in the open sites with fire-cracked rock or burned caliche hearths (Cosgrove 1947; O'Laughlin 1977a).

As noted in this and the previous section, ethnographic examples of facilities used to bake leaf succulents differ in formal attributes from the large fire-cracked rock features and the small fire-cracked rock hearths of Sites 29, 33, and 34 and other sites in the El Paso area. Differences between the large fire-cracked rock features and the ethnographically recorded pit ovens have been attributed to the repeated use of the large fire-cracked rock features, and the small fire-cracked rock hearths are suggested to have been consistently shallower than the pit ovens of ethnographic accounts. The small hearths with burned caliche are also thought to have been shallower than the ethnographically described pit ovens, but the erosion or deflation of most excavated hearths with burned caliche does not permit an accurate assessment of the original depths of these features. Although the ethnographic literature can be a valuable source for ideas concerning the possible activities performed with these fire-cracked rock and burned caliche features, any analogy drawn simply from the comparison of formal attributes should be viewed with skepticism. This is especially true of the fire-cracked rock and burned caliche features of the El Paso area which do not agree totally with the descriptions of pit ovens used by historic Indian groups.

Hard (n.d.) has suggested that hearths with substantial amounts of fire-cracked rock or burned caliche and diameters of 1 m or more are similar enough to the ethnographically reported pit ovens to infer their use as facilities to bake or roast leaf succulents. Hard (n.d.) also implies that hearths of smaller size and with smaller amounts of fire-cracked rock or burned caliche are dissimilar enough from the ethnographically described pit ovens to suggest their use as general purpose hearths for heating or cooking. Although Hard relies heavily on ethnographic accounts for assigning a specific function to larger hearths with larger amounts of fire-cracked rock, he makes no mention of ethnographic accounts detailing smaller hearths with lesser weights of fire-cracked rock or burned caliche used as general purpose facilities. A survey by the writer of the ethnographic literature of historic Indian groups using pit ovens to bake leaf succulents has also failed to disclose general purpose hearths incorporating rock or other similar materials. Thus, Hard's division of hearths with fire-cracked rock or burned caliche into two functionally distinct groups would appear questionable and unsubstantiated. In addition, ethnographic accounts of pit ovens used to bake leaf succulents leave much to be desired. Actual dimensions of pit ovens, the amount of rock in pit ovens, the reuse of pit ovens or of the hearth stones, and the appearance of these features following their use are either not given or are broadly generalized in these ethnographies. Formal analyses of ethnographic pit ovens and archeological features of the El Paso area have only pointed up the deficiencies in the description of pit ovens in the ethnographic literature and the necessity of pursuing other lines of inquiry into the possible uses of the archeological features.

Wetterstrom (n.d.) and Whalen (1977; 1978) have suggested that the smaller fire-cracked rock or burned caliche hearths are general purpose facilities used for preparing meals and/or body warmth. Assuming some benefit is to be gained by incorporating rock or lumps of caliche in hearths used for warming or for cooking, it is to be expected that these hearths would be widely distributed with respect to spatial variability in the environment and that they could be commonplace features of sites in which warming and cooking activities probably took place. However, this does not seem to be the case. For example, small fire-cracked rock hearths occur very infrequently and in small numbers in sites situated above the alluvial slopes flanking the Franklin Mountains (Way n.d.), and fire-cracked rock and burned caliche hearths are not common features of lowland residential sites which have been excavated in the El Paso area (Brook 1966;

1980; Kegley 1979; Lehmer 1948; O'Laughlin n.d. b; Whalen 1979; and others). The conclusions to be drawn from these two examples are that hearths of fire-cracked rock or burned caliche are not ubiquitous features of sites in the El Paso area, that these features are not necessarily well represented at some types of sites, and that the distribution of these features does not accord well with their proposed use as general purpose facilities for regularly performed activities. Hearths found in or adjacent to excavated surface rooms or pithouses where cooking and fire-building for warmth would certainly have taken place are reported to be devoid of rock or caliche lumps (see the above references), and this contradicts the presumption of any advantage to be gained by the incorporation of these materials in features which are thought by Whalen and Wetterstrom to be general purpose facilities. Whalen (1979) also details the spatial distribution of houses, burned caliche hearths, and other features for two Mesilla phase pithouse villages that have been tested in the Hueco Bolson, observes that the burned caliche hearths are located on the peripheries of these sites, and implies that the burned caliche hearths are roasting pits used to process leaf succulents. Whalen's (1979) inference that the hearths in the two above mentioned villages are roasting pits used to process leaf succulents differs from his earlier interpretation of similar features in other sites as general purpose facilities (Whalen 1977; 1978). However, Whalen's (1979) recording that hearths with burned caliche do not occur in or near houses where routine activities requiring heat would be performed and that the burned caliche hearths which he views as infrequently used facilities occur away from houses, supports this writer's contention that hearths containing fire-cracked rock or burned caliche are task-specific facilities. The alternative proposition that small fire-cracked rock hearths and hearths with burned caliche are general purpose hearths used for cooking or body warmth has not been developed in a satisfactory fashion by Wetterstrom and Whalen and does not account for the above noted examples of the distributions of these features. In addition, it should also be pointed out that hearths lacking fire-cracked rock or burned caliche are not as visible archeologically or are less often preserved intact than features incorporating these materials. This bias in visibility and preservation has resulted in a tendency for many archeologists not to fully consider the possible functions of features with fire-cracked rock or burned caliche and the more likely wide spatial distribution of simpler hearths without these materials in different types of sites of various environmental zones of the El Paso area.

Small and large sites with few or many small fire-cracked rock or burned caliche hearths and with relatively light surface scatters of artifacts are the most common kinds of sites recorded for the lowlands and flanks of mountains in the El Paso area. These sites are viewed as special activity sites which were occupied seasonally for short periods of time (O'Laughlin 1979). It is also suggested that the most important activity conducted at sites with small fire-cracked rock hearths was the processing of lechuguilla, sotol, and occasionally soap-tree yucca and that the processing of soap-tree yucca and various seed plants is evidenced at sites with burned caliche hearths. The ephemeral and specialized nature of activities performed at sites with fire-cracked rock or burned caliche hearths is inferred, in part, from a comparison of artifact densities, tool assemblages, and features of these sites with those of other types of sites in the El Paso area (O'Laughlin 1979). Added to this is the proposal that subsistence activities at special activity sites which were occupied for short periods of time will be more directly referable to nearby resources than will the more generalized activities of more permanently occupied residential sites. Thus, it has been possible to demonstrate the probability that the more important uses of the fire-cracked rock or burned caliche hearths are related to their spatial co-variation with leaf succulents (O'Laughlin 1979).

In the following discussion, many of these observations (O'Laughlin 1978; 1979) on the spatial distributions of leaf succulents and fire-cracked rock or burned caliche features are reiterated for an interpretation of the archeological features at Sites 29, 33, and 34. Much of this information has already been introduced in Chapter III where settlement patterns in the project area have been described and in the previous section detailing the distribution of large fire-cracked rock features and leaf succulents in the El Paso area. In addition, the correlation of the spatial distribution of leaf succulents with the pit baking of these plants by historic Indian groups and with archeological features containing fire-cracked rock by Castetter, Bell, and Grove (1938) and Sayles (1935) for arid areas of northern Mexico and adjacent parts of the United States has been noted in the previous section and will not be related again here.

Although burned caliche hearths were not found at the sites of this project, the above mentioned similarities and distinctions drawn between these features and those with fire-cracked rock by others necessitate some consideration of their spatial distribution and implied use. That is, it is suggested that fire- acked rock and burned caliche hearths are special purpose facilities which differ primarily in the materials being processed in them and that these features are not general purpose facilities for meal preparation or warmth. Thus, any attempt to show that the small fire-cracked rock features of this project are not general purpose facilities must also demonstrate that burned caliche hearths were also not used for such general purposes.

Hearths containing burned lumps of caliche are widely scattered throughout the lowlands of the El Paso area away from the Rio Grande. These hearths are found in areas where rock does not occur and where caliche occurs just beneath the surface or is exposed on weathered surfaces. Occasionally rock is found incorporated in hearths of lowland areas at some distance from source areas (Lynn 1976), and some hearths on the La Mesa surface west of the project area contain volcanic rock from nearby lava flows of very limited distribution (Hunter-Anderson 1979). However, the overwhelming number of hearths in lowland areas away from the Rio Grande have only burned caliche, and this is thought to be a reflection of the availability of materials which could be incorporated in features such as these and not an indication of a basic functional difference between the burned caliche hearths and those containing rock. That is, hearths with either lumps of caliche or rock are envisioned as being more effective in the cooking of thick, fleshy plants which would require heat over a period of time, than would simpler hearths without caliche or rock. Although the heat-retentive properties of caliche and various kinds of rocks probably differ, the distribution of hearths with these materials appears to reflect the availability of these materials and not any strict preference by aboriginal groups for certain materials for particular kinds of features.

The burned caliche hearths of lowland areas are numerous but are not randomly distributed about the landscape. Indeed, Lynn, Baskin, and Hudson (1975), Sudar-Murphy and Laumback (1976), and Whalen (1977; 1978; n.d.) note a tendency for sites with these features to be situated near playas (shallow depressions) which may contain some water seasonally. The spatial distribution of these sites conforms well with the modern distribution of soap-tree yucca *(Yucca elata)* which is generally more bundant in playas and more widely scattered in mesquite dune areas or the few remaining areas of grassland away from playas (O'Laughlin and Crawford 1977; O'Laughlin 1978). Soap-tree yucca is also the only naturally occurring and potentially edible plant known to occur presently in lowland areas away from the Rio Grande which would require baking before consumption or further processing for storage. Thus, it can be proposed that features containing heat-retentive materials found away from the Rio Grande in lowland areas were used principally to bake soap-tree yucca.

It is envisioned that the heart and leaf bases of soap-tree yucca would most often be cooked in burned caliche hearths and that the slender flowering stalks of soap-tree yucca were less often baked or roasted with these features and more probably eaten raw or after roasting over the coals of simpler hearths without caliche. The crown of soap-tree yucca is in its best condition or "sweetest" in the spring, though it could be gathered and baked throughout the year. The processing of soap-tree yucca at sites with burned caliche hearths can, therefore, be suggested to have been seasonal and principally in the spring. A number of seed plants also becomes available in the spring and into the summer, and many of these plants have a spatial distribution comparable to that of soap-tree yucca (O'Laughlin 1978). In addition, ground stone tools which could be useful in the processing of seeds are a common attribute of sites with burned caliche hearths (O'Laughlin 1979). However, the parching or roasting of seeds or the cooking of foods prepared from seeds would not require facilities incorporating caliche or the length of cooking time suggested by hearths with caliche. Although a number of different subsistence activities may have been carried out at sites with burned caliche hearths, these features would probably have seen use for a purpose other than the cooking of the crowns of soap-tree yucca only occasionally. The suggested warm weather occupation of sites with burned caliche hearths also lessens the possible use of these features to produce body warmth.

Hearths with burned caliche are generally small and characteristically have diameters of about 1 m. These hearths are often smaller than hearths located at the edges of mountainous areas and containing fire-cracked rock and certainly are smaller than the large fire-cracked rock features of the El Paso area. It would seem that little soap-tree yucca was processed in these hearths with burned caliche as compared to the large fire-cracked rock features found on the peripheries of mountainous areas and that the processing of soap-tree yucca may have been for immediate consumption rather than for storage and later use. Basehart (1974) notes a preference for certain agaves and sotol over soap-tree yucca by the Mescalero Apache whose territory included the El Paso area. Assuming the same prehistoric aboriginal preference for agave and sotol over soap-tree yucca, it could be reasoned that the larger fire-cracked rock features on the edges of mountains are indicative of the bulk processing of leaf succulents other than soap-tree yucca for storage and later use and that the smaller burned caliche and fire-cracked rock hearths of similar size are indicative of the processing of small amounts of leaf succulents for immediate consumption rather than for later use.

Whalen (1979) notes a few large, burned caliche hearths of at least several meters in diameter on the peripheries of two Mesilla phase sites with pithouses in the interior of the Hueco Bolson. In addition to inferrring the processing of leaf succulents in these features, Whalen also implies that these facilities were used to process large quantities of leaf succulents by social groups larger than that of a single household which he infers to be a nuclear family. The smaller burned caliche and fire-cracked rock hearths may be suggested, therefore, to have been used to process small amounts of leaf succulents by small groups of a size similar to that of a household but not necessarily of similar composition. It could also be argued that the larger fire-cracked rock features on the edges of mountainous areas may have been used to process larger amounts of leaf succulents by social groups larger than that of a single household or perhaps by task groups composed of members from several households.

The suggestion that small fire-cracked rock hearths and large fire-cracked rock features were used to pit-bake leaf succulents is also founded on the parallel spatial distributions of these features and leaf succulents other than soap-tree yucca. Although burned caliche hearths and fire-cracked rock features both are envisioned as having been used to bake leaf succulents and some small hearths containing rock are noted for areas where soap-tree yucca is the only leaf succulent present, the greater number of small fire-cracked rock hearths and all of the large fire-cracked rock features are found in or near plant communities where leaf succulents other than soap-tree yucca are relatively abundant (O'Laughlin 1979). The most common of these leaf succulents is lechuguilla which occurs on soils derived from limestone in small and large mountain masses of the El Paso area. North and west of the project area lechuguilla disappears as limestone is replaced by other rock types. *Agave neomexicana* is another leaf succulent that is very similar to lechuguilla and could have been processed in the fire-cracked rock features but it generally is found at higher elevations than lechuguilla in the larger mountains of the El Paso area. The last leaf succulent to be considered is sotol which is also found in the larger mountains of the El Paso area and has a much wider geographical distribution than lechuguilla in that it is not restricted in occurrence to soils derived from limestone. Either lechuguilla or a mixture of these three upland leaf succulents can be found on rocky alluvial soils flanking mountainous areas, and all three of these upland leaf succulents are found at higher elevations in the larger mountains such as the Franklin Mountains, the Hueco Mountains, and the southern and lower portions of the Sacramento Mountains.

Most often, fire-cracked rock features are situated just within or below plant communities containing the upland leaf succulents and on the lower alluvial slopes originating in mountains. The employment of fire-cracked rock in the features certainly reflects the local availability of rock materials for such uses. Fire-cracked rocks are rarely encountered in hearths in areas at a distance from the environs of upland leaf succulents, although rock materials may be locally available. For example, and as noted in Chapter III, small fire-cracked rock hearths are rarely encountered along the Rio Grande above or below the project area although they are numerous on the east side of the Rio Grande in the project area which is relatively close to the Upper Bajada environmental zone where upland leaf succulents occur. It was also observed in Chapter III that the spatial distribution of these features does not follow that of potentially edible plant resources of the floodplain and adjoining margins of the valley or of soap-tree yucca in the project area. Thus, it is proposed that fire-cracked rock features are heat-retentive faclities principally used to bake leaf succulents other than the lowland soap-tree yucca when they are found in or near plant communities of upland rocky slopes. As with burned caliche hearths, facilities containing rock are thought to be more appropriate for the temporally extended baking of thick, fleshy plants and are suggested to have been used to pit-bake the crowns of lechuguilla, sotol, and occasionally soap-tree yucca. The processing of these leaf succulents most probably took place in the springtime when these leaf succulents are in prime condition and beginning to flower. Again, the suggested warm weather use of the fire-cracked rock and burned caliche features argues against their use as facilities to produce body warmth.

Fire-cracked rock features whose primary function is thought to have been the pit-baking of leaf succulents such as lechuguilla and sotol may also have been used to process other plants on occasion. Castetter and Underhill (1935) report the pit baking in stone-filled ovens of the stems of cholla *(Opuntia* sp) by the Papago, and other cacti are mentioned as having been similarly baked in other ethnographic or ethnobotanical accounts. Cacti may have been baked in the fire-cracked rock features of the El Paso area, and these stem succulents have a geographical distribution comparable to that of upland leaf succulents. The baking of stem succulents in fire-cracked rock features is thought to have been an infrequent or comparatively unimportant activity compared to that of baking upland leaf succulents. However, this supposition is based primarily on descriptions of Mescalero Apache subsistence activities for the wider El Paso area which note only the gathering of fruits of cacti and not the baking of stems of cacti (Basehart 1974; Matson and Shroeder 1957). The flowering stalks of soap-tree yucca, the fruits of datil *(Yucca torreyi)*, and rootstalks of cattail *(Typha latifolia)* may also have been processed in the fire-cracked rock features, but these items could just as easily have been roasted on coals in hearths without stone.

Spatial and Temporal Distribution of Small Fire-cracked Rock Hearths

It has been proposed that the principal function of small fire-cracked rock hearths of Sites 29, 33, and 34 and of the large fire-cracked rock features of Sites 33 and 34 was the pit baking of upland leaf succulents such as lechuguilla and sotol. However, a comparison of Figures 5 and 6 shows that sites of the project area with many fire-cracked rock hearths are generally situated 2 to 5 km from the Upper Bajada environmental zone where upland leaf succulents are found. This distance is much greater than that observed for other sites of the El Paso area where the processing of upland leaf succulents is thought to have occurred, but these other sites are located near the bases of mountains some distance from the Rio Grande (see Skinner, Steed, and Bearden 1974 and Whalen 1977; 1978 for general spatial distributions of these features). The situating of most sites of the project area with many fire-cracked rock hearths at a distance of 2 to 5 km from the nearest source of upland leaf succulents is attributed, in part, to the close proximity of the Rio Grande whose reliable source of water and added attraction of other resources not found away from the river have apparently biased the locating of activities concerned with the processing of upland leaf succulents. In addition, sites of the project area with many fire-cracked rock hearths are located on sandy ridges and alluvial fans. The presence of soap-tree yucca in these sandy areas may also have conditioned the placement of sites with fire-cracked rock hearths, but this resource would quickly have been exhausted judging from the large number of fire-cracked rock hearths observed on these sites and the spotty distribution and small numbers of soap-tree yuccas near these sites on the east side of the Rio Grande as compared to the relative greater abundance of soap-tree yucca on the west side of the Rio Grande in the project area. The occurrence of sites with many fire-cracked rock hearths on sandy soil is interpreted as evidencing the greater ease of digging holes for pit ovens as contrasted with the greater difficulty of excavating the shallow and gravelly soils of most ridges and terraces of the Lower Bajada environmental zone.

The inference that the placement of sites with many fire-cracked rock hearths along the east side of the Rio Grande is conditioned by the occurrence of sandy soils in the same area is also paralleled by the non-random distribution of Zone 2 fire-cracked rock features at Sites 33 and 34. The numerous large sand dunes of Site 33 North and South are evident in Figure 7 which shows the topography of Sites 33 and 34, but areas of some duning sands at Site 34 are not readily apparent from Figure 7. As noted in the previous section, large fire-cracked rock features of Zone 2 at Site 33 and 34 are located either on top of or on the edge of some of the larger dunes of earlier deposits. Small fire-cracked rock hearths of Zone 2 at these sites also exhibit a tendency to be located in dune areas of earlier deposits, and neither large fire-cracked rock features nor small fire-cracked rock hearths are located on the gravelly soils between Site 33 South and Site 34 North or on the nearby gravelly ridges and terraces north and east of Sites 33 and 34.

Three or four clusters of small fire-cracked rock hearths are easily defined at Site 34 (Figure 21). Small sand dunes are located in the south central, western, and northern portions of Site 34 North and in the northern portion of Site 34 South. Unfortunately, recent arroyo cutting and slope erosion have removed much of the sands overlying the gravels of Site 34 such that the clustering of hearths on larger accumulations of sands at Site 34 cannot be demonstrated with certainty but is suggested by the occurrence of hearths in the northern portion of Site 34 North and the southern portion of Site 34 South where they are found on some of the deeper, remaining sands. The distribution of Zone 2 hearths at Site 33 South has a random appearance (Figure 19). However, nearly all of Site 33 South has large dunes of Zone 3 deposits, and the distribution of hearths is not as localized as it is at Site 34 or for Zone 2 at Site 33 North. At Site 33 North, there are four clusters of Zone 2 hearths which are located on the edges of large dunes of Zone 3 deposits (Figure 18). These include, but are not limited to, Small Fire-cracked Rock Hearths 35-40, 41-44, 61-67, and 105-109. Additional hearths are located along the sandy north ridgeline of Site 33 North (Small Fire-cracked Rock Hearths 69-90); otherwise few hearths are found in inter-dunal areas or near the three additional and fairly large dunes of Zone 3 deposits. The non-random distribution of Zone 2 hearths at

Site 33 North and their occurrence primarily on the edges of some of the larger dunes of Zone 3 deposits contrasts sharply with the more nearly regular distribution of small fire-cracked rock hearths and other features of Zone 4 at Site 33 (Figure 20). This accords well with the stratigraphy of Site 33 (Chapter V) which suggests that the alluvial fan sloped gently to the south and west during the Zone 4 occupation and that dunes did not begin to form until sometime after the first Zone 3 deposits were laid down and before the Zone 2 occupation.

The small fire-cracked rock hearths of Formative period occupations at Site 33 and possibly Site 34 appear to be clustered on or restricted to the looser eolian sands of these sites where the excavation of pit ovens may have been facilitated. In addition, the tendency for Formative period hearths to be clustered at these sites helps explain the suggested repeated use of Large Fire-cracked Rock Feature 3 and perhaps 1 at Site 33 where the overlapping distributions of fire-cracked rock from multiple pit ovens are thought to have resulted in large surface scatters and multiple subsurface layers of fire-cracked rock. This is certainly indicated for Large Fire-cracked Rock Feature 3 at Site 33 North where numerous small fire-cracked rock hearths adjoin the larger feature and extend into a large dune north of Large Fire-cracked Rock Feature 3 (Figure 18). The clustering of Formative period hearths at Sites 33 and 34 may simply reflect local topographic conditions and a preference for the excavation of pit ovens in the loose sands of dunes. However, the clusters of Formative period small fire-cracked rock hearths, as well as the inferred repeated use of large fire-cracked rock features, may also be indicative of long-term uses of particular portions of these sites by different social groups. The variability in size of the small fire-cracked rock hearths and the greater size of the large fire-cracked rock features may in addition reflect variability in the amounts of leaf succulents that were processed in these features and/or the variability in the size of the group using these features. The composition of groups utilizing these features may also have varied from single nuclear families to larger social groups or task groups composed of members of individual domestic units. The means and organization of production for Formative period populations, however, are not well enough understood at present to assess the significance of the variability in the fire-cracked rock features of Sites 33 and 34.

The temporal distribution of small fire-cracked rock hearths at Sites 29, 33, and 34 is not fully known, and there is some question as to the dates of the presumably repeatedly used large fire-cracked rock features of Sites 33 and 34. Nevertheless, some initial observations on the temporal distribution of these features can be advanced for consideration by others working in the El Paso area.

There are only seven small fire-cracked hearths recorded for the Zone 4 Archaic period occupation of Site 33, and it can be suggested from the subsurface testing of deposits that the total number of hearths for this occupation may be only as high as 15. The presence of small fire-cracked rock hearths implies that some processing of leaf succulents was done at Site 33 during this occupation and that the Zone 4 Archaic period occupation(s) included the possible habitation of this site during the spring. The spatial distribution of small fire-cracked rock hearths and other features for the Zone 4 occupation does hint at the special-purpose nature of the small fire-cracked rock hearths, but this will be dealt with later after a description of the houses of this zone.

The few hearths associated with the sizable Zone 4 Archaic period occupation of Site 33 follows the observation that few hearths occur on other large and presumably Archaic period sites of the project area (Chapter III). In addition, only a few fire-cracked rock hearths were recorded for a large Archaic period site near Las Cruces, New Mexico (Greiser 1973); only one large fire-cracked rock feature near Sierra Blanca, Texas, has been suggested to date to the Archaic period (Skinner, Steed, and Bearden 1974); and the Archaic period levels of La Cueva in the Organ Mountains north of the project area contained little fire-cracked rock while Formative period levels contained quantities of fire-cracked rock (O'Laughlin n.d. a). Although Archaic period sites are difficult to identify in the El Paso area and a number of small fire-cracked rock and burned caliche hearths have been radiocarbon dated to the Archaic period in the Hueco Bolson to the east of the project area (Hard n.d.; O'Laughlin 1979; Whalen n.d.), the impression of the writer from the relatively few known fire-cracked rock features of the Archaic period is that leaf succulents may have been of less importance to Archaic period populations than they were to later Formative period populations. It is also possible that the fewer known fire-cracked rock features of the Archaic period as compared to the Formative period may only reflect changes in population density for the El Paso area.

The small number of radiocarbon dates from fire-cracked rock features and the few ceramics of known and limited temporal distribution that were associated with fire-cracked rock features of the Zone 2 occupations at Sites 33 and 34 allow only a general discussion of the relative popularity of these features during portions of the Formative period.

Radiocarbon dates from fire-cracked rock and other features at Sites 33 and 34 are presented in Chapter V, and ceramic materials from these sites are described in Chapter IX. The two radiocarbon dates and ceramic materials from Site 34 suggest that the 47 small fire-cracked rock features and the single large fire-cracked rock feature of that site date to the Mesilla phase (perhaps as early as AD 1 to AD 1100). There may be as many as 200 to 300 small fire-cracked rock hearths for Zone 2 at Site 33. The majority of ceramic materials at Site 33 is ascribed to Mesilla phase occupations, and it is thought that most of the small fire-cracked rock hearths date to sometime during this phase. Two of the large fire-cracked rock features at Site 33 have radiocarbon dates (160 BC ± 220, 130 BC ± 230) which can be attributed to either a very late Archaic period or early Mesilla phase occupation of Zone 2 (see Chapter V for a more complete discussion of these dates). In either case, some of the small fire-cracked rock hearths of Zone 2 at Site 33 probably are of similar age, although none were radiocarbon dated earlier than AD 550 ± 120. Although eight small fire-cracked rock hearths at Site 33 have near them Mimbres Black-on-white or plain corrugated ceramics which are dated at approximately AD 900-1100, these few associations of intrusive pottery types are probably not indicateive of the number of hearths which were in use during the later part of the Mesilla phase. One small fire-cracked rock hearth at Site 33 North is radiocarbon dated at AD 1200 ± 110 which suggests some use of Site 33 North during the Dona Ana phase (AD 1100 to 1200). However, only two sherds from Site 33 North can be assigned to the Dona Ana phase and imply at best a limited use of that site during this time period. Indigenous and intrusive ceramics of the El Paso phase (approximately AD 1200-1400) are more numerous than those of the Dona Ana phase but are found in only three small areas of Site 33 and are associated with a single, small fire-cracked rock hearth. It does not seem likely that more than a few of the small fire-cracked rock hearths at Site 33 were in use during the El Paso phase.

The larger portion of small fire-cracked rock hearths at Site 33 are believed to date to the Mesilla phase, and the radiocarbon dates and ceramic materials from Site 33 indicate that this site was occupied throughout the Mesilla phase. The fire-cracked rock features of Site 34 are also inferred to have been in use during the Mesilla phase. There is some question as to whether any of the Zone 2 small fire-cracked rock hearths may be from a late Archaic period occupation of Site 33, and only a small number of small fire-cracked rock hearths can be attributed to Dona Ana and El Paso phase occupation of that site. Other sites in the project area with fire-cracked rock features exhibit a similar pattern in that most sites with these features (especially the large sites with many hearths) date to the Mesilla phase and that few of the small fire-cracked rock hearths can be assigned to earlier Archaid period or later El Paso phase occupations (Chapter III). The apparent greater abundance of these features for the Mesilla phase as compared to the Archaic period or El Paso phase is substantiated by similar findings from studies of sites with small fire-cracked rock hearths on an alluvial fan at the east base of the Franklin Mountains (Aten 1972; Gerald n.d. b; n.d. c; Hard n.d.; O'Laughlin 1979; O'Laughlin and Greiser 1973; Thompson 1979). This pattern also seems to be duplicated below the Hueco Mountains and on the east side of the Hueco Bolson (Hard n.d.; Whalen 1978).

The greater abundance of small fire-cracked rock hearths for the Mesilla phase as compared to the Archaic period has been interpreted as indicative of a greater reliance on upland leaf succulents during the Mesilla phase, although it has also been suggested that the differences in the number of small fire-cracked rock hearths between the Mesilla phase and the Archaic period may only be referrable to an increase in population density during the Mesilla phase in the El Paso area. The smaller number of small fire-cracked rock hearths assignable to the El Paso phase as compared to the Mesilla phase cannot be explained by a decrease in population density during the El Paso phase, however, because it appears that the El Paso area experienced the greatest prehistoric density of population during the El Paso phase (Chapter III; Whalen 1977; 1978). In addition, the smaller number of small fire-cracked rock hearths recorded for the El Paso phase as compared to the Mesilla phase does not seem to be proportionate to the shorter duration of the El Paso phase. It can, therefore, be suggested that upland leaf succulents were not as important to El Paso phase population as they were to Mesilla phase population.

The large fire-cracked rock features of Sites 33 and 34 are thought to have been in use during the Mesilla phase. It has been suggested that two of these featues (Large Fire-cracked Rock Features 1 and 3 at Site 33) are the result of substantial accumulations of rock from the close spacing of a large number of small fire-cracked rock hearths, and the radiocarbon dates and ceramics from these two features also indicate a long use of these two areas during the Mesilla phase. This adds further evidence to the above inferred greater popularity of small fire-cracked rock hearths for the Mesilla phase. The other two features (Large Fire-cracked

Rock Feature 2 at Site 33 and possibly Large Fire-cracked Rock Feature 1 at Site 34) are large features which are often referred to as ring middens. The temporal distribution of ring middens in the El Paso area is not well known, but the few dated ones are equally distributed between the Mesilla and El Paso phases (see the section on large fire-cracked rock features). The temporal distribution of numbers of ring middens does not parallel that of small fire-cracked rock hearths. Although the contribution of upland leaf succulents to the diet may have been of less importance during the El Paso phase than during the Mesilla phase, there appears to be evidence that the processing of these plants during the El Paso phase often involved large quantities of the plants and perhaps the cooperation of social groups larger than a single household. That is, the technology for processing upland leaf succulents remains basically the same for the Mesilla and El Paso phases, but the relatively greater importance of ring middens during the El Paso phase is suggestive of a fundamental change in the organization of production; i.e., in the relationship between producers.

Additional implications which can be drawn from the relative abundance and temporal distribution of small fire-cracked rock hearths and large fire-cracked rock features are detailed in Chapter III while presenting an overview of the culture history of the El Paso area and describing settlement patterns of the project area. Because the information obtained from the study of fire-cracked rock features at Sites 29, 33, and 34 does not alter the writer's interpretation of the archeological record, that material is not repeated here and the reader is referred to Chapter III.

The fire-cracked rock features of Sites 29, 33, and 34 have been interpreted as special purpose facilities for processing upland leaf succulents. It has also been suggested that the processing of upland leaf succulents would have been a seasonal activity which most probably took place in the spring. There is a large number of these fire-cracked rock features for the Formative period occupations at Sites 33 and 34, while very few other kinds of features are known for occupations of this period at these sites. Small fire-cracked rock hearths are also the only features found at Site 29, and it can be reasoned from the large number of Formative period fire-cracked rock features in the project area that the hearths at Site 29 are more likely to date to the Formative period than to the Archaic period. In Chapters IX and X it will be shown, among other things, that the artifacts are few in number and seemingly distributed with respect to fire-cracked rock at these sites. The dominance of fire-cracked rock features, the lack of other kinds of features, and the low density of artifacts imply that the Formative period occupations of Sites 29, 33, and 34 were probably of short duration and oriented primarily towards the processing of upland leaf succulents. Comparable sites on the east side of the Franklin Mountains have also been similarly interpreted by Hard (n.d.) and O'Laughlin (1979).

Pits, Postholes, and Ash and Charcoal Hearths

Pits, postholes, and ash and charcoal hearths are few in number and recorded only for Sites 33 and 34. The attributes and possible uses of pits at Sites 33 and 34 are given in Table 10. They, along with the postholes and ash and charcoal hearths of Site 33 North, will be briefly described and estimates of the total numbers of similar features will be presented for each of the zones of occupation at Sites 33 and 34. The functions of most of these features are more ambiguous than that of the fire-cracked rock features of Sites 29, 33, and 34 because the limited available information on similar features in formal attributes leaves open a number of possible uses. Therefore, no attempt will be made to narrowly delimit the possible uses of most of these features and particularly the uses of small pits without fire-cracked rock and the ash and charcoal hearths. With the exception of Pit 8 of Zone 4 and Ash and Charcoal Hearth 1 of Zone 2 at Site 33 North, all of these features were tested or completely excavated either as feature units or by the excavation of 1 m squares. The techniques employed in excavating these features and the kinds of samples taken from these features are identical to those described for the small fire-cracked rock hearths in the previous section. In most cases, a portion of the investigated feature was left intact for possible reexamination in future studies.

The Zone 2 Formative period occupation of Site 34 South has two basin-shaped pits without rocks which were visible on the surface (Figure 21). These pits have been subjected to some slope erosion, and the slope erosion or wind deflation of most of the surface of Site 34 allows the suggestion that other similar features may once have been present. These pits are about 80 cm in diameter and contain only carbonaceous soil and some charcoal (Table 10). The recorded depths are 9 and 21 cm, but erosion of the upper portions of these features makes it probable that they were originally of greater depth.

The function of the two pits at Site 34 South is conjectural. However, the excavation of these pits some distance into the ground surface implies that these features may have been used more for special purpose than for general or routinely performed activities such as meal preparation or warmth. Simple

TABLE 10

ATTRIBUTES OF PITS

Site	Zone	Pit No.	Maximum Dimension (cm)	Depth (cm)	Outline	Section	Matrix	Comments
34	2	1	ca. 80	21	circular	deep basin	dark ashy gray sand with some charcoal	possible hearth or baking pit
		2	78	9	circular	shallow basin	dark ashy gray sand with some charcoal	possible hearth or baking pit
33 North	2	4	84 (top) 35 (btm.)	126	circular	tapering sides with round bottom	light ashy gray sand in lower 55cm followed by 35cm of buff sand and gravel and then 36cm of very light ashy gray sand and small gravel	excavated through Zone 4 and into Zone 5; laminated deposits suggest filling by natural processes; possibly a well
		5	45	11	circular	shallow basin	3-5cm of charcoal in bottom; remainder ashy gray sand and some charcoal	possible hearth
		6	over 65	17	circular?	deep basin	light ashy gray sand with large pieces of charcoal concentrated near bottom; 6.5 kg fire-cracked rock in upper 5cm and overburden, little below	likely baking pit with fire cracked rock possibly from disturbed small fire-cracked rock hearth 81
		7	ca. 125	24	circular	deep basin	5-10cm of ashy gray soil and charcoal in bottom and sloping up one side; 31.7kg of fire-cracked rock dispersed throughout upper light ashy gray sand with some charcoal	possible baking pit with fire-cracked rock and charcoal partially scooped out and now evidenced as small fire-cracked rock hearth 81 or eroded into pit 7 from small fire-cracked rock hearth 81
	4	3	97	6	irregular & elongated	shallow basin	light ashy gray sand indistinguishable from overlying deposits	extramural pit associated with House 2; use unknown
		8	ca. 70	20	unknown	deep basin	ashy gray sand with one piece of fire cracked rock visible	possible baking pit incorporating some rock; questionably associated with house (?) 9; exposed in backhoe trench 2
33 South	4	1	ca. 95	37	ovoid	irregular, sloping to one end and slightly undercut	buff to light ashy gray sand with much small gravel	use unknown; pit appears to have been refilled quickly with much of the soil excavated in constructing the pit
		2	11	6	circular	straight walls, rounded bottom	light ashy gray sand indistinguishable from overlying deposits	use unknown; questionable posthole for facility associated with house 3; possibly a rodent burrow
33 North	5	9	ca. 55	15	circular	shallow basin	light ashy gray sand	possible hearth or baking pit; exposed in waterline trench

surface hearths would have accommodated the latter activities, while the former and more specialized activities may have included the baking or roasting of such items as the crowns of leaf succulents, datil fruits, and cactus stems. The use of pits without rock for the processing of the above food items has been infrequently cited for historic Indian groups of northern Mexico and adjacent portions of the United States (Bell and Castetter 1941; Castetter and Bell 1942; Castetter, Bell, and Grove 1938) and this, together with the finding of only two basin-shaped pits without rock at Site 34, indicates that the use of these features and perhaps some of the activities which would be associated with them were of little importance.

The Zone 2 Formative period occupation at Site 33 is comparable to that of Site 34 in that there are very few features other than the numerous fire-cracked rock facilities. These include four pits, two possible postholes, and a single ash and charcoal hearth. Unlike Site 34, other similar features have undoubtedly gone undocumented for the Zone 2 occupation at Site 33 because of the limited subsurface testing of the deposits of this occupation which are thicker and of greater extent than those of Site 34. Unfortunately, it is not possible to provide a reliable estimate of the total number of these kinds of features from the techniques employed to investigate this site, and similar difficulties in estimating the number of small fire-cracked rock hearths for Zones 2 and 4 at Site 33 have been detailed in the previous section. The diameters of pits, postholes, and the ash and charcoal hearth are less than the intervals between soil cores (either 8 m or 2 m) at Site 33, and the number of these kinds of features found through soil augering cannot be expected to give an accurate estimate of the total number of similar features for either Zone 2 or Zone 4 at Site 33. In addition, the subsurface testing of Site 33 with the excavation of backhoe trenches and 1 m squares was not designed to provide an estimate of the number of small or even large features present at this site. There was also the added difficulty of recognizing, through soil coring, features without fire-cracked rock whose matrix was often only slightly darker than the surrounding soil. It can only be suggested from the extensive subsurface testing of the often weathered and shallow deposits of Zone 2 that small features such as these are not common for the Formative period occupation at Site 33 and that the total number of these kinds of features may be somewhere between two to five times the number of recorded examples.

Pit 4 of Zone 2 at Site 33 North was discovered during 2 m interval soil augering and is of particular interest because it is similar to features which Haury (1957) suggests were used as wells (Figures 16 and 18, Table 10). Pit 4 has a maximum diameter of 84 cm at its orifice and tapers to 35 cm in diameter at its bottom. It is also 1.26 m deep and bears no evidence of ever having had a fire built in it. This feature has, by far, the greatest depth of any of the features investigated at Sites 29, 33, and 34, and it is thought that the most likely function of this feature would be as a well. Wells would not be unexpected for the El Paso area where rainfall can be spatially and temporally quite variable and where permanent sources of water are restricted to mountain springs and the Rio Grande. However, the possible occurrence of a well at a site in close proximity to the Rio Grande is not so expectable. Although the Rio Grande is a generally reliable source of water, the river would change course within the valley or on occasion be dry before the construction of dams upstream (see the section on surface water in Chapter II). Thus, the presumed well at Site 33 may have been dug at a time when either the river was dry or located as much as 3 km away (as it is today).

Whether or not the alluvial fan of Site 33 could have served in the past as an aquifer for wells is uncertain. The soils of the alluvial fan are generally sandy and quite permeable, but heavier soils which could retard the downward movement of water and perhaps raise the water table within the alluvial fan include the floodplain soils which underlie portions of Site 33 and possibly the clay loams of Zones 3A and 5A which are south and west of Pit 4 and at approximately the same elevation as the bottom of this feature (Chapter V). Today the water table is several meters below the surface of floodplain soils just to the west of Site 33, but the construction of dams on the Rio Grande and the use of modern wells which tap subsurface water have lowered the water table of the valley. In addition, recent arroyo cutting of the alluvial fan of Site 33 has probably contributed to a general dessication of the alluvial fan and a lowering of the water table below its surface. In the past, and during periods in which the alluvial fan was not dissected by arroyos, runoff from the Franklin Mountains may have periodically recharged the ground water of the alluvial fan and temporarily produced a water table higher than that of the nearby floodplain. Thus, it is possible that the water table of the alluvial fan may have been high enough at times in the past to have served as a source of water for the occupants who excavated wells similar to Pit 4.

Pit 7 of Zone 2 at Site 33 North was detect·. during the course of 8 m interval soil coring at this site, and pits 5 and 6 and two possible postholes were found during the excavation of 1 m squares around

Pit 7 (Figures 18, 29). Pits 6 and 7 are similar to one another and are fairly large and moderately deep, basin-shaped pits, while Pit 5 has a small diameter of 45 cm and is approximately half the depth of Pits 6 and 7 (Table 10). Parts of the upper portions of these pits have been distrubed by vehicular traffic, but it is thought that the original depth of these features was not much more than that recorded.

Pit 5 contained dark carbonaceous soil and much charcoal, the small diameter and shallow depth of which suggests that it is a hearth used for general purposes. However, numerous fibers of a species of *Yucca* were recovered from the fill of this feature (Chapter VII) which could be taken as evidence of a more specific function. These fibers may be from the leaves of soap-tree yucca which grows on Site 33. When dry, the leaves of this species make an excellent tinder. These leaf fibers may also have been burned during the roasting of either a crown of soap-tree yucca or possibly the young flowering stalks of this species. The evidence is equivocal with respect to ascribing a specific or more general function for this feature.

Pits 6 and 7 both contain carbonaceous soil and large pieces of charcoal. The charcoal and the darker carbonaceous soils are generally found in the bottoms of these features, but they slope up one side of Pit 7 and are dispersed in the upper fill of Pit 6. It seems as though ash and charcoal were scooped out one side of Pit 7, and Pit 6 also seems to have had its contents moved about. Little fire-cracked rock was found near the bottoms of these features, but a large number of fire-cracked rocks were found in the upper fill of Pits 6 and 7. It is not clear whether the fire-cracked rock has been washed into these pits from Small Fire-cracked Rock Hearth 81 or whether the contents of these pits were removed and deposited nearby to be recorded as Small Fire-cracked Rock Hearth 81, and then later washed back into these pits (Figure 29). These pits may, therefore, be comparable to the small fire-cracked rock features described in the previous section as possibly having been emptied of fire-cracked rock. The large size and depth of these pits certainly suggest that they may have been used for roasting or baking foodstuffs, and the possible special purpose use of these facilities may also be suggested by the finding of leaf fibers of a leaf succulent in Pit 6 (Chapter VII).

The two possible postholes of the Zone 2 occupation at Site 33 North are located near Pits 5, 6, and 7 (Figure 29). These possible postholes have straight, vertical sides and slightly rounded bottoms, are 12 and 15 cm in diameter and 11 and 7 cm in depth, and were filled with dark carbonaceous soil. These features are not rodent burrows, and their small size, similar elevations, and close proximity to one another (2.5 m apart) suggest that they may have contained posts for a ramada, lean-to, or some other kind of temporary structure. It is also possible that these features may have held posts for a rack to dry fish or meat, but there is no evidence that either fishing or hunting were of any importance in the Zone 2 subsistence strategy of Site 33. It has been suggested that the occupations of this time period were probably emphemeral and took place during the spring for the purpose of processing leaf succulents; therefore, the erection of temporary shelters for shade or as windbreakers would not be unexpectable. Similar features, however, have not been found in other excavated sites where the occupations are also thought to have been similar (Aten 1972; Hard n.d.; O'Laughlin 1979; O'Laughlin and Greiser 1973; Thompson 1979).

Pit 5 has been radiocarbon dated at AD 1500 ± 110 and overlies one of the possible postholes and a small portion of Pit 6. Pit 5 would, therefore, be of more recent age than Pit 6, the one posthole, and perhaps also the second posthole and Pit 7. Nevertheless, the finding of large pieces of charcoal in Pits 5, 6, and 7 and the rather clear definition of the pit walls and the two possible postholes would indicate that all of these features are of similar and recent age. Charcoal is often small and pit walls indistinct or undefinable for other presumably older features and for features which have been radiocarbon dated to earlier times at this site. The close proximity of Pits 5, 6, and 7 and the two possible postholes allow the suggestion that these features are related to one another and may be the results of several episodes of use of the same area of Site 33 by the same social group. The rather late radiocarbon date of Pit 5 raises again additional questions as to whether these features date to the El Paso phase or whether they may be the remains of later hunter-gatherers in the El Paso area.

The single ash and charcoal hearth of Zone 2 at Site 33 North consists of a thin layer of dark carbonaceous soil and scattered charcoal in an area of approximately 1.5 m in diameter (Figure 18). This feature is exposed on the surface of Site 33 North and was not tested. It is interpreted as having been the locus of a surface hearth which has been deflated and dispersed by winds. Other surface hearths of the Zone 2 occupation at Site 33 may have gone unrecorded, and still others of the Zone 2 occupation at Sites 33 and 34 may have been completely weathered away. These features would have been more subject to wind deflation and slope erosion and would have a lower probability of survival in the archeological record than the subsurface features. These features may also have gone un-

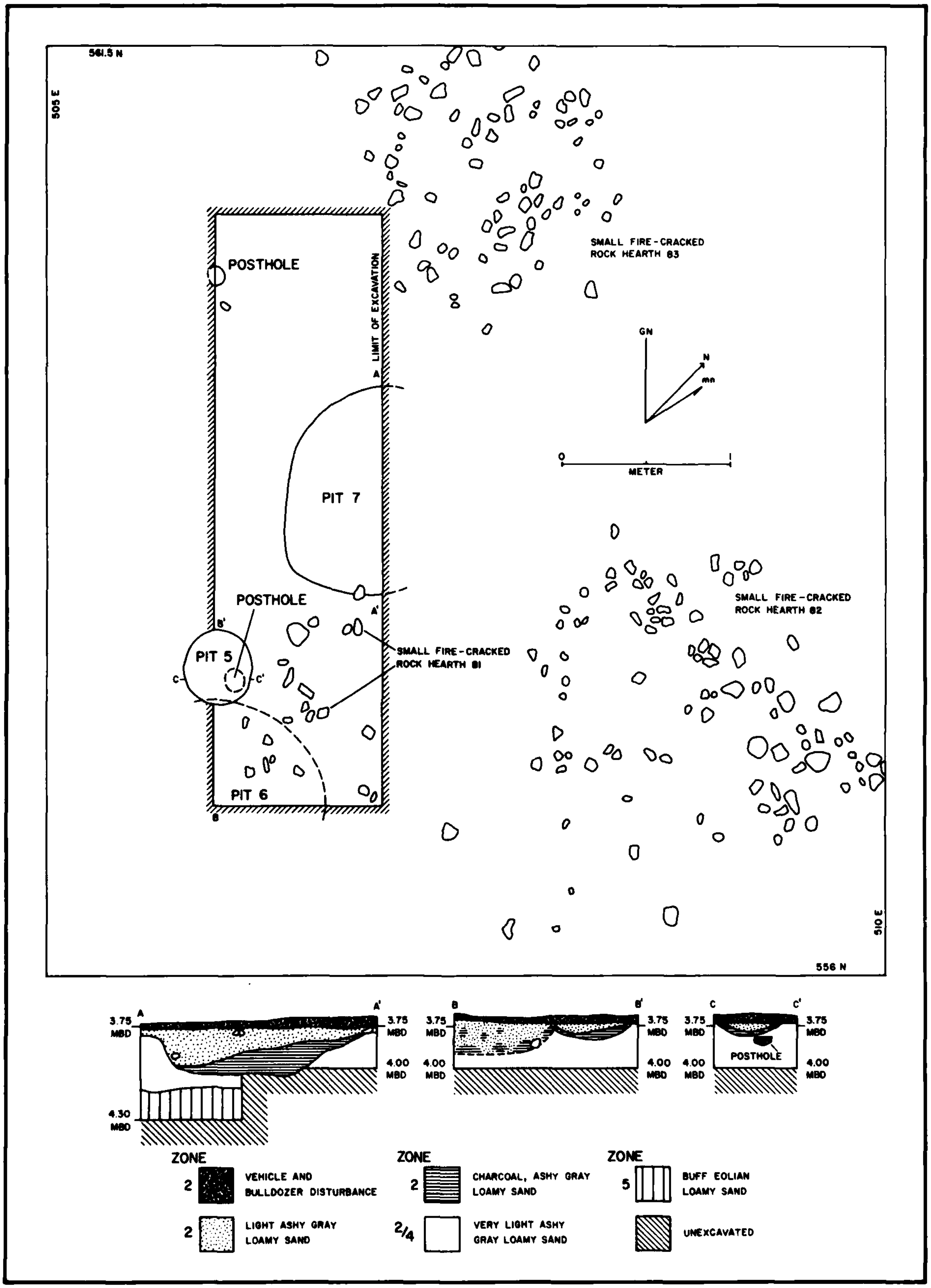


Figure 29. Plan of Pits 5, 6, and 7, two possible postholes, and three small fire-cracked rock hearths; sections of Pits 5, 6, and 7, and one of the possible postholes of Zone 2 at Site 33 North.

recognized in portions of Site 33 where the Zone 2 deposits are fairly dark and contain small, dispersed pieces of charcoal. Surface hearths, as opposed to many of the subsurface features, are considered to be general purpose facilities used for daily or frequently performed activities such as meal preparation and the warming of persons.

The small number of recorded pits, postholes, and ash and charcoal hearths of the Zone 2 occupations at Sites 33 and 34 follows the proposition that these sites were intermittently occupied for short periods of time and that these occupations probably occurred during the spring and were oriented towards the processing of upland leaf succulents. Most of the pits have suggested uses which overlap that of the fire-cracked rock features at these sites, and the pits and the single ash and charcoal hearth are taken to indicate that some other activities may have been performed at these sites besides that of processing upland leaf succulents. However, the rarity of these features implies that the activities performed with them were of little importance. The finding of two possible postholes hints that temporary shelters may have been constructed occasionally.

Although little is known of the spatial and temporal distribution of pits without fire-cracked rock or burned caliche and of ash and charcoal hearths which could help define the nature of activities performed, it is noteworthy that extramural features of sites with either pithouses or pueblos are different from those of Sites 33 and 34 and include deep storage pits (Lehmer 1948) and amorphous, refuse-filled pits (Brook 1966; 1980; Whalen 1977; 1978; n.d.). The differences between the kinds of features found at Sites 33 and 34 and those of sites with pithouses or pueblos indicate fundamental differences in the types of activities performed at them, in the treatment of trash, and in the permanence of occupation. These factors become important in a discussion of the pits of Zone 4 at Site 33 which are generally more like those of sites with pithouses or pueblos than they are of those of Zone 2 at Sites 33 and 34.

The Zone 4 Archaic period occupation of Site 33 has four recorded pits (Figure 20, Table 10) and a single identifiable ash and charcoal hearth (Figure 20). The ash and charcoal hearth was discovered during the course of 8 m interval soil coring, and one of the pits (Pit 8) was sectioned in one of the backhoe trenches. One Pit (Pit 1) was encountered during the excavation of 1 m square test excavations of Site 33 South, and the remaining two pits (Pits 2 and 3) were uncovered during the excavation of two of the houses of Zone 4. For the reasons previously outlined for the small fire-cracked rock hearths and other kinds of features of Zone 2 at Site 33, it is not possible to give an accurate estimate of the total number of small features, such as pits and ash and charcoal hearths, for the Zone 4 occupation of Site 33. In addition, the often dark soils of Zone 4 made difficult attempts, by soil coring, to locate small features which did not contain fire-cracked rock, and the differentiation of houses from small features which might be located immediately adjacent to houses could not be done by soil coring alone. For example, Pit 3 was not suggested by the 2 m interval soil coring of the area around House 2 even though one of the soil cores was located within this extramural feature. It is also noted that the subsurface testing of Zone 4 deposits with 1 m squares and backhoe trenches was limited and often biased towards concerns other than that of locating small features. An effort was made to place backhoe trenches away from suspected houses where small features may be more common for Zone 4, and many of the 1 m square excavations were situated within suspected houses in order to evaluate their occurrence in Zone 4.

Although a reliable estimate of the number of small features without fire-cracked rock cannot be provided for Zone 4, it can be suggested that pits closely associated with houses are probably much more common than the few recorded examples would imply. This is partially substantiated by the finding of four pits in the limited and biased testing of Zone 4, and this number is equal to or greater than the number of documented pits for the Zone 2 occupations of Sites 33 and 34 which together are more extensive than that of Zone 4 at Site 33. Pits are also proportionately more important than small fire-cracked rock hearths for Zone 4 at Site 33 than they are for Zone 2 at Sites 33 and 34.

Pit 8 of Zone 4 at Site 33 is located 4.5 m northwest of possible House 9 and may be associated with this house (Figure 20). This feature was not tested but was sectioned by Backhoe Trench 2. This basin-shaped pit has a diameter of approximately 70 cm and a depth of 20 cm, and the matrix of the fill is a dark carbonaceous soil with a single observed piece of fire-cracked rock (Table 10). Pit 8 is similar in dimensions to Pits 1 and 2 of Zone 2 at Site 34 and the former pit has at least one piece of fire-cracked rock while the latter contained no fire-cracked rock. Although Pit 8 is smaller than Pits 6 and 7 of Zone 2 at Site 33, all three of these pits apparently contained some fire-cracked rock. It is suggested that the use of Pit 8 was comparable to these other pits and that Pit 8 was most likely a special purpose facility used to bake or roast plant foods. The location of Pit 8 is comparable to that of the small fire-cracked rock hearths of Zone 4 at Site 33 where these features tend to be situated on the periphery of the occupied area and generally some distance from houses (Figure 20). This compares with the inference that Pit 8 and the small fire-cracked rock hearths were special purpose facilities which were not used for daily or frequently performed activities. Such activities would probably have occurred closer to the houses of Zone 4.

Pit 2 of Zone 4 at Site 33 is a small, shallow pit which is 11 cm in diameter and 6 cm deep (Table 10). This pit is of unknown use and is located very close to House 3 (see Figure 32). It has the appearance of a posthole but may also be a rodent burrow. Additional work around House 3 would be required to clarify whether this pit is the result of rodent distrubance or part of some extramural facility such as a rack or ramada.

Pits 1 and 3 of Zone 4 at Site 33 are similar (Table 10). They are irregular in form and bear no evidence of having had fires built in them. Pit 1 is rather deep and appears to have been refilled shortly after excavation, and Pit 3 is shallow and is filled with soils indistinguishable from the overlying deposits of Zone 4. Both of these pits contained a few artifacts which consisted principally of chipped stone. Artifacts were rarely found within other pits and fire-cracked rock features of Sites 33 and 34. Pit 3 is located next to House 2 (see Figure 31), and the finding of two pieces of roofing clay in Pit 1 may indicate that Pit 1 was also near a house which was not disclosed by 8 m interval soil coring around this pit. The function of Pits 1 and 3 is uncertain, but it can be presumed from their irregular form, contents, and close proximity (or suggested proximity) to houses that these features may have been used for trash disposal or perhaps storage in the case of the deeper and slightly undercut Pit 1. It has been suggested in the previous chapters and will be discussed further in the next section that the Zone 4 Archaic period occupation(s) of Site 33 was of longer duration, though possibly intermittent and seasonal, than those of Zone 2 at Sites 33 and 34. The fairly substantial investment in housing also implies that the Zone 4 occupation(s) of Site 33 was longer-lived than that of the ephemeral and intermittent occupation of Zone 2 at Sites 33 and 34. Given the fixed locations of houses and the longer duration of occupation(s), it is probable that trash disposal and storage were of greater concern to the Zone 4 Archaic period occupation(s) of Site 33 than for the Zone 2 Formative period occupations of Sites 33 and 34. Although few features were found which could have been used for storage or trash disposal, it has been suggested that these kinds of features may be common around the houses of Zone 4. This is a pattern documented for inferred semi-permanently or permanently occupied sites with houses in the El Paso area (Brook 1966; 1968; Lehmer 1948; Whalen 1977; 1978; n.d.).

The single ash and charcoal hearth of Zone 4 at Site 33 was discovered while soil coring this site, and was tested with a 1 m square excavation (Figure 20, Ash and Charcoal Hearth 2). This feature is a thin lens of carbonaceous soil with some scattered charcoal and appears to be somewhat over a meter in diameter. This feature is also thought to be a surface hearth whose use is envisioned as having been general in nature. As with Pit 8 and most of the small fire-cracked rock hearths, this surface hearth is located near the outer edge of the Zone 4 occupation. Given the difficulty in recognizing these features and their apparent poor preservation, others may have been present in the Zone 4 occupation at Site 33 and were probably distributed both near and far from houses, depending on the tasks involving their use. That is, more specific activities involving some length of time or freedom from the interference of more routinely performed activities are envisioned as probably having occurred away from houses which were probably the loci of daily or frequently performed activities. Comparable features were also recorded within the houses of Zone 4.

The pits of Zone 4 at Site 33 are generally of a different nature than those of Zone 2 at Sites 33 and 34, and the pits, small fire-cracked rock hearths, and even the houses have a spatial distribution unlike that of the features of Zone 2 at Sites 33 and 34. There is some evidence to suggest facilities for trash disposal and storage near the Zone 4 houses, and special purpose facilities tend to be located away from houses and on the periphery of the Zone 4 occupation. Taken together, the features of Zone 4 imply some organized use of space and occupations that were of longer duration than those of Zone 2 at Sites 33 and 34. These inferences will be pursued at greater lengths in the following section.

The only remaining pit to be discussed is Pit 9 of Zone 5 at Site 33. This pit was sectioned during the summer of 1979 as a result of the excavation of a deep trench across Site 33 for a waterline. Pit 9 was uncovered in the trench below Large Fire-cracked Rock Feature 2 at Site 33 North (Figure 18). This basin-shaped pit has a diameter of approximately 55 cm, is 15 cm deep, and was filled with carbonaceous soil (Table 10). The function of this feature is presumed to have been comparable to that of Pits 1 and 2 at Site 34 and was probably a special purpose facility used to bake or roast plant foods. This pit and an associated, thin layer of carbonaceous soil of limited extent are the only evidence for an occupation of Site 33 before the Zone 4 occupation. The limited extent of this occupation and apparent low density of artifacts (none were found in the limited examination of this pit and associated stain) suggest that the Zone 5 occupation was of very short duration and by a small group.

Houses

The survey of Site 33 by Gerald (n.d. d) and later visits to this site by the writer suggested that artifacts and fire-cracked rock features were few in number, widely dispersed, and that they probably were the product of ephemeral occupations during the Mesilla phase. One possible pithouse was observed by Gerald and the writer in one wall of an arroyo, but it was thought that few houses would be found at Site 33 and that they would also date to the Mesilla phase. In many respects, these perspectives on the later occupations at Site 33 were upheld with the limited examination of this site as part of this project. However, it was not anticipated that a large number of houses would be found in the deeper levels at Site 33 nor that they would date to such an early time period.

There is a total of 23 loci of known or suspected houses for the Zone 4 occupation at Site 33. Radiocarbon dates from Zone 4 suggest that the Zone 4 occupation pertains to the Archaic period and that it dates between 4450 BP and 3750 BP (Chapter V). The earliest house previously recorded for the El Paso area is radiocarbon dated to the Formative period and sometime between 1550 BP and 1250 BP (Whalen 1977). Thus, the houses from the Zone 4 Archaic period occupation are the earliest knows examples for the El Paso area, and this certainly adds a new dimension to the local archeological record. Although there are numerous recorded houses for about 2000 BP or later in the American Southwest, there are only a handful of excavated houses which date before 2000 BP and as early as the houses at Site 33 (these will be mentioned later). In addition, only one or two of these earlier houses have been excavated at any given site, and nothing is known of the relationship between houses and extramural features in those sites where a number of houses are suggested to be present (Sayles 1945). The preservation of a large number of houses and other kinds of features in the Zone 4 deposits of Site 33, therefore, afford a rare opportunity to pursue questions of social organization during the Archaic period in one portion of the Southwest. Characterizations of social organization during the Archaic period in the El Paso area and elsewhere in the Southwest have most often been by direct reference to the ethnographic literature of hunter-gatherers. The importance of the Zone 4 occupation at Site 33 for archeological studies of Archaic period social organization should be readily apparent in the following description of houses and the spatial distribution of houses and other kinds of features.

Before proceeding to a description of the Zone 4 houses at Site 33, some description of how these houses were located, an estimate of the total number of houses, and the particular evidence for each of these houses needs to be given. These interests are briefly considered below.

The houses of Zone 4 were located in a number of ways. Cross-sections or partial sections of four houses (Houses 2, 10, 20, 21) were observed in the walls of recent arroyos, and the outline of one house (House 1) was clearly visible on the surface. Backhoe trenches produced evidence of four houses (Houses 3, 9, 11, 15), and eight houses (Houses 1, 4, 5, 6, 10, 16, 18, 23), including one of the houses cut by an arroyo and the single house visible on the surface, were suggested by the 8 m interval soil coring of Site 33. Another eight houses (Houses 7, 8, 12, 13, 14, 17, 19, 22) were discovered while coring Site 33 at 2 m intervals. With the exception of one house (House 22), all of those located by coring at 2 m intervals were identified while attempting to better define the location and form of houses suggested by 8 m interval soil coring or profiles in arroyo cuts.

Soil coring at 2 m intervals, combined with some selectively placed cores, proved very effective in delineating the form and size of many of the houses. Nearly all of the houses contain a dark carbonaceous soil which was generally much darker than surrounding soils in Zone 4. By noting differences in the soil color of Zone 4 deposits from soil cores it was then often possible to suggest house outlines and dimensions. In some cases the pattern of dark carbonaceous soils from soil cores is irregular or amorphous in shape and may be attributed to the presence of extramural features and work areas around these houses (Figure 10). However, many of the houses inferred from soil coring appear to be circular in outline and approximately 3 m in diameter. This pattern was substantiated by the partial or complete excavation of Houses 1, 2, and 3. As an added note, every attempt was made to leave undisturbed the floors of houses by limiting the depth of soil cores to the upper carbonaceous fills of these features.

Twelve of the 23 suspected or known houses were excavated or tested by hand excavation. All excavations were by 1 m squares using natural levels or arbitrary levels within a natural level as described in Chapter IV. Arbitrary levels of excavation were generally 10 cm thick, but the soil in the fill of two houses (Houses 1 and 2) was removed in arbitrary 5 cm levels when natural levels were more than 5 cm thick. Most soils were screened through a 1/4-inch mesh for the recovery of artifacts and floral or faunal remains. The deposits on the floors of Houses 1, 2, 3, and 4, however, were screened with either 1/8-inch or 1/16-inch mesh. Pollen and soil samples were frequently taken from the fill and floors of houses, and great care was taken to recover macrofloral remains for identification or use in radiocarbon dating.

The houses of Zone 4 are easily distinguished from other features of that level. They average about 3 m in diameter (as evidenced by soil coring, profiles in arroyo cuts and backhoe trenches, and excavation) and are much larger than the other kinds of features noted for Zone 4. They also differ from the small fire-cracked hearths of Zone 4 in containing either no fire-cracked rock or, rarely, small pieces of fire-cracked rock which appear to have been moved downward through the soil from overlying small fire-cracked rock hearths. Many of the houses of Zone 4 appear to have burned, and the presence of numerous fragments of fire-hardened roofing clay is one of the more notable characteristics of houses (Table 11). The particular kinds of evidence used to infer the presence and describe the attributes of houses are given below for each of the houses. Seven of these features are considered to be definite houses (Houses 1 through 7), and the remaining 16 features are said to be questionable houses only in that they were either not tested by hand excavation or were tested to a very limited degree (Figure 20).

Houses 1, 2, 3

These three houses were either completely excavated or were tested sufficiently to describe their form, depth, size, and some of the interior and extramural features. Figures 30, 31, and 32 illustrate the circular plan of these structures which were 2.2 to 2.8 m in diameter and 10 to 20 cm deep. A more detailed description of these houses will be presented shortly.

Houses 4, 5, 6, 7

These four houses were suggested on the basis of 2 m interval soil coring to be circular in outline and approximately 3 m in diameter; the circular outline of House 7 became apparent with the removal of some of the upper fill of this house during the excavation of House 1 (Figure 30). House 6 was tested with a 1 m square excavation which was located on the edge of this feature. This excavation revealed the circular outline of House 6 and the sloping walls of the shallow excavation (ca. 12 cm in depth) that produced the saucer-shaped floor of this house. Houses 4 and 5 were also tested with 1 m square excavations near the east side of these features. Both tests hinted that there may be two floors in these houses and possible shallow hearths that were dug some 4 to 7 cm into the upper floor and down to the lower floor. However, this is not certain because of the limited testing of Houses 4 and 5 and because the floors were not completely cleaned off so as to leave largely intact the floors of these features for possible later and more extensive examination. The testing of Houses 4, 5, and 6 also produced burned roofing clay (Table 11).

House 22

This feature seemed from 2 m interval coring to be circular in outline and approximately 3 m in diameter. Two 1 m square tests in this house also revealed that the floor slopes gently toward the center of the house where there was a hearth that was 95 cm in diameter and 10-15 cm deep. One piece of roofing clay was revealed from the tests of this feature (Table 11).

Houses 12, 16, 18, 19

The 2 m interval soil coring of these features showed an irregular or circular pattern of carbonaceous soil some 2 to 4 m in width or diameter, and each of these features was tested with 1 m square excavations near their centers. The floors of these features were not well preserved but were indicated by an even layer of dark carbonaceous soil some 3 to 10 cm thick that graded quickly into lighter colored sands below. Roofing clay was also recovered from Houses 12, 16, and 18 (Table 11).

Houses 9, 11, 15, 17

These features were sectioned or partially uncovered with backhoe trenches. House 9 was evident in both walls of Backhoe Trench 2 as a 10 cm deep saucer-shaped depression with sloping walls. The exposed section was 1.95 m long, and the depression contained dark carbonaceous soil. House 11 was partially sectioned in Backhoe Trench 4 where it was shown as an approximately 20 cm deep depression with a sloping wall and dark carbonaceous soil. This trench (Figure 11 top) exposed only one wall and 1.5 m of the floor of House 11. Houses 15 and 17 were indicated by several meters of dark darbonaceous soils in the bottom and at one end of Backhoe Trenches 7 and 9. These features, as well as Houses 9 and 11, were not tested, and one piece of burned roofing clay was found in an 8 m interval soil core that penetrated House 15 (Table 11).

Houses 10, 20, 21

These houses were sectioned or partially sectioned by recent arroyos. House 10 was cut by a

TABLE 11

ROOFING CLAY FROM SITE 33

		No. of Pieces	Thickness (mm)	No. of Grass Impressions	Branch Impression Diameters (mm)
Zone 2	Non-Feature Areas	1	-	-	-
	Pit 4	14	3	5	2
	Pit 6	1	2	-	-
	Pit 7	2	8	1	8
Zone 4	Pit 1	2	16	1	12
	House 1	19	4-13	14	-
	House 2	716	2-14	311	1-23 Ave.5.1 N = 18
	House 3	85	2-10	56	2-13 Ave.7.3 N = 7
	House 4	103	3-6	34	-
	House 5	3	-	2	-
	House 6	23	3-6	7	20,25
	House(?) 12	7	3-6	5	7
	House(?) 15	1	-	1	-
	House(?) 16	13	4-9	1	1
	House(?) 18	2	-	-	-
	House(?) 20	1	3	-	-
	House(?) 22	1	-	-	-

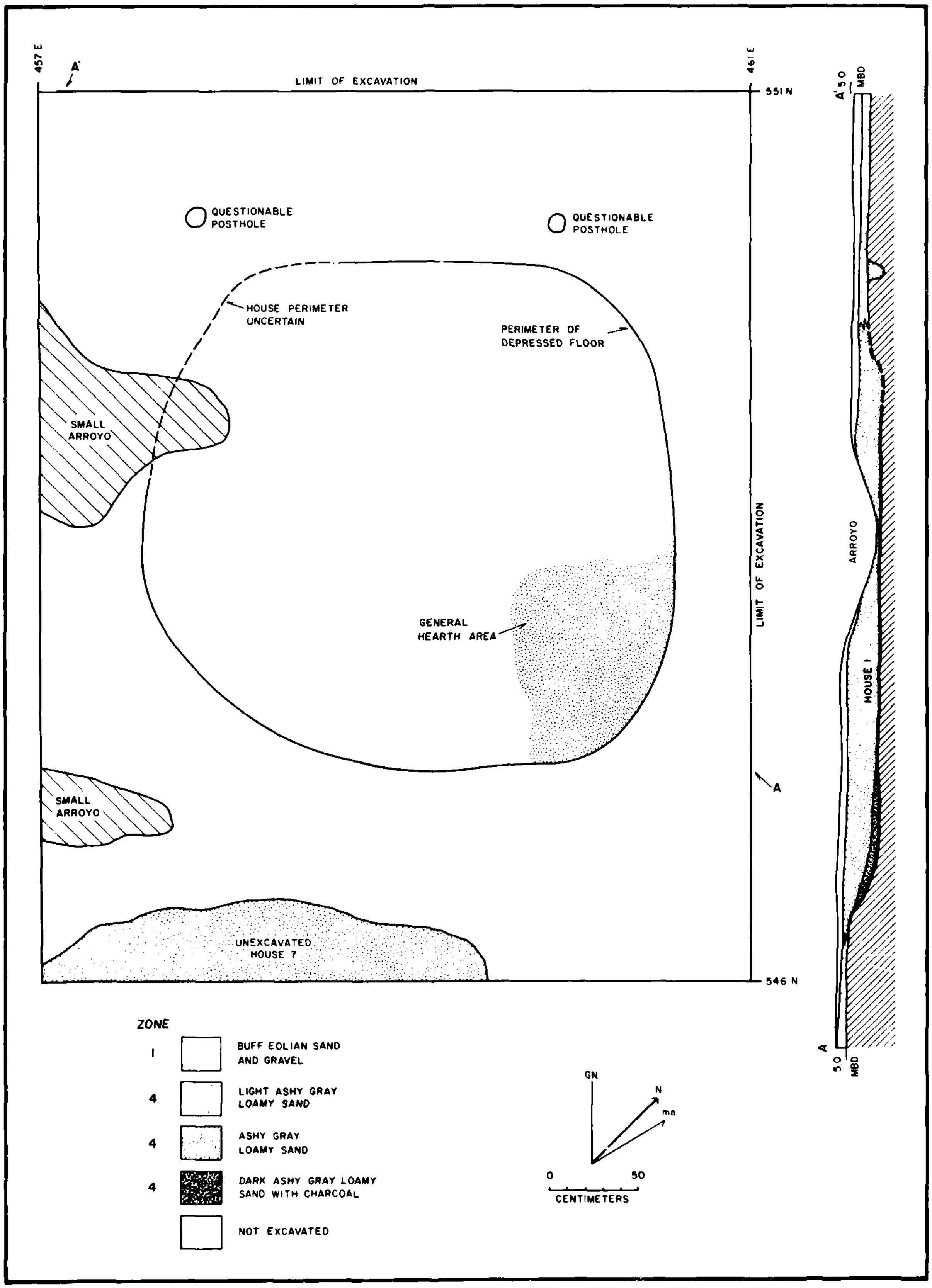


Figure 30. Plan and section of House 1 of Zone 4 at Site 33 North.

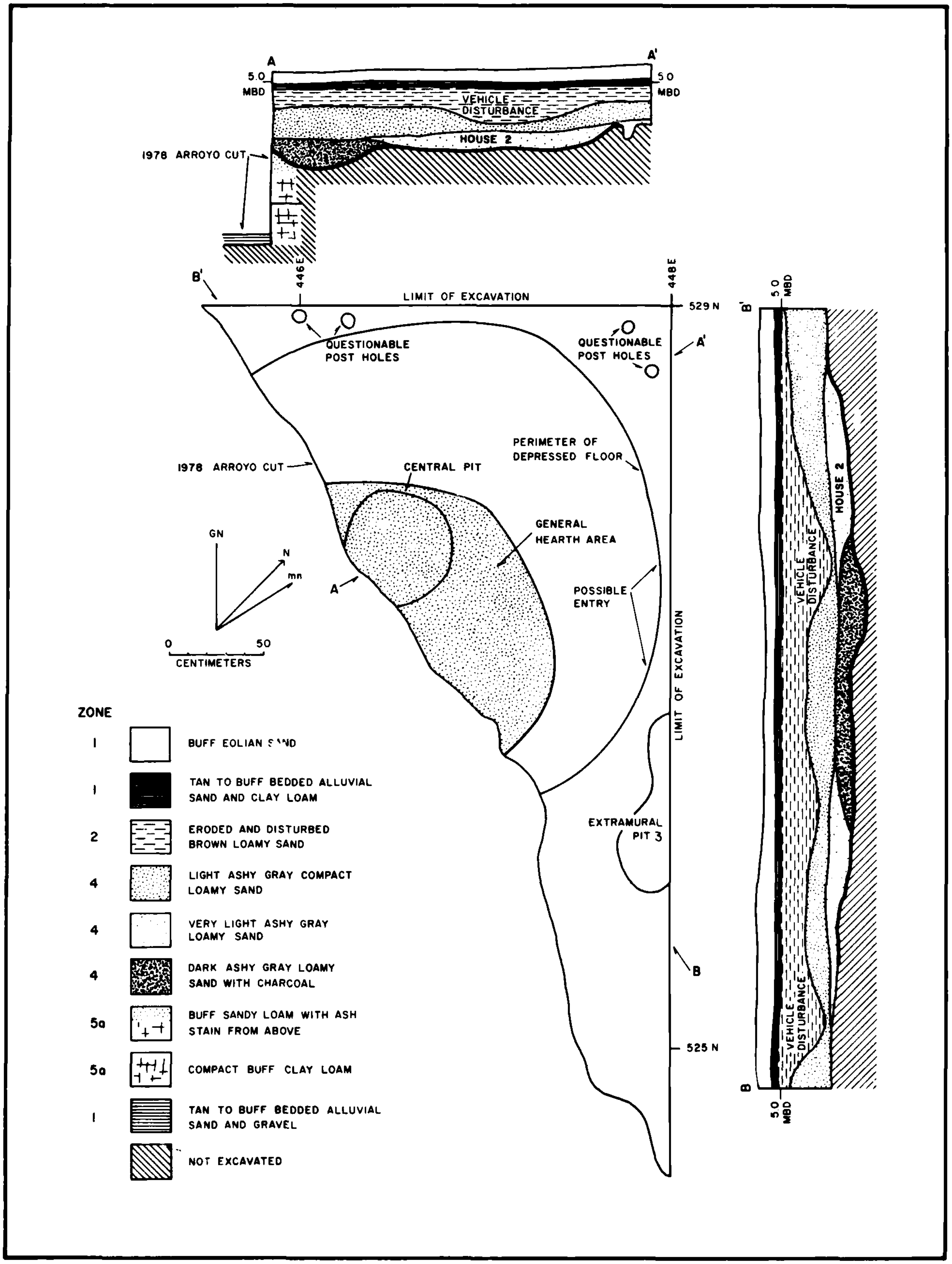


Figure 31. Plan and section of House 2 of Zone 4 at Site 33 North.

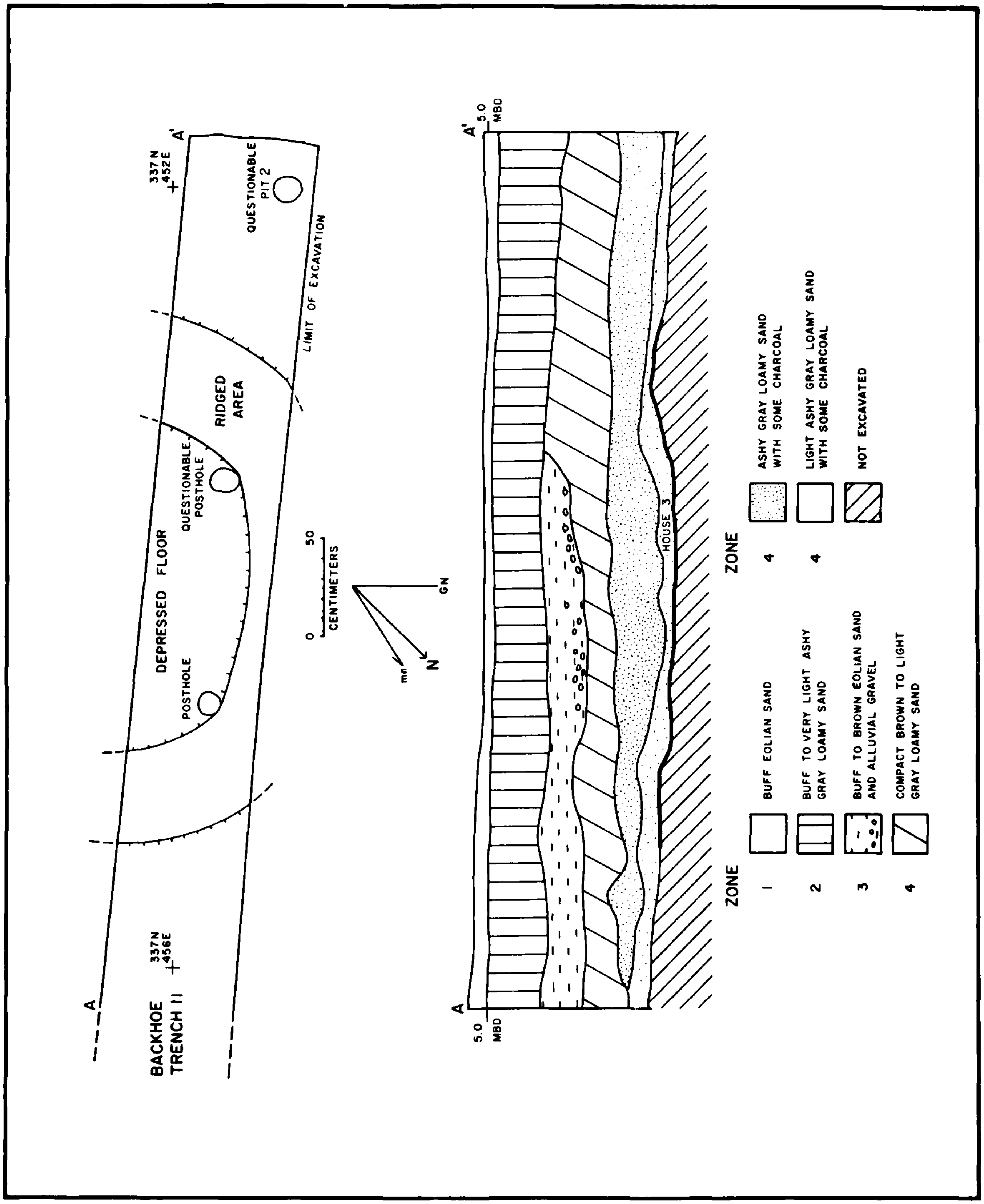


Figure 32. Plan and section of House 3 of Zone 4 at Site 33 South.

small arroyo and was seen as a 3 m wide saucer-shaped depression filled with dark carbonaceous soils. The outer walls of this feature sloped gently toward the center where the depth was approximately 10-15 cm. Soil coring at 2 m intervals revealed a circular form about 3 m in diameter for House 10. Houses 20 and 21 were suggested by dark carbonaceous soils in the north bank of the 1978 arroyo. Too little of these features remained to ascertain their original form and size, and additional arroyo cutting in 1979 has since removed all evidence of these houses. One piece of roofing clay was recovered from the fill of House 20, but none of these features were tested.

Houses 8, 13, 14, 23

The only evidence for these houses was a pattern of dark carbonaceous soils that was 2 to 4 m in diameter as revealed by 2 m interval soil coring. None of these features were tested.

Other Houses

The possible presence of other houses at Site 33 is suggested by the finding of burned pieces of roofing clay in contexts other than house fill (Table 11). Most of these pieces of roofing clay come from Pits 4, 6, and 7 (Figure 18) and a nearby non-feature area of Zone 2. These pits and the non-feature area are located just below and south of the north ridgeline of Site 33 North where soils have been subjected to some slope erosion recently and in the past (Chapter V). Slope erosion, particularly of Zone 4 deposits, may have obliterated most evidence of houses in this area. Two pieces of fire-hardened roofing clay were found in Pit 1 of Zone 4 at Site 33 South (Figure 20), and this may indicate the presence of a nearby house which was not disclosed by 8 m interval coring.

Although only seven of the above mentioned houses have been noted as definite houses, there is considerable evidence that many of the other features are also houses. Because of the limited testing of Site 33, some of these features are more questionable than others. However, other houses are probably present at Site 33 and have gone unrecorded because of the limited examination of this site. Thus, the 23 known or suspected loci of houses may be taken as a good estimate of the minimum of houses at Site 33.

Estimates of the total number of houses cannot be derived from the 1 m square excavations or the 2 m interval soil coring because these subsurface tests centered largely on the suspected loci of houses of Zone 4 rather than on a probabilistic sampling of Zone 4 deposits. The most extensive coverage of Site 33 was achieved by soil coring at 8 m intervals. The area of the Zone 4 occupation is approximately 25,600 square meters, and houses were suggested from eight (2%) of the 400 soil cores taken at 8 m intervals. Assuming that the percentage of houses suggested by 8 m interval soil coring is a good measure of the proportion of the area of the Zone 4 occupation covered by houses and that houses are randomly distributed, then 512 square meters of the Zone 4 occupation could be covered by houses. In that the area of dark carbonaceous soil of houses is rarely less than 3 m in diameter and that houses occur no closer to one another than 1 m (Figure 30), the area occupied by each house would be 4.0 m in diameter. This gives an area of 12.57 square meters occupied by each house and an estimate of 40.7 houses when the area covered by houses (512 square meters) is divided by the individual house area (12.57 square meters). Most of the houses of Zone 4 were found to be clustered in groups of 2 to 3 houses (Figure 20). The houses of Zone 4 are, therefore, not randomly distributed, and it is more likely that there are fewer than 41 houses at Site 33 and that the number of houses is closer to 23, the number for which some evidence exists.

The attributes of the Zone 4 houses at Site 33 are summarized below under the categorical headings of floor, superstructure, hearth, and entry.

Floor. The houses of Zone 4 consist of shallow, 10 to 20 cm, excavations into the sandy soils of Zones 5 and 5A (Houses 1-3, 6, 9-11) (Figures 11 top, 30-33, 34a). In the case of House 3, soils from the excavated area were deposited in a low ridge around the periphery of the house (Figure 32), but this was not noted for other houses. House floors are simply the sandy botom of the excavation and are sometimes compact but are more often loose. The floors are also nearly level or slope gently to the center of the houses (Houses 1-3, 6, 9-11, 22) (Figures 11 top, 30-32). As previously noted, Houses 4 and 5 may have second, upper floors. These later floors appear to be compact, sandy loams which cover the refuse of earlier occupations and are some 1 to 3 cm thick. Artifacts were common on both the original and possible later floors of Houses 4 and 5. House 2 may also have a second floor, but there was no clearly definable floor separating an upper and thin layer of artifacts from those on the excavated floor of the house. The walls of house excavations are not vertical and slope quickly to house floors (Houses 1-3, 6, 9-11) (Figures 11 top, 30-33).

Houses 1, 2, and 3 are circular in form (Figures 30-33a), and a curving outline was noted for Houses 6 and 7 (Figure 30). Soil coring has also suggested that other houses are of similar form. The diameters of the depressed floors of Houses 1 and 2 are 2.8 and 2.75 m respectively (Figures 30, 31), and the areas

a.

b.

Figure 33. Excavated houses at Site 33 North. Arrows point north and are 50 cm long. a. View of House 1 showing the saucer-shaped depression and possible postholes. b. View of House 2 showing central pit-hearth and possible posthole arrangement.

a.

b.

Figure 34. House 2 at Site 33 North and plant impressed roofing clay. a. View of House 2 before excavation of pit-hearth and possible postholes. Note the extent of the general hearth area. Arrow points north and is 50 cm long. b. Branch and grass-impressed roofing clay. Specimen in lower center is 13 mm wide.

of the depressed floor of these houses are 6.2 and 5.9 square meters respectively. The projected diameter of the depressed floor of House 3 is 2.2 m, and the projected diameter of House 3 to the outer edge of the ridged area is 2.75 m (Figure 32). The floor area of House 3 probably lies between 3.8 and 5.9 square meters.

Superstructure. Roof supports are suggested by questionable postholes for Houses 1, 2, and 3. House 1 has two questionable postholes which lie 18 to 36 cm from the perimeter of the depressed floor (Figure 30, 33a). These questionable features have tapered walls and are 11 and 14 cm in diameter and 10 and 12 cm deep respectively. They were not clearly defined and may be the result of rodent or plant disturbance. The distance of these two features from the depressed floor and the absence of similar features around House 1 suggest that these features are not postholes to support the roof of House 1 or that they may relate to an extramural feature such as a ramada or rack. The postholes of House 3 are equally questionable and may also be the result of rodent or plant disturbance (Figure 32). These features were about 11 and 14 cm in diameter and 8 cm deep. The walls of these features could not be accurately defined. Although they are fortuitously located on the perimeter of the depressed floor, it is probable that these two features are not postholes. The four questionable postholes of House 2 range from 5 to 8 cm in diameter and 7 to 8 cm in depth and are located near the perimeter of the depressed floor (Figures 31, 33b). These features taper slightly to their bottoms and were clearly defined by their dark carbonaceous fill. Plants, however, have disturbed the soil in the area of these features, and it is possible that they may be the result of such disturbance.

The evidence for the nature of roof supports is not particularly good. Questionably identified postholes may be the result of plant or animal disturbance, and small features such as these may not preserve well in the loose, sandy soils of Site 33. The questionable postholes of House 3 could suggest an interior arrangement of vertical post supports but this seems unlikely because of their shallow depth. The postholes of House 1 have been questioned because of their distance outside the depressed floor but still they may have been sockets for leaners joining above the center of the house. The possible postholes of House 3 may also have served as sockets for small poles which served as leaners to support the roof. The absence of postholes well within the interior of these three houses, the shallow depth of the suspected postholes, and the finding of these features near the perimeter of these houses suggest that superstructures supporting roofing material were not substantial and that they probably consisted of relatively small leaners which may or may not have been socketed.

Although many of the houses may have burned and contain dark carbonaceous soil and fire-hardened roofing clay, very little charcoal was found in houses which might indicate the materials used in the superstructures of houses. The preservation of charcoal in Zone 4 is not good, and it can only be noted that the species represented in charcoal from houses occur on or near Site 33 today and that mesquite and perhaps tornillo are the most frequently identified species (Chapter VII). One pollen sample from the floor of House 2 contained an appreciable amount of cottonwood and willow pollen, and from this one may infer the use of these species in the construction of superstructures (Chapter VI).

The presence of fire-hardened roofing clay in many of the houses indicates that most were covered with a layer of clay (Table 11). The thickness of the clay layer was measured on those pieces exhibiting smooth outer surfaces and impressions of plant materials on their inner surfaces. These thicknesses ranged from 2 to 16 mm and imply that the clay coating of houses was relatively thin. A number of the pieces of burned roofing clay shows impressions of small branches which, in the two largest samples from Houses 2 and 3, range in diameter from 1 to 25 mm and averaged 5.1 to 7.3 mm respectively (Figure 34b). In addition, there are numerous impressions of grass stems and leaves from most of the houses with roofing clay (Figure 34b). Besides the use of grass stems and leaves and branches of woody plants, some small fragments of reed *(Phragmites communis)* were recovered from the fill of House 3 and suggest some use of this plant for roofing material (Chapter VII).

From the above evidence, house construction can be visualized as having involved the following steps. First, a shallow, saucer-shaped depression was excavated. Second, small leaners were probably placed on the periphery of the excavation and joined near the center of the house. These leaners may or may not have been socketed. Third, the leaners were covered with small branches and then a layer of grass. Finally, the whole superstructure was covered with a thin layer of clay.

Hearth. Hearths appear to be the only floor features and probably occur in most, if not all, of the houses. In House 1 a general hearth area is recognizable and consists of a 5 cm thick lens of dark carbonaceous soil and some charcoal over an area of approximately 1 square meter on the floor near the east wall (Figure 30). A second general hearth area occurs over much of the central portion of the floor of House 2 and is made up of a 10 cm layer of dark carbonaceous soil and some charcoal which dips into a central pit (Figures 31, 33b, 34a). This central pit measures 58 by 67 cm in horizontal dimensions and is 10 cm deep. This pit was not lined and probably served as a hearth. The relationship of the general hearth area and the pit-hearth of House 2 to one another and to a possible second floor in this house is unclear. It may be that the general hearth area is associated with the second floor of the house excavation. It is also possible that ash and charcoal were not regularly removed from the house and were allowed to build up in the central pit and spread over a considerable area of the floor.

House 22 has a central pit-hearth which is 95 cm in diameter and 10 to 15 cm deep, and Houses 4 and 5 were previously noted as possibly having pit-hearths some 4 to 7 cm in depth and over 50 cm in diameter. These latter possible hearths are associated with the questionable second, later floors of Houses 4 and 5. As with House 1, these hearths were also unlined and contained dark carbonaceous soil and some charcoal.

The two recorded general hearth areas of houses are comparable in attributes to the ash and charcoal hearths of Zones 2 and 4 at Site 33, and the four pit-hearths documented for houses overlap some of the pits of Zone 2 at Sites 33 and 34 in depth and diameter (see the previous section). Whereas many of the pits of Zone 2 at Sites 33 and 34 are inferred to have been used principally for special purposes, the use of the general hearth areas and pit-hearths of houses is probably more like that of the ash and charcoal hearths of Zones 2 and 4 at Site 33 which are thought to have functioned as general purpose hearths. The general hearth areas and pit-hearths of houses could have been used for warmth, meal preparation, and perhaps light.

Entry. Possible entryways or doors can be suggested for the east sides of four houses. In House 2 the sloping pit wall of the house was slightly depressed on the east perimeter of the house where traffic may have worn the soil away from the original surface of the excavation (Figure 31). The location of a possible entry is inferred for House 1 by location of the general hearth area near the east wall (Figure 30), and possible east entries are suggestable for Houses 4 and 5 where the questionable second floor pit-hearths are situated near the eastern limit of the carbonaceous soils of these houses. East to southeast entries have been noted for Mesilla phase pithouses with or without excavated ramp entries in the El Paso area, and general hearth areas or pit-hearths have most often been found in front of and near these entires (Hard n.d.; Lehmer 1948; Whalen 1977; 1978; n.d.).

Interpretive Summary of Houses

Archaic period houses at Site 33 are estimated to number between 23 and 41 and are perhaps the most significant class of archeological data detailed in this report. Few houses have been reported for this time horizon from elsewhere in the American Southwest, and the houses from Site 33 predate by more than two-thousand years other previously described houses for the El Paso area. More important than the documented antiquity and large number of houses at Site 33 is the spatial arrangement and excellent preservation of these houses and other features, and the associated archeological materials and information which, with additional archeological research, would afford a rare occasion to undertake a study of social organization during the Archaic period in the El Paso area of the Southwest.

Attributes of the Archaid period houses at Site 33 include small size (ca. 3 m diameter), shallow depth (ca. 10 cm), unplastered and circular floors, unsubstantial construction of mud plaster over a dome of brush and grass, informal hearths, and probable east entries. These attributes are not unexpected of this time horizon and environment and are comparable to those reported for other houses dating between about 3000 B.C. and 500 B.C. in the Southwest (Eddy 1958; Irwin-Williams 1973; Martin and Rinaldo 1950; Sayles 1945). However, only one or two houses have been noted for sites in the Southwest other than Site 33 which predate the Christian era. The nearest examples of sites with numerous houses and ages similar to that of the Archaic period occupation at Site 33 include several sites with inferred wattle-and-daub houses of about 2000 B.C. in the state of Tamaulipas, Mexico (MacNeish 1958), and the Stall Site near Little Lake, Nevada, which has at least seven houses dating between 2000 B.C. and 1000 B.C. (Harrington 1957). Although only a small number of sites with one or two houses and dating before 500 B.C. has been documented in the Southwest, it is probable that some of these same sites contain additional houses and that other sites will be found with evidence of houses as archeological investigations continue in sites of the Archaic period. Thus, Site 33 with its numerous houses is not considered a unique site in the sense of evidencing a previously unknown level of social development for the Archaic period but, rather, is presently viewed as unique in the fortunate and excellent preservation of so man houses.

Mesilla phase houses of the Formative period in the El Paso area date between A.D. 400 and A.D. 1100 and have been referred to by others as "huts" or "pithouses" (Aten 1972; Hard n.d.; Lehmer

1948; Whalen 1977; 1978; 1979; n.d.). With the exception of some post A.D. 900 Mesilla phase houses which tend to be rectangular in shape and somewhat larger and deeper, and which occasionally have plastered floors and pit-walls, the Archaic period houses of Site 33 are similar to most known houses of the Mesilla phase which are also small in size, circular in form, shallow in depth, flimsy in roof construction, and generally lacking in floor features. Differences between the Archaic period houses of Site 33 and Mesilla phase houses dating before A.D. 900 are primarily in the number and arrangement of postholes or sockets for leaners which are temporally quite variable and in the presence of mud plaster over roofing material which is recorded for the Archaic period houses at Site 33 but not for roofs of Mesilla phase structures.

O'Laughlin (1979) and Hard (n.d.) suggest that the minimal investment of energy in housing during most of the Mesilla phase is a reflection of a greater degree of residential mobility of small social groups during this time than during the later part of the Mesilla phase when more substantial pithouses were being built and during the El Paso phase when multi-room, adobe pueblos were being constructed. This interpretation differs from that of Whalen (1977; 1978; 1979; n.d.) who infers from the presence of houses that Mesilla phase communities were occupied on a semipermanent or permanent basis. O'Laughlin and Whalen do agree in inferences derived from the spatial arrangement of houses and other features that Mesilla phase communities were composed of basic social units (households) and that kinship provided the means for a loose, intracommunity integration of these basic social units. Contiguous room pueblos (among other things such as nonrandom spatial distribution of pueblos and intrusive ornaments and ceramics) are taken by Whalen (1977; 1978) as evidence for a greater degree of intracommunity integration of households during the El Paso phase than during the Mesilla phase. He does not hesitate to label this a tribal level of social organization. Although much of the detail and many of the arguments have been omitted for brevity, it sould be apparent that Hard, O'Laughlin, and Whalen place some emphasis on the investment of energy in housing and on the spatial arrangement of houses and other features when approaching questions of residential mobility, permanence of residence, and level and mechanism of social integration.

Characterizations of Archaic period technology and social organization have often relied on generalities drawn from the ethnographic literature on contemporary hunter-gatherers such as that found in the "Man The Hunter Symposium" (Lee and Devore 1968). Social groups during the Archaic period have been envisioned as being relatively small (family to band), flexible in composition and group membership, mobile, and loosely integrated through effective kin and communication networks (Brethauer 1977; Eck 1979; Thompson 1979; Whalen 1978; n.d.). Little is known of Archaic period subsistence-settlement patterns because of the difficulty in recognizing archeological materials of this period in the El Paso area (Chapter III). However, the little that is known of Archaic period subsistence-settlement patterns suggests that there is no marked divergence in these patterns between the Archaic period and the Mesilla phase of the Formative period and that changes in the subsistence-settlement system presumably occurred in a gradual fashion over a long period of time. At present, the Mesilla phase is known to differ, by definition, from the Archaic period principally in the use in the Mesilla phase of ceramic vessels and the bow and arrow and in the possible greater reliance on cultigens. Houses were also once included in the list of elements distinguishing the Mesilla phase from the Archaic period, but the identification of Archaic period houses at Site 33 now negates the incorporation of houses in trait lists which would discriminate these time periods. In addition, the houses and other features of the Archaic period occupation at Site 33 raise some questions concerning social organizations and subsistence-settlement patterns during the Archaic period in the El Paso area and call attention to the ambiguity of meaning assigned to houses of the Mesilla phase with respect to residential mobility, permanence of occupation, and social organization. In the remainder of this section the nature of the Archaic period occupation at Site 33 is approached through a summary description and alternative interpretation of the houses and other features.

The Archaic period houses of Site 33 are estimated to number between 23 and 41, and this number is more than twice that documented for later Mesilla phase sites (Aten 1972; Hard n.d.; Lehmer 1948; Whalen 1977; 1978; 1979; n.d.). If all of the houses at Site 33 were occupied contemporaneously, then a considerable number of people (ca. 60 to 200) would be indicated. Although sizable winter encampments have been recorded for hunter-gatherers along the Rio Grande below El Paso in early historic times (Everitt 1977), a community of hunter-gatherers with 60 to 200 people might be considered unusually large for populations with comparable means and organization of production in arid environments similar to that of the El Paso area. Indeed, some doubt exists as to the contemporaneity of the houses at Site 33 because the radiocarbon dates from features of the Archaic period occupation only suggest that the best dates of this occupation are between 2500 B.C. and 1800 B.C. and not that the houses were necessarily inhabited at the same time (Chapter V). Thus, the Archaic period occupation at Site 33 may have been intermittent, though possible over a short period of time as hinted by the apparent non-superpositioning of houses and the thinness of deposits. Clarification of the contemporaneity of houses must await the recovery of additional information from Site 33. It can be added, however, that a single, large occupation with 23 to 41 houses should not be discounted and that natural resources of the project area are presumably sufficient to support sizable populations of hunter-gatherers for short periods of time (Chapter II).

The houses of the Archaic period occupation at Site 33 are not distributed randomly throughout the 25,600 square meters of this occupation (Figure 20). Although some isolated houses were observed, most of the identified houses occur in groups or clusters of two to perhaps five houses. The isolated and clustered houses may represent individual and temporally different occupations of Site 33 during the Archaic period, and it is remarked that the few radiocarbon dates are from isolated features or different clusters of features and that they differ enough from one another to suggest temporally distinct occupations (Chapter V). In fact, the earliest and latest MASCA corrected radiocarbon dates (2790 B.C. ± 310 and 1590 B.C. ± 210) do not overlap one another at two standard deviations from the mean. Unfortunately, there are too few radiocarbon dates to partition the houses into groups of contemporaneously occupied houses or to be certain that more than one occupation is indicated for the Archaic period.

Inferences on social organization are general in nature and subject to debate. The Archaic period houses of Site 33 average about 3 m in diameter and are small enough to infer their use by nuclear families or small extended families. Clusters of houses may be referable to large extended families or possibly small bands should the clusters of houses not be contemporaneous. Assuming contemporaneity of all of the houses, a social group on the order of a large band might be indicated. Although it is not unreasonable to assume that individual houses may be attributable to families, there is little information other than the size and spatial distribution of houses to suggest that groups of houses may represent larger social groups such as extended families or bands. With the limited testing of houses no regularities in architectural details within or between clusters of houses were found which might help delimit relationships between households. It is also noted that many of the houses had burned and that the houses may have been intentionally razed by fire following occupation of the site. If houses were intentionally fired, then it could be reasoned that clusters of houses represent portions of the site repeatedly occupied by the same household over a short period of time. That is, the use of the site by a household could have been followed by intentional burning of a house and the construction of a new house near the previous one when the site was next occupied by the same household. This would imply the recognition of the habitual use and right to use the same area of the site by a social group and that houses may have been burned to prevent their use by other potentially competitive social groups. Although much of this is conjectural, it does serve to emphasize the point that once discussions extend beyond a single house and its small number of inhabitants, there are numerous possibilities with respect to the number of houses in use at the same time and the relationships between those inhabiting these structures.

Thus far, this discussion has illustrated the potential for pursuing questions of social organization during the Archaic period at Site 33. Attention will now be focused on questions of permanence or seasonality of occupation. Factors suggestive of permanent occupation will be considered first. These will be followed by a presentation of information which may indicate seasonal and intermittent occupation.

As previously mentioned, the houses of the Archaic period occupation at Site 33 are not randomly distributed and occur as isolated houses and clusters of houses. In addition, other features of this occupation exhibit some spatial patterning (Figure 20). Amorphous, trash-filled pits are thought to have been located in close proximity to houses, and the single identified pit which may have been used for storage purposes is also thought to have been near a house. In contrast to these features, small fire-cracked rock features and other pits presumably used for baking or roasting of plants are generally situated some distance from houses and on the periphery of the area occupied during the Archaic period. Whalen (1979) describes similar spatial patterns in houses, pits, and fire-cracked rock features for two Mesilla phase sites east of El Paso and infers from these patterns that space was partitioned in these sites with respect to the nature, duration, and frequency of activities performed with or near these features and that the organized use of space centered on households and extended to an entire community for which he implies some permanency of occupation. Given the similarity in features and their relative positioning within the two Mesilla phase sites and the Archaic period occupation of Site 33, it would be tempting to also conclude permanency of residence for the Archaic period occupation of Site 33. However, the contemporaneity of the features for this occupation at Site 33, as well as those for each of the two Mesilla phase sites, is uncertain, and it is possible that their spatial distribution may relate more to activities associated with individual households of possible different ages and not necessarily to the organized use of space at the community level. That is, activities differing in kind, duration, and frequency may not be temporally or spatially compatible and some allocation of space to these activities may be traceable to spatial patterns in features for individual households as well as entire communities. It is difficult, therefore, without better chronological control, to ascertain whether observed spatial patterns in features are attributable to a single "planned" community or are simply a composite of temporally distinct patterns of features from individual households or small clusters of households.

The observation that houses and other features of the Archaic period occupation at Site 33 exhibit nonrandom and patterned relationships does not, in itself, provide convincing evidence of the permanency of occupation. However, there are other kinds of information which do lend themselves to such an interpretation. First, the presence of trash-filled pits near houses may indicate some concern for the disposal of trash and suggest more than an ephemeral occupation. Second, the finding of one possible storage pit and the burned remains of foodstuffs in one house which were probably gathered at different seasons and stored on the floor of this house would imply an occupation of some duration (Chapter VII). Third, grinding implements and chipped stone materials refer to a wide range of supportive and maintenance activities that would be associated with residential sites inhabited for a longer period of time (Chapters IX and X). There is also some evidence for the curation of stone tools which is not typical of ephemeral and special activity sites in the El Paso area. Finally, year-long occupation of Site 33 during the Archaic period could be argued from the use of mud in the roof construction of houses which can be viewed as evidence for winter residence, the occurrence of a few fire-cracked rock features which have been interpreted as facilities used to process leaf succulents principally in the spring, and the recovery of floral and faunal materials which would be available seasonally from spring to fall (Chapter VII). It is also noted that Site 33 is situated within 6 km (the daily foraging range of some contemporary hunter-gatherers) of six defined environmental zones and important resources of the project area (Chapter II). Taken together, the above mentioned factors provide some credence to a supposition of year-long residence.

The possible intermittent and seasonal occupation of Site 33 during the Archaic period can be inferred primarily from the architectural details of houses. Whalen (1977; 1978; n.d.) divides sites of the El Paso area into residential sites with houses and camps and special activity sites which lack structures and implies that residential sites were the loci of semipermanent or permanent occupation. However, Whalen does not take into consideration the amount of energy invested in houses when discussing the mobility of social groups and the permanence of residential sites. In this respect it is seen that the houses of the Archaic period occupation at Site 33 exhibit shallow and unplastered floors of small area, flimsy roof construction, informal hearths, and no floor features other than hearths. The relatively small investment of energy in these houses contrasts sharply with that envisioned for the larger, deeper, and occasionally plastered houses of the later part of the Mesilla phase and the adobe pueblos of the El Paso phase when residential sites may have been occupied on a semipermanent or permanent basis. Hard (n.d.) and O'Laughlin (1979) interpret houses in the El Paso area such as those at Site 33 as temporary facilities used by social groups who changed residence fairly often in response to seasonal and spatial availability in resources. The intermittent and perhaps seasonal occupation of Site 33 during the Archaic period is certainly hinted at by the previous discussion of the burning of many of the houses and, more importantly, by the suggestion of two floors in three of the houses which appears to be the result of adding a layer of sand to the floor of these houses after some period of disuse. A substantial number of artifacts was found on both floors of the houses with two floors, as well as on the floors of other houses. An average of 18 artifacts per square meter with a range of 4 to 128 artifacts per square meter of floor space was recovered. The finding of so many artifacts on the floors of houses suggests that trash was not always removed from houses and that the intermittent Archaic period occupations of Site 33 may have been of short duration.

If occupations were both intermittent and seasonal, the most probable season of occupation would have been the winter when there were a number of plant foods available along the river and perhaps less in areas away from the river (Chapter II). The use of mud in the roof-wall construction of houses and the increased insulating qualities it affords suggests a winter occupation. It was remarked in the section on small fire-cracked rock hearths that these features are relatively unimportant for the Archaic period occupation as compared to later Formative period occupations at Site 33 and that this may indicate only occasional spring occupation of Site 33 during the Archaic period. Although floral and faunal remains from the Archaic period deposits include resources which are best available from spring to fall (Chapter VII), this does not necessarily mean that Site 33 was occupied when these resources were collected. That is, some storage of foodstuffs was probably practiced and these same foodstuffs may have been cached at Site 33 while populations traversed the countryside during the warmer, biotically productive months of the year. A pattern of restricted wandering during the warmer months with Site 33 serving as a base camp could be envisioned, therefore, and would complement the evidence for the winter occupation of Site 33.

Throughout this chapter attention has been drawn to the differences in kind and number of features between the Archaic period occupation of Site 33 and the later Formative period occupations of Sites 33 and 34. There is considerable evidence to suggest that Formative period occupations were ephemeral, seasonal, and directed principally toward the processing of leaf succulents in the spring. The interpretation of the Archaic period features has not been so simple. The difficulty is largely attributable to the ambiguity of meaning given by the writer and others to similar features in the El Paso area. It would appear that Site 33 was probably occupied on more than one occasion between 2500 B.C. and 1800 B.C. and primarily in the winter. Site 33 may also have served as a base camp from which social groups foraged during the warmer months. Supportive and maintenance activities are indicated by the lithic assemblage and features which correlate well with the presumed lengthy but intermittent occupations of Site 33 during the Archaic period. Houses are viewed as having been inhabited by nuclear families. The spatial relationships between the many Archaic period houses may reflect both kin and communication networks larger than those of a nuclear family as well as temporally distinct occupations.

CHAPTER IX

CERAMICS, GROUND AND PECKED STONE, HAMMERSTONES AND ORNAMENTS

Chapter IX is the first of two chapters describing the artifacts recovered from Sites 33 and 34. This chapter sets forth the attribute analysis of ceramics, ground and pecked stone, hammerstones, and ornaments, and discussions touch upon such topics as the temporal and spatial distribution, raw material procurement, production, and use of these artifacts. Chapter X deals specifically with chipped stone artifacts and elaborates on the temporal and spatial distribution of much of the material introduced in Chapter IX and the relative importance of activities inferred from these materials for the Zone 2 Formative period occupations at Sites 33 and 34 and the Zone 4 Archaic period occupation at Site 33. There were no artifacts found in the investigation of Site 29 or of Zone 5 at Site 33.

Ceramics

Ceramic materials of the Zone 2 occupations at Sites 33 and 34 are not abundant – only 683 sherds were found. Average surface densities for ceramics at Site 33 and 34 are, respectively, 0.015 and 0.004 sherds per square meter. These low densities of sherds on the surfaces of these sites are comparable to those of sites with fire-cracked rock features on an alluvial fan at the east base of the Franklin Mountains (Hard n.d.; O'Laughlin and Greiser 1973; O'Laughlin 1979; Thompson 1979). These latter sites have been interpreted by O'Laughlin (1979) as ephemerally and intermittently occupied sites for processing leaf succulents. This is also suggested to be the case for the Zone 2 occupations at Sites 33 and 34, and the low density of sherds on the surfaces of these sites certainly implies that the Zone 2 occupations were of short duration. In addition, very few sherds were found below the surface and in the Zone 2 deposits of Sites 33 and 34. The density of ceramic materials was found to be between 3 and 4 sherds per cubic meter of soil at Site 33 and less than 0.5 sherd per cubic meter of soil at Site 34.

The analysis of ceramic materials is aimed principally at providing information on the variability in attributes of ceramics which might help to better define the local ceramic chronology for the Formative period and especially for the long-lived Mesilla phase with its rather nondescript brownwares. Various attempts to refine the ceramic chronology for the El Paso area have centered on analyses of temper texture, tempering materials, surface finish and decoration, and rim forms (Lynn, Baskin, and Hudson 1975; O'Laughlin 1977b; 1979; Whalen 1977; 1978; n.d.). These attributes provide the basis for the division of ceramic materials from Sites 33 and 34 into 23 ceramic groups (Table 12). In some cases the ceramic groups correspond to named ceramic types, and in many cases they represent variations in named types. There are also some groups which could not be identified with known types.

The study of ceramic materials from Sites 33 and 34 involved the monitoring of the following described attributes. Temper texture was noted as being fine, medium, or coarse if the tempering particles were, respectively, smaller than 0.25 mm, 0.25 mm to 1.0 mm, or larger than 1.0 mm in diameter. Tempering materials were not identified through petrographic analysis of thin sections, and only the most conspicuous types of tempter were recorded with the aid of a 10 power hand lens. Thus, the temper of sherds was most often assigned to general classes of material such as sand or igneous rock. The occurrence of biotite mica in the paste of some sherds was the single case in which a more specific identification of possible tempering materials was made. Observations were made on the core and surface colors of sherds, and descriptions of the surface finish of sherds included notations on the texturing, smoothing, polishing, slipping, and painting of surfaces. Slip and paint colors were also recorded. The profiles of rim sherds are shown in Figure 35 for all ceramic groups in which rim sherds occur with the exception of rim sherds from one short-necked jar and two neckless jars or hemispherical bowls of Group 1 and one bowl of Group 17 which are similar to those shown.

Group 1

This group is considered a variant of El Paso Brown (Lehmer 1948) which is the diagnostic ceramic type for the Mesilla phase and includes 442 sherds or 65% of the ceramics from Sites 33 and 34. Group 1 sherds are medium to coarse tempered with sand as the most obvious tempering material.

TABLE 12

CERAMIC DISTRIBUTION

Group	1	2	3	4	5	6	7	8	9	10	11	12	13
SITE 33 NORTH													
Surface	233(19)	15(1)	27	35	3	1	16	12	3	9	-	1	1
Excavation: Level 1	14(2)	-	1	-	1	-	1	1	-	1	-	-	-
Excavation: below Level 1	49(1)	10(1)	13	3	-	-	3	6	-	1	-	-	-
Unknown Provenience	7	-	-	-	-	-	-	-	-	-	-	-	-
Total	303(22)	25(2)	41	38	4	1	20	19	3	11	-	1	1
Percent	60.1	5.0	8.1	7.5	0.8	0.2	4.0	3.8	0.6	2.2	-	0.2	0.2
SITE 33 SOUTH													
Surface	83(7)	2	6(1)	5	1	-	1	1	-	1	1	-	-
Excavation: Level 1	9(1)	2	-	-	-	-	-	-	-	-	-	-	-
Excavation: below Level 1	14(1)	3	-	-	-	-	-	-	1	-	-	-	-
Total	106(9)	7	6(1)	5	1	-	1	1	1	1	1	-	-
Percent	76.8	5.1	4.3	3.6	0.7	-	0.7	0.7	0.7	0.7	0.7	-	-
SITE 34													
Surface	32(9)	-	3	-	-	-	3	1	-	-	-	-	-
Excavation	1	-	-	-	-	-	1	-	-	-	-	-	-
Total	33(9)	-	3	-	-	-	4	1	-	-	-	-	-
Percent	80.5	-	7.3	-	-	-	9.8	2.4	-	-	-	-	-

The numbers of worked sherds are shown in parentheses.

TABLE 12 —Continued

Group	14	15	16	17	18	19	20	21	22	23	No. of Worked Sherds	Total Sherds	Percent
SITE 33 NORTH													
Surface	1	1	1	11(1)	-	10	-	6	2	1	21	389	77.2
Excavation: Level 1	-	-	-	3(1)	-	-	-	-	-	-	3	22	4.4
Excavation: below Level 1	-	-	-	-	-	-	-	1	-	-	2	86	17.1
Unknown Provenience	-	-	-	-	-	-	-	-	-	-		7	1.4
Total	1	1	1	14(2)	-	10	-	7	2	1	26	504	100.1
Percent	0.2	0.2	0.2	2.8	-	2.0	-	1.4	0.4	0.2	5.2	100.1	
SITE 33 SOUTH													
Surface	-	-	-	5(1)	1(1)	-	1	-	-	-	10	108	78.3
Excavation: Level 1	-	-	-	-	-	-	-	-	-	-	1	11	8.0
Excavation: below Level 1	-	-	-	1	-	-	-	-	-	-	1	19	13.8
Total	-	-	-	6(1)	1(1)	-	1	-	-	-	12	138	100.1
Percent	-	-	-	4.3	0.7	-	0.7	-	-	-	8.7	99.7	
SITE 34													
Surface	-	-	-	-	-	-	-	-	-	-	9	39	95.1
Excavation	-	-	-	-	-	-	-	-	-	-	0	2	4.9
Total	-	-	-	-	-	-	-	-	-	-	9	41	100.0
Percent	-	-	-	-	-	-	-	-	-	-	22.0	100.0	

The numbers of worked sherds are shown in parentheses.

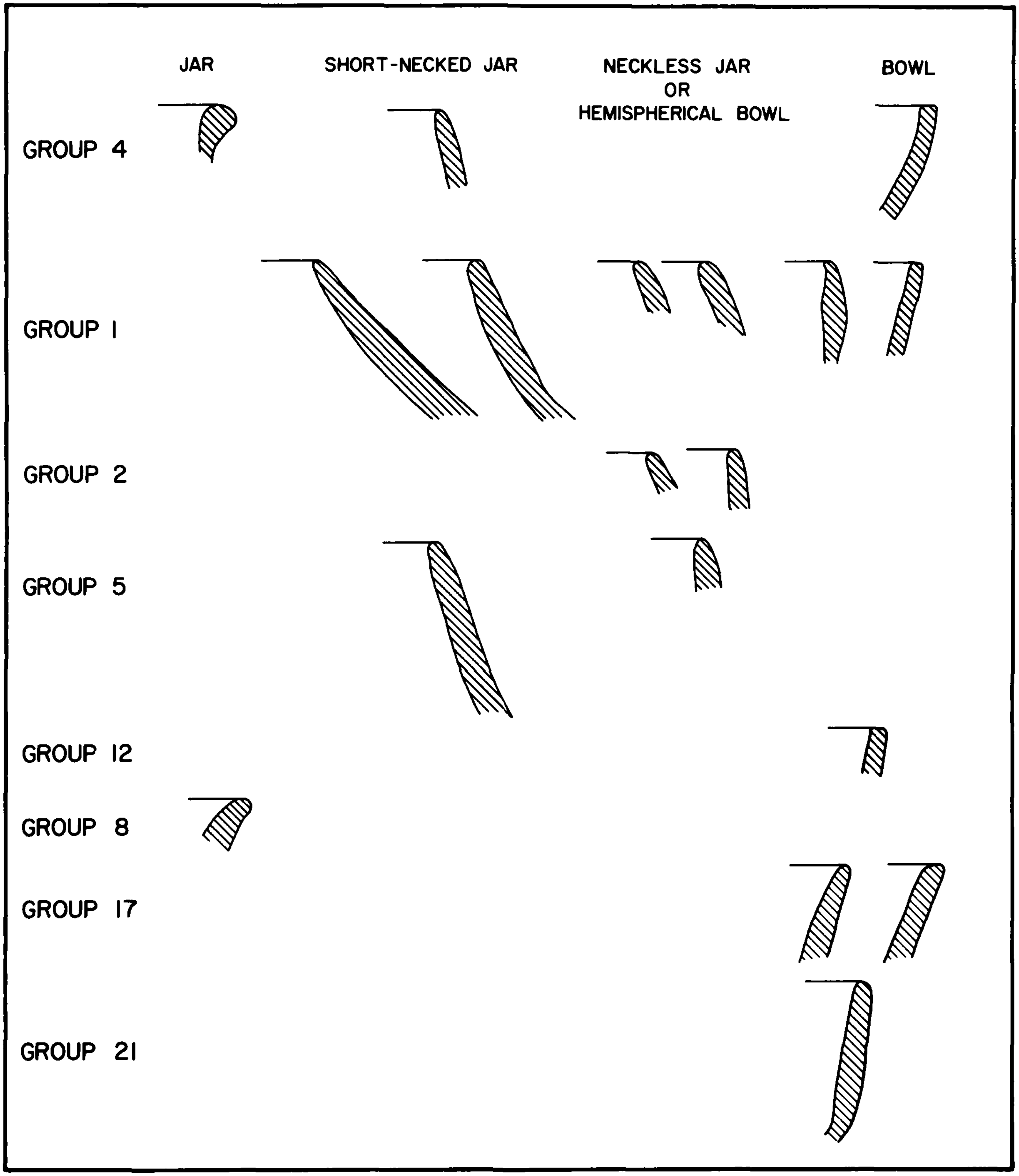


Figure 35. Rim profiles of ceramic groups from Zone 2 of Sites 33 and 34.

Surface color is generally brown but ranges from light gray to reddish brown, and the majority of sherds exhibit a gray or black core. The surfaces of Group 1 sherds are smoothed but not polished. Temper particles are often visible on the surface of sherds, and the inside surface of jars and the outside of bowls exhibit scraping marks. Deep bowls, hemispherical bowls or neckless jars, and short-necked jars are represented by the rim sherds of this group (Figure 35).

Group 2

Group 2 sherds are identical to those of Group 1 with the exception that the surfaces of Group 2 sherds are very smooth with occasional polishing marks and, rarely, marks from the scraping stage of vessel construction. Hemispherical bowls or neckless jars are the only vessel forms suggested by rim sherds (Figure 35). The 37 sherds of Group 2 make up 5% of the ceramic material from Site 33; none were found at Site 34.

Group 3

This group includes sherds with weathered surfaces which could not be placed in either Group 1 or Group 2. That is, the temper texture, tempering materials, and core color of Group 3 sherds are like those of Groups 1 and 2, but the erosion of the surfaces of Group 3 sherds made it impossible to assign these sherds to either Group 1 or Group 2 on the basis of surface finish. The 50 sherds of Group 3 account for 7% of the pottery from Sites 33 and 34.

Group 4

Group 4 is composed primarily of brownware sherds which are thinner (averaging 3.3 mm) than most sherds (4-7 mm) at Sites 33 and 34 and show parallel polishing marks. Some of these sherds also bear red and black painted designs which are composed of solid and stepped lines. The paste of these sherds has a medium to coarse sand temper and black core. These 43 Group 4 sherds comprise 6% of the ceramics at Site 33 and are of El Paso Polychrome (Stallings 1931) which is the dominant locally-made ceramic type of the El Paso phase (about A.D. 1200-1400). The two jar and one bowl rim profiles of these Group 4 sherds are similar to those noted for El Paso Polychrome (Figure 35) (Whalen 1977; 1978, n.d.).

In addition to the above mentioned sherds of Group 4, there are also two sherds of Group 4 which differ from the others in being somewhat thicker (4.5 mm) and in not having polishing marks which are parallel. These two sherds have decorations which consist of a single thick line of black paint. One of these sherds is the rim of a short-necked jar. The profile of this rim is comparable to those of short-necked jars of Groups 1 and 2 and unlike the thickened and everted rims of El Paso Polychrome jars (Figure 35). Whalen (1977; 1978; n.d.) refers to sherds such as these as painted El Paso Brown or bichrome. The suggested time range for sherds with simple, direct rims and one-color decoration is A.D. 1050-1250, and the two bichrome sherds from Site 33 may indicate some occupation of this site during the Dona Ana phase.

Group 5

Included in Group 5 are five sherds from Site 33 which are indistinguishable from those of Group 1 save for the conspicuous presence of biotite mica in the paste of Group 5 sherds. Both Group 5 and Group 1 are medium to coarse, sand-tempered brownwares with dark cores and smoothed surfaces that show scraping marks. Vessel forms of Group 5 are illustrated by two rim sherds which are from a short-necked jar and a hemispherical bowl or neckless jar (Figure 35).

Group 6

Group 6 is represented by one sherd from Site 33 which differs from Group 2 sherds only in tempering material. Group 2 sherds are sand-tempered, while the Group 6 sherd has biotite mica in addition to sand as tempering material. As with the sherds of Group 2, the Group 6 sherd is a medium to coarse tempered brownware with a black core and very smooth surfaces that exhibit a few polishing marks.

Group 7

The 25 sherds of this group make up 4% of the ceramics from Sites 33 and 34 and are similar to Alma Plain (Haury 1936). Group 7 sherds are of a fine sand-tempered brownware and have light gray cores and surfaces which range in color from light brown to reddish brown. The surfaces of these sherds are smoothed and occasionally show polishing marks like those of Groups 2 and 6.

Group 8

Sherds of Group 8 are identical to those of Group 7 except that Group 8 sherds have well-polished and lustrous surfaces, whereas Group 7 sherds are only smoothed and have few polishing marks. The 21 sherds of Group 8 account for 3% of the ceramics from Sites 33 and 34, and the single rim sherd is from a jar with an everted rim (Figure 35).

Group 9

Group 9 includes four sherds from Site 33. The single difference between Group 9 and Group 7 is in tempering material. Group 9 sherds are predominantly sand-tempered with some biotite mica as a noticeable inclusion in the paste, while Group 7 sherds are tempered only with sand.

Group 10

The 12 sherds of this group comprise 2% of the pottery from Site 33. They vary from the sherds of Group 8 in the presence of biotite mica in the paste of sherds of this group. Both groups 10 and 8 are, otherwise, sand-tempered. Groups 7, 8, 9, and 10 are very similar in being fine sand-tempered brownwares. Differences between these groups are found in the surface finish and in the presence of biotite mica inclusions. Groups 7 and 9 exhibit smoothed and occasionally-polished surfaces, and Groups 8 and 10 are well-polished and have lustrous surfaces. Groups 9 and 10 sherds show some biotite mica while Groups 7 and 8 sherds do not.

Group 11

Group 11 is represented by one sherd from Site 33. This sherd is similar to those of Group 8 with the exception that the Group 11 sherd has a thick, dark red slip and a dark gray core. This sherd is from a bowl, is a fine sand-tempered and red-slipped brownware, and has smoothed surfaces which show no polishing marks. This sherd compares favorably with San Francisco Red (Haury 1936).

Group 12

This group is known by one sherd from Site 33 which is a rim sherd from a bowl (Figure 35). This sherd is like that of Group 11 except that the red slip of the Group 12 sherd is more like a thin wash.

Group 13

Group 13 includes one bowl sherd from Site 33. Other than the presence of some biotite mica in the paste and a core that is not markedly different in color from the unslipped exterior surface, the Group 13 sherd is indistinguishable from that of Group 12. In addition to the above, the Group 13 sherd differs from the Group 11 sherd in having a thin red slip rather than a thick, dark red slip.

Group 14

This group is comprised of one plain corrugated brownware sherd from Site 33. The coils of this sherd have been rubbed over, and the core is only slightly darker than the surface which is light brown in color. This sherd also has a medium to coarse temper of sand.

Group 15

Group 15 differs from Group 14 only in the size of tempering material and includes one sherd from Site 33. Group 15 is a fine sand-tempered and plain corrugated brownware.

Group 16

Group 16 is an indented corrugated, brownware sherd from Site 33. This sherd has a medium to coarse sand temper, a light gray core, and a light brown surface color. The coils of this sherd have been rubbed over.

Group 17

Group 17 accounts for 3% of the ceramics from Site 33 and is comprised of 20 sherds of Mimbres Boldface Black-on-white pottery (Cosgrove 1932). Only bowls are represented (Figure 35), and the bowl interiors have a white slip which rarely extends beyond the rim to the outer surface. Design elements include solid triangles, wavy lines, and scrolls. There are no encircling, parallel lines below the rims of bowls, and designs are carried to the lips of vessels. Exterior surfaces range in color from brown to light gray, and all sherds have a fine sand temper. Surfaces are also well-polished and occasionally show polishing marks.

Group 18

This group includes only one sherd from Site 33 which is buff-colored and contains medium-sized temper of sand and dark igneous rock. The surface is well-polished and lustrous. Polishing marks are clearly visible, and the core is of the same color as the surface. This sherd is a fragment of a perforated disk which was approximately 5.3 cm in diameter. The center hole is about 0.8 in diameter, and both the center hole and outer edge of this disk have been ground to shape. Portions of both faces of this disk also show some abrasion.

Group 19

Group 19 is very much like Group 18 in surface and core color and surface finish. Sherds of Group 19 are not as well-polished as that of Group 18, but they do exhibit polishing marks. The temper of these sherds is coarse and composed of sand and crushed rock. The crushed rock is dark-colored and appears to be igneous in origin. The 10 sherds of Group 19 comprise 2% of the pottery from Site 33.

Group 20

Group 20 is made up of one sherd from Site 33 which is lustrous and highly polished. Polishing marks are numerous, and the surface color is uncertain because the sherd had been burned. The surface color appears to have been dark brown, but it may have been gray. The core is black, and the paste is heavily tempered with crushed rock. This tempering material appears to be of igneous origin.

Group 21

This group is similar to Group 17 in all attributes except that the sherds of Group 21 are not slipped and painted. The sherds of this group all belong to the same bowl which is unusual in having a broad rim that joins the lower portion of the side of the vessel at an angle (Figure 35). Seven sherds of this vessel were found at Site 33.

Group 22

Group 22 is an upper Rio Grande glazeware and is tempered with crushed rock. This group has a green glaze on a white slip and includes two sherds from Site 33 of Rio Grande Glaze F or 6 (Kidder and Shepard 1936; Mera 1933).

Group 23

This group is represented by one sherd of upper Rio Grande glazeware from Site 33. This sherd has a black glaze on a red slip and is tempered with crushed rock. Group 23 is classified as Rio Grande Glaze A or 1 (Kidder and Shepard 1936; Mera 1933).

Groups 1, 2, 3, 5, and 6 are closely related and are considered variants of El Paso Brown—the diagnostic ceramic type for the Mesilla phase. Group 1 is the dominant ceramic group at Sites 33 and 34, and this attests to the long and principally Mesilla phase occupations of Zone 2 at these sites (Chapter V). Groups 2 and 3 are also well-represented at Site 33, but only a few sherds of Group 3 were recovered from Site 34. A very smoothed and somewhat polished surface (an attribute of Group 2) does not appear to be a common attribute of what are otherwise identical sherds of Groups 1 and 2. Group 3, of course, includes weathered sherds of either Group 1 or 2. Whalen (1978; n.d.) suggests that sherds of El Paso Brown dating to about A.D. 800-1000 generally show a smoother surface finish than sherds of El Paso Brown which date prior to A.D. 800. Given the relatively small number of well-smoothed and somewhat polished sherds of Group 2 as compared to the less well finished Group 1 sherds, this could be taken as evidence for a considerable occupation of Sites 33 and 34 before A.D. 800. However, the profile of rim sherds contradicts this inference.

The profiles of rim sherds of Groups 1 and 2 are shown in Figure 35 and include examples both from the surface and excavation. With the exception of one direct and flattened rim of a bowl of Group 1, all rim profiles of Groups 1 and 2 are simple or direct with rounded lips. Whalen (1978; n.d.) associates the latter rim profiles with El Paso Brown dated between A.D. 800-1000 and notes that rims of the earlier variety of unsmoothed El Paso Brown are pinched or thinned near the lip. Thus, most of the rim profiles of Groups 1 and 2 are comparable to El Paso Brown which Whalen dates to A.D. 800-1000, while the surface finish of the relatively abundant Group 1 sherds is more like that of the El Paso Brown which Whalen dates before A.D. 800. Because of the small numbers and the weathered surfaces of the sherds from Sites 33 and 34, it is possible that the conflicting indications from the rim profiles and surface finish of Groups 1 and 2 are merely a reflection of the small sample of sherds from these sites and the mixing of ceramic materials of different ages. It is also possible that the ceramic chronology which Whalen has developed for the Hueco Bolson east of the Franklin Mountains does not apply to ceramic materials west of the Franklin Mountains and along the Rio Grande.

Groups 5 and 6 are of rare occurrence at Site 33 and were not found at Site 34. The rim profiles of Group 5 are comparable to those of Groups 1 and 2, and Groups 5 and 6 differ from Groups 1 and 2, respectively, in the presence of some biotite mica in the paste of Groups 5 and 6. The poor representation of Groups 5 and 6 at Sites 33 and 34 and the presence of biotite mica suggest that these groups may be of non-local manufacture. Sherds with biotite mica are of infrequent occurrence in the El Paso area (Lynn, Baskin, and Hudson 1975; O'Laughlin 1977b; 1979) but have been observed with greater frequency by the writer north of the project area along the Rio Grande and particularly near Hatch, New Mexico.

Groups 7 through 13 may represent a second class of ceramic groups which is characterized by fine sand-tempered brownwares or redwares. Groups 7 to 10 are similar to Alma Plain, and Groups 11 to 13 resemble San Francisco Red. Alma Plain and San Francisco Red have been considered intrusive pottery types to the El Paso area from west central New Mexico or possibly northern Mexico (Lehmer 1948). However, Sudar-Murphy and Laumbach (1976) have noted a frequent occurrence of fine-tempered brownwares similar to Alma Plain on the La Mesa surface west of the project area, and the writer has observed sites near Las Cruces, New Mexico, where the ceramic assemblage is made up almost entirely of ceramic materials similar to Alma Plain, San Francisco Red, and Alma Scored. Thus, Groups 7 through 13 may be indigenous to the Rio Grande Valley in or just above the project area and may not be intrusive at Sites 33 and 34. Although Alma Plain and San Francisco Red have a long temporal distribution, ceramic assemblages consisting only of Alma Plain, San Francisco Red, and Alma Scored are characteristic of sites before about A.D. 700-800 in west central New Mexico (Leblanc 1976; Wheat 1955). It is possible, therefore, that Groups 7 through 13 could be relatively more abundant in the project area before A.D. 700-800 and perhaps of greater importance than Groups 1-3, 5, and 6 of El Paso Brown for the earliest occupations with ceramics.

Groups 7 through 13 increase slightly, from 9.3% of the sherds from the surface of Site 33, to 10.5% of the sherds below Level 1 at Site 33. The small and nearly equal percentages of these groups for the surface and subsurface of Site 33 do not substantiate a supposition that they may be early and indigenous ceramics in the project area. However, these percentages are larger than those of similar ceramics previously recorded for a late Mesilla phase site in the project area (O'Laughlin 1977b) and Mesilla phase sites east of the Franklin Mountains in the Hueco Bolson (Lynn, Baskin, and Hudson 1975; O'Laughlin 1979). Future archeological investigations at Site 33 or in the project area hopefully will pursue the question of the temporal distribution of these ceramics.

Groups 14 through 17 and 21 are intrusive ceramics which date to the later part of the Mesilla phase and after about A.D. 700-800. These groups are largely restricted to the surface of Site 33, and those sherds of Groups 17 and 21 occurring beneath the surface are portions of the same vessels represented by sherds found on the surface of Site 33 and immediately below.

Groups 18 through 20 are intrusive ceramics which cannot be associated with named types and whose temporal distribution is not known. Sherds of these groups were found only on the surface of Site 33, and it is presumed that they date to the later part of the Mesilla phase or thereafter.

Groups 4, 22, and 23 include indigenous and intrusive pottery types of the Dona Ana or El Paso phases. Group 4 is composed primarily of sherds of El Paso Polychrome which is the dominant indigenous ceramic type of the El Paso phase (about A.D. 1200-1400). Group 4 also contains two sherds with one-color decoration which may date to the Dona Ana phase (about A.D. 1100-1200). Groups 22 and 23 are glazewares which are intrusive pottery types during the later part of the El Paso phase. Sherds of these groups were found principally on the surface of Site 33, and the few subsurface sherds of Group 4 came from an area where most of the Group 4 sherds occurred on the surface.

Site 34 has ceramic materials of only Groups 1, 3, 7, and 8 which suggests that the Zone 2 occupations at this site probably date before A.D. 700-800 and during the earlier part of the Mesilla phase. The two radiocarbon dates from Site 34 also support such a contention (Chapter V). Ceramic Group 17 is a common intrusive in sites occupied during the later part of the Mesilla phase in the El Paso area, and Group 4 is the dominant ware of the El Paso phase. Sherds of Groups 4 and 17 or other infrequently found sherds at Site 33 which date after about A.D. 700-800 were not found at Site 34. This also supports the supposition that this site was probably occupied before A.D. 700-800. However, sherds were few in number at Site 34, and it is possible that other later occupations may have occurred there.

The ceramic materials of Zone 2 at Site 33 indicate a long use of this site throughout the Mesilla phase, a possible occupation during the Dona Ana phase, and a limited use during the El Paso phase. This follows the radiocarbon dates for Zone 2 at Site 33 which range from 160 B.C., which is perhaps slightly before the Mesilla phase, to A.D. 1500, which is either the end of the El Paso phase or shortly afterwards.

Although it has been possible to suggest the temporal distribution of Zone 2 occupations at Sites 33 and 34 through an analysis of ceramic materials, it has not been possible to refine the local ceramic chronology. The ceramics from Site 34 are few in number and are restricted primarily to the weathered surfaces of this site. The shallow and weathered deposits of Zone 2 at Site 34 and the inability to provide good temporal control over the ceramic material (other than that suggested by the ceramics themselves) did not permit an evaluation of the local ceramic chronology. It is also unlikely that such pursuits would be possible with additional investigations of this site because of the few sherds that are likely to be recovered with additional excavation. Zone 2 of Site 33 has a high potential for refining the local ceramic chronology. Deposits of this zone are relatively thick in some areas and evidence a lengthy occupation during the Formative period. Unfortunately, the presently reported investigation of Site 33 was inadequate to obtain samples of ceramics associated with radiocarbon dates with which to evaluate the ceramic chronology proposed by Whalen (1977; 1978; n.d.). Sherds occurred in small numbers in the largely undifferentiated deposits of Zone 2 at Site 33, and it was not possible to correlate by vertical positioning the few sherds from widely separated excavation units with each other or with radiocarbon dates from some of these same units of excavation. This is the reason for the rather gross division of ceramic materials from Zone 2 at Site 33 into surface, Level 1, and below Level 1 in Table 12.

As previously mentioned, the low density of ceramics on the surfaces and in subsurface excavations at Sites 33 and 34 is suggestive of ephemeral and intermittent occupations of these sites over a considerable period of time during the Formative period. Although sherds are few in number, they are not randomly distributed or at least not so on the surfaces of these sites. Small occupations during the El Paso phase are noted on the surface of Site 33 where sherds of Groups 4, 22, and 23 representing three or fewer vessels were found close together in three small areas. The two Group 4 sherds which may date to the Dona Ana phase were also located near one another on Site 33 and appear to be from the same vessel. Ceramic Groups 17 and 21 which date to the later part of the Mesilla phase were also not widely distributed but rather were located in relatively few small areas of Site 33. The same is also true of Group 19 at Site 33 and Group 7 at Site 34. Usually only one and never more than two vessels were indicated for any of the localized areas of Group 7, 17, 19, and 21 sherds. It was more difficult to identify individual vessels of undecorated brownwares such as Groups 1, 2, 4, and 8, but the pattern of few vessels being represented by sherds scattered over small areas also seems to hold for these groups. Thus, the spatial distribution of some of the ceramic groups and individual vessels implies that the Formative period occupations of the sites were generally by small groups using few vessels. It can also be inferred that the occupations were of short duration, otherwise the discrete spatial distributions of ceramic groups and vessels would probably not have been as apparent as they seem.

In addition to the suggested non-random distribution of ceramic groups and sherds from individual vessels, it was observed during the collection of artifacts from the surfaces of these sites that ceramic materials tended to be most common near fire-cracked rock features. The association of sherds, and notably of worked sherds, with fire-cracked rock is demonstrated in Chapter X, and it is only mentioned here that vessels and worked sherds were apparently used in conjunction with activities involving the use of fire-cracked rock features which are assumed to have been facilities for processing upland leaf succulents.

The attributes of worked sherds are given in Table 13. These are mostly sherds with edges and corners that have been rounded from use (Figure 36a, right). The complete or nearly complete specimens range from 12.0 to 15.6 cm in length and 5.5 to 9.5 cm in width. There is also one ovoid sherd which has been partially ground into shape and shows evidence of the abrasion of edges from use (Figure 36a, left). This latter specimen measures 16.0 by 9.8 cm in size. The association of worked sherds with fire-cracked rock features is interpreted as evidence that the abraded edges and corners are the result of their having been used in the excavation of pits for fire-cracked rock features, in maintaining these features, or in some other activity associated with the processing of plant foods with these features. Similar associations of worked sherds with fire-cracked rock features have been noted by Hard (n.d.), O'Laughlin (1979), and O'Laughlin and Greiser (1973).

Besides the above mentioned worked sherds and the previously mentioned perforated disk of Group 18, the only other sherds exhibiting modification are five sherds from Site 33 which have small holes drilled from both sides of the sherds near one edge. These modifications were apparently for bindings that were used to mend cracks in vessels.

Ground and Pecked Stone

Twenty-seven ground and pecked stone items which include manos, metates, a palette, pestles, and anvils were found on the surface of Sites 33 and 34 or in excavations at Site 33. The attributes of these implements are given in Table 14.

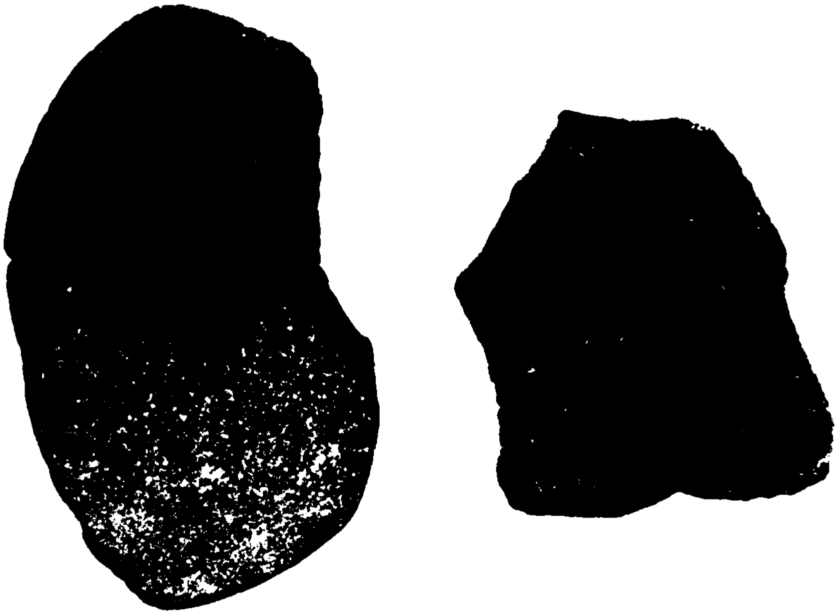
The materials used in manos and metates are sandstone, quartzite, and limestone. A distinct preference is noted for sandstone for use in manos and metates. Sandstone occurs in small amounts in the gravels of terraces and ridges near Sites 33 and 34 but is not of the type used at Sites 33 and 34. In addition, the sandstone near Sites 33 and 34 is not well-suited for grinding implements because of its small size and very friable and unconsolidated nature. The sandstone used in grinding implements at Sites 33 and 34 was most likely obtained in the Franklin Mountains east of the project area. Although quartzite and limestone are abundant in the gravels of terraces and ridges adjacent to Sites 33 and 34, they were not used as frequently as sandstone for grinding implements. In addition, although limestone is much more abundant in the gravels than quartzite, quartzite implements outnumber those of limestone. Rhyolite, which is almost as common as limestone in the gravels near Sites 33 and 34, was apparently not used for grinding implements. The preference of sandstone and quartzite over the locally abundant limestone and rhyolite is certainly related to the ease of manufacture and suitability of these materials for use as

TABLE 13

ATTRIBUTES OF WORKED SHERDS FROM SITES 33 AND 34

No. Items	Condition	Outline	L	W	T	Comments on Edges
1	Complete	Ovoid	16.0	9.8	3-6	Edges and corners rounded from use and partially ground to shape
1	Complete	Sub-rectangular	12.0	9.5	5-8	Edges and corners rounded from use
1	Complete	Irregular ovoid	15.6	5.5	4-5	Edges and corners rounded from use
1	Nearly complete	Trapezoidal	10.0	7.0 (est.)	5-7	Edges and corners rounded from use
24	Fragment	-	1.1-3.6*	-	3-7	Edge rounded from use
17	Fragment	-	3.1-9.2*	-	2-7	Edges and corners rounded from use
2	Fragment	-	2.1,2.6	-	5,6	Edge beveled from use

L = Length in cm
W = Width in cm
T = Range in thickness in mm
* = Range of length of utilized edge only



a.

b.

Figure 36. Worked sherds, pestle, and manos. a. Worked sherds. Length of left specimen is 16.0 cm. b. Quartzite pestle (left), quartzite manos (upper), and sandstone manos (lower). Length of pestle is 14.5 cm.

TABLE 14

ATTRIBUTES OF PECKED AND GROUND STONE

Period or Phase	Artifact Type Name	Material	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	Technique of Manufacture	Outline	Cross-Section	No.of Grinding Surfaces	Shape of Grinding Surfaces	Parallel Striations	Pecked and Unground Surface	Battered End
33N-AE	Metate	Sandstone	5.4+	3.4+	2.0+	153	-	-	-	1	Concave	-	-	-
"	Pestle(?)	Quartzite	14.5	3.7-8.5	-	1267	Unaltered Cobble	Elongated Oval	Round	1	-	-	-	X
"	Mano	Sandstone	11.7	10.8	1.8	414	Ground	Rectangular	Triangular	2	Beveled & Concave	X	-	-
33N-AME	Mano	Sandstone	4.6+	2.8+	2.5	36	Pecked & Ground	-	Plano-convex	1	Slightly Convex	X	-	-
"	Metate	Sandstone	5.2+	2.8+	2.0	52	Pecked & Ground	-	Concave-Plano	1	Concave	-	-	-
33N-AMS	Palette	Quartzite	14.4+	12.8+	1.5	431	Chipped Edge	-	Rectangular	1	Plano	-	-	-
"	Mano	Quartzite	10.5	9.5	5.4	732	Ground	Subcircular	Subrectangular	2	Plano & Convex	X	-	-
"	Metate	Sandstone	7.4+	6.1+	2.9+	136	Pecked & Ground	-	Concave-Convex	1	Concave	X	-	-
"	Mano/Metate	Sandstone	7.4+	7.1+	3.5	227	Pecked & Ground	Subcircular?	Concave-Convex	2	Concave & Convex	-	-	-
"	Mano	Quartzite	10.4	8.6	5.8	678	Pecked & Ground	Oval	Triangular	2	Slightly Convex	X	-	-
"	Pestle	Biotite Schist	8.5+	6.6	2.7	227	Ground	-	Eliptical	-	-	-	-	-
33N-ME	Mano or Metate	Sandstone	3.2+	2.5+	0.5+	6	Pecked & Ground	-	-	1	Plano	-	-	-
33S-ME	Mano	Quartzite	9.0	8.0	4.0	454	Chipped Edges	Subcircular	Rectangular	1	Plano	X	-	-
33N-MS	Mano	Sandstone	14.3	10.2	3.4	632	Pecked & Ground	Oval	Convex-Convex	1	Convex	X	-	-
"	Mano	Sandstone	10.5+	10.3	4.5	443	Pecked & Ground	Oval?	Plano-Convex	1	Plano	-	-	-
"	Mano	Sandstone	7.7+	5.0+	3.5	192	Pecked & Ground	-	Plano-Convex	1	Plano	-	-	-
"	Mano(?)	Quartzite	10.3	8.4	5.9	1104	Unaltered Cobble	Sub-rectangular	Rectangular	1	Convex	-	-	-
"	Metate	Quartzite	9.1+	6.9+	3.3	384	Unaltered Slab	-	Rectangular	1	Plano	-	-	-
"	Metate	Limestone	9.0+	7.0+	5.1	446	-	-	Concave-Convex	1	Concave	-	-	-
"	Mano(?)	Limestone	8.1+	5.1+	3.4	139	Unaltered Cobble(?)	-	-	1	Convex	X?	-	-
"	Mano	Sandstone	10.0+	7.8+	2.5	252	Pecked & Ground	-	Plano-Convex	1	Plano	X	-	-
"	Metate	Sandstone	21.0+	10.2+	7.5	1957	Pecked & Ground	-	Plano-Convex	1	Plano	-	-	-
"	Anvil(?)	Limestone	26.2	15.4	3.8	2993	Unaltered Slab	Sub-rectangular	Rectangular	-	-	-	X	-
33S-MS	Anvil(?)	Limestone	13.8	9.9	4.2	1038	Unaltered Cobble	Sub-rectangular	Rectangular	-	-	-	X	-
"	Metate	Sandstone	11.5+	11.7+	9.2	1573	Pecked & Ground	-	Plano-Convex	1	Plano	X	-	-
34-MS	Mano	Sandstone	13.7	10.6	2.0	397	Pecked & Ground	Sub-rectangular	Convex-Convex	1	Convex	-	-	-
33N-MPS	Mano	Sandstone	12.9	10.6	3.7	699	Pecked & Ground	Sub-rectangular	Convex-Convex	1	Convex	X	-	-

33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic period
AM = Mixed Archaic period and Mesilla phase
M = Mesilla phase
MP = Mixed Mesilla, Dona Ana, and El Paso phases
\+ = Incomplete

grinding implements. Similar preferences for sandstone and quartzite over locally abundant materials have been noted for other sites in the vicinity of the Franklin Mountains (O'Laughlin 1977b; 1979).

With the exception of two unaltered stones, manos and metates were shaped by grinding and pecking. Grinding surfaces were also rejuvenated by pecking, and parallel striations on many of the grinding surfaces suggest that most uses involved a reciprocal (as opposed to a rotary) motion of manos on metates. The finding of mostly small fragments of metates at Site 33 suggests that metates may have been recycled into manos or perhaps hearth stones after they had lost their usefulness as metates, but there is no direct evidence for this.

Little is known of the temporal distribution of forms of manos and metates in the El Paso area although they probably vary temporally and with the nature of activities being performed. Small and often circular manos and basin or flat metates seem to be earlier or more common in ephemerally occupied sites for specialized activities, and two-hand manos and trough or open-ended basin metates seem to be characteristic of late Formative period sites of semi-permanent or permanent occupations. The fragments of metates at Site 33 are too few in number and too small to allow certainty as to their temporal distribution or form, but examples of basin and flat metates are noted from this site. The Archaic period or mixed Archaic period and Mesilla phase manos at Sites 33 and 34 are generally smaller, lighter, and sub-circular to oval in shape (Figure 36, upper right) while those of the Mesilla phase or mixed Mesilla, Dona Ana, and El Paso phases tend to be larger, heavier, and sub-rectangular in shape (Figure 36, lower right). It is not known, however, whether this pattern relates to stylistic or functional differences between Archaic and Formative period manos at Sites 33 and 34.

There are two pestles at Site 33. One comes from mixed Archaic period and Mesilla phase materials and is elliptical in cross-section and made of biotite schist. The other is of less certain identification but it is a tapered quartzite rod which exhibits a possible battered or crushed surface at the larger end (Figure 36, left). This latter specimen was found near House 2 of the Archaic period occupation at Site 33. A third pestle was observed by the writer on the surface of Site 33 but was removed with the cutting of the 1978 arroyo across Site 33 North before this project had begun. This pestle was approximately 30 cm long, 8 cm in diameter, and made of limestone. As with manos and metates, the temporal distribution of different types of pestles is not known in the El Paso area, but they are documented for Formative period sites of semi-permanent or permanent occupation (Lehmer 1948) and for sites in mountainous areas where bedrock mortars occur (Green 1971).

In addition to manos, metates, and pestles, there are also one quartzite palette and two limestone anvils at Site 33. The palette is a thin slab of quartzite which has been chipped to a rectangular form and shows abrasion on one surface. The two anvils consist of unaltered limestone rocks each of which has one flat surface that exhibits pecking or battering marks. The use of the palette was probably comparable to that of metates, but the use of the presumed anvils is unknown.

Grinding implements (including the palette and pestles) are few in number and make up 4.8 to 12.5% of the combined total of chipped stone tools and grinding implements and 0.4 to 0.8% of the combined total of grinding implements and chipped stone tools and debitage from the Archaic and Formative period occupations at Sites 33 and 34.

The low percentage of grinding implements from the Zone 2 Formative period occupations at Sites 33 and 34 is consistent with the proposition that these occupations were ephemeral and oriented toward the processing of upland leaf succulents. The presence of grinding implements suggests that some grinding of seeds or other plant parts did occur at these sites, but the low percentage of grinding implements implies that these activities were of little importance. Comparably low percentages of grinding implements are noted for other sites in the El Paso area where the processing of upland leaf succulents is presumed to have been the most important activity, and higher percentages of grinding implements are noted for seasonally occupied sites where the processing of seeds is thought to have been an important activity (O'Laughlin 1979).

The low percentage of grinding implements suggested for the Arachic period occupation at Site 33 is comparable to that for the Formative period occupations at Sites 33 and 34, but the rationale for the low percentage is somewhat different. It has been suggested that the Zone 4 Archaic period occupation(s) at Site 33 was of longer duration, though probably intermittent, than that for the Zone 2 Formative period occupations at Sites 33 and 34. The low percentage of grinding implements for the Archaic period occupation is interpreted as probably resulting from the curation of these tools and not from the relative unimportance of activities involving these tools. That is, tools are apt to be curated and reused at sites of longer occupation than at those of ephemeral occupation where they may be cached and forgotten or abandoned before they had lost all usefulness. Thus, most stone tools can be expected to occur as a smaller percentage of the total chipped and ground stone assemblage (including manufacturing debris) at longer occupied sites than at ephemerally occupied sites.

Chipped stone tools and grinding implements make up a larger percentage of the total chipped stone and ground stone assemblage for the Formative period occupations at Sites 33 and 34 than they do for the Archaic period occupation at Sites 33 (Chapter X), and this follows the suggested longer duration of the Archaic period occupation as compared to the inferred shorter occupations for the Formative period at these sites. However, the relative percentages of chipped stone tools and grinding implements differ for the occupations with the highest percentage of grinding implements (12.5%) occurring in the excavated materials of the Archaic period. This pattern of chipped stone tools and grinding implements comprising a small percentage of the chipped stone and ground stone assemblage and of grinding implements being a substantial percentage of the combined total of grinding implements and chipped stone tools has been documented for other, non-ephemerally occupied sites of the Formative period in the El Paso area where activities are visualized as having been general in nature (O'Laughlin 1979; n.d. b). However, grinding implements may comprise 50% or more of the combined total of grinding implements and chipped stone tools in these other sites. The lower percentage of grinding implements for the Archaic period occupation at Site 33 may simply reflect the small number of grinding implements and chipped stone tools found in the limited excavation of Zone 4 deposits and not necessarily the importance of activities involving grinding implements. It should be noted, however, that similar percentages of grinding implements and chipped stone tools were found at an Archaic period site near Las Cruces, New Mexico, where occupations may also have been of some duration (Greiser 1973). Thus, the processing of some plant foods (presumably seeds) may not have been as important for the Archaic period as for the later Formative period when corn is of some importance. Obviously, a larger sample of chipped stone tools and grinding implements from the Archaic period occupation is needed to accurately delimit the importance of activities involving the use of grinding implements.

Hammerstones

A total of 10 hammerstones of quartzite and rhyolite was found at Site 33 (Table 15). These are mostly round or oval stones of some 5.0 to 10.5 cm in maximum dimension. These specimens exhibit substantial battering while other hammerstones which were not used as extensively may have gone unnoticed. Limestone does not appear to have been used for hammerstones even though it is abundant near Sites 33 and 34. However, the surfaces of limestone erode quickly when exposed, and some hammerstones of limestone may not have been recognized for this reason. Limestone is a much softer rock than rhyolite or quartzite and would probably not have been used as often as these other materials for hammerstones. Hammerstones may have been used as percussion implements in working chipped stone or in shaping and rejuvenating the surfaces of grinding implements.

Ornaments

Only two ornaments were found, and both of these are from Site 33. One is a disk bead of shell which is approximately 4 mm in diameter. The other is an *Olivella* sp. bead made by grinding down the spire. The disk bead came from the surface of Zone 2 deposits, and the olivella shell bead came from deposits which could not be placed for certain in either Zone 2 or Zone 4. Shell jewelry is neither a common nor frequent attribute of prehistoric sites in the El Paso area and probably functioned within the realm of personal adornment rather than as a status symbol (Whalen 1977; 1978).

TABLE 15

ATTRIBUTES OF HAMMERSTONES

Period or Phase	Material	Maximum Dimension(cm)	Weight(g)	Shape	Battering
33N-AME	Quartzite	6.2	153	Round	Opposite ends
33N-AMS	Rhyolite	7.0	301	Round	80% of surface
33N-MS	Rhyolite	8.5	647	Round	100% of circling ridge
"	Rhyolite	8.8	461	Thick-lens	75% of circling ridge
"	Rhyolite	6.5	328	Subround	100% of surface
"	Quartzite	6.0	121	Oval	Opposite ends
"	Quartzite	5.0	70	Thin-lens	100% of circling ridge
33S-MS	Rhyolite	7.5	454	Round	80% of surface
"	Rhyolite	10.5	788	Oval	75% of circling ridge
33N-MPS	Quartzite	7.6	219	Triangular	Three corners

33N = Site 33 North
33S = Site 33 South
E = Excavation
S = Surface
AM = Mixed Archaic period and Mesilla phase
M = Mesilla phase
MP = Mixed Mesilla, Dona Ana, and El Paso phases

CHAPTER X

CHIPPED STONE AND SPATIAL ANALYSES

The analysis of chipped stone materials recovered from Sites 33 and 34 is the focus of this chapter, and discussions of chipped stone artifacts center on three topics which help characterize and discriminate Archaic and Formative period occupations at these sites: raw material selection, reduction technology, and tool function. Description and interpretation of chipped stone assemblages at Sites 33 and 34 are followed in the closing section of this chapter by an analysis of the spatial distribution of chipped stone, other artifacts, and fire-cracked rock on the surfaces of these sites and a brief consideration of the spatial distribution of chipped stone and ground stone artifacts from these sites and other selected sites of the El Paso area. These analyses of the spatial distributions of chipped stone and ground stone artifacts within and between sites provide some insight into the nature of Archaic and Formative period occupations at Sites 33 and 34 and regional patterns in the relative importance of chipped stone tools and ground stone implements. The attribute analysis of chipped stone artifacts and spatial analyses of chipped stone and ground stone assemblages are oriented principally toward an assessment of the duration of Archaic and Formative period occupations at Sites 33 and 34 and the roles these occupations played in prehistoric adaptive strategies.

Chipped Stone

Chipped stone is the most common category of artifacts recovered from Sites 33 and 34 and encompasses 4,594 items. The surface density of chipped stone materials is relatively light and only 0.08 and 0.01 pieces of chipped stone per square meter were found at Sites 33 and 34 respectively. Subsurface densities, however, vary considerably from 56.73 pieces of chipped stone per cubic meter of soil at Site 33 to 0.29 pieces of chipped stone per cubic meter of soil at Site 34. The surface densities of chipped stone are quite expectable for the inferred ephemeral occupations of the Formative period at Sites 33 and 34, and the relatively high density of chipped stone for subsurface deposits at Site 33 is largely attributable to the Zone 4 Archaic period occupations which are visualized as having been more intensive than those of the Zone 2 Formative period. No chipped stone artifacts were recovered from Site 29 although one flake had been observed in a previous survey (Gerald n.d. d).

In this section, analyses of chipped stone artifacts are directed toward delimiting the criteria for the selection of raw materials, the processes of chipped stone tool production, and the functional attributes of chipped stone tools. Before proceeding, a few definitions are in order and will facilitate later discussions of the above interests. These definitions delimit reduction categories, are principally technological rather than functional in nature, and provide one of many ways of partitioning the variability in chipped stone artifacts.

(1) Cores. A core is any piece of parent material from which smaller pieces are detached through the application of force to some portion of the larger piece. The smaller pieces are termed flakes or flake debitage. Materials used prehistorically in this area occur principally as weathered nodules or pebbles, and quarried materials are practically nonexistent (Lynn, Baskin, and Hudson 1975; O'Laughlin 1977b). Thus, unaltered pebbles or nodules, partially worked cores, and the dorsal surfaces of the first flakes removed from a core have a cortex which may be of a different color or texture than the rest of the parent material because of weathering through geologic time.

(2) Core Tools or Utilized Cores. These are cores which exhibit wear patterns and occasionally marginal retouch along one or more edges. Wear patterns are similar to those of utilized flakes, and retouching is comparable to that of marginally retouched flakes.

(3) Flake Debitage or Unutilized Flakes. These are pieces of material removed from cores or other flakes. They may or may not have cortex on their dorsal surfaces, and a complete specimen is characterized by the presence of a striking platform, and a bulb of percussion and conchoidal fracture patterns on its ventral surface. Those pieces without striking platforms and bulbs of percussion are easily dis-

tinguished from cores by the conchoidal fracture patterns on their ventral surfaces and their overall thinness and size.

(4) Non-Diagnostic Schatter. These are angular pieces of stone which exhibit no ventral face and bulb of percussion like that of flake debitage and no striking platform as would be found on flake debitage or cores. They may, however, show occasional conchoidal fracturing patterns.

(5) Utilized Flakes. These are flakes which evidence use along one or more edges. Utilized flakes do not exhibit retouch, and use is seen as either macroscopic or microscopic wear patterns in the form of small feather flakes, small step fractures, and/or edge rounding and polish.

(6) Marginally Retouched Flakes. These are flakes whose margins have been modified by intentional retouch on one or both faces. Presumably, edges have been modified to produce edge forms and angles for specific purposes. Retouch refers to the process of detaching small flakes from an edge, and utilization is noted by wear patterns similar to those seen on utilized flakes.

(7) Bifaces. These are flakes or cores that have both faces extensively modified by retouch. Twenty-eight percent of this category is classified by form as projectile points for the arming of spears or arrows.

Raw Material Selection

Whalen and Thompson (n.d.) have noted a greater variety and generally a finer texture of chipped stone materials for sites of the Mesilla phase as opposed to sites of the El Paso phase in the El Paso area. They interpret this pattern as evidence of a greater expenditure of energy on the procurement of chipped stone materials during the Mesilla phase. However, Whalen and Thompson fail to recognize the probability that the procurement of chipped stone materials was incorporated into schedules of other activities and that a greater variety of materials does not necessarily imply a greater expenditure of energy for their procurement. That is, populations for most of the prehistoric era have been visualized as highly mobile and moving about the landscape in response to seasonal and spatial variability in resources (O'Laughlin 1979). Thus, the procurement of raw materials for chipped stone tools could be incorporated easily into the mobility patterns of these groups. Only during the El Paso phase is there any evidence of semisedentary or sedentary populations, and the procurement of raw materials for chipped stone tools during that phase may have required an expenditure of energy in an activity that may not have correlated with others. Therefore, an opposite conclusion to that of Whalen and Thompson can be reasoned for the pattern of variety in chipped stone materials for the Mesilla and El Paso phases.

Populations during the Archaic period are generally visualized as having been highly mobile, and there is some evidence of a decrease in mobility through the Mesilla phase and into the El Paso phase (Whalen 1977; 1978; n.d.). If the variety of chipped stone materials varies with the mobility of populations in the El Paso area, then it would be expected that the variety of chipped stone materials would decrease from the Archaic period occupation at Site 33 to those of the later Formative period at Sites 33 and 34. In an attempt to evaluate this proposition, a random selection of 1,376 (30% of the total) chipped stone artifacts including tools and debitage was made, and the rock type variations in color, texture, and inclusions were noted. Color designations follow those of Smithe (1975). A total of 39 varieties of eight different rock types was recorded; they are described in Table 16. The distribution of these varieties of rock types for the various occupations of Sites 33 and 34 are shown in Table 17 where it is noted that the variety of materials varies directly with the size of the sample. In addition, it is also noted that varieties of rock types representing 5% or more of the materials for any sample do not vary greatly between any of the samples and that the most obvious differences can be attributed to the small size of some of the samples. Thus, the supposition that the variety of chipped stone materials varies temporally and with mobility is not substantiated by the findings at Sites 33 and 34.

The increase in the variety of chipped stone materials with sample size at Sites 33 and 34 is attributed to the abundance and variety of these materials in the gravels of the terraces and ridges adjacent to Sites 33 and 34. All of these rock types and most of the varieties of rock types were noted in these gravels, particularly those comprising 5% or more of the samples. Thus, the variety of chipped stone materials is a reflection of their local availability. It is thought that sites more distant from resource areas would provide more information on the possible correlation of variety of chipped stone materials with mobility patterns than would sites near resource areas such as Sites 33 and 34.

The above consideration of the temporal distribution of varieties of rock types at Sites 33 and 34 was extended to a study of materials represented in reduction categories of all chipped stone artifacts recovered from these sites. Reduction categories have been defined at the beginning of this chapter, 'ABLE 16

DESCRIPTION OF MATERI··LS USEI FOR CHIPPED STONE

Material	Number	Description
Obsidian	1	Light to blackish gray, transparent or translucent obsidian
"	2	Blackish gray, opaque obsidian
Chert	1	Ranges from a blocky blackish gray chert with fissures to a banded light gray and light brown chert with a thick buff colored cortex. Both the blackish gray chert and the banded form can occur together in the same nodule
"	2	Ranges from hazel to maroon or red in color, often banded chert. Coarse textured with a dull luster
"	3	Banded amber and light gray colored chert
"	4	Translucent to white chalcedony. Often with dendritic or mossy black inclusions
"	5	Coarse textured, cream colored, and nearly opaque chalcedony
"	6	Cream to buff-yellow colored chert
"	7	Salmon to cinnamon colored chert
"	8	Netted red and light gray colored chert with a waxy luster
"	9	Banded grayish olive, maroon, and cream chert
"	10	Banded scarlet, medium gray, and brown chert
"	11	Ranges from maroon to red chert. Similar to number 2 but finer textured and more lustrous
"	12	Brown to light gray petrified wood
"	13	White to ivory chert
"	14	Light gray chert with a waxy luster
"	15	Smoke gray chert with small dark colored inclusions
"	16	Mottled light and dark gray colored chert

TABLE 16--Continued

Material	Number	Description
Chert	17	Coarse textured, light gray chert
"	18	Coarse textured, salmon colored chert
"	19	Mottled buff and medium gray chert
"	20	Mottled olive-brown, medium gray, and russet chert
"	21	Light brown silicified sandstone (?)
"	22	Grayish brown chert (possibly a shale)
Limestone	1	Light gray to blackish gray limestone
"	2	Grayish olive limestone
Rhyolite	1	Blocky brown to reddish brown rhyolite with numerous phenocrysts. Very coarse textured
"	2	Brown to chestnut, fine grained rhyolite with few phenocrysts
"	3	Medium gray, fine textured rhyolite with numerous quartz grains
Quartzite	1	Medium gray to blackish gray quartzite with a fine to medium texture
"	2	Cinnamon to brown colored, medium to coarse textured quartzite
"	3	Light gray quartzite with a medium to coarse texture
"	4	Cream to salmon colored quartzite with a coarse texture
"	5	Chestnut to cinnamon-brown colored quartzite with a fine texture
"	6	Grayish olive, fine textured quartzite
"	7	Mottled light gray and cinnamon, coarse textured quartzite
Sandstone	1	Reddish brown, fine grained sandstone
Quartz	1	Clear to milky white quartz
Granite	1	Coarse grained, mottled or speckled buff to light gray (includes some andesite)

TABLE 17

DISTRIBUTION OF MATERIALS USED FOR CHIPPED STONE

Material	No.	33 AE	33N AME	33N ME	33S ME	33N MS	34 ME&S	33N MPE	Total	Percent
Obsidian	1	4	5	1	-	4*	-	-	14	1.02
	2	-	2	2	-	4*	-	-	8	0.58
Chert	1	45*	25*	64*	3	10*	5*	15*	167	12.14
	2	15	8	15	6*	3	9*	7*	63	4.58
	3	3	7	10	-	1	1	4*	26	1.89
	4	57*	32*	42*	3	8*	5*	4*	151	10.97
	5	19	6	10	6*	2	1	2	46	3.34
	6	5	2	4	-	-	4	-	15	1.09
	7	3	2	5	-	-	-	-	10	0.73
	8	1	3	2	1	-	1	-	8	0.58
	9	6	-	2	-	-	3	1	12	0.87
	10	-	-	1	-	-	-	-	1	0.07
	11	14	8	18	5*	2	6*	1	54	3.92
	12	1	1	3	-	-	-	-	5	0.36
	13	-	2	1	-	-	-	-	3	0.22
	14	-	-	1	-	-	-	-	1	0.07
	15	4	6	3	-	-	-	2	15	1.09
	16	2	1	4	-	-	-	1	8	0.58
	17	3	1	3	-	-	-	2	9	0.65
	18	1	-	-	1	-	-	-	2	0.15
	19	17	11	17	3	4*	4	1	57	4.14
	20	12	3	6	-	1	-	-	22	1.60
	21	2	3	2	1	1	1	-	10	0.73
	22	1	-	-	-	-	-	-	1	0.07
Limestone	1	39*	37*	63*	10*	9*	10*	17*	185	13.44
	2	1	-	1	-	-	-	-	2	0.15
Rhyolite	1	50*	32*	77*	21*	18*	25*	7*	230	16.72
	2	6	9	17	6*	2	1	5*	46	3.34
	3	1	-	1	1	-	-	-	3	0.22
Quartzite	1	30*	11	13	6*	4*	4	2	70	5.09
	2	18	1	8	-	1	5*	2	35	2.54
	3	8	4	24*	3	-	2	-	41	2.98
	4	1	2	1	-	-	1	-	5	0.36
	5	14	7	-	-	-	-	1	22	1.60
	6	1	2	1	-	-	-	-	4	0.29
	7	1	-	1	1	2	5*	-	10	0.73
Sandstone	1	-	1	2	-	2	1	-	6	0.44
Quartz	1	-	-	2	1	-	-	-	3	0.22
Granite	1	-	1	2	-	1	1	1	6	0.44
Total		385	235	429	78	79	95	75	1376	100.00
No. of Materials Represented		32	30	36	17	19	21	18	39	-

33 = Site 33 North and South
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavated materials
S = Surface materials
A = Archaic period

AM = Mixed Archaic period and Mesilla phase
M = Mesilla phase
M = Mixed Mesilla, Dona Ana, and El Paso Phases
* = 5% or more of period or phase materials

and the distribution of chipped stone items among reduction categories for Sites 33 and 34 is given in Table 18. The principal interest here is whether some rock types were preferred over others for chipped stone tools. This involves considerations of the relative local abundance of raw materials, how easily the different materials are worked, and the qualities of the different materials that make some more applicable for certain kinds of tools than others. These attributes of rock types represented in chipped stone artifacts at Sites 33 and 34 are described below and followed by a discussion of the relative importance of rock types for the reduction categories of chipped stone artifacts found at Sites 33 and 34.

Extremely small amounts of sandstone, granite, and quartz are represented in the chipped stone artifacts at Sites 33 and 34, and these materials are rare in the gravels near these sites. A total of 45 chipped stone artifacts of sandstone, granite, and quartz was found at Sites 33 and 34, and artifacts of each of these materials account for less than 1% of the total number of pieces of chipped stone from these sites. Therefore, these materials will not be considered further in this section. The more common materials represented in the artifacts at these sites and generally in the gravels near these sites are limestone, rhyolite, quartzite, chert, and obsidian.

Limestone is the most abundant rock in the gravels near Sites 33 and 34 and occurs as small to large rocks with a maximum diamension of 5 to 20 cm and an outer cortex. Limestone flakes rather easily, but it is very difficult to thin flakes or cores by percussion or pressure flaking without producing unmanageable hinge fractures. The edges of flakes and cores also wear quickly.

Rhyolite also occurs as small and large rocks with a maximum dimension of 5 to 20 cm but is not as abundant as limestone in the gravels near Sites 33 and 34. Rhyolite varies from a fine-textured stone exhibiting conchoidal fracturing to a coarse stone which tends to fracture or shatter into irregular blocks.

Quartzite is much less abundant than limestone and rhyolite in the gravels near Sites 33 and 34 and occurs as nodules which rarely exceed 10 cm in diameter. Quartzite varies from fine to coarse grain, has a distinctive cortex, generally does not exhibit a good conchoidal fracture, and does not keep an edge well.

Cherts, as used here, include all silicaceous cryptocrystalline stones and include agate, chert, jasper, chalcedony, petrified wood, and silicified sandstone. Cherts are not particularly abundant in the gravels near Sites 33 and 34, but they may be nearly as abundant as quartzite. Cherts occur in nodular or tabular form with a cortex and generally do not exceed 8 cm in maximum dimension. Cherts exhibit a good conchoidal fracture, are easily worked, and keep an edge fairly well.

The last material to be considered is obsidian which is of rare occurrence in the gravels near Sites 33 and 34. Obsidian occurs in small nodules less than 5 cm in size with a distinctive cortex. Obsidian exhibits a very good conchoidal fracture, is easily worked, but does not keep a cutting edge as long as chert.

The distribution of the above common materials for reduction categories and the various occupations at Sites 33 and 34 are given in Table 19, and all chipped stone items from Sites 33 and 34 are enumerated in Table 19 with the exception of the few artifacts (45) of sandstone, granite, and quartz. The relative abundance of materials represented in the chipped stone artifacts does not follow their relative abundance in the gravels near Sites 33 and 34. Cherts are far more common in the artifacts of these sites than they are in nearby gravels. Some preference is also noted for rhyolite over limestone in the artifacts of these sites, while rhyolite is not as common as limestone in nearby gravels. Quartzite, which is not as common as limestone or rhyolite in local gravels, is as well represented as limestone in the lithic samples from Sites 33 and 34. Only small amounts of obsidian were found at Site 33, and this follows its rare occurrence in gravels adjacent to this site.

The prevalence of cherts in the chipped stone artifacts at Sites 33 and 34 follows the suggested greater ease of reduction and generally sharper and more durable edges of cherts than of rhyolite, limestone, or quartzite. Although obsidian has many of the desirable characteristics of cherts, its rare occurrence in the area precludes any extensive use of this material.

In general, cherts are relatively more common and rhyolite and limestone are less common in samples containing Archaic period artifacts than in those consisting of Formative period artifacts of the Mesilla, Dona Ana, and El Paso phases. This reflects the relatively greater number of small flake tools as compared to larger flake or core tools for the Archaic period as compared to the Formative period. As noted in Table 19, utilized flakes, marginally retouched flakes, and projectile points and bifaces are made principally from cherts, while utilized cores are nearly equally represented among cherts, limestone, rhyolite, and quartzite. Cherts occur as small nodules which are most often smaller in size than those of limestone, rhyolite, or quartzite. Thus, tools of chert are often smaller than tools of these other materials. The Archaic period

TABLE 18

DISTRIBUTION OF CHIPPED STONE ITEMS AMONG REDUCTION CATEGORIES FOR SITES 33 AND 34

	33-AE		33N-AME&S		33N-ME&S		33S-ME&S		34-ME&S		33-MPE&S		Total	Percent of Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Unutilized Cores	7	1.7	30	2.2	87	3.8	15	5.0	6	5.2	8	5.4	153	3.3
Utilized Cores	-	0.0	5	0.4	15	0.7	7	2.3	2	1.7	1	0.7	30	0.7
Unutilized Flakes	301	72.7	974	72.2	1605	70.7	190	63.8	69	59.5	107	72.3	3246	70.7
Non-Diagnostic Shatter	83	20.0	253	18.8	423	18.6	73	24.5	21	18.1	23	15.5	876	19.1
Utilized Flakes	20	4.8	64	4.7	110	4.8	10	3.6	13	11.2	5	3.3	222	4.8
Marginally Retouched Flakes	1	0.2	13	1.0	19	0.8	2	0.7	4	3.4	3	2.0	42	0.9
Bifaces and Projectile Points	2	0.5	10	0.7	10	0.4	1	0.3	1	0.9	1	0.7	25	0.5
Total	414	99.9	1349	100.0	2269	99.8	298	100.2	116	100.0	148	99.9	4594	100.0

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

TABLE 19

PERCENTAGES OF MATERIALS FOR REDUCTION CATEGORIES
OF CHIPPED STONE FOR SITES 33 AND 34

	Obsidian							Chert							Limestone						
	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Chipped Stone	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Chipped Stone	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Chipped Stone
Unutilized Cores	-	6.7*	14.3	100.0	-	-	0.1	1.7	2.6	4.5	4.0	3.6	6.7	1.8	5.0	1.5	4.0	9.4	7.7	-	0.5
Utilized Cores	-	-	-	-	-	-	-	-	0.4	0.4	1.0	1.8	1.3	0.2	-	0.5	0.3	-	7.7	-	0.1
Unutilized Flakes	100.0	80.8	61.9	-	-	100.0	0.7	68.1	70.3	68.7	70.0	50.9	73.3	34.6	67.5	81.9	76.3	78.1	61.5	76.2	10.8
Non-Diagnostic Shatter	-	-	-	-	-	-	-	21.7	17.6	17.7	15.0	18.2	8.0	8.9	27.5	12.1	15.2	9.4	7.7	23.8	2.1
Utilized Flakes	-	6.7	19.0	-	-	-	0.1	7.2	6.6	7.3	9.0	21.8	6.7	3.8	-	2.5	2.7	-	-	-	0.3
Marginally Retouched Flakes	-	6.7	-	-	-	-	0.0	0.4	1.1	0.6	-	1.8	2.7	0.4	-	1.5	1.5	3.1	15.4	-	0.2
Bifaces and Projectile Points	-	-	4.8	-	-	-	0.0	0.9	1.4	0.7	1.0	1.8	1.3	0.5	-	-	-	-	-	-	-
Total No. Items for Column	4	15	21	1	-	1	42	235	728	1090	100	55	75	2283	40	199	329	32	13	21	634
Percent of Phase or Period	1.0	1.1	0.9	0.3	-	0.7	-	57.0	54.4	48.5	34.1	48.7	51.7	-	9.7	14.9	14.6	10.9	11.5	14.5	-
Percent of all Chipped Stone	-	-	-	-	-	-	0.9	-	-	-	-	-	-	50.2	-	-	-	-	-	-	13.9

TABLE 19—Continued

	Rhyolite 33 AE	Rhyolite 33N AME&S	Rhyolite 33N ME&S	Rhyolite 33S ME&S	Rhyolite 34 ME&S	Rhyolite 33 MPE&S	Percent of All Chipped Stone	Quartzite 33 AE	Quartzite 33N AME&S	Quartzite 33N ME&S	Quartzite 33S ME&S	Quartzite 34 ME&S	Quartzite 33 MPE&S	Percent of All Chipped Stone	Total No. Items for Row
Unutilized Cores	-	0.5	2.2	1.1	7.4	3.2	0.3	1.3	3.4	3.4	5.9	5.6	11.8	0.6	151
Utilized Cores	-	0.5	1.3	3.3	-	-	0.2	-	-	1.1	4.4	-	-	0.2	30
Unutilized Flakes	89.5	76.6	72.4	51.1	66.7	74.2	13.9	76.3	61.8	70.1	66.2	66.7	52.9	10.7	3211
Non-Diagnostic Shatter	10.5	22.0	23.1	44.6	22.2	22.6	4.7	18.4	29.2	19.8	20.6	22.2	29.4	3.5	869
Utilized Flakes	-	0.5	2.2	-	3.7	-	0.1	3.9	5.1	4.2	1.5	-	-	0.6	221
Marginally Retouched Flakes	-	-	4.4	-	-	-	0.0	-	0.6	1.4	1.5	5.6	5.9	0.2	42
Bifaces and Projectile Points	-	-	2.2	-	-	-	0.0	-	-	-	-	-	-	-	25
Total No. of Items for Column	57	218	450	92	27	31	875	76	178	358	68	18	17	615	4549
Percent of Phase or Period	13.8	16.3	20.0	31.4	23.9	21.4	-	18.4	13.3	15.9	23.2	15.9	11.7	-	-
Percent of all Chipped Stone	-	-	-	-	-	-	19.2	-	-	-	-	-	-	13.5	-

*Percentages are of column totals unlessotherwise indicated.

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation

S = Surface
A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

chipped stone tool assemblage, therefore, would have a greater percentage of small tools than would that of the later Formative period at these sites on the basis of the relatively greater percentage of chert items in the Archaic period deposits. This will be demonstrated in a clearer fashion later. The point of concern here is that there is an apparent preference for chert for the manufacture of small tools because of the ease with which it is worked and because of its generally more durable and sharper edges than those of limestone, rhyolite, and quartzite.

Obsidian is represented mostly by unutilized cores and flakes and utilized flakes. The rare occurrence and small size of obsidian nodules in the El Paso area do not allow an extensive use of this material or its use for larger stone tools. Obsidian has been found to have been used primarily for projectile points in the El Paso area (O'Laughlin 1979).

From the above discussion, it is apparent that chert was preferred over other materials for tools other than core tools and that chert was far better represented in the chipped stone artifacts than it is in the gravels near Sites 33 and 34. Quartzite also appears to be better represented in the chipped stone artifacts of Sites 33 and 34 than would be expected from its relative abundance in nearby gravels, and artifacts of rhyolite and limestone were found in fewer numbers than anticipated from their common occurrence in the gravels near Sites 33 and 34. Few artifacts of obsidian were recovered, and this is consonant with its rare occurrence in the project area. The differential selection of these materials has been related to their local abundance, ease of reduction, and applicability for certain kinds of tools. Technological and functional considerations of these materials will be pursued further in the following two sections.

Reduction Technology

The lithic assemblages of Sites 33 and 34 are characterized by the prevalence of flake and core tools and few finished or formed tools such as bifaces and projectile points (Table 18), and this suggests an expedient manufacture of most tools. That is, the reduction of raw materials for chipped stone tools may be viewed as having relatively few steps, and the reduction technology can be envisioned as a striving toward the production of usable flakes and the removal of flakes from cores such that cores will have surfaces and edges which are also usable. In an effort to further describe the reduction of parent materials into usable tools and temporal patterns in this activity, three attributes of chipped stone items have been monitored for materials and reduction categories: size, presence or absence of cortex, and absence of striking platform or type of platform present. These attributes were chosen partially for their ease of observation and measurement and because the particular constraints of time and money for this preliminary investigation of Sites 33 and 34 precluded the enumeration of many variables.

Although only a limited number of variables relating most directly to reduction technology could be examined as part of this project, the above mentioned variables were selected in anticipation of the high information content they might carry with respect to the nature of Archaic and Formative period occupations at Sites 33 and 34. These variables have also previously been found to give interesting patterns of reduction technology for limited activity and residential sites in the El Paso area (Lynn, Baskin, and Hudson 1975; O'Laughlin 1977b; 1979; O'Laughlin and Greiser 1973). In previous chapters (particularly Chapter VIII), Formative period occupations at Sites 33 and 34 are characterized as having been ephemeral with activities being somewhat specialized and directed principally toward the probable processing of leaf succulents, while the probable intermittent Archaic period occupation of Site 33 is seen as being of longer duration and evidencing a wider range of both maintenance and supportive activities. Aside from some purely technological considerations such as the relationship between the size of the parent material and the size distribution of reduction categories and the connection between the process of chipped stone reduction and percentages of reduction categories exhibiting cortex and platforms, there are a number of expectations for the archeological record which will reflect the specificity of activities and duration of occupation and discriminate the Archaic and Formative period occupations of Sites 33 and 34 if the above generalizations of these occupations are correct.

The local availability of stone materials suitable for chipped stone tools makes possible the manufacture of tools at Sites 33 and 34 without the importation of raw or processed materials. The suggested ephemeral and specialized nature of the Formative period occupations would imply that most tools of these occupations would be produced with a minimum of expenditure of energy and discarded following use and that relatively few tools would be produced elsewhere or curated and removed from Sites 33 and 34. Inasmuch as the Formative period occupations are thought to have focused on the processing of leaf succulents, then chipped stone tools should be comparable to those of similarly interpreted sites of the El Paso area and should be comprised of appreciable numbers of large core and flake tools and few bifacially retouched tools (O'Lauglin 1979). The inferred more lengthy and generalized, though intermittent, occupation of the Archaic period at Site 33 should exhibit patterns in the reduction of chipped stone materials and in the curation of chipped stone tools and raw materials like those of other sites in the El Paso area which have houses and have been occupied for more than a brief period of time (O'Laughlin 1979; n.d. b). Thus, the chipped stone items from the Archaic period occupation are anticipated to show the extensive reduction of stone materials, some curation of unutilized cores and flakes and utilized items, some maintenance of tools, and a variety of small and large flake, core, and bifacially retouched tools. It is expected that the Archaic period lithic assemblage can be distinguished from that of later Formative period occupations in: (1) showing a greater reduction of stone materials as seen in smaller percentages of items with cortex on their striking platforms and other surfaces, more intensively worked and smaller cores, and more evidence of the preparation of platforms and bifacial tool production; (2) exhibiting a greater number of resharpening flakes indicative of maintenance activities; and (3) having a wider variety of tools including proportionately fewer large flake and core tools and more small flake and bifacially retouched tools. The following discussions of the size of chipped stone items, the presence or absence of cortex on chipped stone items, and the absence of striking platforms or the type of platform present elaborate on these expectations while providing the details of reduction technolgy.

Size. The size distribution of chipped stone items for the five common materials (excluding sandstone, granite, and quartz) and the various occupations at Sites 33 and 34 is shown in Table 20 where the maximum dimension of chipped stone artifacts is broken down into four size classes: 0.1 to 2.0 cm, 2.1 to 4.0 cm; 4.1 to 6.0 cm; and over 6.0 cm. Obsidian is restricted to the smaller size classes, and this is consonant with the small size of the nodules of the parent material. Unutilized and utilized cores of chert tend to be smaller than those of rhyolite, limestone, and quartzite, and this follows from the smaller size of chert nodules as compared to those of rhyolite, limestone, and quartzite. Unutilized flakes and non-diagnostic shatter tend to be restricted to the smaller size classes for all materials. Utilized flakes, marginally retouched flakes, and projectile points and bifaces are often larger than unutilized flakes and non-diagnostic shatter for all materials, and limestone, rhyolite, and quartzite utilized and marginally retouched flakes are generally larger than those of chert. Thus, larger flakes are generally used for tools, and the larger flake tools are often made of rhyolite, limestone, and quartzite whose parent materials occur in larger nodules than those of chert or obsidian.

The distribution of size classes for reduction categories and the various occupations at Sites 33 and 34 is summarized in Table 21 where all chipped stone artifacts recovered from these sites have been enumerated. There is some tendency for unutilized cores to be smaller for the Archaic period than for the Formative period, and this is partially accounted for by the greater preference of chert as a core material for the Archaic period. Chert cores are generally smaller than those of rhyolite, quartzite, and limestone, and again, this reflects the general smaller size of chert nodules. Utilized cores tend to be large with the exception of those from the mixed Archaic period and Mesilla phase materials. Once more, utilized cores are mostly of limestone, rhyolite, or quartzite, and there appears to be a selection for utilized cores with a large mass. The poor representation of utilized cores in materials of the Archaic period and the large size of utilized cores of the Formative period will be considered at greater length in the section on tool function.

Unutilized flakes and non-diagnostic shatter tend to be small for all of the occupations, and projectile points and bifaces are generally of moderate size. Utilized flakes and marginally retouched flakes, however, are generally somewhat smaller for the Archaic period or mixed Archaic period and Mesilla phase materials than they are for those not containing Archaic period materials. This is partially a reflection of the greater percentage of chert flake tools for the Archaic period, but the general small size of Archaic period tools also appears to reflect differences in the nature of activities performed during the Archaic period as opposed to those performed during the Formative period at Sites 33 and 34. This will also become more apparent in the section on tool function.

Cortex. Cortex (the outer geologically weathered surface of nodules) was recorded as being either present or absent on the dorsal surface of unutilized, utilized, and marginally retouched flakes and on any surface of unutilized and utilized cores, nondiagnostic shatter, and bifaces and projectile points. The percentage of items with cortex for each of the common materials (excluding the 45 items of sandstone, granite, and quartz) and the reduction categories is given in Table 22. Table 23 summarizes the percentage of items of each reduction category with cortex for the various occupations at Sites 33 and 34 and includes all chipped stone artifacts found at these sites.

TABLE 20

PERCENTAGES OF SIZE CLASSES FOR REDUCTION CATEGORIES OF CHIPPED STONE FOR SITES 33 AND 34

		Obsidian							Chert						
	Size Class*	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Obsidian Items	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Chert Items
Unutilized Cores	1	-	66.7**	100.0	-	-	-	60.0	-	-	4.1	-	-	-	2.4
	2	100.0	33.3	-	-	-	-	40.0	50.0	63.2	38.8	50.0	-	20.0	43.4
	3	-	-	-	-	-	-	-	50.0	36.8	51.0	50.0	100.0	60.0	49.4
	4	-	-	-	-	-	-	-	-	-	6.1	-	-	20.0	4.8
Utilized Cores	1	-	-	-	-	-	-	-	-	33.3	-	-	-	-	10.0
	2	-	-	-	-	-	-	-	-	66.7	25.0	100.0	-	100.0	50.0
	3	-	-	-	-	-	-	-	-	-	25.0	-	-	-	10.0
	4	-	-	-	-	-	-	-	-	-	50.0	-	100.0	-	30.0
Unutilized Flakes	1	100.0	91.7	84.6	-	-	100.0	90.0	75.0	62.5	51.9	44.3	39.3	61.8	57.5
	2	-	8.3	15.4	-	-	-	10.0	23.1	35.2	43.5	48.6	53.6	34.5	38.8
	3	-	-	-	-	-	-	-	1.9	2.3	4.3	7.1	7.1	1.8	3.5
	4	-	-	-	-	-	-	-	-	-	0.3	-	-	1.8	0.2
Non-Diagnostic Shatter	1	-	-	-	-	-	-	-	86.3	62.5	59.1	66.7	30.0	66.7	63.3
	2	-	-	-	-	-	-	-	13.7	34.4	36.3	33.3	50.0	33.3	33.0
	3	-	-	-	-	-	-	-	-	3.1	3.6	-	20.0	-	3.2
	4	-	-	-	-	-	-	-	-	-	1.0	-	-	-	0.5
Utilized Flakes	1	-	100.0	100.0	-	-	-	100.0	23.5	37.5	18.7	-	16.7	20.0	23.4
	2	-	-	-	-	-	-	-	58.8	52.1	70.0	77.8	50.0	60.0	62.6
	3	-	-	-	-	-	-	-	17.6	8.3	11.2	22.2	25.0	20.0	12.9
	4	-	-	-	-	-	-	-	-	2.1	-	-	8.3	-	1.2
Marginally Retouched Flakes	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	100.0	-	-	-	-	100.0	100.0	62.5	71.4	-	-	50.0	63.2
	3	-	-	-	-	-	-	-	-	37.5	28.6	-	100.0	50.0	36.8
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bifaces and Projectile Points	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	100.0	-	-	-	100.0	50.0	70.0	62.5	100.0	-	100.0	65.2
	3	-	-	-	-	-	-	-	50.0	30.0	37.5	-	100.0	-	34.8
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Items for Column		4	15	21	1	-	1	42	235	728	1090	100	55	75	2283

TABLE 20—Continued

	Size Class*	Limestone 33 AE	Limestone 33N AME&S	Limestone 33N ME&S	Limestone 33S ME&S	Limestone 34 ME&S	Limestone 33 MPE&S	Percent of All Limestone Items	Rhyolite 33 AE	Rhyolite 33N AME&S	Rhyolite 33N ME&S	Rhyolite 33S ME&S	Rhyolite 34 ME&S	Rhyolite 33 MPE&S	Percent of All Rhyolite Items
Unutilized Cores	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	7.7	-	-	-	4.5	-	-	-	-	-	-	-
	3	50.0	33.3	30.8	33.3	-	-	31.8	-	-	30.0	-	50.0	100.0	33.3
	4	50.0	66.7	61.5	66.7	100.0	-	63.6	-	100.0	70.0	100.0	50.0	-	66.7
Utilized Cores	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	100.0	-	-	100.0	-	66.7	-	-	-	-	-	-	-
	4	-	-	100.0	-	-	-	33.3	-	100.0	100.0	100.0	-	-	100.0
Unutilized Flakes	1	51.9	36.2	29.5	8.0	25.0	31.2	31.8	54.9	48.5	34.0	36.2	33.3	30.4	39.6
	2	33.3	52.1	50.6	80.0	50.0	68.8	52.2	43.1	39.5	45.7	46.8	33.3	52.2	43.8
	3	14.8	8.6	17.5	8.0	25.0	-	13.5	2.0	11.4	16.6	10.6	16.7	13.0	13.4
	4	-	3.1	2.4	4.0	-	-	2.4	-	0.6	3.7	6.4	16.7	4.3	3.2
Non-Diagnostic Shatter	1	90.9	45.8	42.0	33.3	-	20.0	46.8	66.7	58.3	35.6	31.7	33.3	28.6	40.1
	2	9.1	54.2	52.0	66.7	100.0	80.0	50.0	33.3	33.3	48.1	65.9	50.0	57.1	48.1
	3	-	-	6.0	-	-	-	3.2	-	6.2	11.5	2.4	16.7	14.3	8.5
	4	-	-	-	-	-	-	-	-	2.1	4.8	2.4	-	-	3.3
Utilized Flakes	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	60.0	22.2	-	-	-	35.7	-	-	-	-	-	-	-
	3	-	20.0	44.4	-	-	-	35.7	-	-	-	-	-	-	-
	4	-	20.0	33.3	-	-	-	28.6	-	-	100.0	100.0	-	-	100.0
Marginally Retouched Flakes	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	20.0	-	-	-	9.1	-	-	-	-	-	-	-
	3	-	33.3	60.0	-	50.0	-	45.5	-	-	-	-	-	-	-
	4	-	66.7	20.0	100.0	50.0	-	45.5	-	-	100.0	-	-	-	100.0
Bifaces and Projectile Points	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	100.0	-	-	-	100.0
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Items for Column		40	199	329	32	13	21	634	57	218	450	92	27	31	875

TABLE 20—Continued

	Size Class	Quartzite 33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Quartzite Items	Total No. Items for Row	Percent of All Chipped Stone
Unutilized Cores	1	-	-	-	-	-	-	-	5	3.3
	2	-	-	8.3	-	-	-	3.8	40	26.5
	3	100.0	33.3	50.0	75.0	-	-	46.2	65	43.0
	4	-	66.7	41.7	25.0	100.0	100.0	50.0	41	27.2
Utilized Cores	1	-	-	-	-	-	-	-	1	3.3
	2	-	-	-	-	-	-	-	5	16.7
	3	-	-	-	33.3	-	-	14.3	4	13.3
	4	-	-	100.0	66.7	-	-	85.7	20	66.7
Unutilized Flakes	1	69.0	54.5	41.8	35.6	50.0	66.7	48.0	1571	48.9
	2	31.0	36.4	44.2	42.2	41.7	22.2	40.2	1342	41.8
	3	-	9.1	12.4	15.6	8.3	11.1	10.3	256	8.0
	4	-	-	1.6	6.7	-	-	1.4	42	1.3
Non-Diagnostic Shatter	1	64.3	57.7	49.3	42.9	25.0	40.0	51.9	467	53.7
	2	35.7	34.6	46.5	42.9	50.0	20.0	40.6	347	39.9
	3	-	7.7	2.8	-	25.0	40.0	5.6	43	4.9
	4	-	-	1.4	14.3	-	-	1.9	12	1.4
Utilized Flakes	1	-	-	13.3	-	-	-	7.1	47	21.3
	2	66.7	66.7	46.7	-	-	-	53.6	128	57.9
	3	33.3	22.2	40.0	100.0	-	-	35.7	37	16.7
	4	-	11.1	-	-	-	-	3.6	9	4.1
Marginally Retouched Flakes	1	-	-	-	-	-	-	-	-	-
	2	-	100.0	40.0	-	-	-	33.3	17	40.5
	3	-	-	60.0	100.0	-	100.0	55.6	17	40.5
	4	-	-	-	-	100.0	-	11.1	8	19.0
Bifaces and Projectile Points	1	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	17	68.0
	3	-	-	-	-	-	-	-	8	32.0
	4	-	-	-	-	-	-	-	-	-
Total No. Items for Column		76	178	358	68	18	17	615	4549	-

*1 = Maximum dimension of 0.1 to 2.0 cm
2 = Maximum dimension of 2.1 to 4.0 cm
3 = Maximum dimension of 4.1 to 6.0 cm
4 = Maximum dimension over 6.0 cm
** = Percentage of size class for each reduction category

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation

S = Surface
A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

TABLE 21

PERCENTAGES OF SIZE CLASSES
FOR CHIPPED STONE REDUCTION CATEGORIES
BY PERIOD AND PHASE FOR SITES 33 & 34

	Size* Class	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 ME&S
Unutilized Cores	1	-	-	4.6	6.7	-	-
	2	28.6	43.3	25.3	13.3	-	12.5
	3	57.1	33.3	43.7	53.3	50.0	50.0
	4	14.3	23.3	26.4	26.7	50.0	37.5
Utilized Cores	1	-	20.0	-	-	-	-
	2	-	40.0	6.7	-	-	100.0
	3	-	20.0	6.7	14.3	50.0	-
	4	-	20.0	86.7	85.7	50.0	-
Unutilized Flakes	1	68.8	54.8	43.5	34.7	36.2	49.5
	2	28.6	38.6	44.8	51.1	46.4	43.0
	3	2.7	5.9	10.2	10.5	13.0	5.6
	4	--	0.7	1.6	3.7	4.3	1.9
Non-Diagnostic Shatter	1	81.9	58.9	50.1	39.7	28.6	39.1
	2	18.1	36.4	42.3	54.8	52.4	47.8
	3	-	4.3	5.7	1.4	19.0	13.0
	4	-	0.4	1.9	4.1	-	-
Utilized Flakes	1	20.0	29.7	19.1	-	15.4	20.0
	2	60.0	53.1	59.1	70.0	53.8	60.0
	3	20.0	10.9	17.3	30.0	23.1	20.0
	4	-	6.2	4.5	-	7.7	-
Marginally Retouched Flakes	1	-	-	-	-	-	-
	2	100.0	53.8	42.1	-	-	33.3
	3	-	30.8	42.1	50.0	50.0	66.7
	4	-	15.4	15.8	50.0	50.0	-
Bifaces and Projectile Points	1	-	-	-	-	-	-
	2	50.0	70.0	70.0	100.0	-	100.0
	3	50.0	30.0	30.0	-	100.0	-
	4	-	-	-	-	-	-
Total No. of Items		414	1349	2269	298	116	148

*1 = Maximum dimension of 0.1 to 2.0 cm
2 = Maximum dimension of 2.1 to 4.0 cm
3 = Maximum dimension of 4.1 to 6.0 cm
4 = Maximum dimension over 6.0 cm

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

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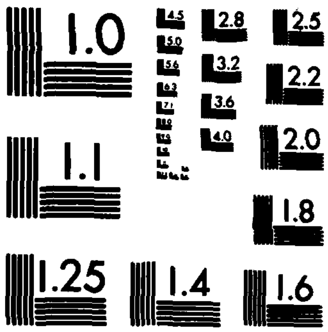

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 22

PERCENTAGES OF CORTEX FOR REDUCTION CATEGORIES
OF CHIPPED STONE FOR SITES 33 AND 34

	Obsidian							Chert							Limestone						
	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Obsidian Items	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Chert Items	33 AE	33N AME&S	33N ME&S	33N ME&S	34 ME&S	33 MPE&S	Percent of All Limestone Items
Unutilized Cores	-	100.0*	100.0	100.0	-	-	100.0	100.0	84.2	89.8	75.0	100.0	100.0	89.2	100.0	100.0	100.0	100.0	100.0	-	100.0
Utilized Cores	-	-	-	-	-	-	-	-	66.7	100.0	100.0	100.0	100.0	90.0	-	100.0	100.0	-	100.0	-	100.0
Unutilized Flakes	0.0	66.7	61.5	-	-	100.0	56.7	36.2	39.8	43.1	47.1	64.3	40.0	41.8	40.7	42.9	45.8	52.0	62.5	37.5	44.9
Non-Diagnostic Shatter	-	-	-	-	-	-	-	33.3	50.0	56.0	73.3	66.7	50.0	52.4	45.5	37.5	50.0	100.0	100.0	0.0	45.7
Utilized Flakes	-	0.0	25.0	-	-	-	20.0	58.8	43.8	52.5	88.9	75.0	80.0	55.0	-	20.0	100.0	-	-	-	71.4
Marginally Retouched Flakes	-	100.0	-	-	-	-	100.0	0.0	75.0	71.4	-	100.0	100.0	73.7	-	100.0	60.0	100.0	100.0	-	81.8
Bifaces and Projectile Points	-	-	0.0	-	-	-	0.0	0.0	30.0	62.5	0.0	100.0	0.0	39.1	-	-	-	-	-	-	-
Total No. Items for Column	4	15	21	1	-	1	42	235	728	1090	100	55	75	2283	40	199	329	32	13	21	634

TABLE 22 —Continued

	Rhyolite							Quartzite								
	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Rhyolite Items	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Quartzite Items	Total No. Items for Row	Percent of All Chipped Stone
Unutilized Cores	-	100.0	90.0	100.0	100.0	100.0	93.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	151	93.4
Utilized Cores	-	100.0	83.3	100.0	-	-	90.0	-	-	100.0	100.0	-	-	100.0	30	93.3
Unutilized Flakes	31.4	37.1	38.7	42.6	55.6	43.5	38.6	31.0	36.4	42.2	42.2	58.3	33.3	39.8	3211	41.5
Non-Diagnostic Shatter	33.3	56.2	66.3	53.7	66.7	71.4	60.8	35.7	57.7	66.2	85.7	100.0	80.0	63.8	869	55.8
Utilized Flakes	-	100.0	100.0	-	0.0	-	66.7	0.0	55.6	46.7	100.0	-	-	46.4	221	54.3
Marginally Retouched Flakes	-	-	100.0	-	-	-	100.0	-	100.0	80.0	100.0	100.0	100.0	88.9	42	81.0
Bifaces and Projectile Points	-	-	0.0	-	-	-	0.0	-	-	-	-	-	-	-	25	36.0
Total No. Items for Column	57	218	450	92	27	31	875	76	178	358	68	18	17	615	4549	-

*Percentages are for the presence of cortex on chipped stone items whithin a cell unless otherwise noted by a column heading.

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation

S = Surface
A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

TABLE 23

PERCENTAGES OF CORTEX FOR CHIPPED STONE REDUCTION CATEGORIES
BY PERIOD AND PHASE FOR SITES 33 AND 34

	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S
Unutilized Cores	100.0	90.0	93.1	93.3	100.0	100.0
Utilized Cores	-	80.0	93.3	100.0	100.0	100.0
Unutilized Flakes	34.2	34.8	42.5	45.8	60.9	40.2
Non-Diagnostic Shatter	34.9	51.4	59.1	65.8	81.0	52.2
Utilized Flakes	50.0	43.7	54.5	90.0	69.2	80.0
Marginally Retouched Flakes	0.0	84.6	73.7	100.0	100.0	100.0
Bifaces and Projectile Points	0.0	30.0	50.0	0.0	100.0	0.0
Total No. of Items	414	1349	2269	298	116	148

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation

S = Surface
A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

Unutilized and utilized cores invariably show some cortex for all materials and occupations (Tables 22, 23). This indicates that cores were rarely exhausted or so extensively worked that no cortex could be found on them. It was observed, however, that unutilized and utilized cores of the Archaic period or mixed Archaic period and Mesilla phase often showed more extensive use than cores of only the Formative period, and this is taken as some indication of the curation and continued working of cores during the Archaic period occupation at Site 33.

The percentages of unutilized flakes with cortex are relatively small for all materials, and the percentages of chert, rhyolite, and quartzite pieces of non-diagnostic shatter with cortex are somewhat higher than those for unutilized flakes (Table 22). The somewhat higher percentages of non-diagnostic shatter with cortex may indicate that more shatter is produced when first testing or preparing cores than during the later removal of primary or secondary flakes. In Table 23, it is noted that the percentages of unutilized flakes and non-diagnostic shatter with cortex are much lower for the Archaic period and the mixed Archaic period and Mesilla phase items than they are for items of only the Formative period. This implies that materials are being worked more intensively during the Archaic period occupation at Site 33 than during the Formative period occupations at Sites 33 and 34.

The percentages of utilized flakes and marginally retouched flakes with cortex vary somewhat with material (Table 22). In general, the percentages of these items of chert with cortex are smaller than those of the other materials and are suggestive of the more intensive working of cherts as compared to the other materials. However, the percentages of utilized flakes and marginally retouched flakes with cortex are commonly higher than those of unutilized flakes and non-diagnostic shatter of the same material. Insofar that utilized flakes and marginally retouched flakes are often larger than unutilized flakes and non-diagnostic shatter, this is not unreasonable and reflects the less extensive working of cores and flakes during the Formative period than it does for the Archaic period. This is seen in Table 23 where the percentages of utilized flakes and marginally retouched flakes with cortex for the Archaic period and the mixed Archaic period and Mesilla phase are most often less than those of Formative period items only.

Projectile points and bifaces generally do not exhibit cortex (Table 22), and this follows the greater working of materials in order to produce these items. As with most of the other reduction categories, the bifaces and projectile points of the Archaic period and of the mixed Archaic period and Mesilla phase have smaller percentages with cortex than do those of only the Formative period (Table 23).

Platform. Platforms (remnants of the striking platforms of cores) for unutilized flakes, utilized flakes, marginally retouched flakes, and projectile points and bifaces were noted as either being absent or one of four types: cortex, single-facet, multiple-facet, and crushed. Items of these reduction categories which were struck from corticate surfaces of cores exhibit cortex platforms, and those items detached from a flat surface prepared by the removal of a single flake have single-facet platforms. Multiple-facet platforms on flakes are the result of the removal of flakes from cores which have striking platforms prepared by the detachment of a series of flakes. Crushed platforms are those platforms which have been oblitereated beyond recognition during the detachment of flakes from cores. The percentages of platform types for unutilized flakes, utilized flakes, marginally retouched flakes, and projectile points and bifaces are given in Table 24 for the various materials (excepting the few items of sandstone, granite, and quartz) and occupations at Sites 33 and 34. Cores will be treated later, and non-diagnostic shatter has not been included in Table 24 because these items do not have platforms or other attributes of flakes.

Projectile points and bifaces rarely exhibit platforms, but the presence of a few platforms does show that some of these were produced from flakes rather than from the extensive modification of cores. The few platforms found on these items follow the expectation that few would be found on highly modified and shaped items.

Multiple-facet and crushed platforms are not particularly common. The relatively few multiple-facet platforms are indicative of the general unimportance of preparing platforms to any extent before removing flakes. The few multiple-facet platforms and the absence of ground platforms are also suggestive of the unimportance of thinning activities relating to the production of bifaces and projectile points. Only marginally retouched flakes of chert and unutilized flakes of obsidian have substantial percentages of multiple-facet platforms. The multiple-facet platforms of obsidian suggest that some platform preparation is necessary for the effective removal of flakes from small nodules of obsidian which is scarce in the El Paso area. The relatively high percentage of marginally retouched flakes of chert with multiple-facet platforms may also reflect platform preparation for the removal of flakes from cores which have characteristics suitable for certain kinds of stone tools. However, this pat-

TABLE 24

PERCENTAGES OF PLATFORM TYPES FOR UNUTILIZED FLAKES, FLAKE TOOLS, BIFACES, AND PROJECTILE POINTS FOR SITES 33 AND 34

		Obsidian							Chert						
	Platform Type*	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Obsidian Items	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Chert Items
Unutilized Flakes	0	25.0**	25.0	38.5	-	-	100.0	33.3	28.7	32.0	29.2	30.0	28.6	32.7	30.2
	1	25.0	16.7	30.8	-	-	-	23.3	23.1	21.1	23.9	38.6	39.3	21.8	23.8
	2	25.0	16.7	23.1	-	-	-	20.0	44.4	44.3	43.0	30.0	28.6	38.2	42.6
	3	-	25.0	-	-	-	-	10.0	1.9	1.6	1.2	-	-	7.3	1.5
	4	25.0	16.7	7.7	-	-	-	13.3	1.9	1.0	2.7	1.4	3.6	-	1.9
Utilized Flakes	0	-	-	25.0	-	-	-	20.0	29.4	41.7	27.5	22.2	16.7	40.0	31.0
	1	-	-	50.0	-	-	-	40.0	41.2	16.7	22.5	55.6	58.3	20.0	26.9
	2	-	-	25.0	-	-	-	20.0	11.8	39.6	43.7	11.1	25.0	40.0	36.3
	3	-	-	-	-	-	-	-	11.8	2.1	1.2	-	-	-	2.3
	4	-	100.0	-	-	-	-	20.0	5.9	-	5.0	11.1	-	-	3.5
Marginally Retouched Flakes	0	-	100.0	-	-	-	-	100.0	100.0	62.5	28.6	-	100.0	50.0	52.6
	1	-	-	-	-	-	-	-	-	25.0	28.6	-	-	-	21.1
	2	-	-	-	-	-	-	-	-	12.5	42.9	-	-	-	21.1
	3	-	-	-	-	-	-	-	-	-	-	-	-	50.0	5.3
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bifaces and Projectile Points	0	-	-	100.0	-	-	-	100.0	100.0	100.0	87.5	100.0	-	100.0	91.3
	1	-	-	-	-	-	-	-	-	-	12.5	-	-	-	4.3
	2	-	-	-	-	-	-	-	-	-	-	-	100.0	-	4.3
Total No. Items for Column		4	14	18	-	-	1	37	180	578	844	80	42	63	1787

TABLE 24—Continued

	Platform Type	Limestone 33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Limestone Items	Rhyolite 33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Rhyolite Items
Unutilized Flakes	0	11.1	27.0	22.3	20.0	25.0	25.0	23.3	25.5	18.6	18.7	23.4	38.9	13.0	19.9
	1	37.0	21.5	23.5	32.0	62.5	25.0	24.7	33.3	30.5	41.7	29.8	44.4	30.4	36.9
	2	51.9	49.7	53.4	48.0	12.5	50.0	51.0	41.2	49.1	39.3	44.7	16.7	56.5	42.4
	3	-	0.6	-	-	-	-	0.2	-	-	-	-	-	-	-
	4	-	1.2	0.8	-	-	-	0.8	-	1.8	0.3	2.1	-	-	0.8
Utilized Flakes	0	-	40.0	22.2	-	-	-	28.6	-	-	-	-	-	-	-
	1	-	20.0	33.3	-	-	-	28.6	-	100.0	-	-	100.0	-	66.7
	2	-	40.0	44.4	-	-	-	42.9	-	-	100.0	-	-	-	33.3
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marginally Retouched Flakes	0	-	-	40.0	-	-	-	18.2	-	-	-	-	-	-	-
	1	-	33.3	20.0	100.0	50.0	-	36.4	-	-	-	-	-	-	-
	2	-	66.7	20.0	-	50.0	-	36.4	-	-	100.0	-	-	-	100.0
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	20.0	-	-	-	9.1	-	-	-	-	-	-	-
Bifaces and Projectile Points	0	-	-	-	-	-	-	-	-	-	100.0	-	-	-	100.0
	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Items for Column		27	171	265	26	10	16	515	51	168	330	47	19	23	638

TABLE 24--Continued

	Platform Type	Quartzite 33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Quartzite Items	Total No. Items for Row	Percent of All Chipped Stone
Unutilized Flakes	0	27.6	30.0	26.3	28.9	16.7	33.3	27.4	859	26.8
	1	24.1	32.7	33.9	28.9	75.0	33.3	33.0	895	27.9
	2	48.3	36.4	39.0	40.0	8.3	33.3	38.8	1382	43.0
	3	-	-	-	2.2	-	-	0.2	29	0.9
	4	-	0.9	0.8	-	-	-	0.6	46	1.4
Utilized Flakes	0	-	55.6	40.0	-	-	-	39.3	69	31.2
	1	33.3	11.1	20.0	100.0	-	-	21.4	60	27.1
	2	33.3	22.2	40.0	-	-	-	32.1	79	35.7
	3	33.3	-	-	-	-	-	3.6	5	2.3
	4	-	11.1	-	-	-	-	3.6	8	3.6
Marginally Retouched Flakes	0	-	-	40.0	100.0	-	100.0	44.4	17	40.5
	1	-	-	40.0	-	100.0	-	33.3	11	26.2
	2	-	100.0	20.0	-	-	-	22.2	12	28.6
	3	-	-	-	-	-	-	-	1	2.4
	4	-	-	-	-	-	-	-	1	2.4
Bifaces and Projectile Points	0	-	-	-	-	-	-	-	23	92.0
	1	-	-	-	-	-	-	-	1	4.0
	2	-	-	-	-	-	-	-	1	4.0
Total No. Items for Cclumn		61	120	271	47	13	10	522	3499	-

*0 = Platform absent
1 = Cortex platform
2 = Single facet platform
3 = Multiple facet platform
4 = Crushed platform
**Percentage of platform type for each reduction category

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

tern is not duplicated in utilized flakes of chert or in utilized flakes and marginally retouched flakes of limestone, rhyolite, and quartzite. Crushed platforms are of some importance only for unutilized and utilized flakes of obsidian and marginally retouched flakes of limestone. The presence of higher percentages of this platform type for these materials is thought to relate to the particular characteristics of the stone which are glass-like in the former and soft and friable in the latter. Crushed platforms of obsidian probably relate to the bipolar cores to be discussed shortly.

In general, the percentages of cortex platforms do not differ markedly for materials and for the reduction categories of Table 24, but there are somewhat higher percentages of rhyolite, quartzite, and limestone with cortex platforms. Single-facet platforms and missing platforms vary more than cortex platforms, and cherts, obsidian, and quartzite tend to have higher percentages of missing platforms while rhyolite and limestone have relatively high percentages of single-facet platforms. These data are interpreted as possibly suggesting the more extensive working of obsidian, chert, and perhaps quartzite and the greater breakage of flakes or the more frequent and intentional removal of platforms commensurate with the more extensive working of these materials. The percentage of flakes without platforms also increases from unutilized flakes to utilized flakes to marginally retouched flakes and finally to projectile points and bifaces for chert, obsidian, and quartzite. This, of course, is the general order for the modification of chipped stone materials and the extent of modification.

Table 25 presents the percentages of platform types for the above mentioned reduction categories and non-diagnostic shatter for the occupations of Sites 33 and 34 and enumerates all items of these reduction categories found at Sites 33 and 34. The percentages of missing platforms are almost identical for unutilized flakes for all of the samples, and this pattern is not altered by considering non-diagnostic shatter. Thus, it would seem that the breakage of flakes and the production of non-diagnostic shatter is common to the earlier and later chipped stone reduction technologies and to the materials being reduced. Smaller percentages of cortex platforms and larger percentages of single-facet platforms for unutilized flakes of the Archaic period and the mixed Archaic period and Mesilla phase as compared to those of only the Formative period imply the more extensive reduction of cores and the corresponding increase in secondary and tertiary flakes.

The percentages of platform types on utilized flakes are temporally quite variable, and the only apparent pattern is the greater percentages of multiple-facet platforms for the Archaic period and the mixed Archaic period and Mesilla phase. This relatively high percentage of multiple-facet platforms for utilized flakes of the Archaic period or mixed Archaic period and Mesilla phase is taken as an indication of some preparation of platforms for the removal of flakes from cores which is not as obvious for the Formative period or other reduction categories.

Marginally retouched flakes have relatively large percentages of missing platforms in all of the samples from the different occupations at Sites 33 and 34, and the percentages of missing platforms are higher for marginally retouched flakes than they are for unutilized or utilized flakes. This accompanies the modification of marginally retouched flakes, and missing platforms are even more evident in projectile points and bifaces which are generally much modified and have no platform. There is a very high percentage of marginally retouched flakes with crushed platforms for the mixed Mesilla, Dona Ana, and El Paso phases. The representation of materials in this sample is not markedly different from other samples (Table 19), and it can only be presumed that either a different technology for reducing stone materials is indicated or that a bias has been introduced with the small size of this sample.

In addition to noting whether platforms were of the cortex, single-facet, multiple-facet, and crushed types or missing for unutilized flakes, three other attributes were monitored on all recovered unutilized flakes from Sites 33 and 34 which include two additional platform types and which probably relate either to the rejuvenation of working edges or biface production (Table 26). A total of five sharpening flakes was found, and these flakes exhibit the rounded and polished edge, from use, of a multiple-facet platform and retouch flake scars on the dorsal surface. These flakes appear to be more important from the Archaic period and were found in only one of the samples of the Formative period. These flakes suggest some rejuvenation of edges of chipped stone tools, and the maintenance of chipped stone tools may have been more important during the Archaic period. However, the sample of sharpening flakes is too small for a definite statement. There are two flakes with lipped platforms which are usually associated with the thinning of tools, especially bifaces. These two lipped platforms would suggest that bifacial thinning activities were of little importance during the occupations at Sites 33 and 34. This is also implied by the relatively few thinning flakes from the various occupations at these sites. Thinning flakes are flakes which exhibit on their

TABLE 25

PERCENTAGES OF PLATFORM TYPES
FOR CHIPPED STONE REDUCTION CATEGORIES OTHER THAN CORES
BY PERIOD AND PHASE FOR SITES 33 AND 34

	Platform Type*	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S
Unutilized Flakes	0	26.2	28.5	25.5	26.3	27.5	28.0
	1	26.2	24.2	29.3	33.2	52.2	24.3
	2	45.2	44.7	43.0	38.9	18.8	43.9
	3	1.0	1.2	0.6	0.5	-	3.7
	4	1.3	1.3	1.6	1.1	1.4	-
Unutilized Flakes & Non-Diagnostic Shatter	0	42.2**	43.2	41.0	46.8	44.4	40.8
Utilized Flakes	0	25.0	42.2	28.2	20.0	15.4	40.0
	1	40.0	17.2	23.6	60.0	61.5	20.0
	2	15.0	35.9	43.6	10.0	23.1	40.0
	3	15.0	1.6	0.9	-	-	-
	4	5.0	3.1	3.6	10.0	-	-
Marginally Retouched Flakes	0	100.0	46.2	31.6	50.0	25.0	66.7
	1	-	23.1	26.3	50.0	50.0	-
	2	-	30.7	36.8	-	25.0	-
	3	-	-	-	-	-	-
	4	-	-	5.3	-	-	33.3
Bifaces and Projectile Points	0	100.0	100.0	90.0	100.0	-	100.0
	1	-	-	10.0	-	-	-
	2	-	-	-	-	100.0	-
Total No. of Items		407	1314	2167	276	108	139

*0 = Platform absent
1 = Cortex platform
2 = Single facet platform
3 = Multiple facet platform
4 = Crushed platform

**Percentage of combined total of unutilized flakes and non-diagnostic shatter without platforms.

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

TABLE 26

PERCENTAGES OF THINNING AND SHARPENING FLAKES
AND LIPPED PLATFORMS FOR UNUTILIZED FLAKES
BY PERIOD AND PHASE

		33-AE		33N-AME&S		33N-M&S		33N-ME&S		34-ME&S		33-MPE&S	
		No	%	No	%	No	%	No	%	No	%	No	%
Thinning Flakes	Obsidian	2	0.7	1	0.1	-	-	-	-	-	-	-	-
	Chert	8	2.7	7	0.7	11	0.7	-	-	1	1.4	1	0.9
	Limestone	-	-	-	-	-	-	1	0.5	-	-	-	-
Total		10	3.4	8	0.8	11	0.7	1	0.5	1	1.4	1	0.9
Sharpening Flakes	Chert	1	0.3	1	0.1	3	0.2	-	-	-	-	-	-
Lipped Platforms	Chert	-	-	1	0.1	1	0.1	-	-	-	-	-	-
Total No. Flakes		301	-	974	-	1605	-	190	-	69	-	107	-

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mexilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

dorsal surface scars of flakes which were removed from a direction opposite that of the platform and within 45 degrees on either side. As can be seen from Table 26, most of these flakes are of obsidian or chert which are two of the two most commonly used materials for bifacial tools in the El Paso area. In addition, thinning flakes are relatively more important for the Archaic period. This provides some evidence for the greater frequency of production of bifacial tools during the Archaic period occupation at Site 33 than for the Formative period occupations at Sites 33 and 34. This is not evidenced by a greater frequency of projectile points and bifaces for the Archaic period, but these were probably highly curated items whose eventual loss location may not relate to that of their production.

Percentages of core types and platform types for cores are provided for the various materials (excepting two cores of sandstone and granite) and occupations at Sites 33 and 34 in Table 27. Five core types have been recognized and include single, double, ridged, and multiple-platform cores and bipolar cores. Single-platform cores are cores from which flakes have been struck from one cortex or single-facet platform, and double-platform cores are noted as having two cortex and/or single-facet platforms which are most often on opposite ends of the core. Ridged-platform cores are similar to those of the double-platform core type in having two striking platforms but the platforms adjoin one another on the ridged-platform cores to form an acute-angled edge. Multiple-platform cores exhibit three or more converging platforms such that they are usually polyhedral or globular in shape. Striking platforms on multiple-platform cores include cortex, single-facet, and prepared multiple-facet platforms. Bipolar cores are cores which have been split by striking a nodule resting on an anvil and show a positive or negative bulb of percussion on one end and a battered or crushed edge on the opposite end.

The bipolar technique for reducing cores is noted only for obsidian and is the primary technique used to initially reduce obsidian cores. Ridged-platform cores occur infrequently, and double-platform cores are not well-represented on most materials of which utilized cores are made. Double-platform cores that were utilized are best represented by quartzite, and in most cases only one of the two platform areas of the double-platform cores was used. Single and multiple-platform cores are the best represented core types. However, no multiple-platforms are noted for utilized cores of limestone and quartzite, and the percentage of multiple-platform and utilized cores is somewhat less for rhyolite than for chert. In general, cortex platforms outnumber single or multiple-facet platforms. The percentages of core types and platform types for all combined materials are similar for unutilized and utilized cores. The kind of core type or platform type would, therefore, seem to have no obvious bearing on whether a core was used or not. It can only be observed that ridged-platform and double-platform cores are not preferred for core tools and that obsidian was not used for core tools. It would appear that obsidian cores were treated much differently from the other materials and that the reduction of obsidian was probably aimed at the production of specific classes of tools such as projectile points.

The temporal distribution of core types for all cores found at Sites 33 and 34 is summarized in Table 28. Half of the samples are very small, and considerable variation is noted between the samples. Comments are best left to the general popularity of core types, and it is noted once more that single and multiple-platform cores are the better represented core types for both unutilized and utilized cores.

The above discussion of size classes, presence or absence of cortex, and platform types has served to emphasize the inferences drawn in the section on raw material selection to the effect that raw materials used in chipped stone tools were, for the most part, locally available and that some materials were preferred over others for certain kinds of tools because of differing characteristics of the parent materials. In addition, it is also possible to characterize differences between the Zone 4 Archaic occupation at Site 33 and the Zone 2 Formative period occupations at Sites 33 and 34. The Archaic period occupation is distinguished from the Formative period occupations at these sites in: (1) having more items of chert; (2) having no observed core tools; (3) having more small flake tools; (4) having smaller and more intensively worked cores; (5) exhibiting a greater reduction of stone materials as seen in the smaller percentages of items with cortex on their platforms and other surfaces; (6) showing some preparation of platforms as seen in the multiple-facet platforms of utilized flakes; (7) perhaps having relatively more resharpening flakes indicative of maintenance activities; and (8) displaying a greater importance of bifacial tool production. On the whole, the chipped stone assemblage for the Archaic period occupation looks very much like that of a relatively long-occupied site where maintenance and supportive activities are important, where stone materials are curated and worked intensively, and where stone tools are probably curated also. Just the opposite could be reasoned for the Formative period occupations where tools are generally large and apparently non-

TABLE 27

PERCENTAGES OF CORE AND PLATFORM TYPES
FOR UNUTILIZED AND UTILIZED CORES FOR SITES 33 AND 34

	Core Type*	Platform Type	Obsidian 33 AE	Obsidian 33N AME&S	Obsidian 33N ME&S	Obsidian 33S ME&S	Obsidian 34 ME&S	Obsidian 33 MPE&S	Percent of All Obsidian Platforms	Chert 33 AE	Chert 33N AME&S	Chert ME&S	Chert ME&S	Chert ME&S	Chert MPE&S	Percent of All Chert Platforms
Unutilized Cores	Single Platform	0	-	-	-	-	-	-	-	40.0	8.7	19.4	16.7	100.0	60.0	24.3
		1	-	-	-	-	-	-	-	-	17.4	11.3	16.7	-	-	11.7
	Double Platform	0	-	-	33.3**	-	-	-	20.0	20.0	17.4	19.4	16.7	-	-	17.5
		1	-	-	-	-	-	-	-	-	8.7	11.3	16.7	-	-	9.7
	Ridged Platform	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	-	-	-	-	-	-	-	-	4.3	-	-	-	-	1.0
	Multiple Platform	0	-	-	-	-	-	-	-	20.0	13.0	12.9	-	-	20.0	12.6
		1	-	-	-	-	-	-	-	20.0	13.0	9.7	16.7	-	20.0	11.7
		2	-	-	-	-	-	-	-	-	17.4	16.1	16.7	-	-	14.6
	Bipolar	0	-	100.0	66.7	100.0	-	-	80.0	-	-	-	-	-	-	-
Utilized Cores	Single Platform	0	-	-	-	-	-	-	-	-	25.0	20.0	-	-	-	14.3
		1	-	-	-	-	-	-	-	-	-	40.0	100.0	-	-	21.4
	Double Platform	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ridged Platform	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Multiple Platform	0	-	-	-	-	-	-	-	-	25.0	20.0	-	50.0	50.0	28.6
		1	-	-	-	-	-	-	-	-	25.0	20.0	-	-	50.0	21.4
		2	-	-	-	-	-	-	-	-	25.0	-	-	50.0	-	14.3
	Bipolar	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Items for Column			-	1	3	1	-	-	5	4	22	53	5	3	5	92

TABLE 27—Continued

	Core Type	Platform Type	Limestone 33 AE	Limestone 33N AME&S	Limestone 33N ME&S	Limestone 33S ME&S	Limestone 34 ME&S	Limestone 33 MPE&S	Percent of All Limestone Platforms	Rhyolite 33 AE	Rhyolite 33N AME&S	Rhyolite 33N ME&S	Rhyolite 33S ME&S	Rhyolite 34 ME&S	Rhyolite 33 MPE&S	Percent of All Rhyolite Platforms
Unutilized Cores	Single	0	-	100.0	14.3	60.0	-	-	26.5	-	100.0	33.3	-	33.3	100.0	38.9
	Platform	1	33.3	-	4.8	-	-	-	5.9	-	-	-	-	-	-	-
	Double	0	33.3	-	14.3	-	50.0	-	14.7	-	-	25.0	-	-	-	16.7
	Platform	1	33.3	-	19.0	-	50.0	-	17.6	-	-	16.7	-	-	-	11.1
	Ridged	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Platform	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Multiple	0	-	-	23.8	20.0	-	-	17.6	-	-	8.3	-	33.3	-	11.1
	Platform	1	-	-	4.8	-	-	-	2.9	-	-	8.3	-	33.3	-	11.1
		2	-	-	19.0	20.0	-	-	14.7	-	-	8.3	100.0	-	-	11.1
	Bipolar	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utilized Cores	Single	0	-	-	-	-	100.0	-	33.3	-	100.0	37.5	-	-	-	28.6
	Platform	1	-	100.0	100.0	-	-	-	66.7	-	-	-	-	-	-	-
	Double	0	-	-	-	-	-	-	-	-	-	-	20.0	-	-	7.1
	Platform	1	-	-	-	-	-	-	-	-	-	-	20.0	-	-	7.1
	Ridged	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Platform	1	-	-	-	-	-	-	-	-	-	12.5	-	-	-	7.1
	Multiple	0	-	-	-	-	-	-	-	-	-	25.0	40.0	-	-	28.6
	Platform	1	-	-	-	-	-	-	-	-	-	2[illegible].0	20.0	-	-	21.4
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bipolar	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Items for Column			2	4	14	4	2	-	26	-	2	16	4	2	1	25

TABLE 27--Continued

	Core Type	Platform Type	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S	Percent of All Quartzite Platforms	Total No. Platforms for Row	Percent of All Platforms
			Quartzite								
Unutilized Cores	Single Platform	0	-	28.6	17.6	33.3	-	-	18.9	45	22.8
		1	-	28.6	-	-	-	-	5.4	16	8.1
	Double Platform	0	50.0	-	23.5	16.7	-	25.0	18.9	34	17.3
		1	50.0	-	5.9	16.7	-	25.0	10.8	22	11.2
	Ridged Platform	0	-	-	-	-	-	-	-	-	-
		1	-	-	-	-	-	-	-	1	0.5
	Multiple Platform	0	-	14.3	23.5	16.7	100.0	25.0	21.6	29	14.7
		1	-	14.3	17.6	16.7	-	25.0	16.2	21	10.7
		2	-	14.3	11.8	-	-	-	8.1	25	12.7
	Bipolar	0	-	-	-	-	-	-	-	4	2.0
Utilized Cores	Single Platform	0	-	-	-	33.3	-	-	14.3	8	21.1
		1	-	-	-	-	-	-	-	5	13.2
	Double Platform	0	-	-	75.0	66.7	-	-	71.4	6	15.8
		1	-	-	25.0	-	-	-	14.3	2	5.3
	Ridged Platform	0	-	-	-	-	-	-	-	-	-
		1	-	-	-	-	-	-	-	1	2.6
	Multiple Platform	0	-	-	-	-	-	-	-	8	21.1
		1	-	-	-	-	-	-	-	6	15.8
		2	-	-	-	-	-	-	-	2	5.3
	Bipolar	0	-	-	-	-	-	-	-	-	-
Total No. Items for Column			1	6	16	7	1	2	33	-	-

*0 = Cortex platform
1 = Single facet platform
2 = Multiple facet platform
**Percentage of core and platform type for unutilized or utilized cores.

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

TABLE 28

PERCENTAGES OF CORE TYPES
FOR UNUTILIZED AND UTILIZED CORES
BY PERIOD AND PHASE FOR SITES 33 AND 34

	Core Type	33 AE	33N AME&S	33N ME&S	33S ME&S	34 ME&S	33 MPE&S
Unutilized Cores	Single Platform	42.9	46.7	34.5	53.3	50.0	50.0
	Double Platform	42.9	16.7	31.0	13.3	16.7	12.5
	Ridged Platform	-	3.3	-	-	-	-
	Multiple Platform	14.3	30.0	32.2	26.7	33.3	37.5
	Bipolar	-	3.3	2.3	6.7	-	-
Utilized Cores	Single Platform	-	60.0	46.7	28.6	50.0	-
	Double Platform	-	-	26.7	42.9	-	-
	Ridged Platform	-	-	6.7	-	-	-
	Multiple Platform	-	40.0	20.0	28.6	50.0	100.0
Total No. of Items		7	35	102	22	8	9

33 = Site 33
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic Period
AM = Mixed Archaic Period and Mesilla Phase
M = Mesilla Phase
MP = Mixed Mesilla, Dona Ana, and El Paso Phases

curated, and where materials do not appear to be intensively worked. In addition, it is also noted that the percentage of chipped stone tools (utilized cores and flakes, marginally retouched flakes, and projectile points and bifaces) are smaller for the Archaic period occupation than for the Formative period occupations. This also follows the supposition that the Archaic period occupation was of some duration with the curation of tools and that the Formative period occupations evidence ephemeral occupation and the more frequent abandonment of tools following their use. Many of these patterns have been pursued at greater length by O'Laughlin (1979) for similar sites in the El Paso area.

Projectile Points. Very few (25) finished or formed artifacts of chipped stone were recovered from Sites 33 and 34. These extensively modified pieces of stone include 18 ovate or lanceolate shaped bifaces which are 7-23 mm thick and seven stemmed projectile points which are 3-9 mm in thickness. All seven projectile points were found at Site 33 and are shown in Figure 37. Little is known of the temporal distribution of projectile points in the El Paso area, and the following discussion of the small sample of projectile points from Site 33 furnishes some information on this subject.

Three projectile points were recovered from the surface of Zone 2 deposits at Site 33. Two of these points (Figure 37a and b) are made of chert and are side-notched with moderate barbs, expanding stems, and convex bases. The third point (Figure 37c) is made of obsidian and may be corner-notched with an expanding stem and moderate barbs. These points are fragmentary but have projected lengths of 2.5 to 4 cm. Corner and side-notched points of moderate size are known for the Mesilla phase of the Formative period (Green 1971; Lehmer 1948; O'Laughlin and Greiser 1973; O'Laughlin 1979; n.d. a), and it is probable from the radiocarbon dates (Chapter V) and ceramic materials (Chapter IX) of Zone 2 that these projectile points are from Mesilla phase occupations at Site 33. Although there is evidence that Site 33 was intermittently occupied throughout the Formative period, no small triangular projectile points which are most typical of the later part of the Mesilla phase and the ensuing Dona Ana and El Paso phases were found.

Two projectile points came from mixed Archaic period and Mesilla phase materials of Site 33 North. One was found on an eroded surface and is the base of a point with an expanding stem and concave base (Figure 37 d), and the other was excavated from soil disturbed by vehicular traffic and is a fragment of a point with a straight stem and base (Figure 37 e). Both of these points are made of chert. The temporal distribution of projectile points with stems similar to these two points is poorly known. However, projectile points with concave bases are suggested to be more common during the Archaic period in the El Paso area (O'Laughlin and Greiser 1973; O'Laughlin 1979; n.d. a).

The last two projectile points were excavated from Zone 4 deposits at Site 33 North and are contracting stem points with moderate to weak shoulders (Figure 37 f and g). These points are 3.2 and 4.5 cm in length and made of chert. One of these points (Figure 37 g) came from the fill of House 2 which has a corrected BC/AD radiocarbon date of 2790 BC ± 310, and both points are from deposits which are suggested to best date between 2500 BC and 1800 BC (Chapter V). The finding of two projectile points with contracting stems in the Zone 4 Archaic period deposits of Site 33 is somewhat anomalous because projectile points with contracting stems are of infrequent occurrence in the El Paso area and Archaic period projectile points of the El Paso area are generally quite varied in form (Beckes 1977a; Chapter III in this report). Projectile points with contracting stems are known from Archaic period and Mesilla phase sites of the El Paso area, but they appear to be more frequent on Archaic period sites and perhaps recycled points from earlier times on Mesilla phase sites (Greiser 1973; O'Laughlin 1979; n.d. a).

Projectile points with contracting stems and ages comparable to those of Site 33 are widely distributed throughout the Great Basin, Southwest, and Transpecos Texas of the United States and southward into the highlands of southern Mexico. To the west of the project area in southwestern New Mexico and southeastern Arizona, projectile points with contracting stems are associated with the Chiricahua stage of the Cochise culture which dates roughly between 4000 BC and 1000 BC (Dick 1965; Sayles 1945). In central New Mexico points with contracting stems are infrequently found in Archaic sites of the San Jose and Armijo phases which are dated between 3000 BC and 800 BC (Irwin-Williams 1973). In Transpecos Texas contracting stem points are characteristic of the middle Archaic dating about 4000 BC to 2000 BC or somewhat later (Marmaduke 1978), and points with contracting stems are typical of Archaic assemblages in Coahuila and Tamaulipas, Mexico, and are suggested to be of similar age (but possibly occurring somewhat earlier and later) to those of nearby Transpecos Texas (MacNeish 1958; Taylor 1966). Farther south in Mexico, contracting stem points are the dominant form of projectile points from 8000 BC or 7000 BC to about 2000 BC in the Tehuacan Valley of Puebla (MacNeish et al. 1967). Although the full significance of projectile points

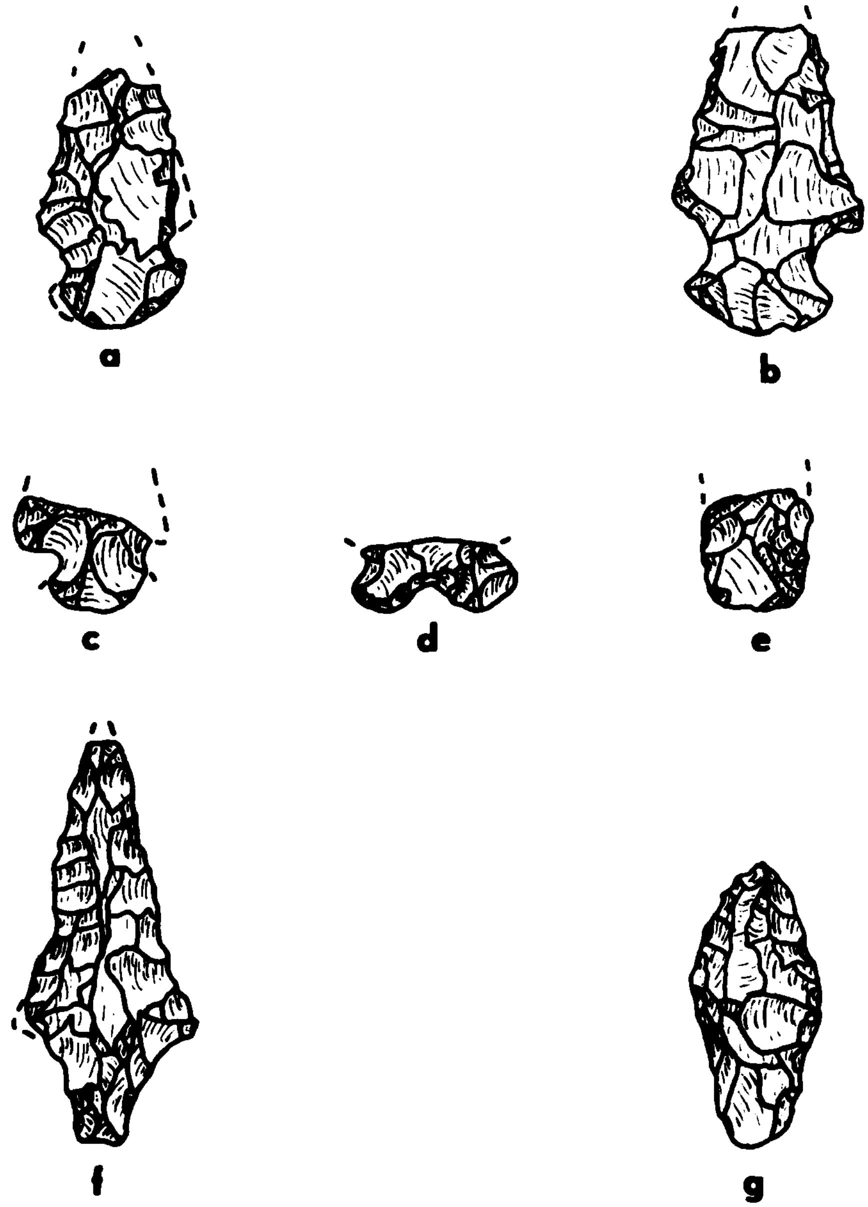

Figure 37. Projectile points. Length of f is 4.5 centimeters.

with contracting stems from the Archaic period occupation of Site 33 must await additional investigation of Site 33, the finding of two contracting stem points in deposits of the Zone 4 Archaic period occupation at Site 33 is not at odds with the suggested date of 2500 BC to 1800 BC for this occupation and is supported by the comparable ages of similar points to the west and north in New Mexico and to the southeast in Transpecos Texas. The recovery of other projectile points with the future investigation of Site 33 would certainly provide much needed information on temporally diagnostic artifacts for the Archaic period in the El Paso area.

Tool Function

Thus far, discussions have centered on the procurement and reduction of raw materials. In this section, attention will be directed to the possible functions of chipped stone tools or, most specifically, the actions involving their use. In recent years emphasis in the study of chipped stone tools has shifted from considerations of stylistic or mechanistic variability to attribute analysis of utilized edges and surfaces (Semenov 1964; Wilmsen 1970). Although many advances have been made in the techniques used to study chipped stone tools, there is still considerable debate over the meanings which can be ascribed to such things as wear patterns, edge angles, edge outline, etc. (Hayden and Kamminga 1979). Therefore, the following study of chipped stone tools may be reviewed as an intuitive analysis based, in part, on the suggested differences in kinds of tools associated with each of the occupations at Sites 33 and 34 from the previous discussions of raw material selection and reduction technology.

The intent of this section is to provide a measure of the differences in activities between the Archaic and Formative period occupations of Sites 33 and 34 and not specific functions of chipped stone tools. That is, the attribute analysis of chipped stone tools is aimed at delimiting general classes of activities performed with these tools such as scraping, shredding, cutting, sawing, and chopping. The assignation of functional labels to chipped stone tools, such as knive, denticulate, plane, and burin, is of little concern here because of the ambiguity of function connoted by such labels which have often been defined by others using only form or reduction stage of an artifact.

A chipped stone tool is defined as any chipped stone item exhibiting patterns of use or wear along one or more edges. The only exception to this definition is projectile points which showed no wear patterns but whose form allowed the inference of their use. All chipped stone items were examined under a 70 power binocular microscope for evidence of wear, and three types of wear patterns were observed: feather scars, step fractures, and edge rounding and polish. No evidence of striations which would indicate the direction of use was noted. Feather scars are morphologically similar to scars produced by retouching the edge of an item but are consistently smaller in overall size. The distal and lateral portions of these scars feather out to meet the surface of the item and distinguish feather scars from step fractures which terminate at their distal ends in abrupt steps or cleavages. Edge rounding and polish is the result of the abrasion of an edge from use and was observed as the rounded and lustrous margins of utilized edges.

There are many factors which can condition the kinds of wear patterns produced on chipped stone tools. These include the material of the tool, the resiliency of the medium being worked, the amount and angle of applied force, the duration of tool use, and the mode of tool usage (scraping, sawing, etc.) (Chapman 1977). It is, therefore, difficult to attribute, *a priori*, particular wear pattern on tools to particular tasks. For this reason, little significance is attached to wear patterns in this study with respect to ascribing specific usages to morphological alterations of utilized edges. Instead, the analysis of wear patterns is directed simply toward the description of assemblage variability.

Wear patterns were observed on 365 edges of chipped stone artifacts at Sites 33 and 34. These include 29 utilized edges on 29 utilized cores, 293 utilized edges on 222 utilized flakes, and 43 utilized edges on 34 utilized and marginally retouched flakes. No projectile points or other bifaces were found to have observable wear patterns. In the following analysis, each utilized edge is treated analytically as a distinct and separate tool. Thus, the 285 utilized chipped stone artifacts have 365 edges which are reported as 365 individual tools.

Additional attributes monitored on utilized chipped stone artifacts are the direction of utilization, the length and shape of a utilized edge, tool weight, and utilized edge angle. These attributes and wear patterns are common to many studies of chipped stone artifacts where there is a concern for the definition of the kinds of motor activities performed with tools and the contexts of tool use (Chapman 1977; Hayden and Kamminga 1979; Semenov 1964; Wilmsen 1970). Other attributes could have been recorded, but the above mentioned variables and their distribution among reduction categories proved to be sufficient for this preliminary study of lithic assemblages at Sites 33 and 34 in terms of suggesting general classes of activities performed with chipped stone tools and providing information on chipped stone assemblages which can help give direction to analyses of chipped stone artifacts in future, more intensive, investigations of these sites.

The direction of utilization for edges exhibiting wear patterns is described as being unidirectional if wear patterns extend from the margin outward over one face of the edge or bidirectional if wear patterns extend from the margin outward over both surfaces of the edge. Unidirectional wear patterns are generally thought to be the product of the transverse movement of an edge against a medium (such as scraping), while bidirectional wear patterns may be the result of the longitudinal movement of an edge against a medium (such as sawing) (Semenov 1964; Wilmensen 1970). Bidirectional wear patterns may also be produced when an edge is struck against a medium in a chopping fashion. Besides noting unidirectional or bidirectional wear patterns on the margins of chipped stone tools, a third type of directional wear was observed on accessory projections of two utilized flakes and two utilized and marginally retouched flakes. These projections showed rotary wear patterns which were evidenced as a slight edge rounding and polish and some feather scars on both sides of all edges of the shafts. Rotary wear patterns are taken as evidence of the use of projections for drilling or perforating materials.

The length of a utilized edge was taken to be only that portion of an edge with observable wear patterns and was measured by following the contour of the utilized edge. In general, wear patterns were found to be distributed continuously, or nearly so, along the edges of utilized items. Rarely were items encountered with discontinuous and widely spaced wear patterns which made measurement of the length of the utilized edge difficult but not impossible by considering the shape of the utilized edge and the material of the tool.

The shape of a utilized edge was recorded as being straight, convex, concave, or sinuous when viewed from above and at an angle perpendicular to the plane passing through or near the major edges of an artifact. A sinuous edge is one that bends in and out in a serpentine fashion. Most sinuous edges have been produced by edge retouch, but there are also some utilized flakes whose edges exhibit natural sinuousity. Often sinuousity is accompanied by projections which give the edge a serrated appearance. This is found principally on marginally retouched flake and core tools where retouched is intentionally spaced to give deep flake scars with intervening projections.

The weights of chipped stone tools were noted to provide a relative measure of the size or mass of tools and are considered more reliable and simpler estimates of tool sizes than those founded on maximum length, width, and thickness measures. It was anticipated that tool weights would show a weak positive correlation with the lengths of utilized edges but that tools within a limited range of weights might have a considerable range of utilized edge lengths or vice versa. Tool weights are an important consideration for those activities (such as chopping) in which the mass of the tool is used in delivering considerable force to the medium being worked. Tool weight is also the only attribute monitored which would necessarily be the same for different utilized edges of the same chipped stone artifact. All other attributes were recorded individually for utilized edges and need not be the same for utilized edges of the same chipped stone artifact.

The last attribute recorded is the angle of the utilized edge which is the angle formed by the projected intersection of the unutilized surfaces of the artifact at the utilized margin of the artifact. The angle produced by the morphological alteration of an edge with use was not measured. Studies by Semenov (1964) and Wilmsen (1970) indicate that certain specific ranges of edge angles are more effective or efficient for certain general categories of tool function than are other edge angles. Wilmsen suggests that an edge angle between 26 and 35 degrees is efficient for cutting meat and skin, that an edge angle between 46 and 55 degrees is useful in skinning, hide scraping, sinew and plant fiber shredding, and heavy cutting of wood, bone, or horn, and that an edge angle between 66 and 75 degrees implies wood working, bone working, and heavy shredding.

General classes of activities performed with chipped stone tools were demarcated through the successive consideration of the observed variability in each of the above described attributes of chipped stone tools. A multivariate statistical analysis of the attributes of chipped stone tools was not undertaken because of the constraints of time and money for this preliminary investigation of Sites 33 and 34 which did not permit the monitoring of many variables or the difficult and time consuming statistical discrimination of tool classes from a mixture of discrete and continuous variables. Instead, the attribute analysis of chipped stone tools proceeded in a step-wise manner with the progressive inclusion of attributes whose relative importance and order was intuitively reasoned. The accompanying discourse outlines the analytical process followed in defining the kinds of activities performed with chipped stone tools, presents descriptive data for each of the attributes and reduction categories, and gives the proportional importance of uses of chipped stone tools for each of the occupations at Sites 33 and 34.

The angle of a utilized edge has been suggested to be more indicative of general categories of tool use than any of the other recorded attributes of chipped stone tools (Semenov 1964; Wilmsen 1970). That is, specific ranges of edge angles have been associated with particular kinds of tool usage, and no other single variable of chipped stone tools has been similarly interpreted. As a starting point in the search for patterns in attributes of chipped stone tools which might be referrable to activities performed with these tools, the edge angle of tools was plotted against the number of utilized edges (Figure 38). This showed no obvious break in the distribution of edge angles which otherwise appeared to exhibit a normal distribution for edges showing both unidirectional and bidirectional utilization. Thus, edge angles could not be used by themselves to partition chipped stone tools into manageable and, hopefully, meaningful classes.

As mentioned in the previous section, chipped stone tools tend to be smaller for the Archaic period occupation at Site 33 and larger for the Formative period occupations at Sites 33 and 34. Thus, it was thought that a division of chipped stone tools into small and large tools would help delineate the differences between these occupations. A comparison of utilized edge lengths and weights of chipped stone tools was then performed; the results are shown in Figure 39. The use of tool weight as a measure of tool size should be comprehensible, but the relationship between length of a utilized edge and tool size is not as clear. Here, the distinction is not simply being drawn between tools of small or large size, but also between tools with small weights and lengths of utilized edges which are inferred to have been manipulated in precision activities and those tools in which the large weights and lengths of utilized edges are suggested to have been used in less precisely controlled actions requiring greater applications of force. Tools having large lengths of utilized edges are, therefore, considered to be more indicative of the latter kind of activity even though their weights may be relatively small. Although the distribution of tool weights against utilized edge lengths in Figure 39 is nearly continuous, it is apparent that there are many more tools with small utilized edge lengths and weights than there are tools with large utilized edge lengths and weights. The first obvious break in the distribution of tools in Figure 39 as one moves away from smaller values of utilized edge length or tool weight was chosen as the demarcation of small tools from large tools. Small tools have utilized edge lengths of 50 mm or less and tool weights of 60 g or less. Large tools have utilized edge lengths of 50 mm or more and/or have tool weights of 60 g or more.

Inasmuch as the edge angles of all tools show a normal distribution (Figure 38), small tools were arbitrarily divided into those with edge angles of less than 55 degrees and those with edge angles of more than 55 degrees. This follows a previous analysis of chipped stone tools by O'Laughlin (1979) from sites in the El Paso area. O'Laughlin suggests that lighter activities will be reflected in tools with edge angles of less than 55 degrees and that these tools would be used on relatively yielding materials with only a small or moderate application of force to the object being worked. Heavier activities are implied for edge angles over 55 degrees and probably involve relatively non-yielding materials, a greater application of force to the object being worked, and generally less precisely controlled activities.

Means and standard deviations for weight, utilized edge length, and utilized edge angle are given for the two classes of small tools and large tools in Table 29. Small tools with edge angles less than 55 degrees have small weights, generally small lengths of utilized edges, and edge angles averaging between 44 and 52 degrees. Marginally retouched flakes are poorly represented in this small class of tools, core tools do not fall in this class, and utilized flakes are well represented. Small tools with edge angles over 55 degrees have weights which range larger than the first class of small tools but smaller than large tools, have edge lengths which lie between the other two classes of tools, and have edge angles larger than the first class of small tools and overlapping that of large tools to some extent. Utilized flakes, marginally retouched flakes, and core tools are all represented in the small tools with edge angles over 55 degrees. Core tools, however, are not as common as they are for the large tools. Large tools have the largest tool weights, the largest utilized edge lengths, and some of the larger edge angles. Neither utilized flakes nor marginally retouched flakes are well-represented by large tools, and core tools are a major constituent of large tools. In many respects, these three classes of chipped stone tools follow the division of chipped stone tools by reduction categories.

In Table 29 the shape of the utilized edge and the direction of utilization are also noted for the three derived tool classes as well as for three reduction categories. The data from Table 29 are expanded in Table 30 where wear patterns are enumerated for the three tool classes and 12 categories which incorporate both utilized edge shape and reduction category. Bidirectional utilization is also noted.

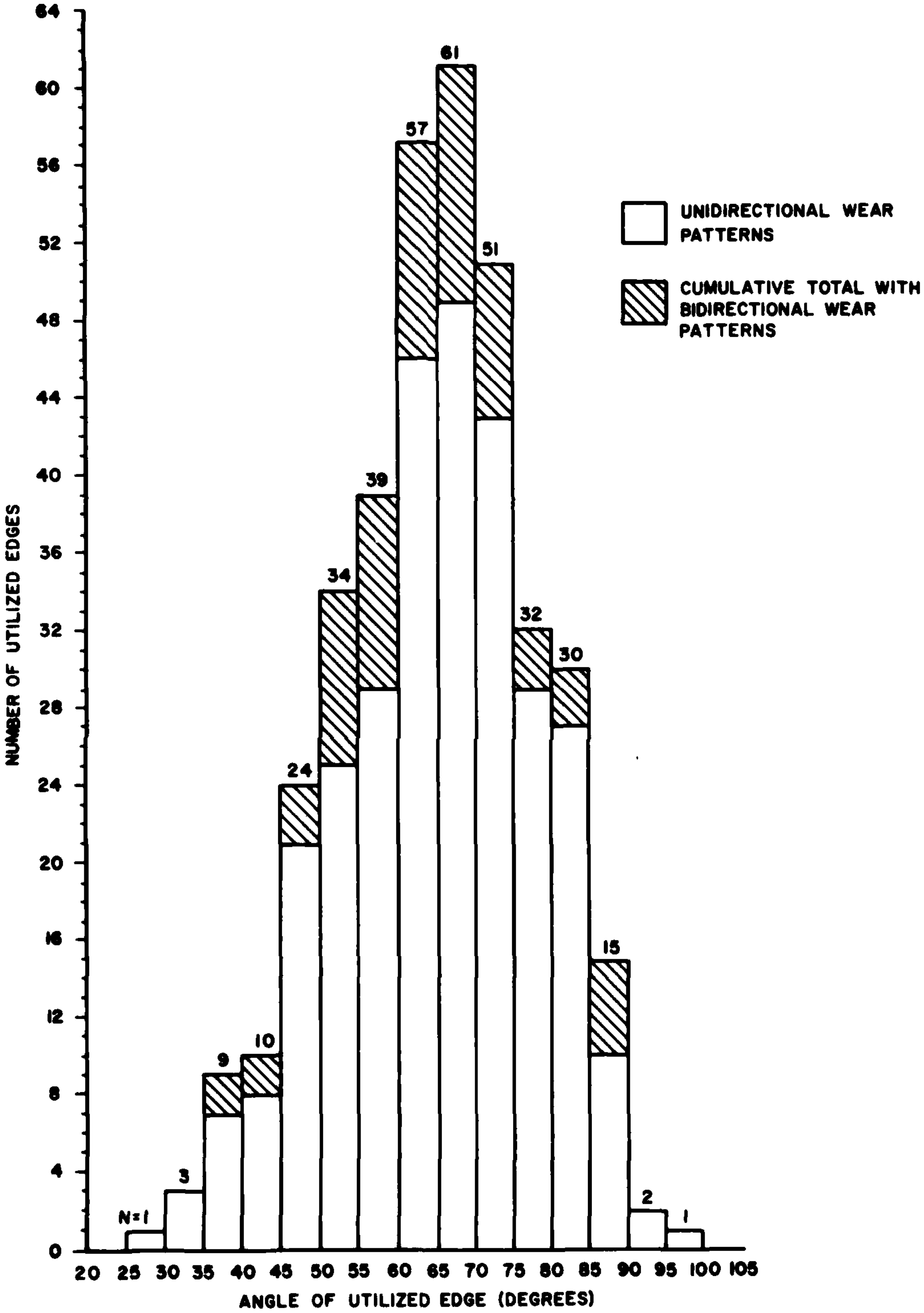

Figure 38. Distribution of edge angles for utilized edges.

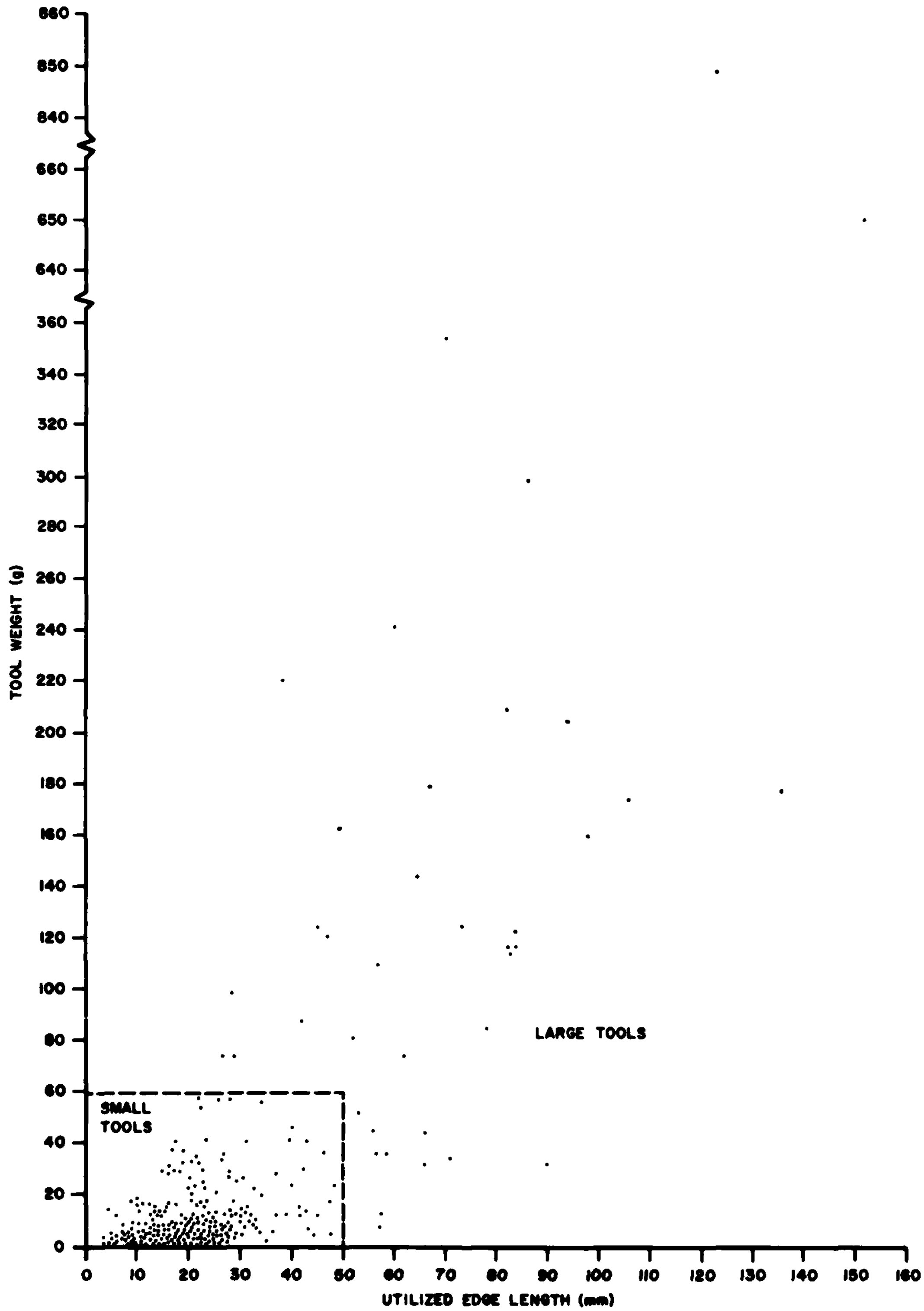

Figure 39. Distribution of utilized edge lengths and tool weights.

TABLE 29

MEANS AND STANDARD DEVIATIONS FOR WEIGHT, UTILIZED EDGE LENGTH, AND UTILIZED EDGE ANGLE FOR CHIPPED STONE TOOLS

		Small Tools Edge Angle Less than 55 Degrees							Small Tools Edge Angle Over 55 Degrees						
		Weight		Length		Edge Angle		No.	Weight		Length		Edge Angle		No.
		Mean	SD*	Mean	SD	Mean	SD	Items	Mean	SD	Mean	SD	Mean	SD	Items
Utilized Flake															
Straight Edge	U**	5.9	7.5	15.8	8.3	47.8	5.6	35	8.2	11.3	15.7	8.1	68.2	8.8	77
	B	12.1	17.3	21.5	11.2	47.9	6.2	9	5.8	5.1	19.8	7.3	67.6	8.0	21
Convex Edge	U	4.0	4.9	19.4	10.7	45.1	4.9	13	8.7	11.4	20.8	10.6	68.8	7.6	26
	B	2.1	1.8	23.9	14.0	49.0	7.3	6	7.2	7.7	23.0	8.9	68.2	9.9	9
Concave Edge	U	4.7	4.7	14.9	9.0	50.3	2.1	6	12.5	14.9	17.1	7.0	67.2	6.8	30
	B	-	-	-	-	-	-	-	7.2	5.9	16.5	4.9	62.8	3.7	5
Sinuous Edge	U	3.2	3.7	15.9	5.1	44.5	8.9	8	10.1	11.6	20.8	6.6	66.7	9.7	32
	B	2.6	-	14.1	-	51.0	-	1	6.4	6.5	20.9	9.3	64.3	6.2	7
Marginally Retouched Flake															
Straight Edge	U	-	-	-	-	-	-	-	13.8	-	30.5	-	67.0	-	1
	B	-	-	-	-	-	-	-	23.5	0.6	37.4	13.0	70.0	16.5	3
Convex Edge	U	-	-	-	-	-	-	-	8.0	4.6	33.4	8.2	85.7	6.0	3
	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concave Edge	U	2.6	2.5	7.2	3.2	49.0	5.7	2	12.0	4.9	14.8	9.0	73.5	11.9	6
Sinuous Edge	U	-	-	-	-	-	-	-	15.3	11.0	27.9	9.7	74.7	6.9	16
	B	5.9	-	33.1	-	52.0	-	1	-	-	-	-	-	-	-
Core Tool															
Straight Edge	U	-	-	-	-	-	-	-	24.4	10.7	14.4	4.3	76.7	3.1	3
Convex Edge	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concave Edge	U	-	-	-	-	-	-	-	41.9	17.7	22.5	0.0	75.0	4.2	2
Sinuous Edge	U	-	-	-	-	-	-	-	17.2	17.6	23.4	13.2	72.5	3.1	4
	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 29--Continued

		Large Tools						
		Weight		Length		Edge Angle		No.
		Mean	SD	Mean	SD	Mean	SD	Items
Utilized Flake								
Straight Edge	U	122.8	123.5	69.3	18.1	67.5	0.7	2
	B	-	-	-	-	-	-	-
Convex Edge	U	37.8	6.9	60.8	6.7	61.3	0.6	3
	B	100.1	86.8	86.1	43.3	63.3	5.1	3
Concave Edge	U	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Sinuous Edge	U	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Marginally Retouched Flake								
Straight Edge	U	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Convex Edge	U	45.3	-	66.1	-	88.0	-	1
	B	162.8	-	49.1	-	87.0	-	1
Concave Edge	U	74.3	-	27.5	-	61.0	-	1
Sinuous Edge	U	74.7	46.9	66.8	23.2	79.0	6.1	7
	B	74.3	-	61.5	-	67.0	-	1
Core Tool								
Straight Edge	U	169.8	73.5	61.3	32.2	81.5	9.2	2
Convex Edge	B	179.1	-	67.1	-	85.0	-	1
Concave Edge	U	99.0	-	28.1	-	75.0	-	1
Sinuous Edge	U	236.2	246.5	79.8	30.6	79.4	5.2	13
	B	198.8	90.4	92.0	12.0	80.3	5.0	3

*SD = One standard deviation
** U = Unidirectional utilization
B = Bidirectional utilization

Weight is in grams
Length is in centimeters
Edge is in degrees

TABLE 30

WEAR PATTERNS EXHIBITED ON UTILIZED EDGES OF CHIPPED STONE TOOLS FOR COMBINED ARCHAIC AND FORMATIVE PERIODS

	1	2	3	4	5	6	7	8	9	10	11	12	Total	Percent of Wear Patterns	Percent of Bidirectional Wear
Small tools (less than 60g and 5cm utilized length)															
Edge angle less than 55°															
Feather use retouch	19(4)*	7(2)	2	4(1)	-	-	1	-	-	-	-	-	33(7)	40.7	41.2
Feather & step use retouch	10(4)	1(1)	2	2	-	-	1	-	-				16(5)	20.0	29.4
Rounded and polished	1(1)	1	-	-	-	-	-	-	-	-	-	-	2(1)	2.5	5.9
Rounded and polished w/feather and/or step use retouch	14	10(3)	2	3	-	-	-	1(1)	-	-	-	-	30(4)	37.0	23.5
Total	44(9)	19(6)	6	9(1)	-	-	2	1(1)	-	-	-	-	81(17)	100.2	100.0
Percent of tool class	54.3	23.5	7.4	11.1	-	-	2.5	1.2	-	-	-	-	100.0	-	-
Percent of bidirectional wear	52.9	35.3	-	5.9	-	-	-	5.9	-	-	-	-	100.0	-	-
Edge angle over 55°															
Feather use retouch	45(7)	9(1)	13(1)	13	-	1	3	3	2	-	2	1	92(9)	37.6	20.0
Step use retouch	1(1)	-	1	-	-	-	2	-	-	-	-	-	4(1)	1.6	2.2
Feather & step use retouch	15	6(2)	11(1)	8(1)	-	1	-	6	1	-	-	-	48(4)	19.6	8.9
Rounded and polished	2	2(1)	-	-	-	-	-	1	-	-	-	-	5(1)	2.0	2.2
Rounded and polished w/feather and/or step use retouch	35(13)	18(5)	10(3)	18(6)	4(3)	1	1	6	-	-	-	3	96(30)	39.2	66.7
Total	98(21)	35(9)	35(5)	39(7)	4(3)	3	6	16	3	-	2	4	245(45)	100.0	100.1
Percent of tool class	40.0	14.3	14.3	15.9	1.6	1.2	2.4	6.5	1.2	-	0.8	1.6	99.8	-	-
Percent of bidirectional wear	46.7	20.0	11.1	15.6	6.7	-	-	-	-	-	-	-	100.1	-	-
Large tools (over 60g and/or 5cm utilized length)															
Edge angle over 55°															
Feather use retouch	1	3(2)	-	-	-	-	-	2	-	1(1)	-	-	7(3)	17.9	33.3
Step use retouch	-	-	-	-	-	-	-	-	-	-	-	1	1	2.6	-
Feather and step use retouch	1	2(1)	-	-	-	1	1	1	-	-	1	5	12(1)	30.8	11.1
Rounded and polished	-	-	-	-	-	-	-	-	-	-	-	2	2	5.1	-
Rounded and polished w/feather and/or step use retouch	-	1	-	-	-	1(1)	-	5(1)	2	-	-	8(3)	17(5)	43.6	55.6
Total	2	6(3)	-	-	-	2(1)	1	8(1)	2	1(1)	1	16(3)	39(9)	100.0	100.0
Percent of tool class	5.1	15.4	-	-	-	5.1	2.6	20.5	5.1	2.6	2.6	41.0	100.0	-	-
Percent of bidirectional wear	-	33.3	-	-	-	11.1	-	11.1	-	11.1	-	33.3	99.9	-	-

*No. with bidirectional wear patterns in parentheses

1 = Utilized flake, straight edge
2 = Utilized flake, convex edge
3 = Utilized flake, concave edge
4 = Utilized flake, sinuous edge
5 = Marginally retouched flake, straight edge
6 = Marginally retouched flake, convex edge
7 = Marginally retouched flake, concave edge
8 = Marginally retouched flake, sinuous edge
9 = Core tool, straight edge
10 = Core tool, convex edge
11 = Core tool, concave edge
12 = Core tool, sinuous edge

Bidirectional utilization shows no marked distribution toward particular wear patterns, shapes of utilized edges, reduction categories, or tool classes. It seems to vary simply with the number of items represented by a tool class, wear pattern, etc. There is a tendency for tools with convex edges to have a slightly disproportionate number of bidirectionally utilized edges, and bidirectional utilization is proportionately higher for small tools with edge angles greater than 55 degrees (31%) as compared to the other two classes of tools (21% and 23%). Wear patterns are generally of three forms: feather use retouch (feather scars), feather and step use retouch (step fractures), and edge rounding and polish with feather and step use retouch. Large tools can be distinguished from the two classes of small tools by proportionately fewer items having only feather use retouch (18% as opposed to 41% and 38%), fewer items exhibiting only feather and/or step use retouch (51% as compared to 61% and 59%), and more items showing rounded and polished edges (49% as opposed to 39% and 41%). It should be noted that large tools include relatively more items of rhyolite, quartzite, and limestone and fewer items of chert than the small tools (see the section on raw material selection) and that the observed differences in wear patterns might also pertain to differences in materials between tool classes. Straight and convex edges are the predominant edge shapes for small tools with edge angles less than 55 degrees, straight edges are well represented among small tools with edge angles greater than 55 degrees, and sinuous edges are characteristic of large tools. Intentional retouch of edges is probably related to the greater occurrence of sinuous edges on large tools which are comprised mostly of marginally retouched flake and core tools. Larger weights, utilized edge lengths, and utilized edge angles and more step use retouch, rounded and polished edges, and edge sinuousity differentiate large tools from small tools and hint at the use of large tools in activities possibly involving an application of greater force with generally coarse-grained materials to relatively non-yielding mediums and the use of small tools in more precisely controlled activities on relatively yielding mediums with mostly fine-grained materials.

In light of the near random distribution of wear patterns, direction of utilization, and utilized edge shapes with respect to the three classes based on tool weight, length of the utilized edge, and edge angle, recourse was taken to the earlier studies of Semenov (1964) and Wilmsen (1970) and the suggestion that unidirectional wear patterns of non-sinuous edges may be indicative of scraping activities, that unidirection wear patterns of sinuous edges may imply scraping or shredding activities, and that bidirectional wear patterns may reflect cutting, sawing, or chopping activities. These activities are indicated in Table 31 for each of the tool classes and utilized edge shapes of reduction categories. The relative importance of cutting, sawing, or chopping for each of the tool classes is also based on a consideration of the weight and edge angle of tools with bidirectional wear patterns. Cutting or sawing is inferred for small tools with edge angles less than 55 degrees, cutting, sawing, or chopping is suggested for small tools with edge angles greater than 55 degrees, and only chopping is proposed for large tools. Light, medium, and heavy activities are thought to be indicated by the weights and edge angles of tools and correspond to the three defined classes of tools. That is, larger weights and edge angles are believed to be indicative of heavier activities involving the mass of the tool, and smaller weights and edge angles are thought to be indicative of lighter activities involving the manipulation of tools. In addition, two more activities have been suggested. These are drilling or perforating and hunting or protection which are founded on flakes with accessory projections showing rotary wear patterns and projectile points which exhibit no wear patterns.

The activities suggested for the chipped stone tools in Table 31 have been transposed in Table 32 to show the relative importance of the different activities for the various occupations of Sites 33 and 34. Some biases in the relative importance of activities have probably been introduced into those assemblages with 27 or fewer utilized edges and projectile points. However, some trends can be noted in the distribution of suggested activities. Heavy activities are more important for assemblages of the Formative period but do not appear to be important for the Archaic period assemblage. Some heavy activities were probably performed during the Archaic period occupation, but they are not believed to have been of much importance as judged from their small percentage for mixed Archaic period and Mesilla phase materials. The percentages of medium activities vary considerably but are always larger than those for either light or heavy activities. These activities either do not vary much temporally and with the nature of occupations or are somewhat less important for the Archaic period occupation. In particular, scraping or shredding and chopping, cutting, or sawing are of relatively less importance for the Archaic period assemblage. Light activities appear to be somewhat more important for the Archaic period occupation than for later Formative period occupations, but the percentages of light activities also vary with

TABLE 31

GENERAL ACTIVITIES PERFORMED WITH CHIPPED STONE TOOLS
FOR COMBINED ARCHAIC AND FORMATIVE PERIODS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Percent
Small tools (less than 60g and 5cm utilized length)																
Light drilling or perforating	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4	1.1
Edge angle less than 55 degrees																
Light cutting or sawing*	9	6	-	1	-	-	-	1	-	-	-	-	-	-	17	4.5
Light scraping	35	13	6	-	-	-	2	-	-	-	-	-	-	-	56	14.9
Light scraping or shredding	-	-	-	8	-	-	-	-	-	-	-	-	-	-	8	2.1
All light activities															85	22.6
Edge angle over 55 degrees																
Medium scraping	77	26	30	-	1	3	6	-	3	-	2	-	-	-	148	39.4
Medium scrapping or shredding	-	-	-	32	-	-	-	16	-	-	-	4	-	-	52	13.8
Medium chopping, cutting or sawing*	21	9	5	7	3	-	-	-	-	-	-	-	-	-	45	12.0
All medium activities															245	65.2
Large tools (over 60g and/or 5cm utilized length)																
Edge angle over 55 degrees																
Heavy scraping	2	3	-	-	-	1	1	-	2	-	1	-	-	-	10	2.7
Heavy scraping or shredding	-	-	-	-	-	-	-	7	-	-	-	13	-	-	20	5.3
Heavy chopping*	-	3	-	-	-	1	-	1	-	1	-	3	-	-	9	2.4
All heavy activities															39	10.4
Hunting and protection	-	-	-	-	-	-	-	-	-	-	-	-	-	7	7	1.9
Total	144	60	41	48	4	5	9	25	5	1	3	20	4	7	376	100.1
Percent	38.3	16.0	10.9	12.8	1.1	1.3	2.4	6.6	1.3	0.3	0.8	5.3	1.1	1.9	100.1	-

* = Bidirectional wear patterns
1 = Utilized flake, straight edge
2 = Utilized flake, convex edge
3 = Utilized flake, concave edge
4 = Utilized flake, sinuous edge
5 = Marginally retouched flake, straight edge
6 = Marginally retouched flake, convex edge
7 = Marginally retouched flake, concave edge
8 = Marginally retouched flake, sinuous edge
9 = Core tool, straight edge
10 = Core tool, convex edge
11 = Core tool, concave edge
12 = Core tool, sinuous edge
13 = Utilized or retouched flake with accessory projection
14 = projectile point

TABLE 32

GENERAL ACTIVITIES PERFORMED WITH CHIPPED STONE TOOLS COMPARING THE ARCHAIC PERIOD AND THE FORMATIVE PERIOD

	33-AE		33N-AME&S		33N-ME&S		33S-ME&S		34-ME&S		33-MPE&S	
	Total Tools	Percent	Total Tools	Percent	Total Tools	Percent	Total Tools	Percent	Total Tools	Percent	Total Tools	Percent
Light Activities												
Drilling or perforating	1	3.7	-	-	2	1.1	-	-	-	-	1	9.1
Cutting or sawing	1	3.7	3	2.9	12	6.6	1	3.7	-	-	-	-
Scraping	6	22.2	21	20.0	18	9.9	8	29.6	1	4.0	2	18.2
Scraping or shredding	-	-	4	3.8	3	1.7	-	-	1	4.0	-	-
Total	8	29.6	28	26.7	35	19.3	9	33.3	2	8.0	3	27.3
Medium Activities												
Scraping	14	51.9	43	41.0	69	38.1	6	22.2	11	44.0	5	45.5
Scraping or shredding	1	3.7	12	11.4	26	14.4	2	7.4	7	28.0	3	27.3
Chopping, cutting or sawing	2	7.4	13	12.4	26	14.4	2	7.4	3	12.0	-	-
Total	17	63.0	68	64.8	121	66.9	10	37.0	21	84.0	8	72.7
Heavy Activities												
Scraping	-	-	1	1.0	8	4.4	1	3.7	-	-	-	-
Scraping or shredding	-	-	5	4.8	9	5.0	5	18.5	1	4.0	-	-
Chopping	-	-	1	1.0	6	3.3	1	3.7	1	4.0	-	-
Total	-	-	7	6.7	23	12.7	7	25.9	2	8.0	-	-
Hunting and Protection	2	7.4	2	1.9	2	1.1	1	3.7	-	-	-	-
Total Tools	27	-	105	-	181	-	27	-	25	-	11	-

33 = Site 33 North and South
33N = Site 33 North
33S = Site 33 South
34 = Site 34
E = Excavation
S = Surface

A = Archaic period
AM = Mixed Archaic period and Mesilla phase
M = Mesilla phase
MPE = Mixed Mesilla, Dona Ana, and El Paso phases

sample sizes. Light scraping or shredding may be of somewhat less importance for the Archaic period as compared with Formative period materials. Activities of hunting and protection may have been of greater concern during the Archaic period, but the relative importance of these activities varies considerably with the small number of projectile points found and were not likely of any great significance for any of the occupations at Sites 33 and 34.

The mixed materials of the Archaic period and Mesilla phase are mostly from restricted surfaces of Site 33 where both Zones 2 and 4 are deflated. Given the low density of lithic materials for the Formative period occupations at Sites 33 and 34 and the high density of lithic materials for the Archaic period occupation at Site 33, it is probable that most of the lithic materials of the mixed Archaic period and Mesilla phase are from the Archaic period occupation at Site 33. Thus, the Archaic period and mixed Archaic period and Mesilla phase lithic assemblages can be combined for a comparison with the combined lithic assemblages of the Formative period. If so done, light activities would be most important for the Archaic period by about 7%, medium activities would be comparable for both periods, and heavy activities would be more important for the Formative period by about 8%. This is also the pattern suggested from a comparison of the smaller and uncombined lithic assemblages.

The relative greater importance of light activities for the Archaic period occupation at Site 33 follows the contention that this occupation was of some duration and more generalized or involving a greater variety of activities than the later Formative period occupations at Sites 33 and 34. Light activities are more indicative of tool manipulation than heavy activities, and the greater importance of light activities for the Archaic period occupation of Site 33 would correspond to the inferred greater importance of maintenance and supportive activities for this occupation.

The relative greater importance of heavy activities for the Formative period occupations at Sites 33 and 34 than for the Archaic period occupation of Site 33 reinforces the contention that the Formative period occupations were specialized in the sense of being oriented toward the processing of leaf succulents. That is, heavy activities may be associated with the processing of leaf succulents before baking or roasting or with their continued processing after roasting or baking. This is not to imply that heavy activities are only referrable to the processing of leaf succulents but that the processing of leaf succulents appears to be the more important heavy activity at these particular sites.

Comparable analyses of lithic materials which delimit the nature of activities performed with chipped stone tools are lacking for the El Paso area with the exception of that by O'Laughlin (1979) for five sites on an alluvial fan below the east flank of the Franklin Mountains. These sites are suggested by O'Laughlin to have been ephemerally occupied principally during the Mesilla phase of the Formative period for the purpose of processing leaf succulents such as lechuguilla and sotol which are constituents of nearby upland plant communities. O'Laughlin differentiates light and heavy activities and cutting, sawing, or chopping and scraping or shredding activities on the basis of utilized edge angle, shape of the utilized edge, and direction of utilization for utilized edges of chipped stone tools defined by the presence of wear patterns. The heavy activities defined by O'Laughlin encompass the medium to heavy activities described in this report for the lithic assemblages of Sites 33 and 34, while his light activities are identical in definition to those of this report. The relative importance of general activities performed with chipped stone tools from the five sites (noted as the El Paso Community College sites) studied by O'Laughlin (1979) are compared with those of Mesilla phase components of Sites 33 and 34 in Table 33 where cutting, sawing, or chopping and scraping or shredding have been similarly distinguished in both studies. The relative contributions of the various activities are comparable for these two groups of sites with discrepancies noted in the higher percentage of light scraping or shredding and in the lower percentage of medium to heavy chopping, cutting, or sawing for the Community College sites. Both groups of sites have somewhat small percentages of light activities (19.7% and 25.5%) and high percentages of medium to heavy activities (79.0% and 71.6%).

The Formative period occupations of Sites 33 and 34 and those of the above mentioned El Paso Community College sites have been characterized as ephemeral occupations for which the processing of leaf succulents is indicated by the preponderance of fire-cracked rock features, the low density of lithic artifacts, and the proximity of plant communities having upland leaf succulents. The near correspondence in general activities performed with chipped stone tools between these sites may, therefore, be taken as evidence in support of the inferred sameness of tasks performed at these sites. However, it is also observed that the percentages of light and medium to heavy activities for the Community College sites are intermediate between those of the Mesilla phase components of Sites 33 and 34 (Table 33) and those of the presumed longer and more generalized Archaic period occupation at Site

TABLE 33

GENERAL ACTIVITIES PERFORMED WITH CHIPPED STONE TOOLS FOR MESILLA PHASE COMPONENTS AT SITES 33 AND 34 COMPARED TO THE EL PASO COMMUNITY COLLEGE SITES

	Sites 33 & 34		Community College Sites	
	Total Tools	Percent	Total Tools	Percent
Drilling and perforating	2	0.9	-	-
Edge angle less than 55 degrees				
Light cutting or sawing*	13	5.6	12	5.8
Light scraping	27	11.6	28	13.5
Light scraping or shredding	4	1.7	13	6.2
All light activities	46	19.7	53	25.5
Edge angle over 55 degrees				
Medium to heavy scraping	95	40.8	87	41.8
Medium to heavy scraping or shredding	50	21.5	41	19.7
Medium to heavy chopping, cutting or sawing*	39	16.7	21	10.1
All medium to heavy activities	184	79.0	149	71.6
Hunting and protection	3	1.3	6	2.9
Total	233	100.0	208	100.0

* = Bidirectional wear patterns

33 (Table 32). Although no heavy activities are suggested by the chipped stone tools of the Archaic period occupation at Site 33 and even though the relative contributions of activities performed with chipped stone tools for the Archaic period occupation of Site 33 and the Formative period occupations of Sites 33 and 34 are substantially different, the intermediacy of the spectra of activities performed with chipped stone tools for the Community College sites does question the utility of describing the activities performed with chipped stone tools in the fashion presented here. Certainly, a larger number of sites of the El Paso area for which the chipped stone tools have been similarly studied are needed in order to fully evaluate the inference drawn herein on tool function. In the next section added attention is given to other means of discriminating the Archaic and Formative period occupations of Sites 33 and 34 through the analyses of spatial patterns in features and artifacts for these and other selected sites of the El Paso area.

Spatial Analyses

The earlier portion of this chapter has been concerned with characterizing the Archaic and Formative period occupations of Sites 33 and 34 through the description and interpretation of chipped stone artifacts found at these sites. The selection and reduction of locally available raw materials for chipped stone tools has been remarked as being similar for the Archaic period and Formative period occupations of Sites 33 and 34, and the Archaic period occupation has been distinguished from the Formative period occupations by the apparent more extensive working of materials, the seemingly larger importance of bifacial thinning and tool resharpening activities, and the evident greater curation of cores and tools. The Archaic period tools have been noted as generally being small and of fine-grained materials, while those of the Formative period occupations have been observed to include large tools of coarse-grained materials. It has also been suggested that light activities involving the controlled manipulation of chipped stone tools are proportionately more important for the Archaic period occupation and that heavy activities using the size or mass of a tool in less precisely controlled actions are proportionately more important for the Formative period occupations. Taken together, these observations support the argument that the Archaic period occupation was of some duration, although probably intermittent, and characterized by generalized, maintenance and supportive activities and that the Formative period occupations were more ephemeral and intermittent and were typified by more specialized, extractive activities. The validity of these inferences is pursued further in the following two analyses of spatial patterns in features and artifacts. The first of these analyses looks at the distribution of features and artifacts on the surfaces of Sites 33 and 34, and the second analysis compares and contrasts chipped and ground stone assemblages from these sites and other selected sites of the El Paso area.

Surface Artifacts and Features of Sites 33 and 34

Gerald (n.d. b), O'Laughlin and Greiser (1973), and O'Laughlin (1979) have investigated six small to large Formative period sites on an alluvial fan at the base of the east side of the Franklin Mountains. These six sites were described as having low surface densities of lithic and ceramic materials, and fire-cracked rock features were the only features noted on the surfaces of these sites. O'Laughlin (1979) suggests that these sites were ephemerally occupied for specialized activities centering on the procurement and processing of upland leaf succulents and bases this interpretation on the proximity of upland leaf succulents to these sites, the common occurrence of fire-cracked rock features which are presumably well suited for baking or roasting leaf succulents, the presence of substantial percentages of large tools indicative of extractive activities, and the nonrandom distribution of fire-cracked rock features and artifacts on the surfaces of these sites.

Chi-square statistics were performed by Gerald (n.d. b), O'Laughlin and Greiser (1973), and O'Laughlin (1979) on the presence or absence of fire-cracked rock features and artifacts for over two thousand 5x5 m grids which were surface collected and mapped at the above mentioned sites. Significant, positive associations were found between fire-cracked rock features and ceramic materials, between ceramics and chipped stone artifacts, and between utilized flakes, marginally retouched flakes, and bifaces. Chipped stone artifacts were noted as being independently distributed with respect to fire-cracked rock features, and ceramic materials were found to be significantly more numerous near fire-cracked rock features. Ground stone implements and worked sherds showing abraded or worn edges from use were also suggested to be found more often near fire-cracked rock features, but sample sizes were too small in some cases for valid tests of association with the Chi-square statistic.

The patterned relationships for sparsely distributed fire-cracked rock features and artifacts of the above related sites are informative because they provide some evidence of discrete activity areas which might be referrable to the individual, intermittent occupations of these sites and different kinds of tasks being performed. The constellation of fire-cracked rock features, ceramics, worked sherds, and possibly grinding implements may represent tasks oriented toward the processing of leaf succulents. The associations of chipped stone tools, other than core tools, presumably reflect distinct loci away from fire-cracked rock features where the preparation of leaf succulents for roasting or baking in the fire-cracked rock features, the continued processing of leaf succulents after cooking, or other supportive activities may have been performed. Independent distributions of fire-cracked rock features and chipped stone indicate that stone reduction activities were not centered on the fire-cracked rock features.

The Formative period occupations of Sites 33 and 34 are thought to be very similar to those of the above described sites. That is, they are also believed to have been intermittent and ephemeral occupations with activities oriented principally toward the processing of leaf succulents. The Formative period occupations of Sites 33 and 34 are noted as having fire-cracked rock features as the most numerous type of feature and as having low surface and subsurface densities of ceramic and lithic materials. Casual observations during the course of surface collecting and mapping at Sites 33 and 34 suggest that artifacts might not be randomly distributed with respect to the fire-cracked rock features of these sites for the Formative period occupations. Therefore, the question is raised as to whether patterned relationships between artifacts and features are discernible for the Formative period occupations of Sites 33 and 34 and comparable to those recorded by Gerald (n.d. b), O'Laughlin and Greiser (1973) and O'Laughlin (1979) for the above mentioned sites. The following spatial analysis of fire-cracked rock features and artifacts on the surfaces of Sites 33 and 34 pursues this query.

The entire surfaces of Sites 33 and 34 were gridded into 4x4 m squares for a total of 2,593 grid squares, and collections of all surface artifacts and estimates of the total weight of fire-cracked rock were made for the grid squares (Chapter IV). It was not always possible to identify individual fire-cracked rock features because of the scattering of fire-cracked rock on deflated or eroded features or the overlapping distributions of fire-cracked rock from closely spaced features (Chapter VIII). Thus, the total weight of fire-cracked rock for each grid square was taken as a measure of the relative importance of fire-cracked rock features. Artifacts from each of the grid squares were partitioned into 10 analytic categories: the total number of sherds, the number of worked sherds (exhibiting abraded or rounded edges from use), the number of pieces of ground stone implements, the number of hammerstones, the number of flakes (unutilized flakes and non-diagnostic shatter), the number of unutilized cores, the number of chipped stone tools for each of the three classes of tools defined in the previous section, and the number of bifaces (unutilized bifaces and projectile points). There are, then, 11 variables recorded for each of the 2,593 4x4 m grid squares of Sites 33 and 34 which can be analyzed statistically for spatial patterns in the distribution of artifacts and features on the surfaces of these sites. Satistical analyses of the subsurface distribution of artifacts and features for the Archaic period and Formative period occupations at Sites 33 and 34 have not been attempted because of the small number and biased locations of test excavations (Chapter IV).

Sites 33 and 34 are located on the same alluvial fan at the mouth of a large drainage which begins in the Franklin Mountains and empties onto the floodplain of the Rio Grande. These sites are defined by the discontinuous distribution of archeological materials on the surface of the alluvial fan and are separated by an arroyo and a low ridge (Figure 7). The Formative period occupations at Sites 33 and 34 show considerable temporal overlap (Chapters V and IX), and Formative period features and artifacts at these sites are comparable (Chapters VIII and IX and the previous section). The surface distribution of artifacts and features for each site appears to be a composite resulting principally from repeated and short-lived occupations by small groups during the Formative period. Although the surface distribution of archeological materials is discontinuous, it is probable that the present definition of two archeological sites has little bearing on the Formative period use of the alluvial fan and that Sites 33 and 34 are referrable to Formative period occupations of one general locality. For this reason, Sites 33 and 34 are not treated as separate entities in the following described statistical analysis.

Coefficients of correlation between the 11 variables recorded for 1,205 of the combined 4x4 m grid squares of Sites 33 and 34 are given in Table 34 with only those correlations significantly different from zero at the 0.01 probability level reported. Only 1,205 or 46% of the grid squares have been used in deriving the correlation coefficients because the remaining 1,388 grid squares contained no fire-cracked rock or artifacts. The inclusion of so many empty grid squares in the calculation of correlation coefficients was unwarranted and would have biased the statistics and raised the values of correla-

TABLE 34

SIMPLE CORRELATION COEFFICIENTS BETWEEN THE CONTENTS OF 4X4M SURFACE COLLECTION GRID UNITS FOR SITES 33 AND 34

	Fcrwt	Totshrd	Wkshrd	Grndst	Hammerst	Flakes	Cores	Lrgtool	Smtool 1	Smtool 2	Biface
Fcrwt	-	0.13*	0.10	-	-	0.09	-	-	0.08	-	-
Totshrd	0.13	-	0.18	0.10	-	0.48	0.17	0.09	0.11	0.21	-
Wkshrd	0.10	0.18	-	-	-	0.13	-	-	-	-	-
Grndst	-	0.10	-	-	0.14	0.15	0.09	0.21	-	-	-
Hammerst	-	-	-	0.14	-	0.07	0.19	0.30	-	0.11	-
Flakes	0.09	0.48	0.13	0.15	0.07	-	0.32	0.20	0.20	0.27	0.08
Cores	-	0.17	-	0.09	0.19	0.32	-	0.30	-	0.08	-
Lrgtool	-	0.09	-	0.21	0.30	0.20	0.30	-	-	-	-
Smtool 1	0.08	0.12	-	-	-	0.20	-	-	-	0.31	-
Smtool 2	-	0.21	-	-	0.11	0.27	0.08	-	0.31	-	-
Biface	-	-	-	-	-	0.08	-	-	-	-	-

*Only correlation coefficients significantly different from zero at the 0.01 level are reported; n equals 1205.

Fcrwt = Weight of fire-cracked rocks in kg.
Totshrd = Total number of sherds
Wkshrd = Total number of worked sherds
Grnst = Total number of pieces of ground stone
Hammerst = Total number of hammerstones
Flakes = Total number of unutilized flakes and non-diagnostic shatter
Cores = Total number or cores
Lrgtool = Total number of chipped stone tools weighing over 60g and/or having utilized edge lengths over 5.0cm
Smtool 1 = Total number of chipped stone tools weighing less than 60g, having utilized edge lengths less than 5.0cm, and utilized edge angles less than 55 degrees
Smtool 2 = Total number of chipped stone tools weighing less than 60g, having utilized edge lengths less than 5.0cm, and utilized edge angles over 55 degrees
Biface = Total number of bifaces and projectile points

tion coefficients without providing any additional information. As it is, there are many significant and positive correlations which give the impression of covariation between the variables and a simple pattern of few or many artifacts and fire-cracked rocks in the grid squares. There are also no significant and negative correlations which might help differentiate groups of variables corresponding to spatially discrete activities. Some of the correlation coefficients are, however, fairly large and hint at relationships between some of the variables. The largest correlations are noted between flakes and sherds, flakes and cores, large chipped stone tools and hammerstones, large chipped stone tools and cores, and the two classes of small chipped stone tools. In addition, there are relatively few significant correlations between the weight of fire-cracked rock and other variables. The weight of fire-cracked rock is reported as having significant correlations with the total number of sherds, worked sherds, flakes, and one class of small chipped stone tools. Flakes and sherds have the highest number of significant correlations with other variables, and this is not unexpected in that they are the most common classes of artifacts at Sites 33 and 34.

The raw correlation matrix for the 11 variables recorded for the 1,205 4x4 m grid squares of Sites 33 and 34 which contained fire-cracked rock and/or artifacts was next treated to a principal factor analysis (Nie 1975). This involved 25 iterations in which diagonal elements of the correlation matrix were replaced with improved estimates of communality (the total variance of a variable accounted for by the combination of all common factors). Four principal factors were extracted by this method which retained only those factors accounting for at least the amount of the total variance of a single variable, as indicated by eigenvalues of 1.0 or greater. The orthagonal or uncorrelated factor axes were then rotated to simplify the columns of the factor matrix and the overall factor structure. This factor analysis was performed using the Varimax program of the Statistical Package for the Social Sciences (Nie 1975). The resulting communalities and factor loadings for each of the 11 variables and the percentages of the total common variance of all 11 variables accounted for by each of the four extracted factors are given in Table 35. Also recorded in Table 35 are those variables for each factor which have factor loadings of 0.4 or more (values generally considered significant), as well as the factor on which each variable has its highest loading. Although only 52.7% of the total common variance of all variables has been accounted for by the four extracted factors, it is interesting that the four factors have different constellations of variables with loadings of 0.4 or more and that these constellations of variables are complemented by the groups of variables with their highest loadings on the same factor. Factor 1 includes hammerstones, cores, and large chipped stone tools and may be indicative of stone reduction activities and perhaps heavy supportive or extractive activities. Ground stone has its highest loading on Factor 1, but the importance of ground stone for this factor is not clear. The two classes of small chipped stone tools have high loadings on Factor 2, and this association bespeaks of discrete areas where most activities involving chipped stone tools were performed. Factor 3 is distinguished by high loadings for worked sherds and total sherds, and fire-cracked rock has its highest loading on Factor 3. Together, these three variables suggest that activities involving the use of ceramic vessels or fragments of vessels and fire-cracked rock features were segregated from activities incorporating the use of stone tools (Factors 1 and 2) or activities relating to the production of stone tools (Factors 1 and 4). Unutilized flakes and non-diagnostic shatter, by-products of chipped stone tool production, have a high loading on Factor 4. Areas of stone reduction are apparently reflected by Factor 4. Projectile points and other bifaces have their highest loading on Factor 4, but do not appear to be an important variable for this or any other factor.

The analysis of relationships between the 11 variables recorded for the surfaces of 4x4 m grid squares at Sites 33 and 34 has, thus far, revealed some patterns which are probably referrable to different kinds of activities performed at these sites and the spatial division of these activities. High correlation coefficients have been noted between large chipped stone tools and hammerstones and unutilized cores and between the two classes of small chipped stone tools. These two sets of variables also have high loadings on the first two factors of the rotated factor matrix. Unutilized flakes and non-diagnostic shatter have a high correlation with total sherds, and these variables are reported as having significant correlations with many of the other variables. Moderate to high loadings for unutilized flakes and non-diagnostic shatter and total sherds are recorded for the four extracted factors of the rotated factor matrix, although total sherds has its highest loading on Factor 3 and unutilized flakes and non-diagnostic shatter have their highest loading on Factor 4. Weight of fire-cracked rock and projectile points and other bifaces have few significant correlations with other variables and low loadings on the four extracted factors of the rotated factor matrix. Weight of fire-cracked rock, however, does seem to be associated with total

TABLE 35

RESULTS OF FACTOR ANALYSIS FOR 11 VARIABLES FROM
1205 4X4M SURFACE COLLECTION GRID UNITS

	Variable Communality	Factor 1	Factor 2	Factor 3	Factor 4
Fire-cracked rock weight(Kg)	0.079	0.052	0.101	0.244	-0.079
Total sherds	0.362	0.148	0.207	0.479	0.261
Worked sherds	0.174	-0.034	-0.036	0.414	-0.017
Ground stone	0.099	0.298	-0.014	0.008	0.102
Hammerstones	0.219	0.457	0.044	0.020	-0.093
Flakes and non-diagnostic shatter	0.836	0.287	0.334	0.389	0.701
Cores	0.226	0.423	0.068	0.124	0.163
Large tools	0.457	0.673	0.052	0.006	-0.024
Small tools Class 1	0.354	-0.004	0.595	0.014	-0.009
Small tools Class 2	0.299	0.080	0.522	0.138	0.027
Bifaces and projectile points	0.023	-0.001	-0.022	-0.038	0.145
Percent of variability accounted for	-	28.5	12.2	7.8	4.2
Variables with highest factor loadings (0.4 or larger)	-	Hammerstones	Small tool Class 1	Total sherds	Flakes & shatter
	-	Cores	Small tool Class 2	Worked sherds	-
	-	Large tools	-	-	-
Factor on which variable has its highest loading	-	Hammerstones	Small tool Class 1	Total sherds	Flakes & shatter
	-	Cores	Small tool Class 2	Worked sherds	Bifaces & points
	-	Large tools	-	Fire-cracked rock	-
	-	Ground stone	-	-	-

Large tools = Chipped stone tools weighting over 60g and/or having utilized edge lengths over 5.0cm

Small tools Class 1 = Chipped stone tools weighing less than 60g, having utilized edge lengths less than 5.0cm, and utilized edge angles less than 55 degrees

Small tools Class 2 = Chipped stone tools weighing less than 60g, having utilized edge lengths less than 5.0cm, and utilized edge angles over 55 degrees sherds and worked sherds. These manifest relations between variables in the correlation and rotated factor matrices are presumed to be attributable to the patterned behavior of the prehistoric occupants of Sites 33 and 34 during the Formative period. The variety and spatial division of activities conducted at Sites 33 and 34 during the Formative period are, nevertheless, not easily rendered from these data. The following statistical treatment draws upon the results of the rotated factor analysis to provide a more simplified form of the relations between the recorded variables.

The 1205 4x4 m grid squares of Sites 33 and 34 were partitioned into five groups through a consideration of the four factor scores for each grid square. Factor scores for each of the grid squares and each of the four extracted factors were computed by multiplying standardized values of the 11 variables of each grid square times a factor-score coefficient matrix which is a product of the transpose of the rotated factor structure matrix times the correlation matrix of the 11 variables (Nie 1975). Grid squares with their highest positive factor score for Factor 1 were placed in Group 1, and Groups 2, 3, and 4 included those grid squares with highest positive factor scores respectively for Factors 2, 3, and 4. Group 5 was comprised of those grid squares which had negative factor scores for all four factors. The mean values for the 11 variables recorded for the surfaces of these grid squares were then subjected to an analysis of variance test to distinguish significant differences in the means of the 11 variables for the five groups of grid squares. Group size, means of the 11 variables for each group, and significant differences between the means of each group at the 0.01 probability level are given in Table 36.

Previous mention has been made of the relatively low percentage (46%) of the grid squares which contained artifacts and/or fire-cracked rock, and it is noted from Table 36 that a substantial number (671 or 26%) of the grid squares (Group 5) have a low diversity of artifacts, small mean counts for total sherds and unutilized flakes and nondiagnostic shatter, and a low mean weight for fire-cracked rock. Thus, less than half of the surfaces of Sites 33 and 34 exhibit artifacts and/or fire-cracked rock and approximately one-fourth of the surfaces of these sites have very little cultural material. The first four groups of grid squares also have comparatively low mean values for artifacts and fire-cracked rock. Taken together, these data reflect the sparse distribution of cultural materials on the surfaces of Sites 33 and 34 and the tendency for cultural materials to be located in only a relatively small portion (20% of the total area) of the surfaces of these sites.

Total sherds, worked sherds, and weight of fire-cracked rock appear to covary with one another and decrease in mean value from their highest values for Group 3 to sequentially lower values for Groups 2, 1, 4, and 5 (Table 36). This group order is, therefore, taken to be a measure of the relative distance from fire-cracked rock features – weight of fire-cracked rock decreases in the scatter away from the center of a feature – which have been described as being nonrandomly distributed and clustered on the surfaces of Sites 33 and 34 (see Chapter VIII and Figures 18, 19, and 21). Group 3 with its significantly higher values for weight of fire-cracked rock and counts of total sherds and worked sherds is considered to be composed of those grid squares containing fire-cracked rock features and closely associated artifacts. Groups 2, 1, and 4 are suggested to represent activity areas at increasing distance from fire-cracked rock features and are noted by significantly different mean counts and combinations of chipped and ground stone tools and chipped stone debitage and a low mean weight of fire-cracked rock. Group 5 is characterized by low mean counts of total sherds and unutilized flakes and nondiagnostic shatter and a low mean weight of fire-cracked rock. Group 5 would appear to be monitoring grid squares which are peripheral to those including fire-cracked rock features and those typified by chipped and ground stone tools and chipped stone debitage. That is, Group 5 may be envisioned as exhibiting light surface densities of artifacts and fire-cracked rock comensurate with the outer limits of activity areas and the lateral spread of artifacts and fire-cracked rock from activity areas with the erosion and deflation of some soil surfaces. Little importance is attached to Group 5 in terms of defining the kinds and spatial division of activities carried out at Sites 33 and 34 during the Formative period.

Group 3 is comprised of 151 grid squares which make up 6% of the total number of 4x4 m grid squares. The mean weight of fire-cracked rock for Group 3 is 10.77 kg per grid square and is significantly higher than the mean weight of fire-cracked rock for the other four groups. The total weight of fire-cracked rock for Group 3 also represents 49% of the weight of all fire-cracked rock from the surfaces of Sites 33 and 34. This disproportionate amount of fire-cracked rock for Group 3 distinguishes this group from the other four groups and calls attention to the presence of fire-cracked rock features in the grid squares of this group. A considerable variety of information has been brought to bear on the interpretation of these

TABLE 36

COMPARISON OF MEAN VALUES FOR THE CONTENTS OF
FIVE GROUPS OF 4X4M SURFACE COLLECTION GRID UNITS
BASED ON FACTOR SCORES FOR EACH GRID UNIT

	Group 1 (Factor 1) n=76	Group 2 (Factor 2) n=75	Group 3 (Factor 3) n=151	Group 4 (Factor 4) n=232	Group 5 n=671	No. Items
Fire-cracked rock weight (Kg)	2.80*	4.16	10.77	1.35	1.30	-
Total Sherds	0.49	0.87	1.82	0.45	0.08	532
Worked Sherds	0.00	0.03	0.24	0.01	0.00	39
Ground Stone	0.18	0.00	0.01	0.02	0.00	20
Hammerstones	0.10	0.00	0.00	0.00	0.00	9
Flakes and non-diagnostic shatter	2.70	3.81	2.01	6.08	0.26	2378
Cores	0.75	0.11	0.08	0.12	0.00	105
Large Tools	0.50	0.03	0.00	0.01	0.00	42
Small Tool Class 1	0.01	0.55	0.00	0.01	0.00	45
Small Tool Class 2	0.18	1.32	0.05	0.05	0.00	131
Bifaces and projectile points	0.00	0.00	0.00	0.06	0.00	14

*Means not significantly different at the 0.01 level are underscored by the same solid line.

Large tools = Chipped stone tools weighing over 60g and/or having utilized edge lengths over 5.0cm

Small tool class 1 = Chipped stone tools weighing less than 60g, having utilized edge lengths less than 5.0cm, and utilized edge angles less than 55 degrees

Small tool class 2 = Chipped stone tools weighing less than 60g, having utilized edge lengths less than 5.0cm, and utilized edge angles over 55 degrees features in Chapter VIII where it has been argued that these features are most probably facilities principally used for baking or roasting the crowns and leaf bases of leaf succulents. Associated with these facilities are the highest mean counts of total sherds and worked sherds. The mean counts of total sherds and worked sherds for Group 3 are significantly different from those of the other groups. A statistically significant association of ceramics with fire-cracked rock features has been recorded for Formative period sites by Gerald (n.d. b), O'Laughlin and Greiser (1973), and O'Laughlin (1979) who interpret these features as facilities used in processing upland leaf succulents. Hard (n.d.) and O'Laughlin (1979) also note a tendency for worked sherds to be located near fire-cracked rock features. Sherds associated with the fire-cracked rock features of Sites 33 and 34 may be from ceramic vessels used in the processing or consumption of leaf succulents or in auxiliary supportive activities connected with fire-cracked rock features. Some of these same sherds, as well as the worked sherds exhibiting edges worn from use, may also be portions of scoops formed from large fragments of vessels and utilized in the construction, use, and maintenance of fire-cracked rock features. Almost no ground stone implements are recorded for Group 3. However, O'Laughlin and Greiser (1973) and O'Laughlin (1979) report associations of mostly broken ground stone implements with fire-cracked rock features at Formative period sites similar to the Formative period components of Sites 33 and 34 and infer that most ground stone implements were used as hearth stones after they had lost their original usefulness. Thus, grinding implements do not appear to be directly involved in activities centered on the fire-cracked rock features of Sites 33 and 34 or other comparably interpreted sites. All other classes of artifacts for Group 3 do not differ significantly in mean count per grid square from most other groups.

There are 75 4x4 m grid squares included in Group 2, and these grid squares are 3% of the total number of grid squares for Sites 33 and 34. The mean weight of fire-cracked rock and the mean count of total sherds from Group 2 are somewhat less than half those of Group 3 and larger than those of Groups 1, 4, and 5. Group 2 grid squares might include some fire-cracked rock features, but most are probably located in close proximity to grid squares containing fire-cracked rock features. Group 2 is distinguished from all other groups by significantly higher mean counts per grid square for the two classes of small chipped stone tools. In the previous section, the two classes of small chipped stone tools have been evaluated as evidencing a wide range of light to medium activities involving both precision and less exact uses of tools. This group would, therefore, seem to represent activity areas centering on or immediately adjacent to fire-cracked rock features where small chipped stone tools were used in the processing of leaf succulents or other supportive or maintenance activities. It has also been mentioned in the previous section that most of the two classes of chipped stone tools are composed of utilized flakes and marginally retouched flakes. O'Laughlin and Greiser (1973) describe a significant association of utilized flakes with fire-cracked rock features, and significant associations are given by O'Laughlin (1979) between utilized flakes, marginally retouched flakes, and bifaces which are reported not to be significantly associated with fire-cracked rock features or core tools. Thus, the significant high mean counts of small chipped stone tools for the grid squares of Group 2 which are adjacent to or included fire-cracked rock features of Sites 33 and 34 suggest a distribution of these tools which resembles that described by O'Laughlin and Greiser (1973) and O'Laughlin (1979) for similar kinds of chipped stone tools at sites that are comparable to Sites 33 and 34 and believed to have been ephemerally occupied for the purpose of processing upland leaf succulents. Group 2 is also noted as having the second highest mean count per grid square of unutilized flakes and non-diagnostic shatter which may be indicative of some activity relating to the reduction of stone for chipped stone tools. However, Group 2 does have the highest mean counts of small chipped stone tools which are comprised mostly of utilized flakes, and the relatively high mean count of unutilized flakes and non-diagnostic shatter may have included a number of flakes which had been used as tools without the production of observable wear patterns.

Group 1 is made up of 76 grid squares which account for 3% of the total number of grid squares at Sites 33 and 34. The relatively small mean weight of fire-cracked rock and small mean count of total sherds for Group 1 are attributed to the more distant relationship of Group 1 grid squares to fire-cracked rock features than either of the grid squares of Group 3 or Group 2. Group 1 is discriminated from the other groups by significant and high mean counts of ground stone implements, hammerstones, unutilized cores, and large chipped stone tools. This group seems to be reflecting a number of activities which are independent of those more closely associated with fire-cracked rock features. Ground stone implements are thought to have been used primarily to process seeds, an activity which appears to be of little importance for the Formative period occupations of Sites 33 and 34 in view of the few grinding implements recovered from the surfaces of these sites. As previously mentioned, ground stone implements have been reported as possibly having been used as hearth stones in fire-cracked rock features at sites similar to Sites 33 and 34 (O'Laughlin and Greiser 1973; O'Laughlin 1979). However, this does not seem to be the case for Sites 33 and 34. The apparent distribution of ground stone implements away from fire-cracked rock features at Sites 33 and 34 would suggest, as is inferred from the floral remains discussed in Chapter VII, that the processing and consuming of seeds were not activities associated with fire-cracked rock features and that grinding activities were located some distance from these facilities. Hammerstones might have been utilized as pounding implements for processing subsistence items or as percussion instruments for shaping or rejuvenating the surfaces of ground stone implements and reducing stone for chipped stone tools. This latter activity is suggested by the high mean count of unutilized cores for Group 1 but is contradicted by the low mean count of unutilized flakes and non-diagnostic shatter for Group 1. Large chipped stone tools are noted for Group 1 and are described in the previous section as tools used in heavy activities oriented principally toward supportive or extractive activities. Large chipped stone tools are also reported in the previous section as being composed of a substantial number of core tools. Therefore, unutilized cores of Group 1 might in actuality encompass some cores which had been utilized without producing observable wear patterns. The separation of small and large chipped stone tools respectively into Groups 2 and 1 follows the observation by O'Laughlin (1979) that utilized flakes, marginally retouched flakes, and bifaces were not significantly associated with core tools at sites similar to Sites 33 and 34. Group 1 appears to be monitoring a variety of activities which are not compatible with those involved in the use of fire-cracked rock features (Group 3) or those performed in close proximity to fire-cracked rock features (Group 2) and include the apparent grinding of seeds, some reduction of stone for chipped stone tools, the possible production and maintenance of ground stone implements, and the use of large chipped stone tools in activities requiring the application of force and not the manipulation of tools. The significant and high correlation coefficients noted previously between some of the artifact classes which have significant and high mean counts for Group 1 suggest that a number of the activities inferred for Group 1 were not performed independently of one another. This is particularly true of those activities involving unutilized cores, large chipped stone tools, and hammerstones.

Group 4 is comprised of 232 grid squares which are 9% of the total number of grid squares. Group 4 is comparable to Group 5 in having a low mean weight of fire-cracked rock and low mean counts for most artifact classes. The little importance of fire-cracked rock, ceramics, and the majority of other classes of artifacts suggests that the grid squares of Group 4 are located away from areas with fire-cracked rock features and generally more distant from fire-cracked rock features than the grid squares of Groups 1, 2, and 3. Projectile points and other bifaces have their highest mean count for Group 4, but the mean counts of this artifact class do not differ significantly between the five groups of grid squares. Projectile points and other bifaces have previously been noted to have the fewest number of significant correlations with other variables recorded for the surfaces of grid squares and are, therefore, independently distributed with respect to fire-cracked rock and most classes of artifacts. Projectile points and other bifaces, unlike all of the other variables, do not help discriminate between the five groups of grid squares. Group 4 is distinguished from the other groups by having the highest mean count of unutilized flakes and non-diagnostic shatter, and it is presumed that this reflects the greater importance of activities relating to the reduction of stone for chipped stone tools for Group 4 than for the other groups. Again, this activity is suggested for grid squares which are some distance from fire-cracked rock features. Gerald (n.d. b), O'Laughlin and Greiser (1973), and O'Laughlin (1979) have reported a similar and independent distribution of unutilized flakes with respect to fire-cracked rock features for sites which appear comparable to Sites 33 and 34 in the density and kind of artifacts and features. Although it is believed that the Group 4 grid squares largely represent areas where stone was reduced for chipped stone tools, it is noted that grid squares of this group include weathered surfaces of Site 33 where both Archaic and Formative period materials are exposed. Thus, Group 4 is composed of grid squares with relatively high densities of unutilized flakes and non-diagnostic shatter from the Formative period occupations of Sites 33 and 34, as well as those grid squares where high densities of unutilized flakes and non-diagnostic shatter are attributable to the mixing of Archaic and Formative period materials on the surface of Site 33.

The foregoing analysis of the distribution of the weight of fire-cracked rock and the counts of 10 classes of artifacts on the surfaces of 2593 4x4 m grid squares of Sites 33 and 34 has resulted in the definition of five groups of grid squares which contain fire-cracked rock and/or artifacts and are characterized by significant differences in mean values of the 11 recorded variables. One of these five groups (Group 5) is composed of grid squares with a low diversity and density of artifacts and a low weight of fire-cracked rock and is believed to include those grid squares where archeological materials are lightly dispersed on the outer limits of activity areas. The other four groups are visualized as representing different kinds of task areas which embrace the fire-cracked rock features of Sites 33 and 34 and three types of activity areas found at increasing distances from these features, as measured by decreasing weights of fire-cracked rock. There are 132 loci of small and large fire-cracked rock features on the surfaces of Sites 33 and 34, and these conspicuous, abundant, and generally clustered features appear to be the foci of many of the Formative period activities at these sites. Fire-cracked rock features, facilities presumed to have been used principally in the processing of leaf succulents, are an important constituent of Group 3 which is distinguished from the other groups by a significantly higher weight of fire-cracked rock and by significantly higher counts of total sherds and worked sherds. The association of ceramic materials with the fire-cracked rock features of Group 3 is taken as evidence for the use of vessels and scoops in the processing or consumption of leaf succulents or other auxiliary supportive activities connected with fire-cracked rock features. The marked distribution of worked sherds towards the fire-cracked rock features of Group 3 appears to reflect the utilization of scoops or large sherds in the construction, use, and maintenance of fire-cracked rock features. Group 2 is made up of grid squares which incorporate a few fire-cracked rock features or are located in close proximity to grid squares containing fire-cracked rock features. Group 2 is differentiated from the other groups by significantly higher counts of small chipped stone tools which are interpreted as reflecting a wide range of light to medium activities which include the processing of leaf succulents and other supportive or maintenance activities. More distant from fire-cracked rock features are the grid squares of Group 1 which have significantly higher counts of ground stone implements, hammerstones, unutilized cores, and large chipped stone tools. Activities monitored by Group 1 do not appear to be compatible with those involving the use of fire-cracked rock features and are comprised of some grinding of seeds, the possible production of ground stone and chipped stone tools, and the use of large chipped stone tools for heavier activities than those suggested for the small chipped stone tools of Group 2. Finally, Group 4 is made up of grid squares located in areas away from fire-cracked rock features. Group 4 is noted as having a significantly higher count of unutilized flakes and non-diagnostic shatter which are indicative of the reduction of stone for chipped stone tools.

The spatially patterned relationships between fire-cracked rock features and the 10 classes of artifacts of the Formative period and on the surfaces of Sites 33 and 34 are not unlike those recorded by Gerald (n.d. b), Hard (n.d.), O'Laughlin and Greiser (1973), and O'Laughlin (1979) for Formative period sites located on an alluvial fan at the base of the east flank of the Franklin Mountains. Fire-cracked rock features are the most common and numerous features at these latter sites which exhibit significant associations of worked and unworked sherds with fire-cracked rock features, an independent distribution of fire-cracked rock features and by-products of chipped stone tool manufacture, and a tendency for small chipped stone tools to be found near one another and apart from fire-cracked rock features. These sites have been interpreted by O'Laughlin (1979) as intermittently and ephemerally occupied sites where activities were somewhat specialized and centered on the procurement and processing of upland leaf succulents. The similarity in the spatial distribution of fire-cracked rock features and artifacts at these sites and Sites 33 and 34 certainly suggests some comparability in the tasks performed at these sites and adds to the inference drawn from the discussion of chipped stone tools from some of these sites in the previous section, the consideration of the attributes and regional distribution of fire-cracked rock features in Chapter VIII, and the accounting of the abundance and intra-site distribution of ceramics and ground stone implements at Sites 33 and 34 in Chapter IX, that the Formative period occupations of Sites 33 and 34 were intermittent, ephemeral, and oriented toward the processing of upland leaf succulents.

The intermittent and ephemeral occupation of Sites 33 and 34 during the Formative period has been argued from such evidence as the discrete clusters of fire-cracked rock features and ceramics, the suggested reuse of fire-cracked rock features and areas of fire-cracked rock features, the low density of artifacts, and the apparent minimal working of chipped stone and little curation of tools. Although the spatial analysis presented here was not aimed at delimiting individual occupations of the Formative period at these sites, the demonstration of patterned relationships between lightly scattered surface artifacts and fire-cracked rock features for relatively large, 4x4 m grid squares at these sites does indicate that the Formative period occupations were ephemeral and possibly infrequent. That is, the recognized spatial patterns of artifacts and features at Sites 33 and 34 are not unexpected for sites where the facilities, tools, and by-products of different kinds of activities are spatially separated, where reoccupation is relatively infrequent and does not obscure spatial patterns with overlapping distributions of features and artifacts of the different occupations, and where occupations are of short duration such that little concern for the accumulation or disposal of trash, the curating of tools, or the maintenance and modification of facilities results in the spatial patterning of cultural materials which is directly attributable to the tasks undertaken at these kinds of sites.

The purpose of the analysis of the distribution of Formative period artifacts and features on the surfaces of Sites 33 and 34 has been to ascertain if spatial relations exist between fire-cracked rock features and the various classes of artifacts and whether these patterns are like those of similarly interpreted sites. Spatial patterns in fire-cracked rock features and artifacts at Sites 33 and 34 are discernible and have been taken to be referrable to four different types of activities. These spatial patterns in fire-cracked rock features and artifacts of Sites 33 and 34 are also similar to those of sites presumed to have been intermittently and ephemerally occupied for the purpose of processing upland leaf succulents. In the following analysis of chipped stone and ground stone assemblages of selected sites of the El Paso area, interests are shifted from a study of the relationships between classes of cultural material within sites to a study of patterns exhibited in certain classes of artifacts between sites. This approach provides additional information on the nature of Formative period occupations at Sites 33 and 34, as well as on the Archaic period occupation at Site 33.

Chipped and Ground Stone Assemblages of the El Paso Area

The remaining portion of this chapter is devoted to the description of chipped and ground stone assemblages of the Archaic and Formative period occupations at Sites 33 and 34 and other selected sites of the El Paso area in an effort to furnish supplementary data in support of the characterization of the Archaic and Formative period occupations at Sites 33 and 34 in this and preceeding chapters. The Archaic period occupation of Site 33 is pictured as having been of some duration, though possibly seasonal and intermittent, with a wide range of generalized, supportive and maintenance activities. Formative period occupations of Sites 33 and 34 are visualized as having been ephemeral and intermittent with somewhat specialized, supportive activities oriented toward the seasonal processing of upland leaf succulents. The analysis of chipped and ground stone assemblages from Sites 33 and 34 and other selected sites of the El Paso area is directed toward the evaluation of the inferred duration of habitation and the relative importance of activities involving the use of either chipped stone tools or ground stone implements for the Archaic and Formative period occupations of Sites 33 and 34. Regional patterns in raw material availability, the reduction of stone for chipped stone tools, and specific uses of chipped stone tools are beyond the intent of this particular analysis, but have been discussed by Lynn, Baskin, and Hudson (1975) and O'Laughlin (1977 b; 1979) in their account of chipped and ground stone assemblages from the sites selected for a comparison with Sites 33 and 34, as well as other sites from the El Paso area.

Chipped and ground stone assemblages from Sites 33 and 34 and other selected sites of the El Paso area are enumerated in Table 37. Chipped stone artifacts from these sites are recorded according to the reduction categories of core, flake (including nondiagnostic debitage), marginally retouched flake, and biface. Utilized cores and flakes have been separated from their unutilized counterparts, and bifaces are noted as including projectile points. Marginally retouched flakes and bifaces which have been used as tools were not distinguished from unutilized, marginally retouched flakes and unutilized bifaces for the assemblages of the Public Free School Land Sites and the sites of Whalen's Hearth Study. For this reason, the count and percentage of chipped stone tools for each site or group of sites subsume all utilized cores, utilized flakes, marginally retouched flakes, and bifaces as a measure of the relative abundance of chipped stone tools at these sites. Ground stone implements are reported as a percentage of the total chipped and ground stone assemblage and as a percentage of the chipped and ground stone tools for each site or group of sites. These data provide indices of the relative popularity of chipped stone tools and ground stone implements at these sites, as well as the proportional abundance of chipped and ground stone tools with respect to the by-products of chipped stone tool production for these sites.

The abundance of chipped and ground stone tools at sites is believed to reflect the duration of occupation and the degree of curation and maintenance of tools. Ephemerally occupied sites, as contrasted with sites of longer-lived habitation, are expected to exhibit larger percentages of chipped stone tools commensurate with a greater tendency

TABLE 37

CHIPPED AND GROUND STONE ASSEMBLAGES
FROM THE EL PASO AREA

	Three Lakes Pueblo		Sandy Bone Site		Public Free School Land Sites		Whalen's Hearth Study		Trans-Mountain Campus Sites		Sites 33 and 34 Formative Period		Site 33 Archaic Period	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Unutilized Cores	19	1.1	8	0.9	9	3.2	-	-	70	5.7	116	4.1	7	1.7
Utilized Cores	0	0.0	2	0.2	?	-	-	-	25	2.0	25	0.9	0	0.0
Unutilized Flakes	1601	96.2	857	97.5	247	87.0	-	-	973	79.5	2511	88.7	384	92.8
Utilized Flakes	12	0.7	2	0.2	6	2.1	-	-	73	6.0	138	4.9	20	4.8
Marginally Retouched Flakes	19	1.1	9	1.0	16	5.6	-	-	68	5.6	28	1.0	1	0.2
Bifaces	13	0.8	1	0.1	6	2.1	-	-	15	1.2	13	0.5	2	0.5
Total Chipped Stone Artifacts	1664	99.9	879	99.9	284	100.0	.100*	-	1224	100.0	2831	100.1	414	100.0
Chipped Stone Tools	44	2.6	14	1.6	28	9.9	-	-	181	14.8	204	7.2	23	5.6
Ground Stone Implements	49		14		12		.016*		7		14		3	
% of Total Chipped and Ground Stone		2.9		1.6		4.2		13.8		0.6		0.5		0.7
% of Chipped and Ground Stone Tools		52.7		50.0		30.0		-		3.9		6.4		11.5

*Average number per square meter

to discard expediently manufactured tools following their use and a lesser attention paid to the curation and maintenance of tools for short-lived occupations. It is also anticipated that ground stone implements will show a pattern of being more common on ephemerally occupied sites than on sites of longer habitation when the relative importance of activities involving the use of chipped stone tools or ground stone implements is comparable for both of these kinds of sites. Thus, sites where activities involving the use of grinding implements were of minor importance can be expected to have low percentages of grinding implements with respect to the total number of chipped and ground stone artifacts and the total number of chipped and ground stone tools. However, sites where activities involving the use of grinding implements were of some importance can be anticipated to show high percentages of grinding implements with respect to the total number of chipped and ground stone tools and higher or lower percentages of grinding implements with respect to the total number of chipped and ground stone artifacts for shorter or longer-lived occupations.

Three types of sites are represented by the sites selected for comparison with the Archaic and Formative period occupations of Sites 33 and 34: residential sites, camps oriented toward the processing of upland leaf succulents, and camps occupied for the purpose of processing seed plants and some lowland leaf succulents. Each of these site types will be briefly defined in the following discussion and illustrated by the chipped and ground stone assemblages from the sites enumerated in Table 37. No attempt will be made to furnish all of the known details of the sites selected for comparison with Sites 33 and 34, and the reader is referred to the noted sources of information on these sites for additional data. In particular, these three site types have been defined previously and discussed at length by O'Laughlin (1979). With the exception of the Public Free School Land Sites and the sites of Whalen's Hearth Study, the sites chosen for a comparison with Sites 33 and 34 have been documented by the writer. This alleviates some of the problems inherent in the classification of chipped stone artifacts by different researchers.

Residential sites are simply defined as sites inhabited on more than a short-term basis. The habitation of a residential site could be for a season, a year, or a number of years. For most of the prehistory of the El Paso area, it appears that social groups changed residences frequently in accordance with seasonal and spatial variability in the availability of resources or conditions suitable for horticulture (O'Laughlin 1979). Only for the El Paso phase of the late Formative period is there any support for the semipermanent or permanent occupation of residential sites. This is imputed by the apparent reliance of El Paso phase occupations on cultigens which is evidenced principally by the locating of residential sites in areas most amenable to horticultural pursuits and the presence of substantial amounts of carbonized cultigens in some of the residential sites of this phase (Brook 1966; 1980; Ford 1977; O'Laughlin 1979; Whalen 1977; 1978). Residential sites of the Archaic period or the Mesilla phase of the Formative period are not known to exhibit such spatial patterning or abundance of carbonized cultigens (Whalen 1977; 1978; Chapter III of this report).

Finding an operational definition of a residential site is not easy because no single variable can always differentiate residential sites from camps. However, the concurrent consideration of a number of variables can discriminate most residential sites from camps. Among the more important variables are site size, density of artifacts, presence or absence of structures, variety of facilities, and presence or absence of distinct trash areas. Whalen (1977; 1978) has furnished summary statistics on many of these variables for a large number of sites located in the Hueco Bolson east of El Paso, Texas, and O'Laughlin (1979) has commented on the applicability of these variables for differentiating residential sites from camps. In general, residential sites can be distinguished from camps by their large size (often over 0.1 hectare), greater density of surface artifacts (commonly over five artifacts per square meter), the presence of houses and a variety of extramural features (frequently disclosed only with excavation), and the presence of distinct refuse mounds or middens. In most cases, sites have been described as being either residential sites or camps solely on the basis of their size and density of surface artifacts. However, O'Laughlin (1979) has demonstrated that geographical and temporal patterning of natural resources for the El Paso area makes some locales more suitable for habitation than others and that the ephemeral and frequently repeated occupation of some locales can result in archeological sites with site areas and densities of surface artifacts overlapping those of residential sites. As previously mentioned, populations appear to have been fairly mobile and changed residence frequently with respect to spatial and temporal variability in natural resources throughout most of the prehistory of the El Paso area. Early to middle Formative period houses of the El Paso area and the Archaic period houses of Site 33 show only a minimal investment of energy and can be described as huts or, in some cases, as shallow pithouses. It is, therefore, not surprising that Formative period structures of the Mesilla phase have been reported from sites which are best described as ephemerally occupied camps (Aten 1972; Hard n.d.; O'Laughlin 1979). Although exceptions can be found to the above characterizations of residential sites, problems in differentiating residential sites from camps have only occasionally been encountered when sizable populations of sites have been considered.

Three Lakes Pueblo and the Sandy Bone Site are believed to be good examples of Formative period residential sites. Three Lakes Pueblo is an El Paso phase site with adobe surface structures, extramural and trash-filled pits, and small refuse mounds and is located east of El Paso, Texas, near a number of small playas on the eastern side of the Hueco Bolson (O'Laughlin n.d. b; 1977b). Remains of corn, beans, and cucurbits were recovered from this site and are reported by Ford (1977). Chipped and ground stone artifacts from Three Lakes Pueblo were obtained by the collection of all surface artifacts over much of the surface of the site and the extensive subsurface testing of structures, pits, and trash areas. The Sandy Bone Site is a late Mesilla phase site situated on the west bank of the Rio Grande and opposite Sites 33 and 34 (O'Laughlin 1977b; 1979). This site was tested by the excavation of 32 square meters of a refuse midden located in the right-of-way of a paved road. One burial is known for this site, and houses are probably present on this site but were not disclosed by the limited testing of the refuse area. Chipped stone assemblages from Three Lakes Pueblo and the Sandy Bone Site are noted as having high percentages of unutilized cores and flakes (97.3% and 98.3%) and low percentages of chipped stone tools (2.6% and 1.6%) (Table 37). This follows the expectation for low percentages of chipped stone tools with their curation and maintenance at sites of long-lived occupation (i.e. residential sites). The importance of activities involving the use of grinding implements at these sites is indicated by the high percentages of grinding implements (52.7% and 50.0%) with respect to the total number of chipped stone tools and ground stone implements. The grinding of corn was presumably a prominent activity at these particular sites, as judged by the proximity of these sites to lands suitable for horticulture and the presence of carbonized corn at Three Lakes Pueblo. Even though grinding implements appear to have been of some import at these sites, they are only a small percentage of the total number of chipped stone and ground stone artifacts (2.9% and 1.6%). This suggests that ground stone implements were also curated and maintained at residential sites.

Camps are defined as sites of ephemeral, short-lived occupation. In contrast to residential sites, camps are noted as generally having small site areas (typically less than 0.1 hectare), light surface scatters of artifacts (commonly less than 5 artifacts per square meter), a limited variety of facilities, and rarely sizable accumulations of trash or houses (O'Laughlin 1979; Whalen 1977; 1978). Activities conducted at camps are also thought to be more restricted or specialized than those for residential sites. This is certainly reflected in the lack of diversity in features within given types of camps, two of which are considered below.

Camps thought to be oriented toward the spring-to-summer processing of native seed plants and some lowland leaf succulents are represented by the Public Free School Land Sites and the sites of Whalen's Hearth Study (O'Laughlin 1978; 1979). These particular camps are located in lowland areas of the Hueco Bolson of El Paso County, Texas, and are characteristically situated in close proximity to playas (Lynn, Baskin, and Hudson 1975; Whalen 1977; 1978). Hearths containing burned caliche, or rarely, fire-cracked rock, are the only features noted for these sites, and artifacts are thinly scattered around and between these features. The hearths have been interpreted as facilities used principally for roasting or baking the edible parts of soap-tree yucca (O'Laughlin 1978; 1979; Chapter VIII of this report). The chipped and ground stone assemblage for the Public Free School Land Sites enumerated in Table 37 is a composite of 11 Formative period sites from which 10 or more chipped stone artifacts were "selectively" collected (Lynn, Baskin, and Hudson 1975). It is thought that bifaces and marginally retouched flakes may be over-represented and ground stone implements under-represented in the chipped and ground stone assemblage for these sites because of the biased sampling technique. It is not known if any of the reported cores from these sites were utilized as tools. The sites of Whalen's Hearth Study include 53 Mesilla phase hearths containing burned caliche (Whalen 1978:169ff). Artifacts were collected from within a 5 m radius of each of these hearths. Whalen provides density figures for chipped stone artifacts and ground stone implements (Table 37), but the composition of the chipped stone assemblage is not given. Ground stone implements may be over-represented as a result of Whalen's collection technique. Although the data on chipped and ground stone assemblages for this type of camp is not the best one could hope for, there are some patterns for these assemblages which contrast with those of the residential sites. The percentage of grinding implements with respect to the total number of chipped and ground stone tools for the Public Free School Land Sites is 30.0%, a figure not too far removed from those of the two above mentioned residential sites. Grinding activities appear to have been of some significance at these camps and were probably oriented toward the processing of seeds of native plants which abound today in the playas of the Hueco Bolson (O'Laughlin 1978; 1979). The percentages of grinding implements with respect to the total number of chipped and ground stone artifacts for the Public Free School Land Sites (4.2%) and the sites of Whalen's Hearth Study (13.8%) are, however, much higher than those of the two residential sites, where grinding implements were apparently curated and maintained. This, it is believed, is because of the caching, discarding, or losing of grinding implements at these presumed ephemerally occupied camps. The percentage of chipped stone tools with respect to the total number of chipped stone artifacts for the Public Free School Land Sites is 9.9%. This figure is also much higher than those for the two residential sites and is taken to be a reflection of the expedient manufacture and discard and not the curation and maintenance of chipped stone tools at these short-lived camps.

The second type of camp is one at which tasks are assumed to have been directed toward the processing of upland leaf succulents. This type of camp is illustrated by the composite chipped and ground stone assemblage from five Formative period sites referenced in Table 37 as the Transmountain Campus Sites (O'Laughlin 1979). These particular sites and other nearby sites which have been mentioned throughout this and preceeding chapters are located on an alluvial fan at the base of the east flank of the Franklin Mountains and in proximity to plant communities with the upland leaf succulents, lechuguilla, and sotol. Sites on this alluvial fan are generally small but range in size from less than 0.1 hectare to over 30 hectares (Aten 1972; Gerald n.d. c). The larger sites are evaluated by O'Laughlin (1979) as having resulted from repeated and short-lived occupations of the same area over a long period of time. Fire-cracked rock features, facilities presumed to have been used to process upland leaf succulents, are the only features recorded for most sites, yet small huts or shallow pithouses have been discovered at two sites (Aten 1972; Gerald n.d. c; Hard n.d.; O'Laughlin and Greiser 1973; O'Laughlin 1979). Artifacts are lightly and extensively scattered on the surfaces of these sites and exhibit well-defined spatial patterns with respect to fire-cracked rock features (Gerald n.d. b; O'Laughlin and Greiser 1973; O'Laughlin 1979). The composite chipped and ground stone assemblage from the Transmountain Campus Sites includes all materials collected from the surfaces of these sites, as well as a small number of artifacts recovered from extensive testing of these sites. As noted in Table 37, the percentages of ground stone implements (0.6% and 3.9%) with respect to the total chipped and ground stone assemblage and the total number of chipped and ground stone tools for the Transmountain Campus sites are very small and smaller than those for the aforementioned residential sites and camps of the first type. Similar percentages of ground stone implements have also been reported for one other camp close to the Transmountain Campus Sites (O'Laughlin and Greiser 1973; O'Laughlin 1979). Tasks involving the use of grinding implements are apparently of little importance at sites of this second type of camp. The percentage of chipped stone tools with respect to the total number of chipped stone artifacts for the Transmountain Campus Sites is 14.8%. This figure is higher than those reported for the residential sites and sites of the first type of camp and follows the expected high percentage of chipped stone tools on ephemerally occupied sites. The presumed expedient manufacture and discard of many chipped stone tools at camps of this second type is also substantiated by the finding of 30.2% chipped stone tools with respect to the total number of chipped stone artifacts at a site considered to be a camp of the second type and located adjacent to the Transmountain Campus Sites (O'Laughlin and Greiser 1973; O'Laughlin 1979).

Residential sites have been differentiated from camps, by definition, as sites of long-lived or, at least, seasonal occupation. In addition, residential sites have been distinguished from camps by consideration of site size, density of surface artifacts, variety and kind of features present, and presence of discrete trash disposal areas. Some of the activities performed at these sites have also been suggested by auxiliary information such as the environmental setting of these sites and the presence or absence of substantial amounts of carbonized cultigens, the nature and diversity of features, and the relative importance of chipped stone tools and ground stone implements at these sites. Chipped and ground stone assemblages from residential sites and the two types of camps are noted as conforming to certain expectations based on the length of habitation and the greater tendency for tools to be curated at sites of long-lived occupation. That is, residential sites were expected to exhibit lower percentages of chipped stone tools than camps and to have lower percentages of ground stone implements than camps when activities involving the use of grinding implements were of comparable importance at these kinds of sites. Similar patterns for percentages of chipped and ground stone tools have been reported by O'Laughlin (1979) for other sites in the El Paso area, and Wimberly and Rogers (1977) write of finding higher percentages of chipped stone tools in ceramic and lithic hearth sites (camps) than in ceramic village sites (residential sites) in the Three Rivers Drainage of the Tularosa Basin which adjoins the northern portion of the Hueco Bolson in New Mexico. In addition, attention should be directed to the lower percentages of unutilized and utilized cores and the higher percentages of unutilized flakes for the residential sites than for the camps of this study (Table 37). This suggests that cores are also being curated for further reduction at sites of long-lived occupation.

Differences between residential sites and camps in the percentages of cores, chipped stone tools, and ground stone implements have been attributed to differences in curate behavior at sites of long-lived or ephemeral occupation. Patterns recognized in the chipped and ground stone assemblages from the above mentioned residential sites and camps, therefore, provide comparative data for evaluating the inferred duration of Archaic and Formative period occupations at Sites 33 and 34. Chipped and ground stone assemblages for the Formative period occupations at Sites 33 and 34 and the Archaic period occupation at Site 33 are detailed in Table 37. The Formative period materials from Sites 33 and 34 include all items assignable to the Formative period that were recovered from the surfaces and extensive subsurface tests of these sites. The Archaic period materials from Site 33 are comprised of those items from subsurface test excavations associated only with the Archaic period deposits. Surface or subsurface items which could not be assigned with certainty to either the Archaic period or the Formative period occupations of Site 33 are not considered here (see Table 18).

The Formative period occupations of Sites 33 and 34 occurred over a long period of time and are characterized as having been intermittent, ephemeral, and directed toward the somewhat specialized task of seasonal processing of upland leaf succulents. This characterization of the Formative period occupations at Sites 33 and 34 is based on numerous observations, of which only the more important are reiterated below. Radiocarbon dates and ceramics from these sites suggest that Formative period occupations may have occurred over a period of 1,500 years, or more. Carbonized macrofloral remains are not very informative on these occupations, but it is noted that remains of leaf succulents were found in some of the features of Site 33. Fire-cracked rock features are abundant features of the Formative period occupations at Sites 33 and 34 and far outweigh in importance the few recorded pits, most of which are comparable to the fire-cracked rock features in the majority of details but generally contain little or no fire-cracked rock. The geographical distribution of fire-cracked rock features of the El Paso area corresponds closely to that of upland leaf succulents and supports the inference that fire-cracked rock features were principally used to roast or bake upland leaf succulents, an activity of some importance for the Formative period occupations at Sites 33 and 34 as judged by the large number of fire-cracked rock features at these sites. There is some evidence for the reuse and clustering of fire-cracked rock features which hints at the intermittent nature of occupations and perhaps some of the individual occupations during the Formative period at Sites 33 and 34. These sites have a low density of surface and subsurface ceramics which is comparable to other ephemerally occupied sites. The spatial distribution of sherds from the same vessels and ceramic types of limited temporal range furnishes additional evidence of individual and small occupations. Lithic materials are also thinly scattered on the surfaces and in the deposits of Sites 33 and 34. It has been noted that fire-cracked rock features and ceramic and lithic artifacts of Sites 33 and 34 show well-defined spatial patterns that are comparable to those recorded for other sites which have been interpreted as short-lived camps where the processing of upland leaf succulents took place. Few grinding implements are recorded for the Formative period occupations at Sites 33 and 34. Chipped stone tools are made of locally available materials and tend to be large in size for use in heavy activities. The occurrence of few grinding implements and the tendency toward large chipped stone tools are likewise recorded for other sites which were presumably ephemerally occupied for the purpose of processing upland leaf succulents. Finally, the transitory nature of Formative period occupations at Sites 33 and 34 is suggested by the minimal working of materials for chipped stone tools and the lack of importance of biface thinning and of chipped stone tool resharpening activities.

It has been inferred that the Formative period occupations of Sites 33 and 34 were ephemeral and oriented toward the processing of upland leaf succulents. If this inference is correct, then the chipped and ground stone assemblage of the Formative period occupations at Sites 33 and 34 should be comparable to those of camps of the second type which appear to have been sites of short-lived occupations for the purpose of processing upland leaf succulents. Chipped and ground stone assemblages of camps of the second type are illustrated by the chipped and ground stone assemblage of the Transmountain Campus Sites, and it is remarked from Table 37 that the chipped and ground stone assemblage of the Formative period occupations at Sites 33 and 34 resembles that of the Transmountain Campus Sites with the exception of smaller percentages of the various classes of chipped stone tools for the Formative period occupations at Sites 33 and 34. The percentages of chipped stone tools with respect to the total number of chipped stone artifacts is, however, fairly high for the Formative period occupations at Sites 33 and 34, higher than those noted for the two residential sites (Three Lakes Pueblo and Sandy Bone Site), and close to that for camps of the first type (Public Free School Land Sites). The percentages of unutilized and utilized cores for the Formative period occupations at Sites 33 and 34 are also higher than those for the two residential sites and comparable to those of both types of camps. The relatively high percentages of cores and chipped stone tools for the Formative period occupations at Sites 33 and 34 are indicative of a lesser concern for the maintenance and curation of chipped stone tools and for the curation of cores for futher reduction as compared to residential sites and support the contention that these occupations were of an ephemeral nature. Although the percentage of chipped stone tools for the Formative period occupations at Sites 33 and 34 is somewhat smaller than those tabulated for other camps in Table 37, this may only be a reflection of the removal of surface artifacts from Sites 33 and 34 by nearby residents and the character of subsurface excavations which were dispersed throughout these sites but not designed for unbiased estimates of the relative proportions of classes of chipped stone artifacts. The percentages of ground stone implements with respect to the total number of chipped and ground stone artifacts and of chipped and ground stone tools are small, comparable to those of the Transmountain Campus Sites, and denotative of the lack of importance of grinding activities at Sites 33 and 34 during the Formative period. On the whole, the chipped and ground stone assemblage of the Formative period occupations at Sites 33 and 34 is most like that of the Transmountain Campus Sites and lends credence to the supposition that Sites 33 and 34 were ephemerally occupied during the Formative period for purposes which involved few activities utilizing grinding implements.

The Archaic period occupation of Zone 4 at Site 33 is believed to have taken place between 2500 BC and 1800 BC and has been viewed as having been of some duration. Taken together, the evidence leaves little doubt that the Archaic period occupation of Site 33 was lengthy, but questions still persist as to whether there was one large occupation or a number of smaller and intermittent occupations and whether occupation was yearlong or seasonal. Carbonized macrofloral remains from the Archaic period deposits at Site 33 include a variety of potential foodstuffs which are available from late spring to fall and within 3 to 6 km of Site 33. Warm weather occupation of Site 33 during the Archaic period may also be indicated by fragments of bird eggs found in two houses. A few, small fire-cracked rock features for processing upland leaf succulents imply some occupation of Site 33 in the spring, but this activity appears to be of little importance for the Archaic period occupation of Site 33 as compared to the later Formative period occupations of Sites 33 and 34. The presence of small, relatively well-insulated houses suggests that the Archaic period occupation of Site 33 included the colder winter months. The macrofloral and faunal remains, fire-cracked rock features, and houses can be evaluated as evidence in support of a yearlong occupation of Site 33 during the Archaic period. However, the few fire-cracked rock features recorded for this occupation can also be taken to reflect the occasional inhabitation of this site during the spring. In addition, most of the carbonized macrofloral remains came from one house. The cooccurrence in one house of plant foods which become available at different seasons suggests their storage and leaves open the possibility that this site served as a base camp and was largely uninhabited during the warmer, biotically productive portion of the year when foraging populations would have been moving about the landscape in response to the geographical and seasonal availability of resources. A large number of houses has been documented for the Archaic period occupation of Site 33, and besides the fire-cracked rock features, there are other extramural features which include storage and refuse-filled pits, hearths, and baking or roasting pits without rock. In addition to the variety of recorded features, it is observed that houses and extramural features exhibit spatial patterns which intimate the organized use of space and some community planning. Furthermore, houses and associated extramural features occur in clusters that may be referrable to individual and intermittent occupations. The spatial patterning of houses and extramural features bespeaks of a long-lived occupation, and there is some evidence for storage facilities and the removal of trash from house areas which would not be expected for ephemerally occupied sites. In contrast to these observations, it is also noted that there is no great investment of energy in houses, that many of the houses have burned, that some houses have more than one floor, and that considerable refuse occurs on the floors of some houses. The latter recordings are more along the line of an intermittently and perhaps ephemerally occupied site. The chipped stone artifacts of the Archaic period occupation at Site 33, as opposed to those of the Formative period occupations at Sites 33 and 34, show a more extensive working of materials for chipped stone tools, a tendency for these tools to be smaller and of finer-grained materials, and for biface thinning and tool resharpening activities to be of greater importance. Chipped stone artifacts of the Archaic period occupation at Site 33 manifest generalized maintenance and supportive activities that might be expected for long-lived occupations. Given the above information, the cultural remains of the Archaic period occupation at Site 33 would best seem to indicate a number of intermittent occupations which probably were of some length and occurred principally during the colder portion of the year.

The Archaic period occupation of Site 33 is presumed to have been of some duration, though possibly intermittent, and it was expected that the chipped and ground stone assemblage of this occupation would be similar to those of other long-lived sites. That is, the chipped and ground stone assemblage of the Archaic period occupation at Site 33 was anticipated to have a low percentage of chipped stone tools with respect to the total number of chipped stone artifacts and a high percentage of grinding implements with respect to the number of chipped and ground stone tools. From Table 37 it is seen that the chipped and ground stone assemblage of the Archaic period occupation at Site 33 does exhibit patterns which contrast with those of the chipped and ground stone assemblage of the more ephemeral occupations of the Formative period at Sites 33 and 34. The Archaic period assemblage has lower percentages of unutilized and utilized cores and chipped stone tools than the Formative period assemblage of Sites 33 and 34, and this suggests the greater curation of cores for further reduction and the greater curation and maintenance of chipped stone tools for the Archaic period. The percentages of ground stone implements with respect to the total number of chipped and ground stone artifacts are comparable for the Archaic and Formative period occupations of Sites 33 and 34, but the percentage of grinding implements with respect to the number of chipped and ground stone tools is higher for the Archaic period occupation of Site 33 than for the Formative period occupations of Sites 33 and 34. This implies a somewhat larger importance of grinding activities and the greater curation of grinding implements for the Archaic period occupation of Site 33 than for the Formative period occupations of Sites 33 and 34.

The percentage of chipped stone tools with respect to the total number of chipped stone artifacts and the percentage of grinding implements with respect to the number of chipped and ground stone tools for the Archaic period occupation of Site 33 are between those of residential sites (Three Lakes Pueblo and Sandy Bone Site) and camps (Public Free School Land Sites and Transmountain Campus Sites). Although the percentage of chipped stone tools for the Archaic period occupation of Site 33 is much lower than those of camps, it is still higher than those for the two residential sites. This would seem to suggest that chipped stone tools were not as well curated for the Archaic period occupation of Site 33 as they were for the two residential sites or that the chipped stone assemblage of the Archaic period occupation of Site 33 is the composite of a number of long-lived and ephemeral occupations. The percentage of grinding implements with respect to the number of chipped and ground stone tools for the Archaic period occupation of Site 33 also does not approach the high percentages of grinding implements noted for the two Formative period residential sites and the lowland camps where grinding activities appear to be of some importance. It is possible that the lower than anticipated percentage of grinding implements, as well as the higher percentage of chipped stone tools, for the Archaic period occupation of Site 33 are only a reflection of the relatively small sample of chipped and ground stone artifacts and the biasing of subsurface tests toward houses. However, it is also possible that the differences in chipped and ground stone assemblages between the Archaic period occupation of Site 33 and the later Formative period residential sites are attributable, in part, to differences in the relative contributions of subsistence items to the diet and attendant subsistence activities. Cultigens, for example, are thought to have made a larger contribution to the diet during the Formative period than during the Archaic period, and the high percentages of grinding implements for the two Formative period residential sites may be reflecting the importance of corn grinding activities at these later sites. However, Archaic and Formative period subsistence strategies are not known well enough to evaluate fully the differences in chipped and ground stone assemblages in these terms.

In summary, the chipped and ground stone assemblages of the Archaic period occupation at Site 33 do have some of the aspects of assemblages from long-lived sites which include the curation of cores for further reduction and some curation of chipped and ground stone tools, but chipped stone tools do not appear to be as well curated and grinding activities seem to be of lesser importance for the Archaic period occupation of Site 33 than for the later Formative period residential sites. These latter observations question differences in subsistence strategies between the Archaic and Formative periods and intimate that the Archaic period occupation of Site 33 may have included intermittent, long-lived and ephemeral inhabitations of the site.

CHAPTER XI

SUMMARY

The results of Phase II Archeological Investigations by the El Paso Centennial Museum of The University of Texas at El Paso of the cultural remains that will be affected by the El Paso Flood Control Project, Northwest Area, El Paso, Texas, of the U.S. Army Corps of Engineers are reported in the foregoing pages. This project will encompass the construction or enlargement of a series of five flood control dams and associated diversion ditches and outflow channels. The focus of this study is the large Archaic and Formative period site known as the Keystone Dam Site. It is identified by the site number EPCM 31:106:2:33 which has been abbreviated as "Site 33" in this report. A large arroyo and a low ridge separate the Keystone Dam Site from the adjacent Formative period site, EPCM 31:106:2:34, which was also tested extensively. A third site, EPCM 31:106:2:29, was examined, and sufficient data were collected from this site to mitigate the loss of the balance of the resource. Investigations of five other sites, EPCM 31:106:2:31, 32, 35, 36, and 37, were limited to brief visitations for the purpose of augmenting available information from an earlier survey of the area.

The objectives of this study were: (1) to characterize the cultural remains of the project area and, in particular, the three tested sites; (2) to elucidate the cultural context in which these remains were deposited; and (3) to evaluate the direct and indirect impacts of the proposed action on the cultural resources for the purpose of designing an efficient program to mitigate the loss of the resources. The first objectives have been covered in the corpus of this report and are summarized here. The third is discussed in Appendix A where it is recommended that two sites (Sites 31 and 35) located on the periphery of the project be fenced and left undistrubed, that adequate data have been recovered from one site (Site 29) to disclaim the need for additional investigation, and that the remaining five sites (Sites 32, 33, 34, 36, and 37) be excavated in part or completely, depending upon the degree of impact, in order that the loss of the important archeological resources they contain may be mitigated.

The present environmental setting has been described, nearby environmental zones have been characterized, and post-Pleistocene conditions have been reconstructed insofar as conflicting evidence or interpretations permit. Environmental parameters that have a direct bearing on the evaluation of archeological materials from the prehistoric sites of the study area have been considered in detail with respect to their spatial and temporal variability.

A variety of stone suitable for use in chipped stone tools and ground stone implements occurs on the terraces and in the arroyos near the sites investigated by this project. Limestone, rhyolite, quartzite, and chert are the most common materials near these sites. Small nodules of obsidian are of rare occurrence in the alluvium of the project area and were little used by the prehistoric occupants of these sites. Sandstone which can be found in the nearby Franklin Mountains was also utilized for ground stone implements and is the only known intrusive material to these sites.

Soils suitable for flood water, rainfall and runoff, and dry-land farming techniques respectively include soils of the Rio Grande floodplain, soils of some of the shallow drainages and alluvial fans of slopes bordering the Rio Grande, and playa-associated soils on the plain west of the Rio Grande. The availability of water is the principal factor limiting the farming of soils. The Rio Grande is the only large, dependable source of water in the study area, but farming of the floodplain would have entailed risks attendant with uncertain magnitude of river flow and river course. Dry-land farming of the plain west of the Rio Grande would apparently have been possible only under conditions of greater than present rainfall. At present, about half of the annual precipitation falls during the summer months and occurs as monsoonal thunderstorms of short duration. Runoff from summer thunderstorms may have made possible the farming of some of the drainages and alluvial fans bordering the Rio Grande. In addition to the Rio Grande, sources of water include ephemeral accumulations of water in playas principally during the summer months and small springs in the Franklin Mountains.

A limited variety of potentially important food plants is found in the six environmental zones (the Mountain, Upper Bajada, Lower Bajada, Riverine, Leeward Slope, and West Mesa zones) which have been defined on the basis of land form, substrate, and observable patterns in the distribution of plant species for the project area. These environmental zones parallel one another and encompass the Franklin Mountains, the alluvial slopes between the Franklin Mountains and the Rio Grande, the Rio Grande floodplain, the dissected slope bordering the west bank of the Rio Grande, and the level plain west of the Rio Grande. Each of these environmental zones is noted as having a different combination of economically important plant foods, most of which are available or in their best condition for harvesting during the warmer, biotically productive portion of the annual cycle. All of the defined evironmental zones are within 3 to 6 km (a distance within the daily foraging radius of contemporary food collectors) of the sites investigated by this project. These six environmental zones also contain the majority of recognized economically important plant species of the El Paso area. Lechuguilla and sotol are common in the upper zones and are leaf succulents which can be consumed at any time of the year but whose hearts and leaf bases are apparently more palatable in the spring. The fruits of datil and prickly pear are other plant foods which occur most frequently in the upper zones. Datil fruits ripen from late spring to summer, and prickly pear fruits are available from late summer to fall. Mesquite can be found in all of the environmental zones but is most common west of the Rio Grande and along the Rio Grande where tornillo and cattail can also be found. Mesquite and tornillo seed pods may be collected and eaten or stored during the fall and winter, and they, together with cattail, constitute important food resources that would have been available to the occupants of sites of the study area during the winter. Other potential plant foods of the project area include the hearts, leaf bases, and flowering stalks of soap-tree yucca, the seed pods of whitethorn, acorns, the fruits of wolfberry, grass seeds, and seeds and greens of numerous herbaceous plants.

Economically important animal resources for the project area include deer, pronghorn, cottontail, jack rabbit, fish, spiny soft-shell turtle, and other water fowl and mammals. It has also been suggested that deer and fish may have played important roles in the winter subsistence strategies of both farmers and hunter-gatherers when natural plant foods were not generally available or were in less than prime condition.

The El Paso area is described as having a climate characterized as semiarid and mesothermal with hot days, cool nights, and a low relative humidity. These conditions are believed to have begun in post-Pleistocene time at about 8,000 years ago, as inferred from the first appearance of desert plant species and plant communities whose geographical distribution is comparable to that of the present. The climate appears to have remained much the same for the last 8,000 years with a possible drying trend noted for the middle Holocene (ca. 8000 to 5000 or 4000 BP) and with minor fluctuations in precipitation in the late Holocene (ca. 5000 or 4000 BP to the present). Pinyon-juniper woodlands of the terminal Wisconsin are noted as having given way to juniper-oak woodlands at about 11,000 years ago, and this latter vegetation type was replaced, in turn, by grasslands with some desert species at about 8,000 years ago. Present desert shrub communities appeared between 5,000 and 4,000 years ago and have since competed with grasslands for dominance. At least, this pattern of climate-associated vegetation changes is suggested by macrofloral specimens identified from woodrat nests in some of the smaller mountains near El Paso.

The prehistory of the study area encompasses the general Southwestern developmental sequence of presumably climate-related adaptive strategies which are subsumed under the following named and dated periods: Paleoindian (10,000-8000 BP); Archaid (8000-2000 BP); and Formative (2000-550 BP). In the El Paso area the Formative period is divided into the Mesilla (AD 1-1100), Dona Ana (AD 1100-1200), and El Paso (AD 1200-1400) phases. The sites of the project area fit into the last 4,500 years of this chronology.

A variety of different field techniques was utilized to collect surface and subsurface data from the sites investigated by this project. All were employed in the study of the 4.1 hectare area encompassed by the adjacent Sites 33 and 34 to which reference will be made in what follows. Only a few of these techniques were used in the examination of Site 29, and, as previously mentioned, the other five sites were simply visited to supplement information provided by an earlier survey of the project area. A grid system was established for Sites 33 and 34, and surface features and artifacts were mapped within 1 m squares of the grid system. Surface artifacts were collected by 4 m grid units. Soil augers were utilized to find the depth at which soil changes occurred and where subsurface features were located as indicated by charcoal, fire-cracked rock, etc. The entire surface of Sites 33 and 34 was sampled at wide (8 m) intervals and many areas were tested at close (2 m) intervals with soil augers in attempts to delineate subsurface features. Backhoe trenches were dug in 11 areas on the two sites in order to clarify details of stratigraphy, to amplify information gained from wide interval soil cores, and to expose certain areas not tested at 2 m intervals with soil augers. Some additional houses and other features were discovered in these trenches. Suites of soil samples were taken for possible use in palynological studies from backhoe trenches where strata were clearly exposed. Finally, 1 m test squares were excavated by hand in 96 loci of the two sites. Some of the features exposed on the surface or subsurface features disclosed by the techniques mentioned above were examined by means of 1 m square hand excavations in order to further define their nature and to expose the relevant stratigraphy.

Artifacts were collected wherever encountered and are stored in the El Paso Centennial Museum where they may be examined by interested researchers. All of the soil removed in the wide interval soil augering, and some of the close interval soil augering, was passed through ¼-inch or finer screen in order to recover artifacts and charcoal. Few artifacts were found in this manner, but a number of fragments of charcoal was collected. Soil samples for flotation were also taken with the augers for macrofloral analysis. All soil removed by hand excavation was screened, and artifacts, charcoal, and flotation and pollen samples were collected by 10 cm or thinner levels. In addition, data were recorded on the number, size, weight, and material of fire-cracked rock when encountered.

Five stratified layers of alluvial and eolian soils are recognized at Sites 33 and 34. Two of these strata, the second and fourth, bear evidence of prehistoric occupations. The first stratum, named Zone 1, consists of recent accumulations of wind-blown sand. Zone 2, the next lower stratum, has nine MASCA corrected radiocarbon dates that range from 160 BC to AD 1500. Two large fire-cracked rock features occur near the bottom of the Zone 2 deposits at Site 33 and are dated before the time of Christ. These early dates and the absence of diagnostic artifacts from these features make it most economical to assume that they pertain to the late Archaic period even though the earlier, Zone 4, Archaic period occupation of Site 33 appears to have terminated by about 1800 BC. Formative period sites with ceramics have been dated by radiocarbon at AD 250 in the El Paso area, and the possibility must also be entertained that these features relate to that period. Radiocarbon dates from Zone 2 at Site 33 indicate intermittent occupation from 160 BC to AD 1500. Zone 2 radiocarbon dates from Site 34 span the time of AD 250-820.

No evidence of human visitation to Sites 33 and 34 was found in the Zone 3 deposits. However, Zone 4 at Site 33 produced evidence of numerous, small, shallow, circular houses. Five radiocarbon dates suggest that the Zone 4 occupation occurred during the Archaic period and sometime between 2500 and 1500 BC. Lithic artifacts are common in and around the houses, but diagnostic tools are rare. Soil Zone 5 was sterile except for a shallow, basin-shaped pit and a thin layer of charcoal-stained soil, neither of which contained artifacts nor sufficient charcoal for radiocarbon dating.

Site 29 is a small site of 125 square meters. Evidence for the prehistoric occupation of this site consists of one exposed, small fire-cracked rock feature and scattered fire-cracked rock from one or two additional features. No artifacts were found at Site 29, and insufficient charcoal was recovered for radiocarbon dating. However, it can be suggested that this site probably dates to the Formative period when fire-cracked rock features were of greatest importance in the project area. The deflated and eroded condition of Site 29 did not lend itself to stratigraphic or palynological studies.

Sites 33 and 34 are situated on a large alluvial fan and remnants of a low, Pleistocene valley terrace. The stratigraphy of this alluvial fan shows a number of correlations with the Bryan-Antevs alluvial chronology for the Southwest and is interpreted as evidencing a trend toward increasing relative aridity through the late Holocene. Zone 5 is made up of alluvial sediments deposited before 4450-3750 BP. A short period of surface stability and soil formation sometime between 4450 BP and 3750 BP is indicated by the Zone 4 occupation. Zone 3 alluvial sediments are thinner than those of Zone 5 and are taken as evidence for a decrease in effective precipitation for the period of 4450-3750 BP to sometime before 2200-2000 BP. Eolian deposition and dune formation are first seen in the upper deposits of Zone 3 at about 2500 BP and also support the inferred trend in aridity from the time of Zone 5 deposition to that of the Zone 3 deposition. A period of arroyo cutting is noted to have occurred sometime between 2500 BP and 2000 BP. Zone 2 deposits show minimal alluvial aggradation of the fan and the intensification of duning for the period of 2200-2000 BP to 450 BP. Again, this suggests the continuation of a drying trend into the second half of the late Holocene. Additional eolian deposition and arroyo cutting are manifest by Zone 1 which dates from 450 BP to the present.

Climatic information, as derived from palynology, has been discussed in considerable detail with the general conclusion that there has been relatively little climatic change during the last 4,000 to 5,000 years, although a slight drying trend seems to be indicated by the increases in Cheno-Am and pine pollen and the decreases in Gramineae, Compositae, ephedra, oak, walnut, and hackberry pollen from the pollen spectra of Zones 5, 4, and 3 to those of Zone 2 at Site 33. This trend is particularly notable during the last 2,000 years when, between ca. 2100 and 500 BP, there seems to have been a decrease in effective precipitation, a reduction in vegetation cover, and possibly an increase in desert shrub communities. This drying trend for the last half of the late Holocene is also reflected by the stratigraphy of Sites 33 and 34. Large counts of Cheno-Am pollen grains were expected as a result of previous experience with palynological studies of local material. Therefore, 300 grain counts were obtained in order that the rarer types might be represented more adequately. Pollen preservation was found to be poor in general, and 10 of the 30 samples submitted did not produce enough pollen for analysis. The possibility of differential preservation severe enough to distort the pollen profiles was considered with the conslusion that it probably did not constitute an insoluble problem. The influence of human activities on the pollen spectra was also examined and was found, with the observation that the spectra associated with human activities did not differ notably from those not so associated, not to represent a serious problem. The vertical scatter of pollen-sterile samples through the stratigraphic columns from which the pollen samples were taken argues against marked diffusion of pollen grains through these columns as a result of water percolation, although the penetration of charcoal stains below burned house floors and hearths demonstrates some movement of macroscopic particles through the soil.

A total of 777 macrofloral specimens from the charcoal recovered from houses, fire-cracked rock features, pits, and nonfeature areas at Sites 33 and 34 was identified. Twelve woody species are represented in the charcoal from these sites. These species are major components of the modern vegetation on or near Sites 33 and 34, and no marked differences were noted in the relative abundance of woody species for deposits and features of different age. Mesquite and tornillo were the woods preferred for use in hearths and possibly in house construction. Mesquite was virtually the only wood used in the fire-cracked rock hearths of the Formative period, although two late Formative period pits were filled with cottonwood charcoal in addition to mesquite. Green wood was apparently used frequently in the l ge fire-cracked rock features and rarely in the small fire-cracked rock hearths. Both types of fire-cracked rock features appear to have been used primarily as ovens in which to bake leaf succulents. Charred remains of leaf succulents were recovered from several of the Formative period fire-cracked rock features and pits. In addition to the use of mesquite and/or tornillo in the construction of the Archaic period houses, there is macrofloral evidence to suggest that cottonwood, creosotebush, wolfberry, Apache plume, and reeds were utilized in the supersturcture. Grass stems and leaves, as well as small branches, are also visible in the preserved fragments of the burned mud plaster that presumably covered the houses.

Data relative to subsistence and recoverable in the forms of charred seeds and fruits were sought from 134 (28% of the total) of the flotation samples from features and from spatially representative soil auger samples obtained at Sites 33 and 34. House 4 of the Archaic period occupation of Site 33 was apparently burned while in use and, as a consequence, produced evidence of a number of foodstuffs, including the seeds and fruits of prickly pear, smartweed, dock, goosefoot or pigweed, bulrush, and tornillo. The seeds and fruits of these plants which would have been procured from different environmental zones and in different times of the annual cycle, furnish evidence of the storage of foodstuffs during the Archaic period occupation of Site 33. The charred food remains recovered from this house account for 62% of the total counts of seeds and fruits from Sites 33 and 34. The other houses that were tested or excavated were apparently abandoned before being burned, because they contained meager evidence of subsistence practices. No charred particles of corn were identified from any of the samples. Therefore, the possibility that the Type A pollen discussed in Chapter VI is that of *Zea mays* remains unsupported even though the presence of corn would not be unexpected for either the Archaic period occupation of Site 33 or the Formative period occupations of Sites 33 and 34.

In the process of examining flotation samples from the numerous non-feature, soil auger loci it was noted that many contained uncharred seeds of the same types as those found burned and unburned in the features. This, together with the very low counts of charcoal seeds and fruits from the small fire-cracked rock hearths and other features, suggests that these food items were accidentally charred because they were in the soil into which the hearths or burned features were excavated rather than because they were the remains of meals prepared in or near the features. The representativeness of the seed samples must be questioned also because of the infrequent occurrence, except in the sample from House 4, of mesquite or tornillo pods and seeds. There can be no doubt that these foodstuffs were available, and it seems equally certain that they would have constituted important food resources for the Archaic and Formative period populations. The facility with which the pods and seeds of these legumes can be identified with the unaided eye makes it unlikely that they were missed in the macroscopic and microscopic sorting of the flotation samples. In short, it seems that the evidence relative to the use by Archaic and Formative period populations of the seeds and fruits of most of the 18 or more species of plants recovered at Sites 33 and 34 is ambiguous. Only those data recovered in House 4 of the Archaic period occupation at Site 33 relative to the use as food of the seeds and fruits of tornillo, bulrush, dock, smartweed, prickly pear, and goosefoot or pigweed seem sustainable. The use of prickly pear fruits as a food item during the Archaic period occupation of Site 33 is additionally manifest by relatively high percentages of *Opuntia* spp. pollen in the deposits of this occupation. It is probable that much supportive information awaits the recovery of additional macrofloral remains in the unexcavated and burned houses on Site 33.

Faunal remains are not well preserved at Sites 33 and 34, and the few recovered bones are probably not indicative of the importance of animal foods or of the kinds of animals taken. Bones comparable in size to those of cottontails and jackrabbits were retrieved from the Formative period deposits of Site 33, and identifiable elements of cottontail and jackrabbit were found in the Archaic period deposits of that site. Fragments of bird eggs were also recovered from two of the Archaic period houses and suggest some spring or summer occupation of Site 33.

The most numerous features observed on Sites 33 and 34 were small fire-cracked rock hearths, of which 193 were recorded and an equal number may remain in untested areas of Site 33. Virtually all these features (all but seven) occurred in the Zone 3 Formative period deposits where a few are dated by radiocarbon from AD 550 to AD 1200. They had a mean size of about one square meter, and contained an average of 35.7 kg of fire-cracked rock. These small hearths contrasted markedly in size with the four large fire-cracked rock features on Sites 33 and 34 which were of irregular shape but ranged in size from 55 to 125 square meters and contained from 33 to 77 times more fire-cracked rock by weight than did the small fire-cracked rock hearths. The large fire-cracked rock features were all found in Zone 2 and were apparently in use only during the Formative period or possibly also during the terminal part of the Archaic period.

The function served by these fire-cracked rock features has been discussed in detail. It is concluded from a consideration of the spatial codistribution of these features and upland leaf succulents in the El Paso area and from examples of ethnographically reported fire-cracked rock features that both of the types of fire-cracked rock features on Sites 33 and 34, as well as the small fire-cracked rock hearths on Site 29, served the same purpose. This was as ovens for baking any of the several upland leaf succulents that are available within foraging distance of the sites. There is evidence to suggest that family-sized social groups utilized the small fire-cracked rock hearths for brief periods of time in the spring. The large fire-cracked rock features were apparently, in some cases at least, merely the result of the accumulation of rocks in areas in which small fire-cracked rock hearths were used and reused over the years while in other cases they may have been constructed and used on single or multiple occasions by larger social groups to bake cooperatively a large number of leaf succulents.

The possibility that small fire-cracked rock hearths may have served general domestic functions was considered and rejected because it was noted that such hearths are rarely found within or in the immediate vicinity of dwellings at any of the excavated sites in the El Paso area. The few hearths that are reported in or near dwellings at other sites of the El Paso area, as well as those in the Archaic period dwellings of Site 33, lack fire-cracked rock. Fire-cracked rock features found in villages are usually located in less accessible, peripheral, areas of the site where they could be used when the occasion demanded for special activities. This is also the pattern observed for the seven small fire-cracked rock hearths of the Archaic period occupation at Site 33.

The temporal distribution of fire-cracked rock features is restricted at Sites 33 and 34 largely to the period between shortly before the time of Christ to ca. AD 1500, that is, to the somewhat drier period of soil Zone 2 deposition. It is reasoned from the large number of fire-cracked rock features recorded for Zone 2 that activities at these sites focused on the use of these features. The rareness of these features in the Archaic period deposits of Site 33 suggests that the special function they served, presumably the baking of leaf succulents, was of little importance.

Eleven pits that differed from the fire-cracked rock features, insofar as rock was sparse or absent, were recorded for the Archaic and Formative period deposits of Sites 33 and 34. Six pits are noted for the Formative period, and the majority of them appears to have served as heating facilities for either general domestic or more specific use, but the specific function they served could not be ascertained. One other Formative period pit at Site 33 proved of interest because its diameter, depth, and location on the alluvial fan make it comparable to those reported in other areas for wells and because it was dug down to a stratum that once may have been an aquifer. The proximal location of the river suggests that a well would have been of use only when the river was dry or when it flowed at a distance from the site on the other side of the floodplain.

There are four known pits for the Zone 4 Archaic period occupation of Site 33. These include refuse-filled pits, a possible storage pit, and a pit containing charcoal and a few fire-cracked rocks which indicate use as an oven or roasting pit. This latter pit is situated near the periphery of the Zone 4 occupation, as are most of the seven small fire-cracked rock hearths which are presumed to be special purpose facilities for cooking leaf succulents. The refuse-filled pits and the possible storage pit are located near houses and suggest some concern for the disposal of trash and storage which are activities usually associated with long-lived habitations. Although few pits were found in the limited testing of areas immediately surrounding houses, close interval soil augering indicates that these features may be common around the houses of Zone 4. One other pit has been documented for Site 33 and is a basin-shaped pit devoid of fire-cracked rock in the deposits of Zone 5. This pit and an associated layer of charcoal-stained soil of small area are the evidence of occupation of the alluvial fan before 4450-3750 BP.

Additional features on Site 33 include two ash and charcoal lenses which are presumed to be general purpose hearths and two possible alignments of postholes which might relate to temporary shelters, ramadas, or racks. One of each of these two kinds of features is noted for the Zone 2 Formative period and the Zone 4 Archaic period occupations. The ash and charcoal, general purpose hearths are difficult to recognize and apparently do not preserve well. Therefore, these extramural features may be or could have been more common for both the Archaic and Formative period occupations of Sites 33 and 34 than the limited testing of these sites would imply.

The recognition of a number (between 23 and 41) of Archaic period houses at Site 33, the Keystone Dam Site, constitutes what is probably the most important class of data reported here. These houses are dated between 4450 BP and 3750 BP and are more than 2,000 years older than other known houses of the El Paso area. The small size (ca. 3 diameter), shallow depth (ca. 10 cm), flimsy construction (thin mud plaster over an unframed, brush dome), unplastered floor, informal hearth, and probable east entry constitute characteristics of these houses that are not unexpected of this time horizon and environment but rarely reported in the detail or from the number of examples expectable at this site. These houses are of a size that appears to be scarcely large enough for a nuclear family-sized social group. The houses are also not distributed randomly over the site but seem to be clustered in small groups which, if substantiated by large-scale excavation, artifact distribution, and extramural features, hold promise for a more complete understanding of Archaic period social organization, particularly household size and composition and economic behavior, than has been available heretofore. Most of the houses are clustered in groups of two to perhaps five houses which may indicate extended family-sized households. However, at present, it is not known if these clusters of houses represent individual and different occupations or components of a larger, band-sized social group. The isolated and clustered houses with their associated trash-filled and storage pits and the peripheral, special use facilities reference an organized partitioning of space with respect to social relations and the nature of activities which are suggestive of an occupation of some duration. The mud plaster coating of the houses suggests that they were occupied during the colder part of the year, while the small fire-cracked hearths and botanical and faunal evidence indicate a spring, summer, and fall occupation. There is reason to suspect, therefore, that the houses may have been utilized throughout the year, perhaps as infrequently visited cache or storage sites during the late spring, summer, and fall and as dwellings during the winter and possibly early spring in an economic regime based on a central-based, wandering pattern. Sizable winter encampments have been recorded for hunter-gatherers along the Rio Grande below El Paso in early historic times, and it has been noted that water and certain plant and animal resources are either available or more abundant in the winter along the Rio Grande than in areas away from the river. Trash was allowed to accumulate on the floors of some of the houses and in a few instances there is evidence of second floors having been superimposed upon the accumulated trash. These observations are interpreted as supportive of a non-permanent, base camp utilization of Site 33.

Ceramic materials of the Zone 2 Formative period occupations at Sites 33 and 34 are relatively sparse. The low density of sherds for these sites and the spatial distribution of sherds of particular vessels or ceramic types with narrow times of manufacture indicate that the Formative period occupations were ephemeral and small. Radiocarbon dates suggest a long Formative period occupation of Sites 33 and 34 from near the time of Christ to about AD 1500. Although few sherds have associated radiocarbon dates and none with a date earlier than

AD 820, there is a large potential for refining the ceramic chronology of the El Paso area with additional investigation of Site 33. Sherds were divided into a number of classes on the basis of tempering and past materials and surface finish and decoration, and most of the ceramic classes fit into named ceramic types. Among the earlier types are El Paso Brown, Alma Plain, and San Francisco Red, the latter two of which may have come from up river to the north or from the broad lowland west of the river. Mimbres Black-on-white and a corrugated ware are intrusives which fit into a later Mesilla phase time period (ca. AD 800-1100), and sherds of the indigenous El Paso Brown with black lines painted on them suggest some occupation between AD 1050 and AD 1250. El Paso Polychrome is a rare, locally-made type at these sites, as are the intrusive Rio Grande Glazes A and F, which fit temporally into the El Paso phase (AD 1200-1400).

Chipped stone constitutes the most numerous class of artifacts from both the Archaic and Formative period deposits at Sites 33 and 34. However, they are lightly scattered on the surface and in the deposits of Formative period occupations and fairly abundant in the deposits of the Archaic period occupation. The relative densities of chipped stone artifacts are suggestive of ephemeral occupations during the Formative period and a more intensive or longer lasting occupation during the Archaic period. The selection and reduction of locally available raw materials for tools has been remarked as being similar for both the Archaic and Formative period occupations. Formal tools are rare for both of these occupations, and reduction technologies are viewed as having been oriented toward the expedient manufacture of tools. There are notable differences between the chipped stone remains from the two periods of occupation. The Archaic period occupation has been distinguished from the Formative period occupations by the apparent more extensive working of materials, the seemingly larger importance of bifacial thinning and tool resharpening activities, and the evident greater curation of cores and tools. The Archaic period tools have been noted as generally being small and of fine-grained materials, while those of the Formative period occupations have been observed to include large tools of coarse-grained materials. It has also been suggested that light activities involving the controlled manipulation of chipped stone tools are proportionately more important for the Archaic period occupation and that heavy activities using the size or mass of a tool in less precisely controlled actions are proportionately more important for the Formative period occupations. Taken together, these observations support the argument that the Archaic period occupation was of some duration, though probably intermittent, and characterized by generalized, maintenance and supportive activities and that the Formative period occupations were more ephemeral and intermittent and typified by more specialized, extractive activities which involved the use of fire-cracked rock features for processing upland leaf succulents.

Chipped stone assemblages of the Archaic and Formative period occupations at Sites 33 and 34 have been compared with those of other sites in the El Paso area. The Archaic period assemblage is noted as having low percentages of tools and cores which are close to those reported for long-lived, residential sites and indicative of the curation and maintenance of tools and the retention of cores for further reduction. The percentages of tools and cores for the Formative period occupations at Sites 33 and 34 are higher than those of the Archaic period occupation of Site 33 or other residential sites and similar to those reported for ephemerally occupied camps where tools are less often curated and more often discarded after use. The Formative period tools of Sites 33 and 34 are also noted as being of comparable composition with respect to inferred usages to those of other Formative period camps where the processing of upland leaf succulents is also believed to have been the most important activity.

Ground stone tools are of uncommon occurrence in the deposits of the Archaic period occupation at Site 33 and the Formative period occupations at Sites 33 and 34. There are data from which to infer that those of the Archaic period may have been curated and that grinding activities were of some importance for the Archaic period occupation. Grinding implements, however, do not appear to have been curated and are thought to have been of little importance for the Formative period occupations.

An analysis of the spatial distribution of fire-cracked rock, ceramics, ground stone artifacts, and chipped stone artifacts on the surfaces of the Formative period occupations at Sites 33 and 34 has disclosed four kinds of task areas. The first type of task area relates to activities presumed to have been directly involved in the processing of upland leaf succulents. Fire-cracked rock features, fragments of ceramic vessels or scoops, and sherds with edges worn from use constitute the principal evidence of the first task area. The second kind of task area includes areas in close proximity to fire-cracked rock features where small chipped stone tools were used in various activities. Large chipped stone tools, ground stone implements, hammerstones, and cores comprise the third type of activity area which is situated farther from fire-cracked rock features than the second type of task area and is taken to be an area of mixed activities including seed grinding, some chipped and ground stone tool production, and heavy activities performed with chipped stone tools. The fourth kind of task area includes peripheral portions of these sites and areas between features where stone was reduced for chipped stone tools. Similar spatial patterns in features and artifacts to those of the Formative period occupations of Sites 33 and 34 have been reported for other sites in the El Paso area which are also thought to have been ephemerally occupied for the primary purpose of processing upland leaf succulents in the spring.

Sites 29, 33, and 34 are the subject of much of this report and were extensively investigated as part of this project. Sites 31, 32, 35, 36, and 37 were simply visited to acquire information in addition to that provided by an earlier survey and are described in Appendix A. These eight sites are illustrative of three kinds of sites which are components of recognized prehistoric settlement patterns of the project area. Residential sites which generally are of large size and exhibit a variety of activities in terms of tools and facilities are distributed relative to ease of access to environmental zones depending upon the adaptive strategies employed. Most residential sites occupied by the hunters and gatherers of the Archaic period, such as Site 33 and possibly Sites 32 and 37, are found on the east side of the Rio Grande where access was readily gained to a number of different environments. However, most residential sites occupied by horticulturalists of the Formative period are located on the west side of the river where arable land in addition to that of the floodplain is available and where the runoff from thunderstorms is more easily controlled in the shallow arroyos draining small catchment areas than on the east side of the river. Small camps where special activities were performed during all periods are more widely scattered but there is still a notable tendency for many of them to be concentrated near the river presumably because water sources are scarce elsewhere. Small camps which are inferred to have been used as loci for the processing of upland leaf succulents include Site 29 and 35 which are of unknown age and Site 31 and a component of Site 32 which appear to have been occupied during the Formative period. The many large camps with numerous fire-cracked rock features of the Mesilla phase of the Formative period are located on the east side of the Rio Grande in proximity to plant communities with upland leaf succulents. These large camps, such as Sites 33, 34, and 36, suggest that upland leaf succulents may have contributed importantly to the subsistence base during much of the Mesilla phase. Settlement patterns of the project area reflect changing adaptive strategies and the relative contribution of native resources and cultivated plant foods which may correlate with inferred changes in population density. Human population of the area seems to have increased gradually, reached a maximum density during the terminal El Paso phase of the Formative period, and died back dramatically thereafter.

APPENDIX A

MITIGATION RECOMMENDATIONS

In this appendix measures necessary for mitigating potential adverse effects on the three tested sites (EPCM:31:106:2:29, 33, and 34) and five others (EPCM:31:106:2:31, 32, 35, 36, and 37) due to the proposed construction of Keystone and Mesa Dams is presented. Both direct and indirect adverse effects on cultural resources are considered, and estimates of the amount of effort involved in mitigating the loss of these sites are given. All of these sites have previously been evaluated as being eligible for inclusion in the National Register of Historic Places by Rex E. Gerald (n.d. d). Gerald suggested that each of these sites was "*significant*" and of a quality for nomination to the National Register due to the probable scientific information they contained relative to prehistoric social systems that once existed in the area. In the following discussion the significance of each site will briefly be touched upon in terms of the general research questions that can be approached by the investigation of the site within the constraints of applicable mitigative measures.

Before proceeding to the individual sites, some detail is required with respect to how estimates of mitigative effort are derived. Estimates are given in terms of man-days in the field for surface collecting and recording and subsurface interval testing with soil augers or shovels, the excavation of small fire-cracked rock hearths or features of similar size, and the excavation of 1 m square test units. These figures are then expanded by 20% to cover field supervisory positions (i.e., one man-day of supervision for each five man-days of labor). The total man-day figure for each site, therefore, only reflects the amount of time in the field for suggested mitigative efforts. Total project time in terms of labor can be computed by multiplying total field man-days by four. It has been our experience that laboratory analyses and report preparation generally require three man-days for each field man-day.

The amount of labor needed to perform the above activities varies from site to site because of site conditions, natural obstructions, and depths of cultural deposits. Estimates are based on the amount of labor required for similar activities at the three tested sites and vary in the following manner:

1. Surface collection and mapping by 4 m grid units and subsurface testing at 8 m intervals followed by subsurface testing with soil augers or shovels at 2 m intervals over 5% of the area: 300 square meters per man-day.
2. Excavation of small fire-cracked rock hearths and features of similar size: 2 to 3.5 man-days per feature.
3. Excavation of 1 m grid units by arbitrary or natural levels not exceeding 10 cm with horizontal and vertical control, screening with 1/4-inch mesh or smaller, and the recovery of special samples such as radiocarbon, flotation, and pollen: 0.7 to 4.0 1 m grid units per man-day.

Site 29

Site 29 consisted of one small fire-cracked rock hearth and perhaps two other badly eroded hearths and was the subject of limited testing as part of this project. No subsurface deposits or artifacts were found. No burned seeds were recovered, and insufficient burned wood was recovered for dating or identification. The lack of deposits and the eroded nature of all hearths precluded any palynological study or pedological investigation. These hearths and their location with respect to ecological zones proved informative in terms of specialzied economic activities centering on the processing of leaf succulents. Unfortunately, the temporal placement of this site was uncertain though most likely it pertained to the Mesilla phase of the Formative period.

Subsurface testing, the excavation of the one nearly intact hearth, and the mapping of scattered hearths stones have exhausted the potential for any additional information to be recovered from Site 29. It is recommended that Site 29 not be considered for further investigation and that an archeological clearance be granted for the immediate site area.

Site 31

This site consists of two small fire-cracked rock hearths and a very light scatter of brownware sherds and lithics over an area of approximately 600 square meters on an alluvial fan at the mouth of a large arroyo and just above the floodplain of the Rio Grande. The sherds exhibit coarse tempering materials which suggest that the site was occupied somewhere between A.D. 600 and 1100 during the Mesilla phase of the Formative period. As with Site 29, the fire-cracked rock hearths and the site location imply a temporary occupation for the processing of leaf succulents, probably during the spring or summer. Sherds located near the hearths fit a pattern observed at many similar sites. There is no evidence of buried deposits, and the hearths appear to have been disturbed by water erosion and silting.

This site is situated just north of the proposed location of Keystone Dam, and potential adverse effects would appear to be in the realm of equipment movement or the grading of a haul road across the site. These adverse indirect effects can be overcome most easily by the placement of a fence around the site for the duration of construction activities; it is recommended that this be done instead of pursuing archeological investigation of Site 31.

Any archeological investigation of this site would center on the recovery of information which would narrow down the period of occupation, yield pollen samples and macrofloral or faunal samples from hearths for clues as to their use, and give data on hearth and artifact spatial relationships that could be used in discussions of activities occurring on the site and around the hearths. However, radiocarbon dates from the hearths would probably not improve the suggested dates of occupation that are now based on the closely associated ceramics; the somewhat eroded nature of the site and hearths suggest that macrofloral samples may not be recovered and that pollen may have been intruded into the hearths recently; and the spacial association of artifacts and features may be disturbed by water erosion. In many respects lines of inquiry which might be pursued at Site 31 will be duplicated at Sites 32, 33, 34, 36, and 37 where the nature of these special use sites can be investigated on a greater scale with cultural materials that have been less disturbed but that will be disturbed or destroyed by the construction of Keystone Dam.

Site 32

This site is located on a gravelly ridge overlooking the Rio Grande floodplain. The total site area is about 14,000 square meters, but artifacts are most densely scattered over 10,000 square meters. Gerald (n.d. d), assisted by this writer, observed and reported a thin scatter of lithics over this site and two small fire-cracked rock hearths. Subsequent, more intensive surveys and additional wind erosion have made it possible to report the existence of a much denser scatter of lithic materials, 13 possible hearths, and a sparse scatter of brownware sherds in one area of this site. A light, ashy gray deposit some 5 to 15 cm thick is in evidence over much of the site and subsurface features are likely to exist. This site is situated within the impounding area of Keystone Dam and will be completely destroyed by grading activities. Thus, a program of mitigation must be designed to recover the maximum amount of information possible.

The primary occupation appears to be preceramic and during the Archaic period. The study of Site 32 should provide additional information on this little-known period. Archeological investigations of this site should pursue the following:

1. The recovery of diagnostic artifacts and radiocarbon samples which will assist efforts in refining the chronology for this period.
2. The recovery of chipped and ground stone artifacts for discussions of raw material selection, reduction technologies, and tool use and discard. This information will also be essential for describing the nature of activities, the permanency of occupation, settlement patterns, and social organization.
3. The locating and testing of buried features which reflect subsistence activities, storage facilities, and/or habitations. Of concern here is whether houses similar to those discovered at Site 33 will be encountered, whether the fire-cracked rock hearths are products of the Archaic occupation or of later occupants of the site, and whether baking pits without fire-cracked rock are more common than fire-cracked rock hearths.
4. The recovery of provenience information on artifacts and features for spatial analyses which will shed light on the use of space, the types of activities, and the social organization.
5. The recovery of macrofloral and faunal remains from features and scattered deposits which will help

delimit subsistence activities and procurement strategies.

6. The recovery of pollen samples which will aid in environmental reconstructions and in determining the nature of subsistence activities.

Through the recovery of the above information it should be possible to compare and contrast Archaic occupations at mesa top Site 32 and alluvial fan Site 33 with respect to differences in subsistence activities, procurement strategies, technology, season and duration of occupation, and social organization.

Questions which can be pursued include:

1. Are the sites of roughly the same time period or not? Can a chronology be developed for future testing?
2. Are the site contents different? Do they represent different types of sites which are products of different segments of the same organization or do they represent different ubsistence, social organization, and settlement patterns?
3. Do the spatial associations of artifacts and facilities reflect similar types or sizes of social groups, and if Site 33 represents a base camp, which seems possible, is an argument for central based restricted wandering supported?
4. Do lithic procurement and reduction strategies reflect low or high mobility of the social groups?
5. How important were leaf succulents in the subsistence base, and how important were corn and other domesticates?
6. Is the Archaic more or less mobile and dependent upon a narrower or a broader range of resources than are suggested for the later Mesilla phase? Are changes in subsistence, social organization, and settlement patterns due to increasing population pressure, environmental change, or a combination of factors?

A later occupation of Site 32 by a small, special task group is suggested by a scatter of brownware sherds near a cluster of fire-cracked rock hearths. This occupation probably dates to the latter part of the Mesilla phase of the Formative period between A.D. 600 and 1100. Spatial associations of artifacts and hearths, radiocarbon dates of the hearths, and analyses of hearth contents should reveal that most hearths date to the Mesilla phase, that hearths were probably used to process leaf succulents, and that occupations were intermittent and of short duration. The accurate dating of hearths is necessary if there are to be useful discussions of the possible subsistence changes that are implied from investigations of the Archaic and early Formative deposits at Site 33. In addition, information on the suggested lengths of occupations, the nature of the activities, and the classes of technological items should permit the investigation of the inferred greater variability in site types, the greater specialization in site types, and the changes in settlement patterns and social organization for the Formative period. The possibility should be examined that these reflect the use of relatively smaller areas by slightly larger and more integrated social groups during the early Formative than during the Archaic.

The investigation of Site 32 would involve the following estimated field time:

1. Surface collection and mapping and interval subsurface testing of 14,000 square meters ...	47 man-days
2. Excavation of 13 hearths	26 man-days
3. Excavation by 1 m squares of 10% of 10,000 square meters, or 1,000 units at 4 per man-day	250 man-days
4. Supervisory positions ...	65 man-days
Total	388 man-days

The above estimate of 388 man-days for the field work at Site 32 is equivalent to 65 crew-days with a crew consisting of one supervisory archeologist and five crew members. Additional time would be needed for laboratory analysis, consultations, and report preparation.

Site 33

The results of testing of Site 33 have already been described in previous portions of this volume in some detail along with the potential for recovery of important data relative to Archaic and Formative occupations in the area. The significance of the Archaic occupation at 2500 to 1800 B.C. has been documented in terms of the new information acquired from a previously little-known period in the El Paso area and the unique preservation of many houses. Site 33 offers the opportunity to pursue a wide range of questions about social organization during this time period. The patterning of houses and their contents with the associated outside work areas should permit some definitive statements relative to the sizes of social units, residence patterns, degree of mobility or sedentism, raw material procurement strategies, and subsistence patterns.

Later occupations during the Formative period are extensive and of respectable depth in some places. As much as 1800 years of occupation may be represented; therefore, the potential for refining the chronology for the late Archaic-early Formative time horizon is great. At present, the chronology of the early Formative period is not well documented and is sorely in need of development. The organization of social groups in space for the pursuit of requisite needs during the Formative period is apparently not understood well given the conflicting opinions of researchers currently working in the area (see O'Laughlin 1979, and this volume). Much of the difficulty in studying the Formative has been with the long Mesilla phase (ca. 1,000 years) where the lack of good chronology markers has made it impossible to divide this phase into shorter segments.

Sites of the Mesilla phase have often been described as either habitation (residential) or special activity sites on the basis of site size and the density of surface artifacts; and some dependence on domesticated plants and the fairly permanent occupation of the residential sites by larger social groups have been implied. The long duration of this phase suggests that changes in social organization, subsistence strategies, and mobility and settlement patterns may eventually be detected. Social units are probably small and mobile and dependent primarily upon hunting and gathering throughout most of this phase. Around A.D. 1000 a number of important changes take place. Communities seem to be larger and more permanently occupied and a greater dependence on domesticated plants is implied. There is also some evidence for a greater degree of social integration than for previous times. These changes may reflect the effects of changing population densities and/or environment.

Investigations of the Mesilla phase at Site 33 should help clarify some of the ambiguities concerning the permanence of occupation and settlement patterns through the use of palynology, site size, and densities of artifacts. All occupations during the Formative at Site 33 have been characterized as of short term and for specialized economic activities. Mobility and length of occupation have been inferred from kinds of features and tools and from chipped stone reduction technologies. Much work in these areas is still required at Site 33 with respect to these later occupations and the potential for clarifying site types, social organization, and subsistence activities is great with the anticipated amount of work which will be required as a result of the direct and indirect impacts resulting from the construction of Keystone Dam.

The adverse effects of the construction of Keystone Dam are best discussed in reference to Figure 40. Keystone Dam, as presently conceived, will be constructed directly over the northern one-quarter of the site, and one or more feet of overburden will be removed to reach suitable soil for the dam. An inspection trench will also be excavated on the upstream side of the center line of the dam and probably will pass through all cultural bearing deposits. Roughly one foot of overburden will be removed to a point about 20 ft. beyond the toe of the dam, and surface disturbance from equipment movement is anticipated for a distance of up to 100 ft. from the toe of the dam (this is shown as the 100 ft. easement on Figure 40). The impoundment area behind the dam will also be graded for drainage, and this will affect a small area in the northeast portion of the site. A 10 to 12 ft. wide trench will be excavated across the western edge of South Site 33 for an 8 ft. diameter cement drainage conduit. Surface disturbance in connection with the excavation and backfilling of the trench is anticipated for a distance of 50 ft. on either side of the trench. Finally, the recent construction of a 54-inch water line across the site has completely disturbed the areas indicated by hatchering on Figure 40.

Direct, adverse impacts on the northern third of Site 33 will occur with the construction of the dam. Indirect, adverse impacts due to equipment movement and the placement of haul roads may also occur but will be limited to well-defined easement areas. Other kinds of indirect adverse effects due to the construction of Keystone Dam are more difficult to define but may include the following:

1. At present there is a great deal of activity by residents in the vicinity of Site 33. These activities include jogging, horseback riding, uncontrolled dumping of trash, hunting, bicycling, and on and off trail traffic with cars, motorcycles, and off-road recreational vehicles. These activities often occur on the maintenance road which parallels the 54-inch water line across the site, but much of these activities is dispersed throughout the undeveloped areas in the site vicinity. With construction of Keystone Dam, access to many of the now developed areas will become restricted and the only undeveloped area will be a narrow band of land bordering the north, west, and east sides of the dam. Although many of the above activities may be reduced by construction of the dam, those activities which continue would be concentrated across

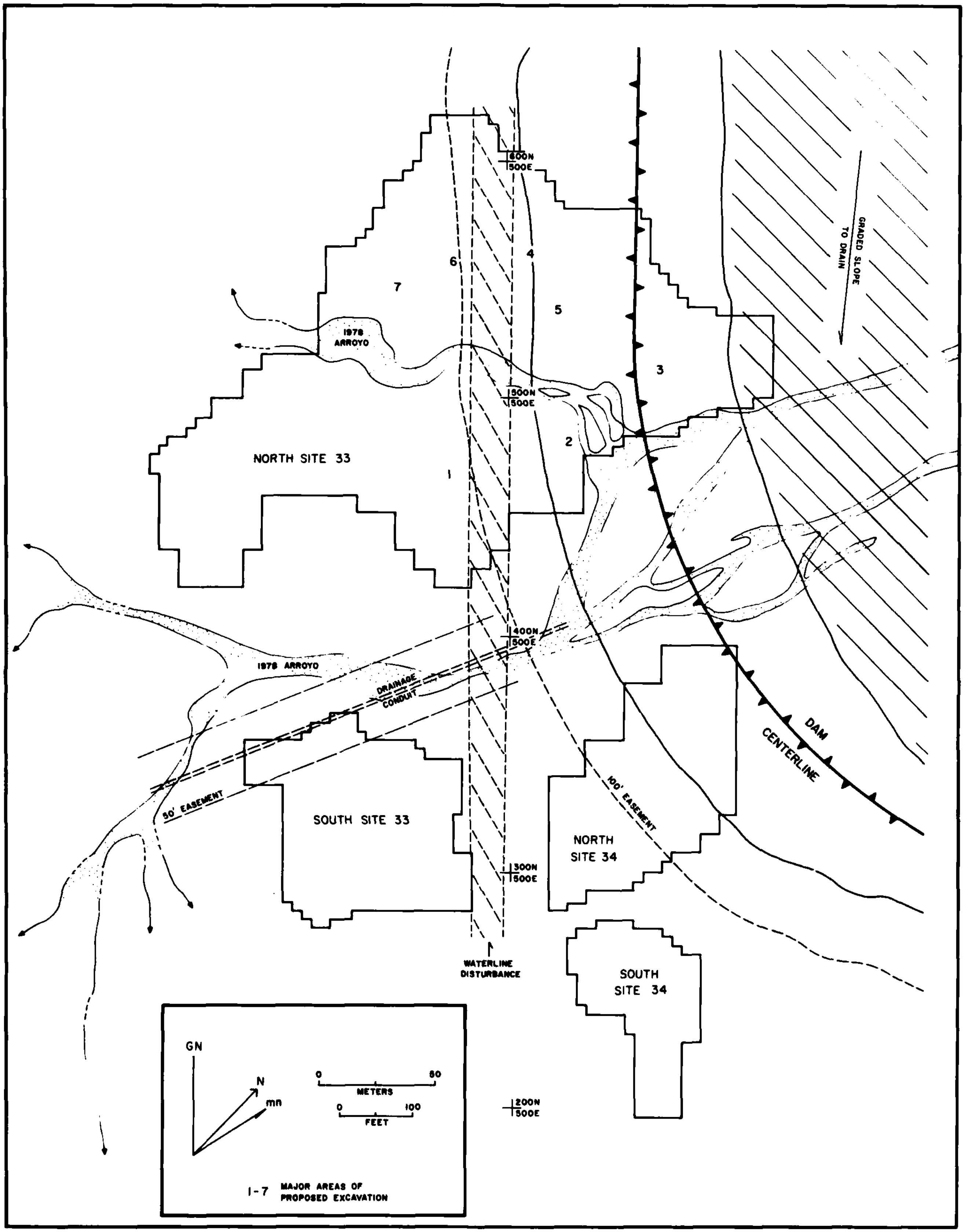

Figure 40. Map of Sites 33 and 34 showing the proposed location of Keystone Dam and construction easements, the area of waterline disturbance, and the seven major areas recommended for excavation.

the southern and western portions of Site 33. As a result, site erosion and disturbance will then probably increase and the collection of artifacts by the public will probably increase substantially also.

2. Construction of Keystone Dam would prevent the arroyo from cutting into the archeological deposits in the future. It has already removed a sizable portion of Site 33. However, some runoff from the toe of the dam is expected and it will probably erode some areas in the western portion of Site 33 North. Over a period of time the erosion of archeological deposits by runoff from the dam will be notable and must be considered a significant, indirect, adverse effect of the federal action.
3. Some mention has been made of using portions of the impoundment area of Keystone Dam for baseball fields or similar, nonstructural public facilities after the City of El Paso assumes responsibility for the maintenance of the dam. If such facilities do come into being in the future, then access roads should be planned to avoid Site 33 and the other sites in the area. The development of public facilities within the impoundment area would also compound the indirect, adverse effects described in 1 above.
4. Perhaps the most serious of all indirect, adverse effects is the possibility of private construction of commercial businesses or residences on Site 33 or in close proximity to Site 33. At present the land on which Site 33 rests is private land and there is little control over activities which may destroy significant information the site is known to contain. Zoning ordinances and the restriction of construction activities where federal funding is concerned may inhibit the destruction of Site 33 but this cannot be assumed. The construction of Keystone Dam will raise the appraisals of lands west of the dam where seasonal flooding now prevents private development. Without public control of those portions of Site 33 which are not to be directly and adversely impacted by construction of the dam, it can only be assumed that cultural resources lying outside of construction easements will eventually be adversely affected if not destroyed entirely.

Before considering field efforts necessary for the mitigation of direct, adverse effects due to construction of the dam and indirect, adverse impacts due to equipment movement and haul roads, etc., a few statements should be made concerning the remaining portions of Site 33. First, the integrity of Site 33 must be placed in its proper perspective. It is not practical to simply divide Site 33 into segments which are to be adversely affected or not by the activities involved in the construction of Keystone Dam. Site 33 is an integrated whole, not the accumulation of independent parts. Public conscience and the coded ethics of professional archeologists (such as those of the Council of Texas Archeologists and the New Mexico Archeological Council) demand that some thought be given to the effects of construction of Keystone Dam on the entire site. Second, the Archaic occupation between 2500 to 1800 B.C. must be considered highly significant because Site 33 is unique in the preservation of so many Archaic houses. Third, archeological investigations of those areas affected most directly by the construction of Keystone Dam will not exhaust the potential for retrieval of scientific information relative to Archaic and Formative period occupations at Site 33. Instead, a greater potential for recovery of information pertaining to the Archaic occupation of 2500 to 1800 B.C. exists in those areas outside of proposed construction easements because of the better preservation of houses and other features and the undisturbed relationship between features and artifacts as a result of the covering of occupational deposits by thick layers of eolian and alluvial deposits.

From the above discussions of potential, direct and indirect adverse effects on the cultural resources of Site 33, the highly significant nature of the cultural resources, and the integral whole of these cultural resources, it would be apparent that recommendations to the President's Advisory Council for the future conservation or the mitigation of the loss of these cultural resources must include the entire site. It is here recommended that the first consideration is the preservation and conservation of as much of the site as possible. It is suggested that a temporary fence be erected immediately along the 100-foot easement and around the edge of that portion of Site 33 North that will not be adversely impacted by the location of Keystone Dam, equipment movement, and haul roads. An additional temporary fence should also be erected along the easement for the construction of the drainage conduit and around the rest of Site 33 South. It is also suggested that those areas of Site 33 not to be impacted by the location of the dam, equipment movement, and haul roads be acquired from the private land holders and placed under public supervision. Plans for a public park or a museum, or for institutional use for the instruction of students in archeology could be pursued at a later date in accordance with guidelines that will assure acceptable standards of data recovery. Phase III Archeological Investigations should, therefore, only be concerned with those areas to be impacted directly or indirectly by the actual construction of the dam. The following program of mitigation is concerned only with those areas; a much larger and more extensive mitigation program would have to be devised if the areas suggested for preservation and conservation could not be acquired and placed under public dominion.

In Site 33 South the excavation of a 10 to 12-foot wide trench some 10 feet deep for drainage conduit may destroy some Archaic and Formative period deposits on the western perimeter of the site (Figure 40). The movement of equipment and backfilling of the trench may also disturb the surface of a sizable area including a large fire-cracked rock feature which appears to be a ring midden that was used for processing large amounts of leaf succulents during the Mesilla phase of the Formative period (Figure 19, Large Fire-cracked Rock Feature 1). It is recommended that Site 33 South be avoided if possible by restricting the construction easement to the north side of the trench in the vicinity of Site 33 South and by placing the conduit 15 feet to the north of the presently planned location. In so doing, no archeological investigation of Site 33 South would be necessary during Phase III.

In Site 33 North the surface and subsurface cultural deposits that will be disturbed include those in the area planned for the location of Keystone Dam, a small area within the impounding area that is to be graded, and a 100-foot construction easement from the toe of the dam to the west. The total area to be impacted from construction activities is 15,296 square meters. Of this area, 2,800 square meters have been totally disturbed by the recent placement of a water line across the site, and arroyo cutting which began in 1978 has removed approximately 768 square meters of cultural deposits. Thus, the total area to be considered for mitigation is 11,648 square meters. This figure will be expanded by some 180 square meters when seven major areas for investigation are described.

Given the large area to be studied as part of Phase III Archeological Investigation, it would be cost prohibitive and unnecessary to excavate the entire area by standard archeological techniques. Thus, a sampling program must be designed which will enable the recovery of sufficient information for both the explication and explanation of prehistoric social systems and changes or stability in them as evidenced at Site 33. It is recommended that Phase III Archeological Investigations center on large area excavations in seven major areas, that some sampling be done of small to medium sized features, and that a portion of the remaining area be tested with 1 m square excavation units. Each of these techniques will be discussed briefly, and estimates of man-days in the field will be given.

The seven major areas to be investigated are numbered 1 through 7 on Figure 40, and each is discussed below:

Area 1. This area includes a cluster of small hearths (9 to 12) located on the north side of a sand dune and probably dating late in the Mesilla phase. Excavations will yield information on feature use, associated artifacts, and radiocarbon dates for chronological studies. The excavation of this area and Areas 2 and 3 will make it possible to better define activities centering on hearths in dune areas during the Mesilla phase, will provide data on subsistence activities and changes in them through time, and will provide information relative to residential mobility and social organization. Excavations are envisioned as going no deeper than necessary to investigate these late features except for a few 1 m squares which should go deeper to sample any Archaic deposits which may be present. Testing with a soil auger in this area did not reveal the presence of Archaic deposits, and later deposits and features are generally within 30 to 50 cm of the surface. A total area of 50 square meters should be investigated. The estimated field time required for the excavations in Area 1 is 90 man-days.

Area 2. This area includes a cluster of fire-cracked rock hearths (7 to 15) visible on the north side of a sand dune. It is comparable to Area 1 in depth of deposits, age, and research potential. It is not certain that Archaic deposits extend beneath these features and excavations should be limited to the features and deposits of the later occupations except for some 1 m squares to test the lower deposits. The sampling of deposits beneath the later occupations of

Areas 1 and 2 should be accomplished as part of the sampling strategy described for 1 m square excavation units. Excavation is recommended of 90 square meters in Area 2. The estimated field time is 162 man-days.

Area 3. This area includes a very large and mostly buried fire-cracked rock scatter around the south and east sides of a large sand dune. Deposits are generally 50 to 80 cm in depth and date from shortly before the time of Christ to about A.D. 1100. No Archaic deposits are known in this area but some squares should be excavated below the later occupations to confirm this. Investigations of this area should yield information similar to that described for Area 1. The greater activity and thicker deposits in this area may be more helpful in refining the local chronology of the early Formative period than any other area to be investigated as part of the Phase III studies. In addition, there is some evidence of small hearths in the area but it is possible the large scatter of hearth stones may be from a very large roasting pit. The definition of the features visible around this large sand dune is important because this should permit the testing of some of the changes in subsistence patterns and social organization that are believed to have taken place between early and late Mesilla phase. A total area of 150 square meters is recommended for excavation in Area 3 and the estimated field time is 270 man-days.

Area 4. This area includes three to five small fire-cracked rock hearths, four or more baking pits without rock, and postholes suggestive of a ramada-like structure. One of the pits was radiocarbon dated at A.D. 1500 ± 110, and this date suggests a late Formative occupation near the end of the El Paso phase or a proto-historic occupation of hunters and gatherers. Artifacts recovered from the vicinity of the above features do not substantiate or refute the above date. Additional work in this area is suggested for the gathering of information which may clarify the temporal placement of these features and perhaps shed light on this archeologically unknown period. Baking pits without rock and postholes for ramada-like structures were not noted in other areas of Site 33 having deposits from the later occupations. Archaic and early Formative deposits are located beneath these shallow features and should be tested as part of the sampling of 1 m square excavation units. A total of 64 square meters should be excavated in Area 4 and the estimated field time is 77 man-days.

Area 5. This area includes three probable Archaic houses and associated work areas from the 2500 to 1800 B.C. occupation. All houses and outside work areas should be excavated in order to recover data relative to Archaic social organization, subsistence, and mobility. The excavation of this area should yield artifacts which will contribute to the understanding of the technology and the procurement strategies, and diagnostic projectile points and other objects will hopefully be recovered to help build a local chronology for this period. Several fire-cracked rock hearths and occupational deposits from later occupations must be excavated in order to reach the underlying Archaic houses and outside work areas. The average depth of excavations will be about 30 cm. A total area of 200 square meters is recommended for excavation in Area 5. The estimated field time is 360 man-days.

Area 6. This area encompasses one probable Archaic house which does not appear to have been occupied very long. The house and outside work areas were not discovered by coring with a soil auger but were found in the excavation of a backhoe trench. This house should be excavated for comparisons with others, and for evidence of variability in social group size, residence patterns, and relative duration of occupation. The total depth of excavation should not exceed 50 cm and very little material from later occupations was noted above this house. A total area of 90 square meters should be excavated in Area 6 and the estimated field time is 172 man-days.

Area 7. In this area there are four or perhaps five Archaic houses, four to six fire-cracked rock hearths, and substantial deposits of both the Archaic and Formative periods. Two of the houses were excavated as part of Phase II Archeological Investigations. Although this area lies outside of the 100-foot easement, it is recommended that additional work be done here to provide information on a second cluster of houses for comparison with those in Area 5. Studies should yield information on residence patterns, social distance, permanency of occupation, and social organization. It is recommended that excavations include the outside work areas of the two already excavated houses, a third house whose outside work area overlaps one of the two excavated houses, and the overlying later deposits and hearths. The depth of excavation would generally be no more than 30 cm. The total area recommended for excavation is 180 square meters in Area 7, and the estimated field time is 324 man-days.

In addition to the excavation of the seven major areas listed above, the excavation of isolated surface and buried fire-cracked rock hearths and pits is also recommended. Data on these features will provide information on the temporal and spatial distribution of these features and their contribution to subsistence activities. Approximately 25 of these features should be investigated for a total of 120 man-days in the field.

Phase III Investigations should also be concerned with those areas between the above listed seven major areas of excavation and isolated features. Sampling of these areas may best be accomplished by the excavation of dispersed 1 m square excavation units. Data from these excavations would be necessary for discussions of site stratigraphy, the spatial and temporal distributions of artifacts which can reflect the nature and relative importance of non-feature activities, and changes in the local environment. The total area which must be sampled is 1,104 square meters, and it is thought that a 5% sample of this area should be adequate. Sampling may best be done by first excavating a series of squares by systematic intervals and then following with the placement of additional squares based on the distribution of artifacts, stratigraphy, and possibly the occurrence of presently unknown features such as houses and pits. The 5% sample size of 1 m square excavation units is 550, and the estimated field time is 990 man-days. Depths of deposits will vary considerably from 10 to 20 cm to about 1.5 m. The excavation of these units is very important because only 7% of the area was tested at 2 m intervals with soil augers and only 0.3% of this area was tested by the excavation of 1 m square units.

Through the excavation of six major areas of interest, isolated features, and 5% of the remaining areas, some 1,244 square meters (not including the 180 square meters of Area 7) of that portion of the site to be impacted by dam construction would be intensively studied during Phase III Archeological Investigations. This represents approximately 11% of the area to be adversely affected by the construction of Keystone Dam, a figure which should prove adequate for archeological studies and within the realm of "reasonable" costs for such work.

The total number of man-days in the field recommended for this site is 2,555, including one supervisor day for each five man-days of excavation. This represents a total of 426 days in the field for a crew of five and one supervisory archeologist.

Site 34

This site has been described in some detail in previous portions of this volume. Evidence of prehistoric occupation at Site 34 consists of numerous small fire-cracked rock hearths, a number of scatters of hearth stones from eroded hearths, one large fire-cracked rock feature, two pits without rock, and a very light surface scatter of chipped stone and ceramics. Subsurface deposits containing cultural materials are thin and scattered about the site. Radiocarbon dates and ceramics suggest that occupations were principally from about A.D. 250 to 850 during the early Mesilla phase of the Formative period. Occupations also appear to have been intermittent, of short duration, and for the purpose of pursuing specialized economic activities relative to the processing of leaf succulents.

The relationship of Site 34 to Keystone Dam is shown in Figure 40. Direct, adverse impacts on Site 34 North as a result of the construction of Keystone Dam are the same as those for Site 33 North and will affect cultural resources lying on the northern one-third of Site 34 North. As with Site 33 North, a construction easement of 100 feet west from the toe of the dam is recommended for the moving of equipment and haul roads. These will result in the disturbance of another one-third of the surface of Site 34 North. Some grading and removal of soils within the easement area will also occur. In addition to the adverse effects on cultural resources resulting from the actual construction of the dam, several types of indirect, adverse effects will probably occur after the dam is built. These include increased public recreational activity in the area and the increased likelyhood that private construction will take place on the site. These types of potential, indirect, adverse effects are described in detail for Site 33. Given the adverse, direct impact that may occur during the construction of Keystone Dam and the potential, adverse, indirect impacts that may occur after the dam is built, recommendations concerning the future disposition of the cultural resources of Site 34 must be comprehensive and must take into account all of Site 34 since the entire site may be affected. Thus, the question becomes one of what should be mitigated and what should be protected under the auspices of a public agency or institution. The question will most easily be answered after first discussing the relative significance (i.e., the potential for recovery of important information) of Site 34.

Cultural remains at Site 34 appear to represent short term and intermittent occupations most likely only during the Mesilla phase. Fire-cracked rock hearths are the principal features, and very few artifacts have been associated directly with the hearths or found in areas away from the hearths. The distribution of hearths and surface artifacts does suggest some spatial patterning or behavior which is interpreted as the reoccupations in the same areas for the seasonal processing of leaf succulents. No subsurface features were found in testing which were not indicated by surface materials, and excavations yielded very few artifacts from the very thin or deflated and eroded deposits. Pollen, macrofloral, and radiocarbon samples were retrieved from features, but they contained little charcoal for the identification or dating. Pollen samples from the thin occupational deposits may be retrieved but difficulty will probably be encountered when trying to relate them to cultural assemblages. Potential avenues for research would be limited primarily to the following:

1. The recovery of charcoal from hearths would allow a refinement of the temporal distribution of activities relating to these hearths and might permit the recognition of changes in subsistence strategies. The recovery of burned wood and other plant parts might also permit a more accurate assessment of the site environment, procurement strategies, and subsistence items.
2. Pollen samples taken from features might aid in a more detailed description of the local environment and subsistence activities.
3. The eroded and deflated condition of most of the site allows for only gross considerations of the spatial distributions of features and artifacts. Nevertheless, surface collections have proven informative in terms of the association between chipped stone, ceramics, and hearths, and these associations bear out the presumption of seasonal plant processing. The surface condition of the site can change noticeably with the seasons, and additional surface collections should be made to improve the present data relative to the spatial distributions of artifacts.
4. The eroded and deflated condition of much of the site, the probable difficulty in dating artifacts recovered from the remaining thin deposits, and the probable lack of artifacts in direct association with features make any refinement of the local chronology at this site a task of improbable success.
5. The excavation of non-feature areas has been shown to yield very few artifacts, and it is unlikely that data relative to the spatial distribution of artifacts will be recovered beyond the observation already noted that artifact density increases as hearth clusters are approached.
6. The recovery of additional artifacts from surface collection and excavation should permit the further study of tool type-raw material association, technology, and tool and container use. Additional studies of artifacts should also allow the testing of inferences derived from Phase II Archeological Investigations concerning residential mobility.

Site 34 should be considered significant because it does possess the potential for providing important information on at least one site type of the Mesilla phase. Studies at Site 34 could make an important contribution to our understanding of the social organization and subsistence strategies that prevailed during this long and still poorly understood period. However, the nature of cultural materials and deposits at Site 34 does not warrant a program of preservation or conservation. That is, the costs of acquiring the land and providing concomitant public supervisory actions and protective measures would undoubtedly be greater than the costs of mitigating the potential, adverse, indirect effects through archeological investigations. This could be accomplished by the following actions which would involve little field time and for which laboratory analyses would also be minimal because of the likelihood that only a few artifacts will be recovered.

1.	The recovery of additional artifacts through surface collection (no additional surface mapping or subsurface interval testing is necessary)	50 man-days
2.	The excavation of 15 of 27 partially intact small fire-cracked rock hearths	30 man-days
3.	The testing of the single large fire-cracked rock feature	10 man-days
4.	The excavation of 60 1 m squares for stratigraphic information, pollen and charcoal samples, and additional artifacts	20 man-days
5.	Supervisory position	15 man-days
	Total	90 man-days

The above estimate of 90 man-days for the field work at Site 34 is equivalent to 15 crew-days with a crew consisting of one supervisory archeologist and five crew members. Approximately two thirds of this time should be devoted to areas to be adversely impacted by activities of dam construction, and one third of this time should be spent in those areas which may be indirectly and adversely affected by the construction of Keystone Dam.

Site 35

Site 35 is located on a mesa top and within a sand dune area near the western end of the eroded terraces which border the eastern side of the Rio Grande floodplain. The site area is approximately 100 square meters and evidence of prehistoric occupation consists of a scatter of fire-cracked rocks from perhaps three small hearths, and a few flakes of stone. As with Site 29, the age of this site is unknown, and a short, seasonal occupation(s) for the processing of leaf succulents is inferred. It is not certain that any of the hearths is intact enough to permit the recovery of pollen, charcoal, and radiocarbon samples. The few lithic artifacts in the site area would permit only a minimal study of such topics as raw material selection, reduction technology, use, and permanency of occupation.

Site 35 is located adjacent to an area to be disturbed by the excavation of a water diversion channel. It is suggested that the potential for disturbance of Site 35 is small and that the potential for the recovery of additional significant information from this site is minimal. It is recommended that this site be fenced during the excavation of the diversion channel and that it not be considered for further archeological investigation.

Site 36

This site is located on a mesa tip in a sand dune area, some 40 m west of Site 35. Gerald (n.d. d) described this site as having one large fire-cracked rock feature with no associated artifacts. A recent visit to the site revealed artifacts very thinly scattered over 5,000 square meters, and eight additional scatters of fire-cracked rock. Apparently wind action has recently uncovered much of this site. Recent changes in the visibility of archeological materials have also occurred at Sites 32, 33, 34, and 37.

Much of the surface of Site 36 has been disturbed by off-road vehicles and motorcycles, and wind erosion has deflated many of the hearths. The greatest density of surface artifacts occurs near the west end of the site and consists of lithic debris averaging about 0.1 pieces per square meter over an area of 900 square meters. Very few pieces of chipped stone were observed over the rest of the site. A few brownware sherds were seen near two of the fire-cracked rock scatters on the southern edge of the site.

All of Site 36 is scheduled for destruction by the excavation of a water drainage channel and mitigation through archeological investigation is recommended. The potential for the recovery of significant information pertaining to past occupations is comparable to that of Site 34, and investigations should pursue the following:

1. Fire-cracked rock scatters should be tested for the purpose of recovering pollen, radiocarbon, and macrofloral samples. These samples would provide some temporal control over the activities at this site, additional information on the use of fire-cracked rock features, and data on the local environment. Research interests should be concerned with the relative importance of the indicated subsistence activities through time. Ceramics at this site suggest a Mesilla phase occupation and the single large feature should date to late in this phase.
2. Artifacts should be collected from the surface of the site by 4 m square units. Surface features should also be mapped with respect to the 4 m square units. These techniques would allow comparability of data with that from Sites 33 and 34 and would permit discussions of the spatial distributions of activities. The proximity of ceramic scatters to hearths should be examined and the spatial relationship should be determined between these and the area of stone-knapping that has been observed.
3. Subsurface testing by interval coring and the excavation of 1 m square units is recommended. Coring would reveal the presence of buried features and deposits and this information together with the distribution of surface features and artifacts would provide a basis for the placement of 1 m square excavation units. It appears as though most of the site has had some surface disturbance and that it has been subjected to periods of wind erosion in the past. Buried features and deposits are not expected to be numerous or extensive. Excavations should be limited primarily to the recovery of stratigraphic information, pollen and charcoal samples, and some additional artifacts. Given the nature of the site and the few artifacts on it, it is unlikely that spatial information beyond that acquired from surface collection and mapping will be recovered.

4. It is expected that relatively few artifacts will be recovered from Site 36, and few of the artifacts are likely to be directly associated with radiocarbon-dated features. Thus, any potential for refining the chronology of the area is limited. However, chipped stone and ceramics could be studied for implications regarding subsistence activities, permanency of occupation, technology, and tool and container use.

The investigation of Site 36 should prove informative relative to the temporal and spatial distribution of short term and seasonal occupations for the purpose of procuring and processing leaf succulents. It would involve the following estimated field time:

1. Surface collection, mapping, and interval subsurface testing of 5,000 square meters	17	man-days
2. Excavation of 10 fire-cracked rock scatters	28	man-days
3. Excavation of 60 1 m squares	20	man-days
4. Supervisory position	13	man-days
Total	78	man-days

The above estimate of 78 man-days for the field work at Site 36 is equivalent to 13 crew-days with a crew consisting of one supervisory archeologist and five crew members.

Site 37

This site is located in a sand dune area on a mesa tip that overlooks Sites 33 and 34. Gerald (n.d. d) recorded one fire-cracked rock scatter without associated artifacts for this site.

Recent visitors to the site have revealed the presence of six additional areas with fire-cracked rock and lithic debris in an area of 7,000 square meters. These cultural materials were undoubtedly newly exposed with wind erosion. Three of four of the hearths are still reasonably intact, and chipped stone materials have an average density of about 0.1 square meter. Fire-cracked rock hearths tend to be located on the southern portion of the site while chipped stone is concentrated in the northern sector. Deposits over some of the site are badly eroded and deflated or disturbed by motorcycle traffic, but there is some indication that they may be as thick as 20 cm in areas where recent eolian sands cover them. The absence of ceramics suggests that most of the deposits and lithic debris are of Archaic age. The age of the fire-cracked rock features is unknown, but these features may date as late as the Mesilla phase.

Approximately 85% of this site will be destroyed by the excavation of a water diversion channel. The remaining 15% includes one fire-cracked rock feature and only a very light scatter of chipped stone. Because of the size of the site and the density of artifacts and features in the area not to be directly impacted by the excavation of the diversional channel, it is recommended that mitigative actions include the entire site.

This site is significant because of the possibility of recovering scientific information about the little-known Archaic period and perhaps about the later Mesilla phase of the Formative period. Relevant avenues of research include the following:

1. The temporal distribution of fire-cracked rock hearths would permit the discussion of the relative importance of activities involving the processing of leaf succulents for the Archaic and Formative periods. These activities are more apparent for the Mesilla phase of the Formative period, and it has been suggested that an increased use of leaf succulents may be due to population and/or environmental pressures. Data from Site 37 and Sites 32, 33, 34, and 36 should permit a full discussion of this subject.
2. The excavation of features and deposits would allow the recovery of pollen, macrofloral, and radiocarbon samples which would aid in dating features and deposits, in determining the use of fire-cracked rock features, and in providing information on the environment necessary for discussions of cultural change or stability.
3. Surface collection and mapping would provide data for use in determining the use of space and the nature of activities. These data may also permit the identification of individual occupations. At present, it is not known if the fire-cracked rock features and chipped stone debris are from the same of different occupations, nor is it known whether the fire-cracked rock features represent seasonal specialized economic activities of the Mesilla phase or one of many activities occurring during the Archaic period.
4. The subsurface testing and excavation of areas between surface features should make better known the distribution of subsurface artifacts and features, as well as site stratigraphy and age. It would be important to note similarities and differences between Site 37 and Sites 32 and 33 and to pursue questions such as whether houses are present on Site 37, whether occupations are general or specialized in nature and of long or short duration,

whether Site 37 represents one locale in a settlement system that reflects central-based restricted wandering, etc. Numerous other questions that could be raised because of the poor knowledge presently available on the Archaic period illustrate the potential for the recovery of significant information from this site.

5. Analyses of recovered artifacts would make possible the study of stone procurement strategies, technology, tool use, subsistence activities, and permanency of occupation. In addition, the dating of deposits or features at this site and the recovery of distinctive forms of artifacts should result in an important contribution to local chronology.

The investigation of Site 37 would involve the following estimated field time:

1. Surface collection and mapping and interval subsurface testing of 7,000 square meters ...	24 man-days
2. Excavation and testing of six fire-cracked rock hearths ...	16 man-days
3. Excavation by 1 m squares of 10% of 6,000 square meters for 600 units at 3 per man-day .	200 man-days
4. Supervisory position ...	48 man-days
Total	288 man-days

The above estimate of 288 man-days for the field work at Site 37 is equivalent to 48 crew-days with a crew consisting of one supervisory archeologist and five crew members.

This appendix contains a discussion of the measures recommended to mitigate the loss of cultural resources believed to exist on eight archeological sites in northwest El Paso that will be directly impacted by actions planned by the U.S. Army Corps of Engineers, Albuquerque District. These sites and the number of field man-days recommended to mitigate the loss of each is as follows:

Site EPCM 31:106:2:29	0 man-days
:2:31	0 man-days
:2:32	388 man-days
:2:33	2,555 man-days
:2:34	90 man-days
:2:35	0 man-days
:2:36	78 man-days
:2:37	288 man-days
Total	3,399 man-days

The above figures include the time for one supervisory archeologist for each five-man crew and are equal to 566.5 six-man crew-days in the field. Laboratory time to be devoted to the cataloging and analysis of artifacts and to the reduction of data is not included and neither is the time required to write the ensuing report and see it through to publication.

APPENDIX B[1]

POLLEN ANALYSIS AT KEYSTONE DAM

Site 33

33.106.2.33[2]

FINAL REPORT

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POLLEN ANALYSIS AT KEYSTONE DAM

SITE 33

33.106.2.33[2]

Introduction

The Keystone Dam site 33 sits on an alluvial fan at the mouth of an arroyo, which drains from the Franklin Mountains to the east, to the Rio Grande in the west. This site is 1-3 m above the flood plain of the Rio Grande. The alluvial fan is topped by dune sand, overlying beds of sand, gravel, silt and clay. The silt and clay deposits may indicate inundation of the site by water (T. O'Laughlin pers. comm.).[5] This inundation could be quite significant when interpreting pollen results, because such inundation may affect preservation of pollen grains.

Vegetation on the site is predominantly mesquite and four-wing salt bush with Larrea tridentata, Opuntia phaecantha, Artemisia filifolia, Ephedra trifurca, Yucca elata and annual species nearby. The arroyos draining into the flood plain have a diverse shrubby flora, dominated by Larrea tridentata, Krameria parvifolia, Coldenia canascens, Rhus microphylla, Fallugia paradoxa, and others (T. O'Laughlin pers. comm.,[6] Williams 1969). The vegetation of the flood plain of the Rio Grande includes Populus fremontii, Salix spp., Bacharris sp., and Distichlis stricta; the area has been invaded in the recent past by Tamarix pentandra and Eleagnus angustifolia (T. O.' Laughlin pers. comm.,[6] Campbell and Dick-Peddie 1964). Vegetation on the terraces and alluvial fans between the Rio Grande and the Franklin Mountains consists mainly of sparse desert shrubs, including Larrea tridentata, Krameria parviflora, Fouqueria splendens, Opuntia spp., Agave lecheguilla, Yucca torreyi, Prosopis juliflora, Acacia spp., Rhus microphylla, etc. (T. O'Laughlin pers. comm.,[6] Gardner 1951). The river flood plain and arroyos are subject to silting, scouring, and cutting, causing some areas to be subject to continuously changing conditions which affect the vegetation (Williams 1969, Campbell and Dick-Peddie 1964).

The Franklin Mountains furnish a diverse habitat for various species such as Quercus emoryi, Celtis pallida, Acacia constricta, Agave lecheguilla, and Berberis trifoliata. Juniper is present, but rare (T. O'Laughlin pers.comm.).[6]

The time of occupation of the site, whether site was continuously or intermittently occupied is not precisely clear to us. However, we are assuming the C-14 dates bracket the time of occupation, that is, 2500BC-1050AD (4480BP- 930BP).[5] This spans archaic to pueblo times (T. O'Laughlin pers. comm.)[7]

The site is located in an area which could have provided access to riparian resources as well as montane resources.[8]

Pollen samples were gathered at several locations by the archeologists for the purposes of determining:

1. How close the Rio Grande was to the site at different times.
2. If river flooding could be detected.
3. If episodes of little or no water in river could be detected.
4. If differences between riverine deposits and alluvial deposits from arroyos could be detected.
5. If suspected correlations between strata at different exposed profiles could be reinforced by similar results from pollen samples.
6. If any trends of climate (mesic to xeric; xeric to mesic) could be detected.

The samples were collected with these questions in mind, and were sent to us for analysis and report (T. O'Laughlin pers. comm.).

Methodology

Preparation of samples - Technique

Recent attempts at pollen recovery from soils from the El Paso area have proven difficult. Horowitz, Gerald and Chaiffetz (n.d.) in order to obtain sufficient amounts of pollen for analysis from samples taken at this site and others in the area, used a 500-1000 gm sample size.

Use of smaller sample sizes and different processing techniques for samples from sites in northwestern New Mexico, in the San Juan basin, have proven successful for obtaining sufficient amounts of pollen. Two methods were employed with the Keystone Dam site samples to discern which method would be more useful for the analysis of 30 samples from site 33. Both techniques eliminate the loss of pollen through the "swirl" technique employed by most pollen researchers. A 50 gm sample was used in Method One which basically used the Mehringer method (Mehringer 1967) but eliminating the swirl technique in favor of mechanical sieving. Method Two employed a technique developed by Dr. Roger Y. Anderson, Department of Geology, University of New Mexico, which allows the pollen-laden sediment to settle out according to grain size, in settling tubes. With this method, 15-20 gm of sediment was used. Method One proved to be the more fruitful one in this case. An account of the two techniques follows.

Method I for processing soil samples:

Sample Amount: 50 gm. (c. 35 mls.)

Step 1. Mechanical Preparation of Sample. The soil sample was screened through a #70 mesh screen that allowed particles smaller than 180 microns to pass through the screen, into a 600 milliliter beaker. The sample was rinsed as it was screened with distilled water. After screening, large sand grains and debris remained on top of the screen. This was checked for pollen loss but revealed none.

Record was kept of the first 8 soil samples processed to monitor pollen loss if it was occurring. Soil reduction (removal of silicates and clays) throughout the process was also noted.

Sample #1	Original Amount (mls.)	After Screening (mls.)	After Processing (mls.)
1	35	25	6
2	35	20	5.8
3	35	15	5.5
4	35	15	5.8
5	30	15	5
6	35	13	5
7	30	12	5.5
8	35	15	5

Step 2. Dispersing Solution. A 3.3% solution of Sodium Hexametaphosphate was added to the beakers to disperse the clays and organic particles. The beakers were then allowed to sit over night. Still, the liquid fraction was very cloudy in appearance due to suspended clay particles. After 24

hours, the liquid part was poured off, leaving the sediment that had settled to the bottom. To check for pollen loss, 50 mls. of liquid during the decant were caught in midstream and centrifuged. Results were negative when checked under the microscope.

Step 3. Removal of Carbonates. 50 mls. of 37% Hydrochloric Acid were added to the beakers that contained the sediment and 150 mls. of water. Reaction was moderate. The beakers were then filled with water to dilute the solution. The beakers were allowed to settle over night and were then poured off and the sample was rinsed with distilled water

Step 4. Removal of Silicates. 100 mls. of 40% Hydroflouric Acid were added to beakers containing also c. 200 mls. of water, then stirred and left overnight to settle. The beakers were then poured off and filled with distilled water to rinse. After this process, some silicates still remained.

Step 5. Transfer to Test Tubes. Beakers were poured off. The sediment that remained was placed into 50 ml. test tubes and rinsed with water. Between 5-6 mls. of sediment (including fine-grain sands) remained of the original 30-35 mls. (50 gm.)

Step 6. Acetolysis to Remove Organic Debris. One part Sulfuric Acid was added to 9 parts Acetic Anhydride to comprise the Acetolysis Mixture. After rinsing the samples in Acetic Acid, the Acetolysis Mixture was added and the samples were placed in a boiling water bath for 20 min. The samples were then removed, rinsed again with acetic acid, then washed with distilled water 3 times. Some samples were acetolyzed twice due to abundance of organic debris other than pollen.

Step 7. Slide Preparation. The samples were then placed in vials with glycerin and slides were made for microscope analysis. At least 2 slides were counted in attempt to observe 300 pollen grains.

Method II for processing soil samples:

Sample amount: 15-20 gm.

Step 1. Sample Preparation: 15-20 gm. of sediment from the same set of soil samples as Method I were weighed, ground in a mortar and pestle and then washed through 180 micron screening into clean beakers, with distilled water.

2. Removal of Carbonates. 5-10 mls. of HCl were added and stirred several times. When bubbling action stopped. the sample in solution was transferred to centrifuge tubes, centrifuged, decanted and rinsed several times.

Step 3. A dispersing agent was used to rinse samples back into beakers. The sample was mixed thoroughly with the aid of a magnetic mixer and poured into settling tubes filled with dispersing agent. After two min., the large, heavy sand grains had settled in the flexible tubing and a clamp was placed above that part of the tube.

Step 4. Removal of Sample From Settling Tubes. After 19 hours, the flexible tubing was removed and the sediment grain sizes above the clamp associated with the pollen were removed into a test tube. Large sand grain sizes and small clay and silt particles were left in the tube.

Step 5. Removal of Silicates. The pollen bearing portion of the sediment was treated with 40% HF in a hot water bath. Spot checks of the large sand grain portion and the silt and clay portion of the samples were made to make sure they did not contain pollen.

Step 6. Slides prepared. The remaining portion of the sample after treatment with HF was rinsed and mounted on microscope slides with glycerin.

Microscope analysis: At least two slides were counted in an attempt to observe 300 pollen grains. Only one sample was evaluated completely, by counting pollen from the two methods. Data is available form this sample, but will not be presented in this report. We would like to analyze more samples which were processed by both methods, to evaluate more accurately the differences in results (if any). We chose the modified Mehringer method, because of the greater certainty of producing pollen, based on scanning the slides from the different processes.

Through the processing technique, the samples were reduced from the original 15-20 gm to 1-3 ml.

Results and Discussion

Results are presented in Table 1.
Discussion will be by zones of stratigraphy as defined by Thomas O'Laughlin (pers. comm.).[5]

It should be noted here that the presence of many palynomorphs, and corroded and distorted pollen grains, made the microscope analysis difficult and more time consuming than is usual. Also, the presence of many shiny "rods", crystalline in shape, about 12 x 4 microns made viewing through the microscope difficult. We have not encountered these before, and are uncertain of their origin. Perhaps these rods are the result of inundation of the site.

Surface sample

Pinch sample taken throughout the area of site. Cheno-Ams (see taxa list) dominate (38.5%, see Table 1) followed by grasses (24.4%). High spine and low spine composites total 10.7%. Small amounts of pine, *Juniperus*, *Salix* sp., *Salix cf. goodingii*, *Acer* cf. *negundo*, *Quercus* sp. and *Tamarix* sp. were counted, as well as *Ehpedra*, *Larrea*, *Solanum* cf. *eleagnifolium*, Rosaceae, Leguminoseae, *Allionia* sp. and *Fouqueria* pollen. Several unidentified pollen types were encountered. Percentages of Cheno-Ams, Gramineae, and Compositae agree with percentages reported from surface sample analyzed by Horowitz, Gerald and Chaiffetz (n.d.)

North wall of Arroyo - Pollen sampling location one

Zone 1 - 4.70 mbd. This unit consists of eolian sands of recent deposit, perhaps post 1500AD. This sample was low in pollen. Dune sands from northwestern New Mexico are known to be poor in pollen (Clary and Cully 1979). This may be due to blowing or washing away of pollen grains through the sandy zone.

Zone 2 - 4.75 mbd - 5,50 mbd. Loamy sands, eolian deposits that have been subjected to drainage, percolation and capillary movements of water make up this zone (T. O'Laughlin pers. comm.).[5]

All samples in this zone but one (4.95 mbd) contain more than 50% Cheno-Ams. Two samples, at the top of this zone, are extremely high in Cheno-Am percent (91.5 and 97.4%). Diversity of taxa is low, from 5-13 taxa, in single samples from this zone.

High pH, water movement, low taxa diversity and poor condition of pollen suggest that differential destruction of some types of pollen grains may be occurring, resulting in over representation of more durable types of pollen, such as the Cheno-Am group.

Bohrer (1968) and Hall (1977) report 50% or more Cheno-Ams associated with sediments from dense stands of Chenopodium, Sarcobatus or Atriplex. Cully (1977) reports over 50% Cheno-Ams within rooms of a villate site (PI-PIII) at Chaco Canyon, New Mexico. Clary and Cully (1979) report more than 50% Cheno-Ams from archeological sites in northwestern New Mexico. Steven LaBlanc (pers. Comm.) reports high levels of Cheno-Ams from archeological sites in the Mimbres Valley. It is possible that the high Cheno-Am percentages here are due in part to human occupation of the site. Human activity is known to create soil disturbances which encourage weedy species of Chenopodium and Amaranthus, and some annual Atriplexes, creating a local pollen and seed rain of Cheno-Ams. Some of these weedy species have extensive documentation as food resources for historic Indian groups in the southwest (Jones 1930, White 1944, Whiting 1966). However, we feel that differential destruction of pollen grains has occurred and is important in producing these high Cheno-Am percentages.

Pine, Ephedra, low spine composite pollen occurred frequently, but in low percentages.

The pollen sample from the 4.95 mbd level is somewhat anomalous in its low Cheno-Am percent (43.6%) and high grass percent (19.3%). The presence of a large clump of Lycium pollen, accounting for 28.0% of the total number of grains affects the other percentages. If Lycium grains are subtracted, N=306, Cheno-Ams=60.8%, and grasses=26.8%. Perhaps conditions of preservation are better at this level, or the pollen is the result of man's activities. A hearth is located at approximately this level (T. O'Laughlin pers. comm.),[9] and it is possible that plants brought into the site altered the pollen rain. Burned or charred remains of Lycium cf. pallidum and Phragmites communis were recovered from the site (T. O'Laughlin pers. comm.).[10] At level 5.05 mbd, 10 cm below, charcoal was observed in the pollen sample, possibly from activities associated with the hearth. The first occurrence of pollen Type A (see taxa description) is from this sample. The abundance of this taxa in this sample and in many of those below it may be the result of man's use of a domestic or wild plant resource.

Cheno-Ams dominate this entire zone, followed by pollen from the Gramineae family.

Samples at the 5.25 mbd and 5.30 mbd level in zone 2 are at the transition between zones 2 and 3.[11] The sample at the 5.25 mbd level contained very few taxa (6) and preservation in the three samples was very poor. Soil samples taken in these two zones (T. O'Laughlin pers. comm.) show:

factor	zone 2		zone 3
%CaCo3	2.7%	increase	5.0%
pH	8.65	increase	9.6[12]
clay content	4.2%	increase	9.0%
organic matter	.23%	decrease	.10%
electrical conductivity	3.24 mmhos	decrease	1.50 mmhos

indicating part of zone 3 is a layer of deflocculating sodic soil, which is unsuitable for pollen preservation.[13] The higher clay content may also indicate a layer of lower permeability, which may have protected sediments beneath from percolation of water from upper to lower beds.

Zone 3 - This zone is a sandy loam, and probably a weathered, eolian deposit (T. O'Laughlin pers. comm.),[5] and is represented by pollen samples from 5.35 mbd and 5.40 mbd. Only the sample from 5.40 mbd contained appreciable amounts of pollen. Diversity of taxa from this sample is high (25) compared to taxa from single samples from zone 2 (5-13). Arboreal pollen such as Quercus, Juglans and Salix occur here, and into zone 4a. High spine composites are found in percentages close to those from the surface sample (see Table 1).

While the diversity of taxa increases, this zone is dominated by Cheno-Ams and grasses, as are the samples from zone 2, and the surface sample. Higher diversity may indicate better conditions for preservation at this level.

Zone 4a - This zone is noted by T. O'Laughlin (pers. comm.)[5] as an eolian, water altered deposit of zone 4, which appears in this stratigraphy directly below zone 4a. The transition from zone 3 to 4 a is marked by samples with high pollen counts unlike transitions in other zones. The samples from 5.40 mbd to 5.50 mbd in zones 3 and 4a are very much alike in their diversity and types of pollen identified. The presence of Quercus, Juglans, Artemisia, Celtis, Larrea, Prosopis, and Opuntia pollen indicates the flora was similar to that of the present.[14]

Zone 4 - The soil of this zone is a sandy loam. Samples were taken in this zone from 5.60 mbd - 5.70 mbd. Between zone 4 and 4a a disconformity occurs (see Figure).[4] The transition between zone 4a and 4 is marked by samples with extremely poor preservation. This occurs between zones 1 and 2 and 2 and 3, and between 4 and 5a. It's not clear why this occurs, but conditions at these transition zones seem to be bad for pollen preservation

The one good sample from 5.65 mbd is characterized by moderately high Cheno-Ams (53.4%) and grass (16.3%). Pine pollen is absent. An Unusually high amount of Opuntia pollen was found (7.8%). Since Opuntia is an insect pollinated plant, characterized by production of fewer, larger, pollen grains than a wind pollinated plant, finding more than a very small percentage of these in a sample is unlikely. Such a high percent of Opuntia pollen is sometimes associated with man's activities in a site. Maps of strata do not indicate any features nearby. It is also possible that a stand of Opuntia was growing directly on this location. High counts of Opuntia pollen have been noted at LA71 in northern New Mexico (in progress). Struever (1979) notes an abundance of Opuntia seeds from this site. Struever notes Opuntia compressa is growing abundantly on and around this site, and may account for the seeds and pollen.

Zone 5a - 5.75 mbd. This is the deepest zone sampled for pollen. It is described by T. O'Laughlin (pers. comm.)[5] as fluvial back-water deposits from river water. This zone is extremely high in clay (31.0%), very different from samples from the upper zones (.4-7.0% clay, T. O'Laughlin pers. comm.).

The pollen results are similar to those from samples in the column above, and riparian species such as *Salix* have not increased at this level. *Populus* and *Salix* pollen occur sporadically throughout the entire column (Table 1). Pollen from this level is not distinguished by a greater abundance of riparian taxa.

540N/498E and 496N/496E

Pollen samples were taken from each of the corners of a one meter square, midway between the level designation and for a maximum thickness of 4 cm in the 10 cm levels and 2 cm in the 5 cm levels (T. O'Laughlin pers. comm.).[15]

540N/498E

Zone 2 - Two samples were derived from zone 2, formerly designated zones 2a and 2b. Cultural materials suggest that pollen sample 3.8-3.9 mbd should correlate with the upper portion of zone 2 in pollen sampling location one ca. 4.9 mbd (T. O'Laughlin pers. comm.).[16]

Sample 3.8-3.9 contains 75.3% Cheno-Ams, 5.8% grass, 2.8% Type A, 2.4% Ephedra, and 7.9% Sarcobatus (the majority of its representation the result of a large single clump of greasewood pollen. This means that it was a more or less single occurrence, one anther part with numerous pollen grains attached, rather than well-distributed in the sample via the pollen rain). Type A which occurs in this sample does not occur in the corresponding stratum of pollen sampling location one (4.9 mbd). Instead it is found slightly lower in that column, still in zone 2, but at 5.05 mbd.

Sample 4.0-4.1 mbd, also from 549N/498E, is similar in appearance to the previous sample. Cheno Ams comprise 65.5%, grasses, 11.4%. Type A makes up 5.7%, Ephedra, 3.2% Both samples contain small amounts of pine, willow, Yucca, Prosopis and Croton. The composites comprise 1.8% in the first sample and 4.4% in the second one. As a unit, the samples from this designation appear homogeneous.

In comparison to pollen sampling location one, at the respective level, 4.9 mbd, there are differences. Since 4.9 mbd of pollen sampling location one does not contain a significant amount of pollen, the level above it, 4.85 mbd, is used for comparison. It does not compare well. Fewer taxa are present, Cheno-Ams are 20% higher (but grasses are similar in number). It does not contain Type A. As such the pollen evidence cannot justifiably support or refute a stratigraphic correlation between the two areas although the cultural material does. The 5.05 level at pollen sampling location one compares more favorably. Cheno-Ams comprise 67.7%. Sarcobatus is present, grass comprises 12.9%, Ephedra, .9%. The composites are higher - 6.1%, but still within a reasonable range. Type A, too, is present with 7.0%. We suggest that a correlation with the 5.05 level is more likely.[16]

496N/496E

Zone 3 - Five samples were submitted for analysis from this sampling area. Preservation was very poor. Only one sample, 4.40-4.45 mbd, zone 3b,[3] contained significant amounts of pollen. The soil from which this sample at zone 3b is derived, a buff to yellow clay loam, is similar to zone 5a of pollen sampling location one and distinct from the beds above and below it. Zone 3b is spread over a good portion of the central portion of the site and is representative of the period 1800BC - 150BC (T. O'Laughlin pers comm.).[5]

Cheno-Am comprise 60.0%, grasses, 12.0%, Ephedra, .3%. The composites are higher than usual - 10.7%, with high spine composites comprising 6.7% and low spine composites making up 4.0%. Opuntia is well represented, with 8.7%. Opuntia is also present in pollen sampling location one, in a similar clay deposit at 5.75 mbd, zone 5a. Here, too, Cheno-Ams, 52.2% grasses, 18.4% and composites, 7.0%, compare favorably. Celtis and Prosopis are also present in both. Type A is present at the 5.75 mbd level of zone 5 a. Whether or not this represents an alluvial or river deposit is not clear. Riverine plant species are not present though, so it is doubtful that a standing body of water is responsible for the deposition of this layer of soil. Those species present reflect the vegetation from the slopes and terraces of the area. The occurrence of Opuntia should be noted. It may be that its presence here is indicative of human utilization.

Past Environment

It is risky to attempt a reconstruction of the environment based solely on pollen analysis. Many factors can cause variation in the natural pollen rain. These factors include varying modes of deposition, varying rates of deposition, differential production of pollen by different types of plants, differential destruction and preservation and other factors (Faegri and Iverson 1964). In an archeological context, the local pollen rain can be affected by man's activities (Bohrer 1968) and variability in results can depend on location of pollen sample (Cully 1979). In addition to these factors, there is incomplete information in most areas about the relation of pollen composition of surface sediments to the surrounding vegetation (Potter and Rowley 1960). With these ideas in mind, we can evaluate our data and those of others from surrounding areas.

Horowitz, Gerald and Chaiffetz (n.d.) maintain that the area supported a rich grassland at the time of occupation of the site. They base this assumption on the high percentage of grass pollen from four sites, including Keystone Dam site 33. This sample was taken at approximately the level of zone 4 (T. O'Laughlin pers. comm.).[17] Our data does not support this idea. In zone 4, our Cheno-Am counts = 53.4%, Gramineae = 16.3%. The highest grass percentage we found at any level (except surface sample) was 19%. Horowitz, Gerald and Chaiffetz (n.d.) found 12% Cheno-Ams and 56% Gramineae in their sample. Our Cheno-Am counts (except surface sample) never fell below 43%. Pollen samples from our three pollen locations indicate a shrub grassland predominated throughout these time periods.

Freeman (1972) proposes a period more mesic than the present, beginning approximately 5000BP, and continuing until approximately 2200BP. This trend coincides with geological studies from New Mexico. Bachuber (1971) states the Lake Meinzer in the Estancia valley was formed around 4000BP, and was dessicated by 3000BP. A dry period occurred in the shallow lake in the San Agustin basin around 2500BP (Powers 1939). Antevs (1955) also proposes a major drought in the west about 2500BP.

The time span from 4000BP to 2000BP would include sediments from pollen sampling location one from zone 5a up to the 5.15 mbd level of zone 2.[18] Samples from zones 3,4,4a and 5a do show a slight trend of lower Cheno-Ams and a higher percent of arboreal taxa (other than pine). However, differences are small, and we do not believe that a conclusion of climatic change is justified, especially since we do not understand the mechanisms of preservation at work here, and the influence on the local pollen rain by the prehistoric inhabitants of the site.

After 2200BP, Freeman proposes a dryer period, extending until sometime before 1055BP, when an episode of more mesic conditions began similar to that occurring around 5000BP. The time of his proposed drier episode at Keystone Dam site probably includes samples from 5.10 mbd to 5.00 mbd,[19] and the time of the more mesic episode, perhaps 4.95 - 4.90 mbd. Our samples at first glance seem to follow this pattern. Cheno-Ams are quite high at the 5.10 mbd and 5.00 mbd level, and are much lower at the 4.95 mbd level. However, charcoal and a hearth at approximately this level indicate that some of these differences may be due to man's activities at the site, and low taxa diversity from individual samples indicates differential preservation of some pollen grains.

Most of the pollen taxa encountered in the study are found either in the surface sample, or reflect taxa that are components of the modern vegetation. Minor trends of increasing and decreasing representation of major types can be seen in the pollen data, but they are probably not significant, and do not necessarily imply changes in the climate. These fluctuations may be due to other causes, particularly human disturbance, differential preservation and the effects of movement of pollen-bearing water through the strata. These facts should not be overlooked in the desire to know more about the past environment.

CONCLUSIONS

Major conclusions from this study are:

1. Cheno-Ams dominate the entire pollen spectrum from all three sampling locations. Gramineae pollen, which seems to covary with Cheno-Am pollen, is second in importance. This continuing pattern throughout the sampling locations indicates a shrub-grassland similar to today's existed in the area of the site. Minor trends in frequencies of Cheno-Ams and grasses can be seen in the pollen data, but they are probably not significant, and do not necessarily imply changes in the climate.

2. Pollen counts could be affected by two important factors, first, differential preservation could be causing over-representation of certain taxa, most often Cheno-Ams, and perhaps grass pollen. Second, man's activities around the site could alter the vegetation and create a local pollen rain with consequent increases in Cheno-Am pollen. The selection and collecting of valuable plant food and subsistence resources such as species of Chenopodium, Amaranthus, grasses, and perhaps Type A pollen could affect pollen representation in localized areas.

3. On basis of pollen types found, there is no way to distinguish a riverine from an alluvial deposit or deposits resulting from episodes of flooding. There appears to be a general mixing of pollen from both kinds of environments.

4. Sampling plan should have included samples from in and around archeological features, such as the hearth and storage cist shown on the stratigraphy. Pollen information from features can sometimes help to determine what plant resources inhabitants of the site were using, as well as what taxa from pollen columns may have been present because they were introduced into the site by man. Consultation with a pollen analyst before sampling plan is set up is worth while, to help gain as much meaningful information as possible.

LITERATURE CITED

Antevs, E. 1955. Geologic climatic dating in the west. Amer. Antiq. 20:4

Bachuber, F.W. 1971. Paleoclimatology of Lake Estancia. Ph.D. dissertation. Univ. of N.M. Albuquerque,, N.M.

Bohrer, V.L. 1968. Paleoecology of an archeological site near Snowflake, Arizona. Ph.D. dissertation. Univ. of Ariz., Tucson, Ariz.

Campbell, C.J. and W.A. Dick-Peddie. 1964. Comparison of phreatophyte communities on the Rio Grande in New Mexico. Ecology 45:3.

Clary, K.H. and A.C. Cully. 1979. Pollen analysis of Block III mitigation project. Final report. Navajo Indian Irrigation Project, Farmington, N.M.

Cully, A.C. 1977. Relation of pollen analysis to archeological excavations, Chaco Canyon, New Mexico. Masters' thesis. Univ. of N.M. Albuquerque, N.M.

Cully, A.C. 1979. Some aspects of pollen analysis in relation to archeology. Kiva 44:2-3.

Faegri, K. and J. Iversen. 1964. Testbook of pollen analysis. Munksgaard, Copenhagen.

Freeman, C.E. 1972. Pollen study of some Holocene alluvial deposits in Dona Ana County, southern N.M. The Texas Journ. of Sci. 24:2.

Gardner. J.L. 1951. Vegetation of the creosotebush area of the Rio Grande valley in New Mexico. Ecol. Monog. 21:4.

Hall. S.A. 1977. Late Quaternary sedimentation and paleoecologic history of Chaco Canyon, New Mexico. Geol. Soc. Amer. Bull. 88:1593-1618.

Horowitz, A., R.E. Gerald, and M.S. Chaiffetz. n.d. Preliminary paleoenvironmental implications of pollen analyses from Mesilla, El Paso and historic sites near El Paso, Texas.

Jones, V. 1930. The ethnobotany of the Isleta Indians. Masters' thesis. Univ. of N.M. Albuquerque, N.M.

Mehringer, P.J., Jr. 1967. Pollen analysis of the Tule Springs area, Nevada. Nevada State Mus. Anthrop. Pap. 13.

Potter, L.D. and J. Rowley. 1960. Pollen rain and vegetation. San Augustine plains, New Mexico. Bot. Gazette 122:1.

Powers, W.E. 1939. Basin and shore features of the extinct Lake San Agustin, N.M. Jour. of Geomorph. 2:345-356.

Struever, M.B. 1979. Evidence of ancient and modern human behavior in flotation remains from Howiri Pueblo. Contract no. 67-905.41-00047. Report to Museum of N.M., Bur. of Anthro. Santa Fe, N.M.

White, L.A. 1944. Notes on the ethnobotany of the Keres. Papers of the Mich. Acad. of Science, Arts and Letters 30.

Whiting, A.F. 1966. Ethnobotany of the Hopi. Mus. North. Ariz. Flagstaff, Ariz.

Williams, J.S. 1969. West slope arroyo vegetation of the Franklin Mountains, El Paso, Texas. The Texas Jour. of Sci. 22:3.

APPENDIX

EXPLANATION OF TAXA

Abronia cf. angustifolia - pollen that compares favorably with sand verbena.

Acacia sp. - acacia.

Acer cf. negundo - maple. The species recognized appears very similar to A. negundo.

Allionia sp. - umbrella wort.

Artemisia sp. - sage.

Betulaceae - Birch family.

Cactaceae - pollen identified to Cactus family, exclusive of members of the genus Opuntia.

Canotia type - pollen that strongly resembles Canotia.

Caryophyllaceae - pollen identified to "Pink" family.

Celtis sp. - hackberry.

Cercocarpus - mountain mahogany.

Cheno-Am - category made up of pollen types from the CHENOPODIACEAE and AMARANTHACEAE that are indistinguishable morphologically with the light microscope. The pollen is periporate and between 22-35 microns in size. Atriplex sp. (saltbush), Goosefoot, (Chenopodium sp.), Salsola sp. (Russian thistle), and Amaranthus sp., (Pigweed), Shadscale (Atriplex confertifolia) and A. powelli, are all members of this category.

Cistaceae - rockrose. Helianthemum is a member of this family.

Cleome sp. - beeweed.

Convolvulus - bindweed.

Croton sp. - spurge.

Dithryea wizlezenii - spectacle pod.

Ephedra - mormon tea. Most of the Ephedra pollen in the samples compare favorably to Ephedra trifurca, a torreyana type Ephedra.

Fagaceae - Oak family. Pollen identified to family only, not to include Quercus sp. (Oak). Other members of the family are beech (Fagus) and chestnut (Castanea).

Fouquieria - ocotillo.

Gramineae - Grass family.Pollen of the grass family excluding Corn, Zea mays. Pollen ranges in size between 30 and 70 microns in diameter.

High Spine Compositae - pollen of the Sunflower family with spines greater than 1.5 microns. Many annual and perennial sunflowers such as Baileya multiradiata, Helianthus (sunflower) Solidago (goldenrod) and Senecio (groundsel) belong to this category. High Spine Compositae are usually insect pollinated and produce less pollen per plant than the Low Spine Compositae that are wind pollinated.

Ilex - Ilex.

Juniperus - juniper.

Juglans - walnut.

Larrea tridentata - creosote bush.

Leguminosae - pollen identified to Legume, or Bean Family.

Liquidambar - sweetgum.

Liliaceae - Lily family, excluding Yucca.

Low Spine Compositae - pollen of the Sunflower family with spines less than 1.5 microns in length. These types are wind pollinated. Ragweed (Ambrosia) and Xanthium belong to this category.

Lycium cf. pallidum - pollen than compares favorably to wolfberry.

Malvaceae - Pollen of the Mallow family.

Opuntia sp. - prickly pear.

Pinaceae - Pollen identified to Pine family but corroded to the point where identification to genun was not possibly.

Pinus sp. - Pollen identified to the genus of pines.

Pinus edulis - pinyon.

Pinus ponderosa - ponderosa pine.

Populus - cottonwood.

Primulaceae - Primrose family.

Prosopis cf. *glandulosa* - pollen that compares favorably with honey mesquite, the glandulosa variety of P. juliflora.

Prosopis cf. *juliflora* - pollen that compares favorably with common mesquite.

Quercus - oak.

Rosaceae - rose family.

Salix cf. *goodingii* - pollen that compares favorably with the Gooding willow, which is very similar to the black willow of the eastern U. S. It grows along streams, up to 7,000 ft. (Kearney and Peebles, Arizona Flora, 1964: 212).

Salix sp. - willow.

Sarcobatus - greasewood.

Solanaceae - Potato family.

Solanum cf. *eleagnifolium* - pollen than compares favorably to silver leaf nightshade.

Sphaeralcea - globemallow.

Tilia - Basswood.

Type A - a puzzling palynomorph. It appears to be a member of the Gramineae, or Grass family. It is large, between 90 and 120 microns in diameter, the same size as Corn (Zea mays) but it is difficult to say for sure if this is corn or not. Most of the grains are corroded, annuli are not obvious usually because of the crumpled and corroded condition of most of the grains. Annuli have been spotted on some. By all definitions (Erdtman and Kapp) the palynomorph keys out to Zea mays. Condition of the pollen in these samples, alteration c. exine and the similarity of this type to a certain recognized fungal spore, makes us cautious in saying for sure if it is Zea mays or not. More correlative evidence is needed - macrobotanical, seed, and archaeological.

Tamarix sp. - saltcedar.

Ulmus - elm.

Vitis - wild grape.

Yucca - Yucca.

TABLE 1

POLLEN COUNTS AND PERCENTAGES

Sample	PINACEAE	PINUS SP.	P. EDULIS	PICEA	ABIES	JUNIPERUS	SALIX SP.	SALIX CF. GOODINGII	POPULUS	ACER CF. NEGUNDO	QUERCUS	JUGLANS	ULMUS	CHENO AMS	GRAMINEAE	EPHEDRA	COMPOSITE HIGH SPINE	COMPOSITE LOW SPINE
Lab #9-Surface		20/5.6				5/1.4	4/1.1	6/1.7		10/2.8	5/1.4			137/38.5	87/24.4	8/2.2	17/4.8	21/5.9
10-4.70mbd						poor preservation - Dune Sand												
1-4.75mbc		11/3.5				1/.3								289/91.5	3/.9		7/2.2	
2-4.80mbc		5/1.6												307/97.4	1/.3	1/.3		1/.3
17-4.86mbc		11/3.0					1/.2							296/83.1	32/9.0		3/.8	3/.8
11-4.90mbd						poor preservation												
3-4.95mbd		24/5.7				1/.2			1/.2					186/43.8	82/19.3	10/2.4	1/.2	
4-5.0mbd		4/1.3					1/.3							265/86.3	31/10.1	2/.6	1/.3	1/.3
15-5.05mbc											2/.6		1/.3	210/67.7	40/12.9	3/.9	14/4.5	5/1.6
5-5.10mbd		14/4.2							1/.3					266/80.1	40/12.0	4/1.2	1/.3	
6-5.15mbd		13/3.9												262/78.0	40/11.9	7/2.0	5/1.5	4/1.2
7-5.20mbc		11/3.4				1/.3								235/77.4	48/15.8	3/.9	3/.9	
8-5.25mbd		10/3.0												274/83.0	29/8.8	3/.9	7/2.1	1/.3
12-5.30mbc						poor preservation												
13-5.35mbc						poor preservation												
14-5.40mbc		1/.3	1/.3				1/.3				4/1.3	1/.3	3/1.0	184/57.5	61/19.7	1/.3	14/4.5	4/1.3
15-5.45mbc		2/.6	1/.3								3/1.0	3/1.0		187/52.9	56/18.0	7/2.2	31/9.9	7/2.2
16-5.50mbc	1/.3	1/.3									5/1.6	2/.6		212/68.4	47/15.1	7/2.3	6/1.9	2/.6
19-5.55mbc						poor preservation												
20-5.60mbc						poor preservation												
21-5.65mbc											4/1.3			167/53.4	51/16.3	3/1.0	27/8.6	20/6.4
22-5.70mbc						poor preservation												
23-5.75mbc		9/2.9					1/.3				12/3.8		4/1.3	165/52.2	58/18.4		11/3.5	11/3.5
24-3.8-3.9		3/.6						1/.2			2/.4			379/75.3	29/5.8	12/2.4	7/1.4	2/.4
25-4.0-4.1m		3/.9					2/.6						1/.3	207/65.5	36/11.4	10/3.2	8/2.5	6/1.9
26-4.25-4.35m						poor preservation												
27-4.40-4.45m		4/1.2									8/2.5		1/.3	195/60.0	39/12.0	1/.3	22/6.7	13/4.0
28-4.60-4.65m						poor preservation												
29-4.75-4.80m						poor preservation												
30-5.15-5.20m						poor preservation												

Sample	ARTEMISIA	CELTIS	LEGUMINOSEAE	LILIACEAE	YUCCA	MALVACEAE	SPHAERALCEA	LARREA TRIDENTATA	TAMARIX	FOUQUIERIA	PROSOPIS	LYCIUM CF. PALLIDUM	CROTON	CF. DYTHYREA WISLEZENII	ACACIA	ABRONIA CF. ANGUSTIFOLIA	ALLIONIA
Lab #9-Surface			4/1.1					15/4.2	8/2.2	3/.8							
10-4.70mbd																	
1-4.75mbc					1/.3						1/.3	3/.9					
2-4.80mbc																	
17-4.86mbc					3/.8						5/1.4						
11-4.90mbd																	
3-4.95mbd				1/.2								119/28.0					
4-5.0mbd													1/.3	1/.3			
15-5.05mbc		4/1.3						1/.3							4/1.3		
5-5.10mbd						2/.6									3/.9	1/.3	
6-5.15mbd			1/.3					1/.3			1/.3				2/.6		
7-5.20mbc											1/.3				1/.3		
8-5.25mbd							1/.3						3/.9				
12-5.30mbc																	
13-5.35mbc																	
14-5.40mbc	1/.3	2/.6	1/.3		1/.3		1/.3	1/.3			2/.6		1/.3		4/1.3		
15-5.45mbc			1/.3								1/.3				2/.6		
16-5.50mbc	1/.3	1/.3	5/1.6					4/1.3									1/.3
19-5.55mbc																	
20-5.60mbc																	
21-5.65mbc		1/.3	4/1.3		1/.3	1/.3					2/.6				2/.6	1/.3	
22-5.70mbc																	
23-5.75mbc	1/.3	7/2.2	3/1.0				1/.3	2/.6			1/.3				14/4.4		
24-3.8-3.9			1/.2		3/.6		3/.6				1/.2		1/.2				
25-4.0-4.1m		3/.9	2/.6		3/.9			1/.3			3/.9		1/.3				
26-4.25-4.35m																	
27-4.40-4.45m		1/.3	4/1.2		1/.3						1/.3						
28-4.60-4.65m																	
29-4.75-4.80m																	
30-5.15-5.20m																	

Sampling Location

TABLE 1—Continued

Sample	ROSACEAE	CERCOCARPUS	CARYOPHYLLACEAE	PRIMULACEAE	SOLANUM CF. ELEAGNIFOLIUM	SARCOBATUS	TYPE A	FAGACEAE	CISTACEAE	CACTACEAE	OPUNTIA	LIQUIDAMBAR	VITIS	CLEOME	TILIA	CANOTIA	CONVOVULUS	PINUS PONDEROSA	ILEX	BETULACEAE	EUPHORBIACEAE	SOLANACEAE	N	UNKNOWNS
Lab #9-Surface	1/.3				5/1.4																		356	16
10-4.70mbd							poor	preservation																
[illegible]-4.75mbd																							316	5
3-4.80mbd																							315	
17-4.85mbd	1/.2		1/.2																				356	
11-4.90mbd							poor	preservation																
[illegible]-4.95mbd																							425	31
4-5.00mbd																							307	11
13-5.05mbd		1/.3				3/1.0	22/7.0																310	1
5-5.10mbd																							332	19
6-5.15mbd	1/.3																						337	5
7-5.20mbd																							303	6
8-5.25mbd			2/.6																				330	
12-5.30mbd							poor	preservation																
13-5.35mbd							poor	preservation																
14-5.40mbd						1/.3	16/5.2		1/.3	1/.3	1/.3												309	2
15-5.45mbd							6/1.9			1/.3	1/.3	2/.6	1/.3										312	3
16-5.50mbd							14/4.5					1/.3											310	
19-5.55mbd							poor	preservation																
20-5.60mbd							poor	preservation																
21-5.65mbd							2/.6				25/7.9						2/.6						313	
22-5.70mbd							poor	preservation																
23-5.75mbd							12/3.9			1/.3				1/.3	1/.3	1/.3							316	
24-3.8-3.9mbd						40/7.9	14/2.8			1/.2								1/.2		1/.2	2/.4		503	
25-4.0-4.1mbd						5/1.6	18/5.7												3/.9		4/1.3		316	
26-4.25-4.35							poor	preservation																
27-4.40-4.45						2/.6	1/.3				28.5/8.7						3/.9				2/.6	1/.3	327.5	
28-4.60-4.65								poor	preservation															
29-4.75-4.80								poor	preservation															
30-5.15-5.20								poor	preservation															

Sampling Location One (samples Lab #9-Surface through 23-5.75mbd); 540N/498E (24–25); 496N/496E (26–30)

EDITORIAL FOOTNOTES

1. This report was received on 28 January 1980 from Misses Cully and Clary under Purchase Order No. TWC 9-10802, issued by the Purchasing Officer of the University of Texas at El Paso on 19 April 1979. The analysis of the stratigraphic data and of the artifacts was not complete at the time of the order and the radiocarbon and other data solicited of other consultants had not been received. As that information and interpretations became available they were transmitted to the palynologists by letter or telephone as is reflected in the "personal communication" citations. References to the appropriate chapters in the foregoing report where documentation may be found are provided as footnotes to assist the reader, but otherwise this report is printed as modified by the writers. Offset reproduction was chosen in order to avoid the distortion that is an inevitable product of the editor's pencil.

2. The complete site designation is "EPCM 31:106:2:33."

3. Zone 3b should be called Zone 3A

4. No figure was included with this report.

5. See Chapter V, Stratigraphy and Dating.

6. See Chapter II, Environmental Setting.

7. See Chapter III, Culture History Overview.

8. Occupants of the site would have had access to the resources of a number of nearby environmental zones. See Chapter II, Environmental Setting.

9. The hearth was actually located at 4.90 mbd and was not associated directly with the pollen sample from 4.90 mbd or 4.95 mbd.

10. A variety of charred macrofloral remains was recovered from the site. See Chapter VII, Macrofloral and Faunal Remains.

11. The transition between Zones 2 and 3 is between samples 13 (5.30 mbd) and 14 (5.35 mbd), neither of which produced sufficient quantities of pollen for analysis.

12. There is an error in this table. The pH for Zone 2 was 8.65, as reported, but that of Zone 3 was 8.96, not 9.6.

13. There is no evidence to support the suggestion that "part of Zone 3 is a layer of deflocculating sodic soil." The percentage saturation of the cation-exchange capacity with sodium was not measured for these or other soil zones of Site 33. Thus, it cannot be stated with certainty that the soils of Zone 3 include

AD-A127 405 THE KEYSTONE DAME SITE AND OTHER ARCHAIC AND FORMATIVE SITES IN NORTHWEST EL PASO TEXAS(U) EL PASO CENTENNIAL MUSEUM TX T C O'LAUGHLIN OCT 80 DACW47-79-C-0004 4/4

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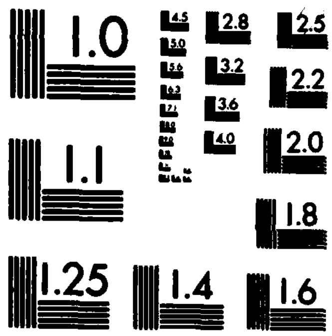

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

or do not include sodic soils. However, the percentages of organic matter and carbonates, electrical conductivity, and pH are within the range of non-saline and non-sodic, predominantly coarse-textured soils of arid environments. In addition, many of the changes in these factors for these two soil zones and others at Site 33 largely reflect variability in the particle size composition of soils and their depth below the surface, and there are also no obvious correlations between these factors and pollen preservation at Site 33.

14. Juglans is not found in the El Paso area today. See Chapter II, Environmental Setting.

15. See Chapter VI, Palynology.

16. Radiocarbon dates and ceramic materials make it unlikely that this correlation is correct. See Chapter VI, Palynology.

17. The Horowitz, Gerald, and Chaiffetz subsurface pollen data from the Keystone Dam Site (EPCM 31:106:2:33) were derived from a soil sample taken from the lower fill of House 2 which was excavated prehistorically from the level of Zone 4 and was covered prehistorically by the soil of that same zone. See Figure 31 and Chapter VI, Palynology.

18. The sample from Zone 5A probably dates before 4000 BP, the samples from Zone 4 may date prior to 4000 BP, and the mentioned samples from Zone 2 could date after 2000 BP.

19. Samples from the lowest portion of Zone 2 (5.15 - 5.30 mbd) are also dated after 2200 BP.

REFERENCES

Antevs, E.

1948 Climatic Changes and Pre-white Man in the Great Basin, with Emphasis on Glacial and Post-glacial Times. University of Utah Bulletin 33(20):168-191. Salt Lake City.

1955 Geologic-Climatic Dating in the West. American Antiquity 20(4):317-35. Salt Lake City.

Aten, Lawrence E.

1972 Evaluation of the Cultural Resources of the Northgate Site, El Paso County, Texas. Texas Archeological Salvage Project, Research Report No. 5. The University of Texas at Austin.

Athens, J. S.

1977 Theory Building and the Study of Evolutionary Process in Complex Societies. *In* For Theory Building in Archaeology, ed. by L. R. Binford, pp. 353-84. Academic Press. N. Y.

Bachuber, F. W.

1971 Paleoclimatology of Lake Estancia. Ph.D. Dissertation. University of New Mexico, Albuquerque.

Baldwin, P. M.

1939 A Short History of the Mesilla Valley. New Mexico Historical Review. University of New Mexico Press, Albuquerque.

Basehart, Harry W.

1974 Mescalero Apache Subsistence Patterns and Socio-Political Organization. *In* Apache Indians XII. Garland Publishing Co., N. Y.

Beckes, M. R.

1977a Descriptive Analysis of Projectile Points. *In* A Cultural Resource Inventory and Assessment of McGregor Guided Missile Range, Otero County, New Mexico, Part II: Special Archeological Studies, pp. 41-80. Texas Archeological Survey Research Report No. 65. The University of Texas at Austin.

1977b Prehistoric Cultural Stability and Change in the Southern Tularosa Basin. Ph.D. Dissertation. University of Pittsburgh, Penn.

1977c Descriptive Report of Text Excavations. *In* A Cultural Resource Inventory and Assessment of McGregor Guided Missile Range, Otero County, New Mexico. Part II: Special Archeological Studies, pp. 3-39. Texas Archeological Survey Research Report No. 65. The University of Texas at Austin.

Beckett, Patrick H.

1973 Gardner Springs Site. Awanyu 1(2):45-7. Archaeological Society of New Mexico. Las Cruces.

1979 Hueco Phase: Fact Or Fiction. *In* Mogollon Archaeology, ed. by P. H. Beckett and R. N. Wiseman, pp. 223-25. New Mexico State University, Las Cruces.

Bell, Willis H. and Edward F. Castetter

1937 The Utilization of Mesquite and Screwbean by the Aborigines in the American Southwest. University of New Mexico Bulletin, Biological Series 5(2). Albuquerque.

1941 Ethnobiological Studies in the American Southwest VII. The Utilization of Yucca, Sotol, and Beargrass by the Aborigines in the American Southwest. University of New Mexico Bulletin, Biological Series VII 5(5). Albuquerque.

Benson, Lyman

1969 The Cacti of Arizona. University of Arizona Press, Tucson.

Binford, Lewis R.

1962 Archaeology as Anthropology. American Antiquity 28(2):217-25. Salt Lake City.

1964 A Consideration of Archaeological Research Design. American Antiquity 29(4):425-41. Salt Lake City.

1965 Archaeological Systematics and the Study of Culture Process. American Antiquity 31(2):203-10. Salt Lake City.

1972 Contemporary Model Building; Paradigms and the Current State of Paleolithic Research. *In* Models in Archaeology, ed. by D. L. Clarke, pp. 109-166. Methuen, London.

1977 General Introduction. *In* For Theory Building in Archaeology, ed. by L. R. Binford, pp. 1-10. Academic Press, N. Y.

1978a Dimensional Analysis of Behavior and Site Structure: Learning from an Eskimo Hunting Stand. American Antiquity 43(1):330-61. Washington, D. C.

1978b Nunamiut Ethnoarchaeology. Academic Press, N. Y.

1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45(1):4-20. Washington, D. C.

Blair, F. W.

1950 The Biotic Provinces of Texas. Texas Journal of Science 2(1):93-117.

Bohrer, Vorsila L.

1972 Tentative List of Utilized Plant Remains from Fresnal Shelter. *In* Training Bulletin. Tularosa Valley Project. Excavations at Fresnal Shelter. Human Systems Research, Inc., Albuquerque.

Breternitz, David

1966 An Appraisal of Tree-Ring Dated Pottery in the Southwest. Anthropological Papers of the University of Arizona, No. 10. Tucson.

Brethauer, Douglas P.

1977 Summary of Cultural Development in the Hueco Bolson and Vicinity. *In* Settlement Patterns of the Eastern Hueco Bolson by Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 4. The University of Texas at El Paso.

Brook, Vernon Ralph

1966 They Didn't Barter to Fill the Larder. The Artifact 4(3):1-15. El Paso Archaeological Society, El Paso.

1975 Development of Prehistoric House Types in the Jornada Branch. Awanyu 3(4):16-31. Archaeological Society of New Mexico. Las Cruces.

1979 Mesilla Phase Artifacts. Transactions of the 14th Regional Archeological Symposium for Southeastern New Mexico and West Texas, pp. 16-33. Carlsbad Archaeological Society.

1980 The Sabina Mountain Site. Transactions at the 15th Regional Archeological Symposium for Southeastern New Mexico and Western Texas, pp. 15-86.

Bryan, K.
1941 Pre-Columbian Agriculture in the Southwest as Conditioned by Periods of Alluviation. Annual Association of American Geographers, 31:219-42.
1954 The Geology of Chaco Canyon, New Mexico, in Relation to the Life and Remains of the Prehistoric Peoples of Pueblo Bonito. Smithsonian Miscellaneous Collections, 122:1-65.

Bryant, V. M., Jr.
1977 Late Quaternary Pollen Records from the East-Central Periphery of the Chihuahuan Desert. *In* Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico, ed. by R. H. Wauer and D. H. Riskind, pp. 3-21. National Park Service Transactions and Proceedings Series, No. 3. U. S. Department of the Interior.

Bryson, Reid A., and W. M. Wendland
1967 Tentative Climatic Patterns for Some Late Glacial and Post-glacial Episodes in Central North America. *In* Land and Water, ed. by William J. Mayer-Oakes, pp. 271-98. University of Manitoba Press, Winnipeg, Canada.

Buffington, L. C., and C. H. Herbel
1965 Vegetational Changes on a Semi-Desert Grassland Range. Ecological Monographs 35:139-64.

Bye, Robert A., Jr., Don Burgess, and Albino Mares Trias
1975 Ethnobotany of the Western Tarahumara of Chihuahua, Mexico. Botanical Museum Leaflets, Vol. 24, No. 5. Harvard University, Cambridge.

Campbell, C. J., and W. A. Dick-Peddie
1964 Comparison of Phreatophytic Communities on the Rio Grande in New Mexico. Ecology 45(3):492-502.

Castetter, Edward F. and Ruth Underhill
1935 The Ethnobiology of the Papago Indians. University of New Mexico Bulletin, Biological Series 4(3). Albuquerque.

Castetter, Edward Franklin, Willis H. Bell, and Alvin R. Grove
1938 Ethnobiological Studies in the American Southwest VI. The Early Utilization and the Distribution of Agave in the American Southwest. University of New Mexico Bulletin, Biological Services 5(4). Albuquerque.

Castetter, Edward F., and Willis H. Bell
1942 Pima and Papago Indian Agriculture. Inter-American Studies I. University of New Mexico. Albuquerque.

Chapman, R. L.
1977 Analysis of Lithic Assemblages. Chapter 11. *In* Settlement and Subsistence Along the Lower Chaco River, ed. by Charles A. Reher. University of New Mexico Press, Albuquerque.

Clary, K. H., and A. A. Cully
n.d. Pollen Analysis of Block III Mitigation Project. Final Report. Manuscript, 1979. Navajo Indian Irrigation Project. Farmington, New Mexico.

Collins, M. B.
1975 Sources of Bias in Processual Data: An Appraisal. *In* Sampling in Archaeology, ed. by J. W. Mueller, pp. 26-32. University of Arizona Press, Tucson.

Cosgrove, C. B.
1947 Caves of the Upper Gila and Hueco Areas in New Mexico and Texas. Papers of the Peabody Museum, Harvard University, Vol. XXIV, No. 2. Cambridge.

Cosgrove, H. S. and C. B.
1932 The Swartz Ruin, a Typical Mimbres Site in Southwestern New Mexico. Papers of the Peabody Museum, Harvard University, Vol. XV, No. 1. Cambridge.

Damon, P. E., C. W. Ferguson, A. Long, and E. I. Wallick
1974 Dendrochronologic Calibration of the Radiocarbon Time Scale. American Antiquity 39(2):350-66. Washington, D. C.

Dick, Herbert W.
1965 Bat Cave. School of American Research, Monograph No. 27. Santa Fe, New Mexico.

Eck, David C.
1979 An Overview of the Culture History of the Hueco Bolson and Vicinity. *In* Excavations at the Transmountain Campus, El Paso Community College, El Paso County, Texas, by Thomas C. O'Laughlin. Publications in Anthropology No. 7. El Paso Centennial Museum, The University of Texas at El Paso.

Eddy, Frank W.
1958 A Sequence of Cultural and Alluvial Deposits in the Cienega Creek Basin, Southeastern Arizona. Masters Thesis. University of Arizona, Tucson.

Ederhoff, Lowell T.
1971 The Mammals of El Paso County, Texas. With Notes on Vegetation. Masters Thesis. The University of Texas at El Paso.

Everitt, Benjamin L.
1977 Historical Background. *In* A Preliminary Appraisal of Cultural and Historical Resources Found Along the Rio Grande Between Fort Quitman and Haciendita, Texas, by Charles A. Johnson II, pp. 21-25. El Paso Centennial Museum Publications in Anthropology No. 5. The University of Texas at El Paso.

Everitt, Cindi, and John V. Davis
1974 The Cruz Tarin Paleo Site. Awanyu 2(4):17-31. Archaeological Society of New Mexico. Las Cruces.

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones
1975 Mammals of New Mexico. University of New Mexico Press, Albuquerque.

Ford, Richard I.
1977 Archeobotany of the Fort Bliss Maneuver Area II, Texas. Appendix E. *In* Settlement Patterns of the Eastern Hueco Bolson, by Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 4. The University of Texas at El Paso.

Freeman, C. E.
1972 Pollen Study of Some Holocene Deposits in Dona Ana County, Southern New Mexico. The Texas Journal of Science 24:203-20.

Friedman, Irving, and Robert L. Smith
1960 A New Dating Method Using Obsidian. American Antiquity 25(4):476-522. Salt Lake City.

Fritts, Harold C.
1965 Tree-Ring Evidence for Climatic Changes in Western North America. Monthly Weather Review, 93:421-43.

Gardner, J. L.
1951 Vegetation of the Creosotebush Area of the Rio Grande Valley in New Mexico. Ecological Monographs 21: 379-403.

Gasser, Robert E.
n.d. Negative Evidence for Roasting Pits: The Flotation Data. Appendix A. Manuscript, 1979. *In* Excavations in the Castner Range Archeological District in El Paso, Texas, by Robert J. Hard. El Paso Centennial Museum, The University of Texas at El Paso.

Gerald, Rex E.
n.d.a. An Archeological Salvage Project in Hudspeth County, Texas. Manuscript, 1959. El Paso Centennial Museum, The University of Texas at El Paso.
n.d.b. A Preliminary Evaluation of the Historic, Cultural, and Environmental Significance of the Ruins of the Prehistoric Northgate Site Community. Manuscript, 1972. El Paso Centennial Museum, The University of Texas at El Paso.
n.d.c. Preliminary Reconnaissance to Evaluate the Cultural and Historical Resources of the Easternmost Two Sections of Castner Range, Fort Bliss, El Paso County, Texas. Manuscript, 1975. El Paso Centennial Museum, The University of Texas at El Paso.
n.d.d. Report on an Archeological Survey of Five Local Protection Project Dams and Associated Drainage and Diversion Channels in Northwest El Paso, Texas. Manuscript, 1976. El Paso Centennial Museum, The University of Texas at El Paso.
1974a The Manso Indians of the Paso del Norte Area. *In* Apache Indians III. Ed. by David A. Horr. Garland Publishing Co., N. Y.
1974b The Suma Indians of Northern Chihuahua and West Texas. *In* Apache Indians III. Ed. by David A. Horr. Garland Publishing Co., N. Y.

Green, John W.
1971 Progress Report on the Excavation of Site EPAS-49 and a Preliminary Report on the Excavation of Shelter One, White Rock Cave. Transactions of the Sixth Regional Archaeological Symposium for Southeastern New Mexico and Western Texas. pp. 101-110.

Greer, John W.
1968a Notes on Excavated Ring Midden Sites, 1963-1968. Bulletin 38:39-44. Texas Archeological Society.
1968b Excavation at a Midden Circle Site in El Paso County, Texas. Bulletin 39:111-31. Texas Archeological Society.

Greiser, T. Weber
1973 Preliminary Field Report on the Findings and Results of the Evaluation of the Cultural and Historical Resources of the Las Cruces Arroyo Lithic Site (EPCM 32:106:10:3) in Las Cruces, New Mexico. El Paso Centennial Museum Publications in Anthropology No. 3. The University of Texas at El Paso.

Hafsten, Ulf
1961 Pleistocene Development of Vegetation on Climate in the Southern High Plains as Evidenced by Pollen Analysis. *In* Paleoecology of the Llano Estacado, ed. by Fred Wendorf, pp. 59-91. Fort Burgwin Research Center, Pub. No. 1. Museum of New Mexico Press, Santa Fe.

Hammerson, Martha M.
1972 The Prehistoric Mogollon Culture and Its Regional Aspects in the El Paso Area. The Artifact 10(1). El Paso Archaeological Society, El Paso.

Hard, Robert J.
n.d. Excavations in the Castner Range Archeological District in El Paso, Texas. Manuscript, 1979. El Paso Centennial Museum, The University of Texas at El Paso.

Harrington, H. D., and Y. Matsumura
1967 Edible Native Plants of the Rocky Mountains. University of New Mexico Press, Albuquerque.

Harrington, M. R.
1957 A Pinto Site at Little Lake, California. Southwest Museum Papers, No. 17. Los Angeles.

Harris, A. H.
n.d. A Vegetational Survey of the Franklin Mountains, El Paso County, Texas. Manuscript prepared for Natural Areas Survey, The University of Texas at Austin. Laboratory of Environmental Biology, The University of Texas at El Paso.
1977 Wisconsin Age Environments in the Northern Chihuahuan Desert: Evidence from the Higher Vertebrates. *In* Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico, ed. by R. H. Wauer and D. H. Riskind, pp. 3-21. National Park Service Transactions and Proceedings Services, No. 3. U. S. Department of Interior.

Haury, Emil W.
1936 The Mogollon Culture of Southwestern New Mexico. Medallion Papers, No. 20. Gila Pueblo, Globe, Arizona.
1957 An Alluvial Site on the San Carlos Indian Reservation, Arizona. American Antiquity 23(1):2-27. Salt Lake City.

Hawley, J. W., W. S. Strain, W. R. Seager, W. E. King, and D. V. LeMone
1969 The Santa Fe Group in the South-Central New Mexico Border Region. New Mexico Bureau of Mines and Mineral Resources, Circular 104:52-76. Socorro.

Hawley, J. W., and F. E. Kottlowski
1969 Quaternary Geology of the South-Central New Mexico Border Region. New Mexico Bureau of Mines and Mineral Resources, Circular 104:89-115. Socorro.

Hayden, Brian and Johan Kamminga
1979 An Introduction to Use-Wear: The First CLUW. *In* Lithic Use-Wear Analysis, ed. by Brian Hayden, pp. 1-13. Academic Press, N. Y.

Haynes, C. V., Jr.
1968 Geochronology of Late Quaternary Alluvium. *In* Means of Correlation of Quaternary Successions, ed. by R. B. Morrison and H. E. Wright, pp. 591-631. University of Utah Press.

Hevly, R. H., P. J. Mehringer, Jr., and H. G. Yocum
1965 Modern Pollen Rain in the Sonoran Desert. Journal of the Arizona Academy of Science 3:123-35.

Hill, James N.
1977 Systems Theory and the Explanation of Change. *In* Explanation of Prehistoric Change, ed. by James N. Hill, pp. 59-103. University of New Mexico Press, Albuquerque.

Hill, James N., and Richard H. Hevly
1968 Pollen at Broken K Pueblo: Some New Interpretations. American Antiquity, 33:(2):200-10. Salt Lake City.

Holloway, Richard G.
n.d. Charcoal and Pollen Analyses. Appendix B. Manuscript, 1979. *In* Excavations in the Castner Range Archeological District in El Paso, Texas, ed. by Robert J. Hard. El Paso Centennial Museum, The University of Texas at El Paso.

Horowitz, A., R. E. Gerald, and M. S. Chaiffetz
n.d. Preliminary Paleoenvironmental Implications of Pollen Analyses from Mesilla, El Paso, and Historic Sites Near El Paso, Southwest Texas. Manuscript, 1980. El Paso Centennial Museum, The University of Texas at El Paso.

Human Systems Research
1972 Training Bulletin. Tularosa Valley Project. Excavations at Fresnal Shelter. Human Systems Research Inc., Albuquerque.

Hunter-Anderson, R. L.
1979 Report on Archaeological Reconnaissance Survey, South Dona Ana County, New Mexico, Airport Site No. 1. Bohannan-Houston, Inc., Albuquerque.

Irwin-Williams, Cynthia
1967 Picosa: The Elementary Southwestern Culture. American Antiquity 32(4):441-57.
1973 The Oshara Tradition: Origins of Anasazi Culture. Contributions in Anthropology, Vol. 5, No. 1. Eastern New Mexico University, Portales.

Irwin-Williams, Cynthia and S. Tompkins
1968 Excavations at En Medio Shelter, New Mexico. Interim Report on the Anasazi Origins Project. Contributions in Anthropology, Vol. 1, No. 2. Eastern New Mexico University, Portales.

Jaco, Herbert B.
1971 Soil Survey of El Paso County, Texas. U. S. Department of Agriculture. Washington, D. C.

Jennings, Jesse D.
1964 The Desert West. *In* Prehistoric Man in the New World, ed. by Jesse D. Jennings and Edward Norbeck, pp. 149-74. University of Chicago Press, Chicago.

Johnson, L., Jr.
1963 Pollen Analysis of Two Archeological Sites at Amistad Reservoir, Texas. Texas Journal of Science 15: 225-230.

Jorde, L. B.
1977 Precipitation Cycles and Cultural Buffering in the Prehistoric Southwest. *In* For Theory Building in Archeology, ed. by L. R. Binford, pp. 385-396. Academic Press, N. Y.

Judge, W. James
1973 Paleoindian Occupations of the Central Rio Grande Valley in New Mexico. University of New Mexico Press, Albuquerque.

Kegley, George B.
1979 Excavations at Hueco Tanks State Park: A Summary and Some Implications. *In* Mogollon Archaeology, ed. by P. H. Beckett and R. N. Wiseman, pp. 19-23. New Mexico State University, Las Cruces.

Kelley, J. C.
1959 The Desert Culture and the Balcones Phase: Archaic Manifestations in the Southwest and Texas. American Antiquity 24:276-88. Salt Lake City.

Kenmotsu, Ray E.
1977 The Botanical Research. Part III: Botanical and Geological Studies. *In* A Cultural Resource Inventory and Assessment of McGregor Guided Missile Range, Otero County, New Mexico. Texas Archeological Survey Research Report No. 65. The University of Texas at Austin.

Kidder, A. V. and A. O. Shepard
1936 The Pottery of Pecos, Vol. II. Papers of the Phillips Academy Southwestern Expedition, No. 7. New Haven.

Kottlowski, F. E.
1958 Geological History of the Rio Grande Near El Paso. West Texas Geological Society Guidebook, 1959 Field Trip, Franklin and Hueco Mountains, Texas.

La Marche, V. C., Jr.
1973 Holocene Climatic Variations Inferred from Treeline Fluctuations in the White Mountains, California. Quaternary Research 3:632-60.
1974 Paleoclimatic Inferences from Long Tree-Ring Records. Science 183(4129):1043-48.

LeBlanc, Steven A.
1976 Mimbres Archeological Center: Preliminary Report of the Second Season of Excavation 1975. Journal of New World Archaeology, Vol. 1, No. 6. Institute of Archaeology, University of California, Los Angeles.

Lee, Richard B.
1969 !Kung Bushman Subsistence: An Input-Output Analysis *In* Environment and Cultural Behavior, ed. by Andrew P. Vayda, pp. 47-49. The University of Texas Press, Austin.

Lee, Richard B., and Irven Devore, eds.
1968 Man The Hunter. Aldine, Chicago.

Lehmer, D. J.
1948 The Jornada Branch of the Mogollon. University of Arizona Social Science Bulletin 17. Tucson.

Lynn, Warren M.
1976 Archeological Testing at the Northeast Sewage Treatment Plant, El Paso County, Texas. Archeological Survey Report No. 15. Texas Historical Commission, Austin.

Lynn, Warren M., and Barbara J. Baskin
1975 An Archeological Reconnaissance of Public Free School Lands, Tally Ranch, Hudspeth County, Texas. Archeological Survey Report No. 14. General Land Office and Texas Historical Commission, Austin.

Lynn, Warren M., Barbara J. Baskin, and William R. Hudson, Jr.
1975 A Preliminary Archeological Reconnaissance of Selected Public Free School Lands in El Paso County, Texas. Archeological Survey Report No. 13. General Land Office and Texas Historical Commission. Austin.

MacNeish, Richard S.
1958 Preliminary Archaeological Investigations in the Sierra de Tamaulipas, Mexico. Transactions of the American Philosophical Society, Vol. 48, Part 6. The American Philosophical Society, Philadelphia.

MacNeish, R. S., Nelken-Terner, A., and I. W. Johnson
1967 Non-Ceramic Artifacts. *In* The Prehistory of the Tehuacan Valley, Vol. 2, ed. by D. S. Byers. University of Texas Press, Austin.

Maker, H. J., R. E. Neher, P. H. Derr, and J. U. Anderson
1971 Soil Classifications and Land Classification for Irrigation, Dona Ana County, New Mexico. Agricultural Experiment Station Research Report 183. New Mexico State University, Las Cruces.

Marmaduke, W. S.
1978 Prehistoric Culture in Trans-Pecos Texas: An Ecological Explanation. Ph.D. Dissertation. The University of Texas at Austin.

Marshall, M. P.
1973 Background Information on the Jornada Culture Area. *In* Technical Manual: 1973 Survey of the Tularosa Basin: The Research Design. Human Systems Research, Inc. Albuquerque.

Martin, P. S.
1963 The Last 10,000 Years, A Fossil Pollen Record of the American Southwest. University of Arizona Press, Tucson.

Martin, P. S., and P. J. Mehringer, Jr.
1965 Pleistocene Pollen Analysis and Biogeography of the Southwest. *In* The Quaternary of the United States, ed. by H. E. Wright and D. G. Frey, pp. 433-51. Princeton University Press.

Martin, Paul S., and John B. Rinaldo
1950 Sites of the Reserve Phase. Pine Lawn Valley, Western New Mexico. Fieldiana: Anthropology, Vol. 38, No. 3. Chicago Natural History Museum.

Martin, P. S., and J. Schoenwetter
1960 Arizona's Oldest Cornfield. Science 132:33-4.

Matson, Daniel S., and Albert H. Schroeder, eds.
1961 Cordero's Description of the Apache, 1796. New Mexico Historical Review 4:335-36.

McAnulty, W. N.
1967 Geology of the Fusselman Canyon Area, Franklin Mountains, El Paso County, Texas. Masters Thesis. The University of Texas at El Paso.

Mehringer, P. J., Jr.
1967 Pollen Analysis of the Tule Springs Area, Nevada. Nevada State Museum of Anthropology, Paper 13, Part 4. Carson City, Nevada.

Mehringer, P. J., Jr., P. S. Martin, and C. V. Haynes
1967 Murray Springs, A Mid-Post Glacial Pollen Record from Southern Arizona. American Journal of Science 265:786-97.

Mera, H. P.
1933 A Proposed Revision of the Rio Grande Glaze Paint Sequence. Laboratory of Anthropology Technical Series, Bulletin No. 5. Santa Fe.
1936 Reconnaissance and Excavation in Southeast New Mexico. American Anthropological Association, Memoir 51. Lancaster, Penn.

Metcalf, A. L.
1967 Late Quaternary Mollusks of the Rio Grande Valley, Caballo Dam, New Mexico, to El Paso, Texas. Science Series No. 1. Texas Western Press, The University of Texas at El Paso.

Nelson, J. W., L. C. Holmes, and E. C. Eckman
1914 Soil Survey of the Middle Rio Grande, New Mexico. U. S. Bureau of Soils. Washington, D. C.

Nie, Norman H.
1975 SPSS: Statistical Package for the Social Sciences. Second Edition. McGraw-Hill Book Company, N. Y.

O'Laughlin, Thomas C.
n.d.a Archeological Investigations at La Cueva. Fieldnotes, 1974. El Paso Centennial Museum, The University of Texas at El Paso.
n.d.b Three Lakes Pueblo, El Paso County, Texas. Fieldnotes, 1975. El Paso Centennial Museum, The University of Texas at El Paso.
1977a Excavation of Two Caves in the Mountain Zone of Fort Bliss Maneuver Area II. Appendix C. *In* Settlement Patterns of the Eastern Hueco Bolson, by Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 4. The University of Texas at El Paso.
1977b Excavations at the Sandy Bone Site. Awanyu 5(2):11-42. Archaeological Society of New Mexico. Las Cruces.
1978 Modern Flora of the Fort Bliss Maneuver Area I. Appendix G. *In* Settlement Patterns of the Western Hueco Bolson, by Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 6. The University of Texas at El Paso.
1979 Excavations at the Transmountain Campus, El Paso Community College. El Paso County, Texas. El Paso Centennial Museum Publications in Anthropology No. 7. The University of Texas at El Paso.

O'Laughlin, Thomas C., and Rex Crawford
1977 Modern Vegetation of the Survey Area. Appendix D. *In* Settlement Patterns of the Eastern Hueco Bolson, by Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 4. The University of Texas at El Paso.

O'Laughlin, Thomas C., and T. Weber Greiser
1973 Preliminary Field Report on the Findings and Results of the Evaluation of the Cultural and Historical Resources of the Spillway Area of the Range Dam Lying Within the Northgate National Registry Site (EPCM 31:106:3:10) in El Paso, Texas. El Paso Centennial Museum Publications in Anthropology No. 2. The University of Texas at El Paso.

Pennington, Campbell W.
1963 The Tarahumar of Mexico: Their Environment and Material Culture. University of Utah Press, Salt Lake City.
1969 The Tepehuan of Chihuahua: Their Material Culture. University of Utah Press, Salt Lake City.

Peterson, R. T.
1963 A Field Guide to the Birds of Texas and Adjacent States. Hough Mifflin Co., Boston.

Potter, L. D.
1967 Differential Pollen Accumulation in Watertank Sediments and Adjacent Soils. Ecology 48(6):1041-43.

Powers, W. E.
1939 Basin and Shore Features of the Extinct Lake San Agustin, New Mexico. Journal of Geomorphology 2:345-56.

Ralph, E. K., H. N. Michael, and M. C. Han
1973 Radiocarbon Dates and Reality. MASCA Newsletter 9(1):1-20. Applied Science Center for Archaeology, University of Pennsylvania, Philadelphia, Penn.

Robinson, W. J., and J. S. Dean
1969 Tree-Ring Evidence for Climatic Changes in the Prehistoric Southwest from A.D. 1000 to 1200. Annual Report to the National Park Service, Department of the Interior, Washington, D. C.

Russell, Paul
1968 Folsom Complex Near Orogrande, New Mexico. The Artifact 6(2):11-6. El Paso Archaeological Society. El Paso.

Sayles, E. B.
1935 An Archaeological Survey of Texas. Medallion Papers, No. 17. Gila Pueblo, Globe, Arizona.

1936 An Archaeological Survey of Chihuahua, Mexico. Medallion Papers, No. 22. Gila Pueblo, Globe, Arizona.

1945 The San Simon Branch. Excavations at Cave Creek and in the San Simon Valley. I. Material Culture. Medallion Papers 34. Gila Pueblo, Globe, Arizona.

Schaafsma, Curt

n.d. Archaeological Salvage Excavations of the Hatch Site, LA3135. Manuscript, 1964. Museum of New Mexico, Santa Fe.

Schiffer, Michael B.

1976 Behavioral Archeology. Academic Press, N. Y.

Schoenwetter, James

1970 Archaeological Pollen Studies of the Colorado Plateau. American Antiquity 35(1):35-48.

Semenov, S. A.

1964 Prehistoric Technology. Barnes and Noble, London.

Setzler, F. M.

1935 A Prehistoric Cave Culture in Southwestern Texas. American Anthropologist 37(1):104-10. Menasha.

Shreve, F.

1942 The Desert Vegetation of North America. Botanical Review 8:195-246.

Silberbauer, George B.

1972 The Gwi Bushmen. *In* Hunters and Gatherers Today, ed. by M. G. Bicchieri, pp. 271-326. Holt, Rinehart and Winston, Inc., N. Y.

Skinner, S. Alan, Paul P. Steed, Jr., and Susan E. Bearden

1974 Prehistory of Milehigh. The Artifact 12(1):1-84. El Paso Archaeological Society. El Paso.

Smith, Ruth D.

1977 Ethnographic Survey of Plant Utilization. Appendix F. *In* Settlement Patterns of the Eastern Hueco Bolson, Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 4. The University of Texas at El Paso.

Smithe, Frank B.

1975 Naturalist's Color Guide. The American Museum of Natural History, N. Y.

Spaulding, W. G.

n.d. Analysis of Pollen from the Las Cruces Arroyo Site, Dona Ana County, New Mexico. Manuscript, 1973. Laboratory of Paleoenvironmental Studies, Department of Geosciences. University of Arizona, Tucson.

Stallings, W. S.

1931 El Paso Polychrome. Laboratory of Anthropology Technical Series, Bulletin No. 3. Santa Fe.

Strain, William S.

1966 Blancan Mammalian Fauna and Pleistocene Formations, Hudspeth County, Texas. Texas Memorial Museum Bulletin 10. Austin.

Sudar-Murphy, Toni, and Karl W. Laumbach

1976 An Archaeological Reconnaissance in West Dona Ana County. Cultural Resources Management Division Report No. 41, Department of Sociology and Anthropology. New Mexico State University, Las Cruces.

Taylor, Walter W.

1966 Archaic Cultures Adjacent to the Northeastern Frontiers of Mesoamerica. *In* Handbook of Middle American Indians, ed. by R. Wauchope, Vol. 4, Archaeological Frontiers and External Connections, pp, 59-94. University of Texas Press, Austin.

Thompson, Marc

1979 A Study of Prehistoric Campsites in Northeast El Paso. Cultural Resources Management Division Report No. 310, Department of Sociology and Anthropology. New Mexico State University, Las Cruces.

U. S. Department of Commerce

1969 Climates of the States, Texas. Climatography of the United States No. 60-41. Washington, D. C.

Van Devender, T. R.

1977 Holocene Woodlands in the Southwestern Deserts. Science 198:183-191.

Van Devender, T. R., and B. L. Everitt

1977 The Latest Pleistocene and Recent Vegetation of Bishop's Cap, South-Central New Mexico. Southwestern Naturalist 22:22-8.

Van Devender, T. R., and David H. Riskind

1979 Late Pleistocene and Early Holocene Plant Remains from Hueco Tanks State Historical Park: The Development of A Refugium. Manuscript, 1978. Department of Geosciences. University of Arizona, Tucson.

Van Devender, T. R., and W. G. Spaulding

1979 Development of Vegetation and Climate in the Southwestern United States. Science 204:701-10.

Van Devender, T. R., and F. M. Wiseman

1977 Preliminary Chronology of Bioenvironmental Changes During the Paleoindian Period in the Monsoonal Southwest. *In* Paleoindian Lifeways. Ed. by E. Johnson. West Texas Museum Association. The Museum Journal 17:13-27. Lubbock.

Van Devender, T. R., and R. D. Worthington

1977 The Herpetofauna of Howell's Ridge Cave and the Paleoecology of the Northwestern Chihuahuan Desert. *In* Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico, ed. by R. H. Wauer and D. H. Riskind, pp. 85-106. National Park Service Transactions and Proceedings Series, No. 3. U. S. Department of Interior.

Way, K. L.

n.d. Franklin Mountains Archeological Reconnaissance Project. Manuscript, 1976. Report prepared for Natural Areas Survey, The University of Texas at Austin. El Paso Centennial Museum, The University of Texas at El Paso.

1979 Results of the 1978 Field Season at Rattlesnake Hill. The Artifact 17(2):1-36. El Paso Archeological Society. El Paso.

Wetterstrom, W. E.

n.d. Analysis of Carbonized Plant Remains. Manuscript, 1979. *In* Special Studies in the Archeology of the Hueco Bolson, by M. E. Whalen. El Paso Centennial Museum, The University of Texas at El Paso.

1978 Plant Remains from Mesilla and El Paso Phase Sites of the Hueco Bolson: A Preliminary Report. Appendix F. *In* Settlement Patterns of the Western Hueco Bolson, by Michael E. Whalen. El Paso Centennial Museum Publications in Anthropology No. 6. The University of Texas at El Paso.

Whalen, M. E.

n.d. Special Studies in the Archeology of the Hueco Bolson. Manuscript, 1979. El Paso Centennial Museum, The University of Texas at El Paso.

1977 Settlement Patterns of the Eastern Hueco Bolson. El Paso Centennial Museum Publications in Anthropology No. 4. The University of Texas at El Paso.

1978 Settlement Patterns of the Western Hueco Bolson. El Paso Centennial Museum Publications in Anthropology No. 6. The University of Texas at El Paso.

1979 Social Organization and Interaction During the Pithouse Period in the Jornada Area. *In* Jornada Mogollon Archaeology, ed. by P. H. Beckett and R. N. Wiseman, pp. 345-58. New Mexico State University, Las Cruces.

Whalen, M. E., and Marc Thompson

n.d. Associated Artifacts. Manuscript, 1979. *In* Special Studies in the Archeology of the Hueco Bolson, by M. E. Whalen. El Paso Centennial Museum, The University of Texas at El Paso.

Wheat, Joe Ben

1955 Mogollon Culture Prior to A.D. 1,000. Memoir Number 10 of the Society for American Archaeology.

Willey, G. R., and Philip Phillips

1958 Method and Theory in American Archaeology. University of Chicago Press, Chicago.

Williams, J. S.

1969 West Slope Arroyo Vegetation of the Franklin Mountains, El Paso, Texas. The Texas Journal of Science, Vol. 22, No. 3. Texas Academy of Science, Austin.

Wilmsen, Edwin N.

1970 Lithic Analysis and Cultural Inference: A Paleoindian Case. Anthropological Papers of the University of Arizona No. 16. Tucson.

Wilson, Ernest W.

1930 Burned Rock Mounds of Southwest Texas. Bulletin 2:59-63. Texas A. heological and Paleontological Society.

Wimberly, Mark

1979 Three Rivers Revisited : Speculation on the Meaning of it All. *In* Mo llon Archaeology, ed. by P. H. Beckett and R. Wiseman, pp. 81-89. New Mexico State Unive ty, Las Cruces.

Wimberly, Mark and Alan Rogers

1977 Archaeological Survey, ree Rivers Drainage, New Mexico: Cultural Su ession: A Case Study. The Artifact 15. El Paso rchaeological Society. El Paso.

Wright, Henry T.

1977 Toward an Explanation o he Origin of the State. *In* Explanation of Preh oric Change, ed. by James N. Hill, pp. 215). University of New Mexico Press, Albuquerq .

Yellen, John E.

1977 Archaeological Approach to the Present, Models for Reconstructing the ast. Academic Press, N. Y.

Yeo, Herbert W.

n.d. Archaeology of the Mesil Valley, New Mexico-Texas. Unpublished Manuscript. El Paso Centennial Museum, The University of Texas at El Paso.

York, J. C., and W. A. Dick-Peddie

1969 Vegetational Changes in Southern New Mexico During the Past Hundred Years. *In* Arid Lands in Perspective, ed. by W. G McGuinnes and B. J. Goldman. University of Arizona Press, Tucson.

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