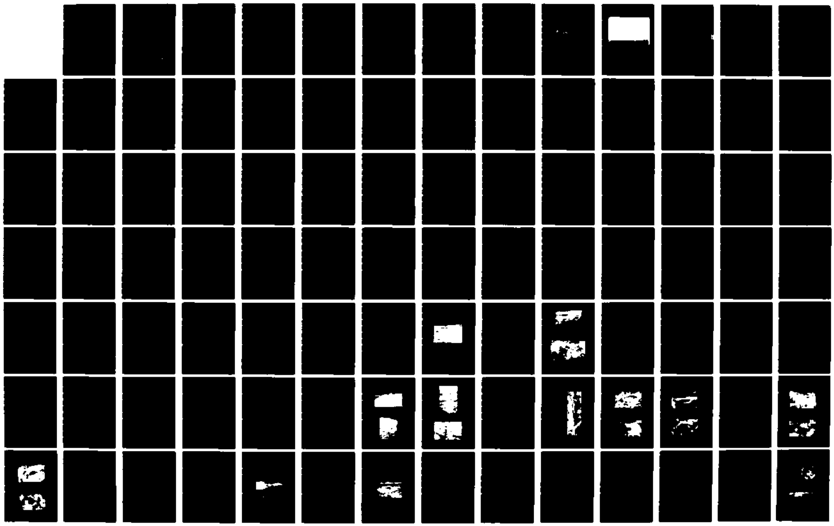
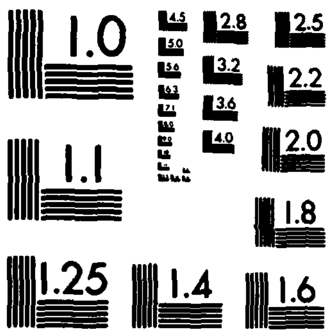
AD-A127 413 THE CERRITO SITE (AR-4): A PIEDRA LUMBRE PHASE SETTLEMENT AT ABIQUIU RESERVOIR(U) SCHOOL OF AMERICAN RESEARCH SANTA FE NM C F SCHAAFSMA NOV 79 1/4

UNCLASSIFIED DACA47-77-C-0046 F/G 8/7 NL





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

THE CERRITO SITE (AR-4)
A PIEDRA LUMBRE PHASE SETTLEMENT
AT ABIQUIU RESERVOIR

by

Curtis F. Schaafsma

Prepared for
U.S. Army Corps of Engineers
Albuquerque District

Submitted by
John D. Beal
Contract Archaeology Program
School of American Research
Santa Fe, New Mexico

ABSTRACT

The Piedra Lumbre Phase is a distinctive historic archaeological complex on the Chama River in Northern New Mexico. This report presents the results of the excavation of AR-4, a Piedra Lumbre Phase Village, and serves as the first comprehensive effort to assign an ethnic identity to the culture group responsible for these archaeological remains. Physical manifestations of the Piedra Lumbre Phase include:

(a) structures of dry-laid stone masonry;

(b) Rio Grande Pueblo pottery;

(c) lithic tools;

(d) limited metal artifacts;

(e) settlement pattern ranging from single masonry structures in isolation to communities with as many as 26 loosely grouped structures; and

(f) evidence of animal (sheep) husbandry.

Speculation prior to the excavation of AR-4 had attributed these remains to Tewa herders working for Spanish colonists, Apaches, Navajos, Utes and/or Genizaros. Two primary goals guided the work at AR-4: (1) accurate and detailed description of the material remains associated with AR-4 and other Piedra Lumbre sites; and (2) determination of the ethnic identity of the group responsible for the Piedra Lumbre Phase. These goals were approached through a variety of analytical procedures including an extensive literature search. From the results of archival investigations, a trait list based on observable archaeological remains was developed for each cultural group which might be responsible for Piedra Lumbre Phase remains. These traits were then compared with the results of archaeological investigations at AR-4.

Archaeological remains from AR-4, when compared with historically derived profiles of known culture groups, indicate Navajo authorship of the Piedra Lumbre Phase. Navajo occupation at AR-4 has been dated between A. D. 1640 and 1710. The Piedra Lumbre Phase may mark a time when Navajos first differentiated from other Apachean peoples, adopted animal husbandry, and experienced substantial changes in social organization. At present the Piedra Lumbre Phase is considered to be the oldest known Navajo archaeological complex.

THE CERRITO SITE (AR-4)
A PIEDRA LUMBRE PHASE SETTLEMENT
AT ABIQUIU RESERVOIR

ERRATA SHEET

p. II - VII. CHRONOLOGY page 223

p. III - VIII.(7th subheading under COMPARISON) Conclusion

p. VII - Figure 128: Micron Values page 233

Map 1 - Salazar Ranch

p.5, 1.9 - candidates

p.5, 1.21 - there seems to be no need

p.5, 1.35 - conversely

p.13, 1.47 - et al.

p.16, 1.6 - tend

p.16, 1.24 - four-wing saltbush

p.16, 1.36 - big sagebrush (Artemisia tridentata)

p.17, 1.27 - kestrels

p.18, 1.28 - (Artemisia)

p.18, 1.35 - after present today. insert This is the writer's inference and not that of Schoenwetter.

p.26, 1.18 - ("Rancherias")

p.27, 1.23 - Duke of Alburquerque

p.28, 1.32 - after 1709. insert The pertinent section from the translation gratefully provided to the writer by David Brugge is repeated here:

p.29 - Please note the correct spellings for the following names:

Oñate

La Cañada

Cañones

Martìn

p.30, 1.26 - down to farm

p.30, 1.27 - Hispanicized

p.30, 1.29 - prerogatives

p.32, 1.8 - grazed

p.32, 1.13 - and a new range

p.32, 1.16 - San Jaquin

p.33, 1.31 - Utes

p.34, 1.27 - Utes

p.37, 1.34 - bedrock

p.49, 1.11 - artifactual

p.51, 1.36 - artifactual

p.62, 1.18 - removed as level 1

p.63, 1.6 - (Figs. 23 and 24)

p.67. 1.26 - four-wing saltbush

p.70, 1.21 - roof's

p.71, 1.21 - buildup

p.77, Fig. 32, 1.1 - in situ

p.80, 1.5 - about a 10-centimeter

p.88, 1.22 - (Figs. 43 and 44)

p.105, 1.36 - "soil chemistry"

p.116, 1.44 - found

p.121, 1.24 - boulders

p.122, 1.9 - (Fig. 67)

p.137, 1.4 - discussion

p.138, 1.19 - varieties

p.140, 1.3 - suggests

p.142, 1.3 - indeterminate

p.143, 1.10 - arkosic

p.143, 1.42 - vessel shapes

p.143, 1.48 - delete (Fig. 22)

p.144, 1.8 - sericite

p.144, 1.10 - (Fig. 82)

p.145, 1.4 - (Ellis 1964:36)

p.146, 1.37 - designs

p.147, 1.5 - after Watson Smith insert (1979, personal communication).

p.147, 1.7 - ca.

p.147, 1.9 - as a late

p.147, 1.14 - contexts (1979, personal communication).

p.148, 1.39 - Reconnaissance

p.149, Fig. 73, 1.5 - Arkosic

p.166. 1.11 - (or variables)

p.166, 1.27 - identifications

p.166, 1.33 - Pedernal

p.167, 1.13 - Pedernal

p.167, 1.41 - intrasite

p.167, 1.49 - Archaic

p.171, 1.51 - 11 tools

p.172, 1.1 - flakes (5)

p.172, 1.2 - Spokeshaves commonly appear as secondary or tertiary wear modifications

p.172, 1.4 - that have such notches

p.172, 1.38 - Pedernal

p.174, 1.24-26 - An interesting test of the idea, that the presence of certain material types on archaeological sites reflects pan-cultural patterns of lithic selection,

p.174, 1.28 - after proportionally insert (see discussions on pages 140 and 167) in

p.184, Fig. 104 - insert See Figure 102 for stage code.

p.185, Fig. 105 - insert See Figure 102 for stage code.

p.191, 1.19 - contemporaneity

p.192, 1.20 - of these has also

p.192, 1.33 - slightly

p.192, 1.39 - polished

p.196, 1.24 - excavations

p.196, 1.40 - intrasite

p.197, 1.20-22 - The coded data for 25 of the 26 projectile points in the study are presented in Figure 116 (data for Point 26 are not presented in Fig. 116).

p.197, 1.37 - (Figs. 116a - 118)

N.B. See attached sheet for Figure 116a, which would follow Figure 116.

p.197, 1.39 - Figure 116a.

p.198, 1.16 - (Figs. 117 and 118)

p.199, 1.40 - 120). The same

p.200, 1.6 - the data

p.200, 1.15 - Piedra Lumbre c

p.201, 1.12-15 - It is this variability that allows Piedra Lumbre points to look like Pueblo points on the one hand and Basketmaker II points on the other.

p.201, 1.16 - Point 26 (Fig. 116a)

p.201, 1.17 - (Fig. 116a)

p.201, 1.45 - (Point 12, Fig. 117)

p.202, 1.37 - Feature L (Point 26, Fig. 116a)

p.202, 1.42 - Lumbre c

p.214, 1.38 - millimeters

p.214, 1.40 - millimeters

p.216, 1.1 - Pedernal

p.216, 1.2 - Pedernal

p.216, 1.50 - Pedernal

p.218, 1.41 - "fulgurites"

p.220, 1.33 - after Appendix C. insert The bulk of Sjoberg's analysis (pages 270-298) does not pertain to the present study but is included as it was submitted in the National Park Service study because it contains supplementary information needed to assess his data, and in some cases, basic AR-4 information is incorporated into the NPS study.

p.225, 1.37 - (Damon et al.

p.226, 1.31 - empirically

p.230, 1.24 - specimen

p.231, 1.3 - (Fig. 128)

p.231, 1.10 - contemporaneity

p.235, 1.9 - Siliceous

p.235, 1.14-16 - were found. A single piece of glass is from the surface near Feature E.

p.235, 1.19 - 1976). It can be disregarded.

p.250, 1.17 - would indicate an early stage of Navajo culture.

p.250, 1.34-37 - Near East. This model proposes a direct relationship between nomadic pastoralism and irrigation agricultural systems, an increased carrying capacity due to the combination of pastoral and agricultural activity

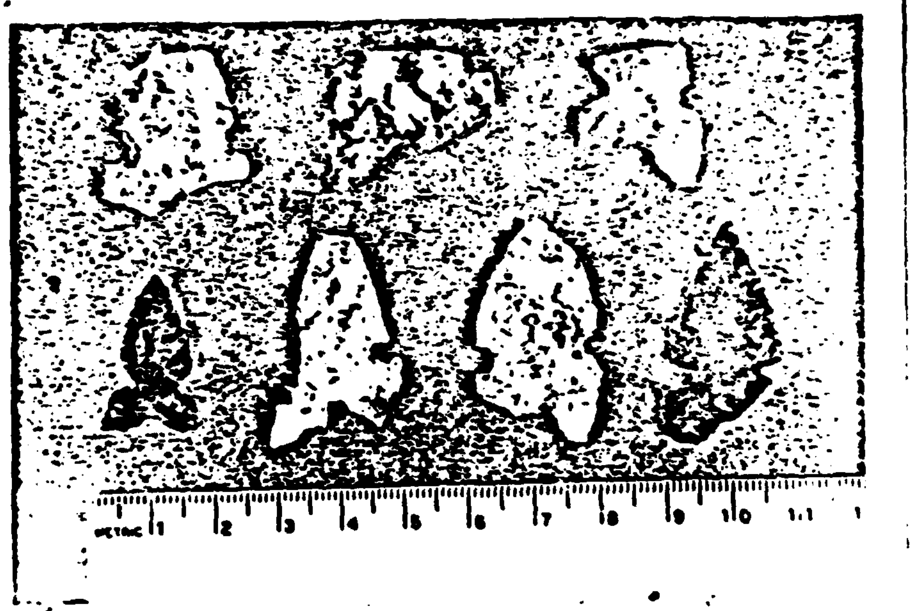
p.250, 1.41-43 - It is suggested that the early Navajos may have adopted elements of pastoral economy as a result of Pueblos controlling agricultural lands.

p.250, 1.46-47 - competition. It is hypothesized that this form of complementary economic specialization between two groups

p.251, 1.11-13 - should attempt to trace the processes which relate to the formation of Navajo culture.

p.266, 1.35 - Artemisia

Figure 116a - Piedra Lumbre Phase Points from the Phase III Survey (see Schaafsma 1976:Fig. 43).



d - Point 26 from Feature L, Grid G, level 1.

The remaining five points are discussed on pages 152-154 in Schaafsma 1976. Three of these points came from the surface of AR-133 excavated in 1979 by Florence Ellis.

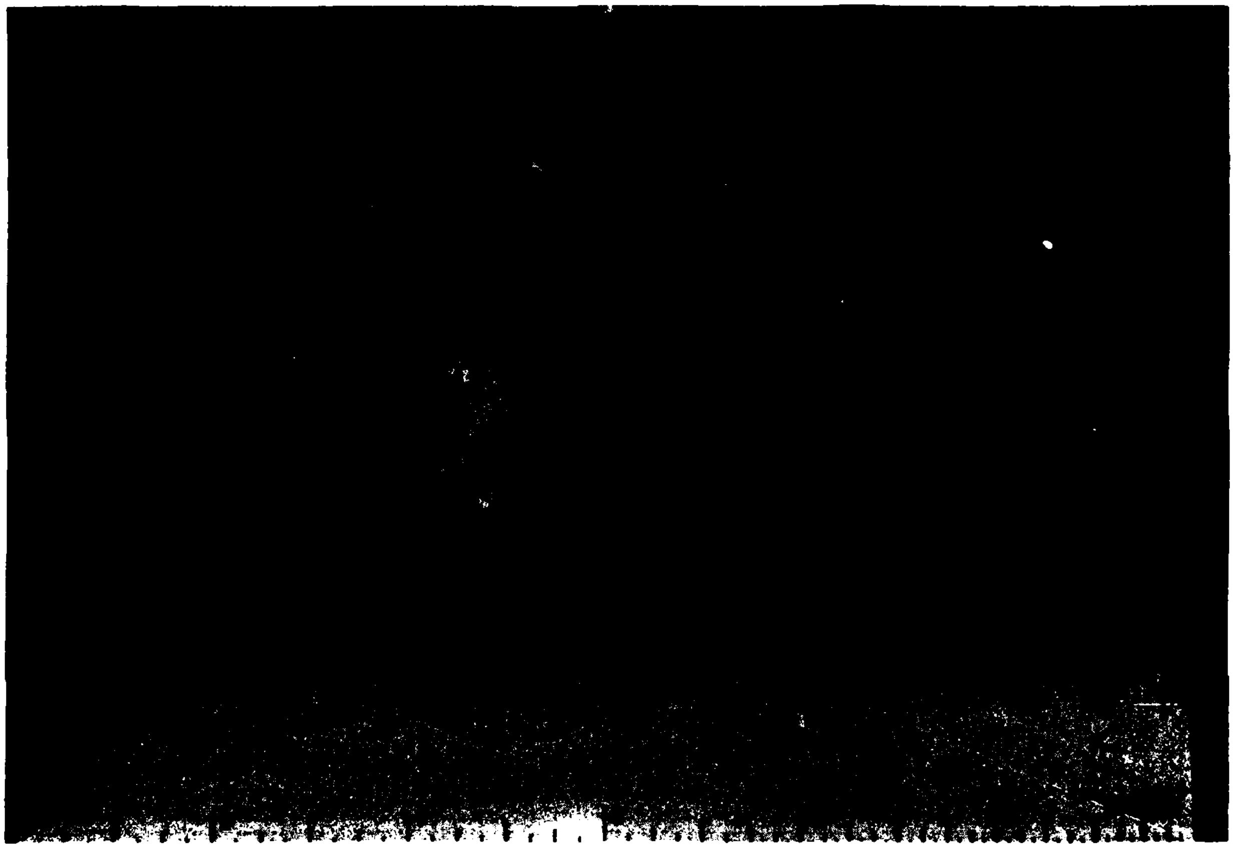


Figure 116a: Piedra Lumbre Phase Points from the Phase III Survey (see Schaafsma 1976: Fig. 43).

1

THE CERRITO SITE (AR-4)

A PIEDRA LUMBRE PHASE SETTLEMENT

AT ABIQUIU RESERVOIR

By Curtis F. Schaafsma

Prepared for
U. S. Army Corps of Engineers
Albuquerque District

Submitted by
John D. Beal
Contract Archaeology Program
School of American Research
Santa Fe, New Mexico

NOV 1979

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

LIST OF MAPS AND FIGURES

LIST OF MAPS AND FIGURES (Cont.)

LIST OF MAPS AND FIGURES (Cont.)

LIST OF MAPS AND FIGURES (Cont.)

I. INTRODUCTION

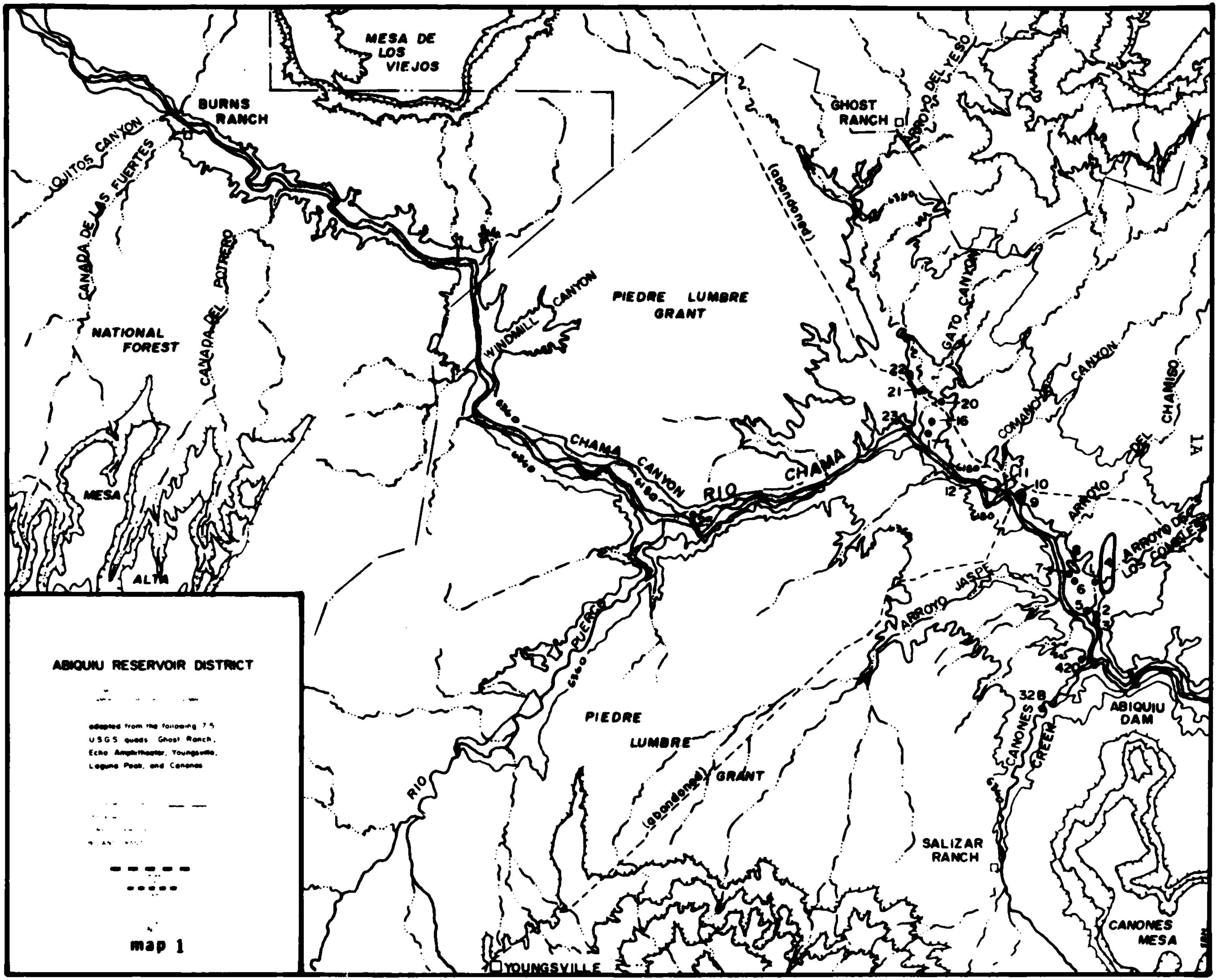
The Cerrito site (AR-4) was one of the first archaeological sites discovered in Abiquiu Reservoir. It was reported to the National Park Service in October 1974, at which time there was a recommendation that it be placed on the National Register. In 1975, it was determined eligible. The site was described in the first survey of the district (Schaafsma 1975b), a special report to the U.S. Army Corps of Engineers (Schaafsma 1975a), and the survey report of the entire reservoir district (Schaafsma 1976). In addition, the writer's summary article on archaeological studies in the district (1978) considered this site in its overall context.

A proposed campground to be built within the Cerrito site led to the present salvage excavation. Since the campground was to cover the whole site, the entire site area was excavated. Subsequently, the campground was not built, but the excavation was completed to mitigate the potential impact on the site resulting from heavy public use of the area. This report is intended to fulfill the requirements of Contract No. DAC47-77-C-0046 between the School of American Research and the Corps of Engineers.

PIEDRA LUMBRE PHASE

The surveys and excavations conducted by the School of American Research in the Piedra Lumbre Valley (Schaafsma 1975b; 1976; 1977) have located 33 sites that belong to a distinctive and heretofore undefined archaeological complex. Some of these sites were described by Hibben in his survey of the Chama Valley (1937:13), but he made no suggestion as to their cultural authorship other than to note that they were "all of late date" (1937:13). It is interesting that he described another type of site as "apparently of Ute or Navajo origin" (1939:13-14). Other than this brief mention, these sites have been ignored by archaeologists and do not appear in regional summaries (Hester 1962; Wendorf and Reed 1955). For purposes here, this archaeological complex will be discussed as the Piedra Lumbre Phase.

Surveys have shown that sites of the Piedra Lumbre Phase occur throughout the approximately 18 square miles of the reservoir district (Map 1) defined by the 6362-foot contour line. In addition, informal adjacent surveys conducted by Mrs. Dart Shibley and John Hayden under the general direction of Dr. Florence Ellis have determined that many other sites of this phase exist in the Piedra Lumbre Valley and vicinity. Within the area surveyed, sites extend along the Chama River from a point near the dam to 20 miles upstream near the Burns Ranch (Map 1) and in the tributary valleys. For the most part, they were built into bluffs above the valleys with the actual structures hidden from the valley floor below. A few, small, possibly farming, sites lie on the first terrace above


MESA DE LOS VIEJOS
BURNS RANCH
OJITOS CANYON
CANADA DE LAS FUERTES
CANADA DEL POTRERO
NATIONAL FOREST
MESA
ALTA
WINDMILL CANYON
PIEDRE LUMBRE GRANT
(abandoned)
GHOST RANCH
ARROYO DEL YESO
GATO CANYON
COMANCHE CANYON
ARROYO DEL CHAMISO
1A
CHAMA CANYON
RIO CHAMA
ARROYO DE LOS COMALES
ARROYO JASPE
RIO PUERCO
PIEDRE LUMBRE GRANT
(abandoned)
SALIZAR RANCH
CANONES CREEK
ABIQUIU DAM
CANONES MESA
YOUNGSVILLE
ABIQUIU RESERVOIR DISTRICT
adapted from the following 7.5 USGS quads: Ghost Ranch, Echo Amphitheater, Youngsville, Laguna Peak, and Canones
map 1

the river. As Hibben observed, the sites are characterized by stone-walled structures of dry-laid masonry, built either in the open or against low sandstone ledges. The structures that use a bedrock ledge for one side commonly face south and front on a natural ledge above the canyons. There is a definite choice of situation.

More than 80 separate structures were observed on survey. Previous limited excavations at AR-3 (Schaafsma 1975b), AR-4 (Features L and M) (Schaafsma 1976), AR-513 (1976) and AR 32 B (Schaafsma 1977) have shown that some of these structures are dwellings and that others are animal pens. The pens have layers of manure and bones of domestic sheep, goats, and wild animals. Charred beans and manos indicate the practice of agriculture (Schaafsma 1976). The sites with masonry structures can be classified either as single unit (presumably single-family habitations), multiple unit with 2 or 3 habitation structures and related secondary structures, or integrated settlements with up to 28 discrete structures. In addition to masonry structures, which are found at 24 sites, there are sherd areas (6), storage cists (2), wall remnants with pottery (2), isolated projectile points (3), and a rockshelter (Schaafsma 1975b; 1976).

The artifacts on these sites are remarkably similar. Ceramics are common on most of them. The pottery types observed on survey or found in previous excavations are Tewa Black, Red or Gray, Tewa Polychrome, micaceous Pueblo utility wares and a plain, sandtempered utility pottery. There is no evidence that the pottery was made locally; all of it appears to be from Tewa villages such as San Juan and Santa Clara or Tiwa villages like Picuris. Previous surveys and excavations produced no glass, manufactured ceramics, or recent metal such as tin cans or buttons. Metal objects were limited to a copper projectile point from AR-513 (Schaafsma 1976). Stone arrowheads relating to this phase are of a basal and side-notched form (Schaafsma 1976: Fig. 43). All sites bear many stone tools: flake knives, scrapers, adzes, choppers, hammerstones, and the work of the culture was accomplished with stone tools. Our previous work showed that, economically, the inhabitants of these sites depended on animal husbandry, agriculture, hunting, and undoubtedly gathered wild plants.

The settlement pattern that is revealed when all 33 sites are considered provides some clues to social organization as well as to spatial dispersion of cultural activities. There are 4 clusters of structures that have been interpreted as villages (AR-4 is one of these). The structures suggest a social organization that allowed the formation of multi-family settlements. The spatial dispersion of these large settlements in the valley may have something to do with the grazing space needed for flocks. Smaller sites throughout the area suggest that there were also social units of 1 to 3 families that were separate from the larger groups. Farming sites are suggested by sherd areas on the terraces above the river, and isolated projectile points indicate hunting in the hills away from the dwellings.

Dating is essential for proper evaluation of these sites. Eleven dendro specimens were recovered from the excavations of 1975 (Schaafsma 1976: 189-90). Only one of these, from Feature D of AR-513 could be dated, producing a reading DR 1817p-1887vv. Other lines of dating (ceramics, architecture, projectile points, stone tools, lack of trade goods, etc.) were at odds with this 1887vv date and suggested instead that the sites dated between ca. 1650 and 1750 (1976). The 1887 date was interpreted as a reuse of the structure, perhaps by a sheep-herder in the late nineteenth century (1976:190). There were no other independent dates for the Piedra Lumbre Phase sites at the time the survey report was written (1976).

THE PROBLEM: ETHNIC IDENTITY OF THE PIEDRA LUMBRE PHASE

The general research problem to be addressed by the excavation and analysis of AR-4 is the determination of ethnic identity for the Piedra Lumbre Phase archaeological complex. Simply put, who lived in these sites? Previous work has demonstrated that the sites clearly date after A.D. 1600 (determined by ceramics and the presence of animal husbandry). They thus would fall in the protohistoric and/or historic period and an identification in terms of modern ethnic groups seems highly possible.

It has previously been proposed that the sites derive from the historically documented Navajo occupation of the Piedra Lumbre Valley (Schaafsma 1975a; 1976; 1978). This interpretation has been offered because it concurred most reasonably with the available archaeological information. Several alternative interpretations, however, have been offered by other archaeologists (Schroeder: personal communication; Brugge: personal communication), and the independent dating of the sites was insufficient to solve the problem. In addition to the need for adequate, independent dating, it was essential to have a better understanding of the nature of the structures, artifacts, economic practices, and so forth than was available following the surveys and earlier limited excavations.

The excavation and analysis of AR-4 was needed to clarify some of these problems. Previous survey work had established that this was one of the largest of the village-like sites in the district. Only AR-33 has a greater concentration of structures (Schaafsma 1976). Site AR-4 had been tested in 1975 and 2 features (Features L and M) yielded abundant materials in the form of ceramics, lithics, and bones; but, unfortunately, no datable dendrochronology specimens. The wide variety of features observable from surface remains (Schaafsma 1975a; 1976) indicated that several types of dwellings were present.

Other remains indicated the presence of several types of animal-tending facilities. Given the amount of fill present in several structures (Features B and D in particular), it seemed likely that excellent material for deriving the needed dates would be found.

The quest for solutions to the problem of the ethnicity of the Piedra Lumbre Phase determined to a large extent what aspects of the archaeological materials recovered from the site would be intensively addressed in this report, as well as which materials would be selected for outside analysis.

METHOD

Heretofore, the question of the ethnic identity of the Piedra Lumbre Phase had been approached in the affirmative manner. That is, the hypothesis was advanced that these are the sites of Navajos described by seventeenth-century Spanish observers. These accounts are well known and clearly indicate that the Navajos were living in the Chama Valley between at least 1598 and about 1710. The verification or refutation of this hypothesis then took the form of comparing the material from the sites with other early Navajo sites and obtaining independent dates that would demonstrate whether or not they were from the time of the records. Testing the hypothesis in this manner required a comparison with other early Navajo archaeological materials (Schaafsma 1975a, 1976) and accurate dates from the sites.

According to Hill, however, "very few propositions can actually be unequivocally confirmed. While we can increase the probability that a particular proposition is better than others, we can rarely reach certainty" (1970:22). Because of this, Hill advised that "the most efficient procedure is to devise tests that are designed to refute each proposition rather than confirm it . . . It is often much easier to demonstrate that a proposition is not valid" (1970:22). He emphasized that:

> ... all conceivably relevant propositions should be considered ... These propositions are then tested, one by one, beginning with the least likely one. Some of them may be discarded immediately, on logical grounds; others may be rejected on the basis of an easily performed test. The investigator may then be left with two or more propositions which cannot, on the basis of presently available evidence, be rejected (1970:22).

Hill's position is well taken, especially since it is grounded in a review of general scientific methodology. Therefore, the basic methodology outlined by Hill will be utilized in the present report.

In this study, a solution to the problem of establishing the ethnicity of the Piedra Lumbre Phase will be sought by considering each of the ethnic groups known to have been present in the Chama Valley during the historic period (since ca. 1600) as potential candidates. Each ethnic group will be treated as a proposition to the effect that each was responsible for the archaeological complex being discussed. Hill observes that there are no specific rules for the development of propositions or hypotheses (1970:21). In the present case, the series of propositions (list of potential condidates) will be derived from the known culture history of the Chama Valley. Selecting the list of possible ethnic groups directly from the list of ethnic groups known to have been in the Chama Valley since about 1600 provides a means to insure that the "propositions will be tested with data that are independent of the data used in generating them in the first place" (Hill 1970:24). The data used to generate them is the established culture history of the Chama Valley which is based upon previous historical (Swadesh 1974) and archaeological knowledge (Mera 1934: Hibben 1937). The initial position is that any of the groups that were in the valley could have been responsible for the sites. On the other hand, there seems no need to expand the list of possible candidates to groups that are not known to have lived in the Chama Valley during this period.

Hill pursues the mechanics of testing propositions:

> First of all, the proposition must be stated so that it is testable -- by reference to empirical data ... a good proposition must have what are called 'test implications' in terms of measurable data ... and these test implications are derived from the proposition itself (1970:22). The test implications for a given proposition actually amount to a listing of all the evidence one would <u>expect</u> to find in the empirical data <u>if</u> in fact the proposition is correct (and conversly, a listing of the kinds of evidence which, if found, would demonstrate it to be false) ... Test implications, then can be considered as synonymous with 'expectations' in the data. They usually take the form of 'If ... then ...' statements ... <u>if</u> the proposition is correct, <u>then</u> one would expect certain data in support of it (1970:23).

The various ethnic groups present during the historic period in the Chama Valley are fairly well-known in terms of the times they were present, the kinds of economic practices they followed, the nature of their social organization, the circumstances under which they were present, the kinds of artifacts they utilized, the kinds of houses they occupied and so forth. In each case, this previous knowledge will serve to generate a series of test implications specific to each group that then can be systematically compared with the archaeological materials. As Hill (1970) suggested, the least likely ones will be considered first.

Given our ability to identify all the ethnic groups that have been in the valley since 1600 by virtue of ample historical documentation, it follows that one of the identified groups must have been responsible for the sites. By the process of elimination it should be possible to arrive at the one group best fitting the archaeological data, and, therefore, the most likely candidate for the authorship of the sites.

RESEARCH DESIGN

To obtain data needed to seek a solution to the problem of ethnic identity of the Piedra Lumbre Phase and to provide an empirical base against which the various proposed ethnic groups can be compared, it was essential to have a governing research design. This research design influenced the manner in which the site was excavated and determined the kinds of analyses that were performed with the recovered archaeological materials. The research design emerged as a means to seek data that would bear on the question of ethnic identity.

While the research problem being discussed was the focus of the current project, it must be recalled that this was also a salvage project intended to mitigate the impact on the site of a proposed campground as well as heavy public use of the area. Accordingly, the researcher was not free to merely select those aspects of the archaeological record that would address the problem and leave the rest intact. To paraphrase Hill, in salvage archaeology it is necessary to collect a great deal of "data" that are not relevant to anything in particular (1970:26). One is not free to pick and choose according to the needs of a preconceived research design. Any salvage excavation has the obligation to collect and adequately preserve certain basic classes of data as well as all ancillary archaeological materials for which we can reasonably anticipate any future usefulness. Lipe has argued that while the salvage archaeologist must concentrate on some problem or set of problems to which the site data apply, he nevertheless ". . . is dealing with sites that are to be destroyed. All that will remain for others to work with are the records and collections he makes. In a very real sense, the salvage archaeologist is also working for the whole profession" (1974:234). In other words, the salvage archaeologist must "attempt to collect representative samples of all types of data the significance of which he is aware" (1974:234). "And, if possible, he has to outguess the data demands of the as-yet-undefined problems of the future" (1974:234).

It was the goal of the field procedures to adequately recover the archaeological materials at the site as well as the contextual information that relates these materials to their proveniences. Consistent with Lipe's discussion, all classes of archaeological remains for which there are presently any relevance were collected and recorded. In certain cases, sampling strategies were employed (as with surface lithic areas); but, in general, a total recovery was the goal. These materials and the site records are stored at the School of American Research.

As Lipe has stated (1974), it is impossible to examine in depth all the material recovered from a site. This is particularly true of outside analyses. Selection of what materials to analyze must be guided by an overall research design which focuses on some problem or set of problems that can be addressed with the excavated materials. The need for critical selection that conforms with some research problem is the inevitable result of funding limitations and the cost of various analyses. The present study presents the results of analyzing those aspects of the materials from the site that potentially can inform on the question of the ethnic identity of the site. The materials and information not discussed here are available for future research.

Dating. Deriving independent dates for the Piedra Lumbre Phase is an essential aspect of this study. It seemed highly likely that materials for this purpose would be recovered from AR-4. Since the culture history of the Chama Valley after 1600 is quite well-known (see Chapter III; Culture History), a major aspect of determining the ethnic identity consists of placing the sites in their proper temporal framework. It also was recognized at the outset that dating would be most reliable if based upon the results of several independent methods. As discussed in the chronology section, materials were collected for dendrochronology, carbon-14, alpha-recoil track, obsidian hydration, and archaeomagnetism.

Economics. Since the economic practices of the various ethnic groups known to have been in the valley are fairly well-known, it was essential to have the best knowledge possible of the economic practices of the inhabitants of AR-4. This was addressed through pollen analysis, soil chemical analysis, a previous faunal analysis, a partial flotation analysis, a detailed discussion of the architectural clues to economic behavior and an in-depth analysis of the lithics.

Architecture. The fullest possible knowledge of the range of architectural types was needed to evaluate the question of ethnicity. Certain groups present in the Chama Valley are well-known in terms of their architecture; others are not. Nevertheless, the kinds of dwellings and ancillary structures are a major insight as to whom the inhabitants of the site might have been. In addition to describing and examining the various architectural forms it was desirable to understand the function of these various forms. The emphasis on economic variability in pollen analysis, complemented by soil chemistry analysis, was intended to address the question of function. Similarly, the interfeature comparison of ceramics and lithics is intended to produce information regarding the functions of different structures.

Settlement Pattern and Inferred Social Organization. The overall structure of AR-4 is summarized in order to define the nature of the settlement when it was occupied. This is based on a combination of information sources derived from the functional interpretations discussed above. It was necessary to determine if this was an integrated village or a casual agglomeration of dwellings. Consistent with this aim, it was necessary to have some idea of whether or not the whole settlement was occupied at one time. If the whole settlement was not occupied at the same time, which structures were likely in use when. The intra-site ceramic comparison and the obsidian hydration study address this question. To adequately discuss the problem of settlement pattern and social organization, it is necessary to consider all the sites in the district. The centralized character of AR-4 can be seen only by viewing it in the overall settlement of the valley. The social organization of many of the groups in the Chama Valley during the historic period, is fairly well-known, either from historic accounts, or by projections from the ethnographic present.

Nature of the Occupation. It was necessary to determine as accurately as possible the nature of the occupation. Was the site a temporary camp, a seasonal camp, or inhabited year-round? Was the site a short-lived, hurried settlement, or occupied for a long time? These questions have a direct bearing on ethnicity. The nature of the occupation is addressed through stratigraphic studies, construction sequences, trash build-up, soil chemistry, pollen analysis, obsidian hydration, ceramic studies, and the pattern of site distribution within the valley. In the valley, it is possible to address the question of what factors appear to have conditioned the settlement pattern. Was it defense, proximity to water or grazing space for flocks? All of these questions inform on the nature of the occupation as inferred from the archaeological remains which aid in turn in assessing ethnicity.

Stylistic Patterns in Artifacts. Many people produce distinctive artifact forms which serve to differentiate them from all other groups. Especially distinctive in this regard are ceramics, projectile points, and finished artifacts. These artifacts are thoroughly reviewed in order to determine which ethnic groups may have been responsible for them.

Distinctive Cultural Practices. Many groups follow distinctive practices which serve to distinguish them from others. For example, Rio Grande Pueblo Indians regularly made petroglyphs in the vicinity of their villages. In addition, Navajos, when they first entered the Southwest, are known to have made very few bone tools (Hester 1962:55). These distinctive practices show up archaeologically as patterns of presences and absences. Taken in aggregate, they often can reveal the ethnicity of an archaeological complex.

ORGANIZATION OF THE STUDY

This report begins with a description of the environment. The discussion demonstrates that there are no factors in the environment which would have prevented the practice of agriculture. The Piedra Lumbre Valley cannot be regarded as a marginal environment. The known culture history of the Piedra Lumbre Valley in particular and the Chama Valley in general is summarized. This is based upon previous work done by the School of American Research and other investigators. The period after A.D. 1600 is given particular emphasis. The archaeological materials from the site are described in Chapter V. All of the structures, artifacts, and environmental aspects are described without reference to ethnicity. The chronology (Chapter VII) is based entirely upon internal evidence or cross-dating from known periods. Following the descriptive data, there is a summary of the whole site based upon the results of the various analyses. The lifeway of the site inhabitants is reconstructed in this section, based upon data in the site and in the district. Once the site is adequately described and dated, the various ethnic groups delineated in the culture history (Chapter III) can be compared with the archaeological complex revealed by the excavation and analysis. Any necessary information derived from the other excavations in the district and the survey of the district will be incorporated into this discussion. After this comparison, an evaluation will be made as to which ethnic group was most likely to have lived in the sites. There will be a discussion of the ways in which this archaeological complex will expand our knowledge of the ethnic group considered most likely to have occupied the sites. There are many more sites remaining in the valley that never have been excavated or analyzed in any way. The results of this study indicate directions for future work on this subject as well as future work in the region.

PERSONNEL AND ACKNOWLEDGMENT

Principal Investigator for the project was Douglas W. Schwartz, director of the school. Administration of the grant and negotiations with the Corps of Engineers was handled by John Beal, administrator of the Contract Program at the school. Project Director was Curtis F. Schaafsma, who also wrote this report. The crew chiefs were Richard Lang, Jane Whitmore, and Steven Horvath. Crew members were Audrey Hobler, Meg Goldberg, Paul Hoylen, David Anderson, Oliver McCrary, Lori Wolf, Tim Maxwell, Michele Binder, Michael Marshal, and John Frissel. The fieldwork was done between August 15 and September 7, 1977 Laboratory observations were done by Jane Whitmore and Tim Maxwell under the direction of the writer.

Several persons contributed directly or indirectly to the present archaeological investigations. Donna Roxey arranged the contract for the Corps and provided much appreciated advice on the conduct of the project. Mr. Lyman Reynolds, supervisor of Abiquiu Dam, assisted in many ways and maintained a constant interest in the archaeological activities at the site. Mr. Joseph

Branch allowed us to cross his private land to obtain access to a detached part of the site. David Brugge, from Region Three of the National Park Service, read sections of the report and provided advice that was greatly appreciated.

Several persons assisted in the preparation of the report. David Noble of the School did the photographs; Susan Hunter did the drafting. Computer programming was done by Rocky Chasko at the University of New Mexico; editing of the report was done by Jane Whitmore and Malinda Elliott; and the manuscript was typed by Mary Day. Mr. Al Schroeder and Mr. Dave Brugge reviewed the manuscript at various stages and made valuable contributions. The assistance of these people is gratefully acknowledged. The responsibility for any errors or inadequacies rests with the author.

II. ENVIRONMENT

LOCATION

The Cerrito site (AR-4) is located in the Piedra Lumbre Valley of north central New Mexico. The Chama River flows through this valley from northwest to southeast (Map 1). Abiquiu Dam is situated 1 mile south of the site in a narrow, steep-walled canyon that was known to the early Spaniards as the "Embudo de la Piedra Lumbre". The dam was built and is maintained by the U.S. Army Corps of Engineers, Albuquerque District. The reservoir, defined by the maximum flood pool (6362 contour) behind Abiquiu Dam, has been referred to as the Abiquiu Reservoir Archaeological District. The Cerrito site and the dam are approximately 7 miles northwest of the community of Abiquiu via U.S. Highway 84 and State Highway 96. Santa Fe is approximately 60 miles to the southeast.

The center of the site is at longitude 106° 25'45", latitude 36° 15'20" (Map 1). The central part of the Cerrito site lies along the bluffs above the Chama to the north and south of Arroyo de Comales (Map 2). The narrow, steep-walled canyon, formed where Arroyo de Comales cuts through the bluffs, approximately bisects the site. Another steep canyon lies to the south of Arroyo de Comales (Map 2, see map pocket). Beginning at the arroyo south of Comales Canyon, the site extends about .5 mile to the north. Site limits were established by the distribution of structures and related features. The site limits on the east closely follow the boundary marked by the fence along the Corps of Engineers' land. The west side of the site is defined by the steep sandstone bluffs above the Chama (Map 2).

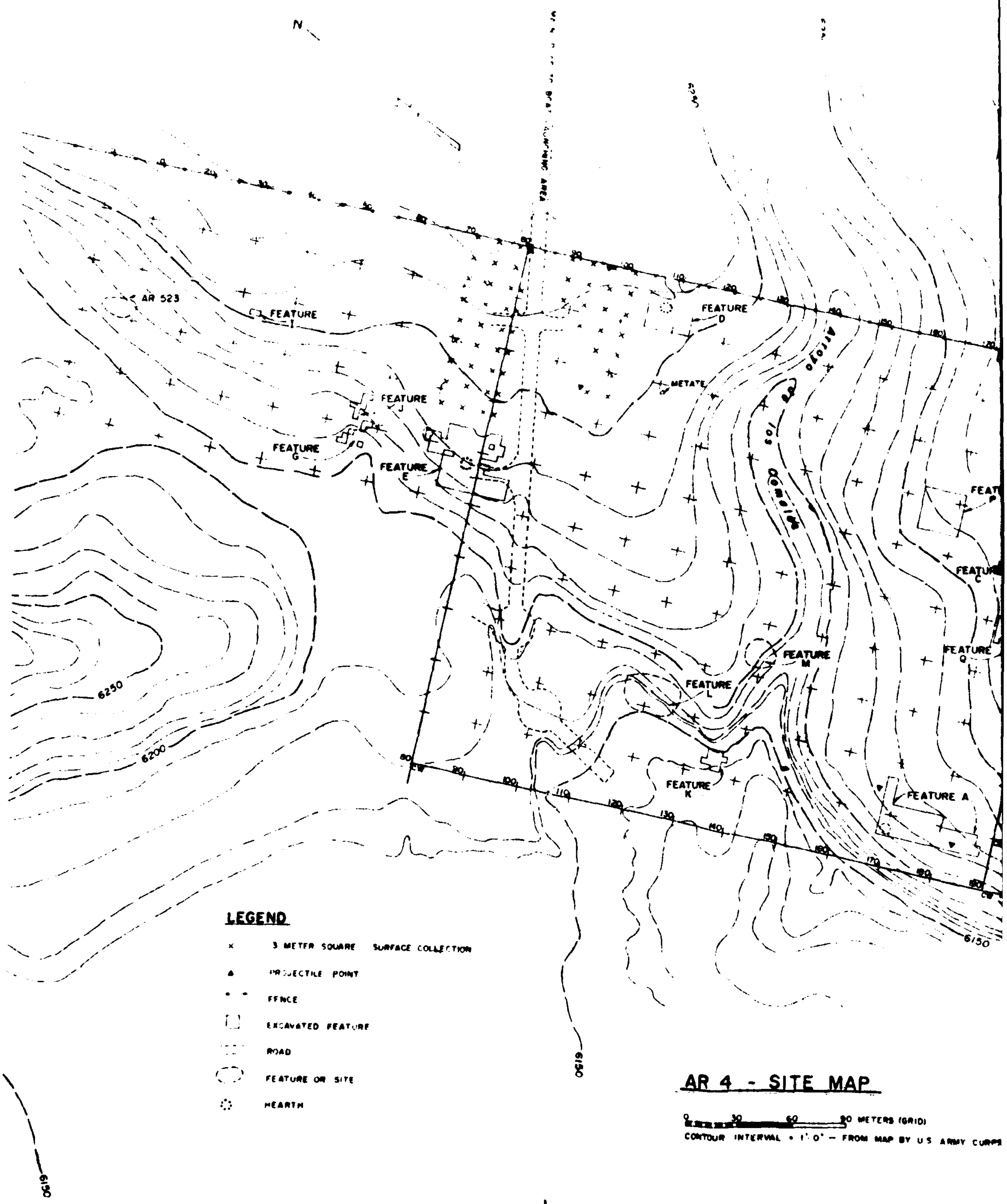
GEOLOGY

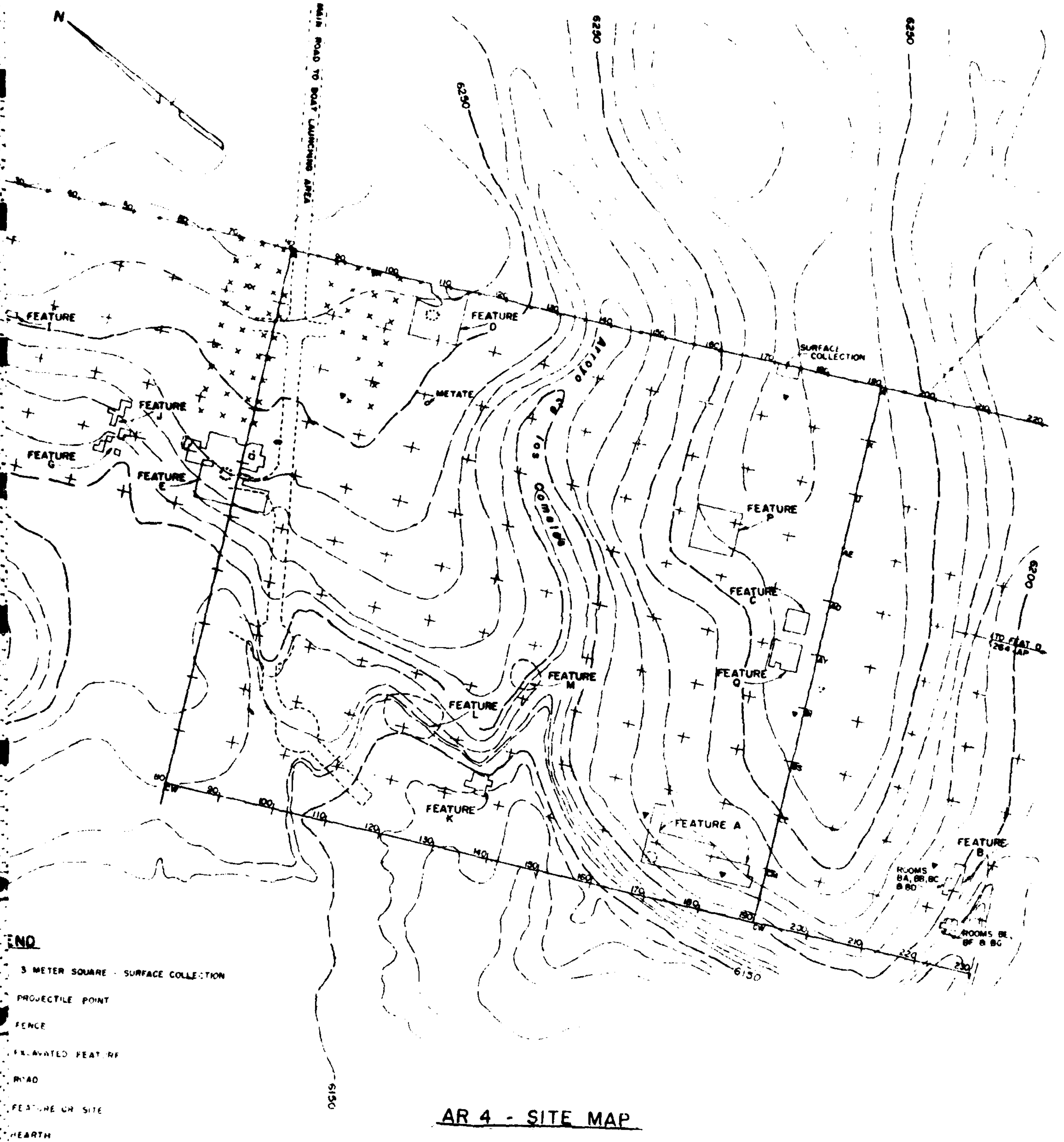
The Piedra Lumbre Valley is the easternmost geologic expression of the colorful formations and land forms that characterize the Colorado Plateau to the west and northwest. The area is composed of massive uplifts of Paleozoic, Mesozoic, and Tertiary formations. Subsequent erosion of these formations has created the valley itself as well as the canyons, badlands, and eroded cliffs that make the valley scenically spectacular. In addition to the uplifted sedimentary strata, the Jemez Mountains on the south side of the valley represent considerable igneous activity which took place during the late Tertiary.

The geology of the area is briefly summarized in the Corps of Engineers' <u>Master Plan</u> (1976:23-25), which contains a useful geological cross-section of the local strata. This cross-section reveals that the lowest formation is the Cutler formation of Permian Age which is a conspicuous formation of sandstone and shale of brick-red to purplish colors. The Cutler formation has eroded into complex spires and badlands in the lower reaches of the Rio Puerco and the middle of the Chama Canyon near the Rio Puerco (Map 1). Resting unconformably on the Cutler formation is the Poleo sandstone member of the Triassic Chinle formation. This stable formation has resisted erosion in most of the valley and forms much of the floor of the central valley as well as the bluffs along the Chama River. The sandstone bluffs at the Cerrito site are Poleo sandstone. As in the Painted Desert of Arizona, the upper part of the Chinle formation consists of varicolored shales. The erosion of these shales has resulted in the badlands so prominent near relocated U.S. Highway 84 in the vicinity of Ghost Ranch. Much of this formation, however, has been removed from the valley by erosion. The remainder of the Mesozoic formations has been eroded completely from the valley and is evident in the colorful cliffs around the valley's perimeter. The most prominent cliffs are composed of Entrada sandstone of the Jurassic Age; and, above this, there are formations of Todilto sandstone, also of the Jurassic Age. The many-colored shales of the Jurassic-Morrison can be seen in the high cliffs above the Entrada sandstone, above which outcrops the Dakota formation of Cretaceous Age. This hard sandstone caps the majority of the mesas on the western through northern arc of the valley, including Mesa Alta on the west, Mesa de los Viejos on the north, and Mesa Montosa on the northeast. Above this formation, Mancos shale forms the rolling country found to the north.

During the Miocene and Pliocene Ages, the strata described above were uplifted and folded in relation to the formation of the Rio Grande Depression (Corps of Engineers 1976:23). The Chama River in the vicinity of the site, roughly between the mouth of Arroyo Seco and the dam (Map 1), flows through a trough or syncline formed in the underlying formations. A notable topographic feature formed by normal faults in this area is a large fault block of the Poleo member that is uplifted between Arroyo Seco and a large fault near the dam (Church and Hack 1939:617). The Cerrito site is situated on the western edge of this block.

Since the uplifting and faulting that took place during the Miocene and Pliocene, the area has been variously eroded and aggraded, and several distinct physiographic features have been formed. As noted, the Mesozoic formations have been largely eroded from the center of the valley leaving the Poleo member as a cap over the Cutler formation in most areas. The contours of this hard sandstone define much of the topography in the present valley. Overlying this formation are at least 3 separate terraces of river gravels which presumably represent aggradation during the Pleistocene. The first terrace, and presumably youngest, is the gravel and loam deposit on the benches above the Chama and downstream from Arroyo Seco. It is equivalent to the "Fernando Loam" described by the Corps of Engineers (1976:26). The second terrace is a distinct topographic feature in the lower reservoir. The Cerrito site is situated at the edge of this terrace. The third and oldest terrace is the actual floor of the Piedra Lumbre Valley and


N
AR 523
FEATURE I
FEATURE D
METATE
FEATURE J
FEATURE G
FEATURE E
Arroyo de los Comales
FEATURE C
FEATURE M
FEATURE L
FEATURE Q
FEATURE K
FEATURE A
6250
6200
6150
LEGEND
3 METER SQUARE SURFACE COLLECTION
PROJECTILE POINT
FENCE
EXCAVATED FEATURE
ROAD
FEATURE OR SITE
HEARTH
AR 4 - SITE MAP
0 30 60 90 METERS (GRID)
CONTOUR INTERVAL = 1'0" — FROM MAP BY U.S. ARMY CORPS



AR 4 - SITE MAP

0 30 60 90 METERS

CONTOUR INTERVAL ... FROM MAP BY U.S. ARMY CORPS OF ENGINEERS generally is at elevation 6340 feet near the Chama Canyon (Map 1).

CLIMATE

Climatological information is based primarily upon two sources, the summary given in the Corps of Engineers' Master Plan (1976) and the study of the climate of New Mexico published by the State Planning Office (1969). The summary given by the Corps is:

> The climate of the area is essentially semiarid. Fairly hot summers in the lower elevations are accompanied by large diurnal ranges in temperature throughout the Rio Chama Basin. The winters are moderate to cold at Abiquiu. Winter usually lasts from early October to late April. According to U.S. Weather Bureau figures, the average daily temperature in summer is 73 degrees and is 35 degrees in winter, with an average yearly high of 96 degrees and an average yearly low of 2 degrees. According to U.S. Weather Bureau figures the average annual precipitation over the last ten years at Abiquiu has been approximately 9.70 inches. Thunderstorms are most active in July and August and reach a peak in mid to late afternoon and are often accompanied by heavy showers and high surface winds (1976:10).

While the Corps states that the average rainfall at Abiquiu has been 9.70 inches, the State Planning Office map of average annual precipitation for New Mexico (1969: Fig. 2) shows the reservoir district lying between the isohyet intervals for 12 and 14 inches, implying that the rainfall in the area would range between these limits, increasing as one moves upriver. Thus, to give a general picture of rainfall in the reservoir district, it can be stated that in the lower elevations near the dam and not far from Abiquiu the average yearly precipitation would be about 10 inches, increasing upstream to a yearly average of around 13 inches in the upper reservoir areas. This gradient is reflected in the vegetation which, at an elevation of 6360 feet near the dam, consists mostly of low junipers with an admixture of sparse black sage; whereas, at the same elevation in the upper reservoir, there is a nearly even mixture of junipers and pinons and a dense stand of the more succulent big sage. In part, this precipitation gradient reflects orographic effects resulting from proximity to the high mesas (Mesa Alta and Mesa de los Viejos) in the upper reservoir.

The precipitation regime is dispersed unevenly throughout the year (Tuan et al 1969:20-34). The rainfall dispersion diagrams that Tuan and others present for Taos and Santa Fe can be used to depict approximate conditions in the Piedra Lumbre Valley. In both diagrams, it is clear that the greatest portion of the yearly precipitation occurs during the summer rainy season from May through September (1969: Fig. 3). Perhaps even more representative of conditions in the Piedra Lumbre Valley is the yearly pattern of precipitation recorded for Jemez Springs on the southwest side of the Jemez Mountains. Most of the precipitation at Jemez Springs accumulates in August with the majority of the yearly total occurring in the 4 summer months of June, July, August, and September (1969: Fig. 3). The pronounced dry season in the midwinter months of November, December, January and February at Jemez Springs is also representative of the Piedra Lumbre Valley climate.

In addition to precipitation variability within the year, there is wide variability between years. "A fact of common experience in New Mexico is that over the years precipitation fluctuates widely about the mean" (Tuan et al. 1969:50). The nature of this variability between years can be observed in the graph of deviations in precipitation from the mean for Santa Fe (Tuan et al. 1969:52). The warm season graph shows that the yearly average for this period (May-October) was 9.55 inches. The standard deviation is 2.74 inches indicating that in approximately two-thirds of the years the warm season average would be within a range of $\pm$ 2.74 inches from 9.55 inches, i.e., a usual range of 6.8 to 12.29 inches. A similar pattern of variability exists during the cold season (November-April) but with a lower mean (4.50 inches) and, consequently, a lower standard deviation (1.69 inches).

Temperature, like precipitation, varies from year to year but is generally more stable (Tuan et al. 1969:65). The daily temperature average according to the Corps of Engineers (1976: 10) is 73° F. in summer and 35° in winter with an average yearly high of 96° and an average yearly low of 2°.

In considering the settlement patterns in a locality such as the Piedra Lumbre Valley, the variations caused by insolation differences between north and south facing slopes in a deep valley (Tuan et al. 1969:68), east and west flanks of mountain ranges (1969:68), air drainage (1969:69), and temperature inversions (1969:70), must be taken into account. After reviewing the temperature differences between the shady and sunny sides of Frijoles Canyon in Bandelier National Monument, Tuan et al. (1969:68) conclude that "it is not surprising that ruins of Indian cliff dwellings are concentrated entirely along the base of the sunny north wall." This situation preference can be seen at AR-4 (Map 2), especially at Features B, K, and M.

The Corps of Engineers notes that "winter usually lasts from early October to late April (1976:10). The complementary period from late April to early October is the frost-free season, a length of time that is a critical variable in considering the climate of a locality and its suitability for human habitation, especially with regard to agriculture." A map supplied by Tuan et al. (1969: Fig. 38) of the average number of days without killing frost over the state shows that the Piedra Lumbre Valley lies between the isopleths for seasons of 140 and 160 days. Their map of the average dates of the last killing frost in the spring indicates that this frost occurs in the Piedra Lumbre Valley between April 30 and May 10 (1969: Fig. 39). Similarly, the average dates of the first killing frost in the fall are between September 30 and October 10 (1969: Fig. 40). Given the allowances for local topography and variability in the length of the frost-free season, the normal period of 140 to 160 days allows an ample season for the practice of agriculture. This statement is supported by the fact that the frost-free season in the Piedra Lumbre Valley is very similar in its length and in the dates defining it, to the Navajo Reservoir District where agriculture was practiced (Tuan et al. 1969; Dittert et al. 1961:16). It is also supported by the practice of agriculture by the Spaniards for over 100 years in the vicinity of Abiquiu Dam along the Rio Puerco and Canones Creek. In addition, the length of the frost-free season in the Piedra Lumbre Valley is considerably longer than that of the approximate 120-day period which exists in the mountain valley where Picuris Pueblo is located (Tuan et al. 1969: Fig. 38; Dick 1965:12). A pueblo population has been maintained continuously at Picuris Pueblo since ca. A.D. 1150 (Dick 1965:7). These considerations demonstrate the general suitability of the local climate for agriculture.

FLORA

Plant communities are closely linked to climatic conditions and usually reflect the climatic situation in which they exist. "The differences and similarities in climate from place to place are most notable in natural vegetation. Temperature and moisture conditions are obviously reflected in the vegetation of the deserts, the grasslands, and the mountain forests" (Tuan et al. 1969:158).

The Corps of Engineers' report (1976:31) summarizes the flora of the area, and the observations are repeated here:

> The vegetation on lands in the vicinity of Abiquiu Reservoir trends from short-grass prairie to pinon-juniper woodland depending primarily upon elevation, slope exposure, and soils. The one-seed juniper is fairly prominent on the steeper slopes of the sides of dissected terraces or plateaus. The juniper and pinon pine are both prominent on the shallow, sandy soils of the Santa Fe formation outcroppings and the portion of the foothills of Cerro Pedernal in the southeast corner of the project lands between New Mexico

> State Highway 96 and the project boundary. Ground cover in the areas is very low due to the large lateral root zones of the pinon and juniper...Grasslands on the project lands are typically flat to gentle sloping plains and sandy loam surface soils and clay loam subsoils. Range conditions tends to be only fair with annual cattle forage production dominated by galleta, blue grama, and bottlebrush-squirrel-tail. Broom snakeweed and other shrubs are also present.

(Also see the Corps checklist in Exhibit F (1976).)

The Corps' summary is accurate in emphasizing the predominance of the mixed pinon-juniper woodland and the open grassland prairies in the lower portion of the reservoir. A major change in flora, however, takes place at the entrance to the narrow canyon about 12 miles above the dam. The Corps' report fails to mention the riparian vegetation that formerly existed along the lower Chama and is still found in the upper reservoir and in specialized form along the secondary drainages of the district. This is an essential consideration when dealing with prehistoric settlements.

Stands of low, rounded, one-seed juniper (Juniperus monosperma) dominate the lower valley where the woods consist of an admixture of low pinons (Pinus edulis), black sage (Artemisia sp.), four-wing saltbrush (Atriplex canescens), Narrowleaf yucca (Yucca glauca), and prickly pear (Opuntia whipplei/compressa). This plant community occurs on all of the sloped and broken areas from Arroyo Seco downstream and is the characteristic floral community at the Cerrito site. On the terrace tops and other level areas away from the streams, the woods are replaced by grasslands or open savannah woods where cholla (Opuntia imbricata) is common. In the more broken sandstone-bluff terrain along the Chama Canyon above the Rio Puerco, one-seed juniper is largely replaced by Utah juniper (Juniperus ostersperma). As mentioned above, the ratio of pinon pine to juniper increases in the upper portion of the reservoir district. Above the Rio Puerco the more succulent, big sagebruch (Artemia tridentada) replaces the black sage found downriver and forms dense stands on the terraces and flat areas. In the wetter, wooded areas above the Chama Canyon, broadleaf yucca (Yucca baccata) is commonly found.

The riparian vegetation along the Chama was formerly a significant part of the local biome. For approximately 12 miles above the dam, however, this vegetative area has been destroyed by inundation from the reservoir. Presumably, it was once characterized by dense stands of cottonwoods and willows such as found today below the dam. Riparian vegetation is also found along the permanent or nearly permanent streams of the area. The wide valley of the lower Arroyo Seco supports a dense stand of cottonwoods, willows, and Rocky Mountain juniper; the well-watered valley bottom of Canones Creek above AR-32 supports many cottonwoods, box elders, and thick willow groves.

The field impressions of the plant communities in the Abiquiu Reservoir summarized above indicate that essentially the same plant species and integrated communities exist in this area as were observed in the Navajo Reservoir District. For this reason, the checklist of plants identified in that area (Dittert et al. 1961:33-34) should be consulted for a fuller understanding of the kinds of plants that can be expected in the Piedra Lumbre Valley.

FAUNA

The Corps of Engineers (1976:32) offers the following summary of the fauna of the Abiquiu Reservoir District:

> Wildlife which now utilize the area in moderate numbers include mule deer, antelope, cottontail, muskrat, raccoon, skunk, coyote, badger, mourning dove, and a variety of waterfowl, non-game birds, and small mammals. None of these are abundant except the mourning doves... Most of the rocky slopes and gravelly banks on the project are too unstable to harbor much wildlife. Cliff swallows and swifts nest on the higher rock faces with canyon and rock wrens. Turkey vultures and ravens nest in the ledges of the high rock faces below the dam. Pack rats use these high cliffs as well as the pinon-juniper area. Rock squirrels, least chipmunks and rock wrens use some of the more stable gravelly slopes. The pinon-juniper areas on project lands support mice, brown tohees, house finches and rufous crowned sparrows, and western flycatchers. Owls and kesrels are also found as well as prairie falcons. Meadowlarks, horned larks, and chipping sparrows are found in the more open areas. Raccoon and skunk are also found on the project as well as cottontails. Pronghorn or mule deer could also be present but none were sighted during the survey taken in 1973. Ground squirrels could also be expected.

During the 1975 survey, many of these animals or their tracks were observed. Antelope are known to be fairly common on the llano del vado to the west of Arroyo Seco; beaver were seen along the upper Arroyo Seco; a pair of great blue heron was observed in the silt flats below Arroyo Seco; and ground squirrels were found to be fairly common, especially in the sandstone bluff areas.

Since there is considerable similarity between the environments of the Navajo Reservoir and Abiquiu Reservoir Districts, many of the animals recorded in the intensive environmental surveys of the Navajo Reservoir District can be expected to live in the Piedra Lumbre Valley. An extensive list of mammals, birds, reptiles, and amphibians found in the Navajo Reservoir District can be consulted in the survey report (Dittert et al. 1961:30-32), as well as the expanded list in the two monographs completed (by A. H. Harris) on the vertebrates of that area

(1963a, 1963b). In addition, the checklist of birds prepared by David M. Niles (1963) on that area is representative of the birds that might be found in the Abiquiu area. It should be noted that all the vertebrate species reported by the Corps of Engineers or observed by the Abiquiu survey crew are listed as present in the Navajo Reservoir District. In amplifying the list of animals to be expected in the Abiquiu District on the basis of projections from the Navajo Reservoir District, several species in particular should be mentioned. Mountain lions (Felis concolor), bobcats (Lynx rufus), and black bear (Ursus americanus) are almost certainly present as they were prehistorically. Elk (Cervus canadensis) are present in the higher elevations and would have been available to hunters based in the Piedra Lumbre Valley. Gambel's quail (Lophortyx gambeli) is undoubtedly present as are many of the birds listed by Harris (1963a) and Niles (1963). The Corps reports that seven species of fish are known to inhabit the reservoir: channel catfish, carp, river carpsucker, white sucker, Rio Grande chub, and brown and rainbow trout (1976:32). Several of these are recent introductions.

ENVIRONMENTAL RECONSTRUCTION

The floral environment in the vicinity of AR-4 at the time of its occupation is revealed by the palynological studies conducted by James Schoenwetter (Appendix A). Plant types identified through pollen analysis consist of: spruce (Picea), pinon (Pinus edulis), Ponderosa (p. ponderosa), juniper (juniperus), oak (Quercus), chenopods such as four-wing salt-brush and greasewood (Chenopodinnae), sagebrush (Artemsia), composites such as sunflowers (Compositae), grasses (Gramineae), Mormon tea (Ephedra), legumes (Leguminosae), probably yucca (Liliaceae), and prickly pear (Platyopuntia).

A comparison of the results of the pollen study and the modern floral environment demonstrates that the plants present at the time of occupation are essentially the same as those present today. Lacking a detailed analysis of the modern pollen rain, it is not possible to say if these species are present in the same proportions as they were formerly.

The finding that the floral environment of the Cerrito site is similar to that of the present is in harmony with the results of numerous paleoenvironmental studies conducted in northern New Mexico, (e.g., Schoenwetter and Eddy 1964; Schoenwetter 1966), which demonstrate that for the past 2,000 years there has been little significant variation in the flora and, by inference, in the climate. Speaking about this period on the basis of studies in Navajo Reservoir, Schoenwetter observed, "So far as could be determined, no different vegetation complexes existed during this period, merely different extents and distributions of the vegetation zones now observable" (1966:20).

That the fauna of the area was similar to that of today is demonstrated by Denis Van Horn's preliminary faunal analysis included in this text as Appendix A. His study of the skeletal remains demonstrated the presence at the time of occupation of turkey (presumably *Meleagris gallopavo*), antelope (*Antilocapra americana*), jack rabbit (*Lepus* sp.), mule deer (*Odocoileus hemionus*), wood rat (*Neotoma* sp.), cottontail (*Sylvilagus* sp.), and vole (*Microtus* sp.). Other animals identified in Van Horn's study are apparently all domesticates. The above wild animals are all typical of the area today and concur with the floral evidence that the environment at the time of occupation was similar to that of today.

III. CULTURE HISTORY

For this study, the culture history of the Piedra Lumbre Valley must be seen in the context of the whole Chama Valley. Previous summaries have been localized, focusing on the Piedra Lumbre Valley in particular (Schaafsma 1975b, 1976, 1977, 1978). The present summary is based upon several basic surveys (Mera 1934; Hibben 1937), the combined ethnohistoric and archaeological work of Ellis (1975), the historic summary of the Spanish-speaking people by Swadesh (1974), the basic field work by the School of American Research, and other sources as they apply. Since the focus of the present study is on identifying the various ethnic groups known to have been in the Chama Valley, the following discussion will be partly chronological and partly group-specific. Thus, while considering a particular group, there will undoubtedly be an overlap in time with other groups. The aim is to provide a thorough review of the times when various groups were present, what they were doing in the valley, and other considerations that might produce some empirical evidence in the archaeological record.

ETHNIC GROUPS

PALEOINDIAN. Indications of PaleoIndians are sparse, but suggestive. A deeply stratified site (AR-413) in the Rio Puerco Valley (Map 1) is likely from this period, and a Meserve point was found in the Phase III survey (Schaafsma 1976). Similarly, Ellis mentions that PaleoIndians were present and cites occasional finds of Clovis and Folsom points (1975:22). Occupation at this time, ca. 10,000 B.C. - 6,000 B.C., apparently was transitory and populations were small.

ARCHAIC - BASKETMAKER II. The archaeological record of the Piedra Lumbre Valley is dominated by Archaic - Basketmaker II sites (Schaafsma 1975b; 1976). That hunter-gatherers were present in the valley throughout the late Archaic is demonstrated by a continuum of projectile point types (Bajada-San Jose-Armijo-En Medio-Basketmaker II) which span a period of over 3,000 years (Schaafsma 1975b; 1976; 1977). The Archaic sites have been a major focus of the School's excavation program in the district. Excavated Archaic sites (AR-2, AR-5, AR-6, AR-7, AR-8, AR-11, AR-12, AR-17, AR-20, AR-21, AR-23, and AR-25) are indicated on Map 1. The excavation and analysis of these sites determined that they were mostly base camps used in the warm season and were related to exploiting the riverine resource area. Independent dates consist of a carbon 14 date of 2,640$\pm$ 110 B.C. from AR-23 and 430$\pm$ 95 B.C. from AR-413 (a two-component site). Of interest in the present study are the 2 large camps (AR-5 and AR-6) located on the first terrace edge directly below AR-4 (Map 1). The lithics from AR-4 will be compared with those from these 2 sites later in the study.

BASKETMAKER III - PUEBLO III. After the termination of the Archaic - Basketmaker II occupation (no later than ca. A.D. 400), the Piedra Lumbre Valley was apparently unoccupied until about

A.D. 1300. Ellis states that 3 sites from A.D. 1100 - 1300 "have been excavated in the ranch (Ghost Ranch) area and others of that period are known here" (1975:22). It may be that our survey indications of a hiatus between ca. A.D. 400 and 1300 (Schaafsma 1978) are the result of working in an area where such sites did not happen to be located (Schaafsma 1976). The occupation must have been minimal since all the survey indications of occupation during this period were limited to a few projectile points of the Basketmaker III - Pueblo I type and a single site (AR-10) with a later Pueblo point (Pueblo III or IV) in a lithic area (Schaafsma 1977).

The Gallina Culture begins just beyond the upper edge of our survey area (Map 1). Hibben discusses a number of "torreones" (1937: Fig. 1) which overlook the Piedra Lumbre Valley that clearly belong to the Gallina culture. We found no sites attributable to the Gallina Culture in our survey area (Schaafsma 1976), which only indicates that for some reason the Gallina people did not leave archaeological sites in the lower valley. Until about A.D. 1250 (Ellis 1975), the Gallina culture would have occupied the western periphery of the valley, as indicated by Hibben's map of the Chama Valley (1937:Fig. 1).

<u>TEWAS</u>. By A.D. 1300 the ancestral Tewa Pueblo Indians were well established in the Chama Valley (Mera 1934; Hibben 1937; Ellis 1975; Wendorf and Reed 1955). "The great Pueblo IV ruins in the Chama are claimed by the Tewa speaking Pueblos of San Juan, Santa Clara and Nambe as those whence came some of their ancestors, and the known sequence of pottery types supports this assertion" (Ellis 1975:20). The Tewa occupation of the Chama Valley is well-known from surveys (Mera 1934; Hibben 1937) and numerous excavations (Ellis 1975; Wendorf and Reed 1955; Hibben 1937; Peckham 1959).

Both the above cited survey and excavation work and our survey and excavation work (Schaafsma 1978) agree that the Piedra Lumbre Valley was the northwestern extension of this Tewa occupation of the Chama. Tree-ring dates from the Riana Ruin (Hibben 1937; AR-420 on Map 1) and the Palisade site (Peckham 1959) yielded dates in the period between A.D. 1300 and 1350. There are presently no indications that after about 1400 (Mera 1934:10, Map 1) the Tewas lived in the Chama Valley upstream from the narrow canyon where Abiquiu Dam is located. All of the Tewa Pueblos before 1600 are typical agricultural settlements. They are characterized by large clusters of contiguous rooms made both of coarsed adobe and stone masonry, which are grouped around plazas containing kivas. The pottery on the earlier sites is typically Wiyo Black-on-White (Hibben 1937; Peckham 1959; Mera 1934) with Biscuit A and Biscuit B dominating on the later sites (Mera 1934). In the survey made by Mera, none of these villages produced Tewa Polychrome (1934).

The Tewa settlement of the Chama Valley between 1400 and 1600 is a pattern of gradual withdrawal downstream toward the Rio Grande river (Mera 1934; Maps 1, 2, and 3). Mera's survey showed that about the beginning of the seventeenth century (ca. 1600), the Tewas had completely abandoned the Chama Valley (1934; Map 3). Speaking of the period between 1325 and 1600, Wendorf and Reed concluded that "both the Pajarito Plateau and the Chama Valley area were abandoned near the end of the period" (1955:153). Thus Wendorf and Reed agree with Mera that the Chama Valley Tewa occupation terminated by about 1600. This summation is in agreement with the Onate journals (Hammond and Rey 1953) which do not mention pueblos in the Chama Valley after 1598. As Mera pointed out, pueblos "could hardly be expected to have escaped mention much after 1600" (1934:18). Schroeder and Matson suggest that Te'euinge in the lower Chama Valley may have been occupied when Castano de Sosa visited the Tewa area in 1591 (1965:133). This would have been a very terminal occupation, however, and Castano would have arrived on "the scene shortly after most of the pueblos on the Chama drainage had been abandoned" (1965:134).

Ellis is of the opinion that the Tewa occupation persisted into the early seventeenth century (1975:39) or "the early edge of the Spanish period" (1975:20). As evidence for this post-1600 Tewa occupation, she cites "the presence of a few bones of sheep and cattle in the trash accumulations at Sapawe" (1975:20) and "a metal piece that once may have been the clasp from an old Spanish book" in one of the excavated rooms in the pueblo of Tsama (1975:20). On the one hand, this evidence does not demonstrate that these pueblos were fully occupied into the seventeenth century, especially given the contrary evidence cited above. On the other hand, it would be of considerable interest to know the actual circumstances responsible for the presence of the sheep and cattle bones in Sapawe. Is it possible that rather than demonstrating "that at least part of this site must have been occupied when the first Spaniards to settle in New Mexico brought their flocks and herds to San Juan Pueblo in 1598" (1975:20), these bones indicate a post-1600 seasonal occupation of the old village of Sapawe by Tewa herdsmen? If so, they would be the first archaeological demonstration that Tewas were herding in the Chama Valley after 1600.

Occasional use of the Chama Valley by Tewas after 1600 is indicated by Ellis who cites their visitation of shrines well into this century (1975:22). Warren (1974:87) was told by a Santa Clara man that in the early 1900's Santa Clara men and members of other pueblos went to a place near Youngsville (Map 1) to gather stone material for artifacts. They went at a certain time of the year, and stayed for a 2-week period. "Some of the older men made arrow points during their stay, while others gathered raw materials to take home" (Warren 1974:87).

In summary, apart from the possibly seasonal reoccupation of Sapawe discussed above, the extensive Tewa occupation of the Chama Valley terminated by 1600. The Chama Valley Tewas established pueblos in the Rio Grande Valley and its eastern tributaries (Mera 1934:20; Ellis 1975:39) where they were all concentrated when Onate and the Spanish colonists arrived in 1598.

NAVAJOS. In 1932, Katharine Bartlett stated that in 1626 "the Navajos (Apaches de Nabahu) lived on the upper Chama river in an open grassland region, northwest of the pueblo of Santa Clara and some 70 miles airline northwest of Santa Fe" (1932: 29). The location she described could only be the Piedra Lumbre Valley. More recently, Hester relied upon the same historic records available to Bartlett to conclude that between 1600 and 1700 the Navajos were living in the Chama Valley (1962: Fig. 25). Hester presented other evidence to support the idea that Navajos were also living farther west during the seventeenth century. McNitt also accepted the historical records which demonstrate that Navajos were present in the Chama Valley during the seventeenth century (1972:6). It was an awareness of these previous interpretations that led the writer, in 1974, to propose that the sites of the Piedra Lumbre Phase represent the habitations of the Navajos described by the Spaniards.

The Spanish historical records that refer to the Navajos in the seventeenth century are many and varied. These letters, military notes, and regional overviews have been addressed by Reeve in a series of articles (1956, 1958, 1959) and by Schroeder (1963). In addition, Hester has summarized this material (1962: 21-23) and the seventeenth century Navajos have been discussed by others in the context of broader studies (Gunnerson 1974; McNitt 1972; Bartlett 1932).

There are 4 main periods covered by the Spanish records which provide a basis for understanding the early Navajos. These are: the period of Spanish exploration of the Southwest between 1540 and 1598; the period of Spanish colonization covered by the Onate journals (1598-1610); the period covered by Benavides' memorials (1625-1629); and the period of the Pueblo Revolt and the subsequent Reconquest (1680-1710).

1540-1598: Coronado spent two years in the Southwest between 1540 and 1542. At that time there were no non-Puebloan peoples living in proximity to the Pueblos and the land between the pueblos was unoccupied (Amsden 1932). The only Athabaskans Coronado met were living on the High Plains east of the Sangre de Cristos (Gunnerson 1974: 15-26). The Pueblos reported that these High Plains, nomads traded with them and sometimes spent winters nearby (Gunnerson 1974:53).

Forty years later in 1581-1582, the Rodriguez-Chamuscado expedition reported substantially the same conditions as those described by Coronado (Gunnerson 1974:46). By 1582-1583, however, some Apaches had settled in the mountains near Acoma and fought with members of the Espejo Expedition (Gunnerson 1974:49). These Athabascans near Acoma and others reported in the vicinity of Hopi were almost certainly among the first Apaches to live west of the Rio Grande and were the first Apaches to have been reported by the Spaniards west of the river.

Gunnerson's summarized Athabascan activity in the Southwest between 1500 and 1600 as follows:

Information gleaned from Spanish documents and supported by other lines of evidence suggests that the history of the Apaches in the Southwest begins in the early 1500's. They apparently first became known to the eastern Pueblo people in 1525 as Plains nomads called Teyas and Querechos who entered the Rio Grande Valley from a northerly direction and attacked various Pueblos. According to Pueblo Indians, the nomadic buffalo hunters finally made friends with all the villages and returned to the Plains, where Coronado and his men observed them in 1541. Sometime after 1542 and before 1582 the Querechos moved permanently across the Rio Grande. Various bands settled in mountainous areas near Western Pueblos, possibly at the invitation of individual Pueblos with whom they formed military alliances and trade relationships. The Querechos or mountain Apaches, who seem to have been the ancestors of part of the modern Western Apacheans were attacking some Pueblos for loot before Onate's colonists arrived in 1598. In contrast, the Plains Apaches remained friendly. In the mountains north and east of Picuris there were, by 1598, Apaches who almost certainly included the ancestors of the Jicarillas (1974:73-74).

1598-1610: By the time Onate and the first Spanish settlers arrived in July 1598, Athabascans had settled widely in the mountains around the Pueblos. This circumstance is reflected in the fact that Apaches were mentioned when the Franciscan friars were assigned to the Pueblos on September 9, 1598 (Hammond and Rey 1953: 345-46). Father Francisco de San Miguel was assigned Pecos Pueblo and the Vaquero Indians (Apaches) to the east; Father Francisco de Zamora, Picuris and Taos and the Apaches "from the Sierra Nevada toward the north and east" (1953:345); Father Alonso de Lugo received Jemez Pueblo along with other pueblos nearby "and, in addition, all of the Apaches and Cocoyes of the neighboring sierras and settlements" (1953: 345). Assignments of the padres in 1598 probably depict fairly accurately the areas in which Apaches were living by this time (Gunnerson 1974:55-74).

While the missionary assignments of 1598 demonstrate that the Spaniards knew of Apaches around the pueblos, there are no actual references to meetings between Spaniards and Apaches until July 1599, nearly a year later (Gunnerson 1974:63). In 1601, Marcelo de Espinosa reported that before the Spaniards arrived, the nomadic hunters who lived in the uninhabited areas around the pueblos raided the villages (Hammond and Rey 1953:639). McNitt cites these Spanish sources as well as San Juan Pueblo traditions to argue that some of these nomads were wandering Apaches who later received the name "Navajo" (1972:11). Thus by 1601 Apaches were known to live in the country around the pueblos. They were reported to have raided the pueblos before the Spaniards arrived but withdrew and/or remained hidden during the first few years of Spanish settlement.

In contrast to the nebulous implications that the Apaches were inhabiting the mountains around the pueblos ca. 1600, there are extensive accounts of the Plains Apaches at this time. Between September 15 and November 8, 1598, the sargento mayor, Vincente de Zaldivar Mendozea, and about 60 men traveled on the High Plains of New Mexico among the buffalo hunting Apaches (Hammond and Rey 1953:398-405). His account makes it clear that the Spaniards were interested in the Apaches and that the Apaches in 1598 were living for the most part on the High Plains. This was still the case in 1605 when the Apaches were described as living among the cattle (buffalo) in tents of buffalo hide and trading buffalo hides to the Pueblos (Hammond and Rey 1953:1013).

Although the Apaches did not raid the Pueblos and Spaniards during the early years of Spanish rule, they began to do so around 1606 when they are known to have raided Jemez and, in at least one case, the Spanish settlement of San Gabriel (Gunnerson 1974:72). Gunnerson is of the opinion that these early Apache raids were carried out by peoples later referred to as the Navajo Apaches (1974:72). Hammond and Rey (1953: 1059) and McNitt (1972:11) agree with Gunnerson that the early raids against Jemez and San Gabriel were made by Navajos. The increasing number of raids by Navajo Apaches against both the Spaniards and Pueblos led to the decision made by Viceroy Velasco on March 6, 1608, to send additional soldiers to reinforce the New Mexico settlements (Hammond and Rey 1953:1059). McNitt suggests that Navajo harassment was one of the main reasons for the abandonment of San Gabriel in 1610 (1972:11).

<u>1625-1629</u>: When Fray Alonso de Benavides wrote his memorials in 1630 and 1634 recounting his observations and experiences while custodian of the Franciscan Fathers in New Mexico between 1625 and 1629, he compiled the fullest contemporary account of the early Navajos. Benavides was fascinated by the Apaches who surrounded the Rio Grande Pueblos, emphasizing them in his accounts in order to impress the Spanish authorities with the potential that existed in New Mexico for converting these people. In stressing this potential, he tended to make exaggerations, especially in regard to population size (Hodge et al. 1945:305). In general, however, his account provides many valuable insights to early Apache life.

Benavides believed that the Apaches were the original inhabitants of the land (Hodge, et al. 1945:81); that they extended to the Pacific Ocean to the west, and to the mythical straits of Anian to the north (Ayer 1916:41). To the east, the buffalo-hunting Apaches ("Vaqueros") were known to range about 100 leagues (260 miles) from the pueblos. To the south, their border was thought to be at the Jornada del Muerto (Hodge et al. 1945:307). Benavides, thus gives the impression of a long established nation consisting of thousands of Apaches completely surrounding the villages of the settled Pueblos.

The Navajo raids begun before the Spaniards left San

Gabriel reached such proportions by 1629 that Benavides went to live in Santa Clara Pueblo hoping to convert the people (Ayer 1916:45; Hodge et al. 1945:85). In September 1629, he selected a delegation of 12 Santa Clara men who spoke Apache (Hodge et al. 1945:86), the leader of whom, Don Pedro, spoke the Apache language well. On the morning of September 17, Benavides said Mass and the group "set out on their journey from the church" (1945:87). "They traveled all that day and on the morning of the next (September 18) came within sight of the first enemy rancheria" (1945:87). The Santa Clara delegation and the Navajos conducted an elaborate ceremony (Ayer 1916:47-48; Hodge et al. 1945:87) inviting the Navajos to visit Santa Clara and to meet with Benavides. The Navajos agreed, and the two groups, Navajos and Pueblos, returned to Santa Clara that night (September 18): "for it was already night when they arrived" (Ayer 1916:48).

The account by Benavides asserts that in 1629 there were Navajo settlements (Rancherias") within one day's walking distance from Santa Clara. This knowledge combined with Father Zarate Salmeron's statement that the Apaches de Navajo were living somewhere near the Chama River (Reeve 1956:299) substantiates Bartlett's previous summary that in 1626 the Navajos were living on the upper Chama River northwest of Santa Clara (1932:29; Hester 1962:21, Fig. 25).

Following the conversion of the Navajo Apaches, Benavides reported that the Santa Clara Pueblos and Navajos became good friends (Ayer 1916:53). "Thenceforth the peace became so firm that they communicated with one another, unarmed, visiting each other'- country with great pleasure" (Hodge et al. 1945:88). However, it seems likely that the 1629 conversion of the Navajos did not have much more of a lasting effect than did the conversion of the Apaches of Quinia (Hodge et al. 1945:89-91), since after 1630 there is no further mention of missionaries being sent to the Navajos (Gunnerson 1974:75-99). Hodge specifically states, "All early efforts to Christianize the Navajo proved failures" (Ayer 1916:267).

Throughout the seventeenth century, the Navajos remained on the western periphery of Spanish and Pueblo settlement. "The Navajo-Spanish frontier was just to the west and north of a line that extended through the outlying Spanish settlements and Pueblos between Taos and Laguna" (Hester 1962:75; Fig. 25). The Navajo settlements began a short distance past the frontier and Hester notes that the Navajos were probably concentrated along the frontier (1962:75). While the historical accounts establish that Navajos in the seventeenth century lived in the Chama Valley and along the frontier, they do not tell us how far to the west they also may have been living.

<u>1680-1710</u>: On August 10, 1680, the Pueblos began a revolt that forced the Spaniards to leave New Mexico. While the Spaniards were fearful of an Apache-Pueblo alliance, it

appears that only a few Apaches participated in the revolt (Gunnerson 1974:100-101). The Spaniards, led by De Vargas, reconquered New Mexico in 1692 (1974:111-125). The following years between 1692 and 1696 were unsettled as various pueblos tried to resist the Spaniards, attempting a major, but abortive, revolt in 1696. Throughout these years, the Pueblos continued a practice begun as early as 1609 (Hammond and Rey 1953: 1089; Gunnerson 1974:69) of retreating to the Apache settlements to escape the Spaniards (1974:122-125). The Navajos accepted many of these Refugee Pueblos (1974:122; Hester 1962:22). In 1696, some of the Tewas of Santa Clara fled to "surrounding neighbors of the Apaches of Navajo, Embudo, and Sierra de los Pedernales" (Forbes 1960:272). The Sierra de los Pedernales is undoubtedly Pedernal Mountain, which overlooks the Piedra Lumbre Valley (Fig. 33) and "Embudo" is the "Embudo de la Piedra Lumbre" (where present Abiquiu Dam is located) cited by Governor Cuervo y Valdez as the boundary of the Navajo Province in 1706 (Hester 1962:77). Thus, after 1692, (if not before) the Tewas and other Refugee Pueblos were retreating to the Navajos, some of whom were living in the Piedra Lumbre Valley.

On June 23, 1706, Governor Cuervo y Valdez addressed a letter to the Duke of Albuquerque, Viceroy of Mexico, in which he describes the Navajos as they were known to him at that time. A portion of that letter is repeated here as it is presented by Reeve:

> (These Indians) live from the said frontier/Piedra Lumbre/up to the banks and fields of the said Grand River/Rio San Juan/. Maintaining themselves by their own labor, they cultivate the land with much care. They sow corn, beans, squash, and all sorts of seeds and grains/except barley and wheat/, such as chile and other plants/cosas/that they have found in the settlements of the Christian Indians of this kingdom; this not being a new practice among the said Apaches, since when they became settled they have practiced the same. They make their blankets of wool and cotton; the one they sow and the other they secure from the flocks of sheep that they raise (Reeve 1958:217).

This report is of significance for a variety of reasons:

1) It was written by the Governor of New Mexico in an official correspondence with the Viceroy of New Spain and is therefore probably fairly reliable.

2) It correlates with other historical references in reporting that the Navajo settlements began in the Piedra Lumbre Valley.

3) It substantiates the other evidence that the frontier of the Navajo Province began at the Piedra Lumbre Valley.

4) It makes it clear that by 1706 the Navajos were living to the northwest as far as the banks of the San Juan River.

5) It indicates that, unlike Benavides, the Spanish in 1706 recognized the Navajos as recent arrivals in New Mexico.

6) It shows the continuation to at least 1706 of the practice of referring to the Navajos as "Apaches" on occasion.

7) It makes it clear that the Navajos were accomplished agriculturists, making use of the Pueblos' domesticates (corn, beans, squash, and later chile) and that they had been known to the Spanish as agriculturists throughout their contact.

8) It states (as did Benavides) that they were settled rather than roaming, nomadic hunters.

9) It reports that the Apaches were weaving blankets by 1706.

10) It reports that they raised cotton (Dubious, but possible in the Largo Canyon).

11) Finally, the report documents that the Navajos were pastoralists by 1706 and were raising flocks of sheep, which provided the wool for their weaving.

While this report probably applied to all Navajos in 1706, whether living in the Chama Valley or farther northwest, it seems to have been drawn in part from observations of Navajos living in the Largo/Gobernador region after 1696 (Carlson 1965).

Military records indicate the presence of Navajos in the Piedra Lumbre Valley as late as 1709. The latest of these is a special order issued by Marques de la Penuela and Juan de Ulibarri on September 7, 1709:

> Inasmuch as the enemy infidel Indians of the Rancherias, Province and Mountain of Navajo continue their invasions, killings and robberies even in view of having made six consecutive campaigns one after the other this year in which they have experienced the rigor of (our) arms I consider it proper for the greater peace and conservation of said Kingdom that the army go out in their pursuit, to execute a seventh campaign to said mountains or rancherias of Navajo or for those of Piedra Lumbre, Chama or Abiquiu (aviquio), where I consider said enemies dwelling, due to the frequency with which they come to raid these jurisdictions... (AGN, PI, NM, Vol. 36, pt. 3 pp. 547-72).

Based on the fact that the Spanish raids against the Navajos began to cease after 1709 (Hester 1962:22) leading to a period of peace between the Navajos and Spaniards between 1720 and 1770 (Reeve 1959), it would appear that the Navajos had moved out of the Chama Valley by 1710. In view of the intensity of the Spanish raids carried out against the Navajos in 1709, there seems every reason the Navajos abandoned the valley. Mounted Ute raiding parties, however, were present in the Chama Valley in the early eighteenth century, and they too may have been partly responsible for the Navajo departure.

SPANIARDS AND GENIZAROS

The first Spaniards to settle in New Mexico arrived in the summer of 1598 (Hammond and Rey 1953:17). These colonists, under the leadership of Don Juan de Onate, occupied the pueblo of Yunque (San Gabriel) which had been relinquished for their use by the Tewas who moved into San Juan Pueblo on the east side of the Rio Grande. This location, at the junction of the Chama and the Rio Grande "remained the capital of New Mexico until Governor Don Pedro de Peralta, Onate's successor, founded Santa Fe in 1610" (Hammond and Rey 1953:17). Thus, for the first years of Spanish settlement in New Mexico, the Spaniards were living at the mouth of the Chama River. It is for that reason that the early accounts in the Onate journals (Hammond and Rey 1953) most likely can be relied upon to depict fairly accurate conditions in the lower Chama River.

It is evident that the Spaniards in the settlement at San Gabriel did not live outside of that settlement. It is also clear that they relied upon the Indians for most of their sustenance. They left San Gabriel for Santa Fe in 1610, and it is unlikely that any Spaniards or Spanish-speaking people lived in the Chama Valley for the remainder of the seventeenth century.

"The settlers who came with Onate were a diverse group in terms of ethnic or national backgrounds. Spaniards were a minority in the population; probably the majority were Mexican Indians and mestizos or mixed bloods of European and Indian parentage. The non-Pueblo population never exceeded 3,000 people during the seventeenth century" (Dozier 1970: 52). During the seventeenth century, Spaniards or Spanish-speaking people who arrived with the Spaniards, were to be found in 2 types of communities:

> (1) the Pueblo villages, some of which had resident missionaries, perhaps a few soldiers, and a missionary workshop, and (2) three main areas of Spanish settlement. The most important settlement was Santa Fe, where the provincial governor and the garrison of soldiers resided; a second settlement was La Canada, near present day Santa Cruz in the Tewa Basin; and the third settle-

> ment region extended from Santa Domingo pueblo to approximately the position of modern Socorro (1970:52).

Thus, north of Santa Fe, the only seventeenth-century Spanish settlement was La Canada; otherwise Spaniards, and related non-Pueblo people were restricted to a few Pueblos.

The Spaniards constituted a well-defined local aristocracy even though intermarriage was common (Dozier 1970:52). The Pueblos were dominated and exploited by the Spaniards throughout the seventeenth century, and there were clearly defined group prerogatives that separated them. Economically, the Spaniards dominated the Indians through the encomienda system. The professional soldier citizens of New Mexico received no regular salary, but instead were granted encomiendas which consisted of the services of a number of Indians (Dozier 1970:54).... "...the main service of the Indians came from the farms and livestock which they cultivated and tended on special tracts of land near the Indian pueblos" (Dozier 1970:54).

> During the seventeenth century, Pueblo lands remained the possession of the Indians, simply because the Spaniards were not tillers of the soil. Instead, under the encomienda system and the missionary program, the Indians provided for the support and economic gain of the intruders from the proceeds of their own land and labor. After the reconquest, the encomienda system was abolished and the Hispanicized population itself began to settle down to form (1970:101).

Thus, before about 1692, no Spaniard or even hispanicized person would have been herding stock anywhere in New Mexico, given the pattern of economic practices and group perogratives in the whole region. Additionally, the Spaniards were restricted in settlement in the northern Rio Grande drainage to Santa Fe and La Canada.

Following the reconquest in 1692, the Spaniards were restricted to Santa Fe until at least 1700. About 1700 a few Spanish families returned to La Canada (Swadesh 1974). From this settlement in 1714, several families moved to Chamita in the lower Chama Valley, close to the old settlement of San Gabriel (Swadesh 1974). This was apparently the first Spanish settlement in the Chama Valley in over a hundred years. These people would have been among those mentioned by Dozier as beginning to farm and maintain herds themselves after the reconquest.

During the next 20 years, a few isolated Spanish-speaking families managed to settle the Chama Valley, slowly spreading upstream from the initial settlement at Chamita. "Early settlement of the Chama Valley and its tributary streams... produced a pattern of scattered ranches inhabited by expanded family groups" (Swadesh 1974:32). This process continued until by 1734 there were Spanish families settled in the main valley of the Chama between El Rito Creek and the vicinity of modern Abiquiu (1974:33). "In 1744 Father Miguel de Menchero reported that the Spanish settlers of the Abiquiu area total twenty scattered families" (1974:34). By 1743, Jose de Riano was in possession of a large ranch in the modern Canones Creek area (Map 1). This is the earliest record of an actual Spanish settlement in the Chama Valley upstream from the present Abiquiu Dam location. The Riano holdings were later divided into the Polvadera and Piedra Lumbre Grants. The ranch was abandoned after an Indian attack in 1745, and not reoccupied (1974:34).

"During the 1730's and 1740's and into the early 1750's the settlements in the Chama watershed were frequently displaced by Indian attacks" (Swadesh 1974:34). "In August 1747 all settlements west of the Rio Grande were attacked by nomadic Indians" (1974:35). While the Utes were blamed at first, and then attacked in return, it was later determined that the raiders were Comanches, and a few Moache Ute allies (1974:35). "In March 1748 the Abiquiu, Ojo Caliente, and Pueblo Quemado settlers asked permission to withdraw from their exposed settlements to a safer community" (1974:35). This they did the following summer, moving in with relatives in La Canada. The Chama Valley settlements were not resettled until April 16, 1750, when the Comanches were still raiding constantly (1974:37).

In the resettled communities of 1750, there were a number of Hopis who were living with Spanish families (Swadesh 1974: 39). These people became the nucleus of the Chama Valley - "Genizaro" population. While loosely described as "detribalized Indians," most of the Abiquiu Genizaros actually came from the pueblos of Hopi, Zuni, Isleta and Santa Clara (1974: 42-43). The Genizaros were granted lands in 1754 at Abiquiu and Ojo Caliente (1974:39). "Abiquiu and Ojo Caliente were corridors for the raiding activities of the Utes and Comanches" (Dozier 1970:85). The Genizaro pueblos were "by design of Spanish authorities placed in locations where they would receive the initial brunt of enemy attacks" (1970:85). The Genizaros became a frontier buffer population of hispanicized Indians who were given grant lands in exchange for the promise of militia service (Swadesh 1974:40). While the Chama Valley settlements persisted after this, it is clear that the frontier was unstable for the remainder of the eighteenth century. Indian attacks were frequent, and the frontier remained at the embudo in the Chama Canyon; that is, Abiquiu remained the northwestern edge of Spanish settlement.

Occasional ranchers, however, did extend beyond Abiquiu in the late eighteenth century. "In 1766 Pedro Martin Serrano petitioned for that portion of the abandoned Jose de Riano grant called Piedra Lumbre, while his brother Juan Pablo Martin petitioned for the adjacent Polvadera tract. Their purpose in petitioning was to obtain more rangeland" (Swadesh 1974:47).

Serrano and Martin apparently settled in some manner in Canones not long after their 1766 petition for the 2 large grants. Both were on good terms with the Utes (Swadesh 1974: 47). It would seem then that Spanish grazing in the Piedra Lumbre Valley would have begun about 1766 with the grants to Serrano and Martin. On the other hand, aside from the short-lived Riano ranch in the 1740's, there are no indications that the Piedra Lumbre Valley was grazing before about 1766.

"Population growth in the Chama Valley was marked in the 1790's and the first decades of the nineteenth century. Agricultural lands were limited in the Chama and tributary valleys, and new range was needed for growing herds. Petitions for grants in the upper Chama drainage were submitted starting in the early 1800's" (Swadesh 1974:48). The first nineteenth-century grant (1806) was the San Juaquin del Rio Chama (1974: 49), which included the Burns Ranch shown on Map 1. By 1814, the Spanish were petitioning for the Tierra Amarilla Grant, north of Tierra Amarilla (1974:50). Nobody, however, apparently moved into the area and no formal petition was made until about 1824 (1974:50). "Abiquiu settlers had been grazing their sheep in the area, possibly since before the first petition" (1974:50). During the 1840's "the Tierra Amarilla Grant was dotted with small summer sheep camps" (1974:62).

Aside from the Serrano and Martin ranches in Canones mentioned above, the Spaniards evidently did not settle beyond Abiquiu until after the American occupation in 1846. Their use of the Chama Valley above Abiquiu was limited to the summer sheep camps mentioned by Swadesh. Support for this is provided by the observations of Lt. J. W. Abert in October 1846:

> Just opposite "San Juan," is the mouth of the "Rio Chama," one of the western affluents of the "Rio del Norte." It flows from the northwest, through a beautiful valley, and, like the other streams of the country, has a narrow bottom, along which the people have settled ... Towards the head waters of the river, fine grass is found, and the country is well adapted to the raising of stock; but all attempts at settlement above the "Abiquiu" have failed from the depredations of the Utah and Navajo Indians (Abert 1846:460).

Schroeder (1965:63) discusses the efforts of the Abiquiu Spaniards to settle the Chama Valley and documents that, until 1851, permanent residence in the valley was prevented by either Navajos or Utes.

Sometime in the mid-nineteenth century, the Spanish people of Abiquiu made successful settlements in the Chama Valley above the present Abiquiu Dam. These people have been the dominant population ever since. They have resided in the communities of Canones, Youngsville and Coyote on the periphery of the Piedra Lumbre Valley for well over a 100 years.

Several definite conclusions emerge from this summary of Spanish settlement in the Chama Valley:

1) There were no Spaniards resident in the Chama Valley during the seventeenth century after the short-lived occupation of San Gabriel.

2) Spaniards did not herd stock in the seventeenth century.

3) Spanish settlement of the Chama Valley began in 1714 leading to about 20 families near Abiquiu by 1735.

4) Settlement in the Chama Valley was unstable throughout the eighteenth century with the whole valley having been abandoned between 1748 and 1750.

5) Spanish settlement did not extend beyond the canyon where Abiquiu Dam is now located until the mid-nineteenth century; the exceptions are a few ranches in the Piedra Lumbre Valley area which are not well known.

6) Spanish grazing of sheep in the Chama Valley above Abiquiu probably began by 1766; by the early nineteenth century Spanish sheep camps extended into the upper Chama Valley.

UTES

The first historical record of the Utes was made in 1626 when they were described as living beyond the Navajos and in thatch-covered huts (Schroeder 1965:54). Before 1700, the south border of the Southern Utes was the San Juan River in New Mexico on the west side of the continental divide, and the San Luis Valley of Colorado on the east (Schroeder 1965: 54). Utes had horses before 1700 and lived in bands (Schroeder 1965:54). The Southern utes and Comanches were allied from the early 1700's to 1746 (Schroeder 1965:73); this alliance was broken after 1750 (Skinner 1968:66). The Utes and Comanches were frequently in the Chama Valley in the early 1700's, primarily on raids.

By 1730 the Utes began to trade at Abiquiu (Swadesh 1974:163). From this time, the Utes made annual trips to the Chama Valley, and eventually an annual trade fair was established at Abiquiu (Swadesh 1974:47).

According to Swadesh (1976: personal communications), the Utes did not live in the Abiquiu area and apparently not even in the Chama River Valley during the eighteenth century. In her opinion, they were headquartered in southern Colorado and along the San Juan River drainage. Schroeder on the other hand states that by about 1746 the Southern Utes had "taken up residence in camps above Abiquiu on the Chama River" (1965: 73). Furthermore, "Between the 1750's and the early 1800's, the territory and raiding pattern of these Utes seems to have changed little," (1965:73). That Utes were in the Chama Valley during the eighteenth century and dominated it during the latter half is supported by both referenced sources, regardless of the question of local residence versus a wide raiding sphere. They quite surely were living year-round in the Chama Valley by the first decade of the nineteenth century (Skinner 1968:66). Spanish use of the upper Chama River could only have been pursued with the concurrence of the Utes.

New Mexico became part of the United States as a territory in 1846. In December 1848, U.S. Indian agent James S. Calhoun met with the Utes for the purpose of making a treaty with them. The treaty was signed on December 30, 1849 (Abel 1915:201). While on this trip to Abiquiu, Calhoun noted that "...the Ute chiefs were encamped a few miles therefrom (Abiquiu), northwest, in their own country" (Skinner 1968:66). A few miles northwest of Abiquiu would be in the Piedra Lumbre Valley. After the Capote Utes signed a treaty with the U.S. Government, an agency was established at Abiquiu in 1852 (Swadesh: personal communication).

In the early 1870's, the Capote Utes "roamed within 5 to 50 miles of Abiquiu and lived most of the time near Tierra Amarilla along a 5-to-10 mile stretch of the Chama River" (Schroeder 1965:73). The utes in the 1860's and 1870's drew rations at the Abiquiu Agency. "Many Capotes, who liked milk, kept goats and were all dependent on the government," except one small band (Schroeder 1965:73). The Capote Ute remained in the Chama Valley and were attached to the Abiquiu Agency until 1878, at which time they were moved to Southern Colorado.

COMANCHES

Between 1700 and about 1750, the Utes and Comanches were allied in raiding all over northern New Mexico. It was primarily Comanches who were responsible for the 1747 raid on Abiquiu (Swadesh 1974:35). After 1750 this alliance was broken and the Comanches no longer frequented the Chama Valley. They were kept out by the presence of their former allies, the Utes.

Comanches never lived in the Chama Valley (Swadesh 1974; Schroeder 1965). Their presence was always related to raiding parties.

JICARILLA APACHES

Prior to about 1700, the Jicarillas were living in the eastern foothills of the Sangre de Cristo Mountains (Gunnerson

1969; Gunnerson and Gunnerson 1971; Gunnerson 1974). These foothills' Apaches farmed, made pottery, and, in some cases, made adobe houses (Gunnerson 1969). They later received the name "Olleros" (Gunnerson 1974). Other Apache groups before 1700 lived farther out on the plains and to the north (Gunnerson 1974). These plains-dwelling Apaches later were called the "Llaneros" (Gunnerson 1974). Both of these groups were later called "Jicarillas."

In the early 1700's, the Utes and Comanches acquired horses and began raiding the Apaches (Secoy 1953; Gunnerson 1974). By the 1720's, Apaches were being driven off the plains and many of them sought refuge near the Rio Grande Pueblos (Gunnerson 1974). Throughout the eighteenth century, the Jicarillas were in the vicinity of the Rio Grande Pueblos and around the Sangre de Cristo Mountains (Gunnerson 1974).

In 1852, a band of Jicarilla Apaches spent the winter near Abiquiu, attracted to the area by gifts which had been given to the Utes by the Agency. In 1853, this group was settled on the headwaters of the Rio Puerco about 10 miles west of Abiquiu and assigned to the Abiquiu Agency. According to Schroeder (1965:66), this was the first permanent settlement of Jicarillas west of the Rio Grande. This was attributed without much question to be the Ollero Band or a part of them. The Jicarillas attached to the Cimarron Agency were moved to Abiquiu in 1878 (Skinner 1968:66). They and the Jicarillas who had been on the Rio Puerco for the previous 25 years were moved to the present Jicarilla Reservation at Dulce, New Mexico. At that time, the Abiquiu Agency was closed.

<u>SUMMARY</u>: The culture history of the Chama Valley discloses that, after A.D. 1600, 6 different ethnic groups are known to have been present: Tewas, Navajos, Spaniards and Genizaros, Utes, Comanches and Jicarilla Apaches. The preceding discussions are intended to provide material needed for comparison with the Piedra Lumbre Phase archaeological complex, particularly site AR-4.

IV. SITE AND FEATURE DESCRIPTION

SITE INTRODUCTION

The Cerrito site (AR-4) is situated along the second terrace on the northeast side of the Chama River Valley (Map 1). This location affords a wide view of the Chama Valley below to the west and southwest. For the most part, the structures are built back from the terrace edge, or on the terrace top, and would not have been visible from the valley floor some 250 feet below. The site extends .5 mile along this terrace (Map 2, see map pocket). Arroyo de los Comales cuts through the terrace in the middle of the site, forming a narrow, steep-walled canyon (Map 2, see map pocket). A short, deep arroyo is at the southern limit of the site. The structures are found in the bluffs overlooking the Chama, along the side drainages, and on the terrace tops. Site limits were established by the distribution of structures and related features.

Each of the features is described below. The same format is used throughout: General (dates, personnel, etc.); Situation; Excavation Method; Description. Exceptions to this occur when unusual locations are being described, such as terraces and corral walls. The excavation method applied in each case is summarized. In general, all collections were made with reference to a site-wide grid system which used the Corps' fence as a baseline (Map 2). The 3 x 3 meter grids away from the structures were collected as single proveniences. Near the features and within them, all grids were subdivided into one-meter squares. Vertical control was by 5- to-10-centimeter arbitrary levels unless it was possible to utilize natural strata. All fill was screened with one-quarter-inch mesh. Photos were taken of all features and of detail relating to features. Scale drawings were also made.

FEATURE A

General: This was the first structure of this archaeological complex found in Abiquiu Reservoir. It has been described in three previous reports (Schaafsma 1975a; 1975b; 1976). The feature had never been inundated and was fairly well preserved when found (Fig. 1). Fieldwork was done on August 24, 25, 26 and 29, 1977. The excavation was directed by Steve Horvath.

Situation: Feature A is located on the edge of a sandstone cliff overlooking the Chama Valley to the west (Figs. 1 and 2). A sheer cliff about 2 meters high is directly west of the structure; a steep slope continues below this cliff. The area is on a bench below a gravel terrace to the east (Map 2). Most of the bench is either exposed bedrock or has a thin cover of sandy soil. One-seed junipers grow on the bench. No secondary structures are in the immediate vicinity, and the nearest other features are to the south (Feature B) and east (Features C and Q -- see Map 2).

Excavation Method: A grid system was laid out over the bench to the south and east of the structure (Fig. 2). Surface collections were made in an area bounded by rows CF-CP and columns 169-188. Within this area, 112 grids were surface collected. The grids immediately around the structure were divided into one-meter squares (Fig. 3). The meter squares numbered on Figure 3 were all surface collected and excavated to sterile bedrock. Vertical control was by 5-centimeter levels. The outermost tier of meter squares was completed first. The tier of meter squares adjacent to the walls was then excavated (Fig. 4): most of these squares were covered by fallen wall. The interior of the structure was completely excavated to bedrock. All fill was screened through a one-quarter-inch mesh screen. Provenience control was by meter square and level within the meter squares. The fallen wall on the west and northwest sides was not removed.

Description: For the most part, the structure was discernible prior to excavation because of the free-standing walls and the location on the bedrock (Fig. 1). The structure is nearly circular; its outline is slightly oval (Fig. 3) with interior dimensions of 3.00 meters x 3.25 meters. The walls are comparatively well built of unshaped flat slabs of sandstone which still stand to a height of 50 centimeters in some parts. There was quite a bit of wall fall (Fig. 1), most of which had collapsed outward. Only five or six big slabs had fallen inside. A rough estimate would place the original wall height at 1 meter. It seems likely that the walls once were covered by mud mortar, although there is no evidence for this belief. There is a low place in the wall at the south end which may have been a doorway. If so, there would have been a sill several courses high. The still-standing walls are between 30 and 40 centimeters wide and rest directly on the bedkrock.

A scatter of lithics, ceramics, and bone occurred throughout the fill of the structure, which was sandy, with much root activity. Most of the fill probably accumulated within the structure as wind drift. This upper fill was of thicknesses varying from 5 - 10 centimeters. In most places, there was no change in fill composition above the sterile bedrock and there was no definite floor. In several places, deep crevices were found that extended as much as 20 centimeters below the surface. These cracks were full of charcoal-rich fill that had unusually high amounts of lithics, ceramics, bone, and other household debris. Crevices with ash-rich fill were also found outside the walls on the east and northeast sides (Fig. 4). Apparently the bare bedrock served as the floor of the structure, and the crevices accumulated debris.

In the northern third there was an ash layer located 1 - 2 centimeters below the surface and extending to bedrock at 5 - 8 centimeters. Soil samples were taken for flotation and

Figure 1: Feature A prior to excavation, view northwest.

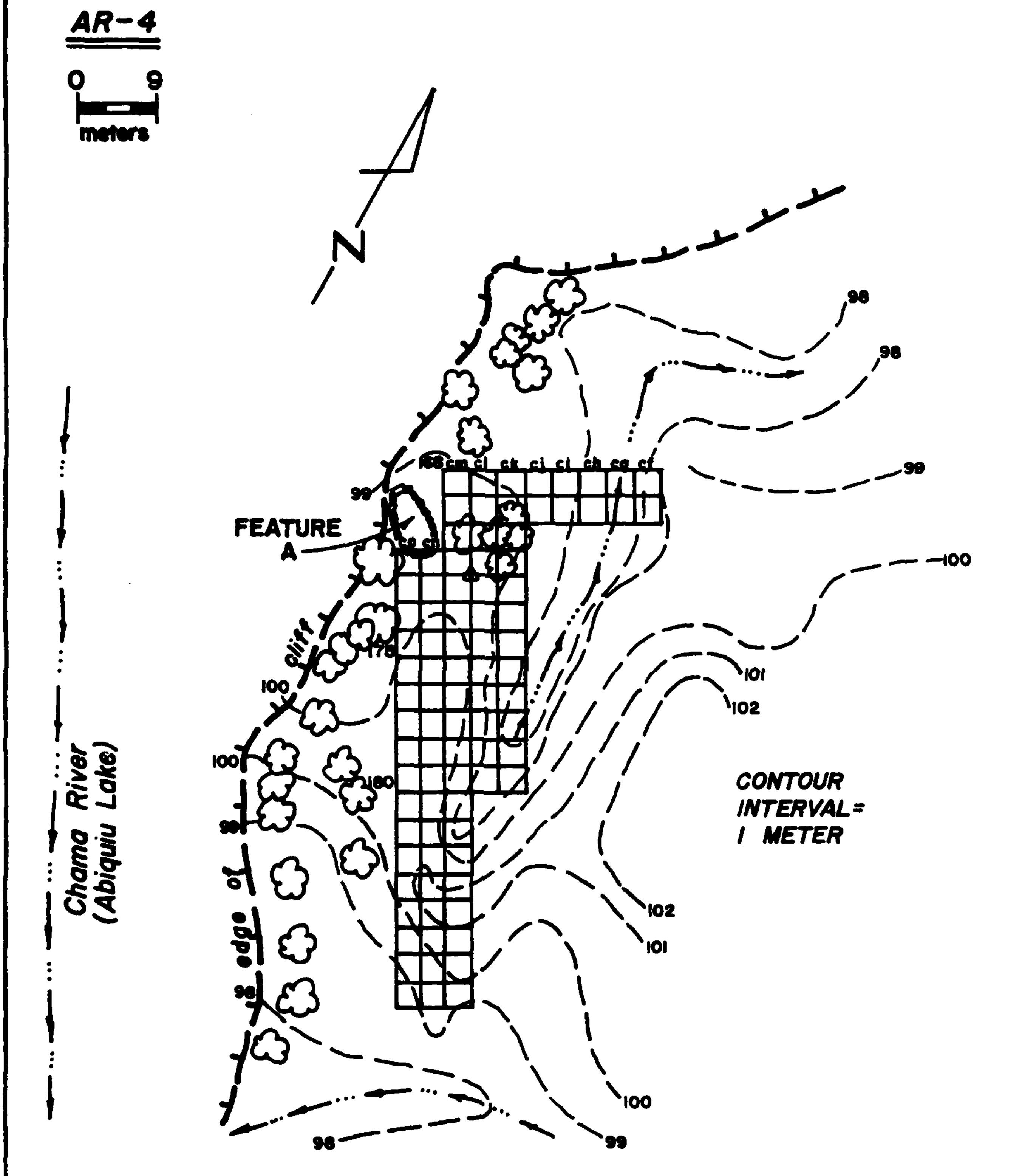


fig. 2: FEATURE A

Figure 4: Feature A, excavated meter squares on east side.

Figure 5: Feature A, ash area and reddened wall in northwest corner.

chemical analysis. The bedrock below the ash layer was burned black. The burned, bedrock floor and the ash layer were clearly associated with the red-burned rocks on the inside of the wall in the northwest corner (Figs. 3 and 5). No large pieces of charcoal came from this hearth area. The fire was not made in a prepared basin but on the bedrock floor against the northwest wall.

Very little evidence remained to suggest the nature of the roof and upper walls. Some large splinters of wood came from beneath the wall fall on the south and east sides. The apparent 1-meter height of the original walls indicates that the superstructure rested on them. The wood splinters suggest that the superstructure was in part wood; it could have been a cribbed log roof. There was no indication of the nature of the roof or upper walls inside the structure.

There were indications of two exterior hearths. One in meter square 2 of grid CO-170 was found under the wall fall. This area of charcoal and ash continued up against the outside of the east wall. A second exterior hearth, located 2 meters to the northeast of the structure, was a circular reddened area on the rock surface. The bedrock in the area was shattered as if by heat. Contemporaneity with the structure is assumed but by no means proven.

Function: This structure was definitely a habitation. Fires were built both inside and outside against the east wall and possibly just to the northeast. The abundance of ceramics inside the structure and the amount of lithic material inside and on the surface nearby indicate that this was a dwelling. The amounts of bone found were also abundant relative to the shallowness of the fill.

It has been suggested that this structure was a lookout for the village (Schaafsma 1975a; 1976). This suggestion is based on the fact that it overlooked the valley below and that most of the other structures were relatively well hidden. The position of Feature A is also very exposed to the prevailing west winds while most of the other structures are in low, protected places that are sheltered on the north and west. Feature A is at an ideal observation point for the whole Chama Valley to the south and west. Voices and noises carry well to this area from the valley below. Even if the structure served as a village lookout, however, it also was lived in at least part of the time.

FEATURE B

General: This is the largest complex of structures at AR-4. It was not discovered until May 1975, at which time it was designated Feature B (Schaafsma 1975a; 1976:76). The complex of structures and enclosing slab and boulder walls

(Fig. 6) was initially thought to have been used for enclosing stock. Excavation showed that there were three primary habitations and that the feature was a major occupational part of AR-4. Feature B was flooded in 1973, and the high-water level covered the area with at least 2 meters of water The walls in the corral and other structures were badly damaged by driftwood washing against them, by wave action, and by the collapse of the ledge above the structures. When first seen in May 1975, the area was covered by a dense tangle of driftwood and weeds that grew after the flood (Fig. 7.) Most of the area was cleared of driftwood in May 1975, because at that time there was a possibility of doing test excavations there. However, no collections or excavations were made prior to the present project.

Seven structures were assigned subfeature letters for purposes of excavation -- BA, BB, BC, BD, BE, BF, and BG. Two crews were assigned to the excavation. Crew 2 under Steve Horvath worked on the east side (structures BA, BB, and BC) while part of crew 3 under Michael Marshal worked on the west side (BD, BE, BF, and BG). Fieldwork was done on August 30 and 31, and on September 1, 2, 6, and 7, 1977.

Situation: Feature B is located about halfway down the north slope of an unnamed side canyon at the south end of site AR-4 (Map 2). The upper slope is gravel. A ledge of sandstone outcrops at the base of the gravel slope which is the same sandstone ledge that forms the bench where nearby Feature A is located. The ledge, which is rough and broken, drops from 1 meter to 2.5 meters forming a protected, south-facing area at the base (Fig. 7). The structures are constructed at the base of this ledge, generally using the ledge as one wall. A sloping, narrow bench below the ledge offered space to locate the structures as well as the work areas. On the west between structures BE and BD, a retaining wall was built to enlarge this work area (Fig. 6). Below the bench where the structures are situated, there is another sloping bench area that has been completely enclosed by a stone wall. The stone wall continues to the lower edge of this bench where a steeper talus slope drops into the canyon bottom. Potholes in the canyon bottom occasionally hold water and must have been utilized seasonally. The whole area is hidden from the Chama Valley to the west by a point of the terrace (Fig. 7). The nearest other features are Feature A to the northwest and Features C and Q to the northeast.

Excavation Method: The site-wide grid system was extended over the feature. The grids near the structures were systematically surface collected using the 3-meter grid system. The grid squares around the structures were divided into 1-meter squares and, where feasible, were excavated to sterile clay or bedrock, and most of the exterior excavations were at the east end (below BA, BB, and BD). Vertical control was by 5-10 centimeter levels that were arbitrarily defined unless natural stratigraphy allowed other means for control. All excavated fill was screened through one-quarter-inch mesh. In a few places midden was left in order to support superimposed walls. The structures were not backfilled.

Description:

1) Corral Wall. Two large areas on the sloping bench below the structures are enclosed by stone walls (Figs. 6, 8, and 9). These walls are made of roughly piled, large sandstone boulders and slabs. While these are now knocked down for the most part (Fig. 9), the original extent of the enclosure can be readily determined. The walls were probably standing about 1 meter high in most places, if not more. Corrals of this nature and size are common on later Navajo sites in the San Juan Basin (Reher 1977: Fig. 2.18B), and similar stone corrals are found below the Hopi villages such as Walpi. Many of these later Navajo and Pueblo corrals make use of a natural cliff on one side and face south. This corral, like those of the later Navajos and Pueblos, probably was used to hold sheep and goats at night.

2) Retaining Wall for Occupation Terrace. The upper part of the corral below structures BE and BD is partly a natural sandstone ledge and partly a retaining wall made of loosely arranged boulders. The space formed above this retaining wall and natural ledge was leveled and partially filled to make a wide, level work area between structures BE and BD (Fig. 10). The ledge and wall are badly collapsed as a result of flood damage.

3) Structure BA. There is a group of three contiguous structures at the east end of the site (Figs. 6 and 11); BA is the eastern-most of these. Structure BA is roughly rectangular. The north wall is formed by the natural rock ledge, which is about 1 meter high. The west wall, which is shared with BB, is very wide and rather crude and is formed by a long pile of irregularly shaped boulders approximately 1 meter wide (Fig. 11). The south and east walls are built of slabs that have been piled between several large, natural boulders. Parts of the wall were built on up to 20 centimeters of fill. The walls are low and the structure may not have been roofed. The fill inside the walls was fairly thin, about 10 centimeters maximum. There was very little cultural material in the fill, and no charcoal was noted. Beneath the shallow fill was the underlying, sterile, red shale found on the bench. There were no features on this surface and no indications of a prepared floor. There also were no features on the floor which dips steeply toward the south (Fig. 11). The structure was apparently appended onto structure BB sometime after the latter was built.

4) Structure BB. This structure is the central room of the three contiguous structures at the east end (Fig. 11). Indications are that it was the oldest of the three and that it was a long-occupied dwelling. The outline of structure BB

is squarish. The structure shares walls with BC on the west and BA on the east. The walls are built on sterile, red shale. The north wall is the natural sandstone ledge 1 - 2 meters high. The room made use of a natural nook in the ledge, so part of the east side is also formed by the ledge. BB is well protected from the north and completely open to the south.

As in the adjacent structure BA, the interior fill was generally shallow, 10 - 20 centimeters in the upper area. For the most part, the fill was wind- and water-deposited sand with some lithics and a few sherds; it was not the result of a midden deposition. Beneath the fill was the same sterile, red shale that was found in BA. There were no floor features aside from the hearth against the south wall.

The hearth was first indicated by the fire-reddened rocks in the wall of this area. Excavation revealed a definite hearth on the floor below the fire-reddened wall. A large area on the south floor (Fig. 11) was covered by a layer of charcoal and white ash; a few obsidian flakes were found in the hearth fill. There was no special preparation of the hearth area; the fires were built on the clay floor against the wall.

Although there were no indications of the nature of the roof and superstructure, the apparent height of the original walls indicate that this dwelling was covered. The ledge must have been used in constructing the roof and upper walls. Presumably this upper structure was made of logs, brush, and mud, which have since eroded; there is no indication that the structure had burned.

5) <u>Structure BC</u>. This structure which was added to BB, must be one of the latest structures at Feature B, if not at AR-4. The structure is roughly triangular and is not built against the natural ledge (Fig. 11) but is separated from the ledge by a wall. The wall shared with BB and the wall on the northwest rest on sterile shale, but on the west and southwest the walls were built on a midden that antedates the structure (Profiles in Fig. 11 and 12). Away from the midden, the fill is 5 - 10 centimeters thick; below the fill is the underlying red shale of the bench. Lithics, ceramics, and occasional bones were found in the fill. Although charcoal pieces were in the fill, it was not an ash-dump. There was no prepared floor, and the used surface was the underlying clay. This used surface slopes from north to south. A natural depression in the southwest corner accumulated midden before the structure was built; when the structure was being used, the top of the midden was part of the used surface. There were no floor features nor were there indications of hearths such as reddened walls or ash lenses. There were no indications of the roof or superstructure. The low height of the walls and the distance from the natural ledge suggest that BC was not roofed.

6) <u>Terrace Downslope from BA, BB, and BC</u>. The whole terrace below these structures was excavated down to sterile

shale using one-meter square horizontal control. This area proved to have only a thin cover of washed material with occasional lithics and ceramics. Only in the west under and below structure BC did the deposit have depth, and this area was definitely a midden. Away from the midden, the deposit was 5 - 15 centimeters deep. The clearing was carried upslope to the base of the walls (Fig. 12); this necessitated removing a great deal of collapsed wall fall that overlaid the fill. Under the wall fall below BC, a copper ring was found (meter square 2 of grid CG-225) in the upper fill beneath the wall slabs. A charcoal and ash lens (20 x 30 centimeters) was found outside the wall of structure BB; as it continued under the wall it may have been drift from the hearth on the other side of the wall.

7) Midden Outside of and Underneath Structure BC. A naturally low place in the bench had been used as a trash dump prior to the construction of structure BC. The resulting midden had a mixture of light-gray soil, with abundant lithics and sherds, and dense black layers of charcoal-rich ash indicating an ash dump. This midden was excavated as subfloor levels inside of structure BC (Fig. 11, Profile A'-A) and as levels exterior to BC. It was of variable depth; in the middle it reached 30 centimeters below the surface. Meter squares 1, 2, 6, and 7 from grid CH-224 outside of BC alone produced 236 sherds (12.0 percent of all sherds from AR-4). Nearly every ceramic type present on the site was found in this midden (see "Ceramics" section of Chapter V): Plain Culinary; Tewa Unslipped; Tewa Red, Buff, Gray, Brown and Maroon; Tewa Polychrome; Tewa Mica Slip; Penasco Micaceous; Vadito Micaceous; and 43 of the 46 Hopi sherds from the site. The Hopi sherds were mostly in the upper level. Thus they were present on the site, and thrown away, before structure BC was built. As will be discussed, this midden is important in unifying the construction sequence of the structures.

8) Structure BD. Prior to excavation, this structure was apparent as a roughly rectangular jumble of collapsed boulders and slabs covered by recent brush (Fig. 13). Excavation determined that the structure was a dwelling and that it was occupied twice, with the structure being used as a trash dump between the occupations and after the second occupation. The structure is best discussed beginning with a description of the initial construction.

A rectangular dwelling with comparatively well-laid sandstone slab walls was built against the base of a high section of the ledge in the middle of the Feature B area (Fig. 6, 11, and 13). This structure made use of the natural ledge on the northwest side and had original walls over 1 meter high (Fig. 14). The walls rest on natural shale. The floor of this original house was the natural, red, bench shale which had been leveled and cleared. There were no floor features; however, the hearth for this oldest house was indicated by fire-reddening on the ledge in the northeast corner. It was not possible to expose this hearth without destroying the wall added by later occupants.

This structure was then abandoned, and, during the subsequent period, the fill which was removed as levels 3 and 4 (Fig. 11, profile C-C') accumulated. Together, levels 3 and 4 were 20 centimeters thick (Fig. 15). The two levels are arbitrary divisions of a uniform deposit consisting of alternating layers of ash-rich midden and windblown sand. The deposit was rich in artifactual material -- lithics, sherds, bones, and so forth. The structure was clearly used as a dump during this time.

When reoccupied, the accumulated midden was leveled and a layer of light brown, sandy, adobe clay 2 - 5 centimeters thick was spread over the midden as a prepared floor (Fig. 11 and 16). In certain areas where this floor was best preserved, a thin (1 centimeter) layer of blow sand between two clay layers indicated that the floor had been resurfaced at least once. At the time of reoccupation, a wall was built that separated the interior from the natural ledge used by the previous occupants. This rough wall rests on levels 3 and 4, which continue underneath it (Fig. 11). This wall made the interior space of the remodeled dwelling somewhat smaller than the original structure.

There was a hearth on the new floor (Fig. 11 and 16), which represents a definite cooking complex in the northwest corner. The clay floor in this area was burned red and was covered by a thin carbonized wood layer. A long slab (85 centimeters x 10 centimeters) served to contain the fire. The slab was added sometime after the fire had been used; there was a 4-centimeter-layer of charcoal from the fire area under it. Two small, burned slabs, probably comal or cooking slabs, were in the hearth area. These slabs measure 25 centimeters x 20 centimeters x 2 centimeters and 15 centimeters x 15 centimeters x 1 centimeter.

There are 5 slabs on the east side of the structure resting on the upper floor. They are not clearly wall fall and may have been some kind of floor feature.

The structure was then abandoned a second time. The interior of the structure again became a trash dump which was excavated as level 2 (Fig. 11). This layer consisted of black and white ash mixed with charcoal-rich, sandy soil; it contained pottery and other occupational debris. The thickness of the layer was variable, 30 - 50 centimeters against the northwest wall and 10 - 20 centimeters at the southeast wall. Clearly someone continued living in the general area after reoccupation of structure BD had ended.

Level 1 accumulated after whoever had added the midden of level 2 also had moved away. This layer consisted of sandy loam with associated blow sand and fallen wall slabs. It had a very low artifact density and was devoid of charcoal stains or flecks. Much of it must have washed in from the slope above.

No evidence of the upper walls or roof was found anywhere in the fill of this complex structure. Two postholes, however, were found in the upper floor. The southeast posthole (Fig. 11) was 12 centimeters in diameter and 50 centimeters deep. The post was still in place and was collected as a dendro-specimen which was later found to be undatable. The southwest posthole (Fig. 11) was 12 centimeters in diameter and 50 centimeters deep; it contained wood traces. These posts cannot be obviously related to the roof construction, but they were well-placed to have helped support beams that might have spanned the room from the south wall to the north ledge. Since they are dug into the upper (remodeled) floor, they may have supported an old, sagging roof from the original occupation.

Two small basins were pecked into the bedrock behind the structure. Their use is unknown.

9) Integration of Structures at East End. An examination of the ceramics from structure BD and the nearby midden provides clues to the sequence of occupation and also some valuable insights into the time of occupation of the whole Feature B. The "Ceramics" section discusses the rarity of Tewa Mica Slip pottery and the fact that all the sherds of this type from AR-4 were found in Feature B. It is also observed that all sherds of this type probably represent one broken vessel. A closer inspection of the provenience of these sherds shows that they were all from either the midden outside of structure BC (in grid CH-224) or from levels 3 and 4 inside structure BD. Since these sherds probably represent one vessel, the presence of sherds in both trash deposits indicates that the deposits were contemporaneous and that some of the trash containing this broken vessel was dumped in the midden while some went into the abandoned structure BD. Whoever filled up the midden in grid CH-224 was also throwing trash inside the abandoned structure (levels 3 and 4 inside structure BD). Spatial proximity indicates that the trash was dumped by the inhabitants of structures BB (Fig. 11). This relationship allows a probable reconstruction of the history of the area.

Structures BB and BD were both built early, perhaps at the same time and perhaps when AR-4 was first being settled. After some time, the dwelling labeled BD was abandoned, but dwelling BB continued to be occupied. The inhabitants of dwelling BB threw their trash into a low spot to the west (grids CH-224 and 225) as well as into abandoned room BD. This practice continued a fairly long time--through the build-up of levels 3 and 4 (20 centimeters) in room BD and until the midden contained 20-30 centimeters of fill. It was during this period that the two Hopi, wide-mouthed jars were thrown away. Then someone moved into abandoned room BD. They smoothed out the trash inside, laid a 3-to-5-centimeter layer of clay as a floor, and walled up the bare rock on the northwest side. They may have shored up a, by then, sagging roof with two upright posts. Perhaps at this time, the inhabitants of structure BB added structure BC as a lamb pen and/or storeroom, since they built this structure over the midden. So, perhaps the building of BC and the reoccupation of BD represent a second construction period.

Structure BD was once again abandoned and the inhabitants of BB again used the structure as a trash dump, as shown by the ash lenses and artifactural material that accumulated above the second floor (level 2). Structure BC was probably used by the inhabitants of BB as a storage room or lamb pen as long as they were there, since the trash buildup there was minimal. The same was true of structure BA which was not used as a trash dump at all.

The pattern of trash buildup and construction in this area indicates that BB was inhabited continuously, as long as Feature B was occupied. Structure BB was therefore a long-lived dwelling. Level 1 in both structures BB and BD represents water-wash and windblown soil accumulated after the final abandonment of Feature B and, in all likelihood, the abandonment of AR-4.

10) Structure BE. Structure BE is part of a complex of 3 structures at the west end of Feature B (Fig. 6 and 17). The 1973 flood damaged this area quite severely; many of the walls were knocked over by driftwood (Fig. 18) and heavy slabs from the ledge behind the structures fell into the rooms. The structures are built at the base of the same sandstone ledge as those farther east in Feature B. In this area, the ledge is about 2 meters high.

Structure BE is D-shaped, being 2.2 meters northwest-southeast x 1.9 meter northeast-southwest (Fig. 19). Walls are of dry-laid stacked masonry; elements are sandstone blocks with only an occasional slab. No chinking is present nor is there any indication of mortar. Present wall height ranges from 45 centimeters to 1.0 meter, there being from 2 to 6 courses remaining. Abundant fallen wall material indicates that the walls were formerly considerably higher, at least 1 meter all the way around. The average wall thickness is 50 centimeters. The walls rest directly on the sterile red shale. An entry exists in the southeast corner where there is a gap approximately 75 centimeters wide.

The fill within the structure was from 15 centimeters to 20 centimeters deep. This material was removed in two levels of 10 centimeters each. Level 1 consisted of surface duff and an upper margin of sandy loam; level 2 was sandy loam mixed with charcoal and the bottom of the level was the sterile clay undersurface. A thin layer of dark charcoal-rich midden existed in the north and northwest half of the structure.

This layer was 4 - 8 centimeters thick. Most of the artifacts associated with level 2 came from this layer. This midden contained small, carbonized charcoal fragments, white ash, and an unidentified organic fluff. Small quantities of sherds, lithics, and bone were in the upper and lower fill.

The well-defined floor surface consists of the sterile bench clay. This surface dips rather sharply toward the southeast, reflecting the original ground surface. There were no floor features. No evidence of a hearth was present on the floor, nor were any of the walls reddened by fires. There is no indication that this was a dwelling. It was occasionally used as a dump.

11) Structure BF. This square masonry room was evidently the dwelling for the complex of structures at the west end of Feature B (Figs. 17 and 20). The north and northwest wall of the room is the natural sandstone ledge, which here is 2.0 meters high. The other walls in the unit are dry-laid, stacked masonry; no wall chinking or use of mortar is evident. All the wall elements are sandstone; both blocks and slabs were used. The average size of the wall elements is estimated to be 40 centimeters x 30 centimeters x 20 centimeters. Existing wall heights range from 25 centimeters to 80 centimeters with 2 to 6 courses remaining. Sufficient fallen wall material (approximately 2 cubic meters) was removed to suggest that the original wall height was nearly 2.0 meters, or as high as the sandstone ledge behind. No well-defined entry was apparent. However, a low area in the southwest wall 1 to 2 courses high and 60 centimeters wide may have been an entry. It is also possible that the room was entered by a raised entry from adjacent structure BE which has the previously described exterior doorway in the southeast corner.

Depth of fill within this structure was for the most part 20 centimeters except in the hearth pit adjacent to the southeast wall where fill extended to a maximum depth of 35 centimeters. The fill was generally sandy loam with occasional charcoal flecks. Small amounts of sherds, lithics, and bones were in the fill. The fill in the hearth pit was charcoal and ash-laden. Level 1 is 0 - 10 centimeters; level 2 is 10 - 20 centimeters with a sterile clay base. Level 3 is the hearth pit fill only, which is 20 - 35 centimeters below surface.

The floor, which dips slightly toward the southeast, is the underlying, sterile, bench clay. A large rectangular sandstone slab, 80 centimeters x 30 centimeters x 5 centimeters, rests on the floor in the east corner. There is no evidence of shaping or wear. There was some charcoal-laden fill around the slab and some partially over it. The slab could have been used as a "table" adjacent to the hearth.

A hearth definitely existed in the southwest corner of the room. The indications are: burned, masonry wall elements;

an irregular subfloor pit; concentrations of charcoal and ash-laden soil; and burned clay surfaces on the floor extending 80 centimeters from the south wall. Because of erosion, the actual form of the hearth is undetermined. Numerous disarticulated slabs occurred in the pit fill suggesting that the hearth was at least informally contained with slabs. Part of the difficulty of determining the nature of the hearth is related to the steep dip of the original ground surface here. The low area was partly filled to level the floor surface and partly employed as the hearth pit. This low area is 1.30 meters east-west x 50 centimeters north-south x 30 centimeters in depth.

There seems to be little question that BF was a dwelling and that it was probably the first structure built in this area. The others were likely added later as storage rooms and/or lamb pens. The whole complex may have been entered by the entry way in structure BE which opens directly onto the level work area that was built up with a retaining wall between this habitation area and structure BD.

12) Structure BG. This small rectangular room shares walls with structure BF to the southwest and structure BE to the southeast (Fig. 17). The northwest wall is the natural sandstone ledge (Fig. 21) which is 1.8 meters high. The walls are constructed of dry-laid, stacked, sandstone masonry elements. Most of the elements are blocks; there are only a few slabs present. No chinking or mortar are present. Average size of wall elements is estimated at 45 centimeters x 25 centimeters x 20 centimeters. Wall height presently ranges from 30 centimeters to 1.20 centimeters with 3 to 7 courses existing. The original walls and roof level may have been near the top of the natural ledge. A large boulder fell into the room from the ledge and rests on the upper fill. This boulder prevented the removal of approximately one-half of the fill.

Fill within the structure consisted of sandy loam containing occasional charcoal fragments but very little artifactural material--only 2 sherds were recovered. Level 1 is 0 - 10 centimeters, consisting of loose surface duff and upper fill. Level 2 is from 10 - 20 centimeters, consisting of sandy loam over the floor surface. The floor is the sterile, red shale substratum with a fairly level surface. There were no floor features evident in the area that could be excavated. There is no indication of an entry nor of the roof.

The location of this small room beside the dwelling BF and its lack of interior features suggest that this was a storeroom for the habitation complex (Fig. 17).

Fig. 7: Feature B, overall as seen in May, 1975. Note large logs and broken ledge above structures.

Fig. 8: Lower part of corral wall below structures BE and BD.

Fig. 9: West side of corral wall below structure BE.

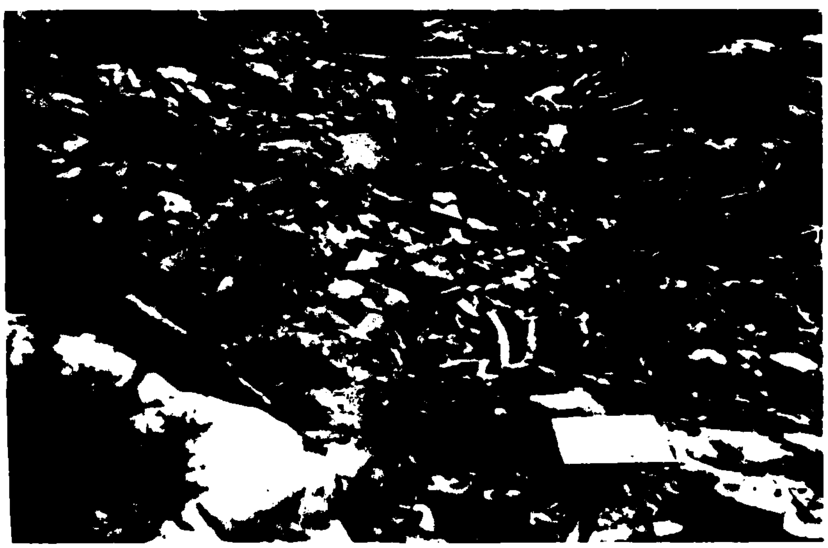
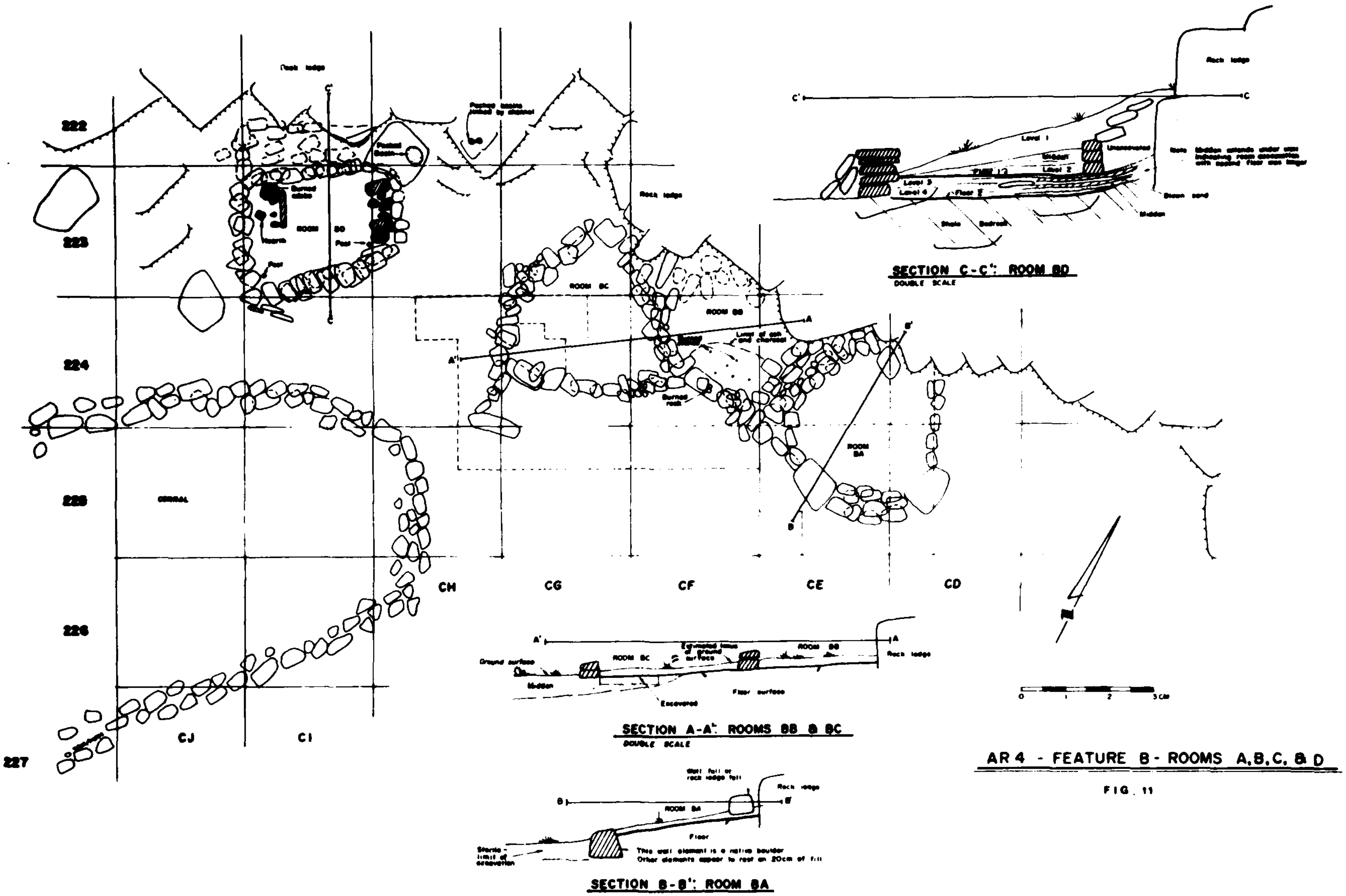


Fig. 10: General view of central Feature B from above structure BE, looking toward BD and BB on east. Note flat work area in foreground.



AR 4 - FEATURE B - ROOMS A,B,C, & D

FIG. 11

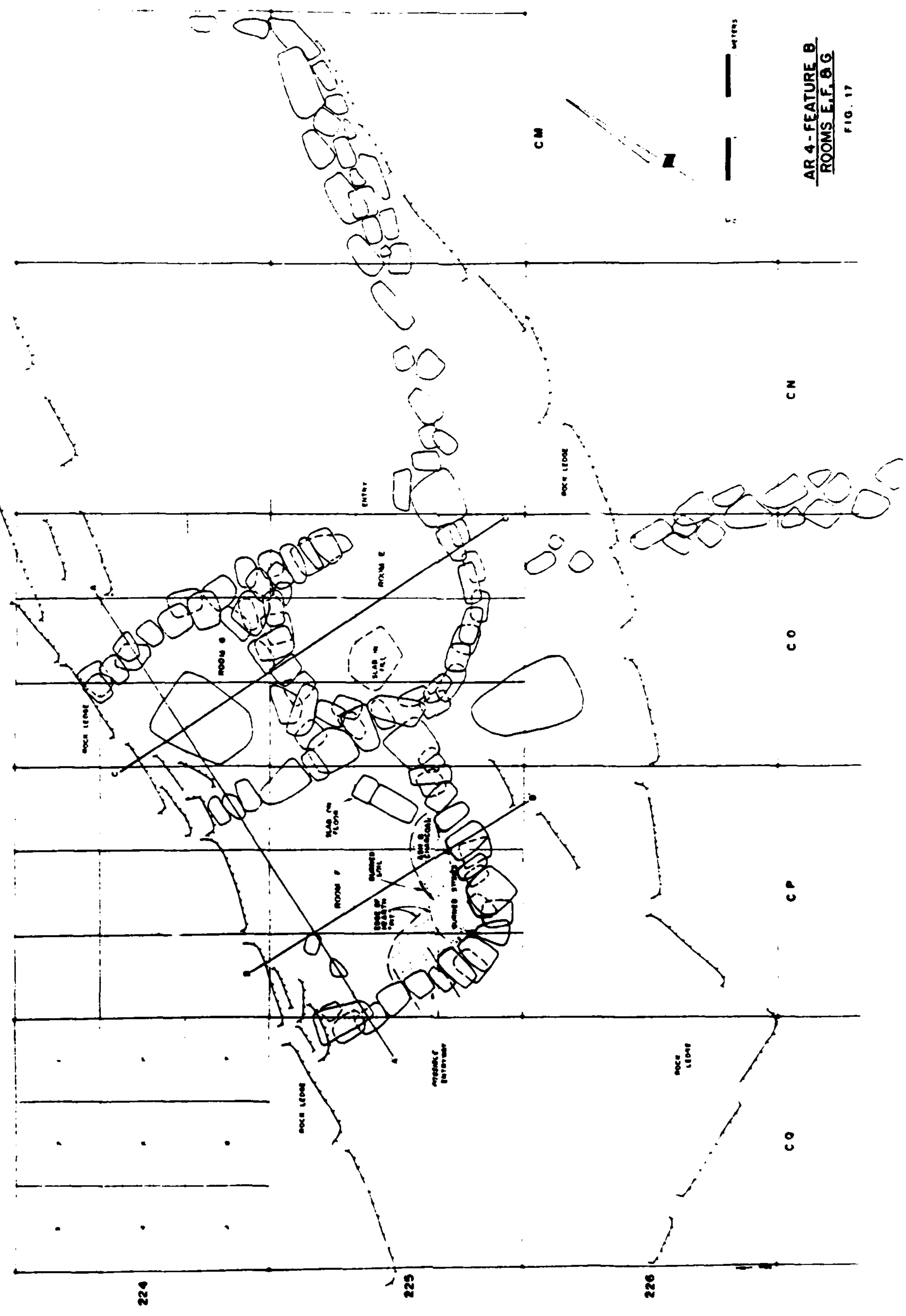
Fig. 12 -- Structure BC, Feature B, overall view west. Note slope and nature of walls and midden under south wall.

Figure 13 -- Structure BD prior to clearing or excavation. Arrow sits on south wall fall. Note sandstone ledge to northwest.

Figure 14 -- Structure BD from ledge above. Floor (#2) is natural red shale. Trowel points north.

Figure 15 -- Levels 3 and 4 half removed from structure BD. Note slab in lower fill. Upper surface is floor #1.

Figure 16 -- Upper floor (#1) of structure BD. Note hearth and slab area in northwest corner.



AR 4-FEATURE B
ROOMS E, F, & G
FIG. 17

Figure 18: Structures BF, BE, and BC before excavation.
Note long driftwood log and displaced masonry walls.

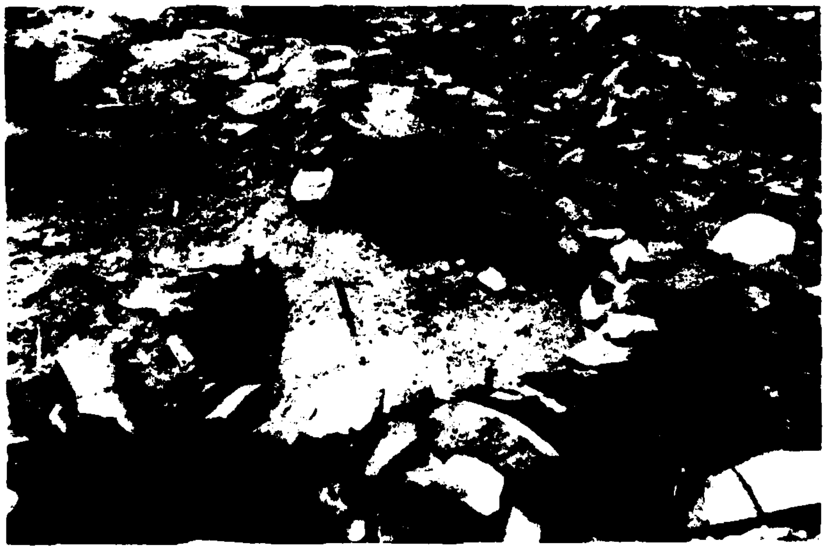


Figure 19: Structure BE after excavation.

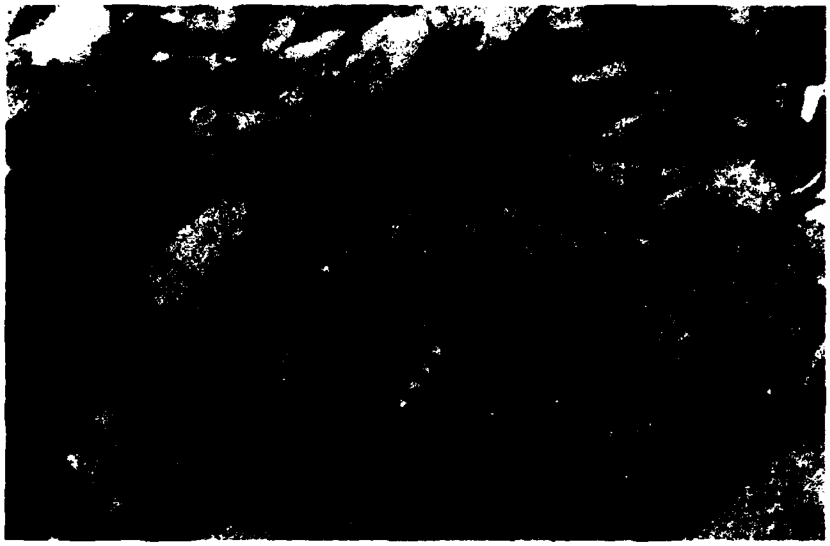


Figure 20 -- Structure BF after excavation. Note slabs on floor and pit in south where midden below hearths was removed.

Figure 21 -- Structure BG after excavation. East wall in foreground, structure BF (dwelling) in background. Large boulder in structure fell into room during 1973 flood, and could not be removed.

Summary of Feature B: Three separate habitations once existed at the base of a sandstone ledge overlooking a small side canyon. The whole settlement was hidden from the Chama Valley to the west. Two of the dwellings have associated smaller buildings which appear to have been added after the main dwellings were constructed. Below the ledge that was a common work space for all dwellings is a sloping ledge enclosed by stone walls. This area was almost certainly used for confining sheep and goats, the bones of which were found in the trash areas inside the structures and beside them. Of considerable interest is the copper ring found below the wall fall of structure BC. The Jeddito Yellow ware found in the midden outside of and underneath structure BC reveals a significant trade connection between the occupants of this site and the Hopis, who were some 200 miles to the west.

FEATURE C

General: This structure was found in May 1975, and the feature letter was assigned at that time. It has been described in two previous reports (Schaafsma 1975a; 1976). Survey indications suggested that it was a dwelling. The structure was not flooded in 1973 nor had there been any vandalism. The excavation, done between August 26 and 30, 1977, was directed by Richard Lang. Part of the time Lang's crew 1 was assisted by members of crew 3. A total of 10-man-days were spent on the excavation. The feature map was made by Susan Hunter.

Situation: The structure is located near the top of a high gravel terrace to the south of Arroyo de Comales (Map 2). The terrace is covered with short grasses, low narrow leaf yucca, and widely spaced one-seed junipers (Fig. 22). Water was seasonally available in the arroyo, and in the somewhat distant Chama River. Feature Q is nearby on the terrace edge to the west, and Feature P is also nearby toward the north (Map 2). The 3 structures almost certainly represent an interacting social group.

Excavation Method: The site-wide grid system was laid over the feature area (Fig. 23). A total of 16 grids were surface collected from the area bounded by rows of AR-AU and columns 184-187 (Map 2). The main structure lies in grids AS-186, and AS-187; excavations were also made in grids AR-185, AR-186, AR-187, AS-185, AT-185, AT-186, and AT-187. All horizontal surface collections and excavations were controlled with one-meter square divisions within the larger 3-meter grid squares. Vertical control was by arbitrary levels--generally one, only 5 centimeters deep.

Description: Before excavation, the structure was indicated by a loose pile of boulders (Fig. 22) on the terrace top where such accumulations did not occur naturally. To the south of the pile was a trash area with a relatively large number of sherds and lithics.

The excavated structure is C-shaped with a wide opening on the south-east side (Figs. 23 and 24). The wall was primarily formed of cobbles and boulders obtained on the terrace margin; the nearest present sources are 12 meters to the west. The few sandstone slabs appear to have been obtained from outcrops about 42 meters downslope to the west. The variable density of the fallen material indicates that the original wall must have been irregular in height. The maximum height, indicated by the fallen wall elements, was on the northwest where it may have been 50 centimeters. Rocks used in the walls averaged about 25 centimeters x 22 centimeters x 12 centimeters, with individual elements ranging from 58 centimeters x 48 centimeters x 23 centimeters to 15 centimeters x 12 centimeters by 8 centimeters. The projected original interior dimensions are 2.0 meters north-south x 3.0 meters east-west. The opening on the east/southeast is 2.8 meters wide.

The soil removed is level 1 both in and out of Feature C was about 5 centimeters thick. It was sandy and of a light orange-brown color. Thin layers of ash were in the lower fill above the floor. Artifacts were not common. A total of 22 sherds were recovered, most of which were in the wall fall on the south side (grid AS-187) or under the surface to the south of this wall. All sherds were from the Tewa villages and there were 5 sherds of Tewa Polychrome. There were 101 lithics collected. It was observed that a significant number of lithics were on the surface suggesting that some deflation had taken place since abandonment of the structure.

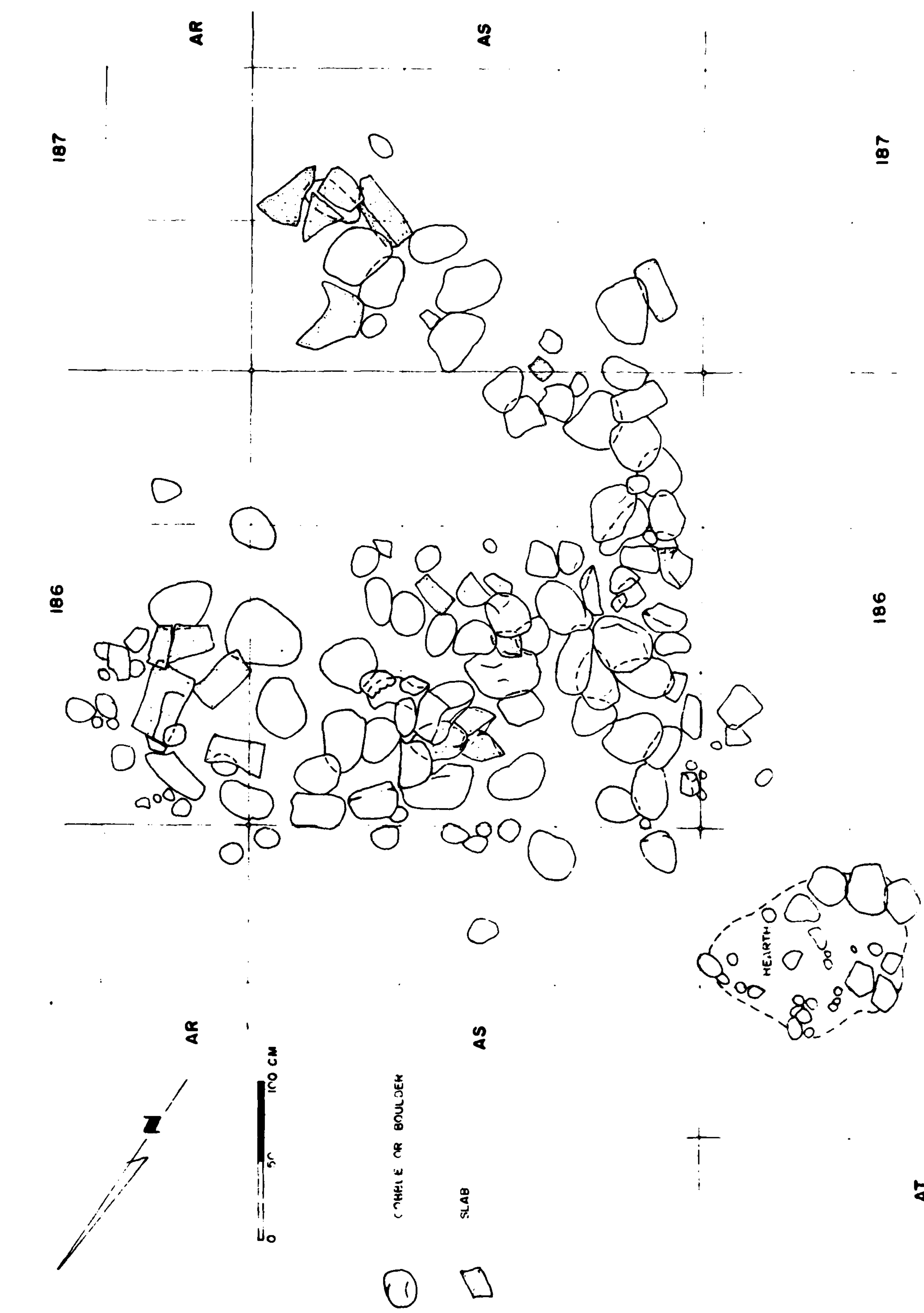
The floor is on a natural surface about 5 centimeters below the present surface, as is the original ground surface (below fill) outside of the walls. The floor is distinctive in that it is somewhat compacted and there is an ashy lens over the floor area and into the interior wall margins. The ashy gray-brown sand layer is about 0.5 centimeters thick and is most obvious in the south interior and under the south walls. Light traces were found under the west wall rubble. No evidence of a hearth area was found although the ash indicates the construction of fires within the feature.

The walls may well have supported some perishable upper material such as logs and brush. On the other hand, a log, brush, and mud mortar structure could have been present for which the rocks were a basal support. If so, the structure may have been similar to a forked-stick hogan. This would be consistent with the entry way on the east side and with the fact that the wall rubble lies over the ashy layer on the original floor. However, there is no evidence of postholes and log remnants which would indicate that such a superstructure existed.

Lang suggests that there probably was no superstructure and that the cobbles were simply piled as an arc, which would have been some 50 centimeters high on the northwest, the area most exposed to the wind, and open to the east and southeast. It would thus have been an open windbreak work area related to nearby Feature Q which has more attributes of a dwelling. This hypothesis would be in agreement with the inordinate width of the southeast opening which measured 2.80 meters.

There is an exterior hearth on the northwest (Fig. 23). This is an area of ashy, grayish orange-brown, sandy soil in which there are about 30 burned cobbles which may be in their natural positions. The area is 1.10 meters north-south x .70 meters east-west. The ash is 1.5 centimeters deep. There is no soil reddening. A few pieces of charcoal were large enough to warrant collection as possible dendro specimens (not datable).

Figure 22: Feature C before excavation. Background is near Feature P. View toward north.



AR 4 - FEATURE C

FIG. 23

Figure 24: Feature C, after excavation. Note exterior hearth in foreground.

FEATURE D

General: This structure was discovered in May 1975, at which time the feature letter was assigned. It was described twice before (Schaafsma 1975a; 1976). It has not been flooded or vandalized. The surface remains of the structure combined with the amount of surface ceramics indicated that it was undoubtedly a collapsed dwelling--an appraisal confirmed by excavation. The excavation was directed by Richard Lang. The dates of collection and excavation were August 16-25 and September 2, 1977. A total of 76 man-days were spent on the work at this feature.

Situation: Feature D is located on the sloping terrace top to the north of Arroyo de Comales (Map 2). The narrow, steep-walled canyon of the arroyo lies about 200 feet to the southeast; and, to the immediate south and west, two shallow drainages flow toward the canyon (Map 2). Feature D was built in a triangle of soil and rock that lies between these drainages. The locality is primarily exposed to the south and is protected from the north by a rise in elevation to the north and northeast. The area offers outside work areas on a reasonably gentle slope. The structure was constructed on a gently sloping sandstone outcrop on which there was a low ledge (28 - 46 centimeters high), which was used for the northeast side of the feature (Fig. 25).

The vegetation in the bottom of the drainages is predominately four-wing saltbrush, snakeweed, black sage, and grasses, with sage and grass dominant. Sandstone outcrops are extensively exposed. Near the feature are one-seed junipers. Chamisa and wolfberry were growing on the feature but were not present over the adjacent terrain.

Excavation Method: The side-wide grid system was laid over the feature and immediate area. Surface collections were made from an area of 90 grids, bounded by Rows A-J and columns 105-113 (Map 2). The vegetation over the structure (Fig. 26) was then cleared. Excavations were begun with the grids exterior to the structure which left the structure and the interior fill as a raised area (Fig. 27). Horizontal control within the excavated grid squares was by 1 meter squares; vertical control was maintained by arbitrary levels below the surface collection, except where natural layers and lenses could be followed. It was obvious that a great deal of soil had washed downslope from the north and covered the original walls. After the interior fill was removed to the floor, the structure was mapped and final photographs taken. Finally, the subfloor fill was removed to the sterile bedrock. All excavated material was screened with one-quarter-inch mesh.

Description: The excavated structure (Figs. 25, 28, and 29) is roughly rectangular, being slightly constricted on the northeast side. The wall base consists of dry-laid, stone masonry, and indications are that the upper walls were made of horizontally laid logs. The doorway was near the east end of the southeast wall. The roof apparently was essentially flat with a firebox or paved hearth area on it. Inside there was a smoothed dirt floor with a hearth area on the west end. Several exterior hearths were found and extensive middens exist around the feature.

The walls rest directly on the underlying bedrock. They are formed primarily of sandstone slabs rather irregularly placed but leaving only small spaces between. Some shale slabs were used, and some blocky sandstone rocks are present, but they are less common than the slabs. Most slabs were obtained in the immediate vicinity of the structure, but a few are of the blocky conglomerate that outcrops on the north side of Arroyo de Comales. This conglomerate was used only near the top of the wall courses suggesting that, as the lower walls neared completion, immediately available stone became scarce, and a small quantity had to be carried 200 feet from the canyon rim to the southeast. The slabs ranged in size from very large elements (76 centimeters x 45 centimeters x 14 centimeters) used in main courses to small slabs used as chinking. There were no indications of mortar. Estimated maximum original height of the stem wall is 1 meter, as suggested by measurements of fallen and standing wall portions. Wall height diminished from SW to NE (upslope). Maximum intact wall height is 59 centimeters as measured outside the northwest corner. The height lessens toward the upper end near the natural ledge where the wall is only 26 centimeters on the northeast. The number of stone courses in place were: zero to 1 on the northeast (bedrock area); 1 to 9 on the northwest; 5 to 9 on the southwest; and 5 to 6 on the southeast, except in the doorway area where only 2 to 3 courses were present (see below). Wall width showed considerable variation ranging from 54 centimeters to 1.17 meters at the west corner. The west and south downslope corners are the most massive (Fig. 25).

The doorway is located in the southeast wall, 83 centimeters from the natural sandstone ledge; the width of the door is 73 centimeters. The width of the wall at this point is 69 centimeters. The wall here is 2 to 3 courses high and measures 15 to 31 centimeters on the southside and 12 to 22 centimeters on the inside. Unlike other wall slabs, the surface of the sill slabs is very worn. Sill slabs have been burned red on the southeast margin through the use of an outside hearth adjacent to and partially overlapping the door sill.

The fill inside of Feature D was divided into two levels. Level 2 was used to isolate the fallen roof hearth and pavement area of the roof fall. Both levels 1 and 2 were essentially a mixture of fallen roofing materials, rotted wall wood and wall rock, and sand, primarily in the northeast end, which had washed and blown into the feature from the rock ledge upslope on that side. Aside from the ashy deposits of level 2, the fill may be described as a medium to light brown, sandy soil containing relatively few artifacts. Most of the artifacts found were resting on the floor surface. Several sherds representing a partial bowl and plate of Tewa Black-on-White were found on or just above the floor surface.

In order to prepare a level floor surface, the slope of the natural ground surface on the southwest, which was mostly bedrock, was modified by dumping relatively clean, ashy soil containing some sherds, lithics, and bones into the area confined by the feature walls. This deposit of subfloor fill was designated level 3 and was removed separately. The surface of the resulting floor, while relatively smooth and level, had the general appearance of a slightly compacted trash deposit. There was no special layer of adobe clay as there was at structure BD in Feature B. The floor curved up toward the walls at the northeast end. Some damage to the floor had been done in various places by rodent burrows. In the northwest corner, an area of the floor about 60 centimeters in diameter located directly against the northwest wall exhibited a texture like that of a wet-laid adobe floor. This does not appear to be a special floor covering, however, but the result of a combination of drippage from an opening in the roof above, possibly a smokehole, and of the construction of fires on the floor. (The floor exhibited fire-reddening.) Both causes would have the effect of hardening the floor surface.

The interior hearth was consistently constructed at the west end on the dirt floor surface. It had been moved about, however, on a north-south axis, resulting in fire-reddening and smudging of a wide area of the west sector of the floor (Fig. 25). The floor surface thus altered extended about 1.10 meters southeast from the northwest wall over an arc about 50 to 70 centimeters wide. The far southwest portion of the hearth area was apparently the latest used, as it was covered by a deposit of white ash about 5 centimeters thick in the center. This deposit was about 80 centimeters in diameter. Unlike other hearth loci in the Feature D area, the ash of the terminal fire was apparently not cleaned out prior to abandonment. At any one time, the hearth area would have occupied about one-seventh of the interior space. An archaeomagnetic sample was collected from this hearth.

Located in the fill of the west-central part of the structure were the remains of a fallen rooftop, hearth complex. This fallen hearth consisted of about 27 slabs of various sizes which exhibited soot blankening, ash coatings, and/or fire-reddening on one surface (Fig. 30). An ash deposit was found both above and beneath the slabs, and there was a related cluster of small, rounded cobbles. The ash of this hearth was concentrated over an area about 52 centimeters in diameter, with a maximum depth of about 10 centimeters. The color of the ash was generally very light gray and was of low organic content. The base of this ash deposit was separated from the floor of the room by about 7 centimeters of slightly organic, sandy soil that apparently had been derived from the roof. On the southwest side, the slabs of the rooftop hearth complex lay up to 38 centimeters above the floor, separated from it by the sandy, organic soil noted as well as by the ash deposit of the floor hearth. This situation suggests the likelihood that close to 40 centimeters of soil capped the roof. The nature of the hearth, which is suggested by the relative distribution of ash and slabs, was a shallow pit excavated into the earth on the roof and rimmed with slabs set on edge and surrounded by slab paving. The hearth was apparently positioned to the southeast of the smokehole. The distribution of slabs in the fill below the hypothesized smokehole suggests that there was a slab coping in the smokehole area. The cluster of 5 or more small, roundish, burned and soot-blackened cobbles about 70 centimeters south of the center of the ash deposit represents cobbles used in some stone heating procedure. They had been piled to the southeast of the hearth area sometime prior to the roof collapse.

The upper walls of Feature D were likely made of logs laid horizontally, as no evidence of adobe walls is present in the fill or exterior soil deposits and there was not enough stone present (Fig. 28) to raise the walls much above 1 meter. The area bordering the collapsed rock wall base on the northwest and east exhibited fill up to about 19 centimeters thick and almost exclusively of rotted wood. Occasional fragments of unrotted wood representing the cores of larger logs as well as charcoal fragments were encountered in this deposit. The roof was likely made of horizontally-laid beams, brush, and up to 40 centimeters of dirt. A reconstruction of the dwelling based upon the field evidence, drawn by Richard Lang, is presented in Figure 31.

Three hearths were excavated outside of Feature D, and 2 additional hearths may be present. The largest excavated exterior hearth lay in the north grid quarter of grid F-109, directly in front of and partially overlapping the door sill (Fig. 25). Fires initially built here burned the bedrock red as well as the natural patches of sand. At some undetermined point, part of the door sill was also burned, along with portions of the rock wall exterior. Ash and trashy soil containing carbonized wood fragments lay downslope to the southwest of the burned area. The hearth was from 5 to 10 centimeters below the surface, and the diameter was about 1.2 meters north-south and 1.1 meters east-west. This is the locus of the C-14 sample.

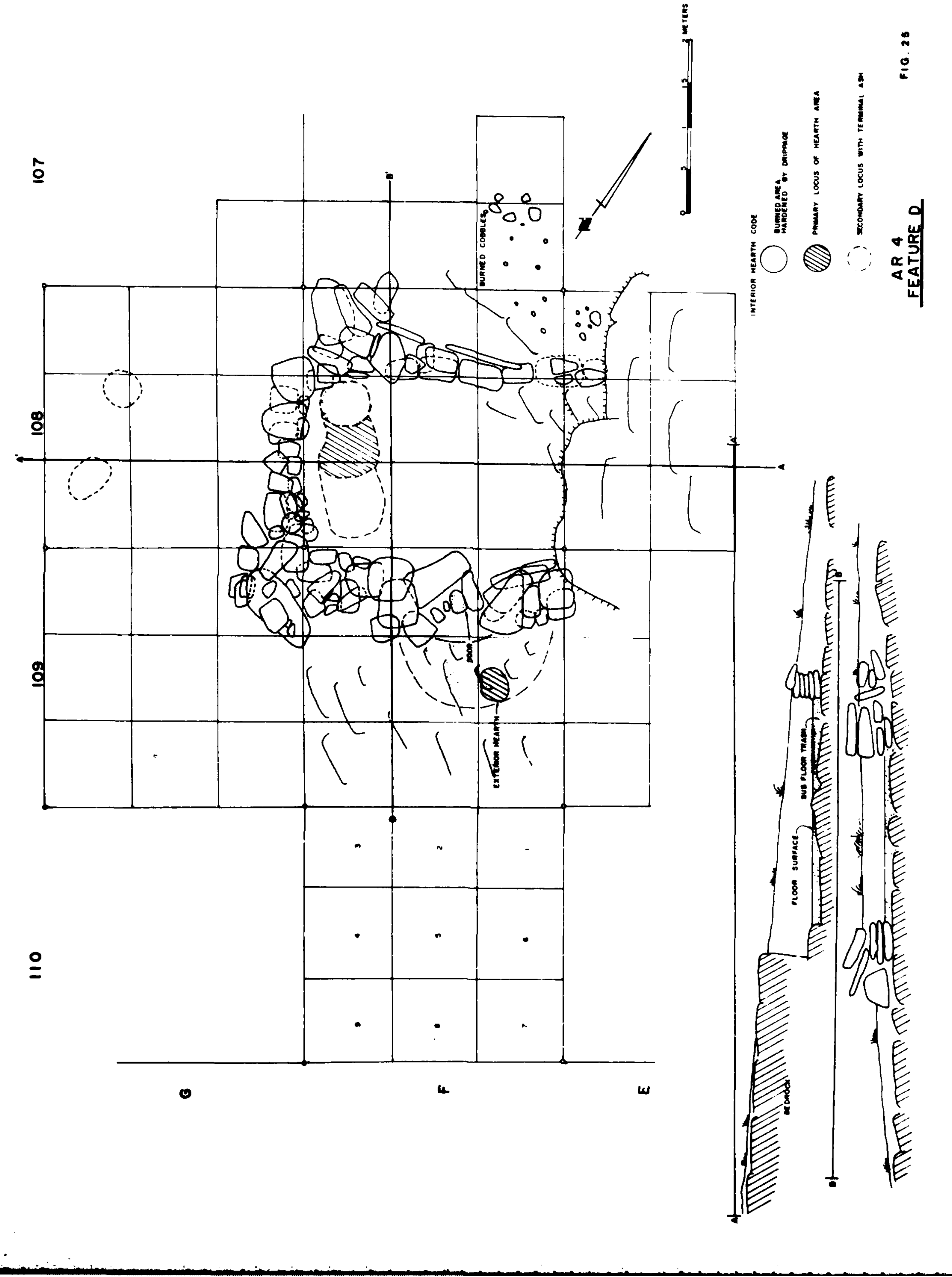
Two other exterior hearths were present to the west of the structure in grid G-108 (meter squares 9 and 4). Both were indicated by fire-reddened soil and surrounding soil flecked with carbon, and both were from 4 to 8 centimeters below the surface. The diameter of the southern hearth was

55 centimeters north-south 45 centimeters east-west. The diameter of the northern hearth was 45 centimeters.

A fourth possible hearth was found 4 centimeters below the surface on the north side of the structure (grid F-107, meter squares 6 and 7). This is a 10 centimeters thick layer of numerous fire-reddened, blackened and heat-cracked cobbles and of small slab fragments and dark brown, ashy soil. No soil-reddening was found. The layer may have been a dump for the contents of another hearth or hearths and rocks used in some heated rock cooking process. A fifth hearth may be in unexcavated grid F-106 where there is a concentration of fire-reddened slabs on the surface.

A complex situation appeared outside the northwest wall. This is in the vicinity of the fourth hearth (grid F-107) mentioned above. A large (20 centimeters), rotted log fragment appeared 10 centimeters below the surface (Fig. 32) at the same level as, and 10 centimeters downslope from, the hearth layer. This was collected as field specimen 185 and proved to be datable. As discussed below, this is the only anomalous date so far obtained at AR-4. There seems to have been considerable soil built up in this area from downslope erosion. In addition, between the log, at 10 centimeters depth, and the structure wall (Fig. 32), there was found at a lower depth of 10 to 19 centimeters below the surface, a mixture of rotted wood and light tan, sandy soil with almost no artifacts and a few core fragments of unburned wood. The source of this soil appears to have been wall logs slumping off the rock wall. The log was thus above the fallen wall logs. The house walls had therefore collapsed before this log was left here. It is believed to represent a reoccupation (see "chronology" section). Other dendro specimens came from this same side of Feature D farther downslope and from the next level below that which contained the anomalous log. As discussed in the "Chronology" chapter (Chapter VII), these specimens are believed to derive from the period of the occupation of the dwelling because they were among the fallen wall logs.

With the exception of grid E-108 and most of the excavated portion of E-109 above the natural sandstone ledge, the whole excavated area outside of the feature evidenced some midden accumulations. Dark-brown to gray-brown, ashy soil of the classic midden type, however, was most common and concentrated downslope from the structure toward the south (grids F-109, G-109, G-110, and H-110). Most of this midden, which was from 5 to 7 centimeters thick, was excavated to sterile bedrock. Throughout the downslope midden area, there were abundant artifacts in the form of lithics, ceramics, bones, etc., as well as such material as heat-cracked rocks and carbonized wood fragments. Most of the ceramics and lithics from the Feature D area came from the midden. The rich midden soil was covered in places by a light brown, sandy soil that had washed in from upslope. There were almost no artifacts



AR 4
FEATURE D

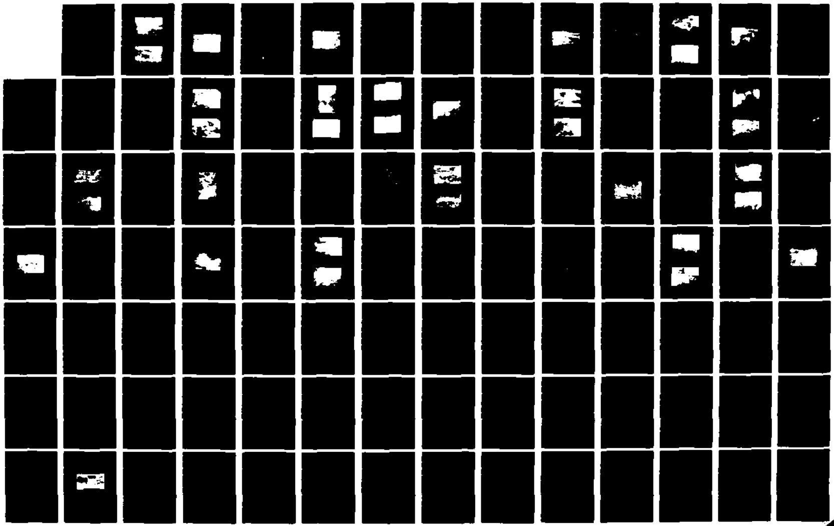
FIG. 28

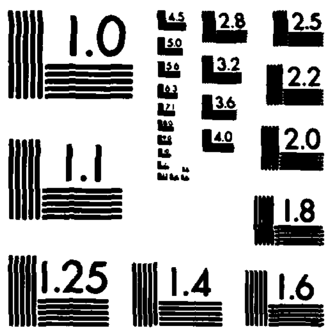
Figure 26: Feature D before clearing or excavation. View southeast.

Figure 27: Feature D with exterior grids cleared to bedrock, and interior fill remaining. View southwest toward Chama River.

AD-A127 413 THE CERRITO SITE (AR-4): A PIEDRA LUMBRE PHASE SETTLEMENT AT ABIQUIU RESERVOIR(U) SCHOOL OF AMERICAN RESEARCH SANTA FE NM C F SCHAAFSMA NOV 79 2/4

UNCLASSIFIED DACA47-77-C-0046 F/G 8/7 NL





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

Figure 28: Feature D, excavated to floor level. View southwest. Note piles of wall slabs removed in excavation. Doorway is low place in wall in left foreground.

Figure 29: Feature D, excavated to floor level. View northeast.

Figure 30: Rooftop hearth complex in fill of Feature D. Note proximity to west wall.

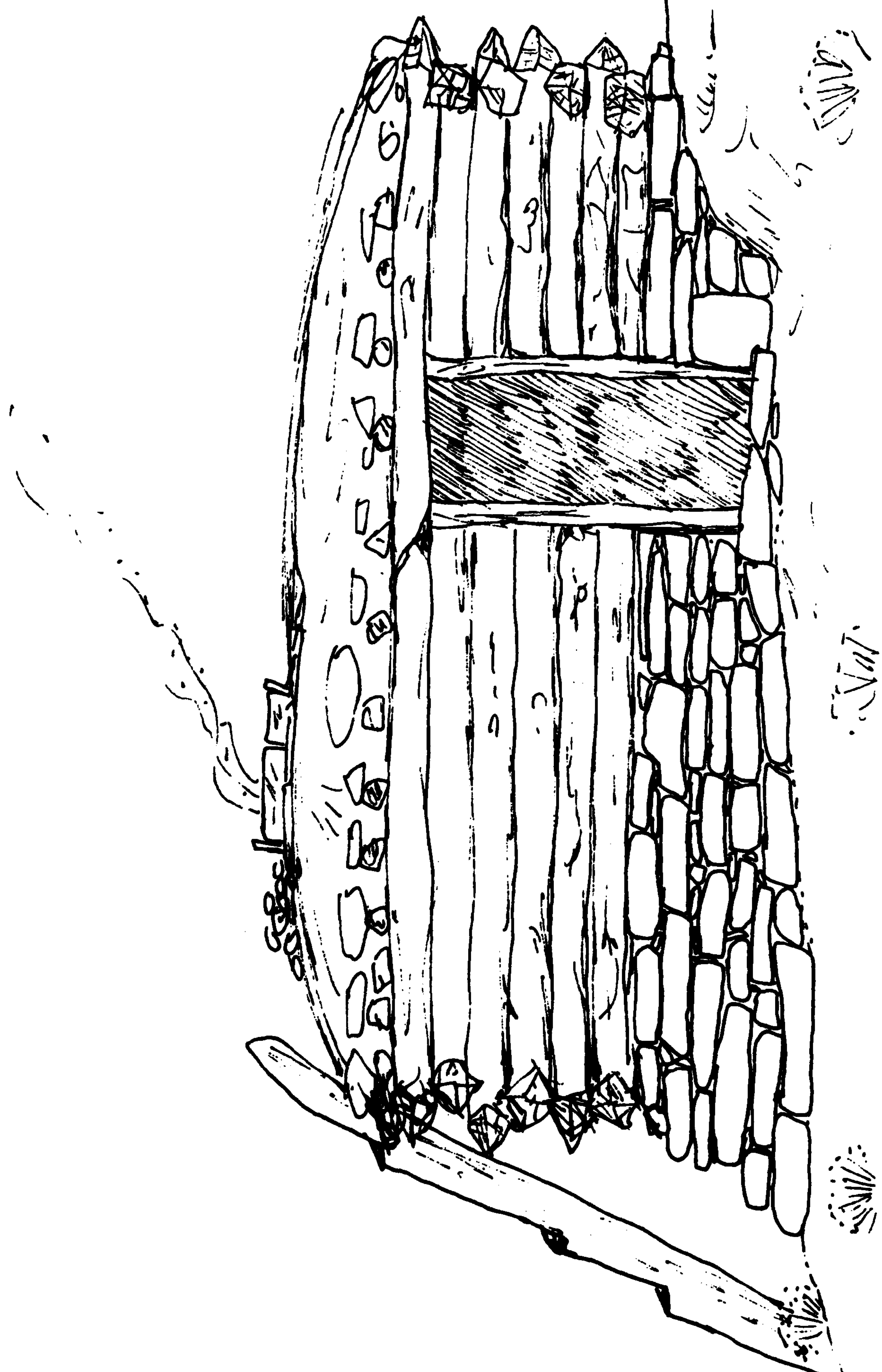


Figure 31: Reconstruction of Feature D. Drawing by Richard Lang.

Figure 32: Rotted log, FS #185, insitu outside northwest wall of Feature D, Grid F-107, meter square 8. Consult Figure 25, Profile B-B-, for nature of fallen walls and depth of fill in this location.

in this layer which varied from 1.5 centimeters (grid F-109) to 4 to 11 centimeters over the lower midden (grid H-110).

In the fill outside the west corner of the structure (grid F-107, meter square 9), there was a concentration of mandibles, cranial fragments, vertebrae, rib shafts, and long bone fragments. The nature of the bones and their concentration here suggest the dump load from a single stew pot flavored with low muscle mass bones and meat parts. All of the bones appeared to be from medium-sized artiodactyles.

There is little question that Feature D was a dwelling. Furthermore, the extent of the trash buildup around the walls and in the downslope midden indicate that it was inhabited for a long time--possibly the life of the whole village. It is one of the few places where it is possible to more than suggest a reconstruction of the upper walls.

FEATURE E

General: This structure was found in May 1975, at which time the letter designation was assigned. It has been described in two previous reports (Schaafsma 1975a; 1976). The feature had not been flooded or vandalized. The heavily traveled boat ramp road (Map 2) is a short distance to the southeast of it. The structure was appraised earlier as a dwelling, an interpretation that is confirmed by the excavation. Excavation work was directed by Jane Whitmore. Steve Horvath and crew 2 also worked part of the time on surface collection. Excavation and surface collection were done on August 16, 17, 22, and 23, 1977.

Situation: Feature E is located near the western edge of the sloping second terrace. The ground is similar to that around Feature D, being a mixture of bedrock and shallow soils. The vertical cliff at the edge of the terrace is 15 meters to the west. While this location allowed the occupants to view the Chama Valley, it is unlikely that the structure could have been seen from the valley below, and thus, while it was located near the terrace edge like Feature A, it could not be regarded as a lookout. Today, there is a sparse cover of grass and black sage near the feature. Low, one-seed junipers grow on the flat area. The occupation area is in a short drainage basin that is below the higher terrace to the east. It is located close to Features J and G to the north and was undoubtedly related to these features (Map 2).

Excavation Method: The site-wide grid system was laid over the feature and surrounding area (Map 2). The grid system encompassed the entire small drainage basin related to the feature, and it was hoped that all the surface materials that had drifted downslope from the feature or otherwise washed within the basin could be collected. Following the surface collection, the grids around the feature were excavated to sterile bedrock, as was done at Features A and D. Initially, the whole grid squares around the feature were to be excavated to the sterile bedrock. It was determined, however, that the cultural stratum was limited to a thin layer no more than 5 centimeters deep, and thus there was no point in clearing the area to sterile bedrock. The exterior excavation was then limited to the 2-meter-wide tier of meter squares around the walls, and the excavation was not carried below the cultural layer. The interior of the structure was excavated by 1-meter squares for horizontal control and arbitrary 5-centimeter levels for vertical control.

Description: As with Feature A, most of the structure could be seen before excavation (Fig. 33), partly because the area has been eroded rather than covered by surface wash as Feature D was. As can be seen in the pre-excavation photograph (Fig. 33), the structure consists of a circular sandstone masonry wall which has eroded badly on the northwest or downslope side. In spite of this erosion, there is every indication that the walls once formed a complete circle and that the structure was similar to Feature A.

The walls are made of dry-laid, stacked sandstone slabs and blocks which were obtained from the immediate area. The present walls still stand to a height of 45 centimeters on the south side (Fig. 33 and 34). The walls have fallen over on the east side and sufficient wall material remains to indicate that the walls were originally between 70 centimeters and 1 meter high. The wall on the northwest is almost completely eroded away. While the wall material presumably washed down the steep ledge and slope to the west, it is not apparent today (Fig. 33). The wall elements are comparable in shape and size to those used in Features A and D.

There is a probable eastern entrance which was closed by slabs that have fallen toward the inside of the structure (Fig. 35). The slabs around the entrance are so large that it is possible that they lined the doorway itself. The upper slab (Fig. 35) which measures 87 centimeters x 41 centimeters may have been used to close the doorway and serve as a windbreak. As at Feature D, there are several courses of slabs in the door sill.

Like the walls on the northwest, the interior fill in this area has washed away. The southern half of the room, however, had a fair amount of the original fill remaining (Fig. 36). The interior fill above the floor was removed in two levels: level 1, the upper 5 centimeters of light-colored sandy soil that is probably windblown, contained occasional charcoal flecks but very few artifacts; level 2 is from about 5 centimeters below surface to the floor, and it too is largely light-colored sand. There was very little cultural material in the fill above the floor.

The underlying sandstone bedrock in this area is very irregular. A dark, reddish clay was apparently brought in to level the surface. The top of this red clay is the floor. There is no special layer above the clay. The floor at the south end was located at about 10 centimeter depth. It has eroded away on the northwest. The material brought in for the floor was removed as level 3. The only floor features were two shaped slabs; however, a lead musket ball and gunflint were found on the floor.

At the northern end of the Feature is a floor-contact hearth, similar to that on the west side of Feature D. The hearth, which is highly eroded and not well-defined by slabs or rocks, consists of fire-reddened soil and spalled rocks. The extent of the burned soil is 1.3 meters x .6 meters. Under the reddened soil, the bedrock was burned. There were some layers of grayish ash in the hearth.

There was no evidence in the fill or around the feature to suggest the nature of the upper walls and/or roof. The walls originally were comparable in height to those at Feature A, and there may have been a cribbed log structure, although there is no evidence for this.

In clearing the area around the outside walls on the south side, an exterior hearth was found beneath the fallen wall elements (Fig. 37). The upper part of the hearth was an ash stain 35 centimeters east-west by 36 centimeters north-south. The stain is 20 centimeters from the wall. In the wall behind the ash stain were two rocks that had been fire-reddened, indicating the fire was built against the outside wall. The proximity to the doorway is similar to the situation at Feature D.

A second possible hearth was found under the wall fall on the north side where there was ash and burned bedrock. The wall was so eroded in this area that it could not be determined if the fire was built against the outside wall, as at Feature A, or if there had been a fire here before the wall was built. Probably, the hearth represents a fire built against the wall.

There was almost a total lack of midden around the structure. The only suggestion of a midden was found to the northeast of the structure where there was a dense lithic concentration. This possible midden was excavated to sterile gravel. Numerous lithics but no ceramics nor any ash were found. Only 9 sherds were associated with Feature E, and nearly all of these were found on the surface downslope to the north or northwest. Only 1 sherd (Tewa Black) came from within the feature. The most obvious conclusion is that the structure was only occupied a short time.

That Feature E was a dwelling seems likely given the interior hearth and the hearth placed outside the probable

Figure 33: Feature E, before excavation, as seen in May, 1975. Pedernal Mountain can be seen in the background. View southwest.

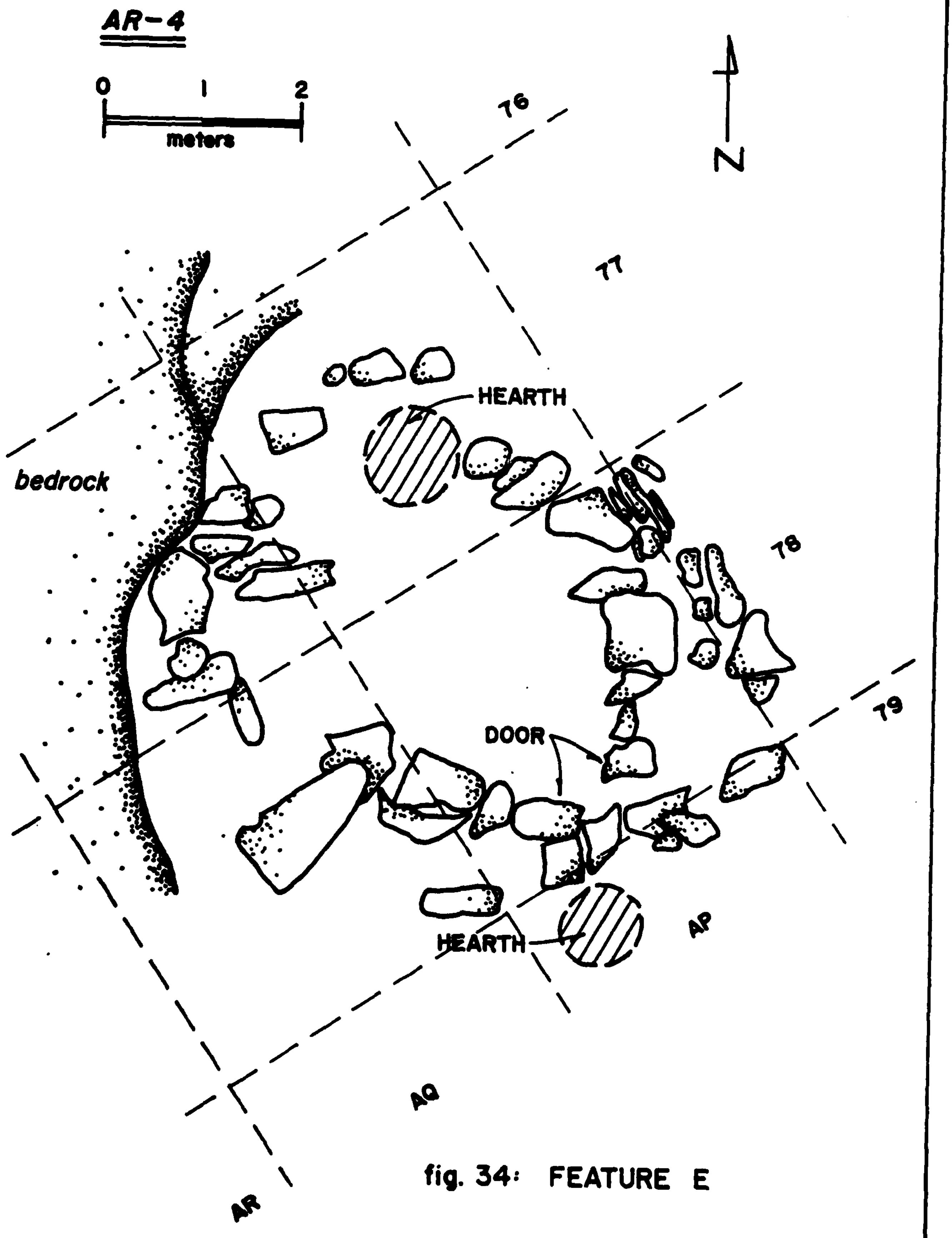


fig. 34: FEATURE E

Figure 35: Feature E slabs fallen inward from probable doorway on east side.

Figure [illegible]: Feature E cleared to floor. Note erosion of northwest side.

Figure 37: Feature E, exterior hearth near doorway on east. Note relationship to door sill.

door on the east side. The almost total lack of ceramics or other occupational debris indicates that the dwelling was not used very long. The presence of a musket ball and gunflint on the floor suggests that it was occupied during a period of hostility.

FEATURE F

On the bedrock of the drainage basin above Features G and F (Map 2) is a circle of burned rocks. The largest rocks are situated along the north side of the structure. The south side consists of small, spalled rocks, which have eroded downslope. Outside dimensions are north-south 2.2 meters x east-west 2.35 meters. The walls are only one course high in most places; however, on the east side there are two courses. There is no fill, and the structure was not excavated. The use is undetermined, but it could be the base of an exterior oven or even a sweatlodge. There is, however, no pile of fire-cracked rocks to corroborate this idea.

FEATURE G

General: Feature G was found and named in May 1975. It was described in two previous reports (Schaafsma 1975a; 1976). The area had not been flooded, but the vegetation was burned in May 1975, so the trees were dead at the time of excavation. The boat ramp access road is a short distance to the southeast (Map 2), and a recently-opened road to a picnic area runs at the base of the terrace to the west. Excavation work was directed by Jane Whitmore. The work was done on August 24, 25, 26, and 31, 1977. As at Feature B, sub-feature designations were assigned: G1, G2, and G3.

Situation: There is a short drainage basin to the north of Feature E, which begins near the Corps' east fence and drains the westward slope of the terrace (Map 2). This drainage drops over the low cliff at the edge of the terrace forming a recessed area with a waterfall at the back of it (Fig. 38). Feature G is related to this recessed area at the base of the waterfall. The bench below the waterfall widens out to the northwest making a flat area that was occupied. As at Feature E, the location is west-facing looking toward the Chama Valley, but it is unlikely that the feature could have been seen from the original valley bottom.

Excavation Method: The divisions of the feature were excavated sequentially--G1, G2, and then G3. The first task was to clear away the dead trees and brush, which in the recessed area of the waterfall was a prodigious task requiring the removal of several large dead junipers and an immense pile of tumbleweeds. It was only after this tumbleweed pile was removed that it was possible to see area G3. The site-wide grid system was then extended onto this area and laid out around the structures and on the bench. The bench was surface collected. It produced only two lithics. Structure G1 was excavated by stripping the 1-meter grid squares outside the walls to sterile bedrock, and then clearing the interior. Structures G2 and G1 were controlled by 1-meter squares at levels that generally followed natural strata. A complete series of pollen and soil samples were taken in addition to collecting all the cultural material.

Description: Prior to clearing and excavation, the most obvious part of Feature G was G1. Built against the base of the cliff at the upper side of the bench, this single structure consists of two short slab walls built into some boulders fallen from the cliff (Fig. 39). Below structure G1, there is a low wall remnant on the north side of the bench. Structure G2 was apparent as a wall remnant in the boulders above the main structure. The area termed G3, including the rockshelter, was largely hidden by brush before clearing and the only indication that the recess had been used was a heavily eroded slab wall that closed in the area below the waterfall to form a corral. Each of these divisions is discussed below.

1) Structure G1. This structure is sub-ovoid, or rounded rectangular in shape (Fig. 40 and 41). The interior dimensions are 4.5 meters east-west x 2.5 meters north-south. The walls extended from several colluvial boulders on the east to a single large boulder on the southwest. The high remaining wall, and the wall with the most rock fall, is to the northwest. Slabs and blocks of sandstone from the immediate bench were used. The fallen wall on the northeast has mostly fallen inside, whereas on the northwest it fell to the outside (Fig. 40). Maximum remaining height of the north wall is 60 centimeters, with 5 courses remaining. The maximum width of this wall is 40 centimeters x 60 centimeters. The rocks used in the wall range from 90 centimeters x 40 centimeters x 40 centimeters to 30 centimeters x 8 centimeters. When finally cleared of fallen wall (Fig. 42), the gap on the southeast suggests that the doorway would have been on the side, near the boulder.

The fill was removed in two levels. Level 1 consisted of very fine, silty, light-brown soil, which extended in most places about 5 centimeters. This level was removed both inside and outside of the structure. It was essentially sterile, except for one lithic found outside the north wall. Level 2 was removed from inside the structure. It consisted of the cultural level bearing flecks of charcoal to the floor. This level was 5 to 10 centimeters deep at the west end and shallower at the east. A single Tewa sherd was found in this level near the isolated boulder.

The floor was discernible as a compacted reddish clay, similar to that found at Feature E. This floor, however, is more compacted and harder than that at Feature E. While the floor is not obviously prepared, there is a possibility that clay was brought in because the bedrock is exposed outside and adjoining the northwest and southwest walls. The floor slopes toward the south. There are no floor features. There is an ash stain about 8 centimeters in diameter accompanied by fire-reddened soil on the floor beside the boulder on the southwest. This apparently was the hearth for the structure. The limited amount of ash in the fill and the small size of the stain indicate that the fires were of limited duration.

Very little cultural material was associated with this structure. One sherd and 1 lithic were in the fill. Several polished cobbles were on the floor on the southeast side (Fig. 40). There was almost no ash or charcoal in the fill and there was no midden outside the structure. The facts that there was a dearth of cultural remains and that the hearth area was small indicate that the structure was used for only a limited time. There is a good possibility that there was no roof nor upper walls. The area may represent a temporary windbreak used for tending sheep in the nearby corral (G3).

2) Structure G2. There is a small rockshelter in an alcove above structure G1, which has a stacked rock wall along its east side. A small protected area under the cliff base, with a sloping floor surface, was enclosed by this limited wall. The area is 3 meters x 2.5 meters and the sheltered area inside is 1.5 meters x 1.7 meters. The height is 60 centimeters x 90 centimeters. The fill inside this rockshelter was removed. There were no artifacts and no charcoal or other evidence of occupation. Excavation revealed a low wall across the south side. It would appear to have been a crude storage area related to structure G1 directly below.

3) Structure G3. The whole recessed area in the cliff where the waterfall is located (Fig. 43) appears to have been used. The wall that closed the front of this recess began on the cliff on the north side where several piled sandstone rocks remain. Rocks were also piled at the base of the cliff between the rockshelter and a large standing boulder (Fig. 44). From the boulder to the other side of the waterfall alcove, the wall can be traced by a line of standing and toppled slabs and boulders that continue to the opposing cliff. The alcove floor is fairly level, being filled with trapped sand. The entire wall very effectively encloses the whole alcove. The original wall undoubtedly utilized logs and brush in the same way that modern Navajos build such walls across alcoves at the base of cliffs (Reher 1977:Fig. 2:26B). Such a corral that made use of a natural enclosure would have had the same function as corrals that have almost fully constructed walls, such as at Feature B--that is, to confine sheep and goats at night. Very likely the flock was kept by the people who lived in the dwelling called Feature J on the cliff above (Map 2 and Fig. 43).

Clearing the brush in the alcove revealed a rockshelter on the north side that had not been observed before (Fig. 44). The rockshelter proved to have a trash deposit with several strata, a layer of animal manure, hearths, and pottery. A section of the main wall closed the west side of the shelter forming a well-protected, south-facing area. The large boulder used as part of the wall on the west side of the shelter (Fig. 44) has a smoothed area on top and a series of sharpening grooves.

Excavation showed that the sandstone blocks and slabs that lay on the alcove surface under and in front of the rockshelter (Figs. 43 and 44) were over cultural levels (see discussion below). These rocks may well represent walls fallen over the cliff edge from Feature J, which is perched on the cliff edge directly above the alcove and the area of fallen rock (Fig. 43). Feature J is a dwelling, but it today lacks masonry walls. It looks as though the walls somehow ended up below, in the alcove.

One whole grid square (AN-58) and one tier of meter squares in another grid square (AO-58) were excavated within the rockshelter. Horizontal control throughout was by the 1-meter squares (seen staked out in Fig. 44). Following the vagaries of natural deposition, 6 levels were removed within this area (Fig. 45).

Level 1 consisted of wind- and water-deposited silt and sand of recent origin, much of which had washed into the alcove during periodic flashfloods. There was also a great deal of pack rat debris and organic material from the tumbleweed pile which occurred over the whole alcove but was only excavated in the rockshelter area where it was of variable depth, from 5 to 8 centimeters. There was almost no cultural material.

Level 2 was a distinct layer of animal manure. This layer was fairly continuous within the shelter but was not present in the area not under the protective overhang. It was 1.8 meters long by 80 centimeters wide and varied from 2 centimeters to 7 centimeters in thickness. On the west side, the layer was at least 10 centimeters deep. There were Penasco Micaceous, Vadito Micaceous, and Tewa Buff and Brown sherds in this layer, as well as occasional lithics. It would appear that this layer came from the time when animals were kept in the corral.

Level 3 was a sandy soil below the manure layer in which ceramics and lithics continued to be found. It was about 5 centimeters deep. At a depth of 10 centimeters below the surface, on the east side of the shelter, charcoal stains began to appear.

Level 4 varied from 12 centimeters below the surface in the northern corner to 23 centimeters below the surface in

Figure 38: Feature G situation, showing low cliff and recessed area with waterfall.

Figure 39: Feature G, structure G1 before clearing or excavation. View northeast.

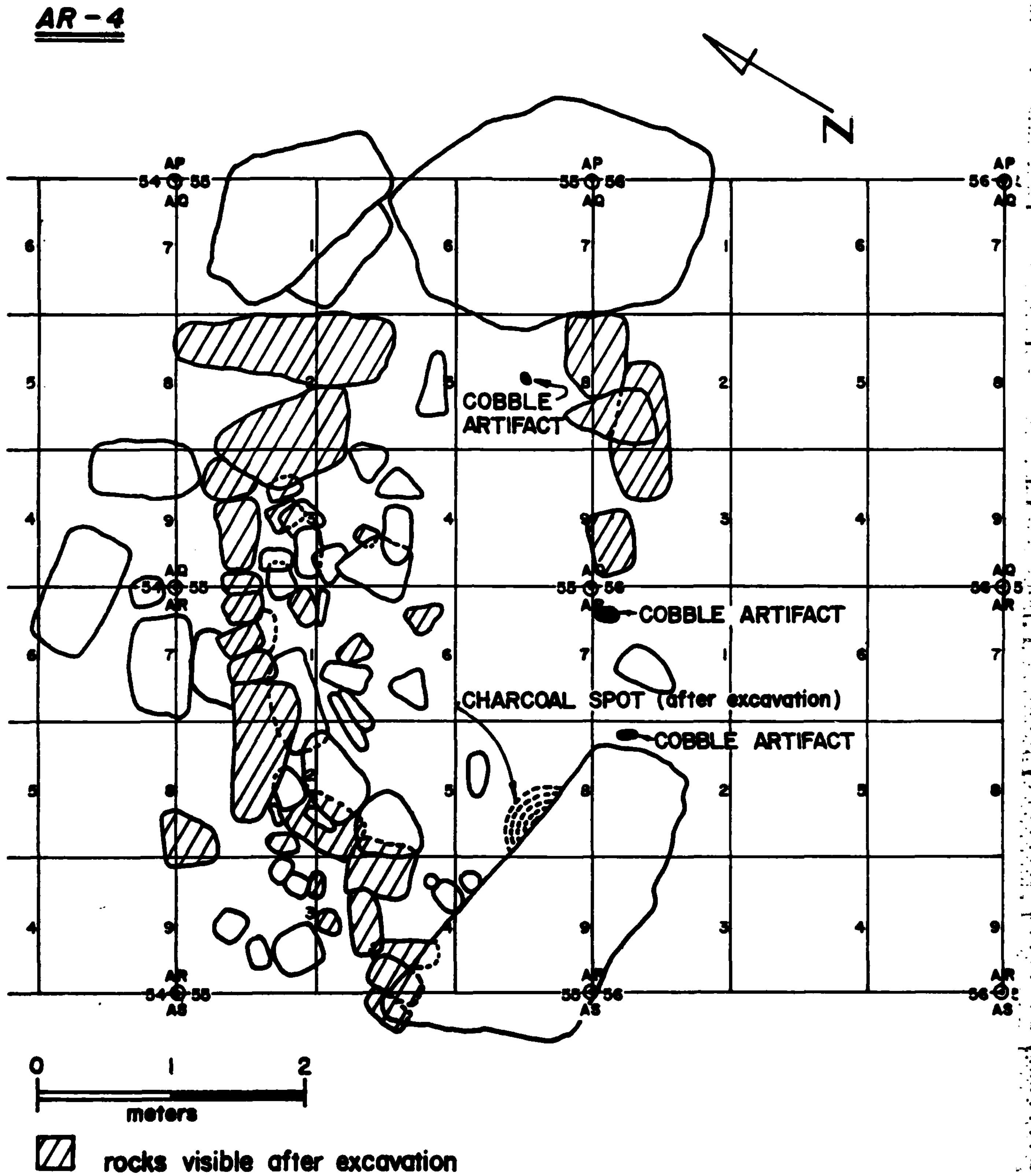


fig. 40: FEATURE G - after excavation

Figure 41: Overall of structure G1, showing collapsed wall in place. View southwest.

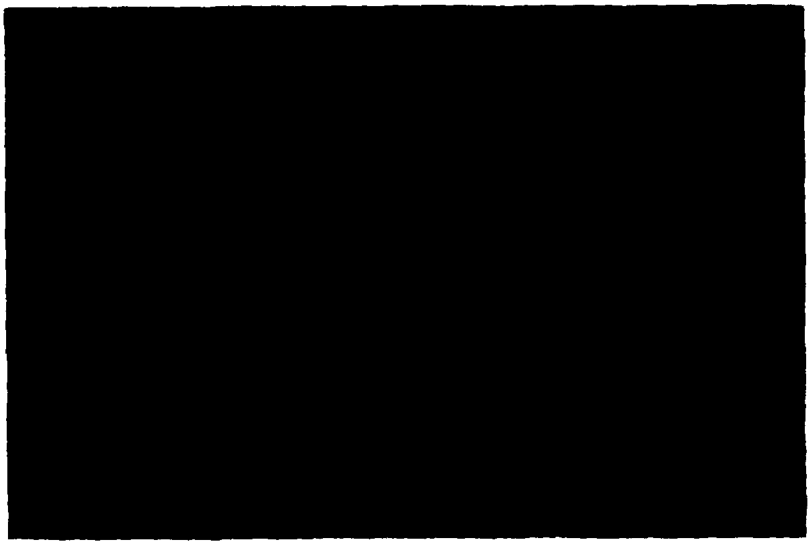


Figure 42: Overall of structure G1, after removal of fallen walls.

Figure 43: Overview of area G3 after brush clearing, but before excavation. Waterfall is at right. Enclosing wall begins on cliff above rock shelter and includes large upright slab on left of shelter. Structure G1 and related bench are in left background. Feature J is on cliff edge in upper right and boulders in alcove may have falled from Feature J. Trash from Feature J was on top of ledge on upper right above fallen boulders.

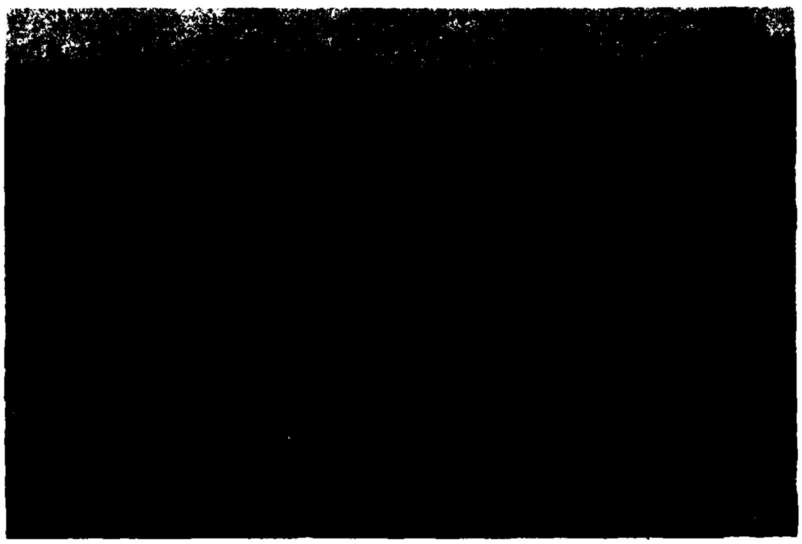


Figure 44: Area G3, rock shelter. Note wall slabs at base of cliff used to close gap in rock shelter/corral between large upright slab and cliff. Piled sandstone slabs on top of shelter (to left) were part of wall enclosing the waterfall corral. Detail of blocks (Feature J walls?) over fill. View northwest.

Figure 45: Area G3 after excavation to level five. Charcoal layers and ash stain appear as dark areas in lower right.

the southeast corner.

Level 5 was a continuation of the charcoal-stained fill. A distinct hearth consisting of a dense concentration of ash was in the south-central part of the excavated area (Fig. 45).

Level 6 contained the remaining fill and exposed the underlying bedrock. Ash-stained soil and sherds continued to the bottom of the deposit. A Tewa Black sherd came from level 6. Final depth in the southeast corner was 40 centimeters below the surface. This depth tapered gradually upslope to the area near the cliff where the bedrock was only thinly buried. The fill was also 40 centimeters deep on the west side. As can be seen in Figure 45, the fill continues beyond the limits of the excavation to the south and east, although the ash concentration was beginning to thin out.

When we began work on AR-4, this rockshelter was completely unsuspected. It proved to be one of the more important areas on the site, representing a well-used, animal-tending facility and a rockshelter work area. The shelter was used as a camping area for a considerable period, as shown by the fill and hearths in levels 4, 5, and 6. Overall, 11 sherds were found, all of which derive from the site occupation period. The excavated fill yielded 41 lithics, which consist of 4 primary cores, 2 secondary cores, 24 flakes, 1 complete biface, 3 pieces of shatter, and 2 pressure flakes. Many of these items display heavy wear patterns. The area was not used for tool making, but tools were used there. The rockshelter was first used as a habitation and/or work area; later it was apparently used primarily if not exclusively to quarter animals (sheep and goats?) as shown by the layer of manure in level 2. Finally, the area was abandoned, and thereafter it appears that the walls of Feature J were pushed or washed over the cliff where they lay covering the whole deposit.

FEATURE H

This feature is a flagstone quarry built within the last 50 years. It received a feature letter in 1975 (Schaafsma 1975a; 1976).

FEATURE I

General: This feature was located in May 1975, and it has been described previously (Schaafsma 1975a; 1976). Earlier it was suggested that this feature could be the eroded remains of a sweatlodge. The feature was excavated by Jane Whitmore and Michele Binder on September 2, 1977.

Figure 46: Feature I before excavation. View east.

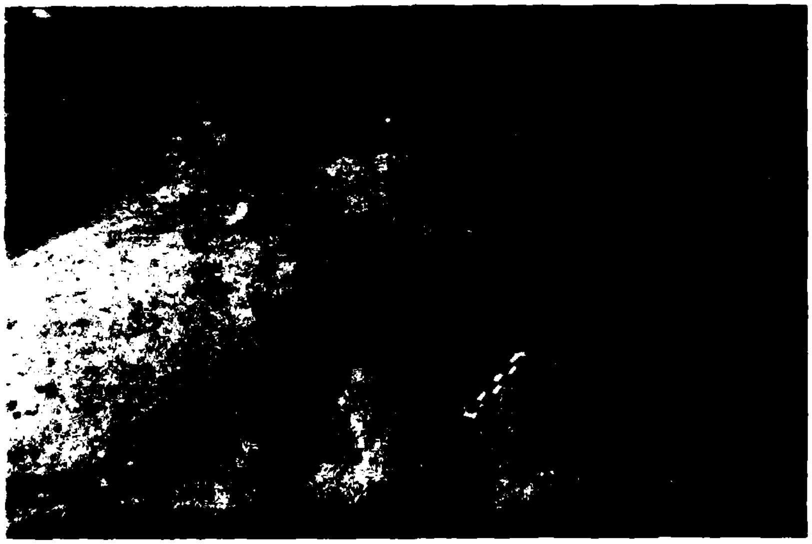


Figure 47: Feature I after excavation.

Situation: Feature I is on bare sandstone bedrock approximately 30 meters east of the rim of the terrace. It is to the north of Features G and J (Map 2).

Excavation Method: The feature was incorporated into the site-wide grid system and was in grid X-34. The area was cleared to bedrock and screened, and soil and pollen samples were collected.

Description: The feature consists of a circle of approximately 9 fire-reddened and cracked sandstone blocks which measures 1.2 meters on the outside and a scatter of smaller fire-reddened and spalled sandstone rocks which measures 2.5 meters north-south by 2.0 meters east-west (Fig. 46). The smaller rocks and reddened sand were cleared from around the main circle (Fig. 47). No cultural material was found in the soil and sand that was removed. Inside the circle, there was a small (26 centimeters x 14 centimeters) area of ash that was 2 centimeters deep. The existence of ash within the circle is an argument against this feature being an eroded sweatlodge, since fires were not made inside sweatlodges as a rule. Whatever the feature was, however, it had burned or had fires made in it, as indicated by the fire-reddened rock. It may have been an exterior cooking oven.

FEATURE J

General: This feature was found in May 1975, at which time the letter designation was assigned. It was described in two previous reports (Schaafsma 1975a; 1976). The tenuous surface indications suggested that this feature may have been a dwelling (1975a; 1976), an interpretation that seems confirmed by excavation. Jane Whitmore, assisted by Michele Binder, directed the excavation.

Situation: This structure is located on the edge of the terrace cliff directly above Feature G (Fig. 43, Map 2). It is a slight depression in the natural bedrock (Fig. 48, 49). One-seed junipers grow in the vicinity in sandy soil areas in the bedrock. The location makes it clear that this structure is part of a complex that includes the corral and other structures below the cliff (Feature F and Feature G).

Excavation Method: The site-wide grid system was extended over the area: magic markers were used to define grid corners on the bedrock. The area was cleared of several trees growing over the structure. The gridded area was surface collected. The fill of the structure was removed as two levels with horizontal control being by 1-meter squares (Fig. 50).

Description: It is unlikely that habitations have been identified on fewer surface indications than those that were present at this feature. The only pre-excavation evidence for the walls were the 2 piles of 2 slabs each, shown in Figure 48. The few sherds found on the surface contrasted with the lack of sherds at Feature G, suggesting that the dwelling for the complex may have been here on top of the cliff (Schaafsma 1975a:5). In addition to the wall remnants and sherds, the low, flat, protected place in the bedrock was adequate and large enough for a small dwelling.

Excavation did not provide any additional evidence for walls (Fig. 49). A few randomly placed blocks may have been used in the walls. There are a large number of blocks and slabs of the size appropriate for use in slab/block masonry walls of the type used elsewhere on the site; these are over the fill in the alcove below (Fig. 43) and their presence strongly suggests that somehow the walls ended up below the cliff. Whether they washed away or were pushed in is indeterminable. In any case it does appear that there once were masonry walls around Feature J. As indicated by the two remaining fragments of wall on the north side the original wall would have made use of the low natural sandstone ledge as the wall base in the area. The walls evidently followed the curve of the bedrock to enclose the floor area seen in Figure 49. The enclosed area would have been 3 meters to 4 meters in diameter, as indicated by the extent of the floor (Fig. 50).

The fill was removed in 2 levels. Level 1, the upper 5 centimeters of soil was loose sand and organic matter. Level 2 was of variable thickness; in the central area it was 10 centimeters deep. Below level 2 was the floor. Ninety-nine sherds were associated with Feature J, most of which came from the levels within the indicated structure, over the floor area. On the other hand, lithics were not common; there were only 18 found in these same levels within the structure.

A distinct floor or used surface appeared at about 10 centimeters depth. This clay surface has a different texture than the fill and there were flecks of charcoal scattered over it. Numerous sherds were on this floor, some of which were from the same vessel. Several pieces of a smoothed wooden implement were found on the east floor; unfortunately, these were too broken for positive identification, but they may possibly have been part of a weaving batten.

Three hearths were found on the floor. They are concentrated along the eastern edge, at the margin of the bedrock on that side. All three hearths consist of ash stains about 5 centimeters deep, which extend below the floor surface to the bedrock (Fig. 50). The bedrock around and adjacent to the hearths is fire-reddened. The southern hearth measures 50 centimeters north-south x 27 centimeters east-west. The northern hearth measures 26 centimeters north-south x 38 centimeters east-west. If the trend of the wall is indicated by the fragments on the north side, these hearths were within the interior of the structure.

Figure 48: Feature J before excavation, view northwest. Note two piles of stacked sandstone.

Figure 49: Feature J after clearing and excavation to floor. View west. Note edge of cliff on left. Possible batten came from floor in front of sign board.

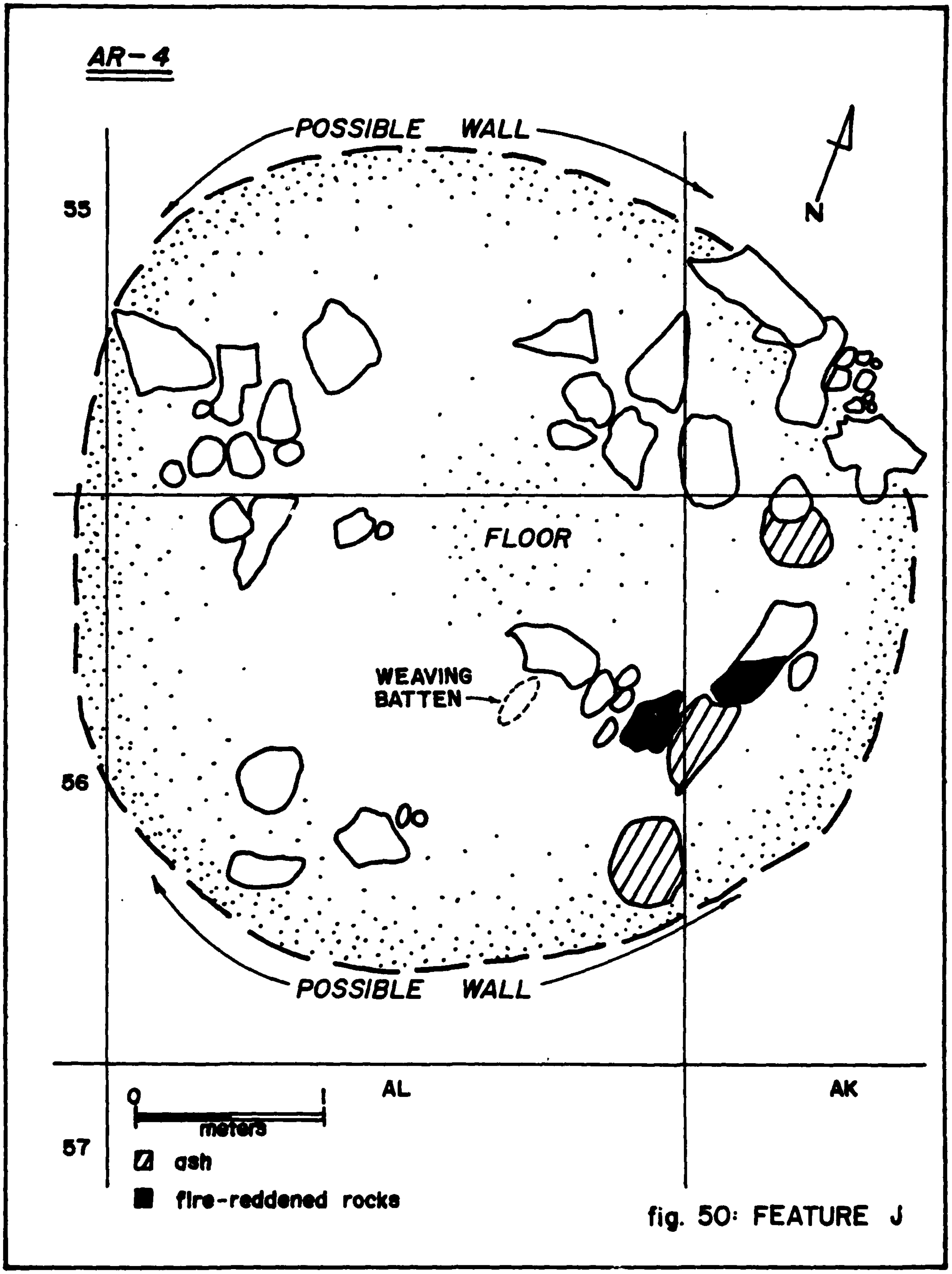


fig. 50: FEATURE J

A trash area was on the slope to the south of the structure. It extended onto the cliff ledges. This material was collected. The distribution of this trash indicates that debris was dumped over the cliff, some of which probably ended up in the alcove below (Fig. 43).

Given the presence of a floor area within the indicated structure, the presence of 3 floor hearths, and the abundance of pottery that came from the fill, it seem highly likely that there was a dwelling here. It is suggested that there were formerly sandstone slab and block masonry walls which somehow were removed and ended up in the alcove below. It is also possible that the walls and upper structure were simply a log and brush windbreak. In either case, people were living here, and this feature would appear to have been the dwelling associated with the corral and structures below.

FEATURE K

General: The feature was discovered in May 1975, at which time the letter was assigned. It has been discussed twice previously (Schaafsma 1975a; 1976). The situation and nature of the walls led to the earlier suggestion that this was a corral, an interpretation confirmed by excavation. The excavation was directed by Steve Horvath, and the work was done on August 18, 22, and 23, 1977. The structure was flooded in 1973 which killed the vegetation nearby. A few blocks may have fallen from the cliff behind the feature at that time, but there was no obvious damage from floating driftwood nor was there an accumulation of driftwood.

Situation: There is a high cliff where the bluff at the west edge of the terrace is cut by Arroyo de Comales (Map 2). The cliff on the north side of the arroyo forms a narrow point that overlooks the Chama Valley to the west (Fig. 51). In a south-facing recessed bench just below the top of the cliff, there is a substantial sandstone slab and block wall which encloses an area at the base of the ledge (Fig. 52). Features L and M are on this same point of land (Fig. 51) and probably were part of the same settlement complex.

Excavation Method: The site-wide grid system was extended over the feature. Collections and excavations were within 16 grid squares in rows CH-CK and columns 134-137 (Fig. 53). All grids in this area were surface collected. Excavations were confined to trenches on the south side and 1-meter pits dug within the enclosure. All of the structure was not cleared. Horizontal control was by 1-meter square, and vertical control was by arbitrary 10 centimeters levels.

Description: The area enclosed by the wall is roughly rectangular. It is 6 x 10 meters in plan view. The northern arc is formed by the natural sandstone ledge, which is about 2 meters high (Fig. 52). This high ledge protects the walled

Figure 51: Situation of Features K, L, and M on north side of Arroyo del Comales. View west.

Figure 52: Feature K, before excavation, as seen in May, [illegible]. Rectangular walls in foreground. 1973 high water reached the top of ledge above, view west.

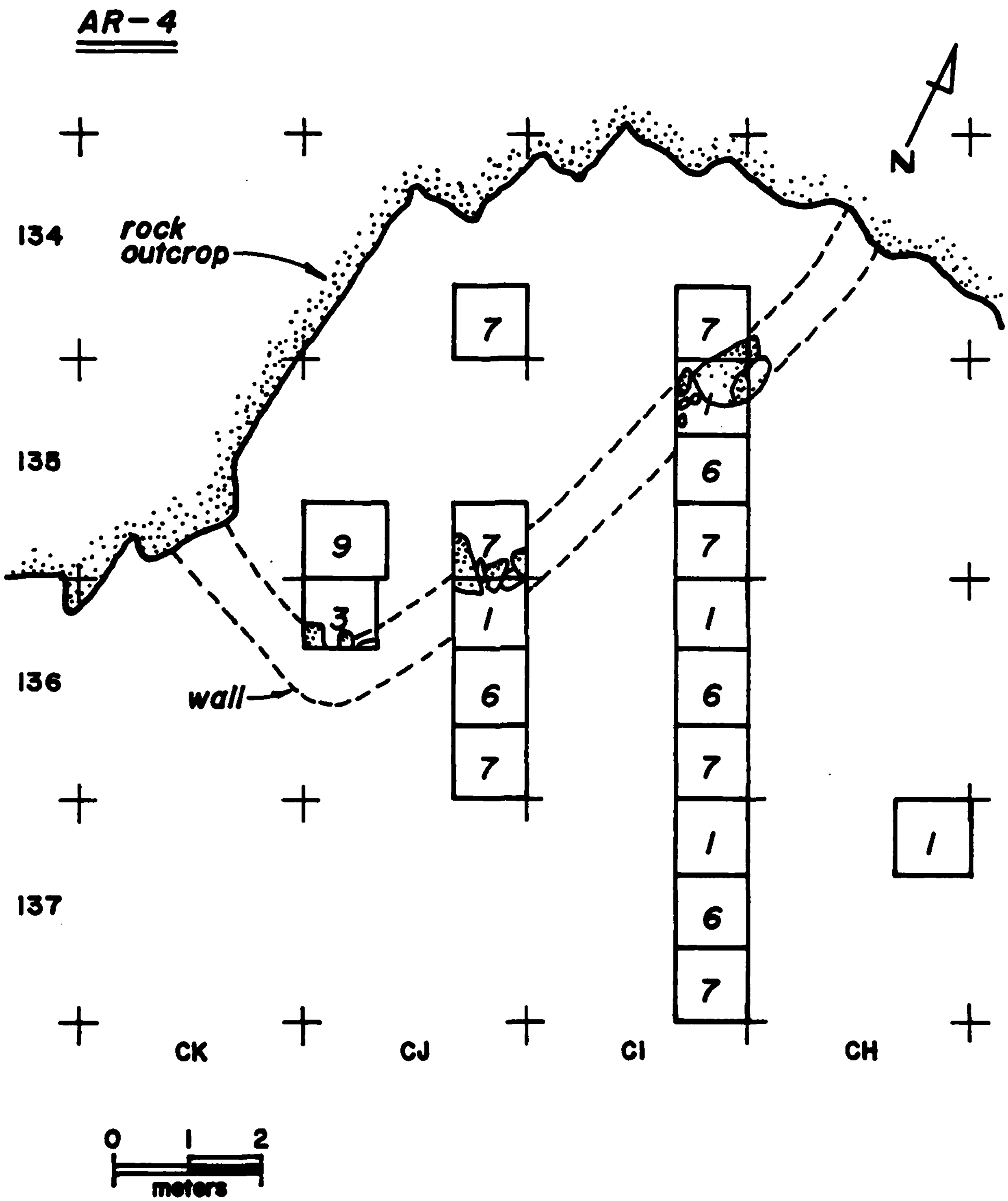


fig. 53: FEATURE K PLAN – Trenches and test pits shown in relation to grids.

Figure 54: Feature K, wall exposed in test trench. Grid CJ-135 meter square 7. Note vertical slab.

area below from the west and northwest winds. The top of this ledge is 3 to 4 meters above the ledge below the structure. The walls on the east and south were constructed of natural, unshaped sandstone slabs and blocks. At present, these wall elements lie jumbled on the ground. At only one place do 2 courses of stone show above the present ground level. Two large slabs are in a vertical position along the wall. The east wall remains standing to a height of 50 centimeters; the south wall stands to a height of 25 centimeters. A thick deposit of soil has built up behind the walls, and before excavation, this deposit reached to the top of the walls. Test pits and trenches showed that the original walls were below this present soil (Fig. 54) and that in some places they were placed on the underlying bedrock and in others on 10 centimeters of soil. The walls probably were constructed originally of logs and brush in addition to rocks.

A manure layer was present in the south tests. This layer was not present within the whole structure. A total of 5 square meters were excavated within the structure. Manure was found in 2 of these near the wall on the south end. Where manure was found, it formed a thin (1 to 3 centimeters) level, and 20 centimeters of fill had accumulated over this layer of manure. On the south, sparse fill was below the manure.

The original interpretation of this feature as a corral is substantiated by the excavation. This conclusion is based on the presence of manure, general layout of the structure, lack of evidence of an alternative use, and soil analysis.

FEATURE L

General: This structure was excavated in May 1975. It has been described earlier (Schaafsma 1976). The 1975 excavation was directed by Christopher Causey, who was assisted by Kathy Bell and Michael Schneider. It took place May 9 - 14, 1975. The structure had been flooded in 1973, but it was at the extreme upper limit of the flood zone and the inundation was minimal. There was, however, a recent growth of weeds and small bushes and a light cover of driftwood from the flood. The collection of lithics around the feature was under the direction of John Beardsley.

Situation: To the east of Feature K and slightly higher is a wide bench which is confined by a low sandstone ledge along the north and east sides and the bluff into Arroyo de Comales on the south (Fig. 51). Built into a recess on the north arc of the sandstone ledge, Feature L, is a circular structure made of sandstone slabs. The bench, which opens to the south, was clearly part of the living space and work area.

Excavation Method: After clearing the vegetation, a 3 x 3 foot grid system was laid around the outside of the walls (Fig. 55). These grids were cleared in approximately 10 centimeter levels to the underlying sterile, red clay substratum. The interior of the structure was divided into quadrants and the interior fill was excavated in naturally defined levels, with up to 3 levels in the deeper part of Quad IV. All material was screened through one-quarter-inch mesh.

Description: Prior to excavation, the structure was seen as a semi-circle of stone slab masonry built against the sandstone ledge (Fig. 56). A few sherds were on the surface of the south-east slope. Clearing revealed that the masonry wall, which had slumped and fallen-in considerably, had originally been somewhat higher. The excavated walls were of the same D-shape as the semicircle visible on the surface (Fig. 57). There was no definite entryway. A low place on the south wall may have served this function. On the east side, the wall consisted of the sandstone ledge.

Three layers were apparent in the interior fill and all were excavated according to their natural contours. Level 0, the upper 10 to 12 centimeters, was the surface soil consisting of windblown sand mixed with vegetation, showing more charcoal with depth. Level 1 began about 10 centimeters deep, and its thickness varied across the structure from about 4 centimeters to 12 centimeters. In Quad 1, the bottom of level 1 was the natural sandstone. In Quads II and III, level 1 contained numerous stains and deposits of ash and charcoal. In some places in the interior, the bottom of this level consisted of a thin ash layer. The top of level 2 was extremely apparent and consisted of a very compacted layer of manure and sandy soil. Level 2 was from 5 to 15 centimeters thick and was present in the deeper quads on the north and southwest sides (III, IV, and part of II). Artifacts, ceramics, and ash were found mixed in the manure layer. Numerous samples of manure were taken (see the "pollen analysis" and "soil-chemicalistry" of Chapter VI). Many slabs from the fallen wall were in this fill. This layer rested directly on the underlying sterile clay.

There was no prepared floor and the bottom of the structure was the natural clay of the terrace. This reddish shale separated readily from the overlying manure of level 2. There were no floor features and there were no indications of hearths on this floor.

There were also no indications of a roof or upper walls. While this situation existed elsewhere, the depth of fill in this feature makes the total absence of roof and wall materials especially noticeable. It is possible that there was neither a roof nor upper walls.

The only exterior hearth found lies about 1 meter to the

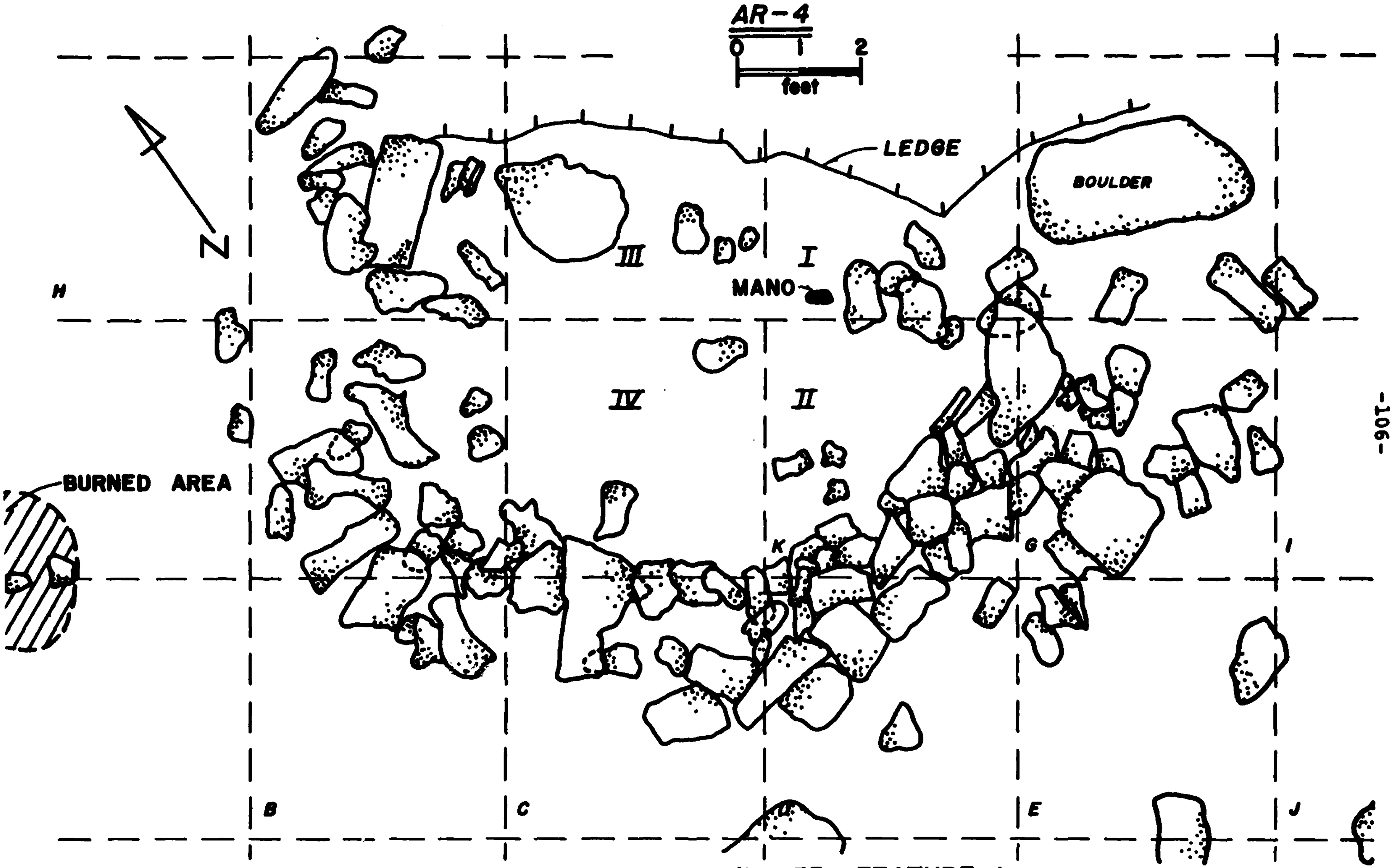


fig. 55: FEATURE L

Figure 56: Feature L before clearing or excavation.

Figure 57: Feature L after excavation.

northwest, just under the surface (Fig. 55). There were several fire-reddened rocks and a circular ash stain.

The lack of floor features and roof indications and the presence of a prominent layer of manure strongly suggest that this was an animal pen rather than a dwelling. The manure continues under the wall in many places suggesting that there was a brush corral or pen here before the more substantial slab wall structure was built.

The ceramics and other artifacts in the manure layer indicate that the structure was used as a dump while animals were being kept there. Level 1, however, represents midden that was deposited after the area's use as an animal pen. Somebody was living in the vicinity who first used the structure as an animal pen and then later used it as a midden dump. This is very similar to what happened at structure BD in Feature B.

FEATURE M

General: This structure has been discussed in three previous reports (Schaafsma 1975a; 1975b; 1976). It was excavated in May 1975. The excavation was directed by Christopher Causey with the assistance of Kathy Bell, Michael Schneider, Victor Contreras, and Floyd Geery. The field work was done May 5 - 8, 1975. The feature had been interpreted earlier as a lamb pen. In light of the findings during the present project, it has been reinterpreted as a dwelling. It is regarded as the habitation structure for the cluster of features in the vicinity (K, L, and M) (Map 2 and Fig. 51). The structure was flooded in 1973 and the 1975 excavation was prompted by the possibility that it might be flooded again in that year.

Situation: Feature M was built against a sandstone ledge at the top of the stepped bluff on the north side of Arroyo de Comales (Fig. 51). It is hidden from the main Chama Valley to the west. The location is well sheltered from the north wind and receives full sunlight. It is a warm place even on bitter, windy days. The location was obviously chosen for these protective characteristics. A sloping bench below the structure was used as a work area.

Description: Prior to excavation, the structure could be seen as 2 stacked sandstone slab walls built against the natural ledge (Fig. 58). A tumble of slabs and blocks lay below the structure; several upright slabs could be seen on the east side.

Excavation revealed that there were 2 rooms or units separated by a stone slab wall (Fig. 59). Unit A is the larger and more obvious. It has well-made, stone-slab walls on the north and south sides and faces east, up the canyon.

The walls, which are not connected, are each built out from the sandstone ledge that is approximately 1.5 meters high. The walls incorporate large basal boulders. There is no wall on the east or open side but boulders and slabs on the slope in front likely fell out from an enclosing wall. A door was almost certainly present in this area. The structure is 2.8 meters wide at the rear and gradually tapers to 1.9 meters on the east side (Fig. 59).

Unit B is separated from Unit A by what is the north wall of the latter. It is enclosed on the east side by a crude wall remnant that is primarily indicated by a vertical sandstone slab in the middle of the arcing alignment of stones (Fig. 59). The natural ledge on the west arcs around toward the east and serves as the northeast side. There is no apparent wall on the northeast corner, and a doorway was possibly present there.

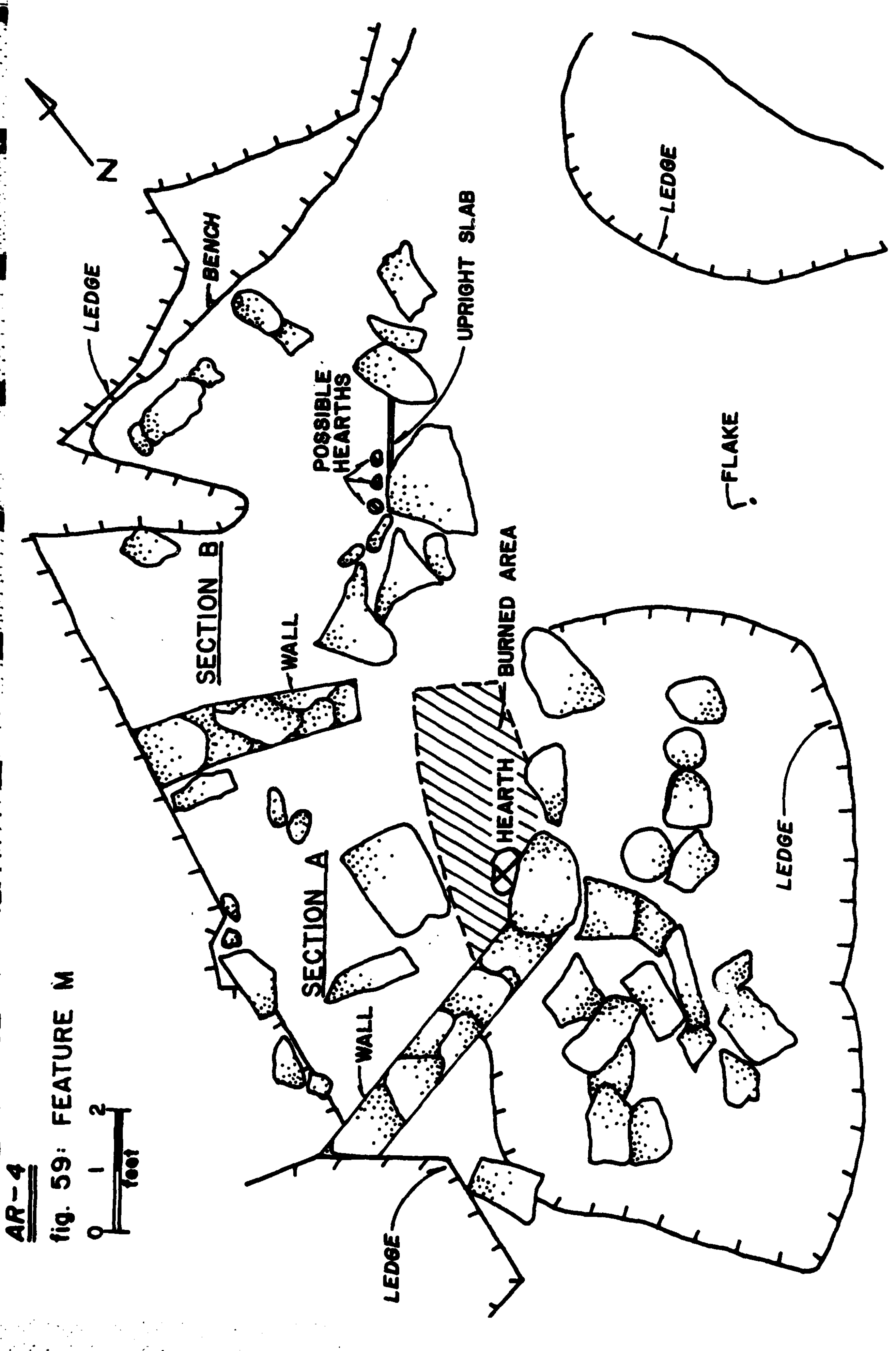
Both units were covered by driftwood, sticks, and weeds left from the 1973 flood. Below this debris was a layer of mixed sand, twigs, juniper berries, and other organic matter, which was probably a disturbed zone from the flood. This layer was approximately 10 to 12 centimeters thick. Substantial sandstone rocks were in places in this layer resting on twigs and leaves. There were likely wall slabs removed in the flood. This disturbed layer was removed from both units and screened. Lithics and ceramics were recovered from level 1 which also contained ash and charcoal. It produced the largest sample of sherds. Level 1 rested on a layer of sandy soil which formed the floor in the structure and may have been brought in to level and sloping, irregular bedrock. This layer (level 2) was 7 centimeters deep on the south side. There was no cultural material in this lowest subfloor level. Clearing this layer revealed the bedrock (Fig. 60).

A hearth was indicated by an ash layer on the south side of the floor. At floor contact, this ash and charcoal layer was 40 centimeters wide. The sandstone wall elements behind this hearth were fire-reddened. There were no other floor features.

In Unit B there was a maximum of 30 centimeters of fill which was divided into 3 levels. The upper 10 centimeters (level 0) was the disturbed, sandy, flood layer. Level 1 was 10 centimeters deep and consisted of sandy soil with rocks and charcoal mixed. There were a few lithics and 3 sherds. Level 2 varied greatly and reached bedrock at 12 to 20 centimeters. This level also was a sandy soil mixed with charcoal that contained occasional lithics and 1 sherd.

There was no obvious floor level in Unit B, and the bedrock seems to have been the used surface, although a layer of dirt may have been present in the depression on the south side (Fig. 61). On the bedrock were the remains of 3 small

Figure 58: Feature M before clearing or excavation.



AR-4

fig. 59: FEATURE M

Figure 60: Feature M, unit A after excavation.

Figure 61: Feature M, unit B after excavation to bedrock.

hearths, indicated by fire-reddened bedrock and small amounts of associated ash.

It was concluded earlier, mainly on the basis of its small size, that this feature was a lamb pen (1976:126). After excavating structures BB and BF at Feature B, it became clear that this structure was well within the range of dwelling sizes at this site. The presence of hearths in both structures further substantiates this new interpretation. The relatively large number of lithics from the structure (134), which includes 3 hammerstones and 8 cores, is also consistent with the interpretation that this was a habitation. Further, there was no indication of manure which would have supported the idea that this was a lamb pen. When the structure was roofed to the height of the natural ledge, it would have provided as much interior space as was probably available in structure BB.

FEATURE N

General: This is an equilateral cross carved on the canyon rim north of Feature A. It has been photographed. A compass reading showed the northern point of the cross to deviate from magnetic north by only about 5 degrees toward the east. Such a close approximation to the magnetic compass reading makes it seem highly likely that this is a modern surveyor's mark. It is unlikely that it related to the occupation of AR-4.

FEATURE O

General: This feature was located in May 1975. It has been previously described (Schaafsma 1975a; 1976). There was no excavation but records were made by Jane Whitmore.

Situation: At the base of the cliff on the south side of the unnamed arroyo where Feature B is located (Map 2), there is a slight alcove where a waterfall passes over the cliff. The feature is at the base of this waterfall (Fig. 62). It can be seen from Feature B.

Description: The small bench at the base of the waterfall was enclosed with a wall. The remnants of this wall consist of isolated stacks of sandstone boulders in an arc around the bench. The enclosed area is 11.7 meters north-south x 15 meters east-west. The wall fragments mark an enclosure that must have been augmented by logs and brush if its purpose were to enclose stock. There were no cultural remains in association. It is presumed that it dates from the occupation of AR-4, based on its proximity to Feature B (as well as Feature C, P, and Q on the terrace to the north) and its similarity to the corral at Feature G.

Figure 62: Feature O from cliff above.

FEATURE P

General: This structure was found in May 1975, at which time the letter designation was assigned. It has been described twice previously (Schaafsma 1975a; 1976). It had not been flooded. A large juniper tree was growing over the feature and the lower limbs were removed under the direction of Abiquiu Reservoir Superintendent Lyman Reynolds. The excavation was directed by Richard Lang and was done on August 30 and 31 and September 1, 1977. A total of 10.5 man-days were spent on the excavation.

Situation: Feature P is located on the crest of the gravel terrace south of Arroyo de Comales (Map 2). It is close to the northwestern edge of this terrace and commands a wide view of the surrounding area. There was apparently no attempt to conceal the feature, but the location could not be seen from the Chama Valley to the west. It is unprotected from the wind. Feature C is on the same terrace about 75 meters to the southwest and can be clearly viewed from the structure (Fig. 22). Feature D, across the canyon, is also in view, as are Features K, L, and M to the west. Feature A to the west can also be seen readily. The vegetation is grass, juniper, yucca, snakeweed, and wolfberry. As at Feature D, wolfberry does not grow extensively on the terrace away from the feature. A large juniper tree grows in the north corner, where it has partially displaced the wall.

Excavation Method: The site-wide grid system was extended over the feature area. An area consisting of 64 grids was surface collected (Map 2). This area is bounded by rows AC-AJ and by columns 164-71. Grids AE-168, AE-169, AE-170, AF-168, AF-169, and AF-170 were excavated wholly or partially around the structure. The excavated area was controlled by 1-meter squares. Surface stripping outside the feature was generally only 1 level (surface soil) deep. All excavated soil was screened with one-quarter-inch mesh.

Description: Prior to excavation, Feature P was visible as a pile of boulders at the base of a large tree (Fig. 63). Ash and charcoal were in the fill around the boulders, and there was a trash area to the south which contained ceramics and lithics. Most of the walls and building material were hidden in the duff and branches under the tree.

The excavated structure (Fig. 64) is subrectangular to ovoid in outline, although wall displacement makes it difficult to determine the original shape. The approximate interior dimensions are 2.8 meters north-south x 2.6 meters east-west. An entry is clearly defined on the east side by an 82 centimeter gap in the boulder wall (Fig. 65).

The walls are primarily formed of alluvial cobbles and boulders from the terrace margin. They are irregularly placed and set upon a foundation of slabs or slab-like cobbles (Fig.

66). The occasional sandstone slabs used in the walls (Fig. 64) were probably obtained from outcrops downslope to the west and north. The remaining wall is 66 centimeters high in 4 courses on the north side and 40 centimeters high in 3 courses on the south. East and west walls are both 24 centimeters high with 2 courses remaining. The original wall height is estimated at about 80 centimeters maximum and 40 centimeters minimum. The present distribution of wall elements suggests that the wall may not have been of uniform height around the perimeter, in which case the highest wall was on the north. Estimates of the original wall width vary from 35 centimeters on the southwest to 75 centimeters on the southeast. Many of the fallen wall stones exhibit fire-reddening and soot-blackening from the fire that apparently destroyed the structure.

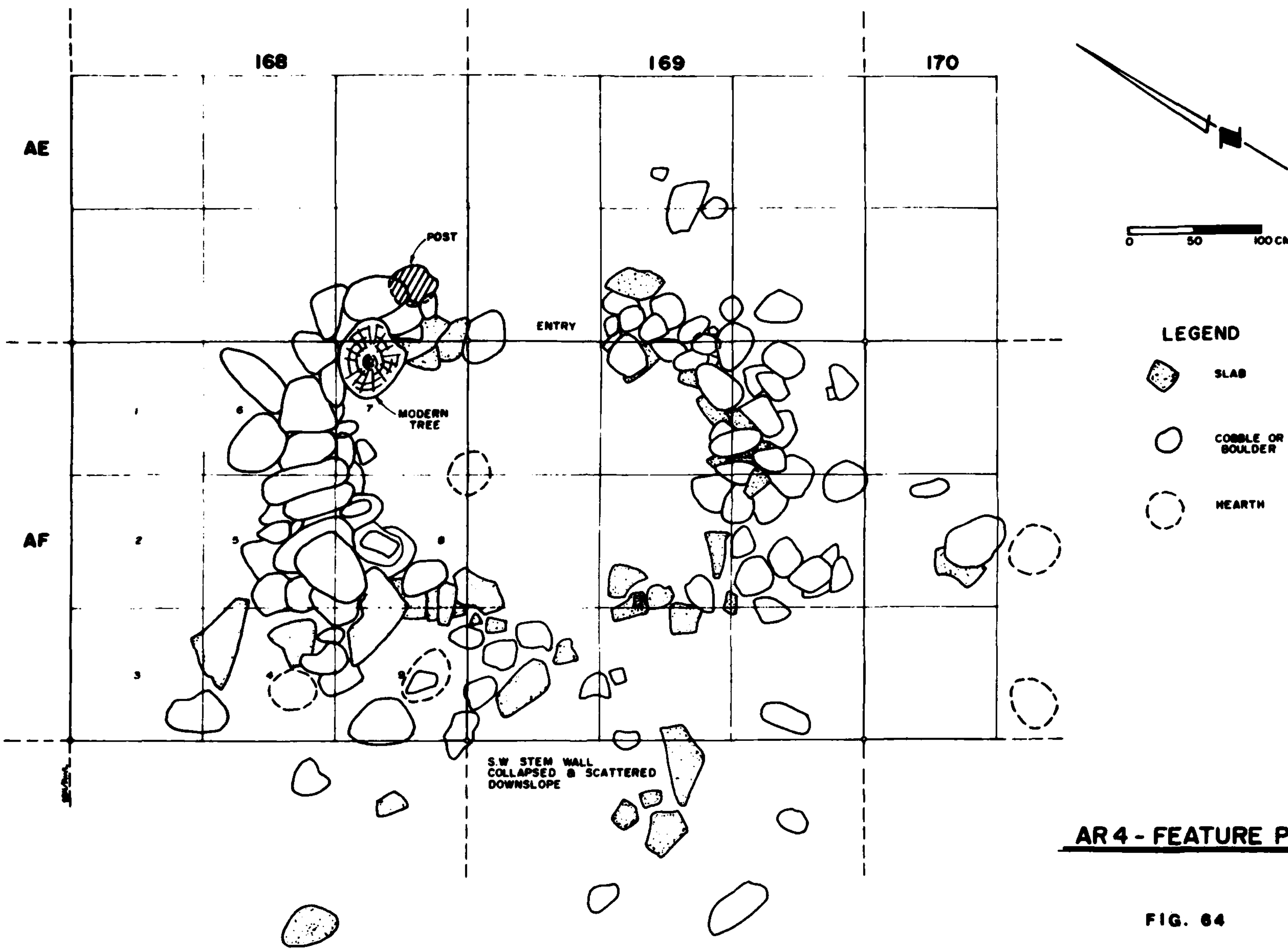
Six meter squares of grid AF-169 were excavated inside the walls. The fill was removed as a single level (level 1), the average thickness of which was about 13 centimeters. This fill was relatively sterile, light-reddish-brown sandy soil that probably derived in part from the dirt of the superstructure. Level 1 overlay a thin lens of ash and burned wood on the floor surface.

The floor was a compacted natural surface of light-reddish-brown sandy soil. It was burned dark, reddish-brown to dark gray in some areas as a result of the collapse of the burning roof. Some pebbles protrude through the surface. There was some ash on the floor, apparently from floor hearths. A detail of the most protected part of the floor on the north side is in Figure 66.

An interior hearth is located in the northwest sector of the house interior (Figs. 64 and 66). This hearth is a shallow pit, 1 centimeter deep and 25 centimeters in diameter, that was filled with gray ash. The floor nearby is burned a dark, reddish-brown.

In spite of the tumbled-down state of the remaining cobble walls, there are fairly good indications of the nature of the superstructure. A post 22 centimeters in diameter was set into a pit on the north side wall margin, 84 centimeters northwest of the entryway (Fig. 64). The top, which barely protruded above the ground, had been burned. The subsurface remnant was 27 centimeters long. It was apparently juniper. The post may have formed part of an entry foyer since it is located near the door and was set vertically. Superstructure materials are represented by burned poles and pole fragments round in an irregular lens of ash and carbonized wood fragments over the floor. The poles were 3 to 8 centimeters in diameter and up to a meter long. They were laying essentially perpendicular to the north wall and apparently represent poles set at an angle, which fell inward when the structure burned. The poles extend under collapsed wall slabs on the north side. The wall cobbles and slabs therefore had been piled outside

Figure 63: Feature P before clearing or excavation.



AR 4 - FEATURE P

FIG. 64

Figure 65: Feature P after excavation. View northwest.

Figure 66: Feature P. Detail of north wall and floor hearth.

the pole (and mud?) superstructure perhaps as a wall base and brace.

The depth of the exterior fill cleared from around the structure varied from 5 centimeters to 10 centimeters and was composed of medium-brown, sandy soil containing some ash and artifacts. A concentration of charcoal-rich soil and ceramics was found to the south, although this was not as rich a midden as first anticipated on the basis of surface indications. There were 3 exterior hearths, which are shown in Figure 64. All 3 areas showed blackening of the natural ground surface. The diameter of the one on the northwest (meter square 9 of grid AF-168) was 35 centimeters. The one on the southeast (meter square 5 of grid AF-170) was 38 centimeters in diameter, and the southern hearth (meter square 4 of AF-170) was 45 centimeters.

Feature P was definitely a dwelling, possibly like a forked-stick hogan with an east-facing doorway. The structure had been burned, and there was no subsequent occupation that used the area as a dump. Exterior work areas are indicated by 3 hearths. The amounts of pottery (370 sherds) and lithics (256) indicate that the dwelling was inhabited for a fairly long time. While the feature was clearly part of a local settlement consisting of Features P, Q and C, the lack of stock maintaining facilities in the area is noteworthy.

FEATURE Q

General: The feature was found in May 1975, and has been described twice previously (Schaafsma 1975a; 1976). The structure had not been flooded. As with Feature P, a juniper tree had grown over the structure, and the overhanging limbs were removed under the direction of Lyman Reynolds. The excavation was directed by Richard Lang. The fieldwork was done on September 1 and 2, 1977. A total of 8.5 man-days were expended.

Situation: Feature Q is located on the western margin of the same terrace where Features C and P are located. The underlying surface is the gravel alluvium of this terrace. Feature C is located about 18 meters to the east on the flat terrace top. Feature Q is on the slope of the terrace. The exposure is primarily to the north and west with some protection from the south and southwest. The location, however, was not selected for its protective characteristics. The vegetation is similar to that described around Features C and P, except that junipers are more dense on this north-facing slope.

Excavation: The site-wide grid system was extended over the feature. An area consisting of 25 grid squares was surface collected (Map 2); it was bounded by rows AX-BD and columns 183-187. The soil around the feature was excavated to sterile bench gravel. The exterior excavations were mainly in a tier of meter squares that were 2 meters wide which encircled the structure. These excavations were in grids AY-185, AZ-184, AZ-185, BA-184, and BA-185 (Fig. 67). Interior fill was removed in 1-meter squares. All fill was screened with one-quarter-inch mesh.

Description: Prior to excavation, the feature could be seen only as a pile of cobbles and boulders under the limbs of an overhanging juniper. Because duff and vegetation under the tree hid most of the structure, the impression was that most of the structure had eroded away. Clearing and excavation showed instead that most of the structure was intact under the fill and vegetation (Fig. 68). There was neither surface pottery nor a trash area evident.

The structure was circular. Interior dimensions are 2.0 meters north-south x 1.98 meters east-west. There has been much wall displacement downslope (Fig. 67), but the underlying wall foundation has remained in place, allowing the original wall to be determined quite clearly.

The wall foundation was made of sandstone slabs or slab-like cobbles on which cobbles and boulders have been laid to form the wall (Fig. 69). The sandstone slabs were obtained from outcrops downslope; the cobbles and boulder, which are alluvial, were from the terrace margin. The foundation is 1 to 2 courses high. The wall is generally 1 rock wide, but was sometimes 2 wide when small stones were used. Remaining maximum wall height is 42 centimeters in 3 courses on the west. The wall varies from 30 centimeters to 55 centimeters in width. The original wall height is projected at about 97 centimeters on the interior and 1.1 meter on the exterior. This estimate is based on the measurements of standing and fallen slabs and other stones on the north side.

A doorway 2 courses high was present on the east-southeast (Fig. 67). The sill is worn as is the one at Feature D, and there is a lack of wall fall in the area. Estimated original width is 35 centimeters at the sill.

The interior fill was removed as one level. Maximum depth was about 12 centimeters. It was sandy and dark, reddish-brown. The fill, which probably derived from upslope erosion and roof collapse, contained lithics, sherds, bones, and fragments of glass slag similar to that in the exterior hearth. The fill was apparently post abandonment wash from upslope, roof material, and wind deposit.

Approximately one-half of the west-northwest interior of the structure had been built up with light-brown soil after construction of the foundation and at least part of the wall. Maximum depth of this deposit was 14 centimeters. It was thickest on the west interior and did not extend under the wall (Fig. 67). This partial filling leveled the floor of Feature Q, compensating for the natural slope. More gravelly soil natural to this location is present on the floor's eastern half. The larger cobbles had been removed from this area where the natural alluvium served as the floor. The floor surface is compact and has acquired a medium, gray-brown color due to ash working into the floor surface.

On the southwest side of the interior (Feg. 67), 4 slabs have been set in the floor, and it is here that floor-surface fires were built. The ash is about 1 centimeter thick on the floor surface, and there was intense soot-blackening over an area about 60 centimeters north-south x 40 centimeters east-west. Adjacent rocks in the west wall were fire-reddened. There were no floor slabs or floor features beside the hearth.

There were no remains to indicate the nature of the superstructure such as logs or roof fall. It is suggested, without corroboration, that some of the interior fill is dirt from the walls and roof. The height of the walls and the structure's circular shape imply that its roof was similar to that of Structure A which might have had a cribbed log roof.

The soil outside the structure had cultural remains to depths of 2 to 12 centimeters. These depths became deeper up the slope. The deepest area was upslope, behind the foundation where erosion was reduced. Much of the lower fill has been washed away. The soil is sandy and medium, reddish-brown. Pebbles were common in the lower area where fill was mixed with underlying sterile alluvium. In all the area outside the structure, there was sterile gravel under the fill. Lithics, bones, and ceramics were recovered from the exterior fill. There was, however, no distinct midden deposit, i.e., ash layers, etc.

There was an exterior hearth in grid BA-187, meter square 1, which is upslope and about 6 meters from Feature Q. This area slopes very mildly near the margin of the gravel terrace. It is at the same elevation as Feature P, 21 meters to the northeast. Fire was built in an area of gravel exposure with the result that the underlying pebbles and cobbles were blackened and reddened. Some cobbles associated with the hearth may have been intentionally placed here. The hearth, which was located primarily by a dark gray ashy soil about 1 to 4 centimeters deep, was 65 centimeters in diameter. The ash layer was covered by 1 to 2 centimeters of sterile surface sand. Associated with this hearth were several pieces of greenish, glass slag. The origin of these pieces is unknown. The hearth represents an exterior activity area that may have been similar to those found outside of Features C and P.

There is little doubt that Feature Q was a dwelling. There were only 70 lithics in association, but the 121 sherds

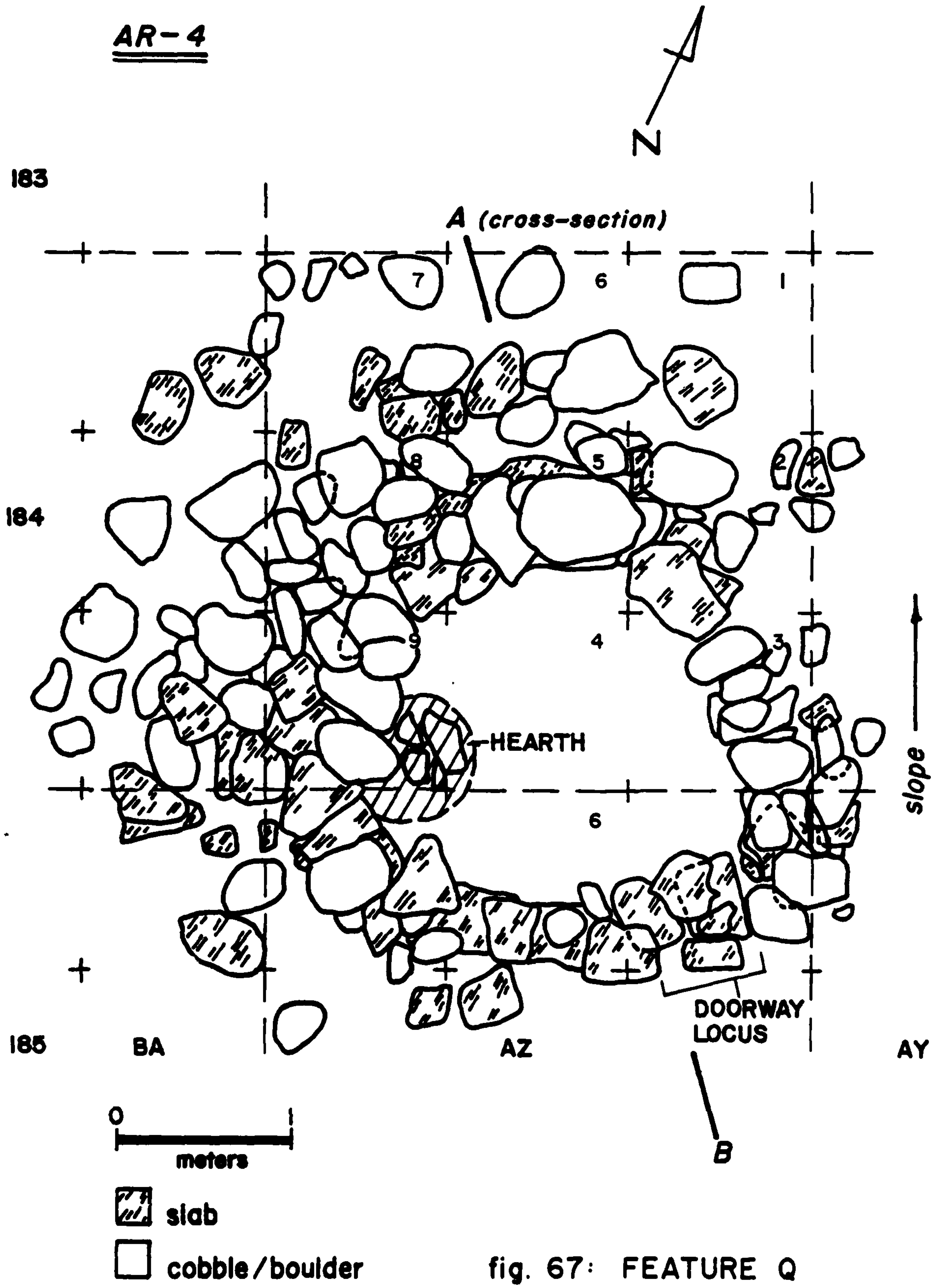


fig. 67: FEATURE Q

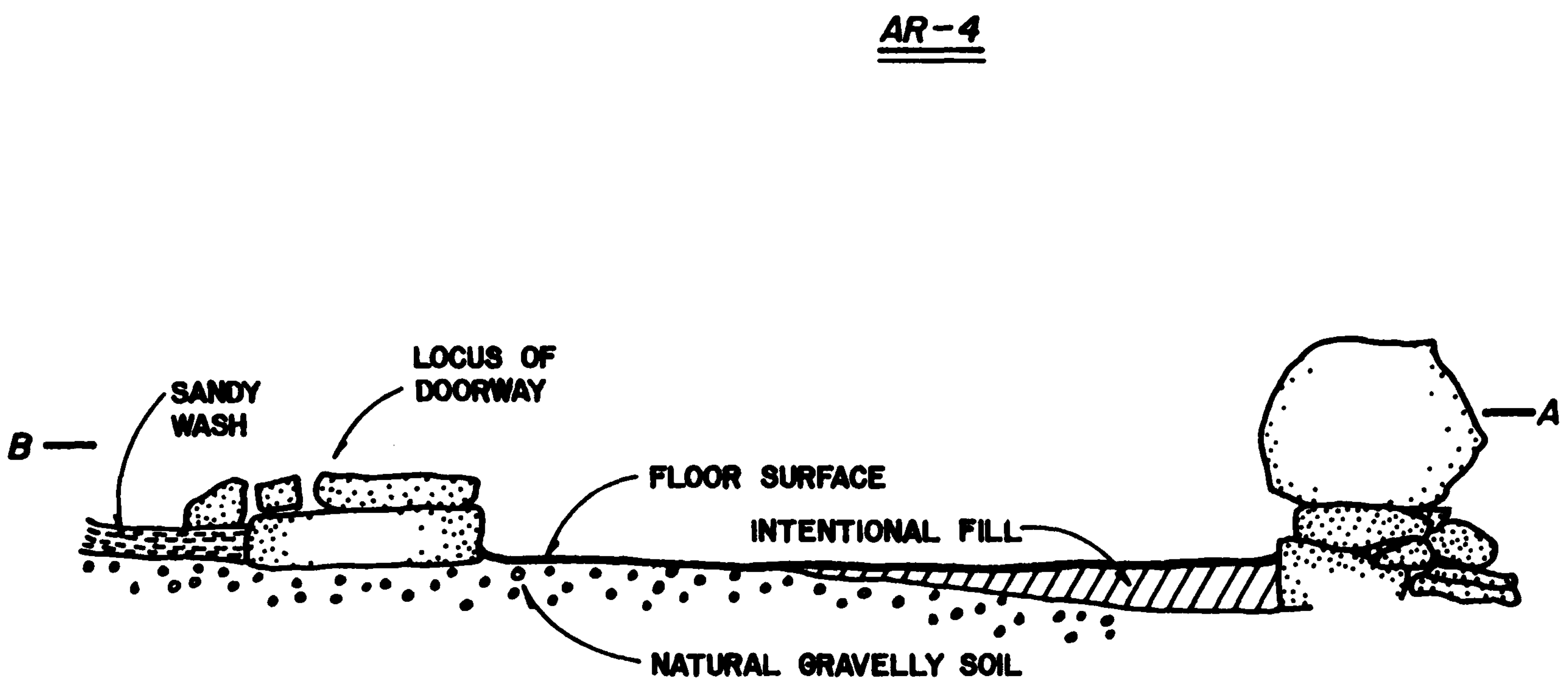


fig. 67: FEATURE Q (cont'd)

Figure 68: Feature Q after clearing, but prior to main excavation. View southwest.

Figure 69: Feature Q after excavation.

indicate a substantial occupation. The nature of the wall, the presence of a prepared interior floor, and the existence of a distinct hearth with associated ash all indicate that this was a dwelling.

There also seems little reason not to think it was related to nearby Feature P. The apparent different types of architecture of these two structures represented are of interest. It could well be that Feature P was a secondary shelter and work area related to the more substantial dwelling that was Feature Q. The situation of Feature Q on the north slope of a terrace margin is anomalous.

FEATURE R

This small exterior hearth was found in August 1977, by Jane Whitmore who recorded it. The feature was not incorporated into the site-wide grid system nor was it excavated. The location would be approximately grid T-35 (Map 2). Feature I is approximately 10 meters to the west. Surface indications are very similar to those of Feature I, consisting of a circle of fire-cracked rocks (1.5 meters in diameter) amid a scatter of fire-reddened and shattered sandstone (2.4 meters). These remains are in an area of shallow, sandy soil in a pocket in the bedrock. The proximity to Feature I and the similarity in appearance and situation to that feature suggest that these two areas were functionally similar. All that can be determined concerning the function itself at present is that it involved fires and heating quantities of sandstone rocks.

AR-523

General: This feature was found in the May 1975 survey by John Beardsley, at which time it received a separate site number (Schaafsma 1976). It is, however, undoubtedly part of site AR-4 and should be regarded as a feature of the larger site.

Situation: The feature is situated on the broken cliff at the west edge of the terrace to the northwest of Feature I.

Excavation Method: It was not incorporated into the site-wide grid system, but, had it been, it would be approximately in column 60, where this column passes over the cliff to the west (Map 2). It was excavated, recorded, and photographed by Jane Whitmore. Excavation consisted of removing and screening the interior fill.

Description: The feature consists of a natural sandstone cavity which was walled up with slab masonry (Fig. 70). The front of the cavity is 1.7 meters wide and 50 centimeters high. The interior is 95 centimeters deep. The natural rock is the base which slopes toward the front. The small slabs

Figure 70: AR-523, slab walled cist.

in the wall may be the remnants of a larger wall that formerly closed the cavity. There is no mortar between the slabs. The interior fill was a maximum of 5 centimeters deep. It was sandy and confined to the front part of the interior. There were no cultural remains.

AR-35

General: As with AR-523, this feature received a separate site number in the May 1975 survey (Schaafsma 1976). It, however, is also almost certainly related to the occupation of AR-4. It was not possible to excavate this feature, but it is mentioned here to complete the overall site description.

Situation: Like AR-523, this feature is on a broken cliff and talus slope. It is on the south side of the unnamed arroyo where Feature B is located (Map 2) and is on the same cliff and slope as Feature O, 200 meters to the northeast. It can be clearly seen from Feature B across the canyon.

Description: The feature is a natural cliff cavity with a low sandstone wall remnant across the front. The natural cavity is 3.25 meters deep, 2.5 meters long and 2 to 3 courses high. From the appearance of the wall, it originally sealed the cavity, although there are not enough rocks below it today to have accomplished that function. There is no pottery in association, and there is only a very thin layer of fill in the cavity. There is no evidence of burning inside. On the roof of the cave, there are a number of crude pecked designs.

It is suggested that, like AR-523, this feature was used either for storage or as a burial crypt. It should be observed that AR-523 and AR-35 are the only walled, natural cavities that were found in the entire survey of the Abiquiu Reservoir District (Schaafsma 1976) and that they are both spatially related to AR-4.

LITHIC AREAS

Lithics occurred over the entire area of site AR-4 (Map 2). They are especially common, however, on the terrace tops and near the features. Wide areas around the features were collected to retrieve these potentially very informative items. The largest collections were made around Features A, D, E, K, and P. In addition to these feature-related collections, which were continuous blocks of grids, several areas were sampled with a systematic scheme that involved retrieving only a portion of the lithics present. The areas that were sampled are to the north and south of the boat launching road (Map 2). The sampling scheme was a simple systematic pattern: Each collected grid was separated from each other collected grid by 3 uncollected grids. The result was a 10 percent coverage of the area with 1 grid in 10 being collected. Considering the nature of the slopes and the concentration of lithics, this method should provide adequate coverage to answer most questions about the lithics.

One question concerning the surface lithics was their cultural origin. The finding of several Basketmaker II points away from the structures (see "projectile points" section) raised the possibility that some of the lithics relate to a late Archaic or Basketmaker II occupation of the terrace. This question was addressed through obsidian hydration (see "obsidian hydration" discussion in Chapter VII). Because of this ambiguity about their cultural origin, the surface collection lithics were not included in the lithic analysis (see "Lithics" section of Chapter V). It is hoped it will eventually be possible to deal with them systematically.

SUMMARY

AR-4 is a complex settlement consisting of several types of structures and associated lithic areas. The structures can be arranged into several different types according to architecture, contents, situation and inferred function. This discussion makes use of artifact descriptions and special analyses that follow.

Dwellings: There are at least 10 dwellings (Features A, BB, BD, BF, D, E, J, M, P, and Q). Two other structures are probably short-occupancy dwellings, or temporary shelters (Features C and G2). There are 3 animal pens (Features BC, K, L) and 3 corrals (Features B, G3 and O). Two small isolated features are either exterior ovens or sweatlodges (F and I). Two walled cists are spatially related to the site, and probably belong to the site occupation (AR-35 and AR-523). In addition, there are extensive lithic areas east of Feature E, west and north of Feature D, and south and east of Feature A.

There are 4 types of dwellings present. Feature D is the largest dwelling and differs from the others in having a rectangular ground plan, and horizontally laid log walls (Fig. 31). There are 4 small dwellings (Features BB, BD, BF and M) that were constructed against south-facing natural ledges and have roughly rectangular shapes. The walls of these structures appear to have been entirely made of coursely laid sandstone slabs and blocks. Three dwellings (Features A, E, and Q) were built on terrace tops or ledges and have lower walls made of coursely laid sandstone blocks and slabs or boulders. They exhibit round or roughly rectangular ground plans. Feature J (lacking walls) may have been of this type originally. A single structure (Feature P) is defined by an arc of boulders and slabs which were either the brace for an upper wall of logs and brush, or were a foundation for the support of a light super-structure. Architectural types at the site are diverse, but consistent in general size (approximately 2.2 to 3 meters inside diameter), use of unshaped slabs, blocks and boulders and logs and/or brush superstructures. The roofs are difficult to define but were either made by cribbing logs (as is possible in Feature A) or by laying logs horizontally and covering with brush and mud (as at Features D, BB, and BD).

Doors were not readily definable in all structures, but where evident (Features A, D, E, P, Q) they faced south to east. In 4 dwellings, the doors were accompanied by raised sills (Features A, D, E, and Q). Floors consisted of either the natural clay undersurface or dirt was brought in to level an uneven surface as in Features D and E. A thin layer of floor plaster was added in only one case (upper floor of Feature BD). None of the dwellings had prepared interior hearths; all of the fires were built directly on the floors, and generally against the west or northwest wall. There were definitely no corner, hooded fireplaces. Floor features occasionally present consisted of flat sandstone slabs (Feature BD, Q) that were placed close to the hearth and may have served as crude tables or work areas above the floor. In one case (Feature D) there is evidence of a roof-top hearth. Hearths were found outside, beside the doors of 3 dwellings (Features A, D, and E) suggesting that this was a common practice. Other exterior hearths appear near some of the dwellings (Features A, D, E, P, & Q).

Occupation: The nature and length of the occupation is inferred from the patterns of trash accumulation and rebuilding. Trash areas were found in association with Features D, B, J, P and possibly Q. The exterior midden to the south of Feature D was extensive. It strongly suggested a stable, long-term occupation. The midden under structure BC demonstrated that the nearby dwelling (BB) had been occupied for a considerable period prior to the construction of structure BC. While not as extensive, the trash area on the slope below Feature J demonstrates that the occupants discarded their trash close to the dwelling as was the case with Features D and BB. Features P and Q produced limited trash areas on the surface near the dwellings which suggest that they may not have been occupied as long as the other dwellings. Indications that abandoned structures were used as trash-disposal areas were found at Features BD and L. Feature BD was used as a trash disposal area after the first abandonment as well as the second. Spatial proximity argues that the inhabitants of structure BB deposited trash in nearby BD whenever the latter was abandoned. Feature L was used as a trash area while stock were penned there as well as after it was no longer used as an animal pen. It is inferred that inhabitants of nearby Feature M were responsible for depositing trash in Feature L. The extensive midden built up in the rock shelter at Feature G (G3) demonstrates a sustained use of this area. The midden was possibly a combination of trash thrown over from Feature J on the cliff above and activities carried on within the rockshelter. Overall, the patterns of trash disposal and rebuilding at Feature B demonstrate a long, stable occupation of AR-4.

Period of Occupation: Relative dating of the various structures at AR-4 was addressed by ceramics, stratigraphy, and obsidian hydration. The intrasite comparison of ceramic types was unable to detect meaningful patterns that would suggest temporal variation. Differences noted in ceramic types could readily be explained as the breakage of single vessels. Furthermore, the main pottery types are not sensitive enough to temporal variation to demonstrate differences in the probable time range represented. The stratigraphic sequence found in Feature B is the primary indicator implying that the site (or parts of it) was occupied over a long time. Obsidian hydration (see below) provided unexpected evidence that the site was occupied over a considerable period. The range of hydration readings appears to span a period that could well be over 100 years. The magnitude of trash accumulations at Features B and D and perhaps L and G3 may support the length of time suggested by obsidian hydration -- as would the construction sequence in Feature B.

Dwelling areas that were long-lived and may have spanned the length of the occupation are Feature B, Feature D, Feature M (and related Features K and L) and Feature J (and related Feature G). These 4 areas may have been occupied throughout the life of the site. There are no extensive trash areas near Feature A and the cluster of Features C, P and Q by which to assess the possible length of occupation. The trash of Feature A, however, may have been dumped over the adjacent cliff edge (and washed away, following inundation). The amount of pottery and lithics from Features P and Q suggest long-term occupations. The soil chemical analysis of these 3 dwellings supports the interpretation of a sustained occupation.

Feature E clearly was not occupied for a long time. The minimum buildup of trash nearby is in agreement with the implications of the soil chemical analysis. The midden to the north of the dwelling lacked ceramics and cannot be regarded as a typical exterior trash area such as the one found near Feature D.

Feature C was used either very minimally or for a short period of time. Structure G1 also could not have been occupied for a long period unless all of the trash was disposed of in the nearby rockshelter (G3).

At times, there were probably up to 9 dwellings being occupied contemporaneously (Features A, BB, BD, BF, D, J, M, P, and Q). With the short-lived dwellings or habitations added (C, G2, and E), there may have been up to 12 structures being occupied at a time. As discussed, complete contemporaneity is difficult to assess, and a safe estimate would be that 7 to 9 dwellings were being occupied at a time. If it is assumed that there was a family per each dwelling, then the settlement may have consisted of 7 to 9 families.

Spatial proximity indicates that these 7 to 9 families would have formed an interacting community. The lithic material evidence cited in Chapter V suggests that they were all participating in the same basic culture pattern. In addition, they all utilized the same basic set of pattern types. The similarity in masonry types, house size, and nature and location of interior hearths all concur with other indications that these were people participating in a common culture pattern, albeit one that had considerable variability (as seen in the projectile points and the variety of house types).

Animal facilities: Animal-tending facilities are associated with 3 of the dwelling areas (Features B, M, and J). The large rock wall incorporated into the 3 dwellings at Feature B could have confined a considerable number of animals. While animal pens were not clearly present at Feature B, soil chemical analysis suggests that structure BC may have been used as an animal pen. The dwelling area centered around Feature M includes 2 distinct animal pens, Features K and L. The stratigraphy of Feature L suggests that nearby Feature K was used to confine animals after Feature L was no longer used for that purpose. It would appear that Feature G was the animal tending facility for Feature J. This area consists of an enclosed natural waterfall area at the base of the cliff and a natural rockshelter (G3). The similarity of the enclosure at G3 to Feature O suggests that the latter may represent a fourth corral that is separated from the dwellings. In general, however, the corrals and animal pens were close to or incorporated into the dwelling area. The fact that several dwellings (Features A, D, E, P, and Q) lack associated animal-tending facilities suggests that either these families lacked herds, or they kept their flocks in the areas near the other habitations.

Other functions: Three small concentrations of fire-reddened rocks were recorded and one was excavated. Feature F is a simple circle of fire-reddened sandstone rocks with no fill or associated artifacts. Feature I is more complex, being a pile of fire-reddened rocks around a circular cluster of large stones. There were no indications in the pollen or chemical analyses indicative of function of Feature I. It was impossible to determine what these features were. They could have been either exterior oven foundations or large hearths.

Two natural cavities in the bluff were walled up with slabs to form storage cists or possibly burials. Their proximity to the rest of AR-4 and the absence of similar features in the rest of the survey area (Schaafsma 1976) strongly suggest that they were part of the site occupation, even though they lacked diagnostic artifacts. One of these (AR-523) was cleared of interior fill and there were no artifacts in the fill.

Lithic analysis: Surface lithic areas are spatially related to the structures. The relationship between a structure and a lithic area can be particularly well seen near Feature A, where the open, sandy bench above the bluff was covered with flakes and other lithic debitage. As discussed in the lithic section of Chapter V, these lithics were collected or well-sampled during the project. If these lithic areas were part of the site occupation, they appeared to evidence considerably more debitage than what a community of this size would have produced for its own purposes in the apparent length of occupation. This suggests "roughing out" chert material of local origin for trade with other groups.

Obsidian hydration analysis addressed the question of whether these lithic areas were contemporary with the occupation. As discussed below in Chapter V, the indications are that most of these lithics were indeed occupationally associated. Specimens from a grid area south of Feature A were included in the formal lithic analysis. A comparison of the lithics from this area shows that these lithics are relatively unutilized and that they are dominantly chert. These results are consistent with the hypothesis that the lithics represent a workshop in which chert was being prepared for trade.

Lifeways: Economically, the inhabitants of the site were dependent upon animal husbandry, minimal agriculture, hunting, and gathering wild plant foods. The animal-tending facilities proved to be localized in 3 main areas. The minimal evidence for agriculture found in the pollen analysis correlates with the lack of grinding tools in the artifacts, and the lack of cultigens in the excavations and in the flotation materials examined. Actual evidence for agriculture is limited to 1 grain of pollen (presumably inspection of a larger sample would locate more), 2 charred beans and possibly 2 manos. Hunting is evidenced by the bones of wild animals and projectile points presumably were used in hunting. Evidence for gathering and processing wild plant foods comes from the skewed pollen spectra which indicate the use of prickly pears and possibly yuccas. Both of these are well known wild plant foods in the Southwest.

As a sketch of the lifeway of the inhabitants of AR-4, the excavation and analysis program summarized above reveals an interacting community of 7 to 9 families living in a variety of small stone and log houses distributed over the terrace and bluffs overlooking the Chama Valley. Most of these dwellings were hidden from the valley to the west, but one of them, Feature A, was situated on the bluff edge in a way that suggests it was a lookout. The effort toward concealment combined with the one structure that could have served as a lookout implies that the people lived during a period when hostile groups were to be expected in the valley below. On the other hand, the widely dispersed dwellings could hardly be termed defensive. They were merely hidden.

These families appeared to have lived in this locality for a considerable time. Whether they maintained the same economy throughout the whole period cannot yet be determined. This is unlikely, however, given the probable rate and nature of culture change during the period indicated by chronological evidence. They undoubtedly hunted throughout the period of occupation and also must have gathered wild plants. The circumstances surrounding the presence of sheep and goat husbandry depends for its interpretation on the proper evaluation of who these people were.

The abundant pottery from the Tewa and probably Tiwa Pueblos shows that the occupants of the site were in contact with the Rio Grande Pueblos. It is suggested that AR-4 occupants prepared and traded chert to the pueblos. They do not appear to have been in trade contact with other pueblos, such as Jemez, in the region.

The question of whether the site was occupied year-round or seasonally cannot be answered definitely with the materials at hand. Schoenwetter (Appendix B) suggests that evidence of oak and juniper pollen in the middens may suggest gathering these plants as green (and pollinating) branches in the early spring for use as firewood. If this was the case, the site would have been occupied in the early spring. Corn pollen would have been present in the mid-summer. Thus available pollen evidence suggests an occupation from early spring through mid-summer. Since plants do not pollinate in the winter, there unfortunately can be no pollen suggestions for winter use.

The substantial nature of the dwellings, especially Feature D, certainly would have allowed occupation throughout the winter. On the other hand, most groups who maintained seasonal camps in the Southwest while herding stock built very simple, easily relocated structures -- usually merely windbreaks of logs, brush, and occasional low-rock walls. Substantial structures would not be usual for seasonal sheep camps in the Southwest. The architectural evidence in combination with the amount of midden buildup around the dwellings implies that the site was occupied year-round.

V. ARTIFACTS

CERAMICS

Ceramic Technique: The present analysis represents an effort to combine computer and traditional typological techniques. The types are based upon traditionally established and previously accepted studies (Mera 1939; Carlson 1965; Frank and Harlow 1974) while a computer has been used as a high-speed clerical assistant to sort and summarize basic classes of information. In addition to gathering the information presented in the computer printouts, sherds were sorted visually, the basic types were separated, and the significant painted types isolated.

A punch card was made for each sherd. The card design is shown in Fig. 71. The codes for each field can be found on Figures 72-81. The codes and classes of information used are specific to this particular sherd collection and were selected to monitor the kinds of information useful for this analysis. Information that is better described visually and verbally is not dealt with in this manner (e.g., paint and design) and is merely noted as being present or absent.

The analysis and coding of sherds was completed by Jane Whitmore and Tim Maxwell at the School of American Research. The author, John Beal, and Richard Lang provided assistance in recognizing different classes of information such as temper and slip type.

The 210 sherds from Feature L and the 18 sherds from Feature M have been described previously (Schaafsma 1976: 157-73, Table 16 and Table 17). In general, they conform to the patterns in the present sample.

Figure 71

CERAMIC CODE AND CARD DESIGN

FIELD	CONTENTS	COLUMN
1	Site Number	1,2,3
2	Grid Number	4,5,6,7,8
3	Meter Square Number	9
4	Level	10,11
5	Feature Letter	12,13
6	Field Specimen Number	14,15,16,17,18
7	See Field 21 (Item Number moved)	19,20,21
8	Thickness	22,23
9	Vessel Shape	24,25
10	Temper	26,27
11	Temper Size	28,29
12	Paste Color	30,31
13	Exterior Surface Treatment	32,33
14	Interior Surface Treatment	34,35
15	Slip Location	36,37
16	Slip Type	38,39
17	Slip Color	40,41
18	Rim Form	42,43
19	Paint	44
20	Utilization	45,46
21	Item Number	47,48,49,50,51

Overall Summary Statistics: In order to provide an overview and reference for the ceramic collection, a summary of each variable is provided in Figs. 72 through 81. These basic summary data will be referred to in the following descussion.

TEWA POTTERY

Tewa Pottery: Slipped Plain and Painted. The post-1600 non-utility ceramics from the Tewa villages are similar in the basic technology of vessel manufacture (Carlson 1965:80). "The decorated Tewa wares are tempered with finely powdered tuff, giving the appearance of fine grit" (Frank and Harlow 1974:16). The resulting paste is very distinctive. While the majority of Tewa sherds have the typical tuff or fine sand temper (Fig. 73), 2 have arkosic sand and 2 have mica temper, which suggests that they were made either in Picuris (Dick 1965:138) or in the Nambe River pueblos. Quartz sand is found in 24 sherds suggesting another ceramic source. Nonutility Tewa pottery of all varieties dominates the present assemblage, making up 75.6 percent (1,491) of all sherds (Fig. 82).

Differences over time and between the Tewa pueblos were mainly the result of using varying colors and amounts of slip in addition to different vessel shapes, designs, and location of the designs (Frank and Harlow 1974; Mera 1939). The varieties or types of Tewa nonutility pottery can be described as Slipped Plain ware, Painted Black-on-white or gray, and Polychrome Painted.

Historically, the Tewa painted pottery in the seventeenth century has its roots in pre-Spanish types such as Sankawi Black-on-cream (Wendorf and Reed 1955:156). The use of carbon paint, the slip type, many of the designs, and many of the vessel shapes were developed before 1600 (1955:156; Mera 1939). Wendorf and Reed summarize the ceramic developments after the arrival of the Spaniards in 1598:

> In this area three apparently simultaneous changes occurred in the ceramics prior to the Pueblo Revolt: appearance of (1) a polished black ware; (2) polished red ware; and (3) a polychrome ware which in its earliest forms differed from the earlier black-on-white only by the addition of limited amounts of red. Many of the designs utilized on the polychrome ware made after A.D. 1700, and perhaps earlier, were derived from imported Mexican ceramics, especially Majolica.
>
> It has been suggested that the red and black wares were introduced by the Mexican Indians who accompanied the Spanish colonists. This seems to be the most plausible explanation, since the strongest appearance of these types was in the area first colonized, and since essentially similar pottery was made in southern Mexico (1955:156).

The suggestion that the red- and black-slipped pottery of the Tewa villages arose in response to ideas carried by Mexican Indians accompanying the Spaniards was questioned by Ellis on the basis of excavations of Taos (Ellis and Brody 1964) and Nambe (Ellis 1964). Specifically, Ellis suggested that San Juan Red-on-Orange and polished, black pottery appeared by, if not before, 1550. The results of stratigraphic analysis at Picuris were, however, temporally in agreement with Wendorf and Reed in documenting the appearance of these types about 1600 (Dick 1965:137-38). Regardless of the origin of these developments, it is certain that the aspects described above were common attributes of Tewa pottery by the latter half of the seventeenth century.

Tewa Pottery: Polished and Slipped Plain. A distinctive feature of Tewa pottery is the production of vessels which were covered entirely or partially with well-polished slip and which were not painted. Differential firing and smudging techniques render the vessels red, black, gray, or several other colors. The varities distinguished mainly by the different surface colors have received various names over the years, such as Posuge Red (Mera 1939:12), Kapo Black (1939: 14), Apodaca Gray (Dick 1965:138-40), and San Juan Red-on-Orange (Ellis 1964). Without distinguishing vessel shape criteria (as for Posuge Red, Mera 1939), it seems most appropriate to discuss these kinds of Tewa plain under the simple terms of Tewa Red, Tewa Black, Tewa Gray, etc., as Carlson has done (1965:80).

Most of the type names for Tewa-painted ceramics (Mera 1939; Frank and Harlow 1974) are based upon the characteristics apparent in whole vessels or at least in large sherds. Many of these types have large areas of plain slip which are generally red (e.g., Tewa polychrome). Because this analysis deals with only small sherds, it was not possible to determine whether a sherd was merely from an area of plain slip, on a vessel that was painted, or whether it was from a plain red vessel, such as Posuge Red. Thus, it is necessary to recognize that some mixing as far as established types are concerned has taken place.

There are 1,027 Tewa-Slipped, Plain-ware sherds in the present collection, comprising 52.1 percent of the total ceramics. These sherds have been separated into 6 color variations: red-orange, buff-tan, black-dark gray, light gray, brown, and maroon (Figs. 80 and 82). A seventh category consists of mica-slipped sherds (Fig. 82). A discussion of these varieties or types is presented below, followed by a summary of their secondary attributes.

1) Tewa Red. The polished red pottery of the historic Tewa Pueblos has long been recognized. It was first described by Mera as Posuge Red (1939:12), a type differentiated by jars with flaring rims (Fig. 83). Frank and Harlow observed, "Traditionally the pottery of San Juan has been plain polished

red or polished black" (1974:31). This description contrasts with Santa Clara pottery which before about 1900 consisted exclusively of the smudged-black form (1974:30). Consequently, those San Juan vessels that are red can be readily separated from the all-black vessels from Santa Clara (1974:32). It seems likely that the 318 red-orange slipped sherds represent trade items from San Juan Pueblo. Frank and Harlow also observed that the San Juan vessels usually have a fine micaceous glitter to the paste not found in Santa Clara vessels (1974:32). Many of the AR-4 sherds have this micaceous glitter, a fact which further suggests their origin in San Juan Pueblo. Also typical at San Juan is the technique of applying the polished slip of all colors to only the upper two-thirds of jars and to only a band below the rim on the exteriors of bowls (1974:31). "The rest of the surface is well-polished bare paste; a shade of orange-tan when the slip is red, and gray when the slip has been smudged black" (1974:31). Sherds of similar nature, with a band of slip below the rim, occur in this collection, further substantiating the belief that these sherds were largely made at San Juan Pueblo.

2) Tewa Buff-Tan. It seems likely that most of these 186 sherds are from San Juan and represent a variation of the plain red (Tewa Red) tradition at that pueblo.

3) Tewa Brown and Tewa Maroon. Sherds with these slip colors occurred fairly regularly in the collection (178 brown, 33 maroon). While distinctive, there is no implication that they represent separate types. These are probably color variations found on poorly-fired, plain red vessels. Some of these sherds may be representative of fire-cloud or similar surface-blemished areas. It seems likely that they, along with the red and buff-tan slipped sherds, are from San Juan Pueblo.

4) Tewa Black and Dark Gray. Polished black to dark-gray pottery is characteristic of Santa Clara Pueblo where it was the exclusive form of surface finish before 1900 (Frank and Harlow 1974:30). Mera's original name for the early form of this pottery, Kapo Black (1939:14), is derived from the Tewa name for that pueblo. Polished black pottery was also made at San Juan (Frank and Harlow 1974:31). Mera's description for Kapo Black limited the term to the seventeenth and eighteenth century form of this pottery which had distinctive vessel shapes (1939:15). As Carlson points out (1965:82), this criterion can rarely be observed in sherds, and a more inclusive term is needed. Past experience with these types shows that there is a definite and meaningful difference between the red pottery from San Juan and the black pottery from Santa Clara and San Juan.

5) Tewa Gray. Vessels with gray surfaces, both unslipped and thinly slipped have previously been recognized (Mera 1939:14; Dick 1965:138-140) and assigned the name Apodaca Gray by Dick, who states that such vessels, in addition to

being consistently a different color from Kapo Black (Tewa Black), have a thinner slip than that found on Kapo sherds (1965:139-40). Dick also suggest that gray, slipped vessels appeared before 1600 (1965:138). Mera, on the other hand, recognizes these gray vessels, but includes them in the Kapo Black type, suggesting that they were the result of inadequate slipping techniques (1939:14). Dick also observed that "Apodaca Gray" areas were found on the lower portion of vessels whose upper parts had a thick Kapo Black slip (1965: 140). This is consistent, of course, with the previously noted San Juan practice of polishing the unslipped paste of the vessel base which then appears polished-gray (Frank and Harlow 1974:31).

Gray sherdshave been separated here because they are distinctive in appearance and because they were described as a separate type by Dick. It should be noted, however, that the 103 gray sherds may simply represent a color variation in vessels that were otherwise part of the smudged-black tradition at Santa Clara, San Juan, and other pueblos in the region.

6) Tewa Mica Slip. Frank and Harlow note that the Tewa sometimes tried to imitate the micaceous pottery of Picuris and Taos but used a different clay and temper: "...the Tewa achieved the same metallic luster by coating their clay with a thick, glittery finish" (1974:27). The 20 sherds in this collection indicate that this practice existed at the time this site was occupied. Such vessels are rare, however, because the 20 sherds in this collection are almost certainly from one vessel broken in Feature B.

7) Tewa Plain--Attribute Summation. The secondary attributes of Tewa Plain pottery are presented in a series of cross-tabulation charts (Figs. 84-91). These are the data charts for the SPSS Chi-square test of association. To properly use them and follow this discussion, it should be recalled that the expected cell row percent is the corresponding column percent, and the expected cell column percent is the corresponding row percent. Refer to the key in the upper, left-hand corner of the charts, and the discussion on page 167. Presenting them collectively in this manner allows for comparison of the similarities and differences between the several slip color variations. Overall, the attributes that relate to the underlying technology (temper size, rim form, vessel shape, surface finish, and so forth) are similar and, when variations (statistical anomalies) occur, such as in paste color, they can be related to firing practices that produced differences in slip color. The mica slipped sherds are not included here. In addition, 16 of the sherds in Tewa Gray slip have since been separated into Tewa Black-on-Gray because of the presence of paint (cf. Figs. 82 and 84).

While obvious difficulties exist in attempting to determine the vessel shape from sherds alone, a general idea of the patterns inherent in a ceramic population can be obtained from the occurrence of different vessel shapes as sherds. Overall, ollas and jars predominate (Fig. 84, column totals)but there are significant numbers of bowls as well. This overall pattern is reflected fairly well in the slip color variations (Fig. 84) indicating that these sherds are derived from the same basic tradition of vessel shape.

Consistent with the predominance of ollas and jars, slip on these sherds is mainly found on exteriors (Fig. 85). Bowls are generally slipped on the interior, or interior and exterior, with the vessels from San Juan generally having only a limited band of exterior slip below the rim (Frank and Harlow 1974:31).

The Tewa slip type was divided into 3 categories: thick, medium, and thin. Overall, thin slip dominates with the thick type being relatively rare (Fig. 86). It should be noted that gray and black are similar, but gray tends to be thin.

Rims are predominantly round with some squared (Fig. 87). Relatively few sherds exhibit the flaring rims (Fig. 83) regarded as typical of Posuge Red and Kapo Black (Mera 1939).

Tewa Plain Slipped pottery has always been recognized for its smooth and generally polished surfaces. Such finishes predominate in the present collection (Figs. 88 and 89). The finishes of interior surfaces are more variable because of differential treatment--often there has been only a cursory smoothing on the interior of jars and ollas, while interiors of bowls are smoothed and polished.

Paste color is influenced by the firing practices which produced the different kinds of slip color. Black and gray vessels tend to have black-dark gray, white-light gray, and gray-white, carbon-streaked pastes, whereas red-and tan-slipped vessels tend to have tan and reddish-orange pastes (Fig. 90). The relationship is, however, by no means a simple dichotomy and many red- and tan-slipped vessels have gray pastes.

The temper of Tewa pottery is generally fine (Frank and Harlow 1974:16), and this is one of the characteristic attributes used in visual identification of this pottery type. Some sherds, however, are also medium- and coarse-tempered. Red-slipped sherds are most consistently fine-tempered (Fig. 91).

In summary, the Tewa Slipped Plain ware conforms in nearly every aspect to the generalizations that have previously been made about this pottery. This overall consistency with previous descriptions of Tewa plain pottery helps confirm the identification based on slip color and temper type that this pottery is unequivocally trade ware from the Tewa pueblos.

In addition to the 1,027 Tewa plain sherds with slip, there are 331 Tewa sherds that lack slip either because they are parts of vessels that were not slipped originally, or because the original slip has been extensively weathered. There are also 13 Tewa sherds of indeterminant slip color, making a total of 345 weathered or unslipped Tewa sherds (Fig. 82).

Tewa Black-on-White: Little has been written (Mera 1939; Frank and Harlow 1974) about Tewa pottery with gray or white slip and black paint designs, but this type of pottery was made in the seventeenth and eighteenth centuries (Carlson 1965: 82). In terms of slip type, color, vessel form, and design, these vessels resemble Tewa Polychrome, with the exception that red slip is not used as it was on the painted Tewa types described by Mera or Frank and Harlow. Tewa Polychrome is recognized by sherds with white, light-gray slip and areas of polished-red slip, and only those sherds that have both the white-slipped areas and red slip can be regarded as Tewa Polychrome. Therefore, some of these sherds undoubtedly are Tewa Polychrome that lack the diagnostic red slip.

Two bowls of Tewa Black-on-White were found in the Gobernador dating ca. 1750 (Carlson 1965:82). These sherds have carbon paint with designs similar to those found on Tewa Polychrome (Fig. 83). Thirty-seven sherds of this kind were found at AR-4. Several are of a flat bowl or plate design from Feature D, and are complete enough to show that no red slip was originally present.

Tewa Polychrome: There are 81 Tewa Polychrome sherds in the present collection (Fig. 82, 83) and painted designs are present on 45 of these. There are both olla and bowl sherds, with one sherd from a carinated bowl of the type illustrated by Frank and Harlow (1974: Figs. 6 and 7) and Carlson (1965: Fig. 36 a-c). Occasional flecks of mica in the paste indicate that these vessels were probably made at San Juan Pueblo. Slipped areas are well-smoothed and polished, and the white slip commonly is cracked. Of the 31 rim sherds, 20 are round, 10 squared, and 1 has a flared rim.

Ogapoge Polychrome: In most aspects, Ogapoge Polychrome (Mera 1939:13) is similar to Tewa Polychrome, and usually cannot be distinguished from the latter type (Carlson 1965: 80) on the basis of small sherds. One characteristic of Ogapoge Polychrome that can be observed in small sherds, however, is the use of red pigment as an integral part of the painted design (Mera 1939:13). One sherd from the present collection exhibits red pigment used in the design with the red outlined in black as is generally the case (Frank and Harlow 1974:Plate II). Mera states that Ogapoge Polychrome was at the height of its development between 1730 and 1750+ (1939:16). The type appeared "sometime between the beginning and the middle of the 18th century" (1939:13).

Pueblo Utility Pottery

Three types of utility or culinary pottery are present in the collection. These have all been previously reported from Nambe (Ellis 1964b) and Picuris (Dick 1965). One type that is generally thin-walled with micaceous paste and temper is typical of modern Taos and Picuris pottery (Frank and Harlow 1974:27). This type is described by the name Penasco Micaceous and was abundant at Picuris after 1600 (Dick 1965:144). The second type is characterized by the use of mica slip on coarse, sand-tempered (askosic or quartz) paste. The third type is also tempered with coarse sand, but it lacks a surface slip. It is suggested that Penasco Micaceous represents trade pottery from Picuris and that the other 2 culinary types were made in the Tewa villages.

Penasco Micaceous: The outstanding characteristic of this pottery that separates it from all other contemporaneous types is its mica-rich paste (Fig. 83). Dick states, "The major tempering material is biotite mica which is found naturally mixed in the clay deposit. Occasional large grains of quartzitic sand are also found in the pottery" (1965:144). Frank and Harlow observed, "The Tewa Indians sometimes copied the style of Picuris and Taos but used a different clay and temper. At Taos and Picuris the clay is formed of decayed pre-Cambrian schists, filled with abundant flecks of mica throughout" (1974:27). Ellis found that a micaceous, slipped and tempered, Plain Culinary type was common at Nambe (1964:37). Since Dick reports that the surfaces of Penasco Micaceous are unslipped except for an occasional thin wash (1965:144) and since the sherds in the present collection also lack a slip or at the most have a thin micaceous wash, it seems likely that this pottery was made at Picuris rather than one of the Tewa villages such as Nambe.

There are 126 sherds of Penasco Micaceous. Of these, 91 have no slip, 5 have an indeterminate or possible wash, 13 have a thin gray slip, and 17 have a thin mica slip that has oxidized to a copper or golden color. Dick described paste color as "medium to dark gray, occasionally orange with a carbon streak" (1965:144). In this collection, 86 sherds have a black, dark-gray paste color, 34 are carbon-streaked, 1 is brown, 2 are white-light gray, and 3 are completely oxidized to a copper-golden color. Dick described the vessels shaped as mainly bowls and jars (1965:144). In this group there are 66 ollas, 11 jars, 4 large bowls, 28 small bowls and 17 whose shape could not be determined. Dick reports that the rims usually have parallel sides with rounded lips and that the ollas have everted rims. Rim sherds are rare in this collection; there are only 10. One of these is tapered (a bowl), 4 are rounded (3 bowls and 1 jar), 4 (Fig. 22) are squared (3 ollas and one bowl), and the 1 flare rim is from an olla. As described by Dick, surfaces are generally rough with occasional striations evident.

Vadito Micaceous: The sand-tempered utility pottery with mica slip that has been made in the northern Rio Grande pueblos since at least 1600 was described by Dick as Vadito Micaceous (1965:42-43). Similar pottery was made at Nambe, where Ellis described it as "micaceous slip, plain culinary, nonmicaceous temper" (1964: Table 1). In most aspects Vadito Micaceous is identical to the contemporaneous unslipped, plain culinary ware from which it is distinguished by its "rich micaceous slip over the coarse culinary type core" (Dick 1965:143). At Picuris, the slip is of mica-rich serecite clay used by present-day potters (1965:143). There are 109 sherds of this type in the present collection (Fig. 83).

At Picuris, Dick described the temper of Vadito Micaceous as: "coarse quartzitic and arkosic sand, mica (sometimes as a natural constituent of the clay), and occasional pieces of gravel up to 10 millimeters in diameter" (1965:142). Most of the temper and paste clays at Picuris are rich in feldspar and best described as arkosic sand. In the present collection, 107 sherds are identified as quartz sand-tempered because of the lack of obvious feldspar, and only 1 sherd is clearly arkosic sand-tempered. Because of the predominance of quartz sand-temper, this pottery probably was not made at Picuris but at one of the Tewa pueblos, such as Nambe, in the Nambe River Valley. This identification, however, can only be verified by an accurate petrographic comparison between these sherds and those collections from the various pueblos.

Dick describes the texture of the core and the temper as "coarse" with granules up to 10 millimeters (1965:142). In this collection, the temper size is primarily medium (49) or coarse (36), with some fine (19), and a few very fine (4). None of the sherds have very coarse temper (granules over 2 millimeters). Temper size supports the suggestion that these vessels were not made at Picuris. On the other hand, paste color is nearly the same as that of vessels from Picuris, where the paste is described as "dark gray" (1965:142). Ninety-four of these sherds have black, dark-gray pastes, 11 of which have a gray carbon streak. Three sherds consist of tan or reddish pastes resulting from oxidation during firing. Dick notes that Vadito Micaceous ranges in thickness from 7.5 millimeters to 12.5 millimeters and that it is generally thicker than Penasco Micaceous. This thickness is greater than that of the AR-4 sherds (4 millimeters to 9 millimeters). As at Picuris, Vadito Micaceous is consistently thicker than Penasco Micaceous.

Vessel shapes at Picuris are bowls and ollas, with ollas being more common (Dick 1965:143). This predominance is also the case at AR-4 where there are 38 ollas, 21 jars, 8 large bowls, and 21 small bowl sherds; the site also had 21 sherds for which vessel shape was indeterminate. There are only 3 rim sherds in all: 1 round and 2 squared. At Picuris, it was noted that the ollas have everted rims and that bowls have parallel sides with flattened lips (1965:143).

At Picuris, "Almost all of the sherds of this type have a thin slip applied to both surfaces of bowls and olla exteriors"

(Dick 1965:143). The slips at AR-4 also tend to be thin (91 sherds). At Nambe, it was noted that the amount of mica in the slip varies greatly "as this slip quickly wears thin" (1964:36). Slip on the AR-4 sherds is present primarily on the exterior (96); 3 sherds have slip on both interior and exterior. Interiors of almost all jars and ollas have smoothed and smudged surfaces. In 62 of these, the interior surface also has a definite polish. Whereas many of the AR-4 sherds have smoothed, polished, and smudged interiors, it was noted at Picuris that only "occasionally" are olla interiors polished (Dick 1965:143). At Nambe, where 13 micaceous Slipped Plain Culinary sherds showed black-smudged interiors, Ellis observed that it was probably produced "as in modern Jemez culinary ware, by rubbing the interior with dung while the vessel was still hot from firing" (1964:36). Dick observed that vessel exteriors at Picuris were generally rough (1965: 143). Of the AR-4 sherds, exteriors are sometimes smooth (29), but generally rough (77). Six of the rough exterior sherds show striations; none of them are polished.

Overall, it is clear that these sherds are of the same generic class (type) as the Vadito Micaceous pottery from Picuris. Temper and minor technological variations suggest, however, that the sherds from AR-4 were probably not made at Picuris. The presence of pottery of this type at Nambe indicates that mica-slipped, nonmicaceous, culinary pottery was being made at a number of pueblos, probably beginning sometime in the seventeenth century. The sherds in the present collection almost certainly represent trade from one, or several, of the pueblos in the northern Rio Grande Valley where this pottery was made.

Plain Utility: Plain Culinary ware is nearly identical to Vadito Micaceous and is separated from that type by the absence of slip alone. Indeed, it is apparent that many sherds of "Plain Culinary" are actually Vadito Micaceous sherds from which the slip has been eroded.

Northern Rio Grande Pueblo plain utility pottery is sand-tempered (Dick 1965:146-7; Frank and Harlow 1974:16). In this collection, temper consists almost entirely of quartz sand (183) and, to a limited extent (3), of arkosic sand. Exteriors are rough, with the sand generally obvious on the surface. Temper size is primarily medium (65) or coarse (78) with 2 having granules over 2 millimeters. While the pastes are mostly black, dark-gray or black with a light-gray carbon streak, the exterior surfaces are generally a light-gray color. Vessel forms are similar to those found in Vadito Micaceous with 100 ollas, 17 jars, 15 bowls, and 32 small bowls among those sherds where vessel shape could be determined. While occasional vessels have striations, these are rare and are not the general form of surface treatment. The few jar or olla base sherds indicate that the vessels were round with flattened bottoms. Mera observed that many pueblo sites in the Rio Grande Valley during the period being discussed have yielded a large percentage of culinary sherds "with interior surfaces burnished and blackened" (1939:15). In this collection, 120 sherds have been well-smoothed and, of these, 71 are also smudged; 48 are polished as well as smoothed and smudged. The interiors are thus very similar to the smoothed and smudged interiors of Vadito Micaceous, and this method of finishing the interiors of Pueblo utility vessels was apparently a regular feature of Rio Grande ceramic technology until at least the beginning of the eighteenth century (Mera 1939:15). The absence of the various smeared, indented, washboard, ribbed, etc., surface treatments observed on other Pueblo ceramics in the Rio Grande Valley (Mera 1935:18; Dick 1965:146-7; Ellis 1964) is noteworthy. Significant is the general lack of surface striations which are a common feature of Late Culinary pottery at Pecos (Wendorf and Reed 1955: 155).

Jeddito Yellow Ware

One of the most significant results of the excavation of AR-4 was the finding of Jeddito Yellow ware (Colton 1956) from the Hopi villages. The sherds from AR-4 conform in every respect with the general description for Jeddito Yellow wares. The temper consists mainly of fine to medium quartz sand with occasional reddish flecks from iron impurities in the Hopi clays. The paste color is the creamy yellow to light tan characteristic of this ware. The surfaces are well-polished and, according to Colton, are generally "compacted" or floated rather than slipped. The interior of a single jar sherd is smoothed but not polished. Surface color is bright yellow to orange, depending upon firing. Vessel walls range from 5 millimeters to 8 millimeters with 36 vessels having walls of 5 and 6 millimeters. There are 46 sherds overall, a number of which can be put together. The number of sherds along with their context indicates that there are probably no more than 3 vessels represented. There are, however, at least 3 vessels. Two of these are wide-mouthed jars without interior paint. One is a jar sherd that, judging by the rough interior surface, must have had a small orifice. The polychrome design in red and black are typical of the late Jeddito types.

Assigning the sherds to one of Colton's types is somewhat difficult because of the size of the sherds and the illustrations he provides (1956). The designs could equally well be present on Payupki Polychrome -- a type present in the Gobernador Navajo sites (Carlson 1965:83-4). Perhaps more important than design, however, is Colton's note that lips of Payupki vessels are usually painted brownish red -- a characteristic of the Gobernador vessels (1965:83-4). All of the rim sherds from AR-4 have this brownish-red paint. In addition, the rim sherds illustrated by Colton for Payupki Polychrome are more typical of the rounded, flaring rims these vessels have (Fig. 83). There seems little question that these sherds from AR-4 are one of these 2 types, and Payupki Polychrome is the more likely. Sikyatki Polychrome ceased to be made ca. 1625, whereas Payupki Polychrome was made from ca. 1700 until ca. 1800. The proper identification of this ware thus has considerable temporal significance.

These sherds were examined by Watson Smith. He recognized them as typical (in design, slip color, etc.) of the Hopi pottery made at Awatovi in the late 1600's (ca 1670 - 1700). Smith declined assigning one of Colton's type names, but instead regarded them as late (post-1650) derivative form of the Sikyatki Polychrome tradition.

The sherds were also examined by Charles Adams, director of the Walpi restoration project, in 1978. Adams stated that these are essentially the same as late forms of Sikyatki Polychrome that are found at Walpi in ca. 1690 contexts.

Of major interpretative interest is the fact that, in his survey of the entire Biscuit ware area, Mera (1934:20) found only one sherd from the Hopi villages. This was a sherd of Sikyatki Polychrome at Tsama (LA-908) located at the junction of El Rito Creek and the Chama River. Mera dated the abandonment of this village as before 1600, and probably before 1550.

Taos Gray

The distribution of this distinctive utility pottery is generally restricted in the Rio Grande drainage to Taos County where it was the typical culinary ware from about A.D. 1000-1300 (Wetherington 1968; Peckham 1963:13). These sherds commonly have coarse quartz temper, and 6 of these sherds account for most of the granule-sized temper found in the whole collection (Fig. 74). The 15 Taos Gray sherds were all found in a restricted area at the south end of the grid collection area near Feature A. The single lug (Fig. 72) found overall was on a Taos Gray vessel. Similarly, 1 of the 2 incised exterior sherds was a Taos Gray sherd (Fig. 76). These obviously different sherds are important in documenting an earlier component at AR-4. They are the first Taos Gray sherds to be found in the Reservoir District.

Intrasite Distribution of Ceramic Types

The distribution of ceramic types within the site can perhaps provide clues to temporal and/or functional differences between various features. An inspection of Figure 82 will disclose that nearly all of the distributions are within the limits of random variability. A formal statistical test was not made because of the many small cases. However, there are no mutually exclusive distributions when numbers are large enough to omit simple sampling error as the cause. Most anomalies can be explained as the breakage of single vessels in features.

Some Tewa plain is present at every feature, and Tewa painted types are distributed in approximately their expected proportions. The few distributional anomalies in Tewa pottery (high amount of Tewa Black-on-White in Feature D; large amount of Tewa mica slip in Feature B) can be attributed to the fact that vessels of this type were broken in the features rather than being due to temporal or functional differences between features.

Collectively, the Pueblo utility types (Penasco Micaceous, Vadito Micaceous, and Plain Culinary) are found at nearly every feature. As was the case with Tewa plain and painted types, the distribution of sherds appears to be within the range of random variation. The few anomalies that do occur, e.g., the high proportions of Penasco Micaceous at Feature A and Q, can be related to the breakage of single vessels in these features.

Most of the Hopi sherds are from 2 vessels broken in Feature B. It is of interest that the presence of this kind of pottery in another feature (P) indicates that the existence of this pottery at AR-4 was likely a general, although rare, phenomenon rather than a freak occurrence.

The Taos Gray sherds exhibit the only really distinctive distribution pattern. They were found on the surface south of Feature A which emphasizes the fact that these sherds from outside the features are from an earlier component and do not relate to the Piedra Lumbre Phase occupation (in Figure 82, they are grouped with Feature A sherds).

The implication derived from this essentially homogeneous distribution of pottery types within the features is that patterns in ceramics do not disclose temporal or functional differences between features and the features were probably contemporaneous. Data on the dating of these types is not sufficient, however, to indicate definite contemporaneity, although they suggest it.

It should be noted finally that nearly all the potsherds were directly associated with a feature -- either inside the structure or in the middens or trash areas near them. Only 3 sherds (other than Taos Gray) were found on the general surface away from features (Fig. 82). Reconnissance activity over all site areas reinforced this distributional bias; as a result large area ceramic collection was not implemented.

Trade Relationships

The summary in Figure 82 and the above discussion point out that the primary trade relationships at AR-4 were with the Tewa Pueblos, especially San Juan and Santa Clara. A minor trade connection is indicated with the northern Tiwa villages, with Picuris possibly supplying the bulk of this pottery. The

	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
	0	237	12.0	12.0	12.0
Olla..................	1	786	39.8	39.8	51.8
Jar..................	2	410	20.8	20.8	72.6
Large Bowl	3	212	10.7	10.7	83.4
Small Bowl	4	327	16.6	16.6	99.9
Lug..................	5	1	0.1	0.1	100.0
	TOTAL	1973	100.0	100.0	

Figure 72--Vessel Shape, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
INDTFM	0	4	0.2	0.2	0.2
MICA	1	128	6.5	6.5	6.7
QUARTZ SAND	2	329	16.7	16.7	23.4
AKRCSIC SAND	3	6	0.3	0.3	23.7
TEWA UNDIFF	4	21	1.1	1.1	24.7
TEWA TUFF,PUMICE	5	1436	72.8	72.8	97.5
TEWA FINE SAND	6	3	0.2	0.2	97.7
HOPI YELLOW W RED SP	7	46	2.3	2.3	100.0
	TOTAL	1973	100.0	100.0	

Figure 73--Temper, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
SILT + CLAY	0	1	0.1	0.1	0.1
VERY FINE	1	394	20.0	20.0	20.0
FINE	2	681	34.5	34.5	54.5
MEDIUM	3	542	27.5	27.5	82.0
COARSE	4	302	15.3	15.3	97.3
VERY COARSE	5	41	2.1	2.1	99.4
GRANULES	6	8	0.4	0.4	99.8
INDTRM	12	4	0.2	0.2	100.0
	TOTAL	1973	100.0	100.0	

Figure 74--Temper Size, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
BLACK-DARK GRAY	1	963	48.8	48.8	48.8
CARBON STREAK	2	524	26.6	26.6	75.4
BROWN	3	40	2.0	2.0	77.4
WHITE-LIGHT GRAY	4	152	7.7	7.7	85.1
COPPER-GOLDEN	5	5	0.3	0.3	85.4
TAN	6	184	9.3	9.3	94.7
REDDISH-ORANGE	7	63	3.2	3.2	97.9
YELLOW-HOPI	8	42	2.1	2.1	100.0
	TOTAL	1973	100.0	100.0	

Figure 75--Paste Color, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
INDTRM	0	57	2.9	2.9	2.9
SMOOTHED	1	332	16.8	16.8	19.7
SMOOTHED + POLISHED	2	1211	61.4	61.4	81.1
ROUGH	3	258	13.1	13.1	94.2
ROUGH W STRIATIONS	4	51	2.6	2.6	96.8
COILS APPARENT	5	6	0.3	0.3	97.1
FINGER SMOOTHING	6	7	0.4	0.4	97.4
SMOOTHED SMDG + POL	7	30	1.5	1.5	98.9
SMOOTHED + smudged	8	19	1.0	1.0	99.9
Incised	9	2	0.1	0.1	100.0
	TOTAL	1973	100.0	100.0	

Figure 76--Exterior Surface Treatment, overall summary

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
INDTRM	0	112	5.7	5.7	5.7
SMOOTHED	1	817	41.4	41.4	47.1
SMOOTHED + POLISHED	2	448	22.7	22.7	69.8
SMOOTHED POL + SMDG	3	184	9.3	9.3	79.1
FINGER SMOOTHING	4	29	1.5	1.5	80.6
ROUGH	5	96	4.9	4.9	85.5
ROUGH W STRIATIONS	6	34	1.7	1.7	87.2
SMOOTHED + SMDG	7	75	3.8	3.8	91.0
SMOOTHED W STRIATION	8	177	9.0	9.0	99.9
INCISED	9	1	0.1	0.1	100.0
	TOTAL	1973	100.0	100.0	

Figure 77--Interior Surface Treatment, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FRE (PERCENT
INDTRM	0	45	2.3	2.3	2.3
INTERIOR	1	55	2.8	2.8	5.1
EXTERIOR	2	982	49.8	49.8	54.8
INTERIOR + EXTERIOR	3	278	14.1	14.1	68.9
UNSLIPPED	12	613	31.1	31.1	100.0
	TOTAL	1973	100.0	100.0	

Figure 78--Slip Location, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIV ADJ FR (PERCEN
INDTRM	0	34	1.7	1.7	1.7
TEWA THICK	1	35	1.8	1.8	3.5
TEWA, MEDIUM	2	322	16.3	16.3	19.8
TEWA, THIN	3	711	36.0	36.0	55.9
TEWA, WT + CRACK	4	42	2.1	2.1	58.0
TEWA, WT + SMOOTH	5	19	1.0	1.0	58.9
MICACEOUS, THICK	6	15	0.8	0.8	59.7
MICACEOUS, THIN	7	131	6.6	6.6	66.3
HOPI, THIN	8	46	2.3	2.3	68.7
UNSLIPPED	12	618	31.3	31.3	100.0
	TOTAL	1973	100.0	100.0	

Figure 79--Slip Type, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FREQ (PERCENT)
INDTRM	0	37	1.9	1.9	1.9
TEWA RED-ORANGE	1	318	16.1	16.1	18.0
TEWA BUFF-TAN	2	186	9.4	9.4	27.4
TEWA BLACK-DK GRAY	3	189	9.6	9.6	37.0
TEWA GRAY	4	119	6.0	6.0	43.0
POLYCHROME	5	101	5.1	5.1	48.2
MICACEOUS-GRY,SH	6	42	2.1	2.1	50.3
MICACEOUS-COPPER,GLD	7	104	5.3	5.3	55.5
TEWA WHITE	8	21	1.1	1.1	56.6
BROWN	9	178	9.0	9.0	65.6
MAROON	10	33	1.7	1.7	67.3
HOPI BUFF-RED,ORANGE	11	27	1.4	1.4	68.7
UNSLIPPED	12	618	31.3	31.3	100.0
	TOTAL	1973	100.0	100.0	

Figure 80--Slip Color, overall summary.

CATEGORY LABEL	CODE	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)	ADJUSTED FREQUENCY (PERCENT)	CUMULATIVE ADJ FRE (PERCENT
TAPERED, ROUGH	1	8	0.4	0.4	0.4
ROUND	2	129	6.5	6.5	6.9
SQUARED	3	39	2.0	2.0	8.9
FLARING, ROUNDEDEDGE	4	16	0.8	0.8	9.7
FLARING, SQUAREDEDGE	5	2	0.1	0.1	9.8
NO RIM	12	1777	90.1	90.1	99.9
Round	20	1	0.1	0.1	99.9
Squared	30	1	0.1	0.1	100.0
	TOTAL	1973	100.0	100.0	

Figure 81--Rim Form, overall summary.

CERAMIC PROVENIENCE TABLE - AR-4 Figure 82

Type	A	B	C	D	E	G	J	K	P	Q	Gen. Sur.	Total	Percent	Remarks
TEWA														Total Non-Utility Tewa
Tewa Red	18	72	0	194	0	0	15	2	15	0	2	318	16.1	75.6%
Tewa Buff-Tan	9	19	2	112	0	1	14	0	29	0		186	9.4	(1491)
Tewa Black	1	18	1	38	3	4	11	1	111	1		189	9.6	
Tewa Gray	13	5	6	38	0	0	6	0	31	4		103	5.2	
Tewa Brown	7	6	5	74	3	1	9	1	72	0		178	9.0	
Tewa Maroon	2	4	0	25	0	0	1	0	1	0		33	1.7	
Tewa Mica	0	19	0	1	0	0	0	0	0	0		20	1.0	
Weathered, Tewa	54	39	3	103	2	4	38	4	94	5		345	17.5	
Tewa Polychrome	7	23	5	38	0	0	0	0	6	1	1	81	4.1	
Tewa Black/white	0	4	0	29	0	0	0	0	4	0		37	1.9	
Ogapoge Polychrome	0	1	0	0	0	0	0	0	0	0		1	0.1	
PUEBLO UTILITY														
Penasco Mica	22	17	0	29	0	2	2	0	1	53		126	6.4	Total Utl;421 21.3%
Vadito Mica	0	44	0	56	1	0	0	0	0	8		109	5.5	
Plain Culinary	7	41	0	77	0	1	3	4	4	49		186	9.4	
HOPI		44							2			46	2.3	
TAOS GRAY	15											15	0.8	
TOTAL	155	356	22	814	9	12	99	12	370	121	3	1973	100.0	
PERCENT	7.9	18.0	1.1	41.3	0.5	0.6	5.0	0.6	18.8	6.1	0.2	100.1		

a b c

d e

Figure 83: Illustrative sherds. A) Tewa Red; B) and C) Tewa Polychrome; D) Penasco Micaceous; E) Jeddito Yellow.

V17	COUNT / ROW PCT / COL PCT / TOT PCT	INDTRM 0	OLLA 1	JAR 2	LARGE BOWL 3	SMALL BOWL 4	ROW TOTAL
1 TEWA RED-ORANGE	COUNT	29	108	103	22	56	318
	ROW PCT	9.1	34.0	32.4	6.9	17.6	31.1
	COL PCT	26.9	26.4	38.6	20.8	42.1	
	TOT PCT	2.8	10.6	10.1	2.2	5.5	
2 TEWA BUFF-TAN	COUNT	23	74	35	24	30	186
	ROW PCT	12.4	39.8	18.8	12.9	16.1	18.2
	COL PCT	21.3	18.1	13.1	22.6	22.6	
	TOT PCT	2.2	7.2	3.4	2.3	2.9	
3 TEWA BLACK-DK GR	COUNT	26	85	40	20	18	189
	ROW PCT	13.8	45.0	21.2	10.6	9.5	18.5
	COL PCT	24.1	20.8	15.0	18.9	13.5	
	TOT PCT	2.5	8.3	3.9	2.0	1.8	
4 TEWA GRAY	COUNT	12	52	20	23	12	119
	ROW PCT	10.1	43.7	16.8	19.3	10.1	11.6
	COL PCT	11.1	12.7	7.5	21.7	9.0	
	TOT PCT	1.2	5.1	2.0	2.2	1.2	
9 BROWN	COUNT	15	82	53	15	13	178
	ROW PCT	8.4	46.1	29.8	8.4	7.3	17.4
	COL PCT	13.9	20.0	19.9	14.2	9.8	
	TOT PCT	1.5	8.0	5.2	1.5	1.3	
10 MAROON	COUNT	3	8	16	2	4	33
	ROW PCT	9.1	24.2	48.5	6.1	12.1	3.2
	COL PCT	2.8	2.0	6.0	1.9	3.0	
	TOT PCT	0.3	0.8	1.6	0.2	0.4	
COLUMN TOTAL		108	409	267	106	133	1023
		10.6	40.0	26.1	10.4	13.0	100.0

Figure 84--Crosstabulation: Tewa Slip Color and Vessel Shape.

V17	COUNT / ROW PCT / COL PCT / TOT PCT	INDTRM 0	INTERIOR 1	EXTERIOR 2	INTERIOR + EXTER 3	ROW TOTAL
1 TEWA RED-ORANGE	COUNT	4	7	247	60	318
	ROW PCT	1.3	2.2	77.7	18.9	31.1
	COL PCT	33.3	14.9	31.5	33.3	
	TOT PCT	0.4	0.7	24.1	5.9	
2 TEWA BUFF-TAN	COUNT	1	16	127	42	186
	ROW PCT	0.5	8.6	68.3	22.6	18.2
	COL PCT	8.3	34.0	16.2	23.3	
	TOT PCT	0.1	1.6	12.4	4.1	
3 TEWA BLACK-DK GR	COUNT	2	5	145	37	189
	ROW PCT	1.1	2.6	76.7	19.6	18.5
	COL PCT	16.7	10.6	18.5	20.6	
	TOT PCT	0.2	0.5	14.2	3.6	
4 TEWA GRAY	COUNT	2	14	83	20	119
	ROW PCT	1.7	11.8	69.7	16.8	11.6
	COL PCT	16.7	29.8	10.6	11.1	
	TOT PCT	0.2	1.4	8.1	2.0	
9 BROWN	COUNT	3	4	155	16	178
	ROW PCT	1.7	2.2	87.1	9.0	17.4
	COL PCT	25.0	8.5	19.8	8.9	
	TOT PCT	0.3	0.4	15.2	1.6	
10 MAROON	COUNT	0	1	27	5	33
	ROW PCT	0.0	3.0	81.8	15.2	3.2
	COL PCT	0.0	2.1	3.4	2.8	
	TOT PCT	0.0	0.1	2.6	0.5	
COLUMN TOTAL		12	47	784	180	1023
		1.2	4.6	76.6	17.6	00.0

Figure 85--Crosstabulation: Tewa Slip Color and Slip Location.

V17	COUNT / ROW PCT / COL PCT / TOT PCT	TEWA THICK 1	TEWA, MEDIUM 2	TEWA, THIN 3	TEWA, WT + CRACK 4	TEWA, WT + SMOOT 5	ROW TOTAL
1 TEWA RED-ORANGE	COUNT	8	88	222	0	0	318
	ROW PCT	2.5	27.7	69.8	0.0	0.0	31.1
	COL PCT	23.5	28.3	32.9	0.0	0.0	
	TOT PCT	0.8	8.6	21.7	0.0	0.0	
2 TEWA BUFF-TAN	COUNT	7	39	139	0	1	186
	ROW PCT	3.8	21.0	74.7	0.0	0.5	18.2
	COL PCT	20.6	12.5	20.6	0.0	50.0	
	TOT PCT	0.7	3.8	13.6	0.0	0.1	
3 TEWA BLACK-DK GR	COUNT	8	90	91	0	0	189
	ROW PCT	4.2	47.6	48.1	0.0	0.0	18.5
	COL PCT	23.5	28.9	13.5	0.0	0.0	
	TOT PCT	0.8	8.8	8.9	0.0	0.0	
4 TEWA GRAY	COUNT	1	33	83	1	1	119
	ROW PCT	0.8	27.7	69.7	0.8	0.8	11.6
	COL PCT	2.9	10.6	12.3	100.0	50.0	
	TOT PCT	0.1	3.2	8.1	0.1	0.1	
9 BROWN	COUNT	10	50	118	0	0	178
	ROW PCT	5.6	28.1	66.3	0.0	0.0	17.4
	COL PCT	29.4	16.1	17.5	0.0	0.0	
	TOT PCT	1.0	4.9	11.5	0.0	0.0	
10 MAROON	COUNT	0	11	22	0	0	33
	ROW PCT	0.0	33.3	66.7	0.0	0.0	3.2
	COL PCT	0.0	3.5	3.3	0.0	0.0	
	TOT PCT	0.0	1.1	2.2	0.0	0.0	
COLUMN TOTAL		34	311	675	1	2	1023
		3.3	30.4	66.0	0.1	0.2	100.0

Figure 86--Crosstabulation: Tewa Slip Color and Slip Type.

V17	COUNT / ROW PCT / COL PCT / TOT PCT	TAPERED, ROUGH 1	ROUND 2	SQUARED 3	FLARING, ROUNDED 4	FLARING, SQUARED 5	NO RIM 12	ROW TOTAL
1 TEWA RED-ORANGE	COUNT	2	28	7	5	0	275	3
	ROW PCT	0.5	8.8	2.2	1.6	0.0	86.8	31
	COL PCT	66.7	37.3	46.7	71.4	0.0	29.9	
	TOT PCT	0.2	2.7	0.7	0.5	0.0	26.9	
2 TEWA BUFF-TAN	COUNT	0	18	4	0	0	164	1
	ROW PCT	0.0	9.7	2.2	0.0	0.0	88.2	18
	COL PCT	0.0	24.0	26.7	0.0	0.0	17.8	
	TOT PCT	0.0	1.8	0.4	0.0	0.0	16.0	
3 TEWA BLACK-DK GR	COUNT	1	16	0	1	0	171	1
	ROW PCT	0.5	8.5	0.0	0.5	0.0	90.5	18
	COL PCT	33.3	21.3	0.0	14.3	0.0	18.6	
	TOT PCT	0.1	1.6	0.0	0.1	0.0	16.7	
4 TEWA GRAY	COUNT	0	3	2	1	1	112	1
	ROW PCT	0.0	2.5	1.7	0.8	0.8	94.1	1
	COL PCT	0.0	4.0	13.3	14.3	100.0	12.2	
	TOT PCT	0.0	0.3	0.2	0.1	0.1	11.0	
9 BROWN	COUNT	0	8	1	0	0	169	
	ROW PCT	0.0	4.5	0.6	0.0	0.0	94.9	1
	COL PCT	0.0	10.7	6.7	0.0	0.0	18.3	
	TOT PCT	0.0	0.8	0.1	0.0	0.0	16.5	
10 MAROON	COUNT	0	2	1	0	0	30	
	ROW PCT	0.0	6.1	3.0	0.0	0.0	90.9	
	COL PCT	0.0	2.7	6.7	0.0	0.0	3.3	
	TOT PCT	0.0	0.2	0.1	0.0	0.0	2.9	
COLUMN TOTAL		3	75	15	7	1	921	1
		0.3	7.3	1.5	0.7	0.1	90.1	10

Figure 87--Crosstabulation: Tewa Slip Color and Rim Form.

COUNT ROW PCT COL PCT TOT PCT	INCTRM 0	SMOOTHED 1	SMOOTHED + POLIS 2	ROUGH 3	ROUGH W STRIATIO 4	SMOOTHED SMDG + 7	ROW TOTAL
TEWA RED-ORANGE 1	5	34	279	0	0	0	318
	1.6	10.7	87.7	0.0	0.0	0.0	31.1
	27.8	51.5	30.2	0.0	0.0	0.0	
	0.5	3.3	27.3	0.0	0.0	0.0	
TEWA BUFF-TAN 2	3	11	165	5	1	1	186
	1.6	5.9	88.7	2.7	0.5	0.5	18.2
	16.7	16.7	17.9	50.0	33.3	50.0	
	0.3	1.1	16.1	0.5	0.1	0.1	
TEWA BLACK-DK GR 3	4	11	172	0	2	0	189
	2.1	5.8	91.0	0.0	1.1	0.0	18.5
	22.2	16.7	18.6	0.0	66.7	0.0	
	0.4	1.1	16.8	0.0	0.2	0.0	
TEWA GRAY 4	3	6	106	4	0	0	119
	2.5	5.0	89.1	3.4	0.0	0.0	11.6
	16.7	9.1	11.5	40.0	0.0	0.0	
	0.3	0.6	10.4	0.4	0.0	0.0	
BROWN 9	3	4	169	1	0	1	178
	1.7	2.2	94.9	0.6	0.0	0.6	17.4
	16.7	6.1	18.3	10.0	0.0	50.0	
	0.3	0.4	16.5	0.1	0.0	0.1	
MAROON 10	0	0	33	0	0	0	33
	0.0	0.0	100.0	0.0	0.0	0.0	3.2
	0.0	0.0	3.6	0.0	0.0	0.0	
	0.0	0.0	3.2	0.0	0.0	0.0	
COLUMN TOTAL	18	66	924	10	3	2	1023
	1.8	6.5	90.3	1.0	0.3	0.2	100.0

Figure 88--Crosstabulation: Tewa Slip Color and Exterior Surface Treatment.

7	COUNT / ROW PCT / COL PCT / TOT PCT	INDTRM 0	SMOOTHED 1	SMOOTHED + POLIS 2	SMOOTHED POL + S 3	FINGER S MOOTHING 4	ROUGH 5	ROUGH W STRIATIO 6	SMOOTHED +SMDG 7	SMOOTHED W STRIA 8	INCISED 9	ROW TOTAL
TEWA RED-ORANGE	1	14	182	73	1	4	5	2	6	30	1	318
		4.4	57.2	23.0	0.3	1.3	1.6	0.6	1.9	9.4	0.3	31.1
		25.9	35.0	27.5	8.3	21.1	29.4	66.7	42.9	25.4	100.0	
		1.4	17.8	7.1	0.1	0.4	0.5	0.2	0.6	2.9	0.1	
TEWA BUFF-TAN	2	11	81	67	5	7	3	1	3	8	0	186
		5.9	43.5	36.0	2.7	3.8	1.6	0.5	1.6	4.3	0.0	18.2
		20.4	15.6	25.3	41.7	36.8	17.6	33.3	21.4	6.8	0.0	
		1.1	7.9	6.5	0.5	0.7	0.3	0.1	0.3	0.8	0.0	
TEWA BLACK-DK GR	3	12	84	43	5	2	2	0	1	40	0	189
		6.3	44.4	22.8	2.6	1.1	1.1	0.0	0.5	21.2	0.0	18.5
		22.2	16.2	16.2	41.7	10.5	11.8	0.0	7.1	33.9	0.0	
		1.2	8.2	4.2	0.5	0.2	0.2	0.0	0.1	3.9	0.0	
TEWA GRAY	4	6	54	45	1	1	6	0	0	6	0	119
		5.0	45.4	37.8	0.8	0.8	5.0	0.0	0.0	5.0	0.0	11.6
		11.1	10.4	17.0	8.3	5.3	35.3	0.0	0.0	5.1	0.0	
		0.6	5.3	4.4	0.1	0.1	0.6	0.0	0.0	0.6	0.0	
BROWN	9	10	94	32	0	4	1	0	3	34	0	178
		5.6	52.8	18.0	0.0	2.2	0.6	0.0	1.7	19.1	0.0	17.4
		18.5	18.1	12.1	0.0	21.1	5.9	0.0	21.4	28.8	0.0	
		1.0	9.2	3.1	0.0	0.4	0.1	0.0	0.3	3.3	0.0	
MAROON	10	1	25	5	0	1	0	0	1	0	0	33
		3.0	75.8	15.2	0.0	3.0	0.0	0.0	3.0	0.0	0.0	3.2
		1.9	4.8	1.9	0.0	5.3	0.0	0.0	7.1	0.0	0.0	
		0.1	2.4	0.5	0.0	0.1	0.0	0.0	0.1	0.0	0.0	
COLUMN TOTAL		54	520	265	12	19	17	3	14	118	1	1023
		5.3	50.8	25.9	1.2	1.9	1.7	0.3	1.4	11.5	0.1	100.0

Figure 89 -- Crosstabulation: Tewa Slip Color and Interior Surface Treatment.

COUNT ROW PCT COL PCT TOT PCT	BLACK-DARK GRAY 1	CARBON STREAK 2	BROWN 3	WHITE-LIGHT GRAY 4	TAN 6	REDDISH-ORANGE 7	ROW TOTAL
1 TEWA RED-ORANGE	52 16.4 13.2 5.1	152 47.8 47.5 14.9	21 6.6 80.8 2.1	9 2.8 8.7 0.9	52 16.4 38.5 5.1	32 10.1 72.7 3.1	318 31.1
2 TEWA BUFF-TAN	70 37.6 17.8 6.8	50 26.9 15.6 4.9	1 0.5 3.8 0.1	12 6.5 11.5 1.2	49 26.3 36.3 4.8	4 2.2 9.1 0.4	186 18.2
3 TEWA BLACK-DK GR	95 50.3 24.1 9.3	47 24.9 14.7 4.6	0 0.0 0.0 0.0	40 21.2 38.5 3.9	3 1.6 2.2 0.3	4 2.1 9.1 0.4	189 18.5
4 TEWA GRAY	73 61.3 18.5 7.1	18 15.1 5.6 1.8	0 0.0 0.0 0.0	20 16.8 19.2 2.0	7 5.9 5.2 0.7	1 0.8 2.3 0.1	119 11.6
9 BROWN	94 52.8 23.9 9.2	44 24.7 13.8 4.3	2 1.1 7.7 0.2	21 11.8 20.2 2.1	14 7.9 10.4 1.4	3 1.7 6.8 0.3	178 17.4
10 MAROON	10 30.3 2.5 1.0	9 27.3 2.8 0.9	2 6.1 7.7 0.2	2 6.1 1.9 0.2	10 30.3 7.4 1.0	0 0.0 0.0 0.0	33 3.2
COLUMN TOTAL	394 38.5	320 31.3	26 2.5	104 10.2	135 13.2	44 4.3	1023 100.0

Figure 90--Crosstabulation: Tewa Slip Color and Paste Color.

17

	COUNT / ROW PCT / CCL PCT / TOT PCT	SILT + CLAY 0	VERY FINE 1	FINE 2	MEDIUM 3	COARSE 4	VERY COARSE 5	INDTRM 12	ROW TOTAL
TEWA RED-ORANGE	1	0	101	162	43	8	2	2	318
		0.0	31.8	50.9	13.5	2.5	0.6	0.6	31.1
		0.0	41.2	40.9	17.0	7.3	13.3	66.7	
		0.0	9.9	15.8	4.2	0.8	0.2	0.2	
TEWA BUFF-TAN	2	1	42	56	57	23	6	1	186
		0.5	22.6	30.1	30.6	12.4	3.2	0.5	18.2
		100.0	17.1	14.1	22.5	20.9	40.0	33.3	
		0.1	4.1	5.5	5.6	2.2	0.6	0.1	
TEWA BLACK-DK GR	3	0	22	53	73	40	1	0	189
		0.0	11.6	28.0	38.6	21.2	0.5	0.0	18.5
		0.0	9.0	13.4	28.9	36.4	6.7	0.0	
		0.0	2.2	5.2	7.1	3.9	0.1	0.0	
TEWA GRAY	4	0	13	53	33	16	4	0	119
		0.0	10.9	44.5	27.7	13.4	3.4	0.0	11.6
		0.0	5.3	13.4	13.0	14.5	26.7	0.0	
		0.0	1.3	5.2	3.2	1.6	0.4	0.0	
BROWN	9	0	52	58	43	23	2	0	178
		0.0	29.2	32.6	24.2	12.9	1.1	0.0	17.4
		0.0	21.2	14.6	17.0	20.9	13.3	0.0	
		0.0	5.1	5.7	4.2	2.2	0.2	0.0	
MAROON	10	0	15	14	4	0	0	0	33
		0.0	45.5	42.4	12.1	0.0	0.0	0.0	3.2
		0.0	6.1	3.5	1.6	0.0	0.0	0.0	
		0.0	1.5	1.4	0.4	0.0	0.0	0.0	
COLUMN TOTAL		1	245	396	253	110	15	3	1023
		0.1	23.9	38.7	24.7	10.8	1.5	0.3	100.0

Figure 91--Crosstabulation: Tewa Slip Color and Temper Size.

small amount of Hopi pottery is significant in documenting a connection with the Hopi villages.

LITHICS

Previous studies in the Abiquiu Reservoir District have focused intensively on the analysis of lithics (Schaafsma 1975b; 1977). The result has been the development of a methodology capable of dealing systematically with these artifacts. The present study draws upon that experience and utilizes methods already developed. Earlier studies showed that, among various cultures, lithics vary in distinct ways and that the analysis of lithic assemblages may be useful in separating the artifacts of different cultures just as ceramic analysis has done in the past.

In the excavation procedure and in the lithic analysis, the primary goal was to obtain and analyze the largest possible collection of lithics that confidently could be associated with the Piedra Lumbre Phase. Lithics were collected from the fill of all structures and the fill immediately surrounding the features. They also were collected from middens exterior to the features and from several large surface lithic areas within the site.

More lithics were collected from AR-4 than could be systematically analyzed; therefore, a selection priority and sampling scheme was necessary. It was decided to begin with the lithics that could be most confidently associated with the primary occupation. The reasons for this decision were twofold: (1) a large collection of lithics associated with this archaeological complex has never before been obtained and studied in Abiquiu Reservoir; and (2) in studying other Piedra Lumbre Phase sites, it may be useful to have a controlled lithic assemblage to serve as a comparison.

The lithics that were "priority one" collections came from within the structures or the fill immediately around the exteriors. Lithics from Features L and M, excavated in 1975 (Schaafsma 1976), were also included. Aside from one grid on the surface south of Feature A (grid CO-184), all the lithics in this analysis are priority one collections and are directly associated with the structures. By context, they are regarded as having been made or used by the occupants of the structures. There is a good possibility that some of the other lithics collected from AR-4 represent other components (see "lithic areas" and "projectile points" discussed below in Chapter V); however, the obsidian hydration evidence tends to refute this suggestion for obsidian artifacts.

The study of lithics addressed several research goals. By selecting an adequately large collection of lithics that confidently could be associated with the primary occupation, it was hoped that the lithic industry of this culture could be described. It has been suggested in the earlier study that the large volume of lithics found on these sites is a reflection of a lithic trade industry maintained by the occupants and the Pueblos (Schaafsma 1976). A large sample of lithics was needed in order to address this question. A related goal was to determine the material selection preferences, trade contacts, and quarry utilizations of the Piedra Lumbre Phase. It has been determined that different cultures utilized different material types (Schaafsma 1977).

Description of Dimensions: The dimensions (variable) and their attributes (values) used in the Abiquiu lithic studies have been extensively discussed and described previously (Schaafsma 1975; 1977). The interested reader is referred to those reports.

Methods: The observation of lithics and coding on to punch card data sheets were accomplished by Jane Whitmore and Tim Maxwell. They worked as a team, alternately observing and recording. Most observations were made with a binocular microscope at a magnification of 10X, with higher magnifications up to 40X being used when necessary. Measurements were made with metal calipers and edge angles were measured with a goniometer.

Numerous studies have shown that precise sourcing of material types can only be accomplished with the assistance of chemical characterization of materials (Earle and Ericson 1977). All of the material-type identification offered here are based upon visual identifications and comparisons between artifacts and type specimens (Schaafsma 1977). The problem that this approach introduces is acknowledged and must be regarded as a source of "noise" in the results. Certain identifications, however, such as the difference between the brightly colored pedernal chert and the obsidian as a general class are unmistakable. While the finer distinctions are reported here, the interpretations are largely based upon the major distinctions until the nature of this variability is better understood.

Overall summary statistics of each dimension are presented in two forms. One is the tabular summation obtained with the SPSS descriptive statistics package. This method is used for fragmentation, cortex location, cortex amount, length, width, thickness, utilized portion, edge angle, and marginal retouch (Figs. 92-100). In addition, the descriptive statistics of dispersion for the continuous variables (length, width, and thickness) are included. The second form of presentation is the row and column summaries on the cross-tabulation charts (Figs. 104-107). This method is used for material type (Fig. 101), stage of manufacture (Fig. 102), and wear pattern (Fig. 103). The lithic totals per feature are also shown as the column totals on the cross-tabulation of material by feature letter (Fig. 106). This overall statistical summation is presented to allow convenient comparison with the sites previously analyzed in Abiquiu Reservoir.

Cross-tabulation charts were prepared for wear pattern by material (Fig. 104), wear pattern by stage of manufacture (Fig. 105), material type by feature (Fig. 106), and stage of manufacture by feature (Fig. 107). As noted, these charts provide summary statistics for the dimensions in the rows and columns in the form of marginal totals. They also provide information on the occurrence of each attribute pair in the form of cell entries. The key to the cell entries is in the upper lefthand corner appearing vertically as count, row percent, column percent, and total percent in that order. For example, in the material type by wear pattern chart (Fig. 104), it can be observed that 123 pieces of 1090 material type (opaque, pedernal chert) have wear pattern "A" (light, unifacial step fracture). Of the 903 pieces of 1090 chert, those with wear coded as "A" make up 13.6 percent. On the other hand, 36.4 percent of the 338 lithics with "A" wear are 1090 chert.

Although these charts are useful for reporting data, they are primarily designed as probability charts for computing expected versus observed values with the Chi-square statistic and a series of related statistical procedures. On these charts, the column percent is the expected cell row percent, and the row percent is the expected column cell percent. For example, the 903 pieces of 1090 chert are expected to have 13.1 percent "A" wear; the observed 123 lithics actually make up 13.6 percent, conforming closely to the expected value. On the other hand, the lithics with "A" wear are expected to be found on 1090 chert in 35.0 percent of the cases; as observed, the figure is 36.4 percent. Anomalies in attribute occurrence or in attribute distribution stand out as cell percent values that are higher or lower than the row or column (expected) percentages. Finally, the charts show all entries, so there are many cells with no or unreliably low entries. Generally, it is advisable not to trust the Chi-square statistic when samples are so small that the lowest expected cell value is 5 or less, because the result of this condition is that the computed Chi-square values, and resulting significance levels, have little interpretive value. Accordingly, the computed significance levels are not reported here. These charts are used in developing artifact types described below and in discussing the patterns of intro-site distribution.

Unutilized Lithics

There are 2,582 lithics in the assemblage covered in this analysis. Of these, 1,003, or 38.8 percent, are unutilized (Fig. 108). Relative to the previously analyzed sites in Abiquiu Reservoir, this proportion of unutilized lithics is extraordinarily low and conversely, the proportion of utilized lithics is exceptionally high. In the previous two analyses, 29,310 lithics have been studied (many from archaic proveniences), and, of these, 62.7 percent (18,375) have been unutilized.

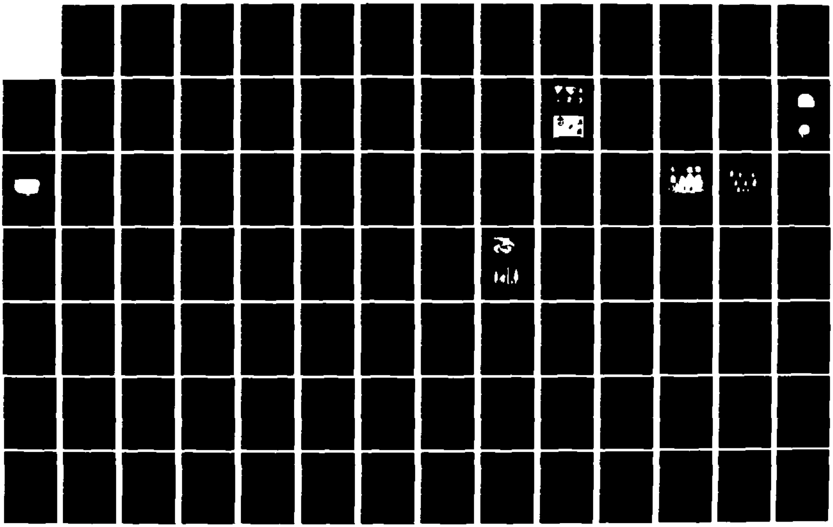
This comparison immediately serves to differentiate the Piedra Lumbre Phase assemblage from the others since the Piedra Lumbre Phase is characterized by a low proportion of unutilized lithics and a complementary high proportion of utilized lithics. The high proportion may be because these lithics were recovered from dwellings and other use areas where it might be expected that all available lithics were well used.

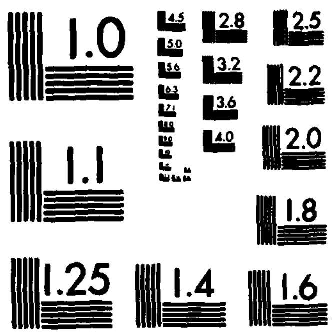
An inspection of Figure 108 shows that bifaces and unifaces (codes 5, 6, 7, and 77) are almost never left unutilized (only 1 partial biface is unutilized). There are thus almost no "blanks": bifaces and unifaces that were not used and presumably represent unfinished projectile points or similar artifacts. On the other hand, there are an extraordinarily large number of cores in this assemblage, many of which (77 primary and 6 secondary) were not used. The significance of the large number of cores in the Piedra Lumbre Phase assemblage needs to be explained. Overall, there are 236 primary cores (Fig. 105). These make up 9.1 percent of all stages of manufacture. In the previous 2 analyses, a total of only 80 primary cores was identified which accounts for only 0.3 percent of the lithics. The same applies to secondary cores -- only 12 of these items have been found previously, while there are 23 (0.9 percent) in this assemblage. In other words, more cores, both primary and secondary, appeared in the analysis of 2,582 Piedra Lumbre Phase lithics than were found in the analysis of the previous 29,310 lithics. It is possible that this high incidence of cores in the assemblage represents items that were actually roughed-out pieces prepared for trade to the Rio Grande Pueblos. Hibben observed that Pedernal chert was abundant on sites as far down the Chama as the Rio Grande (1937:15). This possibility seems particularly relevant to the 77 unutilized primary and the 6 secondary cores, which otherwise seem to have no obvious functional significance in the assemblage.

Proportionately few of the primary flakes (code 3) were unutilized -- 29.7 percent instead of the expected 38.8 percent. This fact indicates that these items, which generally present the most useful edges for knives and scrapers, were indeed generally used. In contrast, the shatter (code 4) is relatively unutilized in this assemblage -- 60.0 percent instead of the expected 38.8 percent. This presumably reflects the generally irregular shape and small size of many of these items that are properly regarded as workshop debris. Similarly, the pressure flakes (code 8) and trimming flakes (code 9) are relatively unutilized: 49.4 percent of the pressure flakes were unutilized instead of the expected 38.8 percent; 70.1 percent of the trimming flakes instead of the expected 38.8 percent. In both of these cases, the small size of the lithics precludes their being extensively utilized as knives, scrapers, or other tools. On the other hand, as has been the case in all previously analyzed assemblages, these pieces of workshop debris were used when the edges were large enough and sharp enough to serve some purpose.

AD-A127 413 THE CERRITO SITE (AR-4): A PIEDRA LUMBRE PHASE SETTLEMENT AT ABIQUIU RESERVOIR(U) SCHOOL OF AMERICAN RESEARCH SANTA FE NM C F SCHAAFSMA NOV 79 3/4

UNCLASSIFIED DACA47-77-C-0046 F/G 8/7 NL





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

Utilized Lithics

The 1,579 utilized lithics (61.2 percent of total lithics) are described in terms of functional categories as has been done in two previous analyses. For extended discussions of this procedure, refer to these reports (Schaafsma 1975; 1977). The formation of lithic classes follows the method already developed. The derived classes are summarized in Figure 109.

The tool classes can be readily related to previously described lithic tools recognized in Southwestern archaeology. The functional implications of the class names (Fig. 109) are grounded in kinds of wear pattern, formal characteristics, and inferences drawn from experimental studies and ethnographic analogies. In light of the on-going debate among archaeologists about wear pattern analysis, functional interpretations, etc., there can be no implication that these functional assignments are absolute. They probably are generally accurate, however, and the names allow ready comparison with work done before on lithic assemblages. Here the functional assignments allow a useful appraisal of the nature of the Piedra Lumbre Phase artifact assemblage.

Light Cutting Knives: There are 646 tools that have been used for light cutting tasks as demonstrated by the presence of light, bifacial, attrition wear (code D) as the primary wear pattern. These tools account for 40.9 percent of all utilized lithics from AR-4, and this proportion is generally consistent with the proportion of light cutting knives found in the Phase IV analysis (Schaafsma 1977: Fig. 155). Such tools would have been used for a wide range of light cutting tasks and a great deal of the cutting and general knife work must have been accomplished with such tools. There are 3 varieties of these light knives -- debitage, core and biface/uniface.

1) Debitage knives. Debitage is defined as any material removed from cores by the application of force. This includes primary flakes, shatter, pressure flakes, and trimming flakes. There are also 6 reused, resharpening flakes. This variety represents flakes and workshop debris that presented edges useful for light cutting tasks, i.e., sharp edges and low edge angle. They were used until dulled and discarded. Some of the flakes undoubtedly were struck directly from cores for use as knives; whereas the shatter, pressure flakes, and trimming flakes represent the use of appropriate workshop debris. Of interest are the 6 reused, resharpening flakes. These are small flakes struck from large tools to remove a worn edge and were used again as small, light cutting knives. Such tools were recognized in the Phase IV analysis (Class 34), but only one of them was observed among 6,556 lithic tools (Schaafsma 1977: Fig. 155).

The primary flakes were used mainly on the edges (137 left lateral edge; 90 right lateral edge) or corners (82).

Some (76) were used on the full perimeter. Only a few were used on the distal end (10) or on the proximal end (23).

2) Cores. Fifty primary cores and 5 secondary cores (total 55) have been used as light knives. The wear pattern suggests that these are functionally very similar, if not identical, to the larger debitage knives. These cores appear to have been used analogously to the workshop debris, i.e., they were used as knives if a sharp edge with the right edge angle presented itself. It is also possible that some of these cores were trimmed especially to obtain a sharp edge.

3) Biface/Unifaces. There are 11 of these tools which are extremely crude in this assemblage (Fig. 110). Most have only a few cursory trimming flakes removed to achieve a desired shape. The one well-shaped biface in the whole assemblage (Fig. 111a) is such an outstanding exception that it may well be a reused Archaic biface. Only a few of these items resulted in a distinct knife shape -- flat with parallel edges (Fig. 110c). For the most part, the knives are similar to flake knives except for the added minimal modification of removing several trimming flakes. Occasionally, the better knives also have been shaped by pressure retouch to further prepare the edge. They appear to be functional equivalents of the debitage and core knives.

Heavy Cutting Knives. It has been discussed that tools with heavy bifacial attrition wear patterns, characterized by step fractures in addition to scalar scars, were more modified by use in cutting harder materials than were the tools with only light, bifacial attrition wear (Schaafsma 1977). They have been used possibly for cutting and grooving such hard, unyielding materials as bone and antler. In both previous analyses, it was found that this type of wear pattern is associated with steeper edge angles than those of the light bifacial attrition wear.

There are 75 tools with this heavy bifacial attrition wear pattern. As with the light knives, they are divided into 3 varieties -- debitage (45), cores (17), and biface/unifaces (13). It should be noted that there are proportionately more of the heavier stages of manufacture (cores and biface/unifaces) represented in this class than in the light duty knives. There is no indication on the tools that any of them were hafted, but it is quite possible that some of the smaller tools were mounted; the larger cores and bifaces were undoubtedly handheld. In the debitage class, there are only flakes (36) and shatter (9); no pressure flakes or trimming flakes display this wear pattern.

Light Scrapers: The tools in this class all have light, unifacial chipping wear (code C) patterns. These are rows of scalar scars on one side of a cutting edge with no step fractures present. Such use modification is believed to result from scraping and whittling soft to medium hard wood or softer materials. Such wear also appears in the initial stages of scraping harder materials, but step features appear fairly soon with bone and antler scraping. In the past, most reports would have called these tools "scrapers." There are 421 light scrapers which make up 26.7 percent of the tools. This figure is not inconsistent with the 17.7 percent of similar light scrapers observed in the Phase IV analysis (Schaafsma 1977:Fig. 155). As above, there are 3 varieties -- debitage (379), core (35), and biface/uniface (7).

Adzes: Unifacial step fracture wear patterns are believed to result from using tools to scrape and plane medium to hard materials such as wood, bone, and antler. There is some suggestion that the more extensive edge damage coded as B (heavy unifacial step fracture) results from scraping harder materials than those scraped to produce the light variety of wear (code A). Both wear patterns are included in the same tool class here. It has previously been demonstrated that unifacial step fracture wear patterns are associated with the steepest edge angles (Schaafsma 1975b; 1977). The 317 adzes are divided into 3 varieties -- debitage (226), cores (59), and biface/unifaces (32). As with heavy duty knives, the adze class contains proportionately more items representing larger stages of manufacture (cores and biface/unifaces) than did the classes of light duty knives and light scrapers (Fig. 109).

Resharpening Flakes. When larger tools, such as adzes, heavy duty knives, etc., developed worn and battered edges, it was more expedient to strike off the worn edge and produce a fresh, sharp edge, than to make a whole new tool. The discarded, worn sections of cutting edge removed in this manner were called "retouch flakes" by Frison (1968), who first brought them to general attention. These items are fairly common on the Abiquiu Reservoir sites and 1,106 (6.8 percent) of them have been recognized in the Phase IV analysis. The term "Resharpening flakes" has been substituted for "retouch flakes" because the latter term was too often confused with "retouch" produced by pressure flaking along margins of some tools. There are 57 resharpening flakes in this assemblage that have wear patterns on the proximal ends indicating their origin. Four varieties are recognized (Fig. 109) which, by their different wear patterns, indicate their original presence on adzes (24), light scrapers (12), light duty knives (18), and heavy duty knives (3).

Spokeshaves: Occasionally lithics are observed with distinct notches in which there are unifacial wear patterns (Codes A, B, and C). Such items are believed to have been used to scrape and smooth small round shafts, beads, tubes, and so forth. It would seem that the wide range of wear patterns in these notches relates to the amount of usage and, possibly, the hardness of the materials being worked but not to the way the tools were used. In this collection, there are 12 tools on which the primary wear is found in notches. The notches occur on flakes (6), shatter (4), and a primary core (2). Spokeshaves commonly appear as additional wear modifications of tools that are primarily used for other purposes. There are 16 tools that have notches as additional wear modifications.

Gravers. Projections with chipped and broken ends are believed to have been used in incising, engraving, and other delicate woodworking tasks. Projections with this type of wear received the code designation J. There are 15 lithics that have this kind of wear on the end of distinct projections -- 2 primary cores, 5 flakes, and 8 pieces of shatter. They are made from obsidian and chert. As with the spokeshaves, gravers or utilized projections appear as minor or additional wear areas on many lithics. There are 9 instances of gravers with secondary or tertiary wear modification.

Drills. Occasional lithics have reciprocal wear patterns on projections suggesting they were twisted in some unyielding material. Such wear patterns are coded as I or H, depending on whether there are step fractures present. Presumably these tools were used as drills. There are 3 such primary tools in this collection, 2 of which are unmodified debitage (flake and shatter); the third is a prepared drill form (Fig. 110d). In addition, 2 items have been used secondarily as drills. These 5 tools represent all the drills in the assemblage.

Choppers. Six tools in this assemblage have large flakes removed from an edge to prepare a blunt cutting edge. These edges display the crushed and battered use modifications that are coded as F -- bifacial percussion on an edge. Such tools have previously been called "choppers" and are believed to have been used in heavy cutting, e.g., bones and sinews, or pounding, e.g., roots, etc. These are not large tools, but among this assemblage, in which mean overall length is 20.145 millimeters, they stand out as larger tools with a mean of 46.2 millimeters and a range of 20 millimeters to 68 millimeters. The mean width is 33.2 millimeters (range: 13 millimeters - 51 millimeters) and the mean thickness is 25.5 millimeters (range 13 millimeters to 37 millimeters). Three of them are made from quartzite, a tough, resistant rock; 2 are pedernal chert; and 1 is obsidian.

Hammerstones. Crushed and battered wear indications that are not on a prepared edge are coded as G. There are 28 tools with such crushed and battered areas that are believed to have been used as hammerstones. Nearly all of these tools (25) are of parent material, unmodified except for use. Also used were a primary core, a secondary core, and a flake. All but one are covered with cortex. The tools are large: mean length 67.8 millimeters. Four are over 100 millimeters long. Pedernal chert and obsidian were not used for hammerstones (Fig. 104). Most of them (96.4 percent) are made of quartzite (codes 2200, 2205, 4000, and 4001), with one made of red jasper (code 1060). Aside from 3 tools that have been used secondarily as grinding tools (code L), hammerstones are generally not used for purposes other than pounding.

Summary. Overall, the Piedra Lumbre Phase lithic industry can only be described as crude. There are very few finished artifacts of any kind, and the bifaces and unifaces are generally items that have been trimmed cursorily by the removal of a few trimming flakes. Occasional tools were shaped by pressure retouch. Most of the work was accomplished with debitage or crude cores, which offered appropriate edges for use as knives, scrapers, or adzes.

The majority (40.9 percent) of tools are knives used for light cutting tasks. An additional 4.7 percent of the knives were used for heavier cutting, perhaps of bone, antler, or wood. Given the paucity of bone artifacts, however, it is clear that very few bone artifacts were being prepared. Scrapers are fairly common (26.7 percent). Both scrapers and knives were used for many different tasks, such as cutting and butchering game and domestic animals, preparing skins, whittling wood, and so forth. Their functions can only be inferred using clues such as the presence of bones which might indicate a butchering function, etc.

Adzes are relatively common (20.1 percent) in this assemblage and probably will serve to differentiate this assemblage from those of other cultures in many cases. For example, adzes make up only 1.8 percent of the assemblage from the Archaic camps (AR-5 and AR-6) directly below AR-4 (Schaafsma 1975b:Fig. 53); and, in the Phase IV analysis, adzes account for only 6.1 percent of the tools (Schaafsma 1977:Fig. 155). Resharpening flakes are fairly common (3.6 percent), and adze wear is found on 42.1 percent of these. Small specialized task tools such as spokeshaves, gravers, and drills occur but are not an important part of the assemblage numerically. The infrequency of these items may reflect a general lack of woodworking and other such activities for which such tools were used.

Hammerstones are a common tool form in the assemblage, making up 1.8 percent (28). In the Phase IV analysis, hammerstones were extremely rare with only 5 examples overall. On the 2 large Archaic sites below AR-4, only 1 hammerstone was found. The frequency of hammerstones helps differentiate this assemblage from the Archaic assemblages, and it indicates that tasks requiring such tools were commonly performed. Similarly, there are more choppers in this assemblage than in the Archaic assemblages. Only 1 chopper was found on the Archaic camps below AR-4 (Schaafsma 1975b;147), and, in the Phase IV analysis, the 5 choppers make up only 0.1 percent.

The collection described above is clearly different from the assemblages that have been found on the Archaic sites in the immediate vicinity of AR-4 in the Abiquiu Reservoir, a fact that reflects the difference in tasks performed by these people as compared with Archaic hunter-gatherers. Basically, the assumption is that different economic practices will lead to different artifact assemblages. The limited comparison presented here seems to bear out this concept, and it should be possible to use this assemblage as a baseline for identifying other Piedra Lumbre Phase lithic sites both in Abiquiu Reservoir and in the region generally.

The Phase IV analysis demonstrated that different cultures utilize different material types. Sometimes this variation is a result of differential access to quarries or participation in different trade networks. It also seems to reflect culturally regulated patterns of preference for material types. For example, AR-10 (believed to be a Pueblo III-IV hunting camp) is less than 2 miles from AR-4 and is on the same side of the Chama River; so these people had access to the same quarries. Nevertheless, 93.1 percent of the material types at AR-10 are obsidian and only 4.4 percent are Pedernal chert. In contrast, at AR-4 only 13.9 percent of the material types are obsidian (all types) and 76.2 percent are Pedernal chert. In the local area, this material type profile should aid in identifying other sites of this culture.

An interesting test of the idea that presences of certain material types on archaeological sites reflect pan-cultural patterns of lithic selection is provided by the occurrence of the material types in the various features at AR-4 (Fig. 106). Each material type is expected to occur proportionally in each feature if there is no factor that would cause the distribution to move away from randomness. In this case, if all site inhabitants are selecting materials according to the same patterns, then the same proportions should occur in all the features. An inspection of Figure 106 will show that this consistency is generally the case. The distribution of 3530 (local Polvadera Peak obsidian) provides an illustration. Polvadera Peak obsidian is expected to be found in each feature in the proportion of 9.2 percent. While there are minor anomalies (high percentage of 3530 in Feature G, low in Feature K, and so forth), overall, no feature has more than 22.7 percent of 3530 obsidian, and all features have at least some pieces of this obsidian. The same distribution consistency exists for the 1090 and 1091 varieties of Pedernal chert. This consistency would appear to corroborate the hypothesis that material selection patterns are culturally regulated so that all people in the cultural pattern participate fairly uniformly.

It was suggested in the first survey of the area that the inhabitants of these sites may have been trading Pedernal chert to the Rio Grande Pueblos. This suggestion was based on the large amounts of lithics on the surfaces of these sites and the apparent predominance of brightly-colored Pedernal chert. With this idea in mind, many of the lithics from the area south of Feature A were systematically collected, since this appeared

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
PROXIMAL END OF FLAK	0.	442	17.1	17.1	17.1
DISTAL END OF FLAKE	1.	97	3.8	3.8	20.9
MIDSECTION OF FLAKE	2.	279	10.8	10.8	31.7
LATERAL EDGE OF FLAK	3.	189	7.3	7.3	39.0
BROKEN BIFACE OR UNI	4.	42	1.6	1.6	40.6
BROKEN CORE--NOT USE	5.	109	4.2	4.2	44.8
LATERAL MIDSECTION	6.	72	2.8	2.8	47.6
BROKEN PARENT MAT.	7.	16	0.6	0.6	48.3
WHOLE	8.	1336	51.7	51.7	100.0
	TOTAL	2582	100.0	100.0	

Figure 92--Summary Statistics: Fragmentation

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NOT PRESENT	0.	1846	71.5	72.0	72.0
DORSAL SURFACE	1.	253	9.8	9.9	81.9
STRIKING FLATFORM	2.	81	3.1	3.2	85.1
BOTH DORS. STRIK.	3.	20	0.8	0.8	85.8
SURFACE OF CORE	4.	121	4.7	4.7	90.6
SURFACE OF SHATTER	5.	187	7.2	7.3	97.9
STRIK. PLAT. CORE	6.	16	0.6	0.6	98.5
SURF PARENT MATERIAL	7.	28	1.1	1.1	99.6
SURF UNIFACE OR BIFA	8.	11	0.4	0.4	100.0
	999.	19	0.7	MISSING	100.0
	TOTAL	2582	100.0	100.0	

Figure 93--Cortex Location.

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
MOST OF SURFACE	1.	87	3.4	12.3	12.3
PARTIAL COVERAGE	2.	563	21.8	79.6	91.9
TRACE	3.	57	2.2	8.1	100.0
	999.	1875	72.6	MISSING	100.0
	TOTAL	2582	100.0	100.0	

Figure 94--Summary Statistics: Cortex Amount.

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
1-5 MM.	0.	5	0.2	0.2	0.2
6-10 MM.	1.	385	14.9	14.9	15.1
11-15 MM.	2.	734	28.4	28.5	43.6
16-20 MM.	3.	580	22.5	22.5	66.1
21-25 MM.	4.	315	12.2	12.2	78.3
26-30 MM.	5.	200	7.7	7.8	86.1
31-35 MM.	6.	128	5.0	5.0	91.1
36-40 MM.	7.	80	3.1	3.1	94.2
41-45 MM.	8.	38	1.5	1.5	95.7
46-50 MM.	9.	33	1.3	1.3	96.9
51-55 MM.	10.	25	1.0	1.0	97.9
56-60 MM.	11.	14	0.5	0.5	98.4
>60 MM.	12.	40	1.5	1.6	100.0
	999.	5	0.2	MISSING	100.0
	TOTAL	2582	100.0	100.0	

VARIABLE LENGTH

MEAN	20.145	STD ERROR	0.242	STD DEV	12.272
VARIANCE	150.612	KURTOSIS	9.656	SKEWNESS	2.488
RANGE	110.000	MINIMUM	2.000	MAXIMUM	112.001
SUM	51913.996				

VALID OBSERVATIONS - 2577 MISSING OBSERVATIONS - 5

Figure 95--Summary Statistics: Length

WIDTH

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
1-5 MM.	0.	46	1.8	1.8	1.8
6-10 MM.	1.	668	25.9	25.9	27.7
11-15 MM.	2.	736	28.5	28.6	56.3
16-20 MM.	3.	454	17.6	17.6	73.9
21-25 MM.	4.	295	11.4	11.4	85.3
26-30 MM.	5.	145	5.6	5.6	91.0
31-35 MM.	6.	86	3.3	3.3	94.3
36-40 MM.	7.	57	2.2	2.2	96.5
41-45 MM.	8.	29	1.1	1.1	97.6
46-50 MM.	9.	25	1.0	1.0	98.6
51-55 MM.	10.	14	0.5	0.5	99.1
56-60 MM.	11.	7	0.3	0.3	99.4
>60 MM.	12.	15	0.6	0.6	100.0
	999.	5	0.2	MISSING	100.0
	TOTAL	2582	100.0	100.0	

VARIABLE WIDTH

MEAN	17.030	STD ERROR	0.209	STD DEV	10.158
VARIANCE	103.190	KURTOSIS	6.560	SKEWNESS	2.162
RANGE	85.000	MINIMUM	4.000	MAXIMUM	89.000
SUM	43886.996				

VALID OBSERVATIONS - 2577 MISSING OBSERVATIONS - 5

Figure 96--Summary Statistics: Width

THICKNES

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
1-5 MM.	0.	1560	60.4	60.5	60.5
6-10 MM.	1.	689	26.7	26.7	87.3
11-15 MM.	2.	180	7.0	7.0	94.3
16-20 MM.	3.	72	2.8	2.8	97.1
21-25 MM.	4.	25	1.0	1.0	98.0
26-30 MM.	5.	25	1.0	1.0	99.0
31-35 MM.	6.	11	0.4	0.4	99.4
36-40 MM.	7.	6	0.2	0.2	99.7
41-45 MM.	8.	2	0.1	0.1	99.7
46-50 MM.	9.	2	0.1	0.1	99.8
51-55 MM.	10.	2	0.1	0.1	99.9
56-60 MM.	11.	2	0.1	0.1	100.0
>60 MM.	12.	1	0.0	0.0	100.0
	999.	5	0.2	MISSING	100.0
	TOTAL	2582	100.0	100.0	

VARIABLE THICKNES

MEAN	6.324	STD ERROR	0.115	STD DEV	5.858
VARIANCE	34.321	KURTOSIS	17.972	SKEWNESS	3.421
RANGE	63.000	MINIMUM	1.000	MAXIMUM	64.000
SUM	16296.996				

VALID OBSERVATIONS - 2577 MISSING OBSERVATIONS - 5

Figure 97--Summary Statistics: Thickness.

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
UT. ORIG. SURF	0.	32	1.2	2.0	2.0
PROX. END FLAKE	1.	114	4.4	7.2	9.2
DIST. END FLAKE	2.	47	1.8	3.0	12.2
LEFT LAT. EDGE	4.	292	11.3	18.5	30.7
RIGHT LAT. EDGE	5.	213	8.2	13.5	44.2
PERIMETER	6.	143	5.5	9.1	53.3
CONVENIENT EDGE	7.	701	27.1	44.4	97.7
NOTCH	8.	11	0.4	0.7	98.4
PROJECTION	9.	26	1.0	1.6	100.0
	999.	1003	38.8	MISSING	100.0
	TOTAL	2582	100.0	100.0	

Figure 98--Summary Statistics: Utilized portion.

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
11-20 DEG.	2.	7	0.3	0.5	0.5
21-30 DEG.	3.	17	0.7	1.1	1.6
31-40 DEG.	4.	116	4.5	7.6	9.2
41-50 DEG.	5.	347	13.4	22.7	31.9
51-60 DEG.	6.	456	17.7	29.8	61.7
61-70 DEG.	7.	297	11.5	19.4	81.1
71-80 DEG.	8.	173	6.7	11.3	92.4
81-90 DEG.	9.	72	2.8	4.7	97.1
>90 DEG.	10.	44	1.7	2.9	100.0
	999.	1053	40.8	MISSING	100.0
	TOTAL	2582-151	100.0	100.0	

Figure 99--Summary Statistics: Edge Angle.

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
BIFACIAL ON FLAKE	0.	9	0.3	0.3	0.3
BIFACIAL ON OTHER TH	1.	5	0.2	0.2	0.5
UNIFACIAL-VENT. FLAK	2.	12	0.5	0.5	1.0
UNIFACIAL-DORSAL FLA	3.	39	1.5	1.5	2.5
UNIFAC OTHER THAN FL	4.	20	0.8	0.8	3.3
CONVENIENT EDGE	5.	1	0.0	0.0	3.3
UNRETOUCHED	6.	2496	96.7	96.7	100.0
	TOTAL	2582	100.0	100.0	

Figure 100--Summary Statistics: Marginal Retouch.

Figure 101

MATERIAL TYPE CODES

Code	Material
1011	Fossiliferous chert
1030	Black chert
1060	Red chert (jasper)
1070	Yellow-brown chert
1073	Olive-brown chert
1090	Pedernal chert-opaque-white
1091	Pedernal chert-chalcedonic
1093	Pedernal chert-chal. - yellow core, translucent rind
1151	Silicified wood, yellow brown, Jemez variety
1400	Chert, misc.
1600	Chert, gray
2200	Quartzite-sedimentary-light gray, granular
2205	Quartzite-sedimentary-light tan or red, fine grain
3500	Obsidian-clear-banded
3510	Obsidian-dense-black
3520	Obsidian-clear-brown tinge (Jemez)
3521	Obsidian-streaky or mottled red or brown (Jemez)
3530	Obsidian-smoky-light gray and/or white inclusions (Povadera Peak)
3700	Basalt-vitrophyre-black/dark gray-fine grained
4000	Quartzite-undifferentiated
4001	Quartzite-snowy white

Figure 102

STAGE OF MANUFACTURE

0 = Parent Material
1 = Primary Core
2 = Secondary Core
3 = Flake
4 = Shatter
5 = Complete Biface
6 = Partial Biface
7 = Complete Uniface
8 = Pressure Flake
9 = Trimming Flake
10 = Resharpening Flake
11 = Partial Uniface

Figure 103

Code	Wear Pattern
A	Light unifacial step fracture
B	Heavy unifacial step fracture
C	Light unifacial chipping
D	Light bifacial attrition
E	Heavy bifacial attrition
F	Bifacial percussion on edge
G	Percussion on an original surface
H	Light rotary chipping
I	Rotary step fracture
J	Attrition on a projection
K	Polish

Figure 104: Crosstabulation: Material X Wear Pattern

Cell contents: COUNT / ROW PCT / COL PCT / TOT PCT

	WEAR PATTERN K	J	I	G	F	E	D	C	B	A		ROW TOTAL
1011.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 100.0 / 0.2 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 0.0
1030.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	2 / 33.3 / 0.3 / 0.1	1 / 16.7 / 0.2 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	[illegible] / 50.0 / [illegible] / [illegible]	6 / 0.2
1060.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 2.3 / 3.6 / 0.0	0 / 0.0 / 0.0 / 0.0	3 / 7.0 / 3.8 / 0.1	7 / 16.3 / 1.1 / 0.3	5 / 11.6 / 1.1 / 0.2	0 / 0.0 / 0.0 / 0.0	[illegible]	[illegible]	43 / 1.7
1070.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 25.0 / 0.2 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 25.0 / [illegible] / [illegible]	2 / 50.0 / 0.2 / 0.1	4 / 0.2
1073.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 33.3 / [illegible] / [illegible]	2 / 66.7 / [illegible] / [illegible]	3 / 0.1
1090.	0 / 0.0 / 0.0 / 0.0	7 / 0.3 / 46.7 / 0.3	2 / 0.0 / 100.0 / 0.1	0 / 0.0 / 0.0 / 0.0	2 / 0.0 / 33.3 / 0.1	21 / 2.4 / 26.9 / 0.8	152 / 16.8 / 23.9 / 5.9	156 / 17.3 / 35.7 / 6.0	2 / 0.2 / 20.0 / 0.1	[illegible]	[illegible] / [illegible] / 41.7 / 17.3	[illegible] / 35.0
1091.	0 / 0.0 / 0.0 / 0.0	4 / 0.4 / 26.7 / 0.2	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	26 / 2.4 / 33.3 / 1.0	283 / 25.7 / 44.0 / 13.2	207 / 19.5 / 47.4 / 8.0	7 / 0.7 / 70.0 / 0.3	[illegible]	[illegible]	[illegible]
1093.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 100.0 / [illegible] / 0.0	1 / 0.0
1151.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 50.0 / 0.2 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 50.0 / [illegible] / [illegible]	0 / 0.0 / 0.0 / 0.0	2 / 0.1
1400.	1 / 1.4 / 100.0 / 0.0	1 / 1.2 / 6.7 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	2 / 2.6 / 2.6 / 0.1	29 / 33.3 / 3.0 / 3.0	13 / 15.3 / 3.0 / 0.5	0 / 0.0 / 0.0 / 0.0	11 / 14.[illegible] / [illegible] / [illegible]	37 / [illegible] / 3.7 / 1.4	[illegible] / 3.3
1600.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	2 / 50.0 / 0.3 / 0.1	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	2 / 50.0 / 0.2 / 0.1	4 / 0.2
2000.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 100.0 / 0.2 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 0.0
2230.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	19 / 57.4 / 67.9 / 0.7	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	5 / 15.2 / 0.8 / 0.2	0 / 0.0 / 0.0 / 0.0	1 / 3.0 / 10.0 / 0.0	0 / 0.0 / 0.0 / 0.0	[illegible]	33 / 1.3
2205.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 2.9 / 3.6 / 0.0	2 / 5.7 / 33.3 / 0.1	0 / 0.0 / 0.0 / 0.0	11 / 31.4 / 1.7 / 0.4	5 / 14.3 / 1.1 / 0.2	0 / 0.0 / 0.0 / 0.0	2 / 5.7 / [illegible] / 0.1	[illegible]	35 / 1.4
3500.	0 / 0.0 / 0.0 / 0.0	1 / 2.6 / 6.7 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	6 / 15.4 / 7.7 / 0.2	18 / 46.2 / 2.7 / 0.7	5 / 12.8 / 1.1 / 0.2	0 / 0.0 / 0.0 / 0.0	2 / 5.1 / [illegible] / [illegible]	7 / 17.9 / 0.7 / 0.3	39 / 1.5
3510.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 12.5 / 1.3 / 0.0	6 / 75.0 / 0.9 / 0.2	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 12.5 / [illegible] / [illegible]	0 / 0.0 / 0.0 / 0.0	8 / 0.3
3820.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	2 / 40.0 / 0.3 / 0.1	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	3 / 60.0 / [illegible] / 0.1	0 / 0.0 / 0.0 / 0.0	5 / 0.2
3821.	0 / 0.0 / 0.0 / 0.0	2 / 2.9 / 13.3 / 0.1	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	3 / 4.3 / 3.8 / 0.1	42 / 60.0 / 6.3 / 1.6	5 / 7.1 / 1.1 / 0.2	0 / 0.0 / 0.0 / 0.0	[illegible] / 12.9 / 2.7 / [illegible]	[illegible] / 12.[illegible] / [illegible] / [illegible]	70 / 2.7
3830.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 0.4 / 16.7 / 0.0	14 / 5.9 / 17.9 / 0.5	127 / 53.6 / 19.1 / 4.9	36 / 15.2 / 8.2 / 1.4	0 / 0.0 / 0.0 / 0.0	[illegible]	[illegible]	237 / [illegible]
3700.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 50.0 / [illegible] / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	1 / 50.0 / [illegible] / [illegible]	2 / 0.1
4000.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	5 / 27.8 / 17.9 / 0.2	1 / 5.6 / 16.7 / 0.0	1 / 5.6 / 1.3 / 0.0	1 / 5.6 / 0.2 / 0.0	1 / 5.6 / 0.2 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	[illegible] / 50.0 / [illegible] / [illegible]	18 / 0.7
4001.	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	2 / 11.1 / 7.1 / 0.1	0 / 0.0 / 0.0 / 0.0	1 / 5.6 / 1.3 / 0.0	2 / 11.1 / 0.3 / 0.1	2 / 11.1 / 0.5 / 0.1	0 / 0.0 / 0.0 / 0.0	0 / 0.0 / 0.0 / 0.0	11 / 61.1 / 1.1 / [illegible]	18 / 0.7
COLUMN TOTAL	1 / 0.0	15 / 0.6	2 / 0.1	28 / 1.1	6 / 0.2	78 / 3.0	664 / 25.7	437 / 16.9	10 / 0.4	[illegible] / 13.1	[illegible] / [illegible]	[illegible] / 100.0

WEAR PATTERN

COUNT ROW PCT COL PCT TOT PCT	K	J	I	G	F	E	D	C	B	A	ROW TOTAL
0.	1 3.6 100.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	25 89.3 89.3 1.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 3.6 0.2 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	28 1.1
1.	0 0.0 0.0 0.0	2 0.8 13.3 0.1	0 0.0 0.0 0.0	1 0.4 3.6 0.0	6 2.5 100.0 0.2	16 6.8 20.5 0.6	50 21.2 7.5 1.9	33 14.0 7.6 1.3	2 0.8 20.0 0.1	49 20.8 14.5 1.9	236 9.1
2.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 4.3 3.6 0.0	0 0.0 0.0 0.0	1 4.3 1.3 0.0	5 21.7 0.8 0.2	1 4.3 0.2 0.0	1 4.3 10.0 0.0	8 34.8 2.4 0.3	23 0.9
3.	0 0.0 0.0 0.0	5 0.4 33.3 0.2	1 0.1 50.0 0.0	1 0.1 3.6 0.0	0 0.0 0.0 0.0	36 2.9 46.2 1.4	418 33.3 63.0 16.2	259 20.7 59.3 10.0	2 0.2 20.0 0.1	159 12.7 47.0 6.2	1254 48.6
4.	0 0.0 0.0 0.0	8 1.1 53.3 0.3	1 0.1 50.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	9 1.2 11.5 0.3	120 15.9 18.1 4.6	100 13.3 22.9 3.9	1 0.1 10.0 0.0	62 8.2 18.3 2.4	753 29.2
5.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 28.6 2.6 0.1	1 14.3 0.2 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 57.1 1.2 0.2	7 0.3
6.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	6 54.5 7.7 0.2	2 18.2 0.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 18.2 0.6 0.1	11 0.4
7.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	5 16.1 6.4 0.2	4 12.9 0.6 0.2	2 6.5 0.5 0.1	2 6.5 20.0 0.1	18 58.1 5.3 0.7	31 1.2
8.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	24 27.0 3.6 0.9	15 16.9 3.4 0.6	0 0.0 0.0 0.0	6 6.7 1.8 0.2	89 3.4
9.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	12 17.9 1.8 0.5	6 9.0 1.4 0.2	0 0.0 0.0 0.0	2 3.0 0.6 0.1	67 2.6
10.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 4.4 3.8 0.1	24 35.3 3.6 0.9	15 22.1 3.4 0.6	1 1.5 10.0 0.0	23 33.8 6.8 0.9	68 2.6
77.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 26.7 0.6 0.2	5 33.3 1.1 0.2	1 6.7 10.0 0.0	5 33.3 1.5 0.2	15 0.6
COLUMN TOTAL	1 0.0	15 0.6	2 0.1	28 1.1	6 0.2	78 3.0	664 25.7	437 16.9	10 0.4	338 13.1	2582 100.0

Figure 105--Crosstabulation: Stage X wear

COUNT ROW PCT COL PCT TOT PCT	A	B	C	D	E	G	J	K	L	[illegible]	[illegible]	[illegible]	ROW TOTAL
1211.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 100.0 0.1 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.0
1030.	1 16.7 0.3 0.0	0 0.0 0.0 0.0	2 33.3 2.0 0.1	1 16.7 0.2 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 33.3 [illegible] 0.1	0 0.0 0.0 0.0	6 0.2
1060.	2 4.7 0.6 0.1	20 46.5 8.0 0.8	7 16.3 6.9 0.3	7 16.3 1.1 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 4.7 [illegible] 0.1	5 11.6 7.1 0.2	43 1.7
1070.	0 0.0 0.0 0.0	1 25.0 0.4 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 25.0 2.3 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 25.0 0.4 0.0	1 25.0 1.4 0.0	4 0.2
1073.	0 0.0 0.0 0.0	1 33.3 0.4 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 2.3 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 0.1 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 0.1
1090.	[illegible] 7.0 25.7 2.7	39 4.3 32.0 1.5	46 5.1 45.5 1.8	277 30.7 44.2 10.7	15 1.7 20.0 0.6	16 1.8 36.4 0.6	7 0.8 38.9 0.3	25 2.8 46.3 1.0	247 27.4 35.0 9.6	37 4.1 27.6 1.4	52 5.8 23.6 2.0	24 2.7 34.3 0.9	903 35.0
1091.	137 12.9 39.1 5.3	61 5.7 24.4 2.4	18 1.7 17.8 0.7	268 25.2 42.8 10.4	41 3.9 54.7 1.6	16 1.5 36.4 0.6	4 0.4 44.4 0.2	23 2.2 42.6 0.9	321 30.2 44.8 12.4	76 7.1 56.7 2.9	71 6.7 27.7 2.7	26 2.4 37.1 1.0	1064 41.2
1093.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 100.0 0.1 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.0
1151.	0 0.0 0.0 0.0	1 50.0 0.4 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 50.0 [illegible] 0.0	0 0.0 0.0 0.0	2 0.1
1433.	13 15.3 [illegible] 0.5	10 17.1 16.0 1.5	7 8.2 [illegible] 0.3	5 5.9 0.8 0.2	1 1.2 1.3 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 4.7 0.6 0.2	1 1.2 0.7 0.0	[illegible] 17.6 [illegible] [illegible]	3 3.9 [illegible] [illegible]	[illegible] 3.3
1605.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 100.0 1.6 0.2	0 0.0 0.0 0.0	4 0.2
2000.	1 100.0 0.3 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.0
2230.	7 21.2 2.0 0.3	8 24.2 3.2 0.3	1 3.0 1.0 0.0	15 45.5 2.4 0.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 3.0 1.9 0.0	1 3.0 0.1 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	33 1.3
2235.	6 17.1 2.3 0.2	6 17.1 2.4 0.2	2 5.7 2.0 0.1	4 11.4 0.6 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	11 31.4 1.5 0.4	2 5.7 1.5 0.1	1 2.9 0.4 0.0	3 8.6 4.3 0.1	35 1.4
3300.	1 2.6 0.3 0.0	2 5.1 0.8 0.1	0 0.0 0.0 0.0	2 5.1 0.3 0.1	2 5.1 2.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 7.7 5.6 0.1	12 30.8 1.7 0.5	3 7.7 2.2 0.1	13 33.3 5.1 0.5	1 2.6 1.4 0.0	39 1.5
3310.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 14.3 0.2 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 25.3 0.3 0.1	1 14.3 0.7 0.0	[illegible] 43.3 [illegible] [illegible]	0 0.0 0.0 0.0	[illegible] 0.3
3320.	0 0.0 0.0 0.0	1 20.0 0.4 0.0	1 20.0 1.0 0.0	1 20.0 0.2 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 40.0 [illegible] [illegible]	0 0.0 0.0 0.0	5 0.2
3321.	[illegible] 5.7 1.0 0.2	3 4.3 1.2 0.1	2 2.9 2.0 0.1	5 7.1 0.8 0.2	2 2.9 2.7 0.1	0 0.0 0.0 0.0	1 1.4 5.6 0.0	0 0.0 0.0 0.0	23 [illegible] [illegible] [illegible]	6 [illegible] [illegible] [illegible]	[illegible]	0 0.0 0.0 0.0	[illegible] 2.7
[illegible]	12 5.1 [illegible] [illegible]	13 5.5 5.2 0.5	13 5.5 12.9 0.5	34 14.3 5.4 1.3	14 5.9 18.7 0.5	10 4.2 22.7 0.4	2 0.8 11.1 0.1	1 0.4 1.9 0.0	70 29.5 10.1 2.7	7 3.0 5.2 0.3	[illegible]	[illegible] 2.1 7.1 0.2	237 9.2
3700.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 50.0 1.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 [illegible] [illegible] [illegible]	0 0.0 0.0 0.0	2 0.1
4030.	[illegible] 27.[illegible] [illegible] [illegible]	3 16.7 1.2 0.1	0 0.0 0.0 0.0	3 16.7 0.5 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 5.6 1.9 0.0	3 16.7 0.4 0.1	3 16.7 [illegible] 0.1	[illegible]	[illegible]	18 0.7
4031.	[illegible]	10 55.6 [illegible] [illegible]	1 5.6 1.0 0.0	3 16.7 0.5 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 11.1 [illegible] [illegible]	0 0.0 0.0 0.0	[illegible] 11.1 [illegible] [illegible]	[illegible]	[illegible] 0.7
COLUMN TOTAL	[illegible] 13.[illegible]	[illegible] 9.7	101 3.9	626 24.2	75 2.9	44 1.7	18 0.7	54 2.1	[illegible] 27.[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 100.0

Figure 106--Crosstabulation: Material X feature

COUNT ROW PCT COL PCT TOT PCT	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	77.	ROW TOTAL
A	0 0.0 0.0 0.0	26 10.1 11.0 1.0	0 0.0 0.0 0.0	124 48.1 9.9 4.8	87 33.7 11.6 3.4	0 0.0 0.0 0.0	1 0.4 9.1 0.0	1 0.4 3.2 0.0	10 3.9 11.2 0.4	3 1.2 4.5 0.1	5 1.9 7.4 0.2	1 0.4 6.7 0.0	258 10.0
B	7 2.8 25.0 0.3	37 14.8 15.7 1.4	2 0.8 8.7 0.1	99 39.6 7.9 3.8	83 33.2 11.0 3.2	1 0.4 14.3 0.0	2 0.8 18.2 0.1	3 1.2 9.7 0.1	6 2.4 6.7 0.2	4 1.6 6.0 0.2	6 2.4 8.8 0.2	0 0.0 0.0 0.0	250 9.7
C	0 0.0 0.0 0.0	18 17.8 7.6 0.7	0 0.0 0.0 0.0	44 43.5 3.5 1.7	31 30.7 4.1 1.2	1 1.0 14.3 0.0	1 1.0 9.1 0.0	1 1.0 3.2 0.0	1 1.0 1.1 0.0	0 0.0 0.0 0.0	3 3.0 4.4 0.1	1 1.0 6.7 0.0	101 3.9
D	16 2.6 57.1 0.6	65 10.4 27.5 2.5	13 2.1 56.5 0.5	261 41.7 20.8 10.1	189 30.2 25.1 7.3	2 0.3 28.6 0.1	5 0.8 45.5 0.2	13 2.1 41.9 0.5	22 3.5 24.7 0.9	23 3.7 34.3 0.9	11 1.8 16.2 0.4	6 1.0 40.0 0.2	626 24.2
E	0 0.0 0.0 0.0	3 4.0 1.3 0.1	0 0.0 0.0 0.0	35 46.7 2.8 1.4	21 28.0 2.8 0.8	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.3 3.2 0.0	4 5.3 4.5 0.2	5 6.7 7.5 0.2	6 8.0 8.8 0.2	0 0.0 0.0 0.0	75 2.9
G	0 0.0 0.0 0.0	5 11.4 2.1 0.2	2 4.5 8.7 0.1	25 56.8 2.0 1.0	8 18.2 1.1 0.3	1 2.3 14.3 0.0	0 0.0 0.0 0.0	1 2.3 3.2 0.0	2 4.5 2.2 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	44 1.7
J	0 0.0 0.0 0.0	2 11.1 0.8 0.1	1 5.6 4.3 0.0	12 66.7 1.0 0.5	2 11.1 0.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 5.6 3.2 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	18 0.7
K	1 1.9 3.6 0.0	6 11.1 2.5 0.2	0 0.0 0.0 0.0	24 44.4 1.9 0.9	16 29.6 2.1 0.6	0 0.0 0.0 0.0	1 1.9 9.1 0.0	0 0.0 0.0 0.0	4 7.4 4.5 0.2	2 3.7 3.0 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	54 2.1
L	0 0.0 0.0 0.0	37 5.3 15.7 1.4	2 0.3 8.7 0.1	385 55.3 30.7 14.9	209 30.0 27.8 8.1	2 0.3 28.6 0.1	0 0.0 0.0 0.0	2 0.3 6.5 0.1	19 2.7 21.3 0.7	23 3.3 34.3 0.9	12 1.7 17.6 0.5	5 0.7 33.3 0.2	696 27.0
M	3 2.2 10.7 0.1	7 5.2 3.0 0.3	1 0.7 4.3 0.0	73 54.5 5.8 2.8	41 30.6 5.4 1.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.7 3.2 0.0	3 2.2 3.4 0.1	3 2.2 4.5 0.1	1 0.7 1.5 0.0	1 0.7 6.7 0.0	134 5.2
P	1 0.4 3.6 0.0	21 8.2 8.9 0.8	2 0.8 8.7 0.1	127 49.6 10.1 4.9	55 21.5 7.3 2.1	0 0.0 0.0 0.0	1 0.4 9.1 0.0	4 1.6 12.9 0.2	18 7.0 20.2 0.7	4 1.6 6.0 0.2	22 8.6 32.4 0.9	1 0.4 6.7 0.0	256 9.9
Q	0 0.0 0.0 0.0	9 12.9 3.8 0.3	0 0.0 0.0 0.0	45 64.3 3.6 1.7	11 15.7 1.5 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 4.3 9.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 2.9 2.9 0.1	0 0.0 0.0 0.0	70 2.7
COLUMN TOTAL	28 1.1	236 9.1	23 0.9	1254 48.6	753 29.2	7 0.3	11 0.4	31 1.2	89 3.4	67 2.6	68 2.6	15 0.6	2582 100.0

D)

Figure 107--Crosstabulation: Stage of Manufacture X feature

STAGE OF MANUFACTURE

		COUNT	ROW PCT	COL PCT	TOT PCT	ROW TOTAL	ROW TOTAL PCT
Retouch Flakes	0.	1	3.6	0.1	0.0	28	1.1
Primary Cores	1.	77	32.6	7.7	3.0	236	9.1
Secondary Cores	2.	6	26.1	0.6	0.2	23	0.9
Primary Flakes	3.	373	29.7	37.2	14.4	1254	48.6
Shatter	4.	452	60.0	45.1	17.5	753	29.2
Biface,Complete	5.	0	0.0	0.0	0.0	7	0.3
Biface,Partial	6.	1	9.1	0.1	0.0	11	0.4
Uniface	7.	0	0.0	0.0	0.0	31	1.2
Pressure Flakes	8.	44	49.4	4.4	1.7	89	3.4
Trimming Flakes	9.	47	70.1	4.7	1.8	67	2.6
	10.	2	2.9	0.2	0.1	68	2.6
Uniface, Partial	77.	0	0.0	0.0	0.0	15	0.6
	COLUMN TOTAL	1003 38.8				2582	100.0

Figure 108--Unutilized summary, percentages computed on total sample of stage--See Fig. 105.

LITHIC TOOLS AR-4 Figure 109

TOOL TYPE	TOTAL	TOTAL %	CLASS %
Knives: Light			
Debitage	580		89.8
Core	55		8.5
Biface/Uniface	11		1.7
Total	646	40.9	100.0
Knives: Heavy			
Debitage	45		60.0
Core	17		22.7
Biface/Uniface	13		17.3
Total	75	4.7	100.0
Scrapers: Light			
Debitage	379		90.0
Core	35		8.3
Biface/Uniface	7		1.7
Total	421	26.7	100.0
Adzes			
Debitage	226		71.3
Core	59		18.6
Biface/Uniface	32		10.1
	317	20.1	100.1
Resharpening Flakes			
Adze	24		42.1
Scraper	12		21.1
Light Knives	18		31.6
Heavy Knives	3		5.3
	57	3.6	100.1
Spokeshaves	11	0.7	
Gravers	15	0.9	
Drills	3	0.2	
Choppers	6	0.4	
Hammerstones	28	1.8	
Overall Total Utilized	1579	100.0	

Total: 2582
Total Utilized: 1579
Percent Utilized: 61.2%
Total Unutilized: 1003
Percent Unutilized: 38.8

Figure 110: Lithic artifacts from AR-4. a--Heavy Bifacial knife; b and c--Unifacial knives; d--drill; e and f--Hafted adzes.

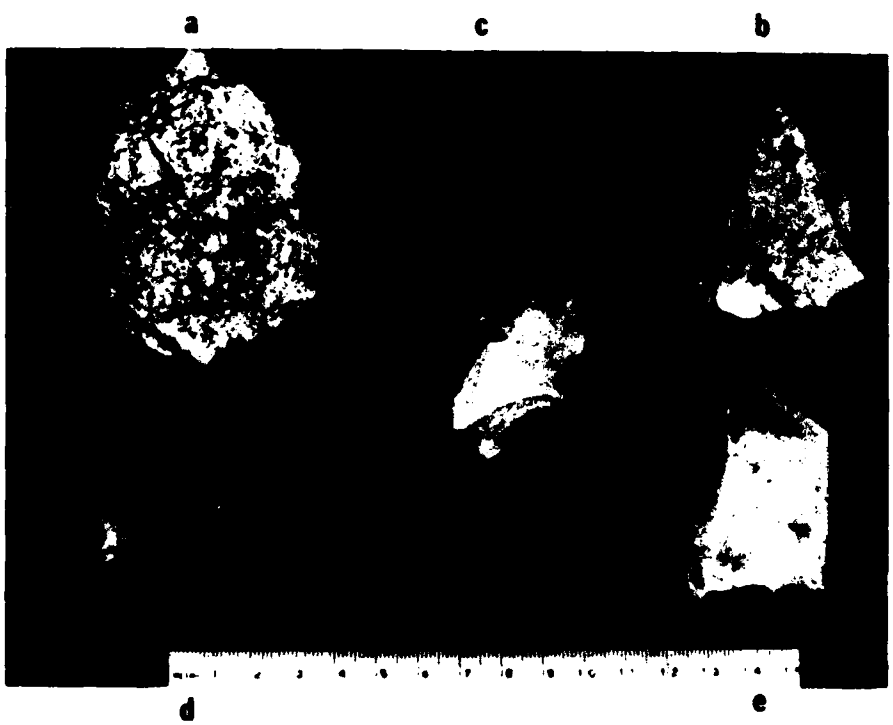


Figure 111: Lithic artifacts from AR-4. a and b--Core type bifaces; c--Unifacial core; d and e--Unifacial hand-held scrapers.

to be a roughing out area (not a quarry) for preparing material to be traded. In the above discussion, the 151 lithics from this area have been summarized with the other lithics from AR-4. When these lithics were separated from the rest, it was found that 147 (97.4 percent) are Pedernal chert, 2 are miscellaneous chert (code 1400), and only 2 are obsidian. The evidence from this one grid affirms the field impression that this area is uncommonly high in Pedernal chert. It can now be seen that it occurs in high proportion relative to the amount of other materials that were being used at the site for other purposes, further strengthening the idea that this area was used for roughing out Pedernal chert -- possibly for use as a trade item. Relative to findings on the rest of the site, the lithics from this area are little utilized (59.6 percent).

The obsidian hydration analysis affirms the field impression that these lithics are contemporaneous with the Piedra Lumbre Phase occupation (see "obsidian hydration" discussion in chapter VII). This demonstration of contemporaniety makes the large lithic area south of Feature A a functionally related part of the site.

Ground and Pecked Stone Tools

Ground and pecked stone tools are conspicuously absent. Those found at AR-4 include 7 manos, several smoothed and polished cobbles, 1 metate fragment, and a small, rounded sandstone slab. The metate fragment is of a type common on Archaic sites, and was found on the surface removed from any structure (Map 2). No metates were found in the structures. Only 6 of the manos can reasonably be associated with the structures and these are unshaped river cobbles with wear facets. Grinding grains and other foodstuffs was not a major part of the technology.

Manos (7): Five manos were found either in or on the surface near Feature L. A complete, one-hand mano or "rubbing stone" was found inside Feature L (Quad I, level 1). This tool is made from medium-fine sandstone and is a natural cobble worn down from use. It is worn on one side only (Fig. 112). The worn face is quite smooth and is flat with only a slight bevel at one end. It may have been used with a circular motion on a flat surface. In form, size, and nature of the face, it resembles the "rubbing stones" from Pecos (Kidder 1932:72). Dimensions are: length, 105 millimeters; width, 90 millimeters; thickness, 27 millimeters.

A nearly round, natural river cobble was found outside Feature L on the sandstone ledge northeast of the structure. Both rounded, convex sides of the cobble display worn and smoothed areas (Fig. 113). There is no other modification of the cobble. The worn sides are gently convex and conform to the cobble contour. Dimensions are: length, 75 millimeters;

width, 70 millimeters; thickness, 42 millimeters. The material is a fine-grained igneous type, probably rhyolite.

A piece of fire-cracked rock from 16 centimeters outside the south wall of Feature L (square L), has smoothed and polished remnants of use facets. It appears to be a fragment from the midsection of a mano fractured in a fire.

Two large manos were found on the surface outside of Feature L. Both were close to each other near a sandstone ledge southeast of the feature. The better example of the two (Fig. 114) is a long, narrow, natural piece of fine-grained sandstone that has the right shape for a mano but was completely unmodified as far as shaping is concerned. One naturally flat side has been roughened with a hammerstone as indicated by numerous dents over the surface. This side has also been worn smooth from use along the entire face. It is the right shape, weight, and size to have been used as a two-hand mano for grinding corn. It is the only mano from AR-4 that resembles in size and shape the typical corn-grinding mano of the Pueblos. Dimensions are: length, 223 millimeters; width 95 millimeters; thickness, 62 millimeters. The second of these is also a naturally flat side exhibiting percussion dents and a smooth surface. It too is heavy and would have been appropriate for grinding corn; the oval shape, however, is unlike most Pueblo manos. Dimensions are: length, 150 millimeters; width, 120 millimeters; thickness, 47 millimeters.

A single cobble mano was associated with Feature D. It was on the surface to the southwest of the structure in the midden in grid H-110. As with the manos described above, this is a natural river cobble with one naturally smooth side displaying smoothing and striations from wear perpendicular to the long axis. There are slight, but discernible, bevels at either end of the worn face. It is a medium-grained, reddish quartzite. A slight worn face may be present on the opposite face. Dimensions are: length, 127 millimeters; width, 65 millimeters; thickness, 55 millimeters.

The above 6 manos are the only grinding tools that can be associated with any confidence with the occupation of AR-4. They are all naturally rounded and smoothed river cobbles that have been used sufficiently to display worn faces and pollished areas. The complete ones are large enough to have been used for grinding corn, and are considerably larger than most of the one-hand manos found on the Archaic sites in Abiquiu Reservoir. On the other hand, none of them has been shaped, as was the practice in most contemporaneous Rio Grande Pueblos (Kidder 1932:69-71). At this point, it is unknown with what kind of surface or metate they were used.

The seventh mano recovered from AR-4 was on the surface northeast of Feature A, in grid CG-166. It was sufficiently far from the structure that there is no assurance that it derives from the primary occupation. The presence of Pueblo

III or IV points and Taos Gray pottery on this bench indicate that earlier people used this terrace. On the other hand, it is similar to the large oval mano from Feature L, and, like the others from AR-4, is a worn, river cobble. Both sides of this oval, rhyolite cobble have been well worn, although bevels on the edges of the faces are minimal. Dimensions are: length 135 millimeters, width 110 millimeters, thickness 37 millimeters.

Metate (1): A single metate was found at AR-4. It was in the bottom of a drainage to the southwest of Feature D in grid V-111 (Map 2). By context, there is no reason to associate it with the main occupation. It is about one-third complete with the break crossing well-worn basins ground into either side. The material is vesicular basalt. In size, shape, and cross-section, it is typical of many basin slab metates from the late Archaic or Basketmaker II Periods. Given the fact that Basketmaker II points were found on the same terrace a short distance to the north, it would appear that this derives from an earlier occupation of the terrace and does not belong to the primary occupation. Dimensions are: length 220 millimeters, width 190 millimeters, thickness (on edge) 45 millimeters, (in middle of basins) 27 millimeters.

Smoothed and Polished Cobbles: Cobbles and cobble fragments with smoothed and polished surfaces were fairly common in and around the structures. This kind of smoothing, however, occurs naturally on river cobbles and it is very difficult to determine what has been produced artifactually versus naturally. Only 4 of these are described here as being worn and smoothed enough to suggest that they were modified by human use.

A whitish, quartzite cobble was found in level 2 of grid BJ-136 at Feature K. One side has a well-polished surface, that clearly was made by moving the stone against an unyielding surface. Dimensions are: length 82 millimeters, width 75 millimeters, thickness 35 millimeters. Two large quartzite cobbles were found at structure G1 that have smoothed surfaces. Both are naturally rounded, oval cobbles. One was on the surface and the other was buried. Dimensions of the surface cobble are: length 145 millimeters, width 105 millimeters, thickness 45 millimeters. Dimensions of the buried cobble are: 144 millimeters, width 95 millimeters, thickness 50 millimeters. The fourth polished stone is from the fill outside of Feature D (grid G-108). This is a small fragment of a thin stone that had been cracked in a fire. One side is worn. The original size is indeterminate, but it is 23 millimeters thick. The use of such tools is unknown but they may have been for dressing hides. It is unlikely that they were used for grinding seeds.

Rounded Sandstone Slab: About one-quarter of a circular shaped, thin sandstone slab was found in the midden outside of Feature D (grid F-108). The arc is well smoothed, and it is very similar to some of the utilized potsherds from the site. While broken, it is possible that it was a spindle whorl.

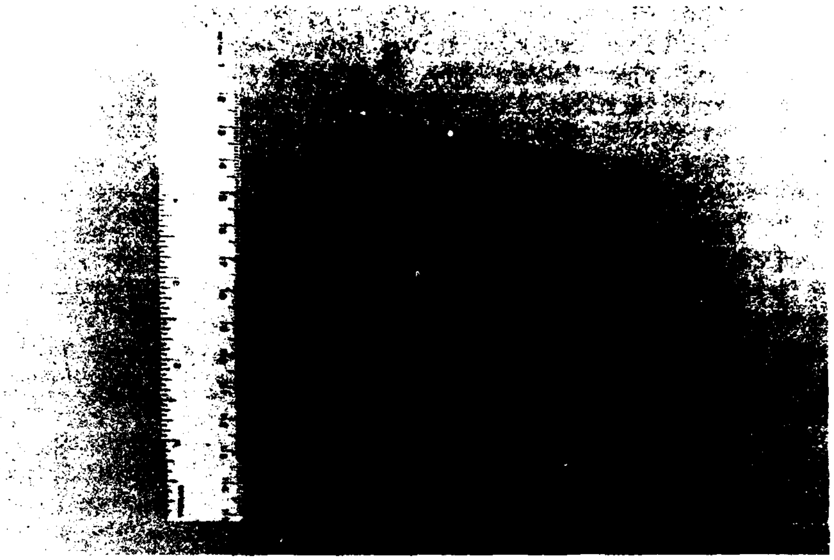


Figure 112: Feature L, one-hand mano.

Figure 113: Feature L, one-hand cobble mano.

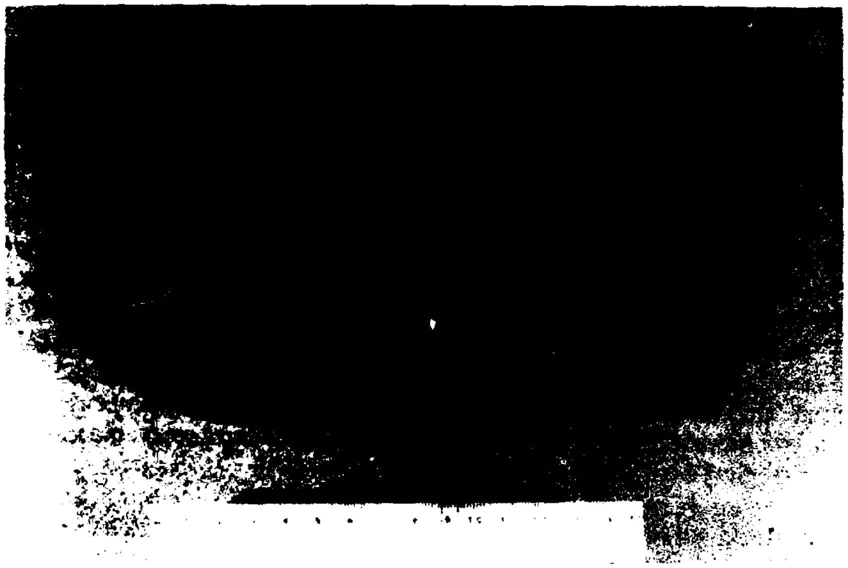


Figure 114: Feature L, two-hand mano.

The dimensions of the fragment are: length 35 millimeters, width 25 millimeters, thickness 5 millimeters. Originally it must have been about 50 millimeters in diameter.

Summary. Considering the amount of fill screened and the number of structures excavated at AR-4, the paucity of ground stone tools is amazing. The few manos that were found are all very crude and are little more than utilized river cobbles. The complete lack of metates, and even metate fragments from the structures, was unexpected. This lack of grinding tools, of course, correlates with the lack of evidence in the flotation materials for corn and other cultigens and with the fact that the only palynological evidence for agriculture was the one grain of corn pollen from the floor of Feature D.

PROJECTILE POINTS

Introduction. The typology of projectile points has always been an enigmatic and elusive problem. All archaeologists are aware that the kinds of points made by different cultural groups vary according to definite patterns. In most cases, however, the identification of point types is based upon visual comparisons between drawings or photographs of projectile points found in definite cultural contexts with the appearance of those found in a research area. Judgments are then made as to whether points "look alike." After working with the several hundred points from the surveys and excavation at Abiquiu, the writer has become acutely aware of the ambiguities and deficiencies of this method of typology. The following discussion represents an attempt to make point typology a more objective endeavor.

The method devised in this analysis utilizes a descriptive code to obtain raw data. The data are then arranged in several ways, the most productive of which makes use of 3 coordinate or tri-polar plots to determine graphically the relationship between 3 measurements. By coordinating several kinds of plots of different measurements, it was found that types could be discriminated in a consistent and objective manner. The types derived by the covariation of measurements on the plots co-occur with other variables that were not plotted and with proveniences within the site. It is felt that this co-occurrence with other variables and the meaningful and consistent intro-site distribution of the derived types obviates the need to evaluate statistically the results of the tri-polar plots.

It is possible to recognize a series of points that are regarded as having been made by the inhabitants of the site and to divide them into 4 distinct types. They are described as "Piedra Lumbre" points. In addition, Archaic, Basketmaker II, Basketmaker III (and/or Pueblo I), and Pueblo III (and/or IV) points can be discerned. The assignment of points to the cultures noted is based upon their similarity to points previously associated with these cultures, together with the formulation of the tri-polar plots, which provides a way to make judgments that are quantitative and consistent from observer to observer.

Descriptive Code. The descriptive code used to convert the attributes of projectile points to information on punch cards was first developed in the Phase IV analysis (Schaafsma 1977:293), although the information derived in that analysis was not synthesized. The descriptive code relies heavily upon a study by G. F. Van Buren (1974). The present modification and application of his work represents an effort to make his exhaustive study operational.

As in the lithic analysis, the information in any given field is regarded as a variable and the data within any variable are termed values. All variables are observed independently of each other as in the lithic analysis. The term "variable" used here is the same as Van Buren's term "characteristic."

The coded data for 25 of the 26 projectile points in the study are presented in Figure 116. Data for Point 26 Fig. 117b is not presented in Fig. 116. The data are ordered from left to right as indicated in the card design (Fig. 115); each row represents the data pertaining to an individual point. Since all the measurements are entered directly in millimeters, this information can be readily extracted. For reference, the initial entry ("4") for the site number is in column 3. In addition to metric data, provenience data can also be derived readily from this list. The overall list, from top to bottom, is ordered sequentially by the item numbers in field 7 (columns 19, 20, and 21), allowing convenient reference to any particular point discussed below. Although only selected information from this list was utilized in the present study, the list provides an exhaustive description of the points from the site that can be used in future studies. The coded data should be constantly compared to the illustrations of the points (Figs. 116 - 118). The points of this culture from the Phase III work (Schaafsma 1976) are included here as Figure 118. Point 26 discussed below is in that illustration and was found in the 1975 excavation of Feature L. Finally, item numbers 20 and 22 are fragments of the same point and are so discussed below.

Typology:

1) Tri-Polar Plots. These plots are a means to depict the relationship between 3 quantitative variables. The measurements are converted to percentages in relation to each other by summing and then dividing each measurement by this total. The resulting 3 percentages are then plotted on tri-polar graph paper. Any set of measurements will fall on only one point on the graph. A proportionately identical set will

fall on the same point, however, since it is the proportionate relationship that is being plotted. Any other set of numbers that results in the same percentages will also fall on the same spot. Thus it is the relationship between variables that is being depicted, not absolute size. The usefulness of tri-polar plots for deriving point typologies is based on the fact that points with similar shapes (overall, blade, base, etc.) will fall in a similar space on the graphs, while points with different shapes will fall in other spaces. Defining these spaces can lead to the recognition of distinct types. Three kinds of plots are considered: 1) overall configuration, i.e., overall length, blade width, and neck width (Fig. 119); 2) blade form, i.e., blade length, blade width, and blade thickness (Figs. 120-121); and 3) stem form, i.e., stem length, base width, and stem thickness (Figs. 122-123). Although some of the points are fragmented (Fig. 116), it was found that the dimensions of most of these points could be accurately projected and these measurements used in the plots.

The configuration plot, or the relationship between overall length, blade width, and neck width (Fig. 119), proved to be the most sensitive discriminator of variations and similarities. This plot expresses the main elements of the shape of a projectile point when it is held flat and observed in plan view. The divisions indicated on this plot constitute the basic types discussed in this report.

<u>List of Types</u>

Archaic (no. 12)
Basketmaker II, variety a (nos. 3, 10, and 17)
Basketmaker II, variety b (nos. 7, 13, 15, and 20-22)--item: nos. 20-22 are the same point
Basketmaker III, (nos. 4, 16, and 19)
Pueblo (II-IV) (nos. 21 and 23)
Piedra Lumbre, type a (nos. 2, 5, 18, 25, and 24)
Piedra Lumbre, type b (nos. 1, 9, 14, and 26)
Piedra Lumbre, type c (no. 8)
Piedra Lumbre, type d (nos. 6 and 11)

Several significant relationships are apparent on this plot. These will also be found on the other plots as well as when the non-metric variables are considered. The Archaic point (no. 12) falls close to Basketmaker IIa, both of which are distant from Basketmaker IIb and Basketmaker III. Basketmaker IIb points are located in a distinct space that is contiguous with Basketmaker III points, while the 2 Pueblo points fall in a tight space that is distinct from all other types. Piedra Lumbre types a and b fall in separate spaces, distinct from the other 2 Piedra Lumbre types. Piedra Lumbre type c (no. 8) falls in a separate space, and Piedra Lumbre d points (nos. 6 and 11) share a distinctive and separate region.

The blade form plots (Figs. 120-121) result in spatial relationships that are similar to those found in the configuration plot. There are 2 plots because there is some overlap between the Piedra Lumbre points and the others that unnecessarily confuses the graph. Figure 120 presents the non-Piedra Lumbre points -- Archaic, Basketmaker IIa, Basketmaker IIb, Basketmaker III, and Pueblo -- and Figure 121 shows the Piedra Lumbre points. The non-Piedra Lumbre plot demonstrates essentially the same relationships that are found on the configuration plot. The 2 varieties of Basketmaker II points are widely spaced and form 2 discrete clusters. As in the configuration plot, Basketmaker III points are near Basketmaker IIb and share a contiguous but separate space. Pueblo points lie between the 2 Basketmaker II types in a tight space. The Archaic point is in a distinct space in proximity to the Basketmaker IIa points. The Piedra Lumbre plot (Fig. 121) again shows a clear separation between types a and b. As before, Piedra Lumbre type c lies between types a and b. The 2 Piedra Lumbre d points fall on the same spot.

It was suggested in the field that point 2 was a reworked Basketmaker II point -- a reasonable suggestion, since it is corner-notched (stem forming method code 5, see Figure 116). It is also approximately the size of the smaller Basketmaker II points. In both the configuration and blade form plots, however, point 2 falls outside the space belonging to either group of Basketmaker II points and it is actually midway between the 2 spaces. In both plots, it falls together with the other points that constitute Piedra Lumbre type a.

The stem form plots are also divided into non-Piedra Lumbre (Fig. 122) and Piedra Lumbre (Fig. 123) types. These plots reveal some relationships that were not apparent prior to making the plots. It should be noted that the 2 types of Basketmaker II points and Piedra Lumbre types a and b have very different relationships when stem form is considered than when the blade alone is considered (Figs. 122 and 123). In both cases the space in which the types fall overlaps or adjoins. The implication is that while the types can be defined on the basis of blade form and overall configuration, the stems may be similar because they belong to the same basic tradition. Thus, the Basketmaker II points are clearly separable on the basis of overall shape and blade form (Figs. 119 and 120) the same situation exists for the 2 types of Piedra Lumbre points (Figs. 119 and 121); however, the points merge when the stems are considered because hafting techniques were constant within these traditions.

Thus, there is information of a different sort lying in the stem form plots. The overlap of forms serves to indicate that the points are actually part of similar traditions (Basketmaker II, Piedra Lumbre Phase, and so forth). On the other hand, the suspicious separation of several points (nos. 18, 9, and 15) indicates the possibility that there may yet be other subdivisions based on stem form.

2) Other Variables. The above discussion has emphasized the results of defining types through the use of tri-polar plots. However, it is apparent from the photographs (Figs. 117, 118) that other variables were also considered in establishing these types. The following discussion can be followed by referring to the photographs and by checking the date tabulation (Fig. 116).

The Basketmaker II (both types), Basketmaker III, and Pueblo points generally have flat or slightly convex bases; none of them have deep basal notches. Piedra Lumbre points (Points 1, 2, 25, and 14, for example) in contrast, commonly have deep basal notches. Piedra Lumbre points cannot be isolated simply on the basis of basal notches, however, because some (Points 5 and 18) have nearly flat or slightly convex bases. The aberrant point form in Piedra Lumbre d (Point 8) has a widely concave base similar to Point 1, which helps to unite it with the rest of the Piedra Lumbre Phase points. Overall, Piedra Lumbre points tend to have wide to deep basal notches whereas earlier points from the Pueblo and Basketmaker II and III periods tend to have flat, slightly concave or convex bases.

The method of modifying a point to permit hafting is another potentially major way to discriminate point-making traditions. For example, in the Pueblo point tradition, the triangular planform is nearly always modified to allow hafting by making 2 notches one-quarter to one-third of the way up the sides from the base (Fig. 117); (Kidder 1932: Fig. 4). There is very little deviation from this method so that the widespread Pueblo points are readily identifiable. In contrast, the earlier points of the Puebloan tradition (Basketmaker III and Pueblo I periods) have small notches in the corners of planforms which tend to be more elongated than those of the later Pueblo points. The stem-forming method can thus serve to differentiate earlier Puebloan points (Basketmaker III-Pueblo I) from later ones (Pueblo II-IV) with remarkable consistency in the vast area of the Southwest where these points are found. In other ways, these points are not very different from one another except in the proportions of their original planform (Fig. 117).

The Basketmaker II points of the Southwest were formed like those of the Basketmaker III period, by the manufacture of well-executed, deep, corner notches in triangular planforms. The resulting points have a remarkable stability throughout a wide area and may have been made for 1,000 years (Irwin-Williams 1973:Fig. 7). The Archaic point (Point 12) was formed by the corner-side-notching of a rounded base on a triangular planform and probably represents the various kinds of corner-notching that were used to make points during the En Medio Phase (1973:Fig. 6c). Thus, in many cases, the stem-forming method may identify the traditions to which points belong. This is especially true in the Southwest during the period ca. 500 B.C. to A.D. 1500.

The Piedra Lumbre Phase points are much more variable in regard to stem-forming method, perhaps indicating a more unstable point making tradition. There are points that are definitely side-notched (Points 6 and 18), points that are basically side-notched but made by wide arcs instead of deep small notches (Points 8 and 14), and points that are formed by removing wide corner-notches (Point 2). There is also a point (Point 1) that has a distinct side notch on one side and a wide arc on the other side. While there is some variation, there is a general pattern to the stem-forming methods of the Piedra Lumbre Phase which consists of constricting the lower planform to produce a flaring base. It is this variability that allows Piedra Lumbre points to look like Pueblo points on the one hand (Point 18) and Basketmaker II points (Point 2) on the other. The well-executed side notches of Point 25 (Fig. 116) should be noted, as well as the side notches on the other Phase III points (Fig. 118).

The tip angle expresses the relationship that exists between blade length and blade width and ultimately the shape of the planform. The greater the blade width relative to the blade length, the greater the tip angle, and vice versa. There is thus a correspondence between tip angle and blade shape. The narrow-bladed Basketmaker III and Basketmaker IIb points all have low tip angles. All the broad-bladed Basketmaker IIa points have, in contrast, high tip angles. The medium-bladed Pueblo points have medium-sized tip angles. The Piedra Lumbre points as a group are more variable. The various types, however, have consistency in relationship to one another. The 2 Piedra Lumbre d points have tip angles between 71° - 80°. The distinctive Piedra Lumbre c point is the only point with a low angle (21° - 30°). The narrow-bladed Piedra Lumbre type b falls in the lower intervals. Thus, while not a reliable discriminator of types in itself, tip angle is a useful secondary check on the validity of typological separations.

Of course, material type cannot be used initially as a basis for defining types. Once separations have been made on the basis of other criteria, however, some additional patterns in regard to material type emerge. It is proposed that these patterns reflect prehistoric conditions such as cultural preferences for distinctive material types and differential access to quarries that could represent travel patterns, social barriers to certain quarries, and participation in different trade networks.

The Archaic point (Point 12) is made of 3530 obsidian from the Polvadera Peak quarry. While this is only one point, the use of this material type is consistent with the results of the previous examination of over 100 Archaic points, which demonstrates that Archaic people definitely selected dark to black-colored materials -- in many cases the local 3530 obsidian (Schaafsma 1977). This situation appears to represent a culturally regulated preference regarding selection of material types.

The Basketmaker II points are more variable in their material types. The local 3530 obsidian (Points 10, 15, 17, 20 and 22), as well as the clear 3520 obsidian from the Pajarito Plateau (Points 7 and 13) were used in addition to the locally available Pedernal chert (Point 3). This selection indicates that, like the Archaic people, the makers of the Basketmaker II points were almost definitely residing in the Chama Valley and that they had a certain amount of trade contact with the people living on the Pajarito Plateau or made trips there themselves.

Two of the Basketmaker III points (Points 4 and 19) are Pedernal chert, and the third point (Point 16) is made of 3530 obsidian. In the Phase III report (Schaafsma 1976:64-5), it was suggested that the Basketmaker III points were carried into the valley by hunters from distant villages. The fact that these points are made of the local materials, however, raises the question of whether there were villages relatively nearby that have not yet been discovered.

The results of the Phase III point analysis revealed that Pueblo points were predominantly made of light-colored chert (Schaafsma 1976: Fig. 42). The 2 Pueblo points in this collection reflect this pattern; both points are made of light-colored chert. This preference for light cherts undoubtedly represents a cultural bias on the part of the Pueblos since they had access to exactly the same range of materials in the valley as did the Archaic people who chose black materials.

Of the 12 Piedra Lumbre points, 10 were made from 3530 Polvadera Peak obsidian, a fact that implies that the points were made in the Piedra Lumbre Valley. It reverses the pattern found on the Phase III survey (Schaafsma 1976:Fig. 43), however, where only 1 out of 7 Piedra Lumbre Phase points was made from 3530 obsidian, while 5 of the 7 were manufactured from light-colored chert (1976:Fig. 43). The point retrieved from Feature L (no. 26) mentioned in the Phase III report is discussed here. It is made from a clear, glassy obsidian coded 3520 which is from the Pajarito Plateau near Bandelier National Monument. This point indicates some trade connections, or travel, involving the Pajarito Plateau. Point 8 (Piedra Lumbre d) is made of tan, fossiliferous chert for which the provenience is presently unknown.

Distribution of Points: The provenience of the points within the site offers clues to the proper cultural affiliation of types. The distribution of point types within the site also suggests that there may be several components present.

Points were found below the surface within structures (Points 1, 2, 5, 8, 14, 15, 16, and 25), below the surface in middens and exterior deposits directly related to the structures (Points 6, 9, 11, 17, 18, 19, 20, 22, 24, and 26), and on the surface away from the structures (Points 3, 4, 7, 10, 12, 13, 21, and 23). Of the 8 points found in the structures, 6 are Piedra Lumbre points. The other 2 points were a Basketmaker IIb point (Point 15) and a Basketmaker III point (Point 16). These 2 points were almost certainly picked up by the inhabitants and brought to the structures for some reason. Of the 9 points found in the middens directly related to the structures, 6 (67 percent) are Piedra Lumbre points. In other words, the remaining 6 Piedra Lumbre points came from middens directly related to the structures, so that all 12 Piedra Lumbre points were directly related to the structures. The remaining 3 midden points are Basketmaker IIa (Point 17), Basketmaker IIb (Points 20 and 22), and Basketmaker III (Point 19). Presumably these earlier points were also brought to the feature vicinities.

Eight points were found on the site surface away from the structures. None of these were identified as Piedra Lumbre points. Both of the Pueblo points were located on the surface among the lithics around Feature A. The presence of these points raises the question of whether some of this extensive lithic area might not be Pueblo in origin. The 1 Archaic point (Point 12) was retrieved from the lithic area east of Feature P in grid F-174. The provenience of this point suggests that this lithic area might represent an Archaic component. Four of the 8 surface points are Basketmaker II. The 2 Basketmaker IIa points (Points 3 and 10) were in the lithic area northwest of Feature D, and their presence suggests that some of these lithics might be from an early Basketmaker II component in this part of the site. The 2 Basketmaker IIb points (Points 7 and 13) were located close to each other (in grids BH-190 and BE-193) on the terrace top southwest of Feature Q. These points and the diffuse lithic area near them might constitute a later Basketmaker II component in this area. The single Basketmaker III point (Point 4) was on the bench edge just above Feature B (in grid CE-220). It either represents a lost hunting point from that period or was brought within the vicinity of Feature B by the occupants of this feature.

The intrasite pattern of point distribution provides strong evidence that the Piedra Lumbre points were made by the builders of the structures. The presence of Archaic and Basketmaker II points in lithic areas away from the structures is equally compelling evidence that there are several small earlier components in the vicinity. Finally, the retrieval of Pueblo points from among the lithics near Feature A raises the question of whether the lithics in this area were distributed by Pueblos or later people. It is the purpose of the obsidian hydration study (see Chapter VII) to address some of the questions raised by the intrasite distribution of point types.

Figure 115

PROJECTILE POINT CARD DESIGN

Field	Content	Columns
1	Site Number	1, 2, 3
2	Grid Number	4, 5, 6, 7, 8
3	Meter Square Number	9
4	Level	10, 11
5	Feature Letter	12, 13
6	Field Specimen Number	14, 15, 16, 17, 18
7	Item Number	19, 20, 21
8	Material	22,23,24,25,26,27
9	Stage of Manufacture	28
10	Fragmentation	29
11	Overall Length	30, 31
12	Weight	32, 33
13	Planform	34, 35
14	Cross Section	36, 37
15	Flaking	38
16	Form of Blade Edge	39
17	Treatment of Blade Edge	40, 41
18	Location of Blade Width	42
19	Blade Width	43, 44
20	Blade Length	45, 46
21	Blade Thickness	47, 48
22	Shoulder Type	49, 50
23	Stem Forming Method	51, 52
24	Stem Form	53, 54
25	Stem Length	55, 56
26	Stem Thickness	57, 58
27	Neck Width	59, 60
28	Base Form	61, 62
29	Base Width	63, 64
30	Tangs (on base)	65, 66
31	Tip Type	67, 68
32	Tip Angle	69
33	Number of Notches	70
34	Location of Notches	71
35	Notch Width	72
36	Notch Depth	73
37	Smoothing	74
38	Wear Pattern	75
39	Location of Wear Pattern	76
40	Special Characteristics	77

				Item Number		Length		Blade Width	Blade Length	Blade Thickness		Stem Length	Stem Thickness	Neck Width		Base Width		
4 E1089	1	D	204	1	3510 11	25	372751 02	13	18	4	5 3 7	7	3	10	5	13	2 66	I1
4 G109	1	D	181	2	3530 11	28	38 452 01	19	19	5	6 5 5	9	5	12	9	15	2 78	A3
4 X 969	0		433	3	1090B49	21	51 324 03	19	15	5	16 5 6	8	5	12	1	17	10 89	D9
4CE2209	0	B	91	4	1091J19	20	372751 01	8	19	4	14 5 4	4	2	5	1	7	11 24	E5
4CD1702	1	A	252	5	3530 31	21	492122 01	14	15	3	5 6 [illegible]	7	3	8	28	11	5 77	E9
4 G109	1	D	176	6	3530 31	12	452722 03	9	10	3	11 3 6	3	2	9	5	12	1148	E9
4BH1907	0		582	7	3520 11	30	50 751 01	28	24	4	16 5 6	6	3	9	28	14	12 35	D6
4CI2235	4	B		8	1400 12	22	501562 02	13	16	4	1219 4	4	2	12	5	15	4 33	D2
4CI1367	2	K	29	9	3530 31	25	37 451 01	12	19	3	6 3 6	3	2	10	28	13	12 65	E6
4 A 973	0	D	427	10	3521 12	21	49 312 01	22	21	4	16 4 5	7	3	16	5	20	12	
4 G109	1	D	190	11	3521 11	13	452721 01	9	10	3	5 3 6	4	3	7	9	11	2 78	
4 F1742	0	P	496	12	3530 31	22	432121 01	16	14	5	6 3 4	8	4	12	3	14	0 47	E1
4BE1938	0		488	13	3500 31	28	37 352 01	14	22	4	3 3 4	6	4	8	1	12	1 64	E5
4 F1090	1	D	152	14	3530 31	32	37 391 01	16	24	5	12 3 5	8	5	13	9	15	2124	A5
4CI2236	2	B	65	15	3530 19	46	37 351 01	22	37	5	2 5 4	13	6	15	1	12	7 74	E9
4CI2236	4	B	80	16	3530 33	25	362751 01	13	22	4	3 5 5		3	7			24	E4
4CH2242	1	B	153	17	3521 12	24	45 351 01	22	16	5	4 5 4	8	5	7	1	14	7 46	E9
4 H111	1	D	576	18	3530 32	19	38 411 01	14	11	3	2 3 8	7	2	9	24	15	1 76	
4AF1686	1	P	407	19	1091A16	15	36 451 01	9	16	2							24	D5
4AE1693	1	P	395	20	3530 18	9	35								1	14	0	
4CH1691	0	A	147	21	1091A31	16	38 431 01	10	10	2	3 3 3	6	2	7	28	11	1 36	D9
4AF1687	1	P	425	22	3530 16	26	362411 04	13		5							124	E5
4CC1834	0	A	90	23	1400 11	17	502742 01	10	11	3	5 3 4	5	2	8	1	12	1 87	E1
4CI1376	2	K	24	24	3500 20	31	501902 0		22	3	5 5 6	6	3				3	C4
4CI2234	4	B	97	25	3500 39	19	38 322 00		12	3	6 3 4	4	2				5 37	D2

Figure 116-- Tabulated Projectile Point Data

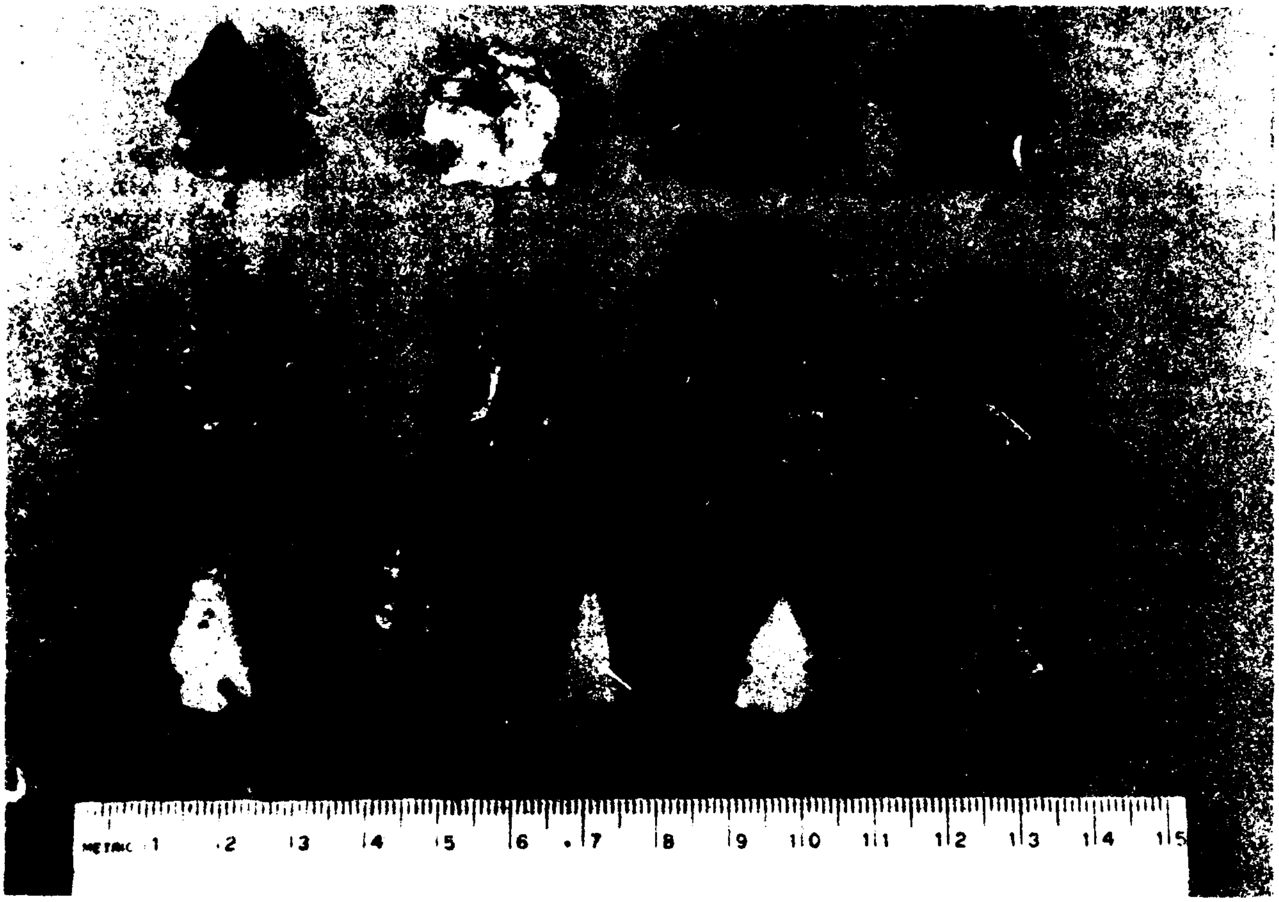
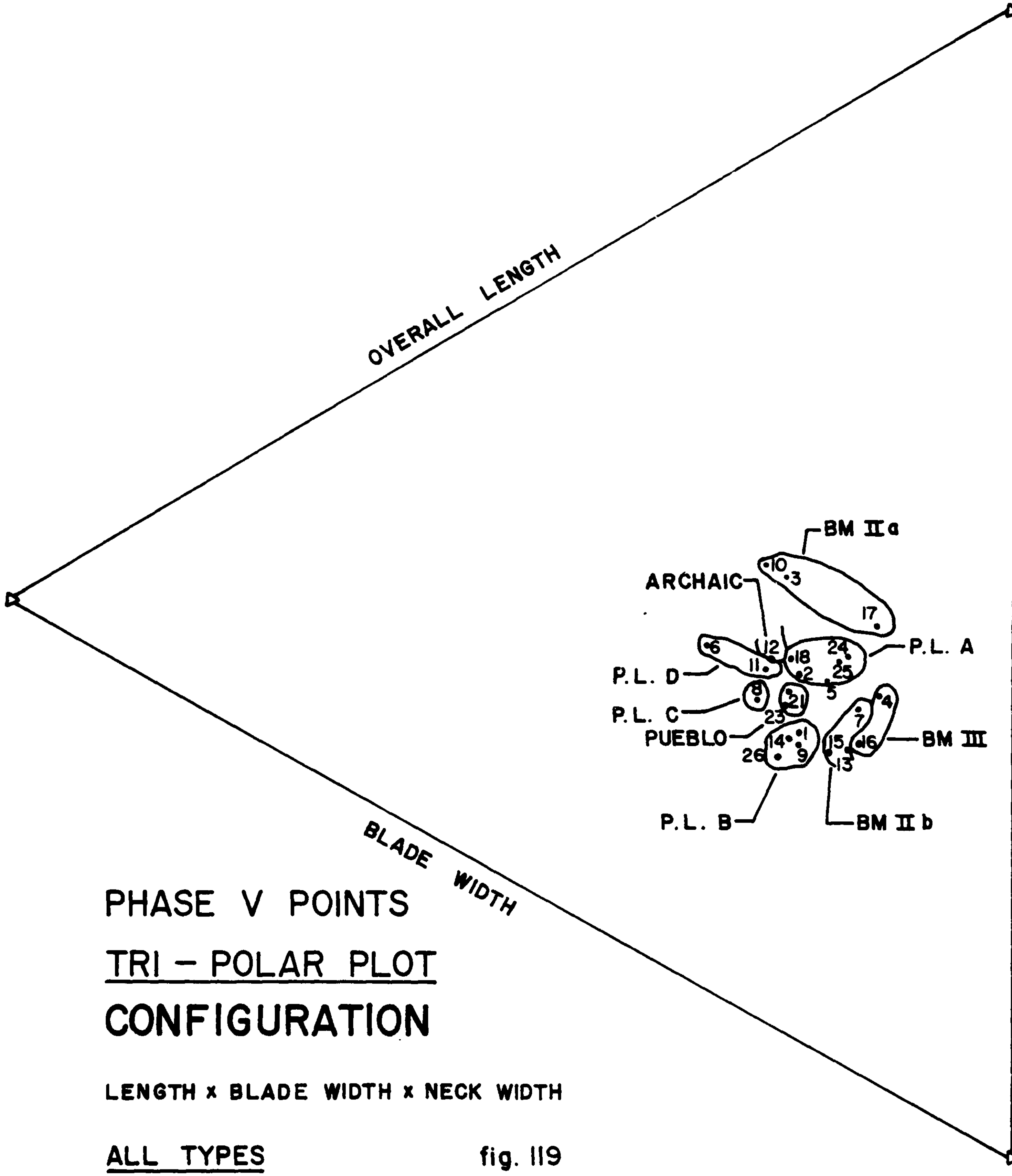


Figure 117: Projectile Points. a--Archaic; b-h--Basketmaker II; i-k--Basketmaker III, Pueblo I; l-m--Pueblo III-IV.

Figure 118: Piedra Lumbre Phase Projectile Points: Type A - a, b, c, d, e; Type B - f, g, h; Type C - i; Type D - j, k.



PHASE V POINTS

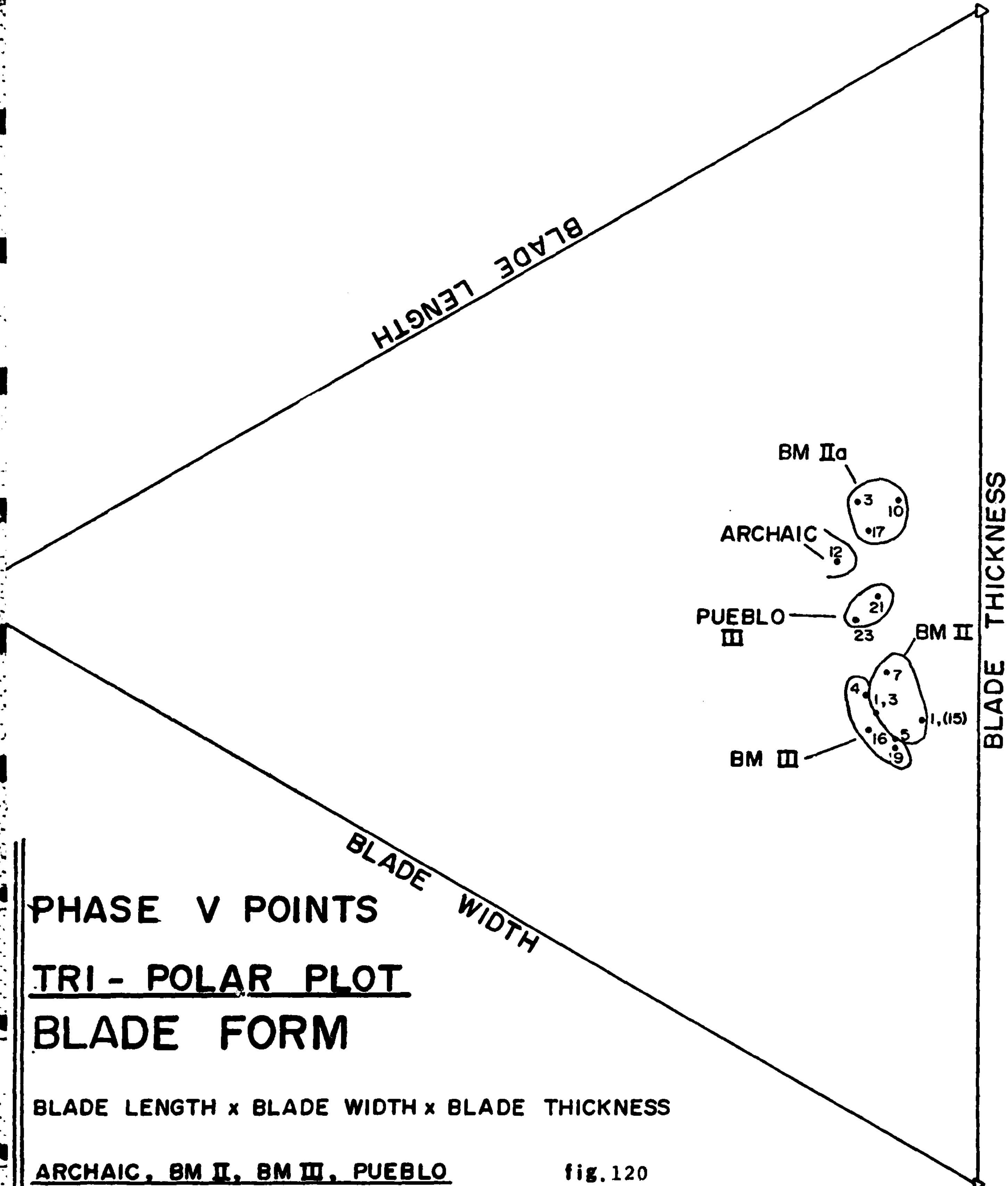
TRI - POLAR PLOT

CONFIGURATION

LENGTH x BLADE WIDTH x NECK WIDTH

ALL TYPES

fig. 119



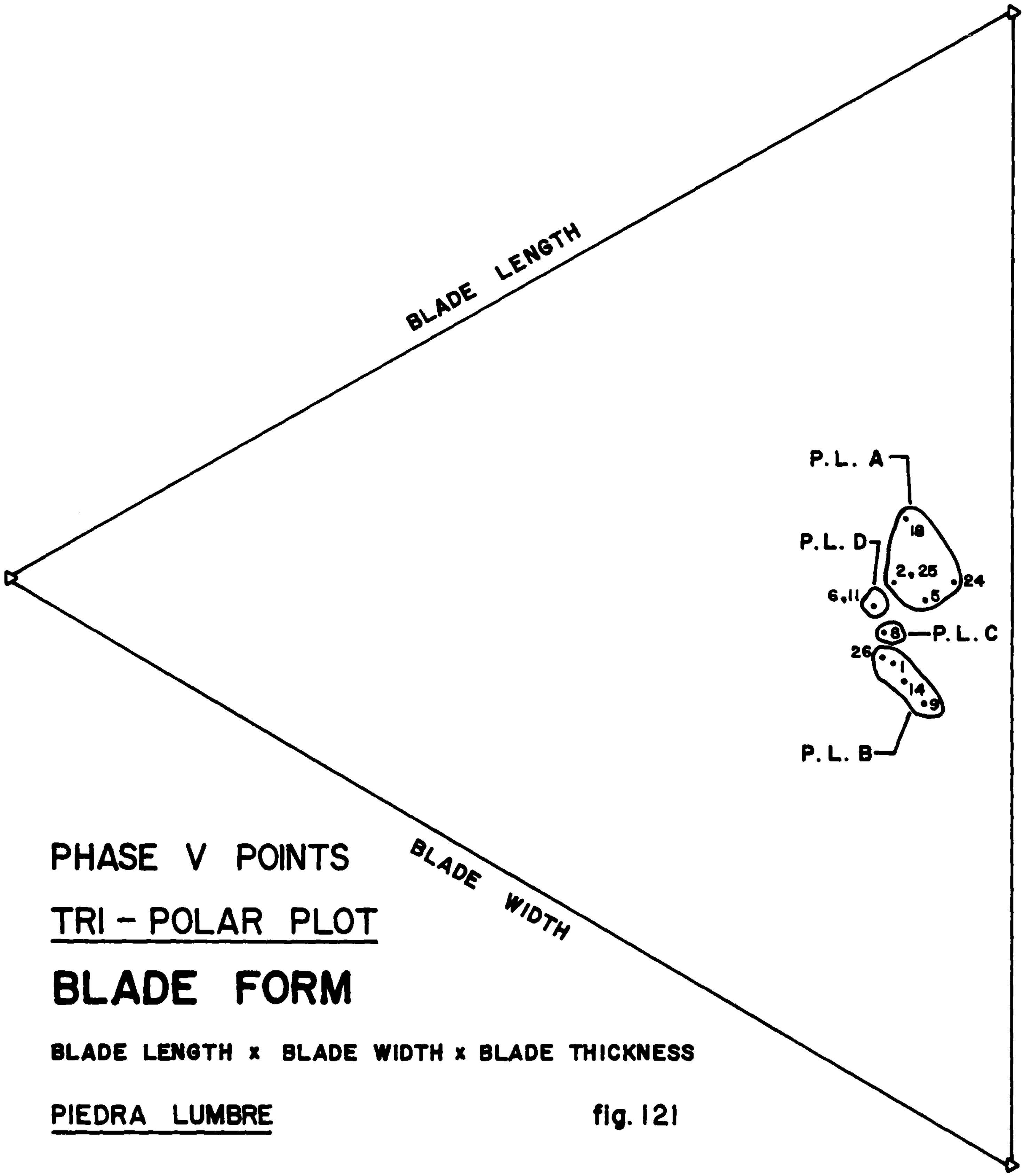
PHASE V POINTS

TRI - POLAR PLOT

BLADE FORM

BLADE LENGTH x BLADE WIDTH x BLADE THICKNESS

ARCHAIC, BM II, BM III, PUEBLO fig. 120



PHASE V POINTS

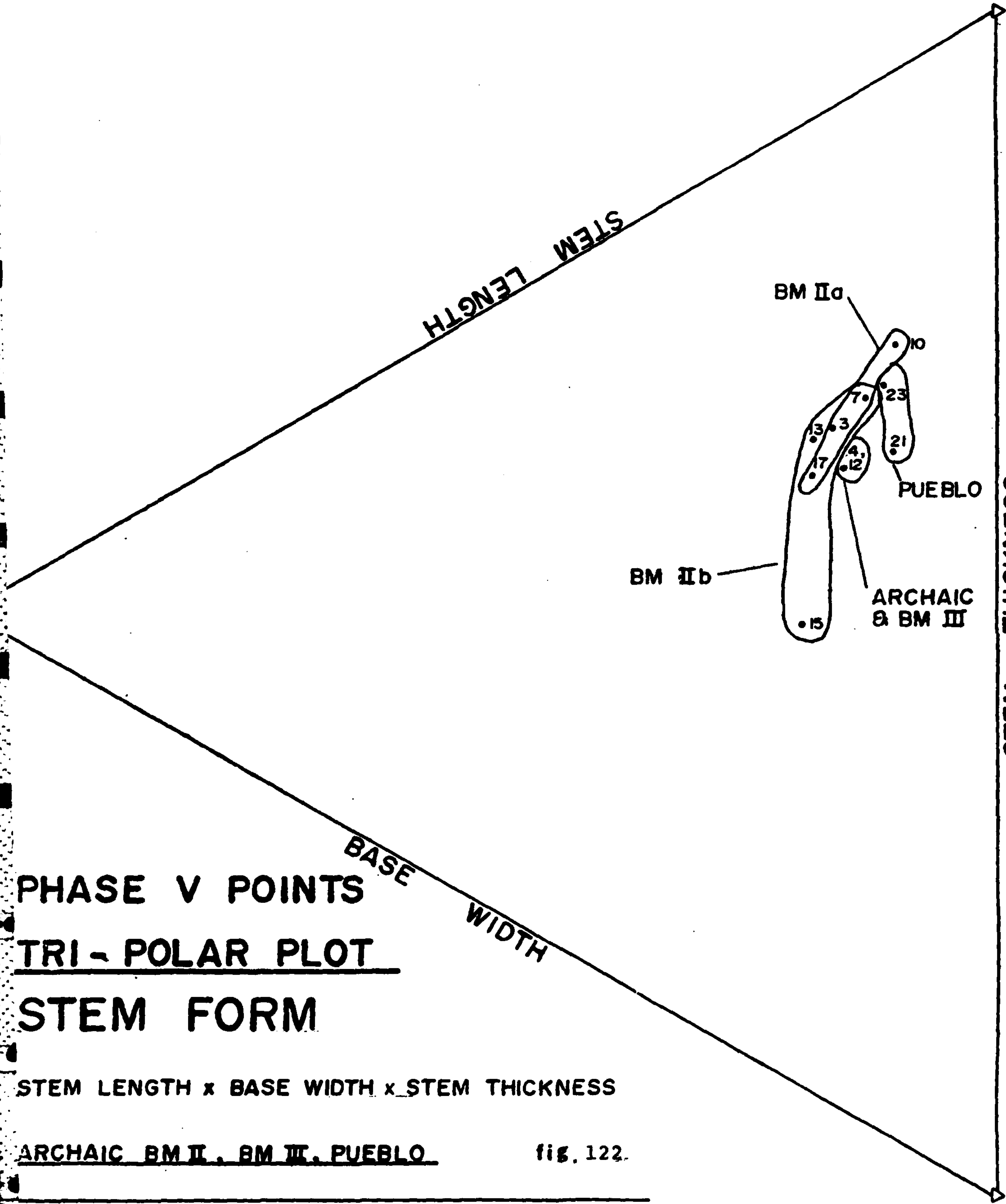
TRI - POLAR PLOT

BLADE FORM

BLADE LENGTH x BLADE WIDTH x BLADE THICKNESS

PIEDRA LUMBRE

fig. 121



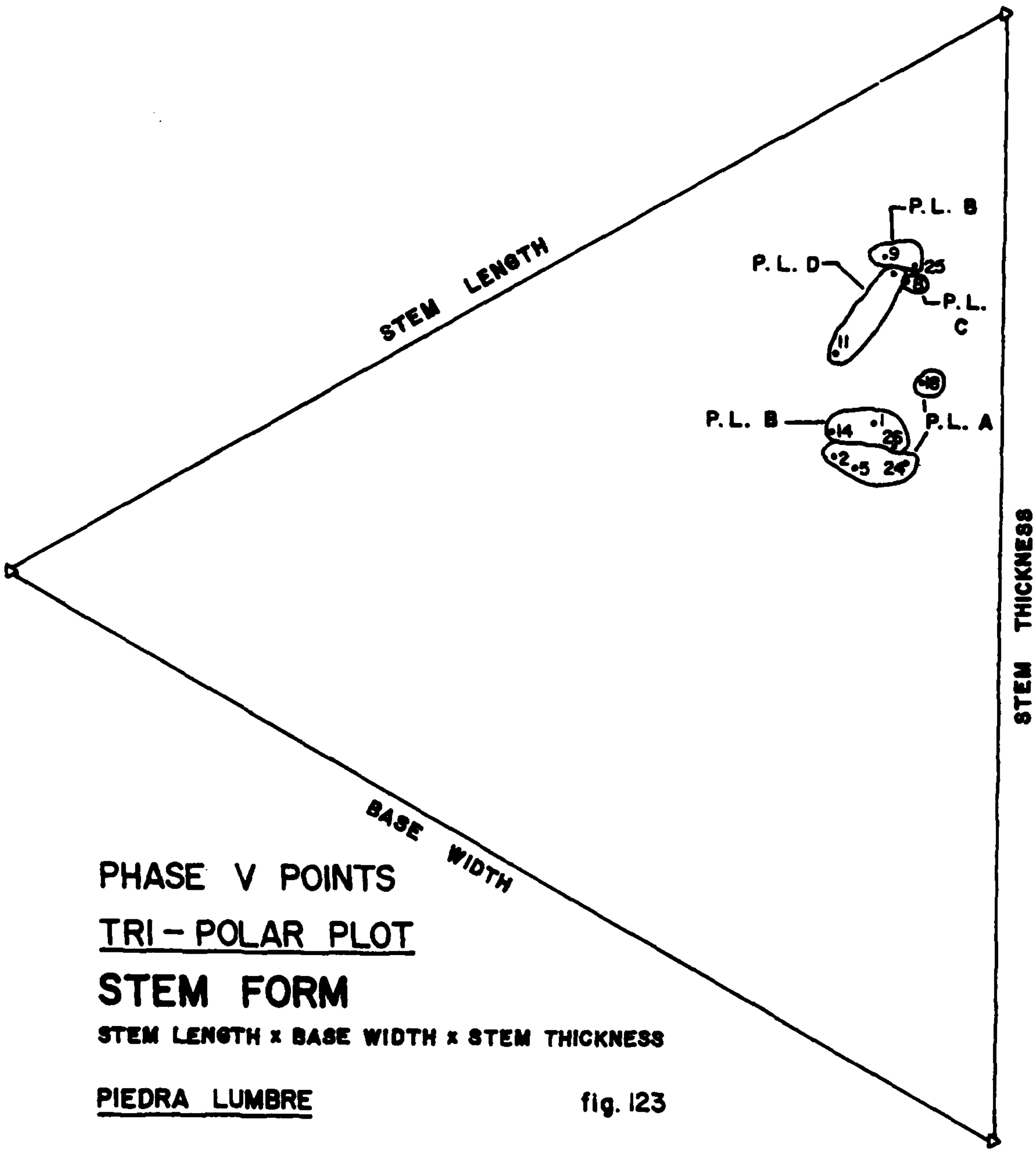
PHASE V POINTS

TRI - POLAR PLOT

STEM FORM

STEM LENGTH x BASE WIDTH x STEM THICKNESS

ARCHAIC, BM II, BM III, PUEBLO fig. 122



PHASE V POINTS

TRI-POLAR PLOT

STEM FORM

STEM LENGTH x BASE WIDTH x STEM THICKNESS

PIEDRA LUMBRE fig. 123

Historical Discussion of Point Types. It has previously been suggested (Schaafsma 1977:290) that the large broad-bladed, corner-notched Basketmaker II points described as Basketmaker IIa emerged historically out of the corner-notched Late Archaic types, such as the form termed AEM-15 by Irwin-Williams and Tompkins (1968:10). The consistent similarity of the Archaic point (undoubtedly some form of En Medio point) to the Basketmaker IIa points makes this continuity a reasonable suggestion. If so, the Basketmaker IIa point type may represent the earlier form of Basketmaker II point. There is equally good reason to suggest that the narrow-bladed type of Basketmaker II point (Basketmaker IIb) is in an ancestral position to the Basketmaker III-Pueblo I points. The consistent similarities of these point types on the plots is a good indication that they are closely related. The differences between them may relate to the shift from atlatl to bows and arrows that occurred about the time of the regional shift in these point types (Grant 1968:48-55). In this case, Basketmaker IIa type would be later than the Basketmaker IIb type and would probably date after A.D. 1. Given the widely documented, cultural continuity from Basketmaker III through Pueblo III and IV, it is apparent that the Pueblo points emerged historically from the earlier corner-notched types. Primarily, this evolution amounted to a change in the shape of the planform and a technological change to side-notching from corner-notching.

The Piedra Lumbre points may represent an historical discontinuity with the Pueblo tradition. In addition to the variability in shapes observable in this collection, the practice of basal-notching was not part of the Pueblo tradition in the early historic period (Kidder 1932).

METAL ARTIFACTS

Ten metal items were recovered from AR-4. These include a copper ring, an iron bolt, a musket ball, an iron plate, metal wire, 4 pieces of folded copper, and an iron projectile point.

Copper Ring. Under the fallen wall on the south side of structure BC (in grid CG-225, meter square 2) at a depth of about 5 centimeters was a copper ring (Fig. 124). Because structure BC was one of the latest structures built at AR-4 (see Feature B description), the presence of the ring under the fallen wall would indicate that it was lost in the last years of the site.

The ring is whole and only slightly out-of-round from wear. It is light-tan to copper-brown in color with a few greenish oxidation blemishes. It has not been metallurgically tested, but is made of copper or a copper alloy. When held sideways, the ring appears to have a slightly tapered shape. The exterior diameter is 20.0-20.7 millimeters, and the interior diameter is 12.5-13.0 millimeters. The width of the band is 5 millimeters and the band is 1 millimeter thick.

There is a distinct design. Six scored lines cross the band to form 6 open spaces. In 4 of the spaces, there are single v-notches cut into the band edge. These notches alternate on either side of the ring. In each of 2 adjacent spaces, there are 2 notches that appear on alternate sides in each space. Across 1 scored line, there are scratches apparently due to wear.

While little is known of Southwestern Indian jewelry in the late seventeenth and early eighteenth centuries, Wesley Jernigan, who has examined the ring, says the ring design is consistent with design motifs employed on early Southwestern jewelry, especially bone rings. His opinion, together with the simple design and incising, suggests that the ring was made by Indians rather than the Spanish.

Iron Projectile Point. On the upper floor of reoccupied structure BD was an iron projectile point. It has an elongated triangular blade and a narrow tapering base (Fig. 125E). The point is 62.5 millimeters long, and the blade is 19.8 millimeters wide while the base width is 6.9 millimeters. It is 3.1 millimeters thick. There are no discernible barbs along the base as were present on the copper point from AR-513 (Schaafsma 1976) (Fig. 125A). The overall shape, however, is similar to the latter point. It is heavily rusted and definitely iron.

Metal Bolt. A very rusted iron bolt was found in the midden fill outside the west side of Feature D (grid G-108). The context indicates that the bolt dates from the occupation of the structure, but the ca. 1760 dendro date of the fill outside the northwest side of this structure indicates the possibility of later materials being present (i.e., mid-eighteenth century).

The bolt appears to be hand-forged. The head is square and slightly off-center. The remaining threads are confined to an area 9 millimeters long on the end, and there may have been only threads on the end. The threads are 2.2 millimeters wide from valley to valley. It is 67.1 millimeter long, and the threaded end is 7.3 millimeters in diameter. The head is 9.1 millimeter across and 8.1 millimeter high. Pending identification by someone familiar with such bolts, the function is left undetermined (Fig. 125C).

Metal Plate. A rectangular metal plate was found on the surface of the midden south of Feature D (grid H-110). The context suggests that it may well be intrusive. It is made of iron and is very rusty. The plate is 58.6 millimeters long, 15.3 millimeters wide (maximum width), and 2.9 millimeters thick. Use is unknown and association with the site occupation is questionable.

Metal Wire. Under the upper floor, in level 3 of structure BD, was a small section of folded, metal wire. One end is a curved hook and the other is a sharply turned hook. It is 34.3 millimeters long. The wire is 1.6 millimeters in diameter. The size and shape of the wire is similar to those of some modern wire earring findings. This connection could mean that the wire is an even older piece of jewelry than the copper ring from the same area, which, by context, is definitely later.

Pieces of Copper Sheet. There are 4 pieces of sheet copper which are all associated by context with the site occupation. They are from Features B, D, and P. One piece of green, folded copper sheet came from under the floor of Feature D in the floor preparation fill. This piece is 29.0 millimeters long, 11.5 millimeters wide, and 2.8 millimeters thick. It is possible that it was crudely folded into this shape for use as an ornament. A second piece of folded copper sheet was in the midden fill outside the west side of Feature D. It is 24.8 millimeters long, 15 millimeters wide, and 1.1 millimeters thick. It, too, may be an ornament, perhaps a tinkler used to fringe clothing. A very thin sheet of copper was in the fill outside the entrance to Feature P. This irregular piece is 41.7 millimeters long, 22 millimeters wide, and 0.3 millimeters thick. The use of these copper items is not clear, but it seems likely that they were used as ornaments, or as raw material for making ornaments (Fig. 125B).

Musket Ball. A single lead musket ball was found on the floor of Feature E (Fig. 125D). The musket ball was at the same level and 30 millimeters distant from a gunflint in the same structure. That the musket ball was made in a two-part mold can be seen by the mold case that encircles it. It is 12.2 millimeters in diameter. The color is a light greenish-gray.

Gunflints. Three gunflints have been found in the Piedra Lumbre Phase sites at Abiquiu Reservoir. One is the above-mentioned gunflint on the floor of Feature E, associated with the musket ball, and 2 are from the second layer of Structure C at AR-513 (Schaafsma 1976: 182-3; Table 19). The latter 2 gunflints are from the same layer in the same structure that yielded a copper projectile point and alpha-recoil track dated pottery of ca. 1660 (Wolfman and Rolniak 1978).

The gunflint from Feature E is 23.8 millimeters x 22.2 millimeters x 11.1 millimeters. It is basically pillow-shaped with the edges equally beveled. The wear pattern would be described as code E: heavy bifacial attrition. This wear pattern indicates that there are pronounced step-fractures extending back from both sides of the used edge. The gunflint was used on all 4 sides. This kind of wear could obviously be produced on a gunflint from striking the "battery" to make the spark. It is made from a yellowish, clear-white chert that resembles pedernal chert. The general color range, however, is different from pedernal chert, and the item may well have been imported.

The 2 gunflints from structure C at AR-513 are of a similar size and shape. One is 26 millimeters x 15 millimeters x 6 millimeters and the other is 19 millimeters x 11 millimeters x 5 millimeters. They, too, are pillow-shaped with the edges equally beveled to the perimeter edge. There is no prepared upper face or "plateau" (Blanchette 1975:Fig. 7). Both are nearly square in outline. The wear pattern on them is characterized also by step-fractures extending away from the utilized edges and would be coded as E: heavy bifacial attrition. In the Phase III report, the origin of these items as gunflints was unsuspected, and they were regarded as specialized, small-mounted, heavy knife tools (Schaafsma 1976:183) based on the heavy wear pattern and their small size. In that report, it was emphasized that nothing like these items had appeared in the analysis of over 12,000 artifacts from the nearby Archaic base camps of AR-5 and AR-6 (Schaafsma 1976:185). To this opinion, it now should be added that the analysis of an additional 22,000 artifacts, mostly from other large Archaic base camps such as AR-12, AR-23, etc. (Schaafsma 1977), also failed to yield anything similar to these very distinctive lithic items. That is, the analysis of over 34,000 lithics, primarily from Archaic base camps, failed to yield objects like these items, but the analysis of only a fraction of this number of lithics from the interior of the Piedra Lumbre Phase structures produced 3 of them.

The identification of these items as gunflints is based on their formal similarity to the gunflints that are commonly found on sites in the eastern United States (Witthoft, 1966:, Blanchette 1975, Hanson 1970). They are in the correct size range and have the same shape and the same kind of heavy wear around the perimeters. Furthermore, they would appear to be of the general type called either Nordic or Aboriginal (Blanchette 1975:46; Witthoft 1966:24). Gunflints of these types are pillow-shaped with the edges beveled symmetrically. They tend to be small and square or rectangular in shape. The main difference between the Nordic and Aboriginal types is the material, which indicates local versus European origin, and the fine flint knapping on the Indian-made gunflints. The Nordic and Aboriginal types were present between 1620 and 1680 (Blanchette 1975; Fig. 1). The presence of a prepared plateau and/or a bevel shape on later Dutch, French, and English gunflints (1975:46-49) demonstrates that these gunflints are not of the later types. While it should be possible to prove through trace element analysis the geological provenience of these pieces of chert, it seems likely that they were made locally. On the other hand, the material is suspiciously unlike the color range of pedernal chert.

If there were muskets present, as indicated by the musket

Figure 124: Copper Ring.

Figure 125: Metal Objects a-e.
a) Copper point from AR-513; b) Copper sheet; c) Iron bolt; d) Lead musketball; e) Iron projectile point.

ball, there also should have been gunflints present to produce the spark that ignited the powder for the explosion that propelled the musket balls. As described by Blanchette (1975:44), these items are part of an integrated system and cannot be used in isolation.

Possible Iron Concretion Musket Balls. Round iron concretions have been a common occurrence in all of the Piedra Lumbre Phase sites excavated so far. They were found in both Features L and M (AR-4) as well as in AR-513 excavated in 1975 (Schaafsma 1976). In the present excavations, there were 63 of these items found. They are naturally occurring iron concretions that have commonly been ground and smoothed to a round shape. Forty-six of these items from the present excavation have been rounded in this way, whereas the remaining 17 are generally round but have rough areas. The average diameter of the 46 rounded concretions is 11.98 millimeters. The range is 7-26 millimeters. The average weight of these 46 rounded concretions is 3.31 grams; range is .5 to 26.4 grams. The majority of these concretions (33) came from Feature D, but they also were found in Feature P (9), Feature Q (10), Feature B (7), and the general surface near the features (4).

In an earlier report (1976), these items were regarded as completely enigmatic. After finding the lead musket ball and the gunflints, it now appears reasonable to suggest that these are replacement musket balls, used by a people who were far from the sources of supply for lead musket balls. In size, they are within the range indicated by the musket ball. In weight, they are light but would have probably served the purpose.

It is clear from the lack of these round concretions on the natural ground near the site and their absence from the large Archaic base camps (especially AR-5 and AR-6, which are below AR-4) that these items were obtained somewhere else and purposefully brought to the site.

OTHER ARTIFACTS

Slag. The presence of several pieces of glassy slag in the fill around Feature Q is hard to explain. These fragments range from 5 to 25 millimeters in length and have greenish, glassy surfaces with many pits. The under-surfaces have sand and dirt in the glass. There is a good possibility that they are "fulgerites" or natural glass formed when lightning strikes a sandy surface. If so, they may have no relationship to the site occupation. On the other hand, their concentration in Feature Q could represent collecting by the occupants, in which case they would be items that were brought into this dwelling area.

Smoothed Wooden Slab. Two pieces of juniper wood were found on the floor of Feature J (meter square 6 of grid AL-56), which were part of the same wooden implement. Both are heavily eroded and grooved by insect galleries. One of them has a definite smoothed surface which, in cross-section, makes a wide arc. This smoothed surface truncates the trend of the natural wood grain, making it discernible even though the wood is heavily eroded. The surface has definitely been smoothed and shaped. The longest remaining piece is 18.7 centimeters long. The original tool was longer than this. The maximum width of the 2 combined fragments is about 5.5 centimeters. The original was somewhat wider. The maximum remaining width is 1.5 centimeters. Smoothed wooden slabs such as this could have been used for many different purposes. It is possible, however, that this is a weaving batten. The presence of sheep and goat bones at AR-4 also makes this a reasonable suggestion.

VI. ENVIRONMENTAL STUDIES

POLLEN ANALYSIS

Pollen samples were taken routinely from all loci and discrete layers for which they could be potentially useful. A series of 24 of these samples were selected for analysis because they possibly could assist in discerning functional variability and potential variation in the pollen record over the life of the site. These samples were analyzed by Dr. James Schoenwetter, whose report is included as Appendix B. As the report indicates, it was not possible to deal with all 24 samples submitted. The 12 in the final discussion represent the ones that are potentially the most informative on functional variability within the features. The others, as well as many not submitted, could potentially shed light on the question of pollen variation over the life of the village, which now seems to be longer than thought when the samples were submitted.

The raw pollen data submitted by Schoenwetter are presented as Figure 126. These data should be considered in the context of Schoenwetter's report. As the report indicates, there is evidence for processing wild foods inside the dwellings and palynological evidence for the cultivation of corn (one pollen grain). This limited amount of palynological evidence for agriculture correlates with the near nonexistence of evidence for agriculture provided by ground stone, flotation analysis, and other evidence. It should be observed that the high frequency of chenopods (98 percent) in Feature L (Fig 126) is from animal manure.

SOIL CHEMISTRY

Twenty-eight soil samples were submitted to Alf Sjoberg of the University of Missouri for analysis. Twenty-five of these were part of the present project, and 3 were analyzed as part of the National Park Service study of inundation effects. The results of Sjoberg's analysis are presented as Appendix C. The purpose of this work was to determine if chemical analysis of soil samples could aid in the functional interpretation of the features. It was especially necessary to determine if the apparent animal manure deposits were actually that. Additionally, soil chemical verification of long-term habitation of the dwellings was needed.

Of considerable interest in the evaluation of Sjoberg's study is the conclusion that Features L and K definitely were used as animal pens. In the case of Feature L, this was fairly clear beforehand, whereas in the case of Feature K it was not certain that the material identified in the field was actually animal manure. Sjoberg's suggestion that structure BC (sample 13) was a corral is consistent with the architecture. The determination that the samples from Feature G are not manure is not contrary to the field identification that manure was present as the samples were not of the manure layer in structure

G3. The soil chemical analysis of Feature J helps confirm the function of this structure as a dwelling. The same is true of Feature A, where the analysis also indicates a dwelling function. The sustained occupation of Feature D is well affirmed. The limited chemical buildup in Feature C is consistent with the other evidence that this structure was little occupied. Similarly, the limited chemical buildup at Feature E is consistent with other evidence that this structure was not long occupied.

FLOTATION

All flotation samples collected from AR-4 were processed by Louanne Jacobsen with cooperation from the Chaco Center on the University of New Mexico campus. The author examined portions of both the light and heavy float in an effort to locate corn kernels, beans and other possible domesticates. Although the above mentioned plants were not indicated by flotation results, processing and use of various wild plant foods was indicated by various hulls, husks and seeds. Identification of these items by species and probable economic value was not pursued. Primary interests had been focused on cultigens; their absence combined with additional expenses accruing from establishing chronological control over the site dictated suspension of flotation studies at this stage.

FAUNAL REMAINS

Large numbers of bones were obtained from the present excavations. Those found in 1975 in Features L and site AR-513 were previously analyzed by Dennis Van Horn in conjunction with that analysis (Schaafsma 1976). His results are summarized here. The funds available for outside analyses were not utilized for a faunal study inasmuch as the author believes Van Horn's earlier study is an adequate, initial analysis of a sample of bones from AR-4.

As previously discussed (Schaafsma 1976), Van Horn's study shows the presence of domestic sheep and goat bones in the fill of Feature L. Only goats (Capra sp.) were present in AR-513. The bones of wild animals such as deer, turkey, antelope, and rabbits were also present. Thus, while the Piedra Lumbre Phase people were raising stock, they were also dependent on hunting wild game. The bones of the present excavations also appear to include domestic sheep and goats as well as the same kinds of wild animals found previously.

PROVENIENCE OF AR-4 Pollen Samples Figure 126

FILL

Feat. G1 #9

Cheno	47
Pinus	41
AP	45
Compos	0
Lili	2

Feat. G3 #3

Cheno	55
Pinus	31
AP	31
Compos	9

Feat. I #5

Cheno	9
Pinus	75
AP	79
Compos	8
Lili	1

Feat. L #7
(Manure)

Cheno	98
Pinus	2
AP	2
Compos	0

HEARTH

Feat. D #14
(Ext.)

Cheno	27
Pinus	52
AP	60
Compos	0

Feat. E #19
(Floor, Int.)

Cheno	31
Pinus	57
AP	64
Compos	0
Lili	1

MIDDEN

Feat. D #13
(Near Struct)

Cheno	25
Pinus	54
AP	63
Compos	10
Junip	5
Quercus	4

Feat. D #11
(separate)

Cheno	20
Pinus	48
AP	67
Compos	0
Quercus	12

Feat. E. #12

Cheno	26
Pinus	63
AP	70
Compos	4
Junip	3
Quercus	3

FLOOR

Feat. BD #18

Cheno	33
Pinus	52
AP	60
Compos	4

Feat. C #17

Cheno	60
Pinus	33
AP	33
Compos	0
Platy	1

Feat. D #15

Cheno	47
Pinus	28
AP	34
Compos	16
Zea	1
Lili	1

VII. CHRONOLOGY

The evaluation of AR-4 in terms of known ethnic groups is heavily dependent upon proper dating. As discussed earlier, the 1887vv tree-ring date obtained in 1975 was at odds with the indications of other dating evidence. The chronological relationships of AR-4 have been determined in several different ways. As discussed below, none of the independent methods yielded dates without ambiguities. The final assessment of the age of the site is based upon the concurrence of the various methods, as well as a summary of other evidence.

Independent chronometric techniques used included dendrochronology, carbon-14, and alpha-recoil tracks; also in this category is obsidian hydration. An archaeomagnetic sample was collected, but not processed. Other chronological evidence comes from ceramic cross-dating, the general pattern of artifact presences and absences, and the likely time when sheep and goat husbandry could have been present.

Dendrochronology. Approximately 30 dendro specimens were collected in the excavations and sent to the Laboratory of Tree-Ring Research at the University of Arizona. Because of our interest in obtaining dates for the site, every possible piece of potentially datable wood was collected. Most of this material was from either cooking fires or small construction material. A few specimens were logs (as in Feature P) that had been set in the ground. No construction logs or beams were recovered in adequate condition to serve as tree-ring specimens. It proved possible to only date 4 of these specimens, and all of these came from Feature D. Three specimens were collected together from the level of fallen and rotted wall outside the northwest side of Feature D. They were from approximately 10 centimeters to 19 centimeters below the surface. All 3 pieces received the same field specimen number (187). The dates on these specimens are: 1585+ - 1668vv; 1580 - 1669vv; and 1612-1709vv. All 3 of these dates are noted as "vv" indicating that there is no way of estimating how far the last ring is from the true outside.

The fourth dendro specimen (Field Specimen No. 185) came from very close to the other 3, outside the northwest wall of Feature D. As discussed in the description of that feature (see Figure 32), this specimen is a large, rotted log from a higher level than the other 3 (7 centimeters - 10 centimeters below the surface). It was laying on the rotted wall material of the next layer, and apparently was deposited after the wall had collapsed. It may be indicative of a later reuse of the structure. The date of this specimen is 1575 - 1760vv.

Carbon-14. It was assumed initially that in the indicated maximum time range (younger than A.D. 1600) carbon-14 would not be a reliable method. Because of this factor, provisions for processing several samples were not made at the beginning of allocating funds for outside analysis. It now appears that additional samples would have been desirable.

Objections to the reliability of carbon-14 in the post-1600 time period have been discussed by Damon et al.:

> The release of significant quantities of radiocarbon-free CO^2 from the combustion of fossil fuels subsequent to the Industrial Revolution (Suess effect) has resulted in recent samples having falsely old radiocarbon dates. Radiocarbon dates less than 350 years old are ambiguous because of this effect (1974:351) . . . This ambiguity results in a sudden inversion of radiocarbon dates during the twentieth century with the radiocarbon dates becoming progressively older as fossil fuel combustion dilutes the radiocarbon content of the atmosphere with stable carbon isotopes. It is therefore doubtful that single radiocarbon dates alone can produce meaningful age relationships for materials younger than 350 years (B.P.) (1974:365).

Late in the process of allocating funds for outside analyses, however, Irene Stehli, Director of the Dicarb Radioisotope Company of Chagrin Falls, Ohio, informed us that in the period of 250 to 300 years B.P. radiocarbon dates should be reliable for this unindustrialized area. In an effort to utilize this potentially very useful dating method, funds were allocated to process a single sample. The sample was processed by Dicarb. The sample is charcoal from the midden over the hearth beside the door of Feature D (grid F-109). This charcoal was dated at A.D. 1660± 50 years.

Alpha Track. Alpha track dating is based on the fact that alpha particles and recoiling nuclei during the alpha decay of uranium-238, uranium 235, thorium-232, and the alpha emitters in the decay chains damage mica to form tracks. Alpha and alpha-recoil tracks in muscovite mica, a common constituent of pottery clay, are erased by annealing at about 650-700 degrees C., which is below the firing temperature of most ceramic materials (Wolfman 1977). After firing, the formation of tracks continues. The age of the sherd is directly proportional to the density of tracks and inversely proportional to uranium and thorium concentrations in the mica of a sherd. The method, still in an experimental stage, is presently being funded by a National Science Foundation Grant under the direction of Daniel Wolfman.

Micaceous sherds from AR-4, AR-3, and AR-513 were submitted to Wolfman for possible dating by this method. Laboratory capacities and the suitability of the various sherds, allowed only the dating of a sherd from AR-513. While this sherd is not from AR-4, site AR-513 is clearly part of the Piedra Lumbre Phase and the date is applicable in the overall attempt to date AR-4. The date (determined with the uranium but not the thorium concentration) of the AR-513 sherd was centered on 1660 (Wolfman and Rolniak 1978a: Fig. 1). The range of error has not yet been determined, but present indications are that it is probably not very large (Wolfman and Rolniak 1978b).

<u>Archaeomagnetism</u>: "Archaeomagnetic dating, which is based on the facts that the direction of the geomagnetic field is changing and that clay or dirt when fired becomes magnetized in the direction of the magnetic field in which it cools, can provide precise and accurate dates" (Wolfman 1977:1). In an effort to obtain an archaeomagnetic date for AR-4, a sample was collected from the hearth on the western floor of Feature D (Fig. 25). Other hearths were available to sample, however the hearth in Feature D provided the best geologic substrate for sampling. Volume of material available for sampling played the deciding role in the selection. The sample was collected with equipment loaned by Dr. W. James Judge and the National Park Service, Chaco Center.

While processing an archaeomagnetic sample from AR-9, presumably a nineteenth century Ute camp (Schaafsma 1977), Wolfman determined that the path of the virtual geomagnetic pole (polar curve) for the Southwest after A.D. 1500 was either unknown (between 1500 and 1839) or the rate of change of the virtual geomagnetic pole was very slow (1839-1975) (Wolfman 1977:3). Either condition precluded obtaining an accurate date for a sample estimated to date after A.D. 1600. Accordingly, the sample obtained from Feature D was not processed. The sample and relevant data, however, are on storage.

<u>Summary of Independent Dating Methods</u>. Dates have been derived by 3 primary independent methods: dendrochronology, carbon-14, and alpha-recoil track. The ambiguities discussed indicate that none of them can be relied upon in isolation. The tree-ring specimens all lack an undetermined number of exterior rings. Furthermore, all 3 specimens (F.S. No. 187) from the wall fall of Feature D are small pieces that could have been cooking fires or small construction pieces. Any of these could have been dead for some time before they were used (in fires, etc.). The 1760vv specimen (F.S. No. 185) was above the fallen wall, and therefore does not date the occupation, but must represent some reuse after the wall had collapsed. The single carbon-14 date is rendered suspicious because of the Suess effect (Samon et al. 1974). However, the influence of this effect in the American Southwest ca. 1660 should be made more explicit. As noted, Stehli is of the opinion that dates from this period would be valid. The alpha-recoil track date from AR-513 suffers from the problem that the method is still in an experimental stage. Nevertheless, present indications are that the method is reliable, and, so far, nothing has appeared which would invalidate the ca. 1660 date.

While objections to all of these dates can be raised, and should be examined in greater detail, the agreement of 3 independent dating methods is, nevertheless, remarkable. With the exception of the one 1709vv date from Feature D, they all indicate dates very close to 1660. This concurrence of 3 completely independent methods is taken as evidence that all

3 are essentially accurate. While coincidence is possible, it seems extremely unlikely that the complex being dated could date much beyond the range of error for the carbon-14 sample (i.e. ± 50 years) and still produce this kind of agreement between methods. A date range of ca. 1660-1710 is therefore offered as having been provided by the independent dating methods.

Obsidian Hydration. The obsidian hydration dating method was introduced nearly 2 decades ago (Friedman and Smith 1960). "However, a number of the original researchers have apparently abandoned it as being too imprecise, not consistent with other chronometric data, etc." (Ericson 1974:7). In addition to the problems noted by Ericson, "the occurrence of anomalies in hydration results has generally been explained in terms external to hydration rates, such as re-use, stratigraphic mixing, fire-burning, etc., rather than examining the technique itself" (1974:7). Nevertheless, recent research by Ericson (1974, and Meighan (Meighan et al. 1974), "has indicated that the reliability of the technique may soon be improved" (Ericson 1974: 7). "Some of the difficulties have arisen from an underlying assumption of the technique that within a geographic region, all obsidian from all obsidian sources hydrates at the same rate" (1974:7). An example of this is provided by the 260-year-per-micron rate proposed by Meighan and others in 1968 for West Mexican obsidian (Meighan et al. 1968). "Examination of this assumption has shown that among several time-controlled artifact groups, the variation in hydration measurements is correlated to different obsidian sources represented in each obsidian group" (Ericson 1974:7). The result of this research is that universal or regional hydration rates are not reliable and a unique hydration rate must be impirically determined for each obsidian source (1974; Findlow et al. 1975; Findlow 1977). As Foote observed: "It is now recognized that there is greater compositional variation in obsidian materials from different geological sources than was initially suspected by hydration workers, and that even subtle chemical differences can significantly affect the rates at which hydration development occurs" (1974:102). Ericson emphasizes that chemical characterization should be utilized to match obsidian artifacts to their sources "prior to the calculation of the obsidian hydration date" (1974: 8). This method is well illustrated in the study by Findlow et al. (1975).

In addition to the recently established need to determine the hydration rate for each obsidian source, the influence of temperature (Friedman and Smith 1960; Foote 1974:102), context, with its possible influence on temperature (Foote 1974:102), erosion (Friedman and Smith 1960:486), and reuse (Hacker 1977:111) must be considered.

The writer has been involved for the past year in an effort to derive the hydration rate for Polvadera Peak obsidian. This project was initiated in cooperation with Daniel Lenihan and the inter-agency, National Park Service study of inundation effects. The basic analytic tasks are being done by the UCLA Obsidian Hydration Laboratory under the direction of Clement Meighan. As part of this project, 29 obsidian samples from AR-4 were submitted to UCLA, with the hydration readings made by P. I. Vanderhoeven (Fig. 127). These samples were selected to accomplish 2 analytic tasks: 1) provide a data point for the hydration rate of Polvadera Peak obsidian once the proveniences (structures, etc.) from which they come have been satisfactorily dated by other means, and 2) test for the possible existence of several components among the lithic areas within the site area. The possible existence of earlier components is suggested by the presence of Archaic and Basketmaker II projectile points, as was discussed above.

The specimens listed in Figure 127 were selected to provide 5 proveniences directly associated with the structures (the control proveniences) and 5 lithic areas where earlier components were suspected. It was essential to know the temporal relationship of the surface lithics to the Piedra Lumbre Phase occupation. The various proveniences are separated from each other by partial horizontal lines in Figure 127. With one exception (structure BD), there are 3 pieces from each provenience. In the following discussion, all reference to individual obsidian pieces will be by the OHL (Obsidian Hydration Laboratory) number shown in Figure 127. The control proveniences are: Feature D, interior fill (5610, 5611, 5612); Feature P, fill around the fallen wall in grid AF-168, meter square 6 (5613, 5614, 5615); Feature B, structure BD, interior fill (levels 2 and 3) (5616, 5617); Feature G3, rockshelter, levels 2 and 5 (5618, 5619, 5620); and Feature A, surface immediately outside the northeast wall in grid CO-169, meter square 6 (5624, 5625, 5626). The remaining pieces are from lithic areas.

Following the procedure discussed by Ericson (1974) and Findlow (Findlow et al. 1975: 1977), the obsidian to be used for both analytic tasks must be from the same geologic source--in this case, the Polvadera Peak source. This can only be accomplished with confidence through the application of chemical characterization or an equivalent technique. It is understood that this will be eventually done, especially for the obsidian to be used in deriving the hydration rate (i.e. used as control points). At this time, however, this has not been done. Nevertheless, Polvadera Peak obsidian is macroscopically one of the most distinctive types in the Southwest. The smokey-gray, translucent character contrasts strongly with the often clear, partly transparent obsidian found on the southern and eastern slopes of the Jemez Mountains. It is probable that macroscopic identifications would be accurate at least 90 percent of the time. All of the obsidian submitted to UCLA and summarized in Figure 127 is macroscopically the Polvadera Peak type.

The test for possible multiple components was to be accomplished before the hydration rate was determined. This required

FIGURE 127

OBSIDIAN HYDRATION READINGS: BASIC PROVENIENCE DATA

OHL NO.	HYDRATION	PROVENIENCE	SAMPLE FIELD NO.
5607	2.1	Surface, south of Feature A	CN-188/0/78
5608	2.6	Surface, south of Feature A	CP-183/0/102 (A)
5609	2.3	Surface, south of Feature A	CP-183/0/102 (B)
5610	2.7	Interior fill, Feature D	F-108^{7}/1/201 (A)
5611	2.8	Interior fill, Feature D	F-108^{7}/1/201 (B)
5612	NHV	Interior fill, Feature D	F-108^{7}/1/201 (C)
5613	2.7	Fill around wall, Feature P	AF-168^{6}/1/406 (A)
5614	2.6	Fill around wall, Feature P	AF-168^{6}/1/406 (B)
5615	4.2/4.9	Fill around wall, Feature P	AD-168^{6}/1/406 (C)
5616	3.3	Interior fill, level 3, Feature B, Structure BD	CI-223^{6}/3/79
5617	3.2	Interior fill, level 2, Feature B, Structure BD	CI-223^{6}/2/65
5618	2.2/2.7	Feature G3, level 2	AN-58^{5}/2/249
5619	3.2*	Feature G3, level 2	AN-58^{7}/2/284
5620	2.6/2.8	Feature G3, level 5	AN-58^{8}/5/307
5621	2.2/3.6	Feature E, midden, surface	AM-70/0/190
5622	3.1	Feature E, midden, level 1	AN-71^{7}/1/200
5623	2.8/3.3	Feature E, midden, surface	AO-73/0/193
5624	2.7/2.8	Feature A, surface near wall	CO-169^{6}/0/185 (A)
5625	2.5	Feature A, surface near wall	CO-169^{6}/0/185 (B)
5626	2.6	Feature A, surface near wall	CO-169^{6}/0/185 (C)

FIGURE 127 (Cont'd.)

OHL NO.	HYDRATION	PROVENIENCE	SAMPLE FIELD NO.
5627	3.3	Surface, east of Feature E	J-74/0/415 (A)
5628	NHV	Surface, east of Feature E	J-74/0/415 (B)
5629	NHV	Surface, east of Feature E	J-74/0/415 (C)
5630	2.6	Surface, northwest of Feature D	Y-97/0/434 (A)
5631	2.8	Surface, northwest of Feature D	Y-97/0/434 (B)
5632	3.0/3.8	Surface, northwest of Feature D	Y-97/0/434 (C)
5633	3.2	Surface, south of Feature A	CM-180/0/52
5634	3.1*	Surface, south of Feature A	CN-180/0/66
5635	2.3*	Surface, south of Feature A	CO-184/0/87

NHV = Indicates that no hydration was visible after slides were twice prepared.

* = "unclear" in original laboratory notes.

4.2/4.9 = Two hydration bands on the same specimen.

Readings made by P. I. Vanderhoeven of the Obsidian Hydration Laboratory, UCLA. Project directed by Dr. Clement W. Meighan.

several assumptions. It is assumed that the obsidian from the 5 control proveniences will be contemporaneous (excluding reuse, etc.) and therefore, will all have comparable hydration rims. Secondly, proveniences away from the structures (i.e., the lithic areas) that are contemporaneous with the structures should yield obsidian with rim readings comparable with those of the control group. Thirdly, older components (Archaic - Basketmaker II, etc.) should produce obsidian with rim readings much greater than the control group. Obsidian from older components would thus be separable from the others by the presence of clearly greater rim readings.

The raw data from Figure 127 are plotted on a vertical scale of micron values in Figure 128. There are 3 separate tallies: 1 for the 5 control proveniences, 1 for the 5 lithic areas, and 1 for the total of all readings. In addition, the OHL number of each specimen tallied is provided which allows reference back to Figure 127. The OHL number of the specimens from the control proveniences are underlined.

The first thing to observe about the data on Figure 128 is that with 2 exceptions (both on the same specimen - 5615 from Feature P), all of the readings fall in a fairly narrow range of only 1.8 microns from 2.1 to 3.8 microns. In addition, within the range most of the readings lie between 2.1 and 3.3 microns, with all of the control readings (excepting speimen 5615) lying in this narrow range. In agreement with the assumption that the presumably contemporaneous control specimens would have comparable rim readings, most of the control readings (64.7 percent) are tightly clustered between 2.5 and 2.8 microns. This cluster forms a well-defined curve (curve 1) which has a mean of 2.68 microns. All of the control readings (again, excepting specimen 5615) lie within a broader curve (curve 2) which has a mean of 2.76 microns. These data indicate that the initial assumption is valid and that the control specimens have a maximum range from about 2.2 to 3.2 microns with an average close to 2.7 microns.

Given the clustering of readings from the control proveniences, there seems every justification for ignoring the anomalous readings from specimen 5615. This could either represent another obsidian source hydrating at a different rate (unlikely) or an older piece of obsidian present on the surface which was incorporated into the wall in Feature P (most likely). Specimens 5616 and 5617 are interesting inasmuch as they both come from structure BD, well within the fill of that complex structure, and both have unusually high readings. If there were adequate grounds for eliminating 5619, which is noted as "unclear" in the analysis records, then specimens 5616 and 5617 would be the only control specimens with valid hydration readings higher than the upper limits of curve 1. It is possible that they represent an older period than do the other control specimens.

How do readings from the lithic areas relate to the curves developed by the control provenience readings? With one minor exception (specimen 5632) all readings from the lithic areas fall within the range of curve 2 (Fig. 127). Since nearly all the lithic area readings fall within curve 2, there is every reason to suggest that these lithics derive from the Piedra Lumbre Phase occupation of the site. Conversely, the test indicates that there is no obsidian hydration evidence for the existence of earlier components among the lithic areas within the site.

In addition to establishing contemporaniety between the lithic areas and the control proveniences, there may be information of another type in the tally of lithic area readings. Only 4 (25 percent) of the lithic area readings fall within the middle range of curve 1. The remaining 12 lie on the outside of curve 2, which is thought to span the total occupation period of the site. On the one hand, this indicates that the lithic areas were used throughout the occupation of the site. On the other hand, it lends support to the validity of the 4 readings outside curve 1 which are the basis for defining curve 2. It is suggested that further work with the material from this site would justify a wider curve (curve 3) and that the 3 apparent clusters in the tally of all readings would disappear. Were these clusters not to disappear, there would be hydration evidence for at least 2 hiatuses in the site occupation -- a situation for which there is presently no other evidence.

Absolute Dating. A tentative hydration rate for Polvadera Peak obsidian within the time period represented by this site can be suggested if it is assumed that the average micron value (2.68) for curve 1 is equivalent to a date of 1660. This equivalence is chosen for this heuristic hydration rate because the average of curve 1 appears to represent the midpoint of the occupation based upon the hydration readings and because the indications of the other chronometric techniques are that the occupation centered about 1660. In addition, 2 of the readings in curve 1 (5610 and 5611) are from the interior fill of Feature D which yielded a carbon-14 date of 1660 ± 50 from the hearth beside the door and 2 dendro dates of 1668vv and 1669vv from the fill outside the northwest wall.

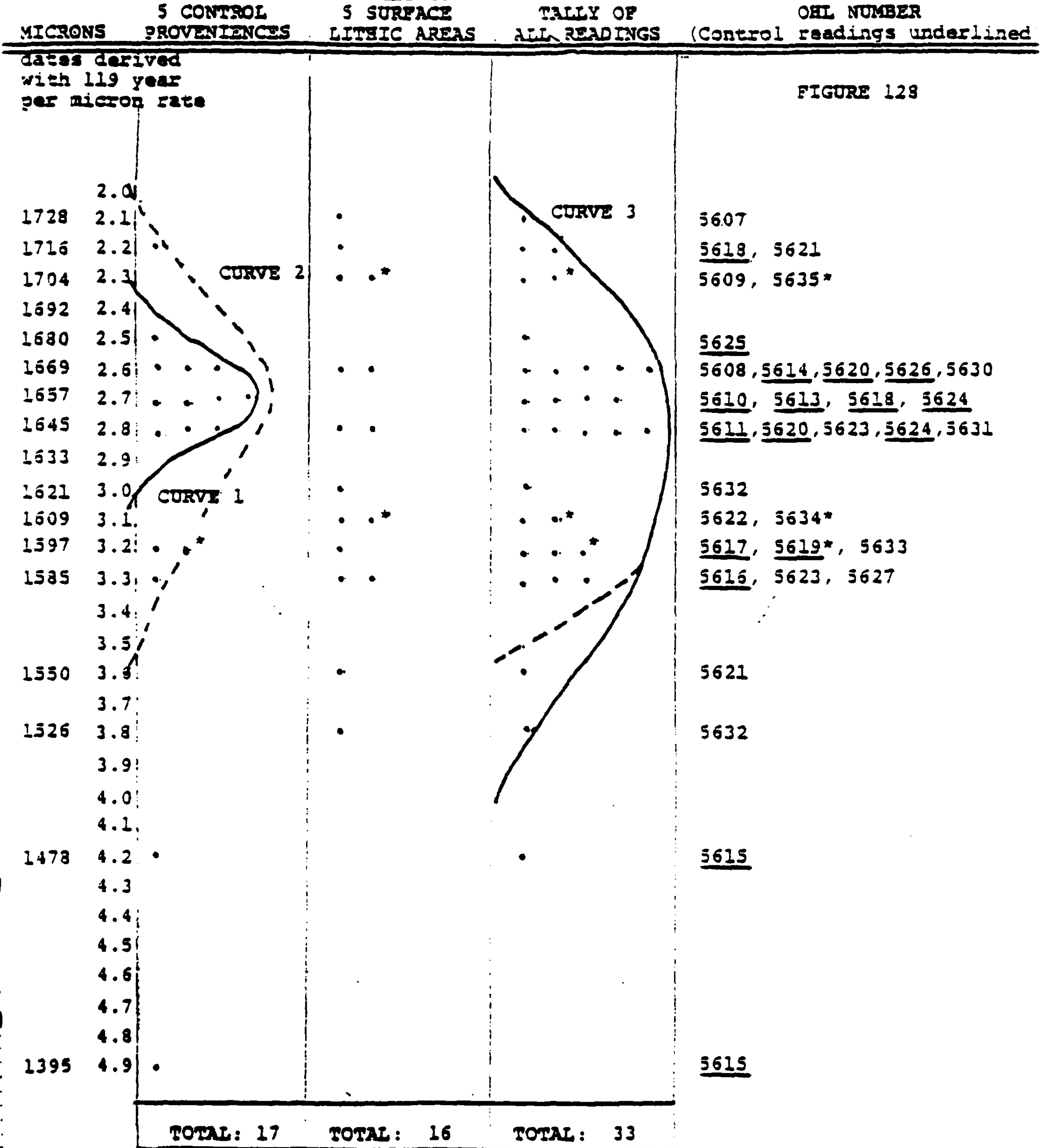
Given this equivalency, the hydration rate is computed with the equation: 2.68/1 = 318/X which states that 2.68 microns are to 318 years (i.e., 1978-1660 = 318 years) as 1 micron is to "X." The value of "X" is 119 years. Thus, the suggested hydration rate for the equivalency of 2.68 microns/318 years is 1 micron/119 years. If this rate is essentially accurate, Polvadera Peak obsidian would have one of the fastest hydration rates yet discovered (compare the approximately 690 years per micron rate reported by McBride (1974:140) and the 650 years per micron rate of the Bodie Hills quarry (Singer and Ericson 1977:181). On the other hand, it is not drastically different from the 260 years per micron rate that has been proved valid in West Mexico (Foote 1974; Meighan et al. 1968).

A partial test of the validity of this suggested rate is provided by computing the age of a 2.68 micron reading with the original Friedman and Smith (1960) rate of 4.5 microns ^{2}/1000 years. The result of this computation ($4.5^2/2.68^2 = 1000/X$) is A.D. 1623. It is of considerable interest that the 1623 date derived by Friedman and Smith's original rate is only 37 years older than the 1660 date being proposed here. It should not be overlooked that their rate provides a date that is older than the one being suggested. On the other hand, several problems of a more general nature emerge if the Friedman and Smith rate were to be accepted. For example, there is presently nothing to suggest that the 3.3 micron (specimen 5616) and 3.2 micron (specimen 5617) readings from structure BD are invalid. Computing the date of the 3.3 micron reading from level 3 of structure BD with the Friedman and Smith rate yields a date of A.D. 1440. This is considerably older than the oldest possible date of circa 1600 for this structure that is indicated by the presence of an iron projectile point on the upper floor and pottery of several types which all date after 1600. Thus, while providing an independent check on the validity of the rate being suggested here, this result concurs with McBride's assessment that this original rate cannot be uncritically applied (1974:139).

Calculating the calendric dates of the micron readings with the simple linear rate of 119 years per micron provides a means for evaluating the readings in terms of years. In all cases, the base year is 1978--since the readings were made in 1978. The year equivalents of each reading are provided in Figure 128. All of the actual readings encompassed by curve 1 are between 1645 and 1680. All of the actual readings covered by curve 2 date between 1585 and 1716. While the 1585 date for level 3 of structure BD (specimen 5616) is somewhat older than is likely, the date is at least within the realm of possibilities (as opposed to the A.D. 1440 date discussed above). As discussed below, the 1716 termination date for the site is not inconsistent with other lines of evidence which indicate when the site was abandoned.

Computation of the dates for specimen 5615 show clearly that this is an anomalous piece of obsidian. The dates are 1478 and 1395, which are totally out of line with the ceramics from Feature P as well as the 2 other hydration readings from that feature. Friedman and Smith's rate would yield dates of A.D. 1107 and A.D. 792.

The 2 oldest readings from the lithic areas (specimens 5621 and 5632) are rendered suspicious when computed with the 119 year/micron rate, but are still worthy of some serious consideration. The dates of 1550 and 1526 suggest that curve 3 representing the total maximum occupation of the site, might not include them - a suggestion indicated by the dashed line of curve 3. On the other hand, the possibility that they may validly belong to the total site occupation requires that curve 3 presently incorporates them.



* = unclear reading
All readings are tallied, even if from same specimen.

In summary, the preliminary linear hydration rate of 119 years per micron proves to generate a temporal distribution of nearly all the readings which is consistent with other lines of evidence indicating the time of occupation of AR-4. Only one specimen (5615) is clearly rejected from this distribution. The distribution of 1585 - 1716 obtained with this rate for the valid readings from the control proveniences is remarkably consistent with the other dating evidence.

Ceramics. The ceramics of the historic and late prehistoric period of the Chama Valley are well known and fairly well-dated from historic events and association with tree-ring dates.

As discussed in the "Ceramics" section of this chapter, all of the pottery types found at AR-4 appeared after 1600, or, at the earliest, shortly before 1600. They were certainly present by 1650. Two of the types (Ogapoge Polychrome and the Jeddito Yellow wares) very likely appeared after 1650. The Tewa plain slipped types and the micaceous utility types continue well past 1750 and in several cases to 1900 without much change. The main type for providing an upper limit for the ceramic series is Tewa Polychrome, which apparently was not made past 1750--at least not in the form found in this site (Mera 1939; Carlson 1965). The Jeddito Yellow wares of the kind found in AR-4 are unlikely to have been made after 1750. They may well have terminated shortly after 1700.

At the time the latest Tewa pueblos in the Chama Valley were being occupied (Mera 1934: Map 2), Biscuit B was at its height and every pueblo in the valley had abundant sherds of this distinctive pottery (Mera 1934; Hibben 1937). Also present at most of these pueblos was Potsuwi'i Incised (Mera 1934:10). Sankawi Black-on-Cream was found on a few sites in small percentages (1934:10). Sherds of Glaze E were found on these sites but no Glaze F. There is no mention of polished black, red, or micaceous pottery of the kind described above as Penasco Micaceous. The pottery set found on the latest Tewa pueblos of the Chama Valley was therefore quite distinctive, being dominated by Biscuit B, Potsuwi'i Incised, some Sankawi Black-on-Cream and Glaze E.

None of the pottery types found on the late Tewa pueblos occurs in the Piedra Lumbre Phase sites. The main lack is Biscuit B, but the lack of Potsuwi'i Incised, Sankawi Black-on-Cream and Glaze E are just as important. As discussed before, the bulk of the evidence shows that the Chama Valley pueblos were abandoned before 1600, and that the pottery set on the pueblos represents a time not much later than 1550 (Mera 1934). The pueblos and the pottery set could have persisted to ca. 1600, as Ellis (1975) has discussed. Sites in the Chama Valley lacking these types could not date earlier than the terminal date of this pottery complex, inasmuch as it so thoroughly dominated the valley at its height (Mera 1934; Hibben 1937). The lack of these types at AR-4 (and the other Piedra Lumbre Phase sites) thus places a baseline or maximum date beyond which they could not date given the ceramic patterns documented for the Chama Valley. This maximum date is approximately 1600.

Overall, the ceramic patterns, both presences and absences, bracket the possible outer limits of the site between ca. 1600 and ca. 1750. The presence of the Hopi sherds and Ogapoge Polychrome indicate the date would be more like 1650 - 1750.

Artifact Presences and Absences. The main tools used by the people who lived in these structures were stone. Silicaceous stones were used for most cutting and scraping tasks; grinding and pounding were done with stone manos and hammerstones. A lithic industry existed. Durable household vessels were limited to Indian ceramics. No American ceramics, crockery, or metal vessels were found. The one piece of glass described above (see section on "other artifacts" in Chapter V) is from the surface near Feature E. Its association with the occupation is very tenuous since no glass was found in the excavations, nor has glass been found on any of the other Piedra Lumbre Phase sites (Schaafsma 1976).

The few metal items from the site are either functionally related to warfare and hunting or to ornaments. The confinement of metal objects to these functions and their scarcity indicates that metals may have been rare, and had only marginally been incorporated into the culture. After about 1850, for example, one would expect to find metal being utilized for axes, cooking vessels and so forth. On the one hand, metal items such as occur in this site could have been acquired by any New Mexican group after ca. 1600 from Spanish sources. On the other hand, the low representation and specialized function of the metal items indicates that this complex would date before 1850 and perhaps before 1830. The use of stone arrowheads also seems unlikely in this area after metal was readily available.

Beginning in 1852, American goods were being issued to Indians of the Chama Valley by the agency in Abiquiu. Such items also would have been available to the Spanish people, either by purchase or trade. Some of these goods should show up in the sites were they to date after this. Metal items (a brass button, iron sheet scraps, etc.) were found in the excavation of AR-9, for example, a presumably late nineteenth century Ute tipi and ramada (Schaafsma 1977). In addition, the Santa Fe trail opened in 1822 (Dozier 1970:102) and by 1830 was bringing abundant manufactured American goods into northern New Mexico (1970:102). One wonders how long it would take for these manufactured ceramics, crockery, metal knives, tin cups, buttons and so forth, to begin showing up on sites that date after ca. 1830 in this area. Such items were certainly abundant on the Spanish homesteads in the Rio Puerco Valley, which probably dates between about 1860 and 1920 (Schaafsma 1976).

Overall, the presence of a few metal objects as well as the presence of flintlock rifles (the musket ball and the gun-flints) corroborate the other evidence that the sites would have to date after 1600. On the other hand, the lack of manufactured items and the rare occurrence of metal objects indicate that the sites would date before 1850. The pattern of artifact presences and absences thus bracket the possible time of occupation between ca. 1600 and ca. 1850.

Sheep and Goat Husbandry. The maintenance of sheep and goats is well confirmed by the presence of their bones, the several rock facilities for housing them, and the soil chemical analysis of their manure. Animal husbandry would not have existed in New Mexico prior to the arrival of Onate's colony in 1598; this establishing again, the 1600 maximum date of the site. It is very unlikely, however, that any group could have been herding sheep and goats in the Piedra Lumbre Valley until after the Spanish colonists had been present for some time. A suggested lower limit of a site such as AR-4 with husbandry in the Piedra Lumbre Valley is ca. 1640. At the other end of the time frame, sheep and goats were kept in the valley until the modern time, and probably only terminated in the area of the Ghost Ranch when Arthur Pack bought the ranch in the 1930's (Pack 1966).

SUMMARY

Ceramics, animal husbandry and the limited presence of metal artifacts demonstrate that the site must date after 1600. The pattern of artifact presences and absences indicates that the site must date before about 1850. Ceramics suggest the site does not post-date 1750. Three independent dating methods concur in dating the site between about 1650 and 1710, with suggestions that the main occupation was about 1660. Preliminary work with obsidian hydration suggests that the site was occupied for a considerable period that may be between 1585 and 1716. The obsidian hydration method argues for a longer span of occupation than do the other methods, and is not inconsistent with the evidence of the other methods in placing the occupation in the late seventeenth and early eighteenth centuries. Overall, a date for AR-4 of between ca. 1640 and ca. 1710 is indicated.

VIII. COMPARISON

As stated at the outset, the problem to be addressed by this study is the determination of ethnic identity of the Piedra Lumbre Phase. The writer has hypothesized that the sites are attributable to the Chama Valley Navajos described by the Spaniards in the seventeenth century. This proposal, however, has the status of an untested theory in need of empirical verification. As discussed, the method to be used involves considering each of the ethnic groups previously documented to have been in the area during the historical period as potential condidates. The culture history chapter summarizes the occupation of the Chama Valley and shows that since 1600 there have been 6 major ethnic groups present: Tewa Pueblo, Spaniard/Genizaro, Navajo, Ute, Comanche, and Jicarilla Apache. A seventh, Anglo, could be added, but considering the nature of the sites, and the history of the area (Pack 1966), this can be dismissed as inappropriate.

Expected archaeological remains of each group will be compared with the archaeological complex described as the Piedra Lumbre Phase. The goal of the comparison will be to point out similarities and dissimilarities exhibited by each of the potential candidates, leading to one or more which cannot be eliminated from accountability for the Piedra Lumbre remains. In the interest of efficiency, only the information necessary to sufficiently reject any group will be brought into the discussion. Potential categories of consideration include: dating, economics, architecture, settlement pattern and inferred social organization, nature of the occupation, stylistic patterns in artifacts, and distinctive cultural practices.

JICARILLA APACHE

Dating: Expected 1852-1881.

Discussion: In the recent past, the Jicarilla Apache have been the dominant Indian group in the Chama drainage. Their reservation today lies at the headwaters of the river. Gunnerson, however, provides ample evidence that they did not move west of the Sangre de Cristo Mountains until forced to do so by Ute and Comanche raiders in the first half of the eighteenth century (1974). Subsequently, they did not move west of the Rio Grande River until 1852 (Schroeder 1965) when assigned to the Abiquiu Agency. This temporal discrepancy is sufficient in itself to reject them as candidates.

Architecture: Expected: Tipis and brush ramadas.

Discussion: In the period when the Jicarillas would have been in the Piedra Lumbre Valley, they would have lived in tipis (Goddard 1913:132; Skinner 1968). The observed dwellings at AR-4 and at all Piedra Lumbre Phase sites are clearly not the remains of tipis. This discrepancy would eliminate the

Jicarilla Apaches as candidates.

Economics: Expected: hunting, gathering, trading.

Discussion: The Jicarillas during the time they were present in the Piedra Lumbre Valley did not practice sheep and goat husbandry (Goddard 1913:140).

Conclusion: Inconsistencies between expectations and archaeological observations in regard to time, architecture, and economics eliminate the Jicarilla Apaches as progenitors of the Piedra Lumbre Phase.

COMANCHE

Dating: Expected 1700-1750.

Discussion: Comanches were documented in the Chama Valley in the early eighteenth century (Swadesh 1974). Temporally, they are potential candidates.

Architecture: Expected tipis.

Discussion: The Comanche never adopted sheep and goat husbandry (McNitt 1972:10; Goddard 1913:140). Similarly, they did not practice agriculture (Secoy 1953:31), especially during the 1700's when the lack of agriculture gave them a tactical advantage over the Plains Apache (1953:29-30). Economic factors would eliminate the Comanche as candidates.

Nature of the Occupation: Expected raiding parties - temporary camps.

Discussion: The Comanche presence in the Chama Valley always was associated with transient raiding parties (Swadesh 1974). They would not have left an archaeological complex characterized by the kind of stability found at AR-4 and throughout the Piedra Lumbre Valley.

Conclusions: Differences in architecture, economics, and the nature of the occupation are sufficient to eliminate the Comanche as originators of the Piedra Lumbre Phase.

UTE

Dating: Expected 1700-1881 - primarily 1800-1881.

Discussion: The Utes were on the western and northern periphery of the Rio Grande settlements from at least 1626 until they were placed on their present reservation in southern Colorado in 1881. Their presence, activities, and culture changed markedly over this time. The historic records (Schroeder 1965; Swadesh 1974; Secoy 1953) indicate that Ute archaeological sites could be anticipated in the Piedra Lumbre Valley after about 1700. However, the period of occupation cannot be separated from the nature of the occupation (see below) at various times. The dating must be evaluated in terms of the nature of the occupation.

Nature of the Occupation: Expected:

1700-1750: raiding parties (Swadesh 1974; Secoy 1953).
1750-1810: trading parties, seasonal occupation for perhaps several weeks or even months at a time (Swadesh 1974). Some small groups stayed year-round in later years (Schroeder 1965).
1800-1850: permanent residents, or at least sufficient for Utes to regard Piedra Lumbre Valley as their "own country" by 1850 (Abel 1915). Minimum of trade goods.
1850-1881: Agency period. More trade goods expected. Gradual move into upper Chama drainage (Schroeder 1965).

Discussion: During the 1640-1710 period when AR-4 was occupied, according to the historical records, Utes were not living in the Chama Valley. They were, however, in trade contact with the Spaniards throughout the later seventeenth century (Secoy 1953:28). Slightly before 1700, the Utes acquired horses (Secoy 1953:28), and they and the Comanches became allies until about 1750 (Swadesh 1974; Secoy 1953:29). Throughout the period 1700-1750, the Utes like the Comanches would only have been in the Piedra Lumbre Valley on raids of short duration. Thus, through 1750, the nature of the Ute occupation would contrast with the stable occupation documented at AR-4. For the remainder of the eighteenth century, Utes occasionally visited the valley. Their sites, however, would be transient and temporary until at least 1800 (Skinner 1968).

Architecture: Expected tipis and ramadas.

Discussion: As early as the mid-eighteenth century, the Utes were reported to be living in tipis (Schroeder 1965:59). Apparently, they adopted the full-mounted, nomadic plains, hunting life style with tipis about the time (ca. 1700) they acquired horses (Secoy 1953:29). Prior to ca. 1700, the Utes were living in "thatch-covered huts" (Schroeder 1965:54). Either house form contrasts sufficiently with the architectural forms observed at AR-4 to disqualify the Utes as the occupants of the site.

Economics: Expected hunting, gathering, raiding, trading, and possible husbandry.

Discussion: Prior to about 1860, hunting and gathering provided the main subsistence of the Utes (Schroeder 1965:66). They dressed hides and prepared deer and bison meat which they traded to the Spaniards. Beginning in the 1930's, the Utes came annually to a trade fair at Abiquiu bringing juvenile captives, meat, and hides to trade for knives, maize, and wheat flour (Swadesh 1974:47). There are indications that their economic patterns were significantly different after 1852 when they were attached to the Abiquiu Agency. The minimal keeping of goats by the Chama Valley Utes (Capote band) about 1869 (Schroeder 1965:73), was clearly a post-agency contact phenomenon and is not representative of economic practices before ca. 1850.

Conclusions: Discrepancies in the expected nature of the occupation in the period before 1750, in architecture, and in economic practices are sufficient to disqualify the Utes as the occupants of AR-4.

SPANIARD/GENIZARO

Dating: Expected 1743 or 1766 to present.

Discussion: There were no settlements of Spanish-speaking people of any kind in the Piedra Lumbre Valley prior to the short-lived Riana Ranch in Canones between 1743 and 1745 (Swadesh 1974:34). The first significant use of the valley as a grazing area began in 1766 with the establishment of the Serrano and Martin ranches (Swadesh 1974:47). After 1766, Spanish-speaking people grazed sheep, goats, cattle, and horses in the Chama Valley, with the only interruptions being due to occasional periods of hostility between them and the Utes (for example: the 10-year period after 1844 [Swadesh 1974:62]). Sheep camps are to be expected in the lower Chama Valley and in the Piedra Lumbre Valley in particular after about 1766 with such camps becoming more common in the early nineteenth century (Swadesh 1974:48, 62).

As discussed, the log which produced the 1760vv tree-ring date (FS No. 185) was lying above the fallen wall logs of Feature D (Fig. 32). Accordingly, it can be inferred that the wall collapsed before the log was deposited. If the 1760vv date is somewhere close to the cutting date, then the wall collapsed before 1760. The log may have been left by an early (ca. 1760?) Spanish sheepherder who used the abandoned structure as a shelter. If so, the 1760vv tree-ring date is in accord with the historically documented time when Spanish sheepherders might have been in the valley.

The complete lack of manufactured trade goods (glass, crockery, ceramics, buttons, and so forth) makes a ca. 1760 date for the site suspect, and very unlikely after about 1830. The lack of these items would almost certainly demand that if these sites were attributable to Spanish-speaking shepherds from Abiquiu, they would have to date from before about 1830. It would also be curious that Spanish shepherds in the period ca. 1760 - 1830 should bring presumably heirloom pieces of Tewa Polychrome and Hopi pottery to their sheep camps.

<u>Economics</u>: Expected husbandry, probably of all types.

<u>Discussion</u>: At any time during the period ca. 1760 - ca. 1830, Spanish stock camps would be seasonal settlement extensions of primary villages such as Abiquiu. They would be economically specialized for the grazing of stock. Other economic activities would not be expected. For example, the pollen evidence for the growing of corn (at AR-4) would not be expected were it a Spanish site. Similarly, the pollen evidence for processing prickly pear and possibly yucca is curious in a Spanish stock camp. Considering, however, that the shepherds at that time would likely have been Genizaros, it is not impossible. The possible preparation of chert as a trade item would also be unexpected but perhaps not impossible given the importance of chert to the Tewa until recent times (Warren 1974). Hunting to the extent implied by the number and variety of bones of wild animals would not be expected, but again is possible since so little is known of Genizaro activities in stock camps of that period.

Economic practices of Genizaros are little known as far as stock camps of ca. 1760 - 1830. Nevertheless, a comparison of what might be expected in such a camp with what was found archaeologically suggests there are substantial inconsistencies.

<u>Nature of the Occupation</u>: Expected sheep camps.

<u>Discussion</u>: Were it possible to establish unequivocally at this time that the sites were occupied year-round, the proposition that the Piedra Lumbre Phase was Spanish in origin could be eliminated. Conversely, if it were established conclusively that the sites were only occupied seasonally, the proposition that they were Spanish sheep camps would be reasonable. As discussed, the substantial dwellings imply year-round occupation.

<u>Architecture</u>: Expected brush, log, and occasionally rock corrals.

<u>Discussion</u>: Spanish grazing practices in the nineteenth century indicate that dwellings would not be present in sheep camps. The Lucero Phase of the Navajo Reservoir District was largely made up of settlers who came from the Chama Valley (Dittert et al. 1961:257); accordingly, they could be expected to follow patterns that were present in the Chama Valley in the early nineteenth century. Dittert et al. describe the post 1870 sheep camps of the Navajo Reservoir area:

> These sites are bedding areas for sheep, located in rock shelters on the canyon wall and mesa top. The shelters have been used as informal corrals for sheep or in some cases they have been made into permanent corrals by the addition of log or rock walls. The sheepherder built fires and camped in the shelter with the sheep (1961:52).

Specifically significant is their observation that rather than build substantial shelters for themselves, the sheepherders slept in the corrals with the sheep.

Sheep camps were likely to be moved fairly often because the flocks were large and would soon deplete grass available in a given locality. Excessive expenditures of energy in structures would be inconsistent with this requirement. The casual nature of herding facilities in the mid-nineteenth century is indicated by the description given by Lt. Albert near Albuquerque in 1846:

> October 15 --- . . . This evening we saw a very large flock of sheep and goats. The pastores said that there were 4,000 in the flock. At night, the herdsman built a large fire, and, seizing some of the lighted brands, ran around the flock; the sheep frightened, all turned their heads toward the centre, in the direction of the fire, and are not, after such a scare, likely to stray away during the night (1848:465).

Known Spanish grazing camps in the nineteenth century lack dwellings in association. The presence of definite dwellings at AR-4 renders the proposition that the Piedra Lumbre Phase consists of Spanish sheep camps dubious.

Conclusion: While not as clear cut as other cases, the overall pattern of temporal, economic, and architectural incongruities make it doubtful that the sites can be attributed to Spanish sheepherders.

TEWA

Preliminary Discussion: Prior to about 1600, the Chama Valley was occupied by the Tewa. This occupation, however, terminated about the time the Spaniards arrived (1598). Considering ceramic, economic, and architectural discrepancies, the proposition that the Piedra Lumbre Phase was the result of the pre-1600 Tewa occupation of the Chama Valley will not be considered. As with the Anglo, this proposition can be dismissed without further discussion.

Throughout the seventeenth century (until 1680), the Tewa grazed flocks for the Spaniards under the encomienda system (Dozier 1970). Dozier notes that these flocks were grazed on land near the pueblos (1970:54). It is conceivable that the Piedra Lumbre Phase was the result of Tewa herdsmen working under the encomienda system in the seventeenth century. This, however, is completely at variance with records for Tewa herdsmen in the Chama Valley (far from the pueblos) and the historically-documented presence of other people in the Chama Valley for the entire seventeenth century.

After the reconquest in 1692 and throughout the eighteenth century, Tewa lands were well-defined. The Tewa tended to remain confined to their own lands (Dozier 1970:100-101). There was little chance that they would be found maintaining a substantial occupation distant from their villages which escaped official notice (Dozier 1970). On the other hand, after 1714, the Chama Valley was gradually settled and formally claimed by Spanish settlers (Swadesh 1974). After about 1714, Tewas did not occupy the Chama Valley simply because it was settled by Spanish people. The proposition that the sites could be post-1692 Tewa is therefore rejected.

A remaining possibility merits discussion: that is, that the sites were created by refugee Pueblos either during the seventeenth century before 1680 or in the unsettled period after 1692.

Dating: Expected ca. 1609 - ca. 1700.

Discussion: Tewa people were reported to have left to join the Apaches as early as 1609 (see "Culture History," Chapter III). At various times other Pueblos left the villages to join the Apaches de Navajo in the Chama Valley with a major exodus reported in 1692 (Forbes 1960). Wilson and Warren cite evidence that the Tewa, in 1696, deserted their pueblos and withdrew to Pedernal Mountain, beyond Abiquiu (1974:20).

Whereas it is well established historically that portions of the Tewa population fled to the Piedra Lumbre Valley after the reconquest, it is equally clear that they fled to join the Apaches de Navajo. In summary, the presence of Tewa Refugees in the Piedra Lumbre Valley is consistent with the dating of the sites, but the context, or nature of the occupation, is not.

Architecture: Expected rock masonry, multi-roomed dwellings.

Discussion: Beginning about 1700 (Carlson 1965; Hester 1962; Vivian 1960), Refugee Pueblo structures are well-known. They are, in almost all cases, substantial, multi-roomed structures. While there are technically multi-roomed structures in Feature B, and Feature M, these are exceptions, and the usual structure both at AR-4 and for the entire known Piedra Lumbre Phase (Schaafsma 1976) is an isolated structure with at most a simple room attached. A comparison of AR-4 with the post-1700 Refugee Pueblo dwellings of Chacra Mesa (Vivian 1960) and Gobernador Canyon (Carlson 1965) will produce significant differences. The Piedra Lumbre Phase dwellings are simpler, more crude, and generally lack contiguous room ground plans.

Stylistic Patterns in Artifacts: Expected typical Pueblo projectile points, manos, and so forth.

Discussion: The projectile points found in the Piedra Lumbre Phase sites have never been attributed to Rio Grande

Pueblo people. Conversely, the typical Pueblo points that should have been present in the seventeenth century (Kidder 1932) are lacking. The manos of the Pueblo people were generally shaped and well-formed (Kidder 1932). The ground cobbles found at AR-4 with no shaping are not typical of Pueblo manos from this time. The ceramics of the sites are dominated by Tewa types. This pottery, however, was widely traded and cannot be regarded as diagnostic of the people living in the sites. The stylistic differences between expectations and observations would cast doubt on Tewa occupancy.

Distinctive Cultural Practices: The Rio Grande Pueblo Indians, and in particular the Tewa, regularly made petroglyphs in the vicinity of their villages (Schaafsma 1972). There are extensive petroglyph sites, for example, on the mesa north of San Juan Pueblo (1972). It has been observed in a number of areas (e.g., Cochiti Reservoir) that petroglyphs were common near herding camps (1972).

Expected: Numerous Tewa petroglyphs.

Discussion: The complete lack of petroglyphs that could be attributed to the Tewa after ca. 1350 is at variance with the documented pattern for their presence throughout the Rio Grande Valley, near the pueblos from at least San Juan to Socorro (Schaafsma 1972). The lack of Tewa petroglyphs in an area where they should be present is a severe objection to the proposition that Pueblos were in the valley and could have been responsible for the Piedra Lumbre Phase.

Conclusion: The proposition that AR-4 was occupied by Tewa Refugees is temporally consistent with the dating. Before 1680, however, the nature of the occupation is clearly one in which there were limited numbers of Tewa running away from the Spaniards and joining other residents (Navajo). There is no mention of a large number of refugees sufficient to have produced sites such as this before the 1692 reconquest. After the reconquest, large numbers of refugees did come to the valley. But this movement was hurried and disorganized and not consistent with the long, stable occupation that is indicated by the evidence at AR-4. Throughout the seventeenth century, there must have been occasional Tewa refugees coming to the Piedra Lumbre Valley. They were always reported, however, to have joined with the Apaches de Navajo who were living in the Chama Valley. The proposition that the Piedra Lumbre Phase was solely the result of refugee Pueblos appears doubtful in light of this information.

NAVAJO

Dating: Expected: ca. 1580 - ca. 1710.

Discussion: AR-4 is dated to the latter half of the historically documented Navajo occupation of the Chama Valley.

There are suggestions in the obsidian hydration analysis that the site could date slightly before 1600. On the basis of dating, the proposition that the Piedra Lumbre Phase (and AR-4) was Navajo in origin cannot be rejected.

Economics: Expected agriculture, hunting, gathering, some husbandry.

Discussion: The economic practices of the Chama Valley can be inferred only from Spanish records such as Benavides' account, (he said they were "very great farmers"), Governor Cuervo y Valdez' account in 1706 (Hester 1962), post-1700 archaeological evidence, and the ethnography of the Navajos. According to the Spaniards, there should be more evidence for agriculture than was found in AR-4. On the other hand, there have previously been no pre-1700 Navajo sites excavated to check those records (Eddy 1966). Hunting and gathering are consistent with the Spanish records and with ethnographically documented practices. Hester reported that "the early Navajos practiced four major kinds of economics identified through archaeology: agriculture, wild plant gathering, hunting, and herding" (1962:58). Of interest is the evidence that the early Navajos, in particular, gathered yucca and prickly pear (1962:58). Sheep and goat husbandry in the late seventeenth and early eighteenth century would be expected on the basis of Governor Cuervo y Valdez's 1706 report. Economically, the proposition that the sites are Navajo appears supported.

Architecture: Expected forked-stick hogans, circular **stone hogan wall bases.**

Discussion: Pre-1700 Navajo architecture is presently unknown (Eddy 1966; Carlson 1965). The only pre-1700 site that can be attributed to the Navajo-Refugee Pueblo complex (LA 2298) is pueblo in concept, being a multi-room masonry structure (Wilson and Warren 1974). This structure is dated 1690, and is presently the oldest known Navajo-Refugee Pueblo site (Brugge, personal communication). Analysis for pre-1700 Navajo architecture must be based on the post-1700 Navajo sites to the west (Vivian 1960; Hester 1962) and northwest (Carlson 1965; Eddy 1966; Keur 1944). Additionally, there is the reference in Benavides' account that the Navajos "...have their sort of lodgings under the ground, and a certain sort of xacales in which they store their crops" (Ayer 1916:45).

Hester was of the opinion that, before 1700, the forked-stick hogan was the only Navajo dwelling type (1962:62-3). This hypothesis was based upon the similarity of the forked-stick hogan to the tipi-like structures thought to have been used by the ancestral Navajos while they were on the High Plains (1962:62). On the other hand, stone-walled hogans (1962:40, Fig. 12) were a common architectural type on Chacra Mesa in the first half of the eighteenth century (Vivian 1960) and also occurred in the period 1700 - 1750 in the Largo Gobernador District (Keur 1944). While stone-walled hogans may have appeared after 1696 as the result of refugee Pueblo contact (Hester 1962), there is nothing to prove this, and such structures may have been present before 1700. Features A, E, and Q, for example, may be this kind of dwelling.

Given the fact that little is known of pre-1700 Navajo architecture, aside from the general notions that they would be small and constructed of the same log, rock, and brush materials as those after 1700, there is nothing about the architectural complex at AR-4 that would disqualify it as being early Navajo.

Settlement Pattern and Inferred Social Organization: Expected bands living in "rancherias."

Discussion: Between 1625 and 1629, Benavides described the Navajos as living in "rancherias" (Hodge et al. 1945:87) which consisted of several families (how many is not stated). The "rancherias" were led by headmen or "chiefs" (1945:87). A site such as AR-4 would be consistent with the "rancherias" described by Benavides, as well as the other early Spaniards until ca. 1709 (see "Culture History" chapter). Another village-like site that would qualify as a "rancheria" is AR-33, several miles up the Chama River from AR-4 (Schaafsma 1976). While the dispersed, apparently single-family units are not mentioned by the Spaniards, this type of site would be consistent with later Navajo settlement patterns (Dittert et al. 1961; Hester 1962).

Although little is known in detail about seventeenth century Navajo social organization, what can be inferred from available data is not inconsistent with the archaeological evidence in the Piedra Lumbre Phase.

Nature of the Occupation: Expected stable, small settlements for about a 100 years.

Discussion: Benavides noted that the Navajos had their dwellings in rancherias "and they always dwell in that spot" (Ayer 1916:45). As discussed, the Navajos were in the Chama Valley for about a 100 years. While any given settlement may not have been occupied over that whole period, Benavides' statement that they always dwell in one place implies they were stable settlements. This documented settlement stability is consistent with the archaeological evidence that AR-4 was occupied over a long period.

Stylistic Patterns in Artifacts: Expected: poorly known.

Discussion: Early Navajo projectile point types are poorly known (Hester 1962; Hester and Shiner 1963). The excavation of post-1700 Navajo sites in the Navajo Reservoir District yielded 2 points which were attributed by Hester and Shiner to the Navajo occupation only because they do not resemble Pueblo forms (1963:53). One of these (1963: Fig. 43, center), is simple in shape; the other point, on the other hand (1963; Fig. 43, left), is a large, triangular-shaped point with side notches and a deep, "V"-shaped basal notch. It thus resembles the Piedra Lumbre points found on the 1975 survey (Fig. 118) and resembles some from the AR-4 excavations in having side notches and a deep "V"-shaped basal notch. It is suggested that this point type was made by Navajos in the late seventeenth and early eighteenth centuries. If so, the type of point with a triangular shape, side notches and a deep "V"-shape basal notch may be an indicator of early Navajo archaeological sites.

Both Brugge (personal communication) and Carlson (1965) are of the opinion that Navajo ceramics are a puebloan tradition and did not develop until after the Navajos were joined by pueblo refugees. If this were the case, then a site such as AR-4 could well date from before the time when Navajos were making their own pottery. Navajo ceramics would therefore not be available to distinguish the sites.

While tenuous, the point types suggest the sites are early Navajo. On the other hand, there is nothing other than the pottery (which is likely trade) to stylistically distinguish the sites and demonstrate that they are not Navajo.

Distinctive Cultural Practices:

Discussion: Distinctive cultural practices are not as amenable to presentation as a set of expected-versus-observed conditions. Instead, a series of generalizations drawn from previous studies will be summarized and then compared with the present archaeological materials.

1) Stone artifacts. "The impression remains that the Navajos were little concerned with the specific forms of the stone artifacts used" (Hester 1962:55). "Identification of Navajo manufactured stone artifacts is extremely difficult" (1962:50).

These summaries of the stone-working practices of the early Navajos by Hester are in accord with the findings of this study. The stone-working techniques are crude with very little concern for preparing finished artifacts. Flakes and pieces of shatter were used as knives, scrapers, and adzes without any apparent effort to shape them into formal tools. Hammerstones are simply properly-shaped natural rocks. This generalization would extend to the manos of the present collection which are unshaped and merely represent naturally-shaped cobbles that were used directly. The stone industry of both AR-4 and AR-513 (Schaafsma 1976) corresponds with the previous summation that Navajo stone tools are crude and undiagnostic in terms of individual items.

2) Refuse Areas. "Low mounds of trash are from 3 to 30 feet away from most hogans. The refuse is thin and limited in extent, averaging 4 to 6 inches in depth and from 1-foot-6

inches to 20 or more feet in diameter" (Hester 1962:47).

The pattern of a thin trash area close to each habitation is partly present at AR-4. As at Feature D, however, such areas are consistent enough with the patterns described by Hester to indicate that the inhabitants were behaving in a manner similar to that of later Navajos.

3) Caches: "Natural rock crevices and overhangs were utilized for the caching of objects which were occasionally sealed within pots. Small overhangs walled up with dry laid or mortared masonry were also used as caches . . . Use was for storage and burial" (Hester 1962:46, Fig. 19).

The 2-walled natural cavities described as AR-35 and AR-523 are believed to be part of the AR-4 occupation due to their spatial proximity to the site and their absence in the rest of the reservoir district (Schaafsma 1976). If they are part of the occupation, then they would seem to be caches of the type described by Hester and widely documented for the early Navajo (Vivian 1960; Hester and Shiner 1963).

4) Bone Artifacts. "Artifacts of bone are not common" (Hester 1962:51). "The new information concerning bone artifacts suggests that they were not important in early Navajo culture, for they are limited in both frequency and type. It is probable that most of the functions of bone artifacts in other cultures were fulfilled in Navajo culture by wooden artifacts" (1962:55).

Bone artifacts at AR-4 are limited to 1 crude, bone handle. No other bone artifacts appeared in the excavation.

5) Conclusion. The comparison of distinctive cultural practices does not lead to the rejection of the proposition that the Piedra Lumbre Phase represents the archaeological culture of the early Navajos. Other interpretations, however, would be possible with the same material. The above is cited to indicate that many of the practices found at AR-4 are in agreement with patterns previously documented for early Navajo culture.

CONCLUSION. Given the presently available evidence about early Navajo culture as based upon other studies and descriptions in seventeenth century Spanish accounts, it is not possible to reject the proposition that the Piedra Lumbre Phase originated with the Navajo. Discrepancies found (dwelling types, etc.) are more readily seen as heretofore unknown attributes of pre-1700 Navajo culture than as the result of a different ethnic group.

IX. CONCLUSIONS

The problem to be addressed by the present study was the ethnic identity of the Piedra Lumbre Phase. The method used was to compare each of the ethnic groups known to have been in the Chama Valley during the historic period with the archaeological remains that collectively constitute the Piedra Lumbre Phase. The ethnic groups were identified and summarized in the culture history chapter. The archaeological materials from AR-4 were then summarized, without reference to ethnic origin. A multi-faceted approach to chronology determined that the best assessment of the date of AR-4 is approximately 1640-1710. Each of the 6 primary ethnic groups documented to have been in the valley since about 1600 was then compared with the archaeological materials. The purpose of this comparison was to seek means to disprove each proposition (reject each group). Sufficient grounds were found to reject all the candidates except for the seventeenth-century Navajos. While it cannot be unequivocally proven that the sites derive from seventeenth-century Navajo occupation, this is the most reasonable proposition.

If the Piedra Lumbre Phase derives from the seventeenth-century Navajo occupation of the Chama Valley, there will be several major additions made to our knowledge of early Navajo culture.

1) The sites would be the oldest known Navajo archaeological complex.

2) The lack of pottery in the Piedra Lumbre Phase that was not clearly traded from nearby pueblos would indicate that the Navajos did not make pottery before ca. 1700.

3) The projectile point types associated with the Piedra Lumbre Phase may constitute the oldest-known kind of Navajo point, and may help identify other early Navajo archaeological sites.

4) The presence of sheep and goat husbandry in the Piedra Lumbre Phase would indicate that the Navajos had adopted husbandry before 1710, if not considerably earlier.

5) The house types of the Piedra Lumbre Phase would change our concept of early Navajo habitations.

6) The "rancherias" or village-like settlements would indicate that pre-1700 Navajo culture allowed the formation of multi-family social groups.

X. DIRECTIONS FOR FUTURE RESEARCH

The excavation and analysis of AR-4 and the evidence that they derive from early Navajo culture lead to a number of avenues for future research. It would be extremely important to know when sheep and goat husbandry first became part of the Piedra Lumbre Phase. This could be accomplished by a combination of direct carbon-14 dating of selected bones and a limited faunal analysis to segregate bones being dated. Material for this study is present in the AR-4 materials.

If the Piedra Lumbre Phase resulted from Navajo occupation of the valley, Spanish records strongly suggest that the "Apaches de Nabaju" were present before 1598. Work at selected sites could determine if the Piedra Lumbre Phase extends to ca. 1598 or even earlier. The nature of the culture at that time would be of considerable interest if the sites are early Navajo. They would then be sites from before the time Navajos acquired many traits that are found at AR-4, such as husbandry, and would indicate cultural origins.

In the valley as a whole, there are large settlements ("rancherias") and single-dwelling (single-family?) sites. Are these different types of sites contemporaneous? Is it possible that the larger sites are earlier? If a difference were to be found in age between the 2 main types of sites, it would suggest that social structure changes occurred over the period of the occupation of the valley. Were these changes the result of adopting new technologies, such as husbandry? Why is there such minimal evidence for agriculture? This question should be examined in depth both with the AR-4 material and at other sites.

The presence of husbandry and the apparent minimal reliance upon agriculture suggest that Navajos in the seventeenth century participated in a complex economic system with the Rio Grande Pueblos. Lees and Bates (1974) have proposed a systemic model for the origins of pastoral nomadism in the Near East. Major tenets of this model project a direct relationship between nomadic pastoralism and development of sophisticated irrigation systems in agriculture, an increased carrying capacity due to both pastoral and agricultural activity in arid lands, and an incentive to maintain some form of economic intercourse between pastoralists and farmers (Lees and Bates 1974:187-192).

It is suggested that early Navajos may have adopted elements of pastoral economy as a result of Pueblos maintaining almost total control over agricultural lands. In the effort to find and fill an economic niche, Navajos adopted herding as a means of utilizing the extant environment with little competition. Indeed, it is hypothesized that this form of specialization between two groups will produce exchange patterns between them (Lees and Bates 1974:191). Such activities might take the form of long-term, inter-family or group (town/village) trade.

Selection processes relating to pastoral economy as practiced by the Navajo might include: lack of native competition in the field; degree of immediate or short-term responsiveness in terms of labor investment; continued allowance for supplemental hunting, gathering, and limited agricultural pursuits; and military advantages accruing from a mobile capability. As is readily evident, many aspects of this proposal articulate favorably with historic and ethnographic data pertaining to Navajo culture history. Continued archaeological work with similar early Navajo settlements should include attempts at quantifying and isolating the selective and evolutionary processes which relate to formative Navajo culture.

REFERENCES CITED

Abel, Annie Heloise (ed)
1915 The Official Correspondence of James S. Calhoun (Washington).

Abert, J.W.
1848 "Notes of Lieutenant J. W. Abert", Appendix No. 6 in Notes of a Military Reconnaissance, from Fort Leavenworth, in Missouri, to San Diego, in California, Including Part of the Arkansas, Del Norte, and Gila Rivers, by Lieut. Col. W. H. Emory (Washington: Wendell and Van Benthuysen) Ex. Dec. No. 41. 30th Congress, First session.

Allen, William C., Rory P. Gauthier, and Richard W. Loose
1976 "An Archaeological Survey near San Mateo, New Mexico: The Keradamex Inc. Lease" (Albuquerque: Office of Contract Archaeology).

Amsden, C.A.
1932 "Navajo Origins", New Mexico Historical Review 7:193-209.

Ayer, Mrs. Edward E.
1916 The Memorial of Fray Alonso de Benavides, 1630 (Chicago: privately printed).

Bailey, J.B.
1940 Diego de Vargas and the Reconquest of New Mexico (Albuquerque: University of New Mexico Press).

Bannister, Bryant
1964 "Tree-Ring Dating of the Archaeological Sites in the Chaco Canyon Region, New Mexico", Southwest Parks and Monuments Association Technical Series Vol. 6, Part 2.

Bartlett, K.
1932 "Why the Navajos Came to Arizona", Museum Notes 5:29-32 (Flagstaff: Museum of Northern Arizona).

Blanchette, Jean-Francois
1975 "Gunflints from Chicoutimi Indian Site" Historical Archaeology 9:41-54 (Quebec).

Carlson, Roy L.
1965 "Eighteenth Century Navajo Fortresses of the Governador District" University of Colorado Studies, Series in Anthropology No. 10 (Boulder).

Church, Fermor S., and John T. Hack
1939 "An Exhumed Erosion Surface in the Jemez Mountains, New Mexico" Journal of Geology 47: 613-29.

References Cited (Cont'd.)

Colton, Harold S.
1956 "Wares 5A, 5B, 6A, 6B, 7A, 7B, and 7C", Pottery Types of the Southwest Ceramic Series No. 3c (Flagstaff: Museum of Northern Arizona).

Damon, P.E., C. W. Ferguson, A. Long, and E. I. Wallick
1974 "Dendrochronologic Calibration of the Radiocarbon Time Scale", American Antiquity 39:350-66.

Dick, Herbert W.
1965 Picuris Pueblo Excavations No. PB-177047, (Springfield, Virginia: Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, National Bureau of Standards, Institute for Applied Technology).

Dittert, Alfred E., Jr., Jim J. Hester, and Frank W. Eddy
1961 An Archaeological Survey of the Navajo Reservoir District, Northwestern New Mexico, Monographs of the School of American Research and the Museum of New Mexico, No. 23 (Santa Fe).

Dozier, Edward P.
1970 The Pueblo Indians of North America (New York: Holt, Rinehart and Winston, Inc.).

Earle, Timothy K., and Jonathan E. Ericson
1977 Exchange Systems in Prehistory (New York: Academic Press).

Eddy, Frank W.
1966 "Prehistory in the Navajo Reservoir District, Northwestern New Mexico", Papers in Anthropology No. 15 (Santa Fe: Museum of New Mexico Press).

Ellis, Florence H.
1964 "Archaeological History of Nambe Pueblo, 14th Century to the Present", American Antiquity 30:34-42.

n.d. "An Anthropological Study of the Navajo Indians", Unpublished Navajo Claims Case, University of New Mexico (Albuquerque).

1975 "Highways to the Past", New Mexico Magazine 53:18-40.

Ellis, Florence H., and J. J. Brody
1964 "Ceramic Stratigraphy and Tribal History at Taos Pueblo", American Antiquity 29:316-27.

References Cited (Cont'd.)

Ericson, Jonathan E.
1974 "Brief Report of the Current Research on the Obsidian Hydration Dating Technique, Obsidian Sources Used in California Prehistory and Chemical Characterization of California Obsidian Sources", in Obsidian Dates No. 1, ed. by Clement W. Meighan, Frank J. Findlow, and Suzanne P. De Atley, Archaeological Survey 3, University of California (Los Angeles).

Findlow, Frank J.
1977 "A Revision in the Government Mountain-Sitgreaves Peak, Arizona, Obsidian Hydration Rate", The Kiva 43:27-29.

Findlow, Frank J., Victoria C. Bennett, Jonathan E. Ericson, and Suzanne P. De Atley
1975 "A New Obsidian Hydration Rate for Certain Obsidians in the American Southwest", American Antiquity 40(3): 345-48.

Foote, Leonard J.
1974 "Western Mexico: Archaeological Testing Ground for the Accuracy of Obsidian Dating", in Obsidian Dates No. 1, eds. Clement W. Meighan, Frank J. Findlow, and Suzanne P. De Atley, Archaeological Survey 3, University of California (Los Angeles).

Forbes, Jack D.
1960 Apache, Navaho, and Spaniard (Norman: University of Oklahoma Press).

Frank, Larry and Francis H. Harlow
1974 Historic Pottery of the Pueblo Indians: 1600-1800 (Boston: New York Graphic Society).

Friedman, Irving and Robert L. Smith
1960 "A New Dating Method Using Obsidian, Part 1. The Development of the Method", American Antiquity 25 (1):476-93.

Frison, George C.
1968 "A Functional Analysis of Certain Chipped Stone Tools", American Antiquity 33(2): 149-155.

Goddard, Pliny Earle
1913 "Indians of the Southwest", Handbook Series No. 2 (New York: American Museum of Natural History).

Grant, Cambell, James W. Baird, and J. Kenneth Pringle
1968 Rock Drawings of the Coso Range, Inyo County, California Maturango Museum Publication 4 (China Lake).

References Cited (Cont'd.)

Gunnerson, Dolores A.
1974 The Jicarilla Apaches: A Study in Survival (De Kalb: Northern Illinois University Press).

Gunnerson, James H.
1969 "Apache Archaeology in Northeastern New Mexico", American Antiquity 34:23-39.

Gunnerson, James H., and Dolores A. Gunnerson
1971 "Apachean Culture: A Study in Unity and Diversity", in Apachean Culture, History and Ethnology, ed. by Keith H. Basso and Morris E. Opler, Anthropological Papers of the University of Arizona, No. 21 (Tucson: University of Arizona Press).

Haecker, Charles M.
1977 "Obsidian Hydration Analysis", in Archaeological Investigations in Cochiti Reservoir, New Mexico eds. Richard C. Chapman, and Jan V. Biella, Vol. 2 Excavation and Analysis (Albuquerque: University of New Mexico, Office of Contract Archaeology).

Hall, Edward Twitchell, Jr.
1944 "Recent Clues to Athapascan Prehistory in the Southwest", American Anthropologist 46:98-105.

Hanson, Lee H., Jr.
1970 "Gunflints from the Macon Plateau", Historical Archaeology IV: 51-58.

Hammond, George P., and Agapito Rey
1953 Don Juan de Onate, Colonizer of New Mexico, 1595-1628 (Albuquerque: The University of New Mexico Press).

Harlow, Francis H.
1973 Matte-Paint Pottery of the Tewa, Keres and Zuni Pueblos (Santa Fe: Museum of New Mexico Press).

Harris, Arthur H.
1963a Ecological Distribution of Some Vertebrates in the San Juan Basin, New Mexico, Museum of New Mexico Papers in Anthropology, No. 8 (Santa Fe: Museum of New Mexico Press).

1963b Vertebrate Remains and Past Environmental Reconstruction in the Navajo Reservoir District, Museum of New Mexico Papers in Anthropology No. 11 (Santa Fe: Museum of New Mexico Press).

Hester, James J.
1962 Early Navajo Migrations and Acculturation in the Southwest, Museum of New Mexico Papers in Anthropology No. 6 (Santa Fe: Museum of New Mexico Press).

References Cited (Cont'd.)

Hester, James J., and Joel L. Shiner
1963 Studies at Navajo Period Sites in the Navajo Reservoir District, Museum of New Mexico Papers in Anthropology, No. 9 (Santa Fe: Museum of New Mexico Press).

Hibben, Frank C.
1937 Excavation of the Riana Ruin and Chama Valley Survey Anthropological Series 2 (1) (Albuquerque: University of New Mexico Press).

Hill, James N.
1970 "Prehistoric Social Organization in the American Southwest: Theory and Method", in Reconstructing Prehistoric Pueblo Societies, ed. William A. Longacre (Albuquerque: University of New Mexico Press).

Hodge, F.W. G.P. Hammond, and A. Rey
1945 Fray Alonso de Benavides' Memorial of 1634 (Albuquerque: University of New Mexico Press).

Irwin-Williams, Cynthia
1973 "The Oshara Tradition: Origins of Anasazi Culture", Eastern New Mexico University, Contributions in Anthropology, Vol. 5, No. 1 (Portales).

Irwin-Williams, Cynthia, and S. Tompkins
1968 "Excavations at En Medio Shelter, New Mexico", Eastern New Mexico University Contributions in Anthropology 1:2 (Portales: Eastern New Mexico University Paleo-Indian Institute).

Keur, Dorothy L.
1941 "Big Bead Mesa: An Archaeological Study of Navajo Acculturation, 1745-1812", Memoirs of the Society for American Archaeology No. 1 (Menasha).

1944 "A Chapter in Navajo-Pueblo Relationships", American Antiquity 10:75-86.

Kidder, Alfred V.

1932 The Artifacts of Pecos (New Haven: Yale University Press).

Lees, Susan H. and Daniel G. Bates
1974 "The Origins of Specialized Nomadic Pastoralism: A Systemic Model", American Antiquity 39 (2): 187-193.

Lipe, William D.
1974 "A Conservation Model for American Archaeology", The Kiva 39:213-45.

References Cited (Cont'd.)

McBride, Harold
1974 "Comments on Hydration Values for Cuahtitlan, Valley of Mexico", in Obsidian Dates No. 1, eds. Clement W. Meighan, Frank J. Findlow, and Suzanne P. De Atley, Archaeological Survey 3, University of California (Los Angeles).

McNitt, Frank
1972 Navajo Wars: Military Campaigns, Slave Raids and Reprisals (Albuquerque: University of New Mexico Press).

Meighan, Clement W., L. J. Foote, and P. V. Aiello
1968 "Obsidian Dating in West Mexican Archaeology", Science 160:1069-75.

Meighan, Clement W., Frank J. Findlow, and Suzanne P. De Atley
1974 Obsidian Dates No. 1, Archaeological Survey 3, University of California (Los Angeles).

Mera, H.P.
1934 A Survey of the Biscuit Ware Area in Northern New Mexico. Technical Series Bulletin No. 6. (Santa Fe: Laboratory of Anthropology).

1939 "Style Trends of Pueblo Pottery in the Rio Grande and Little Colorado Cultural Areas from the Sixteenth to the Nineteenth Century", Memoirs of the Laboratory of Anthropology 3. (Santa Fe: Laboratory of Anthropology).

1940 Ceramic Clues to the Prehistory of North Central New Mexico, Laboratory of Anthropology Technical Series No. 8. (Santa Fe: Laboratory of Anthropology).

Niles, David M.
1963 "Birds Noted in the Navajo Reservoir District", Appendix B, in Ecological Distribution of Some Vertebrates in the San Juan Basin, New Mexico, by Arthur H. Harris, Museum of New Mexico Papers in Anthropology No. 8 (Santa Fe: Museum of New Mexico Press).

Pack, Arthur N.
1966 We Called It Ghost Ranch (Abiquiu: Ghost Ranch Conference Center).

Peckham, Stewart
1959 The Palisade Ruin (Santa Fe: Museum of New Mexico).

1963 Highway Salvage Archaeology 4. (Santa Fe: The New Mexico State Highway Department and the Museum of New Mexico).

References Cited (Cont'd.)

Predock, Antoine
1974 Master Plan for Public Use Recreational Development, Abiquiu Dam and Reservoir, New Mexico (Abiquiu: U.S. Army Corps of Engineers).

Reeve, Frank D.
1956 "Early Navaho Geography", New Mexico Historical Review 31:290-309.

1957 "Seventeenth Century Navaho-Spanish Relations", New Mexico Historical Review 31(1): 36-52.

1958 "Navaho-Spanish Wars, 1680-1770", New Mexico Historical Review 33:205-31.

1959 "The Navaho-Spanish Peace: 1720's - 1770's", New Mexico Historical Review 34:9-40.

Reher, Charles A.
1977 Settlement and Subsistence Along the Lower Chaco River (Albuquerque: University of New Mexico Press).

Schaafsma, Curtis F.
1975a An Archaeological Clearance Survey Report on Abiquiu Reservoir: The Cerrito Recreation Site (Santa Fe: School of American Research).

1975b Archaeological Survey and Excavations at Abiquiu Reservoir, Rio Arriba County, New Mexico. (Santa Fe: School of American Research).

1976 Archaeological Survey of Maximum Pool and Navaho Excavations at Abiquiu Reservoir, Rio Arriba County, New Mexico (Santa Fe: School of American Research).

1977 Archaeological Excavations and Lithic Analysis in the Abiquiu Reservoir District, New Mexico (Santa Fe: School of American Research).

1978 "Archaeological Studies in the Abiquiu Reservoir District", Discovery 2:41-69 (Santa Fe: School of American Research).

Schaafsma, Polly
1972 Rock Art in New Mexico (Santa Fe: State Planning Office).

Schoenwetter, James and Frank W. Eddy
1964 Alluvial and Palynological Reconstruction of Environments, Navajo Reservoir District, University of New Mexico Papers on Anthropology, 13 (Albuquerque: University of New Mexico Press).

References Cited (Cont'd.)

Schroeder, Albert H.
1963 "Navajo and Apache Relationships West of the Rio Grande", El Palacio 70:5-23.

1965 "A Brief History of the Southern Utes", Southwestern Lore 30:53-78.

Schroeder, Albert H., and R. D. Matson
1965 "A Colony on the Move: Castano de Sosa's Journal" (Albuquerque: University of New Mexico Press).

Secoy, Frank R.
1953 Changing Military Patterns on the Great Plains Monographs of the American Ethnological Society 21 (New York).

Singer, Clay A., and Jonathan E. Ericson
1977 "Quarry Analysis at Bodie Hills, Mono County, California: A Case Study", in Exchange Systems in Prehistory, eds. Timothy K. Earle and Jonathan E. Ericson (New York: Academic Press).

Skinner, S. Alan
1968 "Two Historic Period Sites in the El Rito Valley, New Mexico", Plains Anthropologist 13:63-70.

Smiley, Terah L.
1951 A Summary of Tree-Ring Dates from Some Southwestern Archaeological Sites, University of Arizona Bulletin, Laboratory Bulletin of Tree-Ring Research No. 5 (Tucson).

Stephen, A.M.
1893 "The Navajo", American Anthropologist 6:345-362.

Swadesh, Francis
1974 Los Primeros Pobladores: Hispanic Americans of the Ute Frontier (Notre Dame: University of Notre Dame Press).

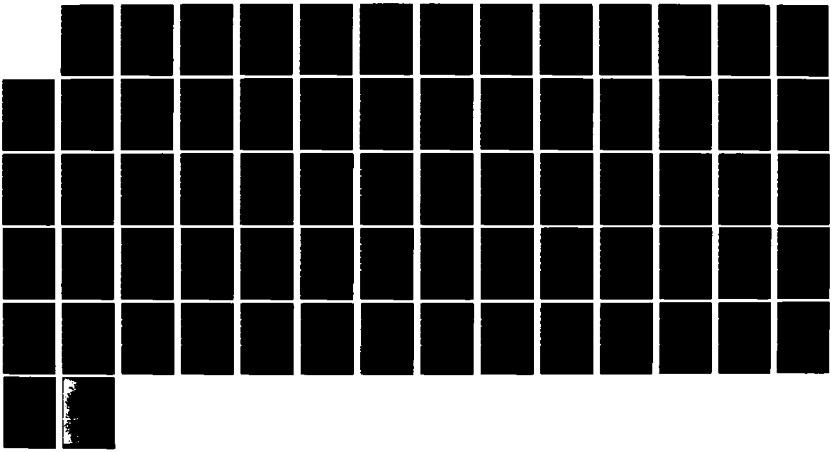
Tuan, Yi-Fu, Cyril E. Everard, and Jerold G. Widdison
1969 The Climate of New Mexico (Santa Fe: State Planning Office).

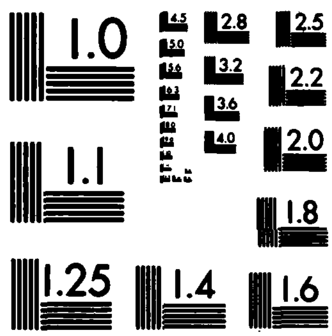
U.S. Army Corps of Engineers
1976 Master Plan for Public Use Recreational Development at Abiquiu Dam, New Mexico (Albuquerque: Corps of Engineers).

Underhill, Ruth
1953 Here Come the Navaho! United States Indian Service Haskell Institute (Lawrence).

AD-A127 413 THE CERRITO SITE (AR-4): A PIEDRA LUMBRE PHASE SETTLEMENT AT ABIQUIU RESERVOIR(U) SCHOOL OF AMERICAN RESEARCH SANTA FE NM C F SCHAAFSMA NOV 79 4/4

UNCLASSIFIED DACA47-77-C-0046 F/G 8/7 NL





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

References Cited (Cont'd)

Van Buren, George F.
1974 *Arrowheads and Projectile Points* (California: Arrowhead Publishing Co.).

Vivian, R. Gwinn
1960 *The Navajo Archaeology of the Chacra Mesa, New Mexico* MS, Masters Thesis, University of New Mexico (Albuquerque).

Wait, Walter K., Jr.
1977 *Identification and Analysis of the "Non-Sedentary" Archaeological Site in Northwestern New Mexico*. Ph.D. Dissertation, State University of New York (Binghamton).

Warren, A. Helene
1974 *The Ancient Mineral Industries of Cerro Pedernal, Rio Arriba County, New Mexico,* New Mexico Geological Society Guidebook, 25th Field Conference (Ghost Ranch, New Mexico).

Wendorf, Fred, and Erik K. Reed
1956 "An Alternative Reconstruction of Northern Rio Grande Prehistory", *El Palacio* 66:37-52.

Wetherington, Ronald K.
1968 *Excavations at Pot Creek Pueblo* Fort Burgwin Research Center, Inc. (Taos).

Willey, Gordon R.
1966 *An Introduction to American Archaeology* Vol. One: North and Middle America (Englewood Cliffs: Prentice Hall, Inc.)

Wilson, John P., and A. H. Warren
1974 "LA 2298 The Earliest Pueblito?" *Awanyu* 2:8-26.

Witthoft, John
1966 "A History of Gunflints", *Pennsylvania Archaeologist* 36 (1 and 2): 12-49.

Wolfman, Daniel
1977 *An Inundated Archeomagnetic Sample, Arkansas Archaeological Survey* (Russellville: February, 1977).

Wolfman, Daniel, and Thomas M. Rolniak
1978a "Effects of Inundation on Alpha-Recoil Track Samples from the Abiquiu Reservoir Region, Appendix II", in *The Mechanical and Chemical Effects of Inundation at Abiquiu Reservoir* by Curtis F. Schaafsma (Santa Fe: School of American Research).

1978b "Alpha-Recoil Track Dating: Problems and Prospects", *Proceedings of the 18th Annual Symposium on Archeometry and Archeological Prospection* (Bonn: In Press).

APPENDIX A

MUSEUM OF ALBUQUERQUE

(505) 766-7878

P.O. Box 1293 ALBUQUERQUE, NEW MEXICO 87103

Archeological Research Program
1918 Mountain Road, N.W.
Albuquerque, New Mexico 87104

Mr. Kurt Schaafsma
School of American Research
Santa Fe, New Mexico 87501

Dear Kurt:

The following is a preliminary list of faunal remains from AR-4 and AR-513:

AR-4 Quad I
- Turkey
- Antilocapra americana
- Capra sp.
- Ovis sp. (domestic sheep ?)
- Lepus sp.
- Odocoileus hemionus

AR-4 Quad II
- Turkey
- Antilocapra americana
- Capra sp.
- Lepus sp.

AR-4 Quad III
- Turkey
- Lepus sp.
- Odocoileus hemionus

AR-4 Quad IV
- Capra sp.
- Lepus sp.
- Neotoma sp.
- Odocoileus hemionus
- Sylvilagus sp.

AR-513-1-1c
Capra sp.
Microtus sp.

AR-513-1-3c
Capra sp.

AR-513-1-4c
Microtus sp.

AR-513-1-5c
unknown avian fragment

AR-513-2-2c
Lepus sp.

AR-513-0-3c
Capra sp.
Lepus sp.
Neotoma sp.

AR-513-2-c/c
Canis familiaris
Capra sp.
Turkey

AR-513-2-1c
Antilocapra americana
Capra sp.
Lepus sp.
Odocoileus hemionus

Sincerely,

Denis Van Horn
Archeozoologist, Archeological Research Program

eld/DVH

APPENDIX B

ARCHAEOLOGICAL POLLEN STUDY OF AR-4

James Schoenwetter
Palynological Laboratory
Department of Anthropology
Arizona State University
October 1977

A suite of 24 sediment samples collected in association with archaeological remains at site AR4 were submitted to the laboratory for analysis in September 1977. Logistical parameters imposed by S.A.R. justified limiting the study to the eighteen first priority samples. Extraction of pollen of all eighteen samples was accomplished. Time allowed, however, only the observation and counting of pollen of twelve of the specimens.

The principal concern of S.A.R. was use of the pollen spectra to elucidate functional distinctions among different feature types occurring at AR4. "Functional" is used here in its anthropological sense, denoting cultural or behavioral patterns of significance in the utilization of the features. Four types of cultural context were sampled in the sediment series analyzed: floors, hearths, middens and feature fills. The issues were two fold: (A) do the pollen spectra provide evidence of distinct use of different types of features, and (B) do the pollen spectra provide evidence of similarity in usage of two or more forms of cultural context. All of the sediment samples selected represent a single horizon in the occupation of the site.

The assumption underlying the analytic procedure used to investigate these issues is that human activity patterns at a given location are reflected palynologically by the disturbing (skewing) effect they have upon the pollen rain which would occur if no human actions of any sort were performed. Thus one may anticipate that there exists a normal, modal, pattern of pollen frequency values which occurs at a given locus at a given time. If the locus is one at which human activities occurred, those behaviors would cause deviations from the modal pollen rain. One must recognize, of course, that other phenomena than human behavior condition pollen rain frequency values, so all observable deviations need not be interpreted as the result of human activity. But one may take the position that all observed deviations require some form of interpretation; that is, no deviation is immaterial. Then the issue is one of determining testable hypotheses which would function to explain observed deviations. When considering a locus where human activities are known to have occurred, such hypotheses may be drawn from ethnographic analogies and other mechanisms archaeologists utilize for this purpose.

One way to identify deviations from a modal pollen rain would be to make qualitative comparisons between the pollen frequency values observed at AR4 and those observed at deposits representing a contemporary non-site context. Unfortunately, this approach cannot be achieved. We may only date non-site deposits to the approximate horizon of occupation ± 100 or 200 years. This degree of precision is not tolerable for present purposes. Also, it is known that the physio-chemical characteristics of a depositional environment affect pollen preservation and thus pollen frequency values. Distinctions between on-site and off-site sediment samples would, therefore, not necessarily reflect human occupancy of the location but the physio-chemical modifications of on-site deposits which are an indirect byproduct of that occupancy.

I chose a statistical approach towards identification of the modal, normal, pollen values expectable at the site if human activities were of no effect in establishing the pollen record. This was accomplished through the identification of the mean frequency value for each pollen type observed in the samples and its standard deviation. Skewing was arbitrarily identified as the occurrence of pollen frequency values exceeding one standard deviation from the mean.

Pollen Type	Mean Frequency	Standard Deviation	Unskewed Frequency
Picea	.1667	.019	.019 - .186
Pinus edulis	43.0833	17.404	26.043 - 60.490
P. ponderosa	1.5833	3.067	0.0 - 4.650
Juniperus	2.8333	2.034	.800 - 4.900
Quercus	2.7500	3.217	0.0 - 6.000
All AP	50.4167	20.922	29.495 - 71.139
Chenopodinneae	38.8333	20.215	18.618 - 59.050
Artemisia	.0250	.433	0.0 - .440
All Compositae	8.4167	3.925	4.492 - 12.342
Gramineae	.3333	.850	0.0 - 1.183
Ephedra	.5000	.645	0.0 - 1.150
cf. Leguminosae	.0250	.595	0.0 - 0.670
cf. Lilliaceae	.0417	.640	0.0 - 0.681
Zea	.0833	.276	0.0 - 0.041
Platyopuntia	.0833	.276	0.0 - 0.041
Unknown	.6667	.624	0.430 - 1.294

TABLE I: Pollen statistics of the 1200-grain total of observations

	$\bar{x}$ of 4 Fill Samples	$\bar{x}$ of 2 Hearth Samples	$\bar{x}$ of 3 Midden Samples	$\bar{x}$ of 3 Floor Samples
Picea	.25	.50	0.0	0.0
Pinus edulis	33.25	54.00	55.00	37.00
P. ponderosa	4.00	.50	0.0	.67
Juniperus	1.50	3.50	5.00	2.00
Quercus	.25	2.50	6.33	2.67
All AP	39.25	61.00	66.33	42.33
Chenopodinneae	49.25	29.00	23.67	46.67
Artemesia	.50	0.50	0.0	0.0
All Compositae	8.50	7.50	8.67	8.67
Gramineae	1.00	0.0	0.0	0.0
Ephedra	.50	.50	.33	.67
cf. Leguminosae	0.0	1.00	.33	0.0
cf. Lilliaceae	.75	.50	0.0	.33
Zea	0.0	0.0	0.0	.33
Platyopuntia	0.0	0.0	0.0	.33
Unknown	.75	.50	.67	.67

TABLE II: Pollen frequency values of the feature types

The use of one standard deviation as an identification value, rather than two standard deviations or some other number, is justified by the size of the pollen counts of individual samples. Because time was limited for accomplishment of this research, only 100 pollen grains were observed in each of the twelve samples analyzed. Given twelve 100-grain samples, skewing would rarely be identified at all if more than one standard deviation were used. Those pollen types having low frequency values are too poorly represented and those having high frequency values are over-represented; in either case it is likely that the pollen value of a given sample would fall within one and two standard deviations of the mean. This would also be true if 200-grain or even 300-grain counts had been made. Use of one standard deviation allows skewing to be easily identified, but it makes statistical evaluation of the significance of skewing more difficult to discern. However, statistical evaluation of skewing is not a practical issue in this study. Skewing is in all cases required to be evaluated in palynological and behavioral terms; its statistical properties are of no particular interest.

The test used to determine whether samples of a given feature type possess palynologically unique characteristics was comparison of the mean pollen values of each feature type against the standard deviations of those values for the pollen record as a whole. Only skewed values were taken into consideration, since only such values are assumed to be the result of human cultural or behavioral patterns. Fill samples are uniquely skewed in a positive direction for Picea and cf. Lilliaceae values, hearth samples are uniquely skewed positively by the cf. Leguminosae value; midden samples are uniquely skewed by positive Juniperus and Quercus values; and floor samples are uniquely skewed by positive Zea and Platyopuntia (prickly pear) values.

The test used to determine whether 2 or more forms of features produce palynological evidence of similarity of function was comparison of skewed pollen values. Two indications of functional similarity occur: Artemesia values are positively skewed in both fill samples and hearth samples, and Picea values are negatively skewed in both midden and floor samples.

None of the skewing identified in these tests is of statistical significance. That is, the probability that the skewing may have occurred as a result of chance is not greater than the .05 level of confidence. Proceeding to evaluation of the results on the basis of ethnographic analogies and ecological parameters, however, a case may be made that the skewing observed is culturally significant and reflects particular patterns of behavior.

The floor samples evidence skewing towards uniquely positive values for Zea and Platyopuntia. The inference one may draw is that maize and prickly pear were plants towards which behavior was directed in a unique fashion at floor locations relative to other locations on the site. Ethnographic analogy suggests the testable hypothesis that the floors of rooms were locations of food processing behavior in the present case.

The midden samples are uniquely skewed for positive values of juniper and oak pollen. Though both plants produce edible fruits, maturation processes are such that pollen would not be harvested with the fruits nor disposed as waste products in food preparation. The human behavior indicated by the skewed values, then, is not related to the subsistence significance of these plants. Ethnographic analogy suggests the testable hypothesis that the trunks and branches of juniper and oak were brought to the site for use as fuel and construction materials. The foliage would contain quantities of pollen if collected during the pollination season. If the foliage were stripped from living plants and disposed of at the midden location, juniper and oak pollen values would be positively skewed by the activity of disposal. The cultural inference drawn from these palynological results is that wood harvesting during early spring involved living plants rather than deadwood. Though such harvests would be more difficult and less conservative of the natural resource, they would provide a more efficient fuel if the deadwood soaked by winter and spring precipitation had not yet air dried.

Hearth samples evidence positive skewing of cf. Leguminosae pollen values. This result is unevaluable because of the problems of taxon identification which support the diagnosis of the pollen type involved. The Leguminosae constitutes a plant family of many genera and species; some have ethnological and ecological significance and others do not. While some genera can be identified on the basis of pollen morphology, most genera and species of the Papillionoidae and Cesaelpinoideae sub-families are not normally distinguishable. These groups are characterized by a highly variable pollen morphology which -- though normally tricolporate and reticulate -- is often not well preserved in inorganic sediment context. Lacking more precise botanical identification of the pollen, generation of testable hypotheses and inferences cannot be based upon the evidence available.

Fill samples evidence positive skewing of Picea and cf.Lilliaceae pollen values. The Lilliaceae pollen observed cannot be more precisely identified botanically because of poor preservation. I have encountered morphologically similar pollen, however, in contexts of association with well preserved Lilliaceae pollen identifiable more specifically to the genus Yucca. I believe -- but cannot confirm -- that the Lilliaceae pollen from AR4 is Yucca pollen. Yucca is an insect-pollinated genus, and thus not adapted to wide dispersal of its pollen upon foliage or soil surfaces. It generally pollinates in April to May. Since a large quantity of pollen is produced, pollen probably clings to the inflorescence and fruit casings in some quantity throughout the life of those structures. Picea is a wind-pollinated genus well adapted for long-distance dispersal of pollen grains by air movements and also by water transport across soil surfaces, as prodigious quantities of Picea pollen are produced and released each season. I think it unlikely, in view of the distinctions in ecological parameters affecting dispersal of the two pollen types and those affecting the locations in which the parent plants can grow and mature, that the skewed values of both pollen types result from the same cultural or behavioral activities.

The ethnographic record provides few clues I can identify that refer to types of human activities affecting the fill of abandoned architectural features. Abandoned features are used as waste dumps, but if this were the case at AR4 one would expect the fill pollen records not to be unique but rather to parallel the midden records. Alternatively, the prior existence of an architectural feature creates a unique depositional environment which is aggraded by slope wash from the surrounding use surfaces and eolian deposition. I suggest that the cf. Lilliaceae pollen actually derived from the area surrounding the features and may represent processing of *Yucca* fruits for food outside the boundaries of room floors. It could have then washed into feature fills as those deposits developed subsequent to abandonment of the features. The *Picea* pollen may derive from spruce foliage utilized in the site for some purpose. However, it is equally likely that it derives from the long-distance wind transportation of spruce pollen and is uniquely skewed in fill deposits because they are uniquely capable of trapping large quantities of windblown materials.

This argument is reinforced by the negative skewing of *Picea* pollen values in both floor and midden deposits, which aggrade solely or primarily through human construction activities. I believe it also accounts for the similarity between feature fill and hearth fill deposits as regards positive skewing of *Artemisia* pollen values.

In summary, pollen analysis of twelve samples representing four distinctive cultural contexts at AR4 were examined to discern palynological reflections of prehistoric activity patterns. It appears likely that palynological indices of similarity in function which occur are only indirectly related to human behavior, as they result from the existence of conditions of depositional environment which are created subsequent to the abandonment of features through transformation processes. Had the human behavior of construction of the features not occurred, however, certain unique palynological characteristics would not have occurred either. Each of the various cultural contexts may be uniquely identified by palynological characteristics. In the case of middens, these may reflect the harvesting of wood from living trees during the early spring. In the case of floors, they may represent food processing activities directed towards both cultivated and wild plant foods.

APPENDIX C

A FINAL REPORT ON SOIL CHEMICAL ANALYSIS
OF DEPOSITS AT AR-4,
AN ARCHAEOLOGICAL SITE IN THE ABIQUIU RESERVOIR, NEW MEXICO

A report submitted to:

Curt Schaafsma

School of American Research

P.O. Box 2188

Santa Fe, New Mexico 87501

by

Alf Sjoberg

American Archaeology Division

Department of Anthropology

22 Switzler Hall

University of Missouri

Columbia, Missouri 65201, USA

February, 1978

CONTENTS

1. INTRODUCTION

As a part of the National Park Service Inundation Study, soil samples from the Abquiu Reservoir were analyzed for pH, phosphorus, potassium, sodium, calcium, and magnesium. Preliminary studies had indicated altered relationships in the amounts of present soil components. Soil chemical analysis was therefore incorporated into the research design of the Inundation Study, and it was hypothesized that the measurement of present soil components constituted variables relevant to determining the effects of inundation upon archaeological sites.

The analysis was limited to those determinations mentioned above. The total amount, i.e. both the inorganic and organic forms of each element was determined by means of highly accurate methods. The type of analytical techniques used, the number of elements analyzed, and the laboratory procedures are identical for all samples processed from Abiquiu, Palmetto Bend, and Chesbro Reservoir projects, making all samples comparable.

Because this report constitutes one part of the National Park Service Inundation Study, chapters 1 to 3 are identical to the main study (sent to Sandra Rayl, NPS) of 160 samples from the Abiquiu Reservoir. It is my opinion that the results of such a large sample are relevant to include for comparative and informative purposes. After the main study results in chapters 4 and 5, a subsection has been added, which includes the results from AR-4. Though the main purpose of the analysis is to show effects of inundation, some other results, which relate to function of structure etc., are discussed.

2. METHODOLOGICAL CONSIDERATIONS

In the National Park Service research design it is stated that: "Chemical remains are a fragile part of the archaeological record and would appear to be capable of severe distortion and even obliteration under the impact of immersion by freshwater. Leaching, changing the pH of the surrounding medium and other changes in the environment of soils exposed to immersion will all apparently contribute to a complex of factors that can alter the chemical traces which are part of the information content of an archaeological site." The basic assumption has been made, without confirming data, that inundation does alter the relationships between chemical elements. Building upon studies by Eddy and Dregne (1964), Lenihan et al. (1977), and McIntyre (1977), it is further assumed that inundation causes a decrease or total disappearance of parts of or whole amounts of elements present prior to inundation.

The testing procedures as outlined in the Inundation Study research design require some discussion. The two applications of soil analysis on the Abiquiu Reservoir samples include:
a) intra-site patterns of surface chemical variability, and
b) patterns of chemical variability of features. It is further said that "if we cannot define meaningful patterns on an uninundated site, we cannot expect to find them on inundated sites. On the other hand, if patterns can be discerned on a control site we are in a position to evaluate the results of analysis on the inundated sites." To evaluate the impact of

inundation, one uninundated site was chosen, to which data from other inundated sites were to be compared, the question of inundation or not is answered with "yes" if the meaningful patterns of the control site are not found on the inundated sites.

It is unclear what is meant by "meaningful pattern," referring to the chemical characteristics of the control site. Any pattern of horizontal or vertical chemical variability must be considered as being meaningful or significant. No sites exist with totally identical chemical characteristics, and one might say, that the patterned chemical variability, either horizontal or vertical, is as unique as a fingerprint. There do not exist two identical fingerprints, and neither do there exist, chemically speaking, two identical sites. The difference in chemical characteristics are, for uninundated sites, always related to human behavior: a unique behavior for each site. Except within extremely broad limits we are not at the present able to classify sites solely on the basis of soil chemical characteristics. Thus, one uninundated site cannot be used as a controlling medium, because the soil chemical components of that specific site constitute a unique case. Furthermore, comparisons between sites will not tell us about effects of inundation. The chemical changes occurring as a result of human activities must be assumed to be much greater than changes resulting from inundation, i.e. if the incoming reservoir water is not heavily polluted. In summary, only by comparing chemical results from analysis of same samples with exactly identical provenience prior to and after inundation, a knowledge of the kind and amounts of chemical pollutants in the water, and with highly accurate analytical procedures, will it be possible to reach conclusions concerning the effects of inundation (cf. Garrison 1977:154).

A complex series of events are involved in the transformation from a dry to a wet environment. The introduction of permanent water coverage greatly increases the number of interactive processes, many of which are dependent upon the chemical properties of the incoming water. It is suggested that the following proposed sampling design will work as a model in future long-term studies of soil chemical alteration on inundated cultural resources:

Sampling Design for Soil Chemical Analysis in Inundation Studies of Cultural Resources

PRIOR TO INUNDATION

Soil Information

A. Horizontal sampling of surface soil following a grid system;

B. Vertical sampling of soil columns at identical intervals following a grid system;

C. Vertical sampling of soil columns from/within structures at identical intervals of same type of structures;

D. Reference samples from off site areas following a grid system or along transects.

Water Information (from stream)

E. Upstream sampling of bottom water at relocateable intervals;

F. Information collected, relating to the kind of upstream industrical activities, and what type of contamination they produce;

G. Rate of stream flow, and angle of slope towards stream.

Sediment Information

H. Horizontal sampling of surface soil of site following a grid system;

I. Vertical sampling of soil columns at identical intervals following a grid system;

K. Vertical sampling of soil columns from/within structures at identical intervals of sampe type of structures.

Agricultural Information

L. Presence or absence agriculturally used land adjacent to stream;

M. If agricultural areas are present adjacent to stream, presence or absence of liming or other chemicals used as fertilizer media.

AFTER INUNDATION

Soil Information

AA. Horizontal sampling of surface soil following a grid system;

BB. Vertical sampling of soil columns at identical intervals following a grid system;

CC. Vertical sampling of soil columns from/within structures at identical intervals of sampe type of structures;

DD. Reference samples from off site areas following a grid system or along transects.

Water Information

EE. Upstream sampling of bottom water, and sampling of reservoir bottom water at relocateable points;

FF. Information collected, relating to the kind of upstream industrial activities, and what kind of contamination they produce;

GG. Rate of stream flow, and angle of slope towards stream.

Sediment Information

HH. Horizontal sampling of surface soil of site following a grid system;

II. Vertical sampling of soil columns at identical intervals following a grid system;

KK. Vertical sampling of soil columns from/within structures at identical intervals of same type of structures.

Agricultural Information

LL. The presence or absence of agriculturally used land on areas surrounding the reservoir, and adjacent to the stream;

MM. If agricultural areas surround the reservoir or the incoming stream, presence or absence of liming or other chemicals used as fertilizer media.

We cannot compare uninundated sites with inundated to reach conclusions concerning the effects of inundation, but inter and intra-site relationships can be investigated. There is no doubt that the chemical variance on an uninundated archaeological site will show a meaningful pattern. This fact underlies the discussion below.

A meaningful pattern is here defined as the inter- or intra-site, archaeologically significant patterning of amounts of soil chemical components. The ultimate effect of inundation is understood as the loss of the meaningful pattern.

No archaeologically significant effects of inundation is the case when the chemical variance in an intra-site context is preserved, i.e. whether an increase or decrease has occurred, the relative difference in amounts of soil components is preserved. On the other hand, effects on archaeologically significant data occur when: 1) there is an increase or decrease in the amounts of one or several, but not all, of the soil chemical components in an intra-site context; when 2) intra-site chemical distinction in relation to the environment is decreased or lost; and when 3) intra-site chemical variance is decreased or lost.

3. HYPOTHESES AND BASIC CHEMICAL DATA

3.1 pH

According to the NPS research design the following tentative effects of inundation are presented:

- the pH value of the soil will change to match that of the water;
- the pH level of the soil will become more acidic in inundated sites;
- inundation by basic water should raise the pH level, and
- if the sediments; after inundation, were truly acidic (pH less than 7.0), preservation would be less favorable to bone recovery.

Based upon these test implications, it is hypothesized that:

H_1 "Absolute pH values will be altered by inundation, but should still yield relative pH values useful for archaeological research. In a loosely compacted soil stratum, pH values will approach the reservoir pH, if this stratum does not lie below a compact soil stratum."

A soil solution is soil water, in which ionic forms of plant nutrients have been dissoved. The pH value is the expression for the concentration of hydrogen (H) ions over hydroxyl (OH) ions. A soil solution is characterized as acid, neutral, or alkaline (basic) dependent upon the relationship between H and OH ions. In a neutral soil solution (pH equal to 7.0), the relationship of H and OH ions is balanced and the number of H and OH ions equal. In an acidic soil solution (pH less than 7.0) the H ions are dominant, and in an alkaline soil solution (pH greater than 7.0) the OH ions are dominant. There is a mutually inverse relationship in the balance between H and OH ions.

The term basic refers to alkalinity, i.e. to a high degree of base saturation in the soil. Saturation is defined as the process or condition of dissolving in a solvent all of a solute that the solvent can absorb, under equilibrium conditions and at a given temperature. Alkalinity implies a relatively high degree of base saturation. Processes including equilibrium maintenance or increase of exchangeable bases such as calcium, magnesium, potassium, and sodium, gives a preponderance of OH ions over H ions in the soil solution, i.e. a reduction in acidity and an increase in alkalinity. When a strong base and a weak acid, for example sodium carbonate (Na_2CO_3), go into solution, hydrolysis takes place (a chemical reaction in which water reacts with another substance to form two or more new substances, which involves ionization of the water molecule as well as splitting of the compound hydrolyzed) and alkalinity is developed. The reaction is as follows:

$$2Na^{+} + CO_3^{--} + 2HOH \rightleftharpoons 2Na^{+} + 2OH^{-} + H_2CO_3$$

The dissociation of the sodium hydroxide (NaOH) is greater than that of the weak carbonic acid (H_2CO_3), and therefore the OH ions will dominate the result. An identical reaction concerns the dissociation of potassium carbonate (K_2CO_3) and of magnesium carbonate ($MgCO_3$).

The factors forming acidity are organic decay, microbial action, and podzolization. The decomposition process of organic matter forms both organic and inorganic acids. Most common of the organic acids is carbonic acid. H_2CO_3, resulting from a reaction of carbon dioxide and water. H_2CO_3 dissolves calcium carbonate ($CaCO_3$) in soil minerals. Strongly acid environments are the result of stronger organic acids, such as sulphuric acid (H_2SO_4) and nitric acid (HNO_3), which are formed both through organic decay processes and from microbial actions on fertilizer materials (sulfur and ammonium sulfate). Strong organic acids are also formed by podzolization, defined as the movement of clays and sesquioxides down the soil profile and their deposition in the B horizon. Acidity can also occur through leaching in drainage waters, by which those metallic cations that could compete with hydrogen and aluminum on the exchange complex are removed.

A basic or alkaline environment is the result of any process which maintains or increases the amounts of the exchangeable bases such as calcium, potassium, sodium, and magnesium. Weathering processes releasing exchangeable cations from minerals and producing ability to be absorbed increases the number of hydroxyl ions. An addition of linestone causes alkalinity. Salts containing irrigation water can produce significantly increased soil alkalinity.

In addition to the reasons mentioned above, there are other factors, which are relevant to the varying decreased or increased hydrogen ion concentration. An increased acidity is the product of acid organic matter, for example leafmold, pine needles, tanbark, sawdust, and moss peat. The presence of chemicals, especially ferrous sulfate will develop sulphuric acid by hydrolysis, resulting in a drastically lowered pH value. The presence of sulfur will have the same effect. A soil sample preparation including oven drying often causes an increase in acidity. Samples collected during summer time when acid producing microorganisms are abundant will be more acid than samples collected during winter or spring.

An <u>increase of alkalinity or decrease of acidity</u> is agriculturally produced through liming (agricultural limes are oxides, hydroxides, carbonates of calcium and magnesium). The place of released hydrogen is, in moderately acid and neutral to alkeline soils, taken by calcium and magnesium bases. A soil dominated by sodium saturation has a much higher pH value than a soil dominated by calcium and magnesium. A ratio of present calcium, magnesium, potassium, and sodium of 4:1:1:9 would mean a higher pH value than if the ratio were 10:3:1:1. For example, the presence of shellfish containing, calcium carbonate ($CaCO_3$) would result in a decrease of acidity.

Finally, variation of the pH value of samples taken only a few centimeters from each other may be the result of local microbial action and an uneven distribution of organic matter in the soil.

3.2 Phosphorous

The suggested effects on amounts of present phosphorous are, as outlined in the NPS design, the following:

-- phosphorus, which as calcium phosphate is the principal component of bone, is water soluble, and

-- phosphorus in flooded areas is changed into phosphine and disperses.

The following was hypothesized:

H_2 "Samples taken for soil-phosphate analysis after site inundation, but relative differences between samples will remain unchanged. Where ferro-phosphate compounds are formed in loose soils, such as sandy loams, phosphates will be lost unless replenished with phosphate from bone apatite, e.g., over a cemetery."

The accuracy level of the method of analysis used ranges between 95-98% recovery. The method extracts <u>total phosphorus</u>, i.e., both organic and inorganic phosphorus compounds.

Inorganic compounds are a) those containing calcium, and b) those containing iron and aluminum. Organic compounds are, among others, a) phytin and phytin derivates, b) nucleic acids, and c) phospholipids. The solubility of inorganic calcium compounds increases with the increased simplicity of the compound, but the simpler compounds are available in very small quantities and they easily revert into insoluble states.

The fixation of added phosphates, when the pH value is in the range of a little less than 8.0 to 8.5, is mostly in the form of calcium phosphates.

In alkaline soils, phosphates will react with the calcium ion and with calcium carbonate. The next step includes a conversion of the calcium phosphate ($Ca_3(PO_4)_2$) to insoluble compounds, such as hydroxy, oxy, carbonate, and fluorapatite (insoluble apatite compounds are formed at pH levels of above 7.0) compounds, the latter being the most insoluble compound known. An excessive amount of calcium carbonate ($CaCO_3$) produces very insoluble compounds.

At a pH level of between 6.0 and 7.0 the fixation is at its minimum.

It is not within the scope of this paper to fully describe the extremely complex and incompletely investigated phosphorus cycle. The behavior of phosphorus in water systems will be discussed in the interpretive section (4.2).

3.3 Potassium

The following assumptions are made in the NPS research design concerning the effects of inundation on amounts of potassium:

-- potassium is likely to be leached downward upon inundation, and

-- the potassium level in the flooded area is much lower than the unflooded area, and it is probably being washed out.

. these assumptions it is hypothesized that:

H_3 "Site inundation will wash out potassium salts from the upper strata of a site, but should not affect the potential analysis of potassium values below those levels saturated by lake water."

Sandy soils are comparatively low in amounts of total potassium. The unavailability of potassium to higher plants is similar to the phosphorus situation, but unlike phosphorus much of potassium is lost by leaching. Relatively unavailable forms (feldspars, micas, etc.) constitute 90-98% of total potassium; slowly available potassium (nonexchangeable, fixed) is 1-10% of total potassium, and relatively available potassium (exchangeable and solution) in the soil is 1-2% of all potassium. These figures are based on the situation in an average mineral soil.

Four factors are known to govern the potassium fixation in the soil:

1. The nature of the soil colloids. Vermiculite and illite clays readily fix potassium in large amounts,
2. wetting and drying,
3. freezing and thawing, which results in the release of fixed potassium, and
4. the presence of excess lime. Well-limed soils fix potassium better than acid soils. It has been shown that potassium deficiency is the result of the presence of excess calcium carbonate ($CaCO_3$).

The amount of potassium lost annually by leaching and erosion is greater than losses of nitrogen and phosphorus, but mostly not as great as losses of calcium and magnesium.

3.4 Sodium

Analysis of sodium was initially not included in the NPS research design.

Sodium is essential to higher animals in regulating the composition of their body fluids, and to some marine organisms, but it is dispensable for many bacteria and most plants, except for the blue-green algae (i.e., the fresh water algae).

The accumulation of neutral soluble salts, such as sodium, calcium, and magnesium chlorides and sulfates, is caused by impeded drainage of arid region soils. The products are excessive surface evaporation and an accumulation of the soluble salta in the surface horizon (cf. salinization). If these soluble salts are dominating, only a small amount of exchangeable sodium is present. The soil is classified as saline and has a pH value usually below 8.5. The soluble salts can easily be leached out in saline soils. This is, agriculturally, done through eradication, i.e., heavy and repeated applications of water (low in sodium), which dissolves the salts and carries them off through tile drains. This methods works especially well with saline soils, where salts are high in calcium and magnesium.

Fresh waters contain small and variable amounts of sodium and potassium, usually in the ratio of from 1:1 to 4:1.

3.5 Calcium and magnesium

High amounts of calcium present at an inundated site were suggested in the NPS research design to be the result of the disintegration of the shell and bone that had previously been present in the site soil.

The calcium and magnesium components of a soil system are integrated in a very complex way. Therefore, only relationships and processes relevant to effects of inundation are discussed.

Calcium and magnesium are macronutrients, i.e., they are used in relatively large quantities by plants. In agriculture, they are added to acid soils in limestone and are called lime elements. Much of present soil calcium and magnesium are held on the surfaces of the colloids as adsorbed cations. Cations are easily released to the soil solution by exchanging with other positively charged ions, hence, the term "exchangeable cations." Assuming that hydrogen from an ocid such as carbonic acid replaces calcium from the soil colloids, the general reaction for calcium is as follows:

$$\mathrm{Ca}\ \boxed{\begin{matrix}\text{Colloidal}\\ \text{surface}\end{matrix}} + 2H_2CO_3 \longrightarrow \begin{matrix}\mathrm{H}\\ \mathrm{H}\end{matrix}\ \boxed{\begin{matrix}\text{Colloidal}\\ \text{surface}\end{matrix}} + Ca(HCO_3)_2$$

Adsorbed calcium	Carbonic acid	Adsorbed hydrogen	Soluble bicarbonate

Much of the calcium becomes mobile through this reaction. The cation exchange replacement occurs very easily and rapidly. Therefore, soils which contain considerably more total potassium than total calcium release the calcium to the soil solution and to leaching much more generously. The same reaction serves for transfer of magnesium.

When exchangeable calcium and magnesium are lost by leaching, the pH value should gradually decrease. In arid regions there should be a general relationship between soil pH and exchangeable calcium and magnesium, except in cases when a large amount of sodium is adsorbed. Arid region soils lack extensive leaching because of low precipitation, and leave the base status of these soils high, i.e., high amounts of potassium, sodium, calcium, and magnesium should be present. A normal soild should have an accumulation of calcium carbonate somewhere in the profile. The drier the climate, the closer to the surface this accumulation will be placed in the soil profile.

Calcium and magnesium are lost in three ways: 1) by erosion; 2) by crop removal, and 3) by leaching. Loss of calcium is greater than loss of magnesium. This is because there is always a larger amount of calcium present in an exchangeable condition. Because liming material contains more calcium than magnesium, this loss ratio will generally be maintained. A low precipitation produces an upward movement and evaporation of water resulting in the accumulation of salts at the soil surface, and because these bases dominate the adsorption, a pH value of 7.0 and above will result.

(Note: This chapter has been based mainly on data from The Nature and Properties of Soils by N. C. Brady.)

4. INTERPRETATION

The reader should have in mind that the interpretations are made with the use of the "control-site approach," and that their validity is seriously affected by this circumstance. Although certain relationships seem to exist, their presence could be totally incidental because of the large number of non-controllable variables of the "control-site approach" (i.e., variation in human behavior and lack of information of water chamistry, etc., as outlined in the proposed sampling design). If the suggested sampling model were followed, there would not be any doubts about the validity of the interpretation because non-controllable variables would have been eliminated. In spite of this, the author is of the opinion that, because of sample size; fitness of data to models of environmental change due to pollution; and the general trend in the comparison of an inundated and an uninundated archaeological environment, the results can partially be considered as representative.

Further, the assumptions made in the NPS research design apparently were built upon the analysis done on <u>four</u> samples (two from inundated and two from uninundated proveniences) from a Chesbro Reservoir site (4SCL52). Four samples, two from each environment, are most certainly not a sample large enough to reach <u>any</u> conclusions. In addition, the "control-site approach," and simple incorrectness concerning the solubility of phosphorus (phosphine) gave rise to assumptions not at all related to the real situation.

(Data on phosphine from chemical dictionary: phosphine is soluble in alcohol, ether and cuprous chloride; slightly soluble in cold water; insoluble in hot water. It is very unlikely that, if phosphorus actually were transferred into phosphine, it would be dispersing.)

Because no explanatory models of an archaeological nature and no comparative studies exist, it becomes extremely difficult to reach conclusions from the present analysis. Except for phosphorus, there are no explanatory models which could be used. The situation is thus one involving extreme interpretative difficulties: the data as such could be characterized as non-usuable because of the "control-site approach." The general trends in the data could be of incidental nature, and because the chemistry involved in inundation has not previously been investigated, we do not know what is actually taking place.

4.1 pH

There does not seem to be any distinct change of the pH value in either direction. A minimal trend towards a slightly more alkaline environment is noticeable. The range of pH varies from slightly to moderately alkaline, both prior to and after inundation. Smaller differences in pH cannot be said to be a result of inundation (see above, p. 12). At a pH level of over 8.0 the exchangeable bases predominate, which is seen in the data by the relatively large amounts of salts, especially potassium and calcium, in both environments. A lowering of the pH level would mean stable and sociated hydrogen, but an increasing pH level would mean dissociated hydrogen with a negative charge on the colloid, recharged by metallic cations. The relationship in mineral soils between pH on the one hand and microorganism activities and availability of plant nutrients on the other indicates that at a pH level of around 8.5 only the availability of phosphorus is decreasing.

The pH level of the uninundated site, AR-512, does not, after a general inspection, show a distinct meaningful pattern, and neither does the pH level of the remaining inundated sites. There seems to be a minimal difference of the pH between inundated and unindated environments. Thus, the pH level of the reservoir water seems to have no effect. It is likely that the concentration of H ions in the water is similar to that of the soil in the Abiquiu Reservoir area. The pH level in dry environments is often the more dependable variable, and because of this, it is recommended that the relationship between pH and the other elements be investigated with computerized techniques.

Mullins (1977:376) reports that the pH level in natural systems ranges between 7.0-8.5, and that the main species in solution is the bicarbonate ion, which most easily makes carbon available to equatic organisms. If the pH level is drastically changes, the result is a depletion of carbon and disappearance of microorganisms from the area.

4.1.1 pH at AR-4

In the same way as the "control-site approach" is not usable, the comparison of different features, even of same type and from same site, is not likely to yield usable data. In this case, the sample is also much too small.

AR-4:	UNINUNDATED FEATURES			INUNDATED (flooded) FEATURES	
Feat.	Type	pH	Feat.	Type	pH
A-1	dwelling, lookout	7.95	BF-15	compound, rooms, corral	8.12
C-2	dwelling	8.33	BE-16	compound, floor	7.99
D-3	dwelling, hearth	7.69	BD-17	compound, fill	8.22
D-4	dwelling, midden	8.23	B-18	compound, fill	8.21
D-5	dwelling, floor, hearth	8.19	BD-19	subfloor	7.79
E-6	dwelling(?)	8.51	BD-20	room, 2nd floor	8.18
E-7	dwelling(?), midden	8.31	K-21	corral, midden	8.61
G-8	lamb pen or dwelling, fill	8.31	K-22	corral, fill	8.19
G-9	lamb pen or dwelling, fill	7.79	L-23	lamb pen or dwelling	8.29
G-10	lamb pen or dwelling, fill	8.24	L-24	manure	7.98
G-11	lamb pen or dwelling, fill	8.17	L-25	manure	8.14
G-12	lamb pen or dwelling, fill	7.67			
I-13	sweatlodge(?), fill	8139			
J-14	dwelling(?), fill	8.36			

What was said in section 4.1 is applicable to the pH environment at AR-4

4.2 Phosphorus

The representative percentage of phosphorus in an arid region mineral surface soil is report by Brady (1974:24; Table 2:3) to be 0.07% (700 ppm). Stream water normally contains 20 parts per billion or 0.02 ppm phosphorus (Garrels et al. 1975:34; Table 5). Except for a few samples from features, the level of 700 ppm to not reached by the majority of the samples. In fact, the amounts of present phosphorus are extremely low in both the uninundated and inundated environment.

The tendency for phosphorus to increase and to even out slightly is the only effect, so far, of inundation that can be "explained."

Eutrophication refers to the enrichment of water by plant nutrients. The term means "well-nourished." The nutrients of most importance are nitrogen, carbon, and phosphorus, but it is still not known whether lower phosphate levels in natural waters will result in slowing down the eutrophication process (Stoker and Seager 1977:425).

The question whether carbon or phosphorus is the main cause of eutrophication has turned into a controversy. The carbon group believes that the sediment is a vast reservoir of phosphorus, that all the phosphorus is available, and that increases or decreases in phosphate concentrations have no effect on algal growth. The phosphorus group believe that the sediment is a sink rather than a source, and that phosphate concentration is directly related to algal growth. If phosphorus and carbon are available in excess, then nitrate becomes the growth limiting nutrient, but since phosphorus has a limited sphere of cycling, the sedimentation effect is a controlling factor. Schindler et al. (1973) report from a lake system that 80% of incoming phosphorus was sedimented and that no return was noted. Upchurch et al. (1974) showed that availability of phosphorus from sediments decreased from the fresher water to the saltier water, and that this decrease related closely to the quantity of iron present. Williams et al. (1970) report that calcareous lake sediments will absorb and retain less added phosphorus than non-calcareous lake sediments, and they also show that the ability of a sediment to absorb added phosphorus decreases with an increase in the phosphorus concentration (Mullins 1977:382-384).

With this background data in mind, we look at the Abiquiu Reservoir. It seems possible to compare the reservoir with a fresh water lake system, though the situations are not identical.

1. There is no doubt that aquatic phosphorus is coming into the reservoir, either carried by streams or through erosion from agricultural lands surrounding the reservoir. Even erosion and transportation of phosphorus from historic agriculture to the deposition in the original stream bed 150 years ago could be of importance (irrigation water carried phosphorus).

2. Being a fresh water system the availability of phosphorus to organisms should be advantageous.

3. The calcareous sediments of the Abiquiu Reservoir would absorb and retain less added phosphorus, but

4. More important, if increased phosphorus concentrations were present (= archaeological sites, or single high peaks within a site), less absorption would occur in those areas, meaning that the increase would concentrate in areas low in sedimented phosphorus.

Mullins (1977:384) states that as the concentration of the phosphates in the water increases, the total amount absorbed by sedimentation decreases. In this way the water system phosphates could be steadily increasing, causing eutrophication.

The data from the inundated sites in the Abiquiu Reservoir tend to verify what is said under point 4, i.e. increasing average amounts and a decreasing variance between samples are two hypothetically possible products of inundation. If one archaeological site is seen as a phosphorus concentration the surrounding areas will absorb added phosphorus, and the sites will lose both chemical distinctiveness in comparison with their surroundings and the intra-site variability.

4.2.1 Phosphorus at AR-4

AR-4: UNINUNDATED FEATURES		INUNDATED (flooded) FEATURES	
Feat.	ppm P	Feat.	ppm P
A-1	730	BF-15	520
C-2	70	BE-16	390
D-3	570	BD-17	705
D-4	1070	B-18	900
D-5	500	BD-19	370

4.2.1. Phosphorus at AR-4 (cont.)

AR-4: UNINUNDATED FEATURES		INUNDATED (flooded) FEATURES	
Feat.	ppm P	Feat.	ppm P
E-6	525	BD-20	800
E-7	370	K-21	1200
G-8	365	K-22	845
G-9	520	L-23	1450
G-10	565	L-24	2700
G-11	330	L-25	3050
G-12	360		
I-13	415		
J-14	770		

There seems to be a general increase in amounts of phosphorus of samples from inundated or flooded features. Compare with the data in section 4.2.

4.3. Potassium, Sodium, Calcium, and Magnesium

No comparative or explanatory data are available relating to these elements.

For all, except sodium, there is a trend towards greater amounts. But again, this can be purely incidental.

The presence of large amounts of calcium and magnesium on the surface is due to what is said above concerning low precipitation in arid climates. Not much sodium seems to be absorbed. Calcium, in addition, forms very complex, insoluble compounds at pH values over 7.5 (cf. Cook and Heizer 1965:19).

4.3.1. Potassium, Sodium, Calcium, and Magnesium at AR-4

AR-4: UNINUNDATED FEATURES					INUNDATED (flooded) FEATURES				
Feat.	K	Na	Ca	Mg	Feat.	K	Na	Ca	Mg (ppm)
A-1	3117.7	916.2	31919.7	4457.5	BF-15	11470.9	903.6	36458.4	6042.7
C-2	6117.8	433.0	17261.9	2074.5	BE-16	17647.5	2403.3	21800.7	5819.3
D-3	6470.8	1299.0	31808.1	3553.3	BD-17	10470.9	803.2	29762.0	6329.9
D-4	10000.3	790.7	34523.9	5478.8	B-18	12059.1	489.5	33854.3	6755.4
D-5	12941.5	476.9	75800.0	6574.6	BD-19	4823.7	690.3	34709.9	5446.9
E-6	15294.5	414.2	52360.6	5798.0	BD-20	6882.5	426.7	36086.4	7744.8
E-7	5823.7	1098.1	21726.3	3872.4	K-21	10294.4	1480.9	31845.3	10340.8
G-8	9412.0	690.3	22693.5	4149.0	K-22	13235.6	75.3	18415.2	4595.8
G-9	13235.6	1123.2	21317.6	7446.9	L-23	10000.3	2458.8	41666.8	8436.3
G-10	11176.8	1612.7	22321.5	5159.7	L-24	5176.6	533.4	64552.0	12670.3
G-11	15000.4	1029.1	25111.7	5904.4	L-25	4117.8	771.8	68300.0	13272.6
G-12	5059.0	376.5	14360.2	4606.5					
G-13	7059.0	1920.2	22656.3	3723.5					
G-14	9529.7	1091.9	54806.9	4925.6					

The chemical variance shows a meaningful pattern in both the inundated and the uninundated environments, and the data do not reveal a trend in either direction (cf. section 4.3.).

4.4 Function of features at AR-4

Below are some suggestions relating to function based upon amounts of elements present in individual samples:

Feature A (sample #21)

The comparatively high amounts of phosphorus, calcium, and sodium point toward permanent occupation. The feature is described as possible lookout for the village in the site report. This is possible, chemically speaking, if such a lookout was occupied more or less continuously.

Feature B (samples 4, 5, 11, 13, 20, and 23)

None of the samples shows extreme values in either direction. The site report refers to the feature as "Compound, Rooms & Corral." If sample # 13 comes from the corral part of the compound, this function is likely (cf. samples #10 and 17) due to organic accumulation resulting in high phosphorus content. Samples 5 and 20 seem to come from identical strata. The flooding effects on the chemical variation of feature B seem to be limited, though this feature was reported to have been worst damaged in the 1973 flood.

Feature C (sample 19)

Feature C is described as "dwelling" with "one of the best trash areas on AR-4" outside of it. That it is a dwelling may be true, but whether or not this dwelling was occupied by living beings is questionable because of the extremely low amounts of all elements. The feature has most certainly not contained animals, and if humans occupied it, they seem to have been extremely careful, specifically in this case, to dispose of their waste outside of the building, creating this "good trash area." In comparison, other floor samples reveal such information that one can conclude that some trash material ended up on the floors inside the buildings.

<u>Feature</u> <u>D</u> (samples 1, 2, and 9)

The amounts of phosphorus in the hearths suggest heating function only. Sample 2 verifies rich organic waste (P value of 1070). The area of sample 9 with a calcium content of 7.58% suggests an activity involving waste very rich in calcium, such as bone, egg shells, or oyster shells.

<u>Feature</u> <u>E</u> (samples 12 and 18)

The function of dwelling is probably correct. The low amounts of phosphorus points toward a short or seasonal occupation. The high calcium value of 5.24% indicates deposition of calcium rich waste.

<u>Feature</u> <u>G</u> (samples 6-8, 16, and 22)

In choosing between a function of dwelling or lamb pen, the results of the chemical analysis definitely points towards dwelling of some kind, used for activities other than those involving large amounts of organic waste. A function as lamb pen would have meant manure with much higher amounts of chemical elements present (cf. samples 24, 25, and 50-52).

Feature I (sample 14)

The amounts of present chemical elements do not contradict the conclusion of function as sweatlodge.

Feature J (sample 15)

The relatively high phosphorus and calcium amounts point toward a dwelling function (cf. Feature D).

Feature K (samples 10 and 17)

Corral is the likely function. The high amounts of calcium (cf. samples 24 and 25) make the presence of manure likely.

Feature L (samples 3, 24, 25, and 50-52)

Large amounts of manure (it is not, at present, possible to conclude if the manure is sheep manure or not) seem to result in large deposits of calcium and magnesium. Following this, samples 24, 25, 51, and 52 should come from animal keeping areas. Samples 3 and 50 show very high amounts of phosphorus, and less calcium, pointing toward an origin in an activity area rich in organic human waste.

5. CONCLUSIONS

Although an intensive search has been made for comparative data and explantory models, phosphorus seems to be the only element investigated thoroughly. This is related to the fact that environmental science is very concerned with this element because of its abundance in community sewage, and its importance in natural systems.

It is not possible, at the present, to reach conclusions other than in very general terms. What is said in this report is of hypothetical character, and only further analysis of samples will falsify or verify the present study. In future sampling it is strongly suggested that a new sampling design be constructed so that non-controllable variables are eliminated and the data base widened.

5.1 Conclusions, AR-4

The effects of the 1973 flood do not seem to have affected the meaningful patterning of intra-site chemical variation. It appears that such effects occur mainly from permanent water coverage or frequently repeated flooding.

APPENDIX I:

RAW DATA

LABORATORY REPORT

SITE: AR-512

ppm (1% = 10000 ppm)

#	Provenience	pH	P	K	Na	Ca	Mg
62	grid E3, $M^2$5, FS-97	8.37	300	7378.7	878.0	22794.1	4621.2
63	grid E4, $M^2$5, FS-98	7.36	160	4285.7	674.4	11557.8	2750.0
64	grid E5, $M^2$5, FS-99	7.85	270	10381.0	636.4	17000.0	3787.9
65	grid E6, $M^2$5, FS-200	8.01	310	10693.1	568.2	26082.2	4356.1
66	grid E7, $M^2$5, FS-38	8.13	160	11386.1	409.1	13789.5	2928.6
67	grid E8-5, FS-40	8.17	165	4752.5	559.1	17906.2	2571.4
68	grid E9-5, FS-42	8.23	205	3861.4	522.7	23512.6	2964.3
69	grid E10, $M^2$9, FS-30	8.19	115	4158.4	657.3	11161.6	2142.9
70	grid E11, $M^2$5, FS-27	8.22	235	5009.9	680.8	17019.0	3598.5
71	grid E12, $M^2$5,FS-204	8.37	160	11148.5	305.2	16173.4	2750.0
72	grid F2-5, FS-95	8.41	160	6923.1	300.6	13061.2	3027.7
73	grid F3-5, FS-94	8.36	25	5692.3	260.1	3673.5	1091.0
74	grid F4-5, FS-93	8.36	100	7846.2	156.1	12347.0	2204.5
75	grid F5-5, FS-92	8.49	165	8615.4	422.0	20204.1	2977.2
76	grid F6-5, FS-91	8.52	120	9846.2	408.1	13061.2	2318.2
77	grid F7-5, FS-36	8.51	145	7846.2	202.3	12551.0	2363.6
78	grid F8-5, FS-34	8.55	55	5846.2	445.1	10816.3	1772.7
79	grid F9-5, FS-32	8.55	255	8153.8	300.6	26938.8	3863.6
80	grid F10-9, FS-25	8.52	235	6461.5	346.8	21224.5	3181.8
81	grid F11-5, FS-23	8.57	40	8153.8	242.8	6734.7	1204.5
82	grid F12, $M^2$5,FS-203	8.61	170	4944.0	169.1	29020.0	3500.0
83	grid F13, $M^2$5,FS-202	8.51	125	4494.4	352.5	17840.2	2954.5
84	grid F14, FS-201	8.48	175	6966.3	791.4	15461.5	3409.1
85	grid F15, $M^2$5, FS-90	8.49	70	16440.0	1641.5	4791.2	1749.3
86	grid F16, $M^2$5, FS-89	8.52	15	7865.2	50.4	2616.6	1090.9
87	grid F17, $M^2$5, FS-88	8.37	85	4944.0	589.9	7373.9	2750.0
88	grid D0-5, FS-53	8.50	270	6382.0	273.4	29257.8	4681.8
89	sample missing						
90	grid D(-1)-5, FS-85	8.46	120	5618.0	557.6	25452.0	3318.2
91	grid D(-2)-5, FS-87	8.48	345	6292.1	784.2	4043.8	3000.0
92	grid D2-5, FS-49	8.57	5	2696.6	723.0	2140.8	613.6
93	grid D3-5, FS-47	6.68	130	11685.4	759.0	11893.4	2681.8
94	grid D4-5, FS-45	7.43	185	8764.0	14.4	19981.0	4000.0
95	grid D5-5, FS-43	7.78	255	7640.4	7.2	22597.5	4181.8
96	grid D8, $M^2$2, FS-126	7.82	200	5842.7	7.2	16888.7	3250.0
97	grid D8, $M^2$4 ?	7.99	320	8089.9	115.4	53520.5	4954.5
98	grid D8, $M^2$4, FS-192	7.97	360	7191.0	230.8	58040.0	5636.4
99	grid D8, $M^2$5, FS-127	8.01	210	8314.6	134.6	17602.3	3409.1
100	grid D8, $M^2$8, FS-128	8.09	175	9662.9	173.1	15937.2	3159.1
101	grid D11, $M^2$5,FS-205	8.02	320	7191.0	190.6	27830.6	4818.2
102	grid E2, $M^2$5, FS-96	8.19	155	4994.0	89.1	22121.8	3818.2

SITE: AR-2

#	Provenience	pH	P	K	Na	Ca	Mg
103	Feat. B/20	8.03	125	7865.2	108.9	20456.7	2954.5
104	Feat. B: charcoal	8.12	415	10561.8	99.0	39724.1	5954.5
105	Feat. B	8.14	580	9887.6	257.4	47098.0	6522.7

SITE: AR-5

ppm (1% = 10000 ppm)

#	Provenience	pH	P	K	Na	Ca	Mg
106	Feat. Q/464; S half of hearth fill	8.37	450	6966.3	564.4	36631.8	5272.7
107	Feat. Q; North half of hearth fill	8.06	300	12359.6	297.0	36631.8	4681.8
108	T34/I; Feat. J	8.13	505	12134.8	247.5	42340.6	5409.1
109	T35/I/3; Feat. A	8.31	580	6966.3	1118.5	46860.1	5659.1
110	T35/I/4; Feat. A	8.03	505	6741.6	405.9	45670.8	5409.1
111	T36/I/3; Feat. B	8.28	560	8764.0	782.1	43054.2	5363.6
112	T36/I/5; Feat. B	8.18	560	6067.4	376.2	41627.0	5318.2
113	U39/I/466; Feat. Y	8.08	305	7415.7	346.5	36156.0	4727.3
114	Y243/I/2/321; Feat.G	7.82	590	6382.0	49.5	48525.2	5636.4
115	536/I/319; Feat. K	7.92	495	10112.4	49.5	44243.6	5272.7
116	539/I/4; Feat. C; W half	8.04	305	12809.0	618.8	31398.7	4545.5
117	539/I/5; Feat. C; E half of hearth fill	8.01	690	7191.0	668.3	41389.2	5431.8
118	Feat. L; fill	7.95	610	9663.0	321.8	49001.0	5727.3
119	Feat. S	8.09	475	6741.6	247.5	51617.5	6045.5

SITE: AR-8

#	Provenience	pH	P	K	Na	Ca	Mg
120	L/I/243	8.04	185	11685.4	346.5	12607.0	6250.0
121	M/I/244	8.03	435	11910.1	2797.0	8563.3	2204.5
122	O/III/274	8.14	375	9438.2	431.3	49952.4	6431.8
123	P/II/278	7.68	515	13258.4	255.6	38296.9	6500.0
124	S/II/282	7.82	225	9213.5	319.5	49714.6	6568.2
125	grid O-21; FS-800	8.39	410	6741.6	255.6	14747.9	4863.6
126	grid P-21; FS-801	8.27	230	12809.0	319.5	18315.9	4272.7
127	grid Q-21; FS-802	8.53	415	9438.2	351.4	37345.4	5318.2
128	grid R-21; FS-803	8.58	215	5168.5	383.4	15937.2	3681.8
129	grid S-21; FS-804	8.63	270	8314.6	287.5	19505.2	4477.3
130	grid T-21; FS-805	8.69	225	13483.1	255.6	17840.2	4409.1
131	grid U-21; FS-806	8.49	195	12359.6	367.4	13796.4	4409.1
132	grid V-21; FS-807	8.72	445	13932.6	543.1	13082.8	4818.2
133	grid W-21; FS-808	8.21	205	9438.2	447.3	17840.2	2727.3
134	grid X-21; FS-809	8.29	200	8314.6	367.4	10704.1	3636.4
135	grid O-22; FS-812	8.67	155	8314.6	447.3	26165.6	3886.4
136	grid P-22; FS-813	8.79	195	6966.3	127.8	31874.4	4386.4
137	grid Q-22; FS-814	8.81	260	16179.8	479.2	26165.6	4000.0
138	grid R-22; FS-815	8.71	185	5393.3	175.7	14747.9	3681.8
139	grid S-22; FS-816	8.93	360	7191.0	447.3	25689.8	4818.2
140	grid T-22; FS-817	8.88	380	26067.4	239.6	20694.6	5113.6
141	grid U-22; FS-818	8.79	335	15056.2	319.5	24976.2	5113.6
142	grid V-22; FS-819	8.68	290	7865.2	191.7	13320.6	4386.4
143	grid W-22; FS-820	8.30	230	10561.8	415.3	14985.7	4136.4
144	grid X-22; FS-821	8.58	220	27865.2	431.3	20694.6	4136.4
145	grid O-23; FS-824	8.86	315	9213.5	335.5	23073.3	4909.1
146	grid P-23; FS-825	8.77	280	8539.3	591.1	12369.2	4250.0

ppm (1% = 10000 ppm)

#	Provenience	pH	P	K	Na	Ca	Mg
147	grid Q-23; FS-826	8.49	235	19550.6	255.6	17602.3	3795.5
148	grid R-23; FS-827	8.72	225	12359.6	575.1	19743.1	3613.6
149	grid S-23; FS-828	8.71	165	8089.9	559.1	22835.4	3159.1
150	grid T-23; FS-829	8.83	145	7640.4	527.2	20456.7	2954.5
151	grid U-23; FS-830	8.74	235	8314.6	335.5	31160.8	4340.9
152	grid V-23; FS-831	8.83	240	8314.6	207.7	44243.6	4727.3
153	grid W-23; FS-832	8.44	400	17752.8	143.8	27354.9	5000.0
154	grid X-23; FS-833	8.48	240	7640.4	559.1	13796.4	3954.5
SITE: AR-9							
189	C/I/2	8.21	400	6741.6	255.6	52093.2	5704.5
190	D/I/15	8.16	245	10112.4	463.3	53758.0	6090.9
191	D/I/16	8.29	380	12359.6	447.3	44243.6	5454.5
192	E/I/3	8.22	235	6741.6	255.6	39961.9	4863.6
193	E/I/39	8.27	485	7640.4	702.9	49952.4	6159.1
194	F/I/29; hearth fill	8.19	235	6292.1	303.5	39486.2	4590.9
195	F/I/29	8.33	335	7865.2	367.4	46860.1	4886.4
196	L/I/2	8.51	525	8988.8	575.1	54471.9	5863.6
SITE: AR-12							
197	A/I/102	8.49	260	11236.0	623.0	53996.2	6022.7
198	M/I/106	8.31	45	9213.5	495.2	10228.4	1863.6
199	Q/I/20	8.42	210	7865.2	958.4	54709.8	5795.5
200	Q/I/22	8.48	280	10112.4	1070.3	57088.5	6068.2
1	T47/II/31c	8.71	190	13033.7	559.1	17126.5	4454.5
2	X//221	8.54	220	7415.7	575.1	37583.3	4000.0
3	X//222	8.47	255	8764.0	766.8	35918.2	3977.3
4	X//263	8.45	365	7415.7	830.7	39248.3	4522.7
5	2//262	8.46	375	9663.0	782.7	29971.5	4613.6
SITE: AR-17							
6	79/Feat. 4	8.41	390	14831.5	655.0	57088.5	6522.7
SITE: AR-21							
7	M/22/6	8.49	325	11910.1	479.2	39248.3	5681.8
8	N/22/7	8.48	315	15056.2	543.1	26641.3	6409.1
SITE: AR-23							
9	906/L_2-53;hearth 7	8.28	245	15505.6	367.4	20218.8	6727.3
10	907/L_2K_2-52,53; hearth 6	8.41	215	13707.9	575.1	11893.4	6090.9
11	859; level IV; hearth 10	8.34	310	8089.9	734.8	46146.5	5068.2
12	hearth 10	8.36	185	10561.8	686.9	42816.4	4454.5

#	Provenience	pH	P	K	Na	Ca	Mg
				ppm (1% = 10000 ppm)			
13	861; level III; hearth 4	8.26	175	13707.9	479.2	14747.9	5318.2
14	grid J2-39; FS-1000	8.31	180	13932.6	511.2	15699.3	6318.2
15	grid J2-40; FS-1001	8.42	130	12584.3	479.2	13796.4	4500.0
16	grid J2-41; FS-1002	8.50	215	11236.0	766.8	14272.1	4272.7
17	grid J2-42; FS-1003	7.83	465	10337.1	367.4	19981.0	5886.4
18	grid J2-43; FS-1004	8.21	310	15505.6	447.3	20694.6	5022.7
19	grid J2-44; FS-1005	8.29	215	7640.4	415.3	13082.8	4500.0
20	grid J2-45; FS-1006	8.49	195	9663.0	447.3	9039.0	4159.1
21	grid J2-46; FS-1007	8.08	155	12809.0	607.0	8087.5	4681.8
22	grid J2-47; FS-1008	8.09	220	12584.3	1421.7	11893.4	6590.9
23	grid J2-48; FS-1009	8.04	90	10786.5	367.4	6184.6	4636.4
24	grid J2-49; FS-1010	8.28	155	12134.8	447.3	6184.6	4909.1
25	grid K2-39; FS-1011	8.47	390	12359.6	511.2	20218.8	6340.9
26	grid K2-40; FS-1012	8.51	465	11011.2	878.6	23073.3	6295.5
27	grid K2-41; FS-1013	8.38	390	19325.8	782.7	26165.6	6000.0
28	grid K2-42; FS-1014	8.39	180	14606.7	335.5	14985.7	3659.1
29	grid K2-43; FS-1015	8.36	135	11460.7	383.4	13558.5	3659.1
30	grid K2-44; FS-1016	8.39	180	11910.1	575.1	10466.2	4136.4
31	grid K2-45; FS-1017	8.18	250	10112.4	734.8	10704.1	4636.4
32	grid K2-46; FS-1018	8.41	270	13707.9	734.8	9276.9	5681.8
33	grid K2-47; FS-1019	8.13	265	25393.3	575.1	11655.6	6522.7
34	grid K2-48; FS-1020	8.31	285	16629.2	814.7	14747.9	6045.5
35	grid K2-49; FS-1021	8.28	175	12584.3	670.9	6660.3	4818.2
36	grid L2-39; FS-1022	8.21	160	10561.8	990.4	5946.7	3636.4
37	grid L2-40; FS-1023	8.33	235	9887.6	399.4	14747.9	5136.4
38	grid L2-41; FS-1024	8.39	315	10561.8	287.5	22835.4	5681.8
39	grid L2-42; FS-1025	8.38	460	13483.1	718.8	19981.0	5772.7
40	grid L2-43; FS-1026	8.34	255	12584.3	479.2	17602.3	4590.1
41	grid L2-44; FS-1027	8.22	245	11685.4	479.2	19981.0	5522.7
42	grid L2-45; FS-1028	8.31	235	14382.0	718.8	13320.6	5500.0
43	grid L2-46; FS-1029	8.19	330	8764.0	351.4	9514.7	5454.5
44	grid L2-47; FS-1030	8.42	215	11236.0	383.4	6184.6	4863.6
45	grid L2-48; FS-1031	8.49	260	9887.6	431.3	8325.4	5500.0
46	grid L2-49; FS-1032	8.71	240	13483.1	1469.6	23786.9	6318.2
SITE: AR-413							
47	I/15/ hearth area B	8.02	75	7640.4	399.4	19981.0	3272.7
48	I/12/ hearth area A	8.12	195	9887.6	527.2	35204.6	5227.3
49	I/12/ hearth area A	8.47	240	8988.8	670.9	43767.8	5295.5
SITE: AR-4							
50	I/128/ quad. IV; Feat. L	8.16	1350	14606.7	750.8	48525.2	7045.5
51	II/78/SQK; Feat. L	8.46	455	14382.0	670.9	73739.3	7272.7
52	I/97/ quad. I; Feat. L; charcoal ash layer	8.51	360	14382.0	607.0	59467.2	6727.3

# Provenience	pH	P	K	Na	Ca	Mg
SITE: AR-32B						
53 2/A/2/ SE section; level 2	8.71	275	12584.3	559.1	39248.5	5909.1
SITE: AR-513						
54 I/3D; Feat. D; SE quarter of S section	8.59	890	10561.8	575.1	74452.9	6272.7
55 I/2C; Feat. C; SE quad.; 4"-6"	8.37	375	10337.1	591.1	62083.7	5590.9

LABORATORY REPORT

SITE: AR-4

#	Provenience	pH	P	K	Na	Ca	Mg
1	F-109-1 Feat. D, hearth	7.69	570	6470.8	1299.0	31808.1	3553.3
2	F-109, Feat. D, midden	8.23	1070	10000.3	790.7	34523.9	5478.8
3	FS-134, Feat. L, Quad IV	8.29	1450	10000.3	2459.8	41666.8	8436.3
4	CP-225-5, Feat. BF, fill	8.12	520	11470.9	903.6	36458.4	6042.7
5	CO-225-1, Feat BE, floor	7.99	390	17647.5	2403.3	21800.7	5819.3
6	AN-58-5, Feat. G3, fill	8.31	365	9412.0	690.3	22693.5	4149.0
7	AO-58-1, Feat G3, fill	7.79	520	13235.6	1123.2	21317.0	7446.9
8	AN-58-7, Feat. G3, fill	8.24	565	11176.8	1612.7	22321.5	5159.7
9	F-108-9, Feat. D, floor, hearth	8.19	500	12941.5	476.9	75800.0	6574.6
10	CJ-136-3, Feat. K, midden	8.61	1200	10294.4	1480.9	31845.3	10340.8
11	CI-223-5, Feat. BD, fill	8.22	705	10470.9	803.2	29762.0	6329.9
12	AQ-78-9, Feat. E, fill	8.51	525	15294.5	414.2	52360.6	5798.0
13	CG-224-9, Feat. B, fill	8.21	900	12059.1	489.5	33854.3	6755.4
14	X-34-1, Feat. I, fill	8.39	415	7059.0	1920.2	22656.3	3723.5
15	AK-56-4, Feat. J, fill	8.36	770	9529.7	1091.9	54806.9	4925.6
16	AR-55-8, Feat. G1, fill	8.17	330	15000.4	1029.1	25111.7	5904.4
17	CH-137-1, Feat. K, fill	8.19	845	13235.6	75.3	18415.2	4595.8
18	AN-71-7, Feat. E, midden	8.31	370	5823.7	1098.1	21726.3	3872.4
19	AS-186-7, Feat. C, floor	8.33	70	6117.8	433.0	17261.9	2074.5
20	CI-223-3, Feat. BD, subfloor	7.79	370	4823.7	690.3	34709.9	5446.[illegible]
21	CO-170-2, Feat. A, fill	7.95	730	3117.7	916.2	31919.7	4457.[illegible]

LABORATORY REPORT (continued)

SITE: AR-4

#	Provenience	pH	P	K	Na	Ca	Mg
22	AN-58-3, Feat. G3, fill	7.67	360	5059.0	376.5	14360.2	4606.5
23	Rm BD, 2nd floor, level 4	8.18	800	6882.5	426.7	36086.4	7744.8
24	Feat. L, Quad II, level 1, sheep manure	7.98	2700	5176.6	533.4	67552.0	12670.3
25	same as #24, compact layer of sheep manure	8.14	3050	4117.8	771,8	68300.0	13272.6

(see also samples 50-52, page 37.)

APPENDIX II:

LABORATORY PROCEDURES

December, 1977

Alf Sjöberg

Archaeological Lab Services
American Archaeology Division
15 Switzler Hall
University of Missouri-Columbia
Columbia, Missouri 65201

DETERMINATION OF pH

To 10 g (approximately) of soil in a 50 ml glass beaker, 20 ml of 0.01 M $CaCl_2$ was added, the solution stirred 3 times on 10 minutes intervals and then let to rest for 30 minutes, after which the pH was measured, and the result reported as "soil pH measured in 0.01 M $CaCl_2$" (Peech 1965:223).

The pH measured in 0.01 M $CaCl_2$ is about 0.5 pH unit <u>lower</u> than that measured in water using 1 part of soil to 2 parts of liquid, but the method, once developed by Schofield and Taylor (1955), has several important advantages (cf. Peech 1965:918-919).

DETERMINATION OF TOTAL PHOSPHORUS

The methodological procedure in the chemical analysis is described through the steps noted in Figure 1.

All samples were dried overnight in an oven at a temperature of around 50°C.

Samples consisting of very fine particle sizes were ground directly after having been dried, while samples with coarser particle sizes had to be screened. The choice of sieve size was made so that the sieved sample would have the same particle size as the ground one.

0.50 g of each sample was then put into a graduated digestion tube, to which were added 2 ml of Perchloric Acid ($HClO_4$) and Nitric Acid (HNO_3) respectively.

The tubes were then placed in an aluminum heating block under a perchloric acid fume hood (Blanchar, Rehm and Caldwell 1965). The HNO_3 was boiled off at a temperature of 170°C. After a stepwise increase to 225°C the remaining $HClO_4$ was left to boil for 1 hour. The tubes were checked regularly so that none of them boiled dry. If the volume in the tubes placed in the center of the heating block had decreased to a minimal level, they were exchanged with tubes from outer positions of the block. The different rate of decrease of sample volume within the tubes is caused by the significant temperature difference between the center and peripheral positions of the block.

After the digestion, the volume of each tube was raised to 50 ml with distilled H_2O, stirred, and left to rest for a period

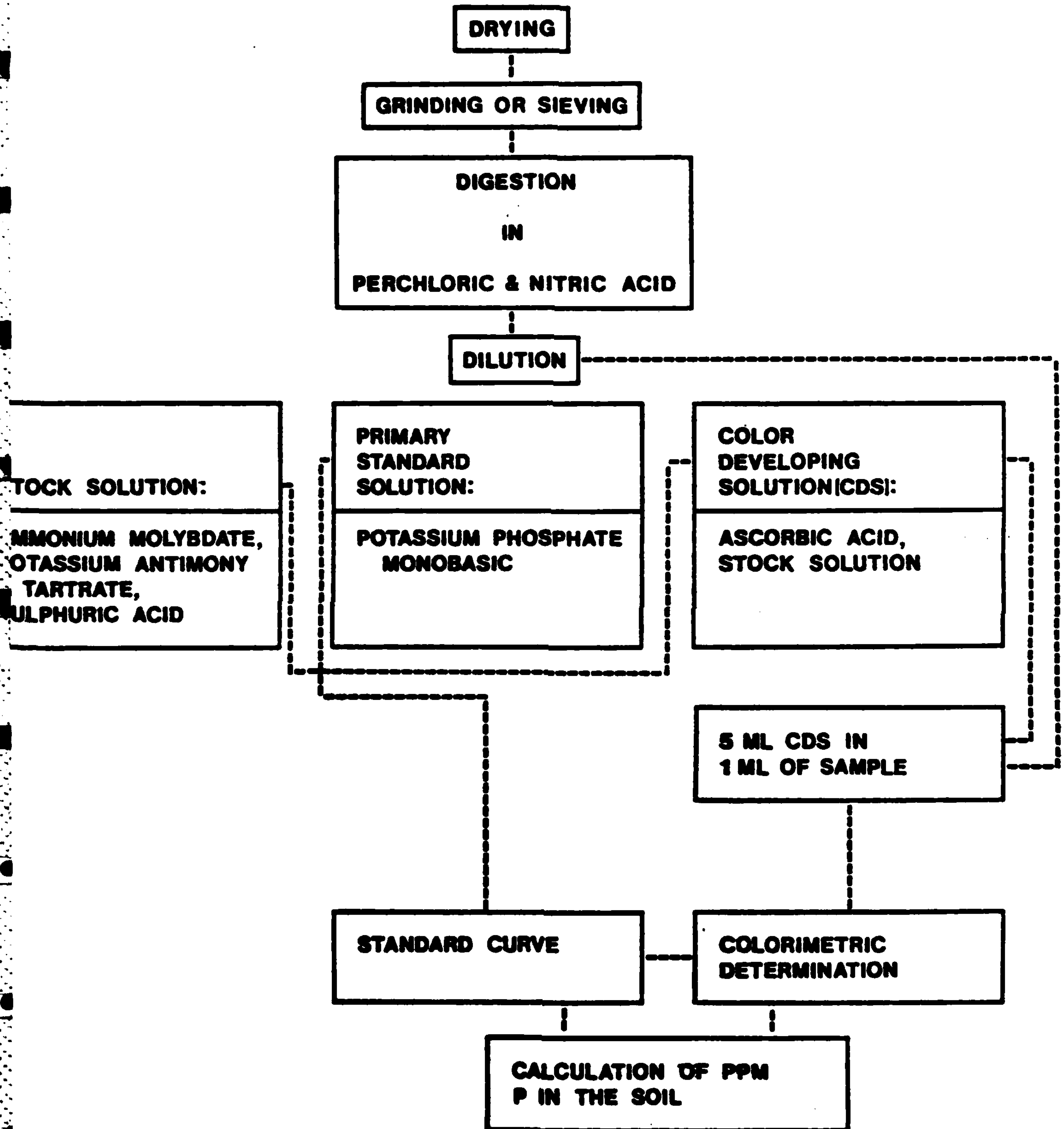


Fig. 1. Analytical procedures for total phosphorus determination

of at least 12 hours.

A stocksolution was made according to a modification of the Murphy and Riley (1962) reagent, consisting of: a) 9.0 g Ammonium Molybdate ($(NH_4)_6Mo_7O_{24} \cdot 4H_2O$) and 0.2 g Potassium Antimony Tartrate ($K(SbO)C_4H_4O_6 \cdot 1/2H_2O$), which were mixed in 500 ml of H_2O, and b) 65 ml Sulphuric Acid (H_2SO_4) and 335 ml of H_2O. Being initially mixed separately, the a) and b) reagents were mixed together and the volume raised to 1000 ml with H_2O.

A primary standard solution, with a concentration of 1000 ppm (parts per million) P, was made by dissolving 4.387 g Potassium Phosphate Monobasic (KH_2PO_4) in sufficient H_2O to yield 1000 ml. A secondary standard solution, with a concentration of 10 ppm P, was made by adding 40 ml $HClO_4$ to 10 ml of the primary standard solution and diluting with H_2O to a volume of 1000 ml. Working standard solutions ranging from 1 to 6 ppm P were made from the secondary standard solution.

The color developing solution, freshly made for every batch of 100 samples, consisted of 2.0 g Ascorbic Acid mixed with 200 ml of the stock solution and raised to 1000 ml with H_2O.

5 ml of the color-developing solution was added to 1 ml of each of the working standard solutions as well as to 1 ml of the samples. After 1 hour their absorbances were read on a Spectronic 20 colorimeter at a wavelength of 740 nm. The absorbance of the standards was plotted against the known concentration. From this graph the concentrations of the soil samples were calculated (cf. Fig. 2).

This method is a combination and modification of several (Ahler 1973; Blanchar, Rehm and Caldwell 1965; Frei, Peyer and Schütz 1964; and Murphy and Riley 1962). Information relating to the analytical procedure can be found in Eidt and Woods (1974), Proudfoot (1976), Provan (1971), and Woods (1977), among others.

Jackson (1958:175) describes four method for extracting total Phosphorus. The second method mentioned by Jackson is similar to the one used for the present analysis. The chemical analysis, as described above, is accurate and has good reproducibility. A linear regression of P content and absorbance gave a correlation coefficient (r) of 0.9998 (cf. Frei, Peyer and Schütz 1964:324). The regression line plotted in Figure 2 is based upon the mean absorbance from 6 standard curves. The linear relationship between absorbance and concentration is evidently true judging from the r value of 0.9998 and the straight line. One of the absorption laws, Beer's law, states the following: "the fraction of light absorbed is directly proportional to the concentration of the colored constituent (Kirk-Othmer 1964:788-789). The chemical analysis conforms closely to Beer's law: the slope of the regression line is just below optimal linearity as is expressed by the regression equation $y = 0.0957x + 0.0028$. A direct proportionality, as stated by Beer's law, would have meant $y = 0.1x$.

The analysis was done with partial use of equipment and facilities of the Department of Agronomy, University of Missouri at Columbia.

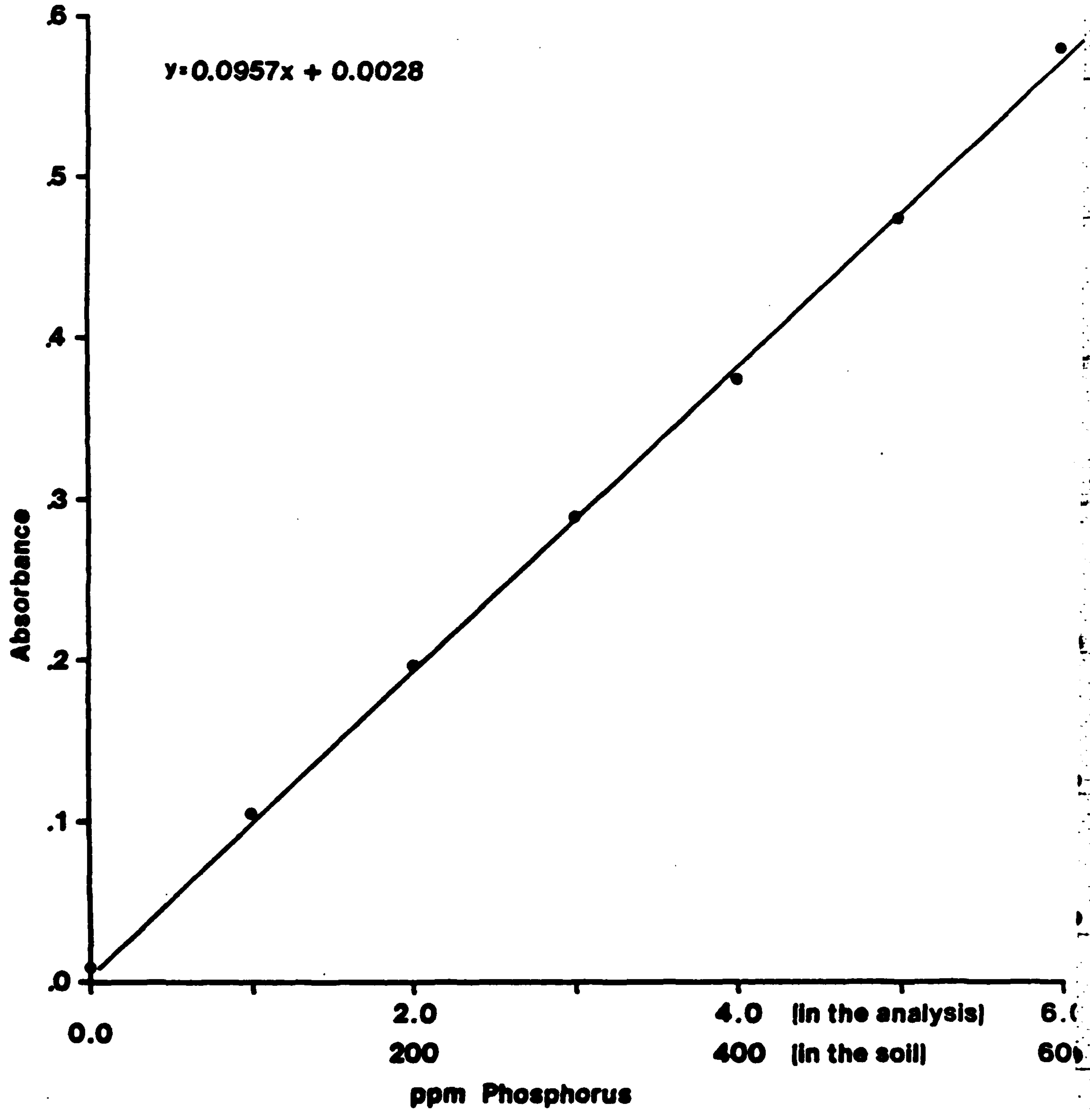


Fig. 2. Standard curve for total phosphorus determination

DETERMINATION OF TOTAL POTASSIUM

After a 500 fold dilution and an addition of 5 ml Lanthanum, the digest resulting from the total P determination, containing $HClO_4$ only, was used for total Potassium determination.

This was done with Flame Emission Spectrometry (air/acetylene flame) on a Jarrell-Ash # 82-000; 0.5 m Ebert Spectrometer (cf. Tite 1972:264-266).

The analysis was done with equipment and facilities of the Department of BioChemistry, University of Missouri at Columbia.

DETERMINATION OF TOTAL SODIUM

After a 50 fold dilution and an addition of 2.5 ml Lanthanum, the digest resulting from the total P determination, containing $HClO_4$ only, was used for total Sodium determination.

This was done with Flame Emission Spectrometry (air/acetylene flame) on a Jarrell-Ash # 82-000; 0.5 m Ebert Spectrometer (cf. Tite 1972:264-266).

The analysis was done with equipment and facilities of the Department of BioChemistry, University of Missouri at Columbia.

DETERMINATION OF TOTAL CALCIUM

After a 50 fold dilution and an addition of 2.5 ml Lanthanum, the digest resulting from the total P determination, containing $HClO_4$ only, was used for total Calcium determination.

This was done either with Flame Emission Spectrometry (nitrous oxide/acetylene flame) on a Jarrell-Ash # 82-000; 0.5 m Ebert Spectrometer or with Atomic Absorption Spectrometry on a Perkin-Elmer Model 303 Atomic Absorption Spectrophotometer. (cf. Tite 1972:264-266).

The analysis was done with equipment and facilities of the Department of BioChemistry, University of Missouri at Columbia.

DETERMINATION OF TOTAL MAGNESIUM

After a 50 fold dilution and an addition of 2.5 ml Lanthanum, the digest resulting from the total P determination, containing $HClO_4$ only, was used for total Magnesium determination.

This was done with Atomic Absorption Spectrometry (Magnesium Hollow Cathode Lamp; air/acetylene flame) on a Jarrell-Ash # 82-000; 0.5 m Ebert Spectrometer or on a Perkin-Elmer Model 303 Atomic Absorption Spectrophotometer (cf. Tite 1972:264-266).

The analysis was done with equipment and facilities of the Department of BioChemistry, University of Missouri at Columbia.

6. REFERENCES

Ahler, S. A.

1973 Chemical Analysis of Deposits at Rodgers Shelter, Missouri. Plains Anthropologist 18:116-131.

Blanchar, R. W., G. Rehm, and A. C. Caldwell

1965 Sulfur in Plant Materials by Digestion with Nitric and Perchloric Acid. Soil Science Society of America Proceedings 29:71-72.

Brady, N. C.

1974 The Nature and Properties of Soils. MacMillan Publishing Co. Inc., New York

Cook, S. F. and R. F. Heizer

1965 Studies on the Chemical Analysis of Archaeological Sites. University of California Publications in Anthropology #2. University of California Press, Berkeley and Los Angeles.

Eddy, F. W. and H. E. Dregne

1964 Soil Test on Alluvial and Archaeological Deposits, Navajo Reservoir District. El Palacio 71:5-21.

Eidt, R. C. and W. I. Woods

1974 Abandoned Settlement Analysis: Theory and Practice. Field Test Associates, Shorewood, Wisconsin.

Frei, E., K. Peyer, and E. Schultz

1964 Untersuchungen uber die Phosphorsaurebestimmung mit Molybdanblau in Bodenextrakten. Schweizerische Landwirtschafliche Forschungen 3:318-328.

Garrels, R. M., R. T. Mackenzie, and C. Hunt

1975 Chemical Cycles and the Global Environment. Assessing Human Influences. William Kaufmann Inc., Los Altos, California

Garrison, E. G.

1977 Modeling Inundation Effects for Planing and Prediction. In Conservation Archaeology. A Guide for Cultural Resource Management, edited by M. B. Schiffer and G. J. Gumerman, pp. 151-156. Academic Press, New York.

Kirk-Othmer

1964 Encyclopedia of Chemical Technology. John Wiley and Sons, New York.

Lenihan, D. J., T. Carrell, T. S. Hopkins, A. W. Prokoptex, S. L. Rayl, and C. S. Tarasovic

1977 The National Reservoir Inundation Studies Project Preliminary Report. Southwest Cultural Resource Center, National Park Service, Santa Fe, New Mexico.

McIntyre, A.

1977 Soil Chemistry Changes at 4SCL52. In The Archaeological Resources of Chesbro Reservoir, edited by J. C. Winter. Society for California Archaeology. Occasional Papers in Cultural Resource Management #1.

Mullins, T.

1977 The Chemistry of Water Pollution. In Environmental Chemistry, edited by J. O'm. Bockris, pp. 331-400. Plenum Press, New York.

Murphy, J. and J. P. Riley

1962 A Modified Single Solution Method for the Determination of Phosphate in Natural Water. Analytica Chimica Acta 27:31-36.

Peech, M.

1965 Hydrogen Ion-Activity. In Methods of Soil Analysis edited by C. A. Black, pp. 914-926.

Proudfoot, B.

1976 The Analysis and Interpretation of Soil Phosphorus in Archaeological Contexts. In Geoarchaeology, edited by D. A. Davidson and M. L. Shackley, pp. 93-113.

Provan, D. M. J.

1971 Soil Phosphate Analysis as a Tool in Archaeology. Norwegian Archaeological Review 4:37-50.

Schindler, D. D., H. King, R. V. Schmidt, J. Prokopowich, V. E. Frost, K. A. Reid, and M. Capel

1973 In J. Fish. Research Bd. Can., 30(10):1415-1440.

Schofield, R. K. and A. W. Taylor

1955 The Measurement of soil pH. Soil Science Society of American Proceedings 19:164-167.

Stoker, H. S. and S. L. Seager

1977 Organic Chemical Pollution: Petroleum, Pesticides, and Detergents. In Environmental Chemistry, edited by J. O'M. Bockris, pp. 401-427. Plenum Press, NY.

Tite, M. S.

1972 Methods of Physical Examination in Archaeology. Seminar Press, New York.

Upchurch, J. B., J. K. Edzwald, and C. R. O'melia

1974 Env. Sci. Tech., 8(1):56-58.

Williams, J. D., J. K. Syers, R. F. Harris, and D. E. Armstrong

1970 Env. Sci. Tech., 4(6):517-519.

Woods, W. I.

1977 The Quantitative Analysis of Soil Phosphate. American Antiquity 42:248-252.

END

FILMED

5-83

DTIC