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THE ARCHEOLOGY OF SIVU'OVI
THE ARCHAIC TO BASKETMAKER TRANSITION AT PETRIFIED FOREST NATIONAL PARK

by
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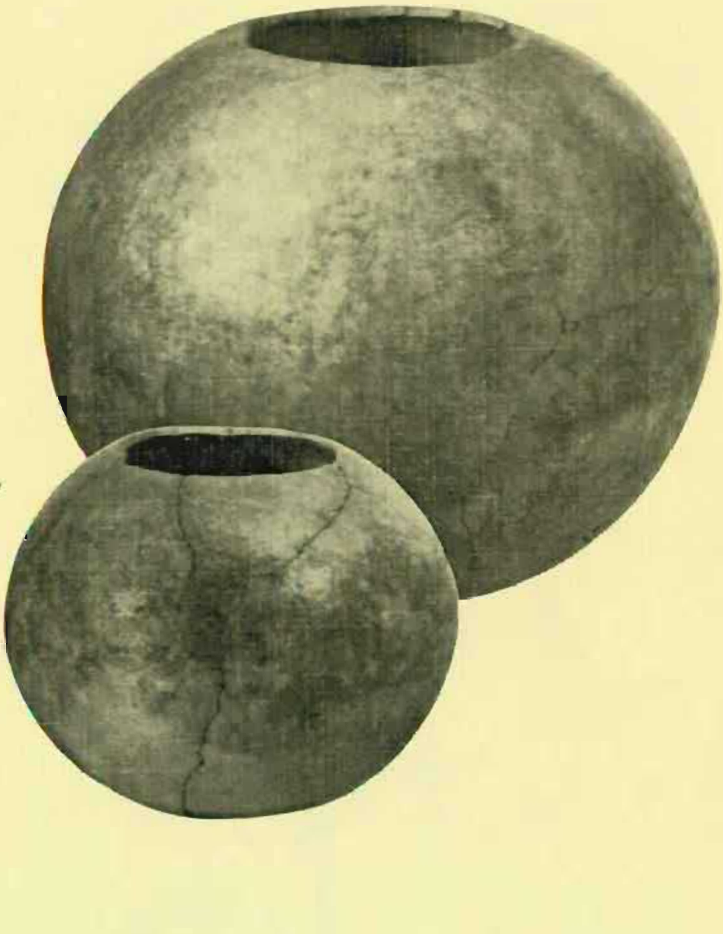

Western Archeological and Conservation Center
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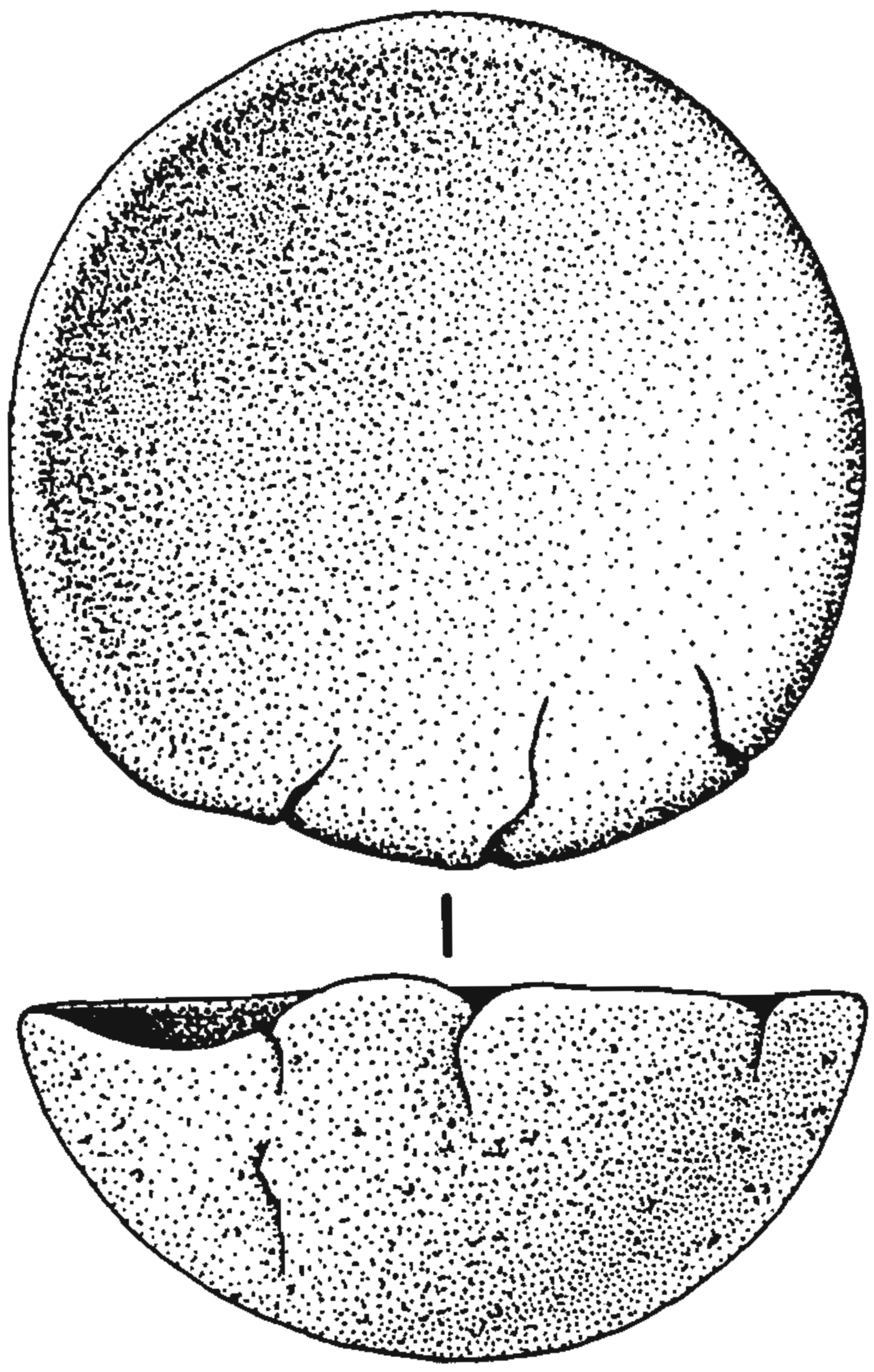

"One will always find something new and interesting with each trip . . ."

A. C. Vroman, *Photography in the Great South-West,* 1901.

Abstract

During 1989 and 1990, small-scale excavations were conducted at Sivu'ovi (AZ Q:1:114 [ASM]), Petrified Forest National Park, Arizona. Sivu'ovi is a large (12-acre) Basketmaker II site that includes the remains of over 45 pit structures. Also within the site boundary, but not tested as part of the current fieldwork, are several small field houses that date to a later Pueblo period occupation. The site contains an abundance of artifacts on the surface, including Adamana Brown pottery, the earliest identified ware in the region.

Two eroding pit structures, two extramural units, and five shovel tests were excavated at the site. In addition, archeologists conducted a systematic surface collection of artifacts in a 180-square-meter area. Over the course of the project, two extramural features were excavated and three main stratigraphic divisions were discerned. Over 3,600 artifacts, ecofacts, and other samples were collected, including four complete or fully restorable Adamana Brown vessels, a partially restorable Adamana Brown vessel, 1,072 sherds, over 2,600 flaked stone artifacts, 26 ground-stone artifacts, numerous and varied floral and faunal remains, and over 35 other artifacts and samples. Analyses included soil chemistry, pollen, macrobotanical, and faunal analyses, ceramic and flaked stone classification, radiocarbon, archaeomagnetic, and obsidian hydration dating, and x-ray fluorescence sourcing of obsidian. The current project also allowed a re-evaluation of data (including radiocarbon dating) from the contemporaneous Flattop Site.

Chronometric data indicate a pre-A.D. 300 date for occupation at Sivu'ovi and the Flattop Site, perhaps as early as 300 B.C. at Sivu'ovi. However, occupation from A.D. 1 to 200 may be the best estimate at this time for the Basketmaker II occupation at both sites. These are the earliest dates yet for sites with ceramics in the middle Little Colorado River region. Lithic analysis indicates that the lithic technology, with a high percentage of formal tools and faceted platforms, shows stronger affinities with the Archaic tradition than with the later Pueblo period, while ground stone at Sivu'ovi most resembles Pueblo period types. In both respects Sivu'ovi appears to be transitional between the Archaic and Pueblo periods.

Pollen, floral, and faunal analyses indicate that the natural environment at the time of occupation of Sivu'ovi was roughly similar to present conditions, but may have been slightly wetter. The ubiquity of maize in the floral and pollen samples suggests a heavy dependence on maize agriculture, but several species of wild plants were used as well. Although limited in number, faunal remains tentatively indicate that jackrabbit, prairie dog, artiodactyls, and turtle were procured. Architecture and artifact caches at both Sivu'ovi and the Flattop Site indicate that the locales served as warm-season residential sites.

Testing confirmed that Sivu'ovi contains abundant and varied data, and further work at the site is recommended to mitigate the effects of continued erosion and to realize more of the site's information potential.

Project Summary

Project Name: Basketmaker site salvage.

WACC Project Number: PEFO 1989 A.

Park Package Number: None.

Type of Project: Archeological testing.

Project Archeologists: Jeff Burton, Don Christensen, Kathy McConnell, Heidi Fassler, Ron Beckwith, Pam Thorne, members of the WACC staff, and volunteers Frank and A. J. Bock, Greg and Faith Caffey, Dwayne Cassidy, Bob Cooper, Frank Enoch, Melody Krueger, Dick Lord, Dessamae Lorrain, Jack, Pat and Sandy McCreery, Allen Scott, Brian Small, and Jim and Kitty Stoddart.

Fieldwork Dates: August 15-31, 1989, July 17-19, and September 1-3, 1990.

Person Days in Field: 46 (WACC), 137 (VIP), 16 (Park).

Project Location: Sivu'ovi (AZ Q:1:114 [ASM]), Petrified Forest National Park, Arizona.

Project Scope: Site mapping and inspection, surface collection of 45 2-m by 2-m units, excavation of two eroding structures, two 1-m by 2-m test units, and five shovel test units.

Summary of Management Recommendations: An ongoing program of inspection and small-scale archeological salvage is recommended to identify and retrieve important data before it is lost and to help mitigate the effects of massive ongoing erosion at the site.

Acknowledgments

Funding for the excavations at Sivu'ovi (AZ Q:1:114 [ASM]) was provided by the Petrified Forest Museum Association (PFMA) and a private donation. I thank Executive Director Dwayne Cassidy and the other members of the PFMA board for their continued support. Volunteers from the American Rock Art Research Association (ARARA) and park staff donated a tremendous amount of time and effort on behalf of this project.

Fieldwork during the first season was supervised by Kathy McConnell and Heidi Fassler. Excavation, mapping, laboratory processing, and cataloguing were performed by WACC archaeologists Ron Beckwith, Don Christensen, Marcia Donaldson, Charlotte Morris, and Pam Thorne, and volunteers Frank and A. J. Bock, Greg and Faith Caffey, Dwayne Cassidy, Bob Cooper, Frank Enoch, Melody Krueger, Dick Lord, Dessamae Lorrain, Jack, Pat and Sandy McCreery, Allen Scott, Brian Small, and Jim and Kitty Stoddart. In addition to helping in excavation, Dick Lord severed as project photographer in the field. Their excellent work, under sometimes difficult conditions, provides the basis for this report.

I thank the special consultants who contributed to the research at AZ Q:1:114, including Bill Deaver (archaeomagnetic dating), Marcia Donaldson (floral remains), Suzanne Fish (pollen analysis), Bill Gillespie (faunal remains), Richard Hughes (obsidian sourcing), Ken McIvers (soil chemistry), Tom Origer (obsidian hydration), and John Sheppard (radiocarbon dating). Trinkle Jones identified the pueblo period ceramics.

Many individuals helped in the production of the report. Trinkle Jones, as project supervisor, did all planning and budgeting for the project. She and others on the Western Archeological and Conservation Center staff provided administrative support. Ron Beckwith drafted the artifact illustrations and maps. Jim Roberts, Maree Lee Smith, Sarah Tuttle, and Michael Peters restored the ceramics. The report was edited by Mary Farrell, Linda Gregonis, and Lynne D'Ascenzo. Mary Farrell, Trinkle Jones, and Keith Anderson provided comments on the draft final report.

Mike Schiffer reviewed a draft of Chapter 4. Nancy Parezo and Carol Kramer commented on various aspects of the research design. Jeff Dean, of the University of Arizona Tree-ring Laboratory, selected and provided charcoal samples from the Flattop Site for radiocarbon dating. Jeff also allowed access to the Tree-ring Laboratory's computer to run the University of Washington's radiocarbon calibration program. The Hopi language site name was suggested by Ekkehart Malotki; it means "vessel on a high place," and refers to the pottery cache discovered at the site.

To these and others, and especially to Mary and my son Daniel, many thanks.

Jeff Burton
Tucson, Arizona

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Chapter 1
Introduction

National Park Service archeologists from the Western Archeological and Conservation Center (WACC) in Tucson conducted excavations at Sivu'ovi (AZ Q:1:114 [ASM]), Petrified Forest National Park, during August 1989 and July and September 1990. The purpose of the excavations was to salvage data that could have been lost through active sheet wash and gully erosion.

AZ Q:1:114 consists of the remains of a large Basketmaker period pit house village and several small, Pueblo period rubble mounds. The site, located on a bluff in the southern portion of the park, covers over 12 acres. Over 45 eroding pit structures have been noted at the site. Adamana Brown Ware sherds occur on the site surface; this pottery type, considered the earliest in the region, is associated with the Adamana phase, as defined by Reed (1947). Although not well-dated, the predominance of Adamana Brown suggests Sivu'ovi was occupied during the Basketmaker II period (pre-A.D. 600).

Portions of the site were first recorded in 1940 (Jepson 1941). During a survey of the Petrified Forest National Park boundary, the site was rerecorded by Jones (1986). Jones noted the importance of the Adamana phase component of the site and recommended salvage excavations. Fieldwork for the present project was limited to portions of the Basketmaker II Adamana component, where erosion threatened to destroy features.

Fieldwork at the site was conducted over two seasons. During the 1989 fieldwork, supervised by Kathy McConnell and Heidi Fassler, the site was mapped, 45 2-m by 2-m units were surface collected (180 square meters), two 1-m by 2-m units and five shovel tests were excavated, and two pit structures were partially excavated. During the 1990 fieldwork, supervised by the author, excavations were completed at the two structures, with additional floor features excavated and archaeomagnetic samples collected.

Over 3,600 artifacts, ecofacts, and other samples were collected, including four complete or fully restorable Adamana Brown vessels, a partially restorable Adamana Brown vessel, 1,072 sherds, over 2,600 flaked-stone artifacts, 26 ground-stone artifacts, numerous and varied floral and faunal remains, and over 35 other artifacts and samples. Auxiliary analyses included soil chemistry, radiocarbon dating, obsidian hydration and sourcing, pollen analysis, and archaeomagnetic dating.

The Basketmaker II period is the least studied period of occupation in the region. Prior to the work at Sivu'ovi, only two other sites dated to the Adamana phase had been excavated at Petrified Forest: Metate Ruin (briefly reported in Hough 1901, 1903) and the Flattop Site (Cosgrove 1934; Wendorf 1950, 1953). Research questions for excavation at Sivu'ovi were developed through re-analysis of data from the Flattop Site, as well as through reference to survey data and other Basketmaker studies. Research focused on subsistence, technology, and chronometrics.

The excavations provided new information on early subsistence and technology in the Petrified Forest region, and provided the first chronometric dates for Adamana Brown Ware. In this report, Chapters 2 through 4 contain contextual and background information for the excavations at Sivu'ovi, along with a reanalysis of data from the Flattop Site. The research design is discussed in Chapter 5. In Chapters 6 through 8, the site, archeological methods, and stratigraphy are described. Recovered artifacts and ecofacts are discussed in Chapters 9 through 14. In Chapter 15 I deal with the chronological placement of the site and Adamana Brown Ware and in Chapter 16 I discuss the data recovered in light of the research questions posed for the site. Recommendations for future management and research are included in Chapter 17. Results of technical analyses are included as appendices.

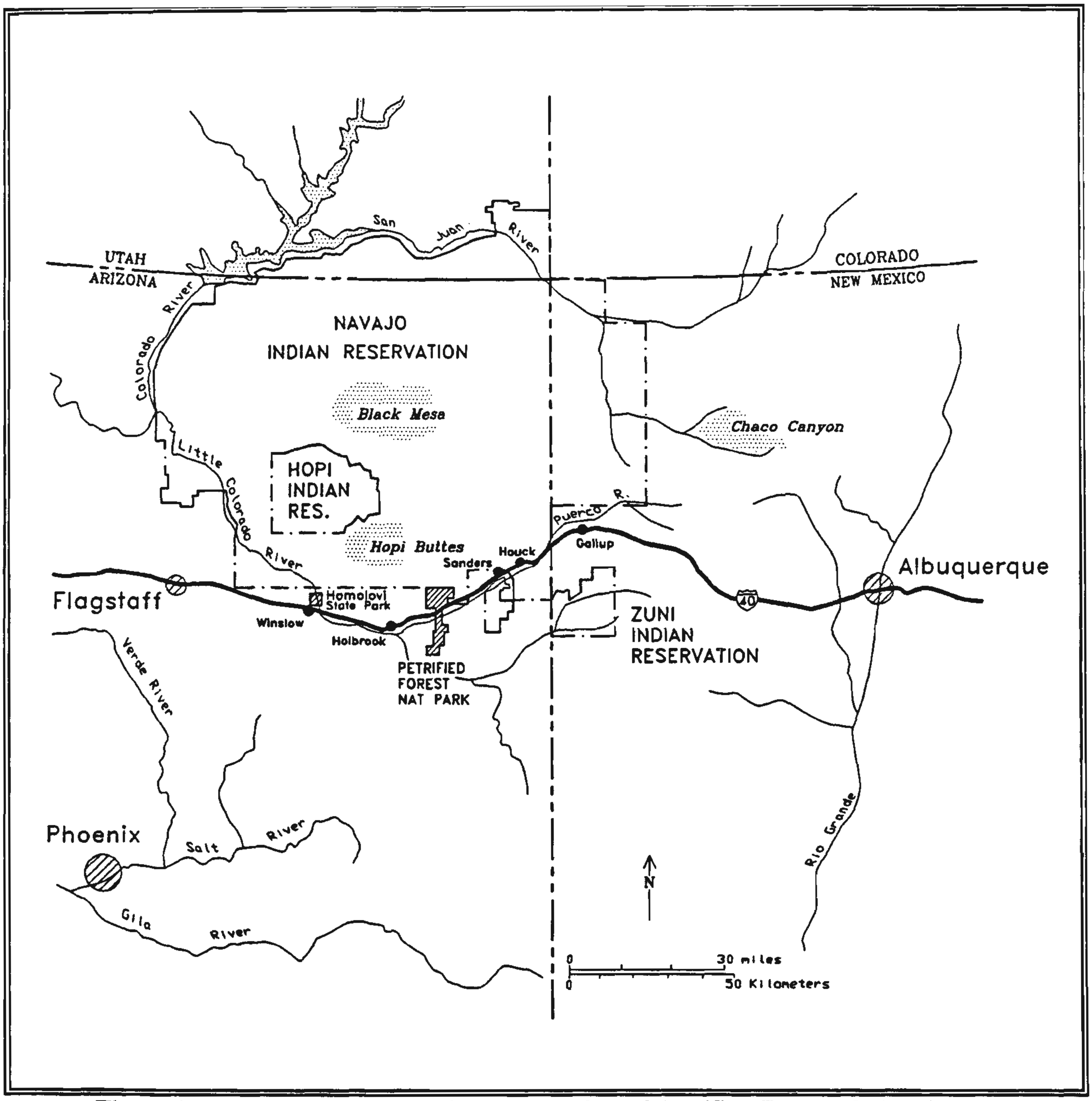

Figure 2.1. Regional map showing the location of Petrified Forest National Park.

Chapter 2
Environmental Setting
Jeffery F. Burton and Kathleen M. McConnell

Petrified Forest National Park is located in the Painted Desert region of the Little Colorado and Puerco river valleys. The park, located 32 km (20 miles) northeast of the town of Holbrook, Arizona, lies within the Colorado Plateau physiographic province (Figure 2.1). The park encompasses a variety of landforms, from rolling grasslands and mesas in the southern portion of the park to eroded badlands in the northern section. Extensive exposures of petrified wood are concentrated mainly in the southern portion of the park but occur throughout the region as well.

The site of Sivu'ovi (AZ Q:1:114 [ASM]) is in the southern portion of the park, at an elevation of 1,690 m (5,540 feet) above mean sea level (amsl). The site is on a bluff that rises 100 feet above Jim Camp Wash (Figures 2.2 and 2.3). This ephemeral wash extends along a southwest trending valley, 1.25 kilometers from the bluff edge. It drains into Cottonwood Wash, which in turn drains into the Little Colorado River 9.5 km (6 miles) south of the site.

At present the climate at the park is windy and semi-arid with an average annual precipitation of 22 cm (8.7 inches). The precipitation pattern is biseasonal, with winter storms from the north and west and summer thunderstorms generated by the flow of moisture from the south. The average frost-free period at the park is 180 days (Smith 1945), a timespan suitable for maize cultivation.

The Petrified Forest region currently has little surface water. Nearby washes are ephemeral, although water is generally present just below the surface. There are no active springs within the park, but springs may have been present prehistorically; springs at Zuni Well, Agate Bridge, and other areas in the park flowed until the 1940s (Stewart 1980).

The bedrock geology of the area consists of irregular sandstone beds separated by siltstones and mudstones. All of these beds are part of the Petrified Forest Member of the Triassic Chinle Formation. The major sandstone unit in the site vicinity is the Rainbow Forest sandstone bed, which contains colorful petrified logs. More recent sediments of the site area consist of alluvial clays and gravels overlain by aeolian sands stabilized by vegetation.

Stabilized dunes form knolls along the eastern edge of the bluff. Elevation gradually drops from east to west. A basin in the western portion of the site contains a dense silty clay alluvium. Chert cobbles and worn petrified rock are visible where erosion and deflation occur, particularly around the eastern bluff edge. Erosion of petrified wood-bearing strata overlying the site explains the abundance of petrified wood logs on the site (Billingsley 1985). Although the smaller chunks of petrified wood could have been carried to the site, the large logs appear too heavy to have been transported by the prehistoric inhabitants.

Wendorf (1953:13) suggested that within the park only aeolian soils are suitable for agriculture, because the alluvial soils are too alkaline. If Wendorf's thesis is correct, arable land appears to be plentiful in the area surrounding the site.

Vegetation

AZ Q:1:114 is located within the Plains Grassland biotic community (Brown 1982:115-121). Predominant vegetation in the site area consists of grama grass (*Bouteloua* spp.), alkali sacaton (*Sporobolus* sp.), and Indian ricegrass (*Oryzopsis hymenoides*) (Stewart 1980:figure 2). Other plants include galleta grass (*Hilaria jamesii*), ring muhly and purple muhly (*Muhlenbergia* sp.), needle grass (*Stipa comada*), amaranth (*Amaranthus graecizans*), loco weed (*Astragalus* sp.), rock sage (*Artemisia filifolia*), black sage (*Artemisia arbuscula*), four-wing salt bush (*Atriplex conescens*), shadscale (*Atriplex*

confortifolia), Mormon tea (*Ephedra antisyphilitica*), and snakeweed (*Gutierrezia sarothrae*). Succulents and cactus varieties include Whipple cholla (*Opuntia whippeli*), narrow-leaf yucca (*Yucca angustissima*), prickly pear (*Opuntia palyacantha*), and spurge (*Euphorbia* sp.). Flowering plants on the site are desert zinnia (*Zinnia acerosa*), daisy (*Erigeron caespitosus*), desert mallow (*Sphaeralcea ambigua*), wild rose (*Rosa* sp.) and mint bush (*Poliomintha incana*) (Brown 1982). A riparian zone along Jim Camp and Cottonwood washes, east of the site consists mainly of cottonwood (*Populus* spp.), willow (*Salix* spp.), and tamarisk (*Tamarix pentandra*), an exotic plant that recently has become established within the park (Johnson 1985:75).

Fauna

During fieldwork, observation of fauna was limited to pronghorn (*Antilocapra americana*), coyote (*Canis latrans*), raven (*Corvus corax*), hawks, and cattle. Recently, mule deer (*Odocoileus hemionus*), rattlesnake (*Crotalus viridis*), and migratory waterfowl have been seen in the site vicinity. Porcupines (*Erethizon dorsatum*) are common along the dry washes east of the site. Other common wildlife in the park includes: gophers (*Thomomys bottae*), prairie dog (*Cynomys gunnisoni*), ground squirrels (*Spermophilus spilosoma*), antelope squirrel (*Ammospermophilus leucurus*), jackrabbit (*Lepus californicus*), cottontail (*Sylvilagus audubonii*), bobcat (*Felis rufus*), badger (*Taxidea taxus*), striped skunk (*Mephitis mephitis*), and spotted skunk (*Spilogale putorius*). Rare sightings of black bear (*Ursus americanus*), mountain lion (*Felis concolor*), and gray fox (*Urocyon cinereoargenteus*) also have been made in the park. In prehistoric times elk (*Cervus canadensis*), white-tailed deer (*Odocoileus virginianus*), bighorn sheep (*Ovis canadensis*), and bison (*Bison bison*) may have been present in the region.

Paleoenvironment

Any change in the amount or predictability of rainfall would have had profound impacts on the prehistoric occupation of the region. Euler and others (1979) and more recently Gumerman (1988a) have compiled paleoclimatic data from a number of sources to reconstruct past climatic change on the Colorado Plateau. Generally, by about 4000 B.P. climatic conditions were similar to those of today, with alternating periods of increased moisture and drought. The period between A.D. 950 to 1150 is the best documented period of increased effective moisture on the plateau (Euler and others 1979:1096). Three periods of low effective moisture, low water tables, down-cutting, and high temporal variability in rainfall have been identified: A.D. 250 to 400, 800 to 950, and 1350 to 1500 (Gumerman 1988a). In addition, there is some evidence for a short-term drought around A.D. 1000. A fourth major dry period started around A.D. 1875. Along with overgrazing and groundwater pumping, it may have brought about the demise of springs within the park and the invasion of juniper into former grasslands (Stewart 1980).

Chapter 3
Cultural Background

In order to provide a contextual framework for this project, the prehistory of the region is briefly discussed below and archeological work at other Basketmaker period sites in the region is summarized. A more complete synopsis of archeological work in the region is available in Stewart's (1980) overview of the Petrified Forest National Park and Plog's (1981) overview of the Little Colorado River Planning Unit.

Previous Archeological Research

Archeological investigations at Basketmaker II and III sites in the upper and middle Little Colorado River area reflects the general trends in the development of archeological method and theory. The first anthropological investigations in the region centered around ethnographic studies; archeological work was designed primarily to acquire specimens for museum collections and secondarily to provide evidence about prehistoric societies. Completion of the railroad through the region in 1883 not only eased access to many sites, but also provided a means of shipping specimens back to Eastern museums. Public interest in the prehistory of the region was fueled by the visibility of many sites with standing architecture. The nearby Hopi and Zuni pueblos also provided impetus. Early sites, difficult to see and without obvious cultural continuity, generally were overlooked.

Jesse Walter Fewkes (1898, 1904) conducted surveys and excavations in the Little Colorado River Valley and in the Hopi Mesas for the Smithsonian Institution and the Bureau of American Ethnology. Part of Fewkes' study focused on tracing Hopi migrations through the analysis of pottery and architecture. Concentrating his excavation efforts on burials at large sites in order to obtain whole vessels, Fewkes in 1896 and 1897 collected over 2,824 artifacts (mostly pots) and other specimens from numerous ruins, mostly dating to the Pueblo IV period.

Walter Hough, Fewkes' assistant, continued the tradition of collecting for museums. In charge of the Gates-Museum Expedition, Walter Hough collected 2,500 specimens through purchase and excavations (Hough 1901, 1903). Hough visited 55 sites in the White Mountain, Hopi, and Petrified Forest regions. He remarked on the wide extent of pothunting, noting that Holbrook served as a "collection center" for various museum purchases (Hough 1903:326-327; 357-358), probably because of its location along the railroad. Hough conducted excavations at 18 sites, including Metate Ruin and Milky Hollow Ruin in the Petrified Forest area. Metate Ruin is within the present park boundaries somewhere east of Agate Bridge (the exact location is unknown; Figure 3.1) and Milky Hollow Ruin is located nine miles east of Petrified Forest (Figure 3.2). Both appear to be Adamana phase pit house villages and both sites were badly eroded. Although the exact nature of Hough's work is unclear, he collected surface artifacts and conducted a little excavation at both sites. Material from the sites should be at the Smithsonian Institution along with other material from the Museum-Gates Expedition.

The pottery at the two sites was described as a coarse gray-brown plain ware. The only decoration noted was scratched lines in the paste of a few sherds. Slab-lined houses and numerous metates were noted at Metate Ruin. Over 70 houses were noted eroding out at Milky Hollow Ruin (Hough 1903:Plate 53); the houses were described as "small and rudely built" (Hough 1903:319). Numerous stone artifacts, including stone balls, pipes, and a hoe were noted (collected?) at the site. Bone stems that fit the stone pipes were also found (Hough 1903:plate 52). Shell ornaments and perforated slabs were also noted at the site. Hough (1903:318) considers the sites an "archaeological enigma in light of present knowledge." In a later elaboration on the sites Hough (1905:898) states:

"people who once lived here were not related in any way to the others of this region." He goes on to say "that [they are of a] different people, and perhaps a different time."

Frank H. H. Roberts (1931), in his work at Kiatuthlanna, a Zuni ancestral village and multicomponent site southeast of Petrified Forest National Park (see Figure 3.2), conducted the first large-scale excavation of a pit house site in the region and wrote one of the earliest site-specific excavation reports in the region. In 1929 Roberts excavated 18 pit houses, three jacal structures, a 49-room pueblo, four kivas, and a number of burials at the site. Based on ceramic cross dating, Roberts inferred that the pit houses dated to the Basketmaker III and Pueblo I periods, and the pueblo to the early Pueblo III period. The Pueblo I component of the site was later used to define the Kiatuthlanna phase (Gladwin 1945).

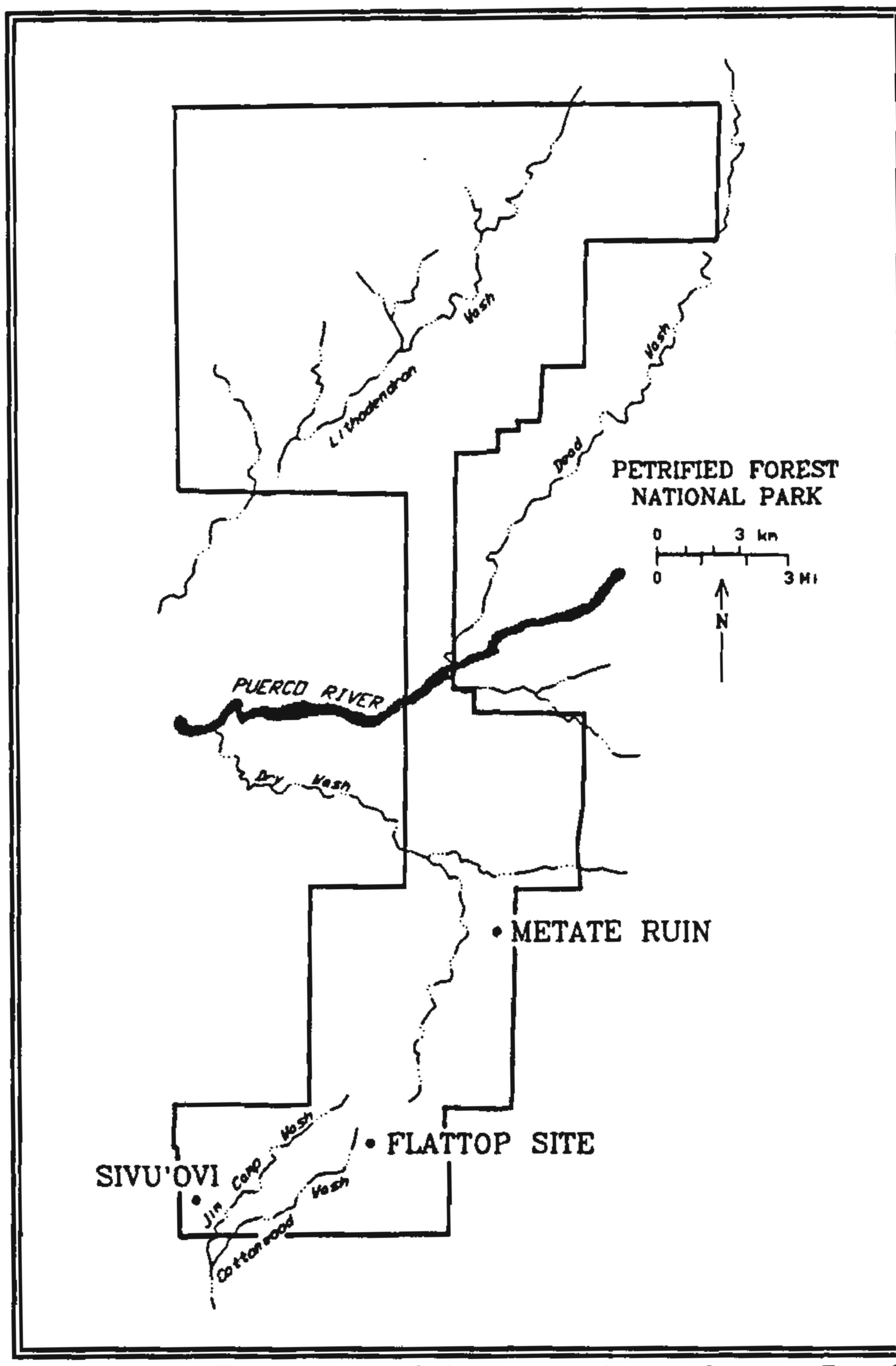

Figure 3.1. Excavated Adamana phase sites at Petrified Forest National Park.

Federally-funded research during the Depression greatly accelerated archeological research in the area. Under contract with the Works Progress Administration (WPA), H. P. Mera (1934) of the Laboratory of Anthropology, Santa Fe, conducted the first systematic study of pottery in the region at what was then Petrified Forest National Monument, recognizing and describing several new types. He recorded 109 sites, including some outside the monument. Workshop and stone industries were noted in the monument, although no chronometric information was available to tie them to particular time periods. Mera noted the remains of daub structures, and defined early pottery types (Adamana Brown, Woodruff Brown, and Woodruff Smudged) at slab-lined pit house sites. Mera's pottery chronology, although later refined, is the same one in use today.

As part of the same WPA project, C. B. Cosgrove (1934) conducted excavations at two pueblos (Agate House and Puerco Ruin) and at a pit house village (the Flattop Site) within Petrified Forest National Park. Information from these excavations is available in Cosgrove's preliminary report; his untimely death less than a year after the fieldwork prevented the completion of a final report.

Cosgrove spent one day at the Adamana phase Flattop Site (Figure 3.1), excavating two pit houses. The fill in one was only a foot deep, with a few flakes of charcoal and ash. No artifacts or floor features were present in either pit house, although Cosgrove noted that there was an abundance of sherds and lithics on the site surface.

The Awatovi Expedition, 1935-1939, sponsored by the Peabody Museum, excavated 21 sites on Antelope Mesa north of Petrified Forest National Park. At Jeddito 264 (see Figure 3.2; Daifuku 1961), the largest of two Basketmaker III-Pueblo I sites excavated during the expedition, seven pit

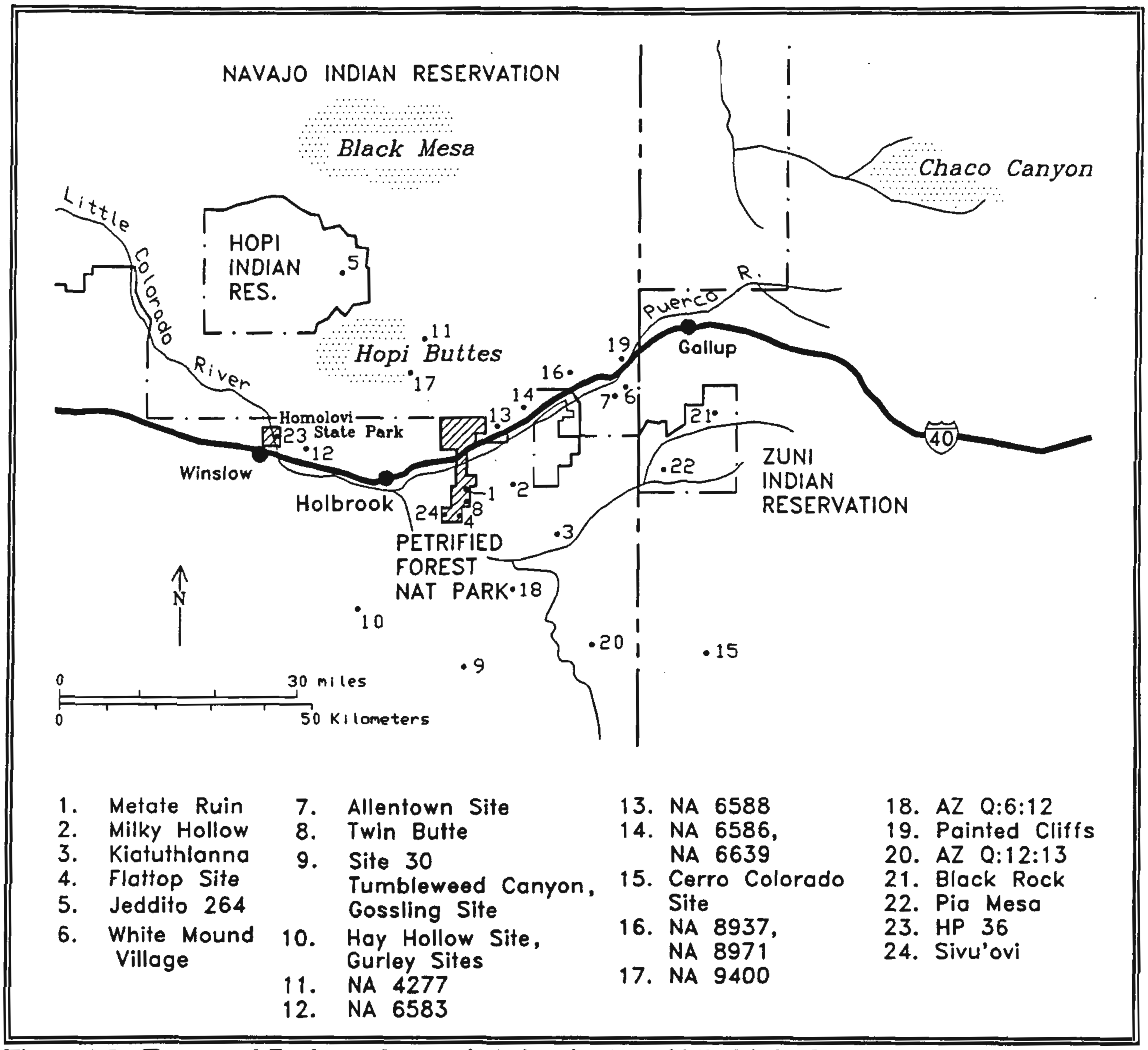

Figure 3.2. Excavated Basketmaker period sites in the middle Little Colorado River region.

houses, 19 slab-lined storage chambers, seven contiguous surface storage chambers, six outdoor fire pits, and one rectangular Pueblo II room were excavated. Only four chipped-stone artifacts, all projectile points, were recovered, although other artifacts were numerous. Most of the pottery recovered was Lino Gray; decorated wares included La Plata, White Mound, and Kana-a Black-on-white.

In 1936, Harold S. Gladwin (1945) of Gila Pueblo, excavated seven sites that became the type sites for his Puerco River Valley phase chronology. Major excavations were conducted at White Mound Village (Figure 3.2), north of the Puerco River near the New Mexico border, and at six smaller pueblo period sites in Red Mesa Valley, New Mexico. Emil Haury, in charge of the White Mound work, excavated six pit houses, three series of surface storerooms, and several other features including 33 burials. Some of the burials had pottery or ornaments, but the majority lacked any associated grave goods. Ceramics, including nineteen whole vessels, were predominantly Lino Gray; decorated wares included White Mound Black-on-white and polished red wares with black interiors. One of the pit houses was dated to the Kiatuthlanna phase (Basketmaker III-Pueblo I), and the rest to the later White Mound phase. Because tree-ring cutting-dates clustered in the late A.D. 700s, site occupation (and the White Mound phase) was inferred to have been from A.D. 750 to 800 (Gladwin 1945).

The Allentown Site (Figure 3.2), located on a ridge of a mesa south of the Puerco River northeast of Petrified Forest, was excavated in 1939. Roberts (1939, 1940) excavated 20 pit structures with accompanying granaries and surface shelters, and three unit-type ruins with kivas. Tree-ring dates suggested a date of A.D. 800-900, falling within what is now considered late Pueblo I times (Bullard 1962). Roberts excavated 150 human burials; because of poor preservation, only 15 were considered suitable for anthropometric studies. Dog and turkey burials also were common at the site.

At Petrified Forest National Park, Jepson (1941) continued Mera's work, surveying a 51-square-mile area and recording 230 sites. Using pottery cross dating, he placed 34 sites in the Basketmaker period, 28 in Pueblo II, 41 in Pueblo III, and four sites in Pueblo IV. He suggested that the apparent lack of Pueblo I sites might be due to the lack of trade wares, because the period is locally defined by intrusive pottery. One hundred of the sites consisted of only one room, 72 had two to seven rooms, eight had seven to 12 rooms, four had 13 to 20 rooms, and three contained over 20 rooms. Jepson noted problems of both erosion and burial of sites by blowing sand. He inferred that site location was determined by proximity to suitable building stone, and that nearness to water and farmlands was not a factor. Although Jepson's settlement analysis was innovative for the time, it is partially biased by his consideration of only stone architecture sites, which are more visible than jacal structures or pit houses.

Erik Reed (1947), expanding on Mera's and Jepson's work, defined pottery horizons for the Petrified Forest area through ceramic cross dating, and placed all but 40 of the 280 sites recorded by Mera and Jepson into temporal groups. Six percent of the identified sites belong to his Adamana horizon, 21 percent to the Lino-Woodruff period, 42 percent to the Holbrook period, 20 percent to the Walnut horizon, 10 percent to the Tularosa-St. Johns, and two percent to the initial Pueblo IV (Homol'ovi) focus. One-third of Reed's ceramic collection was curated at the Museum of Northern Arizona, one-third at the park (now apparently lost), and one-third was discarded.

Fred Wendorf (1948) reanalyzed the portion of Reed's (1947) ceramic collection that was deposited at the Museum of Northern Arizona. Due to time limitations, Wendorf focused on 100 sites, most of them pre-Pueblo III in age. He defined seven ceramic groups through seriation of pottery types:

- Group 0 (Adamana Brown), present at 19 sites, was dated to before A.D. 500.
- Group 1 (Lino Gray and Woodruff Brown), with 23 sites, was dated to A.D. 500-700.
- Group 2 (White Mound Black-on-white, Lino Gray, and Woodruff Brown), present at 21 sites, was dated to A.D. 700-800.
- Group 3 (Kana-a Black-on-white and Kiatuthlanna Black-on-white), at four sites, was dated to A.D. 800-900.
- Group 4 (Black Mesa Black-on-white and Holbrook Black-on-white), present at 12 sites, was dated to A.D. 900-1100.
- Group 5 (Sosi Black-on-white and Walnut "A"), present at over 44 sites, was dated to A.D. 1050 to 1120.
- Group 6 (Chaco Black-on-white and Walnut "B"), at over 46 sites, was dated to A.D. 1120-1200.

To clarify and test his pottery groupings, Wendorf excavated two sites in Petrified Forest National Park (Wendorf 1950, 1951, 1953). In 1949 Wendorf excavated eight pit houses at the Flattop Site (Figure 3.1). These were small houses that were constructed by excavation into bedrock. Only one of these slab-lined structures contained a well-defined hearth, suggesting seasonal occupation. Ceramics were predominantly Adamana Brown Ware, but small amounts of coil-and-scrape brown ware also were recovered from the floors of six of the houses. The site contained an extensive and varied lithic assemblage, including 32 corner-notched projectile points. An unspecified number of maize cobs also were recovered. Because intrusive Adamana sherds at the Bluff site near Forestdale (Haury and Sayles 1947) were tree-ring dated to before A.D. 600 (perhaps as early as A.D. 300), the Flattop Site was considered to date to the same time (Wendorf 1950, 1953). Wendorf's work at the Flattop Site is discussed in more detail in Chapter 4.

Wendorf also excavated two trenches at the Twin Butte Site (Figure 3.2). He discovered numerous features including three turkey burials, eight human burials, two pit houses, storage rooms, a deep adobe-walled granary, agricultural features, and storage pits. Pottery included Lino Gray, Lino Black-on-gray, and White Mound Black-on-white. Wendorf posed and tested several hypotheses to account for the presence of two distinct pottery traditions (Mogollon brown and Anasazi gray) at the site. He discounted both simultaneous occupation by Mogollon and Anasazi groups and temporally distinct occupations by the two. Three lines of evidence suggested to Wendorf that the Mogollon artifacts had been imported: architecture at the site was similar to Anasazi types; Anasazi ceramics were more numerous; the Mogollon ceramics were present in burials as though associated with status. Although earlier Adamana Brown ceramics were found in the lowest levels of the site, the site was considered to date to the later Basketmaker III period (White Mound phase). Artifacts were more diverse and more numerous than at the Flattop Site, and abundant faunal remains were recovered. Wendorf noted a change in projectile points from the Flattop Site. New traits present include axes, ornaments, mauls, and bone and shell artifacts. The presence of brown wares was interpreted to indicate extensive trade (Wendorf 1951, 1953).

From 1956 to 1958, William J. Beeson, at the urging of Emil Haury, surveyed a huge area at the confluence of the Zuni and Little Colorado rivers (Beeson 1966). Beeson spent ten person months surveying and recording 325 sites. A high level of effort and low level of documentation is suggested by Beeson's records, which indicated he walked up to 23 miles a day, and recorded up to 21 sites in a day. Collected sherds aided in assessing temporal and cultural placement of the sites, and Beeson posited the following culture history: during Pueblo I times populations grew, were stable until Pueblo III, and then started to decline. Small pueblos appeared to occur in clusters. Later sites exhibited more Zuni influence, while Hopi influence was negligible. Large Pueblo III sites occurred at river junctions, and Pueblo IV sites occurred only at locations that had been occupied during Pueblo III times. Beeson also defined an Adamana "pottery boundary" between sites that contained over 70 percent Adamana Brown ceramics and nearby sites that contained less than 6 percent of that ware (Beeson 1966).

The Chicago Natural History Museum's Southwest Archaeological Expedition (SWAE), led by Paul Martin, conducted 15 seasons of fieldwork between 1957 and 1972, excavating 34 sites and conducting extensive surveys in the upper Little Colorado area near Vernon and the Hay Hollow Valley (Figure 3.2). In 1957 SWAE excavated eight pit houses at "Site 30." Between six and seven of the pit houses had been burned; few artifacts were found on the floors. Architecture, ceramics, and the lack of a kiva suggested a Mogollon affiliation. Comparisons with the Forestdale area (Haury 1940) led Martin and Rinaldo (1960) to suggest that the site may have been occupied between A.D. 600 and 800. Three beams that radiocarbon-dated to between A.D. 1100 and 1200 were discounted.

In 1960 seven sites were excavated by SWAE, including pit houses and surface rooms. At the Tumbleweed Canyon Site, three structures and associated storage pits were excavated; a radiocarbon date of 1645±50 B.P. was used to date the site to A.D. 275 (Martin and others 1962). At the Gossling Site, SWAE excavated two pit houses, estimated to date from between A.D. 900 and 950

(Martin and others 1962). Relative frequencies of several artifact types indicated that two-hand manos, small triangular points, bone awls, and bone and shell rings increased through time; one-hand manos, basin metates, rubbing stones, mauls, drills, and barbed projectile points decreased through time (Rinaldo 1964).

Plog (1974) reports on SWAE surveys and excavations in the Hay Hollow Valley during the 1967-1968 field season and previous years. The Hay Hollow Site, with house clusters, storage pits, and crude brown ware pottery, was dated to between 200 B.C. and A.D. 200. At the County Road Site, four excavated pit houses were dated to 1000 B.C. Maize was found at both sites. The Connie and Kuhn Sites, both pit house sites on mesa tops, were tested and dated to between A.D. 200 and 700. The Gurley Sites included a series of one to two pit houses and a kiva-like structure. Lino Gray, Forestdale and Alma Plain wares, and White Mound, Red Mesa, and Kiatuthlanna Black-on-white ceramics were recovered. The sites were dated to between A.D. 500 and 750.

An intensive survey of Hay Hollow Valley covered five square miles in 1967 and 20 square miles in 1968, resulting in the recording of 405 sites (Zubrow 1975). Based on the surveys and excavations at the Gurley Sites, as well as previous work by SWAE, Plog (1974) noted that during the transition from the Basketmaker to Pueblo periods there was an increase in storage space, a decrease in heat-treated projectile points and basin metates, an increase in slab metates, and an increase and then decrease in the use of trough metates.

During the first large "salvage archaeology" project in northern Arizona, undertaken for a proposed pipeline, the Museum of Northern Arizona and the Laboratory of Anthropology (Santa Fe) excavated a site in the area north of Petrified Forest Park (Wendorf and others 1956). The site, NA 4277 (Figure 3.2), is a trash-filled, rectangular, burned pit house with a fire pit and ventilator. Three hundred forty sherds were recovered, including 42 percent Walnut Black-on-white, 30 percent Tusayan Corrugated, and 8 percent Padre Black-on-white. The site was interpreted to date to the early twelfth century, and was later placed in the McDonald phase by Gumerman (1988b:18). The only other material recovered were three unidentified bones, one of them possibly from a turkey.

Breternitz (1957) conducted salvage excavations at four sites along Interstate 40. At NA 6583 (Figure 3.2), near Winslow, two pit houses were excavated. One, a brush structure, included a fire pit, postholes, and a brown ware jar (paddle-and-anvil made with angular sand temper) identified as Tonto Brown. The second house had seven postholes, and a fragmentary adult burial with two shell bracelets, but no fire pit. On the surface was burned human bone, a refired Kana-a Black-on-white bowl, and a burned bone awl. The cremation was considered unique for its locale and posited time. All sherds except those of the Tonto Brown jar were found on the surface. The predominance of Kana-a Black-on-white pottery (44%) and the lack of Lino Gray and Black Mesa Black-on-white suggest the site dates to the Pueblo I period.

NA 6588, near Petrified Forest National Park (Figure 3.2), was first discovered when a slab-lined hearth and a basin-shaped fire pit were exposed in a roadcut. Both features were on top of hard red sand, which may have been Altithermal in age (5500 to 2000 B.C.). One hearth had a Basketmaker projectile point, a unifacial hand stone, and an anvil stone; the other hearth had a possible chert scraper. An additional Basketmaker point, a unifacial hand stone, a grinding stone, an unfinished unifacial mano, and charcoal flecks were noted on the surface. Because no ceramics were found, the site was assumed to be pre-A.D. 500, possibly Basketmaker II on the basis of the projectile point types.

NA 6586, northeast of Petrified Forest (Figure 3.2), had been almost destroyed by a borrow pit; it included two pit houses, of which one was burned. Only portions of one pit house were excavated: on the floor were a hand stone, a unifacial mano, a petrified wood hammerstone, a polishing pebble, and a piece of limonite. Ceramics, including Tusayan and Cibola White Wares and smudged brown wares (possibly Mogollon), were dated to the late Pueblo II to early Pueblo III period.

NA 6639 (Figure 3.2) is a Kiatuthlanna phase pit house that was exposed in a road cut on a sand ridge north of the Puerco River. Approximately half of the pit house was excavated. Abundant charcoal suggested the structure may have been burned. Artifacts were excavated by house fill, floor fill, floor, and surface; abundant artifacts in fill included worked bone, an obsidian corner-notched projectile point, and manos. On the basis of ceramics the site was dated to the Pueblo I, and possibly the Pueblo II period. Breternitz (1957) posited several conclusions beyond temporal placement of the four sites. For example, the sites show evidence of early contact with the Anasazi to the north and the Mogollon and Hohokam to the south. Breternitz suggested that the red sand erosional surface may explain the typological mixing so common in the area.

Bullard (1962) excavated the Cerro Colorado Site southeast of Zuni (Figure 3.2). Eighteen structures were excavated, including 14 dating to the Basketmaker III period, one to the late Pueblo I period, two to the early Pueblo II period, and one, a kiva, to the late Pueblo II period. The major portion of Bullard's report reviewed the Hohokam, Anasazi, and Mogollon chronologies prior to A.D. 900. Tree-ring evidence dated the White Mound phase, typified by White Mound Black-on-white, to A.D. 750 to 800, which places the phase within early Pueblo I rather than Basketmaker III. Because ceramics from Twin Buttes suggest it is in the White Mound phase, the site occupation would be later than previously thought. Bullard classes the Allentown Site and Kiatuthlanna as late Pueblo I sites, and calls the Flattop Site, with its unique characteristics, an "orphan."

In 1964 and 1965 George Gumerman (1966), working for the Museum of Northern Arizona, excavated two Basketmaker II pit house sites (NA 8937 and NA 8971; Figure 3.2), located between the towns of Sanders and Lupton on Interstate 40. Both sites were located on deep aeolian sand slopes. Excavation at NA 8937 revealed nine oval pit houses, three with shallow hearths (one slab-lined). One pit house was differentiated from the others by its greater size and architectural features. Three bell-shaped roasting pits contained sand and fire-cracked rock. The artifact assemblage included 26 manos, 12 metates, 28 hammerstones (19 of petrified wood), and seven bone awls. Relatively little chipped stone was recovered; in addition, projectile points were all fragmentary, with no bases recovered.

The second site, NA 8971, was revealed in an arroyo, buried by one meter of sand. Four oval pit houses, smaller than those at NA 8937, were excavated. Numerous holes and depressions, including two 1-m-deep storage pits, were found inside the pit houses. The assemblage includes eight manos, one metate, three hammerstones, and virtually no chipped stone. The ground stone and the presence of maize pollen suggested agricultural subsistence. No bone was recovered, possibly because of the high moisture content of the soil. The site was considered Basketmaker II in age, because the only pottery (six Pueblo II sherds) appeared to have been redeposited from a nearby Pueblo II site. In the preliminary report, Gumerman and Olson (1968:116) indicated that four radiocarbon dates of charcoal from burned pit houses are "so conflicting as to be worthless." Because architecture and the artifact assemblage differs greatly, not only from other sites in the area, but also from classic Basketmaker II culture as defined elsewhere, Gumerman and Olson assigned the sites to the newly created Black Creek phase.

In 1966, John Cramer (personal communication in Gumerman and Skinner 1968:188) excavated two preceramic pit houses (NA 9400; Figure 3.2) near Dilkon for a gas pipeline project. The small assemblage and lack of chronometric information hinder the comparative potential of the site, but Gumerman (1988b:178) suggests that architecturally the site appears to date to the Black Creek phase (Basketmaker II).

At site AZ Q:6:12 (Figure 3.2), southeast of Petrified Forest near Hunt, Gwinn Vivian (1967) excavated a slab-lined pit house, which had a fire pit, charcoal and a charred juniper log, and a metate resting on two cobbles with four pieces of an unfired red clay bowl under it. The site also contained a slab-lined cist, a rock concentration interpreted to be from pit excavation, and a cooking pit with fire-cracked rock, charcoal flecks, and a maul. The 74 sherds from the site were all Lino types, including Lino Gray, fugitive red, and smudged. Other artifacts at the site include a metate in house fill, a mano in the fire pit fill of a house, a chopping tool in the cist, and a mano and several chalcedony cores on the surface. The pottery suggested the site dated about the same as the Twin Buttes Site, but whereas Wendorf said Twin Buttes was in the White Mound phase (A.D. 700-800), Vivian placed AZ Q:6:12 in the earlier La Plata phase (A.D. 600-700), based on similarities to La Plata phase houses in the Gallup and Lupton areas.

An interim report on excavations along Interstate 40 between Sanders and Lupton (Gumerman and Olsen 1968) discusses excavation of 14 pueblos, 53 pit houses, and 171 burials, and the recovery of 130 whole vessels. This short report also describes the cultural chronology of the region; a final report apparently was never funded.

Alan Ferg (1978) conducted work at a two-component site (White Mound phase and historic Navajo) near Lupton on Interstate 40 for the Painted Cliffs Rest Area (Figure 3.2). A pit house, five hearths, five burials, a series of slab-lined surface storage rooms, a pit feature, and an extramural work area were excavated. A Kana-a Gray jar and Lino Gray jar were found on the floor of the pit house. Other artifacts included Kana-a Black-on-white ceramics, gypsum, two metate fragments, and worked bone. Surface storage rooms contained an Alma plain seed jar and Kana-a Black-on-white sherds. Also recovered were ten whole or restorable vessels, 36,407 sherds (20 worked), 31 metates, 25 manos, a cooking slab, 12 hammerstones (eight of petrified wood), three mauls, 9,280 flakes (82% chert, 13% petrified wood, 5% other), 135 cores (90% chert, 9% petrified wood), 100 projectile points, point preforms, and drills, 34 bifaces, 17 unifacially retouched flakes, worked bone, shell, and stone ornaments. Faunal analysis by Paul Johnson identified toad, turkey, jackrabbit, cottontail, gopher, kangaroo rat, dog or coyote, bear, and mule deer at the prehistoric site, and cow and sheep in the historic component. An archaeomagnetic date of A.D. 798±30 from a hearth supported the ceramic dating of the site. The site remains the only completely reported excavated site along Interstate 40 in northeast Arizona.

Doyel and Debowski (1980) excavated a pit house and extramural features at AZ Q:12:13 for the Tucson Gas and Electric Company's Springerville Project (Figure 3.2). Ceramics recovered from the site were sand-tempered brown wares (Alma Plain and Forestdale Smudged *afinis*) and Lino Gray. Charred seeds of bee-plant, chenopod-amaranths, sunflower, and grasses were well represented at the site. A single maize cupule was recovered from an extramural hearth. Few flaked stone tools were present. Ground-stone artifacts consisted of basin metates and one-hand manos. AZ Q:12:13 was interpreted as a seasonally occupied limited activity site dating to between A.D. 600 to A.D. 800, based on ceramic data. Radiocarbon dates from the site of 1775±145 B.P. (A.D. 175) and 1540±180 B.P. (A.D. 410) were considered inconsistent with the ceramic data.

Fowler (1988) tested site NM:12:K3:263 at Black Rock, New Mexico (Figure 3.2), on the Zuni Indian Reservation prior to road reconstruction. The site contained a jacal structure, a slab-lined semi-subterranean structure, a pit feature, and a possible pit structure. Artifacts included plain polished brown ware, metate fragments, and chipped stone. Architecture and artifacts place the site as Basketmaker II in age; six non-cutting dates indicate post-A.D. 420 construction.

Varien (1990) conducted excavations at three sites along Pia Mesa road (Figure 3.2), on the Zuni Indian Reservation. Two of the sites consisted of pit houses and slab-lined surface features tree-ring and radiocarbon dated to circa A.D. 400, making these the earliest dated excavated sites on the Zuni Indian Reservation. Floral remains were dominated by amaranth and goosefoot, but a few maize kernels and cupules also were recovered. Only six bone fragments were recovered and of those only two could be identified (both woodrat). Ceramics from the two early sites are sand-tempered brown wares and red wares. Some of the brown ware contained small flecks of mica similar to the selenite found in Adamana Brown. Lithic analysis suggested an expedient technology: there was little heat treatment, and some shatter, cores, and cortical flakes were present. However, the analyzed sample from the two sites is quite small (n=16 and 46).

Ongoing research is being conducted at a pit house village (HP-36) within Homolovi Ruins State Park near Winslow (Figure 3.2). The site contains a Basketmaker III and a Pueblo III component. Three Basketmaker structures, three Pueblo period structures, and 20 extramural features have been excavated over the course of three field seasons (Adams 1989:181; Young 1990). Cultural material, including abundant floral and faunal remains, promise to yield significant data on the Basketmaker to Pueblo transition.

Prehistory

Based on archeological work conducted in the region since the late 1800s, numerous chronologies have been proposed, refined, and debated (Figure 3.3). Early chronologies for the Petrified Forest vicinity varied little from the original Pecos classification (Stewart 1980). The earliest detailed chronology was developed by Colton (1939, 1943), based on his informal surveys and on excavations by Fewkes and others at Pueblo IV sites in the region (Gumerman 1988b:175). Gumerman and Skinner (1968) provided a framework for the Holbrook area to the west, which combined Colton's phase system with the Pecos classification. Gumerman and Olson (1968) provided a similar chronology for the upper Puerco River Valley to the northeast. Based on extensive work in the Hay Hollow Valley, 30 miles south of Petrified Forest, Longacre (1964) developed a chronology that focuses on the development of agriculture and large villages: Stage I, Incipient Agriculturalist; Stage II, Initial Sedentary Agriculturalist; Stage III, Established Village Farming; Stage IV, Beginning of Planned Towns; Stage V, Established Towns; and Stage VI, Large Towns.

The earliest chronology specifically developed for the Petrified Forest area was proposed by Mera (1934), who assigned various pottery types to the culture periods of the Pecos Classification. Reed (1947) used the concept of ceramic horizons to form a sequence of pottery types based on ceramic cross dating. Reed's phases differ slightly from the original Pecos Classification. Using Breternitz's (1966) reevaluation of tree-ring dated pottery, Wells (1988, 1989) found that most sites recorded during recent surveys at Petrified Forest fall into transitional categories, such as Pueblo II to III. Wells developed a chronology that augmented the ceramic horizons originally defined by Reed (1947) with data on changes in architecture, projectile point types, and rock art styles. Although this chronology is less precise than those developed for surrounding regions, it seems justified given the lack of directly dated sites at Petrified Forest. The Wells chronology parallels that of Plog's (1983, 1984) political and economic alliances.

Based primarily on distinctive groupings of ceramic types, Plog (1983, 1984) suggested that between A.D. 400 and 1450, ten broad cultural patterns are evident. Three of these, the Adamana (characterized by Adamana Brown pottery), the Little Colorado (Little Colorado White Ware), and the Jeddito (yellow and orange wares), were centered along the Little Colorado River. The White Mountain pattern (White Mountain Red Ware) is centered on the Upper Little Colorado River Valley. The White Mound pattern (Kana-a-style ceramics) was widespread throughout the Colorado Plateau; others such as the Zuni or Kayenta patterns are of more limited extent. These "political and economic alliances," as Plog has termed them, have a homogeneous distribution of one or more ceramic types, a homogeneous architectural style, and at least some large central sites. It has been postulated that the alliances may have linked smaller villages into larger social groupings during times of increased environmental risk (Plog 1984).

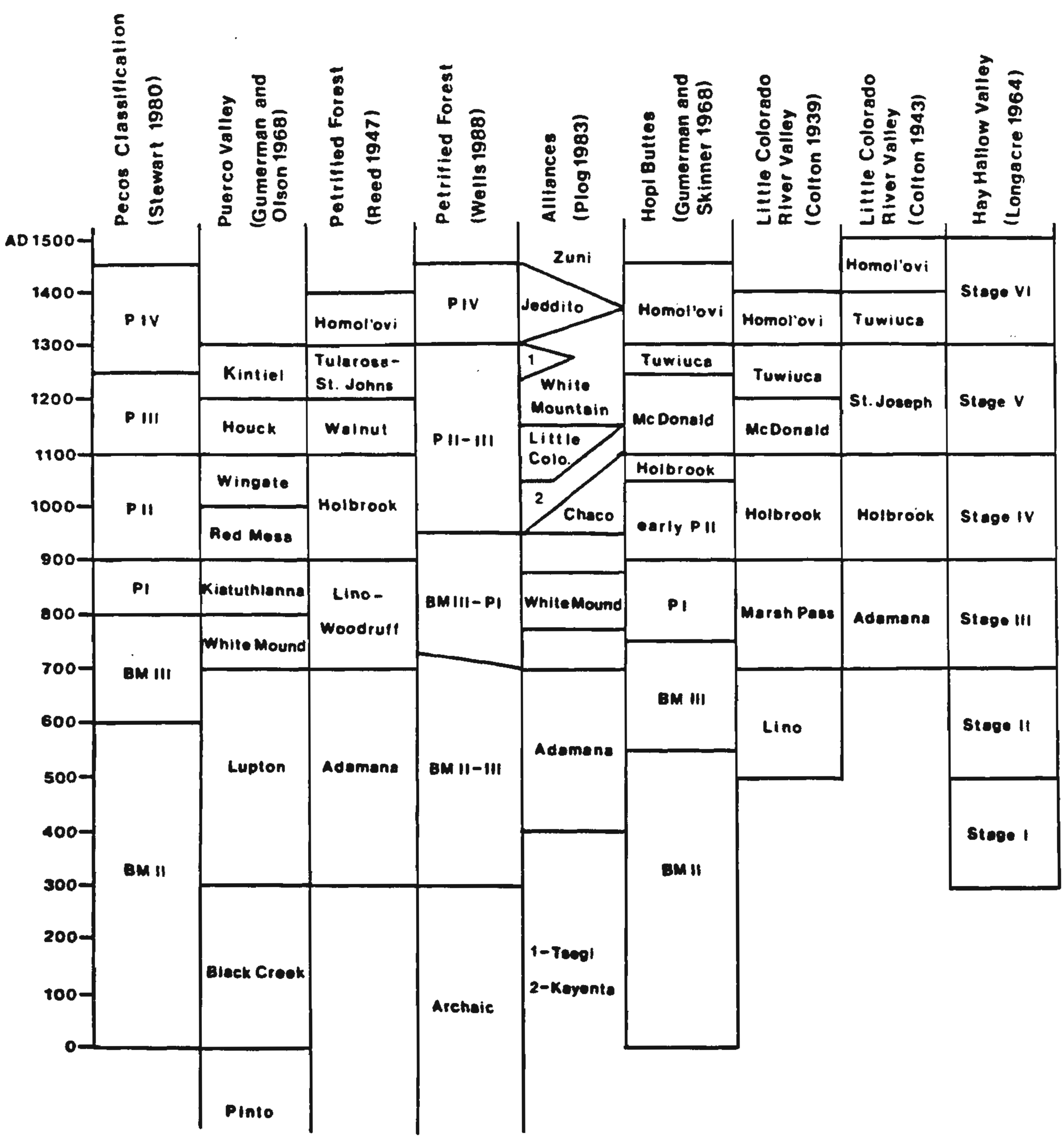

Figure 3.3. Chronologies developed for the middle Little Colorado River region.

The following culture history is based primarily on Wells (1988), but also includes elements from other work in the region.

Paleo-Indian and Archaic Periods

To date, the only evidence of Paleo-Indian occupation (9500 to 6000 B.C.) of the region is from surface finds of fluted points (Huckell 1982), including two within Petrified Forest National Park (Tagg 1987). No Paleo-Indian sites in datable strata (or contexts) have yet been found. The Archaic period (6000 B.C. to A.D. 300) is well represented by a number of sites at Petrified Forest (Tagg 1987) and in the vicinity (Wendorf and Thomas 1951, Sims and Daniel 1962). The Archaic period marks a shift from the big game hunting of the Paleo-Indian Period to a broader subsistence base of hunting and gathering. Basin metates, bifacial tools, and the lack of pottery are considered diagnostic of Archaic period sites. Projectile points at these aceramic sites include Bajada (Pinto-like) and Jay-style types (Irwin-Williams 1973). Utilization of maize is indicated during the late Archaic period (Tagg 1987).

Basketmaker II-III Period

Basketmaker II-III sites (A.D. 300 to 700) are indicated by the presence of Adamana Brown pottery and side-notched projectile points. The Basketmaker II-III period is marked by increasing sedentism, which is reflected in the change from production and use of formal bifacial tools (common during the earlier Archaic period) to use of an expedient flake technology (Parry and Kelly 1987). Small percentages of Lino Gray and Woodruff Brown pottery may be present as well. Eleven percent of the recorded sites at Petrified Forest fall into this period (Wells 1989). Settlements consist of shallow to deep pit houses and associated slab-lined cists, located on isolated buttes and dune ridges.

Sites with Adamana Brown pottery are larger and possibly more numerous than sites in any other period; this has been equated with initial settlement of the region (Mera 1934) or interpreted as indicating a sudden influx of people, perhaps from the south where paddle-and-anvil constructed pottery is a more common technique. Schroeder (1979) has postulated the presence of Yuman-speaking "Hakataya" in the area. According to Plog (1983), Adamana phase sites are distinctive in terms of their location, architecture, and ceramics. This "strong normative pattern" has been argued as reflecting an alliance characterized by specialized production, trade and exchange, and possibly social ranking.

Basketmaker III-Pueblo I Period

This period (A.D. 700 to 950) is recognized by the presence of Kana-a Black-on-white, Kiatuthlanna Black-on-white, Woodruff Brown, and Lino Black-on-gray ceramics. Lesser amounts of Black Mesa Black-on-white and Red Mesa Black-on-white may also be present. Trough metates and corner-notched projectile points are indicative of this and later periods. This period sees the establishment of the first year-round villages around A.D. 700 and the development of one-level decision-making hierarchies between A.D. 700 to 1100 (Lightfoot 1981). Settlements are located in diverse topographic settings and include from five to fifteen pit houses. In general, the pit houses are deep and have associated features such as wall niches, floor pits, and entry ramps. Surface and subsurface storerooms are also common. Fourteen percent of the recorded sites at Petrified Forest date to this time period.

Pueblo II-III Period

This period, dating from A.D. 950 to 1300, is indicated by the introduction of corrugated pottery, above-ground habitation rooms, slab metates, and side-notched projectile points. Sites can be divided into early (A.D. 950 to 1100) and late (A.D. 1100 to 1300) based on ceramics and, to some extent, architecture. Some pottery types such as Holbrook Black-on-white, Puerco Black-on-white, Black Mesa Black-on-white, and Showlow Black-on-red are common throughout the Pueblo II and Pueblo III periods; others are found only at later sites: Walnut Black-on-white, Padre Black-on-white, Tularosa Black-on-white, Snowflake Black-on-white, and St. Johns Polychrome. Early sites, consisting of 8 to 15 rooms and a kiva, appear to be clustered around great kiva sites, such as McCreery Pueblo (PEFO Site 236; Jones 1986), the Plaza Site (Gumerman 1969, 1988b), and the Sundown Site (Gumerman and Skinner 1968), or possibly around other larger villages (Wells 1988:150). Site clusters appear to be regularly spaced across the landscape, with habitation expanding into new, previously unexploited micro-environments.

Lightfoot (1981) suggests that two-level decision-making hierarchies began to emerge between A.D. 1100 and 1250 in response to population and environmental pressures. In the Little Colorado River region, sites become larger (up to 50 rooms) but fewer in number after A.D. 1000. It has been suggested that this aggregation did not occur in areas such as Hopi Buttes and Petrified Forest because of their fragile and marginal environments (Gumerman and Skinner 1968; Jones 1987). This seems to be the case at Petrified Forest, where 79 percent of the recorded sites have Pueblo III components (Wells 1989). Evidence of aggregation could, however, be obscured by the lack of fine temporal resolution in the ceramic chronologies.

Pueblo IV Period

Pueblo IV sites (A.D. 1300 to 1450) contain small triangular projectile points and ceramics including Homol'ovi Corrugated, Black-on-red and Polychrome, Awatovi and Jeddito Black-on-yellow, Pinedale and Fourmile polychrome, and Zuni glaze wares. Piki stones and kachinas in rock art and kiva murals mark the introduction of the Kachina Cult during this time span. The Pueblo IV period has been traditionally divided into an early (Tuwiuca) and late (Homol'ovi) phase (Colton 1939); typically the late phase is marked by the introduction of Zuni glaze ware and Jeddito Black-on-yellow pottery. Few sites (4%) in Petrified Forest have been attributed to Pueblo IV however, and previous archeological work (mostly surveys) has not generated the data needed to test this refinement. In general, Pueblo IV occupation sites are large, with over 100 rooms, several kivas, and frequently a plaza, and are located along major drainages or at springs. Only two large sites are known in the Petrified Forest region: Puerco Ruin, within the park along the Puerco River, and Wallace Tank Ruin (Stone Axe Pueblo), at a spring 7 km (4.3 miles) southeast of Puerco Ruin. Only a handful of smaller Pueblo IV sites, such as artifact scatters and rock art, have been recorded within the park. The entire Petrified Forest region was seemingly abandoned by the end of Pueblo IV times, although the Hopi and Zuni may have continued to use the area for resource procurement or as a travel corridor. The next documented occupation in Petrified Forest was by the Navajo beginning around A.D. 1750 (Stewart 1980).

Chapter 4
Formation Processes, Adamana Brown Ware and the Flattop Site

Many of the inferences regarding the early Basketmaker occupation of the Petrified Forest region are based on data from the Flattop Site. As the only fully reported excavated Adamana phase site, the Flattop Site has provided the basis for reconstructions about the initial occupation of the area (Wendorf 1950, 1953). The Flattop Site is discussed in detail here because some of the hypotheses generated from the Flattop data can be tested at Sivu'ovi (AZ Q:1:114 [ASM]). Following this review and reanalysis of the Flattop data, research questions pertinent to Sivu'ovi are outlined in Chapter 5.

The Flattop Site is an early pit house "village" located within the boundary of Petrified Forest National Park, in northeast Arizona. The site was excavated in 1949 by Fred Wendorf of the Museum of Northern Arizona, and a brief preliminary report was published in 1950. Data from the Flattop Site and from the Twin Butte Site (a slightly later site also at Petrified Forest) formed the nucleus of Wendorf's Ph.D. dissertation, published as *Museum of Northern Arizona Bulletin* 27 (1953). The Flattop Site is the only other site, besides Sivu'ovi, excavated and fully reported that has a preponderance of Adamana Brown ceramics. Adamana Brown Ware, a paddle-and-anvil constructed pottery, is unique in the Little Colorado River Valley where all other pottery is constructed by the coil-and-scrape method. Seriation analysis of sherds found during survey work suggested that Adamana Brown Ware is the oldest pottery in the Petrified Forest region (Mera 1934; Wendorf 1948). This chapter focuses on the temporal placement of the Flattop Site specifically and Adamana Brown Ware in general. In addition, Wendorf's other interpretations of site use are discussed in light of formation processes that may have influenced these inferences.

The Flattop Site is located on the largest of several isolated buttes called the Flattops. The butte stands 150 to 200 feet above the surrounding terrain, which is characterized by eroded badlands. The site was recorded initially by Mera (1934) who created the first pottery classification for the Petrified Forest region. The pottery that Mera named Adamana Brown was the only type that occurred in substantial quantities by itself, as it did at the Flattop Site and four other sites. The pottery also occurred in small amounts at other sites, mixed with other ceramics. This distribution suggested to Mera that Adamana Brown Ware was the earliest pottery in the Petrified Forest area, and that the five sites where it predominates were "colony" sites, that is, among the earliest settled. Adamana Brown Ware's spatial association with slab-lined pit houses, considered an early architectural form, was cited as evidence supporting the early temporal ascription.

Cosgrove, excavating two pit houses at the Flattop Site in 1934, noted an abundance of sherds and flaked stone on the surface. No hearths were encountered in the pit houses. The 1-ft-deep fill of the pit houses contained a few flecks of charcoal and wood ash but no sherds or artifacts of any kind (Cosgrove 1934:15). Although few inferences were possible, the lack of formal hearths was seen as indicating an early occupation.

In 1948, Wendorf identified 19 sites with Adamana Brown Ware in an analysis of a ceramic collection made at Petrified Forest by Jepson (1941) and Reed (1947). Wendorf followed Mera's reasoning on the seriation of pottery at the sites. Because ten of the sites contained only Adamana Brown Ware the pottery type was considered to be very early. The presence of other ceramics at the other nine sites was inferred to indicate they were "reoccupied at a later date" (Wendorf 1948:30). Wendorf suggested the type was earlier than Lino Black-on-Gray, which was tree-ring dated to A.D. 500-700. Therefore, he though that Adamana Brown Ware predated A.D. 500.

In 1950, Wendorf excavated 8 of 25 pit houses visible on the surface at the Flattop Site. No extramural areas were excavated and he does not mention if sediments were screened. Artifacts were provenienced by fill and floor contact. Wendorf also made an extensive surface collection, attempting to collect all sherds. The main focus of Wendorf's research, based on a culture-historical framework, was the more precise dating of Adamana Brown Ware. The cultural affiliation of the Flattop Site was ambiguous. Wendorf compared traits such as house type with those at various excavated sites to infer both Mogollon and Anasazi influences at the site, while ceramics were stated as being most like Hohokam, Prescott, and early Sinagua wares. In his overview of Southwest prehistory, Bullard (1962) would not assign the Flattop Site to either the Anasazi or Mogollon, noting that the only specific Anasazi trait present at the Flattop Site was slab-lined walls (Bullard 1962:179).

Four inferences made by Wendorf about the Flattop Site will be discussed:

1. Chronology: No absolute or chronometric dates were obtained from the Flattop Site. Dating of the site relied on the seriation placement of Adamana Brown Ware, on Adamana Brown Ware intrusives at the Bluff Site (Haury and Sayles 1948) and other sites, and to some extent on lithic and architecture styles.
2. Seasonality of occupation: Primarily because of the lack of interior hearths, Wendorf inferred only seasonal (apparently summer) occupation.
3. Site activities: The artifact assemblage (with abundant ground stone), floral remains, and the lack of faunal remains indicated a heavy reliance on agriculture.
4. Warfare: The abundance of projectile points, the lack of bone, and the apparent defensive location were considered evidence of regional social stress or warfare.

Chronology

Simple, primitive pit houses and unpainted, unslipped pottery suggested an early archeological complex. In the absence of chronometric data, dating of the Flattop Site was based on four lines of evidence: seriation, cross-dating (at the Bluff Site), negative evidence (the absence of later wares), and stratigraphy (relative stratigraphic position of Adamana Brown Ware at other sites).

The seriation of pottery types is an established (if problematic) technique, and the early temporal placement of Adamana Brown Ware and the Flattop Site seems reasonable. There may be however, other reasons for the presence of a single pottery type at a site besides an early "colonizing" occupation. Short-term occupation, social isolation, or functional differences may influence the availability, use, and discard of pottery.

The Adamana Brown Ware was cross-dated to the A.D. 300s because of Adamana Brown Ware found at the Bluff Site, 60 miles south. This cross-dating has two potential problems. First, the relationship of the Adamana Brown Ware to dated features or artifacts at the Bluff Site is problematic. The context and quantity of Adamana Brown Ware differ greatly at the two sites. Only 34 Adamana Brown Ware sherds were found at the Bluff Site, all in pit house fill (Haury and Sayles 1947). At the Flattop Site, in contrast, Adamana Brown Ware constituted 85 percent of the ceramics, and nearly all of the ceramics were found on house floors. Therefore, the Adamana Brown Ware at the Flattop Site appears more likely associated with the use of the structures. With so few sherds, all in unclear contexts, the Adamana Brown Ware at the Bluff Site could represent scavenging, later intrusions, or earlier deposits disturbed by the Bluff houses. Second, there are also some potential problems in the dating of the features themselves at the Bluff Site. The pit houses there were excavated as a unit, with no distinctions between floor and fill proveniences. Charcoal, tree-ring dated to A.D. 300s, was found in the fill and presumed to be structural remains. All artifacts found in the fill also are assumed to date to the A.D. 300s; however, fill artifacts are not necessarily coeval with the structures. For example, fill artifacts may be earlier, if a borrow pit for roof plaster was located in an old trash deposit. They may be later, thrown in by later occupants after the house was abandoned. Data presented in the published report are inadequate to address this problem. No areas outside of pit houses were excavated, which might have provided information on the presence or distribution of site occupations previous or subsequent to the pit house occupations. One researcher (Bullard 1962) states that the Bluff Site most likely was occupied to Pueblo I times; such a long-term occupation corroborates the possibility that other depositional processes might have been at work. In addition, Adamana Brown Ware may have had a long-lived popularity: nine sherds from Bear Ruin – A.D. 650-700, based on tree-ring dating of structural wood (Haury 1940) – and a few sherds associated with lower levels of the Twin Butte site, which contained better-dated Basketmaker III-Pueblo I pottery types (Wendorf 1953), suggest survival of Adamana Brown to Basketmaker III times. Some of the vessel shapes, including a duck effigy and ladles, are considered to be later Basketmaker III-Pueblo I traits (Wendorf 1950).

Seasonality of Occupation

Wendorf's main evidence cited for only warm-season occupation at the Flattop Site was the lack of formal hearths in the pit houses: the only hearth found was in a somewhat larger pit house that he called a community house. Other houses had indistinct burned areas on the floors, either centered in the room or near the wall. Wendorf also cited the small house size as additional support for the idea of seasonal occupation. Indeed, Bullard states that "the non-Anasazi Flattop Site [has] the smallest houses on record" (Bullard 1962:118).

Refuse disposal patterns could also provide supporting evidence for seasonal occupation (Crown 1983), because there appeared to be dispersed sheet trash on the site rather than confined trash disposal areas; however, extramural areas were not tested. Further, the physiography must be considered. Even long-term year-round occupation may leave little trash because it could be easily disposed over the edge of the butte.

But the refuse pattern does not contradict seasonal occupation. Several pit houses contained abundant pottery and ground stone, which may have been cached for the next season as part of the "site furniture" (Binford 1979:264; Schiffer 1985). The metates and manos recovered showed no evidence of being worn out, and apparently had substantial remnant uselife. Wendorf suggested that placement of metates near walls forced the grinder to face the wall, indicating that the structures had open brush side-walls (for view). This inference illustrates that Wendorf was assuming that objects were left where they were used. It seems at least as likely that the metates were in storage (cached). Wendorf does not go so far as to suggest that the few metates found upright against house walls were used by workers on their sides or heads!

The Reid Relative Abandonment Measure (Schiffer 1976) can be used determine the nature of the occupation at the Flattop Site. The Reid Measure calculates the ratio of the frequency of floor artifacts to fill artifacts, with the assumption that the lower number of floor artifacts and the higher the number of fill artifacts the earlier the structure was abandoned. Data for applying the measure are presented in Table 4.1. Figure 4.1 charts the data using the number of restorable vessels on floors. Because pottery may be underrepresented at early sites, the data in Figure 4.2 uses the number of artifacts (including vessels) on the floor. Structures abandoned early would contain little or no de facto refuse due to scavenging and reuse. A high density of secondary refuse in fill would indicate a trash-filled structure, abandoned during occupation. Application of the measure suggests that the pit houses were not likely to have been abandoned all at once. With little de facto refuse on their floors and more sherds in their fill, Houses H, J, L, M, and N (Cluster 1) appear to have been abandoned first. Houses A, D, and P (Cluster 2), with more usable items on floors and substantially fewer artifacts in the fill, were probably abandoned later. Three houses showed

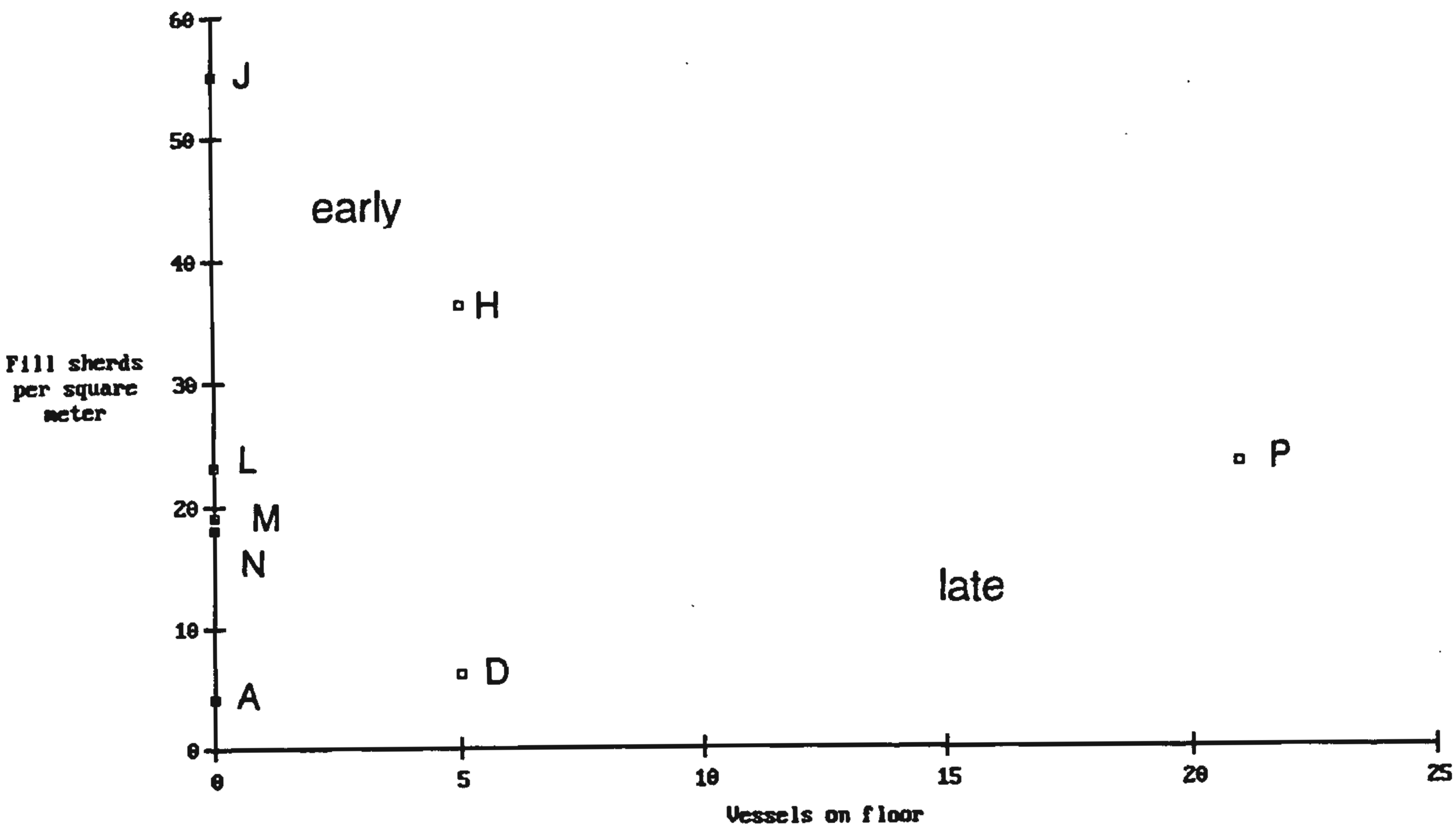

Figure 4.1. Application of the Reid Relative Room Abandonment Measure to the Flattop Site using the number of vessels on the floor.

evidence of burning; fill artifacts suggest that one was abandoned early and two late. The early and one of the late-abandoned burned houses contain artifacts in amounts and in a pattern (near walls) suggesting storage. One of the burned houses had an extremely high number of artifacts with remnant uselife, however, suggesting hoarding toward the end of the site occupation. This abandonment pattern does not contradict a seasonal use of the site; material may have been stored in pit houses in good condition for the next season, apparently for reuse.

Site Activities

An unspecified number of charred maize cobs, numerous ground-stone artifacts, and the lack of bone (n=6) suggested to Wendorf that major subsistence was derived from the practice of agriculture. Even with these converging lines of evidence, this inference rests on several assumptions. First, it assumes that bone would be preserved at the site. Two pH samples do indicate that acidic soil would not be a problem in bone preservation at the Flattop Site.

Second, the agriculture/no hunting inference assumes both a systematic inventory, and that evidence for both would be equally present. The excavation does not appear to have constituted a systematic inventory. Wendorf excavated only houses; bone refuse would not be expected in houses, because hearths, and therefore many work activities, are assumed to have been located outdoors. Only two extramural features were excavated: a hearth and a storage bin (with seven Adamana Brown sherds); both adjacent to excavated houses. If the houses were filled with trash they may provide evidence on activities that occurred outside houses at the site. In Wendorf's report, the large "community" pit house is the only one considered trash filled. However, calculating the floor area of the structures from the house plans depicted in the report and comparing the area in square meters to the sherd count (Schiffer 1979), ratios of floor sherds to fill sherds indicate that some houses may be trash filled, but ratios for most (compared to the trash-filled house) suggest that they were more likely filled through sheet wash (Table 4.1). Using Seymour and Schiffer's (1987)

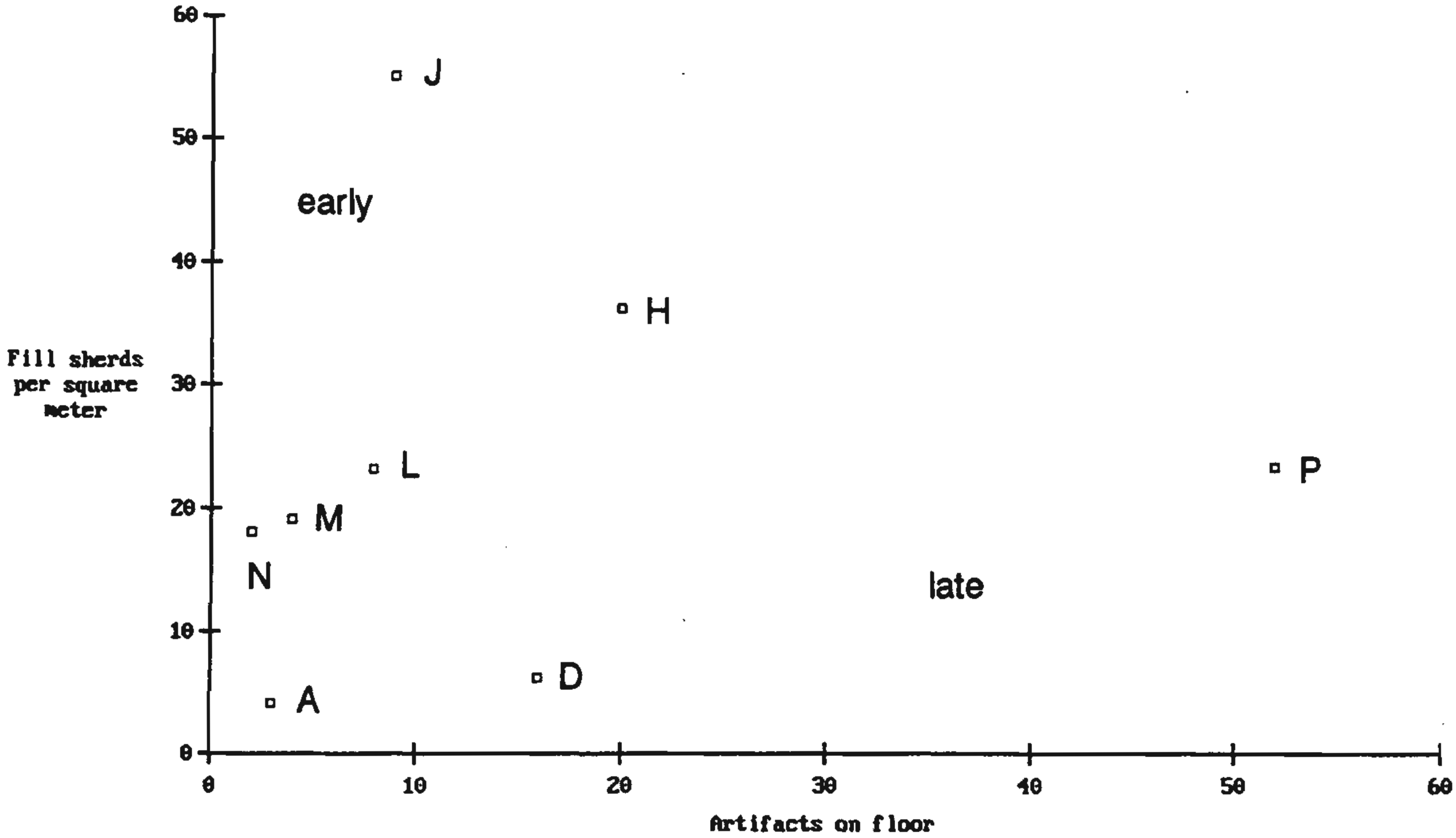

Figure 4.2. Application of the Reid Relative Room Abandonment Measure to the Flattop Site using the number of artifacts on the floor.

technique of comparing house assemblages to extramural areas (presumably Wendorf's surface collection could be equated with extramural areas), it appears that the houses are not representative of the site as a whole. Because of the lack of bone, Wendorf explains the abundance of flaked stone tools as evidence of warfare, but most of the flaked stone was recovered during surface collection rather than during house excavation. This may indicate activity that areas associated with meat processing could have been missed by excavation only in pit houses.

Third, the agriculture/no hunting inference also implies a lack of wild food gathering, evidence for which may be hidden. Because sediments were not screened and no flotation samples were taken (not common at the time), only large floral remains such as maize would be recovered.

Even if bone was not found in extramural trash deposits, it may still be premature to discount hunting in the Flattop occupants' subsistence. Bone could have been processed or removed with meat to another base camp. Ground stone did not occur as fragments, but over half of the illustrated projectile points are fragments, as are all knives. This suggests remnant use life of the ground stone was high while that for flaked stone was low, which could indicate that activities involving flaked stone artifacts were important at the site. Ground stone may have been site furniture, used by a group that refurbished their hunting tool kits at the site, discarding worn out hunting equipment such as broken projectile points. Nevertheless, there is little hard evidence to confirm that the flaked stone material is temporally associated with the pit houses, and not with a discrete, temporally separate occupation: in fact, one projectile point was a Paleo-Indian type (Wendorf 1953:70).

Warfare

The abundance of projectile points and the lack of bone indicated to Wendorf (1953:74-75) that the points were "used primarily for war rather than hunting." The location of the site on an apparently defendable butte also contributes to this inference. As discussed above, evidence for hunting may have been missed. If Adamana Brown Ware turns out to be a good time marker, the entire "Adamana Brown Ware period" may not have been characterized by warfare in the region, because other Adamana Brown Ware sites are in open, "undefendable" locations (Mera 1934; Wendorf 1950:47). If hunting is considered a potential subsistence activity at the Flattop Site, the location could as easily be interpreted as providing a long-distance view of game. If one assumes an agriculture-based economy, the soil capability of the surrounding area should be assessed before defense is determined to be the only explanation for the butte-top settlement.

Conclusions

Although the pit house architecture and Basketmaker projectile point types suggest that the Flattop Site is indeed an early site, dating the site through Adamana Brown Ware to before A.D. 300 is problematic at best. Chronometric and absolute dates from this or other Adamana Brown Ware sites are needed. Ideally radiocarbon dating of the corn recovered by Wendorf would provide the best dating, but charcoal from his burned structures also would provide additional chronometric information. Although "old wood" could be a potential problem (Schiffer 1987), radiocarbon dating would help bracket the dates of occupation, which at this time cannot even be estimated. Distribution of de facto refuse does suggest that the site was only seasonally occupied. Although processing of vegetal products including maize is indicated, hunting may have been important at the site also, reducing the reliability of Wendorf's warfare-stress hypothesis. Bullard (1962) calls the Flattop Site an orphan; further work at Adamana Brown Ware sites could help find its home in Southwest prehistory.

Table 4.1. Flattop Site Excavation Summary.

Provenience	sherds per m²[a]	restorable vessels	metates	manos	hammer-stones	misc. stone	flaked stone	proj. points	maize[b]
A floor	33	-	-	1	2	-	-	-	X
fill	4	-	-	-	-	-	2	-	-
D floor[c]	88	5	3	5	1	1	1	-	-
fill	6	-	-	-	-	-	-	1	-
H floor[c]	13	5	1	9	2	2	-	1	-
fill	36	-	-	-	-	-	1	-	-
J floor	0	-	1	3	-	2	2	1	X
fill	55	-	-	-	-	-	-	-	-
L floor	13	-	2	3	2	1	-	-	-
fill	23	-	-	-	-	-	-	-	-
M floor	0	-	-	-	1	2	1	-	-
fill	19	-	-	-	-	2	-	-	-
N floor[d]	4	-	-	-	-	1	1	-	X
fill	18	-	-	-	-	-	-	-	-
P floor[c]	209	21[e]	2	17	6	4	1	1	X
fill	23	-	-	-	-	-	-	-	-

a. includes those from restorable vessels
b. unknown if from floor or fill
c. burned
d. community house noted as trash-filled
e. one is unfired fiber-tempered brown ware

Chapter 5

Research Orientation and Data Requirements

As discussed in Chapter 3, past research in the region, including overviews, surveys, and excavations, has resulted in the development of a basic chronology and subsistence-settlement model for the region (Gumerman 1988b; Stewart 1980). As a result of this work, general research domains have been identified for Petrified Forest National Park (Jones 1987:9-11). For ease of reference these can be divided into four thematic categories: chronology, economic and environmental orientation, regional interaction and trade, and technological change. Although specific problems for these domains have been developed most explicitly for the Pueblo period (for example, Burton 1990; Jones 1987), the themes are general enough to provide a framework for earlier sites, such as Sivu'ovi (AZ Q:1:114 [ASM]).

Chronology

Although the research domains overlap, questions concerning chronology are basic. For the Pueblo period, the Petrified Forest National Park area is peripheral to well-defined archeological culture areas, and archeological sites within the park and their occupation dates do not correspond well to existing typologies and chronologies for those areas. But for the Basketmaker II period Petrified Forest is squarely within the boundary of the Adamana tradition as defined by Wendorf (1953), Beeson (1966), and others (Mera 1934; Plog 1983, 1984). Adamana sites have been assumed to represent the initial occupation of the region. Further, Plog (1983, 1984) interprets survey data showing a widespread, well-defined and near-exclusive distribution of Adamana Brown Ware as evidence of a political and economic alliance. There are however, little excavation data for Basketmaker II sites in the area. Although inferences about the timing and intensity of this early settlement hinge on the temporal ascription of Adamana Brown Ware, the pottery never has been directly dated, as discussed in Chapter 4. Chronometric data, such as radiocarbon dating of specimens from Sivu'ovi or the Flattop Site, obsidian hydration analysis, tree-ring and archaeomagnetic dating, and artifact cross-dating, are considered critical in testing inferences about the culture history of the Basketmaker II period. Analysis of artifacts and features will provide additional information on similarities, and, by extension, on possible relationships among early inhabitants of the Petrified Forest region and groups proximal in space and time.

Data required to answer these questions consist of temporally diagnostic artifacts, such as ceramics and projectile points, and nonartifactual material, such as organic matter for radiocarbon dating. Contextual information, such as that gained from the excavation and documentation of stratified profiles, is of utmost importance to establishing intrasite chronology. Typological classification or attribute analysis of ceramics and other artifacts may clarify the timing and extent of ties with adjacent areas. Analysis of technological attributes of the lithic assemblage may also help establish the temporal range of the site; distinct variation in debitage attributes between preceramic or early ceramic and later ceramic assemblages has been established for other areas (Parry and Kelly 1987:285-304; Sullivan and Rozen 1985; Rozen 1981).

Economic and Environmental Orientation

This research domain includes determining whether sites represent the remains of dry farming, gathering, or hunting activities. Collections of fossil pollen and flotation samples, as well as careful screening of excavated deposits to retrieve macrofossils, will help reconstruct the past environment and interpret human adaptation at these sites. As demonstrated by Gumerman (1988a), studies of a broad range of environmental data can facilitate explanations of the cultural and economic differentiation of prehistoric groups. Those data can be used as a baseline with which to compare Petrified Forest data.

Other questions also revolve around determining economic and environmental orientation. For example, the degree of sedentism has been related to the adoption of agriculture, the development of storage facilities, technological innovations, and architectural effort. Inferences regarding whether sites in different periods were occupied year-round or only seasonally have been tied to larger questions of mobility, population aggregation and expansion, risk minimalization, and fertility. Although the current sample from Sivu'ovi is extremely small relative to the entire site, evidence such as presence (or absence) of seasonally sensitive animal and plant taxa could provide initial assessments of seasonality.

Artifact assemblages and features, architecture, and other evidence can be used to suggest site functions. Techno-functional artifact types such as projectile points or mortars, if found as de facto refuse (artifacts left at time of abandonment), could provide evidence of subsistence. The ratio of storage to living space can be used to estimate the occupants' reliance on cultigens. Charred food remains on floors may offer further evidence of plant use. Pollen from insect-pollinated plants in structures, or cultigen pollen incorporated into floor or hearth plaster, would also indicate utilization and possibly food sources. Secondary refuse in midden deposits may contain additional data.

Other evidence of subsistence might be present directly or indirectly in faunal remains. For example, the ratio of cottontail to jackrabbit remains not only can indicate hunting but can also suggest amounts of cleared cultivated land, because of the different habitats each exploits. Small mammal remains, even without butchering evidence, may show evidence of cultural use (Szuter and Gillespie 1990).

Regional Interaction and Trade

Evidence for this domain can be derived from the presence of exotic items, such as nonlocal pottery, obsidian, or turquoise, especially if these can be traced to their source. It is expected that several lines of evidence may be necessary to differentiate between various degrees of trade and interaction versus the mobility of a single group. For example, if the inhabitants of the region were highly mobile, occupying Sivu'ovi only seasonally, exotic material could have been obtained during a far-reaching seasonal round. Such mobility could result in a pattern of similar architectural styles, features, and artifacts at different sites over the region, not unlike what might be expected from a regional alliance as postulated by Plog (1983, 1984). Therefore, the more evidence for year-round occupation at Sivu'ovi, the less one could attribute similarities to mobility. To make the strongest case that Adamana Brown Ware signifies an alliance, Sivu'ovi should exhibit not only similar patterns in architecture, other features, and artifacts to those found at the Flattop and other Basketmaker II sites, but also a stable, long-term and possibly year-round occupation.

Studies of the technology exhibited by a sample of flaked stone from the site may establish whether tools or other prepared pieces, such as preforms, were being manufactured in quantities larger than those necessary to support the local population.

Although developed for pueblo studies, the Reid Relative Room Abandonment Measure (Schiffer 1979) can be adapted and used to identify late-abandoned structures and postulate a model of site occupation. In this technique a high ratio of fill sherds to restorable vessels (or artifacts) on the floor suggests that a structure was emptied of usable vessels (which were moved to other areas) and the structure used by inhabitants of nearby structures for the disposal of trash, which would include sherds. A low ratio of fill sherds to vessels (or artifacts) suggests that vessels or de facto refuse were left on the floor and the structure used for trash disposal, theoretically because the structure was in use up until that entire portion of the site was abandoned.

De facto refuse in structures could provide information on abandonment of the site as a whole. For example, violent or unexpected abandonment, such as from fire or warfare, would curtail normal curation processes, and de facto refuse might represent nearly the entire systemic inventory of a moment in time. A gradual population decline would result in depleted de facto refuse because of "draw down" (not replacing broken, discarded, or worn items in anticipation of a move) and perhaps scavenging. A gradual population decline could also result in enriched de facto refuse in some portions of the site, due to scavenging and stockpiling by the last inhabitants. For example, valuable items left as de facto refuse may indicate a hurried abandonment, or that the inhabitants expected to return. Relatively heavy items left behind may suggest the distance to the next settlement.

Frequencies of exotic trade items such as turquoise and obsidian can be used as indices of reliance on trade as an economic base at Sivu'ovi compared to other sites. A decrease in the occurrence of exotic items and the increasing frequency of local ceramics or changing composition of ceramic assemblages may indicate the collapse or reorganization of regional networks necessary for the survival of the local society, thereby leading to site abandonment.

Technological Change

Even with a small test excavation, Sivu'ovi should provide data on technological change. Studies of the aboriginal use of petrified wood are especially important because of its widespread use, both geographically and temporally. For example, differentiation between the products of primary and secondary reduction at quarries and sites will provide information on the stage of reduction (raw material, preforms, or finished tools) at which materials were being transported or traded. Data from Sivu'ovi may be compared with data from earlier Archaic and later Pueblo period sites to investigate changes in lithic technology through time. The use of pottery has often been seen as a radical technological change, with far-reaching implications for sedentism and storage. Is the introduction of Adamana Brown Ware, the first pottery in the region, reflected in storage and cooking features, as compared to earlier Archaic and later Pueblo period sites? Likewise, the ground stone and lithic reduction technologies have been postulated to be very different between Archaic and Pueblo period groups. One-hand manos and basin-shaped metates are considered characteristic of the more mobile populations of the Archaic period, while rectangular, two-hand manos and trough metates characteristic of the Pueblo period with its increasing reliance upon agriculture (Morris 1990). Does lithic reduction and ground stone at Sivu'ovi support a gradual modification of the Archaic style, with interim forms, or an abrupt change?

Intrinsic dating (for example, obsidian hydration) and context within stratified deposits will provide data on technological change and differential use of raw material through time. What kinds of tools (such as, bifaces or blade cores) were being manufactured? How does the technology compare with other Pueblo period, Basketmaker period, and Archaic period sites analyzed (Burton 1990; Jones 1983, 1986; Tagg 1987)?

Significance of Research

Increase in sedentism is one of the salient characteristics of human evolution. Whether seen as an inevitable, linear process or a more stochastic development proceeding in fits and starts, the transition from highly mobile hunter-gathering orientations with low population density to sedentary, aggregated groups of people is one of the most critical subjects of archaeological inquiry (Rafferty 1985).

In the American southwest, although numerous studies focus on increasing sedentism during the transition from pit house to pueblo (Basketmaker III to Pueblo time periods; for example, Gilman 1987; Plog 1974), few deal with the transition from mobile hunters and gatherers to early sedentary agriculturalists (the Archaic to Basketmaker II transition) possibly because of the lack of chronometric control for this pivotal time period. The determination of prehistoric settlement patterns necessary for such reconstructions depends, however, upon precise chronological control. Although several chronometric techniques can be used on excavated sites, the most expedient, efficient, and efficacious chronometric data in site-specific and region-wide surveys in the American Southwest are derived from pottery types.

Excavations at Sivu'ovi can provide information on a little-studied but important period of Petrified Forest prehistory. Modern chronometric techniques such as radiocarbon, obsidian hydration, and archaeomagnetic dating can provide chronological control unavailable to Wendorf (1951, 1953) in his early excavation at the Flattop Site. Substantiated dates for Adamana Brown Ware cannot only aid in the placement of Sivu'ovi in the culture history of the region, but also increase the usefulness of the pottery type as a dating tool in other areas. Surface evidence indicates that Sivu'ovi contains valuable information; even small-scale excavations may contribute to the understanding of the development of agriculture and sedentism in the region.

Chapter 6
Site Description

Jeffery F. Burton and Kathleen M. McConnell

Sivu'ovi (AZ Q:1:114 [ASM]) is a large Basketmaker village covering over 12 acres on an unnamed butte overlooking Jim Camp Wash and Cottonwood Wash. The site consists of the remains of numerous pit structures, sherds and other artifacts, and an extensive lithic scatter. Also within the site boundaries are several small pueblos (field houses), and to the north is a large petrified wood quarry (see Figure 6.1).

Carl Jepson recorded nine separate sites on the bluff in December 1940; these were later assigned Museum of Northern Arizona site numbers (Jepson 1941; PEFO site numbers 7 through 14 and 29 [MNA site numbers NA 4707 through NA 4714 and NA 4729]). Jones (1987) combined several of Jepson's sites (PEFO 12, 13, and 14) as AZ Q:1:114. For this project the site boundaries of AZ Q:1:114 were further expanded to include the entire 12-acre bluff with its various densities of cultural material.

Pit Structures

During site mapping, 47 pit structures were noted eroding out of the edges of the bluff. Preservation of the pit structures varied from completely eroded features (now sandstone slab concentrations) to largely intact obvious pit houses with upright embedded slabs. Most have numerous artifacts associated with them, including one or more manos or metates. The large number of structures now visible suggests massive erosion since 1940 because Jepson noted only six structures and a few storage bins.

Artifact Scatter

There is a light density surface artifact scatter over the entire bluff, with concentrations around and below eroding features. In addition, on the western flank of the bluff, the artifact density is high in areas that appear to be deflated by wind erosion. This suggests that additional remains are present under aeolian sand in other portions of the site. Flaked-stone pieces are the most numerous artifacts on site, and include both petrified wood and cobble chert artifacts. During site mapping, 84 metates, 45 manos, and numerous other artifacts were noted.

Scattered throughout the site, but mainly along the bluff edge, are numerous petrified wood logs, some of which have been utilized as cores. North of and adjacent to the bluff is an extensive petrified wood quarry area. Logs, large petrified wood blocks, cores and core fragments, and hammerstones are present.

Rubble Mounds

There are five field houses and one small pueblo located within the site, including one field house apparently not recorded by Jepson. These habitations can be distinguished by large amounts of petrified wood blocks used as wall-building materials and corrugated, black-on-white and black-on-red ceramics in the immediate vicinity. Pueblo structures existed at one time on the eastern edge of the mesa, but have fallen off the bluff since Jepson recorded them. There appears to be no separation between the artifact scatters associated with these structures and the artifacts associated with the pit houses.

Two other small pueblos are located 150 m to 200 m north of the site. There are also several

Figure 6.1. Sivu'ovi site map.

Pueblo period field houses below the bluff to the east of the site. These sites include a dense scatter of Pueblo II ceramics, including black-on-white wares, several types of corrugated wares, and a small amount of black-on-red ware, as well as ground- and flaked-stone artifacts.

Previous Site Designations

During his 1940 survey, Jepson marked sites with large wooden stakes with engraved site numbers. Jepson's sites were located along all edges of the bluff. Six of these stakes were found, mostly near prehistoric features, during the present field work. Although none of the stakes were still in place or readable, they did, along with Jepson's site descriptions, allow his sites to be identified (Figure 6.2). Jepson's site information is included below, along with the results of Reed's (1947) ceramic analysis. Jepson's different site boundaries could reflect a different perspective on site

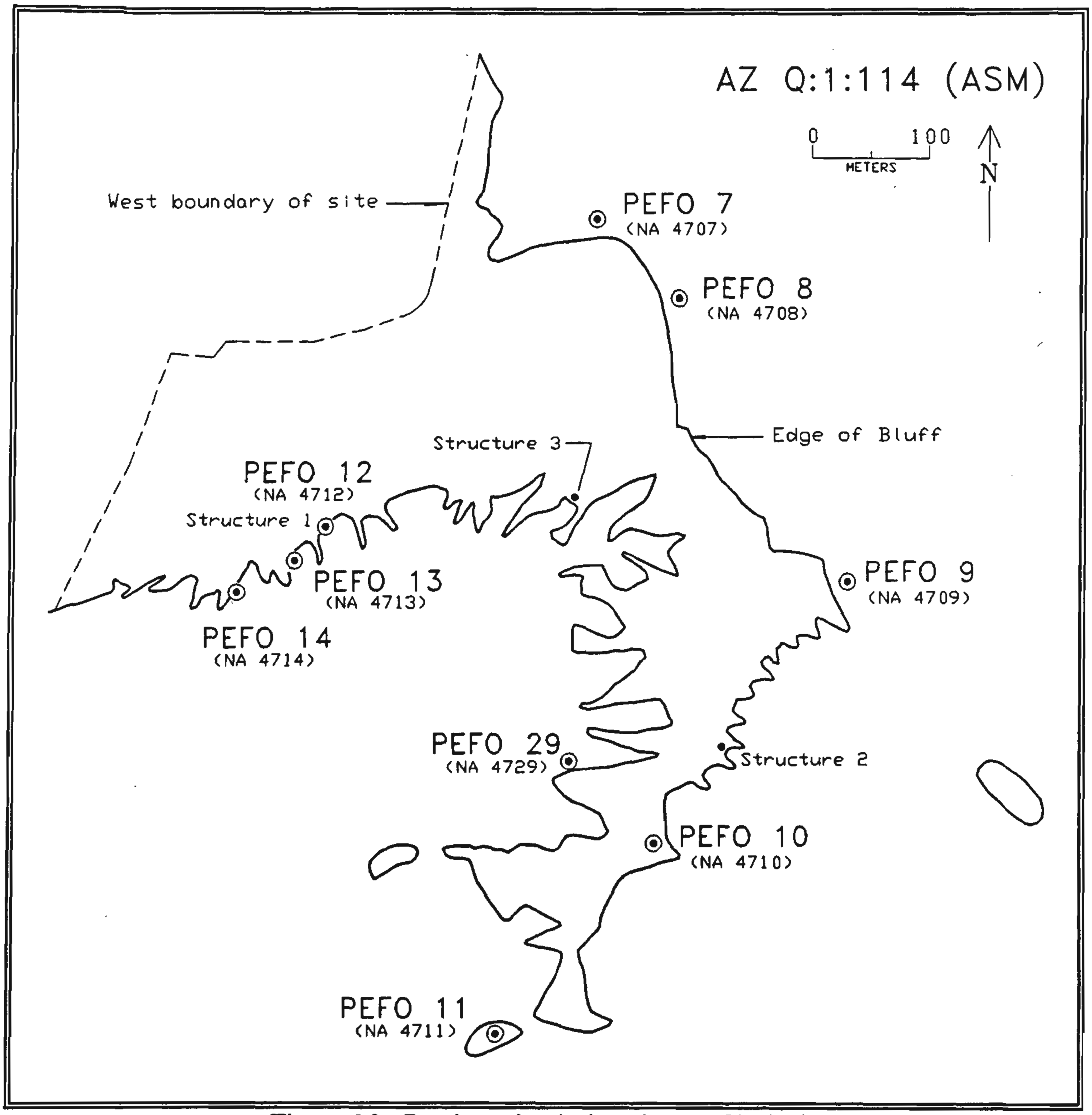

Figure 6.2. Previous site designations at Sivu'ovi.

boundary criteria, or the exposure of more interstitial cultural material over the last 50 years. Whatever the case, his data are still valid for those portions of the site he recorded.

PEFO 7 (NA 4707)
This site consists of a completely eroded pueblo of petrified wood, apparently only one room in size. Artifacts noted at the site by Jepson included four manos, two metates, hammerstones, debitage, and a few sherds. The site was dated to the Adamana phase based on the only artifact collected: an incomplete, but restorable Adamana Brown seed jar (Reed 1947).

PEFO 8 (NA 4708)
This site consists of a completely eroded one-room pueblo, constructed of petrified wood. Artifacts

at the site included three manos, two metates, hammerstones, debitage, and a few sherds. The site was dated to the Pueblo II period and the Adamana phase based on collected ceramics, which included Holbrook Black-on-white, Puerco Black-on-white, brown corrugated, and Adamana Brown (Reed 1947).

PEFO 9 (NA 4709)
This site consists of a completely eroded pueblo, most likely only one room, constructed of petrified wood. Artifacts noted at the site included three metates, manos, hammerstones, debitage, and a few sherds. Apparently no collections were made from the site.

PEFO 10 (NA 4710)
This site consists of a small partially eroded two-to three-room pueblo, constructed of petrified wood. Two apparent storage bins of vertical sandstone slabs also were noted at the site. Numerous sherds, seven metates, and manos, hammerstones, debitage, and several circular stone disks, postulated to be storage bin covers, were noted. Apparently no collections were made at the site.

PEFO 11 (NA 4711)
At this site, Jepson noted some partially eroded storage bins made of vertical sandstone slabs. Several sandstone disks and manos, seven metates, debitage, and a few sherds were noted. Apparently no collections were made from the site.

PEFO 12 (NA 4712)
This site consists of four pit houses, each about 2.5 m by 3 m in size, indicated by vertical slabs of sandstone. A few hammerstones and manos, six metates, and debitage were noted at the site; no sherds were present. This site appears to correlate with Structure 1, excavated during this project and Feature 4 recorded by Jones (1987).

PEFO 13 (NA 4713)
This site consists of a partially eroded pit house, 2.5 m by 2.5 m in size, indicated by vertical sandstone slabs. A few sherds, hammerstones, debitage, manos, and four metates were noted at the site. Collected ceramics included one possible Walnut Black-on-white, one brown corrugated, and seven Adamana Brown sherds, indicating a Pueblo II-III and Adamana phase occupation (Reed 1947).

PEFO 14 (NA 4714)
This site consists of a completely eroded, one-room, petrified wood pueblo. Numerous sherds, a few hammerstones, debitage, manos, and four metates were noted at the site. Collected ceramics included Holbrook Black-on-white, brown corrugated, and Adamana Brown, indicating Pueblo II and Adamana phase occupations (Reed 1947).

PEFO 29 (NA 4729)
This site consists of a single partially eroded pit house indicated by vertical sandstone slabs. A few sherds, hammerstones, debitage, manos, metates, and circular discs were noted at the site. Jepson indicated that the site appeared to be very old. Only Adamana Brown was present in the collection of ceramics from this site (Reed 1947).

Chapter 7
Methods

Jeffery F. Burton and Kathleen M. McConnell

Between August 15 and 31, 1989, July 17 and 19, and September 1 and 3, 1990, excavations were conducted at Sivu'ovi (AZ Q:1:114 [ASM]), a Basketmaker II village at Petrified Forest National Park. The primary goal of the project was to salvage data useful for addressing important research questions from this badly eroding site. Multiple methods were used in the fieldwork at the site. The strategies and methods used during various phases of fieldwork, analysis, and research are discussed below. Methods used in specialized analyses are presented in the following chapters or as appendices.

Field Methods

Fieldwork was conducted by a team of up to four archeologists and eight volunteers. The crew was based at the Park Headquarters, 30 miles north of the project area. Fieldwork consisted of surface inspection, mapping, systematic surface collection, and the excavation of shovel test pits, 1-m by 2-m units, and structures. To facilitate intersite comparison, the methods used are comparable to those used at other sites in the region.

Surface Inspection and Collection

At the initiation of fieldwork, the site was inspected to confirm site condition, to become familiar with the location of previous features noted by Jepson (1941) and Jones (1987), and to determine the optimal locations for excavation. The project area was walked at 5-m intervals, and all observed diagnostic artifacts (such as decorated ceramics or stone tools) were flagged, plotted by transit, and then collected. Based on this field inspection, the site boundaries of AZ Q:1:114 were enlarged to include all of the cultural remains on the bluff top. In addition to the artifacts collected, a charcoal sample was taken from an eroding pit structure in the central portion of the site (see Structure 3 on Figure 6.1)

Mapping

Excavation units, separately collected surface artifacts, the surface-collection grid, and visible features were plotted by plane table and alidade or transit. Emphasis was placed on showing the deep incursions into the site by erosion so that the rate and severity of erosion could be monitored and to help in interpreting concentrations of eroded artifacts (see Figure 6.1). Excavation and surface-collection units were placed on a grid orientated to magnetic north. In addition, detailed contour maps were prepared for the two small portions of the site subjected to systematic surface collection and shovel testing. The original maps are on file at the Western Archeological and Conservation Center in Tucson.

Systematic Surface Collection

A surface collection of all artifacts was made on a peninsula of the bluff that is surrounded on three sides by steep washes, down which the slab wall remains of structures can be seen (Figure 7.1). This area was chosen for a surface collection because of the high density of both lithic and ceramic artifacts, including several finished lithic tools. A large amount of cores and flakes, both retouched and unretouched, and manufacturing debitage are present. Hammerstones and polishing stones also were collected from this area.

Figure 7.1. Surface collection.

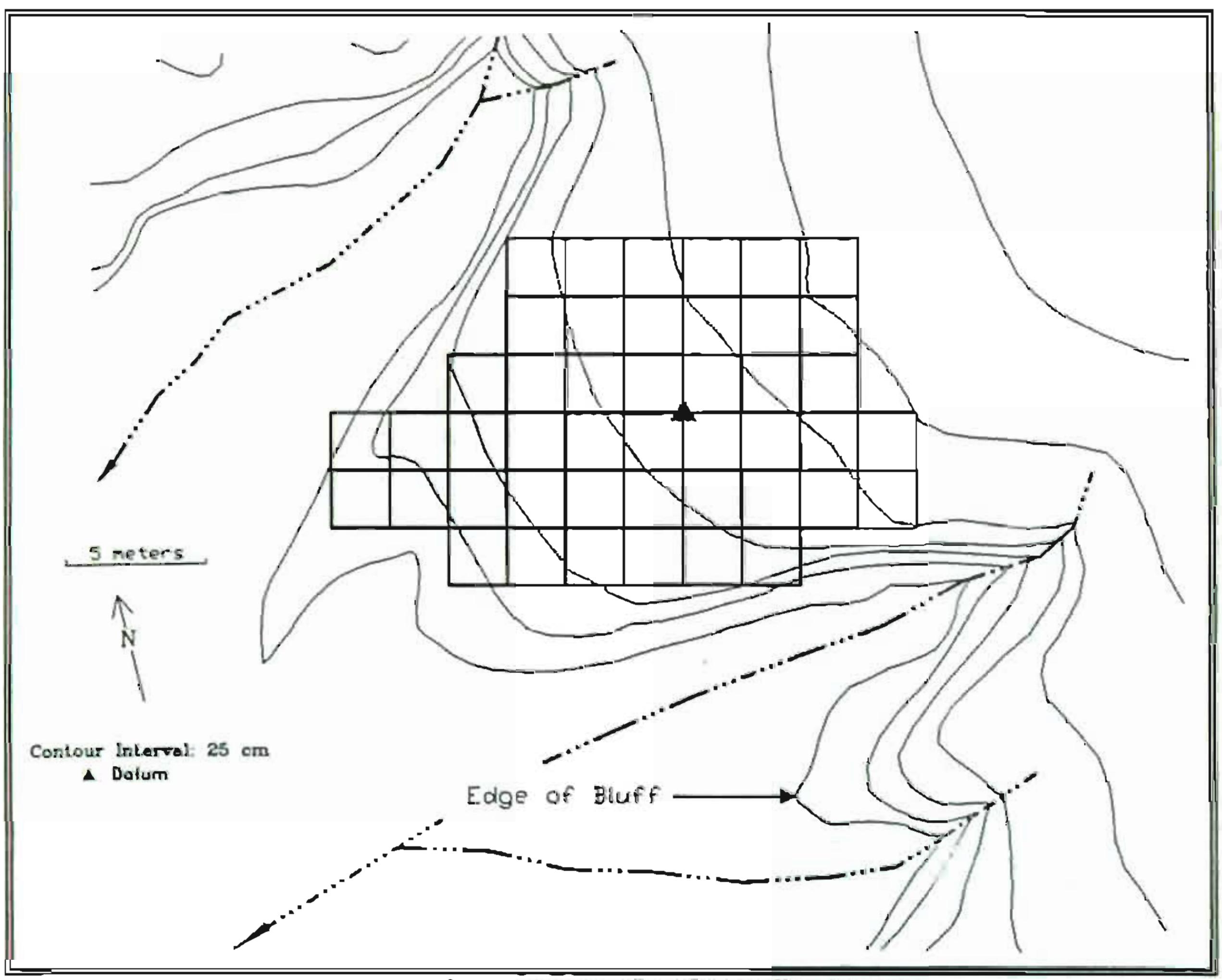

Figure 7.2 Contour map of surface collection area.

Although the surface of this area is deflated due to wind and water erosion, the cultural material does not appear to have been transported by natural formation processes. Its central position with regard to surrounding structures can be surmised from the sandstone slabs eroding down the slopes. The quantity of lithic artifacts in all stages of tool production present may indicate that this area was an activity area, but the equally dense distribution of sherds argues that it may instead represent a deflated trash deposit.

Within this area, a grid of 45 2-m by 2-m units was laid out using magnetic north as a reference (180 square meters in all). A detailed contour map was prepared of this area (Figure 7.2). All artifacts visible on the surface were collected and bagged separately for each 2-m by 2-m quadrat.

Shovel Test Pits

Surface indications show that the central west portion of the site is a natural water-holding basin due both to the deep, sandy soil and a surrounding rise on three sides. The basin was thought to be a potential source of pollen from agricultural vegetation. To test this hypothesis, five shovel test pits were excavated in this area. At an average depth of 25 cm from the present ground surface, well into the compacted soils, pollen and soil samples were taken from each unit for subsequent analysis. A detailed contour map was prepared of this area (Figures 7.3 and 7.4).

Controlled Manual Excavation

Two 1-m by 2-m test units were excavated in the western portion of the site. The main purpose of the units was to help establish stratigraphic relationships and the westward extent of the site. This is the only boundary of the site that is not defined by erosion.

Within each 1-m by 2-m unit, each 1 by 1 m quadrant was excavated and collected separately. The original ground surface of the datum corner was considered the "0-elevation"; any corner above the datum corner was excavated as a positive level (for example, +3 to 0 cm). Excavation proceeded by arbitrary 5-cm levels. The units were excavated mainly by shovel, but trowels, dustpans, and picks were used as needed. Units were excavated until sterile soil was encountered. All excavated dirt was passed through 3-mm (1/8-inch) mesh hardware cloth. Although 6-mm (1/4-inch) mesh would have been consistent with other work in the region, the finer mesh was used because of the particular research problems posed for this project. If lithic reduction was an important activity, the finer mesh would help in the recovery of small flakes that could provide clues to the type of stoneworking that occurred there. Each class of recovered material (for example, lithics, ceramics, bone, floral material) was bagged separately by unit and level. Surface artifacts were bagged separately. Formal artifacts were piece-plotted in three dimensions, where possible, and bagged separately. All debitage and ceramics, despite size, were collected. Features and disturbed deposits encountered within units were excavated and screened separately from the remaining matrix.

Unit level records were used to document the findings, including features, in each excavated level. Flotation and pollen samples were taken from feature areas such as hearths, charcoal concentrations, and soil discolorations. All sizable pieces of charcoal were collected for botanical analysis and possible radiocarbon dating. Following excavation, sidewall profiles were recorded on graph paper, the unit was photographed; and time markers were placed in the bottom. All units were backfilled to approximate pre-excavation ground surface contours.

Structure Excavation

Prior to excavation, overlying aeolian sand was partially removed to delineate each structure. Initial excavation within each structure consisted of two 1-m by 1-m excavation units. These units were excavated in arbitrary 5 cm levels following the methods detailed above. Following the completion of these units, the remainder of the structure was excavated by natural strata as one or more proveniences (Figure 7.4 and 7.5).

Structure 2, as indicated by sandstone slabs visible in the side wall of an erosion gully, was partially covered by at least 0.5 m of fill, therefore it was not mapped prior to excavation. Because at least half the fill consisted of aeolian deposited sandy silt, it was thought expedient to shovel scrape and not screen the sediments until occupational fill (dark brown ashy fill with charcoal and artifacts) became visible. Only artifacts encountered during digging were saved from within this overburden.

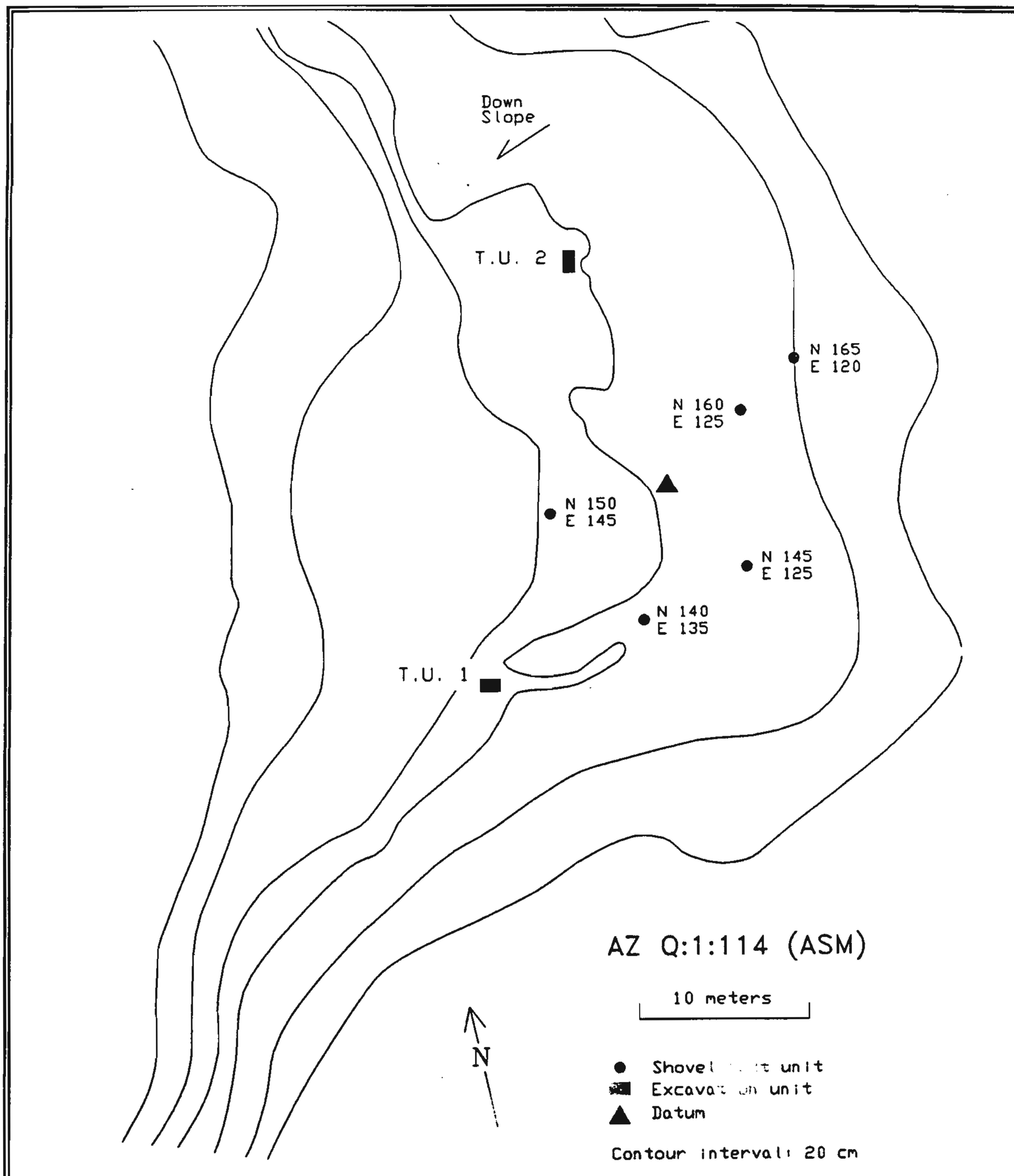

Figure 7.3. Contour map showing location of excavation units and shovel test pits.

All other sediments were screened through 3-mm (1/8-inch) mesh hardware cloth. Pollen samples were taken from undisturbed floor areas and features as appropriate. Due to the abundance of floral remains and time constraints, only a portion of the floral remains from some features was saved. Artifacts in floor contact were left in situ until mapped in place.

Subfloor strata were tested only in small areas with the excavation area expanded if warranted. The fill of subfloor features were removed as one level if no internal stratigraphy was apparent. Pollen samples and flotation samples were taken from each pit feature and from the floor of each structure. After the floor plan of each excavated structure was drawn showing all floor and wall features and in situ artifacts, both black-and-white and color photographs were taken.

Laboratory Procedures

All materials from surface collection and excavation were processed initially at a field laboratory set up at the park headquarters and later transported to the Western Archeological and Conservation Center (WACC). Ceramics and lithics were washed with tap water and a small amount of isotonic soap. Bone and shell were dry-cleaned using toothpicks and brushes. Flotation samples were processed following the methods outlined in Bohrer and Adams (1977:37). Most flotation samples taken in the field exceeded the suggested one-liter volume, in which case one liter from each sample was measured before processing, and the remainder of the fill was dry-screened through 3-mm (1/8 inch) mesh. Artifacts found in the samples were added to the appropriate collection taken from the same provenience.

Restorable vessels were repaired by the Conservation Laboratory at WACC under the supervision of Jim Roberts. Artifacts and samples not sent to specialists for analysis were analyzed and catalogued during field work at the temporary facility at Petrified Forest National Park or later at WACC. Chipped stone and ceramics made up the bulk of analyzed artifacts, with ground stone and other miscellaneous items present in lesser quantities. A discussion of the methods used in these analyses is presented in the appropriate chapters below. Certain materials, such as mineral and daub samples, were only catalogued. Generally, cataloguing was undertaken concurrently with analysis of artifacts from each provenience.

Artifacts were catalogued following the Automated National Cataloguing System (ANCS) and assigned permanent catalog numbers. The ANCS catalog numbers are used in this report. Catalog numbers assigned to the collections from Sivu'ovi are PEFO-5505-5704, 5828-5953, 9151-9153, and 9155-9327. The Petrified Forest National Park Accession Number is 488 and the WACC Accession Number is 672. All artifacts, faunal specimens, botanical remains, and mineral samples are curated in the Museum Collections Repository at WACC. Fieldnotes are curated in the WACC Division of Archeology Archives, and photographs, slides, and negatives are curated in the WACC library (Accession Number 89:29).

Materials requiring specialized analyses were sent to the following persons or institutions: botanical remains to Marcia Donaldson (Department of Anthropology, Arizona State University), pollen samples to Suzanne K. Fish (Arizona State Museum), faunal remains to William Gillespie (Department of Geosciences, University of Arizona), and soil samples to Ken McIvers (California State University, Sacramento). Samples for radiocarbon dating were sent to the Radiocarbon Laboratory, Washington State University. Obsidian was sent to Richard Hughes (California State University, Sacramento) and Tom Origer (Sonoma State University) for sourcing and hydration analysis, respectively. Samples for archaeomagnetic dating were collected and analyzed by William Deaver (Department of Geosciences, University of Arizona). Methods and results for each of these analyses are presented in the following chapters or as appendices.

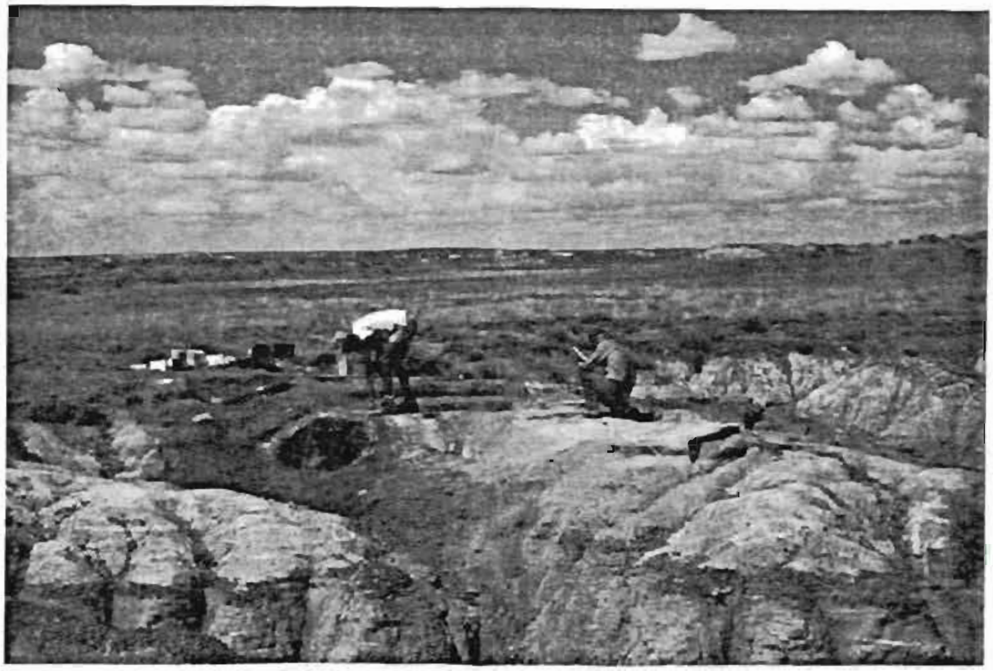

Figure 7.4. Excavation at Structure 1, 1990 field season.

Figure 7.5. Overhead view of excavation at Structure 2, 1989 field season.

Chapter 8

Structures, Features, and Stratigraphy

Jeffery F. Burton and Kathleen M. McConnell

This chapter describes the characteristics of the structures, features, and sediments encountered during excavation at Sivu'ovi (AZ Q:1:114 [ASM]). Two partially eroded slab-lined pit structures, containing 24 floor features and numerous postholes, were completely excavated. In addition, two extramural features were located during testing. In the course of this work, three main soil strata were discerned on the basis of soil color, texture, compaction, and, to a lesser extent, cultural remains.

Structures

Structure 1

This structure is located in the southwest portion of the site (see Figure 6.2). Prior to excavation, walls were defined by upright tabular-fracturing sandstone slabs visible on the ground surface. Less than 50 percent of the structure remained; the rest had apparently eroded down slope. A possible attached storage bin or entrance way is indicated by a short perpendicular line of slabs that extends from the southeast wall (Figure 8.1). Surface artifacts within the area defined by the slabs consisted of a petrified wood core, a petrified wood core/hammerstone, four quartzite hammerstones, a stone ball, a worked sandstone slab, eight Adamana Brown sherds, two metates, and a stone bowl (Figures 8.2 and 8.3).

The base of the structure wall was constructed by placing upright slabs into a trench dug into the sterile clay subsoil. In a few places cobbles and blocks were used to support the slabs. Below the floor of the structure is a very compact native grayish-white clay. The floor or occupation surface was a thin level layer of compacted brown sand, less than 1 cm thick. Directly above the compacted floor sand was a layer of light brown, apparently wind-deposited sand. This deposit was deeper along the slab-lined walls and appeared fire-altered (burned) around several post holes. Above and mixed in with the floor and fill strata was a large amount of burned cottonwood and reed material, as well as burned daub, that indicates the structure burned sometime after the aeolian sand had begun to accumulate, that is, after abandonment.

Artifacts recovered from the uppermost stratum included 15 Adamana Brown sherds, two cores, a core fragment, a retouched flake, and nine pieces of debitage. The floor fill, about 5 cm of compacted mottled sandy clay with abundant charcoal, contained three sherds, three utilized flakes, and 12 unmodified flakes. Floor artifacts consisted of a petrified wood hammerstone, a shaped sandstone slab, a pendant fragment, a stone ball, two flakes, and two Adamana Brown sherds.

Six floor features were encountered in the structure, including a possible hearth and five storage pits. One of the pits (Feature 3) contained an artifact cache, another (Feature 5) was empty but had a shaped sandstone slab cover. The remaining pits contained a mixture of other fill.

Feature 1 consists of a shallow prepared basin-shaped depression, possibly a hearth. Archaeomagnetic samples were taken from this feature and from the rim of adjacent Feature 5, described below (see Appendix D).

Feature 2 consists of a hole 30 cm in diameter and 26 cm deep. The pit does not appear to have been plastered and could have been a posthole.

Feature 3 consists of a large storage pit. The top half of the pit has eroded away; however, an intact cache was found in the bottom 50 cm of the pit (Figures 8.4 and 8.5). This consisted of two 20-cm-diameter Adamana Brown jars and one 35-cm-diameter Adamana Brown jar. One of the

Figure 8.1. Structure 1 prior to excavation.

Figure 8.2. Detail of Structure 1 prior to excavation.

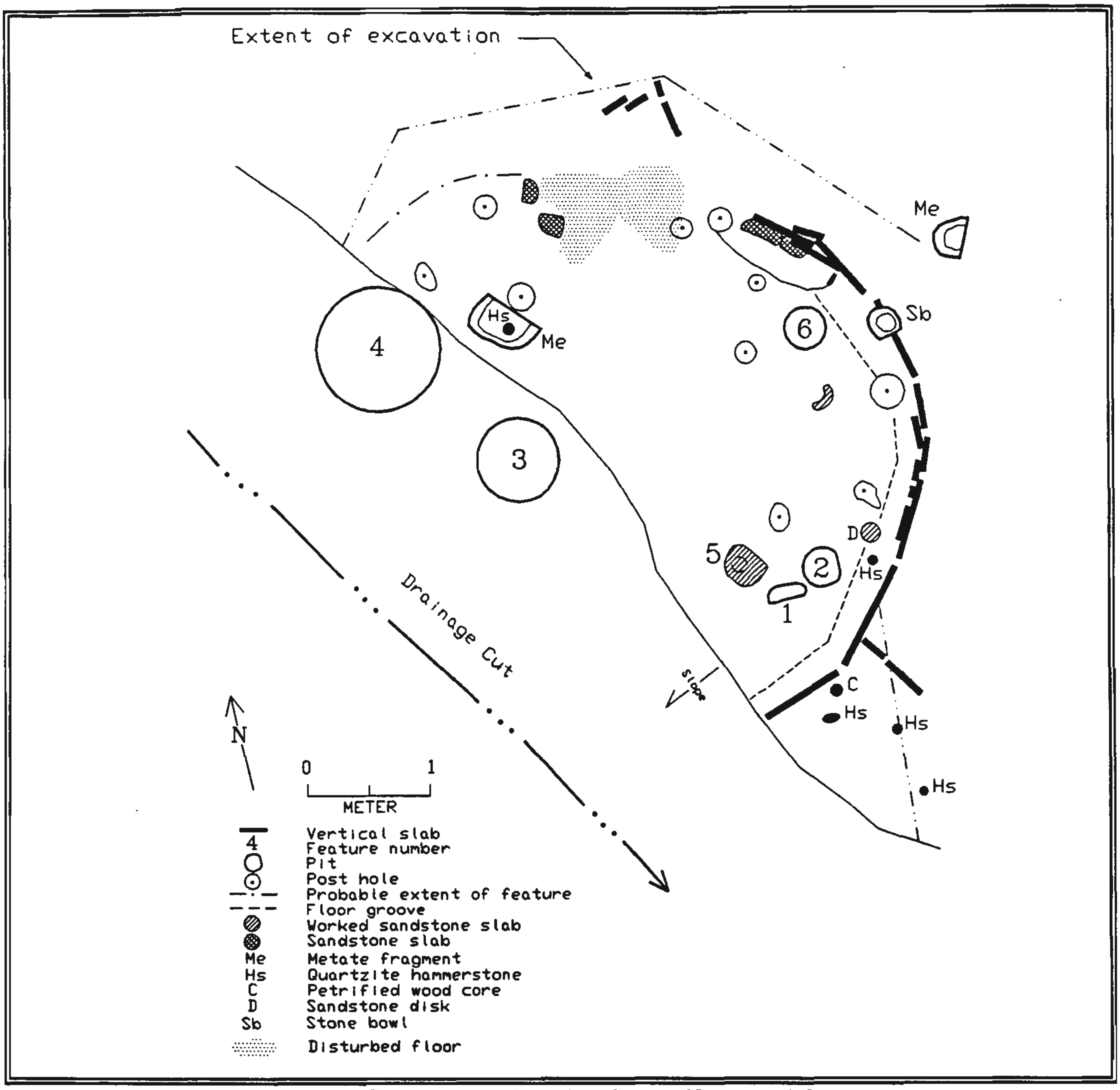

Figure 8.3. Structure 1 plan showing artifacts and features.

smaller jars contained inside it a miniature (5 cm diameter) unfired Adamana Brown bowl and an assemblage of debitage. Other contents of the pit included a quartzite lapstone-anvil, a quartzite hammerstone, three formal two-hand manos, and three shaped circular sandstone slabs. Only one sherd was recovered from the pit fill.

Feature 4 is a pit 1 m in diameter by 74 cm deep. The upper fill of the pit consisted of loose sand. The lower fill consisted of mottled charcoal, sand, and clayey sand. At the base of the pit there was a layer of very compact sand, similar to that found in contact with the structure's floor. The pit, dug into very compact clay, was apparently not plastered. Charcoal and nine Adamana Brown sherds were recovered from the pit fill.

Feature 5 is a small (20-cm diameter, 26-cm deep) bell-shaped storage pit with a shaped sandstone slab cover. The pit was empty except for a small amount of loose sand and charcoal at the bottom. The floor remnants around the edge of this feature appeared to have been fire-altered; archaeomagnetic samples were collected.

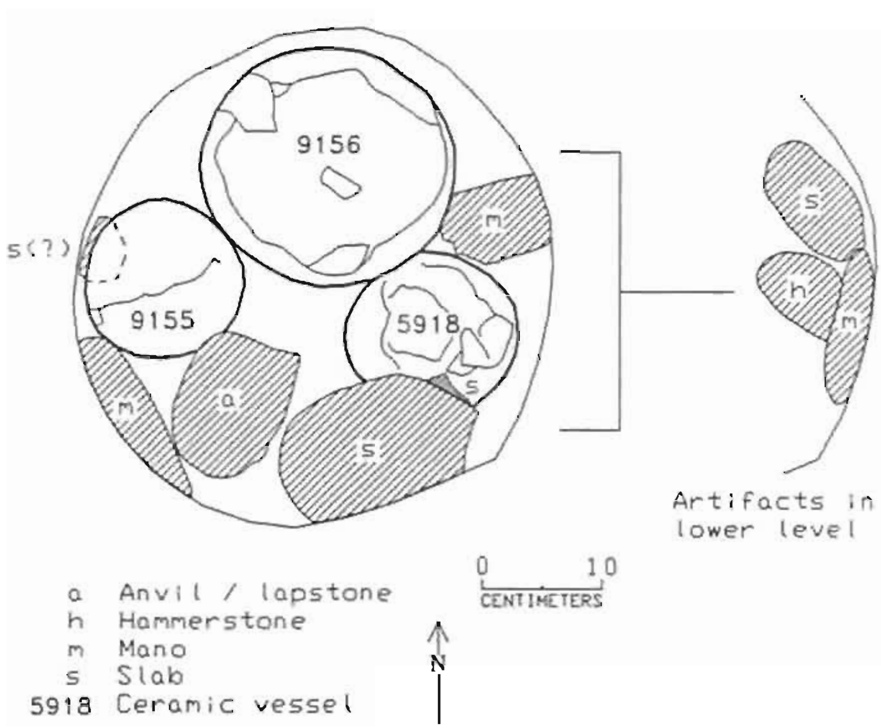

Figure 8.4. Feature 3, Structure 1.

Feature 6, possibly a large posthole, measures 30 cm in diameter by 20 cm deep.

Structure 2

This structure is located near the eastern edge of the bluff. Although an erosion channel runs through the southwest portion of the structure, it appears to be at least 80 percent intact. The east wall of the structure is defined by intact upright stone slabs in the erosion cut. The curvature of slab walls and the position of postholes indicate an oval-shaped structure, 5 m long on an east-west axis by 3.5 m wide (Figures 8.6 and 8.7).

The entryway appears to be situated facing the southwest, based on the very compact and thick floor and the lack of floor features, however, the erosion channel through this portion of the structure may have obscured any features. The extent of the

Figure 8.5. Feature 3, Structure 1, during excavation.

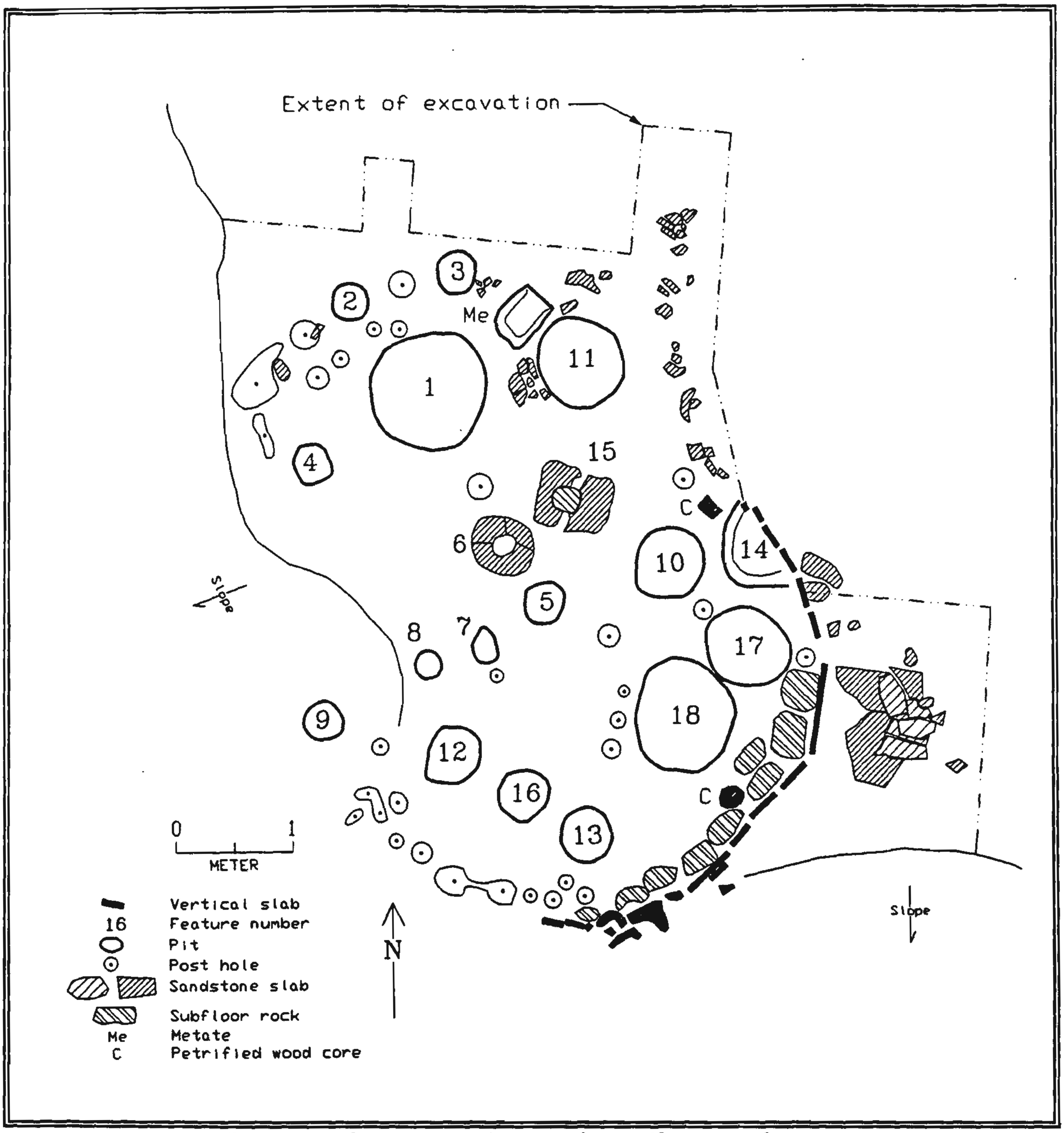

Figure 8.6. Structure 2 plan showing artifacts and features.

floor that remained was covered by a layer of charred organic debris, burned daub, and sand. Some daub pieces held the impression of reeds and twigs. The downslope sandstone slab wall has been reinforced with petrified wood blocks and quartzite cobbles (one is a large 20-cm by 20-cm by 15-cm petrified wood core).

The upper 50 cm of fill consisted of loose tan sand. This stratum was not screened, but 91 Adamana Brown sherds, three flakes, four flake tools, a core fragment, a hammerstone, and a stone ball were collected during excavation. Below this was a 5-cm to 10-cm thick layer of compact dark brown clayey loam mixed with abundant charcoal. Artifacts recovered from this level (floor fill) included 196 Adamana Brown sherds, 28 pieces of debitage, six flake tools, pieces of a stone bowl,

Figure 8.7. Structure 2 after excavation.

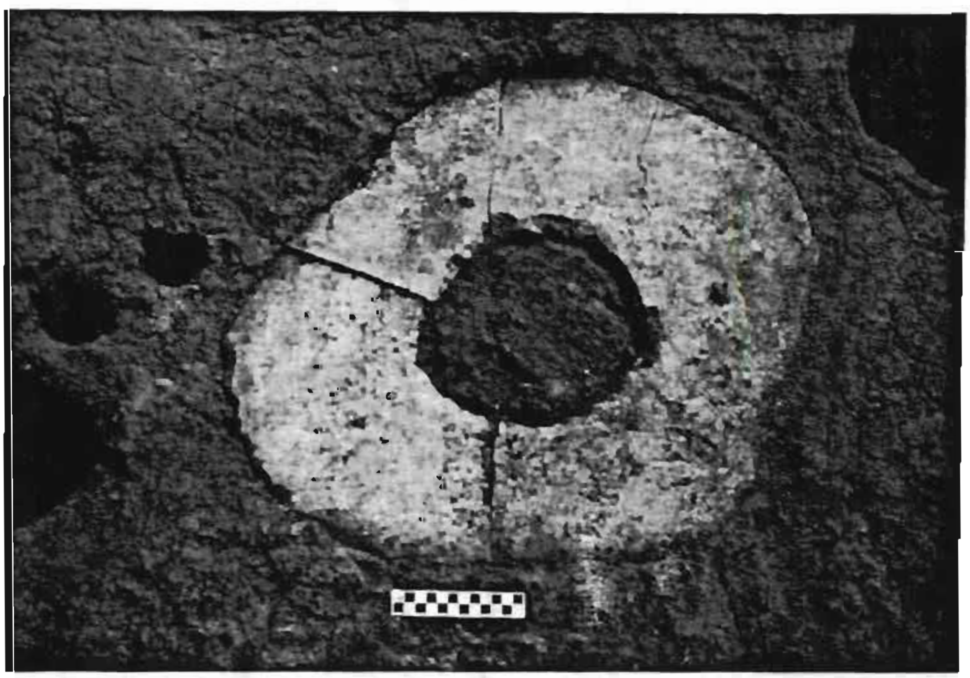

Figure 8.8. Feature 6, Structure 2, prior to excavation of fill.

and a core and hammerstone fragment. The structure floor consisted of very compact brown clay subsoil with a thin layer of compact sand. Floor artifacts consisted of a badly decomposed red sandstone metate, 20 Adamana Brown sherds, four pieces of debitage, and a utilized flake. The abundant charcoal in the floor fill and in numerous floor features (see below) indicates that the structure burned.

Structure 2 contained 18 floor features, including two slab-reinforced storage pits, 15 other storage pits, and a feature of unknown use. Five of these pits (features 1, 5, 6, 7, and 11) contained abundant charcoal and were apparently open at the time of abandonment. Two (features 4 and 8) contained loose sand. The structure appears to have been remodeled; three of the floor features (features 10, 17, and 18) were sealed by a more recent floor. Fill for these features, which contained few artifacts and no charcoal, may have come from the construction of later floor pits.

Feature 1 consists of a storage pit 110 cm in diameter by 65 cm deep with mud-plastered walls and floor. Three strata were noted during excavation of the pit contents. From 0 cm to 30 cm below the floor the fill consisted of clayey loam, from 30 cm to 35 cm there was a dense layer of charcoal. The lower portion of the pit, from 35 cm to 65 cm, contained sand, charcoal, several large slabs (one with a worked edge), a core fragment, two flake tools, two unmodified flakes, a core, and 13 sherds. Several rodent holes penetrate the pit walls.

Feature 2 is a bell-shaped storage pit 72 cm deep, 22 cm in diameter at the top and 42 cm in diameter at the bottom. Fill in the upper portion of the pit consisted of loamy soil, while the lower portion consisted of loose silty loam with compact sand at the base of the pit. The pit contained 12 burned sandstone chunks (the largest measuring 15 by 10 by 6 cm), three sandstone slab fragments, a burned red sandstone mano, charcoal, three flakes, a flake tool, a few burned animal bones, and 14 sherds. The upper portion of the pit is mud plastered. Most of the artifacts and all of the fire-altered chunks and slabs were concentrated near the bottom of the pit. This mix suggests a trash deposit, and the feature may predate the construction of Structure 2. Or, it may have been purposefully filled with material from the site surface during remodeling.

Feature 3 (40 cm by 25 cm in diameter and 26 cm deep) is a small pit, possibly a posthole. It was filled with clayey loam with hard-packed sand at the base.

Feature 4 is a pit 30 cm in diameter and 46 cm deep. The upper portion of the pit is mud plastered, and there was compact sand at the bottom. Fill consisted of clayey loam. No charcoal was recovered from features 3 and 4, suggesting they were filled prior to the burning of the structure.

Feature 5 (39 cm by 31 cm in diameter and 46 cm deep) is a small, basin-shaped, mud-plastered pit. Fill consisted of clay loam and charcoal. Three Adamana Brown sherds were recovered from this pit.

Feature 6 is a 50-cm-deep, bell-shaped storage pit, capped by a perforated sandstone slab (Figure 8.8). There were traces of white plaster on both sides of the slab. The slab opening is 21 cm in diameter, and the base of the pit is 70 cm in diameter. Three strata were identified within the pit fill. From 0 cm to 10 cm below the floor surface the fill consisted of clayey loam. From 10 cm to 30 cm the fill was sandy silt with sherds and charcoal. The bottom 20 cm of the pit contained loose sandy silt with some charcoal. Along the walls at the base of the pit was a very compact brown sand. Sixteen Adamana Brown sherds and a small piece of worked pigment were recovered from this feature.

Feature 7 (21 cm by 18 cm in diameter and 25 cm deep), is a pit, the upper portion of which appears to have been mud plastered. The pit fill contained charcoal and a single Adamana Brown sherd.

Feature 8 is a mud-plastered pit 17 cm in diameter and 25 cm deep. It contained very loose sand and a large cylindrical basalt artifact (described in Chapter 11) of unknown use.

Feature 9 is a pit 28 cm in diameter and 35 cm deep. Flecks of smooth, compacted mud adhering to the upper portion indicate the pit may have been plastered.

Feature 10 is a large (66 cm by 55 cm in diameter and 30 cm deep), irregularly-shaped pit. The pit was capped by the compacted sand of the structure floor. The clayey loam fill of the pit contained two sandstone slabs (one worked) and a quartzite hammerstone, but no charcoal.

Feature 11 is a 1.1-m-deep, well-preserved, bell-shaped, mud-plastered pit. The pit fill was not stratified, although large patches of ash and charcoal were present. The upper 30 cm of fill contained the rim of a ground-stone bowl. The pit contained sections of charred cottonwood 15 cm long and 12 cm in diameter, some with bark intact. The pit also contained large pieces of burned daub and gray ashy soil. Pieces of a large (approximately 35 cm in diameter), partially reconstructible Adamana Brown jar were recovered from the bottom third of the pit.

Feature 12 is a sub-rectangular straight-walled pit 70 cm at the widest diameter and 53 cm deep across the flat base. Plaster remains in patches on the walls and across the base of the pit, most noticeable around the top 10 cm to 15 cm of the pit walls where it is 3 cm to 5 cm thick. The pit fill consisted of brown sandy silt with a small amount of charcoal in the top 10 cm.

Feature 13 is a cylindrical pit near the southeast perimeter of the structure, 38 cm in diameter and 25 cm deep. It has remnants of a light tan plaster around the perimeter of the straight walls on the east and south edges of the opening. The pit contained one small piece of sandstone slab.

Feature 14 may have been a reinforced posthole: located next to it is a shallow pit 30 cm by 50 cm in size, excavated into raised, plastered earth. Soil discoloration and hardening suggests burning, and samples for archaeomagnetic dating were taken from this feature (see Appendix D).

Feature 15 is a subrectangular straight-walled pit capped by a perforated sandstone slab (see Figure 7.5). The dimensions of the pit are 55 cm by 60 cm, by 30 cm deep, with a flat base. There is no evidence of plastering of the pit walls. The fill is a dark brown, very compact silt with a high clay content. There was no internal stratigraphy to the fill, and it contained no artifacts. The shaped, nearly-square perforated slab measures 60 cm by 65 cm, or slightly larger than the pit itself. The 10.5 cm-diameter perforation is covered by a small circular slab of the same material with a diameter of 25 cm and thickness of 2.5 cm (see Figure 11.6).

Feature 16 is a completely plastered basin-shaped circular pit, 35 cm in diameter and 17 cm deep. The pit fill consisted of medium brown compact sandy silt, and ash, charcoal and small (1 to 2 cm long) pieces of burned daub. There were no artifacts in the fill.

Feature 17 is a large (72 cm by 60 cm in diameter and 63 cm deep), irregularly shaped pit capped by the compacted sand of the structure floor. No artifacts or charcoal were present in the clay loam fill of the pit. The southwest portion of the pit has a well-preserved mud-plastered edge.

Feature 18 is a large (106 cm by 94 cm in diameter and 45 cm deep) irregularly shaped pit, also capped by the structure floor. The clay loam fill contained no artifacts or charcoal.

Extramural Features

Two shallow features were encountered in excavation Unit 2. One is a concentration of sandstone slabs, oxidized soil, and charcoal flecks in a 1-m by 0.5-m area. The feature is amorphous in both plan and cross section. It may be the disturbed remains of a slab-lined hearth. A flotation sample taken from the feature yielded no floral remains. A petrified wood core, a petrified wood flake tool and an Adamana Brown sherd were associated with the feature.

The other feature located in Unit 2 consisted of a concentration of sandstone slabs, oxidized soil, and charcoal flecks. Semi-circular in plan (52 cm by 37 cm) and basin-shaped in profile (14 cm deep), the feature may have been used as a fire pit. A large Adamana Brown sherd was associated with this feature.

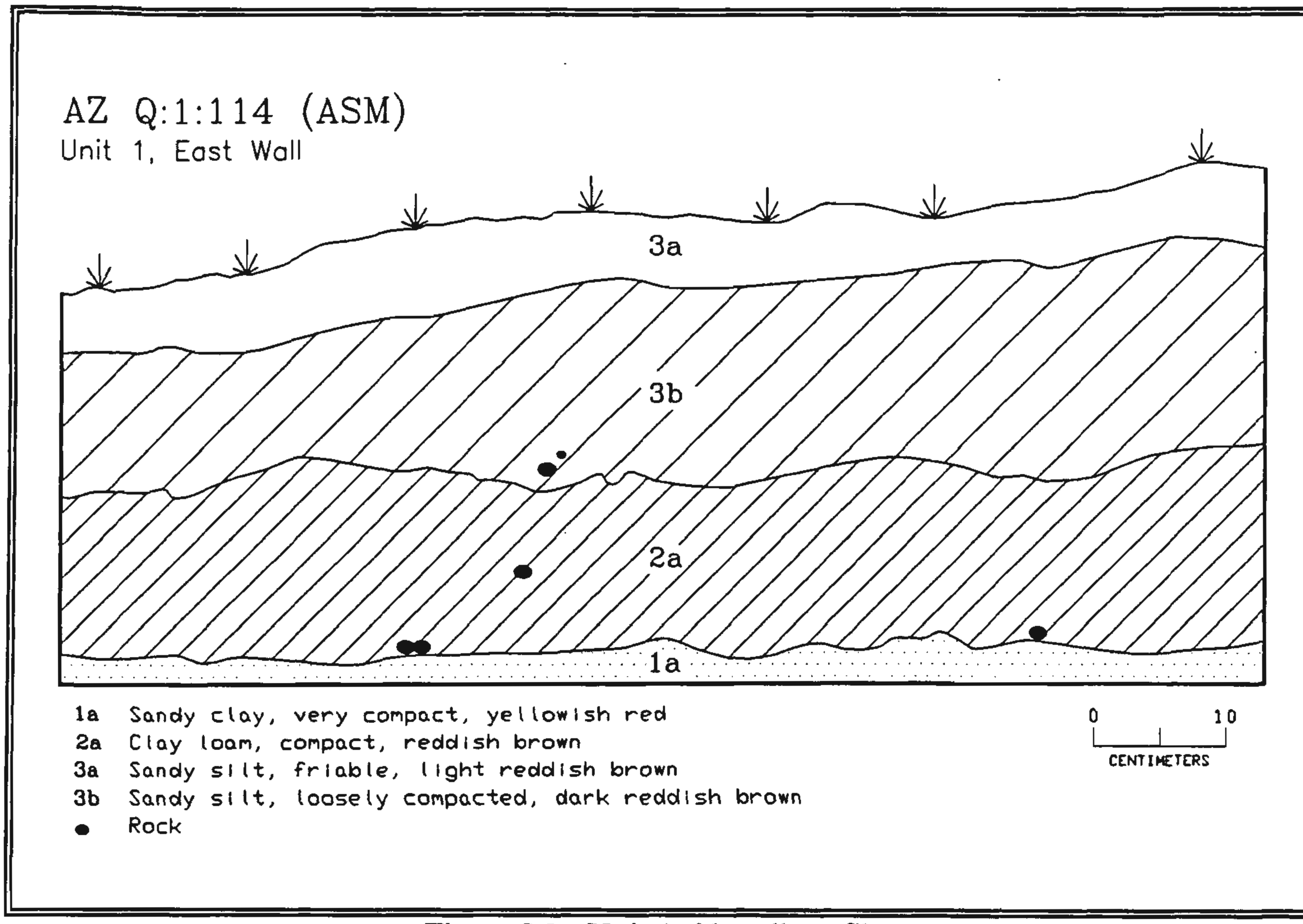

Figure 8.9. Unit 1 sidewall profile.

Stratigraphy

The soil strata across the site are fairly uniform, exhibiting no great variation between that exposed in the test units, the shovel tests, or the structure excavations. The soil surface is an aeolian deposit of loose, sandy silt with grass and brush roots. The depth of this aeolian deposit was the primary variation in stratigraphy across the site. The strata are described below and a representative soil profile is depicted in Figure 8.9.

Stratum 1, the lowest stratum, was divided into two subunits; Stratum 1a consists of a culturally sterile, very dense, compact, yellowish red (Munsell color 5 YR 5/6-4/6; Munsell 1975) sandy clay. Stratum 1b is a sterile, very dense, compact, pinkish-gray (5 YR 7/2-6/2) clay. Based on observation of eroded areas within the site, Stratum 1a appears to overlay 1b. Stratum 1a was completely eroded from the area of Structure 1.

Stratum 2, is the primary cultural deposit at the site. It contains ash, charcoal, and lithic and ceramic artifacts in varying densities throughout the site. It was subdivided into two subunits based on location and soil color. Stratum 2a, in extramural areas, is a compact dark reddish brown (5 YR 3/3-3/2) clayey loam with some waterworn pebbles. It varied in thickness from 5 to 25 cm. Stratum 2b, within structures and features, is a compact, very dark grayish brown (10 YR 3/2.5-3/2) to black (10 YR 2/1) clayey loam.

Stratum 3, consisting of aeolian deposits, was subdivided into two units based on compactness. The amount of cultural material within this stratum was highly variable, with artifacts here most likely the result of pedoturbation (natural mixing processes). Stratum 3a is the upper 5-cm root zone, which contains abundant organic debris, insect larvae, insect burrows, and water worn pebbles. The soil is a very loose light reddish brown (5 YR 6/3-6/4) sandy silt. Stratum 3b (12 to 16 cm thick) is friable clayey sand, dark reddish brown (5 YR 3/3-3/2) in color, with some pebbles.

Soil Chemistry

Chemical soil analysis was performed on selected samples to provide information relevant to site formation processes. Soil samples were tested for phosphate concentrations, carbonates reaction, and pH value (see Appendix A).

Of all the nutrient elements, only phosphate (PO_4) suffers practically no loss during natural chemical weathering, and fortunately PO_4 is associated with nearly every human activity. Butchering, burials, and disposal of food remains and bodily wastes raise PO_4 levels dramatically (Eidt 1984:27-29). A concentration of PO_4 indicates the former presence of bone, bodily waste, or animal matter. PO_4 quickly fixates with calcium (Ca), iron (Fe), and aluminum (Al), remaining in insoluble form exactly where applied to the soil (Eidt 1984:27), and is therefore considered a good indicator of the intensity of site use. Further, it has been suggested that recent grazing does not affect PO_4 levels to a significant degree (Custer and others 1986). Unlike soil color, often used to define "midden" areas, PO_4 is not affected by noncultural soil formation processes, such as the decay of oak leaves or granite. Studies of prehistoric farming settlements indicate that the highest PO_4 values come from burial areas, the next highest from dwelling areas, and the lowest from work areas (Eidt 1984:34).

Human activity initially acidifies soils because of the humic and fulvic acids formed in midden soils. However, soil pH is not as stable as phosphate and any changes caused by cultural activity would tend to diminish with time. Anthropomorphic soils can become basic as organic acids decompose and other elements high in carbonates, such as bone and ash, are left behind. Soils of the Petrified Forest area tend to be alkaline naturally.

The interpretation of the soil chemistry data from Sivu'ovi is hindered by the lack of comparative data and the limited scope of the present work. Regardless, the data do provide a few insights, and would likely become more useful as more soil chemistry analysis is undertaken in the region.

Positive phosphate readings were noted in all of the samples. The highest amounts were recorded in Structure 1 and in one of the shovel test pits. These results seem to indicate heavy occupation throughout the site area, although the level of naturally occurring phosphate in the surrounding area is unknown.

Carbonate reactions were observed in all but two samples taken from postholes. The strongest reaction was noted in samples from Structure 1. The presence of naturally-occurring carbonates at the site is not known, but the lack of carbonates in the two samples from postholes indicates the carbonates may be cultural in origin.

The pH of the soil samples was uniformly high with a mean of 9.2, indicating a very strongly alkaline soil. The highest pH reading (9.6) was from the cache pit (Feature 3, Structure 1). This suggests, all things being equal, that the preservation of pollen at the site would be poor, while that of bone should be good. Elsewhere, two soil samples from the Flattop Site returned pH readings of 8.1 and 7.8 (Wendorf 1953:74).

Chapter 9
Ceramics

Three restorable vessels, one unfired vessel, one partially restorable vessel, and 1,072 sherds were recovered during fieldwork at Sivu'ovi (AZ Q:1:114 [ASM]). All, except one sherd from excavation and 28 surface-collected Pueblo period sherds, consist of a single ceramic type: Adamana Brown.

Adamana Brown Ware

The Adamana Brown ware series consists of Adamana Brown, along with a few other minor variations of Adamana Brown. The ware was first named and described by Mera (1934:4):

> The pottery is a mediumly coarse-textured ware ranging in color, with considerable variability from a light warm gray, through a tan to, when highly fired, a light red. . . . the paste has a dense and homogeneous appearance but has little tensile strength, being easily fractured and somewhat friable. In color it conforms to the surface to which it is contiguous. The temper used is a fairly coarse water-worn sand containing numerous flecks of mica, the occurrence of which on all surfaces is a distinguishing feature of the type. As the mica has a decidedly nacreous cast it strikingly resembles fragmentary mussel shell. Exterior surfaces of jars and both surfaces of bowls are usually well smoothed but show little attempt to produce a polish. The interiors of jars especially, present an uneven appearance like that produced by the paddle and anvil process of shaping.

Although Mera suggests that mica resembling shell was used in the sand temper, Jones (1987) suggests the material could be heat-altered selenite (see also Shepard 1953:190-191). Selenite, a type of gypsum, is common in the Petrified Forest region. Unfortunately, no petrographic analysis has yet been conducted to resolve this issue.

Other pottery types in the Adamana Brown series are named for added decoration: Adamana Fugitive Red (Mera 1934; Colton and Hargrave 1937), Adamana Grooved, and Adamana Incised (Wendorf 1953). None of these types was recovered from Sivu'ovi during the present fieldwork.

Sherds

A total of 1,025 Adamana Brown sherds were collected during the excavations. Distinction between bowl and jar sherds was not tabulated, nor were rim sherds segregated. Five hundred twenty-three sherds were recovered from the controlled surface collection, 354 sherds were recovered during the excavation of Structure 2, 77 sherds were recovered from excavation Unit 1, 38 sherds were recovered from Structure 1, and 14 sherds were recovered from excavation Unit 2. In addition, 19 unusually large sherds were collected during the general surface inspection.

The frequency of sherds across the surface of the site is highly variable, ranging from less than 1 per 100 square meters to over 10 per square meter, with the higher densities near eroding house structures. Within the surface collection area the number of sherds ranged from 2 to 39 per 2-m by 2-m unit, with an average density of 3 per square meter. Most of the sherds (58%) were found in 14 of the 45 2-m by 2-m units (56 square meters) located near the edge of the eroding bluff. The distribution of Adamana Brown sherds recovered form the surface collection units is illustrated in Figure 9.1. Ceramic densities appear to correlate with flaked stone artifact densities (see, for example, Figure 10.8), which may indicate that both sherds and flakes on the surface represent sheet trash. As mentioned in Chapter 7, the higher densities in this area near the edge of the bluff may be the result of soil deflation, rather than prehistorically defined activity areas or trash dumps.

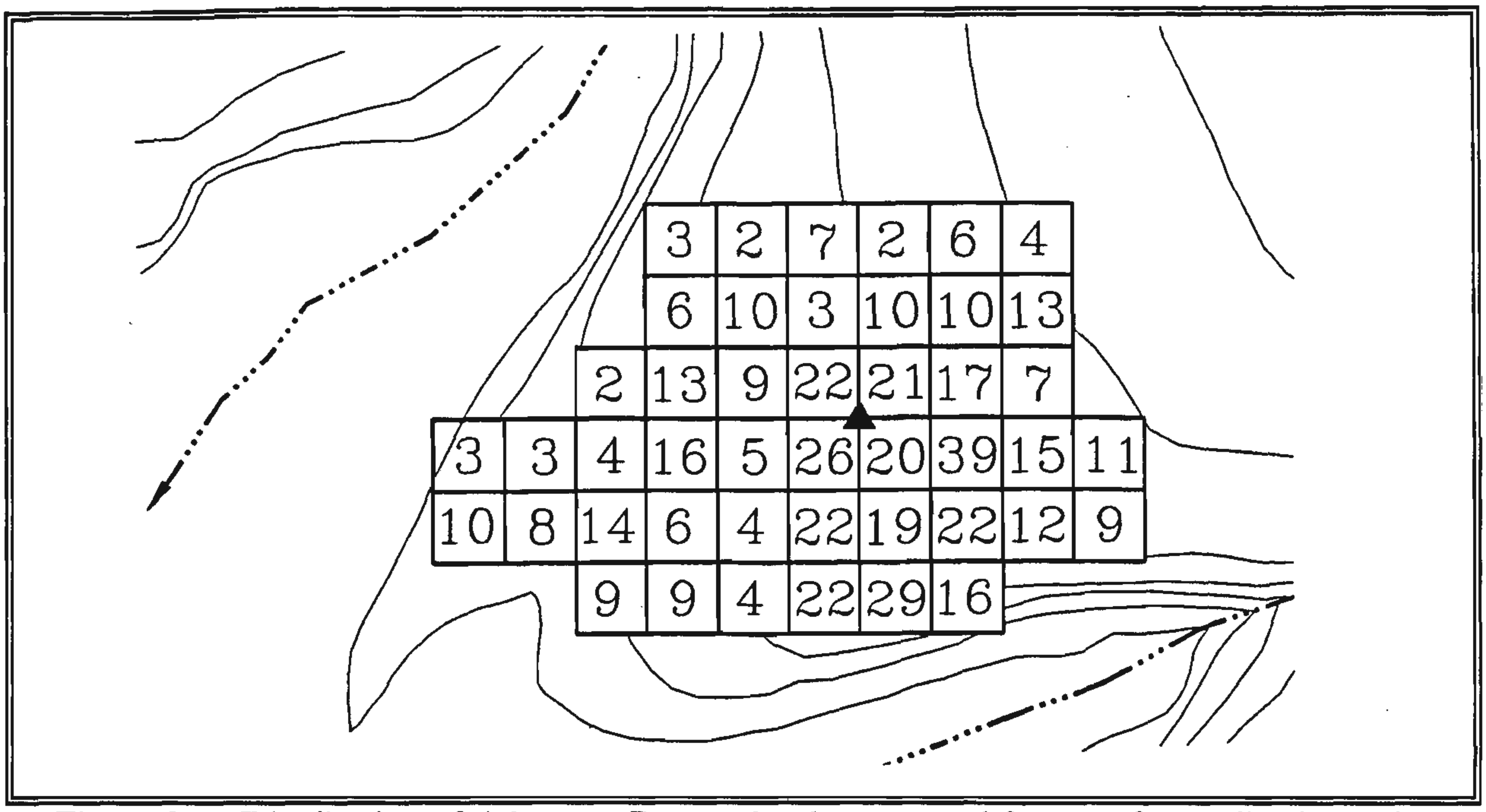

Figure 9.1. Distribution of Adamana Brown sherds recovered from surface collection units.

The distribution of sherds recovered during excavation is shown in Table 9.1. Most were recovered from the fill of Structure 2. The few sherds recovered in excavation Unit 2 suggests that unit is near the western limit of the site.

Two sherds from the surface collection units had ground edges, but the pieces were too fragmentary to determine their original size and shape, or to infer function in their modified state. These items are included in the sherd tabulations.

Vessels

Four complete and one partially restorable Adamana Brown vessels were recovered during the excavations. These include three globular jars with no necks, a globular jar with a tall neck, and an unfired miniature bowl. Four were from Structure 1, Feature 3, a subfloor storage pit (see Figures 8.4 and 8.5), and the remaining item was from Structure 2, Feature 11. Sherds from the restorable vessel are not included in the ceramic tabulations and discussion.

The fired vessels have uneven interior surfaces suggestive of paddle-and-anvil manufacture. The vessel shapes are typical for Adamana Brown. At the Flattop Site, Wendorf recovered 26 restorable or partially restorable Adamana Brown vessels. Of the identifiable shapes his most common types were globular jars with no necks (38 percent), bowls (19 percent), and globular jars with tall necks (14 percent). Each of the restorable vessels from Sivu'ovi is described below and illustrated in Figure 9.2.

PEFO-9156 is a large globular jar with a restricted opening and no neck (Figure 9.2a). It measures 27.3 cm high by 32.0 cm in diameter. The vessel wall is 0.7 cm thick at the rim, with a 12-cm diameter opening. The paste varies from dark gray (Munsell color 5YR 4/1; Munsell 1975) to reddish gray (5YR 5/2). The exterior of the vessel is very slightly polished and sooted. There is a small, circa 15 cm by 20 cm area of burned residue inside, suggesting use in cooking. There is no apparent use wear on the vessel bottom. The vessel rim is worn, perhaps from a cover or from storing the vessel inverted. This specimen was recovered from Structure 1, Feature 3.

PEFO-9155 is a globular jar with a restricted opening and no neck (Figure 9.2b). It measures 18.1 cm high by 22.0 cm in diameter. The vessel wall is 0.5 cm thick at the rim, with a 10 cm

very dark gray (7.5YR N 3/0) to pinkish gray (7.5YR 6/2). The interior contains some burned residue. The neck portion of the vessel has 28 drilled holes, paralleling a series of cracks, which apparently were used to repair the vessel in the past. It was recovered from the fill of Feature 11, Structure 2.

Pueblo Period Ceramics

Twenty-nine non-Adamana sherds were collected during fieldwork, all but one during the general surface inspection. The remaining specimen was from Unit 2, level 3, at the western edge of the site. The distribution of the surface-collected specimens is depicted in Figure 6.2. All are clearly associated with the later Pueblo period rubble mounds located within the site boundary.

Black-on-white wares recovered include Cibola (n=11), Little Colorado (n=2), and Tusayan (n=1) series. Identified types within the Cibola White Ware series are Tularosa, Puerco, and Gallup Black-on-white, and a Sosi style sherd. A single Walnut Black-on-white sherd is the only identifiable type within the Little Colorado White Ware series. The Tusayan series is represented by a lone Black Mesa-Sosi style sherd. White Mountain Red Ware is represented by two sherds, one identifiable as St. Johns Black-on-red. Plain wares include eight sherds identified as Little Colorado Corrugated, two sherds identified as Reserve Corrugated, one sherd of Exuberant Gray Corrugated, and two unidentifiable corrugated sherds. Table 9.2 provides a summary of the Pueblo Period ceramics recovered. These sherds indicate a late Pueblo II-early Pueblo III (A.D. 1000-1200) occupation within the site area.

Table 9.1. Distribution of Adamana Brown Sherds Recovered During Excavation.

Unit 1	Level 1	11
	Level 2	14
	Level 3	22
	Level 4	17
	Level 5	11
Unit 2	Level 1	9
	Level 2	3
	Level 3	2
	Level 4	-
	Level 5	-
Structure 1	Surface	8
	Upper fill	15
	Floor fill	3
	Floor	2
	Feature fill	10
Structure 2	Surface	-
	Upper fill*	91
	Floor fill	196
	Floor	20
	Feature fill	47

* not screened

Table 9.2. Pueblo Period Ceramic Types Recovered from AZ Q:1:114.

White wares
- Cibola White Ware
  - Tularosa Black-on-white (3)
  - Puerco Black-on-white (2)
  - Gallup Black-on-white (1)
  - Sosi Style (1)
  - Indeterminate (4)
- Little Colorado White Ware
  - Walnut Black-on-white (1)
  - Indeterminate (1)
- Tusayan White Ware
  - Black Mesa-Sosi Style (1)

Red wares
- White Mountain Red Ware
  - St. Johns Black-on-red (1)
  - Indeterminate (1)

Brown and gray wares
- Little Colorado Gray Ware
  - Little Colorado Corrugated (9)
- Mogollon Brown Ware
  - Reserve Plain Corrugated (1)
  - Reserve Indented Corrugated (1)
- Cibola Gray Ware
  - Exuberant Gray Corrugated (1)
- Indeterminate
  - Corrugated (2)

Chapter 10
Flaked-stone Artifacts

Flaked stone represents the major artifact category recovered during fieldwork at Sivu'ovi (AZ Q:1:114 [ASM]), comprising 70 percent of the specimens collected. Analysis of the flaked stone was designed to be comparable to that done by other researchers in the region (Burton 1990; Jones 1983, 1986; Rozen 1979; Sullivan and Rozen 1985; Tagg 1987; Wells 1988), using the same or similar artifact categories and material classifications. The flaked-stone artifacts can be divided into three gross categories: tools, cores, and debitage. Within these categories are more specific artifact classes (or types). Table 10.1 is a summary of the flaked-stone artifacts recovered during this project; over 2,600 pieces of debitage, flaked-stone tools, and cores were recovered.

Table 10.1. Summary of Flaked Stone Tools Recovered from AZ Q:1:114.

	General surface collection	Surface collection units	Excavation units	Structures	Vessel contents*	total
Flaked-stone tools						
Projectile points	6	-	-	-	-	6
Other bifaces	13	11	-	-	-	24
Scrapers	1	1	-	-	-	2
Retouched pieces	11	49	-	5	2	67
Utilized flakes	-	90	1	14	25	130
Cores-core fragments	2	157	12	9	-	180
Debitage	9	1,988	79	66	91	2,233
Total	42	2,296	92	94	118	2,642

* Structure 1, Feature 3

Flaked-stone Tools

Tools in this analysis are defined as pieces modified by use or retouch. These can be divided into three types: utilized flakes, retouched pieces, and formal tools (such as projectile points). These roughly represent a gradation of more intensification and purposefulness in tool production, design, and maintenance. The overwhelming majority of tools recovered at AZ Q:1:114 are utilized flakes and retouched pieces rather than formal shaped tools. The distribution of flaked-stone tools recovered from the surface collection units is depicted in Figure 10.1 and the distribution of those recovered during excavation is listed in Table 10.2

Formal Tools

Formal tools consist of projectile points, bifaces, and scrapers that exhibit the deliberate manufacture of a specialized tool form, rather than the advantageous retouching of an edge. Rozen (1984:456) suggests that it is reasonable to assume such distinctive implements were functionally distinguished

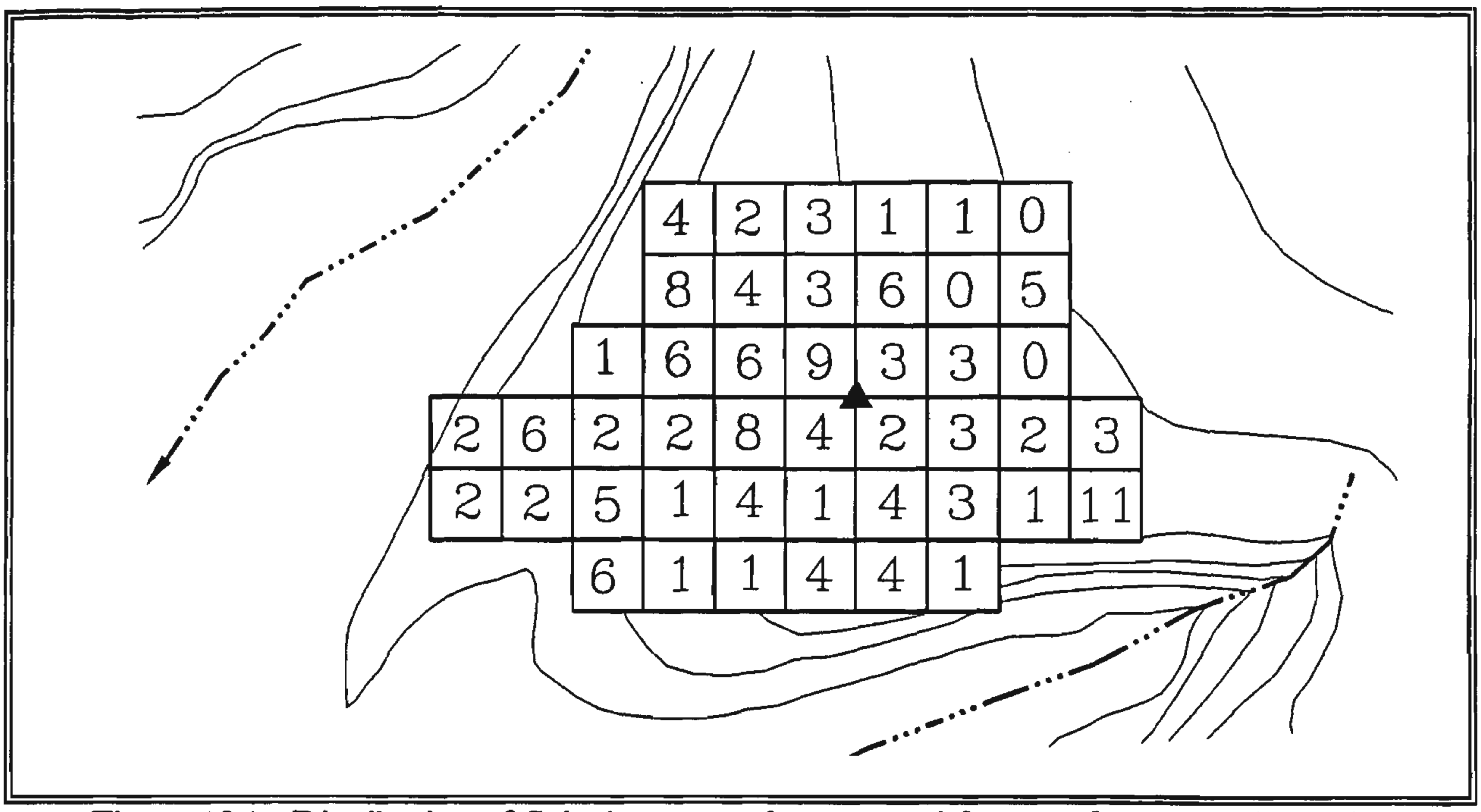

Figure 10.1. Distribution of flaked stone tools recovered from surface collection units.

Table 10.2. Distribution of Flaked-stone Tools Recovered During Excavation.

Unit 1	Level 1	-
	Level 2	-
	Level 3	-
	Level 4	-
	Level 5	-
Unit 2	Level 1	-
	Level 2	1
	Level 3	-
	Level 4	-
	Level 5	-
Structure 1	Surface	-
	Upper fill	1
	Floor fill	3
	Floor	-
	Feature fill	1
	Vessel contents	27
Structure 2	Surface	-
	Upper fill*	4
	Floor fill	6
	Floor	1
	Feature fill	3

* not screened

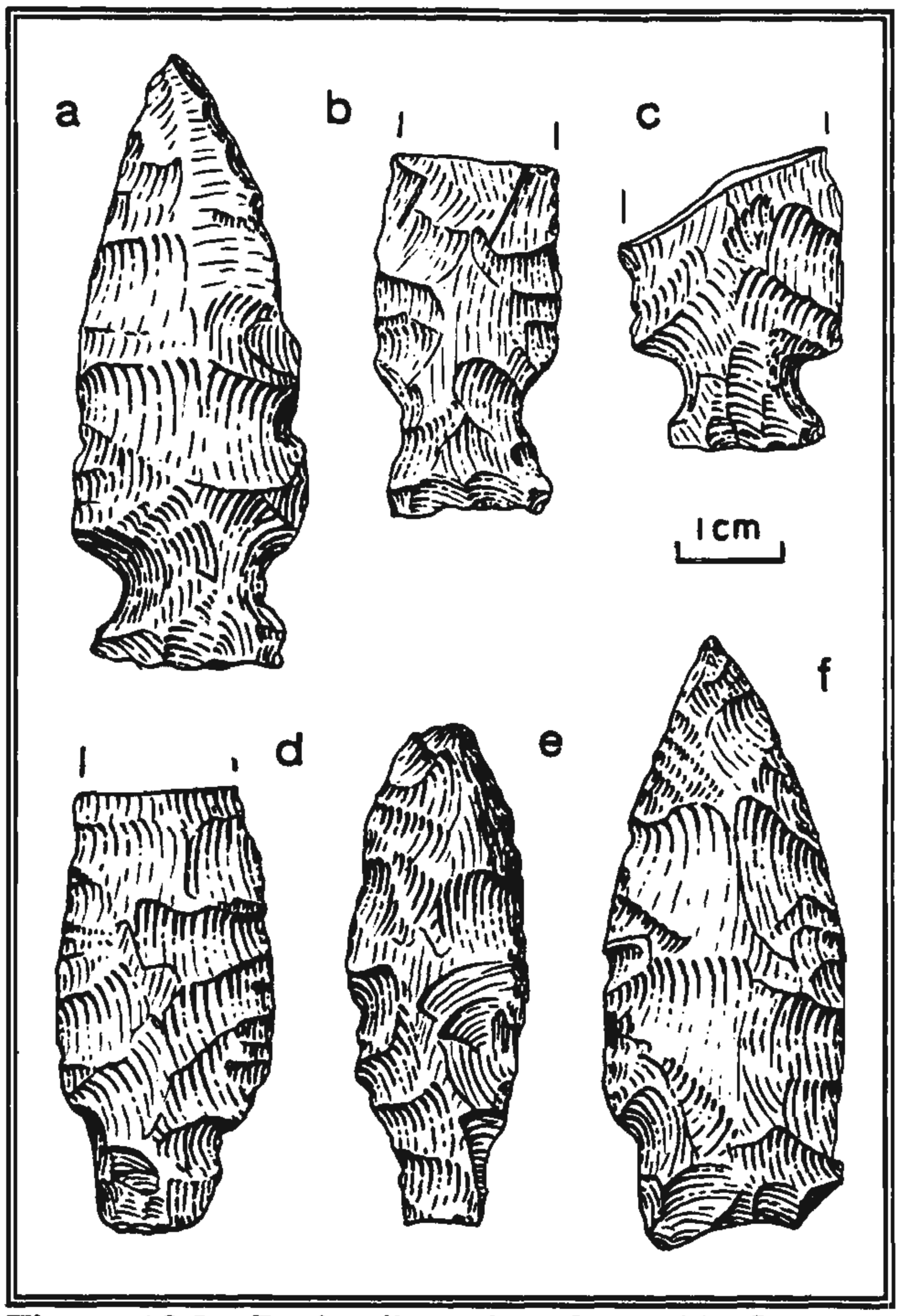

Figure 10.2. Projectile points from AZ Q:1:114; a. PEFO-5586, b. PEFO-5828, c. PEFO-5537, d. PEFO-5535, e. PEFO-5538, f. PEFO-5838.

Table 10.3. Metric Attributes of Projectile Points from AZ Q:1:114.

Cat. No.	Material	Description	Size (cm)			A	B	Wt
			L	W	T			
PEFO-5535	petrified wood	side-notched, reworked	-	2.1	0.5	(0.2)	1.1	5.5 g
PEFO-5537	chert	side-notched	-	2.1	0.4	0.4	1.5	2.3 g
PEFO-5538	petrified wood	stemmed, reworked	4.6	1.7	0.6	-	1.8	5.0 g
PEFO-5586	petrified wood	side-notched	5.7	2.2	0.5	0.3	1.8	6.9 g
PEFO-5828	chalcedony	side-notched	-	1.8	0.6	0.3	1.5	4.3 g
PEFO-5838	petrified wood	concave base	5.6	2.3	0.6	(0.2)	0.2	7.5 g

A. depth of notch
B. basal width or depth of concave base (PEFO-5838)

prehistorically. Formal tools comprise 14 percent (n=32) of the flaked-stone tools recovered at Sivu'ovi. Fourteen were recovered from the surface collection units and the remainder were surface collected from throughout the site.

Projectile Points

Six projectile points were recovered from AZ Q:1:114. All were from the general surface collection. Three of the points, all of petrified wood, are complete. The remaining three points, of chert, chalcedony, and petrified wood, are basal fragments. Metrical attributes for the projectile points recovered are presented in Table 10.3.

Four side-notched points with straight bases (Figure 10.2a-d) fit Rozen's Type 4 subtype (1981:191), which have been found elsewhere in Basketmaker II and late Archaic contexts. One has been extensively reworked (Figure 10.2d). A unique stemmed point (Figure 10.2e), which also has been reworked, may originally have been a Type 4 point as well. One concave base point with shallow side-indentations (Figure 10.2f) fits Rozen's Type 7 (1981:194), which has been found in late Archaic contexts. Over 80 percent of the classifiable projectile points recovered by Wendorf at the Flattop Site also fit within these two types.

Other Bifaces

Twenty-three bifaces, not including the projectile points discussed above, were recovered. All were recovered from the surface, 11 from the surface collection units and 12 from throughout the site during the general surface inspection. These can be divided into finished bifacial tools (n=11), choppers (n=2), drills (n=2), preforms (n=5), and roughouts (n=3).

Finished bifacial tools have been interpreted as general purpose tools, perhaps for butchering, drilling, and light wood-working. A taxonomy for these items has yet to be fully developed, however, and it is not known if differences in form are functionally significant. Nine were collected from throughout the site and two, including a fine, parallel-flaked specimen (Figure 10.3a), were recovered from the surface collection units (see Figure 10.3).

Two bifacially worked heavy core tools, classified as choppers, were collected during the general site inspection. These hand-held tools were presumably used for chopping.

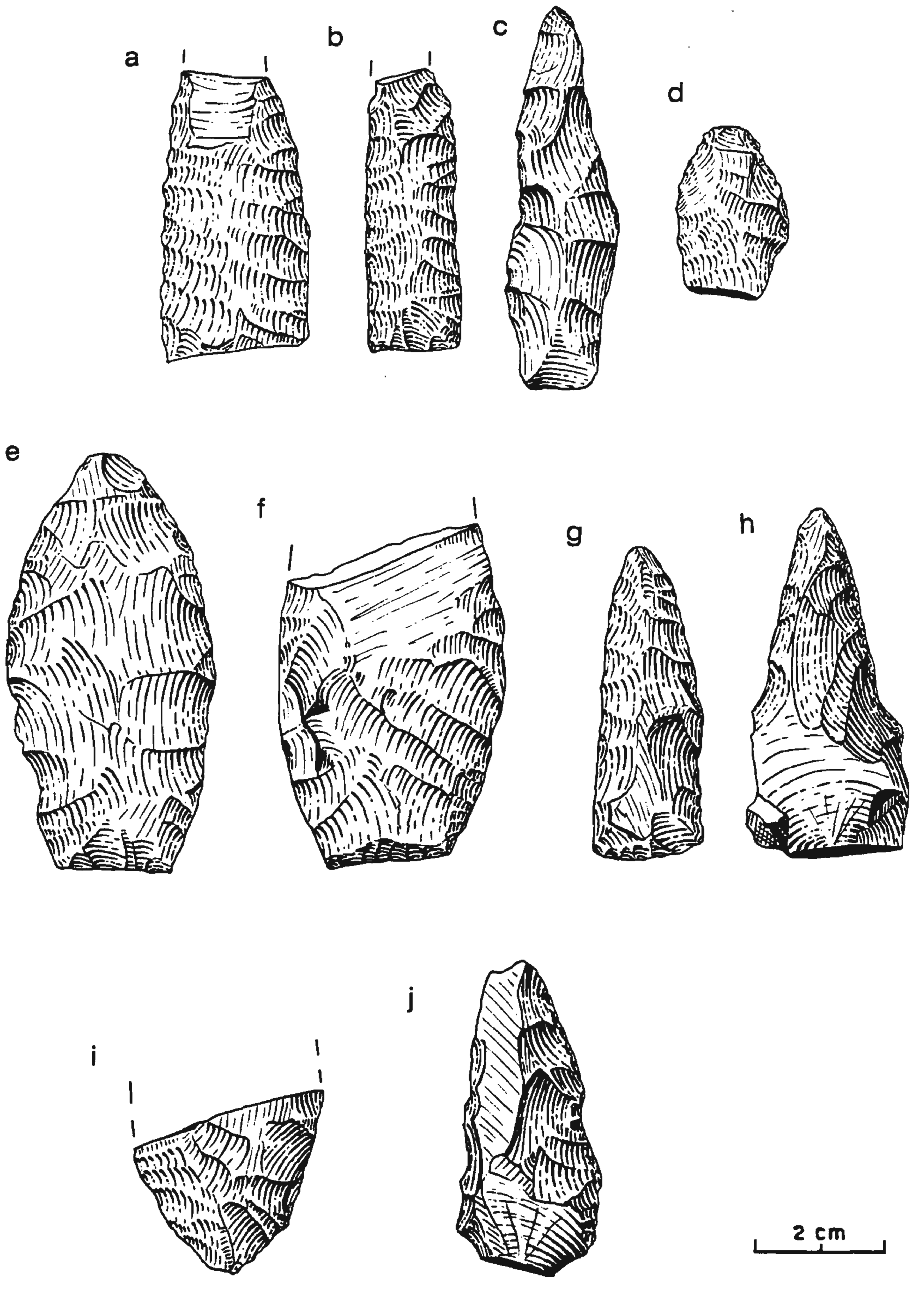

Figure 10.3. Finished bifacial tools and drills from AZ Q:1:114; a-f,i-j. bifacial tools, g-h. drills (a. PEFO-5571, b. PEFO-5584, c. PEFO-5588, d. PEFO-5568, e. PEFO-5583, f. PEFO-5564, g. PEFO-5585, h. PEFO-5587, i. PEFO-5668, j. PEFO-5695).

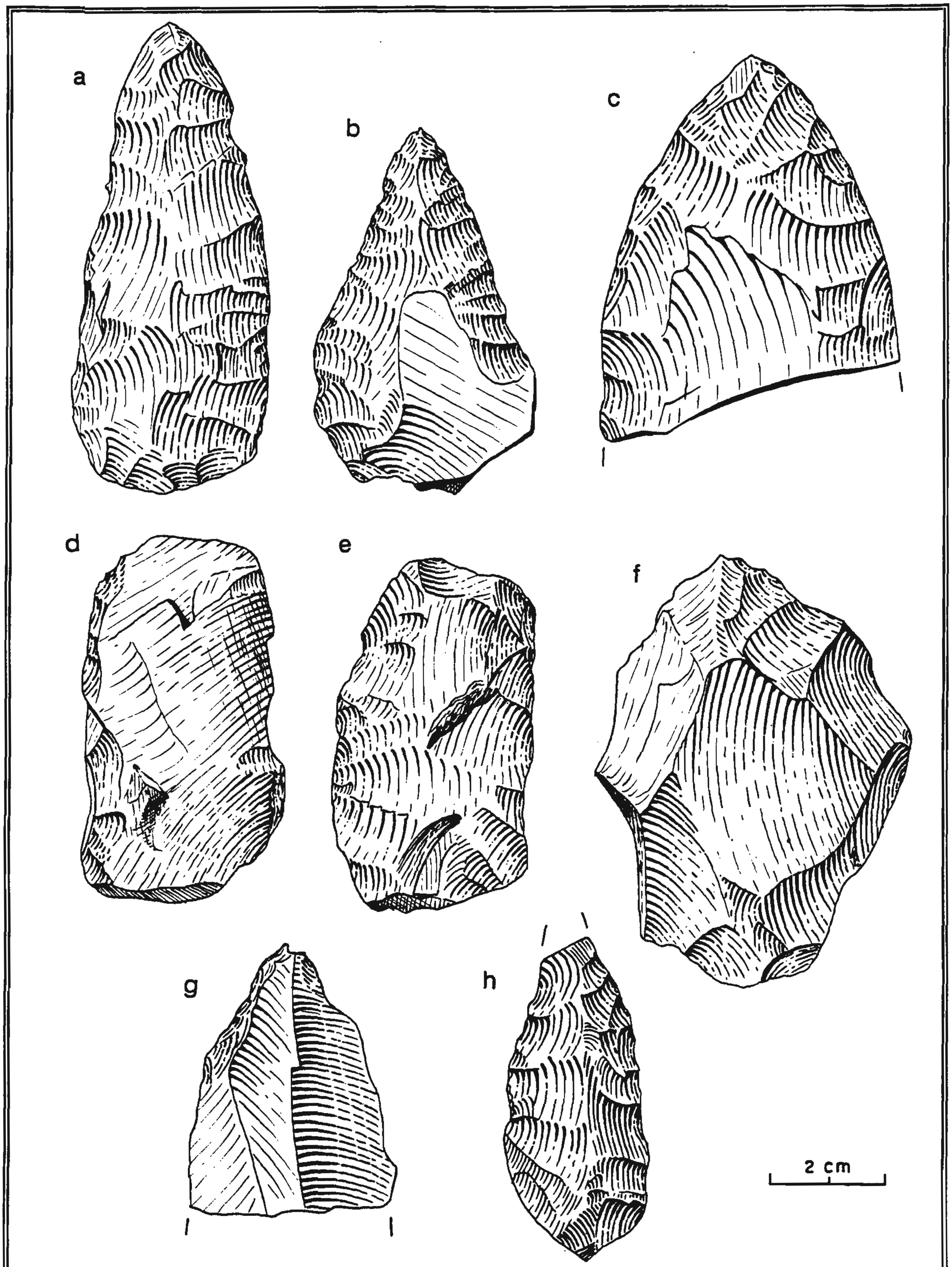

Figure 10.4. Preforms and roughouts from AZ Q:1:114; a-e. preforms, f-h. roughouts (a. PEFO-5539, b. PEFO-5862, c. PEFO-5534, d. PEFO-9233, e. PEFO-9235, f. PEFO-9232, g. PEFO-5566, h. PEFO-5570).

Drills have narrow, parallel, lateral edges at the distal end, which flare to a broader base. The projection is rounded. The two examples from Sivu'ovi both appear to be reworked from bifacial tools. These drills are distinguished from the drills classified under retouched pieces (below) in that they are larger and bifacially worked. One was recovered during the general site inspection and one was recovered from the surface-collection units (Figure 10.3).

Five preforms and three roughouts were recovered from the surface-collection units (Figure 10.4). Preforms and roughouts represent unfinished products (Crabtree 1982:49). Preforms differ from roughouts in that they are more finished; preforms have centered edges, a lenticular cross section, and a well defined base and tip (Basgall 1983; Burton and Farrell 1990:48-49).

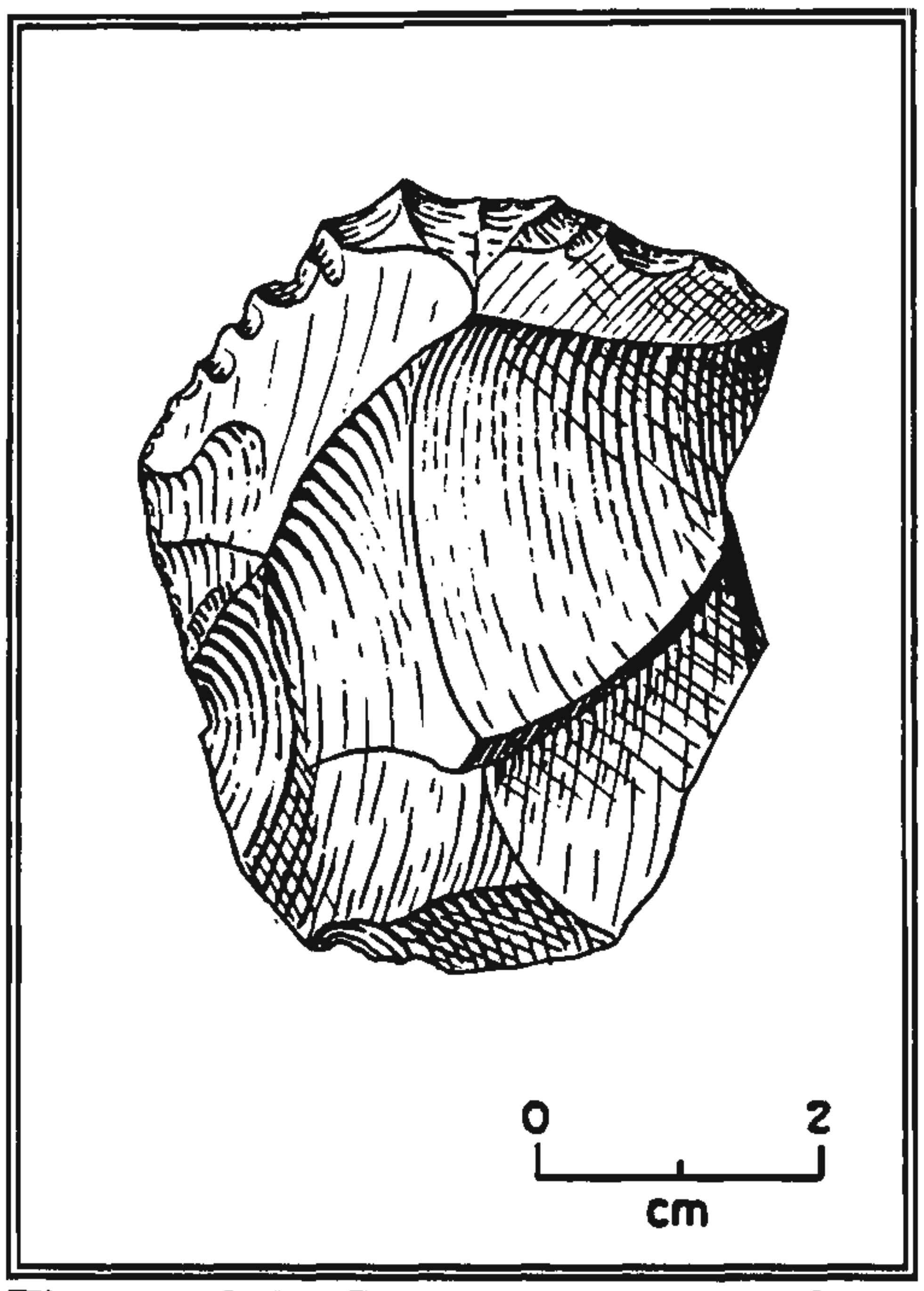

Figure 10.5. Scraper recovered from AZ Q:1:114 (PEFO-9236).

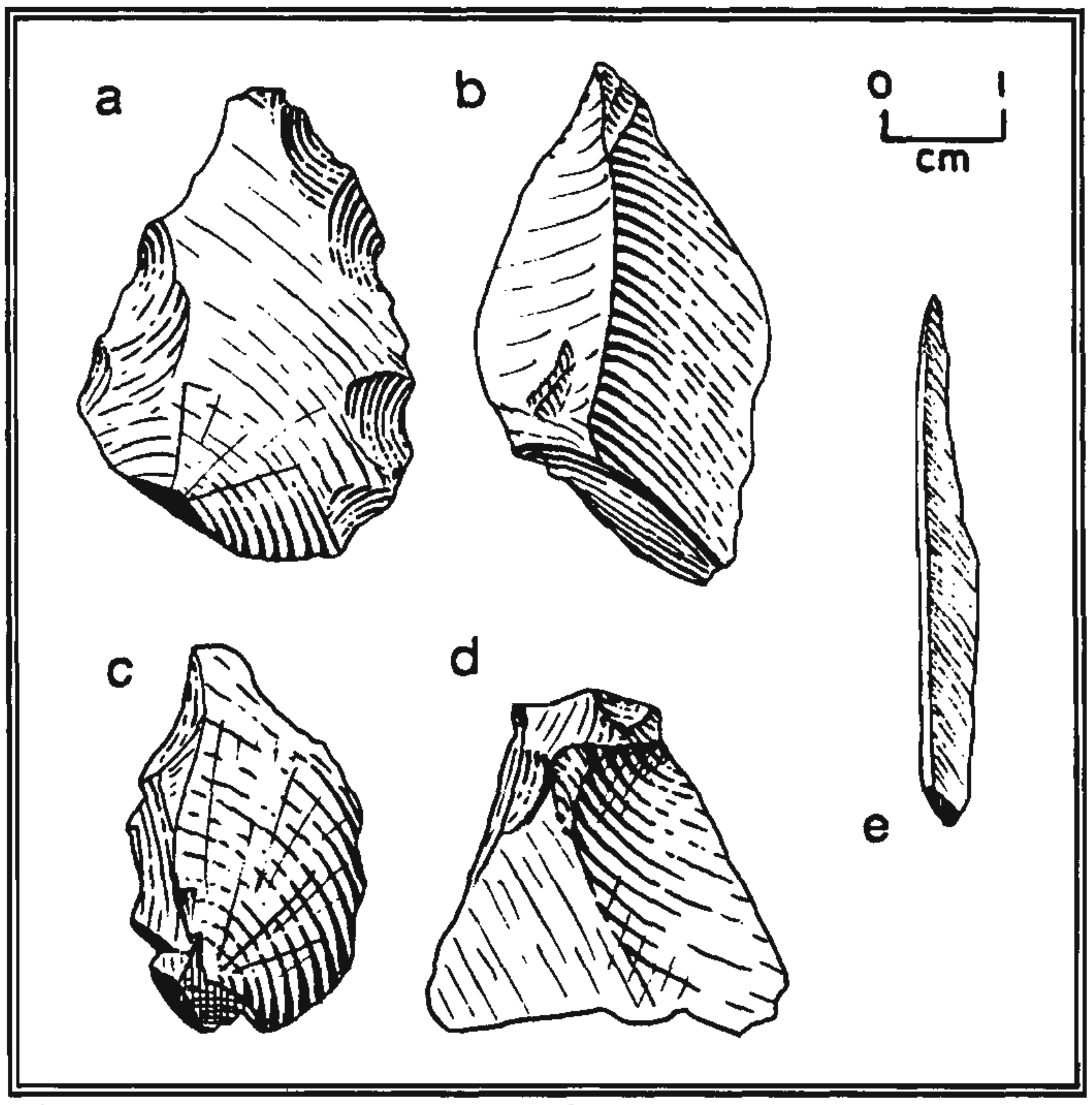

Figure 10.6. Retouched pieces recovered from AZ Q:1:114 (a.PEFO-9233, b-d. PEFO-9234a-c, e. PEFO-9229).

Scrapers

Two scrapers were recovered, one from the surface collection units and one during the general surface inspection. These have invasive, contiguous retouch along one or more edges. Both are relatively thick and steep angled (for example, Figure 10.5).

Retouched Pieces

Representing a significantly less "intensive" tool technology than formal tools, retouched pieces were modified (retouched) by pressure flaking to create or maintain a desired working edge (Crabtree 1982:50). An artifact is considered a retouched piece if an edge exhibits three or more contiguous flake scars which may also show use wear, or if there is a single "notch" that exhibits use wear. These are distinguished from utilized flakes by regular, apparently systematic, and invasive flaking; utilized flakes have much smaller flake scars, probably the result of crushing during use. Retouched pieces consist largely of minimally modified flakes suitable for quick use and discard; flaking can occur on one or more edges.

Retouched pieces were divided into eight categories, modified from Cameron (1987:123-124). These categories are based upon gross morphological characteristics: end worked, edge worked, multiple-edge worked, notches, denticulates, perforators, drills, and fragments. These categories may suggest functions, but it should be noted that the classification is arbitrary and for convenience and descriptive purposes only; no microscopic wear analysis has been done at this point. This general classification was used because the tool assemblage is typical of later Southwestern expedient lithic technology and does not reflect specific "formal" types of tools such as "convex side-scrapers" or "thumbnail scrapers." As Rozen (1984:456) points out, such categories can erroneously suggest unverified functions.

In all, 67 retouched pieces were recovered during the 1989-1990 fieldwork at AZ Q:1:114. This accounts for 28 percent of the flaked stone tools recovered. One was recovered from Structure 1, four were recovered from Structure 2, two were from inside a vessel in Feature 3 of Structure 1 (the cache pit), 49 were collected from the surface collection units, and 11 were collected from throughout the site. All, save one chert example, are petrified wood.

Representative examples of the retouched pieces recovered are depicted in Figure 10.6 and the various subtypes are discussed below. The 11 specimens from the general surface collection are not included in the following discussion.

<u>End-worked flakes</u>

These consist of three petrified wood flakes with retouch on one or both short axes. All were recovered from surface collection units. These account for 5 percent of the retouched pieces from controlled proveniences.

<u>Side-worked flakes</u>

This category consists of one chert and 21 petrified wood flakes retouched on one or both long axes. One was from Structure 1; three, including the single chert example, were from Structure 2, and the remainder were from the surface collection units. These account for 38 percent of the collection.

<u>Multi-edge worked flakes</u>

Six petrified wood pieces are retouched on one or both long axes and one or both short axes. Typically, these items have been continuously modified around the flake margin, excluding the platform. These most likely represent a continuum in use of side and end retouched pieces. All were recovered from the surface collection units. These account for 11 percent of the retouched pieces.

<u>Notched flakes</u>

These are retouched pieces with one or more isolated indentations along a short length of one or more sides. The notch can be formed by either a simple blow or systematic retouch. Indented items were classified as notches even if they also were end or side (edge) worked. Eleven petrified wood notched flakes were recovered, all from the surface collection units. These account for 20 percent of the retouched pieces.

<u>Denticulates</u>

These are retouched pieces with three or more contiguous notches along one or more edges. The notches leave intervening tooth-like projections that show wear. It has been suggested that denticulates could have been used to shred fiber or deflesh hide. Two petrified wood denticulates were recovered from the surface collection units. These account for 4 percent of the retouched pieces.

Perforator

Five petrified-wood perforators were recovered, three from the surface collection units and two from inside one of the vessels found in Feature 3, Structure 1. Perforators have a single long, narrow projection suitable for piercing. They account for 9 percent of the retouched pieces.

Drill

Two drills, made of petrified wood, were recovered from the surface-collection units. They have a narrow, parallel, lateral edges at the distal end, which flare to a broader base. The projection is more rounded and worked than the perforators above. These account for 4 percent of the retouched pieces.

Unclassified fragments

Two petrified wood flakes from the surface collection units exhibit retouching along one or more edges, but are too fragmentary to allow further classification.These account for 4 percent of the retouched pieces.

Utilized Flakes

Utilized flakes consist of flakes or pieces of debris that are used without further modification to exploit an existing sharp edge and edge angle. Most likely such pieces were only used for a short time, perhaps for a single task, or until the edge was dulled or no longer suitable for use. Utilized flakes have one or more edges modified by use, rather than by intentional retouch. This use wear is predominantly in the form of unilateral step fracture, accompanied by edge crushing and abrasion.

One hundred thirty utilized flakes were recovered, representing 58 percent of the flaked stone tools from controlled collections. All but four of the utilized flakes are petrified wood. Two from the vessel in Feature 3, Structure 1 and two from the surface collection units are chert. One was recovered from excavation Unit 2, three were recovered from Structure 1, ten were recovered from Structure 2, 25 were from inside one of the vessels in Feature 3, Structure 1, and 90 were from the surface collection units.

The 25 utilized flakes from inside the vessel in Feature 3 appear to be a special case. These, along with 91 others from the cache that do not show use wear, are of similar shape and size. With parallel or sub-parallel lateral edges, and length more than twice the width, most fit the "blade" definition of Crabtree (1982). No direct evidence was encountered of the prepared core and specialized blade technology usually associated with blades, but 80 percent were of the same material, a white-grey petrified wood. The remaining blades were made from a variety of petrified wood and chert, mostly in shades of red. Differentiating the two main material types, as in Tables 10.4 and 10.5, illustrates that the white-grey material has a higher length to width ratio, and a tighter standard deviation in dimensions than the red material. Virtually all have at least one pointed end. The blades with use wear are generally longer and wider, but thinner, than the unmodified blades. If the blades were produced, or at least sorted, for their distinctive shape, those that epitomized the long and pointed form may have been used most frequently. These sorted flakes were likely specialized tools, perhaps perforators used in basketry or hide work, and apparently valuable enough to curate. The 91 unmodified flakes from the cache are included in tabulations and discussions of unmodified debitage.

Table 10.4. Metric Attributes of Utilized Flakes from Vessel in Feature 3, Structure 1.

	Length			Width			Thickness		
	A	B	All	A	B	All	A	B	All
Number	16	9	25	16	9	25	16	9	25
High	25	30	30	14	18	18	6	6	8
Low	16	16	16	5	5	5	1	1	1
Mean	20.9	21.8	21.2	8.5	9.5	8.8	2.7	3.9	3.1
Std dev.	3.0	5.2	3.8	2.1	4.4	3.0	1.2	1.2	1.7

A. white/gray petrified wood.
B. other petrified wood.

Table 10.5. Metric Attributes of Unmodified Flakes from Vessel in Feature 3, Structure 1.

	Length			Width			Thickness		
	A	B	All	A	B	All	A	B	All
Number	74	17	91	74	17	91	74	17	91
High	29	29	29	18	15	18	9	9	9
Low	10	12	10	3	4	3	1	1	1
Mean	17.9	19.4	18.1	7.8	9.0	8.0	3.6	3.4	3.6
Std dev.	3.5	4.4	3.7	3.1	3.1	3.2	1.6	2.1	1.7

A. white/gray petrified wood.
B. other petrified wood.

Cores

One hundred seventy-eight cores and core fragments were recovered during fieldwork at AZ Q:1:114. An artifact is considered a core if it exhibits one or more negative flake scars (Crabtree 1982:43). Generally these are cobbles or blocks of lithic material from which tools, and hence flakes and debris (debitage), were produced. Large flakes could be used as cores. A flake core is distinguished from a retouched flake based on the larger size of the flake scars and observable use wear. Cores were subdivided into eight types, based on the number and types of platforms and extent of flake removal. Cores reused as tools and core-hammerstones, often given the ambiguous label "core tools" (Crabtree 1982:30), are also dealt with here. Most of the cores and core fragments were from the surface-collection units (n=157), 12 were from the two excavation units and nine were from the two structures. The distribution of core recovered from the surface collection

Table 10.6. Distribution of Cores Recovered During Excavation.

Unit 1	Level 1	-
	Level 2	1
	Level 3	2
	Level 4	2
	Level 5	-
Unit 2	Level 1	5
	Level 2	2
	Level 3	-
	Level 4	-
	Level 5	-
Structure 1	Surface	1
	Upper fill	3
	Floor fill	-
	Floor	-
	Feature fill	1
	Vessel contents	-
Structure 2	Surface	-
	Upper fill*	1
	Floor fill	1
	Floor	-
	Feature fill	2

* not screened

units is shown in Figure 10.7 and the distribution of core recovered during excavation is shown in Table 10.6. Two cores collected during the general surface collection are not included in the following discussion.

Core-hammerstones (Battered Cores)
Core-hammerstones are cores that have been used subsequently as hammerstones or else deliberately retouched to form a sharper battering edge (distinct from the blunt, rounded surfaces of stream-rolled cobbles). The sharp edge may prove useful as a retouching tool, or as a pecking stone to manufacture or roughen ground-stone artifacts (Jeter 1980:239; Rozen 1984:489); use wear caused by retouching would create rounded battered edges, while that from pecking would result in step fracturing. Most in this collection exhibit a small amount of step fractures, rather than severe rounding. This slight edge damage may have resulted from some other type of use. Rozen (1984: 489) suggests other possible uses for such core-hammerstones such as pounding bark, cracking nuts, and splitting bone. Five petrified wood core-hammerstones were recovered from the surface-collection units and one was recovered from the surface at Structure 1.

Unidirectional Cores
One chert core and 13 petrified wood cores were classified as unidirectional cores, which have flakes removed from one platform and in only one direction (Crabtree 1982:57). One petrified wood unidirectional core was from the surface at Structure 1. The remainder were from the surface-collection units.

Bidirectional Cores
Six cores were classified as bidirectional cores; these are cores that have had flakes removed from two directions (Crabtree 1982:16). All are petrified wood. Five were from the surface collection units and one was from the fill of Structure 1.

Multidirectional Cores
Eighteen multidirectional petrified wood cores were recovered; these have flakes removed in more than two directions (Crabtree 1982:43). Two were from Structure 2 (Feature 1 and 4), two were from excavation unit 1, and 13 were from the surface collection units.

Bipolar Cores
Three bipolar chert cores were recovered; these have primary flakes removed from opposing ends. They are created by placing a cobble on an anvil and striking it with a hammerstone, flaking both ends at the same time (Crabtree 1982:16). One was recovered from the surface collection units and two were recovered from the same level (15 cm) of excavation Unit 2.

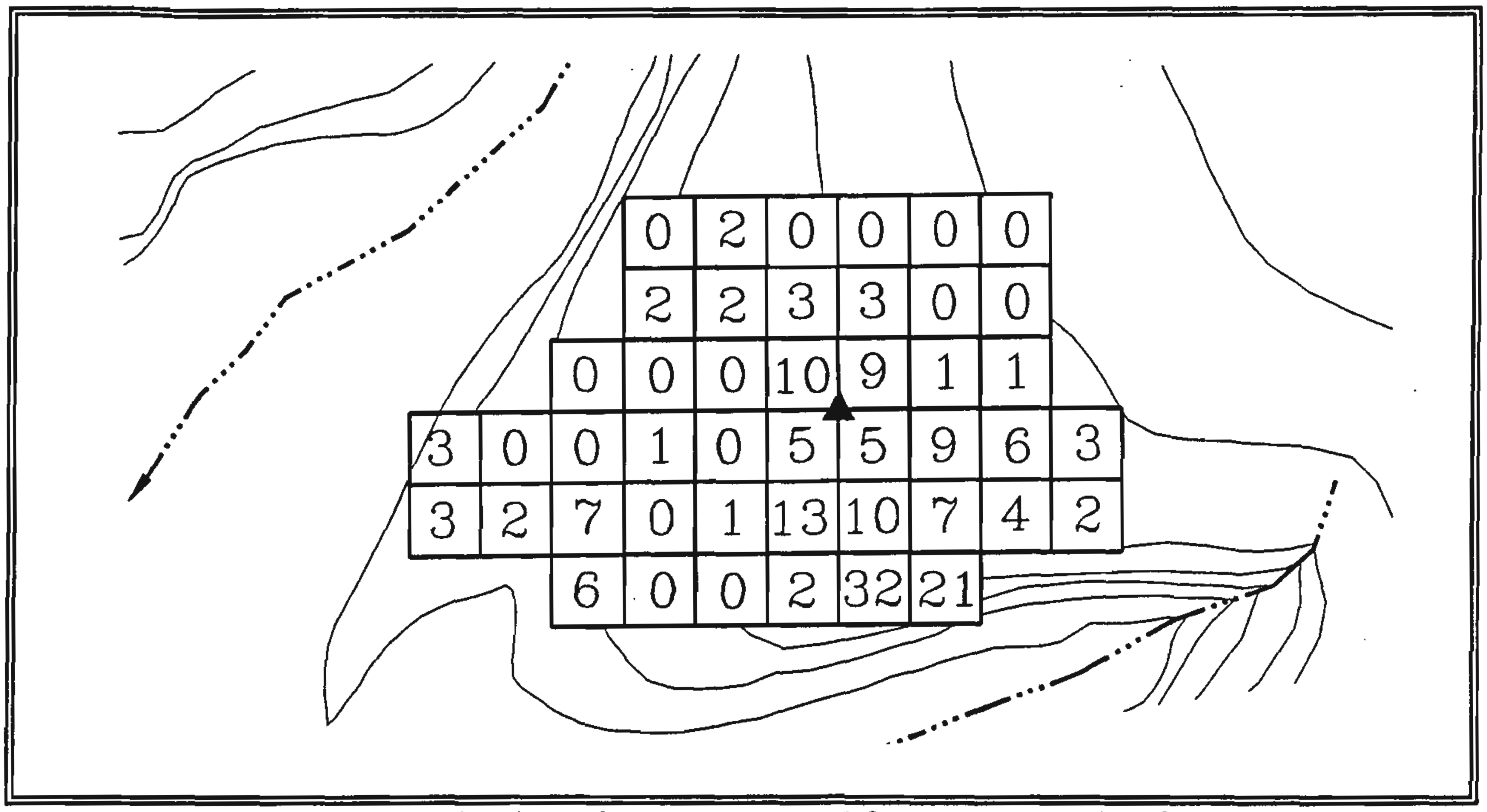

Figure 10.7. Distribution of cores recovered from surface collection units.

Exhausted Cores

Eleven exhausted cores were recovered. Nine are petrified wood and two are chert. All were collected from the surface-collection units. These are subjectively defined as cores from which all usable flakes have been removed. Usually the original form cannot be identified. Exhausted cores can result from the diminished amount of material, reduction of platform size, or the development of step and hinge fractures (Crabtree 1982:33).

Tested Cobbles-Blocks

Nine tested blocks were recovered. These consist of cores with only a few flakes removed in an unpatterned manner, or pieces of raw material that exhibit impact scars. Presumably, the artifacts were "tested" for flaws and suitability for reduction by hitting the material in various spots, thus creating the impact scars. They differ from battered cobbles in that the impact scars are fewer and not localized. Three petrified wood, four chert, and one quartzite tested cobbles-blocks were collected from the surface collection units and one petrified wood tested cobble-block was recovered from excavation Unit 2.

Core Fragments

One hundred twenty-five core fragments were recovered during the present fieldwork. Core fragments are pieces of a shattered core, broken along flaws or some other structural weakness during reduction. They are chunky in form, and exhibit at least one negative flake scar. In the surface collection units, over 80 percent were petrified wood (n=101) and the remainder were chert (n=14). One petrified wood and four chert core fragments were recovered from Unit 1, level 4 (20 cm), two of petrified wood were from Unit 2, level 2 (10 cm), one of petrified wood was from the fill of Structure 1, and two of petrified wood were from Structure 2 (structure fill and Feature 10 fill).

Debitage

By far the largest class of artifacts recovered at Sivu'ovi was debitage — the flakes of lithic material resulting from tool manufacture and core reduction. This does not include pieces that were subsequently modified by use (retouched and utilized). During fieldwork, 2,219 pieces of debitage were collected (nine from the general surface collection are not considered further). Debitage is a useful indicator of lithic technology and past behavior (Berry 1984; Rozen 1981; Schiffer 1976; Sullivan and Rozen 1985). Because debitage usually remains at the area of manufacture, it would seem a more reliable source of manufacturing data than finished tools (Collins 1975:19). Collins (1975) and Berry (1984) discuss the potential complexity in the life of a flake; it is still not well understood how to determine all of the natural and cultural transformation processes that may be affecting flaked-stone assemblages.

Sullivan and Rozen (1985; Rozen and Sullivan 1989) provide a simplified method of "interpretation-free" categorization aimed at estimating the intensity and type of lithic reduction. Sullivan and Rozen's categories are aimed at distinguishing two kinds of lithic reduction, primary and secondary, in archeological contexts:

> Primary reduction (*e.g.*, core reduction) is the reduction of pieces of material that have not been artificially detached from other pieces of material. Secondary reduction (*e.g.*, tool manufacture) is the reduction of items that have been previously detached from other pieces of material. We assume that, in comparison to primary-reduction assemblages, those produced by secondary reduction will be characterized by a more restricted range of flake size, smaller flakes, and less cortex, all other factors, such as material size, being equal. We also assume that soft-hammer biface reduction yields assemblages that, in comparison to those produced by hard-hammer core reduction, have higher percentages of flake fragments, and lower percentages of whole flakes and debris [Rozen and Sullivan 1989:173].

Collections composed of both the remains of core reduction and tool manufacturing will exhibit intermediate characteristics of the two kinds of reduction. When primary reduction is intensive (that is, when many flakes are detached from the core), it would produce relatively more smaller flakes and flake fragments and fewer cortical flakes, making it hard to distinguish from secondary reduction. When the object of secondary reduction is the manufacture of bifaces, however, it can be distinguished from primary reduction, regardless of intensity, based on platform characteristics. The by-products of biface manufacture will have faceted platforms rather than plain or cortical ones. The initial stages of biface reduction would have lower frequencies of faceted platforms than later stages (Rozen 1981).

For this analysis debitage was divided into five analytic groups, the first four including petrified wood from different contexts, and the fifth including all chert: (1) petrified wood from the surface collection units (n=1,988), (2) from structures (n=56), (3) from excavation units (n=69), (4) from the contents of a vessel from the cache pit (n=91), and (5) chert from all proveniences (n=107).

Distribution

The distribution of debitage recovered from the surface-collection units is depicted in Figure 10.8. The surface density of debitage in the surface-collection units ranged from 9 to 98 per 2-m by 2-m unit, with an average density of 11 per square meter (Figure 10.8). For comparison, surface-collection units at a quarry area north of Puerco Ruin contained over 55 flakes per square meter and a midden just outside the ruin walls contained 20 per square meter (Burton 1990:156). The debitage to sherd ratio in the surface collection units at Sivu'ovi is 3.6, a similar ratio to that of plaza trash at Puerco Ruin. The relatively low density of debitage and the low debitage to sherd ratio at Sivu'ovi suggests that the surface-collection units represent a trash deposit rather than an activity area associated with lithic reduction. The abundance of Adamana Brown sherds and lack of other pottery types in the surface collection area indicates the deposit dates to the Basketmaker II occupation of the area, however, later reuse and scavenging cannot be discounted.

The distribution of debitage recovered in the excavations is shown in Table 10.7. Most came from the upper levels of the excavation units and from structure fill. Seventy-five percent of the debitage (n=21) within the floor fill of Structure 2 came from a 5-cm level of a single 1-m by 1-m unit. By far the greatest concentration of debitage was from a vessel in Feature 3, Structure 1, that contained 91 unmodified flakes, along with 25 utilized and 2 retouched flakes.

Material Types

Five material types are represented in the debitage collection. These are petrified wood, chalcedony, chert, quartzite, and obsidian. In this analysis, chalcedony was lumped with petrified wood. Very little was present and it is not possible to consistently differentiate it from the clear "heart wood" found in petrified logs. Both materials have similar flaking qualities (Schiffer 1976:104) and are available locally. Scattered logs of various colors abound throughout the area. Most of the petrified wood at Sivu'ovi is similar to that found in the surrounding area and at Rainbow Forest, 1.5 km (1 mile) northeast. Chert and quartzite cobbles are found on site and locally in old terraces and drainages. A lone obsidian flake from one of the surface-collection units, chemically sourced (XRF) to Government Mountain near Flagstaff (see Appendix B), is the only unquestionably imported raw material.

Petrified wood comprises over 95 percent of all material types recovered. Table 10.8 shows the distribution of material types in various analytical units. The highest percentages of non-petrified wood material was found in the extramural excavation units. Petrified wood was most likely the preferred material at Sivu'ovi due to its overwhelming abundance in the site area.

Table 10.7. Distribution of Debitage Recovered During Excavation.

Unit 1	Level 1	6
	Level 2	29
	Level 3	18
	Level 4	7
	Level 5	9
Unit 2	Level 1	10
	Levels 2-5	-
Structure 1	Surface	-
	Upper fill	9
	Floor fill	3
	Floor	2
	Feature fill	3
	Vessel contents	91
Structure 2	Surface	-
	Upper fill*	3
	Floor fill	28
	Floor	4
	Feature fill	5

* not screened

Table 10.8. Percent of Lithic Material Types at AZ Q:1:114.

provenience	petrified wood	chert	other[a]
Surface	95	5	nil
Unit 1	88	12	3
Unit 2	80	20	-
Structure 1	94	6	-
Structure 2	100	-	-
Vessel[b]	100	-	-

a. quartzite and obsidian
b. Feature 3, Structure 1

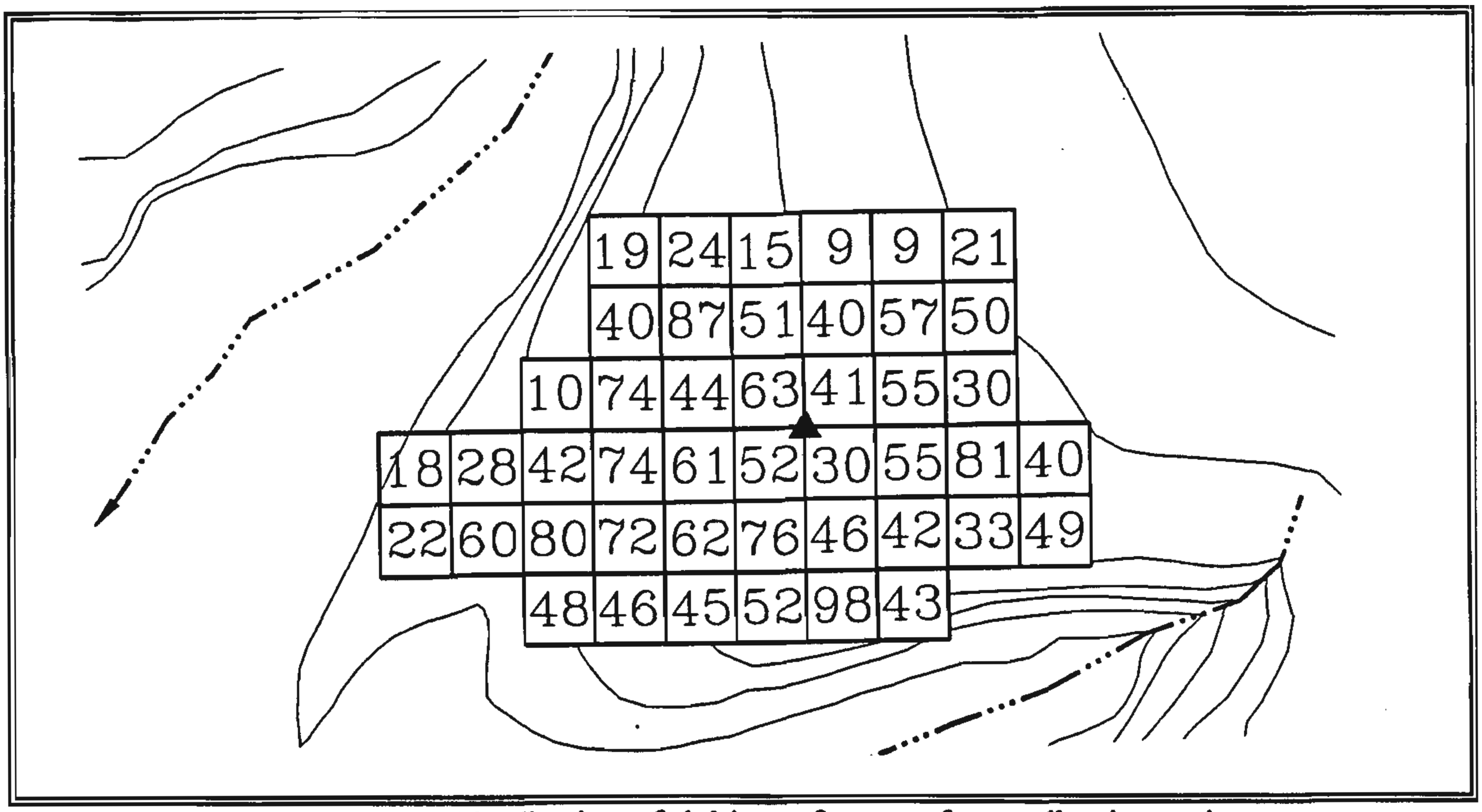

Figure 10.8. Distribution of debitage from surface collection units.

Size-Sort Data

Size classifications of debitage have been used to infer the type, intensity, or stage of lithic reduction (such as primary reduction-quarrying versus secondary reduction). Size-sort analysis is often based on replication experiments (Patterson 1983, 1990; Stahle and Dunn 1982; Basgall 1983).

In replicative experiments biface production produces an exponential curve, with a lot of relatively small flakes, no matter what the stage of reduction (such as preform or finished tool; Basgall 1983; Patterson 1983, 1990; Stahle and Dunn 1982; Figure 10.9).

Size sorting at sites where the predominant activity was tool maintenance shows a truncated distribution, with fewer large flakes (Bettinger and others 1984; Burton 1986; Figure 10.10a-b). Size sorting at biface reduction sites produces a curve similar to that produced experimentally (Basgall 1983; Goldberg and others 1990; Figure 10.10c-d, compare with Figure 10.9), while at quarry sites a bell-shaped curve results, with few large and small flakes, and many mid-sized ones (Patterson 1983; Goldberg and others 1990; Figure 10.10e-f). Figure 10.10g shows the size-sort results for Puerco Ruin, a Pueblo IV site at Petrified Forest (Burton 1990) and Figure 10.10h shows the size sort results for an Archaic site at Petrified Forest (Tagg 1987). Although different lithic technologies were postulated for the sites, expedient flake technology and bifacial reduction, respectively, each show a similar flattened curve.

As often noted, experimentally derived data contain potential pitfalls when applied to actual sites subjected to centuries of formation processes and the archeological realities of incomplete recovery. Therefore, size-sort data usually are used to derive lithic reduction inferences only in conjunction with other evidence (see Basgall 1983; Bettinger and others 1984; Burton 1986; Goldberg and others 1990).

All debitage from Sivu'ovi was size-sorted through nine nested hardware-cloth screens with openings of decreasing size. Artifacts were assigned to the size class of the screen through which they would not pass. The size classes are: (1) less than 6 mm (1/4 inch), (2) 6 mm to 12 mm, (3) 12 mm to 18 mm, (4) 18 mm to 24 mm, (5) 24 mm to 30 mm, (6) 30 mm to 36 mm, (7) 36 mm to 42 mm, and (8) greater than 42 mm. This method is less time consuming than other methods of measurement, and provides an assessment of relative size for far more artifacts than would have been otherwise possible.

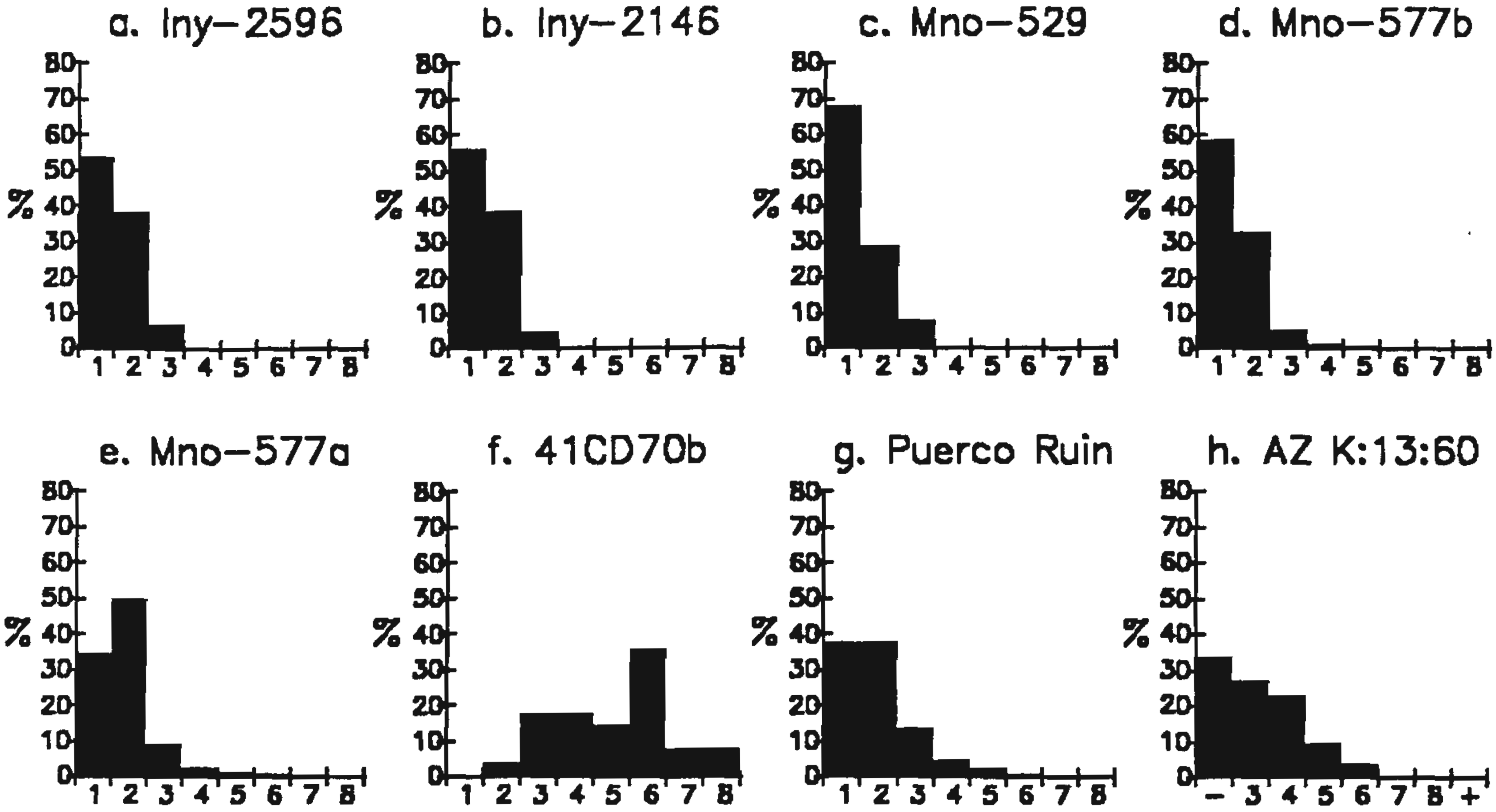

Figure 10.9. Size-sort data from controlled experiments; a-d. Stahle and Dunn 1982, e-g. Basgall 1983, h. Patterson 1983.

At this time, however, many of the size sort studies are not directly applicable to the Petrified Forest region. Replication studies have focused on chert and obsidian, rather than petrified wood, and on biface production, rather than the more expedient flake production that may have prevailed at Petrified Forest. Few comparable studies have been conducted in the Southwest; most consider only measurements of complete flakes or platform thickness (Burton 1990 and Tagg 1987 are exceptions). Nevertheless, size sorting does provide another means of comparison among different areas of the site, and will provide a basis for comparisons with other sites in the future.

Size-sorting patterns for the various proveniences (Figure 10.11) are fairly similar , suggesting primary reduction. That is, they appear most similar to the results from quarry sites with few small flakes. Results could, however, be biased by sampling: in the surface-collection area, smaller flakes that would indicate biface or flake production may have been overlooked or buried by a thin layer of sand. Other areas most likely represent secondary trash deposits, as larger flakes and other debris are more likely to be cleaned up from an activity area than small ones (Schiffer 1987). The lack of flakes in the smaller size classes from the surface collection area could also indicate a secondary trash deposit there. A similar pattern was noted at Puerco Ruin, where trash was deposited in defined areas (Burton 1990). Excavation within the surface collection area would be necessary to test this proposition.

The size-sort results of the vessel contents diverge from the others in that few large pieces are present. As noted above, the vessel contents appear to have been purposefully selected for their size and shape and in themselves would not be expected to yield data on lithic-reduction strategies.

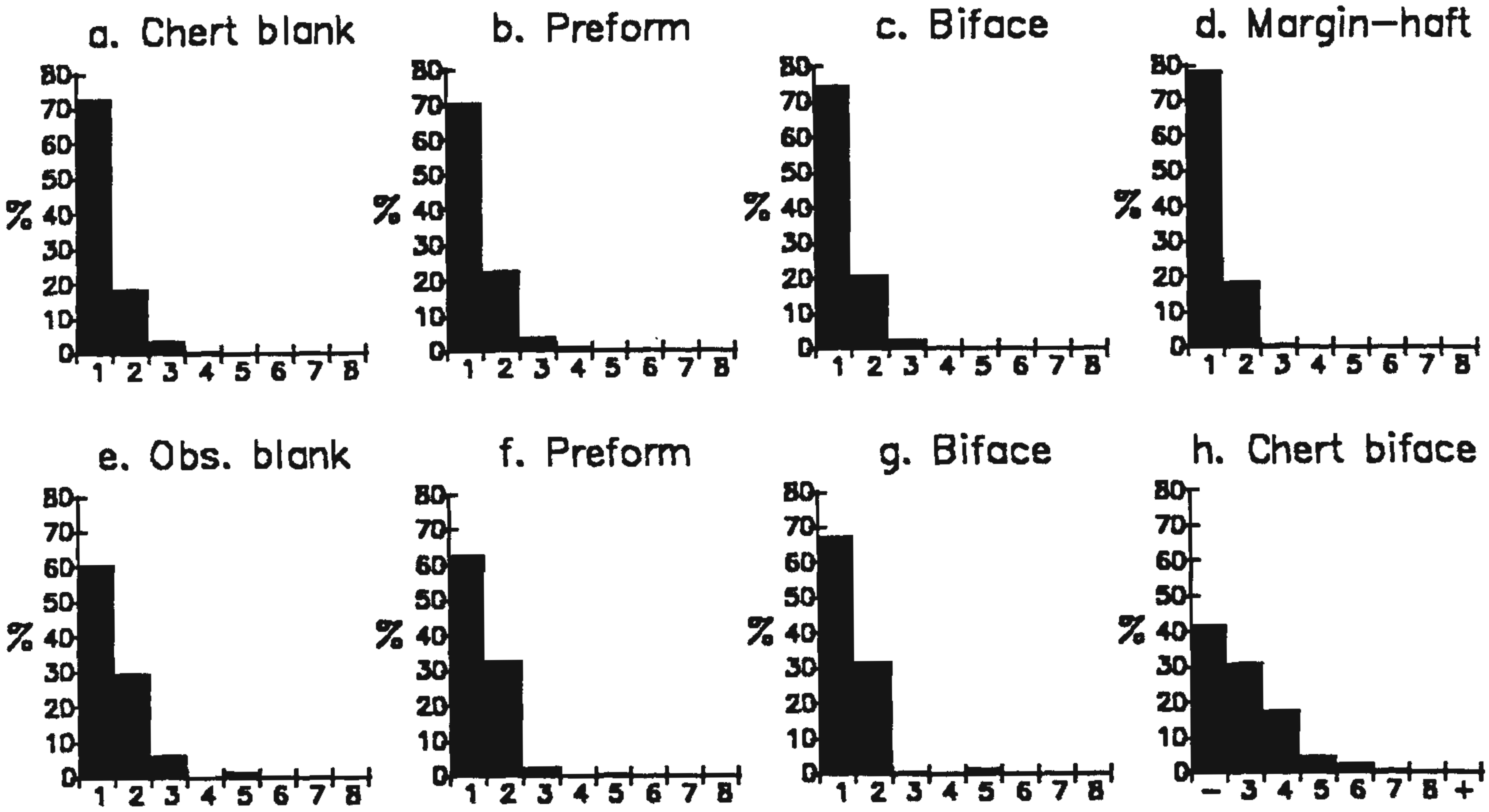

Figure 10.10. Comparative size-sort data; a. Burton 1986, b. Bettinger and others 1986, c. Basgall 1983, d-e. Goldberg and others 1990, f. Patterson 1983, g. Burton 1990, h. Tagg 1987.

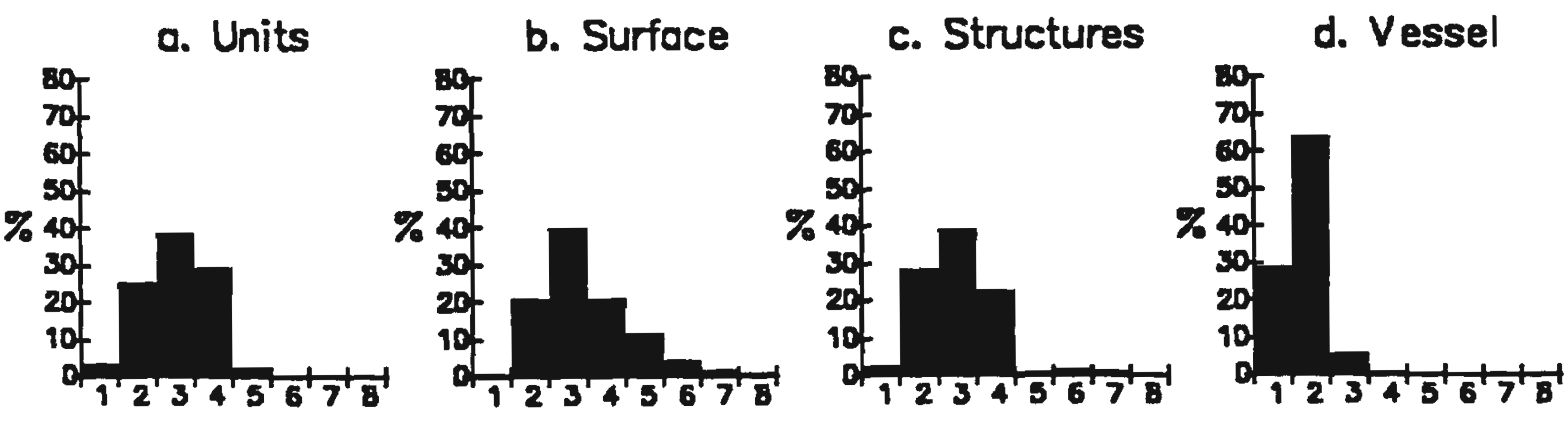

Figure 10.11. Size-sort data from AZ Q:1:114.

Mean Weight

Patterson (1983) notes that mean flake weight is directly correlated to size and hence should provide the same information as the size-sort data. Lower mean weight may indicate secondary reduction, and higher mean weight, primary reduction or quarrying activities. Figure 10.12 shows the mean weight of all debitage and of complete flakes recovered by provenience (see also Appendix C). Both calculations yield similar results, with chert and petrified wood from the surface-collection units the heaviest, then debitage from excavation units and structures, and finally the vessel contents.

The intrasite variability in weight at Sivu'ovi is probably at least partially due to recovery techniques: smaller flakes are more likely to be recovered in excavation than in surface collection. Nevertheless, the debitage from Sivu'ovi overall is strikingly heavier than that recovered at Puerco Ruin, a nearby site dating to the Pueblo IV period. Mean weights for room and plaza units at Puerco Ruin were less than 3 grams. Even in the units excavated outside the pueblo walls, inferred to be the site of initial stages of reduction, most debitage weighed between 4 and 5 grams. At Sivu'ovi, in contrast, debitage weights are commonly twice that. Following Patterson (1983), these differences indicate that either more primary reduction, or less intensive reduction, occurred at Sivu'ovi.

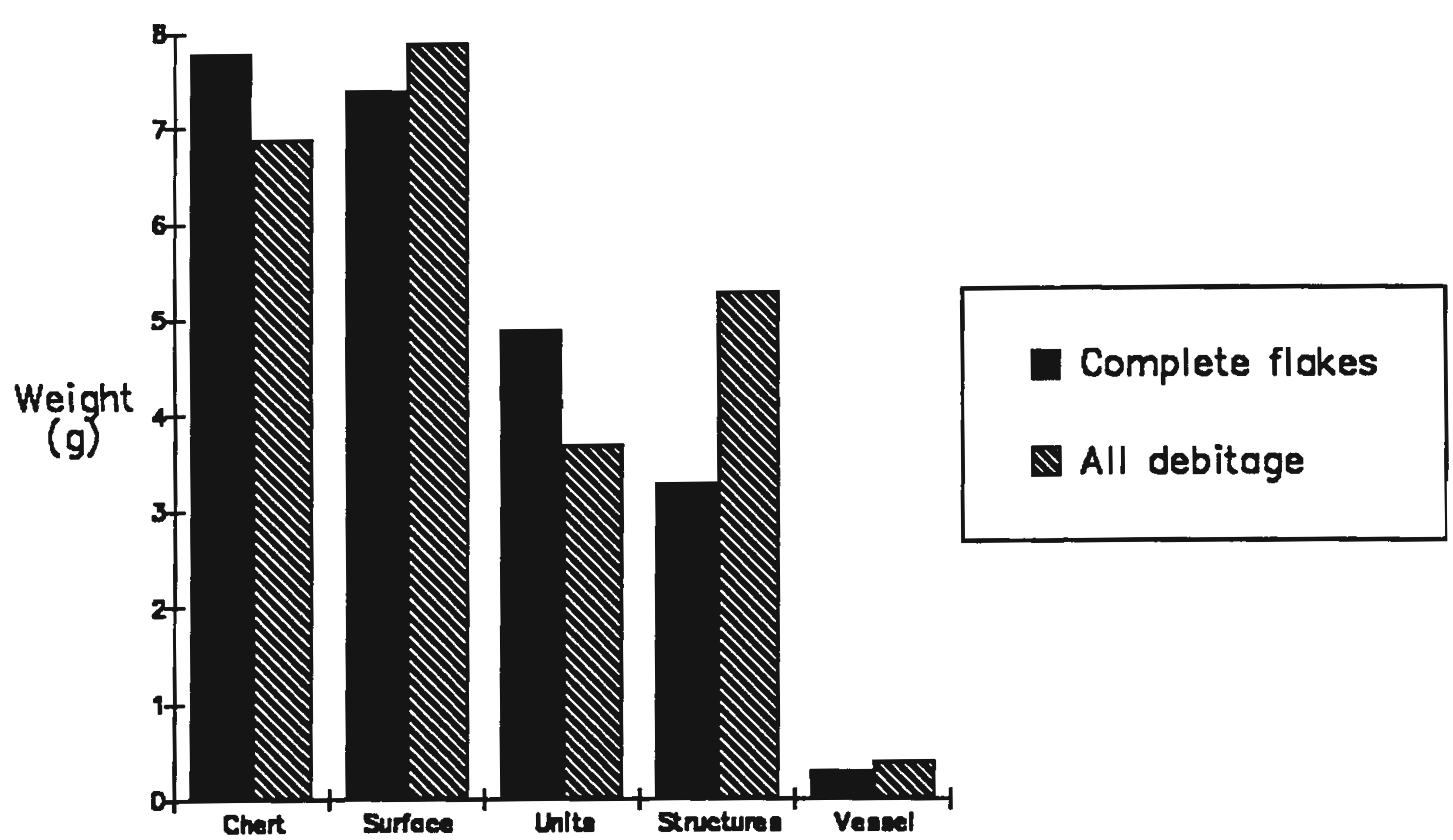

Figure 10.12. Mean weight of complete flakes and all debitage from AZ Q:1:114.

Debitage Type
All debitage was analyzed using the flake classes defined by Sullivan and Rozen (1985; Rozen 1981, 1984), a schematic of which is presented in Figure 10.13. Debitage exhibiting use-wear visible with the unaided eye or under a 10-x hand lens were classified under the category of tools and are not included here. The debitage types in the Sullivan and Rozen classification are complete flakes, proximal fragments, medial-distal fragments, split flakes, and debris. A summary of debitage types by provenience is provided in Appendix C. A **complete flake** is defined as having its striking platform and all edges intact. **Proximal flakes** have an intact striking platform, but one or more edges are missing. **Medial-distal fragments** lack a striking platform. **Split flakes** have a bulb of percussion that is split at the point of applied force, thus removing a portion of one or both margins. **Debris** includes nonorientable pieces that lack a single interior surface. Sullivan and Rozen (1985) determined that primary (core) reduction produces more complete flakes and debris, while secondary reduction (tool-making) generates mostly proximal and medial-distal flake fragments.

There are two potential problems in applying Sullivan and Rozen's classification. First, their study is based predominately on cobble chert, and may be less applicable to other lithic materials, such as large blocks of petrified wood. Second, as Sullivan and Rozen note, the model assumes that all material at a site is what Schiffer (1985) terms "primary refuse." Cleanup and trash disposal will affect distributions, and may be difficult to sort out from primary refuse.

Figure 10.14 depicts the percentage of debitage types at AZ Q:1:114. The high percentage of complete chert flakes indicates unintensive reduction of this material. For petrified wood, on the other hand, the high percent of fragments indicates intensive use. Because petrified wood is more brittle than chert, these differences may be partially due to material type. But there are intrasite differences in petrified wood debitage types that may indicate behavioral differences. Large flakes and debris, indicating primary reduction, and distal-medial fragments, reflecting secondary reduction, appear to be inversely correlated: secondary reduction is represented in the excavation units and surface collection area, while primary reduction is represented in the structures. This pattern seems to be biased by trash disposal patterns. Structure 2 was trash-filled, and larger flakes (and perhaps associated debris, if part of a single event) are more likely to be cleaned up and deposited in a trash

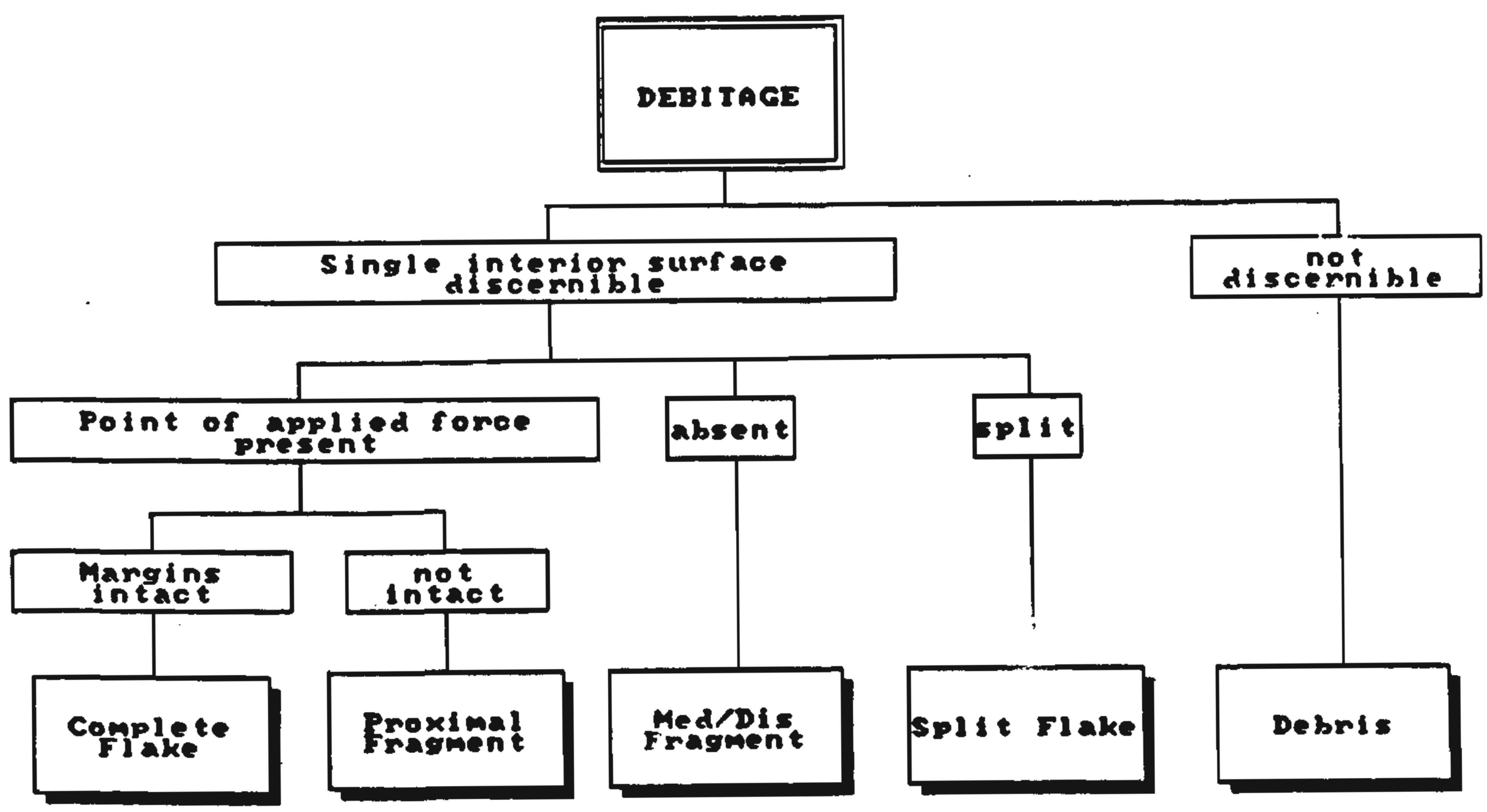

Figure 10.13. Debitage categories, adapted from Sullivan and Rozen (1985:759).

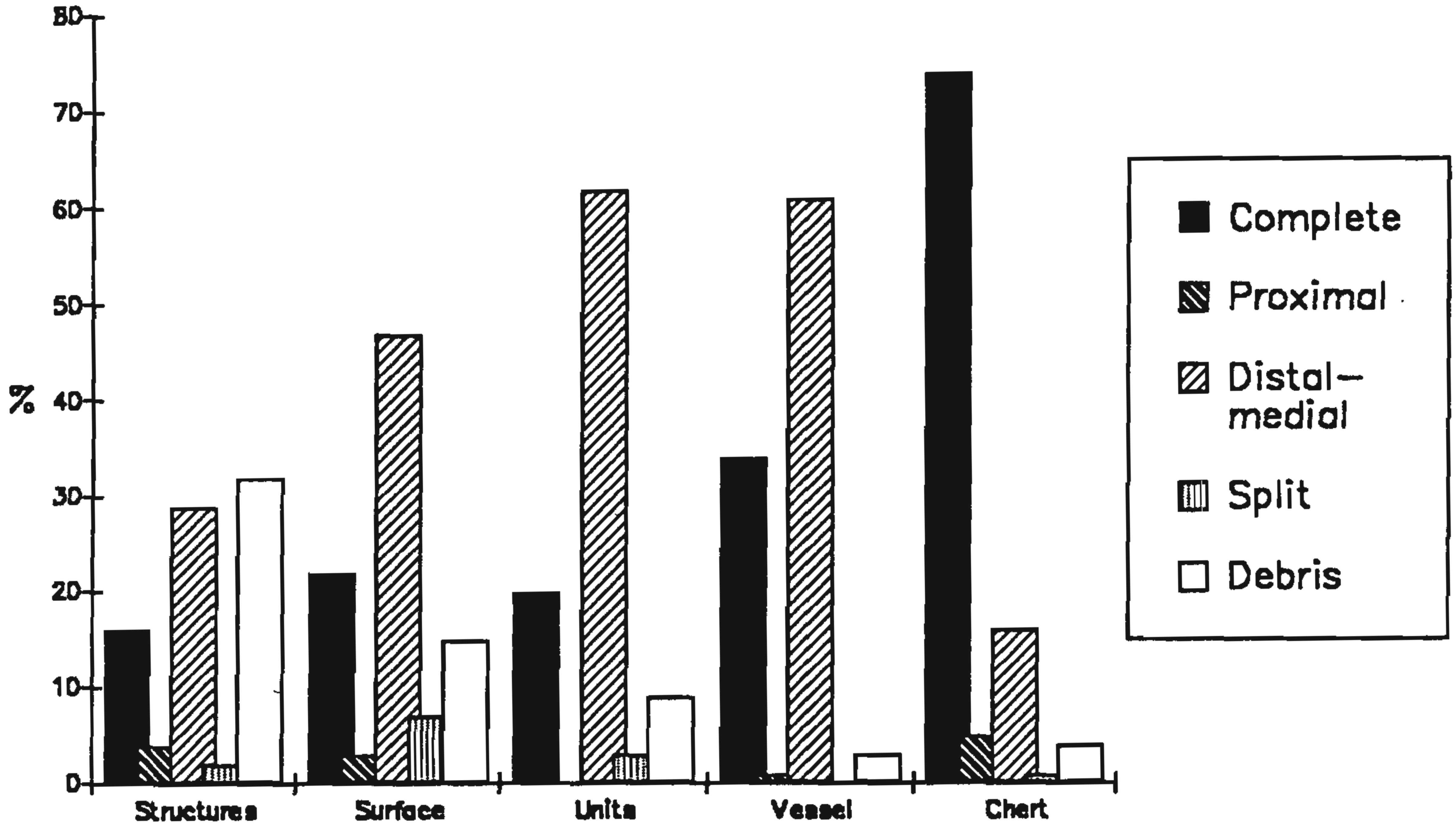

Figure 10.14. Percentage of debitage types from AZ Q:1:114.

dump than smaller items (Schiffer 1987). For example, 75 percent of the flakes in Structure 2 were found in a 1-m by 1-m area, perhaps the remains of a single dumping event.

The vessel contents are mostly complete flakes and medial-distal fragments, and most are of a distinctive shape, as discussed above. The lack of proximal fragments may indicate these were not considered useful for the purpose at hand.

Platform Type

Platform types can be divided into four classes: cortical, crushed, plain, and faceted (Rozen 1979, 1981). **Cortical platforms** have any amount of cortex; they are assumed to be indicative of the initial stages of reduction. **Crushed platforms** have failed under the impact of the detaching blow, although the point of applied force and bulb of percussion are left intact. Crushed platforms generally have been attributed to initial hard hammer reduction. **Plain platforms** consist of a single plane, roughly perpendicular to the dorsal and ventral surfaces of the flake. They lack cortex or intersecting flake scars and are usually flat and smooth. These have been interpreted as flakes removed from a core that has been moderately reduced, that is, most or all of the cortex has been removed; desirable striking platforms may have been created by the initial flake removal. A **faceted platform** has one or more flake scars intersecting the platform. Faceted platforms may be from more intensively reduced cores, or "bifacial" cores; they are found on biface-thinning flakes, which are characterized by a pronounced lipping of the platform as well. Faceted platforms usually are associated with secondary reduction.

Platform type classifications for the project area as a whole are illustrated in Figure 10.15 (see also Appendix C). These data parallel and support that of flake type. The high percentage of chert with cortical platforms indicates primary reduction of that material. Plain and faceted petrified wood indicates secondary reduction. Again, structure fill has less evidence of secondary reduction than the

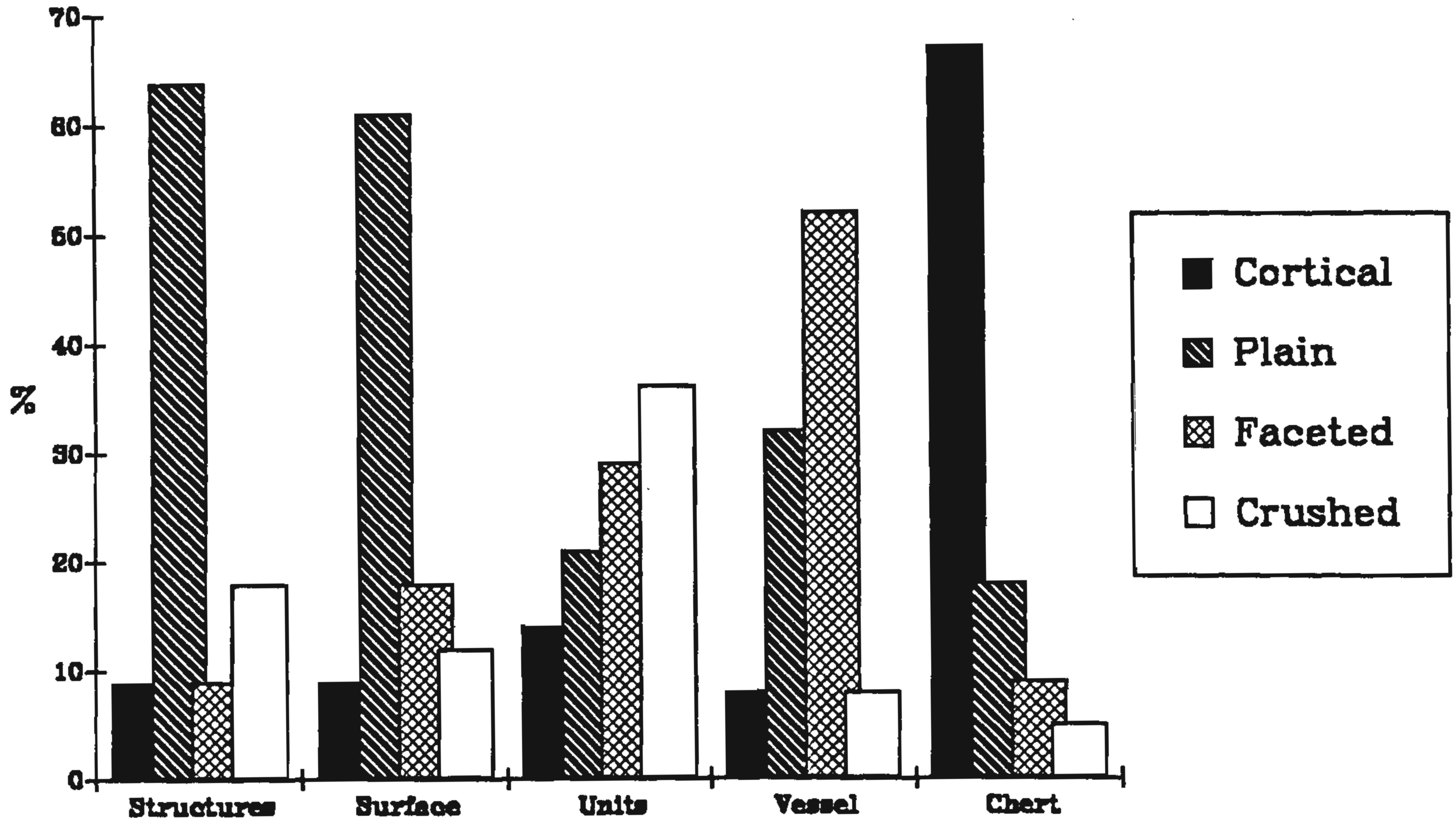

Figure 10.15. Percentage of flake platform types from AZ Q:1:114.

excavation units and the surface collection area, but this distribution is considered the result of trash disposal. The high percentage of faceted and plain platforms of the flakes from the vessel shows that these items were produced relatively late in a production sequence, reflecting their finished nature.

Discussion

Serendipitously, a variety of site types has been recently excavated and analyzed at Petrified Forest National Park for several CRM-driven projects. These sites include Puerco Ruin, a large Pueblo IV site, with over 100 rooms and four kivas and an adjacent quarry/workshop area (Burton 1990); two small campsites and a small pueblo with midden, located along the Park Mainline Road, dated to the Pueblo II-III period (Jones 1986); Locus 3 of AZ Q:1:42, an artifact scatter dated to the Basketmaker III period (Jones 1983); and an Archaic campsite with possible habitation features and a hearth (Tagg 1987). By comparing the results of the lithic analysis at Sivu'ovi with these other Petrified Forest sites as summarized in Table 10.9, a diachronic picture of lithic production emerges. It must be noted, however, that data from Sivu'ovi are from only a small portion of the site, and so conclusions must be considered tentative.

The general trend in the Southwest toward a more expedient lithic technology, that is, a trend from formal tools, such as bifaces, to retouched and utilized flakes (Parry and Kelly 1987: 290-292), is apparent in the data from Petrified Forest. The clearest indicator of this trend in the Petrified Forest data is the steady decline in the percentage of formal tools, itself: while the Archaic site had 67 percent formal tools, the Basketmaker II-period Sivu'ovi has only 31 percent, the Basketmaker III period site had 13 percent, and the Pueblo II-III and Pueblo IV sites had 5 and 7 percent formal tools respectively.

The debitage to tool ratio at Sivu'ovi falls midway within the generally declining pattern from the

Archaic period to the Pueblo period. The large debitage to tool ratio at Puerco Ruin seems anomalous because some of the most intensive collection and excavation at the site occurred at the adjacent quarry/workshop. Utilized flakes were not used in calculating these ratios because other researchers did not use this category.

Usually in the Southwest, the trend toward using a expedient technology also is reflected in the decreasing percentages of flakes with faceted platforms through time (Rozen 1979, 1981). This decline is demonstrated by data compiled by Parry and Christenson (1986) from sites in the northern Southwest: at Archaic sites, 41 percent of flakes had faceted platforms; at Basketmaker II sites, 41 percent; at Pueblo I sites, 34 percent; and at Pueblo II sites, 22 percent. Data from Petrified Forest are not so clear-cut, although the Basketmaker II and Archaic sites have generally more than later Pueblo period sites. The low percentages of faceted flakes at Petrified Forest may be due to differences in raw material as well as technology. Petrified wood, though commonly present at other sites in the region, rarely comprises a significant percentage of lithic assemblages much beyond the Petrified Forest area. Comprising up to 95 percent of flake material at the Petrified Forest sites, petrified wood may have intrinsic characteristics that make faceted flakes less likely with biface production, or more difficult to recognize in the archaeological record. For example, the low ratio of complete flakes to flake fragments at Sivu'ovi may be due to petrified wood's tendency to shatter. Faceted platforms would not be visible on distal or lateral fragments.

More likely, however, the small percentage of faceted platforms reflects the easy availability of petrified wood. In the majority of Southwestern cases, good quality lithic material is available only at localized areas, used as quarry sites. Bifaces are produced and transported back to long- or short-term occupation sites, where further reduction of the bifaces produces high percentages of faceted flakes. In the Petrified Forest region, on the other hand, good quality lithic material is nearly ubiquitous. Flake assemblages at occupation sites will therefore have many of the characteristics of quarry sites (such as the high percentage of debris at Sivu'ovi). The percentages of faceted platforms, even where biface reduction is dominant, will be diluted by large numbers of simple test flakes or initial reduction flakes. The low percentage of flakes with cortical platforms at Sivu'ovi compared to other sites at Petrified Forest, however, suggests little primary reduction took place at the site. The low ratio of cortical to faceted platforms at Sivu'ovi indicates later stages of tool production at Sivu'ovi. Secondary reduction at Sivu'ovi is also supported by the presence of biface preforms and roughouts indicative of a bifacial technology.

The discrepancies in the evidence for biface production may be resolved by considering the relatively high number of retouched and utilized flakes in the Sivu'ovi assemblage. These indicate that an expedient flake technology was common at the site. The relatively high core to debitage, and core to tool, ratios for all the Petrified Forest sites provide more support for expedient flake/core technology In biface reduction, a "core" is neither a desired end product nor a waste product except in the earliest stages of reduction; flakes are the waste product, while the "core" is transformed into a biface. In expedient flake technology, on the other hand, flakes are end products, and exhausted cores are waste. The presence of an expedient flake technology may be the result of an abundance of readily available raw material (Parry and Kelly 1987), as well as sedentism. Biface reduction may be the optimum way to test and reduce material for transport in mobile populations, but even mobile populations did not rely so heavily on this conservative technology if material were readily and widely available.

In summary, the percentage of formal tools appears to be the least ambiguous temporal indicator, apparently useful over a wide range of site types (campsites to pueblos, in this example). Other measures of the trend from biface reduction to expedient flake technology may be influenced by site function, and availability of raw material. Containing evidence of bifacial reduction and expedient flake-core production, the lithic technology at Sivu'ovi appears transitional between the Archaic and Pueblo periods in form as well as in time.

Table 10.9. Comparison of Lithic Analysis Results for Sites at Petrified Forest National Park.

	Puerco Ruin (Burton 1990)	Mainline Road sites (Jones 1986)	AZ Q:1:42[a] (Jones 1983)	Sivu'ovi (this project)	AZ K:13:60 (Tagg 1987)
Time period	Pueblo IV	Pueblo II/III	Basketmaker III	Basketmaker II	Late Archaic
Sample size	26,763	603	599	2,632	512
Percent petrified wood	95	86	80	95	76
Debitage to tool ratio[b]	134.5	19.3	21.7	22.9	28.4
Core to debitage ratio	.01	.05	.10	.08	.02
Core to tool ratio[b]	2.0	.89	2.2	1.8	.50
Percent formal tools[c]	7	5	13	31	67
Percent faceted platforms	8	4	n/a[d]	19	11
Percent cortical platforms	12	37	32	9	18
Cortical to faceted platform ratio	1.5	8.9	n/a	.47	1.6
Percent complete flakes	25	38	35	22	44
Percent flake fragments	61	33	23	49	55
Percent debris	14	39	42	29	3
Complete flake to fragment ratio	.41	1.6	1.5	.45	.83

a. Locus 3 only
b. excluding utilized flakes
c. projectile points and bifaces
d. not tabulated (24% had lipped platforms)

Chapter 11
Ground-stone and Miscellaneous Artifacts

Jeffery F. Burton and Kathleen M. McConnell

Grinding Tools

During mapping and surface inspection of Sivu'ovi (AZ Q:1:114 [ASM]), 84 metates and 45 manos, or fragments thereof, were noted and classified. All of these are included in the discussion that follows. In addition, six complete manos and three metates or metate fragments were encountered during the excavations and a palette was recovered in the controlled surface collection. Only the manos encountered during the excavations and the palette were collected.

Manos

Forty-five manos or mano fragments were noted during the site mapping and surface inspection. In addition, six complete manos were recovered in the excavations, three from Feature 3 of Structure 1 (the cache pit) and three associated with Structure 2.

Seventy-eight percent of the manos noted at the site and all of the manos recovered during excavation were formal two-hand manos. These are rectangular, loaf-shaped artifacts made of course-grained red sandstone. Most were unifacially used with a high amount of remnant use-life apparent. Pecking and repecking are visible in some, as is extreme wear such that the mano is worn to one-hand mano size and the use-wear surface is curved. The rectangular shape of the two-hand mano is unmistakable, however, as the formal one-hand manos are circular to oval in shape. Metric attributes of the manos recovered during excavation are given in Table 11.1 and the artifacts are illustrated in Figure 11.1.

Formal, one-hand manos were not as common (22 percent of the manos on the surface). Most of the one-hand manos are made of gray or black quartzite cobbles. The use wear consists of polishing on one side.

Metates

Trough metates were the most common type noted at the site (n=76; 87%), followed by basin (n=6; 7%) and slab (n=5; 6%) metates. Virtually all of the metates were manufactured of a red, course-grained sandstone that occurs naturally on a small butte just northwest of the site.

The trough metates at the site appear to fit the three subtypes identified by Woodbury (1954:50): (1) scoop-shaped with a closed end, (2) scoop-shaped with a secondary depression or shelf at the closed end ("Utah type"), and (3) trough, open at both ends. The fragmentary nature of many of the metates made it impossible to determine which subtype occurred most frequently. Of the three metates encountered in the excavations, one of the two from Structure 1 was a "Utah type" (Figure 11.2). The remaining specimens each have a single closed end (Woodbury's first type).

The grinding surface of the trough metates was worn in a rectangular, U-profile. Another characteristic of some of the trough metates is the reuse pattern. The side profile of the troughs shows a ledge on each side indicating the metate was reused with a shorter mano.

The basin metates are round with a circular to oval basin-shaped grinding surface. In some of the basin metates, the lip is of even width around the whole circumference, giving the appearance of a large ground-stone bowl.

The slab metates are roughly the same thickness as the trough metates and have the same rectangular shape. They could be a preform, or initial use form, of the trough metates, however, some of these are made of a different material type, a tabular fracturing fine grained brown

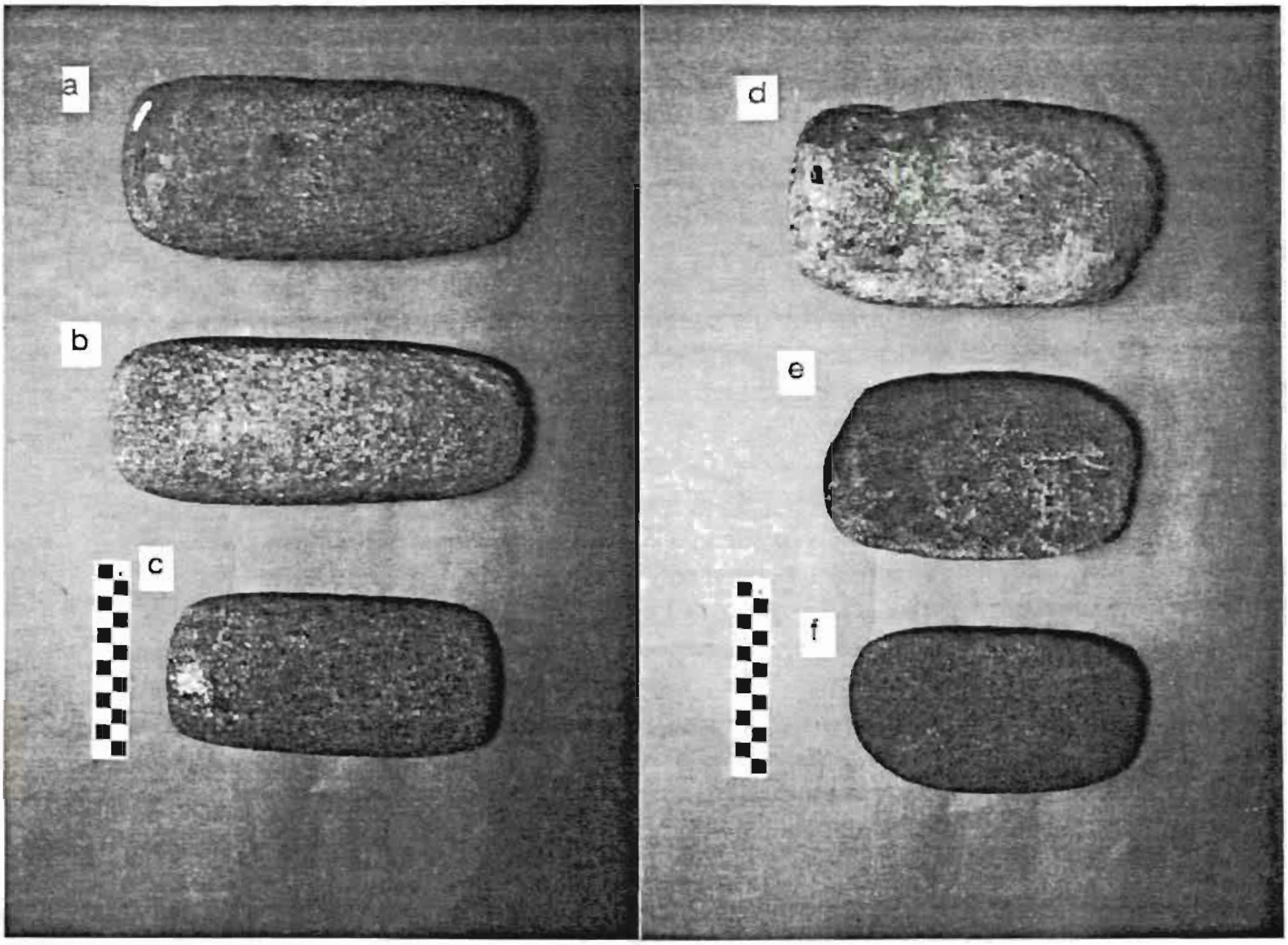

Figure 11.1. Manos recovered from AZ Q:1:114; a. PEFO-9239, b. PEFO-9238, c. PEFO-5915, d. PEFO-9316, e. PEFO-5902, f. PEFO-5914.

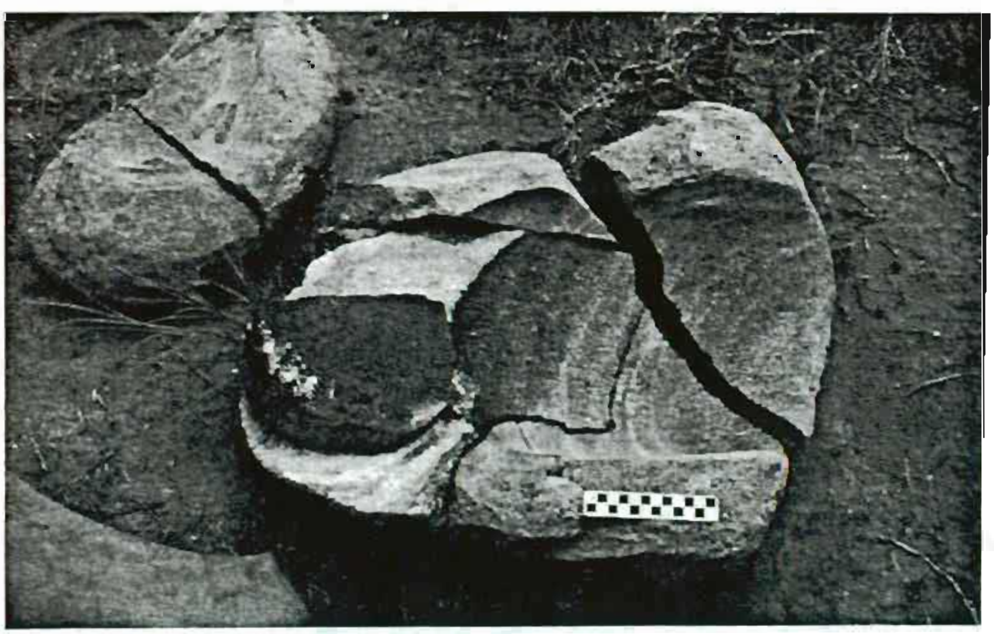

Figure 11.2. "Utah" type metate from Structure 1.

Table 11.1. Metrical Attributes of Manos Recovered During Excavation at AZ Q:1:114.

Cat. no.	Provenience	Size (cm)			Wt (g)	Notes
		L	W	T		
5902	Structure 2, surface	18.7	11.0	5.5	1464	2*
5914	Structure 2, surface	17.5	9.8	4.5	1000	2
5915	Structure 1, Feature 3	19.8	9.9	4.4	1207	1**
9238	Structure 1, Feature 3	24.5	10.1	6.1	2454	1
9239	Structure 1, Feature 3	24.0	10.8	7.2	3137	1
9316	Structure 2, Feature 2	21.5	11.7	6.4	2475	3*

Notes:
1. unifacial, loaf shaped (sub-rectangular)
2. unifacial, oval shaped
3. bifacial, oval shaped

* burned
** with slightly ground upper surface

sandstone. These are generally larger, with use wear consisting of polishing and some striations on the flat surface, but not heavy grinding as in the trough metates.

Palette

A unifacial gray sandstone palette was recovered from the surface collection units (PEFO-5831). It is a very smooth oval-shaped slab measuring 13.0 cm by 10.0 cm by 2.8 cm. The object lacks an area of well-defined use wear, but its size and polish suggest it was used in grinding, perhaps pigment.

Discussion

Material types noted include red sandstone, tabular brown sandstone, and quartzite. There is a preference shown for manufacturing particular types of tools from specific raw materials. The main raw materials used were red quartz sandstone, which was used for the formal manos and round basin and trough metates. Grey to black quartzite was the material of choice for the one-hand manos, while tabular fracturing sandstone was the material of choice for polishing slabs. The source area of most of the materials utilized lies on or very near the site itself. A small butte (see Figure 2.1) on the east side of the bluff has a stratum of red quartz sandstone within easy reach. Quartzite cobbles can be picked up on the talus slopes of the east side of the mesa, along with chert cobbles and chalcedony cobbles. The tabular fracturing brown sandstone composes one stratum of the mesa on which the site lies and is easily available.

The types of metates and manos recovered from Sivu'ovi are typical for Basketmaker sites in the region. Trough metates were the most common type recovered at the Flattop Site (89 percent; Wendorf 1953:59-60), as were two-hand manos (87 percent; Wendorf 1953:60). These artifact types were also common at the Bluff Site (Haury and Sayles 1947) and at two early sites on the Zuni Indian Reservation (Varien 1990).

Three aspects of manos have been used to infer the intensity of use: type, length, and number of used surfaces. These measures of intensity of use, in turn have been extrapolated to make inferences about a group's dependence on agriculture. To apply these inferences to Petrified Forest, manos at Sivu'ovi can be compared with those from Puerco Ruin, a 100-plus room pueblo dating to the Pueblo IV period (Burton 1990; Table 11.2). The frequency of manos is similar at the two sites, and comparisons may give an indication of trends through time.

Morris (1990) suggests that the one-hand manos and basin metates correlate with less dependence on agriculture than two-hand manos and trough metates. Following this reasoning, the residents of Sivu'ovi were less dependent on agriculture than the Puerco Ruin inhabitants: 22 percent of all manos at Sivu'ovi (including those on the surface) were one-hand types, compared to only 4 percent at Puerco Ruin.

Hard (1986) suggests that mano length is proportional to increased dependence on agriculture, because the larger surface allows more grinding per unit of time. Using this measure, Sivu'ovi and Puerco Ruin exhibit the same dependence on agriculture; manos at Sivu'ovi are approximately the same length and width as those at Puerco Ruin, but are more massive (see Table 11.2). Perhaps thickness, as well as length, needs to be considered in measures of intensity of use.

Adams and Greenwald (1979) looked at the number of grinding surfaces on manos, and suggests that multifacial manos equate with more time spent grinding, and therefore more dependence on agriculture. No multifacial manos were found at Sivu'ovi, and only a few are noted from Puerco Ruin. Multifaceting may be an indicator of the availability of raw material, as well as intensity of use; sandstone for manos is naturally abundant at both sites.

Table 11.2. Mean Length, Width, and Thickness of Manos from Sivu'ovi and Puerco Ruin.

Site	Number	Length	Width	Thickness
Sivu'ovi (BM II)	6	21.0	10.6	5.7
Puerco Ruin (P IV)	16	21.6	10.0	3.9

Figure 11.3. Perforated slab on slope below Structure 3 (see Figure 6.1).

Other Ground-stone Artifacts

Worked Sandstone Slabs

Within this group are three distinctive subclasses: perforated slabs, edge-worked slabs, and small discs.

Perforated slabs at Sivu'ovi vary greatly in size, overall shape, shape of perforation, and thickness. Numerous slabs shaped into crescents, circular disks, or rectangles were observed throughout the site (Figure 11.3). Three perforated slabs were collected from Sivu'ovi, two from Structure 2 and one from the surface. The two specimens discovered in situ during the excavation of Structure 2 indicate that the slabs were placed atop floor pits, reinforcing the edges of the opening.

PEFO-5919, a hexagonal-shaped slab measuring 35 cm in diameter with a circular perforation 13 cm in diameter in the center, was collected from the surface as a representative example (Figure 11.4).

The perforated slab from Structure 2, Feature 6, consists of three pieces that originally may have been a single piece. It is oval measuring 54 cm in diameter. It has a 21.7 cm by 19.5 cm opening (PEFO-9313; see Figure 8.7).

The other perforated slab from Structure 2, this one from Feature 15, consists of two pieces from what had been manufactured originally as a single rectangular piece (PEFO-9315). The slab measures 61 cm by 57 cm. The opening is 10.5 cm in diameter. When discovered, a small, shaped sandstone slab measuring 28 cm in diameter and 2.3 cm in thickness covered the perforation (PEFO-9314; see Figure 11.5).

Several small, shaped sandstone slabs were recovered from the site. The degree of shaping runs the gamut from roughly shaped to well ground. The slabs may have served a variety of functions, including pit and vessel covers or working and cooking slabs.

Feature 3 of Structure 1 (the cache pit) contained three shaped slabs (PEFO-5915, -9240, -9241). Two are roughly circular (24 cm and 18 cm in diameter) and one is more irregular in plan (20.7 cm by 18.7 cm by 1.2 cm; see Figure 11.6). One of the circular slabs is stained by pigment (yellow limonite) on one side, while one side of the irregular specimen has a smooth, ground groove surrounded by a small ground area.

Another shaped slab from Structure 1 served as a cover for a small floor pit (Feature 5). The slab is circular (31.7 cm by 28.8 cm by 1.7 cm) and has a ring-shaped stain on the bottom side where it was in contact with the shoulders of the pit, approximately 12 cm in diameter. It has traces of white plaster on the top side (PEFO-9312; Figure 11.7).

A small, shaped slab was recovered from the floor of Structure 1. It is circular, 15.3 cm by 13.7 cm by 1.4 cm, and burned (PEFO-9311). In addition to the complete specimens, two shaped sandstone slab fragments were recovered, one from the floor fill and one from the fill of Feature 4. The original size or shape of these specimens could not be determined (PEFO-5625, -5626).

A small, shaped circular sandstone disk was collected from the surface of the site (PEFO-9318). Made of gray sandstone, 3.9 cm in diameter by 0.8 cm thick, it may have functioned as a gaming piece.

Balls

Two complete and two fragmentary stone balls were collected from the site (Figure 11.8). Although numerous ideas have been forwarded, the function of these common artifacts is not known (Woodbury 1954:171).

One fragment (PEFO-5867) is roughly one-half of a brown sandstone smooth-surfaced ball. Recovered from the surface, it measures 5.6 cm by 5.2 cm. The second fragment (PEFO-5913) is about three-quarters of a ground-stone ball measuring 6.1 cm in diameter. This smooth sphere,

Figure 11.4. Surface-collected perforated slab from AZ Q:1:114 (PEFO-5919).

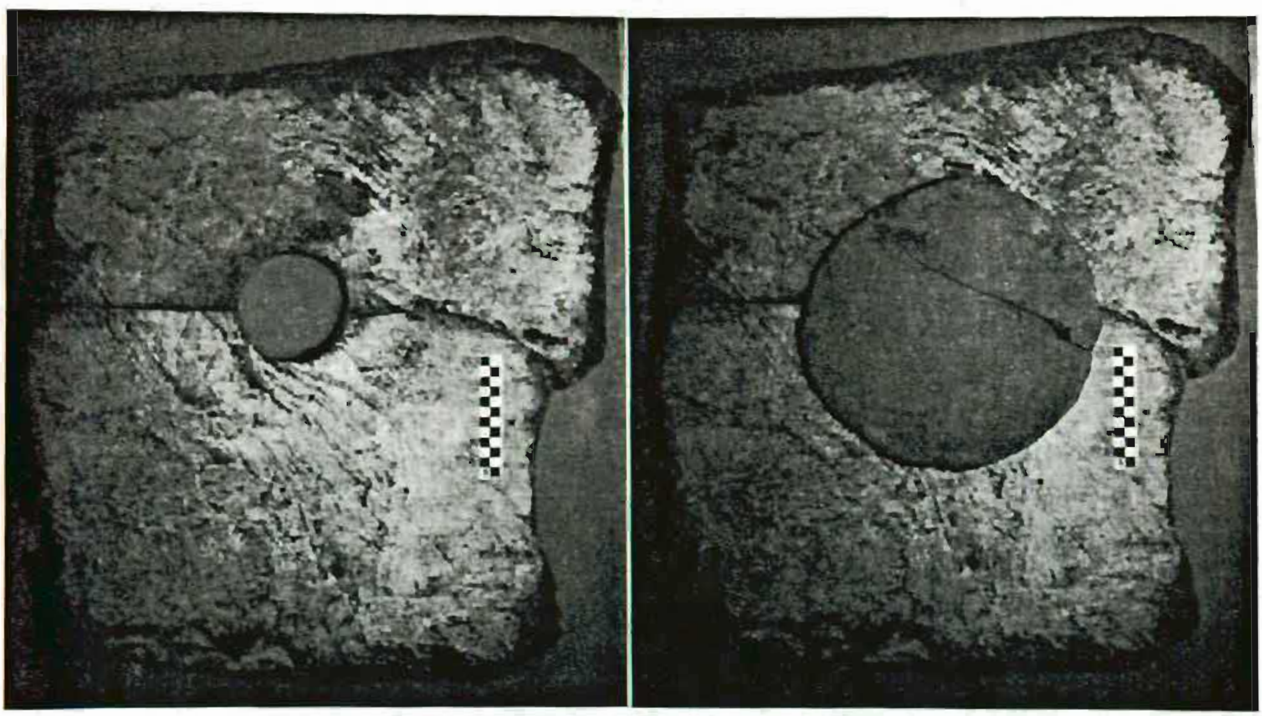

Figure 11.5. Perforated slab (left) and with slab cover (right) from Structure 2, Feature 15 (PEFO-9315, -9314).

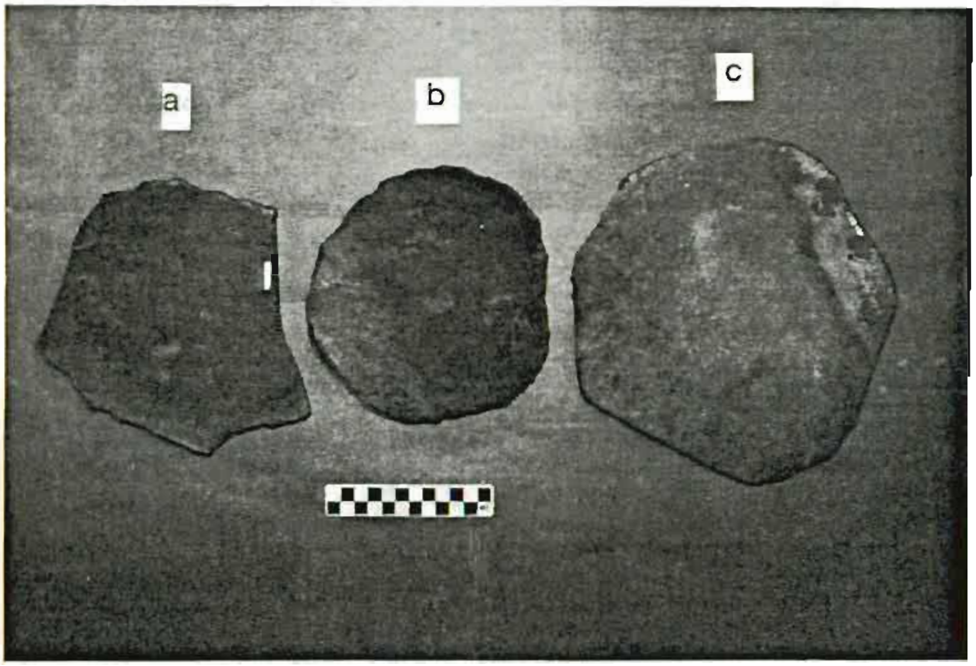

Figure 11.6. Shaped slabs from Feature 3, Structure 1; a. PEFO-9240, b. PEFO-5915, c. PEFO-9241.

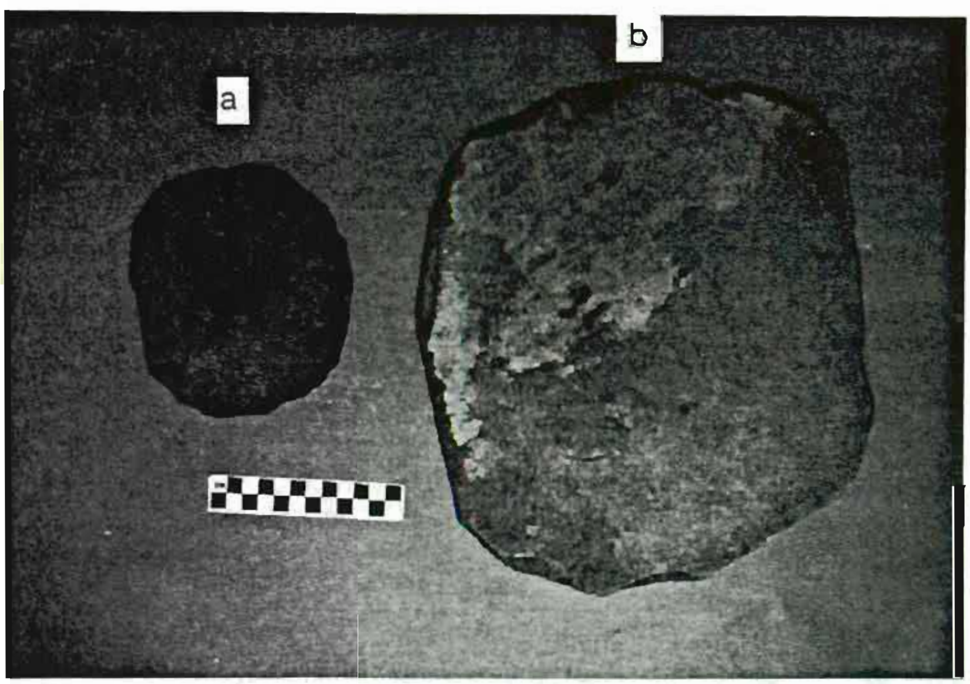

Figure 11.7. Other shaped slabs from Structure 1; a. PEFO-9311, b. PEFO-9312

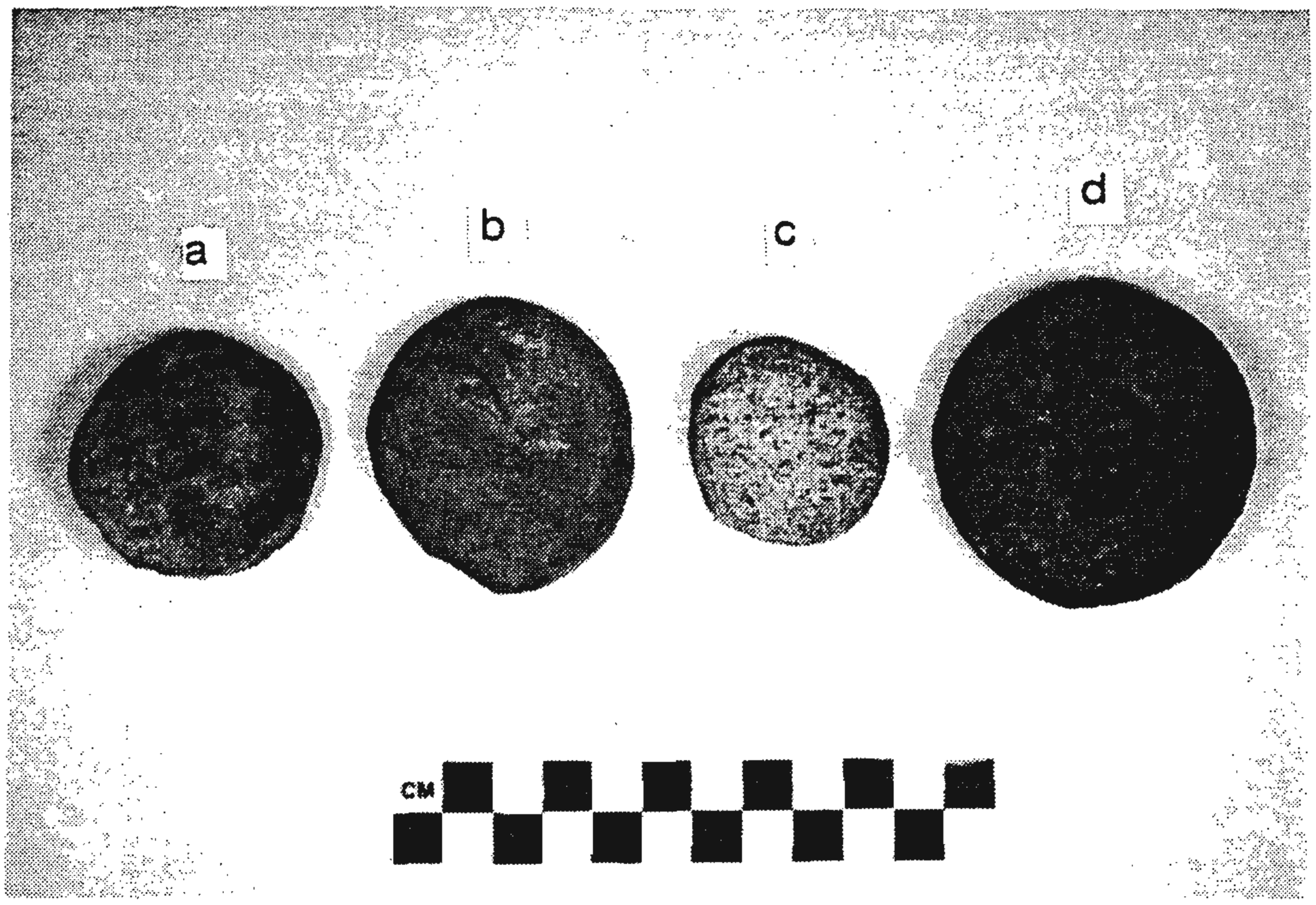

Figure 11.8. Stone balls from AZ Q:1:114; a. PEFO-5627, b. PEFO-5867, c. PEFO-5619, d. PEFO-5913.

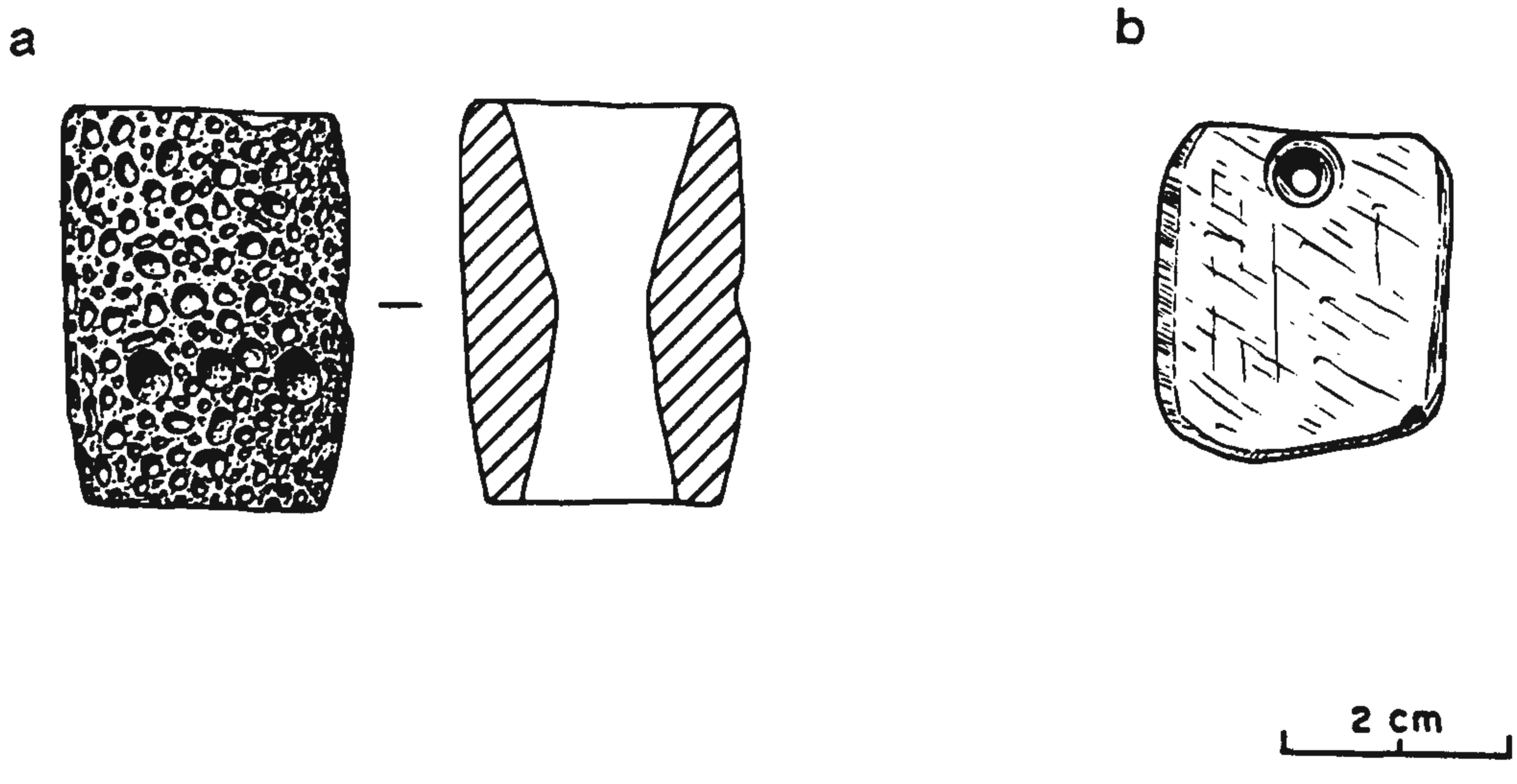

Figure 11.9. Miscellaneous ground stone artifacts from AZ Q:1:114; a. basalt pipe (PEFO-5505), b. slate pendant (PEFO-5897).

made from red sandstone, had been burned. It was recovered from the upper fill of Structure 2.

A complete specimen (PEFO-5627) from the floor of Structure 1 is made of brown sandstone. It is 4.9 cm by 4.8 cm by 3.7 cm in size and weighs 96.4 g. It has an irregular rough surface and may be burned. Another complete specimen (PEFO-5619), made of gray sandstone, is oval shaped, with a slightly flat top and bottom. It is 4.1 cm by 3.9 cm by 3.3 cm, and was found on the surface at Structure 1.

Stone Bowl

Part of a stone rim of a basalt ground-stone bowl was recovered from the floor fill of Structure 2. Approximately three-quarters complete, the rim measures 12 cm in outside diameter and 8 cm in inside diameter (PEFO-5901). A large nearly complete stone bowl was found on the surface at Structure 1 (see Figure 8.3); it was not collected.

Basalt Cylinder

A small cylinder shaped from vesicular basalt was the only artifact found in a small floor pit of Structure 2 (Feature 8). It measures 8.7 cm by 5.9 cm by 4.7 cm and weighs 250.0 g (PEFO-9317). The function of this artifact is unknown. The material is not available in the immediate site area.

Pipe

A complete vesicular basalt pipe was collected from the surface. Slightly tapering and conical in shape, it is 3.5 cm long, tapering from 2.7 to 2.2 cm in diameter (PEFO-5505; Figure 11.9a). The biconically drilled perforation is 1 cm in diameter at the outer edge narrowing to 7 mm in diameter at the narrowest point. The walls vary from 3 mm at the top and bottom edges to 9 mm at the narrowest point. The artifact is similar to one recovered from the Flattop Site (Wendorf 1953:figure 32d) and others from the Bluff (Haury and Sayles 1947), SU (Martin 1943), and Milky Hollow (Hough 1903:plate 52) sites. A specimen from Milky Hollow was attached to a bone stem.

Pendants

One complete pendant and two pendant fragments were recovered during fieldwork at AZ Q:1:114. One is from the surface and one apiece was found in structures 1 and 2.

The compete specimen, discovered in the floor fill of Structure 2, is rectangular with rounded edges and has been drilled in the center of one end. It measures 2.9 cm long, 2.7 cm wide, and 0.5 cm in thickness (PEFO-5897; Figure 11.9b). The biconical perforation is 3 mm in diameter. Made of pale gray slate, all the edges are ground smooth and the edges of the sides and bottom of the pendant are bevelled. The two flat surfaces are ground smooth but show striations irregularly scratched across the surfaces.

One of the fragments (PEFO-9237), from the floor of Structure 1, measures 2.0 cm wide and 0.3 cm thick. The hole, 0.4 cm in diameter, is drilled from one direction. Made of an unidentified white stone, the original size and shape can not be determined.

The other fragment made out of gray slate (PEFO-9320) was found on the surface during site mapping. Measuring 0.4 cm thick and drilled from both directions, its original size and shape are unknown.

Other Artifact Classes

Hammerstones

Twelve hammerstones were recovered during the excavation and the controlled surface collection. Hammerstones are used in the shaping or production of other artifacts. They may be used to strike flakes off of a core or to shape or sharpen a ground-stone artifact. All of the hammerstones appear to be unmodified cobbles, shaped through use, which exhibit concentrated battering on ends and edges. These consist of quartzite cobbles and unflawed cobbles of petrified wood. Occasionally flakes spalled off during use; if more than one negative flake scar is present, the artifact is considered a core-hammerstone. The six artifacts classified as core-hammerstones, all made of petrified wood, are discussed in Chapter 10 under cores.

Nine quartzite hammerstones (including two fragments) were recovered: three from the surface collection units, one from the floor of Structure 1, four from the ground surface at Structure 1, and one from the fill of Structure 2. Only three petrified wood hammerstones were recovered, two from the surface collection units and one from Structure 2, Feature 10.

The working surface of the hammerstones is apparently determined by the material type and hence shape. Petrified wood hammerstones are usually blocky and battering is located on the edge. The working surface of the cobble quartzite hammerstones is usually located on the most acutely convex surface.

Anvil-lapstone

A large artifact classified as an anvil-lapstone was found in Feature 3 of Structure 1 (the same storage pit that contained the vessel cache). Made of a large quartzite cobble, it is subtriangular in plan and rectangular in profile, and measures 23.5 cm by 15.0 cm by 12 cm thick (Figure 11.10; PEFO-5916). The shape of the original cobble does not appear to have been modified. One side of the cobble exhibits smoothing and pecking of the undulating surface. The stone may have functioned as a sturdy and hard work surface.

Pigment

A small fragment of dark, reddish-brown hematite with numerous ground facets was recovered from the fill of Feature 6, Structure 2. It measures 3.3 cm by 2.8 cm by 1.6 cm and weighs 18.9 g (PEFO-9319). This material is common in the Painted Desert region and was most likely procured for use as a pigment.

Figure 11.10. Anvil-lapstone from Feature 3, Structure 1 (PEFO-5916).

Fire-altered Rock

Twelve burned and fire-cracked red and gray sandstone slabs and chunks were found at the bottom of Feature 2, Structure 2. The largest measured 15 cm by 12 cm by 6 cm in size. None of the specimens was collected. Fire-cracked rock often results from repeatedly heating stones in a fire, and then dropping them into baskets for food boiling. Fire cracking may also be the result of use in hearths or roasting pits. The rather coarse texture of the rocks recovered suggests the latter uses rather than in food boiling.

Chapter 12
Floral Remains
Marcia L. Donaldson

Flotation and charcoal samples were collected during the excavation of Sivu'ovi (AZ Q:1:114 [ASM]) in hopes of recovering some information about Basketmaker plant exploitation and subsistence patterns. Although the excavations included extramural tests as well as pit structures, not all flotation samples collected contained enough material to warrant analysis. As a result, all inspected samples represent proveniences within two pit houses (structures 1 and 2). A detailed discussion of the natural site setting can be found in Chapter 2.

Methods

The light fraction of the flotation samples was received after having been separated from the soil matrix by a simple flotation technique. The dried samples were inspected under a binocular microscope at 8x and all seeds and diagnostic plant parts removed for identification. Identifications were made to the level of genus, and species when possible, using a comparative seed collection as well as seed identification manuals (for example, Martin and Barkley 1961).

Charcoal samples were primarily recovered during excavation, although two flotation samples yielded pieces suitable for identification. Selection of charcoal samples to identify was made on the basis of size and amount of charcoal available as many charcoal samples contained only small flecks in a soil matrix. Identifications were made through the use of a comparative charcoal collection, mostly to the level of genus.

In all, eight flotation samples were inspected, split evenly between the two structures. In addition, charcoal from 12 proveniences was selected for identification, supplemented by charcoal from two flotation samples.

Results

All of the flotation samples inspected were taken from within the excavated structures (Structure 1 and Structure 2). Both pit houses were quite shallow and most flotation samples contained abundant evidence of recent contamination and disturbance. Root hairs were common in most samples, suggesting that the samples were taken from the active plant zone. In addition, disturbance is indicated by numerous chiton fragments and insect feces. In a few proveniences it was obvious from fecal material and the state of recovered seeds that some rodent (or other small mammal) activity had taken place. The lack of depth and the recent disturbance to the deposits seems to have provided a poor environment for the preservation of botanical material deposited during the prehistoric occupation.

One of the major problems of archaeobotanical analysis is the separation of plant remains related to the prehistoric occupation from those that result from the natural "seed rain." In an open site such as AZ Q:1:114 the major criterion is frequently whether a specimen is charred (Minnis 1981). Charring dramatically increases the resistance of botanical materials to microbial action as well as erosion, thus enabling it to survive cycles of freezing and thawing, wetting and drying and other elements of bioturbation. Although quite a few specimens were recovered from the samples, few were charred.

Plant remains recovered from archaeological contexts represent only a fraction of plant resources utilized prehistorically. Because only the more durable portions of a plant, usually the seed or fruit, are preserved, we have little evidence of the softer plant parts that form a large part of ethnographically recorded diets. Such parts would include the greens, roots, and tubers of plants that are rarely preserved in archeological strata (Munson and others 1971). Therefore, although analysis of plant remains sheds some light on the botanical resources utilized prehistorically, it by no means paints a complete picture (Tables 12.1 and 12.2).

Table 12.1. Plant Taxa Recovered from AZ Q:1:114.

Scientific Name	Common Name	Occurrence
Scirpus sp.	Sedge	seed
Oryzopsis hymenoides	Indian Ricegrass	seed*
Sporobolus sp.	Dropseed	seed
Chenopodium spp.	Goosefoot	seed*
Atriplex sp.	Saltbush	charcoal
Boraginaceae	Borage Family	seed
Lappula cf. Redowskii	Stick-seed	seed
Euphorbia cf. glyptosperma	Spurge	seed
Eriogonum sp.	Wild Buckwheat	seed
Plantago sp.	Plantain, Indian wheat	seed
Opuntia sp.	Prickly Pear Cactus	seed
Zea mays	Maize	cupules*
Populus sp.	Cottonwood	charcoal
Salix sp.	Willow	charcoal
Juniperus sp.	Juniper	charcoal

* Indicates burned specimens

Grasses

The most abundant type of seed recovered from AZ Q:1:114 was that of Indian ricegrass (*Oryzopsis hymenoides*), a large-seeded type of grass that tends to ripen in the early summer. Most of the caryopses recovered were unburned, suggesting probable post-occupational deposition. The only two burned specimens that appear to have been deposited prehistorically were from Feature 11 (a bell-shaped pit) in Structure 2. *Oryzopsis* provided an important wild food source for such Southwestern groups as the Hopi and Zuni, particularly in times of food shortages (Jones 1938, Whiting 1939). The seeds are easily collected and nutritious, containing 6 percent sugar and about 20 percent starch (Harrington 1967).

Although dropseed (*Sporobolus* sp.) also served as an important food source in time of food shortage (Whiting 1939), the presence of one, unburned seed in a large jar (PEFO-9156) in Structure 1 does not indicate that this taxon was used prehistorically at AZ Q:1:114. Instead, the seed probably was introduced recently by insect activity. A possible unburned, immature sedge seed (*Scirpus* sp.) was recovered from another vessel (PEFO-9155) within the same structure. Again the matrix had been severely disturbed and contaminated, and it is unlikely that this tentatively identified specimen is related to the prehistoric occupation. However, sedge normally grows in consistently moist soil, and it is unusual to recover a specimen from a site located in such an arid setting.

In addition to the grass seeds and caryopses recovered, charred grass stems were found in samples taken from Features 5 and 6 in Structure 2. Although they lack diagnostic features necessary for more specific identification, the grasses may have been used as roofing material and collapsed into the structural features.

Weedy Plants

This group made up the bulk of recovered plant remains from the Sivu'ovi flotation samples. With the exception of two burned goosefoot seeds (*Chenopodium* sp.) from Feature 11 in Structure 2, all of the seeds were unburned and apparently recently introduced contaminants. This is particularly true of the mostly non-economic taxa that were recovered, such as stick-seed (*Lappula redowskii*) and other members of the Borage family. Stick-seed was very abundant in a vessel (PEFO-9155) from Feature 3 of Structure 1. It was associated with many insect parts and rodent feces, and appeared to be in various stages of fragmentation, ranging from complete to tiny pieces, that may be the result of rodent gnawing. This suggests that the jar contents may have been disturbed by rodent and insect activity.

Minor economic taxa recovered include wild buckwheat (*Eriogonum* sp.), plantain (*Plantago* sp.), and spurge (*Euphorbia cf. glyptosperma*). Only two possible, unburned buckwheat seeds were recovered from a vessel (PEFO-9156) in Structure 1, which has already been noted as being contaminated by recent intrusive activity. Unburned spurge seeds also were found in samples from this vessel, and though the roots were sometimes used as a sweetener or for medicinal purposes (Stevenson 1915), the seeds seem to be post-occupational contaminants. Plantain (or Indian wheat) was found in several contexts of both structures, although it was most numerous in the disturbed contents of a vessel (PEFO-9155) from Structure 1. Ethnographically, both the leaves and seeds of plantain were collected for consumption (Castetter 1935; Curtin 1949), but it never seems to have been a major food source. In AZ Q:1:114 its presence seems to be associated with disturbed contexts that suggest post-occupational deposition.

Cactus

A single, unburned prickly pear (*Opuntia* sp.) seed was recovered from the contents of a vessel (PEFO-9156) from Structure 1. This represents a disturbed context and it may be that the seed was brought in through rodent or insect activity. Prickly pear was most certainly an important food source ethnographically. The fruits ripened in the early fall and were often cooked, eaten raw, or dried for storage (Stevenson 1915).

Domesticated Taxa

Although maize, beans and squash formed the traditional subsistence basis for Southwestern groups, their remains survive unevenly in prehistoric contexts. Only a few maize (*Zea mays*) cupules were recovered from flotation samples taken from both of the excavated structures at AZ Q:1:114. Cupules are the unit of the maize cob that hold the kernels in place. Their recovery from the archaeological strata attest to the consumption of maize at the site.

Ethnographically, maize appears as the main food staple of most Southwestern groups. Green maize was often collected early for roasting (Cushing 1920), while the main crop of mature ears was harvested in the fall and the maize allowed to sun dry on the cob. Most long-term storage of maize was "on-the-cob," often stacked or hung on storage room walls. Archaeologically, maize has been found in Archaic contexts and was an established crop by Basketmaker II times. Most evidence suggests that the main type of maize cultivated was similar to Onaveno, a flint variety. The frequent recovery of charred cupules may reflect the use of maize cobs as fuel.

Charcoal

As noted previously, most of the charcoal inspected was recovered during excavation, with only two samples originating from flotation samples (Table 12.3). Most of the specimens identified seem to represent structural wood rather than fuel, many of the pieces being quite large, and smaller ones

Table 12.2. Summary of Plant Taxa Recovered from AZ Q:1:114 Flotation Samples.

Structure 1

Taxon	Feature 2	Feature 3 PEFO-9155+	Feature 3 PEFO-9156+	Feature 3 PEFO-9156+
cf. Scirpus sp.	-	1	-	-
cf. Sporobolus sp.	-	-	-	1
Oryzopsis hymenoides	-	10	-	2
Chenopodium spp.	-	4	-	1
Atriplex sp.	-	10	-	2
cf. Eriogonum sp.	-	2	-	2
Boraginaceae	-	10	-	-
Lappula cf. Redowskii	-	66	-	-
Plantago sp.	-	10	-	1
Euphorbia cf. glyptosperma	-	-	1	1
Opuntia sp.	-	-	-	1
Zea mays	2c*	1c*	1c*	-

Structure 2

Taxon	Posthole A, B	Feature 11	Feature 14	Feature 15
Oryzopsis hymenoides	48	60(2*)	-	-
Chenopodium sp.	-	2*	-	-
Atriplex sp.	-	1	-	-
Plantago sp.	1	1	-	-
Zea mays	-	-	3c*	2c*

+ vessel contents
* charred
c cupule(s)

often appearing to be fragments of the same piece. Almost 93 percent of the identified pieces represent the *Populus-Salix* (cottonwood-willow) category. Although sometimes distinct, the wood structure of the two taxa often overlaps making positive identifications between the two difficult. In this case, most of the wood assigned to this category appears to be cottonwood. Cottonwoods probably were available along sections of nearby washes (particularly Cottonwood Wash) and seem to have served as the major architectural, and perhaps fuel source.

Juniper was more common in Structure 1, primarily from different levels of the fill. This may indicate that it too served primarily as structural material. Juniper is a longer lasting wood and more resistent to insect depredation than cottonwood; its relative scarcity in relation to cottonwood suggests that it was not readily available. The only other type of charcoal noted was saltbush (*Atriplex* sp.), a local shrub that probably served as a fuel source. Its presence within the disturbed contents of Vessel 3, Structure 1 is difficult to interpret given the disturbed nature of the contents. Shrub charcoal is frequently recovered from archaeological contexts, particularly hearths, and seems to represent the use of local, abundant fuel sources.

Table 12.3. Identified Charcoal Recovered from AZ Q:1:114.

Structure 1

Provenience	C/F	*Populus-Salix*	*Juniper*	*Atriplex*	Unknown	Total
Upper fill (PEFO-9250)	C	2	4	-	-	6
Upper fill (PEFO-9258)	C	17	3	-	-	20
Floor fill (PEFO-9249)	C	10	-	-	-	10
Floor fill (PEFO-9253)	C	9	-	-	1	10
Floor (PEFO-9255)	C	25	-	-	-	25
Feature 3 (PEFO-9274)	F	7	1	2	-	10
Feature 4 (PEFO-9254)	C	10	-	-	-	10
Total		80	8	2	1	91

Structure 2

Provenience	C/F	*Populus-Salix*	*Juniper*	*Atriplex*	Unknown	Total
Floor fill (PEFO-9260)	C	10	-	-	-	10
Floor fill (PEFO-9261)	C	7	-	-	-	7
Floor fill (PEFO-9264)	C	15	-	-	-	15
Floor (PEFO-9263)	C	20	-	-	-	20
Posthole A (PEFO-9259)	C	4	-	-	-	4
Feature 11 (PEFO-9276)	F	15	-	-	-	15
Feature 12 (PEFO-9262)	C	8	1	-	-	9
Total		79	1	-	-	80

C/F Charcoal/Flotation Sample

Discussion

Botanical remains recovered from AZ Q:1:114 were dominated by unburned specimens that were probably introduced relatively recently to the archeological deposit through insect and rodent activity. Although two vessels from Structure 1 yielded many seeds and a variety of taxa, most of the specimens seem to be post-occupational contaminants rather than stored remains. With the exception of scattered maize cupules, none of the remains from Structure 1 were charred. Structure 2 also contained scattered, charred maize cupules, as well as the charred seeds of ricegrass and goosefoot in a bell-shaped pit (Feature 11).

The few charred remains recovered suggest a use of local wild resources as well as domesticated crops, represented here by scattered maize cob fragments. The two wild resources that probably served as food sources were goosefoot and Indian ricegrass, which provide edible seeds from early (ricegrass) to late (goosefoot) summer. Maize generally ripens in the fall, although gathering of green maize could take place in the late summer.

Charcoal identification revealed an unexpectedly high proportion of cottonwood-willow when compared to other available resources. Many of the specimens inspected were large chunks that may well have represented structural remains, although small pieces from flotation samples also were predominantly cottonwood-willow. If this indicates the use of this category for fuel as well, it suggests that cottonwood-willow was readily available.

Although several Basketmaker sites have been excavated in the region, very few have yielded any botanical information. Charred maize cobs were recovered from the Flattop Site (Wendorf 1953).

The presence of maize, as well as trough metates, led Wendorf to hypothesize a subsistence pattern based on a combination of hunting-and-gathering and agriculture. Structural remains included juniper and perhaps cottonwood, and the remains of reeds also were found.

Evidence from Basketmaker sites in the Zuni area indicates the use of both maize and wild resources, most of which would be available in the AZ Q:1:114 area (Table 12.4). Analyses by Ruppé (1988, 1990) of samples from three Basketmaker sites duplicate the exploitation of goosefoot and ricegrass, but also indicate the use of other annuals such as members of the mustard family (Cruciferae), potato family (Solanaceae), and composite family (Compositae). Maize was recovered from two of the three sites. Charcoal remains reflect a use of local resources, which, because the sites are located at a higher elevation, represent primarily coniferous taxa.

The botanical remains recovered from AZ Q:1:114 are consistent with traditional views of Basketmaker subsistence and with botanical data retrieved from contemporary sites. It appears that the site inhabitants utilized the local plant communities for food resources, fuel, and construction materials. Domesticated crops, such as maize, also served as an economically important food source that may have provided a more consistent subsistence base than wild resources alone.

Table 12.4. Comparison of Charred Taxa Recovered from AZ Q:1:114 and three Basketmaker sites near Zuni, New Mexico.

	AZ Q:1:114	NM:12:K3:201[1]	NM:12:K3:202[1]	NM:12:K3:26[2]
Flotation				
# samples	8	5	5	2
Graminae	-	+	-	-
Oryzopsis hymenoides	+	+	+	-
Zea mays	+	+	+	-
Chenopodium	+	+	+	+
Amaranthus	-	+	+	-
Cheno-ams	-	+	-	-
Cleome-Polanasia	-	+	-	-
Cruciferae	-	-	+	-
Lepidium	-	-	+	-
Solanaceae	-	-	-	+
Compositae	-	+	-	-
Charcoal				
# samples	14	5	5	2
Unk. Conifer	-	+	+	+
Pinus	-	+	-	-
P. edulis	-	+	+	+
Picea	-	+	-	-
Pseudotsuga	-	+	-	-
Juniperus	+	+	+	+
Populus-Salix	+	+	+	-
Quercus	-	+	-	-
Atriplex	+	-	-	-

1 Ruppé 1989
2 Ruppé 1990
+ present in collection

Chapter 13
Pollen Analysis
Suzanne K. Fish

Eight pollen samples were processed from Sivu'ovi (AZ Q:1:114 [ASM]), including one from the modern ground surface, two from shovel tests, and five from structures. Three samples were from Structure 1, one from floor fill and two from vessels in Feature 1 (a storage pit). Within Structure 2, one sample was from floor fill and the other was from the fill of Feature 19, a pit covered with a sandstone slab. Analysis of pollen was undertaken to provide additional data, beyond that indicated by macrobotanical remains, on paleoenvironmental conditions and prehistoric subsistence at Sivu'ovi.

Methods

Lycopodium spore tracers were added to 60 cc of sediment in order to monitor the extraction procedure. Dilute hydrochloric acid was used for deflocculation. A swirl and timed settling rate as described by Mehringer (1967:136-137) was used initially to separate polleniferous materials from the heavy fraction. Heavy liquid flotation with zinc bromide of 2.0 density further reduced the sample matrix. Residual silicates were then removed with hydrofluoric acid. A final treatment with potassium hydroxide removed organic detritus. The extract was mounted in glycerol for routine examination at a microscope power of 600X.

A standard sum of 200 pollen grains, exclusive of cultigen types, was identified for each sample, and serves as the basis of percentage calculations in Table 13.1. This sum has been shown to adequately register distributions of representative pollen from Southwestern vegetation (Martin 1963:30-31). Cultigens were tabulated in addition to the standard sum in order to avoid percentage constraint of types more indicative of environmental conditions. Cultigen types are presented in Table 13.1 as the number of grains encountered during completion of standard sum of all other types, and can be compared among samples on that basis. Maize was the only cultigen pollen identified in this analysis.

After completion of the tabulation, additional material was scanned at a lower magnification to detect rare types. Pollen types found only by scanning are indicated by a plus sign (+) in Table 13.1. Large aggregates of six or more grains are also noted by an asterisk (*) following the percentage or number of the type. Because clusters would be less efficiently transported by wind than single grains, the presence of aggregates is likely when plant sources are immediate to the sampling locus. Aggregates are therefore useful evidence in evaluating introduction of pollen by human activity.

Results

Environmental Implications

The sample from the modern site surface (see Table 13.1) provides a baseline pollen assemblage from current vegetation that has not been subjected to residential or agricultural disturbance. Both it and the prehistoric samples exhibit pollen distributions typical of xeric, open, scrub dominated landscapes in Northern Arizona (Hevly 1968; Gish 1982). Arboreal types account for just over 40 percent of the modern sample, with pine (*Pinus*) and Juniper (*Juniperus*) more abundant than oak (*Quercus*). A substantial proportion of pine pollen in particular may be blown from distant sources. Juniper is higher in the modern sample than in the archeological ones, suggesting more scattered or distant trees at the time of occupation. Removal of nearby trees for construction or firewood, as well as environmental factors, might have contributed to lower amounts of juniper pollen in the past. Alternatively, Stewart (1980) suggests that the invasion of juniper into grassland areas is due in part to overgrazing in historic times.

Nonarboreal pollen is composed primarily of types from the sunflower family (Compositae), chenopods and amaranths (Cheno-ams), and grasses (Gramineae) to a lesser extent. The first category is divided among bur sage and related species (*Ambrosia*-type), sagebrush (*Artemisia*), and a variety of other shrubby or herbaceous Compositae genera (high spine Compositae). Pollen of the type produced by bur sage is more abundant in most of the prehistoric samples than in the modern one. These differences may reflect climatic or other environmental factors diverging from modern counterparts during the Basketmaker occupation. Bur sage species are sometimes weeds on cultivated land (Agricultural Extension Service 1958:258), and higher *Ambrosia*-type pollen in the archeological proveniences could result from agricultural disturbance.

Higher Cheno-am values than in the modern sample occur in a majority of the prehistoric samples along with several instances of aggregates. This pollen type includes both shrubs such as saltbush and herbaceous species that colonize culturally disturbed habitats. The edible seeds and greens of many species are also likely to have been transported into site proveniences as resources. Shovel-test samples in areas of suspected agricultural activity produced higher Cheno-am frequencies than at present, suggesting the former presence of weedy species. Pollen of *Sarcobatus* (greasewood) can be distinguished morphologically from that of other chenopods. It occurs in small amounts in the modern and archeological samples.

Archeological Contexts

Shovel tests were made in an agriculturally promising portion of the site that receives natural drainage and contains deep sandy clay soil. Two samples from a depth of about 25 cm are both marked by relatively high Cheno-am values. The sample from N140/E135 yielded aggregates. In the second sample, maize pollen was seen in the scanning of additional material after tabulation of 200 pollen grains. Both lines of evidence are suggestive of previous cultivation, but do not constitute unequivocal proof. It is also possible that food debris was deposited in areas away from features in the site environs.

The sample from the floor fill of Structure 1 produced the most varied resource pollen record, probably reflecting midden inclusions that may post-date occupation of the feature. Maize pollen was seen in scanning. Cheno-am pollen occurred in high quantities and large aggregates, as would be most likely with use of young herbage as a vegetable. Percentages of other pollen types were correspondingly reduced. Aggregates were present of a Compositae type with high spines, perhaps sunflower or a number of other utilized species. Grass and wild buckwheat (*Eriogonum*) pollen grains also were encountered in aggregates. Grasses provide seeds and a wide range of craft materials; Indian ricegrass (*Oryzopsis*) was recovered in flotation at the site. Wild buckwheat stems and seeds have been eaten by Southwestern aboriginal groups (see, for example, Wyman and Harris 1951; Bean and Saubel 1972).

Two of the intact vessels from Feature 3 of Structure 1 (a storage pit) were sampled. Contents of vessel PEFO-9156 were marked by the highest amount of maize pollen in any site sample. Vessel PEFO-9155 yielded a lower amount. Both vessels contained pollen of beeweed (*Cleome*), a weedy annual so prized by the Hopi that they tolerated it in their fields to insure a continued supply (Whiting 1939:77-78). Beeweed greens were eaten and used to make paint (Robbins and others 1916:59). Markedly lower Cheno-am values in the vessels than the structure fill reinforce an interpretation of fill quantities as indicating a resources bias.

Maize pollen was not abundant in the floor fill of Structure 2, occurring only in scanning after sample tabulation. Cheno-am pollen was seen in aggregates. Numerous aggregates and relatively high frequencies identified grass as an important utilized plant. Beeweed pollen was present in the floor fill and in the fill of Feature 19 (a pit covered by a sandstone slab), which also contained maize pollen. A trace of yucca pollen in Feature 19 could have been introduced on stored plant products, but this amount cannot be confidently distinguished from a natural background level.

The occurrence of maize pollen in both structures and a shovel test at AZ Q:1:114 indicates a role as an important site resource. Beeweed is likely a utilized weed from agricultural fields according to Hopi analogy, however, chenopods or amaranths were found to be particularly abundant in the suspected agricultural locale. Resources identified by pollen include maize, chenopods or amaranths, grass, beeweed, wild buckwheat and possibly yucca, a level of diversity that could undoubtedly increase with further samples.

Table 13.1. Pollen Frequencies in AZ Q:1:114 samples.

Pollen type	Modern surface	N140 E135	N150 E145	Structure 1 floor fill	Vessel[a] PEFO-9156	Vessel[a] PEFO-9155	Structure 2 floor fill	Structure 2 Feature 19
Artemisia	4.5	1	2	1.5	3	1	4	2.5
Ambrosia-type	8	12.5	16	9.5	27.5	21	25.5	23.5
High-spine compositae	11	3	5.5	3[b]	8	6.5	2.5	7
Cheno-am	21	44.5[b]	32.5	68.5[b]	30	23	28.5[b]	33
Gramineae	6.5	1	4.5	5[b]	4	7.5	26[b]	8
Sarcobatus	2.5	-	.5	-	-	1	.5	-
Cleome	-	-	-	-	2	-	1	+
Eriogonum	1.5	2	3	2[b]	.5	3.5	+	4
Sphaeralcea	-	-	.5	-	-	1	-	+
Rosaceae	.5	-	-	-	-	-	-	-
cf. Leguminaoae	.5	-	-	-	-	.5	-	-
Yucca	+	-	-	-	-	-	-	.5
Ephedra	+	.5	1	-	-	1	+	-
Pinus	17.5	23	18.5	5	9	14.5	7	10.5
Quercus	3.5	2	2.5	1	3.5	2.5	.5	2
Juniperus	21	8.5	9.5	2.5	8.5	12	2	4.5
Onagracraceae	-	.5	-	-	-	-	-	-
Indeterminate	2	1.5	4	2	5	3.5	2.5	3.5
Zea[c]	-	-	+	+	13	4	+	2

a. Feature 3, Structure 1
b. indicates a pollen type occurring in aggregates of six or more grains.
c. number of grains; not included in percentage calculations.

+ indicates a pollen type encountered only in scanning of additional material after completion of 200 grain standards.

Chapter 14
Vertebrate Remains
William B. Gillespie

The 1989-1990 excavations at Sivu'ovi (AZ Q:1:114 [ASM]) produced only 12 bone specimens, two from Structure 1 and 10 from Structure 2. Despite the small number, at least five taxa are represented: black-tailed jackrabbit (*Lepus californicus*), Gunnison's prairie dog (*Cynomys cf. C. gunnisoni*), white-footed mouse (*Peromyscus* sp.), and unidentified specimens of turtle and artiodactyl. Other unidentified specimens include bone fragments of small mammal (rabbit-sized), small vertebrate (small mammal or nonmammal), and large mammal (artiodactyl-size). Frequencies of the taxa recovered from the site are given in Table 14.1. With one exception, the turtle, the recovered bones are all of animals presently found in the area.

Results

Turtle

The turtle specimen, found in Structure 2, includes six very small, freshly broken pieces of three marginal elements of the carapace. Total length of the entire specimen is less than 3 cm and all fragments are calcined white or gray, indicating use by humans.

Not enough of the bone and scute suture patterns is preserved to allow positive identification. No turtles are presently known from this portion of the Little Colorado-Puerco River Valley. Published sources (for example, Lowe 1964; Stebbins 1966) indicate that confirmed records of native turtle populations are lacking for the Little Colorado Valley, however, recent research by Cecil Schwalbe, University of Arizona herpetologist, has confirmed the existence of a presumably native population of painted turtle (*Chrysemys picta*) near St. Johns, 60 km to the southeast. It is likely that this species, and perhaps others, was more widespread along the Little Colorado and Puerco Rivers prior to the extensive habitat modifications of the past 100 years (C. Schwalbe, personal communication, 1990). Size and morphology of the recovered specimen's are compatible with this species, and it is the most likely source. Both Sonoran mud turtle (*Kinosternon sonoriense*) and western box turtle (*Terrapene ornata*) are more remote possibilities. The specimen does not appear to be from desert tortoise (*Gopherus agassizi*).

Turtles and tortoises were used by the historic and protohistoric Hopi, frequently as rattles worn on dancers' legs in ceremonial dances. Beaglehole (1936) noted that the Hopi went on long-distance trips to obtain tortoises, a practice that has persisted to the present. At Awatovi, Olsen (1978) found several specimens of painted turtle shells in post-contact associations. Four painted turtle shells,

Table 14.1. Frequencies of Vertebrate Taxa Recovered at AZ Q:1:144.

	Structure 1		Structure 2			
Taxon	Floor	Fea. 3	Fill	Fea. 2	Fea. 11	Total
Lepus	-	-	-	-	2	2
Cynomys	-	-	-	1	-	1
Peromyscus	-	-	-	-	1	1
Unid. Turtle	-	-	-	1	-	1
Unid. Small Vertebrate	-	-	1	1	-	2
Unid. Small Mammal	-	-	-	1	-	1
Unid. Artiodactyl	1	-	-	-	-	1
Unid. Large Mammal	-	1	1	-	1	3
Total	1	1	2	4	4	12

apparently rattles, were found in association with a human burial. Olsen noted the present apparent absence of painted turtle from the Little Colorado drainage, and suggested that turtles may have been obtained through trade.

One other prehistoric occurrence of turtle from this region is a single artifact found at Puerco Ruin (Gillespie 1990). This artifact, presumably an ornament, is a shaped subrectangular section from the plastron of an unidentified turtle with a drilled hole in the center. Although unidentified, this specimen may also be from *Chrysemys picta.*

It is not clear whether the burned turtle specimen from AZ Q:1:114 represents use for food of a locally available species, or an ornamental or ceremonial usage of an item brought to the site from a considerable distance.

Other Taxa

The two jackrabbit bones from the site are a distal humerus and a second phalanx, both from Structure 2, Feature 11 (floor pit). The humerus has been charred and the phalanx damaged from weathering, indicative of exposure on the ground surface prior to burial.

The single prairie dog element from the site is a nearly whole ulna of a subadult individual (proximal epiphysis is partially fused).

The one mouse element from the site is a nearly complete half-mandible, including the incisor and the first two molars, from a small *Peromyscus*, the genus of white-footed mice. Tooth row alveolar length is 3.70 mm and first molar length is 0.82 mm. Size and morphology are comparable to specimens of *P. crinitus* (Canyon mouse), the smallest of four species of *Peromyscus* found in the Petrified Forest (Hoffmeister 1986). The recovered specimen is larger than compared examples of *Reithrodontomys megalotis* (Western harvest mouse), which also occur in the area. On the basis of bone color and appearance, this is the only specimen in the collection that is considered to be a post-occupational intrusion.

The four fragments of large mammal bone from the site (from four different excavation units) are all in the size range of artiodactyl long bones. One of these, from Structure 1, has been tentatively identified as being from an artiodactyl femur; others are scraps of unknown elements. All are thoroughly burned, either white or gray, and all are less than 3 cm in length.

Discussion

Perhaps the most notable attribute of the faunal assemblage from Sivu'ovi is its small size — only 12 small specimens. Despite this scarcity, several taxa are represented, including one animal, a turtle, that is no longer found in the site vicinity.

Another noteworthy characteristic of this small assemblage is the predominance of burned bone remains; 9 of the 12 specimens are burned. Eight are calcined white or gray from intense heating, such as from discard into a fire pit, and one (a jackrabbit bone) is black from charring. This suggests that most of the bones preserved at the site are foodstuff discards. The only specimen thought to be noncultural in derivation is the single mouse bone.

The predominance of burned specimens, and the paucity of unburned bones, suggest that soil conditions may be unfavorable for the preservation of unburned bone. A primary factor may be the sandy texture of sediments. High permeability and high porosity of sand-size sediments means buried bones are exposed to oxygen and to repeated wetting and drying. These conditions promote micro-organism activity and destruction of the organic portions of bone (the collagen). Burned specimens, where volatile organic components have been driven off, may be relatively immune to further decomposition from microorganism action. Site sediments are alkaline, suggesting that inorganic chemical weathering is not a major factor.

Chapter 15
Chronometrics

A broad range of dating techniques was employed, with varying degrees of success, to determine the temporal placement of Sivu'ovi (AZ Q:1:114 [ASM]). The results of artifact cross dating, radiocarbon dating, obsidian hydration analysis, and archaeomagnetic dating are presented. Unfortunately, no wood suitable for tree-ring dating was encountered during the present work. To provide further information on the chronological placement of Adamana Brown Ware, charcoal samples previously collected by Wendorf (1951, 1953) from the Flattop Site also were submitted for radiocarbon dating.

Cross Dating

Relative dating at the site is provided by comparing the abundant ceramics, other artifacts, and architecture at Sivu'ovi with other sites in the region. It should be kept in mind, though, that cross-dating at Sivu'ovi is somewhat tenuous. Not only is the Basketmaker II period poorly dated, but even the earlier Archaic and later Pueblo period assemblages in the Petrified Forest region do not fit well into established chronologies (Jones 1987; Wells 1989).

Ceramic Dating

Of the ceramics recovered during excavation and controlled surface collection, all, save one intrusive Pueblo sherd, were Adamana Brown. The problems with the dating of Adamana Brown Ware have been discussed above in Chapter 4 and will not be restated here. Suffice to say that available evidence indicates that Adamana Brown Ware was manufactured prior to A.D. 600 or 500 (Jones 1987:197). Twenty-nine Pueblo period ceramics collected during the general surface inspection represent 12 different Pueblo II-III types (see Table 9.2), which indicate a later reuse of the site area between A.D. 1000 and 1200.

None of the coil-and-scraped sand- and rock-tempered brown wares (including some Alma Plain) noted by Wendorf (1953) at the Flattop Site were recovered in the limited work at Sivu'ovi. The scraped wares may have been temporally or functionally distinct from Adamana Brown Ware, or the Flattop Site and Sivu'ovi may have participated in different interaction networks.

Other Temporally Diagnostic Artifacts

The few projectile points (n=6) recovered from Sivu'ovi are typical late Archaic-early Basketmaker types. Four side-notched points with straight bases fit Rozen's Type 4 subtype (1981:191), which has been found elsewhere in Basketmaker II and late Archaic contexts. A unique stemmed point, which has been reworked, originally may have been a Type 4 point as well. One concave base point with shallow side indentations fits Rozen's Type 7 (1981:194), which has been found in late Archaic contexts. But, because all the points were recovered from the surface, their temporal association with the main occupation at Sivu'ovi or with Adamana Brown Ware ceramics is not unambiguous.

Although numerous formally retouched tools were present at Sivu'ovi, debitage analysis suggests that expedient flake technology also was prevalent at the site. Although more properly seen as an indicator of sedentism than as a relative dating tool, expedient flake technology is typical of, and in some instances considered indicative of, Pueblo period sites (Perry and Kelly 1987). At the same time however, the flaked stone assemblage at Sivu'ovi had a much higher percentage of formal tools and flakes with faceted platforms (both considered "early" traits) than later Pueblo period sites.

Table 15.1. Radiocarbon Results.

Provenience	Lab number	Material	No. rings	Age
Flattop Site, House D, log 5	WSU-4188	juniper	30±	1590±95 B.P.
Flattop Site, House D, log 7	WSU-4190	juniper	50	2090±70 B.P.
Flattop Site, House D, log 11	WSU-4193	juniper	150	1530±90 B.P.
Flattop Site, House H, cist 1	WSU-4189	*Populus-Salix*	2	2040±100 B.P.
Flattop Site, House H, log 5	WSU-4191	*Populus-Salix*	5	1830±70 B.P.
Flattop Site, House H, log 5	WSU-4192	*Populus-Salix*	5	1740±150 B.P.
Sivu'ovi, Structure 1, floor	WSU-4219	*Populus-Salix*	>10	1900±95 B.P.
Sivu'ovi, Structure 1, feature 4	WSU-4220	*Populus-Salix*	>10	1950±95 B.P.
Sivu'ovi, Structure 2, feature 11	WSU-4221	*Populus-Salix*	10	1830±95 B.P.
Sivu'ovi, Structure 2, feature 11	WSU-4222	*Populus-Salix*	13	1700±100 B.P.
Sivu'ovi, Structure 2, feature 6	WSU-4223	*Populus-Salix*	6	1920±90 B.P.
Sivu'ovi, Structure 3, fill	WSU-4224	*Populus-Salix*	8	2280±90 B.P.

Table 15.2. Calibrated Radiocarbon Dates.

Provenience	Lab number	1 sigma range	2 sigma range
Flattop Site, House D, log 5	WSU-4188	A.D. 355 - 562	A.D. 230 - 640
Flattop Site, House D, log 7	WSU-4190	342 B.C. - 2	360 B.C. - A.D. 54
Flattop Site, House D, log 11	WSU-4193	A.D. 419 - 638	A.D. 262 - 660
Flattop Site, House H, cist 1	WSU-4189	199 B.C. - A.D. 58	363 B.C. - A.D. 208
Flattop Site, House H, log 5	WSU-4191	A.D. 76 - 317	A.D. 5 - 382
Flattop Site, House H, log 5	WSU-4192	A.D. 80 - 430	91 B.C. - A.D. 610
Sivu'ovi, Structure 1, feature 4	WSU-4219	86 B.C - A.D. 228	166 B.C. - A.D. 341
Sivu'ovi, Structure 1, feature 11	WSU-4220	91 B.C. - A.D. 131	199 B.C. - A.D. 317
Sivu'ovi, Structure 2, feature 11	WSU-4221	A.D. 66 - 324	89 B.C. - A.D. 410
Sivu'ovi, Structure 2, feature 6	WSU-4222	A.D. 120 - 390	50 B.C. - A.D. 650
Sivu'ovi, Structure 2, feature 6	WSU-4223	88 B.C. - A.D. 212	167 B.C. - A.D. 322
Sivu'ovi, Structure 3, fill	WSU-4224	406 - 311 B.C.	756 - 117 B.C.

Architecture

The rubble mounds, apparently one- to two-room field houses, are associated with the Pueblo occupation of the site and are not considered further here. Pit structures generally are considered a Basketmaker period trait, but later use of pit structures is not uncommon in the region (Adams 1989; Harrell 1973).

Bullard (1962:112-172) reviewed existing data and noted the following trends in Basketmaker pit houses in the Anasazi region. During the Basketmaker II period, pit houses were shallow and circular, with walls reinforced with sandstone slabs. Floors contained few hearths, but had numerous large storage pits. During the Basketmaker III period, pit houses became deeper, oval to rectangular in shape, and apparently larger (12-16 square meters in size). Antechambers, partition walls, benches, and fire pits were common. Although there were a variety of floor features, less floor space was devoted to storage pits. Recent data from the Zuni area (Varien 1990) suggest that Basketmaker II pit structures there fit this pattern, being small (less than 2.3 m in diameter), shallow, and circular. Slab-reinforced walls are common in the Zuni examples, and one structure had a slab-paved floor. No hearths were encountered.

The two Sivu'ovi houses best fit the Basketmaker II style. Both have large floor pits, and most of the floor area of Structure 2 was devoted to pits. Although partially eroded, both appear to be circular to oval in shape and shallow. Structure 2 had no hearth, and a possible hearth in Structure 1 may have been used as a "heating pit," similar to those common at Basketmaker II sites in southwestern Colorado (Morris and Burgh 1954). Although the structures are large (3.5 m and 5 m largest maximum dimension) compared to those at Zuni and the Flattop Site, size differences could reflect differences in function, seasonality, or even construction constraints. For example, the Flattop houses had been excavated into bedrock, which certainly could inhibit house size; further, one house at the Flattop Site, a large "community" house (House N; Wendorf 1953), is roughly the same size as the Sivu'ovi examples.

Radiocarbon Dating

Twelve charcoal samples were submitted for radiocarbon analysis, including six from Sivu'ovi and, for comparison, six from the Flattop Site.

Samples from the Flattop Site were selected from curated specimens by Jeff Dean of the University of Arizona Tree-ring Laboratory. Three samples each from two structures (House D and H) were selected. To eliminate the possibility of "old wood" (Schiffer 1986) affecting the dates, the samples were selected from structural wood and included only the outer portion of logs, as indicated by bark or other evidence. All three samples from House D (Wendorf 1953; also called House 4 [Wendorf 1950]) were juniper and all of the samples from House H (also called House 8) were *Populus-Salix*. Both structures had been burned and had numerous artifacts on the floor, including five Adamana Brown vessels each (see Table 4.1).

The Sivu'ovi samples (all *Populus-Salix*) were taken from three structures: two from Structure 1, three from Structure 2, and one from an unexcavated structure eroding out in the central portion of the site (Structure 3; see Figure 6.1). Outer portions of what appeared to be structural material were selected for analysis. Structures 1 and 2 had Adamana Brown Ware vessels or sherds associated with the floor and in the fill. Although the artifact assemblage of Structure 3 is not known, the structure's surface indications, such as a perforated slab (see Figure 11.4) and upright wall slabs, are the same as those of structures 1 and 2.

Charcoal samples were submitted to the Radiocarbon Laboratory at Washington State University, Pullman. The results of these assays are presented in Table 15.1. The laboratory dates were converted to calendar dates using the University of Washington Quaternary Isotope Laboratory's

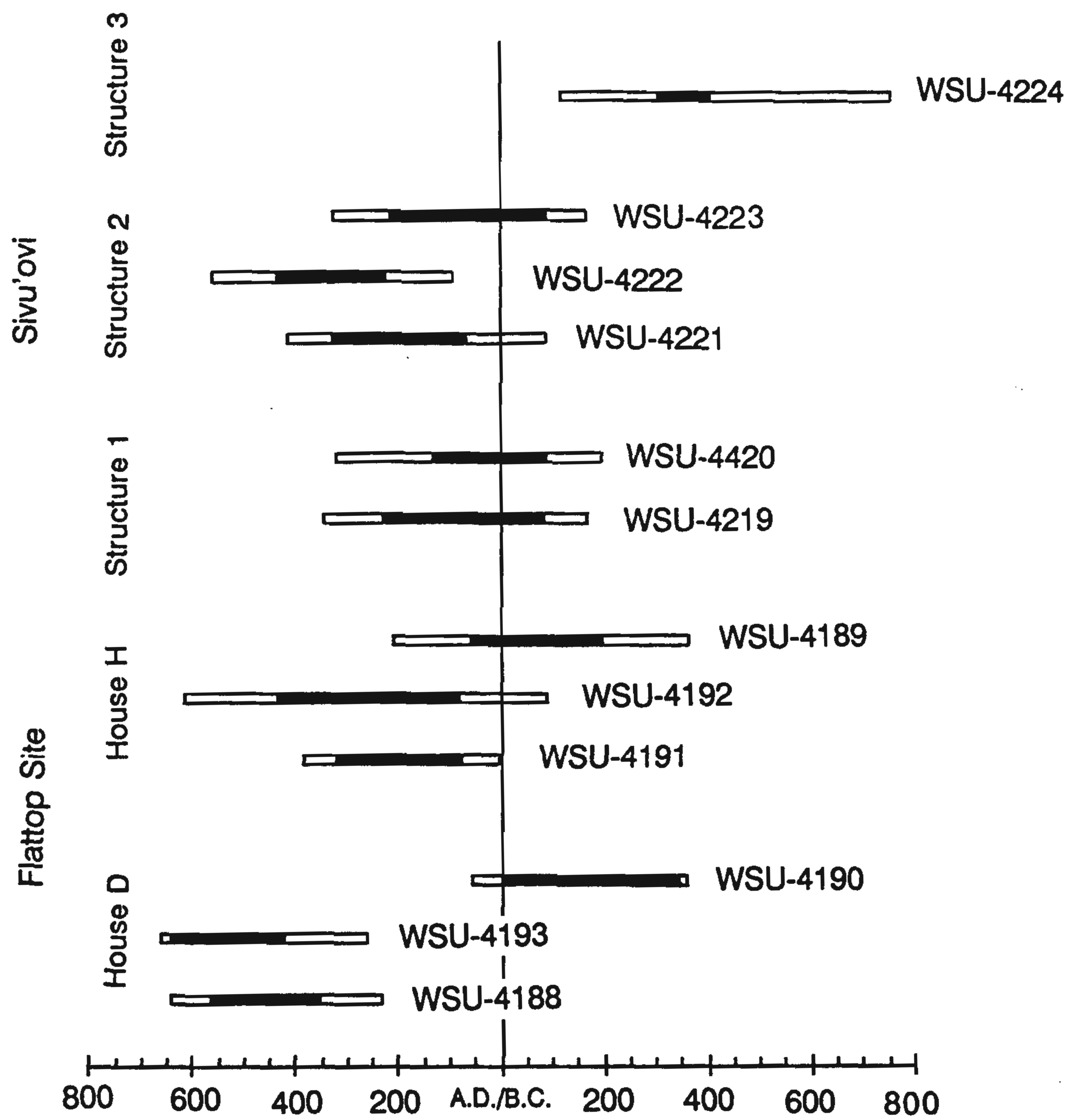

Figure 15.1. Calibrated radiocarbon dates, showing one and two sigma ranges.

computer calibration program (1987, version 1.3). These results are shown in Table 15.2 and Figure 15.1. The dates for each of the structures were then averaged (see Long and Rippeteau 1974) to provide a refined date for each structure. At a one sigma range, House D at the Flattop Site dates to between A.D. 130 and 318 and House H to between A.D. 35 and 215. At Sivu'ovi, Structure 1 dates to between 86 B.C. and A.D. 131, and Structure 2 to between A.D. 82 and 252. Structure 3, with one radiocarbon assay, dates to between 406 and 311 B.C. (Table 15.3, Figure 15.2)

Table 15.3 Averaged Radiocarbon Dates.

Provenience	Number	1 sigma range	2 sigma range
Flattop Site, House D	3	A.D. 130 - 318	A.D. 70 - 376
Flattop Site, House H	3	A.D. 35 - 215	86 B.C. - A.D. 250
Sivu'ovi, Structure 1	2	86 B.C. - A.D. 131	93 B.C. - A.D. 230
Sivu'ovi, Structure 2	3	A.D. 82 - 252	A.D. 33 - 260
Sivu'ovi, Structure 3	1	406 - 311 B.C.	756 - 117 B.C.

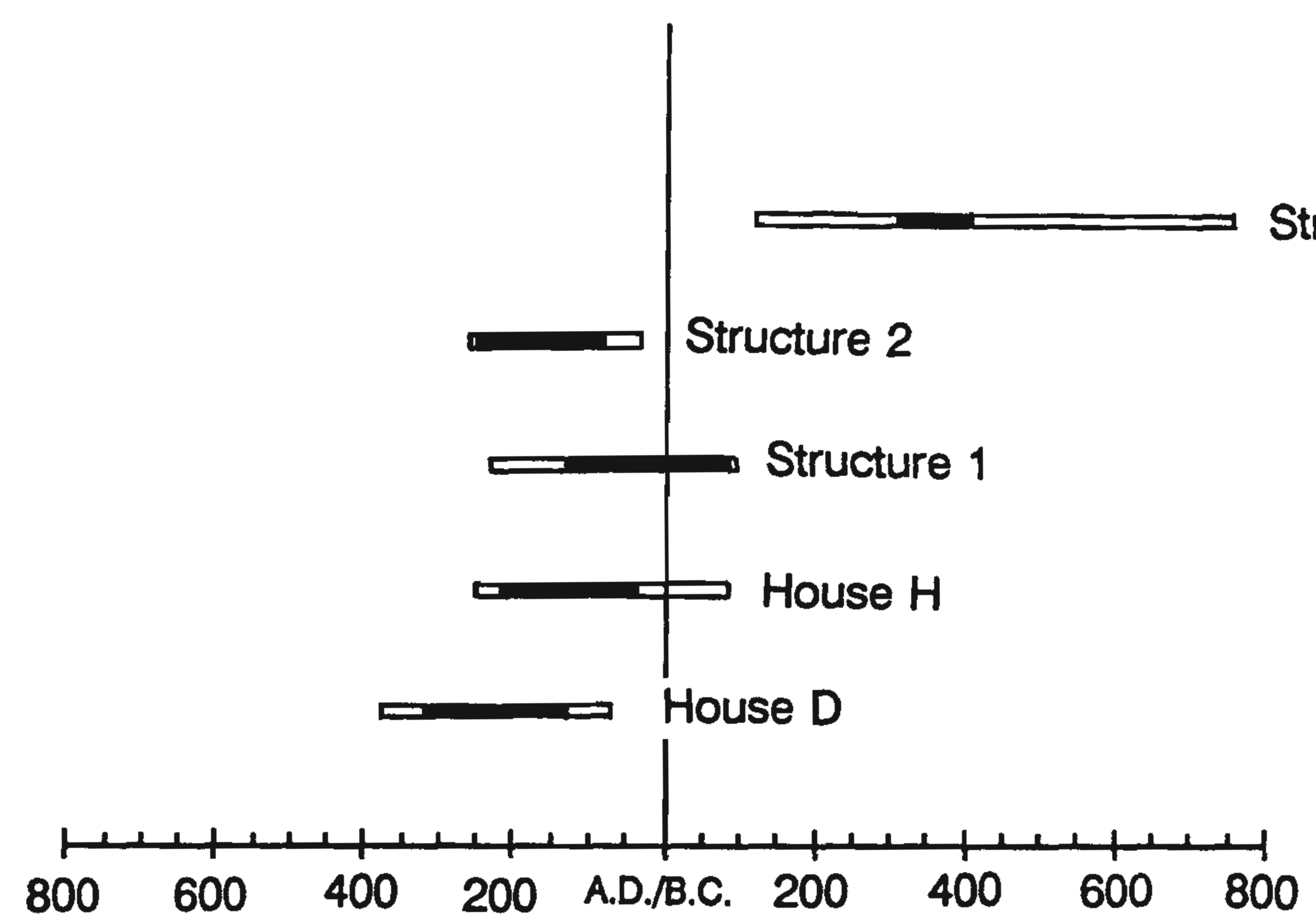

Figure 15.2. Averaged radiocarbon dates for structures, showing one and two sigma ranges.

Obsidian Hydration Dating

Obsidian hydration dating, widely used throughout the western United States, has only recently come into common use in the Southwest. Numerous variables, such as chemical composition of the glass and effective hydration temperature (EHT), can affect the accuracy of the method (Jackson 1984). But EHT can be somewhat accounted for and source-specific curves have been developed. Notable applications of obsidian hydration dating in the northern Southwest have been done by Jennings

(1971), Schroedl (1988), and Cartledge (1986) at Archaic period sites. The little work at Pueblo sites is summarized by Findlow and others (1975; Findlow 1977), who used those data to construct the first source-specific hydration rate for Government Mountain obsidian. More recently, Michels (1973) developed a linear rate for Government Mountain obsidian based on induced hydration experiments.

Only one piece of obsidian was recovered at Sivu'ovi, during the controlled surface collection. Chemically (XRF) sourced to Government Mountain (Appendix B), it had two hydration bands, 1.9 and 3.7 microns (Appendix E). Using the Michels rate these bands convert to dates of circa A.D. 1100 and A.D. 300; using the Findlow rate they convert to circa A.D. 1550 and 150. Either rate could be used in making inferences about the prehistory of Sivu'ovi, and both the A.D. 150 and A.D. 300 date fall within the time span suggested by the radiocarbon dates. The Michels rate provided the best fit with other data at nearby Puerco Ruin (Burton 1990), and the A.D. 1100 date of the second rim is more consistent with the date suggested by the Pueblo period ceramics. Using Michel's rate, one could argue that the flake was removed from an abandoned Basketmaker II tool, when it was scavenged and reworked by later Pueblo occupants of the site area.

Archaeomagnetic Dating

Two series of archaeomagnetic samples were collected, one from each excavated structure (Appendix F). Structure 1 specimens were collected from a possible hearth (Feature 1) and from oxidized sand around Feature 5, a slab-covered storage pit. At Structure 2, specimens were collected from Feature 14 (a reinforced posthole?), from patches of burned floor, and from burned daub in the floor fill. The results from both structures were poorly clustered and unpatterned, and neither sample was datable. It appears that the samples were not suitably magnetized.

"Reid Measure"

The Reid Relative Room Abandonment Measure (Schiffer 1976) can be used to infer the nature of the occupation at Sivu'ovi. Although developed for Pueblo sites, it may be applicable to other site types as well. While a site may have been occupied over a long period of time, individual pit houses were not (Cameron 1990). When rot, fungus, and insect infestation made one pit house uninhabitable, the occupants could have constructed another nearby. Structures abandoned early in the span of site occupation would contain few artifacts on the floor (de facto refuse) because the artifacts have been scavenged and reused. An abandoned structure could have been used as a trash dump and a high density of secondary refuse in fill would indicate a structure abandoned during occupation. The Reid Measure calculates the ratio of the frequency of floor artifacts to fill artifacts, with the assumption that the lower the number of floor artifacts and the higher the number of fill artifacts the earlier the structure was abandoned. Application of the measure to data from the Flattop Site suggests that the pit houses there were probably not all abandoned at the same time (see Chapter 4). Radiocarbon dating of the two Flattop structures supports the Reid Measure; both indicate that House H was built and abandoned earlier than House D.

Data used in applying the Reid Measure to the two structures at Sivu'ovi are summarized in Table 15.4. Figure 15.3 charts the Sivu'ovi data and that of the Flattop Site (for comparison) using the number of restorable vessels on floors and Figure 15.4 uses the number of artifacts (including vessels) on floors. The Reid Measure for the two structures at Sivu'ovi indicates Structure 2 was abandoned early in the site occupation: there are few floor artifacts, and a moderate amount of artifacts in the fill, suggesting use as a trash dump. Structure 1, with more floor artifacts, and few fill artifacts, was abandoned later. This is not supported by radiocarbon data, however, which

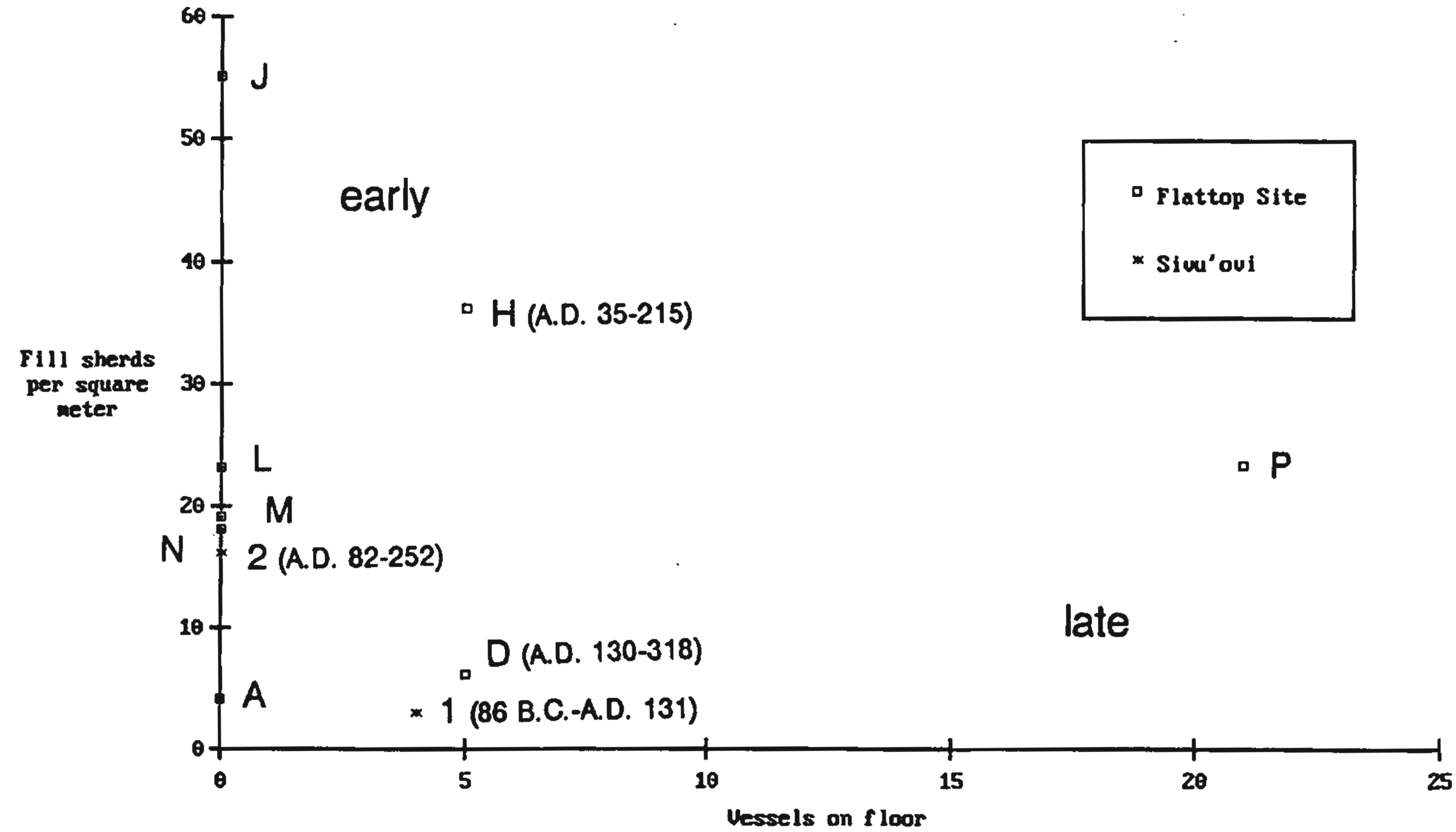

Figure 15.3. Application of the Reid Relative Room Abandonment Measure to Sivu'ovi and the Flattop Site using the number of vessels on the floor.

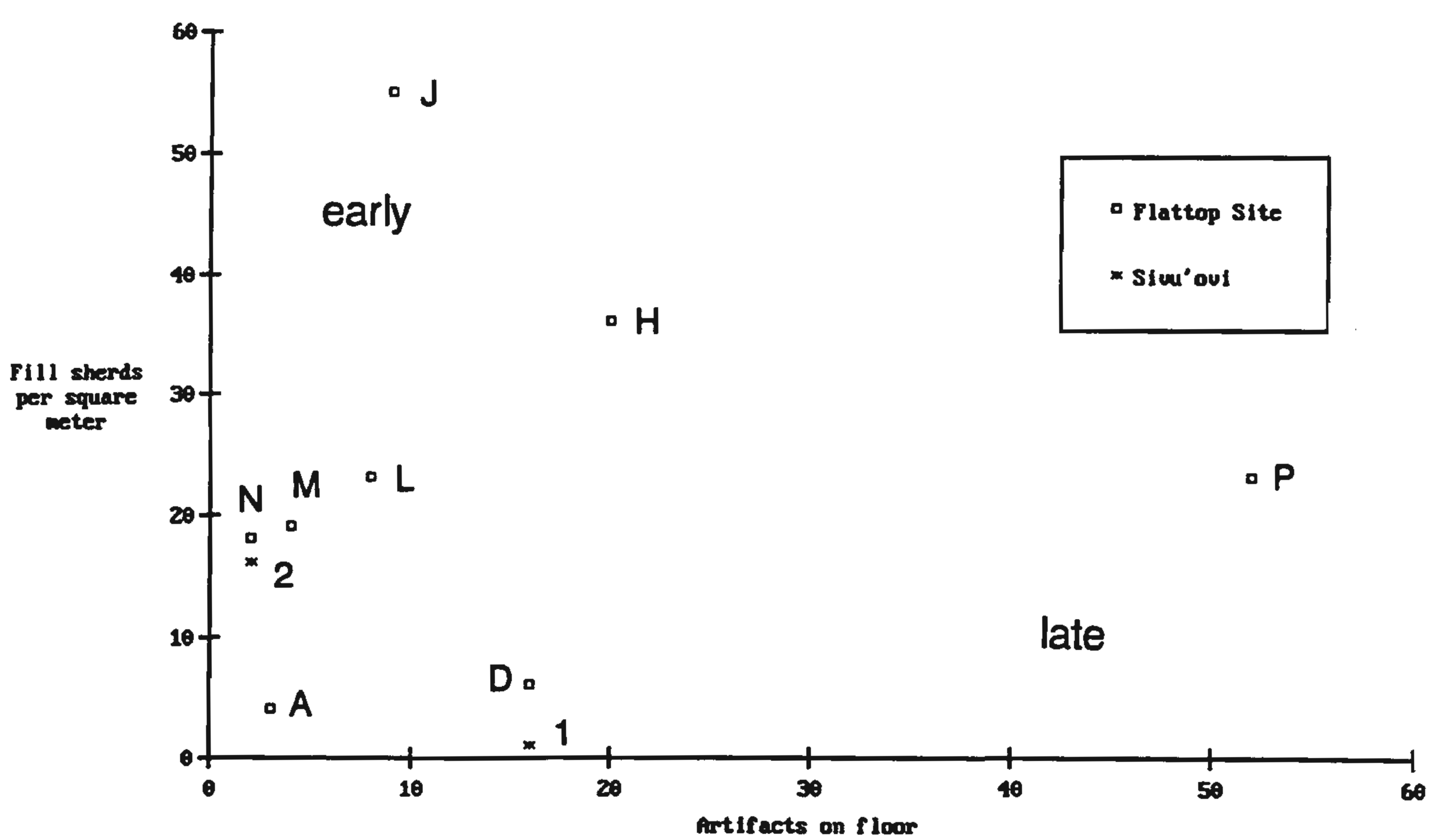

Figure 15.4. Application of the Reid Relative Room Abandonment Measure to Sivu'ovi and the Flattop Site using the number of artifacts on the floor.

indicated Structure 1 was constructed earlier. Although the disparity could be considered explicable with the normal vagaries or imprecision of radiocarbon dating, they may also reflect seasonal rather than complete abandonment of the site.

Discussion

Although the cross dating and obsidian hydration dating agree, the radiocarbon dates provide the most substantial chronometric data for Sivu'ovi. The radiocarbon evidence indicates the site was occupied before A.D. 300, although some use of the site may have been as early as 400 B.C. and possibly as late as A.D. 400. The early date was deduced for Structure 3, which may not be associated with Adamana Brown pottery. Most of the dates for the Flattop Site and Sivu'ovi overlap between A.D. 1 and 200.

These dates for the Basketmaker II occupation at Sivu'ovi, the Flattop Site, and for Adamana Brown Ware in general, are certainly not egregious, compared to other dated Basketmaker II sites with ceramics. Two sites in the Zuni area with brown ware ceramics similar to Adamana Brown were tree-ring and radiocarbon dated to the A.D. 400s (Varien 1990). The Bluff Site, with intrusive Adamana Brown Ware (see Chapter 4), was tree-ring dated to the A.D. 300s (Haury and Sayles 1947), and the Hay Hollow Site with "crude" brown ware pottery was radiocarbon dated to A.D. 200-250 (for a discussion of problems with these data, see Berry 1982:39-44). The chronometric data from Sivu'ovi and the Flattop Site do, however, help tie together and confirm previously inferred dates from less direct evidence, and provide an estimate for the potential time range for Basketmaker II sites of this type in the region.

Table 15.4. AZ Q:1:114 Excavation Summary (Structures).

Provenience	sherds per m²	restorable vessels	metates	manos	hammer-stones	misc. stone	flaked stone	proj. points	maize
Structure 1									
floor[a]	>1	4	3	3	2	7	120	-	X
fill[b]	2	-	-	-	-	-	25	-	-
Structure 2									
floor	1	-	1	-	-	-	5	-	-
fill[b]	16	1+	-	1	2	2	49	-	X

a. includes Feature 3 contents
b. includes feature fill
+ partial

Chapter 16
Summary and Conclusions

During 1989 and 1990, limited test excavations were conducted at Sivu'ovi (AZ Q:1:114 [ASM]), Petrified Forest National Park, Arizona. Sivu'ovi is a large (12-acre) Basketmaker II site consisting of the remains of over 45 pit structures. Also within the site boundary, but not tested as part of the current fieldwork, are several small field houses that date to a later occupation during the Pueblo period. Two eroding structures, two extramural units, and five shovel tests were excavated at the site and a systematic surface collection of artifacts in a 180 square meter area was conducted. Over the course of the excavations two extramural features were excavated and three main stratigraphic divisions were discerned. Over 3,600 artifacts, ecofacts, and other samples were collected, including four complete or fully restorable Adamana Brown vessels, a partially restorable Adamana Brown vessel, 1,072 sherds, over 2,600 flaked stone artifacts, 26 ground-stone artifacts, many and varied floral and faunal remains, and over 35 other artifacts and samples.

Abundant and varied cultural remains were recovered. Analysis included soil chemistry, pollen, macrobotanical, and faunal analyses, ceramic and flaked-stone classification, radiocarbon, archaeomagnetic, and obsidian hydration dating, and x-ray fluorescence sourcing of obsidian. The current project also allowed a reevaluation of data from the contemporaneous Flattop Site. These analyses were designed to address specific questions derived from the general research domains that have been developed for the Petrified Forest region (Jones 1987) regarding: chronology, economic and environmental orientation, regional interaction, and technological change. The following discussion is organized around each of these research domains, although in actuality they overlap; for example, none of the other questions can be addressed without an adequate chronological framework.

Chronology

The primary research question within the theme of culture history was to establish the temporal range of the site. Ceramics, other artifacts, and features (architecture) fit well with the few other Basketmaker II sites excavated in the region.

Radiocarbon dating indicates a pre-A.D. 300 date for occupation at both Sivu'ovi and the Flattop Site, perhaps as early as 300 B.C. at Sivu'ovi. Most of the 12 dates overlap at A.D. 1 to 200, however, which may be the best estimate for the Basketmaker II occupation at these two sites. These dates are the earliest yet for ceramics in the middle Little Colorado River region.

The Adamana Brown ceramics represent the most radical departure from the Archaic period, with chronometric data confirming that Adamana Brown ware is the first pottery type in the Petrified Forest area. The dates, although earlier than previously expected (see Chapter 4; Jones 1987:197), are not inconsistent with those for pottery-containing sites elsewhere in the region, such as at Zuni (A.D. 300s; Varien 1990), the Bluff Site (A.D. 300s; Haury and Sayles 1947), and the Hay Hollow Site (pre-A.D. 300; see Berry 1982). The Tumbleweed Canyon Site, however, dated to A.D. 225 and located 30 km southwest, contained pit houses and maize pollen, but no ceramics (Martin and others 1962).

Economic and Environmental Orientation

Pollen, floral, and faunal analyses indicate that the natural environment at the time of occupation of Sivu'ovi was similar to current conditions, with a few exceptions. First, the turtle remains and abundant cottonwood and willow (*Populus-Salix*) charcoal suggest nearby riparian areas had more consistent water. Second, pollen and floral remains indicate that there was less pinyon and juniper in the site vicinity prehistorically than today.

The evidence for wetter conditions at Sivu'ovi corresponds to data collected for the region as a whole. The period from 200 B.C. to A.D. 250 was marked by a high water table, soil aggradation, and high effective moisture, followed by a period with a low water table, soil degradation, and low effective moisture between A.D. 250 and 400 (Dean 1988:156; Euler 1988:194). Chronometric data suggest site use sometime between A.D. 1 and A.D. 300, perhaps begun in the wetter period and declining with drier conditions.

The ubiquity of maize in the floral and pollen samples, present in six out of seven of the pollen samples and five out of eight of the flotation samples, suggests a heavy dependence on maize. Storage of maize is indicated by abundant pollen in one of the vessels of the cache pit (Feature 3, Structure 1). An area of the site that was suspected of being an agricultural field based on topography may not have been so: soil chemistry suggests trash disposal, and the pollen results were ambiguous. Fields more likely may have been located east of the site on the floodplain along Jim Camp Wash and Cottonwood Wash, following a pattern noted by Jones (1987).

Most of the ground stone is consistent with maize production. Over 80 percent of the metates at the site are the trough type, and all of the manos recovered in excavation and 78 percent of those on the surface of the site are two-hand. These forms, with their longer grinding surfaces, are thought to indicate more dependence on agriculture than basin metates and one-hand manos (Hard 1986; Morris 1990). Dependence on agriculture was far from complete, however: other types of ground stone on the site surface could indicate concurrent processing of other commodities (such as wild plants). Further, the ground stone did not exhibit the extreme use wear considered characteristic of intensive agriculture, such as multifaceted manos (Adams and Greenwald 1979).

The use of wild plants is indicated by charred Indian ricegrass seeds and pollen, charred goosefoot seeds, and pollen from beeweed, chenopods or amaranths, grass, and wild buckwheat. Based on pollen, yucca may also have been used. Overall, the pollen and floral remains are less diverse than samples recovered at nearby Puerco Ruin (Donaldson and Miksicek 1990; Fish 1990) and more diverse than at a nearby Archaic site (Tagg 1987). Increasing diversity of plant remains may indicate increasing sedentism: that is, sites are expected to yield evidence of foods procured or processed during the occupation. Sites occupied year-round would produce the full range of foodstuffs, while those occupied seasonally will show evidence only of seasonal foods. In addition, sedentary peoples would more intensively exploit a given area, while mobile peoples could be more selective. The relationship appears to hold true for Petrified Forest, if one assumes increasing sedentism from the Archaic to the Pueblo period. However, sampling and preservation must be considered. A much smaller area was excavated at Sivu'ovi than at Puerco Ruin, and there may be preservation differences between the sites. Other factors may be at work as well: Zuni Basketmaker II sites (with a similar sample size) contained more diverse floral and pollen remains than Sivu'ovi, perhaps due to environmental differences (Varien 1990).

Although limited in number, faunal remains tentatively indicate similar genera were procured as at Puerco Ruin (Gillespie 1990): jackrabbit, prairie dog, and artiodactyl (deer, pronghorn, sheep). Turtle remains also were found at Puerco Ruin. Notably missing in the Sivu'ovi collection in comparison to that from Puerco Ruin are cottontail, birds, and carnivores. Again, this lower diversity may be due to sample size or poor preservation.

The amount of bone recovered from Sivu'ovi is similar to that recovered from the Flattop Site, where Wendorf (1953) inferred that the paucity indicated that the abundant projectile points were used for warfare rather than hunting. Wendorf's idea is intriguing, but other explanations must be considered before hunting is discounted. Soil chemistry results indicate that soil acidity is not a problem in bone preservation at Sivu'ovi, but other factors, such as soil abrasion or permeability (leading to rapid wetting and drying), may account for the lack of bone at early sites in the Petrified Forest area. High carbonates in the soil samples from Sivu'ovi may be from decomposed bone. Further, as at the Flattop Site, the paucity of faunal remains may be only apparent, resulting from sampling houses rather than extramural trash areas.

No data collected in the test excavation point to year-round sedentary occupation at Sivu'ovi. Although elsewhere Gilman (1987) has found evidence that pit houses were used by sedentary populations, pit houses at Sivu'ovi were likely occupied only seasonally. First, the lack of formal hearths at Sivu'ovi, as at the Flattop Site, suggests no winter occupation. Sivu'ovi's location, on a wind-swept bluff, would offer little protection from the harsh winters, and interior hearths would seem obligatory for year-round occupation. Second, caching at Sivu'ovi and the Flattop Site may indicate seasonally occupied sites. The pottery vessels and their contents in Structure 1, Feature 3 appear to have been carefully stored. Careful storage is more consistent with inhabitants expecting to return as part of a seasonal round than with final abandonment of a site occupied year-round (Binford 1979). In the latter case, one would expect that lighter and valuable objects would have been removed, or that other processes such as "draw down" and scavenging (Schiffer 1987) would be apparent. Third, all floral remains recovered indicate a late-summer occupation, with no evidence for occupation during other seasons.

The substantial construction of the structures, with slab-lined walls and slab-reinforced pits, indicate recurrent use. Binford (1990) correlates circular to semi-circular house shapes built on the ground surface with fully nomadic and semi-nomadic groups. The Sivu'ovi houses, round but built in shallow pits, appear transitional between those of nomadic and sedentary groups. Building materials at Sivu'ovi (wood, daub, and sandstone slabs), fit with ethnographic data compiled by Binford for semi-sedentary groups.

Regional Interaction and Trade

Because the testing conducted at Sivu'ovi was small in scale, inferences about regional interaction and trade are tentative. No data yet recovered appear to support a political or economic alliance as postulated by Plog (1983, 1984). No ceramics other than Adamana Brown were recovered in the excavations at Sivu'ovi (contrary to the Flattop Site), but the paddle-and-anvil construction of that ware may indicate a southern influence (see Schroeder 1979). Although abundant petrified wood occurs in the vicinity, there is no evidence of large-scale lithic production for trade. The debitage found cached in the vessel appears to represent sorted flakes for household use rather than specialized production. Projectile points, typical late Archaic-Basketmaker types, are not specific to the area considered part of the Adamana Brown Ware alliance. Most materials used for artifacts are locally available, with the exception of an obsidian flake and possibly two vesicular basalt artifacts. The obsidian flake, which was sourced to Government Mountain near Flagstaff, was most likely obtained though trade.

It is not expected that 40-some households, 1 for each of the 45 identified pit structures, migrated in and out of Sivu'ovi each year. Some of the storage pits and structures were filled with trash, indicating not all were in use at the same time. The large size of Sivu'ovi appears due not to a large influx of people but recurrent use, although no population estimate can be made with the limited sample. In fact, if Sivu'ovi was not occupied year-round, one would expect roughly similar sites elsewhere for other seasons. This would artificially inflate population estimates of the region and mimic a homogeneous distribution of traits that could be attributed to an alliance.

Part of Plog's argument for an Adamana phase alliance rests on the presence of larger "community" houses at sites such as Flattop, however, the Flattop "community" house is similar in size to the two excavated at Sivu'ovi. It may be that the small houses at Flattop, rather than the large one, were atypical. The Flattop houses were dug into bedrock, and the smaller size may have reflected construction difficulty, or specialized function such as storage.

Technological Change

Two aspects of the material culture suggest an abrupt shift in technology from the Archaic to the Basketmaker II periods. First, most clearly, is the extensive use of pottery for cooking and storage. What appears to be selenite temper suggests local production. Second, ground-stone specimens, especially those recovered in excavation, resemble Pueblo period types, rather than Archaic period objects.

The pattern fits that noted by LeBlanc (1982), who suggests that the transition from the Archaic to the Basketmaker periods (occurring around A.D. 200) is far more abrupt than the shifts from Basketmaker to later Pueblo periods. LeBlanc suggests that a trait complex, including ceramics, trough metate, new housing types, storage, and possibly new cultigens, was imported as a whole. LeBlanc further argues that this trait complex was adopted *en masse*, quickly and by a lot of people, accompanying an intrusive group or marking newly formed social relationships (alliances). If Adamana Brown Ware is indeed associated with the initial occupation of the Petrified Forest region, as Mera (1934) suggests, then its accompanying trait complex may have made settlement in a resource-poor area possible. This argument would be much strengthened if there were no preceramic occupation of Sivu'ovi. Verification of the early construction of Structure 3 (circa 350 B.C.) through salvage excavation and additional chronometric dating may be extraordinarily useful in examining this hypothesis. If the structure is as early as the radiocarbon date suggests, the absence of Adamana Brown Ware would indicate that the Adamana Brown Ware trait complex was not necessary for occupation there. If the structure is early and Adamana Brown Ware is present, then estimates for the beginning date for this complex would need to be revised backward significantly.

Flaked-stone technology at Sivu'ovi, on the other hand, includes traits common at both earlier Archaic and later Pueblo sites, with evidence suggesting gradual trends rather than abrupt changes. Sivu'ovi indicates biface production and use was on the decline, while expedient flake technology was on the rise. In fact, the expedient technology, often associated with sedentism, appears to precede year-round occupation at Sivu'ovi because abundant lithic material was readily available in the immediate vicinity.

Summary

Testing indicates that occupation at Sivu'ovi began between A.D. 1 and A.D. 200 or 300, and possibly as early as 300 B.C. As a warm-season residential site, subsistence revolved around maize agriculture and collection of local wild plant resources. The presence of ceramics, the types and amounts of ground stone, and the ubiquitous evidence of maize represent abrupt departures from nearby Archaic sites, supporting LeBlanc's (1982) idea that the transition from the Archaic period to the Basketmaker period was more abrupt than the transition from the Basketmaker period to the Pueblo period. Lithic technology, on the other hand, reflects a more gradual transition, with a mixing of traits commonly associated with both Archaic and Pueblo periods. Well-constructed features and structures suggest sedentism, although evidence does not indicate year-round occupation. Most likely Sivu'ovi was the site of seasonal, but recurrent habitation over a period of at least several years (if not centuries). Future research at Sivu'ovi and other early sites will, it is hoped, shed more light on this pivotal period of human prehistory.

Chapter 17
Management Recommendations

In this chapter, I discuss management recommendations and provide some suggestions for future research at Sivu'ovi (AZ Q:1:114 [ASM]). The limited extent of the present work must temper any conclusions. It is clear, however, that the site has the potential to address a number of research questions, which I have only touched upon in this report.

Because the site is currently undergoing massive, apparently unstoppable, erosion, the site should be inspected annually to identify areas most fruitful for salvage excavation. Although many sites at Petrified Forest National Park are subject to severe erosion (Wells 1989), the case for additional work at Sivu'ovi seems indisputable: it is a rare early site, it is one of the largest known sites of its kind in the middle Little Colorado River region, it has been shown to have a great potential for further data, and massive erosion is quickly destroying the site. Essential questions remain regarding the nature of site occupation, and further work at the site can be pivotal in testing models of the initial occupation of the region as posited by Plog (1983, 1984), Schroeder (1979), and others (Mera 1934). Data from the site could address issues of general anthropological interest, such as the development of agriculture and sedentism, political and economic interaction, and colonization versus in situ development.

An ongoing program of small-scale archaeological salvage would be ideal for mitigating the effects of erosion with a minimum of cost. This strategy has been successfully done at a large multi-component site in the Grand Canyon (Balsom, personal communication 1991). With detailed site mapping and much background research already completed at Sivu'ovi, research could easily expand upon the themes investigated in this report. Because of the critical time frame in the face of erosion, recommendations here are specific and should be implemented as soon as possible. Unfortunately, the rate of erosion is swift enough (several feet since the 1986 survey) that the recommendations may well be outdated soon.

These recommendations, arranged around the research domains posited in Chapter 5, include both recommendations requiring immediate action and proposals for long-term research.

Chronology

First, Structure 3, which yielded the earliest radiocarbon date of the 12 submitted, is eroding and should be excavated soon to determine how this date is applicable to the Adamana phase chronology. Less critical in timing, but important to further refine dating, are accelerator radiocarbon dating of annuals from structures 1 and 2 and conventional radiocarbon dating of material from House P at the Flattop Site. Dated annuals from structures 1 and 2 could provide an estimate of the occupation span of these structures and possibly the site. House P appears to be the last occupied of the excavated structures at the Flattop Site and hence could provide an estimate of the end date for the Adamana phase. A search should be made at University of Arizona Tree-ring Laboratory and the Museum of Northern Arizona to determine if suitable samples for dating are available from House P.

Economic and Environmental Orientation

To provide more accurate assessments of subsistence, extramural areas near structures should be excavated, and potential midden areas should be identified and excavated. The area to the west of Structure 2 would seem an ideal place to start; it contains some of the deeper soil of the site where features may be preserved, and it may have been an activity area – Structure 2 was trash filled, and a trashed-filled pit (Feature 2. Structure 2) was found in this area. Extramural storage pits, cooking features, and trash deposits could provide information not available from structures. In addition, sealed pits within structures, where bone preservation may be better, should be sought out during monitoring and salvaged as soon as possible.

Regional Interaction and Trade

Because the perceived diversity of the assemblage is greatly influenced by sample size, inferences about regional interaction and trade would be enhanced by a larger data set.

Technological Change

Sivu'ovi appears likely to provide data on the processes and technology surrounding the introduction of ceramics. Excavations at Structure 3 would provide additional data concerning the timing of the introduction of Adamana Brown Ware. If the early date holds up, the presence or absence of pottery associated with this structure would require the reevaluation of previous theories on the introduction of ceramics. Further, petrographic identification of the temper and clay could help determine local versus nonlocal production.

Finally, information and cultural material retrieved by the current project should be made available to the public, perhaps at one of the park museums or visitor centers. The cached Adamana Brown vessels are fine specimens of aesthetic and popular interest, which illustrate an intriguing story – why were the vessels and other items carefully stored and then never retrieved? The interpretive themes could cover various aspects, such as storage, colonization, immigration, agriculture, and pottery technology. A reconstruction of the cache pit with its contents would make an impressive display on the lifeways of a people over 1,700 years ago.

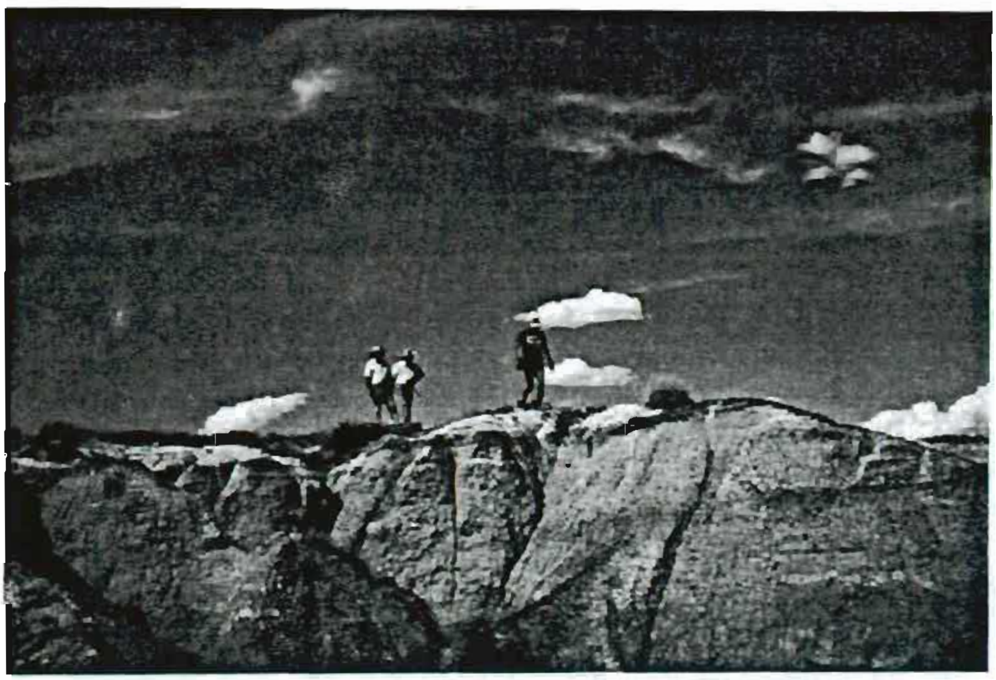

Figure 17.1 Erosion scarp at Sivu'ovi.

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Appendix A

Soil Chemistry Analysis

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Chemical Soil Analysis

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Background

This report covers the methods and results of the chemical analysis of 10 soil samples from Petrified Forest National Park. The samples were submitted for analysis by the Western Archeological and Conservation Center, National Park Service, Tucson, Arizona.

The chemical changes in the soil resulting from human occupation include substantial increases in nitrogen, calcium, carbon and phosphorus compounds. Cook and Heizer (1965) conducted an in-depth study describing the amounts generated by a hypothetical group of inhabitants. Of the above elements, phosphorus, in the form of phosphates, has proven to be the most reliable indicator of land use by prehistoric populations. this is due to the tendency of phosphate to remain fixed in the soil where deposited, with little horizontal or vertical movement.

The use of soil phosphate analysis in investigating archaeological sites was well established in Europe by the late 1930s but it was not until 1948 that similar work was conducted in the United States. Even so, the use of phosphate analysis was seldom performed in North America until a simple and relatively fast "spot test" was developed by R. C. Eidt in 1972 (Woods 1975:9-10).

Procedures

Ten soil samples from site AZ Q:1:114 (ASM) in the Petrified Forest National Park were chemically analyzed for qualitative phosphate values, soil pH, and carbonates reactions. The ten soil samples were taken from two habitation structures and selected shovel test pits. The color classification of each sample was determined using the Munsell Soil Color charts.

The test for phosphate (PO_4) values followed the procedures outlined by Eidt (1973:206-210) and modified by Woods (1975). Two reagents are prepared: Reagent A consists of 30 milliliters of 6 Normal hydrochloric acid added to five grams ammonium molybdate dissolved in 100 milliliters of distilled water. Reagent B is prepared by dissolving .5 grams of ascorbic acid in 100 milliliters of distilled water. The hydrochloric acid in Reagent A releases the phosphates from the soil sample, which form a phosphate molybdate compound by combining with the ammonium molybdate. Reagent B reduces this compound, yielding molybdenum blue.

The phosphate values are determined by evaluating the physical characteristics of the chemical reactions in the soil sample. These reactions include the time of appearance and the intensity of the molybdenum blue coloration, length of the rays emanating from the sample, and the extent of the ring surrounding the sample. The samples are assigned values ranging from one (for a negative phosphate reading) to a six, in accordance with the recorded results. It must be noted that this is a subjective test and requires careful interpretation by the analyst. Woods pointed out that there is no linear relationship between the values and that a value of five may have several hundred times more phosphate content than a sample with a value of two (Woods 1975:23).

Carbonates testing is an integral part of overall soil analysis. As middens develop, relatively high levels of calcium, nitrogen, carbon and phosphates accumulate in the soil. Carbonates result from interaction of calcium, carbon dioxide, and phosphates. Age estimates for archaeological sites have been done using the depth of leached carbonates as a chronological control (Johnston 1975). One problem is that carbonates will not last long in acidic soil. Therefore, its use as a chronological indicator would be limited to sites with neutral or alkaline soils.

The carbonates testing was made using a 2.5 gram soil sample on a clean glass sheet. Three drops of muriatic acid were added to the sample and the observed reaction was subjectively recorded: None=0; Weak=1; Medium=2; Strong=3.

The pH reading is an important component of soil analysis. In acid soils (pH values below 7.0) the phosphate is bound with iron and aluminum compounds. With alkaline soils (pH above 7.0), phosphate will usually be bound with calcium. These phosphate compounds will remain in the soil where deposited and generally are not subject to leaching. Of course, if the soil itself is disturbed, so is the phosphate.

Studies have been done on the relationship of the soil pH to prehistoric sites. In general, the evidence shows that midden sites tend to have higher pH values than the surrounding soils. Although the initial occupation of the site would lower the pH because of humic and fulvic acids formed in the midden soil, after site abandonment the soil pH will increase as a result of complex chemical processes.

The pH of each soil sample was determined using a Coleman Metrion IV pH meter. A volume of 25 milliliters of distilled water was added to a 20 gram air dried soil sample. The sample was then screened through a #28 Tyler screen. The mixture was stirred every 15 minutes for one hour prior to taking the pH reading.

Results

Table 1 lists the soils analysis data for each sample from the two structures and the shovel test pits. The phosphate value is the PO_4 rating; the carbonate reaction is under the CO_3 heading.

Phosphate Testing

All samples had positive PO_4 readings (Table 2). The values ranged from 4.00 to 5.25. The lowest reading was 4.00 from posthole B; the strongest from Structure 1 (5.25 from the fill of unit N85/E122 and level 4 of N88/E122). The mean PO_4 value was 4.70.

pH Testing

The pH values ranged from 9.0 (strongly alkaline) to 9.6 (very strongly alkaline) with a mean pH of 9.1 (very strongly alkaline).

Carbonates Testing

Only the two samples from the postholes in Structure 2 were negative. The other eight samples tested positive for carbonates with medium to strong reactions.

Munsell Color Chart Classification

All ten soil samples were color classified by use of the Munsell Color charts. Readings were from air dried samples and are listed in Table 1. The numerical chart values equate to the following soil color names, on the 5 YR and 10YR Hue charts.

Munsell Value	Color
5YR 4/3, 3.5/3	Reddish brown
5YR 3/3, 3/2.5 & 3/2	Dark reddish brown
10YR 3/2.5, 3/2	Very dark grayish brown
10YR 2/2	Very dark brown
10YR 2/1	Black

Table 1. Chemical Soil Analysis Data

Unit	Depth	PO_4	pH	CO_3	Munsell Color	
					Wet	Dry
N160/E125	25 cm	5.00	9.1	2	5YR 4/3	5YR 3/2
N165/E120	25 cm	4.25	9.1	2	5YR 4/3	5YR 3/2
N145/E125	25 cm	4.75	9.4	2	5YR 3.5/3	5YR 3/2
Structure 1	upper fill	5.00	9.1	3	10YR 3/2	10YR 2/1
Structure 1	floor fill	5.25	9.3	3	10YR 3/2	10YR 2/2
Structure 1	Fea 2	5.25	9.0	3	10YR 3/2	10YR 2/1
Structure 1	Fea 3	4.50	9.6	2	5YR 4/3	5YR 3/3
Structure 2	Fea 5	4.25	9.0	2	5YR 4/3	5YR 3/2.5
Structure 2	posthole A	4.75	9.1	0	5YR 3/3	5YR 3/2
Structure 2	posthole B	4.00	9.0	0	5YR 4/3	5YR 3/3
mean		4.70	9.2	2		

Table 2. Detailed PO_4 Data.

Phosphate Ring Test Results						
Unit	Depth	Time of ap-pear	Ring %	Structurela Length	Intensity of Color	Overall Rating
N160/E125	25 cm	4 sec	100	7 mm	Med Dark	5.00
N165/E120	25 cm	23 sec	100	7 mm	Pale +	4.25
N145/E125	25 cm	11 Sec	100	7 mm	Med Dark	4.75
Structure 1	upper fill	3 sec	100	7 mm	Med Dark+	5.00
Structure 1	floor fill	4 sec	100	6 mm	Dark	5.25
Structure 1	Fea 2	4 sec	100	6 mm	Dark	5.25
Structure 1	Fea 3	12 sec	100	6 mm	Pale -	4.50
Structure 2	Fea 5	17 sec	100	4 mm	Pale +	4.25
Structure 2	posthole A	7 sec	100	6 mm	Med Dark	4.75
Structure 2	posthole B	15 sec	75	6 mm	Vry Pale	4.00

Appendix B

Obsidian Source Analysis

Richard E. Hughes

September 15, 1990

Mr. Jeff Burton, Archaeologist
National Park Service
Western Archeological and Conservation Center
1415 North 6th Avenue
Tucson, AZ 85705

Dear Jeff:

On page two of this letter you will find a table presenting x-ray fluorescence (xrf) data generated from the analysis of an obsidian flake from site AZ Q: 1: 114 in the Basketmaker Salvage, Petrified Forest National Park, Arizona. This research was conducted pursuant to U.S.D.I., National Park Service, Purchase Order no. PX 8100-0-0173, dated August 15, 1990.

Laboratory investigations were performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a Rh x-ray tube, a 50 kV x-ray generator, with microprocessor controlled pulse processor (amplifier) and bias/protection module, a 100 mHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30 mm^2 area. The x-ray tube was operated at 35.0 kV, .30 mA, using a .127 mm Rh primary beam filter in an air path at 300 seconds livetime to generate x-ray intensity data for elements zinc (Zn Kα), gallium (Ga Kα), rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα), and niobium (Nb Kα). Barium (Ba Kα) intensities were generated by operating the x-ray tube at 50.0 kV, .35 mA, with a .63 mm copper (Cu) filter at 300 seconds livetime. Data processing for all analytical subroutines is executed by a Hewlett Packard Vectra™ microcomputer with operating software and analytical results stored on a Hewlett Packard 20 megabyte fixed disk. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from analysis of up to 26 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology , the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France). Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988a).

All trace element values in the table are expressed in quantitative units (i.e. parts per million [ppm] by weight), and these were compared directly to values for known obsidian sources that appear in Jack (1971), Nelson (1984), Baugh and Nelson (1987), and Hughes (1988b). Artifacts were assigned to a parent obsidian type if diagnostic trace element concentration values (i.e., ppm values for Rb, Sr, Y, Zr, and Ba) corresponded at the 2-sigma level. Stated differently, artifact-to-obsidian source (geochemical type) matches were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards. The term "diagnostic" is used here to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations show low intra-source variability and marked variability across sources. Diagnostic elements, then, are those whose concentration values allow one to draw the clearest geochemical distinctions between sources. Although Zn, Ga, and Nb ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they don't usually vary significantly across obsidian sources (see Hughes 1982, 1984, 1990). This is particularly true of Ga, which occurs in concentrations between 10-30 ppm in nearly all sources in the study area. Zn ppm values are always high in Zr-rich, Sr-poor peralkaline volcanic glasses (like those in northwestern Nevada, for example, where concentrations are >150 ppm), but otherwise they do not usually vary dramatically between sources.

The trace elemental composition measurements presented in the enclosed table are reported to the nearest ppm to relect the resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. The resolution limits of the present x-ray fluorescence instrument for the determination of Zn is about 3 ppm; Ga about 2 ppm; for Rb about 5 ppm; for Sr about 3 ppm; Y about 2 ppm; Zr about 4 ppm; Nb about 3 ppm, and for Ba about 10 ppm. When counting and fitting error uncertainty estimates (the "±" value in the table) for a sample are greater than calibration-imposed limits of resolution (e.g. the 12 ppm value for Ba which slightly exceeds the 10 ppm detection limit value), the larger number is preferred as a more conservative, robust reflection of elemental composition and measurement error due to variations in sample size, surface and x-ray reflection geometry (see Hughes 1988a).

Trace Element Concentrations

Cat. Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Obsidian Source (Chemical Type)
PEFO-5545	58 ±5	17 ±3	109 ±5	72 ±3	19 ±2	76 ±4	49 ±3	307 ±12	Government Mtn./ Sitgreaves Peak

All trace element values in parts per million (ppm); ± = pooled expression (in ppm) of x-ray counting uncertainty and regression fitting error at 300 seconds livetime.

The geochemical data for this specimen indicate that it matches the trace element profile of obsidians of the Government Mountain/Sitgreaves Peak geochemical type (*sensu* Jack 1971: Table 1), San Francisco Volcanic Field, Arizona.

I hope this information will help in your analysis of other materials from the site. Please contact me at my laboratory ([916] 364-1074) if I can be of further assistance. As you requested, I have forwarded this specimen to Mr. Tom Origer at Sonoma State University for obsidian hydration analysis.

Sincerely,

Richard Hughes

Richard E. Hughes, Ph.D.

Appendix C
Debitage Analysis Tables

Debitage Analysis Summary Table

Surface Collection Units

		Petrified Wood				Chert			Other			Total		
		Count	Percent	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt
Flakes														
Complete	Cortical	39	2	433.6	11.1	47	426.5	9.1	1	11.1	11.1	87	871.2	10.0
	Plain	270	14	2235.9	8.3	13	53.2	4.1	2	1.6	0.8	285	2290.7	8.0
	Faceted	73	4	324.3	4.4	7	40.7	5.8	0	0	-	80	365.0	4.6
	Crushed	62	3	311.1	5.0	4	31	7.8	0	0	-	66	342.1	5.2
	Total	444	22	3304.9	7.4	71	551.4	7.8	3	12.7	4.23	518	3869.0	7.5
Proximal	Cortical	10	1	91.5	9.2	4	10	2.5	0	0	-	14	101.5	7.3
	Plain	74	4	691.3	9.3	1	7.9	7.9	1	5.6	5.6	76	704.8	9.3
	Faceted	25	1	97.8	3.9	0	0	-	0	0	-	25	97.8	3.9
	Crushed	7	0	39.6	5.7	0	0	-	0	0	-	7	39.6	5.7
	Total	116	6	920.2	7.9	5	17.9	3.6	1	5.6	5.6	122	943.7	7.7
Medial-Distal		783	39	4341.4	5.5	15	67.7	4.5	2	14.7	7.35	800	4423.8	5.5
Split		32	2	209.6	6.6	1	1.5	1.5	0	0	-	33	211.1	6.4
Debris		613	31	6844.1	11.2	4	23.3	5.8	0	0	-	617	6867.4	11.1
Total		1988		15620.2	7.9	96	661.8	6.9	6	33.0	5.5	2090	16315.0	7.8
Platform														
	Cortical	49	9			51	67		1	25		101	16	
	Plain	344	61			14	18		3	75		361	56	
	Faceted	98	18			7	9		0	0		105	16	
	Crushed	69	12			4	5		0	0		73	11	
	Total	560				76			4			640		

Debitage Analysis Summary Table

Unit 1

		Petrified Wood				Chert			Other			Total		
		Count	Percent	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt
Flakes														
Complete	Cortical	2	3	14.7	7.4	4	18.9	4.7	0	0	-	6	33.6	5.6
	Plain	3	5	5.5	1.8	1	4.3	4.3	0	0	-	9	52.9	5.9
	Faceted	3	5	10	2.7	0	0	-	0	0	-	3	8.0	2.7
	Crushed	4	7	10.9	3.3	1	9.1	9.1	0	0	-	5	22.4	4.5
	Total	12	20	39.1	3.3	6	32.3	5.4	0	0	-	16	67.3	4.2
Proximal	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	0	0	0	-	0	0	-	0	0	-	1	2.3	2.3
	Faceted	0	0	0	-	0	0	-	0	0	-	1	2.9	2.9
	Crushed	0	0	0	-	0	0	-	0	0	-	2	4.1	2.1
	Total	0	0	0	-	0	0	-	0	0	-	4	9.3	2.3
Medial-Distal		40	66	98.4	2.5	2	5.2	2.6	2	3.8	1.9	44	105.4	2.4
Split		2	3	23.1	11.6	0	0	-	0	0	-	2	23.1	11.6
Debris		3	5	27.5	9.2	0	0	-	0	0	-	3	27.5	9.2
Total		61		188.1	3.1	8	37.5	4.7	2	3.8	1.9	69	232.6	3.4

		Petrified Wood		Chert		Other		Total	
Platform									
	Cortical	2	17	4	67	0	-	6	22
	Plain	3	25	1	17	0	-	10	37
	Faceted	3	25	0	0	0	-	4	15
	Crushed	4	33	1	17	0	-	7	26
	Total	12		6		0		27	

Debitage Analysis Summary Table

Unit 2

		Petrified Wood				Chert			Other			Total		
		Count	Percent	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt
Flakes														
Complete	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Faceted	1	13	4.7	4.7	0	0	0.0	0	0	-	1	4.7	4.7
	Crushed	1	13	24.9	24.9	0	0	-	0	0	-	1	24.9	24.9
	Total	2	25	29.6	14.8	0	0.0	-	0	0.0	-	2	29.6	14.8
Proximal	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Faceted	0	0	0	-	1	2.0	-	0	0	-	1	2.0	2.0
	Crushed	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Total	0	0	0.0	-	1	2.0	-	0	0.0	-	1	2.0	2.0
Medial-Distal		3	38	23.5	7.8	0	0	0.0	0	0	-	3	23.5	7.8
Split		0	0	0	-	0	0	-	0	0	-	0	0.0	-
Debris		3	38	15.3	5.1	1	2.0	0.4	0	0	0.0	4	17.3	4.3
Total		8		68.4	8.6	2	4.0	2	0	0.0	0.0	10	72.4	7.2
Platform														
	Cortical	0	0			0	0		0	-		0	0	
	Plain	0	0			0	0		0	-		0	0	
	Faceted	1	50			1	100		0	-		2	67	
	Crushed	1	50			0	0		0	-		1	33	
	Total	2				1			0			3		

Debitage Analysis Summary Table

Structure 1

		Petrified Wood				Chert			Other			Total		
		Count	Percent	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt
Flakes														
Complete	Cortical	1	6	5.8	5.8	0	0	-	0	0	-	1	5.8	5.8
	Plain	5	31	20.9	4.2	0	0	-	0	0	-	5	20.9	4.2
	Faceted	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Crushed	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Total	6	38	26.7	4.5	0	0	-	0	0	-	6	26.7	4.5
Proximal	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Faceted	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Crushed	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Total	0	0	0	-	0	0	-	0	0	-	0	0.0	-
Medial-Distal		7	44	19.9	2.8	1	0.4	0.4	0	0	-	8	20.3	2.5
Split		0	0	0	-	0	0	-	0	0	-	0	0.0	-
Debris		3	19	101.9	34.0	0	0	-	0	0	-	3	101.9	34.0
Total		16		148.5	9.3	1	0.4	0.4	0	0	-	17	148.9	8.8

		Petrified Wood		Chert		Other		Total	
Platform									
	Cortical	1	17	0	-	0	-	1	17
	Plain	5	83	0	-	0	-	5	83
	Faceted	0	0	0	-	0	-	0	0
	Crushed	0	0	0	-	0	-	0	0
	Total	6		0		0		6	

Debitage Analysis Summary Table

Structure 2

		Petrified Wood				Chert			Other			Total		
		Count	Percent	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt
Flakes														
Complete	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	1	3	2.1	2.1	0	0	0.0	0	0	-	1	2.1	2.1
	Faceted	1	3	0.3	0.3	0	0	0.0	0	0	-	1	0.3	0.3
	Crushed	1	3	0.8	0.8	0	0	-	0	0	-	1	0.8	0.8
	Total	3	7	3.2	1.1	0	0.0	-	0	0.0	-	3	3.2	1.1
Proximal	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	1	3	3.1	3.1	0	0	0.0	0	0	-	1	3.1	3.1
	Faceted	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Crushed	1	3	6.5	6.5	0	0	0.0	0	0	-	1	6.5	6.5
	Total	2	5	9.6	4.8	0	0.0	0.0	0	0.0	-	2	9.6	4.8
Medial-Distal		19	48	31.5	1.7	0	0	0.0	0	0	-	13	24.2	1.9
Split		1	3	1.6	1.6	0	0	0.0	0	0	-	1	1.6	1.6
Debris		15	38	104.6	7.0	0	0	0.0	0	0	-	12	58.0	4.8
Total		40		150.5	3.8	0	0.0	-	0	0.0	-	31	96.6	3.1
Platform														
	Cortical	0	0			0	-		0	-		0	0	
	Plain	2	40			0	-		0	-		2	40	
	Faceted	1	20			0	-		0	-		1	20	
	Crushed	2	40			0	-		0	-		2	40	
	Total	5				0			0			5		

Debitage Analysis Summary Table

Vessel Contents (Structure 1, Feature 3)

		Petrified Wood (white-gray)				Petrified Wood (other)			Chert			Total		
		Count	Percent	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt	Count	Wt.(g)	Mean Wt
Flakes														
Complete	Cortical	2	3	0.5	0.3	0	0	-	0	0	-	2	0.5	0.3
	Plain	7	10	3.4	0.5	2	0.2	0.4	0	0	-	9	3.6	0.4
	Faceted	13	19	3.0	0.2	2	0.5	2.2	0	0	0.0	15	3.5	0.2
	Crushed	2	3	0.7	0.4	0	0	-	0	0	-	2	0.7	0.4
	Total	24	34	7.6	0.3	4	0.7	0.2	0	0.0	-	28	8.3	0.3
Proximal	Cortical	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Plain	1	1	0.1	0.1	0	0	0.0	0	0	-	1	0.1	0.1
	Faceted	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Crushed	0	0	0	-	0	0	-	0	0	-	0	0.0	-
	Total	1	1	0.1	0.1	0	0.0	0.0	0	0.0	-	1	0.1	0.1
Medial-Distal		43	61	20.3	0.5	17	7.0	0.4	0	0	0.0	60	27.3	0.5
Split		0	0	0	-	0	0	-	0	0	-	0	0.0	-
Debris		2	3	1.3	0.7	0	0	0.0	0	0	-	2	1.3	0.7
Total		70		29.3	0.4	21	7.7	0.4	0	0.0	-	91	37.0	0.4
Platform														
	Cortical	2	8			0	0		0	-		2	7	
	Plain	8	32			2	50		0	-		10	34	
	Faceted	13	52			2	50		0	-		15	52	
	Crushed	2	8			0	0		0	-		2	7	
	Total	25				4			0			29		

Appendix D
Radiocarbon Dating
John C. Sheppard

Washington State University

Department of Chemical Engineering

Pullman, WA 99164-2710
(509) 335-4332
FAX: (509) 335-7632

RADIOCARBON DATING LABORATORY
Office: (509) 335-4731
Lab: (509) 335-2417

SAMPLE REPORT FORM - FINAL REPORT

NAME OF SUBMITTER	DATE RECEIVED
Beverly A. Mohler	09-04-90
DATE REPORTED	**WSU ACCOUNT NUMBER**
12-06-90	15L 3813 1002 #135

WSU SAMPLE NUMBER	YOUR SAMPLE NUMBER	^{14}C AGE, YEARS B.P.
4188	PET-1, House 4, Log 5	1590 ± 95
4189	PET-5, House 8, Cist 1	2040 ± 100
4190	PET-6, House 4, Log 7	2090 ± 70
4191	PET-23a, House 8, log 5	1830 ± 70
*4192	PET-23b, House 8, log 5	1740 ± 150
4193	PET-39, House 4, log 11	1530 ± 90

* Sample 4192 was counted in a 100cc detector. The sample was equivalent to about 32 mg. of carbon. /YW.

Sample Processed by: Welter
Sample Calculated by: Welter/Sheppard
Sample Reported by: Sheppard

NOTE: All analyses are based upon the Libby half-life (5570 ± 30 years) for radiocarbon. To convert ages to the half-life of 5730 years, multiply the age given above by 1.03. Zero age date is A.D. 1950. (Reference: Editorial Comment, RADIOCARBON, Vol. 7, 1965.)

Washington State University

Department of Chemical Engineering

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(509) 335-433[illegible]
FAX: (509) 335-763[illegible]

RADIOCARBON DATING LABORATORY

Office: (509) 335-4731
Lab: (509) 335-2417

SAMPLE REPORT FORM - FINAL REPORT

NAME OF SUBMITTER

Beverly Mohler

DATE RECEIVED

09-04-90

DATE REPORTED

01-25-91

WSU ACCOUNT NUMBER

15L 3813 1002 #135

WSU SAMPLE NUMBER	YOUR SAMPLE NUMBER	^{14}C AGE, YEARS B.P.
4219	PEFO - 9255 Str. 1, floor	1900 ± 95
4220	PEFO - 9258 Str. 1, fea. 4	1950 ± 95
4221	PEFO - 9264a Str. 2, fea. 11	1830 ± 95
4222	PEFO - 9264b Str. 2, fea. 11	1700 ± 100
4223	PEFO - 9325 Str. 2, fea. 6	1920 ± 90
4224	PEFO - 9327 Str. 3, fill	2280 ± 90

Sample Processed by: Welter
Sample Calculated by: Welter/Sheppard
Sample Reported by: Sheppard

NOTE: All analyses are based upon the Libby half-life (5570 ± 30 years) for radiocarbon. To convert ages to the half-life of 5730 years, multiply the age given above by 1.03. Zero age date is A.D. 1950. (Reference: Editorial Comment, RADIOCARBON, Vol. 7, 1965.)

Appendix E

Obsidian Hydration Analysis

Thomas M. Origer

SONOMA STATE UNIVERSITY ACADEMIC FOUNDATION, INC.

ANTHROPOLOGICAL STUDIES CENTER
CULTURAL RESOURCES FACILITY
707 664-2381

Jeffrey Burton, Archaeologist
Western Archaeological & Conservation Center
National Park Service
1415 North 6th Avenue
Tucson, AZ 85705

November 1, 1990

Dear Jeff:

This letter reports the hydration measurements taken from one specimen from site AZ Q:1:114. This work was completed pursuant to Purchase Order No. PX 8100-0-0175 dated August 15, 1990.

The analysis was completed at the Sonoma State University Obsidian Hydration Laboratory, an adjunct of the Anthropological Studies Center, Department of Anthropology. Procedures used by our hydration lab for thin section preparation and hydration band measurement are described below.

Each specimen was examined in order to find two or more surfaces that would yield edges which would be perpendicular to the microslide when preparation of the thin section was completed. Two small parallel cuts were made at an appropriate location along the edge of each specimen with a 4 inch diameter circular saw blade mounted on a lapidary trimsaw. The cuts resulted in the isolation of a small sample with a thicknesses of approximately one millimeter. Each sample was removed from its specimen and mounted with Lakeside Cement onto permanently etched petrographic microslide.

The thickness of the samples was reduced by manual grinding with a slurry of #500 silicon carbide abrasive on a glass plate. The grinding was completed in two steps. The first grinding was terminated when the sample's thickness was reduced by approximate 1/2, thus eliminating any micro-chips created by the saw blade during the cutting process. The slides were then reheated, which liquified the Lakeside Cement, and the samples inverted. The newly exposed surfaces were then ground until the proper thickness was attained.

The correct thin section thickness was determined by the "touch" technique. A finger was rubbed across the slide, onto the sample, and the difference (sample thickness) was "felt." The second technique employed for arriving at proper thin section thickness is termed the "transparency" test. The microslide was held up to a strong source of light and the translucency of the thin section observed. The sample was sufficiently reduced in thickness when the thin section readily allowed the passage of light.

A protective coverslip was affixed over the thin sections when all grinding was completed. The completed microslides are curated at our hydration lab under File No. 90-H961.

The hydration bands were measured with a strainfree 40 power objective and a Bausch and Lomb 12.5 power filar micrometer eyepiece on a Nikon petrographic microscope. Six measurements were taken at several locations along the edge of the thin section. The mean of the measurements was calculated and listed on the enclosed table with other information. These hydration measurements have a range of +/- 0.2 due to normal limitations of the equipment.

The specimen is enclosed. If you have questions regarding this hydration work, please do not hesitate to contact me.

Cordially,

Thomas M. Origer, Director
Obsidian Hydration Laboratory

AZ Q:1:114 — Submitted by: Jeff Burton — October 1990

Lab#	Catalog #	Description	Provenience	Remarks	Readings	Mean	Source
01	PEFO 5545	Flake	N136;E260/Surface	Band 1	1.8 1.8 1.8 1.9 2.0 2.1	1.9	
01	PEFO 5545	Flake	N136;E260/Surface	Band 2	3.6 3.6 3.6 3.6 3.7 3.9	3.7	

Lab Accession No.: 90-H961 — Technician: Thomas M. Origer

Appendix F
Archaeomagnetic Dating
William B. Deaver

October 30, 1990

Mr. Jeff Burton
Western Archeological and Conservation Center
P.O. Box 41058
Tucson, Arizona 85717

Dear Jeff:

Enclosed you will find the data report sheets on the two samples from AZ Q:1:114 (ASM). Neither of these samples provided usable archaeomagnetic determinations. Research and experience indicate that samples that exhibit a95 values of greater than 8.8 degrees are probably not suitably magnetized and are not reliable indicators of the past geomagnetic field at the time the features were heated. Regardless of the reliability, samples as imprecise as these will not provide meaningful archaeomagnetic dates.

We cannot explain why these samples are of such poor quality. The most obvious explanation is that very few magnetic grains were ever magnetized. A less likely explanation is that the archaeological magnetization was not stable. Archaeologically these samples are well within the chronological range from which good archaeomagnetic results have been obtained elsewhere in the Southwest.

Consistent with our policy you will not be billed for the full cost of analysis. The final costs for this job are summarized below:

Collection: 2 samples @ $60.00/sample.........	$ 120.00
Travel: Food: 2 days @ 20.00/day.............	$ 40.00
Mileage: 965 miles @ $0.25/mile......	$ 241.25
NRM Analysis: 2 samples @ $ 25.00/sample......	$ 50.00
Total Due....................................	$ 451.25

I am disappointed that these samples did not pan out any better. From what I saw of the burned daub in Structure 2 and the profile of the burned house to the east there are materials that appear to be suitably heated. I am keeping the samples in the off chance that I may do some more analysis to determine why the samples did not pan out. I will keep you apprised of any developments should they arise.

Sincerely,

William L. Deaver
Archaeomagnetic Program, Department of Geosciences
University of Arizona

ARCHAEOMAGNETIC DATA REPORT

Archaeomagnetic Program, Department of Geosciences, University of Arizona

Lab Number: PF001 Field Number: PF001

Provenience: AZ Q:1:14 (ASM), Structure 1

Collector: William L. Deaver Date: 2 September 1990

Magnetic Declination at Sampling Site: 10.07° (sun compass)

Geographic Latitude: 34.81° N Longitude: 250.11° E of Sampling Site

Archaeomagnetic Results

Optimum Alternating Field used for Demagnetiztion (H): 0.0 milliTesla

Total specimens submitted (N1): 14 No. used for final results (N2): 14

Mean Archaeomagnetic Inclination: 49.13°

Mean Archaeomagnetic Declination: 0.82°

Mean Magnetization (JR): 3.773E-02 amperes/meter

Radius of 95% circle of confidence around mean direction (a95): 12.0°

Precision Parameter (k): 11.93

Latitude of Virtual Geomagnetic Pole (PLAT): 85.16°

Longitude of Virtual Geomagnetic Pole (PLONG): 61.64°

Semi-major axis of 95% oval of confidence around pole (DM): 15.88°

Semi-minor axis of 95% oval of confidence around pole (DP): 10.51°

Outlier Specimens and Criteria for Deletion: None

Remarks: Specimens collected from hearth and oxidized sand around covered ash/storage pit. Specimens are poorly clustered, no pattern with respect to specimen location. Further analysis unwarranted.

Date Interpretations at 95% Confidence

Curve: CSU SWCV588	Curve: UA1982
1. NOT DATED	1. NOT DATED

Signed: [signature] Date: 31 Oct 90