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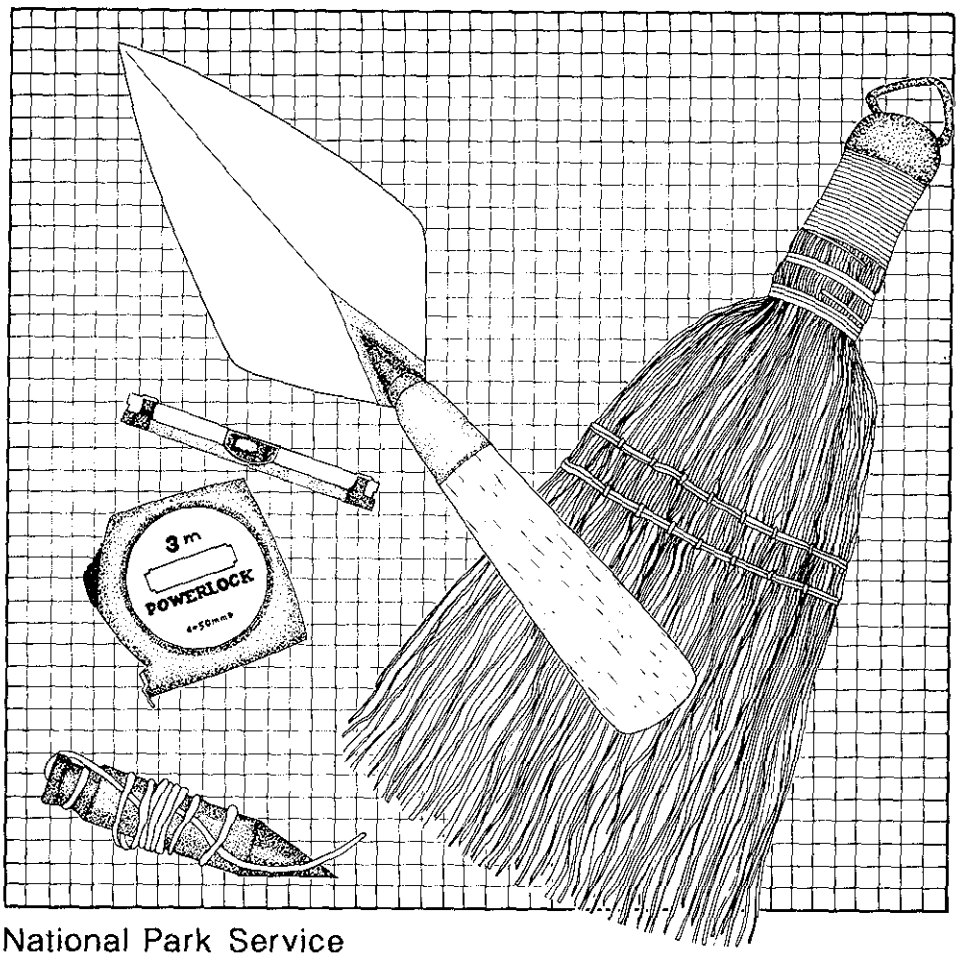
ABORIGINAL HUNTER-GATHERER ADAPTATIONS OF ZION NATIONAL PARK, UTAH



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ABORIGINAL HUNTER-GATHERER ADAPTATIONS OF ZION NATIONAL PARK, UTAH

by

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Midwest Archeological Center
Technical Report No. 1

United States Department of the Interior
National Park Service
Midwest Archeological Center
Lincoln, Nebraska

1990

ABSTRACT

This report presents the results of test excavations at sites 42WS2215, 42WS2216, and 42WS2217 in Zion National Park in southwestern Utah. The excavations were conducted prior to initiating a land exchange and were designed to assess the scientific significance of these sites. However, such an assessment is dependent on the archaeologists' ability to link the static archaeological record to current anthropological and archaeological questions regarding human behavior in the past.

Description and analysis of artifacts and ecofacts were designed to identify differences and similarities between these particular sites. Such archaeological variations were then linked to the structural and organizational features of hunter-gatherer adaptations expected for the region including Zion National Park. These expected adaptations regarding the nature of hunter-gatherer lifeways are derived from current evolutionary ecological, cross-cultural, and ethnoarchaeological ideas.

Artifact assemblages collected at sites 42WS2217 and 42WS2216 are related to large mammal procurement and plant processing. Biface thinning flakes and debitage characteristics suggest that stone tools were manufactured and maintained at these locations. Site furniture such as complete ground stone manos and metates, as well as ceramic vessel fragments, may also indicate that these sites were repetitively used by logistically-organized hunter-gatherers or collectors. The ceramic vessel fragments exhibit attributes that are characteristic of Southern Paiute Utility ware circa A.D. 1000 to 1400.

ACKNOWLEDGMENTS

The completion of the project and this report is due to the much appreciated cooperative efforts of many people who deserve to be acknowledged for their contributions. This report (Utah Project No. 487-NA-032N) is produced in cooperation with the National Park Service, Midwest Archeological Center, in accordance with Supplemental Agreement No. CA-6115-7-8010 and in furtherance of Master Cooperative Agreement No. CA-6000-4-8020 between the National Park Service, Midwest Region, and the University of Nebraska-Lincoln. The National Park Service staff at Zion National Park were more than helpful during our stay there and made life enjoyable in spite of difficult logistics. In particular, Larry Hays, Resource Management Specialist, assisted us in uncountable ways with not only our professional needs, but our personal well-being as well. I can not thank him enough for his good humor and interest in our work. Ranger Bob Lineback made field camp a pleasant experience and also was helpful in supplying information about large mammal movements on the Kolob Plateau. At our field camp on Firepit Knoll we could not have asked for better neighbors than Tom and Jennifer Gillette, who tolerated our intrusion into their backcountry paradise with good spirits and friendship. Their search and rescue missions for a lost crew member and backpack were gratefully appreciated.

In Lincoln at the National Park Service, Midwest Archeological Center, Ralph Hartley capably supplied us with our field and spiritual needs and many conversations on theoretical archaeology. F.A. Calabrese, Chief of the Midwest Archeological Center, also provided his considerable talents in our support and eased the crew through an economic crisis of minor proportion.

At the University of Nebraska, Jenny Waters handled most of the lab preparation and data recording of the artifacts, Steve Baumann contributed to the analysis of the lithics, and Jesslyn Brown produced the illustrations for the report. Susan Vetter was most helpful with geology and computers and I thank her for tolerating me. Alan Osborn, Principal Investigator, was attendant at all stages of this work and his efforts and assistance go beyond the call of duty and cannot be thanked enough.

And finally, I would like to thank my crew, Karen Kramer, Roxanne Gissler, and Rusty Greaves. Their enthusiasm and professionalism were superlative. I would especially like to thank Karen for sharing her knowledge of lithics and Rusty for his assistance with process geomorphology. They all kept me near the boundaries of reality when the heat of late afternoon was producing severe cerebral meltdown.

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INTRODUCTION

The following report details the results of test excavations at three prehistoric sites in Zion National Park (Figure 1). The test excavations were conducted as a part of a land exchange process by Zion National Park and the National Park Service Midwest Archeological Center. The archaeological evaluation was necessary to determine if the three sites in question were eligible for listing in the National Register of Historic Places.

Although absolute chronological information was not recoverable from the sites and the material evidence is sparse, the three sites represent the static remains of a prehistoric hunter-gatherer adaptation to the arid environmental conditions of the eastern Great Basin and western Colorado Plateau. Material evidence also indicates that the sites and the Cave Valley-Spendlove Knoll area have been used extensively from Archaic through late prehistoric times and probably during the historic period as well.

The perspective presented in this report is processualist, i.e., it is believed the most productive way of researching human adaptation is through evolutionary, ecological, and systemic theoretical frameworks (Binford 1983; Hunter-Anderson 1986; Osborn 1984, n.d.; Osborn and Hartley 1984; Simms 1984). While this report is largely descriptive, it is my intent to place the archaeological record of Zion National Park in a regional and evolutionary-ecological framework.

Provincialism and particularism inhibit the growth of archaeology as a science and unnecessarily places constraints on archaeological research. However, due to the efforts of a number of scientists discussed below, great strides are being made in placing localized archaeological phenomena into the larger environment of arid-land hunter-gatherer adaptations. It is hoped that this report makes a similar contribution.

Previous research within and without the boundaries of Zion National Park has largely been concerned with the description of manifestations of the so-called Virgin or Western Anasazi and Fremont cultures (Jennings 1978; Wetherill 1934; Rudy and Stirland 1950; Schroeder 1955; Aikens 1965; Connor and Vetter 1986; Walling et al. 1986; Dalley and McFadden 1985; Moffitt et al. 1978; Tucker 1985). Numerous surveys, inventories, and excavations, have also been conducted in and around the park (See Walling et al. 1986:4-5; Connor and Vetter 1986:14-16; Hartley 1986) with, again, the emphasis on the more visible and, in some researchers' perspectives, less problematic "agriculturalists" of the Virgin Anasazi and Fremont. Until the early 1980s the paradigmatic and methodological approaches to the archaeology of southwestern Utah have been normative, cultural historical, and empiricist. That is, there has been an almost total concern by archaeologists in that area to place archaeological phenomena within cultural taxonomic and typological descriptive frameworks

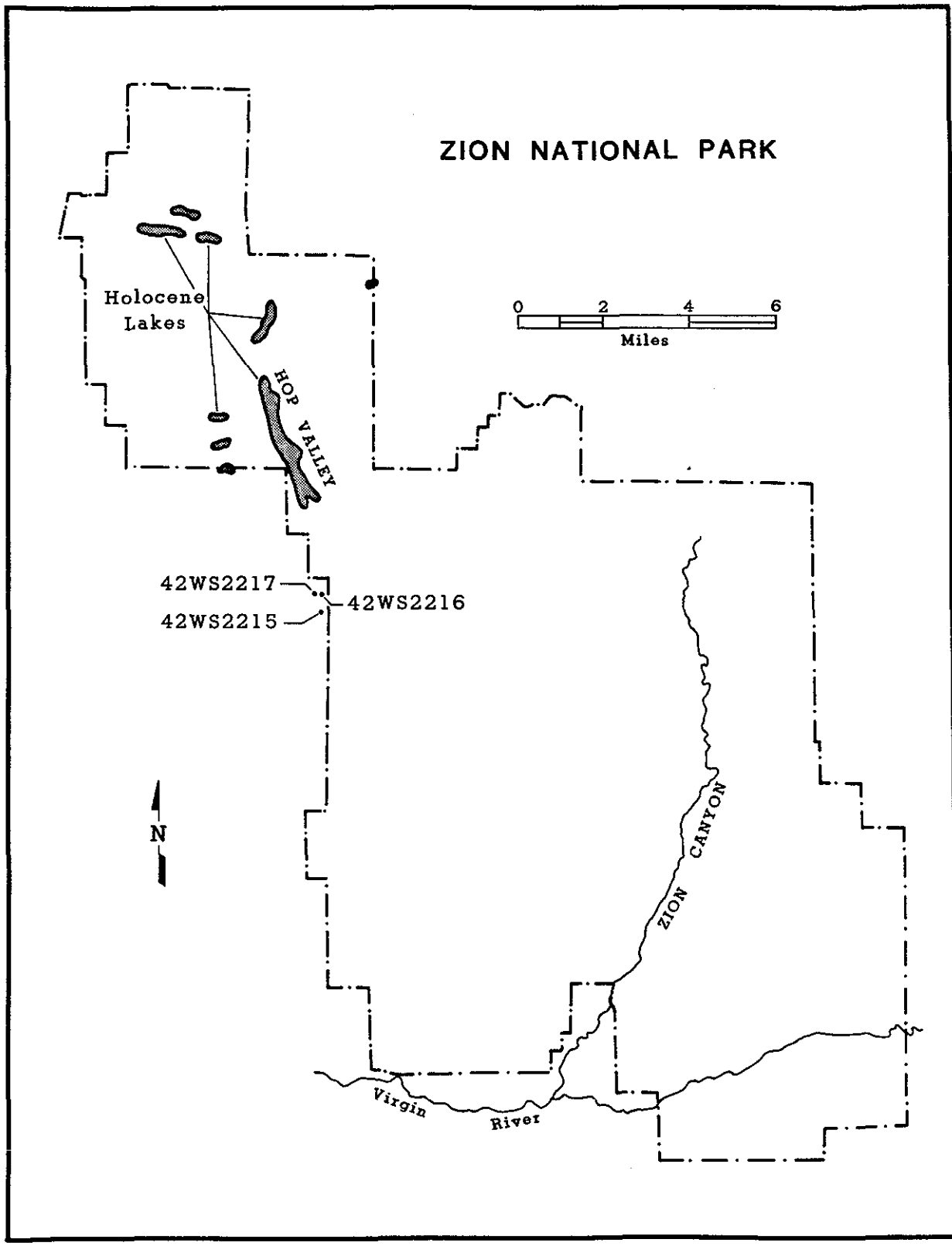


Figure 1. Location of investigated sites and Holocene lakes in relation to current Zion National Park boundaries.

(O'Connell et al. 1982:227-233). Little has been offered in the way of scientific explanation for the cultural adaptations and evolution of the aboriginal populations which once inhabited what is now Zion National Park. It has been assumed that the Virgin Anasazi were sedentary agriculturalists, as evidenced by the presence of cultigens, permanent structures, and painted ceramics. However, this attention to the Virgin Anasazi/Fremont as agriculturalists has diminished the impetus for research into the hunter-gatherer adaptations that have operated in the region for over 10,000 years. Furthermore, there has been a disconcerting lack of attention to late prehistoric and historic hunter-gatherer archaeology in spite of the extensive ethnographic and ethnohistoric research conducted in the region (Euler 1966; Fowler 1982; Steward 1938; Kelley 1934, 1964).

However, beginning with Thomas's (1973, 1983) innovative research in the Monitor Valley of Nevada the direction of hunter-gatherer archaeology in the Great Basin and Colorado Plateau began to change substantively with an explicit focus on ecological dynamics and cultural processes of systemic evolution and adaptation. Thomas does not stand alone for the impetus behind the then new directions in hunter-gatherer archaeology. Other researchers including O'Connell (1971), Bettinger (1977), Madsen and Berry (1975), and Madsen and O'Connell (1982) began long-term research programs that focused on understanding the operation and variability of prehistoric cultural systems.

Recently, explicit evolutionary ecological and processual research programs have been developed and applied to the archaeological record of the Great Basin/Colorado Plateau. Osborn (1984, n.d.), Simms (1984, 1985), and Simms and Isgreen (1984) have applied ecological theory (e.g. Charnov 1976; MacArthur 1972; Pianka 1978) to the investigation of subsistence strategies and human nutrition, as well as the organization of technology and human land use on regional and sub-regional scales. The goals of this research have been to provide comprehensive and testable hypotheses which demonstrate the relationships between the static materials of the archaeological record and the dynamic prehistoric behaviors that produced that record. The aforementioned research has demonstrated that human settlement-subsistence strategies are highly complex responses to an array of ecological dynamics and environmental properties. These include the distribution of resources, seasonality of resources, human population dynamics (e.g., division of labor, labor scheduling, reproductive requirements, and mobility options), climatic regimes, and technological organization, to name just a few of the variables that comprise any particular adaptation.

While the data presented in this report may not be substantive for specific suppositions about the nature of aboriginal foraging in the Zion area, it is adequate for forming coherent and workable research questions.

Binford (1980) has developed a general model of hunter-gatherer systems based on subsistence and mobility strategies which form a continuum from "foragers" to "collectors." Binford (1980) states in this regard that " . . . foragers generally have high residential mobility, low-bulk inputs, and regular daily food-procurement strategies." In depth discussions of this model and its ramifications can be found in Binford (1980, 1983), Hunter-Anderson (1986), Kelly (1980, 1983), O'Connell (1987), and Osborn (1984, n.d.).

There is little argument that the human populations that have inhabited the Great Basin/Colorado Plateau over the past millennia have been hunter-gatherers of the foraging mode, with some debatable exceptions. Ethnographic and ethnohistorical accounts of the Shoshonean-Paiute groups have at least established that those groups were foragers and that their range represents one of the largest geographic regions in the continental United States inhabited by hunter-gatherers. The three excavated sites, discussed in more detail in later sections, appear to confirm the post A.D. 1300 use of Cave Valley by the Southern Paiute. Thus the emphasis on foragers.

However, the evidence from these sites and from other research conducted in the area clearly demonstrates prehistoric utilization through a long range of time and the development of alternative subsistence strategies. The utilization of cultigens by aboriginals in the Zion area has been definitely established (Connor and Vetter 1986:71-72; Heath 1986:477-495). However, the role of cultigens in arid land adaptations, as well as the presumed differences in mobility, technology, and land use strategies that accompany horticulture, are poorly understood.

It is the intent of this report to describe the archaeological sites excavated in Cave Valley in 1987 and to try and place those sites within a broader regional perspective. As discussed previously, the paradigm presented here is processual and discussion will center on and proceed from an environmental/ecological perspective of hunter-gatherer adaptive systems. Many of the arguments presented here are considered controversial. However, they are explicitly scientific and include implications and hypotheses derived from a substantial body of ecological theory.

If archaeology is to grow beyond its empiricist-particularist stage, then controversy must be seen as an opportunity to learn and to eliminate ignorance about prehistory. Simple tabulations of projectile point types and ceramic styles have never explained any aspect of human evolution and adaptation. This point is especially crucial when we consider that archaeology, and cultural resource management in particular, is under a steady and potentially destructive attack that takes the form of budget cuts and hostile perceptions of archaeology as a superfluous curiosity. The "boom years" of the 1960s and 1970s are over and archaeologists still have done little to demonstrate

their discipline's relevance to the greater scientific community or society at large.

Archaeology's ultimate goal should be the explanation of how and why human populations evolve and adapt in the context of changing environmental parameters and ecological dynamics. This goal carries with it an enormous responsibility and implication for understanding not only prehistoric cultures, but extant ones as well. In this vein, this report is offered as a small contribution toward the realization of that goal.

ENVIRONMENT, ECOLOGY, AND ABORIGINAL ADAPTATIONS

Increasingly, archaeological and ethnographic research, particularly in arid environments, has focused on the ecological dynamics of hunter-gatherer subsistence and mobility strategies (Hitchcock 1983; Hunter-Anderson 1986; Osborn 1984, n.d.; Osborn and Hartley 1984; Kelly 1980, 1983; O'Connell 1987; O'Connell and Hawkes 1981, 1984; Simms 1984, 1985; Simms and Isgreen 1984). It has become increasingly evident that hunter-gatherers in arid environments have highly flexible, even complicated, sets of responses and strategies for coping with patchy resource distribution, related to water scarcity, and temporal/spatial incongruities in both plant and animal foods. Prehistoric Anasazi and historic Southern Paiute cannot be categorized simply as sedentary horticulturalists. They most probably had a complex array of strategies ranging from simple foraging to some forms of "tethered nomadism" (Taylor 1964; Binford 1983:341). These strategies, either singly, or in combination, could have been implemented in response to many different environmental variables including fluctuations in resource availability, labor scheduling related to bulk resource procurement, or access to critical non-food resources.

For the arid environment of southern Utah and surrounding areas Osborn (1984) has introduced the concept of "moisture islands" and "island hopping" in the investigation of hunter-gatherer/horticultural adaptations. Essentially, the extremely arid environment of the southern Colorado Plateau and southeastern Great Basin provinces has numerous small mountain ranges which provide "islands" of environmental conditions conducive to fairly intense exploitation by human populations. These "moisture islands," while ecologically patchy, contain resource aggregations of animal and plant foods that would enable mobile human populations to survive on a long-term basis. Many of the aggregated resources, particularly nut and seed resources, could be cached and stored for relatively long periods, enabling hunter-gatherers to gain both time and space utility (Binford 1983:331). Such food caches would serve as a reserve or insurance in case preferred resources were not available in adequate supply (Osborn 1984). Hunter-gatherer populations would be able to ameliorate the often high seasonal fluctuations in the yield and distribution of resources in the patchy arid habitats of the southern Colorado Plateau.

The Markagunt Plateau of southwestern Utah, as well as the Lower Kolob Plateau, represents a "moisture island" that was regularly, and perhaps heavily, exploited by prehistoric aborigines. Evidence indicates that Zion National Park and surrounding lands have been utilized by aboriginal populations from the Archaic Period (8000 B.P.) through the historic time period (Walling et al. 1986). The following discussion will provide information on both general and specific environmental attributes of southwestern Utah and the Cave Valley-Spendlove Knoll area that have affected the use of the area by human

populations. Furthermore, the general ecology of hunter-gatherer adaptations is discussed in order to delineate the possible structure and organization of the subsistence-settlement system of the three sites examined during the 1987 field season.

Precipitation, Temperature, and Climate

The great topographic and climatic diversity of Zion National Park is typical of the arid and semi-arid deserts of the Southwest and Great Basin. Tables 1 and 2 tabulate precipitation and temperature data from 16 stations in southwestern Utah. The selected stations offer a range of elevation, precipitation, and temperature data which are useful in characterizing the environmental and ecological dynamics of the area.

Mean annual precipitation is quite low for all stations, as would be expected in an arid or semi-arid climate (Table 1). However, the relationship between mean annual precipitation and elevation of the recording stations is notable. There does not appear to be a well defined relationship between the annual mean precipitation value and increasing elevation. In other words, the orographic effects of higher elevations do not appear to produce any appreciable increase in precipitation above that which occurs at the lower elevation. A simple linear regression of precipitation and elevation data suggests little correlation ($r = 0.45$; $R = 0.21$; $df = 16$; $p = 0.058$). The linear regression demonstrates a pattern of vertically erratic precipitation. The zonation of plant communities by elevation is probably due less to increased precipitation than to decreased evapotranspiration at higher altitudes.

For the most part, precipitation in the Zion area is insufficient for maize agriculture without irrigation of some type (Stewart and Donnelly 1943). However, seasonality of precipitation has greater affects on the composition of plant communities than mean annual precipitation indicates (Pianka 1978:50). The time that precipitation is available to plants is, in general, more critical than the amount that is available throughout the year.

Pianka (1978:51) states,

> Winter rain is generally much less effective than summer rain because of the reduced activity (or complete inactivity) of plants in winter; indeed two areas with the same annual march of temperature and total annual precipitation may differ greatly in the types of plants they support and in their productivity, depending upon their seasonal patterns of precipitation . . . an area receiving about 50 cm of precipitation annually supports either a grassland vegetation or chaparral, depending upon whether the precipitation falls in summer or winter, respectively.

Table 1. Altitudinal and precipitation data for selected stations in southwestern Utah. Stations are listed by elevation in ascending order.

Station	Elevation (meters)	MAP	RAP Min	RAP Max	PET	Runoff
1. St. George	879	218	90	419	706	30.3
2. Leeds	1,036	336	172	517	668	76.1
3. Hurricane	1,158	281	91	393	---	----
4. Springdale	1,213	373	203	528	706	88.7
5. Cannan	1,524	374	322	465	---	----
6. Orderville	1,600	380	197	619	---	----
7. New Harmony	1,609	556	382	706	---	----
8. Modena	1,666	285	127	483	519	70.4
9. Enterprise	1,753	424	190	597	---	----
10. Cedar City	1,791	339	214	476	569	90.9
11. Pinto	1,800	394	181	650	457	152.9
12. Parowan	1,820	331	179	530	519	95.0
13. Pine Valley	1,951	483	319	665	---	----
14. Ranch	2,042	619	380	885	---	----
15. Panguitch	2,042	252	152	379	395	----
16. Hatch	2,134	287	172	431	---	----

MAP= Mean annual precipitation, mm.
RAP= Range annual precipitation, mm.
PET= Potential evapotranspiration, mm.

Table 2. Temperature data in degrees Celsius for selected stations in southwestern Utah. (From U.S.D.A., Weather Bureau Climatic Summary Of The United States 1936.)

Station	Elevation (meters)	MAT	MACM	MAWM	FFD	ET
1. St. George	879	15.3	3.3	28.3	186	14.4
2. Leeds	1,036	14.3	2.3	26.9	203	14.1
3. Hurricane	1,158	N.A.	N.A.	N.A.	N.A.	----
4. Springdale	1,213	15.3	3.9	27.5	190	14.4
5. Cannan	1,524	N.A.	N.A.	N.A.	N.A.	----
6. Orderville	1,600	N.A.	N.A.	N.A.	N.A.	----
7. New Harmony	1,609	N.A.	N.A.	N.A.	N.A.	----
8. Modena	1,666	8.8	-2.9	21.7	131	12.9
9. Enterprise	1,753	N.A.	N.A.	N.A.	N.A.	----
10. Cedar City	1,791	10.5	-0.5	23.2	144	13.3
11. Pinto	1,800	7.1	-3.0	19.2	79	12.4
12. Parowan	1,820	9.3	-1.9	21.6	123	12.9
13. Pine Valley	1,951	N.A.	N.A.	N.A.	N.A.	----
14. Ranch	2,042	N.A.	N.A.	N.A.	N.A.	----
15. Panguitch	2,042	5.6	-6.7	17.5	80	11.9
16. Hatch	2,134	N.A.	N.A.	N.A.	N.A.	----

MAT= Mean annual temperature, degrees Celsius.
MACM= Mean annual coldest month, degrees Celsius.
MAWM= Mean annual warmest month, degrees Celsius.
FFD= Frost free days or growing season.
ET=Effective temperature, degrees Celsius.

Precipitation in and around the Park comes in the forms of summer thundershowers and winter frontal storms (Hamilton 1984:9). Since winter precipitation in the area would be largely unavailable for plants due to their winter dormancy, the summer monsoonal thunderstorms become absolutely critical for growth of wild plants and cultigens. The pattern of precipitation then, is for monsoonal thunderstorms largely during the months of July, August, and September, and frontal precipitation from November through February (Hamilton 1984:10). Frontal precipitation, while not playing an immediate role in plant growth in the general region, is the largest moisture component in the hydrologic regime of Zion National Park. In the higher elevations of the Park, snowmelt from the frontal precipitation recharges the groundwater, streams, and springs. Thus frontal precipitation is as critical for animal and human populations as the monsoonal moisture is for plant communities. While monsoonal precipitation ultimately contributes to plant production, frontal precipitation creates the abundance and distribution of water as a critical resource.

There are numerous sources of water within the Park including springs, seeps, streams, and former lakes. The Virgin River is the most obvious water source in Zion National Park. However, other small streams including La Verkin Creek and North Creek were probably of greater importance to prehistoric groups. Such perennial and intermittent water sources were important factors in determining settlement locality by both hunter-gatherers and horticulturalists. Insufficient moisture in these "moisture islands" or upland areas could have brought about the need for complex mobility and subsistence strategies to offset such failures.

The fluctuation of the mean annual range of precipitation is even more radical than that of elevational differences (Table 1). This fluctuation can have devastating effects on wild and domesticated plant production. Given these fluctuations hunter-gatherers would have had to monitor their environment very closely. However, mean annual rainfall and its variability are only crude measures of ecological variables.

Other measures of ecological and environmental variability are much more appropriate than dealing with precipitation and its relationship to hunter-gatherer adaptations. Mean annual temperature appears to be more sensitive to elevational differences than the same measure of precipitation (Table 2). Temperature readings for the mean annual coldest and warmest months reveal that the climate of southwestern Utah is extreme in both spatial and temporal terms. The average number of frost-free days recorded at each station presents an idea of the average length of the growing season in southwestern Utah (Table 2). It appears that cultigens could have been grown at higher elevations such as Parowan, Utah, with an average frost-free period of 123 days. However, the determination of growing season is more complex than these figures indicate.

Chang (1968:77) reports that maize agriculture requires 110 frost-free days and a mean temperature of 10 degrees Celsius. Therefore, gross precipitation or temperature duration is not as critical for maize production as the timing of these variables in relation to the developmental stages of Zea mays. Climatic data from the station at Springdale, Utah (1,210 m a.s.l.), near the southern Park entrance, indicates that the frost-free season lasts from May 10 to October 4. This frost-free period is sufficient for maize horticulture. As the elevation increases there is a marked reduction in the number of days between killing frosts. For example, Parowan, Utah (1,820 m a.s.l.), has an average frost-free season that lasts from May 27 to September 27; the minimum frost-free season extends from July 3 to September 5. The predictability of the critical temperature and precipitation variables is tenuous. As a result, maize horticulture was most probably not a significant component of prehistoric subsistence.

Such spatial and temporal variability in the climate of southwestern Utah would have necessitated that aboriginal populations rely on two strategies to cover the risk of plant food failure, i.e., adjustments in mobility and storage of food resources.

The environs of Zion National Park demonstrate substantial variability in seasonality of precipitation and temperature, and in essence, create a multitude of ecological problems which prehistoric populations had to confront. This variability can be seen in three dimensions, i.e., time, space, and degree of effect. By using Park weather data and Holdridge's (1967 in Pianka 1978:67) classification system of climate and vegetation, this area can be described as a cool, temperate-desert scrub. However, this classification obscures the climatic and vegetational variability that characterizes the region. The climatic data as presented do not account for the array of adaptive problems that confronted prehistoric peoples in southwestern Utah. At this point, it is necessary to examine the ecology of southwestern Utah in terms of hunter-gatherer adaptive systems. Essentially, the following discussion will examine the relationships between the environmental factors of effective temperature (ET), primary biomass, runoff, and prehistoric aboriginal populations.

Effective Temperature, Primary Biomass, and Runoff

Scientific research requires that investigators employ measures of variability expressed in a common observational language. In order to construct frames of reference, one must initially have an idea of which variables are meaningfully correlated and how these variables are measured.

Effective temperature, primary biomass, and runoff are environmental measures relevant to our investigation of hunter-gatherer adaptations in southwestern Utah. Ultimately, these ecological measures can provide information about the climatic

conditioners, primary and secondary biomass, and net above ground productivity (NAGP) of various types of biological communities and habitats (Odum 1971; Pianka 1978; Ricklefs 1979). They are extremely relevant to the determination of the "resource structure" of a given environment (Binford n.d.; Kelly 1980). The resource structure, in turn, will condition the strategies and tactics of mobility and location of hunter-gatherer populations (Binford 1983; Hunter-Anderson 1986).

Effective temperature (ET) (Bailey 1960) is essentially,

> . . . a measure of both the length of the growing season and the intensity of solar energy available during the growing season. Since biotic production is primarily a result of solar radiation coupled with sufficient water to sustain photosynthesis, we can expect a general relationship to obtain between ET value and global patterns of biotic activity and hence production . . . in a very simplistic sense we might expect 'food rich' environments when ET is high and 'food poor' environments when ET is low (Binford 1983:349).

In calculating ET, two variables are employed. The equation is as follows (Binford n.d.; Hunter-Anderson 1986:132):

$$ET = \frac{(18\ (\text{mean WM})) - (-10\ (\text{mean CM}))}{(\text{mean WM} - \text{mean CM}) + 8}$$

where: mean WM = the mean temperature of the warmest month;
mean CM = the mean temperature of the coldest month
(in degrees Celsius).

Thus, we have a method for characterizing given environments which measures the relationship between the "total amount and yearly distribution of solar radiation characteristic of a given place" (Binford 1983:349). Effective temperature (ET) values also serve as a constant of solar radiation that will be used later in this discussion.

The effective temperature (ET) values from the eight weather stations surrounding Zion National Park range from 14.4 to 11.9 (Table 2). The Cave Valley-Spendlove Knoll area is situated at an elevation of approximately 1,900 m. Extrapolation from the elevational and ET data in Table 2 revealed the Cave Valley-Spendlove Knoll area has an ET value equal to 12.0 to 12.5.

Net above ground productivity (NAGP) and primary and secondary biomass have been calculated by Whittaker (1975; Pianka 1978:48) for the major biomes and ecosystems of the earth. These variables are instructive in looking at the resource structure and accessibility in the Park. These variables also enable us to understand the ecological patchiness of this general region. Whittaker (1975) has established that mean annual precipitation

is strongly correlated with NAGP and Binford (n.d.; Kelly 1980:13-18) has noted a similar correlation with rainfall runoff. While many other factors play a role in the calculation of NAGP it can be generally stated that the NAGP for the Zion National Park region is within the desert scrub ecosystem which ranges from 10-250 dry grams per square meter per year. Various localized habitats within the region would, of course, range higher, such as the pinyon-juniper and coniferous forest zones. However, with the exceptions of cultivated fields, small patches of deciduous forest, and marshes, the NAGP would rarely be above 500 dry grams per square meter per year.

Hunter-Gatherer Adaptations in Southwestern Utah

Global ethnographic data has been compiled for hunter-gatherers in relation to ET values (Binford n.d., 1983:349-353; Kelly 1980). The results of these studies are presented in Table 3.

Table 3. Settlement Pattern and ET for selected ET values (from Binford 1983:350, Table 23.2).

ET Range	Fully Nomadic	Semi-Nomadic	Semi-Sedentary	Sedentary
15 - 14	9.3%	65.6%	9.3%	15.6%
13 - 12	7.5%	60.3%	22.6%	9.5%
11 - 10	11.1%	46.6%	26.6%	15.4%

The column headings, e.g., fully nomadic and semi-nomadic, are qualitative assessments of the mobility strategies of the world's hunter-gatherers ranging from foragers (fully nomadic) to collectors with extreme logistical strategies (sedentary) (see Binford 1983). The greatest proportion of hunter-gatherers in the ET ranges characteristic of southwestern Utah are categorized as semi-nomadic (Table 3). This categorization implies that some degree of logistical strategies are incorporated in the overall subsistence-settlement system.

While this broad empirical generalization implies a logistically organized subsistence system, two other factors will condition the need for such a system. First, southwestern Utah has a well-defined winter season at which time plant production ceases and food resources are temporally incongruous. This temporal incongruity creates an overwintering problem (Binford 1983:351). And, second, the environment is patchy and exhibits spatial incongruity of resources. These two factors have a

synergistic effect on each other and amplify the problem of establishing residential locations for utilization of the minimum amount of critical food and non-food resources. Empirically, ethnographic hunter-gatherer studies indicate that temporal and spatial incongruities in resource distribution exacerbate one another and require the adoption of logistical strategies and food storage. However, storage implies that there are bulk resources to be found in the environment that can be efficiently procured and processed in sufficient quantities to alleviate the overwintering problem. As will be demonstrated later, this is the case for Zion National Park.

The extremely low NAGP for the region surrounding the Park has significant implications for primary and secondary biomass and its accessibility to hunter-gatherer populations. Accessibility of plant and animal resources to hunter-gatherer populations is a factor conditioned by the nature of primary productivity and primary biomass of the environment (Binford n.d.; Hunter-Anderson 1986; Kelly 1980). Primary biomass is " . . . the total amount of standing plant material present in a region at a particular point in time" (Kelly 1980:14). The primary biomass quantity of a given area corresponds generally to the amount of precipitation runoff (Binford n.d.; Kelly 1980). Runoff values for the Zion region are extremely low signifying low primary biomass (Table 1). Generally, low primary biomass environments also have correspondingly low secondary (animal) biomass. Exceptions to this generalization can be found away from the equator in the temperate zones where environmental patchiness and seasonality increase and animals are quite often aggregated. Seasonality, of course, is also a factor in the aggregation of plant food resources. Such anomalous conditions most decidedly characterize the region surrounding the Park.

Several expectations can be derived from the previous discussion of the nature of prehistoric settlement-subsistence systems in the Zion region. First, the environmental attributes and ecological variables of the region demonstrate both temporal and spatial incongruity in distribution of critical limiting resources, e.g., bulk foods, water, and growing season. Therefore, it is expected that prehistoric populations employed a mixed subsistence-settlement system with varying emphasis on logistical and storage strategies due to variable environmental and ecological factors during the course of an annual cycle, e.g., droughts and fluctuations in growing season length. The critical factor in the utilization of logistical/storage strategies is the way in which the overwintering problem in the region had to be handled.

Binford (1983:351; emphasis in original) states,

> Basically three methods are available: (a) exploiting species who have themselves solved the overwintering problem (that is hunting other animals); (b)storing edible products accumulated largely during the growing season; or (c)storing

density and hence availability. **Although we must recognize that storage may not always be feasible, the degree to which it will be practiced can be expected to vary with decreases in the length of the growing season.**

Second, given the use of logistical strategies by the prehistoric populations in the region one might expect that there will be " . . . regular environmentally correlated patterns of intersite variability deriving from increases in the number and functional character of special-purpose sites" (Binford 1983:356). Also, Binford (1983:356) points out that, " . . . the more specialized character of resource 'targets' . . . [leads us to] . . . expect an increase in the redundancy of the geographic placement of special purpose sites . . . . "

And finally, horticultural strategies will be selected when the problems of locating residential and logistical sites cannot be overcome by mobility strategies.

The previous discussion has been formulated on a large global scale. Relationships between hunter-gatherer settlement-subsistence systems, environment, and correlated ecological dynamics have been described in terms of global and regional patterns. However, the three small "sites" located in Cave Valley must be analyzed on a more appropriate scale. It is now necessary to shift from the discussion of general land use and mobility strategies of global hunter-gatherers to the examination of specific resources and how their utilization conditioned the nature of the archaeological record in the region and in the Cave Valley-Spendlove Knoll area.

Habitat and Resources

Traditionally, archaeological reports contain requisite sections listing the flora and fauna of the area surrounding the site and often palynological, ethnobotanical, and osteological summarizations of the types of pollen, seeds, and bones recovered from the site. Unfortunately, this approach provides little, if any, substantive linkages between presence of subsistence remains and the dynamics that produced them. Even more unsettling is the common practice of determining, on the basis of a few seeds or pollen samples, the importance of various resources in the prehistoric diet. There simply are no productive methodologies at this time from which such determinations can be made. This problem also exists in faunal analysis; however, it is not so critical.

There are approaches, based in ecological theory, that show much promise in alleviating this problem. Such approaches may also provide explanatory frameworks that can be tied systematically to more general discussions of hunter-gatherer adaptations. A quantitative assessment of the floral and faunal resources of the Cave Valley-Spendlove Knoll area does not exist.

However, a qualitative discussion of the modern resources found there should serve as the basis of the possible prehistoric resource structure of the area.

The diversity of floral communities within the Park and surrounding region is well documented (Walling et al. 1986:32-39; National Park Service 1983:7.1; Westfall et al. 1987:6-7). Archaeobotanical data including pollen and macro-botanical remains is similarly diverse and variable throughout the region (Lindsay 1986; Heath 1986; Hevly and Edwards 1987; Coulam 1984; Madsen 1984). Given the lack of paleoenvironmental information for Zion National Park, characterization of habitats follows all the caveats that have been presented for reconstructing prehistoric environments from descriptions of modern floral communities. Therefore, the purpose here is to suggest patterns of possible floral and faunal exploitation in the area.

The western edge of the Markagunt-Kolob Plateau region can be divided into four general environmental zones including desert, pinyon-juniper, pine-oak, and fir-aspen "belts" (Figure 2). Within these zones are various patchy habitats which could have been important subsistence sources for prehistoric aboriginal populations. These zones are not intended to convey the impression that habitat distinctions are clear cut and invariable, on the contrary, the opposite is true. However, the zones do tend to have certain plant and animal resources that are more pronounced than others. Detailed listings and descriptions of flora of the Park and the surrounding region can be found in other sources (Connor and Vetter 1986; Walling et al. 1986; Simms and Isgreen 1984). The list of plant and animal resources of potential economic importance to prehistoric populations is extensive, but methods to measure that importance are not readily available.

A list of subsistence resources generally regarded as highly important among Great Basin hunter-gatherers is provided in Table 4. More importantly, these resources are either extant in the Park, or they have been documented in the region. The plant resources listed are specific to the Cave Valley-Spendlove Knoll area. These plants were observed either on the excavated sites or within a one-mile radius of the sites. Cattails, though not observed in the Cave Valley-Spendlove Knoll area, were observed along the Virgin River in Zion Canyon. They are included in this listing because of their possible presence at the nearby Hop Valley Lake (Hamilton 1984:56-58; Figure 1). All of the resources listed, with the exception of prickly pear cactus and yucca, could have served as storable bulk resources. The presence of ground stone, particularly at 42WS2216, indicates that the processing of seed/nut resources had been conducted there. Furthermore, the caves of Cave Valley and particularly the cave sites, 42WS202 and 42WS203 (Aikens 1965), at Lambs Knoll at the southern end of the valley, attest to the presence of storage facilities in the immediate vicinity. No large pinyon

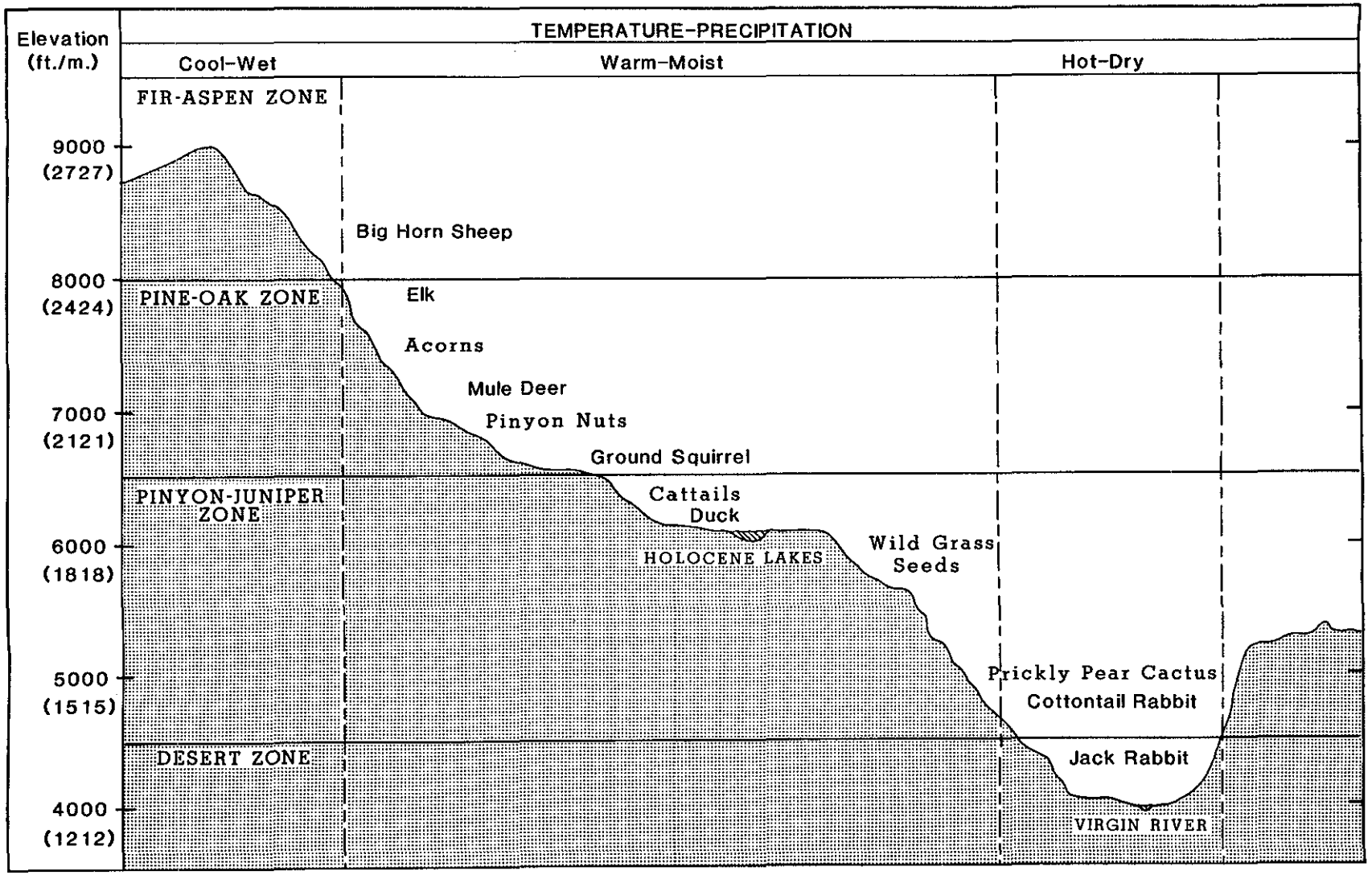


Figure 2. Generalized habitats and resource patches in relation to elevation in Zion National Park.

Table 4. Potential plant and animal resources for prehistoric groups in the Cave Valley-Spendlove Knoll area.

Species	Type of Resource	Season of Availability
Quercus gambellii (Gamble's Oak)	acorns	fall
Pinus monophylla (Pinyon pine)	nuts	fall
Elymus cinereus (Gt. Basin wild rye)	seeds	summer - fall
Oryzopsis hymenoides (Indian rice grass)	seeds	summer - fall
Opuntia sp. (Prickly pear cactus)	fruit	summer
Yucca sp. (Yucca)	fruit	summer
Typha latifolia (Cattail)	roots/pollen	spring - summer
Odocoileus hemionus (Mule deer)	meat/skins	l. summer-e. fall
Ovis canadensis (Bighorn sheep)	meat/skins	l. summer-e. winter
Antilocapra americana (Pronghorn)	meat/skins	l. summer-e. fall
Lepus sp. (Jackrabbit)	meat/skins	spring-l. fall
Sylvilagus sp. (Cottontail rabbit)	meat/skins	spring-l. fall
Citellus sp. and (Large ground squirrel)	meat/seed caches	spring-l. fall
Anas sp. (Ducks)	meat/eggs	l. spring - fall

groves were observed, although Gambel's oak is quite extensive, particularly around Firepit Knoll.

Sites 42WS2215, 42WS2216, and 42WS2217 would have also been in a strategic position for the exploitation of animal resources. The topography of Spendlove Knoll and Firepit Knoll creates something of a bottleneck where large mammals, such as deer, bighorn sheep, and possibly elk, could have aggregated during their seasonal migrations from the grass meadows of the higher elevations of the Kolob Plateau down into Cave Valley, Hop Valley, and Lee Valley. Evidence of large mammals is extensive. In modern times, this area has been observed as being a major migration route and winter range for mule deer. Rock art from Cave Valley and other areas of the Park attest to the presence of bighorn sheep during the prehistoric period (Connor and Vetter 1986). They were probably quite numerous in the Cave Valley area. Little is known about the presence of elk in the area, however an elk bone was recovered from the Lambs Knoll cave sites (Aikens 1965). The exploitation of elk from this location is a possibility worth considering. Burned bone recovered from 42WS2217, if prehistoric, could be an indication of large mammal exploitation at this site. Although Pronghorn probably were not found in the Cave Valley-Spendlove Knoll area, they may have been present in the lower elevations of the open country to the west of the Park.

Smaller animals, such as ground squirrels and rabbits, may have also been important resources in Cave Valley. The presence of sand dunes and their attendant grass species, e.g., Indian rice grass, create optimum environments for rodents. Rodents also create seed caches which, at times, are large enough to be efficiently exploited by humans. Both jackrabbits and desert cottontails were observed in the area in considerable numbers. Jackrabbits inhabit the more open areas, while cottontails tend to like more covered habitats. Both species could be economically important to human populations in Cave Valley.

The inclusion of ducks in the listing follows the same reasoning as that applied to the previously discussed cattails; the presence of lakes to the north of Cave Valley. Whether ducks were present prehistorically is unknown, however, the exploitation of waterfowl is well documented for Great Basin hunter-gatherers. If they were present, aggregations of ducks during the summer molt could have been an important resource.

The list of potential floral and faunal resources presented here may seem somewhat attenuated when compared to other such listings which are exhaustive in covering every possible edible species, e.g., Steward (1938). These resource patches were highly aggregated resources, particularly during the fall season. The distance between these patches was not great and they overlapped in many instances. However, these resources were likely the "target resources" which could provide the minimum required subsistence levels for alleviating the overwintering problem either through storage or logistical strategies.

Simms (1984, 1985) has developed a middle range approach to address the problem of determining the importance of various resources in prehistoric subsistence systems. His perspective is derived directly from the body of theory of evolutionary ecology (Simms 1984; O'Connell et al. 1982; Winterhalder and Smith 1981). In particular, he has chosen to apply optimal foraging models (MacArthur and Pianka 1966; Charnov 1976; Charnov and Orians 1973; Krebs et al. 1981; Krebs et al. 1983) to the problem of subsistence resource acquisition in the Great Basin. Again, an in-depth examination of ecological theory is not the goal of this report and the reader is referred to the sources cited previously.

Optimal foraging models are seen here as a way of characterizing the resource structure of the region and of seeking patterned information that can be linked back to the previous discussion of hunter-gatherer subsistence-settlement systems and archaeological expectations.

Simms (1984, 1985) opted to apply an optimal foraging model known as the "diet-breadth model" to the study of prehistoric subsistence in the Great Basin. Simms (1985:170; emphasis in original) states that, the diet breadth model,

> predicts that in a fine grained environment where resources are encountered at random, a predator will take a resource only if the **handling time** (collecting plus processing time, after the resource has been encountered) is less than those of alternative resources. This model can be used to predict the order in which resources will be added to or deleted from a changing diet.

Further predictions were developed by Simms (1985:170) for his archaeological study of pinyon exploitation in the Great Basin (emphasis by Simms):

> 1. High-ranking [relatively inexpensive] resources will always be taken when they are encountered. This implies that even a **very rare** item may be taken if it is highly ranked [Royama 1970].
>
> 2. The inclusion of lower-ranked resources in the diet will depend **not on their own abundance, but on the abundance of higher-ranked items.**
>
> 3. As the abundance of higher-ranked items decreases, lower-ranked items will be included in the diet. Conversely, as the abundance of higher-ranked items increases, lower-ranked items will be excluded from the diet **no matter how abundant they are** [MacArthur and Pianka 1966; Emlen 1966; Schoener 1971; Charnov and Orians 1973].

As Simms (1985:170) cautions, it is important to understand that "the diet-breadth model does not predict the dietary importance of a particular resource. Rather, it predicts the order in which resources will be added to the diet."

These predictions have implications for the exploitation of the various resource patches in the Cave Valley-Spendlove Knoll area (Table 4). The resources are ranked with respect to their return rates in Table 5. They are all highly ranked and are quite possibly the "target resources" that drew aboriginal populations to the area.

The Cave Valley-Spendlove Knoll area includes a suite of vegetative patches, i.e., Gambel's oak, pinyon, wild rye, and rice grass, that would be attractive to many mammal species at certain times of the year. Specific patches are determined by topography, elevation, soils type, and decreased evapotranspiration.

Hunter-gatherer and horticultural groups were certainly aware that several different "package sized" mammals habitually used the patchy or mosaic vegetation of the region at specific times of the year. These various mammals were either killed or monitored near these sites. For example, rodents would tend to have higher and more concentrated populations in the grass species patches on the sandy soil of Cave Valley. Deer and bighorn sheep would also be concentrated in the area during their annual fall migrations from higher elevations.

The study area does contain the requisite resources to overcome an overwintering problem including hunting (logistical strategy) or plant storage (storage strategy). Both strategies could have been employed singly or in combination given the variable state of localized ecological dynamics and the subsistence state of local hunter-gatherer populations (Binford 1978). Under favorable conditions subsistence strategies more characteristic of the foraging end of the foraging/collector continuum were probably used. Some sites in the area could have played a role in residential mobility in contrast to logistical mobility (Binford 1983:339). Neither adaptive strategy is mutually exclusive.

Simms' diet breadth model provides several implications for resource ranking and characterization of the environmental attributes specified for the Cave Valley-Spendlove Knoll area. First, it may seem from appearances that this area represented a "Garden of Eden" to aboriginal peoples. It must be remembered, however, that this environment is ecologically patchy and environmental conditions are erratic. At particular seasons, the Cave Valley-Spendlove Knoll area was probably important to prehistoric populations as a focus for animal resources. If fluctuations occurred in the animal populations, plant resources would become more important in the diet given their lower return rate relative to animals. In addition, plant foods would be included in the diet in differential proportion to the

Table 5. Ranked food resources available to prehistoric hunter-gatherer and horticulturalist populations of the Zion National Park region (Simms 1984:93-94).

Rank	Resource	Type	Return Rate (1)
1	Deer/Bighorn Sheep	animal	17,971 - 31,450
2	Antelope	animal	15,725 - 31,450
3	Jackrabbit	animal	13,475 - 15,400
4	Gophers (2)	animal	8,983 - 10,780
5	Cottontail Rabbit	animal	8,983 - 9,800
6	Cattail	pollen	2,750 - 9,360
7	Ground Squirrel (3) (Large)	animal	5,390 - 6,341
8	13 - Lined Ground Squirrel	animal	2,837 - 3,593
9	Ducks	animal	1,975 - 2,709
10	Gambel Oak	acorns	1,488
12	Pinyon Pine	nuts	841 - 1,408+
17	Bulrush	seeds	1,302 - 1,699
22	Great Basin Wild Rye	seeds	266 - 473
23	Indian Rice Grass	seeds	301 - 392
28	Cattail	seeds	128 - 257

(1) Return rate expressed in calories per hour.

(2) Thomomys sp.

(3) Citellus sp. and Spermophilis sp.

accessibility of animal foods. Therefore, we would likely see a correspondent differentiation in the types of sites that occur in the area.

Therefore, artifact assemblages should reflect a greater role for exploitation of animal resources than plant resources. However, given the need to obtain and process storable resources it can also be expected that plant processing technology will be no small component of the sites in the area. Thus, assemblage variability relates directly to seasonal variability. In addition, the location of sites would be made with a preference for those areas in which animals could be taken.

SITE DESCRIPTIONS AND STRATIGRAPHY

All three sites are on the east side of Cave Valley. Cave Valley is on the Lower Kolob Plateau (Figure 3), a part of the greater Markagunt Plateau. This general area has experienced considerable tectonic and volcanic activity over the millennia as evidenced by the faults and basalt flows which are conspicuous features of the landscape (Hamilton 1984). To the west of the site area lies the West Cougar Mountain Fault, which forms the western side of Cave Valley, and the Hurricane Fault which demarcates the western boundary of the Markagunt Plateau. To the east, the East Cougar Mountain Fault separates Cave Valley from Lee Valley (Hamilton 1984:100). Associated with the East Cougar Mountain Fault are the Spendlove Knoll and Firepit Knoll cinder cones. Sites 42WS2216 and 42WS2217 are situated on the south sloping flanks of Spendlove Knoll on aeolian sand which covers the basalt ridges extending from the extinct cone. Perennial springs were observed along the Navaho sandstone cliffs on the east side of Cave Valley and slightly further east in Lee Valley. Wolf Springs Wash and other springs provide additional sources of water for the area.

To the northwest of Spendlove Knoll lies Hop Valley where a rather large lake was formed due to a massive landslide approximately 1,500 years ago (Figure 1). Some of the sediments date to 670 ± 200 years B.P. (Hamilton 1984:56-57). Several other older Holocene lakes once existed in this area. However, no dates are given for most of them. An exception is Paria Lake dated to 3610 ± 300 years B.P. (Hamilton 1984:58). The importance of these lakes to the aboriginal populations of the area is, as yet, undetermined.

The following stratigraphic descriptions and profiles are intended to provide a general composite of the sedimentary matrix of each site. Given the small areas exposed, these descriptions are the best approximation of structure and content of the strata of the site sediments. However, the descriptions are not intended to be definitive statements on the geomorphological processes responsible for the development of the landforms on which the sites were situated.

The three sites were previously surveyed and recorded in August, 1986, by G. Dalley and D. McFadden of the Cedar City District, Bureau of Land Management. Their observations are noted in the following site descriptions.

42WS2215

Site 42WS2215 was a chipped stone and ground stone scatter on the west edge of a small sand dune located near the east side of Cave Valley (Figures 4 and 5), 695 m south of 42WS2216. Elevation of the site was approximately 1,835 m (6,020 ft). The total areal extent of the dispersed artifacts was 800 square

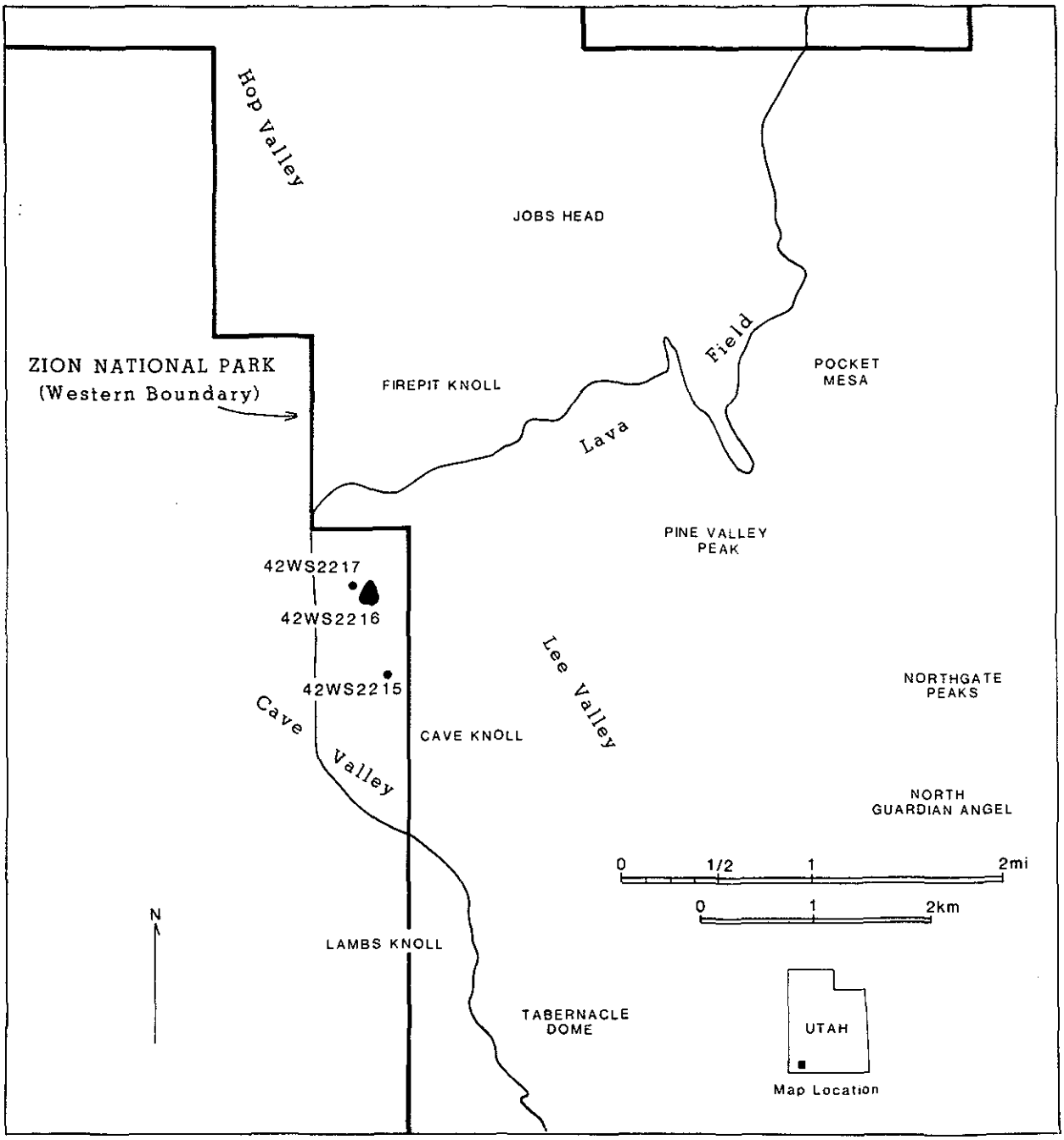


Figure 3. Location of investigated sites in relation to local topographic features.

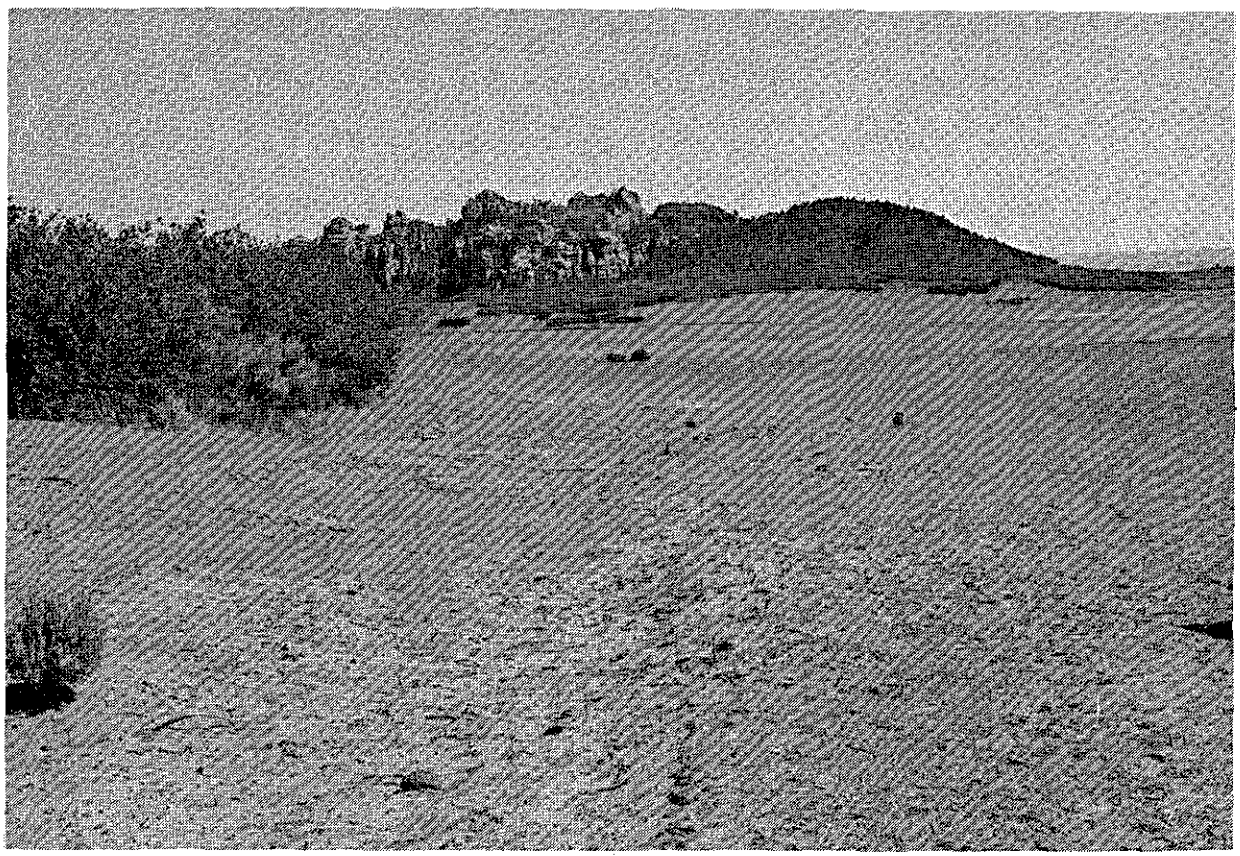


Figure 4. General view of Site 42WS2215 looking south toward the northwestern portion of Lambs Knoll.

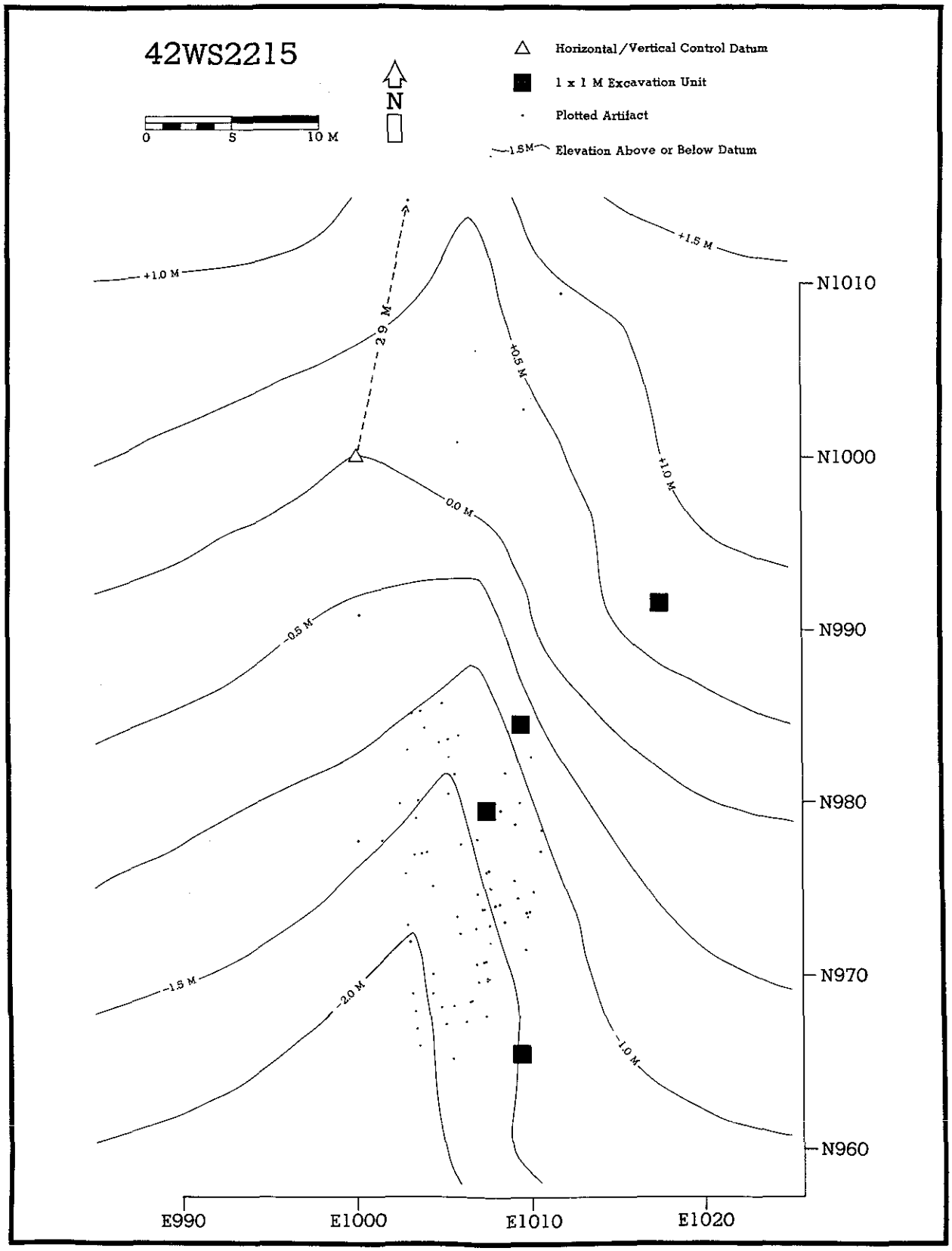


Figure 5. Contour map of Site 42WS2215 and surface artifact distribution in relation to shallow erosional feature.

meters; however, the majority of artifacts was recorded and collected from a 200-square-meter concentration near the southern end of the site.

Relatively recent natural and cultural disturbances to the site were indicated by a small erosion channel that flowed southward through the middle of the site to a small man-made dike. Deflation of the west side of the dune was also apparent. An old agricultural field bounded the site on the west and north. Artifact collectors may have also disturbed the site.

Vegetation on and surrounding the site was predominantly rye grass (Elymus sp.), with lesser proportions of cheatgrass (Bromus tectorum), sagebrush (Artemesia tridentata), Gamble's oak (Quercus gambellii), and service berry (Amelanchier sp.).

Sediments were aeolian sands with poorly developed horizons and little or no soil development. The uppermost stratum (A00) is an unconsolidated aeolian mantle of recent deposition. This layer contains a small amount of undecomposed organic material. Its well defined lower boundary is marked by fine plant roots and a pronounced change in textural consistency of the sediments. Basalt clasts ranging in size from one to six centimeters in diameter were numerous on the surface and within the stratum.

Horizon A0 was slightly more structured and consolidated than the overlying A00. Organic materials were not readily evident under hand lens inspection. The lower boundary of A0 and the upper boundary of A1 were quite distinct and defined by laminae of decomposed organic material. It is believed that these laminations represent episodes of deflation and the removal of surfaces older than the present A00 and A0 layers. A1 may have been, at one time, a permanently moist B horizon as evidenced by the large dead roots in the profile.

Stratum B1 may have also been a permanently moist horizon. It contained several roots over six millimeters in diameter, as well as numerous basalt clasts averaging three millimeters in diameter. All of the horizons were composed of rounded to well rounded aeolian sand with little or no structure and apparently relatively recent in age.

Artifacts recorded by Bureau of Land Management archaeologists in August, 1986, included slab metate fragments, a unifacial chopper, a scraper, and a preform fragment. During site testing in June, 1987, four one-square-meter excavation units were located along the west edge of and on the dune in an attempt to expose intact cultural deposits and to collect information on the stratigraphy of the dune. Materials for radiocarbon samples were virtually non-existent and no samples were collected. There were also no surface or sub-surface indications of cultural features.

42WS2216

This site (Figures 6 and 7) was on a wide ridge extending south from Spendlove Knoll and at an elevation of 1,929 m (6,330 ft). The Navajo sandstone cliff forming the eastern boundary of Cave Valley was approximately 300 m east of the site with a dry stream bed running along the base of the cliff. A small arroyo along the western edge of the site effectively separated it from 42WS2217. The slope of the site varied from approximately four degrees on the lower southern slope and increased accordingly northward toward Spendlove Knoll to approximately seven degrees.

Recent disturbance was evidenced by a narrow dirt road along the north and east boundaries of the site. A well used road and recent cabin structure are located immediately to the south and southeast of the site boundaries. Agricultural disturbances, including brush clearance, plowing, and cattle grazing, have also affected the site. In addition, this site has been extensively collected by artifact hunters. Non-cultural disturbances including deflation and colluvial erosion were also evident.

On-site vegetation was dominated by cheatgrass (*Bromus tectorum*), with lesser proportions of rice grass (*Oryzopsis* sp.), sagebrush (*Artemesia tridentata*), Gambel's oak (*Quercus gambellii*), yucca (*Yucca* sp.), and prickly pear cactus (*Opuntia* sp.), with pinyon (*Pinus* sp.) and juniper (*Juniperus* sp.) higher on the cinder cone.

The stratigraphy of the site revealed a greater thickness of the A horizon when compared to the corresponding horizons of the other two sites. However, this observation may be due more to the small number of excavation units in relation to the larger area of 42WS2216, i.e., a smaller excavation and exposure window. It may also indicate a longer period of stability allowing A horizons to be deposited with little or no deflation between depositional events.

Deflation was apparent in some areas of the site and involved the recent aeolian mantle, Horizon A00, poorly consolidated sand with no apparent structure. The lower boundary was well defined by a relatively dense root mat derived from the grasses covering the slope. Volcanic clasts of basalt and tuff were moderately frequent and ranged in size from four millimeters to four centimeters.

Horizon A0 was aeolian sand with some undecomposed organic matter. Clasts were present, but not to the same degree as the horizon above and below it. The boundary between A0 and A1 was partly defined by an increase in volcanic clasts generally ranging in size from two millimeters to four centimeters, with a few clasts as large as 12 cm. Horizon A1 also revealed a decrease in the proportion of fine roots present. Horizon A2 continued the same general characteristics of the overlying horizon, with a notable increase in the number of large roots and considerably more bioturbation. A moderate structure was present

Figure 6. General view of Site 42WS2216 looking north toward crest of Spendlove Knoll.

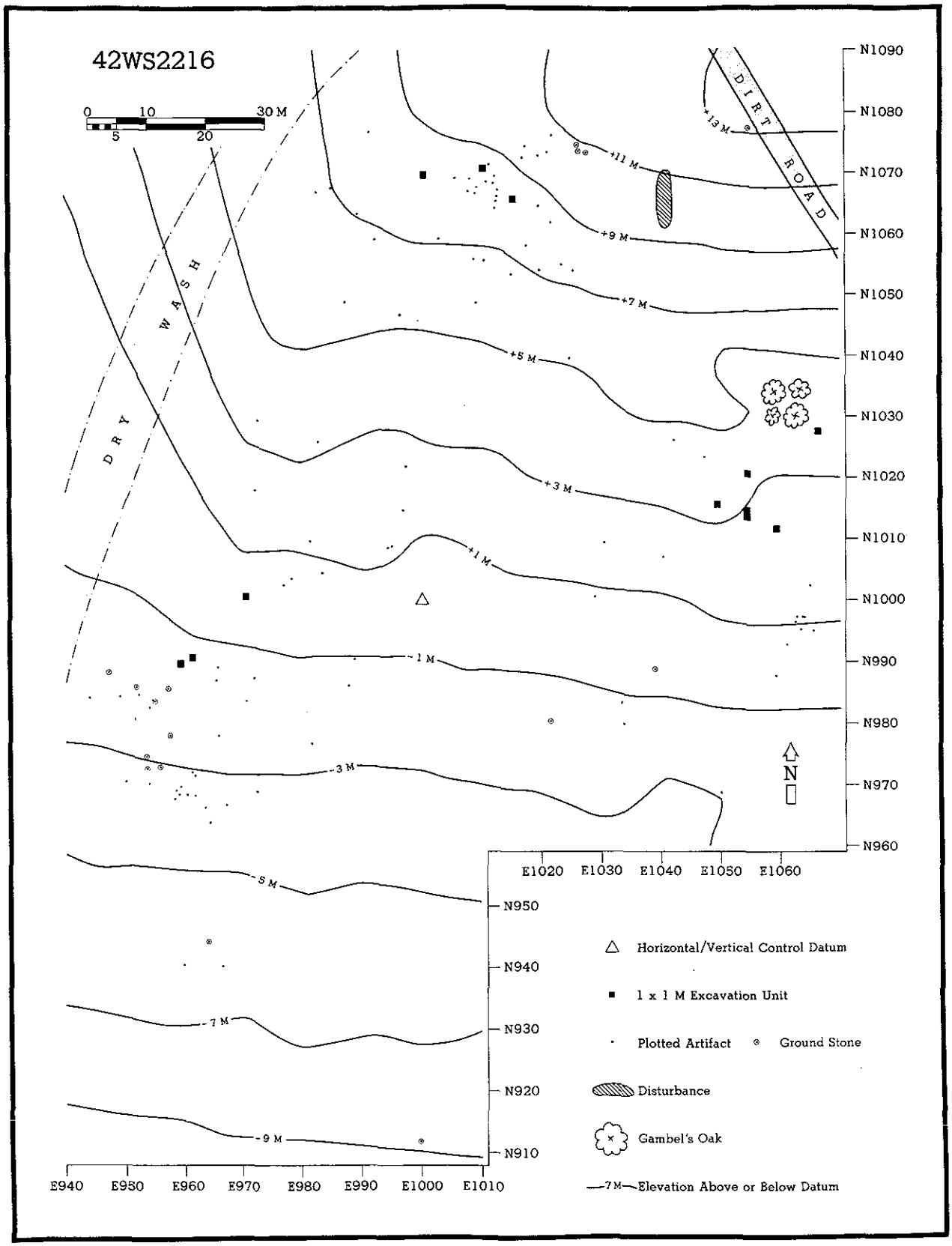


Figure 7. Contour map of Site 42WS2216.

in horizon A3, differentiating it from previous horizons. Horizon A3 may have represented a transitional A-B horizon.

The noticeable cultural attribute of 42WS2216 was the relative abundance of ground stone evident on the upper slope and southwest corner of the site. Chipped stone debitage was also widely and sparsely dispersed. No surface or sub-surface indications of features or structural remains were apparent. Previous BLM recording of the site indicated the presence of a mano, numerous slab metates, a biface fragment, hammer stone, and an Elko Corner-notched projectile point. Total area excavated during the June, 1987, test was 12 one-meter-square units. It was determined from surface collection transects that the total surface scatter of the site was 12,000 square meters.

42WS2217

This site is on the south trending ridges extending from the base of Spendlove Knoll 190 m southwest of 42WS2216 (Figures 8 and 9). Surface artifacts observed were predominantly chipped stone debitage, Southern Paiute brownware sherds, burned bone, and ground stone fragments. Possible structural remains were present in the form of a somewhat linear alignment of basalt boulders (Figure 10). The cultural significance of this alignment remains unknown. No features were found in association with the boulders, and artifacts were quite sparse in the excavated units around the boulders. Although the boulder alignment could have been prehistoric, the presence of a recent building foundation approximately 30 m to the west of the boulders and the road through the site indicates that recent activities may have been responsible for the alignment.

Natural disturbance to the site was evident in active deflation of the sand dune and slopewash. Modern human disturbance to the site was indicated by the building foundation, road, beer bottles, cigarette filters, and rusted cans. In addition, Park rangers and local informants stated that the site had been heavily collected and that "buckets of points" had been removed from it.

On-site vegetation was a fairly dense (Figure 8) combination of sagebrush, Gambel's oak, and pinyon/juniper, with specimens of antelope brush and rice grass also observed.

Sediments were aeolian sand with volcanic clasts, e.g., basalt and tuff, being evident over much of the site. Figure 11 illustrates the considerable amount of disturbance occurring naturally at the site along with evidence of substantial deflation and bioturbation. Horizon A00, the aeolian mantle, was relatively thin ranging from as little as two centimeters to seven centimeters in thickness. In some areas, the A00 horizon was in contact with the A2 horizon (Figure 11). The boundary between A00 and A1 horizons was somewhat indistinct, but nevertheless visible over most of the excavated area. Horizon A1

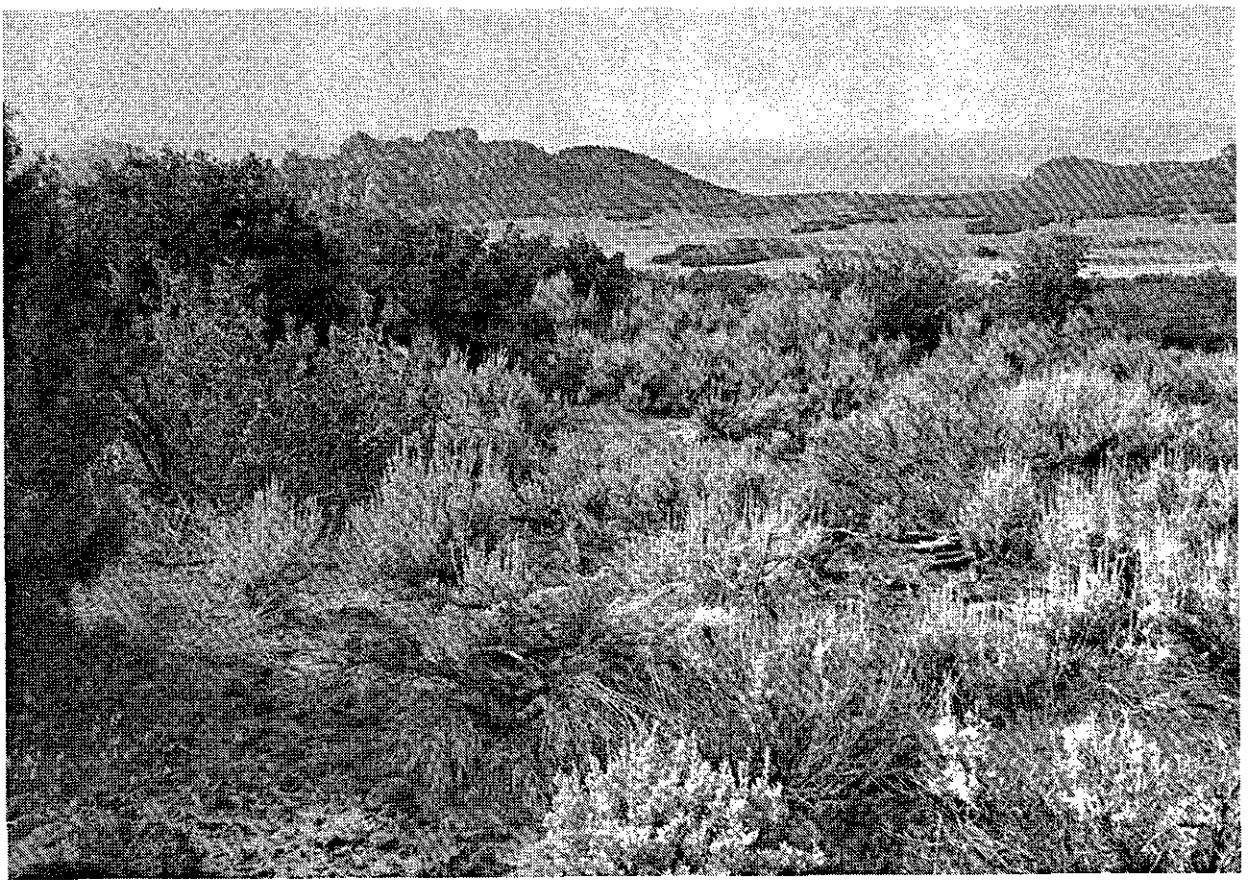


Figure 8. General view of Site 42WS2217 looking south toward the western portion of Lambs Knoll.

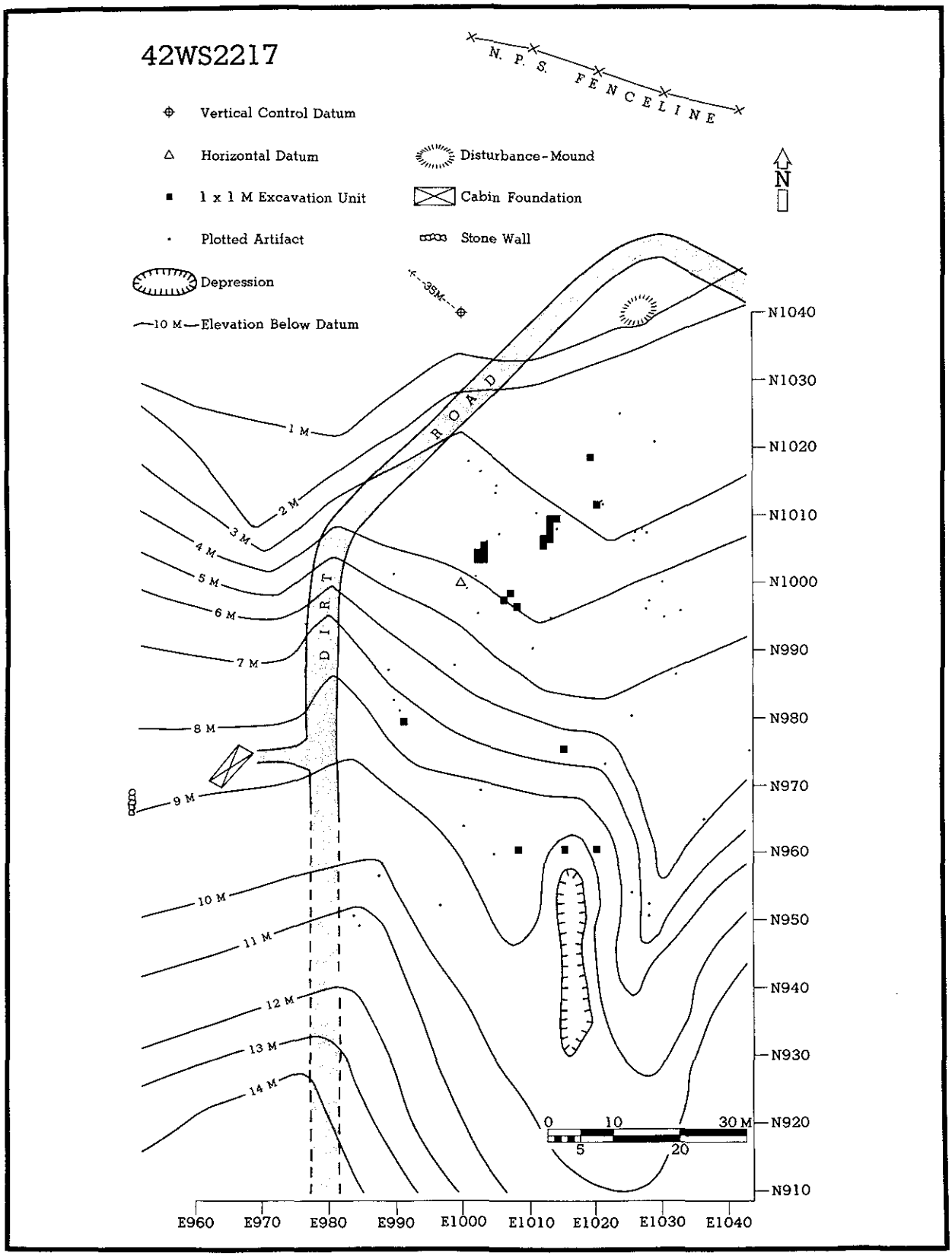


Figure 9. Contour map of Site 42WS2217.

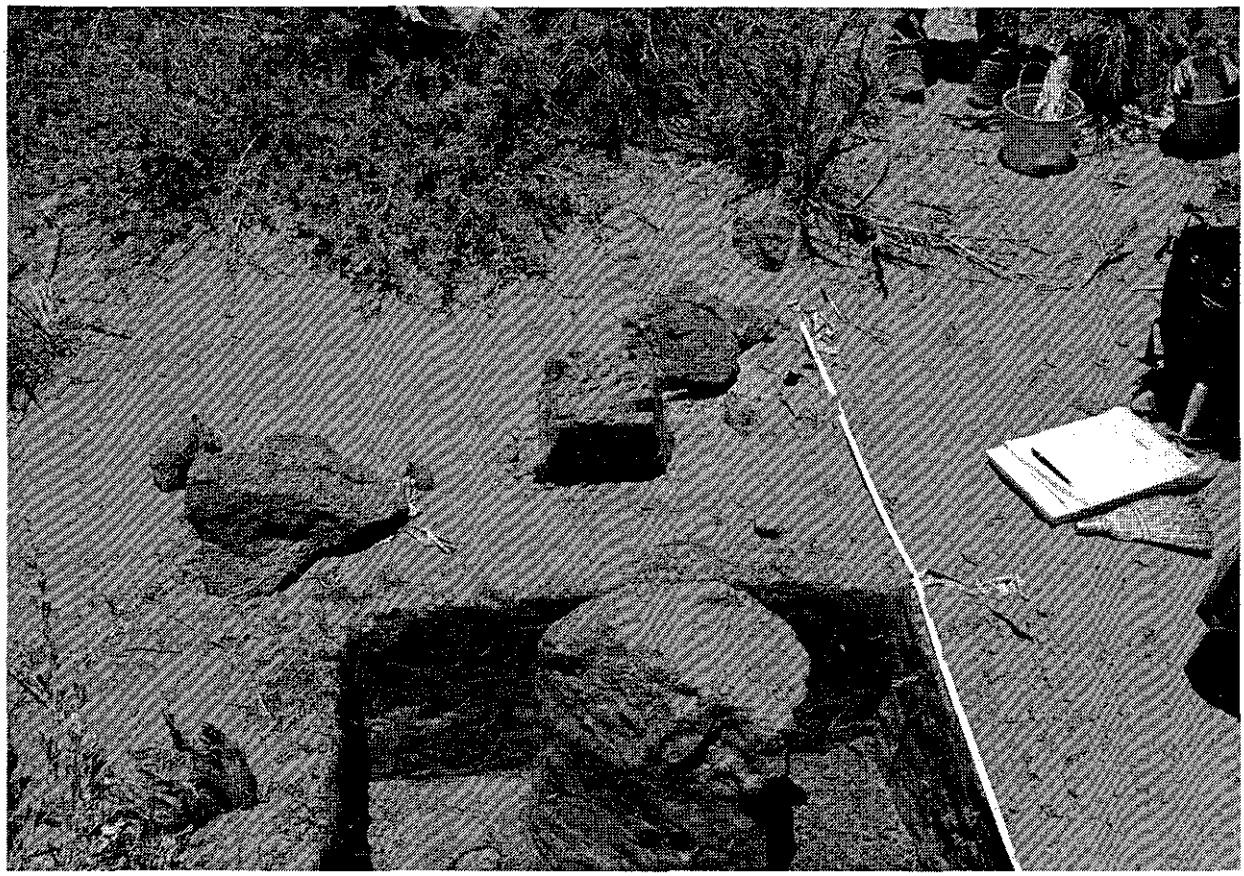
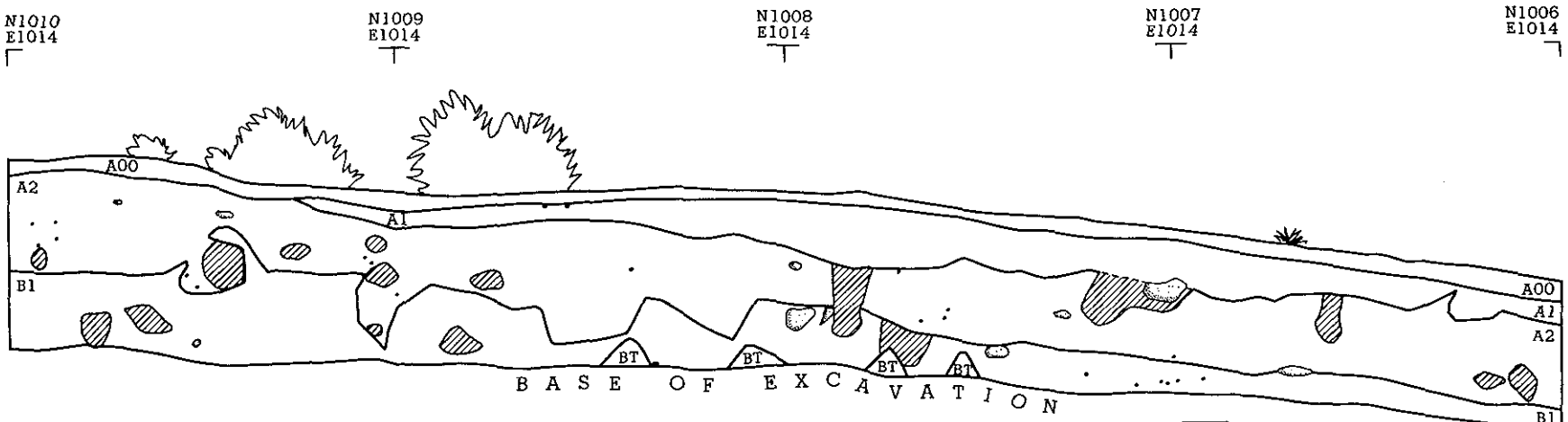
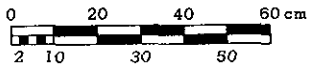


Figure 10. Test excavation of possible boulder alignment at Site 42WS2217.





N

42WS2217

N 51 BLOCK

EAST WALL PROFILE

Krotovina

Root

Rock

STRATA LEGEND

A00 - Aeolian sand, 10YR5/6, in which individual grains are very rounded, with a diameter of approximately 0.25 mm, are well sorted and of approximately the same size. Organic components are predominantly undecomposed, roots, leaves, twigs, etc.

A1 - Aeolian sand, 10YR5/6, grains are well rounded, approximate diameter 0.25 mm, and organics (non-decomposed) comprising 7% of the matrix. This horizon had a very distinct upper boundary comprised largely of thick root mat. Lower boundary was very distinct. Sand was non-sticky, non-plastic, with a weak blocky structure and peds of approximately 2 cm. There were very few clasts and most were less than 1 cm in diameter.

A2 - Well rounded aeolian sands, 10YR3/3, 0.25 mm in diameter with 1% undecomposed organics. Lower boundary was somewhat indistinct where rodent and root disturbance had taken place. The sand was non-sticky, non-plastic with a weak blocky structure and peds of approximately 2 cm. Overall composition included 1 - 2% volcanic clasts ranging from 3 - 4 cm in diameter and 1 - 2% fine roots 3 mm - 1 cm in diameter.

B1 - Sandy silt, 10YR4/6, with a particle size range of 0.1 - 0.25 mm diameter. This was a non-homogeneous zone and was very slightly sticky and very slightly plastic with a moderate blocky structure and peds of 4 - 5 cm. Upper boundary was somewhat indistinct. Volcanic clasts of 5 - 8 cm diameter were associated with the upper boundary and there were numerous roots up to 3 cm in diameter in this highly moist zone.

BT - Very fine aeolian sands, 2.5YR4/8, of 0.1 - 0.25 mm diameter, the larger grains making up approximately 15% of the matrix. Sand was slightly sticky and slightly plastic with strong structure and platy peds up to 5 cm in size. This zone appeared to be indurated with some form of salt. Clasts were virtually nonexistent. This zone was probably permanently moist given the association of large roots at this level.

Figure 11. Stratigraphy of the eastern wall of Block N 51 at Site 42WS2217.

appeared to be of recent deposition due to the presence of undecomposed organics in its sediments. Horizon A2 exhibited heavy bioturbation and an increase in the proportion of volcanic clasts present, as well as fine plant roots throughout. Horizon B1 was distinctive in that it contained a high proportion of silt. The B1 level also exhibited more evidence of bioturbation, an increase in the size and number of plant roots, and a high moisture content. Volcanic clasts decreased in number from the upper to lower boundaries of horizon B1. The BT horizon was likely a permanently moist zone with few volcanic clasts visible. Overall, the successional surfaces of the site have experienced repeated episodes of deposition and deflation as well as a higher level of bioturbation than the other two sites.

Artifacts recovered by BLM archaeologists in 1986 included a fingernail impressed Southern Paiute brownware sherd, a ground stone fragment, chipped stone cores, and a Cottonwood type projectile point base. There were no surface indicators of cultural features, and aside from the previously discussed boulder alignment, no structural remains. Approximate site area was determined to be 2,400 square meters. However, given the impacts by the road and the known intensity of artifact collecting, the site may have been larger in area. Isolated artifacts were also observed over most of the ridge top and arroyos that bordered the site on its east and west sides. Total area excavated in 1987 was 22 square meters.

FIELD METHODS

The major considerations for testing the three sites were to determine the horizontal and vertical extent of the archaeological deposits and the presence of cultural features and structural remains. In general, similar field methods were used for all sites.

A primary vertical and horizontal site datum was first established on each site and pre-excavation photographs of the site and surrounding area were taken. A north-south baseline was established relative to the primary datum to serve as the basis for the surface collection transects and the horizontal provenience grid. Two meter-wide transects were established perpendicular to the north-south baseline in order to ascertain the spatial limits of the site based on surface materials. Transect intervals along the baseline were 10 m and each transect was further divided into 10 m long segments. Transect segments were extended east and west as far as surface artifacts were encountered. This transect grid was designed to provide systematic coverage of the site but it was not intended as a sampling procedure. All artifacts encountered in the transect segments were collected and densities from each segment were then plotted on the site map to determine areas of artifact concentration. Once the transect collections were made and examined, further surface collection was conducted and all visible artifacts were point plotted and collected. Because of its small area, 42WS2215 was completely surface collected and point plotted with no transect grid being established.

Once surface collection and plotting were completed excavation units were selected for their potential of having intact deposits with cultural materials. This was not always an easy task given the largely aeolian sand context of the three sites. Both relatively intact and deflated areas of high and low surface artifact density were excavated to provide information on these types of contexts.

Excavated sediments were initially dry screened through 1/4-inch mesh hardware cloth. However, during the course of excavation at 42WS2216, it was observed that small biface thinning flakes and pressure flakes were probably being overlooked. Finer screen mesh (1/8-inch) was obtained for use during the remainder of the excavations at the three sites. Vertical control was established and maintained throughout the excavations by arbitrary 10 cm levels. Excavation by natural level was also conducted in some units to more carefully define the stratigraphy of the sediments. Descriptive notes, plan maps, and profiles were recorded for each unit. Recovered artifacts were collected by arbitrary level and recorded on both excavation unit forms and artifact catalog forms.

In general all three sites had experienced quite obvious recent disturbance in the form of agricultural use and roads

which ran through or along the edges of the sites. Furthermore, Zion National Park rangers and local informants both stated that past arrowhead collecting on the three sites had been heavy and that "buckets of points" had been removed from 42WS2217.

ARTIFACT ASSEMBLAGES

The following discussion of chipped stone tools, lithic debitage, groundstone implements, and ceramic materials from sites 42WS2215, 42WS2216, and 42WS2217 will focus on pattern recognition. Specifically, artifact assemblage variation will be linked systematically to arguments concerning prehistoric hunter-gatherer adaptations in the region surrounding Zion National Park.

Chipped Stone Tools and Debitage: Description

The analysis of chipped stone tools and debitage was conducted to assess the range of morphological/technological variability of the artifacts, and particularly to ascertain the pattern of tool production and maintenance that had taken place at the sites. The information derived from the analysis is the basis of discussion of technological organization.

The morphological classes of chipped stone tools recovered from the sites are enumerated in Table 6. No tools were recovered from 42WS2215. However, two bifacial tools were recovered from 42WS2216. One is a leaf-shaped, yellow-red chalcedony biface (Figure 12c). The entire edge of this tool exhibits small flake scars produced by minimal retouch. This tool was recovered approximately 20 cm below ground surface. The second tool appears to be the basal portion of a Cottonwood series projectile point (Figure 12d), although, given its size, this tool could also have functioned as a knife. There is no indication of resharpening and the transverse break appears to be an impact fracture. It was manufactured from a low quality grayish-brown chert. It was recovered from the site surface.

Formal tools recovered from 42WS2217 were more numerous. Eleven projectile points were recovered including three Desert Side-Notched projectile points (Figure 13e, g) and eight Cottonwood Triangular points (Figure 12e, f). One distal fragment of a projectile point or perforator was also recovered (Figure 12g). All of the projectile points exhibit some form of impact or manufacturing fracture. The Desert Side-Notched points were made from obsidian and chalcedony while the Cottonwood Triangular points were of obsidian, chalcedony, chert, and quartzitic materials. Two bifacial tools were recovered from 42WS2217. One was of a grayish-white quartzite and was the largest biface recovered from the site surface (Figure 12a). This tool is incomplete and the haft type is unknown. Flake scars occur around the entire circumference. Although this biface might be described as a preform it exhibits a utilized edge indicating that it served as a tool. The function is unknown. (A similar rectangular biface was observed in the Park's collections. It exhibited a side-notched hafting element.) The second biface may have functioned as a cutting tool. It was manufactured from a banded yellow-brown chalcedony.

Table 6. Formal chipped stone tool frequencies and percentages.

Site	Projectile Points	Bifacial Tools	Graver/ Perforator	Unifacial Blades
42WS2215	0	0	0	0
42WS2216	0	2	0	0
42WS2217	11	2	3	1
Totals	11	4	3	1

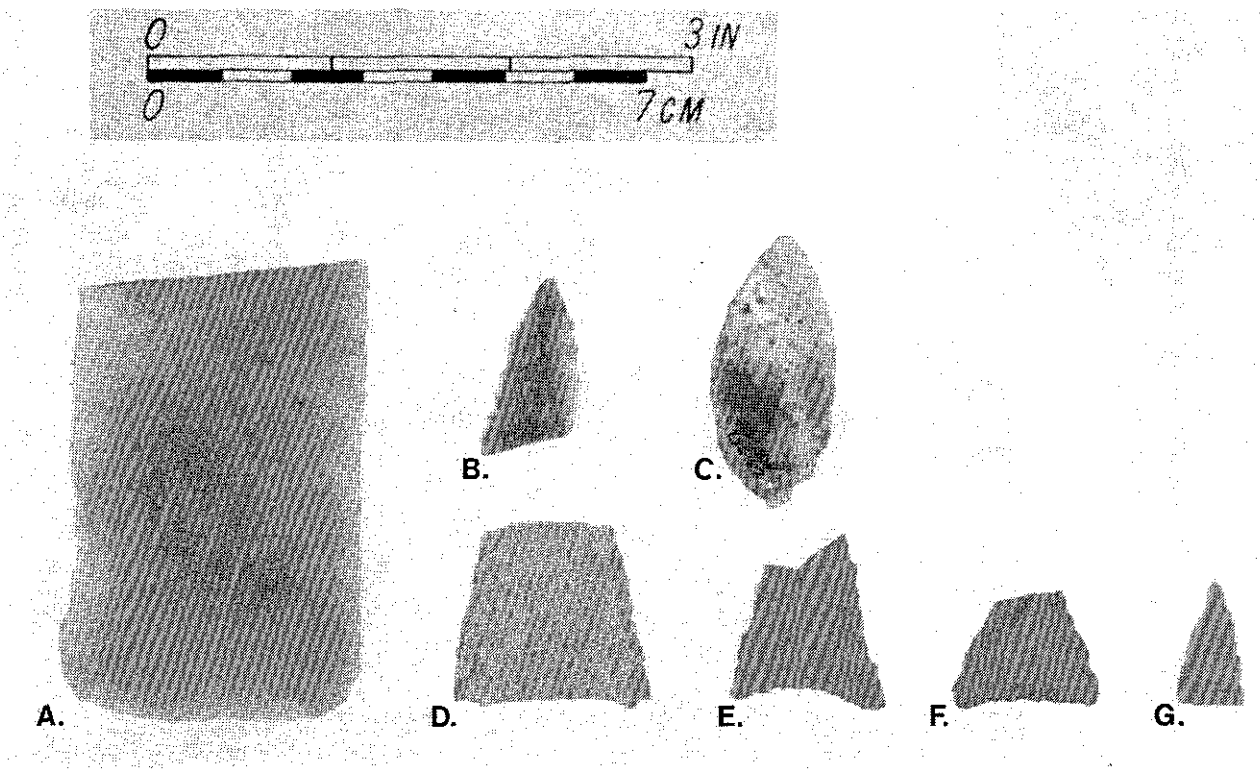


Figure 12. Bifacial tools from sites 42WS2216 and 42WS2217 (a, 42WS2217-PP-14; b,42WS2217-N51-7-5; c,42WS2216-E52-16-2; d,42WS2216-PP-60; e,42WS2217-N51-17-14; f,42WS2217-L50-18-6; g,42WS2217-T458-2).

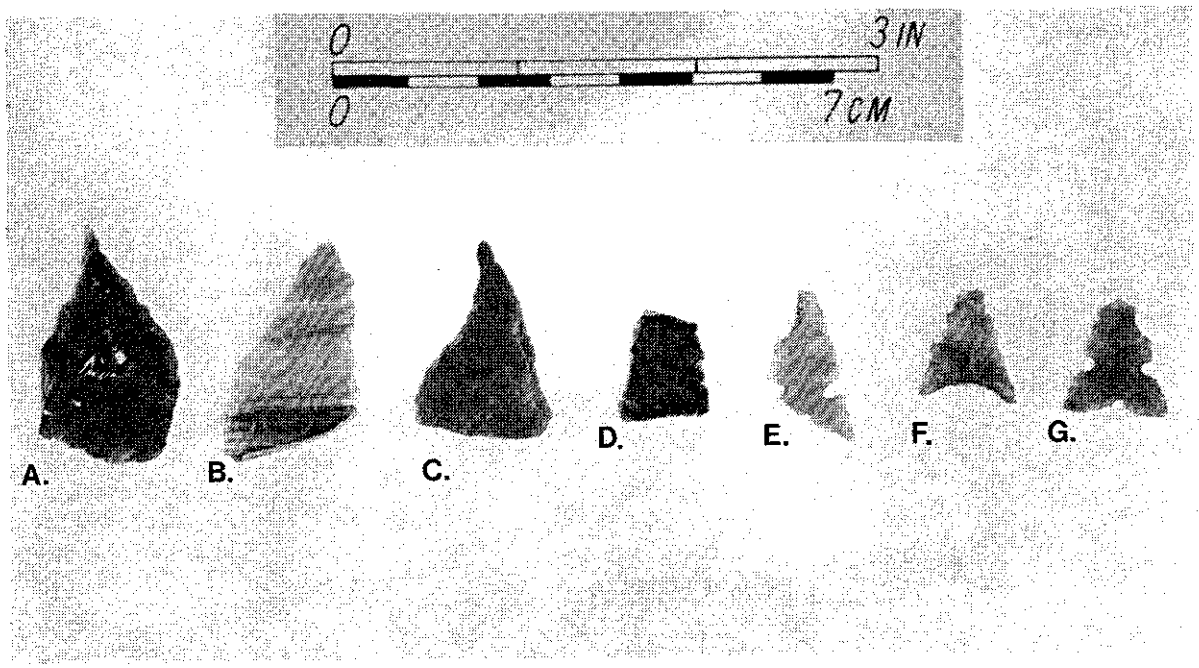


Figure 13. Bifacial tools from sites 42WS2216 and 42WS2217 (a,42WS2217-T6510-1; b,42WS2217-N51-7-4; c,42WS2217-PP-37; d,42WS2217-PP-19; e,42WS2217-L50-24-4; f,42WS2217-T1059-1; g,42WS2217-N51-14-5).

Three graver/perforators were recovered including one of obsidian and two of reddish-brown chert (Figure 13a, c). These tools could indicate some type of animal hide preparation although, scrapers which are often associated with hide processing were conspicuously absent from the assemblages. The relative scarcity of faunal remains suggests that the graver/perforators were made for purposes other than animal skin preparation. A unifacial obsidian blade that exhibited utilization on both lateral edges was recovered at 42WS2217. The relative paucity of formal tools and debitage class similarities may indicate a curate technology (Binford 1978, 1979). Furthermore, all projectile points were broken and the other formal tools were either broken or apparently exhausted and discarded.

The classification of debitage from the three sites was based on Tipps' (1983:112) flake type definitions (Table 7 and Figure 14). Those definitions are as follows:

> Initial reduction: flakes are generally angular and thick in cross section. Cortical coverage is variable and flakes may lack prepared platforms.
>
> Thinning: flakes are curved to slightly curved from proximal to distal ends. They are longer than they are wide and slightly thick to thin in cross section. They exhibit flake scars on the dorsal surface and may have prepared platforms. They may exhibit cortex.
>
> Lipped thinning: flakes exhibit the same attributes as thinning flakes with the addition of a pronounced platform that results in a lip on the ventral surface.
>
> Pressure: flakes are usually smaller and thinner and markedly longer than wide. They have a small bulb of force with a prepared, often abraded, platform. They frequently have only one ridge on the dorsal surface and rarely exhibit cortex.
>
> Shatter: angular fragments lacking platforms and termination points. These fragments do not exhibit other distinct qualities of true flakes, such as dorsal flake scars.
>
> Unidentifiable: flakes that cannot be identified to a specific type due to missing or overlapping attributes for the types described above.

The small proportions of initial reduction and shatter debitage types indicate that little core reduction took place at the sites (Table 7). Although large lithic fragments were recovered, there were no partial or exhausted cores.

Table 7. Debitage frequencies and percentages.

Site	IRF	BFTF	IF	PF	SHAT	UNID	TTL
2215	6(7.3)	45(54.9)	1(1.2)	7(8.5)	5(6.1)	18(21.9)	82
2216	27(11.5)	136(57.9)	4(1.7)	11(4.7)	7(3.0)	50(21.3)	235
2217	29(3.4)	468(55.4)	10(1.2)	168(19.9)	17(2.0)	152(18.0)	844

IRF- initial reduction flake
BFTF- biface thinning flake
IF- interior flake
PF- pressure flake
SHAT- shatter
UNID- unidentifiable
TTL- total

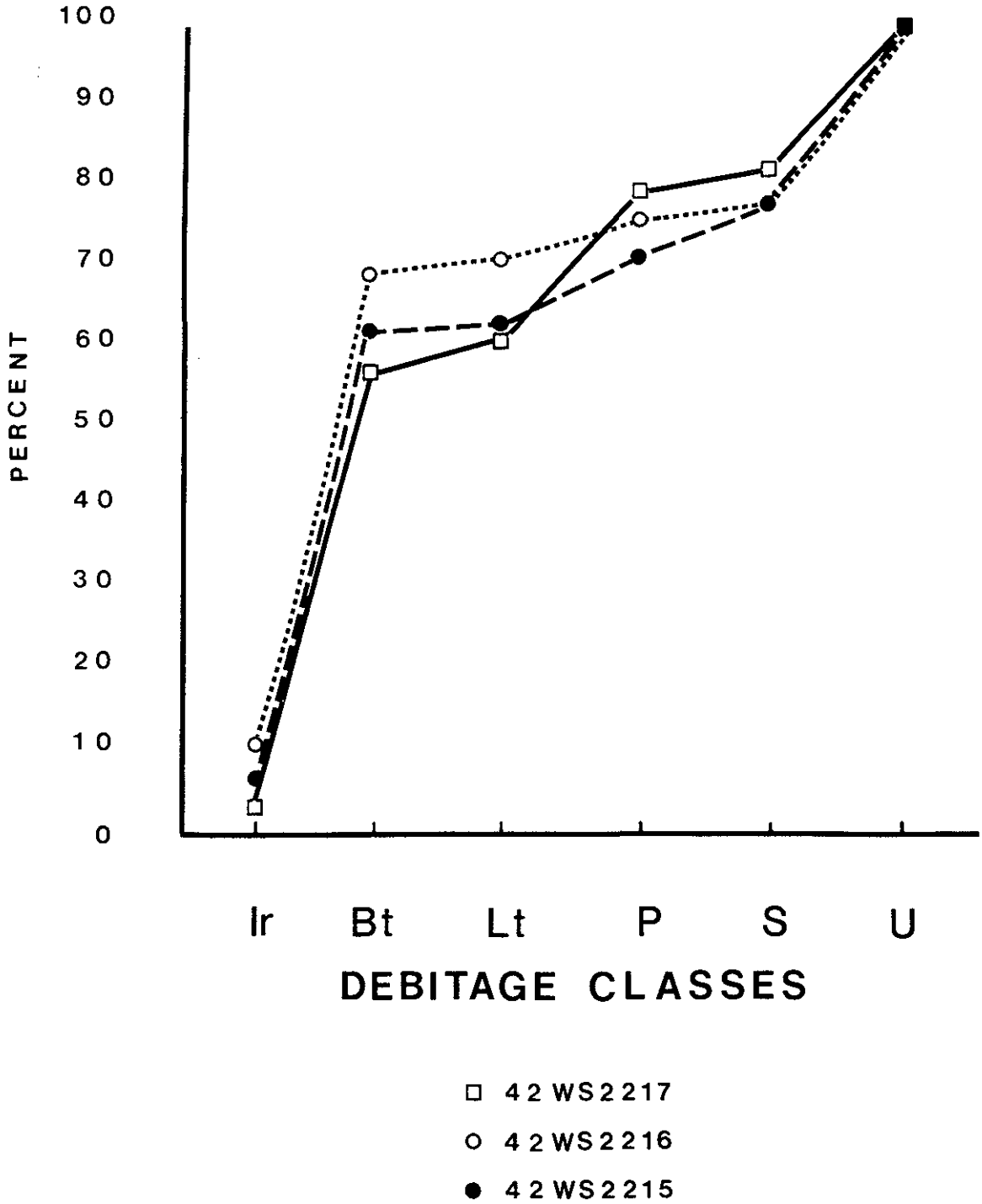


Figure 14. Cummulative percentage graph of debitage classes. (Ir- Initial reduction flakes; Bt- Biface thinning flakes; Lt- Lipped thinning flakes; P- Pressure flakes; S- Shatter; U- Unidentifiable).

Biface thinning flakes dominate all three site assemblages and comprise more than half the debitage. This large proportion of biface thinning flakes indicates reduction of bifacial preforms and maintenance of tools and projectile points. Pressure flakes form a significant proportion of the 42WS2217 assemblage with considerably lesser representation in the other site assemblages. The larger proportion of pressure flakes in the 42WS2217 assemblage could be evidence of more intensive bifacial tool maintenance.

Unidentified flakes are probably biface thinning flakes, but they did not meet all criteria for placing them in that class. Proportions of unidentified flakes are also quite similar between the sites, a possible clue to the similarities of lithic technological organization and use strategies for the sites and the Cave Valley-Spendlove Knoll area.

Tabulation by class of lithic debitage size provides further insight into the reduction strategies employed at the sites (Figure 15). Size classes 1 and 2 comprise 87.8 percent of the assemblage from 42WS2215, 74.03 percent from 42WS2216, and 94.9 percent of the lithic debitage from 42WS2217. The extremely high percentage of size class 1 debitage from 42WS2217 is possibly indicative of more intensive tool maintenance and final production of preforms than at the other sites. The size class 1 category was comprised predominantly of pressure and biface thinning flakes and unidentifiable debitage. The scarcity of items in debitage size classes greater than class 3 from 42WS2217 further indicates terminal reduction.

Use wear classes provide additional support for the scenario that lithic technology strategies were largely focused on biface production/maintenance (Table 8). Several specimens from the modified class were broken bifacial and unifacial tool edges. The types of tools represented could not be determined from these fragments, but it was presumed that the bifacial edges represent projectile point fragments. Unfortunately, no refits could be made between the tool and debitage specimens.

The patterns of selection of raw materials are interesting, particularly the predominance of chert and chalcedony at the three sites (Table 9). Sites 42WS2215 and 42WS2216 display a lower proportion of chalcedony relative to chert, but 42WS2217 had a nearly equal representation of the two materials (Figure 16). These substantial disproportions between the site assemblages could have been due to several factors, e.g., different raw material selection criteria or variable representation of materials at sources. Chert and chalcedony are readily available from stream cuts exposing Quaternary gravels near the Cave Valley-Spendlove Knoll area. Local availability of chert and chalcedony seems to be the rule for sites in the park region, particularly the St. George Basin (Westfall et al. 1987; Walling et al. 1986; Dalley and McFadden 1985). Colors of the chert and chalcedony recovered from the sites in the Park ranged through a multitude of reds, yellows, browns, whites, and grays

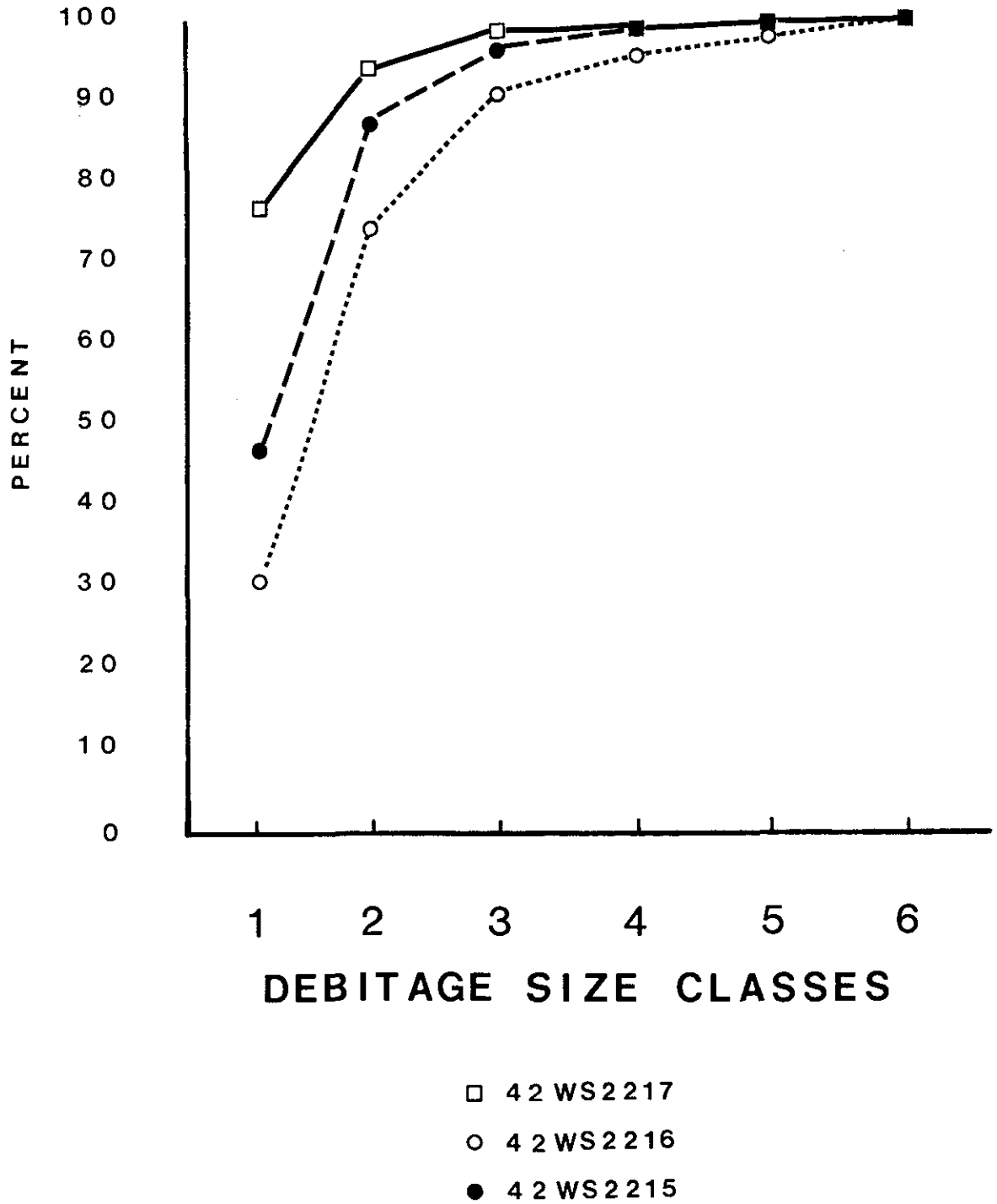


Figure 15. Cummulative percentage graph of debitage size classes. (Size classes: 1-1 cm; 2-2 cm; . . . N-N cm diameter template circles).

Table 8. Tabulation of use wear for all debitage classes.

Nature of Use Wear	42WS2215		42WS2216		42WS2217	
	%	n	%	n	%	n
Utilized	3.66	3	3.40	8	1.66	14
Modified	3.66	3	4.25	10	0.95	8
No Use Wear	92.68	76	92.34	217	97.39	822
TOTAL		82		235		844

Table 9. Lithic debitage categorized by raw material types.

Lithic Raw Material	42WS2215		42WS2216		42WS2217	
	%	n	%	n	%	n
Chert	62.19	51	60.00	141	46.91	396
Chalcedony	24.39	20	28.10	66	41.46	350
Quartzite	3.66	3	4.68	11	2.36	20
Petrified Wood	1.22	1	2.98	7	1.06	9
Obsidian	6.10	5	1.70	4	6.04	51
Dirt Stone	00.00	0	00.00	0	0.47	4
Basalt	1.22	1	1.28	3	0.11	1
Unidentifiable	1.22	1	1.28	3	1.54	13
Totals	100.00	82	100.00	235	100.00	844

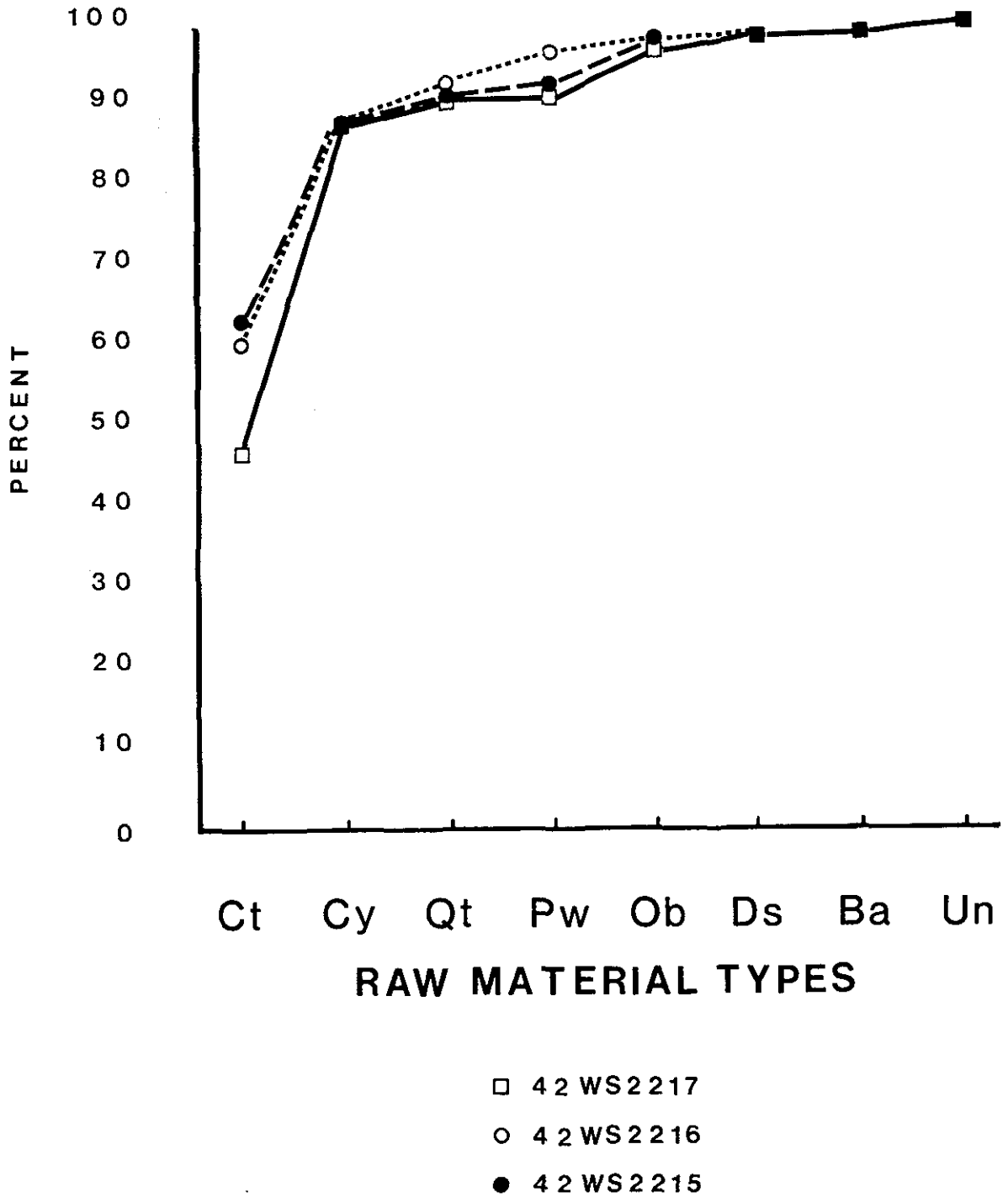


Figure 16. Cummulative percentage graph of lithic raw material types (Ct- Chert; Cy- Chalcedony; Qt- Quartz; Pt- Petrified wood; Ob- Obsidian; Dt- Dirt stone; Ba- Basalt; Un- Unidentifiable).

with attendant color gradations. Since different colors of these materials can come from the same nodule, a color classification was not devised. Other local materials include quartzite, petrified wood, basalt, dirt stone, and unclassifiable raw material types. All of these were available within the Park area.

Although obsidian comprises a small component of the assemblages, it is important from the standpoint of determining possible ranges of prehistoric mobility and of raw material sources known to the prehistoric aborigines who utilized the sites. The source of the obsidian items from the three Zion sites has not been located. However, archaeologists have used trace element analysis to determine the chemical "signatures" of known obsidian sources in the region. For example, Nelson and Holmes (1979) have examined the source characteristics of obsidian from several locations in western and southwestern Utah, e.g., Modena, Black Rock, and Wild Horse Canyon. The Modena area is approximately 85 km northwest of the Park and the other areas, largely centered around Milford, Utah, approximately 100 km north of the Park. However, Walling et al. (1986:408-409) have presented evidence from the Quail Creek excavations that obsidian in that area can be obtained from local gravels. Quail Creek is approximately 20 km southwest of the Cave Valley-Spendlove Knoll area. Connor and Vetter (1986:46) have noted that "obsidian scatters" exist at the Horse Ranch and Buck Pasture Mountain locations in the Kolob area of the Park. This could indicate local sources of obsidian within Park boundaries; however, further lithic source studies are required.

Chipped Stone Assemblages: Interpretation

On the basis of lithic debitage comparisons, the three artifact scatters examined in this study appear to be quite similar (Figures 14-16). Site 42WS2217 differs from the other two sites in that it has a greater representation of pressure flakes, as well as size class 1 debitage in the lithic assemblage. Again, this attribute may be indicative of maintenance of bifacial tools at this site. The similarities of size classes may also be indicating the relative size of raw material available, i.e., size of the selected material may be conditioning design constraints and reduction strategies of bifacial preforms and finished tools. The overall pattern suggests that, at least with lithic technology, similar types of strategies were being used and tasks performed at the sites. In other words, there is internal assemblage redundancy in the debitage component that is indicative of the connection of the lithic assemblage and the sites to the overall subsistence-settlement system.

All three sites exhibit similar proportions of lithic raw materials (Figure 16). Even with the posited ease of access to lithic raw materials, in terms of quantities and spatial proximity, prehistoric hunter-gatherers may have been selecting

materials from relatively few sources. Binford (1983:284) has developed an expectation concerning lithic raw material and its relationship to the organization of subsistence-settlement systems:

> Manufacturing debris from lithic processing is apt to vary in content seasonally [representing different proportions of different sources], since there is very likely to be seasonally variable exploitation of different geographical areas and lithic raw materials would generally be obtained within the context of normal subsistence procurement schedules. Given residential mobility, lithic source variability as indicated in primary debris should be correlated with the geographical position of the residential site.

There is a significant difference between 42WS2217 and the two other sites in the proportions of cherts, chalcedonies, and to a lesser extent, obsidian raw material (Figure 16). Could this difference be due to the changing economic role of the Cave Valley-Spendlove Knoll area in relation to residential and logistical sites in the larger region as was expressed in the quoted expectation? A definitive answer to the question is not forthcoming from this analysis, however it would seem to be a fundamental research objective for the region.

Another critical expectation concerning debitage and tool relationships has been expressed as follows:

> Manufacturing debris occurring on special purpose sites which are intermediate between residential sites and procurement sites [such as hunting stands or camps] may well exhibit considerable lithic debris from work on partially finished or 'staged' items. Flakes or bifacial retouch, core reduction, or the use of a 'disproportionate' number of tools designed for the modification of other raw material such as wood, antler, bone, or fiber might well be anticipated. On such 'intermediate' locations, work scheduling would generally be carried out in 'dead time' on items introduced in anticipation of this activity ... This means that many 'incomplete' items would be further modified on such locations, resulting in 'disjunctive' debris to tool relationships (Binford 1983:284).

In order to apply the above expectation to the present analysis simple debitage to tool rations were calculated with the following results. Site 42WS2215 had no tools; however, sites 42WS2216 and 42WS2217 exhibit debitage-to-tool ratios equal to 117.5:1 and 46.89:1, respectively. The resultant ratios are most certainly "disjunctive," however the sample discussed here is quite small. The correspondence between Binford's expectations

and the lithic assemblages from the three sites, particularly 42WS2217, is very provocative. Given the overwhelming dominance of biface thinning flakes and pressure flakes and little core reduction debitage, the lithic materials brought to 42WS2217 most certainly were "staged." The presence of three graver/perforators is also titillating, since they could represent the tools used to work on "other raw material." However, there are other equally plausible factors that might account for the nature of the chipped stone assemblages from the three sites.

A possible factor was spatial differentiation of activity areas at the sites, particularly if 42WS2216 and 42WS2217 represent portions of a contemporaneous site complex that was used as a special purpose location for animal hunting and wild plant gathering. Another alternative is that the sites were relatively contemporaneous but were used at different times during a single seasonal round or on an intermittent basis over a period of years. Successional occupations with differential emphasis on certain technological components could indicate a changing economic value for the site location. In other words, 42WS2217 and 42WS2216 may have been utilized differently in the subsistence-settlement system even though they were located next to or overlapping each other during their respective use periods. The dominant activity at 42WS2217 may have been large mammal hunting, while 42WS2216 was used as a wild plant resource extractive location.

Two questions are raised by the previous discussion. What expectations exist for the organization of hunter-gatherer lithic technology as observed in the archaeological record? Can the assemblages from the three sites be characterized in terms of the expedient/curated technology organizational continuum?

To answer the first question, two significant contrastive propositions have been developed by Binford (1983:262):

> [1] ...in non-curated technologies, replacement rates are directly proportional to the frequency of participation in activities in which tools were used. In curated assemblages, replacement rates are directly proportional to the life span or utility of the tool under maintenance care, and may bear no direct relationship to the frequency of activity performance involving tool use.
>
> [2] ...in non-curated assemblages, debris from manufacture, and the by-products of the activities in which tools were used should be spatially associated. However, in curated assemblages where tools are transported and returned to a residential location for repair...we can expect there to be no necessary regular relationship between the by-products of activities in which tools were used and the numbers of tools themselves. Similarly, we can

expect that tool manufacturing debris will only regularly be associated with broken or discard parts of tools, and not vary with the number of tools manufactured 'from scratch' which would have been removed from the location.

The answer to the second question can only be partially addressed due to the lack of sufficient pattern recognition research for the Zion region. As noted previously, the assemblages under discussion, particularly 42WS2217, have many properties of a curated technology. To reiterate, these properties are:

1. Proportionally less representation of initial reduction debitage.
2. Proportionally greater representation of debitage which indicates "staged" biface manufacture and biface maintenance.
3. Formal tools of the assemblage are either broken or quite likely "exhausted."
4. Frequencies of formal tool types indicating a dominance of one type of activity, but also evidencing other types of activities, e.g., projectile points versus graver/perforators.
5. Evidence for utilization of manufacturing debris (e.g., frequency of utilized flakes [Table 8]).

This analysis of the lithic assemblages from the three sites is not without ambiguity, particularly the last property, utilized flakes. In a curated technological organization "flakes from bifacial 'cores' are apt to characterize special purpose sites. Such flakes can be expected to show relatively high use ratios . . . " (Binford 1983:284). In this instance there simply is no scale for measuring that use ratio. Utilized bifacial flakes represent a situational use of lithic by-products for immediate purposes. The proportions of utilized flakes presented in Table 8 are only indications of that aspect. However, this problem can be addressed in future analysis by the type of comparative componential analysis presented here.

Further complications to this scenario of a curated assemblage are due to the lack of knowledge about the range of inter-site variability of lithic assemblages within the Park region. In a narrower dimension, the limited excavations of the three sites do not allow for a thorough examination of site use through time. While the debitage component of all three sites is proportionally redundant, there is not sufficient information available at this time to assess the degree and scale of re-use of the Cave Valley-Spendlove Knoll area. In other words, the research problem of "palimpsests" (Binford 1983:367) can not be adequately addressed in this study.

However, and as will be discussed in greater detail, there is strong evidence to believe that the Cave Valley-Spendlove Knoll area environment offered specific critical resources to the prehistoric populations of the region. Recurrent use of the area through a seasonal round and over the years has left a healthy

archaeological record (Connor and Vetter 1986; Hartley 1986). The problem to be addressed is that recurrent and regular use of the area could have led to the spatial association of artifacts that "may never have occurred together as an organized body of material during any given occupation" (Binford 1983:368). This is most decidedly the problem for associations of Virgin Anasazi, Southern Paiute, and Fremont archaeological manifestations in the Zion region.

Ground Stone Tools Description and Analysis

Ground stone was recovered from all three sites. The predominant material was sandstone, most probably obtained from the cliffs on the east side of Cave Valley. The presence of ground stone at all three sites immediately suggests that wild plant processing was the focus of some of the activities.

The morphological attributes of the ground stone also would be expected in a highly mobile forager adaptation. Virtually all of the specimens were in a highly fragmented condition. Many of the ground stone items exhibit breakage surfaces which were considered "fresh," i.e., the presence of unweathered, lighter colored edges on the pieces in question. Other pieces evidenced considerable angularity and truncation of grinding surfaces indicating breakage after those surfaces had been produced. The intensive degree of fragmentation of ground stone from the three sites is evidence for a high disturbance level, either by humans or non-humans, such as grazing cattle.

Tabulations of ground stone attributes are given in Table 10. Ground stone from 42WS2215 was recovered entirely from the surface. At 42WS2216, only one subsurface specimen, a mano, was recovered. It was discovered 40 cm below the surface. Most of the remaining ground stone recovered at this site was from two spatial concentrations, one near the top of the slope and a second in the southwest corner of the site (Figure 5). At 42WS2217 one identifiable metate fragment was recovered from beneath the surface, and six sandstone spalls were found within 10 to 30 cm below the surface.

In general, the ground stone from the sites could be categorized as lightly used. That is, grinding surfaces were neither deep nor extensive (Figure 17). In this regard, most of the metate fragments are very similar to the grinding slabs described by Walling et al. (1986:418). However, several metate fragments exhibited grinding on both sides. Pecking was also evident on specimens from 42WS2215 and 42WS2216 (Figure 18). However, this attribute could not be reliably assigned to several pieces because of the highly weathered condition of the sandstone.

Metate morphology, when this could be determined, ranged from tabular, relatively thin specimens, to unshaped pieces of sandstone up to 160 mm in thickness. It appeared that most of

Table 10. Observations regarding groundstone tools from sites 42WS2215, 42WS2216, and 42WS2217.

Site	Frequency	Type(1)	Ground Surfaces	Material Type	Burned
42WS2215	8	Met.	Unifacial	Sandstone	1
	2	Met.	Bifacial	Sandstone	0
	1	Indet.	None	Sandstone	0
Sub-total	11				
42WS2216	29	Met.	Unifacial	Sandstone (27) Andesite (2)	5
	2	Met.	Bifacial	Sandstone	
	4	Mano	Unifacial	Sandstone (3) Basalt (1)	
	1	Mano	Bifacial	Sandstone	
	14	Indet.	None	Sandstone	1
Sub-total	50				
42WS2217	6	Met.	Unifacial	Sandstone	1
	3	Mano	Bifacial	Andesite (2) Sandstone (1)	
	8	Indet.	None	Sandstone	1
Sub-total	17				

1) Met.= metate
Indet.= indeterminate

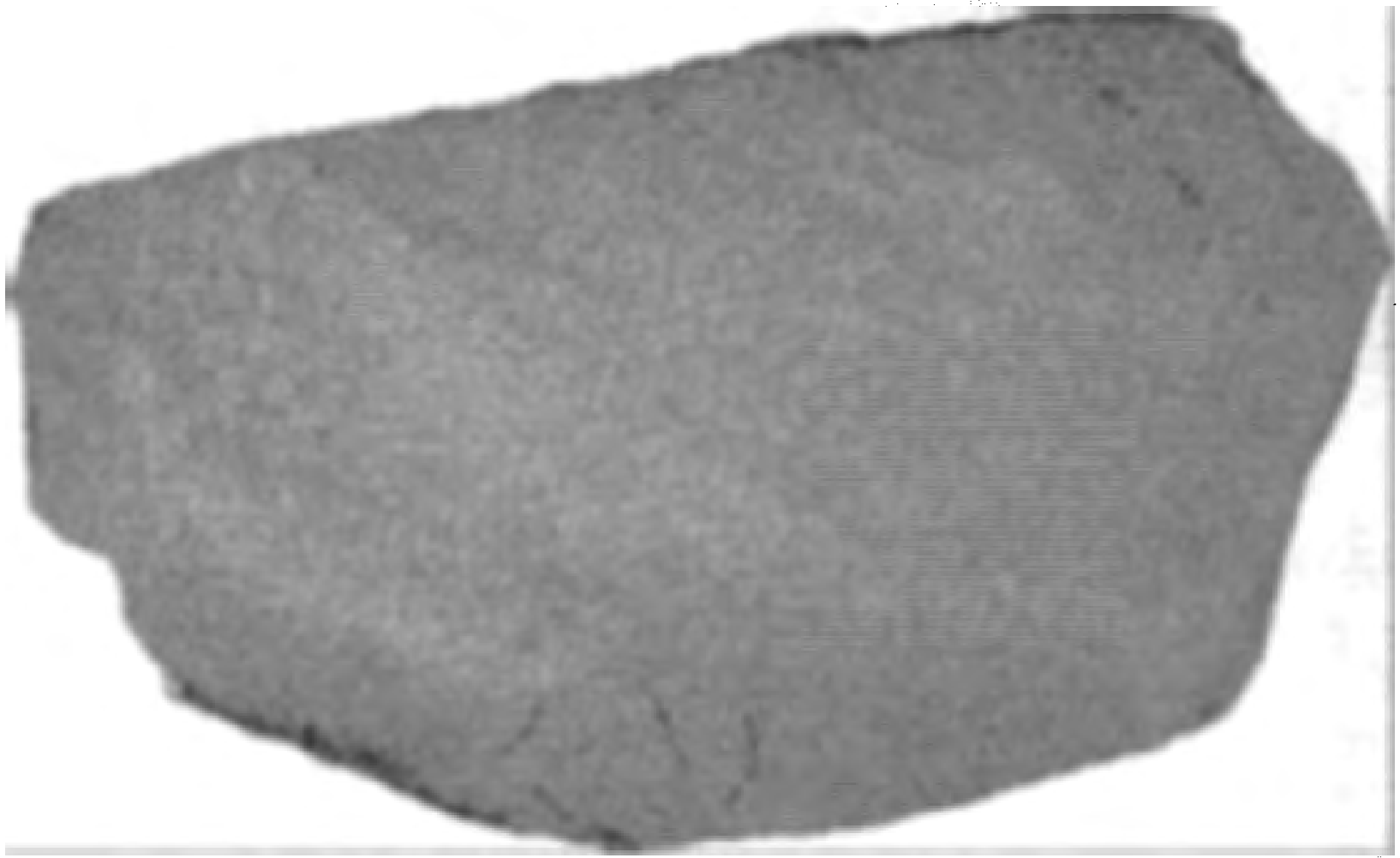


Figure 17. Slab metate exhibiting single smoothed grinding surface (42WS2216-PP104).

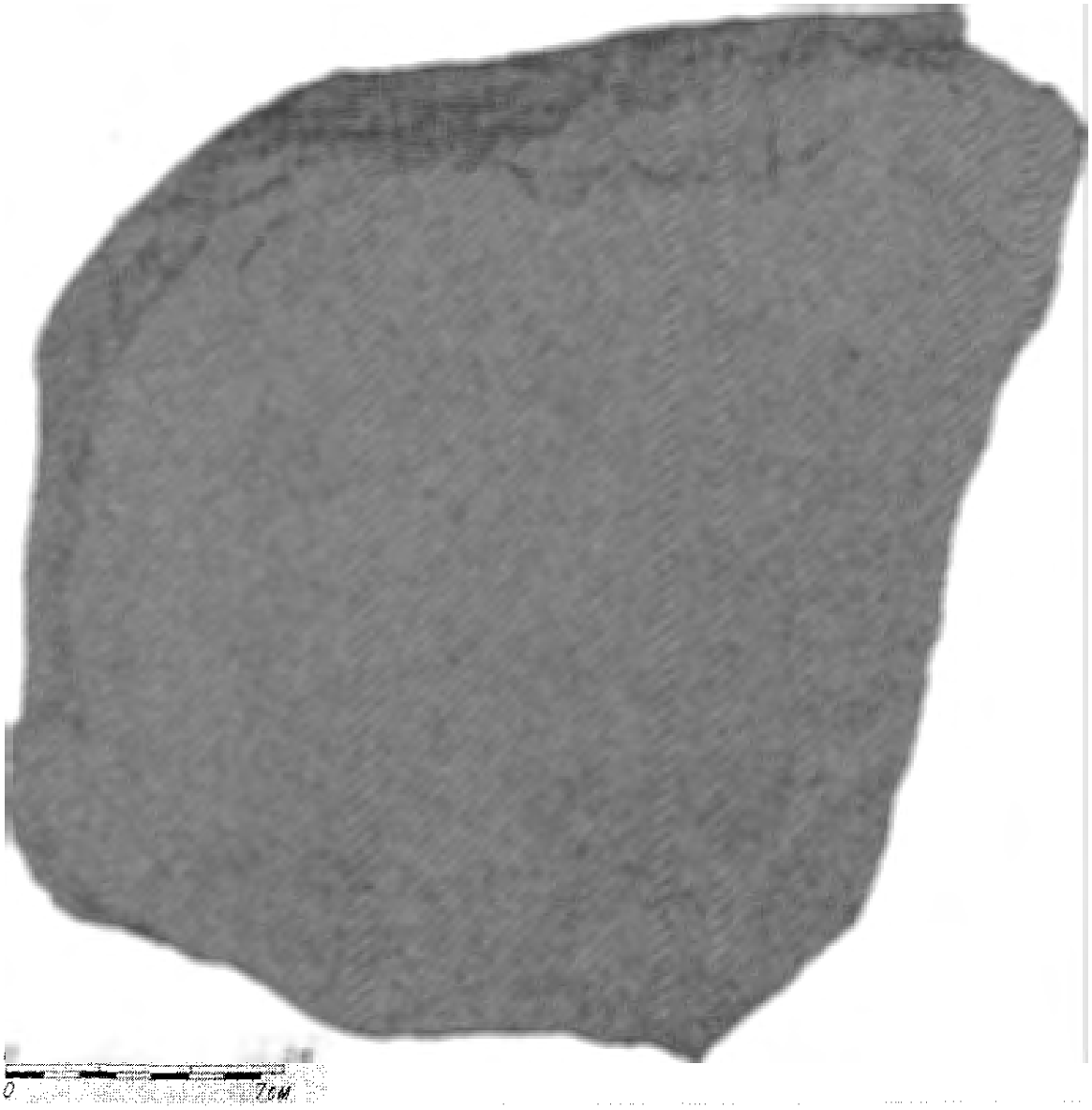


Figure 18. Slab metate exhibiting roughened bifacial grinding surfaces (42WS2216-PP-4).

the metates and some of the manos were produced and used only at the sites. However, two manos from 42WS2217 were of a material that does not occur in the immediate area and, more than likely, were transported to the site from some distance. Several of the metate and indeterminate fragments (Table 10) appeared to have been burned suggesting that hearths had once been present at the sites.

Most of the pieces are small and probably obtained from the sandstone outcrops only a few hundred meters to the east of the sites. Most grinding surfaces are not deep or extensive indicating short-term use. Several metates did exhibit bifacial grinding surfaces and biconcave cross-sections (Figure 18). The remainder of recognizable metates are unshaped on the underside. This could indicate a situational use of local materials to perform a task (Binford 1983:280). From another perspective of the organization of technology the large ground stone could also have functioned in the role of site furniture (Binford 1983:278-279). The difference between situational technology and site furniture is that the former definition covers a more direct response to immediate needs or opportunities to exploit subsistence resources, while site furniture suggests some planning depth and anticipation of redundant activities at the site. The evidence for recurrent occupations from all three sites is not overwhelming. However, as discussed elsewhere in this report, the suggestive proximity and similarity in artifacts of 42WS2216 and 42WS2217 may indicate that these two sites were actually one site. In any event, little investment had been made in procuring, producing, and maintaining the ground stone artifacts and apparently they were discarded after limited use.

Ceramic Material: Description

Twenty-three pottery sherds were recovered during surface collection and test excavation. With the exception of one sherd from 42WS2216, all others were recovered from 42WS2217. All of the sherds fall within the range of attributes assigned to the Southern Paiute Utility Ware type (Baldwin 1950), with the exception of a sherd which appears to be an Anasazi type. A petrographic analysis of three of the sherds from the collection is presented in Appendix A. An inventory of all ceramic sherds recovered from these two sites is provided in Appendix B.

Almost all of the sherds recovered are body fragments of rather small size and little can be said about the type of vessel they once represented. The most obvious attribute is exterior surface treatment. Thirteen sherds were fingernail impressed (Figure 19a-f); eight displayed very deep "pinched" finger impressions (Figure 19g-n); and, two were plain (Figure 19o). Fingernail impressions generally covered nearly the entire surface of these sherds.

Surface color was predominantly a brown but ranged from reddish brown to black, sometimes with all colors present on the

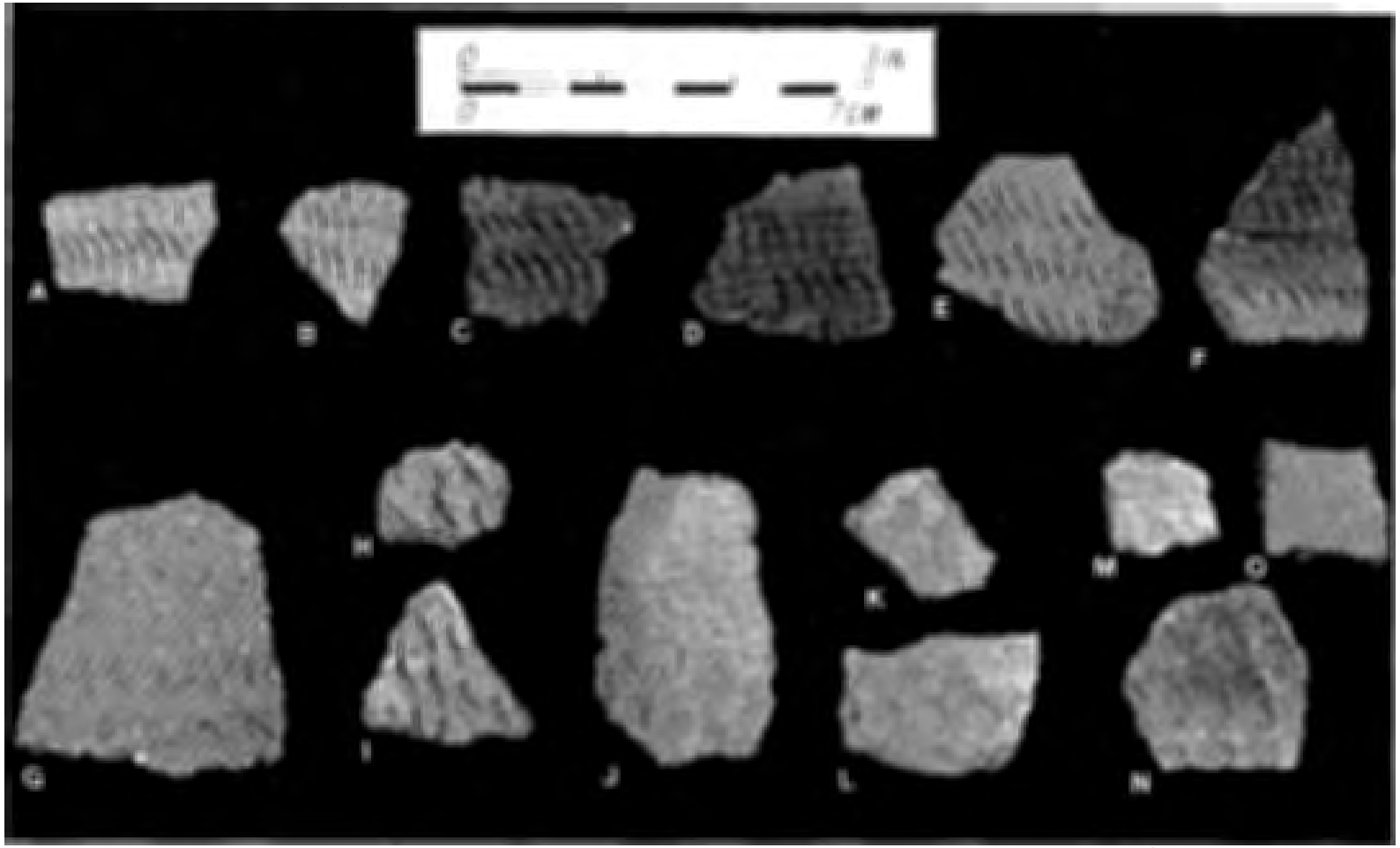


Figure 19. Ceramic vessel fragments from 42WS2216 and 42WS2217. (a, 42WS2217-T7S10-1; b, 42WS2217-T6S9-1; c, 42WS2217-T4S8-1; d, 42WS2217-T4S8-1; e, 42WS2216-PP-7; f, 42WS2217-PP-2 (2 sherds); g, 42WS2217-N51-3-3; h, 42WS2217-PP-4; i, 42WS2217-T7S11-1; j, 42WS2217-L50-17-2; k, 42WS2217-P52-10-3; l, 42WS2217-T11S9-1; m, 42WS2217-T11S10-2; n, 42WS2217-L51-4-4; o, 42WS2217-T1S4-3)

same sherd. Coale (1963:2) has stated that this condition can arise from two factors "(1) uneven and poorly controlled firing, or (2) subjection to subsequent, higher temperatures in cooking use." Tempering material is detailed in the following petrographic analysis, however visual examination of the sherds indicated that temper type was uniform throughout the collection. Two of the sherds did exhibit the addition of sherd fragments as tempering material. The sherds were tested for the presence of carbonates with negative results. In several instances temper was exposed on both the exterior and interior surfaces. Wall thickness ranged from five millimeters to 7.5 millimeters with an average thickness of all sherds of six millimeters.

Eight sherds exhibit two very interesting characteristics. First, these were the only subsurface sherds recovered, all others were surface collected. Second, these sherds have a punched surface treatment that is apparently unusual for brownwares of the Great Basin. However, Walling et al. (1986:373) referred to "Paiute Corrugated," although no illustrations of "Paiute Corrugated" were included in that report. According to Jennings (1978:167) this style of punched surface treatment resembles the types known as Promontory or Great Salt Lake punched. Temper and color are the same as described for the fingernail impressed pottery.

Faunal Remains

A total of 203 bone fragments was recovered from the surface collection and excavation of 42WS2217. Faunal remains were not recovered from the other two sites. Given the minute assemblage size and extreme fragmentation, calculations such as MNI (minimum number of individuals) are irrelevant. However, quantitative information, such as frequencies and percentages, is presented. Most of the bone was unidentifiable either to species or anatomical element, however two metapodial fragments were assessed to be from a large mammal in the body size range of desert bighorn sheep (*Ovis canadensis*) and/or mule deer (*Odocoileus hemionus*). Eight long bone fragments and two vertebra fragments were also recognized as being from a large mammal. Rodent/lagomorph size bone was also present with two specimens observed. Only seven percent of the faunal materials could be identified to mammal body size class.

Completely unidentifiable bone fragments totaled 171 specimens (84 percent). Ten fragments (five percent) were cancellous bone and seven fragments (four percent) were of tooth enamel. While the fragments of cancellous bone were too small for positive identification, they could quite possibly have come from articular ends of bones or from vertebra. The fragments of tooth enamel indicated at least the presence of skulls or mandibles.

The size of fragments, measured on their long axis, ranges from two millimeters to 72 mm with 166 fragments (81.7 percent) observed in the five millimeter to 16 mm range. This extreme fragmentation indicates intense mechanical attrition of the original bone brought to the site either through breakage or treadage by humans or as a result of being burned. One hundred eighteen bone fragments (58.1 percent) had been burned. Most of the burned bone was calcined, i.e., burned to a bluish-gray or white color, which is usually regarded as a sign of high temperatures. Burned bone fragments specifically identified were a metapodial fragment and a lagomorph size bone.

Weathering stages based on taphonomic research by Behrensmeyer (1978), when they could be assigned to a specimen, were generally in the Stage 2 category indicating relatively rapid burial. This is not surprising given the aeolian sand context of the site.

The greatest proportion of bone fragments was recovered from the surface to 10 cm below the surface with 107 specimens (52.7 percent) represented. This level, as noted previously, was mainly recent blow sand. Although bone was found throughout the strata of excavated units, a second concentration was encountered in the 20-30 cm below surface level with 54 specimens (26.6 percent) recovered. This pattern corresponds to a similar concentration of chipped stone material at the same stratigraphic level and provides further evidence of at least two occupations of the site.

Although this small, fragmentary sample (203 pieces) of faunal material offers limited information, it does provide some clues about the activities carried out at the site. The simple fact that the bone was highly fragmented could indicate intensive processing for marrow or production of bone grease. On the other hand, the preponderance of burned fragments could indicate the roasting of meat still attached to the bone, or the disposal of bone waste by fire. Unfortunately, there is a caveat which, at least for the surface bone, renders even the description of faunal remains tentative. The evidence of recent use of the site and surrounding area by modern non-aboriginal hunters was quite extensive. Cartridge casings and deer skeletons were quite numerous in the immediate area. Five different skeletons were observed within a few hundred meters of the site and numerous individual bones were scattered across the lower ridges of Spendlove Knoll. That modern hunters could have left burned bone at this site is a distinct possibility. This question can perhaps be settled once accelerator radiocarbon dates have been obtained for the bone from several levels of the site.

SUMMARY AND CONCLUSIONS

The archaeological investigations discussed in this report were designed to establish the scientific significance of three prehistoric sites in the Cave Valley area of Zion National Park, Utah. As static, inanimate prehistoric remains, these sites provide relatively little information about the past. However, such remains are the material consequences of prehistoric land use in this region. Critical resources in the Basin and Range-Colorado Plateau region are quite varied with respect to topography, season of availability, and quality. These resource characteristics imposed a series of constraints on prehistoric, subsistence-based peoples. Their adaptive responses to such environmental problems are reflected in the distribution of residential sites, limited activity areas, storage facilities, rock art, isolated tools and debris, and so forth. The three Cave Valley sites that have been discussed in this study can be assigned scientific significance once they have been integrated into a broader and more inclusive explanatory scheme. Such a framework is derived from current ecological and ethnoarchaeological arguments within anthropology and archaeology.

The boundaries of Zion National Park encompass lands that represent a microcosm of the physiographic transition between the Basin and Range and the Colorado Plateau provinces. The Park is situated in the Grand Staircase physiographic subdivision between the Grand Canyon region of Arizona and the southern high plateaus and Escalante Desert of southwestern Utah. As a result, all major life zones including the desert, pinyon-juniper, pine-oak, and fir-aspen communities in this transition can be found within the confines of the Park. These vegetative communities and their attendant fauna are distributed along an altitudinal gradient that runs from 1,200 to more than 2,700 meters (4,000-9,000 feet) above mean sea level. Topographic and microclimatic variation within this region creates an environmental mosaic in which critical resources for human populations exhibit both spatial and seasonal "patchiness."

Our understanding of prehistoric/historic aboriginal use of this region in southwestern Utah can be greatly enhanced if archaeological observations can be related to variation in this local/regional environment. Such linkages between the static archaeological record and environmental variables are delineated and interpreted dynamically via contemporary ecological and anthropological theory. The empirical world is filled with recognizable patterns; however, some patterns or correlations are spurious or uninterpretable. Current causal explanations of the interrelationships between the physical and the biological environment can be utilized to recognize spatial, temporal, and content-related patterns in the archaeological record that reveal past human adaptations in this region. This is the purpose of such emphasis in the initial chapters of this report.

What insights have been gained about aboriginal occupation(s) and use of lands in and around Zion National Park in southwestern Utah? First, ecological variables such as net annual above ground primary productivity for the study area is approximately 500 dry grams per square meter per year. This relatively low level of primary productivity corresponds with the global average for desert scrub ecosystems. Highland areas within and around the Park provide "moisture islands" or areas of increased precipitation and primary production that differ dramatically from the surrounding desert lowlands. These highland areas, in turn, support greater numbers of large mammals including bighorn sheep, elk, and mule deer. The effective temperature (ET) for the study area equals 12.25 degrees Celsius. This effective temperature (ET) value correlates with semi-nomadic hunter-gatherer adaptations throughout the world. Therefore, some degree of logistical mobility is expected. The presence of moisture islands and large game animals that could serve as the focus of an overwintering strategy leads us to expect reduced residential mobility during certain periods of the annual cycle, probably winter.

Second, the three artifact scatters (42WS2215, 42WS2216, and 42WS2217) are along the upper margins of a broad expanse of stabilized aeolian sands on the eastern side of Cave Valley. This south-trending slope between Firepit and Spendlove knolls has served as a migration route and winter range for large mammals including bighorn sheep, elk, and mule deer. Such animal resources are highly ranked prey for human predators and can provide between 18,000 to 31,000 kcal of energy per hour of handling time. When available such animal resources could have provided an optimal solution to the overwintering problem in this region. Given a decrease in the availability of these large mammals, aboriginal hunter-gatherers would be expected to shift to lower ranked items including increased dependence on plants such as acorns, pinyon nuts, wild rye, and Indian rice grass. These plant resources provide between 300 to 1,400 kcal per hour of handling time.

Third, both controlled surface collection and test excavation at these three sites yielded artifactual assemblages composed of both chipped and ground stone tools, lithic debitage, limited ceramic fragments, and a small quantity of faunal remains. Almost all formal tools including projectile points, larger bifaces, and perforators were either broken or exhausted. In addition, formal tools represent a very small proportion of the total artifact assemblage from all three sites. Biface thinning or maintenance flakes dominate all debitage collections. Both flake size distributions and use wear patterns suggest that biface production and maintenance were significant activities at these sites. Given these observations, similar activities appear to have been conducted at each of these sites. It is suggested that aboriginal occupants of the area possessed a curate technology (Binford 1978, 1979).

Fourth, sites 42WS2217 and 42WS2216 exhibit markedly different formal tool assemblages. At present, there are several possible interpretations that might account for such variation. Sites 42WS2217 and 42WS2216 reflect activities related to large mammal hunting and wild plant processing, respectively. Therefore, site use by aboriginal peoples could have been determined by seasonally differentiated activities. An alternative interpretation of tool assemblage differences is that shifts in exploitative strategies caused shifts in the economic use of this particular location in Cave Valley.

Fifth, all three sites produced ground stone tools including complete and incomplete metates and/or manos. Such large ground stone implements can be classified as site furniture or site-specific hardware (Binford 1979). Site furniture includes implements and facilities that are used by various individuals at forager residential sites and collector field camps, locations, and stations. Site furniture includes such items as hearth stones, stone anvils, manuports and/or cores, and recycled vessels. For example, a cracked or patched cooking vessel might be laterally recycled into a logistical site for dry food storage.

Binford (1979:264) comments in this regard,

> One process which I have observed with regard to site furniture has been discussed as the "size effect " . . . Upon arrival at a known site, one generally searches for the "furniture" and pulls it "up" out of its matrix for use. This means that large items of site furniture get continuously translated "upward" if a deposit is forming.

The presence of site furniture may indicate planning depth and anticipation of redundant activities at these sites.

Sixth, fragments of ceramic vessels were recovered from both sites 42WS2216 and 42WS2217; twenty-two of these potsherds were found at 42WS2217. Twenty sherds possess exterior surfaces that are finger-nail impressed or finger "punched." Twenty-two of these sherds exhibit attributes characteristic of Southern Paiute Utility Ware. This ceramic classification appears to be filled with ambiguities and contradictions. Fowler and Fowler (1981:140) state that Southern Paiute Utility Ware or "Southern Paiute Brown" can be found throughout southern Nevada, southeastern California, southwestern Utah, and northern Arizona. In turn, these Southern Paiute wares are similar to Shoshonean Wares that occurred in the Great Basin, the Snake River Plain, and the northern Colorado Plateau. Fowler and Fowler (1981:141) and Pilles (1981) also emphasize that in a number of instances Southern Paiute ceramics cannot be readily separated spatially or temporally from Ute, Owens Valley protohistoric Northern Paiute, Shoshoni, Yavapai (Las Vegas Valley Tizon Brown), or Apache wares that occur between A.D. 1000 to 1400. Cultural historical interpretations, then, appear to be quite tenuous and offer

little insight into aboriginal adaptations in southwestern Utah. Few archaeologists discuss the functional role these ceramic vessels played in aboriginal subsistence.

These ceramic vessel fragments are small and do not allow determination of vessel size or morphology. Archaeological and ethnographic examples of "Southern Paiute" ceramic vessels exhibit bowl and open, conical, or pointed bottom pot forms (Fowler and Fowler 1981:140; Fowler and Matley 1978:32-33,38 [Figure 5, i,j,k]).

Interestingly, Simms (in Simms and Isgreen 1984) points out that brownware ceramics tend to occur primarily in the pinyon-juniper zone in southwestern Utah and the riparian zone of southern Nevada and the Colorado River. In addition, he suggests that brownware ceramics were perhaps cached or were manufactured as expedient alternatives for baskets at short-term and/or long-term residential sites in the pinyon woodlands.

Archaeologists working in the Zion area might also expect to observe several other ceramic vessel forms. For example, Pilles (1981:168) refers to generalized functions for various vessel forms utilized by the Southern Yavapai:

> Vessel forms were limited and rather simple: a narrow necked jar for water storage, a shallow food dish, a deep bowl with an incurving rim for cooking, a globular jar with a wide and tall neck for cooking, and a globular bowl with an outcurved rim for water carrying and drinking. Thick walled jars were used for water storage and thin walled jars with a wide mouth were used for cooking.

Archaeologists now realize that ceramic vessel manufacture and use is not confined to aboriginal peoples that were dependent on domesticated crops. Therefore, the presence of ceramic vessel fragments at two of these Cave Valley sites discussed in the present report cannot be assumed to reflect prehistoric horticulture.

Several research problems have been raised by the present research with respect to the archaeological record of Zion National Park. First, more detailed information on the sources of lithic raw materials within the Park is needed. Second, Holocene paleoenvironmental data must be established for archaeological use. This is particularly important for the prehistoric lakes of the Kolob area. Third, archaeologically, there is little information on the relationships between the canyon and upland sites of the Park. In addition, chronometric data is lacking for the known upland sites. Finally, the extant information on the sites within the Park must be integrated within the larger view of the surrounding region.

Cultural Resource Management Considerations

The potential of Zion National Park is that of a vast archaeological laboratory. While considerable attention has been given to archaeological sites in Zion and Parunuweap Canyons (Connor and Vetter 1986; Schroeder 1955; Wetherill 1934) and numerous site inventories have been conducted (Thompson 1964; Lindsay and Madsen 1973; Stiger 1978; Anderson 1978, 1979; Hartley 1983, 1986), an integrated overview of known archaeological manifestations is needed. This overview must also include archaeological research from southwestern Utah.

Such an overview cannot be a reiteration of sites and their contents. A theoretical framework, such as the one suggested in this report, must guide the assessment of archaeological and ecological variability. Pattern search and recognition techniques, such as the diversity/redundancy measures used in this research, must also be inherent to the archaeological overview.

The upland sites in Zion National Park should receive more intensive study than they have. If excavations are to be carried out, then they must be conducted in a manner that maximizes information return for resources spent. Excavations should be conducted with special regard for site structural, paleoenvironmental, and geomorphological data.

The need for more intensive inventories and site surveys, particularly in the Kolob area of the park, is necessitated by the existing relatively easy access to these sites. Even during the excavations at the Cave Valley sites, at least one artifact was removed from 42WS2216 by an unknown visitor. As Osborn et al. (1986:124) have observed, in relation to Canyonlands National Park, "indirect impacts" by visitors have drastic and permanent effects on archaeological resources. Vandalism has already occurred at many of the rock art sites in Cave Valley and arrowhead collecting is known to have occurred extensively in the Kolob area. Intensive survey and site recording does not reduce the problem of unauthorized modification of archaeological sites, but it does increase their information potential for future research.

REFERENCES CITED

Aikens, C. Melvin
1965 Excavations in Southwestern Utah. University of Utah Anthropological Papers No. 76. Salt Lake City.

Anderson, Adrienne
1978 Archeological Reconnaissance, Taylor Creek Development, Zion National Park. Memorandum to Superintendent, ZION, October 19, 1978. On file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

1979 Archeological Evaluation Trip, Air Monitoring Facility and Springdale Sewer System. April 23-24, 1979. Memorandum on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Bailey, Harry P.
1960 A Method of Determining the Warmth and Temperateness of Climate. Geografiska Annaler 52:1-16.

Baldwin, Gordon C.
1950 The Pottery of the Southern Paiute. American Antiquity 16:50-56.

Behrensmeyer, Anna K.
1978 Taphonomic and Ecologic Information from bone weathering. Paleobiology 4(2):150-162.

Bettinger, Robert L.
1977 Aboriginal Human Ecology in Owens Valley: Prehistoric Change in the Great Basin. American Antiquity 42:3-17.

Binford, Lewis R.
1978 Nunamiut Ethnoarchaeology. Academic Press, New York.

1979 Organization and formation processes, looking at curated technologies. Journal of Anthropological Research 35(3):255-273.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45:4-20.

1983 Working at Archaeology. Academic Press, New York.

n.d. The Subsistence Ecology of Hunter-Gatherers. Unpublished manuscript in possession of author, Department of Anthropology, University of New Mexico, Albuquerque, New Mexico.

Chang, Yen-hu
1968 Climate and Agriculture: An Ecological Survey. Aldine, Chicago.

Charnov, Eric L.
1976 Optimal Foraging: The Marginal Value Theorem. Theoretical Population Biology 9:129-136.

Charnov, Eric, and Gordon H. Orians
1973 Optimal Foraging: Some Theoretical Explorations. Department of Biology, University of Utah, Salt Lake City.

Coale, George L.
1963 A Study of Shoshonean Pottery. Tebiwa 6(2):1-11.

Connor, Melissa A., and Susan M. Vetter
1986 Archeological Investigations at Zion National Park. Midwest Archeological Center Occasional Studies in Anthropology No. 19, United States Department of Interior, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Coulam, Nancy J.
1984 Plant Macrofossils: A Comparison of Natural and Cultural Samples and Implications for Interpretation. In, Archaeological Excavations in the Sevier and Escalante Deserts, Western Utah, by S.R. Simms and M.C. Isgreen, pp.354-370. University of Utah Archaeological Center, Reports of Investigations 83-12. Salt Lake City.

Dalley, Gardiner F., and Douglas A. McFadden
1985 The Archaeology of the Red Cliffs Site. Bureau of Land Management, Utah State Office. Cultural Resource Series 17. Salt Lake City.

Emlen, J.M.
1966 The Role of Time and Energy in Food Preference. American Naturalist 100:611-617.

Euler, Robert C.
1966 Southern Paiute Ethnohistory. University of Utah Anthropological Papers 78. Salt Lake City.

Fowler, Catherine S.
1982 Settlement Patterns and Subsistence Systems in the Great Basin: The Ethnographic Record. In, Man and Environment in the Great Basin, edited by D.B. Madsen and J.F. O'Connell. Society for American Archaeology Papers 2:121-138.

Fowler, Catherine S., and Don D. Fowler
1981 Southern Paiute: A.D. 1400-1776. In The Protohistoric Period in the North American Southwest, AD 1450-1700 edited by David R. Wilcox and W. Bruce Masse, pp. 129-162. Arizona State University, Anthropological Research Papers No. 24.

Fowler, D. D., and J. F. Matley
1978 The Palmer Collection from Southwestern Utah, 1875. University of Utah Anthropological Papers 99 (Miscellaneous Collected Papers 26). Salt Lake City.

Hamilton, Wayne L.
1984 The Sculpturing of Zion. Zion Natural History Association, Zion National Park, Springdale, Utah.

Hartley, Ralph
1983 Archeological Survey, Zion National Park, 1982. Manuscript on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

1986 Archeological Survey, Zion National Park, 1985. Manuscript on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Heath, Kathleen M.
1986 Seeds of Change: Macrofossil Analysis and Interpretation from Quail Creek. In Excavations at Quail Creek, pp. 477-498, by B.A. Walling, Richard A. Thompson, Gardiner F. Dalley, and Dennis G. Weder. Bureau of Land Management, Utah State Office. Cultural Resource Series 20. Salt Lake City.

Hevly, Richard H., and Gloria Judges Edwards
1987 Pollen, Vegetal Material and Flotation Analysis. In Green Spring: An Anasazi and Southern Paiute Encampment in the St. George Basin of Utah, pp. 165-177, by D.A. Westfall, W.E. Davis, and E. Blinman. Bureau of Land Management, Utah State Office. Cultural Resource Series 21. Salt Lake City.

Hitchcock, Robert K.
1983 The Ethnoarchaeology of Sedentism: Mobility Strategies and Site Structure Among Foraging and Food Producing Populations in the Eastern Kalahari Desert, Botswana. Unpublished Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Holdridge, L.R.
1967 Life Zone Ecology. Tropical Science Center, San Jose, Costa Rica.

Hunter-Anderson, Rosalind L.
1986 Prehistoric Adaptation in the American Southwest. Cambridge University Press, Cambridge.

Jennings, Jesse D.
1978 Prehistory of Utah and the Eastern Great Basin. University of Utah Anthropological Papers No. 98. Salt Lake City.

Kelly, Robert L.
1980 Hunter-Gatherer Settlement Systems. Unpublished Master's thesis, University of New Mexico, Albuquerque.

1983 Hunter-Gatherer Mobility Strategies. Journal of Anthropological Research 39(3):277-306.

Kelley, Isabel T.
1934 Southern Paiute Bands. American Anthropologist 36:548-560.

1964 Southern Paiute Ethnography. University of Utah Anthropological Papers, No. 69. Salt Lake City.

Krebs, John R., Alasdair I. Houston, and Eric L. Charnov
1981 Some Recent Developments in Optimal Foraging. In Foraging Behavior: Ecological, Ethological, and Psychological Approaches, edited by A.C. Kamil and T.D. Sargent, pp. 3-18. Garland, New York.

Krebs, John R., David W. Stephens, and William J. Sutherland
1983 Perspectives in Optimal Foraging. In, Perspectives in Ornithology: Essays Presented for the Centennial of the American Ornithologists' Union, edited by A.H. Brush and G.A. Clark Jr., pp. 165-216. Cambridge University Press, Cambridge.

Lindsay, La Mar W.
1986 Quail Creek Archeology: The Pollen Study. In, Excavations at Quail Creek. by B.A. Walling, Richard A. Thompson, Gardiner F. Dulley, and Dennis G. Weder. Bureau of Land Management, Utah State Office. Cultural Resource Series 20. Salt Lake City.

Lindsay, La Mar, and Rex E. Madsen
1973 Report of archeological surveys of the Pipe Springs National Monument Water Supply System Project, Kaibab Indian Reservation, Mohave County, Arizona; Zion National Park Sewer Extension Project, Washington County, Utah; Arches National Park Road and Sewage Disposal Areas San Juan County, Utah. Manuscript on file National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

MacArthur, R.H.
1972 Geographical Ecology: Patterns in the Distribution of Species. Harper and Row, New York.

MacArthur, R.H., and Eric R. Pianka
1966 On Optimal Use of Patchy Environment. American Naturalist 100:603-609.

Madsen, David B.
1984 Pollen, Packrats, and Pine Along the IPP. In, Archaeological Excavations in the Sevier and Escalante Deserts, Western Utah, by S.R. Simms and M.C. Isgreen, pp. 336-353. University of Utah Archaeological Center, Reports of Investigations 83-12. University of Utah, Salt Lake City.

Madsen, David B., and Michael S. Berry
1975 A Reassessment of Northeastern Great Basin Prehistory. American Antiquity 40:391-405.

Madsen, David B., and James F. O'Connell (editors)
1982 Man and Environment in the Great Basin. SAA Papers No. 2. Society for American Archaeology, Washington, D.C.

Moffitt, Kathleen, Sandra Rayl, and Michael Metcalf
1978 Archaeological Investigations Along the Navajo-McCullough Transmission Line, Southern Utah and Northern Arizona. Museum of Northern Arizona, Research Paper 10. Flagstaff.

National Park Service
1983 Draft Natural Resources Management Plan and Environmental Assessment for Zion National Park, Utah. Manuscript on file, Midwest Archeological Center, Lincoln, Nebraska.

Nelson, Fred, and Richard D. Holmes
1979 Trace Element Analysis of Obsidian Sources and Artifacts from Western Utah. Antiquities Section Selected Papers 15:65-80. Utah State Historical Society. Salt Lake City.

O'Connell, James F.
1971 The Archeology and Cultural Ecology of Surprise Valley, Northeastern California. Unpublished Ph.D. dissertation, University of California, Berkeley.

1987 Alyawara Site Structure and Its Archaeological Implications. American Antiquity 52:74-108

O'Connell, James F., and Kristin Hawkes
1981 Alyawara Plant Use and Optimal Foraging Theory. In, Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses, edited by B. Winterhalder and E.A. Smith, pp. 99-125. University of Chicago Press, Chicago.

1984 Food Choice and Foraging Sites Among the Alyawara. Journal of Anthropological Research 40:504-535.

O'Connell, James F., Kevin T. Jones, and Steven R. Simms
1982 Some Thoughts on Prehistoric Archaeology in the Great Basin. In Man and Environment in the Great Basin, edited by D.B. Madsen and J.F. O'Connell, pp. 227-240. Society for American Archaeology Papers No. 2. Washington, D.C.

Odum, E.P.
1971 Fundamentals of Ecology. Saunders, Philadelphia.

Osborn, Alan J.
1984 Comments Concerning the Archaeological Research Potential and Significance of the Gibson Dome Locality in Southeastern Utah-a Proposed Site for a High-Level Nuclear Waste Repository. Solicited Report Submitted to the State of Utah High-Level Nuclear Waste Office, Salt Lake City, Utah.

n.d. Prehistoric Archaeology of the Island-in-the-Sky. In preparation, Department of Anthropology, University of Nebraska and National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Osborn, Alan J., and Ralph J. Hartley
1984 Research Design for Understanding and Interpreting Aboriginal Adaptations in Southeastern Utah. Manuscript on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Osborn, Alan J., Susan Vetter, Ralph Hartley, and Karl J. Reinhard
1986 Archeological Inventory of Lavender Canyon, Salt Creek Archeological District, Canyonlands National Park. Manuscript on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Pianka, Eric R.
1978 Evolutionary Ecology. Harper and Row, New York.

Pilles, Peter J., Jr.
1981 A Review of Yavapai Archaeology. In The Protohistoric Period in the North American Southwest, AD 1450-1700 edited by David R. Wilcox and W. Bruce Masse, pp. 129-162. Arizona State University, Anthropological Research Papers No. 24.

Ricklefs, Robert E.
1979 Ecology. Chiron Press, New York.

Royama, T.
1970 Factors Governing the Hunting Behavior and Selection of Food by the Great Tit (Parus major L.). Journal of Animal Ecology 39:619-668.

Rudy, Jack R., and Robert D. Stirland
1950 An Archeological Reconnaissance in Washington County, Utah. University of Utah Anthropological Papers No. 9. Salt Lake City.

Schoener, Thomas W.
1971 Theory of Feeding Strategies. Annual Review of Ecology and Systematics 2:369-404.

Schroeder, Albert L.
1955 Archeology of Zion Park. University of Utah Anthropology Papers No. 22. Salt Lake City.

Simms, Steven R.
1984 Aboriginal Great Basin Foraging Strategies: An Evolutionary Analysis. Unpublished Ph.D. dissertation, Department of Anthropology, University of Utah. Salt Lake City.

1985 Pine Nut Use in Three Great Basin Cases: Data, Theory, and a Fragmentary Material Record. Journal of California and Great Basin Anthropology 7(2):166-175.

Simms, Steven, and Marilyn Isgreen
1984 Archaeological Excavations in the Sevier and Escalante Deserts, Western Utah. University of Utah Archaeological Center, Reports of Investigations 83-12. University of Utah, Salt Lake City.

Steward, Julian H.
1938 Basin-Plateau Aboriginal Socio-Political Groups. Bureau of American Ethnology Bulletin No. 120. Bureau of American Ethnology, Washington, D.C.

Stewart, Guy R., and Maurice Donnelly
1943 Soil and Water Economy in the Pueblo Southwest. Scientific Monthly 56:31-44.

Stiger, Mark A.
1978 Additional Archaeological Sites in Zion National Park. Manuscript on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Taylor, W.W.
1964 Tethered Nomadism and Water Territorality: An Hypothesis. 35th Congreso Internacional de Americanistas, Actas y Memorias 2:197-203. Mexico City.

Thomas, David Hurst
1973 An Empirical Test for Steward's Model of Great Basin Settlement Patterns. American Antiquity 36:155-176.

1983 The Archaeology of Monitor Valley: I. Epistemology. Anthropological Papers of the Museum of Natural History 58(1):1-194.

Thompson, Richard A.
1964 Letter to Frank Oberhansley, Zion National Park, June 22, 1964. Letter on file, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Tipps, Betsy
1983 The Captains Alcove: Test Excavations in Glen Canyon National Recreation Area, Kane County, Utah. Unpublished Master's thesis, Department of Anthropology, Washington State University, Pullman.

Tucker, Gordon C., Jr.
1985 Results of Archaeological Excavations in Washington County, Utah: Line 1 (Revised), Utah Section-Tobin Division. Nickens and Associates, Montrose, Colorado.

United States Department of Agriculture Weather Bureau
1936 Climatic Summary of the United States. Sections 1-26. U. S. Government Printing Office, Washington, D.C.

Walling, Barbara A., Richard A. Thompson, Gardiner F. Dalley, and Dennis G. Weder
1986 Excavations at Quail Creek. Bureau of Land Management, Utah State Office. Cultural Resource Series 20. Salt Lake City.

Westfall, Deborah A., William E. Davis, and Eric Blinman
1987 Green Spring: An Anasazi and Southern Paiute Encampment in the St. George Basin of Utah. Bureau of Land Management, Utah State Office. Cultural Resource Series 21, Salt Lake City.

Wetherill, Ben W.
1934 Summary of Investigations by the Zion National Park Archeological Party. Zion and Bryce Nature Notes, 6 (1), Zion National Park.

Whittaker, Robert H.
1975 Communities and Ecosystems. Second edition. Macmillan, New York.

Winterhalder, Bruce, and Eric Alden Smith, editors
1981 Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses. University of Chicago Press, Chicago.

APPENDIX A:

PETROGRAPHIC ANALYSIS OF SELECTED CERAMICS FROM 42WS2217, ZION NATIONAL PARK

David V. Hill

Three sherds were subjected to petrographic analysis from the larger collection discussed earlier in this report. The samples were selected to cover the range of decorative variation observed in the collection. Sample No. 1, recovered as a piece plot, was decorated with a series of parallel fingernail impressions. Sample No. 2, recovered during excavation, was marked by fingertip impressions. Sample No. 3, surface collected, most likely represents the base of a pointed-bottom vessel. It bears no decoration.

The samples were prepared for analysis by cutting and mounting the sherds in profile. This was for clear observation of construction techniques. Two sessions, of 30 minutes each, were spent with each sample to record compositional and construction information. Point counting was not attempted since the small sample size precluded meaningful statistical manipulation of the data. Also, the lack of comparative rock samples from the project area makes comparison of the tempering agent to particular outcrops difficult.

Petrographic Analysis

All of the samples were tempered with a light-colored, silica-rich, igneous rock. The texture of the rock fragments ranged from aplitic to fine grained. The mineral suite contained in the rock type consists of mostly twinned and untwinned feldspars. Quartz, brown hornblende, pyroxene, biotite, hematite, and magnetite are also present. Some of the biotite has been altered to hematite and clay minerals. Although both extrusive and intrusive igneous rocks are present in and around Zion National Park, the lack of comparative samples from outcrops precludes the assignment of the ceramic tempering material to one particular source over another (Gregory 1950).

Temper particles range in size from 710 to 2,000 microns. They are oriented in such a way that the long axis of the grains parallels the walls of the vessel. This type of preferred orientation results from the vessel walls being thinned by the paddle and anvil method. This technique of thinning vessels, as well as fingernail and fingertip impressing, has been noted in Shoshonean ceramics from western Colorado (Hill and Kane 1988; Buckles 1971).

Even though they have different surface treatments, the ceramics analyzed from 42WS2217 are all tempered using the same

rock type. This suggests that the vessels were made within the same area if not the same site. The use of the paddle and anvil method for thinning vessels and the style of decoration intimate that the makers were Shoshonean.

REFERENCES CITED

Buckles, William G.
1971 The Uncompahgre Complex: Historic Ute Archeology and Prehistoric Archeology on the Uncompahgre Plateau in West Central Colorado. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Gregory, H.E.
1950 Geology and Geography of the Zion Park Region, Utah and Arizona. U.S. Geological Survey Professional Paper No. 220. U.S. Government Printing Office, Washington, D.C.

Hill, David V., and Allen E. Kane
1988 Characterizations of Shoshonean Occupations and Ceramics from Southwestern Colorado. In Archeology of the Eastern Ute: A Symposium, edited by Paul R. Nickens, pp. 62-78. Colorado Council of Professional Archeologists Occasional Papers No. 1.

APPENDIX B. CERAMIC INVENTORY

SPECIMEN: T1S4-3

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing on exterior, reducing on interior, or possibly just uncontrolled.

CORE COLOR: Reddish brown from exterior to black on interior.

TEMPER: Crushed igneous rock.

FRACTURE: Moderately sharp

SURFACE FINISH: Relatively smooth

LUSTER: Dull

SURFACE COLOR: Reddish brown

WALL THICKNESS: 7 mm

DECORATION: None

SPECIMEN: T4S8-1, 3 pieces

CONSTRUCTION: Paddle and anvil.

FIRED: Reducing

CORE COLOR: Variable brown to black

TEMPER: Crushed igneous rock, temper exposed on interior surface.

FRACTURE: Generally crumbling

SURFACE FINISH: Fingernail impressions covering most of the surface

LUSTER: Dull, but small mineral flecks reflect light.

SURFACE COLOR: Brownish black

WALL THICKNESS: 6 mm

DECORATION: Fingernail impressions

SPECIMEN: T6S9-1

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Crushed igneous rock

FRACTURE: Moderately crumbling

SURFACE FINISH: Fingernail impressions

LUSTER: Dull

SURFACE COLOR: Brown same as interior

WALL THICKNESS: 6 mm

DECORATION: Fingernail impressed

SPECIMEN: T8S8-2, same description as Specimens T1S4-3, T4S8-1 and T6S9-1.

SPECIMEN: T7S11-1

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Possible organic,

FRACTURE: Moderately sharp, with some crumbling

SURFACE FINISH: Deep fingernail impressions, have a corrugated look.

LUSTER: Dull

SURFACE COLOR: Brown

WALL THICKNESS: 7 mm

DECORATION: Fingernail impressed

SPECIMEN: T7S10-1

CONSTRUCTION: Paddle and anvil

FIRED: Oxidizing

CORE COLOR: Gray

TEMPER: Crushed igneous rock

FRACTURE: Sharp

SURFACE FINISH: Rough, fingernail impressed; interior smooth.

LUSTER: Dull

SURFACE COLOR: Brown

WALL THICKNESS: 6 mm

DECORATION: Fingernail impressed

SPECIMEN: T11S9-1, 2 pieces

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Fine to extremely coarse crushed igneous rock, size ranges variable.

FRACTURE: Moderately sharp

SURFACE FINISH: Exterior punches or impressions; interior smooth.

LUSTER: Dull

SURFACE COLOR: Exterior brown; interior dark brown.

WALL THICKNESS: 7 mm

DECORATION: Oval impressions

SPECIMEN: T11S10-2, same description as previous specimen.

5 mm thick.

SPECIMEN: PP2

CONSTRUCTION: Paddle and anvil.

FIRED: Uncontrolled

CORE COLOR: Grayish brown

TEMPER: Small to coarse grain igneous rock, not well sorted.

FRACTURE: Sharp

SURFACE FINISH: Exterior rough, fingernail impressed, temper shows; interior smooth temper visible.

LUSTER: Dull

SURFACE COLOR: Brown to black.

WALL THICKNESS: 5 mm

DECORATION: Fingernail impressed

SPECIMEN: PP4

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Fine to coarse grain igneous rock, not well sorted.

FRACTURE: Moderately crumbling to sharp.

SURFACE FINISH: Exterior very rough; interior smooth temper visible.

LUSTER: Dull

SURFACE COLOR: Exterior brown; interior dark brown.

WALL THICKNESS: 7 mm

DECORATION: Fingernail impressed but very rough and indistinct.

SPECIMEN: PP 7

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown to dark brown.

TEMPER: Crushed igneous rock.

FRACTURE: Slightly crumbling to sharp.

SURFACE FINISH: Exterior fingernail impressed with some smoothing; interior smooth.

LUSTER: Dull, but minerals (pyrite? quartz?) reflect light.

SURFACE COLOR: Exterior brown; interior black.

WALL THICKNESS: 6 mm

DECORATION: Fingernail impressed.

SPECIMEN: PP 7

CONSTRUCTION: Paddle and anvil.

FIRED: Uncontrolled

CORE COLOR: Grayish brown

TEMPER: Crushed igneous rock.

FRACTURE: Sharp

SURFACE FINISH: Exterior fingernail impressed; interior smooth parallel brushed.

LUSTER: Dull

SURFACE COLOR: Brown to black

WALL THICKNESS: 5.5 mm

DECORATION: Fingernail impressed

SPECIMEN: PP10

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Dark brown

TEMPER: Medium grain igneous material.

FRACTURE: Crumbly

SURFACE FINISH: Exterior, smoothed or perhaps eroded, fingernail impressed; interior, smooth. Temper visible on both surfaces.

LUSTER: Dull

SURFACE COLOR: Light brown exterior; dark brown to black interior.

WALL THICKNESS: 7.5 mm

DECORATION: Fingernail impressed.

SPECIMEN: PP45

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Crushed igneous rock.

FRACTURE: Sharp

SURFACE FINISH: Exterior, smooth fingernail impressed; interior smooth with some evidence of brushing.

LUSTER: Dull

SURFACE COLOR: Exterior and interior same color of brown.

WALL THICKNESS: 5 mm

DECORATION: Fingernail impressed.

SPECIMEN: L50-17-2, N1003 E1003, Level 1

CONSTRUCTION: Paddle and anvil.

FIRED: Uncontrolled

CORE COLOR: Brown

TEMPER: Small to medium grain igneous rock.

FRACTURE: Crumbling to sharp.

SURFACE FINISH: Exterior, rough with "punches"; interior smooth to rough with random brushstrokes.

LUSTER: Dull

SURFACE COLOR: Predominantly brown, with some gray.

WALL THICKNESS: 7 mm

DECORATION: Punches, resembles Promontory Punched.

SPECIMEN: L50-24-7, N1004 E1003, Level 1, 0-10 cm, BS., 3 pcs., all refit. (Same description as previous specimen, but surface colors are black or very dark grayish brown).

WALL THICKNESS: 5 mm.

SPECIMEN: L51-4-4, N1005 E1003, Level 1, 0-10 cm BS.

CONSTRUCTION: Paddle and anvil

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Small to medium grain crushed igneous rock.

FRACTURE: Crumbling to moderately sharp

SURFACE FINISH: Exterior rough with punches; interior moderately rough.

LUSTER: Dull

SURFACE COLOR: Brown to grayish brown.

WALL THICKNESS: 6 mm

DECORATION: Deep pinches or punches.

SPECIMEN: N51-17-4, N1008 E1013, Level 1, aeolian cover.

CONSTRUCTION: Paddle and anvil

FIRED: Oxidizing

CORE COLOR: Variable gray to brown.

TEMPER: Variable, in some places there is none, in others medium size grains of probable igneous rock.

FRACTURE: Crumbling

SURFACE FINISH: Exterior is moderately rough; interior smooth.

LUSTER: Dull

SURFACE COLOR: Exterior is brown; interior grayish brown.

WALL THICKNESS: 7 mm - 9 mm

DECORATION: A small protuberance perhaps a lug or boss.

SPECIMEN: N51-3-3, N1005 E1012, Level 2, 10-20 cm BS.

CONSTRUCTION: Paddle and anvil.

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Crushed igneous rock.

FRACTURE: Sharp

SURFACE FINISH: Exterior rough, punches, temper showing; Interior smooth with random and parallel brush strokes.

LUSTER: Dull

SURFACE COLOR: Exterior brown; interior gray to black.

WALL THICKNESS: 6 mm

DECORATION: Nearly obliterated fingernail pinches.

SPECIMEN: P52-10-3, N1011 E1020, Level 2.

CONSTRUCTION: Paddle and anvil

FIRED: Oxidizing

CORE COLOR: Brown

TEMPER: Small to medium grains of igneous rock, not well sorted.

FRACTURE: Crumbling to sharp.

SURFACE FINISH: Exterior rough, with pinches, temper showing; Interior smooth with brush strokes.

LUSTER: Dull

SURFACE COLOR: Brown

WALL THICKNESS: 6 mm

DECORATION: Punches, probable rim fragment.

REPORT CERTIFICATION

I certify that Aboriginal Hunter-Gatherer Adaptations of Zion National Park, Utah by Gaylen R. Burgett, 1990

has been reviewed against the criteria contained in 43 CFR Part 7(a)(1) and upon recommendation of the Regional Archeologist has been classified as available.

Regional Director

9/28/90
Date

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