Cultural Resources Overview

Little Colorado Area, Arizona

Fred Plog

CULTURAL RESOURCES OVERVIEW:

LITTLE COLORADO AREA, ARIZONA

by

Fred Plog

For

Apache-Sitgreaves National Forests
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PREFACE

Since 1979 the Southwestern Region of the Forest Service and the Bureau of Land Managment in New Mexico and Arizona have been producing a series of joint cultural resource overviews. This is the first volume from the State of Arizona. It is also the first published overview by a researcher, Dr. Fred Plog, who has had many years of first hand experience with the data base from most of the overview area. This gives the overview a special flavor not characteristic of earlier works which tended to summarize the data gathered by others. Beyond Dr. Plog's intimate archeological familiarity with the region, he has worked with many projects in timbering and range management involving cultural resource sites. This background is brought together here in a series of chapters which discuss the prehistoric cultures of the overview area. Dr. Plog has also provided a discussion of the term "significance," as applied in Historic Preservation usage, derived from his experiences in the overview area but general enough to be applicable in other places. His final management chapter reflects considerable thought on how one articulates cultural resources with other resources and suggests ways for improving the management of cultural resources. We are pleased to make this volume available to managers and students of archeology alike.

PAUL D. WIENGART
Director of Recreation
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ACKNOWLEDGEMENTS

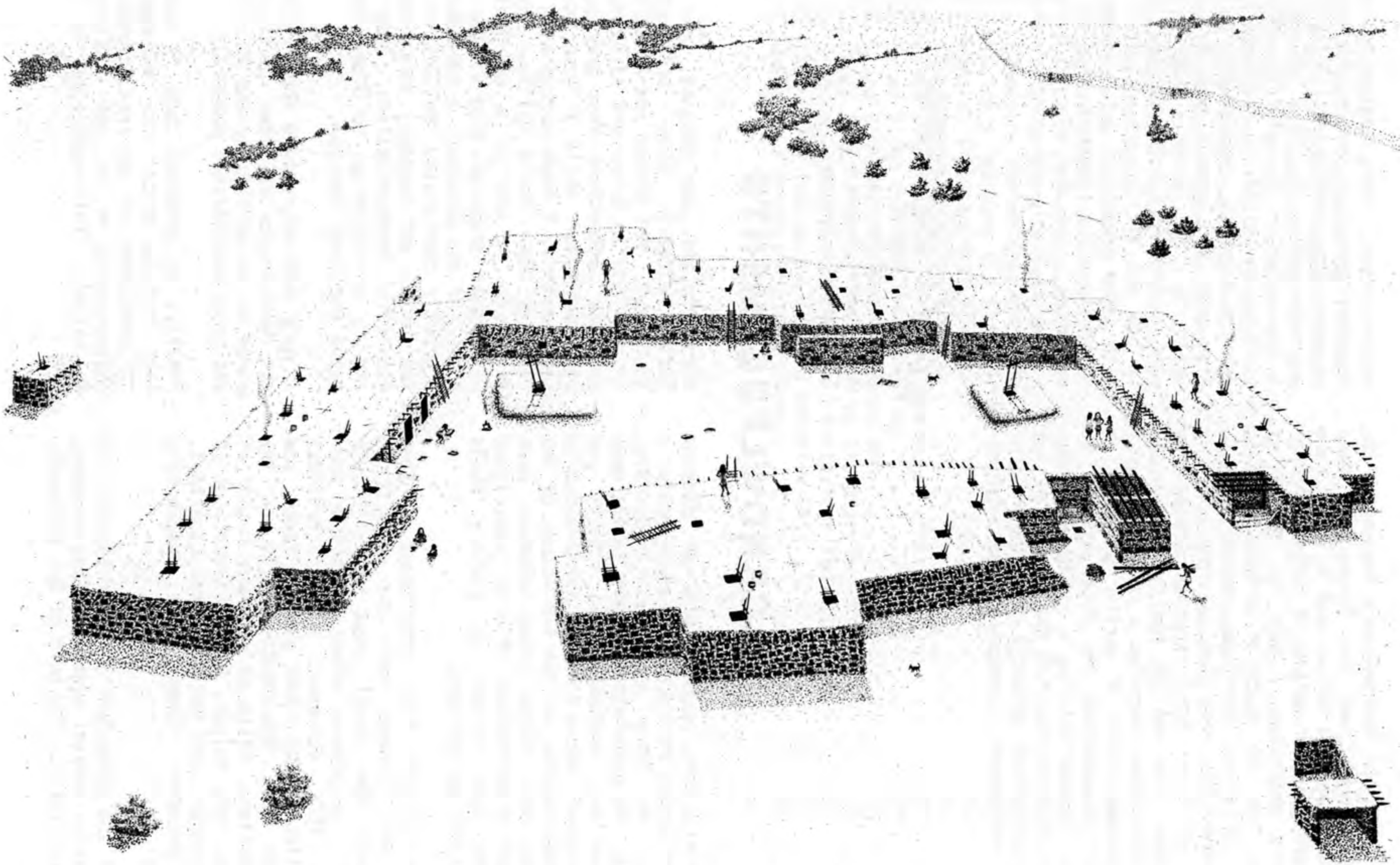
Identifying the contributions of individuals in a work that attempts as extensive a summary as this one is impossible. Clearly, the major contributors to the work are the many archeologists, student and professional, whose work has contributed to our understanding of the prehistory of the overview area. While I have sometimes been critical of particular efforts, even these analyses have helped in shaping basic perceptions of the past.

My own students have contributed to this study both through their own efforts to interpret the local past and through specific assistance given to me in preparing this document. Their critical evaluations of my ideas are the final, and probably most important, aspect of the contribution. While an enormous number of students have helped, the contributions of Judy Brunson, Jeff Hantman, Kent Lightfoot, and Steadman Upham were especially critical.

Without the foresight of archeologists and managers in federal agencies, this document would not exist. The help of Dee F. Green, Chris Kincaid, John Douglas, John Koen, and Paul Weingart have been especially important. Pat Giorgi and Bruce Donaldson, in addition to Green and Kincaid, provided valuable suggestions that greatly improved the document. While I have worked with many editors, I have worked with none more talented than David Gillio. My debt of gratitude to him is a substantial one. Jeff Boyer prepared some of the illustrations for the document, a contribution that I greatly appreciate. Polly Davis prepared the index, and Gassaway Brown helped with geological interpretations. Both my thanks and my apologies go to Donna Calkins who typed the final version.

I very much appreciate the help of all of the individuals at other institutions who aided me in gaining access to site records and other unpublished materials.

Finally, my greatest debt is owed to the late Paul S. Martin who introduced me to the prehistory of the area, shaped my early understanding of it, and challenged me to do better. This monograph is for Paul.



Artist's reconstruction of Broken K Pueblo.

THE LITTLE COLORADO OVERVIEW UNIT

INTRODUCTION

This document describes the prehistoric cultural resources of the Little Colorado Overview Unit. The unit is defined pursuant to a cooperative agreement between the USDA Forest Service and the USDI Bureau of Land Management. The agreement divides the State of Arizona into a series of overview units and designates one of the two agencies as lead for each (see Map 1). The goal of the agreement is the preparation of overview documents that generally follow the guidelines established in the BLM cultural resources manual, section 8111. The documents are intended to serve a number of purposes:

a) to guide in the assessment of cultural resource values within the study area,
b) to aid in the preparation of planning documents, and
c) to provide a context for the preparation of Class II sample surveys.

This particular inventory unit consists of portions of the Apache-Sitgreaves and Coconino National Forests and of the BLM Apache-Navajo Planning Unit (see Maps 2 and 3).

The Little Colorado Overview Unit covers an area of roughly 8000 square miles in north central Arizona. It is bounded on the north by the southern edge of the Navajo Reservation, on the east by the Arizona-New Mexico state line, on the south by the Mogollon Rim and on the west by an irregular line formed by the Navajo-Coconino County line to the northern edge of the Apache-Sitgreaves and Coconino National Forests, westward along that edge and then south along Highway 87 to the Mogollon Rim. Roughly 2000 square miles of the area is Federal land administered by the Forest Service, 340 square miles is administered by the Bureau of Land Management, and 680 square miles is State Trust land. Thus, of the total area, 36% represents government administered lands, and 64% is owned privately.

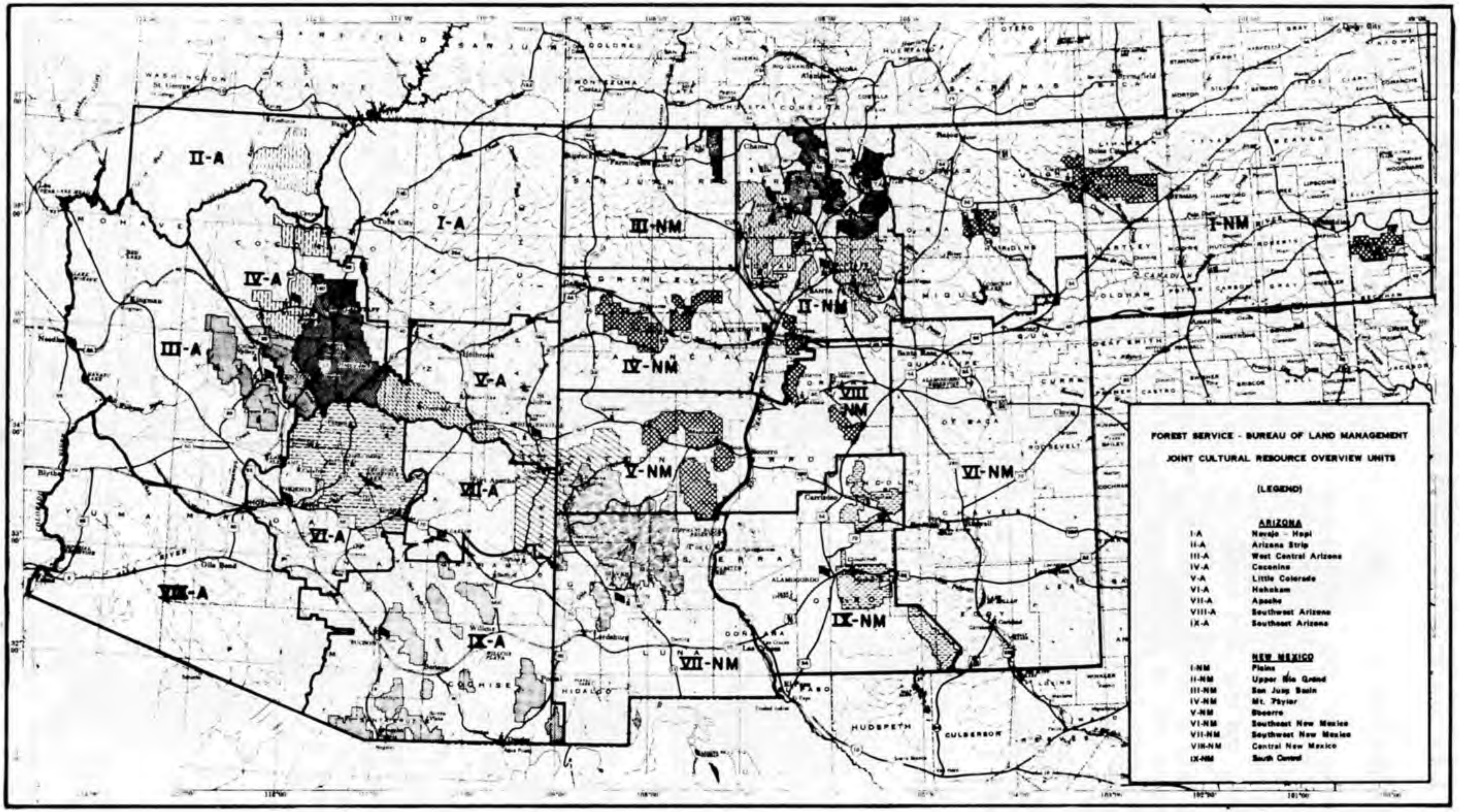
The study area lies on the Colorado Plateau in the southeastern and south-central portions of the Little Colorado River drainage. The southern boundary of the drainage lies within the study area. The highest elevations, at about 11,000 feet, are in the southeastern corner of the study area and the lowest elevations are in the northwestern corner. The entire Little Colorado Basin is an area of 26,977 square miles. In general, the land surface slopes gradually downward from southeast to northwest although there are occasional minor, and some major, changes of elevation. Thus, the study area is a drainage basin associated with a relatively large river. The study area and its major cultural and natural features are shown in Maps 2 and 3.

GEOLOGY

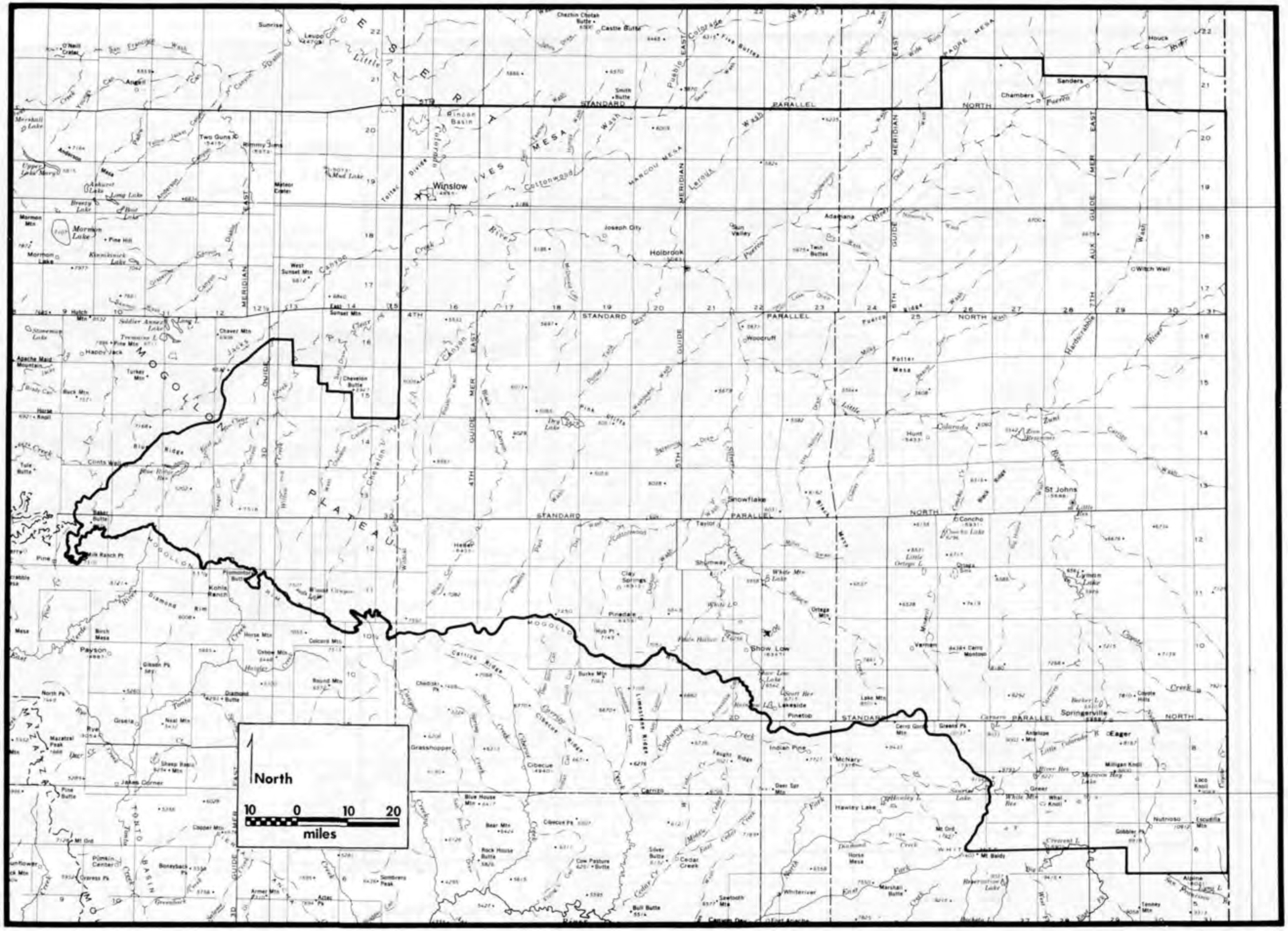
As one would anticipate given the substantial altitudinal variation, the geology of the area is complex. Figure 1 illustrates the major stratigraphic units used by geologists in describing the area. These are of importance to this study principally when they occur as surficial or near-surficial deposits. Given this perspective, the geology is best described in four categories or zones (see Map 4). The following discussion is based substantially on pertinent geological maps prepared by the Arizona Bureau of Mines (1960, 1967).

Zone 1: The Basalt Highlands

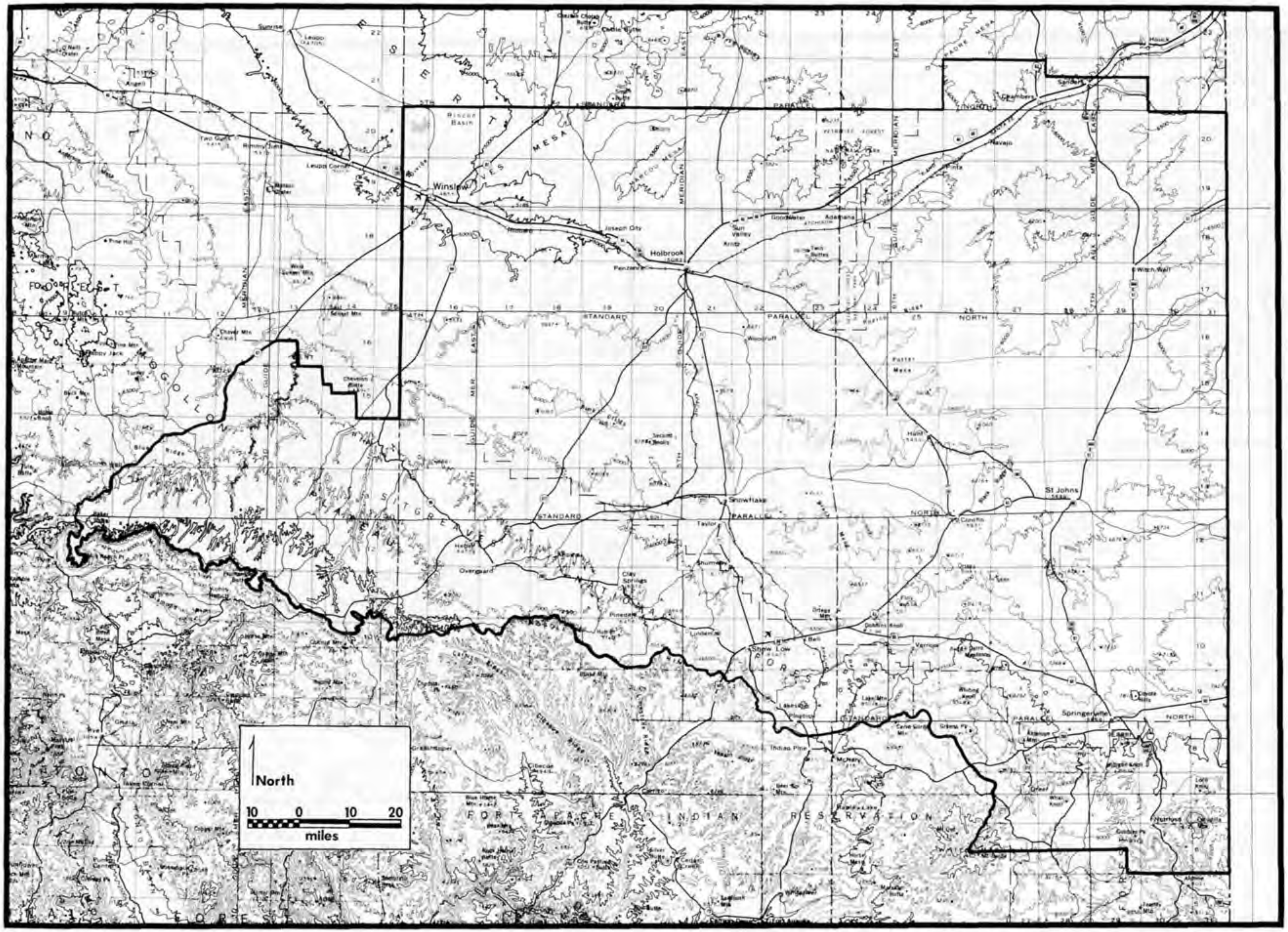
The Basalt Highlands lie in the southeastern corner of the study area. This zone is roughly bounded by lines running from Show Low north to Shumway, east to Concho, and then southeast to about 15 miles north of Alpine, Arizona. The predominant surficial and immediate subsurface deposits in this area are tertiary (upper peaks) and quaternary (lower cones and flows) basalt flows and cinder cones, with remnants of the largest of the volcanoes ranging up to 11,000 feet in elevation. In some more deeply eroded drainages, there are exposures of the Datil formation and also what Sirrine (1955) has called the Eagar formation of conglomerates, sandstones, and shales. Drainage bottoms are also commonly filled with quaternary and tertiary sediments derived from the parent materials mentioned above. Except in the deeper river valley and in the immediate vicinity of cinder cones, soil formation is minimal.



Map 1. Forest Service-Bureau of Land Management joint cultural resource overview units.



Map 2. The Little Colorado overview area: cultural features.



Map 3. The Little Colorado overview area: natural features.

Richville Formation: light brown, yellow-brown, and white mudstone, sandstone, gravel, conglomerate, caliche, travertine, and limestone.

Bidahochi Formation: white to light brown sandstone with minor interbeds of mudstone, siltstone and volcanic ash.

Datil Formation: black basalt flows interbedded with white volcanic ash, white sandstone and red to gray siltstone.

Eager Formation: red sandstone, shale, and conglomerate.

Mesa Verde Group: light yellow-brown, light green and red-brown sandstone and siltstone with some conglomerates. Local interbeds of coal.

Mancos Shale: dark gray shale and siltstone with thin interbeds of yellow-brown sandstone and siltstone.

Dakota Sandstone: light brown to yellow-brown sandstone and conglomerate. Often contains coal seams at or near base.

Chinle Formation: red-brown, purple, gray, green-gray interbedded sandstone, siltstone, and shale. Often contains petrified wood.

Shinarump Formation: yellow-orange to pale orange coarse sandstone and conglomerate.

Moenkopi Formation: red-brown to chocolate-brown interbeds of siltstone and shale.

Kaibab Limestone: dark gray to yellow-gray fossiliferous, silty-limestone with locally abundant chert nodules. Local interbeds of fine-grained sandstone.

Coconino Sandstone: light gray to white, fine- to medium-grained sandstone.

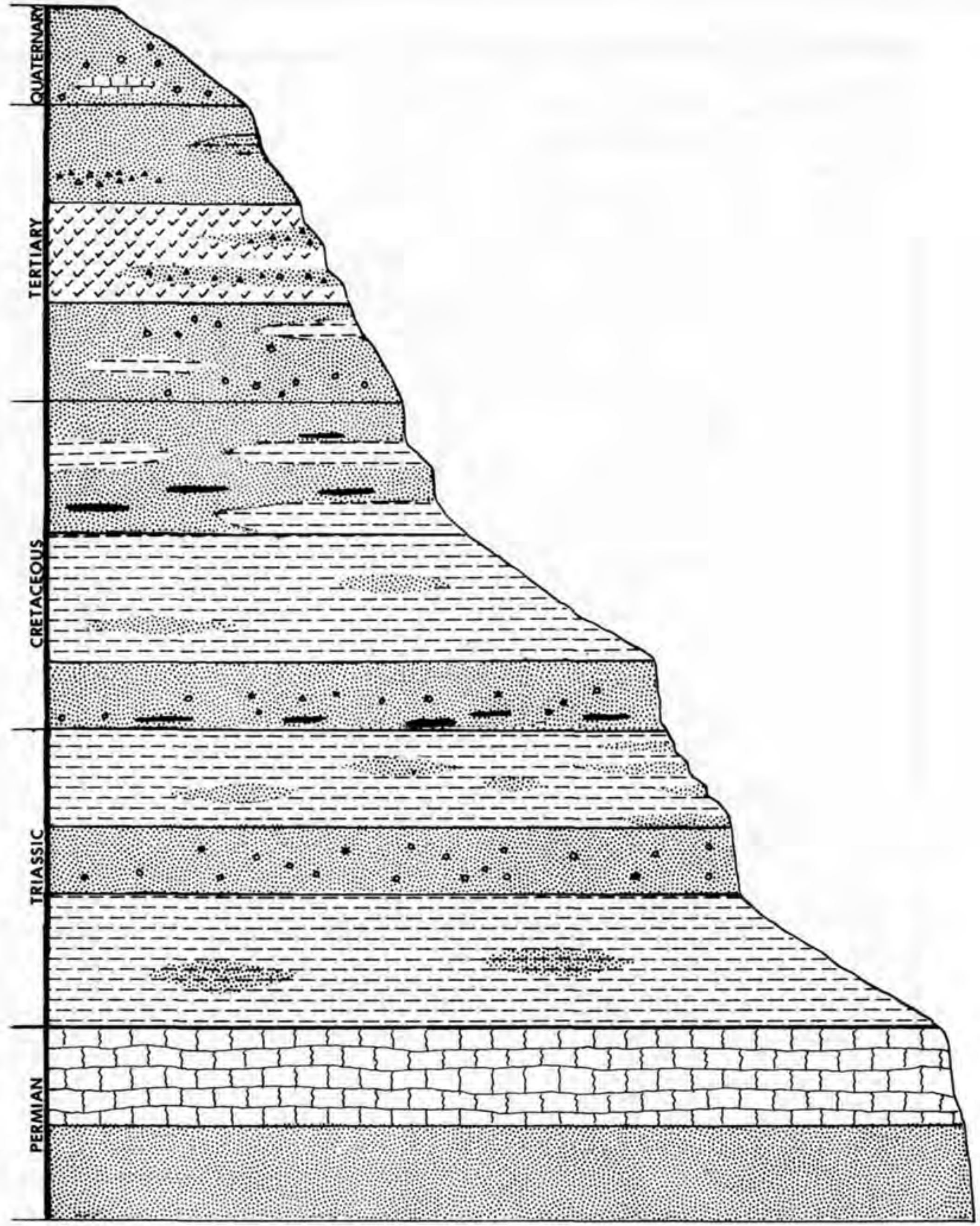
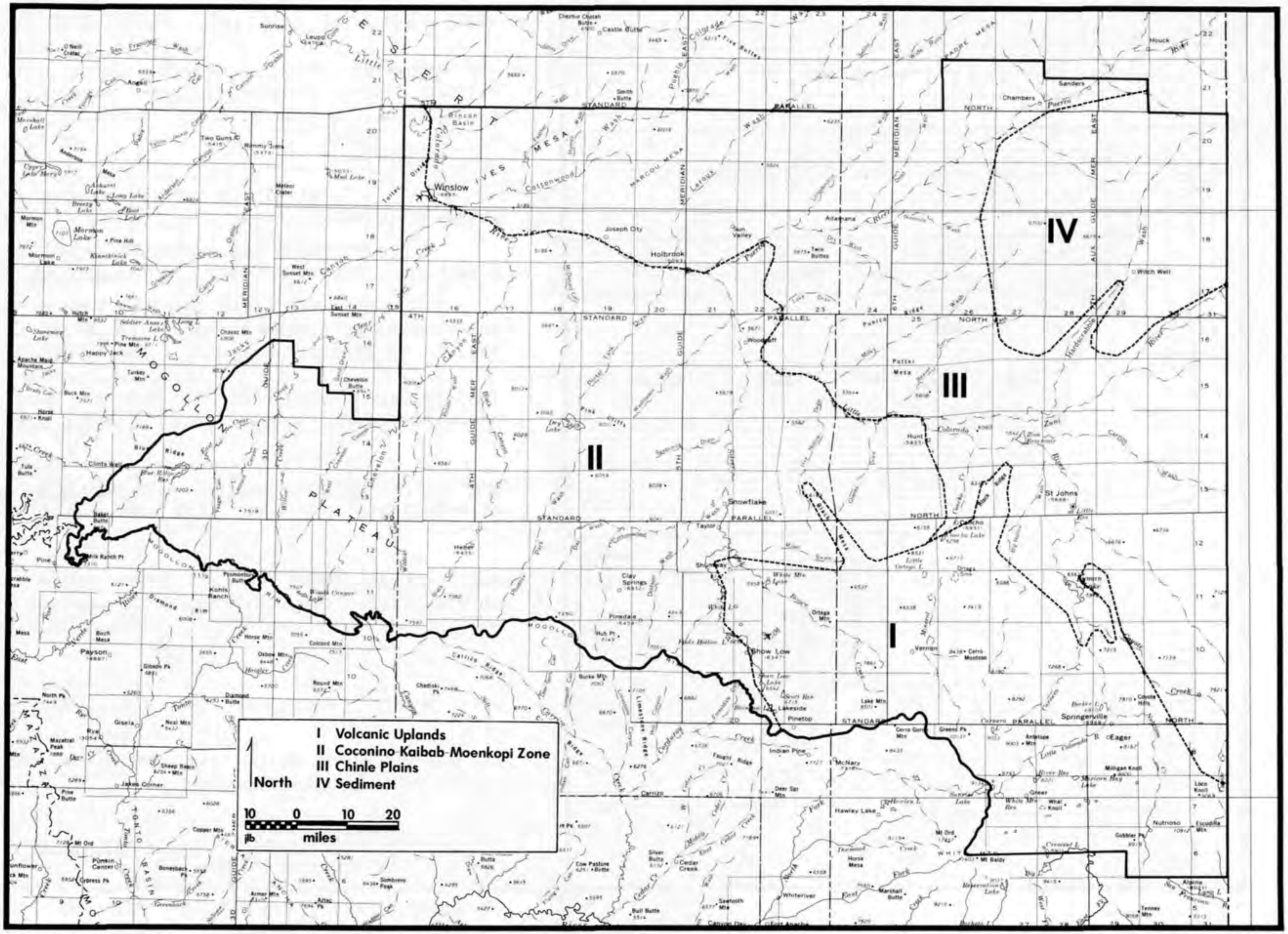


Figure 1. Geological sequence of the Little Colorado overview unit. (Formations not to scale.)



Map 4. Major geological zones of the Little Colorado overview unit.

Zone II: Coconino-Kaibab-Moenkopi Uplands

The largest portion of the study area is occupied by this zone which lies generally to the south of the Little Colorado River and to the west of the Basalt Highlands. Outcrops of the Moenkopi Sandstone and Kaibab Limestone and soils derived from these are most typical of this area. These are generally thin and unproductive soils.

The extreme southern end of the zone, along the Mogollon Rim, is typified by Moenkopi Sandstone and Mogollon "Rim Gravels" and sediments and soils derived from them. In the southeastern portion of the zone between Linden, Aripine, and Zeniff, Arizona, there are extensive areas covered by relatively deep quaternary and tertiary gravel deposits. Occasional basalt flows meander into the zone from the Basalt Highlands, and there are roughly a half dozen isolated cones or flows.

Zone III: Chinle Plains

Immediately to the north of the Little Colorado River is an area where the predominant circumsurficial materials are derived from deposits of the Chinle Formation of which the Painted Desert and the Petrified Forest are a part, although the latter are more colorful than the majority of areas. Occasionally, along the major drainages, there are relatively extensive zones of Quaternary and Tertiary sediments. At its extreme northeastern tip the Dakota Sandstone and the Mesa Verde Group are exposed along with a few zones of basalt flow. Over much of the area the soil formation is close to nil with decomposed Moenkopi sediments forming the ground surface.

Zone IV: Sediment Zone

The headwaters of Hardscrabble Wash and the Puerco River and its tributaries in the extreme northeastern sector of the study area are overlain by deep quaternary and tertiary sands, silts, and gravels. These areas are poorly described and specific characterization of their geological characteristics is not possible at present.

Other Considerations

More recent geological events in the study area are poorly described. Cooley and Hevly (1964), Hevly (1964), and Bowman (1975) have discussed erosional sequences in two areas, both of which lie within the Coconino-Kaibab-Moenkopi Uplands as defined above. While the most recent epoch of vulcanism in the area can be bracketed at 2,000 to 1,000,000 years ago, it is currently impossible to be any more specific. Finally, the highest points in the Basalt Highlands were affected by glaciation as recently as late Wisconsin times (terminal Pleistocene) and again at some time between 2500 and 6800 BP (Merrill and Pewe 1972). Nevertheless, much remains to be known of the nature of natural processes during late Pleistocene and early Holocene times.

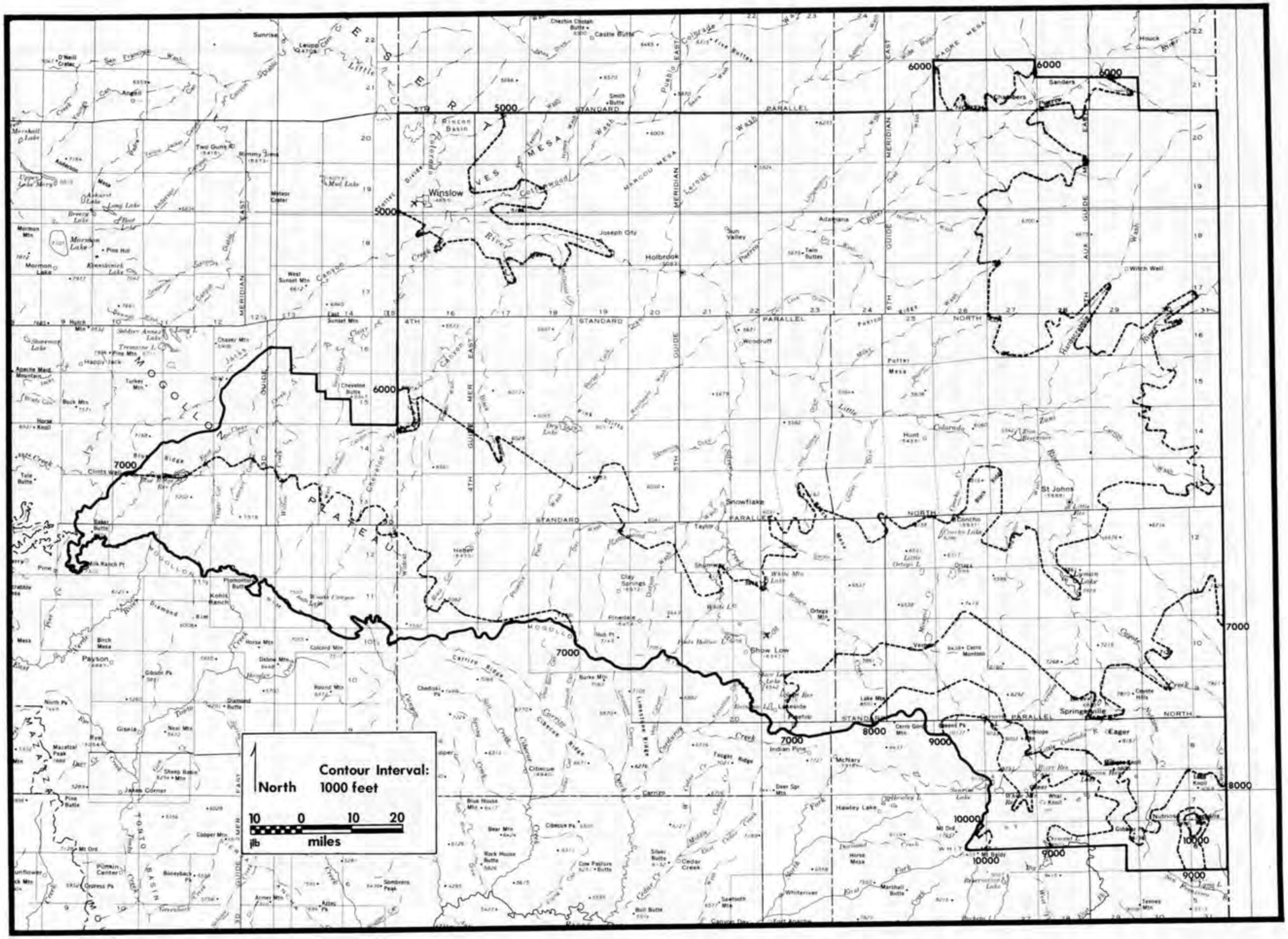
The area is not rich in mineral resources. Managanese occurs in a few localities along the Mogollon Rim at the western end of the overview area. Two occurrences of copper have been noted just east of Lyman Lake and near the end of the study unit almost due north. Salt occurs in sporadic deposits north of St. Johns and Concho.

TOPOGRAPHY

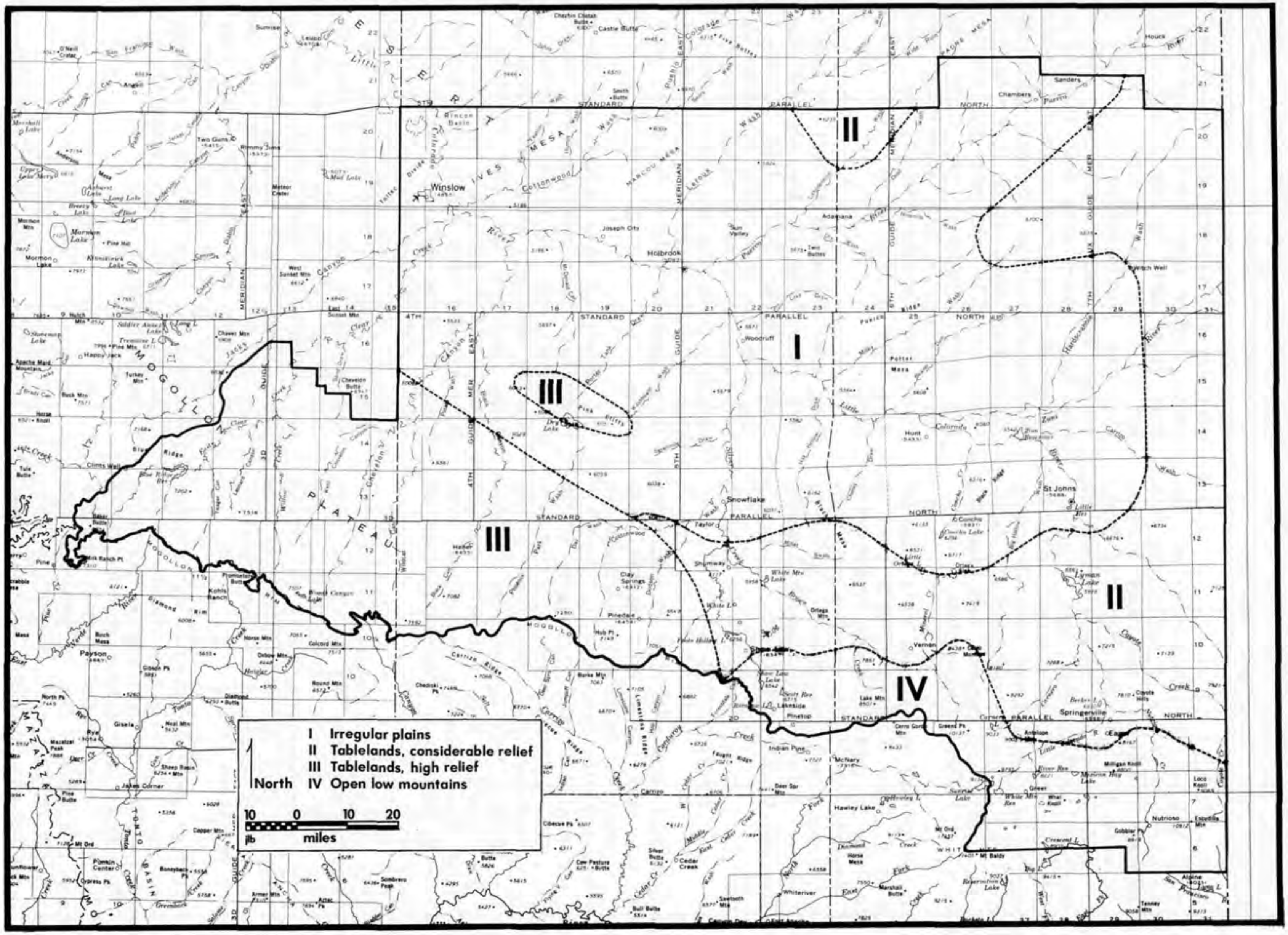
As noted earlier, the basic topographic configuration of the study area as a whole is that of a basin. As indicated in Map 5, the margins of the basin lie within the study area at its high southern and eastern extremes with the southeast corner as the highest portion of the study area. Following the Hammond system (1962), the area can be subdivided into a series of discrete categories (see Map 6).

In the southeastern corner of the study area is a zone best defined as open low mountains formed by vulcanism. Twenty to fifty per cent of the land surface is gentle; relief averages between 1000 and 3000 feet within a radius of a few miles, and most of the gently sloped land is on upland (as opposed to valley bottom) surfaces.

To the north of this zone is an area of tablelands with considerable relief. Fifty to eighty percent of the land is gently



Map 5. Elevation of the Little Colorado overview unit.



Map 6. Major topographic zones of the Little Colorado overview unit.

sloping and most of this land is on upland surfaces. Relief locally is generally on the order of 500 to 1000 feet. The area is actually highly variable in terms of the specific landform configurations. Ridges, cones, buttes, and deeper and wider as well as narrower and shallower valleys all occur.

The zone forming the remainder of the southern boundary is one of tablelands with high relief. There are two major differences between this and the preceding zone. First, local relief is typically more on the order of 1000 to 3000 feet. Second, the zone consists of a relatively monotonous series of parallel and north-trending ridges. Some major ridge zones are separated by deeply cut canyons but have the same parallel ridges between them.

The center of the study area is a zone of irregular plains. Fifty to eighty percent of the land is gently sloped, again with most, upwards of fifty percent, of the gently sloped land on upland surfaces. Local relief is minimal, however, rarely more than 100 to 300 feet.

PRECIPITATION

Average annual precipitation at recording stations in the study area varies from about 7.5 inches at Holbrook and Winslow to 24 inches at Alpine (see Map 7). Mountain peaks above Alpine receive upwards of 30 inches. In general, precipitation is closely correlated with elevation (r=.86) (Johnson 1974). This correlation is best along the Mogollon Rim. Rainfall is both lower and less clearly correlated with elevation in the lower central portion of the study area.

The most outstanding characteristic of precipitation patterns in the area, however, is their extreme variability. Both spatially and temporally, there is little that can be said to be typical of any portion of the basin. Let us consider temporal variation first.

Precipitation is not evenly distributed over the year. It falls principally during a summer monsoon period lasting from July until September and during the period of peak winter continental storms between December and March. May is generally the driest month of the year. Winter precipitation tends to be more variable than summer precipitation both overall and in relation to elevation.

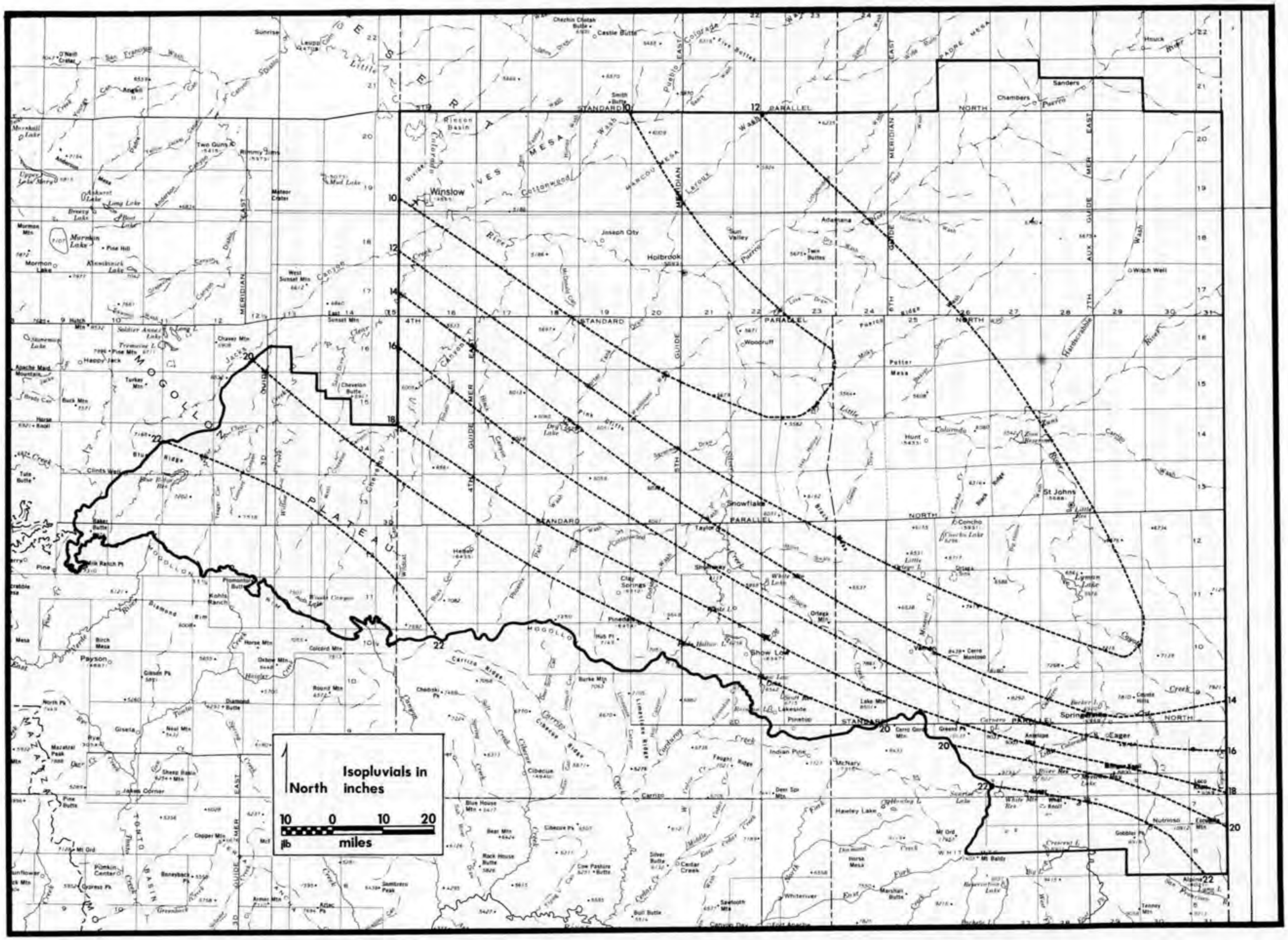
Spatially, extremely high and low departures from the average precipitation are constant throughout the study area. There is a general tendency toward somewhat less deviation from yearly averages in the northern and eastern sectors of the study area. Higher areas have more precipitation than lower ones in the driest years, but not in the driest summers. Minimum April and June precipitation is greater in the eastern and southern highlands area. There are fewer years with less than 75 percent of normal precipitation in this same area. When precipitation gradients that are more substantial than normal occur in the area, these normally separate the northeastern and eastern edges of the study area from the remainder. Such departures are most likely in November, March, May, June, and July (the preceeding is drawn from Visher 1954).

Yet, even these data fail to convey the full complexity of the variability. The average summer storm that passes through the area has a diameter of about 10 miles with several 1 to 3 miles diameter cells actually producing the rain (Johnson 1974). Thus, a given storm will water one area but leave another only a few miles away quite dry.

The effect of this pattern may be seen by comparing the precipitation records of Pinedale and Holbrook. Using 5-year running averages, there are 7 precipitation peaks evident in the Pinedale record between 1921 and 1971 (Lightfoot 1981). During these high years, Holbrook was also high in three but was low or average in four. During six years of low precipitation in Pinedale, Holbrook was high or above average in four and also low in only two. This is not to argue that the precipitation patterns in the two communities are negatively correlated. More accurately, they simply vary randomly in relation to one another, despite the long term correlation of rainfall with elevation. Any other pair of communities might also be expected to vary randomly, although some communities will vary proportionally and some inversely.

TEMPERATURE

Temperature, like precipitation, varies



Map 7. Precipitation variability in the Little Colorado overview unit (after Greenwood 1960).

closely with elevation (r=.88, Johnson 1974). Average January temperatures are about 32° F. at lower elevations and about 28° F. at higher elevations. Average July temperatures are around 76° F. at the lowest elevations and 64° F at the higher. Thus, variation is somewhat more pronounced during the summer. Extremely cold, below zero, temperatures occur throughout the study area during the winter months. Map 8 illustrates the clinal pattern of temperature variation. The only notable difference from the distribution of precipitation is the markedly less sharp variation immediately along the Mogollon Rim.

Variation in the length of the growing season is somewhat different from that for temperature (see Map 9). The longest growing season (over 160 days) occurs immediately along the northeastern edge of the study area. The shortest growing season is along the Mogollon Rim where a season of 100 to 120 days is typical at lower elevations and less than 100 days at the highest.

In the lower elevations of the Little Colorado River Valley, a growing season of 160-plus days is characteristic, while the average is around 150 days in the surrounding foothills. Deviations from these averages, especially at higher elevations, are substantial. At Pinedale, for example, a growing season as short as 103 days is likely in one year out of four, and a season as short as 87 days in one year out of 16 (Lightfoot 1981). Virtually the same conditions prevail at McNary and can be expected to be even more extreme at higher altitudes.

HYDROLOGY

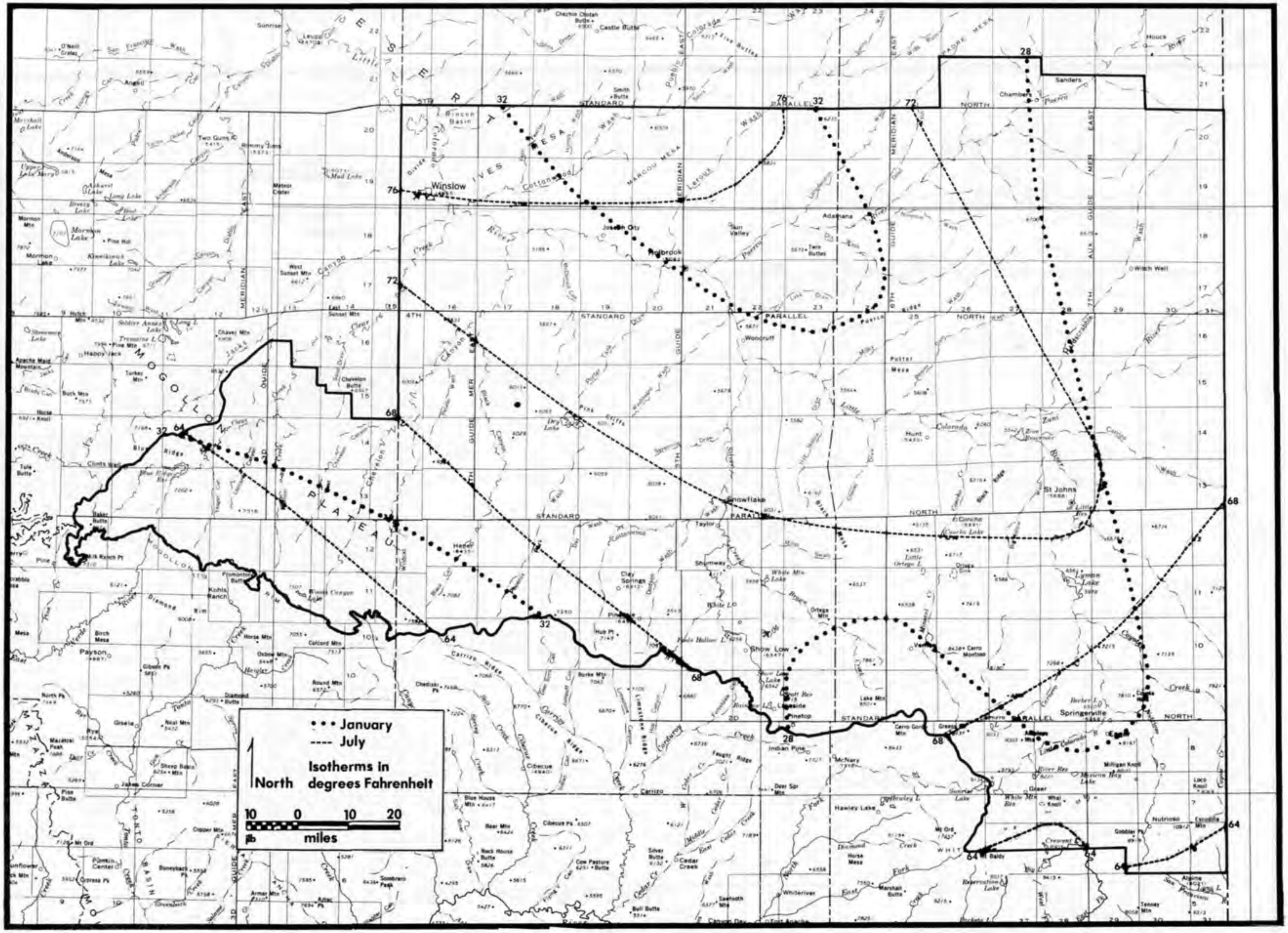
Hydrological data are important both as a means of assessing the availability of surface waters in the study area and because, in an area where recording stations are sparse, they provide backup information concerning the distribution of precipitation (the following discussion is based on Johnson 1974).

The pattern within the study area is basically one of boom and bust. At any point in time, most drainages are carrying either a great deal of water or no water at all. Of course, there is often a subsurface flow that can be tapped by digging a well.

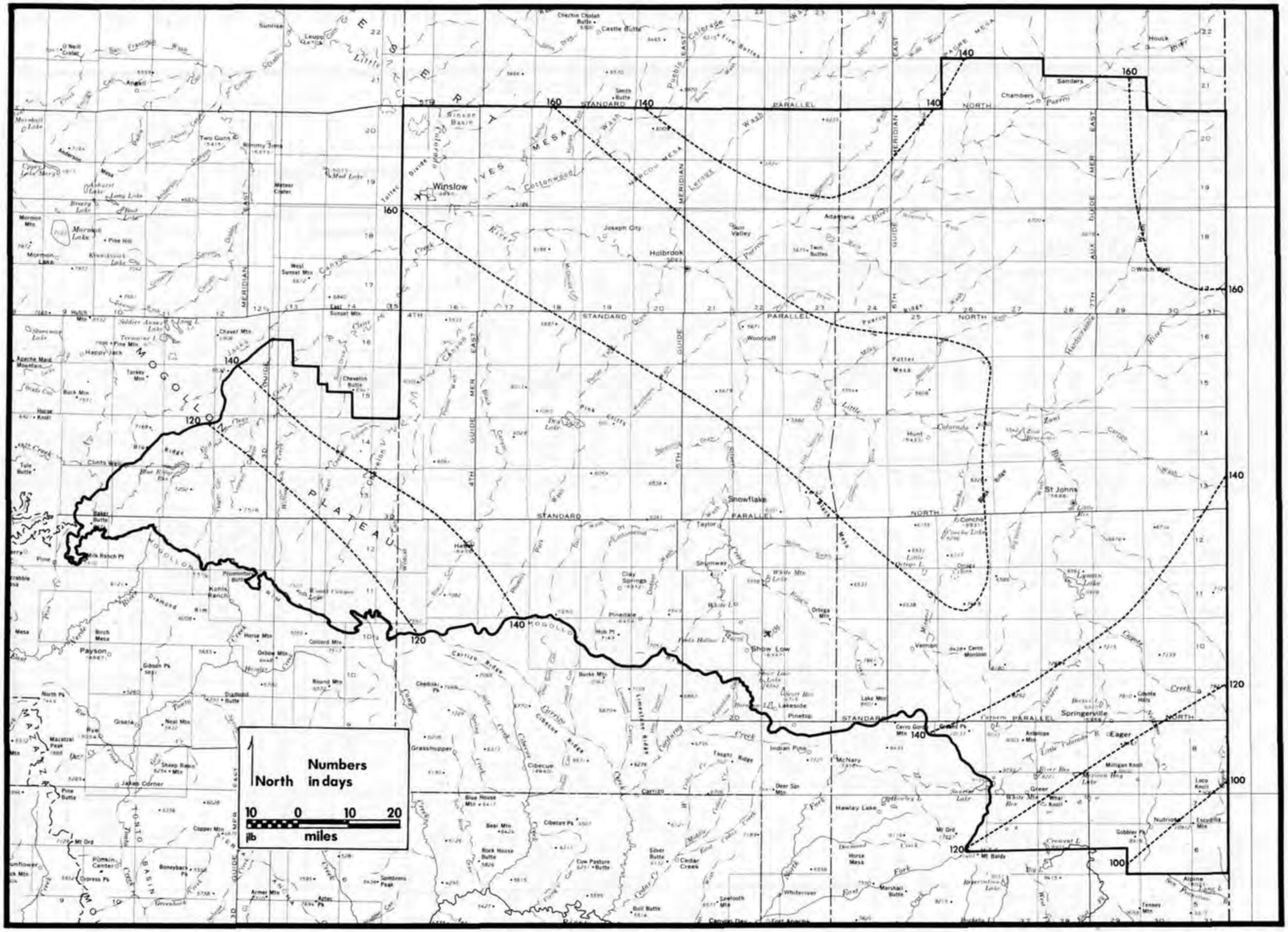
The extent of this variation is indicated in Table 1. Of particular importance is the relationship between the maximum and minimum flow. The values indicate that maximum values for the recorded drainages are on the order of 20 to 40 times the minimum annual value. Table 2 illustrates several other aspects of the variation. While one recording station is typically the lowest in the winter months (Zuni), it is not so typically the lowest during the summer months. There is in fact no pattern to where the summer low occurs. Similarly, while the highest stream flow in winter months occurs in Clear Creek, the highs in the summer are equally divided between Clear Creek, Holbrook, and Woodruff. It should be noted that Zuni, Holbrook, and Woodruff are all on the Little Colorado River. This indicates that a high stream flow at one point along the river course does not mean that the flow will necessarily reach a downstream point in the same abundance.

Table 1. Variation in stream flow in the Little Colorado overview unit

	Mean Discharge/ Square Mile	Maximum Recorded	Minimum Recorded	Maximum/Minimum
Chevelon	45.96	105,300	5560	18.94
Clear Creek	92.71	196,500	5050	38.91
Silver Creek	14.14	59,460	2,250	26.55
Little Colorado	20.92	51,870	2,130	24.35



Map 8. Variation in mean temperature in the Little Colorado overview unit (after Greenwood 1960).



Map 9. Variation in the number of frost-free days in the Little Colorado overview unit (after Greenwood 1969).

Table 2. Decadic variation in stream flow in the Little Colorado overview unit

	Pre 1925	1925-34	35-44	45-54	55-64	65-73
WINTER						
Ratio	5.12	5.30	15.23	64.20	36.30	44.48
Lowest	Chevelon	Hunt	Zuni	Zuni	Zuni	Zuni
Highest	Holbrook	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek
SUMMER						
Ratio	14.6	112.03	98.27	15.92	16.71	22.88
Lowest	Chevelon	Woodruff	Clear Creek	Clear Creek	Zuni	Zuni
Highest	Woodruff	Clear Creek	Woodruff	Holbrook	Holbrook	Clear Creek

Table 3. Variation in seasonal stream flow in the Little Colorado overview unit by decade (Values are ratios to the overall mean for each recording station)

		Pre 1925	25-34	35-44	45-54	55-64	64-73
	W			1.41	.76	.75	1.37
LCR-Lyman	S		1.21	.94	.85	1.12	
	W			3.01	.51	.52	2.42
LCR-Zuni	S			.64	1.05	1.31	.77
	W		2.86	3.51	.31	.26	.60
LCR-Hunt	S		2.99	.56	.80	.68	.67
	W	3.47	1.78	1.09	.58	.45	1.09
LCR-Woodruff	S	1.45	2.14	.65	.93	.82	.83
	W	5.48			.57	.61	1.63
LCR-Holbrook	S	.41			.58	.87	1.33
	W		2.29	1.02	.91	.48	1.09
Silver Creek	S		2.03	.77	1.08	.75	.85
	W	1.01	1.05	1.20	.94	.79	1.08
Chevelon	S	.82	.57	.58	1.16	1.33	1.22
	W	1.20	1.28	.96	.71	1.28	
Clear Creek	S	.13	.05	.67	3.04	.54	

LCR = Stations along Little Colorado River
W = Winter
S = Summer

The ratios between the high and low recording stations are also shown in the table. It is evident that variation is substantial. Table 3 illustrates the relationship of decadic summer and winter flows to the average for the recording station. While there is nearly always some drainage that experiences a shortage of winter stream flow, one or more drainages are at or above average in every decade except 1955-1964. One or more drainages are above average for the decade in every year when the summer figures are considered.

SOILS

Given the complex variation in geology, precipitation, and stream flow over the study area, a complex distribution of soils is expectable. Defining the pattern of variation in soils is difficult; detailed soil maps exist only for some planning units on the National Forests, central Apache County, and some locations between Holbrook and Show Low. County level soil studies are too gross for local analyses and too detailed for regional generalizations. Thus, the description of soils presented herein is a composite of a variety of specific studies (USDA Soil Conservation Service 1959, 1964, 1972a, b, 1975). The distribution of different soils is shown in Map 10. Brief definitions are given in the key to Map 10. Map 11 shows the erosional pattern within the study area.[1]

These are, of course, zonal patterns. Azonal variation is substantial, perhaps best reflected in the fact that one of the more extensive soil zones is defined on the basis of alternating zonal and azonal patterns. Within most of the zones, there are at least small pockets, on the order of several acres, of moderately deep to deep noncalcareous sandy and/or loamy soils.

VEGETATION AND FAUNA

The distribution of flora and fauna is elevationally zoned. There is little consistency in the manner in which specific zones have been defined. The pattern shown in Map 12 is derived basically from Lowe's study (1964). However, the subsequent discussions and definition draw heavily upon the Forest Service's study of the Mogollon Rim Planning Unit (USDA FS 1972) and the work of Aitchison and Theroux (1974). Major associations and plant communities occurring within them are defined in Table 4.

While these definitions account for modal patterns in the area, it is important to recognize that ecotonal distributions are substantial. There is, for example, a broad belt where a scrubland forms the transition between the juniper pinyon woodland and the desert grassland. Similarly, there is considerable variation in the relative percentages of different dominants. In some areas of the juniper pinyon woodland juniper is predominant, pinyon in others. It is not possible at present to describe the details of this variation. Examples of major associations are shown in Figures 2 through 5.

Figure 2. Desert grassland in the Little Colorado overview unit.

Figure 3. Grassland-woodland transition in the Little Colorado overview unit.

1. *An erosion map that will apparently differ considerably from this one is currently* under preparation by the Soil Conservation Service.

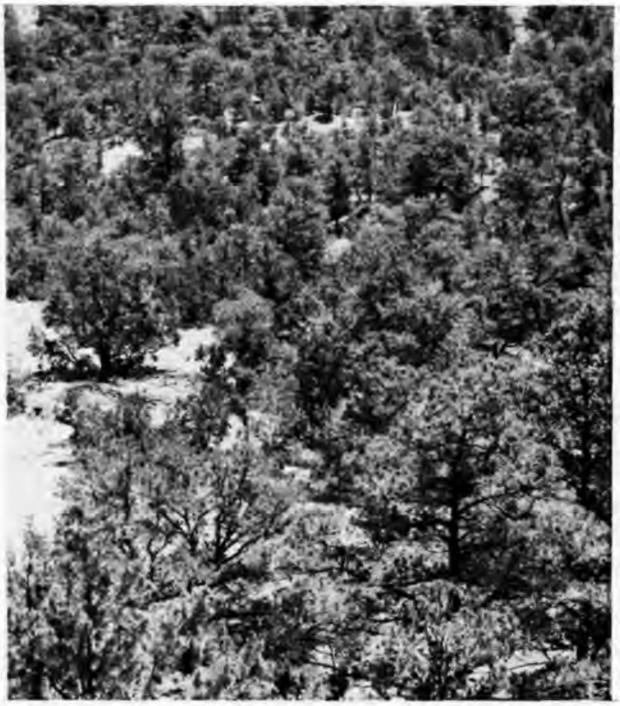


Figure 4. Woodland in the Little Colorado overview unit.

Figure 5. Coniferous forest in the Little Colorado overview unit.

Cross-cutting the major vegetative associations are riparian communities that cannot be mapped here because of their limited spatial extent. Three of these are of primary importance: cottonwood-willow, rabbit brush, and salix. Salix communities occur at the highest elevations and most frequently toward the eastern end of the study area. Especially along permanent streams, cattail, rushes, and tuberous plants occur. The cottonwood-willow association is typical of some of the larger canyons at higher elevations and toward the western end of the study area. In addition to cottonwood and willow, walnut and wild grape are characteristic. Species characteristic of the surrounding community are often present in greater than usual abundance. Rabbit brush communities, often mixed with sage and/or saltbush, are typical of riparian habitats in the juniper pinyon woodland and to a lesser extent in the grassland.

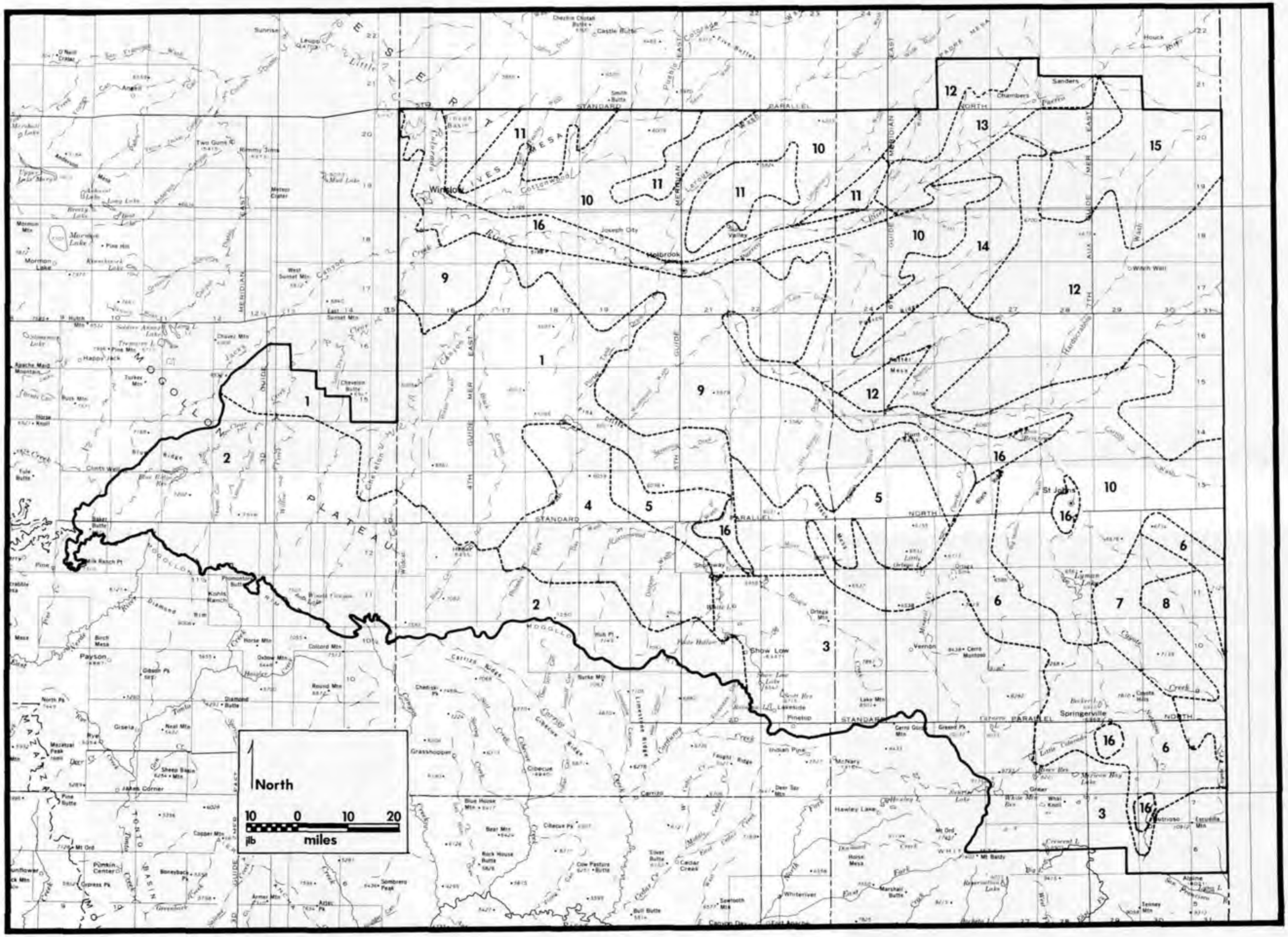
RECONSTRUCTING PAST ENVIRONMENTS

It would, of course, be a mistake to assume that past environmental conditions in the area were identical to those of the present. At the same time, it would be a mistake to assume that the limits of past variation in all environmental categories are equal. It is clearly more expectable that the distribution of flora and fauna have changed than that there has been any major change in geological formations. Therefore, this discussion will briefly recapitulate each of the categories just discussed to identify areas where there is evidence for past conditions that differ from those of the present.

Geology

There are few grounds on which one might anticipate any major differences between the manner in which the geology of the area has been described and a description that might have been written at any point in the last 12,000 years. The major deposits that cover the study area were in place by the time of earliest human occupation. There are two exceptions. As noted earlier, there was a period of glaciation at the highest altitudes between 2500 and 7000 BC. There were people in the general area during this period. However, since this high altitude area was never one in which people lived, the direct geological effect on their livelihood was probably minimal.

In addition, it is possible that there were volcanic eruptions in the area during the period of human occupation. If such eruptions occurred after AD 1, we would almost



Map 10. Soils of the Little Colorado overview unit.

Key to Map 10. Definitions of Major Soils of the Little Colorado Overview Unit (definitions verbatim or close paraphrase from USDA-SCS).

1. Soils are generally very shallow or shallow, but moderately deep in some places. They are medium to moderately coarse. Those developed on limestone are strongly calcareous. Locally, there are soils developed on the Coconino sandstone. The sandy material that weathers from the sandstone is removed by wind and water and deposited locally. Occassionally, the ground surface is rock outcrop.

2. Soils are deep to moderately deep. They are developed on sandstone, limestone, or rim gravel deposits. The surface soils are a cobbly loam. Variability is high from one locale to another within the area.

3. "Shallow and very shallow, stony, medium to fine textured, noncalcareous soils developed on basalt. Small areas of deep soils occur locally as well as medium textured, cindery soils on volcanic cinders. Basalt rock land is interspersed throughout the area."

4. "Shallow to deep soils developed on old sandy and gravelly alluvium. The surface soil is medium to moderately coarse textured and the subsoils are moderately fine to fine textured. Many of the soils are gravely throughout the profile. A lime accumulation occurs in the lower subsoil above which the soil is noncalcareous. Locally a clay soil is found where old calcareous claybeds occur. This soil may have a thin, moderately fine textured surface soil."

5. "The soils are dominantly shallow lithosols on shales and sandy shales. Large areas of rock land occur in local areas. There are dark colored pebbles on the surface. The textures vary from medium to moderately coarse."

6. "Very shallow to shallow soils developed on basalt. The soils are usually medium textured and strongly calcareous throughout. There is a zone of lime accumulation immediately above the bedrock on the underside of large boulders. The surface soil aggregates are moderately water-stable. Rock outcrops are common."

7. "Very shallow to deep soils. The parent material consists of sandstone and shales, a thin, discontinuous deposit of old sands and gravels on the sandstones and shales, and alluvium along the intermittent drainageways. There are shallow and very shallow residual soils on the sandstone and shales with included areas of rock land. Moderately deep to deep medium textured soils are developed on the old sands and gravels."

8. "Deep to moderately deep soils developed on old sand and gravel deposits. The sand and gravel parent material varies greatly in depth and rests upon sandstone and shales. Locally the gravels contain a fair amount of basalt. The surface soils are medium textured and the subsoils are moderately fine textured. The soils are noncalcareous in the surface soil and upper soil. Soils with gravelly surfaces and subsoils are more common than soils lacking gravel. A zone of lime accumulation occurs in the lower subsoil."

9. "Very shallow to moderately deep, highly calcareous, medium to moderately coarse textured soils developed in place on the Moenkopi formation of the interbedded sandstone and shale. Locally the parent material contains strata of gypsum. Deep, moderately coarse to moderately fine textured alluvial soils occur in the swales."

10. "The rapidly eroding vari-colored shales of the Painted Desert badland occupy 15 to 25% of the area. Moderately fine to moderately coarse textured deep alluvial soils occur on fans and narrow flood plains. Very shallow soils with pebbly surfaces and moderately fine textures have developed in places on shales."

11. Calcareous sands and moderately coarse to medium textured calcareous soils with a zone of lime accumulation in the subsoil. The parent material is moderately fine to moderately coarse, stratified old alluvium. The sands occur as low ridges and mounds.

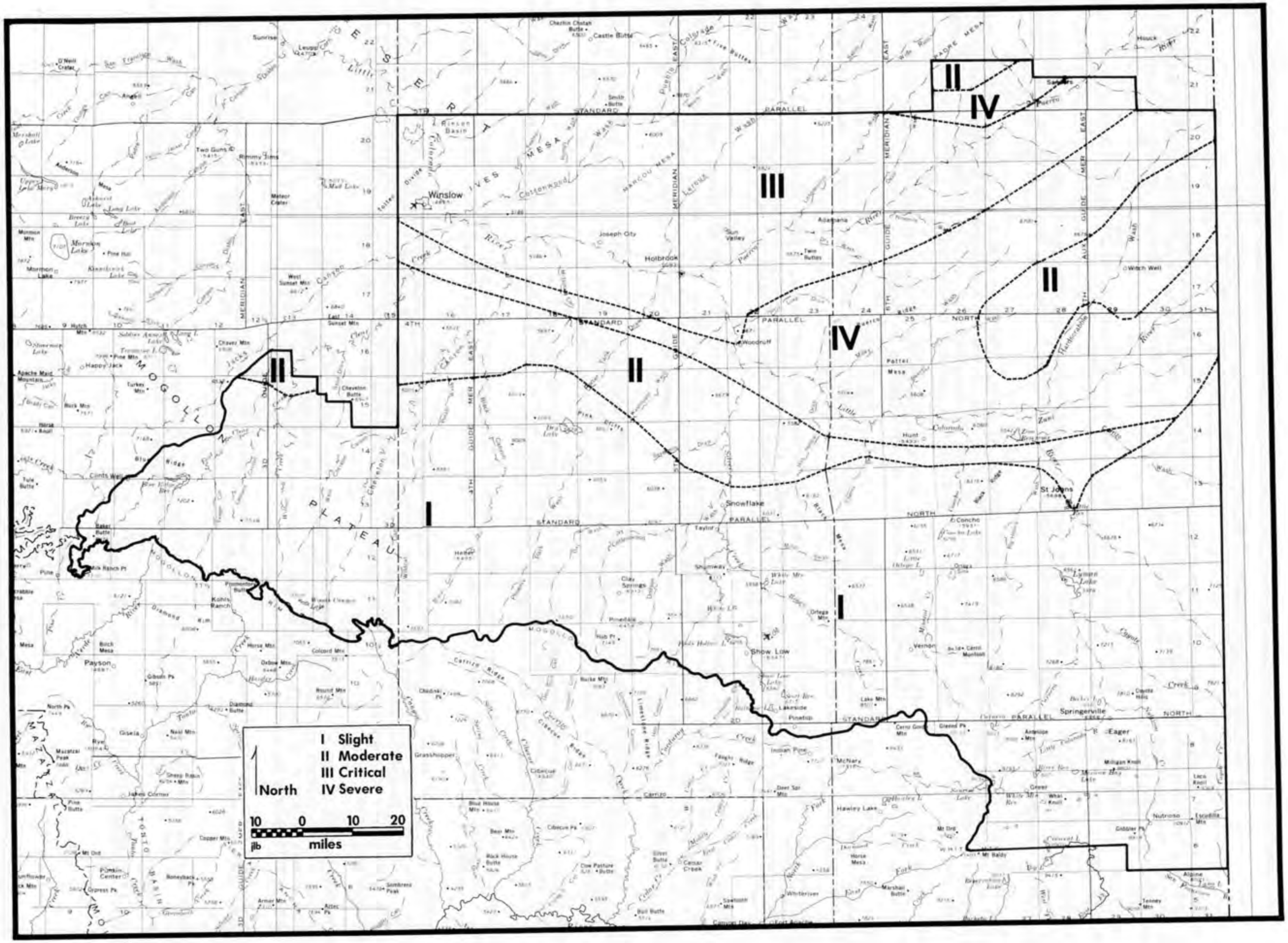
12. A complex pattern of zonal and azonal soils developed on moderately fine to moderately coarse textured stratified old alluvium. The zonal soils have medium to moderately coarse textured surfaces and medium to moderately fine textured subsoils and are noncalcareous in the surface and upper subsoil. The azonal soils are aeolian and alluvial, moderately coarse and coarse texured and noncalcareous. The wind transported soils have been deposited in linear northeast southwest pattern of low ridges and dunes.

13. Moderately coarse to medium textured, moderately deep to deep soils on the ridges and on long gentle slopes. They are noncalcareous in the surface and in the upper subsoil. Shallow and very shallow residual soils with silted topsoil phases are on the breaks adjacent to the flood plain, and include shale and sandstone escarpments. There are medium to moderately fine textured soils along the narrow floodplain.

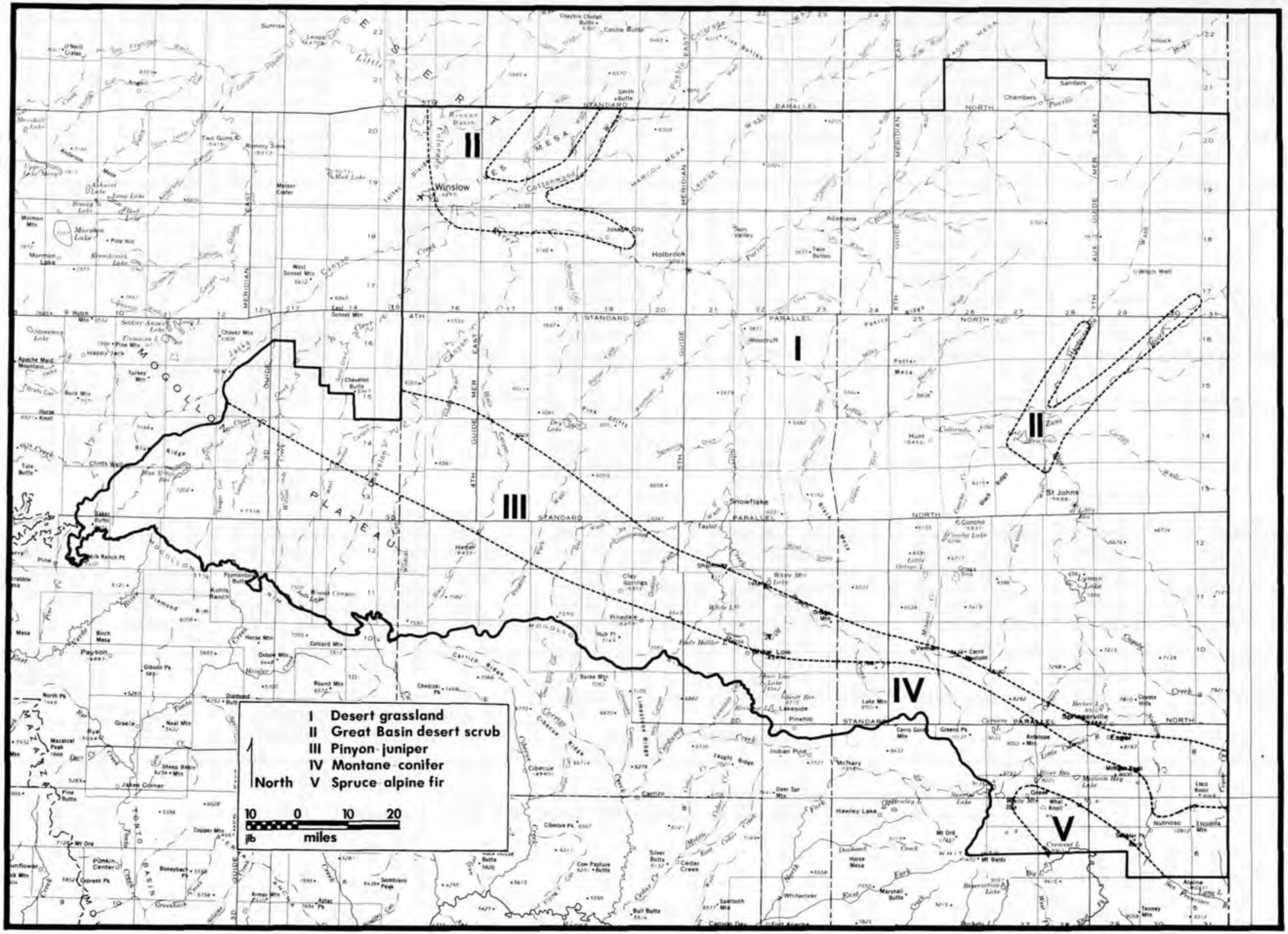
14. Deep to very deep, moderately coarse to coarse textured soils. The parent material is re-worked sand and loamy sand from nearby old alluvial deposits. Soils may be calcareous or noncalcareous on the surface but are usually calcareous in the subsoil.

15. Sands and sandy loams are on the low ridges and loamy sands occur along the narrow swales and moderately sloping alluvial fans. In the gently sloping interspersed areas are soils with moderately coarse textured surface soils and medium textured subsoils.

16. Alluvial and colluvial soils of the major drainages.



Map 11. Variation in the degree of erosion in the Little Colorado overview unit.



Map 12. Modern vegetation of the Little Colorado overview unit.

Table 4. Plant and animal constituents of the major Communities of the Little Colorado overview unit (After Aitchison and Theroux 1974)

Biome	DESERT SCRUBLAND	SHORTGRASS GRASSLAND	PINYON-JUNIPER WOODLAND	PONDEROSA PINE FOREST		PINE-FIR FOREST		
Plant Community				Ponderosa Pine	Pine-Bunchgrass Park	Pine-Fir	Mountain Meadow	Fir-Aspen
Dominant Vegetation	Shadscale Fourwing Saltbush Dropseed	Blue Grama Galleta Sand Drop-seed Fleabane Winterfat Wolfberry Juniper Pinyon	Fringed Sage Rabbit Bush Pinyon One-Seed Juniper Ponderosa Pine Gambel Oak Skunk Bush	Ponderosa Pine Gambel Oak Alligator Juniper Buckbrush Squirrel Tail Lupine Rabbit Brush N. Mex. Locust Mtn. Muhly Arizona Fescue Mutton Grass Golden Pea	Arizona Fescue Mtn. Muhly Pine Dropseed Squirrel Tail Muston Grass Western Yarrow Ponderosa Pine Buckbrush Skunk Bush Gambel Oak Geranium Red & Yellow Pea	Arizona Fescue Ponderosa Douglas Fir Gambel Oak White Fir Oregon Grape	Tufted Hair-grass Timothy Redtop Sedges Rushes Clover Dandelion	Bracken Fern Honeysuckle Douglas Fir Aspen White Fir Strawberry
Mammals	Pronghorn Jackrabbit Gray Fox Coyote	Pronghorn Blacktail Jackrabbit Desert Cotton-tail Gray Fox Coyote	Elk Desert Cotton-tail Kit Fox Spotted Skunk Deer Mouse Pocket Mouse Kangaroo Rat	Elk Muledeer Abert's & Golden Mantled Squirrel Porcupine Mountain Lion	Elk Muledeer Badger Valley Pocket Gopher Bobcat Coyote	Elk Muledeer Black Bear Least Chipmunk Longtail Weasel Red Squirrel	Elk Pocket Gopher Deermouse Mex. Vole	Elk Black Bear Lion Red Squirrel
Birds		Meadowlark Night Hawk Horned Lark Chestnut Collared Longspur	Lark Sparrow Black Throated Gray Warbler Black-Chinned Sparrow Bush-tit Rock Wren	Turkey Goshawk Mtn. Chickadee Golden Eagle Ruby Crowned Kinglet	Turkey Western Blue-bird Chippin Sparrow Lazuli Bunting Pygmy Nuthatch	Western Goshawk Evening Grosbeak Am. Raven Spotted Owl Mtn. Chickadee	Turkey Robin Pine Siskin Slate-colored Junco	Turkey Band Tail Pigeon Am. Raven Stellar's Jay Spotted Owl

certainly have recovered evidence in one or more of the excavations that has occurred in the area. However, excavations in sites dated before AD 1 are minimal and current excavations do not even approach a continuous series. Thus, it is impossible to be certain that the earliest human occupation of the study area was not affected on one or more occasions by vulcanism.

Topography

Because of the basic geological stability of the study area, it is unlikely that major topographic patterns have varied during the period of human occupation. Local conditions have, however, probably varied considerably. This variation is likely to have been greatest in areas where erosion, as depicted in Map 11, is greatest. In these areas, there were periods of time in the prehistoric past when erosion was an active process and periods when deposition was an active process (Hevly and Cooley 1964, Bowman 1975).

Neither the number of such events nor the periods of time at which they occurred can be described at present. Given the extreme variability in precipitation and stream flow that has been described, it seems unlikely that there is any good correlation from one drainage to another except at extremes of precipitation. However, one can postulate that there were periods when stream channels were shallow and gentle terrace systems well developed. In other periods channels were deeply entrenched. The extent and stability of dune fields in the area is also likely to have varied considerably over the span of human occupation of the area.

Precipitation and Temperature

Two lines of evidence inform our understanding of past variation in climatic conditions in the study area: pollen (Schoenwetter 1962, Hevly 1964, Schoenwetter and Dittert 1968, Briuer 1977, Zubrow 1979) and tree-rings (Dean and Robinson 1977). Both indicate that there has been substantial variation in the past. It is not clear, however, that variation during the last 2000 years is beyond what can be described on the basis of current conditions.

The growth of tree-rings reflects moisture and temperature conditions during the preceding 12 months. Dean and Robinson (1977) have used this correlation to generate maps of dendroclimatic variability from AD 680 to 1970. The maps illustrate the climatic conditions that existed during each decade between these years. In general, wider rings are formed during periods that are wet and cool, narrower rings during periods that are warm and dry. For mapping purposes, deviations are expressed in "standard normal units" of departure from mean conditions. Three mapping stations in or immediately adjacent to the study area (W. Puerco, Little Colorado, N. Central Mountains) are used in an effort to understand past variation.

Pertinent information from these stations is shown in Table 5. If readings from the various stations were highly correlated, one would expect an average of zero in the long run. For this reason, the values shown are absolute values. In the average decade, the difference between the station with the widest and the station with the narrowest ring width was 1.67 standard normal units, indicating that, in general, variation in ring formation (inferentially, temperature and precipitation) was substantial. There was also some variation from century to century with the most recent centuries characterized by more variation than was typical of earlier ones. Thus, modern climatic data indicate somewhat more extreme variation than was typical at most points in the past. Equability within the study area has been decreasing since 680 AD.

To understand the tree ring data one may also consider extreme values. Table 6 shows the percentage of years in which at least one station had a value of less than -1 standard normal units and in which values at the other stations were all less than -1, or between -.1 and -1, or between 0 and +1, or above +1. The typical situation that occurred when extremely warm and dry conditions existed at one station was that at least one other station was above or well above average, wetter and cooler than usual.

These data suggest that, through the period of time from AD 680 to the present, there is little point in attempting to describe average conditions over the study area;

Table 5. Mean difference between minimum and maximum tree-ring width values at recording station

CENTURY	MEAN	STANDARD DEVIATION
900-1000	1.125	.835
1000-1100	1.75	.682
1100-1200	1.9	.945
1200-1300	1.2	.627
1300-1400	1.6	.625
1400-1500	---	---
1500-1600	---	---
1600-1700	1.15	.935
1700-1800	2.04	.961
1800-1900	2.05	.974
1900-present	2.17	1.29

Table 6. Conditions when at least one station in the study area is -1 standard normal unit from the mean

ALL BELOW -1	3 (8%)
AT LEAST ONE STATION BETWEEN -.1 and -1	16 (44%)
AT LEAST ONE 0 to +1	10 (28%)
AT LEAST ONE 1+	7 (19%)

what was typical of the area was substantial variability in temperature and precipitation. Since it is unlikely that three observations out of a population of thousands of potential observations would hit loci with high and low extremes, it is probable that conditions were even more varied than these data suggest. Pertinent aspects of the dendroclimatological record will be considered in subsequent discussions of major prehistoric adaptations and events.

The precise interpretation of pollen samples recovered from prehistoric contexts is highly problematical. Any given sample reflects both local and regional environmental conditions. Further, the degree to which one or the other of these is represented depends on the context of deposition; for example, wind causes some pollen grains to be carried much greater distances than others. In addition, when samples are taken from cultural contexts, at least some of the types recovered are the product of human behavior while others are the product of natural processes.

Nevertheless, palynologists have used these data to discuss changes in the seasonality of moisture and in overall effective moisture. Schoenwetter studied pollen samples from a variety of cultural and noncultural loci in the study area (1962). He interpreted the samples in terms of the seasonality of rainfall, opposing heavy summer dominant regimes such as those of the present to times when precipitation was more evenly distributed over the entire year. Conditions similar to those at present occurred between 1400 and 1200 BC, between AD 1000 and 1200, and from AD 1350 to the present. Heavy summer rainfall was also characteristic from AD 1200 to 1350 but with additional evidence indicating local standing water. Light summer rainfall regimes existed at about AD 300 and between AD 350 and 1000.

Hevly (1964) defines four pollen zones for the area. Zone four was characteristic of the last glaciation when conditions were cooler and wetter than at present. Zones II and III, falling between the time of Christ and about 7000 BC, are periods of increasing aridity, although conditions were generally cooler and wetter than at present. Pollen Zone I lasts from AD 1 to the present and is characterized by conditions about like those of today.

Schoenwetter (Schoenwetter and Dittert 1968) subsequently summarized information from the study area and other parts of the Colorado Plateau. He interprets variation in the frequency of arboreal pollen as indicative of periods of drought and periods of moisture greater than present. On the Colorado Plateau, periods of drought occurred at AD 200-300, AD 1075-1150, AD 1250-1325, AD 1550-1600, and AD 1850-1900. All of these dry periods before AD 1450 are represented in the study area. The pollen record is inadequate for generalization after that date. Additionally, there were dry periods between about AD 750 and 850 in the study area.

Wetter periods on the Colorado Plateau occurred between AD 300 and 400, 525 to 575, 625 to 675, 925 to 975, 1200 to 1250, 1350 to 1425, 1450 to 1475, 1600 to 1650, and 1800 to 1825. Only the period between 1350 and 1425 is clearly reflected in the study area. While this problem may simply result from a dearth of pollen samples from appropriate time periods, variation is not outside of the boundaries of the modern pollen remains in the other intervals. In general, there is good agreement between these conclusions and the dendroclimatological records discussed earlier. However, the latter are more precise chronologically, and therefore, there are exceptions.

Hydrology

There are no direct means for reconstructing prehistoric hydrology. Indirect evidence derived from geology and paleoclimatic reconstructions provide the only information for inferences concerning this phenomenon. Therefore, one can do little more than extrapolate back from the modern case on the basis of dendroclimatological and palynological reconstructions. There is little reason on the basis of either of these to conclude that hydrological conditions were any less variable over the study area in the past than they are in the present. There were almost certainly periods of several decades when stream flow was characteristically higher and less varied than at present just as there were periods when it was lower and more varied.

Soils

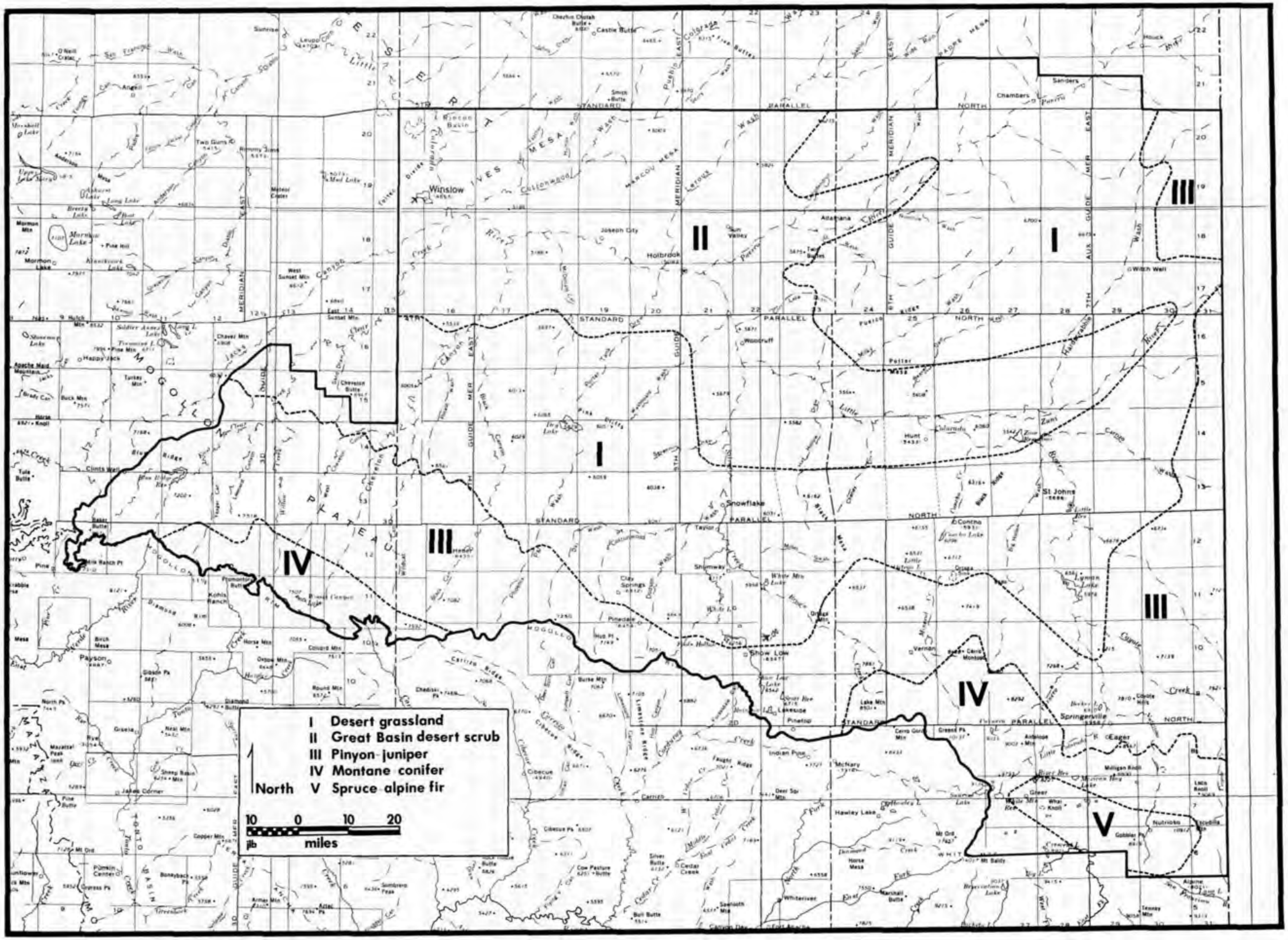
Buried paleosols provide a direct means of assessing differences between modern and prehistoric soils in an area. Pertinent studies have not been done to any meaningful degree within the study area. The soils currently found on the ground surface are, in most cases, of relatively recent origin. One can only use uniformitarian principles to infer that the kinds of soils forming in particular environmental loci today are the same as those that formed in similar loci in the past.

Vegetation

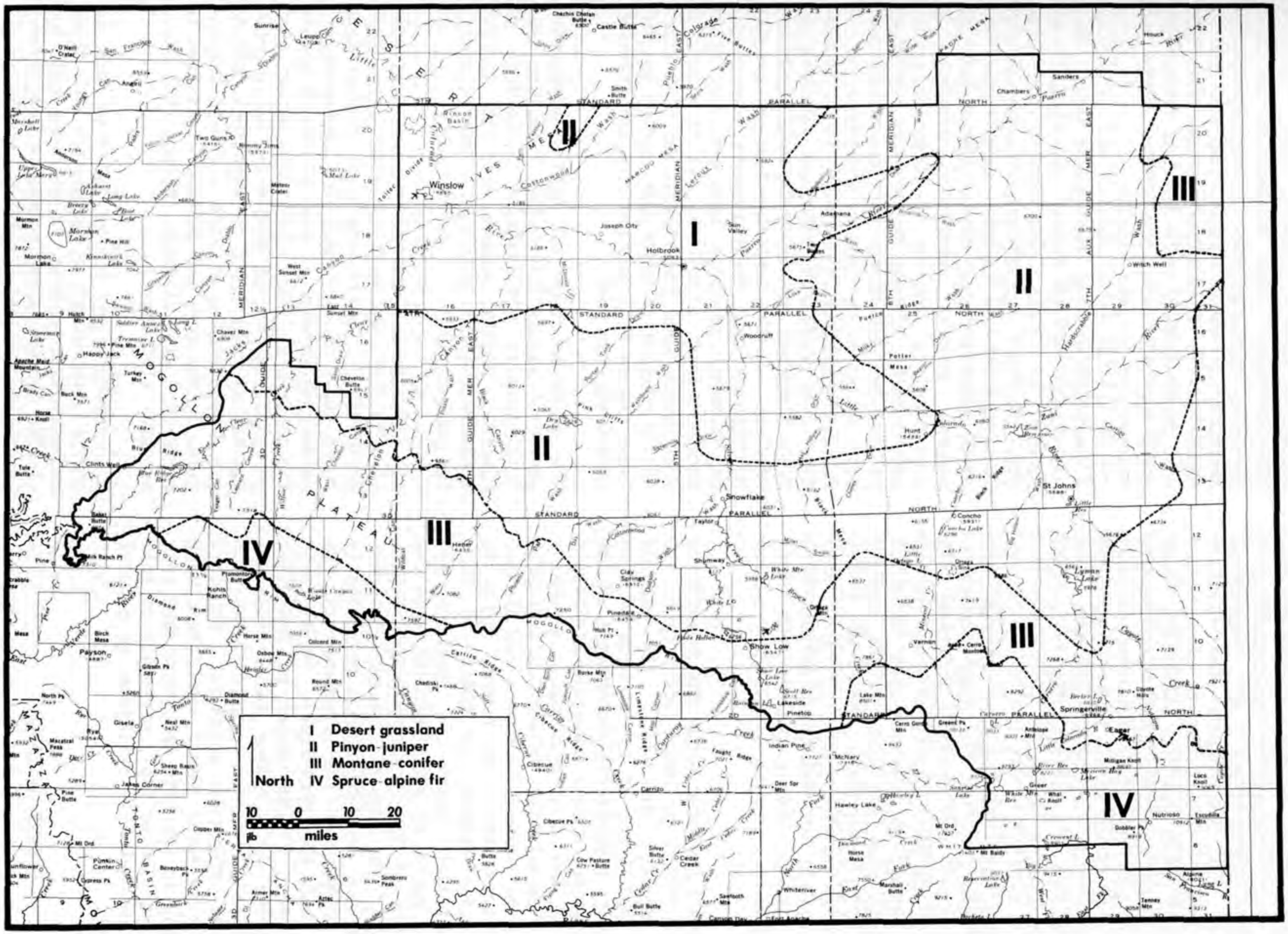
Prehistoric vegetation patterns can be reconsructed from pollen evidence, although to a more limited degree than would be desirable. At the end of the last glaciation, about 12,000 years ago, vegetative distributions in the area were considerably different than at present. Hevly (1964a: 185) concludes that the pollen from Laguna Salada samples indicates that the spruce-fir community grew at the margins of that lake, roughly 2000 feet below its modern boundary. If this figure is extrapolated to other communities, then most of the remainder of the study area would have been covered by a spruce-fir-ponderosa forest, and pine parkland communities with perhaps a willow-alder association among mountain meadows following the major river courses.

During the remainder of the sequence up to AD 1, vegetative patterns would have reflected a gradual change toward conditions more like those at present. Briuer (1977) does note evidence of hickory and elm pollen in cave deposits from the study area as late as 3000 BC.

After AD 1, conditions were more or less like they are at present (Map 12). However, Hevly concludes that such a statement must allow variation on the order of 500 vertical feet in the precise location of boundaries between plant communities. The implications of this statement are shown in Maps 13 and 14. If one assumes that modern conditions are at the dry extreme, the result of a 500 foot depression of community boundaries is illustrated in Map 13. If one assumes that modern conditions are at the wet extreme, the result of a 500 foot elevation of community boundaries is shown in Map 14.



Map 13. Extent of major plant communities in the Little Colorado overview unit given a 500 foot depression from current conditions.



Map 14. Extent of major plant communities in the Little Colorado overview unit given a 500 foot elevation from current conditions.

In point of fact, modern conditions are probably between the two. Moreover, dendroclimatological data suggest that shifts in temperature and rainfall conditions are of too short a duration to produce such widespread alterations of vegetative patterns. Had temperature and rainfall shifts been of the duration that seemed likely when Hevly made his statement, these extremes might have been reached. However, currently available evidence suggests that greatly reduced variation is expectable and the figures may represent extremes that existed during a relatively few restricted epochs of drastic change.

Bohrer has described another pattern that was characteristic of the area prehistorically (1972). Her analyses indicate that vegetation in the vicinity of what are now deeply entrenched washes once included Typha, Equisetum and other plant species indicative of moist conditions. She infers that during these wetter periods, when downcutting was not occurring, streams were flowing through grassy swales with reeds and cattails growing in the stream channels.

Hevly (n.d.) has also noted the potentially important effect of human activity on the pollen record. He notes, for example (1964), that there is an increase in pine pollen after prehistoric abandonment of the area and before modern lumbering activities begin. He has also observed a generally negative correlation between prehistoric increases in numbers of humans and juniper pollen frequencies. As humans begin to increase in numbers at about AD 900, juniper pollen began to decline and increased again at about AD 1200 when the abandonment of the area by humans began. Apparently, the use of juniper for construction and for fuel had a sufficiently drastic effect on the abundance of the species that the prehistoric pollen rain was altered. Pinyon pollen on the other hand, varies in a manner quite different from juniper, in close correlation with changes in effective moisture. Probably because prehistoric humans would have been less likely to use this important food tree for construction or fuel, variation in this pollen type reflects variation in natural conditions.

FUTURE RESEARCH

The preceding summary represents the result *of surveying a great diversity of environ*mental information, none of which was prepared specifically for the purpose of understanding the overview area. While I believe these data represent the best possible description of environmental conditions, much remains to be known. While it is reasonable to believe that pertinent studies will be done concerning some topics, there are others where new information is less likely.

A variety of the management activities undertaken by the Forest Service and the Bureau of Land Management contribute directly to understanding environmental conditions in the overview area. Specifically, timber, range, soil, hydrological and mineral studies contribute directly to archeologists' ability to reconstruct past environments. There is no need that such studies be undertaken for the direct purpose of pursuing better understanding of cultural resources. However, it is imperative that cultural resource managers be kept informed of on-going environmental studies. Slight modifications of project designs may make their product more useful to cultural resource managers and other archeologists. Similarly, it is essential that these same individuals be kept aware of the results of major new studies so that these can be used in improving the information presented here.

The reconstruction of past environments goes well beyond information resulting from land-managing activities. A variety of specific studies would help to improve understanding of prehistoric events within the study area.

1. Existing information concerning glaciation in the area is suggestive rather than definitive. Familiarity with glacial land forms would be desirable for archeologists conducting surveys at high altitudes within the study area. One might then expect that our understanding of glaciation would grow. Control of this topic is important both to our understanding of high altitude adaptations in the area and because glaciation is correlated with climatic changes that occur at other altitudes.

2. Geomorphology in the overview unit is poorly understood at present. To date, archeologists working in the area have not elected to employ geologists or geographers to provide an understanding of paleosols or deposition/erosion sequences. Greater

understanding of these phenomena would increase our knowledge of the conditions under which prehistoric peoples lived.

While it is possible that this knowledge will accumulate as the result of limited geomorphological studies done in conjunction with specific projects, the rate at which such studies have been done in the past does not give one great hope.

Similarly, the extreme hydrological variation within the study area suggests that the results of a single drainage study cannot be generalized. Thus, our understanding of the environment in which prehistoric peoples lived will be most greatly improved as the result of a regional study, if such can be arranged.

3. There are currently only three tree-ring stations within the study area.

Clearly, our understanding of variation in temperature and precipitation will be greatly increased if more stations are developed. Most archeologists are aware of the importance of tree-ring dating, but are unaware that the majority of tree-ring samples recovered in the study area cannot be dated. This problem increases the need to see that all possible samples are sent to the Laboratory of Tree-Ring Research.

4. Palynological studies provide information concerning climate and vegetation patterns. A large quantity of pertinent material has been taken from the overview unit. However, no single synthesis of these materials exists at present. It would be useful to arrange for a study that focuses specifically on the study area. In the context of such a study, an effort to resolve some of the interpretive problems that currently beset palynology, e.g., the effects of cultural as opposed to natural factors (such as wind) should be undertaken. In the meantime balancing the effect of these forces is impossible and the reconstruction of prehistoric climates correspondingly difficult.

RESOURCE ACQUISITION

INTRODUCTION

The natural environmental characteristics of the Little Colorado Inventory Unit have been described above. In this chapter, those same characteristics are again considered, but from the perspective of the prehistoric people whose survival was dependent on their ability to harness the resources and overcome the environmental difficulties of the area. No human population uses all of the resources of the area in which it exists; some potentially useful resources are simply not identified as such. Similarly, not every environmental variable is relevant to the ability of the group to survive in an area. What may be critical for one group with one subsistence strategy may be quite irrelevant for another. Even with the subsistence strategy as a constant, human population size has a crucial effect on the extent to which any given natural variable poses a limit for a particular group.

Both subsistence strategies and size of human populations varied drastically during the prehistoric occupations of the study area. While there is little concrete evidence that informs our understanding of local patterns, PaleoIndian peoples are generally assumed to have been "big-game hunters." While this characterization overemphasizes the importance of big game in the diet of most such groups, there is greater evidence of the use of large fauna during the PaleoIndian stage than in any succeeding ones. Similarly, Desert Culture peoples are generally believed to have been hunters and gatherers, lacking the degree of dependence on agriculture characteristic of later groups. While the inhabitants of the Southwest after the time of Christ have generally been viewed as agriculturalists, growing evidence suggests that the temporal relationship of hunter-gatherers and agriculturalists is less clearly delineated than past reconstructions suggest.

For this reason, I have chosen not to describe the strategies that the prehistoric residents of the study area used in modal patterns. The following discussion will instead emphasize particular patterns of resource utilization for which good evidence exists. To the extent that these appear to be characteristic of particular periods or areas, these limitations will be noted.

GEOLOGICAL RESOURCES

In most areas, geological resources are useful as raw materials for manufacturing artifacts and buildings. The sole exception to this principle is the use of naturally sheltered loci such as caves as dwelling units. In the study area, the contact between the Coconino Sandstone and the Kaibab Limestone is an example. Where this contact is exposed, usually in relatively deep canyons in the western quarter of the study area, erosion has created caves and rock shelters that served as both temporary and permanent dwelling places.

The Coconino Sandstone is relatively soft. It was probably a major source of tempering material for ceramic manufacture. Slabs cut from the sandstone were also used as deflectors. The Kaibab Limestone and the Moenkopi, Mesa Verde, and Dakota Sandstones were frequently used as a building material after about AD 900. In some cases the materials were used in the form of natural blocks, while in others raw sandstone was shaped.

Some facies of the Moenkopi Sandstone are sufficiently soft that, when wetted, they can be turned into a coarse plaster. They were used as such by inhabitants of the area after the time of Christ. Travertine deposits occuring as hills or hill caps in the vicinity of St. Johns appear to have been similarly used by both prehistoric and early modern occupants of the area (Sirrine 1955).

All of the previously mentioned sandstones, the Kaibab Limestone and local basalts were used to make mortars, pallettes, metates, and manos. Quartzite cobbles derived from the Rim Gravels were also used as manos, hammerstones, and pestles.

Minerals found in the various geological formations were used by prehistoric peoples in manufacturing chipped stone tools. The Rim Gravels were a source of quartzite, cherts, chalcedonies, and a variety of igneous rocks. Basalts sometimes achieved sufficient hardness to be used by prehistoric peoples. The Datil Formation is a source of sandstone, siltstone, rhoyolite, latite, andesite, basalt, quartzite, jasper, quartz, granite gneiss, schist, and other minerals in conglomerate lenses. Siltstone occurs in the Mancos and Mesa Verde Formations. Quartzite and chert pebbles are derived from the Mesa Verde Formation. Chinle deposits are a source of cherty limestone, siltstone, mudstone, quartzite pebbles and especially petrified wood. The Kaibab Limestone yields a highly calcareous chert. Mudstone, siltstone, chalcedonies, and cherts can be recovered from the Moenkopi Formation and derived sediments. In addition, some alluvial deposits derived from these, especially along major river valleys, are characterized by extensive zones of desert pavement containing many nodules of sufficient size to be used in chipped stone tool manufacture. This is not to argue that all chipped stone tools were made of local materials. Imported resources will be discussed in a later section.

As noted earlier, halite, copper, and manganese are present in the study area. There is no clear evidence that any of these were extensively used by either prehistoric or modern peoples. They were used as pigments or in the case of halite as a condiment by prehistoric peoples.

Clays are abundant in the area, although especially pure clays and some kaolins are associated with the Chinle Formation and sediments derived from it. These were used by prehistoric peoples in manufacturing ceramic vessels. Sands and river sediments were used as tempering material.

In prehistoric North America, corn is almost never used as an important subsistence resource unless a technology involving soaking it in a basic solution is present (Katz et al., 1971). Halite and alkali deposits may have been used for this purpose, although the use of wood ash is more likely.

LANDFORMS

Since all of the earth's surface is a landform of some variety, every cultural resource locus occurs on a landform. Nevertheless, there are a number of situations that seemed to have represented especially desirable loci for the activities of prehistoric peoples.

Many early villages are located on promontories, often basalt-capped mesas overlooking broad alluvial valleys. These locations may have been valued because they provided a view of game movements through the area, or information on the movement of non-local peoples into the area. Some such promontories are also frequent loci of very late prehistoric settlements, sometimes enclosed by walls. Apparently, these were defensive locations.

Terraces immediately above floodplains were a favored dwelling location of most prehistoric and early modern agricultural peoples. The floodplains themselves were a frequent field location. The slope of the land surface has an important general effect on the ability of prehistoric peoples to use an area for intensive agriculture. Irrigation, gridding, and terracing are possible only on gently sloped land. The strategies can be used on slopes with increasingly steeper grades in the order listed above (Plog and Garrett 1972). Because of the high porosity of sand, dune fields are a favored agricultural locus for the Hopi. It is likely that the same was true in prehistoric times.

Volcanic necks and high mountain peaks are often the location of prehistoric or ethnohistoric shrines. The more visible of these were undoubtedly also important in defining transportation routes through the area.

TEMPERATURE AND PRECIPITATION

Temperature and precipitation are important resources for any agricultural people. Unfortunately, the two are negatively correlated in the study area: the greatest precipitation occurs at the highest elevations and the greatest number of frost-free days at the lowest. This problem was overcome through at least three discrete behavior patterns. First, some prehistoric and early modern populations settled at the intermediate elevations where neither precipitation nor temperature conditions were ideal but were at least tolerable.

Second, some groups solved the problem by planting crops in a number of different loci, not in the expectation that all fields would yield a harvest in a given year but only in the expectation that some would. In a cool, wet summer, there was insufficient growing time at high altitudes, but adequate moisture was obtained in areas where the growing season was sufficient. In a warm dry year, precipitation was inadequate at lower elevations, but the growing season was sufficient and precipitation was adequate at higher elevations. This practice is common among the Hopi, who plant fields over a 40-mile linear distance with nearly 2000 feet of altitudinal variation.

A final strategy was more or less formalized exchange relationships among groups occupying highland as opposed to lowland areas. The crops of the two areas did not always succeed in the same year, and resources were transferred to offset deficiencies in one area when they were abundant in the other. This practice was characteristic of early modern peoples in the area (Lightfoot 1979) and may have been typical of some prehistoric peoples also.

SOIL

Good soil is an important resource for agricultural peoples. Modern hybrid corn, the most important and demanding of the local crops, generally requires a minimum soil depth of about ten inches. It does best when pH values are between 6.0 and 7.0. Soils with these characteristics are quite limited within the study area. Of the soil types described earlier, only types two, three, and six meet these conditions. Unfortunately, deposits of these soils are all at the highest elevations where growing seasons are marginal. The deeper alluvial soils at low elevations, where the growing season is long, have generally high pH values.

Of course, these figures are generated specifically for the case of modern corn. Hopi fields have pH values between 8.0 and 8.5 (Bradfield 1968), suggesting that Hopi corns may be specifically adapted to greater alkalinity. It is known that the Hopi have maintained strains of corn specifically adapted to particular climatic and environmental extremes (Whiting 1934, 1937; Plog 1978b). So, it is not unlikely that some or all of the native strains may be more tolerant of pH conditions unfavorable for modern corn.

If this factor is set aside, there are soils capable of sustaining corn agriculture throughout the study area, although soil depth is a significant problem in the zones covered by soil types one, three, five, six, and ten. In general, the distribution of the best agricultural land is quite patchy. Prehistoric sites, in contrast with modern ones, rarely occur on top of, but rather adjacent to, the best agricultural soils.

FLORA

During the prehistoric, historic, and modern utilization of the study area, most of the floral resources have been used for one purpose or another. A compendium of the uses to which particular resources were put would be as long as this study itself is intended to be. Moreover, it would be highly problematical. While there are some relatively clear associations between particular plants and use patterns (e.g., medicines) there are other uses that can be fulfilled with a variety of different resources. There are, for example, literally hundreds of plants that could be used to make a brush or a broom and dozens from which baskets could be made. While the ethnobotanical literature ascribes particular uses to resources, it is dubious that, over the centuries this report covers, there was much constancy in the use of particular floral resources for particular tasks. There are three areas in which the use of those resources is particularly important to understanding human use of the area, construction, subsistence, and fuel.

Spruce, fir, ponderosa, juniper, and pinyon are all suitable construction materials. In recent times, ponderosa and fir have been the most important. This selectivity reflects two factors: (1) the size and shape of the trees allows cutting a large number of relatively standardized pieces; and (2) the modern road system facilitates movement of trees from their cutting to their use loci. Prehistorically, juniper appears to have been the most important resource utilized in most of the study area. There are several reasons for this changed behavior. First, prehistoric dwelling places were much smaller. As a result, neither size nor standardization of beams and boards were as important as they are today. Also, prehistoric technologies were less suitable for harvesting large trees. Second, prehistoric peoples lacked the ability to move large quantities of lumber from the acquisition site to the use site. Pinyon was probably not a preferred building material prehistorically because of its importance as a food source.

Commonly used native food plants are listed in Table 7. These resources are based on ethnobotanical studies among the Hopi (Whiting 1939), Navaho (Elmore 1944) and various groups living immediately below the Mogollon Rim (Gallagher 1977). References to the parts of each plant utilized are from these sources. References to the season of availability at elevations at which the resource can be found are from Kearney and Peebles (1960), although I have modified some estimates to reflect my own perceptions of plant distributions.

It is apparent that a great variety of resources are available in the study area, most below about 8000 feet. Some resources are available during all seasons except winter. Potentially, all of the resources mentioned can be stored in one fashion or another, although nuts and grains are generally more storable than greens and some grains are more easily dried than others.

In Table 8 various nutritional aspects of selected resources are given. Corn (Zea) and beans (Phaseolus) are included in the table for comparative purposes. These data are based on tables in Hoffman (1974) and Gallagher (1977). The nutritional qualities of natural resources are clearly sufficient for a well balanced diet, even excluding the many natural resources for which appropriate data are unavailable.

Any of the woody plants available in the study area could have been used for fuels, as could grasses. The most efficient fuel resources are, and were, those that concentrate combustible materials. Pine, juniper, and pinyon would probably have been the preferred fuel sources, although the size of ponderosa relative to the then extant technology would have resulted in small trees or dead wood of this type being utilized. While oak is not abundant, it may have been valued for smelting and other activities requiring a high temperature.

FAUNA

A variety of the animals found in the study area represent potentially important food resources. The most important of these are desert cottontail (Sylvilagus audobonii), jackrabbitt (Lepus californicus), beaver (Castor canadensis), black bear (Ursus americanus), raccoon (Procyon lotor), javelina (Tayassu tajacu) elk (Cervus canadensis), mule deer (Dama hemionus), white-tailed deer (Dama virginiana) pronghorn (Antilocarpa americana), and turkey (Meleagris gallopavo). In addition, seasonal wildfowl may have represented important resources along the major river and streams and around the playas. The Little Colorado Spinedace (Lepidoma vittata), Bluehead Mountain Sucker (Pantosteus discobolus), and speckled dace (Rhinichthys osculus) now occur in permanent streams. Native brown trout and a variety of other fishes may have inhabited the streams and rivers when they were more permanent.

There are many other small mammals and birds that may have been eaten by prehistoric peoples. Faunal work in the area is miminal at present, and conditions of bone preservation are not good. Therefore, one must assume that if smaller animals were eaten, little evidence has survived to the present. Weight and meat yields for some of the more important animals mentioned above are shown in Table 9.

STRATEGIES OF RESOURCE UTILIZATION: FOOD

The discussion to this point has emphasized available resources and broad patterns of utilization. The use of geological resources in construction and for artifact manufacture will be discussed subsequently. The issue of utilizing locally available materials, as opposed to their exchange, will also be considered later. Two strategies of resource utilization will be addressed here: the collection and production of foodstuffs and the acquisition of fuel.

The two major strategies used in procuring foodstuffs were hunting and gathering and agriculture. There is no question that food production, agriculture, is the later of the strategies. However, the precise point at which the shift to agriculture occurs, and the extent to which prehistoric peoples relied on this strategy, remain important questions. In general, the earliest suggestive evidence of domesticates in the Southwest dates to between

Table 7. Commonly used food plants

NAME	COMMON NAME	PART USED	SEASON	ELEVATION (Feet)
Pinus edulis	Pinyon	nut	Fall	6000-7500
Juniperus sp.	Juniper	berries	Fall	6000-8000
Typha	Cattail	stem, head		-8000
Sporobolus sp.	Alkali-sacation, dropseed	seed	June-October	-6000
Oryzopis humenoides	Indian rice grass	seed	June-August	-8000
Scirpus	Bullrush	stalk		-9000
Tradescantia sp.	Spiderwort	greens	Spring	
		root	August-September	-9500
Allium sp.	Wild Onion	bulbs	April-August	-9000
Calochortus sp.	Mariposa, Sego Lily	bulb	Aprin-June	-8000
Yucca sp.	Yucca	root, bud	April-July	-8000
Juglans Major	Walnut	Nut	Fall	-700
Quercus sp.	Oak	Nut	Fall	-800
Celtis reticulata	Hackberry	berry	Summer	-6000
Morus microphylla	Mulberry	berry	Summer	-6000
Humulus americanus	Hop	yeast		-9500
Urtica sp.	Nettle	greens	Spring	-9000
Phoradendron sp.	Mistletoe	berries		-7000
Eriogonum sp.	Buckwheat	root	March-April	-9000
Rumex sp.	Dock	stems, leaves	March-April	-6000
Chenopodium	Lambs quarter	leaves	Spring	-9000
		seeds	Summer	
Amaranths	Amaranth	leaves	Spring	-8000
		seeds	Summer	
Acanthochiton wrightii		leaves	Summer	-6000
Portulaca oleracea	Purslance	seeds	Late Summer	-8500
Stanleya sp.	Desert Plume	leaves	May-September	-6000
Descuriana sp.	Tansy mustard	leaves		-7000
Cleome serrulata	Beeweed	leaves	Spring	-8000
Wizlenia melilotoides	Jackass clover	leaves	Spring	-6000
Ribes sp.	Current, goose berry	berries	March-June	-10,000
Amelanchier sp.	Service berry	berry	April-June	
Rubus sp.	Raspberry	berry	May-September	-9000
Fragraria sp.	Strawberry	berry	May-September	-11,000
Rosa arizonica	Rose	fruit		-8000
Astragalus ceramicus imperfectus	Milkweed	root	Spring	-7000
Rhus trilobata	Squawbush	seeds, berries		-7500
Vitis arizonica	Grape	berry	Fall	-7500
Mentselia sp.	Stickleaf	seeds		-7000
Echinocereus sp.	Hedgehog	fruit, flesh	Spring	-8000
Mammilaria sp.	Pincushion	flesh		-8000
Neomammilaria sp.	Fishhook			
Opuntia sp.	Prickly pear, cholla	fruit, flesh		-6000
Cymopterus	Wild celery	leaves, root		
(there are possibly other carrot and celery-like plants utilized)				
Actostaphylos uva ursi and	Bearberry	berries		-8000
pungens	Manzanita	berries		-8000
Convovulvus arvensis	Bindweed	root		-7000
Ipomoea e batata	Morning glory	root		
Monarda menthaefolia	Beebalm	leaves		-8000

Table 7 (continued)

Chamaesaracha Coronopus		berries		-7500
Physalis fendleri	Ground cherry	berries	Summer	-7500
Solanum Jamesii	Wild potato	tuber	July-September	-8500
Sambucus sp.	Elderberry	berries	June-July	7500+
Helianthus annus	Sunflower	seeds	March-October	-7000
Artemisia sp.	Wormwood, sage	greens, seeds		-9000
Pectis angustifolica	Marigold	greens	August-September	-7000

Table 8. Nutritional characteristics of some commonly used food plants per 100 grams (Gallagher 1976)

PLANT	CALORIES	PROTEIN (grams)	CARBOHYDRATE (grams)	CALCIUM (milligram)	IRON (milligram)
Allium	38	1.5	8.7	27	0.5
Amaranth (seed)		14.6			
Amaranth (raw)	36	3.5	6.5	2.7	3.-
Chenopodium	43	4.2	7.3	3.1	1.2
Descurainia	31	3.0	5.6	1.8	3.0
Fragraria	37	0.7	8.4	21	1.0
Helianthus					
seed	560	24.0	19.9	120	7.1
flour	339	45.2	37.7	348	13.2
Juglans*	628	20.5	14.8	-	6.0
Opuntia	42	0.5	10.9	20	0.3
Phaseolus	53	1.9	11.2	9	1.0
Pinyon	635	13.0	20.5	12	5.2
Prunus	58	1.2	14.3	22	0.4
Quercus		10.4			
Sambucus	72	2.6	16.4	38	1.6
Solanum	76	2.1	17.1	7	0.6
Portulaca	21	1.7	3.9	103	3.5
Ribes	50	1.4	12.1	32	1.0
Rubus	73	1.5	13.6	22	0.9
Rumex	28	2.1	5.6	66	1.6
Vitis	69	1.3	15.7	16	0.4
Yucca	403	1.2	93.0	0.2	
Zea	348	8.9	72.2	22	2.1
Phaseolus	340	22.3	61.3	144	7.8
Cucurbita					
Summer	19	1.1	4.2	28	0.4
Winter	50	1.4	1.4	22	0.6

Table 9. Meat yields of associated food animals (Gallagher 1976)

NAME	WEIGHT (pounds)	YIELD (%)
Castor canadensis	50	70
Cervus canadensis	600	50
Lepus americanus	4.5	70
Odocileus virginianus	175	50
Sylvilagus	2.8	70
Ursus americanus	300	70

2000 and 3000 BC. In the overview unit, the situation is the same (Briuer 1977). However, Berry (n.d.) has recently questioned much of the evidence that has sustained this view. He argues that there is no conclusive evidence for corn, the earliest of the domesticates, until shortly before the time of Christ. Berry's argument is a sound one; examples of earlier occurences are so few in number and so poorly dated that they are best treated as random events. Whether post-depositional transformation processes or simply episodic and unsustained utilization of the resources are responsible for the observed random pattern, it is no longer reasonable to believe that domesticates achieved any widespread distribution in the area until after the date Berry suggests. Even given this date, one cannot infer that local peoples were significantly dependent on domesticates. Plog (1974; see also Plog and Cordell 1979) has suggested that the widespread adoption of subsistence strategies based on domesticates does not occur until about 1000 AD.

Gasser (n.d.a, n.d.b, 1978) summarized the results of his analyses of floral samples from relatively late sites in and adjacent to the study area. He concluded that the ten most important plant foodstuffs were corn, goosefoot, Indian rice grass, wild buckwheat, winged-pigweed, sunflower, globe-mallow, juniper, purslane, and pepper grass. Macrofossil remains recovered through both excavation and flotation were used in the study.

While Gasser noted substantial variation among remains from the sites he studied, too few sites are included in the analysis to be certain whether the variation is spatial or temporal. Of particular importance is the general absence of evidence of heavy utilization of either beans or squash. In fact, there is more substantial evidence for the use of cottonseed than beans. Beans have generally been considered an essential complement to corn for a balanced diet since they provide lysine which is missing in corn. However, Gasser notes that corn-chenoam complementarity is the equivalent of corn-bean complementarity. In summary, Gasser's data suggest that domesticates may never have been as important a part of local diets as traditional reconstructions have suggested.

Gasser's results support a suggestion of a more varied diet that was made by Hill (1970) who believed that the last inhabitants of Broken K Pueblo returned to a significant reliance on hunting and gathering. The specifics of Hill's claim are open to question. Phillips (1972) restudied the floral and faunal specimens from Broken K in an effort to evaluate Hill's conclusion. He investigated the possibility that apparent patterns of change through time might have resulted from differential trash dumping. Having developed nonecofactual measures of the magnitude of dumping, he discovered that no case could be made for variation in the magnitude of reliance on hunting, and that there may have been some decrease in reliance on corn and perhaps cucurbits relative to gathered products. On balance, his data suggest a far less consequential change than the major shift that he postulated. Nevertheless, Hill's original inference seems increasingly valid as an indicator of substantial variation in subsistence strateges in the area.

Gasser (n.d.a, n.d.b, 1978) ultimately suggests that it is reasonable to view late subsistence strategies as focusing on three different sets of resources; domesticates, wild plants that grow in dense stands and yield high quantities of fruit within a limited area, and weedy species that grow in disturbed habitats such as those surrounding villages the fields. Given the enormous climatic variability noted earlier, it is quite likely that, from year to year and village to village, the mix of specific subsistence resources utilized was quite complex.

Unfortunately, no project done to date in the study area has focused on subsistence. The majority of existing evidence is in the form of simple lists of floral and faunal remains in the appendices of site reports. A few specific studies have been done that inform some aspects of prehistoric subsistence although the data bases they employ are less than spectacular.

Hoffman (1974) has described gathering strategies that might have been employed by prehistoric peoples in the overview unit. She uses Hopi ethnobotanical records as a basis of assessing what might have been regarded as usable foodstuffs. When possible, these are evaluated in terms of their nutritional content. The climatic factors that would have produced variation in the availability of particular wild plants are then described. These are summarized in terms of the combinations of wet and dry summers and wet and dry winters. Plants that would have been available at various altitudes under different conditions are described. Hoffman's effort is not to argue for four discrete climatic regimes, but only to suggest the availability of spatially and temporally dispersed foodstuffs under virtually all conditions and the relatively complex decisionmaking that would have been necessary to harness those foodstuffs.

Minnis and Plog (1976) have discussed the potential importance of the distribution of Agave parryi for both subsistence and locational studies. Nineteen occurences of this species on the Apache-Sitgreaves National Forest are all in association with archeological sites. The natural habitat of Agave parryi is south of the Mogollon Rim. Thus, the observed stands are stands resulting from the importation of the plant into the area for subsistence and maintenance purposes.

Freeman (1973) has attempted to explain variation in the faunal remains recovered during excavation in sites in the Purcell-Larson locality. Antelope, deer, goat, turkey, fox, jackrabbit, conttontail, ground squirrel, and pocket gopher remains were recovered from the site. A variety of efforts to interpret the faunal assemblages were confounded by the relatively limited quantity of floral remains that were recovered from the sites. Freeman considers the characteristics of local soils and finds some suggestive evidence of differential preservation resulting from variation in soil moisture and phosphorus. I suspect, however, that the real difficulty with preservation results from the absence of localized trash dumping; middens are uncommon in the area while extensive areas of sheet trash are quite common. Given the immense preservation problem, prospects for either intra- or inter-site faunal analyses in the area do not seem good.

Acker (1972) investigated the relationship between site locations and the characteristics of the soil in the vicinity of sites using data from the Purcell Larson area. She analyzed soil nitrate, potassium, phosphorus, and pH. The only significant relationship she noted was between site, room, and check dam densities and pH. All of the former are highest when soil pH is in the vicinity of 6.9 to 7.2. Densities drop regularly above the latter value. In general, soil pH is correlated with surficial geology. Neutral values are recorded for soils derived from the Moenkopi Sandstone and alkaline values for Kaibab Limestone-derived soils.

Acker also comments on the generally low nitrate values for the soil. Without substantial replacement of the nitrates, it is unlikely that sustained corn planting would have been successful in the area. Moreover, it is dubious that such replacement was in fact possible for prehistoric peoples. Thus, frequent movement of populations or their fields is likely. Interestingly, there is a relatively regular eastward shift of population every 50 to 100 years after about AD 1000.

Schemenas (1973) analyzed corn remains from O'Haco Rockshelter and several other sites in Chevelon Canyon. She discussed a number of criteria that can be used for differentiating between corn that is consumed while green and mature corn. On the basis of this criteria, she argued that most of the corn consumed in the area was eaten while green. While this result does not preclude the possibility that some corn was harvested and stored elsewhere for consumption, it does suggest that mid- to late summer green corn may have been a crucial resource for Desert Culture and Puebloan peoples and that the initial role of corn in the diet may have been during the months just prior to the appearance of abundant fall-harvestable resources.

Sarayadar (1970) discussed the likelihood that prehistoric peoples living in Hay Hollow Valley might have experienced a shortage of usable agricultural land. In the study he discusses a number of different approaches to the estimation of population in the area and to the determination of the acres required per person. Different climatic and productive conditions are considered. He concludes that it is unlikely that any shortage of land would have been experienced in the Valley before AD 975. After this date, without intensification or diversification of subsistence strategies, a shortage of good agricultural land would have been likely. Interestingly, the earliest irrigation canal in the valley dates to about

AD 1000. Lightfoot (1978c) has developed similar evidence for the Springerville area.

STRATEGIES OF RESOURCE UTILIZATION: FUEL

The published literature concerning Southwestern archeology gives no attention to the fuel requirements of prehistoric peoples. While there are exceptions (Sanders 1976; Miller 1980), the situation is much the same in other parts of the world. Yet, it would be naive to assume that fuel requirements were never a problem in prehistory.

To take the Colorado Plateaus as an example, portions of the area are virtually devoid of major fuel sources. Certainly, one can use sage, saltbush, chamiso and even grasses for fuel, but the efficiency of these sources is limited because of the small sizes of the twigs from such plants. Even given a dense ground cover, available fuel does not approximate that of a woodland or forest zone.

Pine forests present a different problem: fuel is readily available, but in packages that are difficult to manage. In these environments, one would suspect that younger and smaller, rather than older and larger, trees were harvested along with dead wood. In the overview unit the optimal zone for obtaining fuel is the woodland (pinyon-juniper, juniper-pinyon) zone. Individual trees are of a more manageable size, large branches occur closer to the ground, and deadwood is available.

In an effort to assess the potential role of fuel problems in the study area the woodland zone was chosen as a focus. This choice is logical for a number of reasons. First, it appears to be the most densely occupied environment in much of the northern southwest. Second, modern records concerning the woodland have been generated by the Forest Service. Finally, for the reasons discussed in the preceding paragraph, it would seem to represent an optimal situation in regard to the availability of fuelwood; any problems it presents would likely be greater in other environments.

Essential to an evaluation of fuelwood problems are (1) an estimate of availability of fuelwood and (2) an estimate of the rate of utilization of fuelwood. In both instances it is necessary to assume the equivalency of the present and the past, with any differences between the two a potential source of difficulty in respect to the conclusions reached. In some parts of the Southwest, the Forest Service has been involved in estimating the availability of fuelwood for use by modern peoples. I obtained data for the Heber District of the Apache-Sitgreaves National Forest (Hart and Caskey, personal communication). Because only a few plots have been studied and because, as elsewhere in the northern Southwest, there is substantial variation in fuelwood densities with altitude, the mean figure of 3.4 cords per acre is not tight. For this reason the high (5.5 cords per acre) and low (2.7 cords per acre) density will also be used in the subsequent discussion. It seems unlikely that prehistoric figures would have been substantially different from these. Paleoenvironmental reconstructions have generally suggested changes in the boundaries between particular plant communities rather than changes in the density of plants in them.

Data on fuelwood consumption are far more difficult to obtain. Fortunately, Russell (n.d.) recorded the rate of consumption of seven households on the Navaho reservation. The data were recorded in "pickup-trucks-full," a rough equivalent of one cord of wood. Coal was also used by the households in question. While I suspect that because coal is a more efficient fuel, a truckful of coal is more than the equivalent of one cord of wood, I have used an identity between the two. (The maximum number of truckloads of coal used by any household was three out of a total of 13 truckloads of fuel.) Given the small sample size, variation is again high. Mean per capita utilization was 2.7 cords per year with a low of 1.33 cords per capita and a high of 5.33 cords.

The utility of the Navaho as an analog to prehistoric Southwesterners is, of course subject to question. Undeniably, prehistoric peoples could have been more conservative in their use of fuel. At the same time, they used fuel for ceramic manufacturing, which the Navaho do not, and lacked the more efficient stoves employed by the Navaho. Thus, it seems probable that the range of utilization rates should overlap even if a precise figure cannot be established. For these reasons, I feel comfortable in using the figures for relatively gross projections.

Tables 10 through 12 illustrate overall rates of utilization for populations of different sizes. One might conceive of the population figures as representing either the population of a single site or the population density/square mile. The "low" figures assume a low per capita rate of utilization and high availability of wood. The "high" figures use a high rate of utilization and low availability of wood and the average figures use average values for both.

The preceding Tables illustrate use rates per year and per generation, which is assumed to average 30 years. The column labelled "site radius/generation" indicates the radius of the zone around a site of a given population that would have been utilized in a generation. A final issue is the time required for the regeneration of the forest. An average value of 100 years is assumed. Thus, the figure indicates the distance that people living in a site of a given size would have to go to obtain wood before the nearby forest was completely regenerated. Of course, some regeneration would have occured in the interim. But, to the extent that less than fully regenerated stands were used, the overall rate of regeneration was decreased and the wood that could be obtained was smaller and less efficient as fuel.

A number of conclusions can be reached using these data. First, consider the average situation. After only a single generation, the inhabitants of a site in a region where sites housing 100 or more individuals occurred at a density of one per square mile (or the inhabitants of a region with an average density of 100 per square mile) would have begun to impinge on each other's resouces. If sites with 50 inhabitants occurred at a density of one per square mile in a region (or if average density in a region was 50 per square mile) the ability of a woodland to regenerate itself would have been taxed after a century. I do not wish to argue that average site density over the study area was ever this high. Equally clearly, there were times and places when it was.

Given the worst case (high consumption and low availability), a population density of 50 per square mile (or an equivalent average site size) would have produced a problem within a generation. An average density of 11 people per square mile would have been sufficient to tax the ability of a woodland to regenerate itself. An average density such as the latter is not unreasonable for the overview area.

Given the best case (low consumption, high availability), only a region with a population density of 500 per square mile or greater, or one in which sites with a population of 500 occurred in the average square mile, would have experienced difficulty after a single generation. The ability of the forest to regenerate itself, however, would have been taxed with high population density or average site sizes of 100 people.

Three implications of this simple simulation are clear:

(1) Under any conditions, sites housing 1000 or more people would have had fuel wood requirements that would have impinged on nearby peoples, unless a minimum radius of 5 miles and an average radius of a little over six miles around the site was unoccupied. The latter situation, I suspect, rarely occurred. Thus, some means of allocating/conserving fuelwood was almost certainly necessary once sites of this size began to occur in particular regions. To the extent that sites had more than 1000 individuals, the problem would have become increasingly greater.

(2) In any other than the most optimal environments, pressure to begin conserving fuelwood, or measures to allocate the resource equitably, or to move to new areas were fuelwood was more abundant, would have been felt within a generation in places where population density exceeded 100 per square mile. These pressures would have been felt within a few generations if population density exceeded about 25 per square mile.

(3) In less than optimal environments, or among peoples with less conservative practices, these pressures would have been felt sooner or with lower population densities.

There are many flaws in these data. Yet, even granting substantial variation, it is clear that fuelwood could have been a resource limiting the ability of prehis-

Table 10. Rates of fuelwood utilization using mean figures for fuelwood availability and consumption (3.4 cords/acre - 2.7 cords per capita)

NUMBER OF PEOPLE	ACRES/YEAR	ACRES/GENERATION	SITE RADIUS/ GENERATION (miles)	SITE RADIUS BEFORE REFORESTATION (miles)
5	4.00	120	.24	.45
10	7.90	237	.34	.63
20	15.90	477	.49	.89
50	40.00	1,200	.77	1.40
100	79.00	2,370	1.09	1.98
200	159.00	4,770	1.54	2.81
500	400.00	12,000	2.44	4.46
1000	790.00	23,700	3.43	6.27
2000	1590.00	47,700	4.90	8.89
5000	4000.00	120,000	7.72	14.10

Table 11. Low fuelwood utilization rates based on high availability and low consumption (5.5 cords/acres - 1.3 cords per capita)

NUMBER OF PEOPLE	ACRES/YEAR	ACRES/GENERATION	SITE RADIUS/ GENERATION (miles)	SITE RADIUS BEFORE REFORESTATION (miles)
5	1.20	36	.13	.24
10	2.40	72	.19	.35
20	4.80	144	.27	.49
50	12.00	360	.42	.77
100	24.00	720	.60	1.09
200	48.00	1,440	.85	1.55
500	120.00	3,600	1.34	2.44
1000	240.00	7,200	1.89	3.46
2000	480.00	14,400	2.68	4.89
5000	1200.00	36,000	4.23	7.73

Table 12. High fuelwood utilization rates based on low availability and high consumption (2.7 cords/acre - 5.33 cords per capita)

NUMBER OF PEOPLE	ACRES/YEAR	ACRES/GENERATION	SITE RADIUS/ GENERATION (miles)	BEFORE REFORESTATION (miles)
5	9.90	297	.38	.70
10	19.70	591	.54	.98
20	39.50	1,185	.77	1.40
50	99.00	2,970	1.22	2.22
100	197.00	5,910	1.71	3.13
200	395.00	11,850	2.43	4.43
500	999.00	29,700	3.84	7.04
1000	1970.00	59,100	5.42	9.90
2000	3950.00	118,500	7.68	14.02
5000	9999.00	297,000	12.15	22.30

toric Southwestern peoples to survive and expand. There clearly were sites and regions where density values as great or greater than those I have used and where fuelwood availability is equal to or less than that we have postulated. Both ethnographic and archeological research sensitive to this issue are essential.

FUTURE RESEARCH

There is no aspect of the preceding discussion that cannot be informed by more research and more detailed research. Beyond a probably incomplete list of specific resources utilized, it is possible to say little about resource utilization in the area that is more than inspired guesswork based on ethnographic analogy or ethnographic models. The collection of more floral and faunal data is clearly imperative. One potential source of such information is cave deposits where preservation is generally good. Data from these loci must be treated with caution since they may have been special-use sites, as Schemenas' argument concerning green corn suggests. Similarly, Briuer (1975) has noted the great difficulty one encounters in attempting to separate natural from cultural materials at these sites.

Ultimately, more substantial efforts to recover floral and faunal remains during routine excavations of open air sites will solve the problems caused by the current dearth of information. The routine flotation of some sediments will be necessary. Even when only characoal is recovered, the results can help to provide an empirical basis for evaluating the likelihood that prehistoric peoples in the area actually faced fuelwood crises. Further studies of the differential preservation of floral and faunal materials in localities with different soils will also increase understanding of the areas in which efforts to obtain large floral and faunal samples are likely to be most profitable.

HISTORY OF RESEARCH

Research within the Little Colorado area began in the late 1800s. By current standards, the records generated by the earliest work are poor. In the case of surveys, one can determine what sites were found and obtain a very rough idea of their location. It is close to impossible, however, to determine which areas were investigated and which were not. Early reports of excavation generally indicate only the site at which work was done. Only museum quality pieces were saved and, even for these, provenience information is no more specific than an indication of the site from which they were taken.

While the quality of work improved over time, there are still problems even during the last two decades. Survey was rarely done with the detailed inspection of the ground surface that is now current and it is generally impossible to even assess the average level of intensity of particular projects. Similarly, while provenience data are more precisely maintained in the case of excavation, tabular summaries of excavated materials are not common.

These comments are not intended as criticism of the individuals responsible for particular projects. To assess the diversity of work that has been conducted in an area against some single standard of recording and reporting would be unfair. However, it is important to any attempted interpretations of prehistory within the overview area that the diversity of standards and techniques employed in data recoverey and reporting be clearly understood.

The first systematic archeological field research in the area was that done by Bandelier in the early 1880s (Bandelier 1890). Bandelier does note some earlier work by Cushing, but no records of this work have been found. Bandelier's own efforts centered on the St. Johns area. He notes the presence of pueblo sites between Zuni and St. Johns and in the Little Colorado River Valley between St. Johns and Springerville. In general, site descriptions are brief. Similarly, his descriptions of the locations of some of the sites do not correspond to cultural and natural features with which he identifies them. One important aspect of his research was the identification of prehistoric irrigation channels in the Little Colorado River Valley.

In 1897, Jesse Walter Fewkes began work in the overview unit as a part of his effort to trace Hopi migration myths. Initially he visited and did limited excavation at Kintiel (Pueblo Grande, Wide Ruin), Pinedale, and Four Mile (Fewkes 1898). Subsequently, he excavated at the Homolovi group, Chevelon Ruin, and Chavez Pass. Published accounts provide little detail concerning the nature of the excavations, the nature of the architecture at the sites, or the nature of any artifacts other than whole ceramic vessels.

Walter Hough (1903) developed survey records on a number of sites in the overview unit. His efforts focused on the Petrified Forest area, where several large sites were recorded, and in the area between Holbrook and Show Low. Hough visited Show Low (Huning, Whipple) Ruin, Shumway Ruin, and a variety of other sites in the area. His records are insufficient for relocating the majority of these, and some very large sites that he describes have not been noted by subsequent investigators.

Palmer (1905) excavated at three sites in the overview unit. One of these is located 25 miles south of Snowflake and may be Show Low Ruin. The others are identified as the "Juniper Ridge" ruins and may or may not correspond with the ridge currently identified by that name. Palmer also indicates that he "visited" 80 other sites although there is no indication that any survey records were developed. His description of the sites at which he worked is minimal. Of considerable interest, however, is the following observation:

> . . . in no case did I find any part of the wall standing above ground. But only in part is this utter devastation to be attributed to natural causes. Men now living in the section where these ruins are found have told me that the destruction has been greater in the last ten than in the preceding twenty years--by vandal relic-hunters, ravages of stock, and

> last but by no means least, the despoilation of these ancient monuments by people living near them. The walls are thrown down, the stones hauled away and used in private residences and even for public buildings. (1905:531)

> From September 11th to 15th I visited a number of ruins, but found in each instance that I have been preceded by others who had made more or less thorough research. In every case, the burial place had been looted; in fact, the only apparent object of those who had committed these depredations was to obtain pottery from the graves. There were no evidences whatever of any scientific work, save only that which I was informed had been performed by representatives of the government. (1905:533)

In my experience, there is little evidence today of the magnitude of destruction that Palmer describes in the area. This circumstance raises the most unpleasant possibility that many sites appearing to be undamaged at present were in fact devastated a sufficiently long time ago that the site surfaces have returned to an undisturbed appearance. This seems even more likely in view of the following comment:

> The traffic in prehistoric wares from the Holbrook district has been deplorably active. Many thousands of pieces of excavated pottery have been shipped from Holbrook alone, and collections embracing several thousands of pieces are now in the hands of dealers at various towns in the district, and are offered for sale. These collections have been made, for the most part, by Indians and native Mexicans in the employ of the traders . . . . (Hewett 1904:9)

Leslie Spier (1918) undertook a survey of sites in the planning unit. There is substantial correspondence between the sites he visited and those identified by Bandelier, Fewkes, and Hough. Locational information is poor, however, and it is impossible to say with any confidence how many of the sites he recorded had not been previously recorded by his predecessors.

One major excavation for which no records apparently exist occurred at the site of San Cosmos to the southeast of St. Johns. Artifactual materials from the site are at the Field Museum of Natural History and the approximate location of the site is shown in one publication (Martin and Willis 1940). However, no records of the excavation were found at the Field Museum. (This site may in fact be Homolovi ruin, nowhere near St. Johns.)

It is worth noting that up to this point in time other portions of the Southwest were experiencing more substantial archeological attention. Moreover, standards of field work and reporting were apparently higher elsewhere. As a result, Kidder (1924) has very little to say concerning the prehistory of the study area in his synthesis of Southwestern prehistory.

During the 1930s better work was reported for the overview unit. Haury and Hargrave (1931) conducted excavations at Kintiel, Show Low, Pinedale, and Bailey (Stotts Ranch) Ruins. Their effort was intended primarily to recover tree ring specimens from these sites to flesh out the master plot of the dendrochronology. As a result, architecture and artifacts are poorly described.

The first high quality report produced from the area was a result of Roberts' work at Kiatuthlanna (1931). He excavated 18 pithouses, 5 jacal structures, and 53 pueblo rooms at this particular location. Architecture, ceramics, and skeletal material are described in detail as is the nature of the excavation itself. It was on the basis of this work that Roberts argued for an evolutionary sequence from pithouse to jacal to masonry structures. It should be noted, however, that the ceramics from the various structures are of similar styles raising the possibility that all of these different architectural units were in use at the same time.

In 1933, H. P. Mera conducted survey and excavations in the vicinity of the Petrified Forest. He excavated and restored Agate House and a second site immediately adjacent to the Rio Puerco. One hundred nine sites within and near the Petrified Forest and in the McDonald Wash area west of Holbrook were recorded. The resulting publication (Mera 1934) provides only minimal information concerning the results of the effort and Mera's analysis is restricted largely to ceramic typology.

In 1939 and 1940, Frank Roberts described the results of three summers' work at sites in the Whitewater District. Again, he excavated in architecturally diverse situations including 20 pithouses, a number of small pueblos and granaries and a large pueblo that appears to have the characteristics of a Chacoan outlier. Ceramic artifacts and burial patterns (there were 150 excavated burials) are described in detail.

In 1942, Katharine Bartlett described evidence recovered from aceramic sites in the Little Colorado River Valley. She labeled these sites the Tolchaco Focus and argued that the flaked stone industry resembled Lower Paleolithic ones found in the Old World. While no specific date was assigned to the sites, she argued that they must be earlier than AD 500 because of the absence of pottery on them. This complex, and its interpretation as a "pre-projectile point" phenomenon, has been the subject of a continuing dialogue in the literature (Ascher and Ascher 1965; Sims and Daniel 1967, Keller and Wilson 1976).

In 1945, Harold S. Gladwin (1945) reported on his major effort at White Mound Village. Six pithouses, surface storage rooms and additional features were excavated. The report provides a detailed architectural description and an analysis of ceramic variation along with consideration of some other artifact classes.

Fred Wendorf (1948) summarized patterns of ceramic variation on sites in the Petrified Forest area. Continuing work by the staff of the Laboratory of Anthropology, subsequent to Mera's initial effort in the area, had increased the total of known sites in this location to 304. On the basis of ceramic types, Wendorf divided the sites into seven distinct temporal units.

In 1949, George Ennis described the results of a survey of a ranch east of Snowflake. Mr. Al Levine, the owner of the ranch, had previously identified sites on it. Ennis revisited and made ceramic collections from 82 sites on the ranch. Ceramic variation is used to generate a system of seven ceramic groups. Prehistoric population of the ranch is reconstructed using room counts.

In 1950, Wendorf described the excavation of eight pithouses at the Flattop Site in the Petrified Forest National Monument. The report includes brief architectural and ceramic summaries. Because pottery at the site was Adamana Brown, a micaceous, paddle-and-anvil plainware, atypical of the Plateau area, Wendorf chose not to assign the site to any time period or cultural group.

Danson and Malde (1950) published a brief description of Casa Malapais, near Springerville, Arizona. Architecture and ceramics are briefly described. The site is a Pueblo IV site with roughly 60 rooms and a Great Kiva. Because access to the site is difficult and because it is virtually invisible from any surrounding location, the authors agrue that it was a defensive site.

Wendorf (1951) described the excavation of the Twin Butte Site in the Petrified Forest National Monument. The site is a Basketmaker III village from which 12 structures and 8 burials were excavated. The report is a brief description of architectural, ceramic, and burial patterns. In 1953, Wendorf (1953) published a summary of his work at Flattop, Twin Butte, and one large and relatively later pueblo. This report is the most complete synthesis of his work and the most comprehensive of the available discussions of the prehistory of this locality.

Wendorf and Thomas (1951; Thomas 1952) described artifactual materials from lithic sites near Concho. The materials have a relatively extensive distribution on hillslopes in the area. They argue that the "Concho Complex" is a local Desert Culture manifestation.

Danson (1957) discusses the results of his surveys in western New Mexico and eastern Arizona. Two of the localities he surveyed are within the study area. Near Nutrioso, he recorded nearly 50 sites and in the Springerville-Eagar area, nearly 60. The report contains a summary of architectural and artifactual patterns, the evolution of ceramic types, and patterns of cultural variation.

In 1957, the Southwest Archeological Expedition of the Field Museum of Natural History began its excavations in the Upper Little Colorado portion of the study area. This effort resulted in publication of two surveys, one in the Little Colorado area in general (Rinaldo n.d., Longacre 1962, 1964, 1970) and one in Hay Hollow Valley (Plog

1974, Zubrow 1975). Excavation was undertaken at the Beach Sites near Concho (Martin and Rinaldo 1960), sites 30 and 31 near Vernon (Martin and Rinaldo 1960a), Table Rock Pueblo near St. Johns (Martin and Rinaldo 1960b), Tumbleweed Canyon near Lyman Lake (Martin et al., 1962), Rim Valley and Hooper Ranch Pueblos near Springerville (Martin, Rinaldo, and Longacre 1961; Martin et al., 1962), Mineral Creek Site, Thode Site, and Chilcott Sites near Vernon (Martin, Rinaldo, and Longacre 1961; Martin et al., 1962), the Goesling Site near St. Johns (Martin et al., 1962), Carter Ranch (Martin et al., 1964, Longacre 1970), Broken K (Martin, Longacre, and Hill 1965, Hill 1970), County Road, Hay Hollow (Martin 1967, Fritz 1974), Plebisite (White 1968), Gurley (Plog 1974), Joint (Martin et al., 1975), and the Kuhn and Connie sites in Hay Hollow Valley (Thompson and Longacre 1972). Gregory (1975) and Zubrow (1975) report test excavations at a number of sites in the same valley. Longacre and Graves (1976) have reported on surface studies at a PaleoIndian Desert Culture site near St. Johns. Excavations at Swinburn Cave and the Hatch Site, and the Phipps Site are undescribed and unpublished. Earlier site reports generally provide a comprehensive discussion of artifactual and architectural variation at the sites. Later reports reflect a stronger problem orientation, but the general description of architectural and artifactual variation is poor.

In 1960, William Wasley described the results of salvage excavation along U.S. Highway 66 between Houck and Lupton. Excavation occurred at 10 sites and resulted in recovery of information concerning 16 pithouses, 43 surface rooms, 7 kivas, 6 trash deposits and 18 burials. Little detailed artifactual or architectural information is presented. The author notes the presence of contemporary pithouse and pueblo settlements until as late as the Pueblo II period and also comments on the substantial admixture of Anasazi and Mogollon traits in the area.

Jack Sims and D. Scott Daniel (1962) describe chipped stone artifacts from a site immediately to the west of Winslow. Projectile points recovered by an amateur collector were studied. The authors argue that there is evidence of both Clovis and Pinto occupations at the site.

The excavation of a painted kiva near Winslow was described by Pond (1966). The kiva at Homolovi II contained Jeddito Black-on-yellow pottery. Wall paintings were fragmentary.

Gumerman (1966) reported the excavation of 13 pithouses at two aceramic sites along Highway 66 between Sanders and Lupton. The architectural patterns at the two sites are described and compared to reports of Basketmaker II houses elsewhere in the Southwest. Artifactual materials recovered during excavation are briefly mentioned.

Beeson (1966) described the results of a survey in the Little Colorado and Zuni River confluence area that he undertook between 1956 and 1958. The intensity of the survey was variable. Three hundred and twenty-five sites were recorded. Ceramic and architectural data are presented and used in assessing the temporal and cultural placement of sites within the survey area.

In 1967, Calvin Jennings (n.d.) summarized the results of Museum of Northern Arizona excavations at Puerco Ruin in the Petrified Forest National Monument. Fifteen rooms, two kivas, and a burial were excavated. The report includes detailed architectural and artifactual information. The site was occupied between AD 1250 and 1350.

Vivian (1967) discussed the excavation of three sites near Concho and Hunt. Two of the sites are prehistoric: one was a twelfth century single room structure, inferred to be a field house, and the second was a Basketmaker III slab lined pithouse. The third site was a three room Mexican homestead. Artifactual and architectural remains are briefly summarized.

In 1968 Gumerman and Skinner published a summary of the prehistory of the central Little Colorado Valley. While the primary focus of the article is an area along the north edge of the overview unit between Holbrook and Winslow, much of the discussion is relevant to the overview unit itself. The primary utility of the article is the summary of temporal variation in architectural, artifactual, settlement, demographic, and cultural patterns.

Gumerman and Olson (1968) provided a similar synthesis of the Puerco area between Sanders and Lupton. Their article adds some additional information to Wasley's (1960) description that was discussed earlier. It is perhaps worth noting at this point that salvage archeology in conjunction with the construction of I-40 continued through the early 1960s. Unfortunately, apart from the Wasley and Gumerman-Olson articles, the results of this major effort are unreported. Field notes and artifactual materials remain at the Museum of Northern Arizona.

Gumerman (1969) described the archeology of the Hopi Buttes district. This area lies to the north of the overview unit. However, many of the evolutionary patterns discussed by Gumerman are characteristic of the study area. The report describes both survey and excavation in the area and contains detailed architectural and artifactual summaries as well as a thorough discussion of spatial and temporal variation in demographic, subsistence, and technological patterns.

Wilson (1969) discussed the results of survey in a number of localities between Flagstaff and Holbrook, some of which lie within the study area. The survey coverage itself is spotty. However, the volume contains a major synthesis of Sinagua prehistory and much detailed discussion of ceramic types and ceramic variation over the area. The survey is briefly summarized in one earlier report (Wilson 1967).

Vivian (1969) reported the results of salvage excavations by the Arizona State Museum near Pinedale, Arizona. Five sites were excavated, two of which had no structures. The remaining sites include a two room and a three room pueblo and a pithouse village with an associated work area. Architectural and ceramic remains are very briefly summarized.

Grebinger and Bradley (1969) described the result of excavation near Heber associated with the same project. The site is a double component temporary camp site consisting of work areas around hearths. The first occupation was before AD 1000 and the second sometime afterwards. Artifactual summaries are provided.

Lindsay et al., (1969) summarized the results of a survey done in conjunction with a proposed dam project on Clear Creek. Nine sites were recorded including petroglyphs and rock shelters. Descriptive detail is minimal for all pertinent observations.

In 1970, DeGarmo began survey work in the Coyote Creek drainage. Sixty-three sites were recorded between the headwaters of the creek and its confluence with the Little Colorado River. During the next year DeGarmo (1975) excavated at Coyote Creek Pueblo. The report includes detailed architectural and artifactual summaries and an interpretation of productive and organizational patterns at the site.

In 1973, Harrill described the result of excavation at the DoBell Site, a large pithouse village south of the Petrified Forest. Four pithouses and one kiva were excavated. The report includes detailed information concerning architecture, artifacts, and burials (see also Birkby 1973).

In 1975, Donaldson reported the results of a 1% sample survey of the White Mountain Planning Unit on the Apache-Sitgreaves National Forest. His monograph focuses principally on the distribution of sites over the planning units and employs computer mapping in this task. A summary of local cultural history is also provided.

In 1976, F. Plog, Hill, and Read reported the results of survey in the Chevelon drainage south of Winslow. The results summarize ceramic and architectural patterns and discuss analytical approaches that are taken in the project.

In 1977, Hantman described the results of a survey of an 800 acre area in the Chevelon drainage. Thirty-one sites were located during the survey. In addition, non-site manifestations within the study unit are discussed. Sites are described but there is little architectural detail. The report includes a detailed analysis of ceramic variation over the sites in the study area.

In 1977, Lightfoot and DeAtley discussed the results of a survey of an 8 square mile area near Pinedale, Arizona. Ninety-one sites and non-site areas were identified in the study. The report includes a detailed analysis of locational patterns within the area, but no summary of artifactual or architectural remains. In 1978, Lightfoot described the results of survey in an immediately adjacent area of similar size. Sixty-one sites and additional non-site areas are discussed. The report includes a summary chronology for the area, but no detailed analyses of ceramic or architectural patterns. Ceramic variation is described in some detail in a subsequent report (Lightfoot 1981).

In 1978, Plog (1978) and others described the results of survey in the Springerville-Alpine area. Roughly 60 sites in the area were located during a 1% planning survey. The report includes detailed analyses of architecture and variation in chipped and ground stone artifacts. Settlement and locational patterns are also analyzed.

In 1979, Lerner described the results of a 1% planning survey in the Clear Creek and Chevelon drainages (Lerner 1979a, b). Eighty-nine sites were located. The reports briefly describe architectural patterns in the area. Ceramic and locational patterns are discussed in detail.

Doyel (1979, in press) discusses the results of a survey and excavation project north of Springerville. Twenty-five sites were located and excavation was undertaken at ten of these. The report contains detailed information on architecture, artifacts, flora, and fauna recovered during the study. The sites in question appear to be temporary agricultural camps the majority of which were inhabited between AD 900 and 1150. In the same year, Doyel discribed the results of the excavation of a small pueblo east of Springerville.

Stewart (1980) has completed an overview of the Petrified Forest National Park. In point of fact, the discussion in the overview covers much the same area that this one does. Its focus is more heavily on space-time systematics and it thus provides information that is complementary to this study. Sites and projects in the Park itself are summarized in the document.

The Museum of Northern Arizona (various authors, in press and in preparation) has undertaken a study in conjunction with the construction of the Coronado generating station and associated facilities. Early reports on this effort are very sketchy. The overall results of the project are, however, now being summarized and include a number of important detailed studies of architectural, artifactual, subsistence, and palynological patterns. The study locations are scattered throughout the study area and the results of this project will be crucial to understanding the area's prehistory.

A parallel project associated with the Cholla generating station is currently being summarized by archeologists at the Arizona State Museum (Teague and Mayro 1979; others in press and in preparation). Survey in conjunction with this project resulted in the location of several dozen sites within the study area, and excavation and/or detailed surface mapping has been done at a sample of these. The report will again obtain detailed analysis of architectural and artifactual patterns within the area.

One major unreported project, the results of which are being summarized currently, is the continuing efforts of the Chevelon Archeological Research Project. Between 1971 and 1978, survey records were developed on roughly 1500 sites on the Apache-Sitgreaves and Coconino National Forests. Thirty-six architectural units on some twenty sites were excavated. The only excavations reported in detail to date are rockshelters in Chevelon Canyon (Briuer 1977). Architectural, artifactual, palynological, and especially subsistence variation are described in this report.

A major omission in the preceding discussion of the later history of archeological research in the overview area is information concerning numerous small projects done either by institutions under contract or by agency employees. In general, these reports are highly variable both in substance and quality. Many contain little more than a description of sites encountered equivalent to what would be found on a site survey form. Thus, the records of the projects available at present consist substantially of the site survey records themselves.

Southwestern institutions that house the majority of the site records, excavation records, and artifactual materials are Arizona State University, the Laboratory of Anthropology, Museum of New Mexico, the Museum of Northern Arizona, the University of Arizona, and the Western Archeological Center of the National Park Service. Outside of the Southwest, the Field Museum of Natural History and the Smithsonsian Institution house major collections. The American Museum and the Heye Foundation also have pertinent materials. While there are records of research in the area by scholars from California institutions, no evidence that the pertinent materials still exist could be found. In all cases, the material items held are incomplete, reflecting the once accepted practice of disposing of some classes of artifacts. Unfortunately, in some instances the degree of disposal was relatively complete. Burial data from the overview unit and nearby areas has been summarized by Turner (1967).

PREHISTORY OF THE OVERVIEW UNIT

INTRODUCTION

There is a major problem in developing a summary of the prehistory of this or any other large spatial unit, one that arises because archeologists have sometimes been careless in the extent to which chronologies were based on developmental as opposed to strictly chronological concepts. Chronological terminologies use distinctive artifactual styles, sometimes in combination with absolute dates, to isolate relative or absolute temporal horizons. Developmental terminologies on the other hand postulate a regular evolution of architectural, artifactual, and/or settlement forms. In general, the postulated evolutionary trajectory is linear and involves increases in complexity, technological sophistication, aesthetic appeal or some combination of these.

Price (1975), Millon (1975), and Cordell and Plog (1979) have discussed problems that arise when developmental terminologies are used as, or incorporated into, chronological terminologies or when the distinction between the two is not kept clear. Empirical research increasingly demonstrates that many, if not most, prehistoric societies survived on the basis of exchange relationships that linked at least productively and sometimes culturally, different groups. Given such diversity, a developmental typology created to describe the prehistory of one region or locality may be inappropriate to one quite close by. Yet, in efforts to synthesize regional prehistory, diverse regions and localities can be and have been forced into monistic frameworks.

Theoretical literatures dealing with evolutionism increasingly emphasize concepts such as "saltation" or punctuated equilibrium (Gould 1977; Gould and Eldridge 1977). These developments are paralleled by changes in approaches to historical sequences that emphasize the uneven course of development from region to region that underlies the emergence of larger and more complex pan-regional systems (Wallerstein 1974). These approaches again raise doubts as to the likelihood of constructing a single regional developmental chronology.

At this point, it is impossible to avoid describing the prehistory of the overview area in developmental terms, because so many of the studies undertaken in the area have used such approaches. For this reason, the prehistory of the area will be described from a number of perspectives. First, a summary description in terms of traditional developmental typologies will be provided. Because of the difficulties just discussed, no effort will be made to identify each and every cultural resource in relation to this typology. Second, more reliable chronological approaches and data will be summarized. Finally, specific dimensions of diversity will be described and an attempt will be made to describe the complexity of evolutionary patterns in the study area.

PALEOINDIAN

PaleoIndian sites are the earliest found within the overview unit. In general, these are defined by the presence of lanceolate projectile points with either short (Clovis) or long (Folsom) flutes (Figure 6). The precise date of the earliest occupation of the area cannot be established at present. Sites older than 20,000 years have been identified in Mexico (Irwin-Williams 1967) and in South America (MacNeish 1971). Given the generally accepted hypothesis that the first inhabitants of the New World came from Asia across the Bering land mass, it is likely that prehistoric peoples either passed through or inhabited the study area before 20,000 years ago. At present there is no corroborating evidence. The site of Tule Springs in southern Nevada dates from 10,000 to 13,000 years ago suggesting PaleoIndian presence in the southwestern region by this time. But, again there are no corroborating dates from the study area.

The earliest certain evidence of prehistoric activity in the area is the presence of Clovis points near Sanders (Danson 1961; Olson 1964) and west of Winslow (Sims and Daniels 1962). While the two points in question are surface finds, Clovis points elsewhere in the Southwest date to between 9000 and 9500 BC (Irwin-Williams 1967:8).

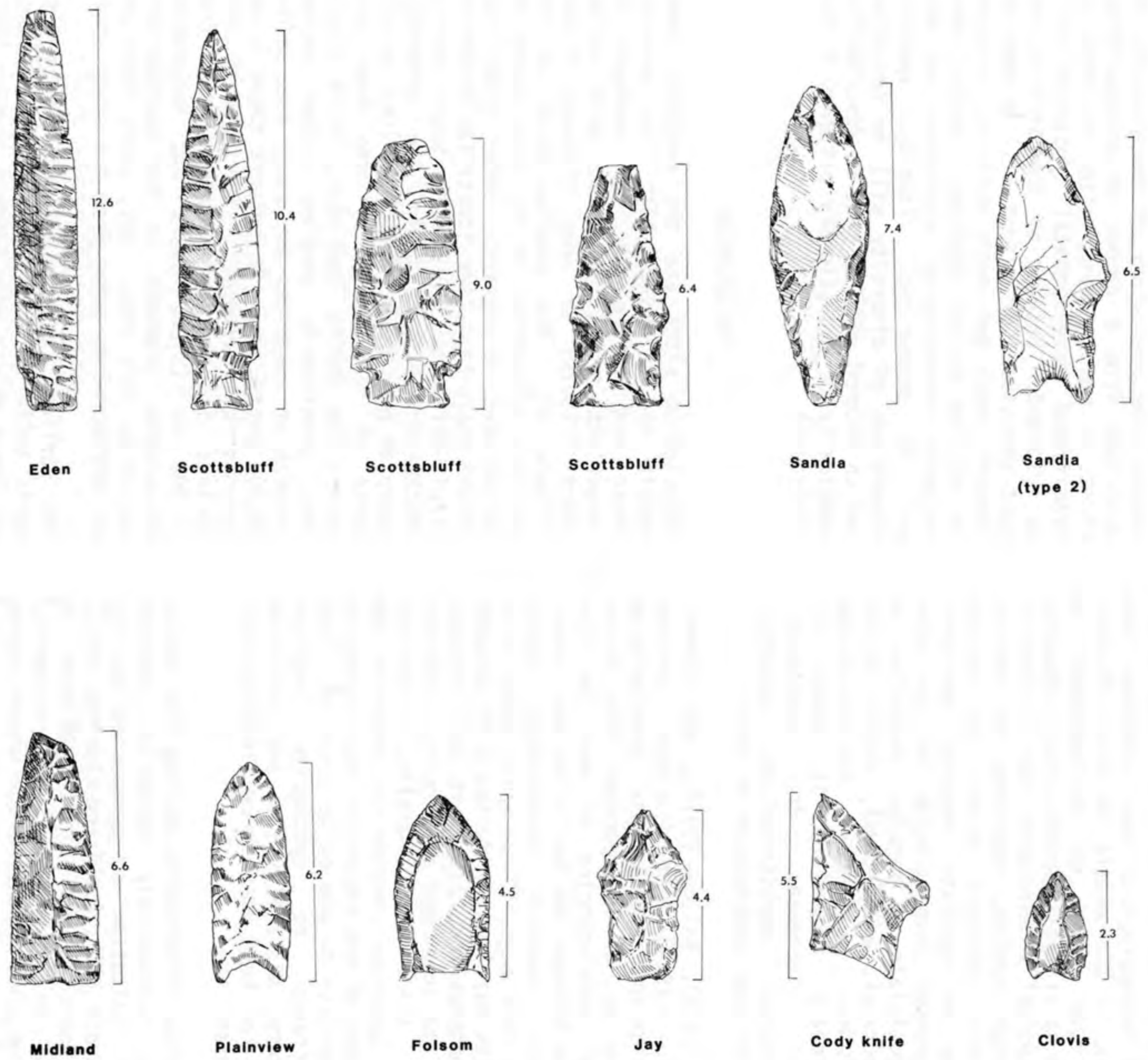


Figure 6. Early projectile points. All measurements are given in centimeters.

These points represent, therefore, the earliest reasonably certain evidence of human habitation of the area.

A possible candidate for equal or greater antiquity is the Tolchaco Complex (Bartlett 1942, 1943; Ascher and Ascher 1965; Keller and Wilson 1976). While Bartlett originally assigned the sites of this complex to a time earlier than AD 500, Krieger incudes it in a Pre-Projectile Point Stage, implying that it is earlier than Clovis (Krieger 1962, 1964). Fish (1974) and Keller and Wilson (1976), however, argue that the sites are quarry and lithic processing sites. This is based upon large quantities of cores and chipping debris. Keller and Wilson (1976) conclude that the sites were utilized from Archaic through Pueblo times.

This interpretive problem results from the nature of the sites. Those that I have observed are better characterized as low density artifact scatters than as sites. That is, they can and sometimes do occur as very low density scatters over an area of many hundreds of square meters. Site "boundaries" are often formed by erosional channels with the artifact distributions occurring again on the other side of the wash.

The sites occur in the midst of lag gravels and include materials derived from the Kaibab Limestone, the Moenkopi Sandstone and the Mogollon Rim Gravels. The ratio of unmodified gravel and cobbles to worked pieces is quite high. There are occasional sherds on some sites and lithic materials that are indistinguishable from those found on Pueblo period sites.

At the same time, I have observed and others have reported to me (Jewett, personal communication) artifacts that are not generally associated with typical Paleo-Indian or Archaic assemblages of the area. Of particular importance are at least three residual turtle-back, or Levallois, cores observed at sites southeast of Winslow. The presence of such cores does not necessarily argue for assigning Tolchaco to a Pre-Projectile Point stage. It does, however, suggest that the gravels were utilized by peoples with a lithic industry different from that typical of the area during any currently well described time period.

Thus, in my mind, the Tolchaco issue remains unresolved. That known cultural and temporal markers are found on the sites does not preclude their use as quarry sites by earlier or culturally different peoples. That this problem will ever be resolved is uncertain. The sites are surface sites and, given the attention they have received and the extensive erosion in the areas where they occur, it is reasonable to expect that buried components would by now have been found. The most pressing need for future research concerning the phenomenon is an attempt to identify loci where either superposition or the presence of dateable materials will allow a genuine chronometric approach to the problem.

The next cultural complex evident in the area is Folsom, which typically dates to between 8200 and 8800 BC (Irwin-Williams 1980). Folsom points have been identified near Sanders, St. Johns (Agenbroad 1967; Longacre and Graves 1976), Concho (Agenbroad 1967), Winslow (personal observation), and Springerville (USDA Forest Service site files). With one exception, the points are isolated surface finds. (In addition, the point from south of Winslow came from what is described as a Folsom site. However, the landowner refused access to the site and its existence cannot, therefore, be verified.)

The Vernon site southwest of St. Johns has yielded considerably more information than the isolated surface finds. Longacre and Graves (1976) describe the sample collections that were made on the site surface. Two components were identified, a Concho Complex and a "fluted point" component. While they are reluctant to identify the fluted points as Folsom points, they are similar to Folsom points and the differences may easily be attributable to the basalt used in manufacturing chipped stone artifacts at the site. (It is generally more difficult to fashion refined forms from the basalt available in the area.) Wilmsen (1970:80) analyzed functional attributes of chipped stone artifacts found on the site and concluded that stone tool manufacture and repair, plant and seed processing, and butchering all occurred at the site. This result suggests that Folsom populations were at least seasonally resident in the area. All of the remaining evidence suggests only that they were passing through the area.

Clearly, little is known concerning the PaleoIndian occupation of the area. In general, archeologists are quite sensitive to Clovis, Folsom, and other PaleoIndian point types. A far greater quantity of materials is known from southeastern Arizona and from New Mexico (Irwin-Williams 1980). Given the likelihood that, for much of the period in question, the study area was covered by pine parkland (see earlier environmental discussion), it may have been marginal to the major PaleoIndian population centers in the Southwest.

DESERT CULTURE

Desert Culture sites are distinguished from PaleoIndian sites on the basis of the replacement of lanceolate projectile points by stemmed and side-notched points, and the addition of a substantial ground stone tool complex. While PaleoIndian sites are said to lack ground stone tools, there is clear evidence to the contrary (Duncan 1968, Longacre and Graves 1976). Nevertheless, it is reasonable to argue that the abundance and diversity of ground stone tools was greater during the Desert Culture period. The most typical forms are round or oval cobble manos and basin shaped metates. Desert Culture sites are differentiated from later sites on the basis of the absence of pottery and, possibly, differences in projectile point forms. While the hunting of Pleistocene megafauna and other big game was important to PaleoIndian groups, Desert Culture peoples relied on a diet of gathered resources and small game.

Desert Culture manifestations are known to occur throughout the area. Generally, these can be divided into two complexes: the Pinto Complex and the Concho Complex. Pinto points are stemmed and have indented bases and serrated or rough edges. Concho Complex points are generally thinner, more triangular or lanceolate and side-notched, although they do sometimes have indented bases. In general, Pinto points are found to the north and the west of the overview unit, while points similar to those of the Concho Complex are more common to the east. In my opinion, the remainder of the chipped and ground stone tools are quite similar in the two complexes as they are manifested within the study area.

Pinto points are known from the vicinity of Houck (Gumerman and Skinner 1968), west of Winslow (Syms and Daniel 1967) and at O'Haco Rock Shelter and other nearby sites in the Chevelon drainage (personal observation). Points of the Concho complex are known from the Vernon site (Longacre and Graves 1976), the Beach sites (Martin and Rinaldo 1960), the Hay Hollow site (Martin 1967; Fritz 1974), and from the Concho area generally (Wendorf and Thomas 1951; Thomas 1952).

Irwin-Williams (1967) has argued that the study area represents a boundary between the various traditions that she defines within Picosa culture, the term she uses for specifically Southwestern Desert Culture manifestations. In general, the data from the overview unit support her argument; Concho complex materials are more common to the south of the Little Colorado River and to the east of Silver Creek, while Pinto materials are more common to the north of the Little Colorado River and to the west of Silver Creek. However, given the relatively small number of points in question, and the problems inherent in interpreting projectile point styles as distinctive of different cultural groups, the precise interpretation of the pattern is a problem. The evidence suggests a style boundary, but considerable research is necessary to provide any meaningful cultural or behavioral interpretation of that boundary.

Dating the Desert Culture remains within the study area is also problematical. The earliest dates are from O'Haco Rock Shelter (Briuer 1977). The basal deposit there dates to about 7000 to 8000 BC. Associated cultural materials cannot be classified as either clearly PaleoIndian or clearly Desert Culture. The overlying stratum dates to between 2000 and 3000 BC. This stratum contains Desert Culture materials and also primitive corn cobs. Continued occupation of the rock shelter on at least an intermittent basis continues until AD 1, the traditional date for the end of the Desert Culture. The deposits are not sufficiently well stratified, nor are cultural materials sufficiently abundant, to use in defining a detailed cultural sequence for the area.

A widespread occupation of the study area is not suggested until substantially later. An open air site near O'Haco rock shelter with Desert Culture-like artifacts and a hearth (CS-193) yielded a date of 810± 170 BC (all radiocarbon dates used herein are tree-ring corrected). The Desert Culture camp site on the shore of Laguna Salada is radiocarbon dated to somewhere between 1850 and 1770 BC (3520 BP± 60 [GrN-1614]). The County Road Site in Hay Hollow Valley (Reals 1965) has three dates: 1300 BC± 75 (GX0274), 410 BC± 70 (GX0272), and AD 30± 50 (GX0273). The Hay Hollow Site is dated to between 420 BC and AD 260 (Fritz 1974).

Materials are insufficient for describing the settlement pattern during this stage in any great detail. Martin observes that the Desert Culture sites at Laguna Salada and Little Ortega Lake were very different; the artifact assemblage at the former contained a great quantity of manos and milling stones while that at the latter is largely chipped stone (1960:114). A similar situation may characterize the Desert Culture sites along Chevelon Creek.

Should this apparent pattern be confirmed, then the existence is indicated of specialized activity loci at which drastically different activities were carried out. It is unlikely that the two excavated sites with houses, County Road and Hay Hollow, represent true villages. Even given the overlap of a two sigma range around the dates, it is improbable that the County Road houses were contemporaneous. It is difficult to argue that the inhabitants of these earlier settlements were composed of more than a single family.

Diet was based largely on hunted and gathered materials. Briuer (1977) and Fritz (1974) provide detailed discussions of the floral and faunal evidence recovered from O'Haco Rock Shelter and the Hay Hollow Site respectively. Bohrer (1972) has discussed pertinent palynological evidence. At the same time, Bruier's comparison of cultural and nearby natural sites indicates that major caution must be exercised in attributing the presence of foodstuffs to human activity as the bulk of the floral and faunal inventories overlap.

Corn is present at Hay Hollow, County Road and at O'Haco Rock Shelter in levels dated to 3000-2000 BC. Cucurbits and beans apparently are present in later strata, although the results of analyses of cultigens are not yet published. One preliminary study (Schemenas 1974) argues that much of the corn at these and other sites in Chevelon Canyon was eaten while still green. It is not possible to argue at present that cultigens represented any substantial portion of the diet.

THE PITHOUSE AND PUEBLO PERIODS

The major problem encountered in providing a coherent synthesis of regional prehistory during the PaleoIndian and Desert Culture periods is the paucity of data. When one begins to deal with the period of time after AD 1, data are no longer a problem as there are numerous excavated sites and even more numerous survey records. Nevertheless, there is a major synthetic problem, chronology. Cordell and Plog (1979) have discussed this problem at greater length than I intend to do here.

Briefly, the difficulty is twofold. First, there are relatively few chronometric determinations that sustain the various dating schemes used in the area. Second, "correlations" with dated loci have been pursued on the basis of arguable architectural and artifactual similarities. In addition, there are a variety of specific interpretive problems with respect to artifacts and architecture that will be considered in detail in subsequent chapters. Here, I intend only to review major approaches to chronology, identify basic problems with them, and discuss their relationship to actual chronometric determinations.

As noted earlier, one can identify two polar extremes in the approaches that archeologists take to the construction of chronologies: strictly chronological treaments and developmental ones. Between these poles are approaches that represent some combination of the two. All have been used in the study area.

The foremost of the strictly chronological approaches are those based on ceramics. Of course these embody a developmental element since they presume an orderly succession of ceramic types. However, this succession is viewed as a product of changes in "style" or "taste" and is, therefore, arbitrary in respect to major developments. The most clearly developed of these schemes is that used by Wilson (1969) in his survey of a number of localities, several of which lie within the study area. Wilson, following an approach originally used by Colton in a variety of his works, defined major "ceramic groups" in dating his sites. These ceramic groups are shown in Table 13.

Unfortunately, many of the ceramic types present in the eastern half of the overview area were not present in Wilson's survey

Table 13. Ceramic groups for the survey area

Group 1:	A.D. 700s	DOMINANT:	Lino Gray Lino Black-on-gray Rio de Flag Brown
		PRESENT:	La Plata Black-on-white White Mound Black-on-white Verde Brown
Group 2:	A.D. 800s	DOMINANT:	Lino Gray (mostly body sherds?) Kana-a Gray Kana-a Black-on-white Rio de Flag Brown
		PRESENT:	Coconino Gray Medicine Gray Probably Verde Brown
Group 3:	A.D. 900-1050 ±	DOMINANT:	Lino Gray (mostly body sherds?) Coconino Gray Medicine Gray Tusayan Corrugated Kana-a Black-on-white "Early" Black Mesa Black-on-white Black Mesa Black-on-white Rio de Flag Brown
		PRESENT:	Kana-a Gray Diablo Brown, Yaeger Variety Verde Brown San Juan Red Ware (Deadmans Black-on-red)
Group 4:	A.D. 1050-1100 ±	DOMINANT:	Tusayan Corrugated Black Mesa Black-on-white Holbrook Black-on-white Diablo Brown, Yaeger Variety Sunset Brown Var. "A" alone or Var. "B" Usually much less than "A"
		PRESENT:	Diablo Brown Diablo Red Tsegi Orange Ware (Tusayan Black-on-red)
Group 5:	A.D. 1100-1200 ±	DOMINANT:	Walnut Black-on-white Snowflake Black-on-white Diablo Brown Diablo Red Sunset Brown Var. "A" and Var. "B" ("B" usually = "A") Types II and IV Corrugated
		PRESENT:	Tusayan Corrugated Black Mesa Black-on-white Sosi Black-on-white Flagstaff Black-on-white Holbrook Black-on-white Padre Black-on-white Diablo Brown, Yaeger Variety Tsegi Orange Ware

Table 13 (continued)

Group 6:	A.D. 1200-1300	DOMINANT:	Walnut Black-on-white Snowflake Black-on-white Diablo Brown Diablo Red Sunset Brown Var. "B" or Var. "B" much greater than "A" Grapevine Brown Types II and IV Corrugated
		PRESENT:	Tusayan Corrugated Moenkopi Corrugated Flagstaff Black-on-white Tusayan Black-on-white Kayenta Black-on-white Holbrook Black-on-white Padre Black-on-white Leupp Black-on-white Pinedale Black-on-white McDonald Painted Corrugated Showlow Black-on-red Klagetoh Black-on-yellow Jeddito Black-on-orange "Pinto-style" polychrome Tusayan Polychrome Kayenta Polychrome St. Johns Black-on-red and Polychrome (other 13th century polychrome types)
Group 7:	A.D. 1300 ± -1400	DOMINANT:	Jeddito Black-on-yellow Kinnikinnick Brown
		PRESENT:	Bidahochi Black-on-white Snowflake Black-on-white Pinedale Black-on-white Diablo Brown Diablo Red Kinnikinnick Red Kinnikinnick Corrugated Types VII and VIII Corrugated Homolovi Corrugated Tuwiuca Black-on-orange Jeddito Black-on-orange Bidahochi Polychrome Homolovi Polychrome Jeddito Polychrome Chavez Pass Black-on-red Chavez Pass Polychrome Four Mile Polychrome (other very late 13th and 14th century polychrome types)
Group 8:	Apache	DOMINANT:	Apache Plain

localities and are not, therefore, included in his chronology.

A second approach used in the area in recent years is one that does not rely on the formulation of specific ceramic groupings but on the dating of individual sites using tree-ring dated ceramics. This approach utilizes Breternitz's (1966) study of the association between particular ceramics and dated wood samples. In some instances, the dates used are guesstimates utilizing a best approximation of the materials found at the sites (e.g., Plog 1974). In others, "mean ceramic dates" are calculated for each site using an average weighted by the relative quantities of each dated type (e.g., Lerner 1979a, 1979b). Dates for types likely to be found in the study area are given in Tables 14 through 18.

A third effort is that used in the Chevelon Archeological Research Project (F. Plog 1976). This chronology is a refinement of the Wilson approach that utilizes technological attributes of Black-on-white wares.

Ceramic criteria of successive time periods are shown in Table 19. The approach is a simplification of Wilson in the sense that the major changes in dominant types indicated by Wilson also embody shifts from one ware to another.

The two best examples of developmental chronologies developed for the area are those of Roberts (1935) (see Table 20) and Longacre (1964, 1970) (see Table 21). Robert's chronology was subsequently applied outside of the area while Longacre's was not. Although both chronologies are developmental they proceed along quite different lines. Roberts' focus was on material culture or technology. While specific material items replace one another through the sequence, there is a general pattern of increasing sophistication and complexity followed by a subsequent period of regression. Longacre on the other hand

Table 14. Associated tree-ring dates for plainware types likely to be found in the overview unit (after Breternitz 1966; dates rounded to nearest decade)

TYPE	INDIGENOUS	BEST INDIGENOUS*	TRADE	BEST TRADE*
Alma	270-950	300-950	780-1330	
Angell	910-1260		1080-1130	
Deadmans	690-1210	780-1200	690-1120	850-1100
Forestdale	640-710		610-1110	
Lino	350-1280	570-870	700-1050	700-880
San Francisco	740-950	760-950		
Sunset	810-1280	1080-1140		
Tonto	1110-1350			
Winona	810-1280	1080-1200		
Rio de Flag	690-1260	800-1060	750-780	

*In this Table, and those following, "best" dates are those that bracket the major cluster of dates.

Table 15. Associated tree-ring dates for corrugated ceramics likely to be found in the Little Colorado inventory unit (after Breterniz 1966; dates rounded to nearest decade)

TYPE	INDIGENOUS	BEST INDIGENOUS	TRADE	BEST TRADE
Alma	740-910	760-910	640-710	
Elden	1030-1280	1090-1200	1020-1050	
Kana'a	680-1190	760-900	690-970	780-970
Linden	1080-1330	1280-1330	1030-1210	1130-1190
McDonald	1110-1330	1200-1300		
Moenkopi	980-1390	1080-1290	810-1280	1080-1200
Tusayan	980-1390	1080-1290	800-1320	1000-1280

Table 16. Associated tree-ring dates for black-on-white types likely to be found in the Little Colorado inventory unit (after Breternitz 1966; dates rounded to nearest decade)

TYPE	INDIGENOUS	BEST INDIGENOUS	TRADE	BEST TRADE
Black Mesa	1080-1390	1060-1180	700-1280	880-1130
Chaco	830-1180	1050-1130	1070-1190	1070-1190
Dogozhi	980-1390	1140-1200	810-1280	1090-1200
Escavada	810-1280	930-1130		
Flagstaff	980-1390	1120-1290	910-1320	1070-1200
Gallup	810-1280	1000-1130	ca. 1190	
Holbrook	700-1280	1080-1130	1020-1060	
Kana'a	640-1290	730-820	670-1280	780-950
Kayenta	1100-1500	1200-1290	1020-1320	1270-1310
Kiatuthlanna	720-1090	850-910		
La Plata	430-870	570-870	640-850	730-850
Lino	350-1280	570-870	700-1050	700-880
Padre	1090-1280	1100-1200		
Puerco	810-1120	1010-1120	1080-1310	
Red Mesa	720-1230	880-1130	990-1290	
Snowflake	1010-1230	1100-1200	1080-1230	
Sosi	980-1290	1100-1190	810-1280	1080-1200
Reserve	930-1280	1070-1120	1010-1280	1030-1090
Tusayan	980-1290	1140-1290	960-1320	1090-1300
Walnut	910-1390	1090-1250	960-1280	1050-1200

Table 17. Associated tree-ring dates for polychrome types likely to be found in the Little Colorado inventory unit (after Breternitz 1966; dates rounded to the nearest decade)

TYPE	INDIGENOUS	BEST INDIGENOUS	TRADE	BEST TRADE
Cameron	1060-1140	1070-1140	920-1130	1120-1130
Cedar Creek	1230-1350	1300-1350	1200-1310	1270-1300
Cibicue	1320-1350	1340-1350		
Citadel	1050-1290	1120-1200	910-1280	1120-1200
Four Mile	1130-1390	1300-1390	1030-1390	1300-1390
Gila	1110-1390	1250-1390	1130-1390	1270-1390
Heshotauthla			1050-1610	1300-1400
Kayenta	1100-1500	1270-1290	1020-1280	
Kiet Siel	1100-1290	1250-1290	1070-1280	
Kinishba	1230-1310	1300-1310	1300-1350	1340-1350
Maverick	1200-1310	1270-1290		
Pinedale	1130-1350	1300-1350	1110-1350	1280-1300
St. Johns	1030-1310		960-1610	1200-1300
Show Low	1180-1380	1300-1380		

Table 18. Associated tree-ring dates for black-on-red, yellow, and orange types likely to be found in the Little Colorado inventory unit (after Breternitz 1966; dates rounded to the nearest decade)

TYPE	INDIGENOUS	BEST INDIGENOUS	TRADE	BEST TRADE
Abajo	610-870	760-880	610-1120	700-900
Deadmans	840-870	860-870	680-1110	780-1070
Gila			1130-1350	1300-1350
Jeddito	1260-1430	1300-1400	1030-1610	1300-1400
Klageto	1170-1280	1270-1280	1170-1280	1270-1280
Medicine	980-1220	1080-1130	910-1160	ca. 1100
Pinedale	1130-1350	1280-1350	960-1350	
St. Johns			1140-1390	
Tsegi	980-1290	1130-1290		
Tusayan	980-1290	1090-1290	810-1280	1050-1200
Show Low	ca. 1200		1110-1270	1030-1180

Note: These types represent only a small percentage of Black-on-red, orange, and yellow types known from the area. The majority of types are poorly dated.

Table 19. Chevelon chronology

TIME PERIOD	PREDOMINANT WARE
AD 1200-1275	80 percent or greater Cibola White Ware (PGM)
AD 1125-1200	Mixture of Cibola and Little Colorado White Ware
AD 1050-1125	80 percent or greater Little Colorado White Ware (SShO)
AD 800-1050	Predominance of Tusayan White Ware (PSO)
AD 500-800	Early Cibola and Tusayan Types (Lino, La Plata)
AD 300-500	Predominance of Plainwares (Mogollon Brownware, Alameda Brownware, Tusayan Gray Ware)

Note: For an explanation of the Chevelon "alphabetic" ceramic typology see the discussion in "Ceramic Technology."

focuses on the establishment of agriculture and large villages within the area, although he ultimately uses ceramics to date each of the phases. Plog (1974) modified the Longacre chronology for analyzing sites in the Hay Hollow Valley.

Between the ceramic and the developmental chronologies are a number that are explicitly neither, but draw on elements of each. Fundamentally, these efforts develop from Kidder's (1924) Pecos chronology. Kidder's chronology, which embodies more and shorter time periods and lacks the explicit developmental focus of Roberts', is shown in Table 22.

Modifications of the Pecos chronology began with the advent of tree-ring dating and a gradual increase in the number of localities to which archeologists attempted to apply the scheme. Gladwin's (1945) (see Table 23) was one of the first systematic efforts to use tree-rings in attempting to define a local sequence. While these dates were used to establish phase boundaries, architecture and ceramics continued to be the major criteria employed in defining the material culture of each phase.

Later efforts by Wasley (1960), Rinaldo (n.d.), and Gumerman and Skinner (1968) further diversify the specific temporal boundaries that were used to separate phases and the specific ceramic and architectual forms that are said to be associated with particular periods (see Tables 24 through 26). In the case of the Wasley and

Table 20. Robert's developmental chronology

PERIOD	DEFINING CHARACTERISTICS
Basketmaker AD 1-400	primitive corn and squash; slab-lined cists; atlatl wood houses over saucer shaped depressions
Modified Basketmaker AD 400-700	sedentary existence; new variety of corn; beans; slab-lined pithouses; plainware ceramics; occasional painted types; bow and arrow
Developmental Pueblo AD 700-1100	pithouses; jacal surface structures, occasionally adobe and/or slab-lined; small single story masonry pueblos; black-on-white ceramics; cranial deformation
Great Pueblo AD 1100-1300	large, multistoried masonry pueblos; great kivas; diversity of black-on-white pottery; corrugated pottery; black-on-red and polychrome pottery
Regressive Pueblo AD 1300-1520	large pueblos with plazas and great kivas; elaborate polychrome and other painted types

Table 21. Longacre's developmental chronology

PHASE	DEFINING CHARACTERISTICS
Incipient Agriculturalists AD 300-500	preceramic; corn, beans, squash; shallow pithouses with storage pits; 2-4 houses per settlement; basin metates; oval manos notched projectile points
Initial Sedentary Agriculturalists AD 500-700	deeper and larger pithouses; 1-5 houses per village; random layout of houses; random distribution of sites; Lino Gray, Alma Plain, Kana'a Neck-Banded, San Francisco Red, Alma Incised, Alma Neck-Banded
Established Village Farming AD 700-900	large deep pithouses; 5-15 houses per village; more settlements in more diverse locations; clusters of settlements; Alma Plain, San Francisco Red, Woodruff Smudged, Forestdale Smudged, White Mount Black-on-White, Kiatuthlanna Black-on-White, Red Mesa Black-on-White
Beginning of Planned Towns AD 900-1100	above ground non-contiguous rooms; true masonry pueblos later in phase; kivas; 8-15 rooms per settlement; clusters of settlements focused on sites with great kivas; Brown Textured, Reserve Black-on-White, Snowflake Black-on-White; Wingate Black-on-Red
Established Towns AD 1100-1300	large masonry pueblos with kivas; great kivas; larger but fewer sites along major drainages; 3 to 50 rooms per site; Brown Textured, Tularosa Black-on-White, Houck, Querino, and St. Johns Polychromes
Large Towns AD 1300-1500	large (50-100 room) settlements; fewer settlements; settlements restricted to major drainages; several kivas per site; plazas frequent; Pinedale, Four Mile, Heshotautha, Kwakina, and Kechipawan Pinnawa Glaze-on-White

Table 22. Kidder's Pecos chronology

PERIOD	DEFINING CHARACTERISTICS
Basketmaker I pre-200 BC	Pre-agricultural; pre-ceramic
Basketmaker II 200 BC-AD 400	agriculture; atlatl; pre-ceramic
Basketmaker III AD 400-700	pithouses; slab-houses; plainware; early Black-on-White
Pueblo I AD 700-900	cranial deformation; neck-corrugation; above-ground masonry rooms; Black-on-White pottery
Pueblo II AD 900-1100	villages, corrugated pottery; Black-on-White, Red pottery
Pueblo III AD 1100-1300	large communities; diversity of ceramic traditions; art
Pueblo IV AD 1300-1600	contraction of settlement; disappearance of corrugated pottery

Table 23. Gladwin's chronology

PHASE	DEFINING CHARACTERISTICS
White Mound AD 730-800	below-ground pithouses, surface jacal rooms; Lino Gray, White Mound Black-on-White, Polished Red Ware
Kiathuthlanna AD 800-870	major features added to pithouses; surface rooms; kivas; Kiatuthlanna Black-on-White, Lino Gray, Polished Red Ware neck-banding
Red Mesa AD 850-930	surface houses of adobe and wattle and daub; kivas; Red Mesa Black-on-White, indented corrugated
Wingate AD 930-1000	true masonry, multi-room surface structures; kivas; Gallup Black-on-White, Wingate Black-on-Red, gray indented corrugated

Wasley and Gumerman and Skinner schemes, it is unclear precisely what evidence was used in adjusting phase boundaries. Rinaldo gives no dates, but simply describes equivalents to the Pecos chronology. One element of the Wasley chronology deserving note is the effort to separate sites showing "Mogollon influence" from those that do not.

The majority of these chronologies, whether explicitly developmental or not, reflect an effort to define a linear sequence for the locality under investigation. The following patterns of change seem to underly basic understanding of the area: from aceramic to ceramic; from plainware to corrugated; from black-on-white to black-on red, yellow, orange to polychrome; from atlatl to bow and arrow; from simple shallow pithouses to large, deep, and complex ones; from the absence of kivas to their presence with the subsequent addition of great kivas; from simple jacal to complex masonry surface rooms; from small to large villages; from a random to a dense to a clustered settlement pattern, both within and between sites. While local variants of these sequences are clearly recognized, none of the efforts recognize a need for major revision of the fundamental aspects of the Kidder and Roberts efforts.

Linearity through time and homogeneity at any point in time (with the recognized need to identify outside "influences") have been the guiding principles of chronology-building in the area.

Admittedly, many of the early efforts involved careful attention to tree-ring dates in justifying or modifying particular local sequences. However, in the interim, a conviction seems to have grown among archeologists working in the area that there are sound chronometric data that sustain the overall patterns of technological succession on which the chronologies are built. It is essential, therefore, to turn to these data and then consider their relationship to the chronologies.

CHRONOMETRIC DATA

Four techniques have been used in obtaining absolute dates for sites in the study area; radiocarbon dating, tree-ring dating, archeomagnetic dating and obsidian hydration dating. Obsidian hydration dating has been applied exclusively in the western sector of the overview unit. Results to date (Findlow et al., 1975; Findlow and DeAtley 1978) are efforts to construct a curve for the area and have not yet provided meaningful determinations for sites not dated by other techniques. Archeomagnetic dates are available only for Hay Hollow Valley. Thus, the majority of the absolute dates are either tree-ring or radiocarbon dates. Available dates are listed in Tables 26 through 29. I do not believe that these lists are complete. The existing literature contains references to determinations that were made, the specific results of which are unreported. Similarly, there are, to my knowledge, more dates than have been reported in the published literature. Nevertheless, the determinations in these tables represent the vast majority of absolute dates available at present. A number of conclusions can be reached using these data.

In order to make statistically acceptable inferences about sites, a population of dates is required. One may take as a minimum roughly fifteen observations for any two populations (sites, areas) that are to be compared. Using this criterion, there are only 10 sites in the entire study area with a large enough population of dates. One of these sites is dated by radiocarbon, the remainder by tree-ring. Of these 10 sites the majority are either very early or very late.

Only two well-dated sites fall in the time period between about AD 800 and 1250. Of these, one is sufficiently complex that there is not a well dated room or deposit

Table 24. Wasley's "Highway 66" chronology

PHASE	DEFINING CHARACTERISTS
Lupton ?-600 AD	large shallow pithouses; slab-lined storage cists; Alma Plain, Lino Gray
La Plata AD 500-700	Lino Gray, early black-on-white
White Mound AD 700-800	deep pithouses with features (ventilators, benches, antechambers, etc.) White Mound Black-on-White, Lino Gray
Kiathuthlanna AD 800-900	Kana'a Gray, Kana'a Black-on-White, Kiathuthlanna Black-on-White
Red Mesa AD 900-1000	some masonry, but generally crude jacal walls; kivas; prepared floors; multi-room settlements; Red Mesa Black-on-White
Wingate Phase AD 1000-1100	masonry construction; linear, multi-room settlements; kivas; Wingate Black-on-Red

Table 25. Rinaldo's chronology

PHASE	DEFINING CHARACTERISTICS
Vernon Phase (Basketmaker II & III)	Alma Plain, Vernon Plain, Lino Gray, San Francisco Red, Reserve Smudged; Pithouse villages
Mineral Creek (Pueblo I)	Kiathuthlanna and Red Mesa Black-on-White, Alma and Vernon Plain, Reserve Plain Corrugated; pithouse villages, surface pueblos(?)
Pinyon (Pueblo II)	Snowflake, Reserve Black-on-White, Wingate Black-on-Red, Alma and Vernon Plain, Reserve Plain and Indented Corrugated, Gray Indented Corrugated; small surface houses, rectangular; coursed masonry
Montosa (Pueblo III)	Tularosa, Snowflake Black-on-White, Show Low Wingate Black-on-Red, Vernon Plain, Reserve Plain, Reserve Indented, and McDonald Corrugated medium size, course boulder masonry pueblos
Springerville	Polychromes, Wingate Black-on-Red, Tularosa Black-on-White, Reserve Plain and Indented Corrugated with more smudged interiors; large two or more story masonry pueblos

Table 26. Gumerman-Skinner chronology

PHASE	DEFINING CHARACTERISTICS
Black Creek AD 1-600	aceramic or Adamana Brown; large shallow pithouses
Basketmaker III AD 600-800	circular surface structures with prepared clay floors, brush superstructure; Lino Gray, Black-on-Gray
Pueblo I AD 800-900	circular to sub-rectangular pithouses with major features (entry ramps, benches, etc.); Kana'a Black-on-White, Brown and Gray Wares
Holbrook Phase AD 900-1100	shallow, rectangular pithouses with four-posts; clay and stone rectangular surface rooms; Holbrook Black-on-White
McDonald Phase AD 1100-1250	shallow rectangular and square deep pithouses; rectangular surface rooms in blocks; kivas; plazas; Holbrook, Walnut, Padre, and Leupp Black-on-White
Tuwiuca, Homolovi AD 1250-?	large villages around plazas; kivas; great kivas; black-on-red, yellow, orange and polychrome ceramics

Table 27. Dated sites from the Chevelon drainage (Estimated dates are AD unless otherwise indicated; radiocarbon dates are tree-ring corrected)

SITE NUMBER	ESTIMATED DATE	CHRONOMETRIC DETERMINATION
43	1200-1275	1160p-1219vv
		1163p-1240vv
58	1050-1125	410±150
68	1200-1275	1240±50
96	1200-1275	1485±50
141		910±90
185	1200-1275	1250±40
189	1050-1125	1125±50
193	Desert Culture	810 BC ± 170
316	500-800	660±50
343	1200-1275	640±260
345	1200-1275	1155±50
412	1125-1200	1104fp-1195vv
457	1200-1275	1420±170
450	800-1000	1555±170
462	1200-1275	915±180
470	1050-1125	870±175
		987p-1092+vv
503	1200-1275	1238p-1281+vv
516	1050-1125	1140±160
552	1125-1200	1325±120
553	500-800	1370±125
608	850-1000	810±130
634	1050-1125	1180±195
689	1125-1200	1112-1160vv
		1114fp-1192vv
	1200-1275	1187-1262vv
690	1125-1200	1110p-1198vv
729	1125-1200	1210±150
731	1125-1200	970±165
		1210±150
		1410±150
	1200-1275	1197-1274vv
734	1200-1275	1112p-1191vv
		1115p-1201vv
		1111p-1224vv
900	1200-1275	780±175
		1115fp-1239vv

Table 28. Dated Sites from Hay Hollow Valley (Dates are AD unless otherwise indicated; radiocarbon dates are tree-ring corrected)

SITE NUMBER, NAME	ESTIMATED DATE	CHRONOMETRIC DETERMINATION
Broken K	1175-1285	870±70; 1020±70; 1070±65; 1020±50; 1260±115; 1210±110; 1275±105; 1230±120; 1250±115; 1230±110; 1208p-1259vv
Carter Ranch	1100-1200	1071p-1118r; 1059p-1116c; 1043p-1130vv; 1026p-1142v; 1051-1156v; 1020±60; 1180±70; 1180±70
Connie	300-600	285±105; Archeomag.: 650±31; 690±24
County Rd.	Desert Culture	1300 BC ±75; 410 BC ±70; 40 BC ±95
Country Rd. Canal	1000-1300	1390±95
Hay Hollow	Desert Culture	23 radiocarbon dates ranging from 470 BC to AD 305
Hay Hollow Canal	1000-1300	1095±100 1355±105
Gurley	500-750	675±95; 615±145; 525±65; 1000±110; Tree-ring: 766?; 726?
Joint	1000-1300	48 tree-ring determinations ranging from 1188vv to 1255vv; strong cluster 1240-1250
Kuhn	200-700	1360±105 1520±95
Swannie	1200-1300	Archeomag.: 1185±37; 1185±41
Webb Tank	700-900	Archeomag.: 760±22; 670±49; 800±22
83	1100-1300	990±85
137	500-700	780±95
186	500-700	640±120
195	1000-1200	1215±85
196	1100-1300	745±90
199	600-750	990±140
201	1100-1200	1360±90
511	1200-1450	1030±80
530	600-700	260±100

Table 29. Dated Sites from the Houck-Lupton area (all dates are AD)

SITE	ESTIMATED DATE	CHRONOMETRIC DETERMINATION
Allentown	unknown	ca. 130 tree-ring dates ranging from 775vv to 1015vv; clusters ca. 850 and 950-1000
White Mound	730-800	28 tree-ring dates from 675r to 768v. cluster at ca. AD 730
Wide Ruin	unknown	ca. 260 dates 1119vv to 1282v; cluster at about AD 1276
NA 7295	500-700	6 tree-ring dates from 802-804
NA 7298	unknown	17 tree-ring dates from 532vv to 1123vv clusters at ca. 500 and 1123
NA 7299	500-1100	17 tree-ring dates from 990vv to 1119vv clusters ca. 990, 1010, 1116
NA 8038	900-1100	9 tree-ring dates from 914vv to 942v
NA 8039	900-1100	6 tree-ring dates from 1087vv to 1115r; cluster at ca. 1115

Table 30. Dated Sites from the remainder of the overview unit (Radiocarbon dates are tree-ring corrected; dates are AD unless otherwise indicated)

SITE NUMBER	ESTIMATED DATE	CHRONOMETRIC DETERMINATION
Beach Sites	Desert Culture	1300 BC ±60
Chilcott	900-1100	1170±80
Coyote Creek Pueblo	1150-1300	tree-ring dates cluster at 1174-1194; range from 1174-1280
Coyote Creek-3	unknown	7 tree-ring dates from 1012vv to 1119vv
Coyote Creek 3-11	unknown	9 tree-ring dates from 967vv to 1101vv
Four Mile	unknown	1143fp-1214vv
Hooper Ranch	1200-1375	1220±60 1380±65 1085±80
Mineral Creek	1000-1200	730±55 950±50
P:7:1	unknown	2 tree-ring dates 1195vv-1200vv
P:12:6	unknown	4 tree-ring dates 932vv-938vv

Table 30 (continued)

Pinedale	1100-1300	ca. 80 tree-ring dates ranging from 1068vv to 1378vv; cluster at 1275-1325vv
Rim Valley	1175-1275	1070±50
Show Low	14th century	500+ tree-ring dates from 1118vv to 1384vv cluster at 1335-1384vv
Table Rock	1300-1450	1335±55 1235-1346vv
Tumbleweed	300-500	223±50
CMNA#30	600-800	750±55; 860±55; 940±55; 14 tree-ring dates from 776vv to 822vv; cluster at 800-820

from it; once the overall dates are broken down by component, their number is inadequate. Thus, the existing determinations are satisfactory only for the purpose of drawing broad contrasts between the beginning (aceramic, plainware, pithouse) and end (large pueblo, polychrome) of the sequence. The majority of sites date between these extremes and cannot be represented by well-dated sites at present.

Some of the sites were dated using ceramic seriation or other techniques prior to absolute determinations and others were not. In the case of those sites that were dated using other criteria (see Tables 22 through 25), the probability is about .70 that the absolute date falls within the range established on the basis of architecture/artifacts. This figure is far too low to support the argument that existing typologies are adequate for dating sites. Moreover, the figure would be far lower were it not for the 150 to 200 year range used in approximating dates on the basis of artifactual criteria. Generally, when sites are dated to a period of 100 years or less, the probability is very high that absolute determinations will fail to fall within the accepted range.

Even if one takes what are supposed to be relatively clear temporal manifestations such as aceramic pithouse villages or large late sites, the range of dates is high. Aceramic pithouse villages date from 400 BC to about AD 300. This figure would be far higher were it not for the fact that some investigators have rejected radiocarbon determinations for such sites on the ground that they were "too late." Large late sites could be as early as AD 1100 and as late as AD 1400. In two areas (Chevelon Drainage, Hay Hollow Valley) there are plainware pithouse villages that date to this same time period.

In summary, there are currently absolute dates for far fewer than 1% of the sites in the study area. These dates suggest a far more complex pattern of distribution of both architecture and artifacts than linear chronologies allow. While it is possible that more dates would support the efficacy of these chronologies, existing dates do not. These dates suggest a very uneven distribution of people over the study area at any one time and that the material items possessed by contemporaneous peoples was highly diverse.

CHRONOLOGIES AGAIN

That absolute dates fail to support the chronology that has been used in the overview area should not be a surprise. In fact, if one carefully scrutinizes the chronologies themselves their inadequacies are obvious. Take Breternitz's (1966) tree-ring dated ceramic types, the most specific of the chronologies, as an example. If one studies the dates in Tables 9 through 13, a number of conclusions are evident. First, for the majority of types the span of time assigned is so long that it is of limited utility for dating purposes. Second, there are substantial conflicts between the "indigenous" and "trade" dates for a large number of types. Finally, there were time periods when only a few types were present and others when many were present. Table 26 illustrates this problem for the case of Black-on-white types. Prior to AD 800, most ceramic types were of such longevity that their occurence on a site specifies very little. After AD 800, the longevity of types decreases dramatically. What is not evident in the table is that after this time period the spatial area over which the types occur also decreases dramatically. Thus, the distributions of types are highly uneven temporal indicators.

Given these problems with absolute dates, it is best to consider the chronologies in a very much broader frame. If one asks what characteristics are common to them, other than the linear succession of technologies noted earlier, a number of conclusions can be reached. First, some time around the time of Christ, some populations in the study area began to make and use ceramic artifacts. Yet, from the time of Christ until about AD 700 there is little that is definitive about the artifactual inventories in the area; few temporal boundaries are agreed upon. Most chronologies do, however, note a break at about AD 700. From this date until AD 900 many breaks are noted suggesting that this period was one during which a great diversity of changes in technological behavior and organization were occurring. Subsequently, most of the chronologies seem to agree on breaks at about AD 1100 and AD 1300, the former corresponding to the advent of large masonry pueblos and the latter to a period of abandonment or greatly decreased population. Yet, to take even these dates as watersheds applicable to the majority of peoples living in the area would be a mistake. At this point, one can only note the need for far more sophisticated chronometric studies.

Table 31. Black-on-White types present at fifty-year time intervals. Dates are "best" dates from Breternitz (1966)

DATE (AD)	TYPES
600	Chapin, Lino, La Plata
650	Chapin, Lino, La Plata
700	Chapin, Lino, La Plata
750	Chapin, Kana'a, Lino, La Plata
800	Chapin, Kana'a, Lino, La Plata
850	Kiatuthlanna, Lino, La Plata, Piedra
900	Kiatuthlanna, Piedra, Red Mesa
950	Escavada, Red Mesa
1000	Escavada, Gallup, Red Mesa
1050	Chaco, Escavada, Gallup, Mesa Verde, Puerco, Red Mesa
1100	Black Mesa, Chaco, Escavada, Gallup, Holbrook, McElmo, Mancos, Mesa Verde, Padre, Puerco, Red Mesa, Snowflake, Sosi, Reserve, Walnut
1150	Black Mesa, Dogozhi, Flagstaff, McElmo, Mancos, Mesa Verde, Padre, Snowflake, Sosi, Tusayan, Walnut
1200	Dogozhi, Flagstaff, Kayenta, McElmo, Mesa Verde, Padre, Snowflake, Tusayan, Walnut
1250	Flagstaff, Kayenta, McElmo, Mesa Verde, Tusayan, Walnut
1300	None

EVOLUTIONARY PATTERNS

The discussion to this point has been heavily particularistic. Detail was necessary in order to convey a sense of the specific items of information we now possess, major hypotheses that have been tested, and alternative methodologies that have been employed. Now the focus shifts to a summary of some of the broader patterns of organization and change that were characteristic of the overview unit prehistorically. The discussion is far more speculative, and yet it remains a summary of what I think we know. Analytical strategies that will improve our understanding of the region's prehistory are considered in later sections. In this one, demography, productive strategies, and organizational strategies are considered.

DEMOGRAPHY

With the possible exception of the Black Mesa area, no region of the Southwest has seen a more extensive set of demographic analyses than the Little Colorado overview unit. While the results of these efforts are by no means perfect, they do suggest significant patterns of variation both through time and from locality to locality within the study area.

Longacre's (1976) was the first effort to describe the pattern of population growth for the study area. He used survey information for the Upper Little Colorado area that he had collected along with Rinaldo. His reconstruction is a plot of change in the number of sites and the mean number of rooms per phase, using his own phase system as described earlier. He concluded that population in the Upper Little Colorado area began to increase somewhere between AD 500 and 700. A peak was reached between about AD 1200 and 1300, with population declining to zero during the next 200 years.

Plog (1974) focused specifically on the demographic record for Hay Hollow Valley. He used room counts per 50-year period, modifying the observed room numbers to take into account the probability of site occupation and changing ratio of habitation to storage rooms. He found evidence of an initial period of population increase peaking at about AD 450, after which population declined. A second episode of increase began at around AD 700, peaking at about AD 1150. This peak was followed by the rapid abandonment of the Valley. Differences between Plog's and Longacre's reconstructions reflect both the specific local conditions of the valley, where more early sites seem to occur, and differences in dating.

Zubrow (1975) reanalyzed the Hay Hollow data using the total number of habitation rooms. His reconstruction more closely approximates that of Longacre, lacking the early epoch of increase noted by Plog. Zubrow's methodological discussion is sketchy and it is impossible to resolve the differences between his reconstruction and Plog's. F. Plog (1975a) subsequently constructed population records for the Purcell Larson area showing a generally similar pattern to those of Longacre and Zubrow. Lightfoot (1978d) has discussed the pattern of population growth in the vicinity of Springerville. Basically, human occupation of this area appears to be late, no earlier than about AD 1050-1100. The local increase is rapid with a few groups remaining in the area until the fourteenth century.

Orcutt (Cauthen 1972, Orcutt 1974) reworked the Hay Hollow Valley, Purcell-Larson and Chevelon data in an effort to identify some of the methodological problems associated with population reconstructions. Using Hay Hollow data, she demonstrated that, if one assumed that sites grew slowly and declined rapidly (as opposed to the even growth rates assumed by F. Plog 1974), a substantially different curve was generated. Prior to about AD 900, her reconstruction is characterized by a series of short fluctuations. After this date, the epoch of growth and decline she describes is more rapid than that noted by Plog. Her analysis also showed that there are separable elements of the growth process that result from increased numbers of sites and increased site size. The major growth epoch is associated with an increase in site size and may, thus, represent change in organization or length of site occupation rather than increased numbers of humans.

Orcutt has also attempted population reconstructions based upon a diversity of different indicators: number of sites, site size, number of rooms, aggregate floor area, artifact density, and total number of artifacts. While she found that the curves generated using these different data bases are highly correlated, there are enough differences to cause substantial concern. Of particular interest is a far greater than expected increase in artifact densities and counts toward the end of the sequence, which may again suggest organizational change or change in the length of site occupation. Orcutt's final (1974) study includes an insightful summary of methodological difficulties that must be overcome if our reconstructions are ever to attain a desirable level a reliability.

While all of the reconstructions just mentioned are speculative, they suggest a number of conclusions concerning change in human numbers through time. First, there is little indication of other than episodic utilization of the study area until about the time of Christ. Second, there may have been a population increase culminating at about AD 450. Third, all lines of evidence suggest a major increase in population between about AD 900 and 1150. Fourth, further analysis is required to be certain that this last increase is the product of a real increase in human numbers rather than organizational change or change in the average length of site occupation.

Spatial variation through the study area is much less well understood. It is evident, however, that drastic differences in the time at which population peaks occurred in particular areas. To date, there has been only one attempt to understand the spatial dynamic of changing human numbers, that of Slatter.

Slatter (1973, 1979) has assessed the relationship between climatic variation and population shifts in the overview unit. Using dendroclimatological records, he noted: (1) years in which tree-ring width (inferentially, rainfall) was more than one standard deviation below normal, (2) sets of 3 years in which tree-ring width was more than one standard deviation below normal (since the 1 to 2 year surplus produced by modern Western Pueblos would have been exhausted during this period), and (3) sequences of drought lasting several decades. This record was then compared with variation in room counts through time for (a) the Chevelon drainage and (b) the Purcell-Larson locality within it. A strong negative correlation between population and rainfall occurred for the drainage, while that for the locality was strongly positive.

Slatter sought to resolve this problem by assessing the possibility that the environmental characteristics of the locality were different from those of the drainage as a whole. He noted variation in the amount of land with a slope of less than 8%, land profile, relief, and elevation throughout the drainage. A cluster program was then used to define five different landform types, four of which were judged to be marginal for farming when precipitation, temperature, and local soil alkalinity were investigated. The area with the best growing conditions was determined to be that in which the Purcell Larson locality occurred.

Reanalyzing the data, he found that the positive correlation between rainfall and population in the Purcell Larson area was a product of a tendency for prehistoric peoples to leave more marginal areas and move into this area during drought periods. Slatter also notes that the overall magnitude of population movement/displacement was a reflection of the total number of droughts and dry years during a period of several decades and that the end of the occupation of the drainage was a period during which both three year droughts and dry years were especially frequent. Subsequently, Slatter extends his analysis to other areas of the Southwest where high quality survey data are available and showed that similar patterns occur there. In general, his results are very close to those of Euler et al., (1979).

Providing a specific definition of a "marginal" as opposed to a "non-marginal" area is, of course, a problem. Zubrow (1975) undertook an exhaustive analysis of the carrying capacity of microhabitats in Hay Hollow Valley and was able to demonstrate major differences. However, the zones that he studied lie in such close proximity to one other that all would have been easily reached by the inhabitants of the vast majority of sites. I suggest that the juniper-pinyon woodland probably represented the optimal habitat prehistorically. In respect to agriculture, the best balance of temperature and precipitation occur at elevations where the woodland predominates. In respect to hunting-gathering, this biome contains most of the resources of adjacent ones in addition to its own unique resources. Nevertheless, there is substantial variation in the extent to which this habitat was used both spatially and temporally. Similarly, there are areas well outside of the current, and any reasonable prehistoric, limits for the woodland zone. Since the majority of intensive surveys to date have been done in woodland areas, the pattern of distribution of population may differ in significant ways from what appears to be the case at present.

No analysis undertaken for the overview unit has utilized any sophisticated strategy for separating the effects of natural population increase from those of migration. Interpreting the overall demographic history of the area will be impossible until such studies are undertaken. Similarly, there has been no effort to test major hypotheses dealing with variation in human numbers either spatially or temporally. Such efforts will need to take a number of factors under consideration. First, the initial distribution of human occupation of the area probably had an effect on the distributions for the next several centuries. That is, given that the evidence of early occupation is not even throughout the study area, one might anticipate growth from a number of early nodes. Second, the effect of increased sedentism on population distributions requires investigation. If the growing population of the area is a product of an increased birth rate rather than migration, evidence of increased sedentism and its correlation with increasing numbers of humans becomes critical. Also, there appears to be a correlation between the major epoch of population increase in the area and intensified agricultural practices. While the ability of intensified practices to succeed in the long run in the overview unit is dubious, short term success in resource production may have fueled population increases. Finally, it is not beyond the realm of possibility that the population of the study area was relatively stable after about AD 700. The apparent increases may simply reflect the movement of people in and out of marginal and nonmarginal environments and changes in site size and site organization.

PRODUCTIVE PROCESSES

Probably because so much of the emphasis on research in the Southwest during this century has been on excavation, much existing intepretation tends to emphasize the autonomy of individual settlements. This perspective is one that had been subject to increasing question in recent years. The contrasting viewpoints are perhaps most evident in the works of Leone (1968) and S. Plog (1980b).

Leone's dissertation was an analysis of the relationship between economic and social autonomy. His basic assumption was that the adoption of agricultural subsistence strategies provided local peoples with a means of achieving independence at the level of individual villages or settlements. His effort is intended to demonstrate, using ceramic styles, that increasing social autonomy accompanied this productive change. That either agriculture or ceramic production might have been handled by other than autonomous units is simply not considered.

S. Plog has focused on patterns of ceramic production within the Plateau Southwest in considering the question of autonomy. He basically questions the notion of autonomy, suggesting that the preponderance of evidence supports a pattern of ceramic production in a few loci with subsequent widespread exchange of the craft product.

In retrospect, there is little about either the environment or the probable demographic patterns in the study area that lend credence to a notion of autonomy. The major characteristic of the environment is extreme spatial and temporal variation in the distribution of all resources and in climate. Similarly, population densities in the area were low. Following Wobst's discussion of "minimum equilibrium size," the smallest groups necessary for a population to reproduce itself, interaction among widely dispersed peoples would have been necessary to ensure survival. Thus, whether one is considering the exchange of mates, exchange of resources, exchange of information concerning the availability of resources, or the exchange of finished goods, available evidence increasingly supports the conclusion that autonomy within the study area was quite limited. The reasons for making this claim will be clarified by reviewing aspects of our current understanding of a variety of productive alternatives.

The initial occupants of the study area, during the PaleoIndian, Desert Culture, and Basketmaker periods were almost certainly either nomadic or semi-sedentary. It is tempting to view the subsistence strategy of such groups as one that requires little intergroup contact. Such a conclusion might be correct in a highly equable environment with an even spatial and seasonal distribution of resources. However, in an environment such as that of the study areas with marked temporal and spatial variation in resource availability, autonomy at the family level would be close to suicidial. A network for monitoring information on the availability of resources within particular localities would have been essential. If group size was small, interfamilial contacts would also have been essential in order to maintain a viable human breeding pool. Hoffman's (1974) analysis suggests that quite discrete resource sets would have been available given the particular environmental conditions of adjacent summers and winters. This observation only strengthens the suggestion that successful groups in the area probably managed on the basis of a substantial exchange network. In this sense, the absence of autonomy was essential to survival.

The notion that agricultural subsistence strategies would have increased the extent of autonomy is essentially derived from Leone's (1968) study. His reasoning stems from the common sense notion that people could have planted resources in immediate proximity to their domiciles rendering them at least somewhat more autonomous. Such an argument fails, however, to take into consideration the likelihood that the crops in any given field would have produced a harvest during a particular growing season. Given the substantial evidence of differential distributions of temperature and rainfall conditions developed earlier, the likelihood of all fields producing in all years, or even most fields in most years, was minimal. The adoption of intensified productive strategies (irrigation, terracing, and gridding) would have accentuated the problem. While these strategies improve soil and increase the precipitation "harvest," they also increase the dependence of local peoples on a favorable climate at a highly specific location.

Furthermore, more intensive strategies also require the allocation of labor and water and soil situations among competing groups which decreases the extent of autonomy. In summary, a successful agriculturalist in the study area would have had a considerable interest in the maintenance of at least reciprocal ties with nearby groups to ensure a backup in years when local crops failed. Similarly, during the period when agriculture was a common strategy, population densities were still not sufficiently high to decrease dependence on a sizeable inter-community network in order to ensure a viable population of mates.

The discussion of the availability of fuel and fuel needs in an earlier section suggests another basis for questioning the autonomy of local groups. After the time of Christ, it appears likely that the inhabitants of the larger sites would have had fuel needs that would have impinged on those of surrounding groups. After about AD 900, population density is sufficiently high that a widespread problem with fuel is possible. It seems probable that exchange relationships sufficient to distribute available resources existed in many areas after this time.

A number of different lines of evidence bearing on the production of craft goods have been or will be developed. Even in the case of a resource as simple as lithic raw materials, no compelling case can be made for local independence. The majority of raw materials used by peoples in the study area were locally available, and there is no time period during which materials that would have required transport from distant sources are not also in evidence.

While obsidian is the foremost instance of such a resource, petrified wood and basalt are others. Certainly, one cannot argue that such resources were essential, that the viability of local groups would have failed without them. However, the very fact that evidence of such widespread exchange exists shows a substantial commitment to obtaining "preferred" raw materials even if these came from distant sources.

Local specialization in the production of craft goods is suggested by evidence from Broken K (Longacre 1964) and Coyote Creek Pueblos (DeGarmo 1975). However, the most compelling information is that generated by petrographic and other detailed analyses of ceramic artifacts. If, as has been typically assumed, ceramic artifacts were being produced in every, or even the majority of, contemporaneous settlements, one would expect at least a normal distribution (and more likely a highly disparate distribution) of technological characteristics. Recent analyses suggest the opposite; many ceramic types are sufficiently homogenous in their technological characteristics that only one or two productive centers are suggested. For the majority of types, no more than a few production centers are suggested.

The alternative is to believe in a highly regular and rigid system of communication and enforcement that standardized the product of the discrete producers living in individual villages. Such an assumption is unreasonable as it requires postulating an even higher degree of organization than its alternative. Certainly much remains to be known of the number and location of such centers. However, it is no longer reasonable to believe in village level ceramic production; the issue is one of learning more about the productive centers.

Certainly, I do not intend to espouse the notion that the inhabitants of the study area were, in any sense, full time craft or productive specialists. Available evidence does not suggest a pattern on the level of those of state organized societies. However, the existence of some degree of specialization resulting in a substantial degree of interdependence between inhabitants of different sites and localities now seems clear. Further, it is not beyond the realm of possibility that specialization was far more pronounced than available evidence suggests. Our poorest evidence of specialization pertains to food resources. And, given the great environmental diversity of the study area, it is in respect to these resources that it is easiest to imagine significant differences in the productive foci of different settlements and localities.

ORGANIZATIONAL PATTERNS

None of the preceding should be construed as an argument for large and complex organizational entities in the prehistoric Southwest generally or in the overview unit specifically. While I believe it is likely that such organizations did exist at some times and in some places, my intent has been to express the need to look beyond narrow notions of village autonomy and to consider the multiple levels of organization in which prehistoric individuals participated. Varying degrees of independence and interdependence existed at each such level.

It would be pointless to even consider the possibility that the household was not an important organizational entity in the study area since households are organizationally significant in virtually every area of the world. Moreover, the fact that site size in the area approximates two or three rooms on the average suggests that the household may have been the very most typical residential unit at most times and in most places in the study area. Meals and the acquisition of basic local raw materials, were likely the exclusive domain of households. Productive activities were less likely so, although some simple stone tool items (chipped stone artifacts, for example) were likely household products. Similarly, some specialized products may have been made in specialized households. Nevertheless, it would be, on balance, a mistake to see the household as a self-sufficient unit.

Sites or settlements are a second level of organization. As noted above, most sites in the overview area are sufficiently small that they most probably were the abode of a nuclear or extended household. However, at all periods there appear to have been sites that were larger, possible central places in regional or local settlement systems.

Of particular importance is the observation that at any time period even the largest of sites in the study area were quite diverse in respect to their spatial organization. Large pithouse villages are an example for which one may define a number of discrete settlement types. Gladwin's excavations at White Mound produced a description of one such type (1945). White Mound style villages are composed of three or more pithouses and sometimes a kiva surrounded by an arc of surface rooms. A village may consist of one or several such "cells." White Mound style villages occur from the very northern edge of the overview unit to within a few miles of the Mogollon Rim, and from the far eastern to the far western edge. Kiatuthlanna, White Mound, and Kana'a Black-on-white are typical in the painted ceramic inventory.

Adamana style villages typically lack painted ceramics but may be contemporaneous with White Mound ones. The Connie Site (Thompson and Longacre 1972) is an example. The site consists of 35 pithouses, 11 "smaller structures," 1 probable kiva, and 6 features, all bounded by a cobble wall. Crudely made brownwares (probably Adamana Brown) are typical of such sites in the study area. With archeomagnetic dates of AD 650 and 690, this site and others of its type would appear to be contemporaneous with White Mound style villages. While they do not appear to occur in the westernmost sector of the overview unit, they occur periodically in the northern and eastern portions.

Along these at least relatively formally arrayed villages are others with an incredible diversity of house types including combinations of above and below ground houses, circular and rectangular houses, etc. While these are in part contemporaneous with White Mound and Adamana villages, the possibility of episodic habitation is a clear one.

No effort is made here to offer an explanation for this diversity. The grounds for arguing that it is either exclusively spatial or temporal are weak. Thus, the possibility exists of some overarching pattern that unites sites in different segments of the study area. A similar problem exists in the case of pueblo architecture, although this variation is far more extensively described in the existing literature. Some pueblos have plazas, others do not. Some pueblos have great kivas, others do not. Some pueblos are compact and cellular, while others are linear or even circular. Examples of these different layouts can be found at a great diversity of times and places. A further problem in defining unitary architectural patterns is increasingly clear evidence of pithouse villages, at least some of which are sizeable ones, that are contemporaneous with the pueblos.

It is not currently possible to claim that the inhabitants of villages with similar layouts participated in important pan-regional organizational systems. It is however, interesting that both White Mound and Adamana style villages seem to share similar ceramic inventories. One wonders if the same might not prove true for pueblos were they considered from this perspective. An alternative interpretation is one that pertains to intra-village organization; sites have similar layout because their inhabitants had similar, but not necessarily linked, organizational patterns. Differential access of household groups to storage and ceremonial space appears to be evident in the arrangement of kivas and storage rooms with respect to habitation units. However, no exhaustive study that would clarify the extent of diversity exists at this point.

Even the change from pithouse to pueblo architecture has not been explicitly considered from an organizational perspective beyond some fairly obvious suggestions (cf. Plog 1974, Martin and Plog 1973). Yet, there are clear consequences of such change. First, in general, pithouses seem a far more adaptive living environment for much of the study area since it would have been possible to maintain a far more even temperature in these below-ground edifices at all seasons of the year. Thus, there must have been some important functional or sociological reason for shifting from the predominate use of one form to the other. And yet, the competing explanations are polar opposites. For example, one can note that the construction of a pithouse can be undertaken independent of the construction of other ones--they are discrete construction units. With pueblos, independence becomes more difficult since walls are built off of and, in some cases, support one another. Thus, the shift could be a counterpart of a change to a more tightly coordinated labor regime.

At the same time, the wooden construction materials required for pithouses are generally heavier and bulkier than those needed for erecting a masonry structure. Also, since an excavated pit can be badly damaged by rain, there may have been a greater need to construct pithouses within a short period. Given these last arguments, labor coordination may have been more of an imperative than constructing a masonry room which conceivably could have been done bit-by-bit over a long period. Thus, this architectural shift which can clearly offer major organizational clues, remains an enigma.

Given all of this diversity, the point seems clear that there were large central sites in the study area. The precise role that these played in regional and local organizational systems remains to be specified. However, economic and political control seem likely possibilities.

Even in those times and places where large central sites were not common, there is good evidence for the existence of multi-site communities. In an earlier chapter, the reasons why multi-site communities linking peoples in diverse environmental zones would have made sense in the face of the environmental diversity of the study area were discussed. Distributions of ceramic and chipped stone artifacts lend credence to the possibile existence of such communities. That one can define communities with distinctive inventories of chipped stone raw materials is not a surprise since such a pattern might simply reflect local availability. That there should be commonalities in the imported raw materials does not sustain a propinquity argument, however. Similarly, the localities, or at least zones defined by the distribution of similar corrugated and black-on-white technologies, correspond reasonably well with localities defined by the use different chipped stone raw materials. Such a pattern suggests that the groups inhabiting such localities were cooperating in the procurement or production of a diversity of materials.

Undoubtedly, exchange was also an important component of such systems. Specific evidence of exchange was noted earlier. Similarly, there are likely caloric limits on the distance (ca. 30 kilometers; Lightfoot 1979) over which foodstuffs would have been exchanged. The range and magnitude of exchange that existed prehistorically within the area remains to be understood as does the manner in which it was organized.

Another concern for the study area is the distribution of material items associated with different of the classic culture areas described for the Colorado Plateau. If one equates Mogollon with Mogollon Brownwares, Sinagua with Alameda Brownwares, and Anasazi with Tusayan Graywares, then there are discrete sectors of the study area associated with each, although there is also considerable overlap. Basically, graywares are more common to the north, Mogollon Brownwares to the east and Alameda Brownwares to the west. At the same time, these ceramic distributions appear to be cross cut by highly varied architectural patterns. Whether the ceramic distributions represent any actual organizational entity seems problematical. At present it is more reasonable to regard them as commonalities that result from sharing among proximate local groups and in the distribution of craft products from centers.

Finally, there is suggestive evidence of exchange with far distant peoples. Plog, Upham, and Weigand (in press) have summarized the evidence for exchange between inhabitants of the plateau and mountainous areas and MesoAmerican groups. While it is unreasonable to view such exchange as the product of some singular organizational device, e.g., pochteca, it is now equally unreasonable to reject the growing evidence that spatially and temporally varied exchanges did occur.

On balance, much of the locational literature is suggestive of the maximum common level of organization in the area. Where locational studies have been done, the statistics suggest a pattern of dispersed site clusters (Upham 1980). These clusters are likely to have been the most important of the organizational levels above the household. I do not intend to deny the possible existence of major organizational centers. However, I suspect that such centers were highly episodic in space and time relative to enduring local site clusters. A variety of more abstract theoretical propositions which, given further research, may further inform some of these tentative conclusions are discussed in a subsequent chapter.

FUTURE RESEARCH

Understanding of the early prehistory of the overview unit is hampered substantially by a paucity of pertinent information. Evidence of PaleoIndian peoples is minimal and ephemeral. PaleoIndian sites are such "rare events" or occurrences that designing a survey strategy specifically for the purpose of locating them would be virtually impossible. Virtually the only meaningful strategy that one might pursue would be survey in areas of high erosion.

Although they are somewhat more abundant, the same problem exists in the case of Desert Culture sites. However, survey and ancillary studies specifically for the purpose of understanding this class of sites can be specified in somewhat greater detail. Although they have been heavily impacted by pothunting, rockshelters and caves in the western quarter of the overview area may still contain Desert Culture remains. Management, pending scientific use of the resource, is a high priority for these sites. Of particular importance are emphases on floral, faunal, and chronometric samples that seem to be abundant in such sites.

Open air Desert Culture sites may be a more common occurrence. This conclusion must remain tentative, however, until more satisfactory criteria for separating aceramic from preceramic sites are identified. If a large percentage of aceramic sites and aceramic low density artifact scatters prove to be Desert Culture sites, then these sites can be treated as a routine occurrence in most surveys in the area. The preservation of floral, faunal, and chronometric specimens in such sites is generally problematical. For the time being, the most profitable studies will focus on the provision of a clear criterion for specifying Desert Culture chipped stone tool inventories.

Varying somewhat from locality to locality, the abundance of sites is high from the centuries after the time of Christ. Generally, there is no difficulty in anticipating that sites of most time periods will be located in most large scale survey efforts. The principal problem in working with the chronology for these sites is the problematical manner in which chronometric specimens have been obtained. There is no question that sufficient determinations have been made to evaluate at least some chronological hypotheses in some areas. However, when the number of such determinations ranges from one to five hundred per site and the average site has less than a half dozen determinations, testing chronological hypotheses is an impossibility.

In recent years, it has also been common to submit samples for dating before analyses of other chronological data was complete. Since dating is invariably expensive, this strategy is not a judicious one. Effort should be spent in carefully framing a number of competing chronological schemes for the study area and localities within it. Samples can then be obtained from sites and components or strata within sites that are pertinent to testing at least one or two aspects of the pertinent propositions. Further development of archeomagnetic and obsidian hydration dating, since these strategies are less expensive, would also greatly increase our control of chronology.

Undoubtedly, archeologists working in the area will continue to use artifactual cross-dating. It is incumbent on such investigators to recognize the very preliminary state of existing ceramic chronologies. Unless great effort be spent in improving these, the boundary between fiction and fact will remain unknown for the overview area.

CERAMIC TECHNOLOGY

INTRODUCTION

Ceramic artifacts have been the major focus of analysis within the overview unit. Yet, current understanding of variation in ceramic technology is confused. The confusion is a result of analyses that have used drastically different typological systems and with relative insensitivity to consistency. Nevertheless, the analyses that have generated the confusion have created a depth of understanding of specific issues that is unequalled elsewhere in the world.

The most widely used typological system in the area has been that developed by Colton (1955a, b; 1956; 1958) and others working with him at the Museum of Northern Arizona. This system is based upon a set of roughly three dozen attributes. Types of that system that are commonly found in the overview area are as follows:

Tusayan Gray Ware
- Lino Gray
- Lino Black-on-Gray
- Kana'a Gray
- Coconino Gray
- Tusayan Corrugated
- Moenkopi Corrugated

Tusayan White Ware
- Kana'a Black-on-White
- Black Mesa Black-on-White
- Sosi Black-on-White
- Dogozhi Black-on-White
- Shato Black-on-White
- Tusayan Black-on-White
- Kayenta Black-on-White

Little Colorado Gray Ware
- Little Colorado Corrugated

Little Colorado White Ware
- Holbrook Black-on-White A,B
- Padre Black-on-White
- Chevelon Black-on-White
- Pinedale Black-on-White
- Walnut Black-on-White
- Leupp Black-on-White

Tsegi Orange Wares
- Tusayan Black-on-Red
- Tusayan Polychrome
- Kayenta Polychrome
- Jeddito Black-on-Orange
- Jeddito Polychrome
- Klageto Black-on-Yellow
- Klageto Polychrome
- Kin Tiel Black-on-Orange
- Kin Tiel Polychrome

Homolovi Orange Ware
- Homolovi Corrugated
- Homolovi Plain

Winslow Orange Ware
- Tuwiuca Orange
- Tuwiuca Black-on-Orange
- Homolovi Polychrome
- Chavez Pass Black-on-Red
- Chavez Pass Polychrome
- Black Axe Plain
- Homolovi Black-on-Red
- Black Axe Polychrome

Jeddito Yellow Ware
- Jeddito Black-On-Yellow

Alameda Brown Ware
- Rio de Flag Brown
- Angell Brown
- Sunset Red
- Kinnikinnick Brown
- Chavez Brown
- Grapevine Brown
- Tonto Red (Brown)
- Verde Red (Brown)

Cibola White Ware
- White Mound Black-on-White
- Kiathuthlanna Black-on-White
- Red Mesa Black-on-White
- Puerco Black-on-White
- Gallup Black-on-White
- Excavada Black-on-White
- Reserve Black-on-White
- Tularosa Black-on-White
- Snowflake Black-on-White
- Pinedale Black-on-White

Mogollon Brown Wares
- Alma Plain
- San Francisco Red
- Various Corrugated Types

White Mountain Red Wares
- Wingate Black-on-Red
- Puerco Black-on-Red
- Querino Black-on-Red
- St. Johns Polychrome
- Springerville Polychrome
- Show Low Polychrome
- Four Mile Polychrome
- Pinedale Polychrome

In general, differences in temper, surface treatment, and type of paint are the key attributes for defining painted wares. The typological differences within the wares are generally stylistic. The strength of this system is that it is based upon a set of attributes that are sensitive to the manner in which prehistoric potters would have manufactured a vessel. Also, it was developed under the auspices of a single individual and, therefore, the definitional consistency is substantial, if not absolute.

There are two weaknesses in Colton's system. Many of the attributes used to define a type are irrelevant for distinguishing different types. Also, definitions for some of the most common types in the overview area were never written because Colton had less familiarity with the ceramics of this area than of areas closer to Flagstaff. Detailed criticism of the approach is made in Hantman, et al., (in press). Major wares and types are shown in Figures 7 through 17.

Another typology is that used by the Chevelon Archeological Research Project between 1971 and 1978. This typology was developed explicitly to remedy some of the difficulties with the Colton approach. It is most basically a ware level system that is based upon readily observable temper, surface treatment and paint characteristics. This system and the manner in which its categories equate with those of the Colton system are shown in Table 32.

The strength of this system is that it is based only on attributes that are in fact necessary to distinguish between the categories. The pertinent attribute states form the name of the class. In one respect, the typology is also more consistent than Colton's; it defines differences within Cibola White Ware that are at least as great as the differences Colton used to separate the other major wares. The weakness of the typology is that it does not incorporate any attributes reflecting stylistic variation. As a result, stylistic information is lost.

One of the results of the intensive use of these systems in the area is a growing recognition of the problems that arise from the use of a typology that incorporates both style and technology into a single system. Implicitly, there is no reason to assume that style of decoration and technique of manufacture either reflect the same cultural processes or vary at the same rates.

Efforts to resolve conflicting aspects of the association of stylistic and technological attributes probably underlie the inconsistencies that have been identified in descriptions of ceramic variation in the area (Swarthout and Dulaney in press; Fish 1978; Hantman et al., in press; Sullivan in press). It is for this reason that Hantman, et al., (in press) and implicitly Sullivan (in press), advocate the use of discrete typologies for analyses of ceramic variation. This is not to argue that the existing typologies are not useful for ballpark communications about the nature of the ceramic materials that are the focus of a particular study. It does argue that most detailed inferences concerning prehistoric human behavior will require typologies that are sensitive to variation in each domain independently. For this reason, the following discussion focuses separately on style and technology.

STYLE

Most of the studies of variation in ceramic design style have dealt with painted ceramics. These will be considered first. S. Plog (1976) provides a thorough discussion of the terms that have been used to describe variation, the approaches that have been used in the study area, and the problems that have arisen in particular approaches. He also summarizes a number of different approaches that have been used within the study area.

The earliest studies of stylistic variation presumed a typological system. Typical elements, motifs, and even "styles" were described for the major painted wares by Colton and others. While there are many comments on particular styles and their spatial and temporal distributions in the site reports of the study area, the earliest systematic effort to explicitly deal with style was Wasley's (1959) discussion of stylistic trends in Southwestern prehistory. He argued that one might best view the different major styles as horizon markers. Wasley's work was apparently discredited by Breternitz's study of the association between particular ceramic types and tree-ring dates (1966).

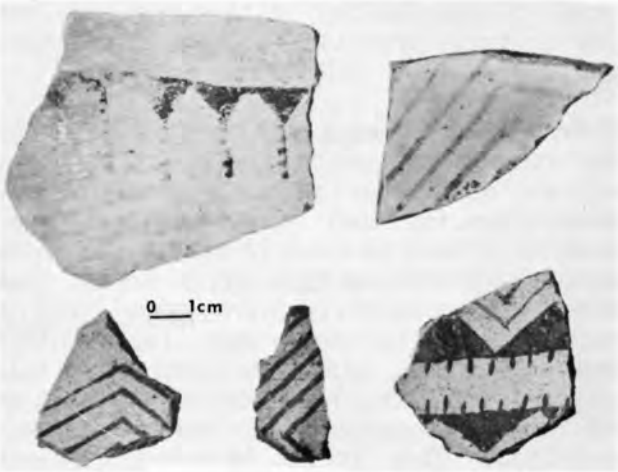


Figure 7. Lino-Kan'a style sherds.

Figure 8. Black Mesa style sherds.

Figure 9. Sosi style sherds.

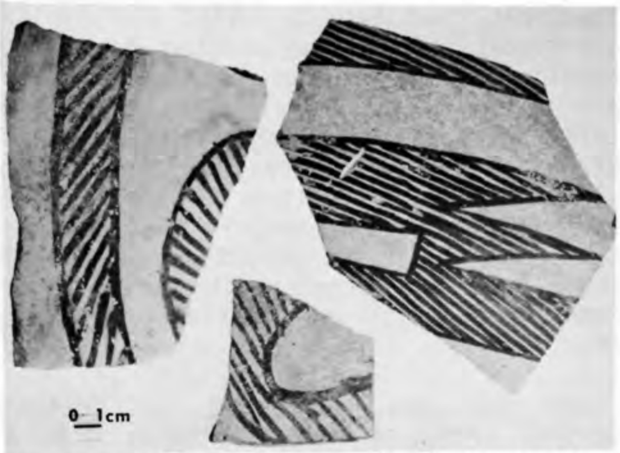


Figure 10. Dogozhi style sherds featuring typical parallel banded lines.

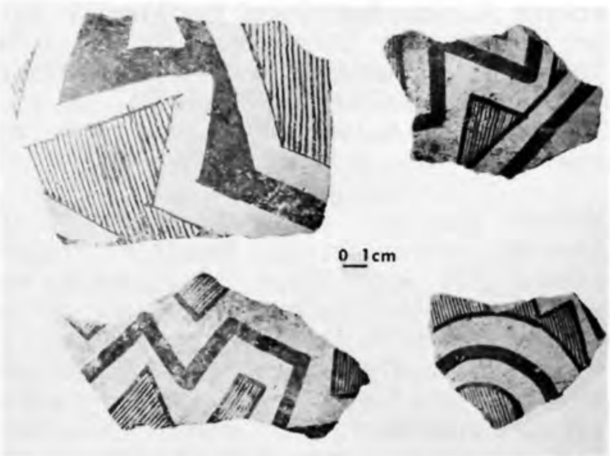


Figure 11. Tularosa/Reserve style sherds.

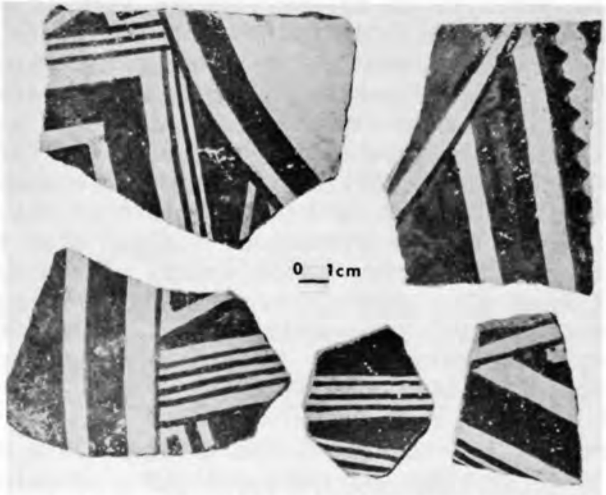


Figure 12. Flagstaff style. Sherds from the overview area representing the Flagstaff style.

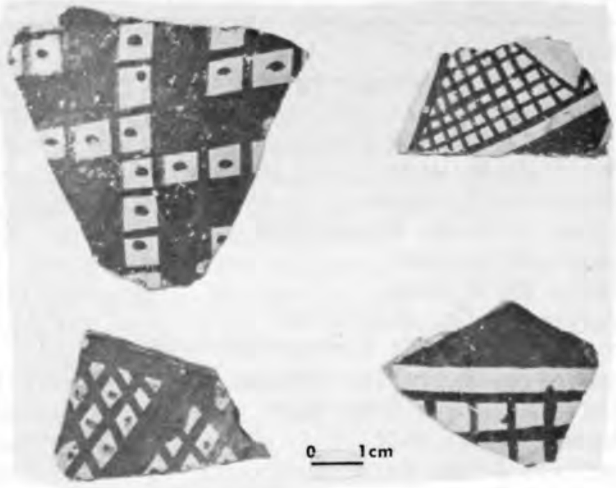


Figure 13. Kayenta style sherds.

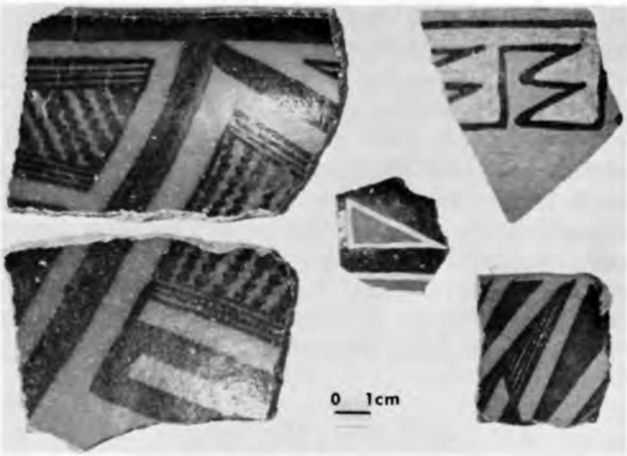


Figure 14. Polychrome sherds typical of the Little Colorado overview unit.

Figure 15. Banded ware.

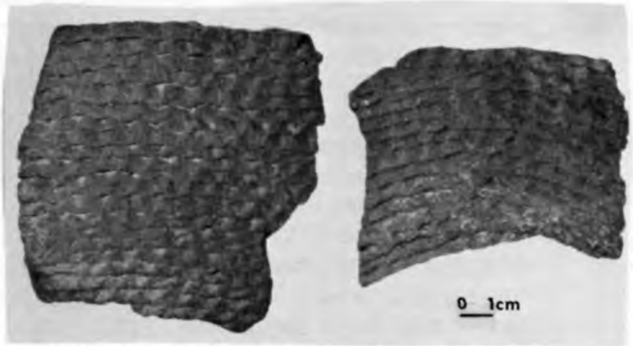


Figure 16. **Indented Corrugated sherds.**

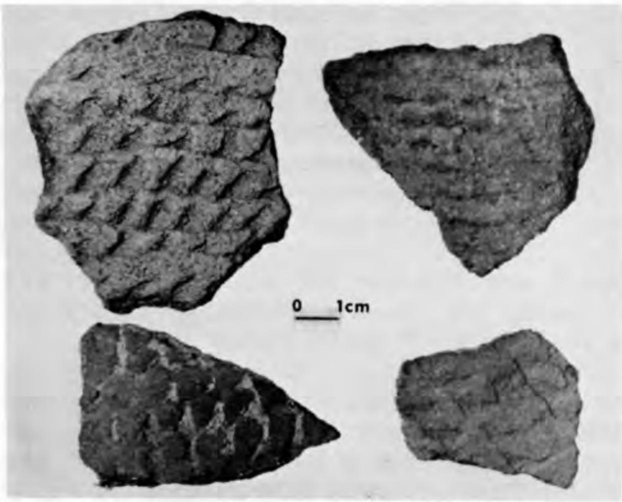


Figure 17. Obliterated Corrugated style sherds which are a variation of Corrugated style sherds illustrated above.

Figure 18. Ceramic artifacts.

In the early 1960s Longacre and others began to explore a theory of style based upon what S. Plog (1976) has termed "learning theory." This approach uses a series of assumptions, the most important of which is that daughter-potters learn design styles from mother-potters and that design styles will be localized within regions, localities, and even sites to reflect the prevailing matrilocal residence behavior of the Western Pueblo. S. Plog (1980a) has summarized the many criticisms of the theoretical assumptions underlying this approach. More important to this

Table 32. Ceramic Equivalencies for the Overview Unit

CHEVLON ALPHABETIC TYPE	COLTON EQUIVALENT
Polished Gray Organic	No equivalent
Polished Gray Mineral	Cibola White Ware
Polished Sand Mineral	Cibola White Ware
Polished Sand Organic	Tusayan White Ware
Slipped Sherd Organic	Little Colorado White Ware
Slipped Sherd Mineral	Cibola White Ware
Unslipped Sand Mineral	Cibola White Ware
Unslipped Sand Organic	Tusayan White, Gray Ware
Red Brown Crushed Rock Corrugated	Mogollon, Alameda Corrugated Types
Grey Sand Corrugated	Tusayan Grayware Corrugated Types
Grey Sherd Corrugated	Little Colorado Gray Ware
Red Brown Crushed Crock Plainware	Alameda Brown Ware
Red Brown Polished Plainware	Mogollon Brown Ware
Red Brown Sand Plainware	Mogollon Brown Ware
Red Brown Sherd Plainware	No equivalent
Red Brown Volcanic Plainware	Alameda Brownware-Sunset Types
Grey Plainware	Tusayan Gray Plainware

report are the various studies undertaken following the ideas of learning theory and an evaluation of their status today.

The first of the studies was Cronin's (1962), a ceramic design analysis of various types from a number of sites in the Upper Little Colorado area. Cronin's study was interpreted to indicate that the design style on different types at the same site were more similar than those on the same type at different sites. S. Plog (1978) has identified both statistical and empirical problems with the study, and argues that the variation described in the study reflects spatial and temporal differences between the sites to a far greater extent than any site-specific patterns.

Longacre (1964) drawing upon concepts used by Smith (1962), defined the "Snowflake School" of potters and three varieties that they produced. The three varieties in question are widely recognized as Holbrook Black-on-white, Reserve Black-on-white, and Snowflake Black-on-white. Given the widespread distribution of these types, it is dubious that they are distinctive products of a local school in the sense that Longacre envisioned.

Longacre (1964, 1970) also argued for localization of design traditions within particular rooms and particular areas of the burial ground at Carter Ranch Site and for sharing of design traditions among other sites in the vicinity of that one. A reanalysis of the data by S. Plog (1978) indicates that none of the pertinent arguments Longacre makes can be sustained when appropriate statistical procedures are applied. Hill (1970) constructs a similar argument for Broken K Pueblo, also in Hay Hollow Valley. S. Plog (1978) has again demonstrated that the results are questionable.

Leone (1968) studied the nature of interaction between sites in Hay Hollow Valley by evaluating color variation in plainware ceramics (Cohn and Earle 1967) and design variation on painted sherds (Howe, Menkes and Redman 1967). He evaluated the homogeneity/heterogeneity of collections of sherds from individual sites occupied over the span of habitation in the valley. While Leone interprets the variation as a reflection of changing village autonomy, other potential explanations for the variation were not evaluated (Tuggle 1970).

Connor (1969) extended Leone's analysis to the 14th century sites of Pinedale, Fourmile and Shumway in the surrounding area. Her preliminary analysis generated results similar to Leone's. A subsequent reanalysis (Tuggle 1970:75-76), however, showed that the degree of homogeneity characteristic of the sites did not change when the data from them were pooled.

Maley (1970) and Ester (1970) followed this same analytical tradition in regard to the distribution of ceramics in different room types and site areas at the Joint Site and interaction between villages.

S. Plog (1976, 1977a) employed a multivariate approach to the study of design variation that attempted to isolate aspects of the variance that could be assigned to space, time, function, and exchange. While he argues that exchange is the most important of the factors, aspects of the variation are traced to each of the other factors.

Graves (1978) studied variation in White Mountain Redware styles throughout the overview area. He isolated both spatial and temporal components of the variation and argued for different contemporaneous areas of manufacture and distribution for different types.

Lightfoot (1981) has used design variation to argue for exchange between multi-site communities in the Pinedale area.

Hantman and Lightfoot (1978) have used metric attributes of design variation as a means of creating a chronology sensitive to short-term temporal variation. Their work strongly suggests that variations in line width and line spacing are the most sensitive temporal markers.

Hantman, et al., (in press) argue for a system of stylistic variation similar to that originally proposed by Wasley (1959) and resurrect his argument that the styles are horizon markers. This approach is illustrated in Figures 7 through 13. A similar system has been proposed by Sullivan (in press).

Studies of variation in plainware and corrugated ceramics are much less common. In addition to the studies associated with Leone's work that were mentioned earlier, Cook (1970) has described color variation in plainware ceramics, arguing again for socially patterned distributions. Rafferty and Brunson (1978), Sipe (1978) and Brunson (1979) had proposed design categories for corrugated ceramics based upon a statistical analysis of sherd attributes and have argued for a patterned and largely spatial distribution of the different classes used in the analysis (see Figures 16 and 17).

Function

Function at this point, has been less thoroughly studied than either style or technology although there are implications for the study of both that derive from the reports of S. Plog (1977), Rudecoff (1975), and Lerner (1979a, b). Plog and Rudecoff described evidence indicating that there are substantial differences in the pattern of variation in bowls and jars. Bowl sizes are far more tightly clustered than are jars, although both distributions are unimodal. Significant differences in line size, type of hatching, design elements, and design composition between the two categories can be demonstrated. Thus, both spatial and temporal studies should control for functional variation. Hantman (1977) and Lerner (1979a, b) indicate that when materials are from spatially and temporally different areas, the problem may not be so extreme as when materials are from nearby sites. Further attention must be given to classes of ceramic artifacts other than containers and to reused artifacts (see Figures 18 and 20).

TECHNOLOGY

As is the case with style, the earliest discussions of technological variation in ceramics occur in individual site reports and the first systematic discussion of the variation is in Colton's definition of various wares and types. Specific studies dealing with technological variation include the following.

Martin (1941) sponsored a study of 16 sherds of Alma Rough, Alma Plain and San Francisco Red from the SU site, just outside the study area in New Mexico. The study established that the types in question were commonly made with sand temper.

Martin and Rinaldo (1960) described the results of petrographic analyses of 80 sherds from the Table Rock Pueblo site near St. Johns. They note that sherd temper occurred in 30 Alma Plain specimens.

Martin, Rinaldo, and Longacre (1961) noted that 17 sherds from the Mineral Creek site and 26 from the Hooper Ranch site were analyzed petrographically. Sherd temper was not common in Alma Plain but was common in most painted types from these sites.

Longacre (1964) used the results of petrographic analyses of 20 black-on-white and black-on-red sherds from the Hay Hollow Site to argue that all the ceramics were made of the same materials and probably

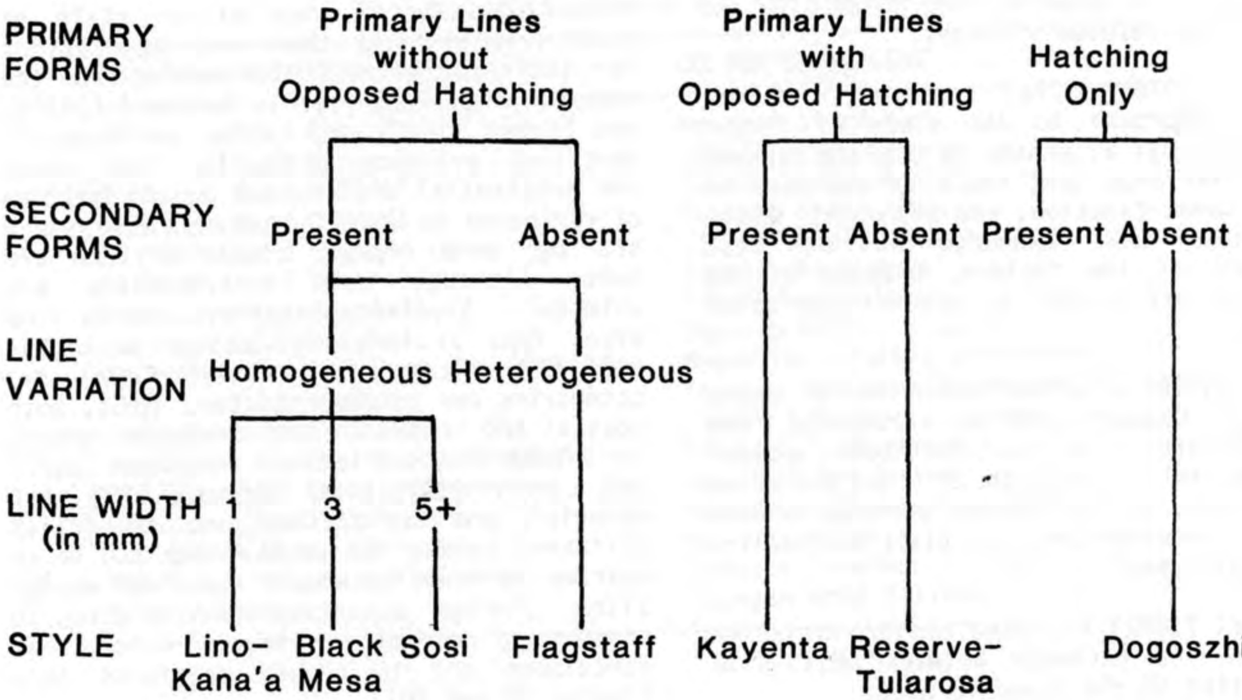


Figure 19. Dendrogram illustrating attribute based system of style definition.

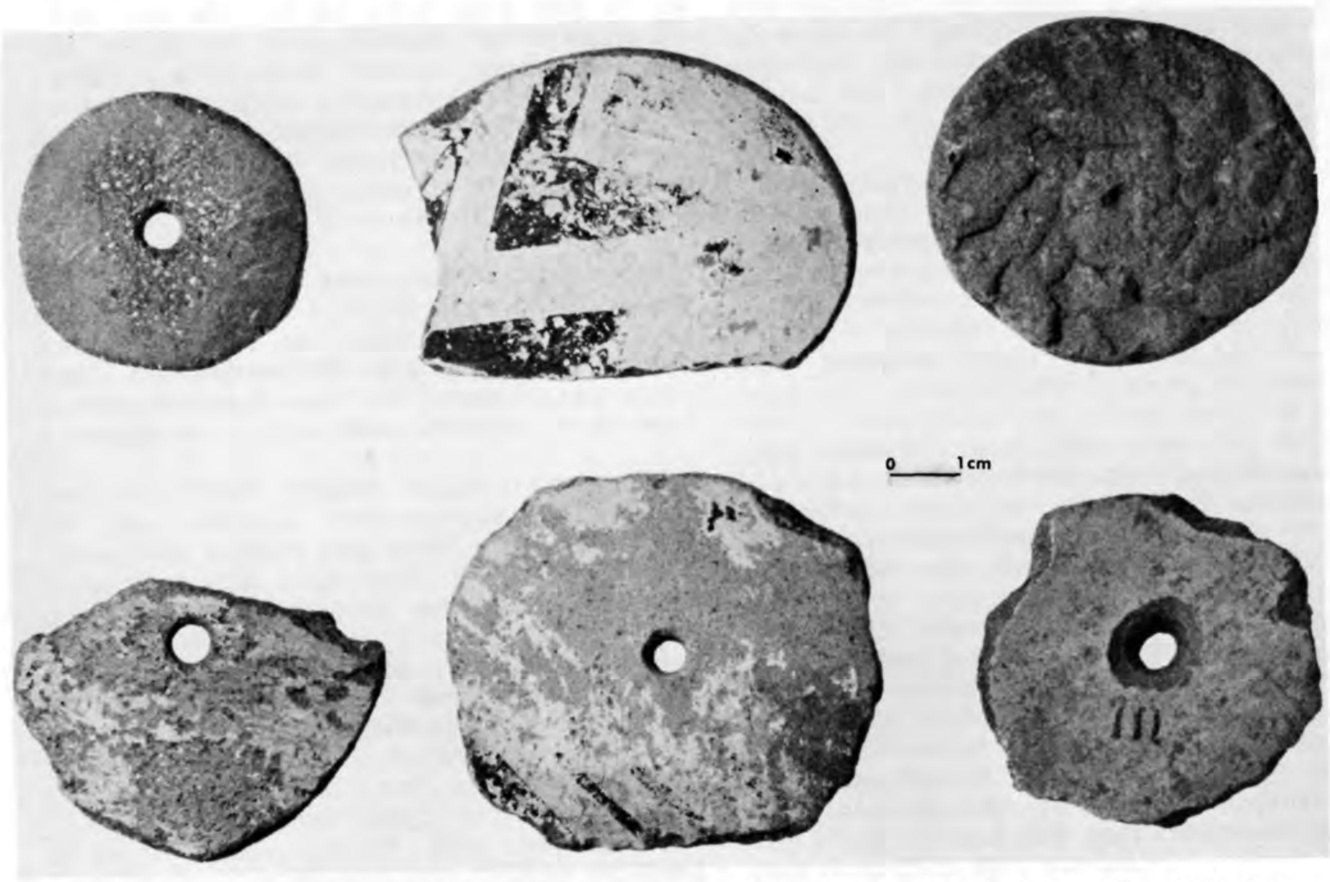


Figure 20. Ceramic artifacts which appear to have been reused in a role different than originally intended. The center sherd of the top row appears to be a scrapper. The other sherds have been drilled for decorations or spindle whorls.

locally. S. Plog (1977:75) described the conflicting results of this report and the original and subsequent analyses of materials from the site.

Gamboa (1972) undertook a simple visual mapping of the distribution of the alphabetic types within the Chevelon drainage. His analyses suggested quite different distributional patterns for the various types within this drainage.[1] The earliest classes, USM and USO, occur at quite dispersed loci, although there is a tendency for a relatively heavy USM and a relatively heavy USO site to occur in pairs. PSO predominates along the southwestern edge of the drainage although there are some loci in the very center and at the northern extreme of the drainage where it is also abundant. Polished Sand Mineral (PSM) has a spotty distribution that correlates closely with PSO. Slipped sherd organic, the largest single category, occurs in high concentrations at sites throughout the drainage. PGM is concentrated in the southeastern part of the drainage and shows a strong zonal pattern of decline from the centers of heaviest concentrations.

Aceves (1970) studied a sample of black-on-white sherds from the Chevelon drainage in an effort to differentitate chemically between mineral and carbon paints. She determined that the percentage of iron and manganese in the clays from which the vessels were made was so high, and the separation of pigment from the clay body so difficult, that all sherds appeared to be mineral. In addition, she discovered that the quantity of magnetic particles in all sherds examined was too small to use a magnetic test as a basis for the differentiation.

DeAtley (1973) undertook a petrographic study of 61 plainware sherds from 6 sites in the Purcell Larson locality of the Chevelon drainage. Her study summarizes archeological literatures concerning techniques of ceramic manufacture and the relationship of raw materials used in manufacture to the function for which the vessel is intended. She began with sherds of all but one of the classes used in sorting sherds from the area using the alphabetic typology: Red Brown Crushed Rock, Red Brown Sand, Red Brown Polished, Red Brown Sherd, and Red Brown Volcanic. Her analysis indicated that three groups were represented petrographically: sherd temper, silicious temper including sand and variable quantities of crushed rock, and volcanic. Sherd tempered vessels proved to be predominantly bowls, which she infers to have been used in cooking, while silicious tempered vessels where predominantly jars, inferred to have been used in storage.

DeAtley notes that while her study began with a set of temporally disparate data, the temporal patterning strongly suggests a preponderance of jars at the two earliest and the two latest sites and of bowls in the two intermediate ones. Thus, she argues, site function may have inadvertently affected the sample. However, subsequent analyses (S. Plog n.d.) have shown that sherd tempered vessels are the common ware from about AD 1000 to 1100 within the area. Therefore, her results can not be attributed to sample bias, leaving the interesting possibility that storage, at least in jars, did not occur at a constant level during the prehistory of the area.

There is another important implication of DeAtley's study. Given that Red Brown Crushed Rock is the equivalent of Tonto Brown (an Alameda Brown Ware), and that Red Brown Sand is the equivalent of Alama Plain (a Mogollon Brown Ware), then perhaps the plainware sherds of these types in the Chevelon drainage are a locally manufactured ware that represents an admixture of the two traditions. Alternatively, somewhere in the vicinity of the study area there was a ceramic manufacturing center where a technology blending the two traditions was utilized. Otherwise, the two should be easily separable. In my opinion, there are within the study area clearly distinguishable Alma Plain and clearly distinguishable Tonto Brown. In the absence of further petrographic studies, it is impossible to describe the precise extent to which the variation between the two is clinal with a discrete intermediate type.

Wait (1975) used spectrographic techniques to analyze a collection of 61 sherds, again from the Purcell Larson area. He was able to demonstrate, using statistical procedures, that Cibola White Ware sherds and Little Colorado White Ware sherds were clearly made with different raw materials.

1. Maps 15 through 21 contain definitions of the "alphabetic" types.

In addition, he argues that one can differentiate two groups of Cibola White Ware sherds, one with high values of zirconium and titanium and the other with high values of iron, strontium, zinc, and rubidium. Similarly, Little Colorado White Ware sherds sort statistically into two groups, one high in titanium, the other high in manganese. It was difficult to explore the spatial and temporal implications of these findings. However, since there is limited temporal variation between the sites, it appears likely that more than a single source of manufacture is indicated for each group.

Wait's analysis of the spatial patterning in the distribution is intriguing, if not conclusive. One of the Cibola groups isolates a cluster of sites in the center of the drainage. The other groups two sites at the northern and southern ends of the drainage. These two sites may be somewhat later than the others, but they are also both sites with four wall structures that potentially played an important role in exchange relationships as discussed elsewhere. The anlysis of the Little Colorado White Wares is somewhat more difficult to interpret. While one group consists of the five northernmost sites, the second includes sites from the entire drainage.

Wait proposed an argument concerning the use of different raw materials for bowls and jars that is similar to DeAtley's. However, subsequent investigations by S. Plog (1980a) suggest that, since jars and bowls produce drastically different quantities of sherds, Wait's argument is highly problematical.

Read (1974) used limited neighborhood classification analysis to study the distribution of classes defined using the Chevelon typology over sites in the area. He argued that the clusters of sites generated by the analysis represented temporally discrete groups. S. Plog (1980a) described tree-ring dates that support this argument for at least a portion of the time period in question.

Muessel (1975) used X-ray diffraction to study a sample of 44 Little Colorado White Ware sherds from the Purcell Larson area of the Chevelon drainage. He found that the population of sherds could be separated on the basis of the relative quantities of quartz, feldspar, and calcite. Group one shows no calcite and a predominance of quartz over feldspar; group two shows a predominance of quartz over feldspar over calcite; group three has a predominance of quartz over roughly equal quantities of feldspar and calcite; and group 4 a predominance of feldspar over quartz over calcite. There is considerable variation in the frequencey of sherds for the 11 sites that Muessel studies that are from a single class. In three sites, all sherds were from the same class. In two cases, three were from one group and one from another, and in the remainder of cases the sherds were equally divided between two groups.

Muessel was unable to find any clear spatial patterning in the distribution of these different groups. However, there was an apparent temporal pattern. Sherds from the earliest sites were from groups two and three. Group one was middle to late and group four was late.

Unfortunatley, the sherds used in Muessel's study were selected specifically because they had no paint on them, so as not to interfere with design analyses. As a result, our understanding of this pattern of technological change cannot be refined. However, there is a suggestion that the manufacturers of Little Colorado White Ware were attempting to use raw materials that were free of calcite. While they may also have been attempting to replace quartz-rich with feldspar-rich clays, this pattern may simply be the product of the kinds of sherds that were used to manufacture the sherd temper. Earlier, there would have been little choice but to use quartz-laden Tusayan White Ware sherds for the temper, while later Little Colorado sherds could themselves have been used, reducing the quartz fraction in the temper.

F. Plog (1976) discussed the justification for the development of the Chevlon typology and defines each of the classes used in this approach. S. Plog (1976) describes the results of 22 SShO and 20 PGM sherds from the Chevelon area done by Elizabeth Garrett. Igneous rock fragments were found in the SShO but not in the PGM samples. Analyses of additional samples from the study area and sites to the north and west of it suggested that sherds from south of Winslow were very similar to Chevelon sherds.

Fifty-five sherds of black-on-white ceramics representing Reserve, Snowflake, Puerco, and Wingate wares as well as unspecified plainware sherds were analyzed as part of the Tucson Gas and Electric Project near Springerville (Rugge and Doyel 1979). They assigned sherds to one of three classes on the basis of varying sherd, quartz, feldspar, quartzite, sandstone, granite, chert, and volcanic inclusions. Suggestions concerning the probable local origin of each of the classes are given. Plain and corrugated wares were both more variable and of different tempering materials then the painted types.

Dulaney (in press) discusses the results of his analysis of 75 sherds obtained during the various phases of the Coronado Project in the northern part of the study area. The results of Dulaney's study are complex and highly intriguing and the discussion is more thorough than in any of the previously mentioned reports. Some of the major conclusions reached are:

a. Alama Plain sometimes does, but sometimes does not, have sherd temper inclusions.

b. There is little petrographic relationship between Alma Plain and Woodruff Smudged even though both are said to be Mogollon types in the traditional literature.

c. Despite clear evidence that tempering particles were purposefully added to the sherds and were not accidental inclusions, variation over the project area is minimal for the two types in question. This suggests highly localized manufacture.

d. Evidence for localized manufacture is substantially greater for those painted types which generally date to AD 950-1150.

e. Even the earliest Cibola types in the project area had sherd temper present in some sherds (unpainted Lino-like plainware).

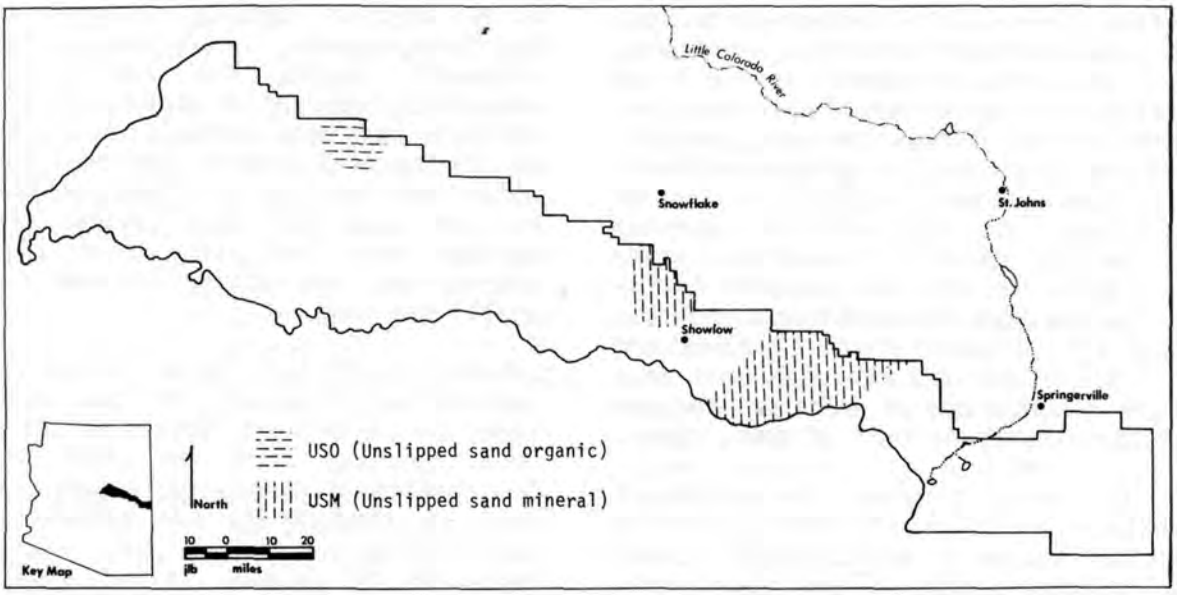
Dulaney's report also contains useful suggestions concerning the directions that future studies might take and the standards of analysis and reporting that should be sought. There is no question that, had these same standards been met in earlier reports, our ability to generalize about technological variation would be substantially greater.

As a part of ongoing research on the Apache-Sitgreaves National Forests, Elizabeth Garret has summarized the results of analyses of about 160 (some are still in progress) sherds from the breadth of the Apache-Sitgreaves National Forests. While the results of these analyses are not yet complete, they suggest discrete regions over the study area in which petrographic characteristics are substantially the same.

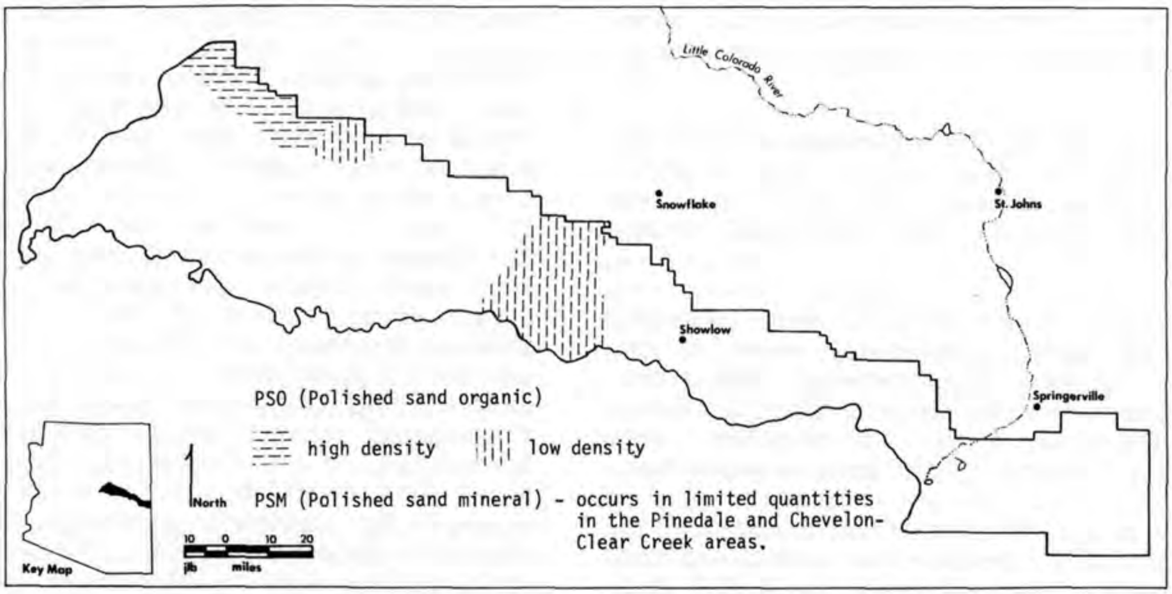
Jeffrey McAllister (1978) has mapped the spatial distribution of the different types in the painted classes of the alphabetic typology using the SYMAP program. The results of these studies are shown in Maps 15 through 21. In general, these maps correspond closely both with those generated by Brunson in her studies of corrugated variation mentioned above and the petrographic zones as visually defined on the basis of Garrett's petrographic analysis.

S. Plog (n.d.) undertook a cluster analysis of all the types in the Chevlon typology. His analysis indicates four covarying groups. Group one consists of USO, USM, Gray, and Red-Brown Sand, essentially the earliest Tusayan White and Gray Wares, Mogollon Brown Wares and Cibola White Wares. Group two consists of PSO, and Gray Sand and Sherd Corrugated, the Tusayan White Ware and Gray Corrugated types and Little Colorado Gray Ware. Group three consists of SShO, Red-Brown Sherd, Polished and Volcanic, a basic complex of sherd tempered pottery plus the Sunset types of Alameda Brown Ware. The final group consists of PGM and Red-Brown Corrugated, an association of Cibola White Wares with Mogollon and Tonto Corrugated types. The analysis strongly suggests that the various alphabetic classes occur in a pattern that is either spatially or temporally patterned, or both.

Plog also investigated the relationship between corrugated and plainware ratios and the more readily dateable black-on-white classes. He found that while there was an association, it was spatially varied. In the Chevelon Canyon area, corrugated sherds are relatively rare, even at later time periods. Sites with a majority of corrugated sherds typically have greater than expected quantities of SShO and less than expected quantities of USM and USO and PSO. However, PGM does not pattern in relation to the corrugated



Map 15. Distribution of USO and USM ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.

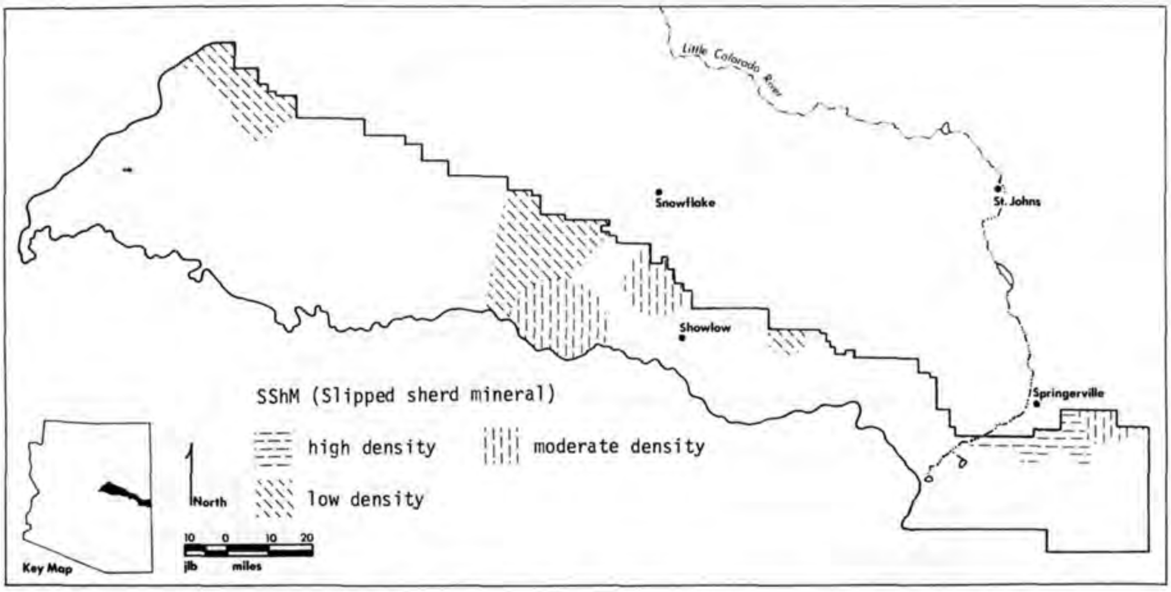


Map 16. Distribution of PSO and PSM ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.

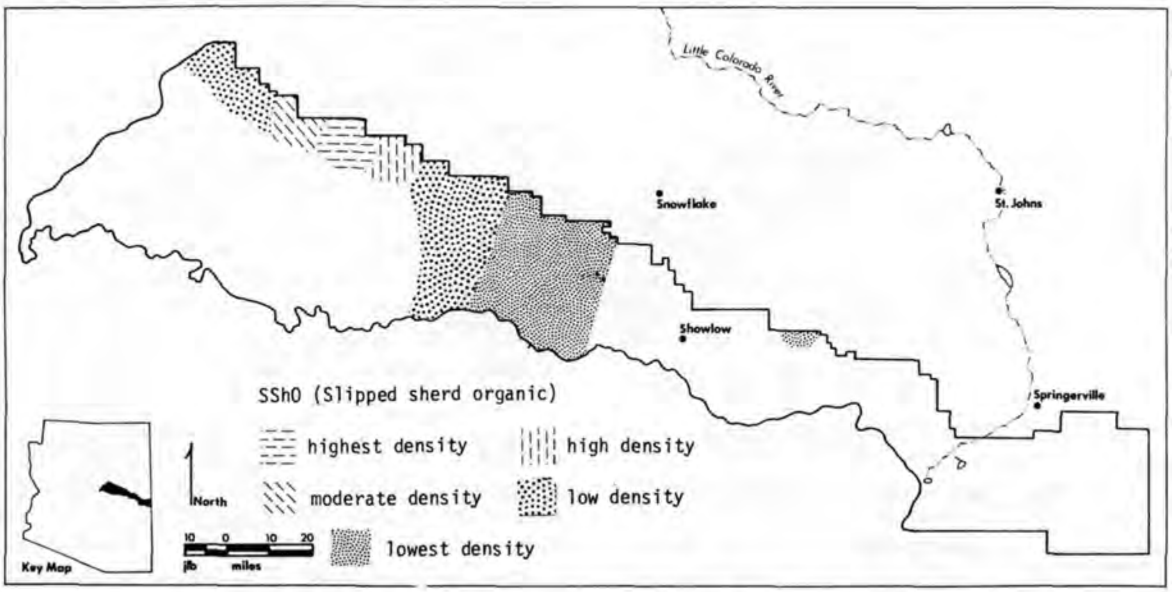
plainware proportion. In the Purcell-Larson area, sites with a majority of corrugated have greater than expected quantities of PGM and SShO, less than expected quantities USO and USM and expectable quantities of PSO. In this area, there seems to be a gradual plainware-to-corrugated transition that breaks during the period of time when PSO predominates.

FUTURE RESEARCH

While none of the techniques employed are new in principle, research during the last two decades has greatly expanded the detail of understanding of both the technological and stylistic aspects of ceramic variation. The number of petrographic samples that have been analyzed is nearly ten times that



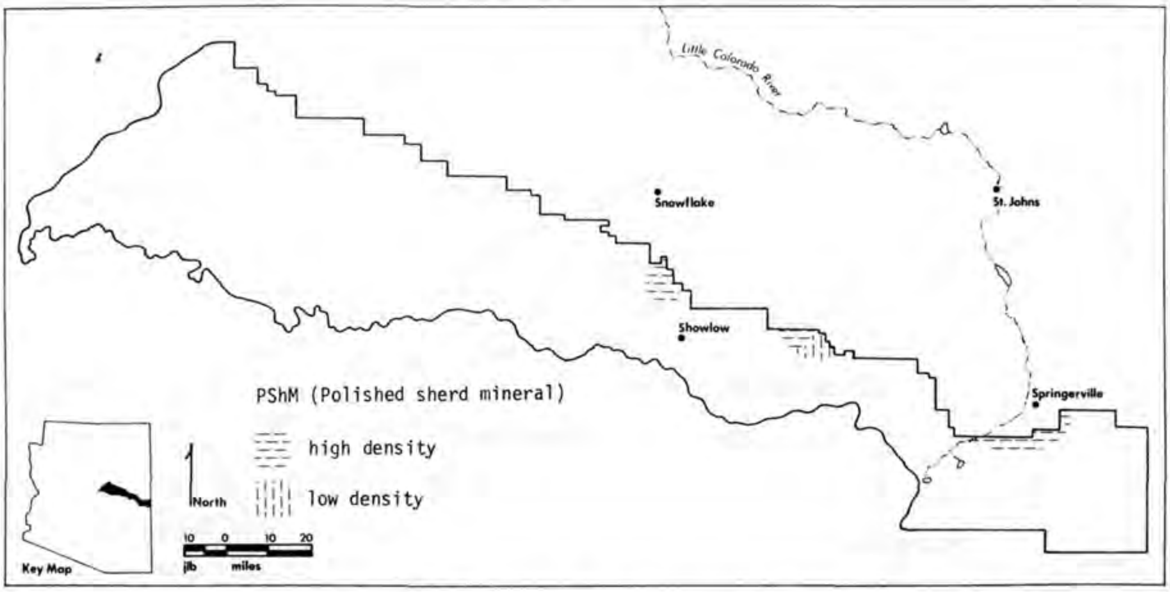
Map 17. Distribution of SShM ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.



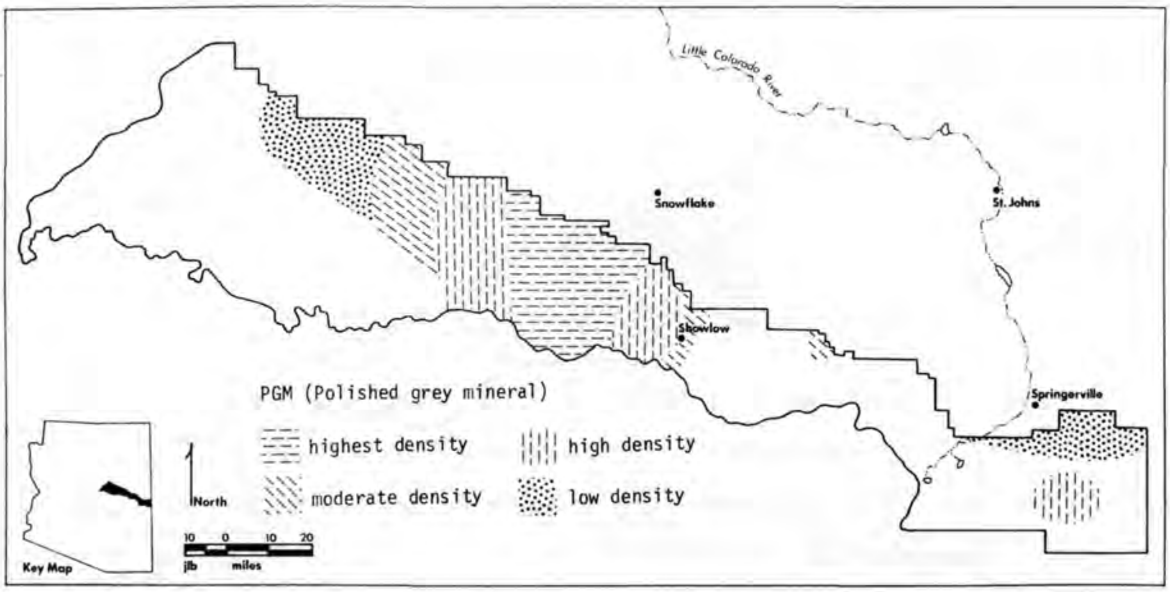
Map 18. Distribution of SShO ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.

done during the entire preceding period. Specific efforts to map the distribution of design elements and attributes both within and between sites has yielded successful, if not always conclusive, results. A much different issue generated by these efforts is the status of traditional typologies given our rapidly increasing understanding of the details of variation.

There seems to me no question that there is great utility in the continued use of the traditional typology. A well trained analyst can sort sherds into meaningful categories on the basis of minimal observations and, therefore, with considerable speed. The weakness of this approach is, of course, the great number of observational errors that arise when a



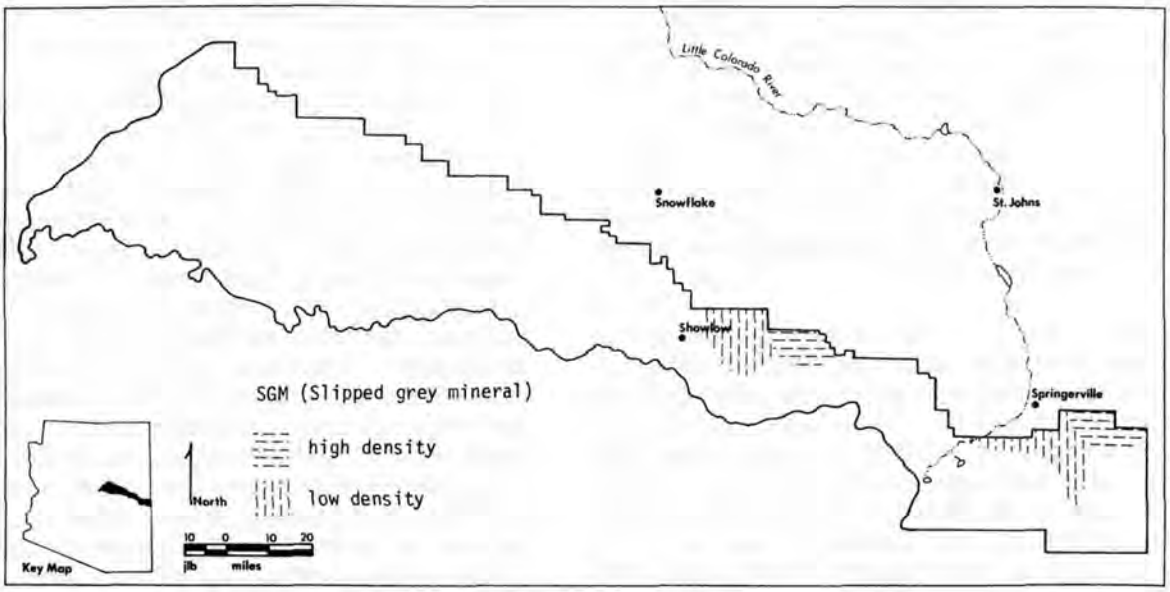
Map 19. Distribution of PShM ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.



Map 20. Distribution of PGM ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.

relatively few attributes are used to place sherds or vessels in a system that is based on dozens of attributes. It is not surprising that the high rate of disagreement among similarly trained analysts reported by Fish (1978) occurs nor that the more substantial disagreement over even whole vessels reported by Swarthout and Dulaney (in press) should happen. Current efforts to generate a set of definition of Cibola White Ware types should greatly clarify the pattern of black-on-white types within the study area.

Yet, in the case of every ware there remains great need for clarification. Despite the commendable overall level of comparability that Colton was able to



Map 21. Distribution of SGM ceramics of the Chevelon classification system from the Apache-Sitgreaves National Forests.

achieve, there are conflicts in his typology. For example, the definitions for Walnut C and Holbrook B in the Little Colorado White Ware are identical. Similarly, St. Joseph Black-on-white is defined on the basis of two sherds. Variability in plain and corrugated wares has never been adequately studied with a view toward consistency. The extent of overlap between Woodruff Smudged, Forestdale Smudged and San Francisco Red has never been adequately determined nor has that between most of the types in the Forestdale, Alma, Woodruff series.

I am not suggesting that there is a need to sit around tables covered with sherds and decide what is what. At issue is simply resolution of the question of the kinds and details of the attributes that are to be used in the system. Most of the current confusion exists either because inferred spatial and temporal contexts, rather than formal attributes, were used to define new types. Laboratory variation in the definition of attributes, or actual attributes used, add to the confusion. Given an agreed consistency in attribute systems and observational techniques, there should be no problem in using the traditional typology as a first-instance communication concerning the nature of ceramic materials that are common in a particular project. Such an approach might proceed as follows for each of the major wares.

1. General: Types should be defined at the intersection of relatively clear, but relatively simple, stylistic and technological categories.

2. Black-on-White: A number of current types appear to be defined almost exclusively on spatial and/or temporal grounds. The use of such terms should be abandoned. A technological system based upon the existing Chevelon system and a system such as that described earlier should be used to generate the types.

3. Black-on-Red, Orange: Little attention has been given to either stylistic or technological variation in these types within the study area. Carlson's (1970) work with White Mountain Redwares is the exception. Graves' (1978) analysis suggests that many of the same style categories that are useful for black-on-white types will serve for these. Technological variation is largely an open question at present.

4. Polychromes: The existing definitions of polychromes probably represent the most consistent set of defined types at present.

5. Plainware: In the case of plainware, style is essentially a matter of surface color and surface treatment. Yet, there is no consistent set of categories at present. These should be generated. Technological