

**THE DAN CANYON BURIAL, 42SA21339, A PIII BURIAL  
IN GLEN CANYON NATIONAL RECREATION AREA**

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## EXECUTIVE SUMMARY

The Dan Canyon burial was discovered at a time when the philosophy, ethics, and legislation concerning the study of human remains are in a state of flux. A number of important sensitive issues germane to managers, archeologists, and American Indians are discussed in the introduction. The subsequent analysis provides a detailed scientific account of these remains and a glimpse of a segment of a people's past lifeway while remaining sensitive to the wishes of the American Indians.

The burial and associated grave goods of site 42SA21339 were exposed by wave action in a location frequented by boaters at the Glen Canyon National Recreation Area. The Park Superintendent made the decision that the burial should be removed immediately to prevent further damage by visitors and lake water. The Park Archeologist and other park personnel documented and mapped the site. Subsequently, two Native American groups were consulted concerning the disposition of the burial materials, the Navajo and the Hopi. The Navajos' response allowed up to a year for analysis, while the Hopi requested that analysis be limited to five months.

In analysis, several issues were addressed using a variety of data, including paleopathological, chronological, technological, social, and economic information. At the request of the Hopi, the methods used for recovery of data emphasized non-destructive and non-intrusive procedures.

The site is near Moqui Canyon, on the Colorado River arm of Lake Powell, on the west slope of the Red Rock Plateau, near the maximum range of both the Kayenta and the Mesa Verde Anasazi.

Consisting only of two features, the site includes the grave of a child with burial goods and a remnant of a small granary, with no other cultural materials. Burial goods include a variety of perishable and nonperishable goods, including an anomalous ceramic canteen in the style of Tusayan Black-on-red, but decorated with a white mineral paint. Compared with burial goods included with other Anasazi of the same age group, these goods are commensurate with those expected for an individual of average economic and social status. Artifacts indicate this burial is late PIII, Horsefly Hollow Phase in the period A.D. 1210 to 1260, the final Anasazi occupation of this area (Lipe 1970).

The human remains and associated food remains indicate that this average, healthy child experienced periodic nutritional stress, probably due to an inadequate and homogeneous diet. The coprolites recovered from the burial are uniquely homogeneous, the macrobotanical portion consisting only of highly processed grass seed, probably all rice grass (*Oryzopsis*). Pollen extraction yielded mostly grass pollen (Poaceae). The remaining pollen suggested that Mormon tea (*Ephedra*) had been ingested, possibly medicinally, and that death occurred in winter or early

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spring. Developmental and other skeletal characteristics indicate this individual was approximately 3.5 years old at death and was in good health. Regularly spaced Harris lines indicate some form of periodic stress.

Investigations in nearby areas indicate that this was a period of environmental degradation and that Anasazi populations may have experienced nutritional stress or other consequential forms of physiological stress. Studies of both prehistoric populations and living populations suggest that a number of methods were employed to support individuals through periods of stress, and to promote the well-being of the group. This burial has provided much unique and important information regarding the economic and dietary systems, and the general health of an individual.

Reburial was conducted on March 6 and 7, 1991, near Page, Arizona, by representatives of the Hopi, Glen Canyon National Recreation Area, and the Midwest Archeological Center (MWAC). Research results were presented to the Hopi representatives on the evening of March 6, along with two copies of the draft report for review. This meeting allowed candid discussion regarding philosophies, research goals, laws, jurisdiction, and finances. The remains were reburied near their point of origin on March 7.

The original field work was performed by Chris Kincaid and Marla Knickrehm of the

Glen Canyon National Recreation Area, under very difficult conditions. Analysis of the cultural materials was conducted by Steve Dominguez, MWAC, who also coordinated all the analyses. Karl Reinhard and Kari Sandness of the University of Nebraska at Lincoln were contracted to analyze the human remains and the pollen and macrobotanical remains. Dennis Danielson of MWAC analyzed the phytoliths. Cherie Edwards of UNL sorted material collected from screening and identified macrobotanical remains. Linda Scott-Cummings of PaleoResearch Laboratories in Denver identified the wood. Mo Ghazi of UNL identified the material of the pendant. Bret Radcliff of UNL examined the insect remains. Rob Bozell of the Nebraska State Historical Society identified the faunal materials.

In addition to the specialists mentioned above, we would especially like to thank Robert Hannay and Amy Smith, who promptly reported the burial to Park authorities. We would also like to thank the Hopi Tribe, who kindly allowed this research, especially Leigh Jenkins, Chairman of the Division of Cultural Affairs of the Hopi, and Dalton Taylor of Shungopovi; Ranger Steve Luckeson for efforts in recording and protecting the site; Phil Geib of the University of Northern Arizona for his extremely helpful observations on the artifacts; John Lancaster and John Ridenour of Glen Canyon National Recreation Area; and Adrienne Anderson, Rocky Mountain Regional Archeologist, for help in the financial and bureaucratic issues.

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## INTRODUCTION

The Dan Canyon burial that is described in this report was an unexpected and inadvertent discovery. From the perspective of archeologists, its discovery occurred at a time when the philosophy, ethics, and legislation concerning scientific excavation and study of human remains are in a state of flux (Calabrese 1990; Goldstein and Kintigh 1990). This unanticipated discovery placed the resource management staff at the Glen Canyon National Recreation Area and the National Park Service's regional office staff in a situation which perhaps could have been generally anticipated, but for which there were no established procedural guidelines to direct the Service's specific course of action. This created a series of problems.

The burial, that of a child, was discovered on June 17, 1990, by a group of park visitors who reported the remains exposed near the shore of Lake Powell to Park Ranger (Law Enforcement) Steve Luckeson at the Halls Crossing Ranger Station. Ranger Luckeson happened at that time to be with Lieutenant Rudy Cook, the San Juan County Sheriff, who also serves as the county medical examiner. Lieutenant Cook's presence was fortuitous, for without it, valuable time would have been lost in notifying appropriate local law enforcement and other officials. When human remains are discovered, Utah state law requires the involvement of the local coroner or medical examiner until such time as the discovered remains are determined to be prehistoric in age. Those officers have the authority to order the remains exhumed until such a determination can be made, with or

without involvement of archeologists or Native American groups.

A visit to the burial location by park rangers and Lieutenant Cook led by the individuals who made the discovery resulted in the collection of remains exposed on the surface and an attempt to protect the intact portion of the burial from further disturbance or deterioration. Based on the observations of the medical examiner and Ranger Luckeson, it was concluded that the burial was indeed prehistoric and the park's Division of Resource Management was so notified on June 18. Chris Kincaid, the Park Archeologist, arrived at the location late in the afternoon of June 18 and, accompanied by Marla Knickrehm and Ranger Luckeson, began documentation and mapping of the site. The remainder of the burial was removed on the morning of June 19, 1990.

The Superintendent of Glen Canyon, John Lancaster, determined that the burial should be removed immediately to prevent desecration by visitors who knew its location, as well as to prevent further damage by the water of Lake Powell. At that time it was the policy of the National Park Service, upon discovery of human remains thought to be prehistoric, to consult with the Native American tribe or political entity thought to be most closely affiliated with the discovered remains, and to initiate discussions to determine the appropriate disposition of such remains (National Park Service Cultural Resource Management Guidelines, NPS 28, 1985:Chapter 7, page 8). While the directive of the

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policy is to initiate consultation, the decision as to what is to be done with the remains is left to Service managers.

Had the 1990 Native American Graves Protection and Repatriation Act (NAGPRA) (P.L. 101-601; November 16, 1990) been in effect at the time of discovery, consultation with Native Americans would have been required before removal of the burial (Section 3(C)(2)). A superintendent now does not have authority to remove a burial without consultation taking place beforehand. If through consultation it is determined that removal is not to be permitted, or that immediate reburial of the remains is required, there may be no need for the involvement of professional archeologists. Under such circumstances, the county sheriff, medical examiner or coroner, park officials, and tribal elders, shamans, or other tribal representatives can simply remove, transport, and re-bury prehistoric Native American human remains and associated grave inclusions. Archeologists need only be involved with burial remains if analysis is to be conducted and if there is something to be learned both biologically and culturally from study of those remains (Calabrese 1990).

Burial materials were removed to the Wahweap District Ranger's office for initial documentation. Consultation was initiated with the Navajo and Hopi tribes on July 6th. The decision as to which tribes should be contacted was based on the geographical proximity of the Navajo reservation and the theoretical assumption, based on archeological evidence and the cultural ties between prehistoric Anasazi and modern Pueblo

peoples. The decision to consult with the Hopi rather than any other contemporary Pueblo group was based on their close proximity to the find.

In most instances when burial remains are found, it is impossible to determine cultural affiliation with living Native American groups. Determining just which tribe has jurisdiction is of considerable concern, however. According to the NAGPRA, ownership of the remains would rest with the tribe which has the closest cultural affiliation (Section 3(a)(2)), in this case the Hopi. If cultural affiliation with any group cannot be reasonably ascertained and if the land is recognized by a final judgment of the Indian Claims Commission or the United States Court of Claims as the aboriginal land of a specific Indian tribe, the remains would be judged to belong to that tribe (Section 3(a)(2)(C)(1), in this case the Navajo).

In the case of the Dan Canyon burial the response of the Navajo to the initial consultation was that analysis would be permissible prior to reburial, while the initial Hopi response was that immediate reburial was preferred. Since the presence of ceramics suggested Anasazi ancestry, consultation continued with the Hopi. Had that vessel not been present, cultural affiliation could not have been determined.

Simultaneously with consultation with the Navajo and Hopi Tribal Preservation Officers, a letter was initiated with the Bureau of Reclamation seeking funding for analysis and curation of burial remains. While the management of Glen Canyon National

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Recreation Area remains the responsibility of the National Park Service, the decisions concerning the level at which water is to be held in Lake Powell rests with the Bureau of Reclamation. Fluctuation of water held in man-made reservoirs often causes erosion and destruction of archeological resources. In this case, the exposure of the Dan Canyon burial was a direct result of fluctuation of the Lake Powell pool.

Similar dual-bureau management situations exist at Curecanti National Recreation Area and at Jackson Lake in Grand Teton National Park. In both of these instances, the Bureau of Reclamation has taken responsibility for wave-action erosion and has provided funding not only for emergency archeology but also for long-range resource evaluation and excavation projects. However, such support is not the case at Glen Canyon. Initial contacts with personnel at the National Park Service's Rocky Mountain Regional Office also indicated that Service funds were not available to assist with analysis of this burial.

In the consultation process with the Hopi no firm date was set for the reburial and by early August the burial was still at Glen Canyon National Recreation Area. During discussions with Chris Kincaid and a visit to the park in early August, Cal Calabrese learned of the burial and had an opportunity to examine the remains. It was immediately obvious that Kincaid's initial assessment of the scientific importance of the burial was accurate. The good preservation of the remains, the variety of materials present, and the lack of comparable burials indicated that the arche-

ological information potential of the burial was outstanding. Efforts were therefore renewed to secure funding for at least limited documentation.

After discussions with Regional Archeologist Adrienne Anderson concerning the scientific importance of the burial, it was agreed that limited funds would be made available to the Midwest Archeological Center to accomplish a study of the remains.

We will no doubt be confronted again in the future with questions as to who is to fund analysis when it is required. The NAGPRA does not address the problems of inadvertent discovery, emergency recovery, or funding of analysis. There is no mandate in the law that directs agencies to evaluate the scientific significance of discovered human remains or to provide funding for required analysis or reports of findings. From the initial contacts with the regional office, there was no additional detailed guidance beyond that given in NPS-28, the Service's "Cultural Resources Management Guideline" (National Park Service 1985), to cover contingencies pertaining to procedures for consultation concerning the Dan Canyon burial and the options open to park management concerning analysis and reporting of the find. (Such guidelines are, however, now being prepared consistent with the NAGPRA.) With funding assured, a joint project was developed between researchers from the Midwest Archeological Center and the University of Nebraska.

Park Archeologist Kincaid again initiated discussions with Leigh Jenkins, the Hopi

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Cultural Preservation Officer, indicating the Service's desire to study the remains and advising him of the availability of funding for such a project to be completed within a specified time frame. Hopi tribal representatives agreed to a limited study under certain conditions, which were acceptable to the Service (see Appendix A). The burial materials were subsequently transported to Lincoln, Nebraska, and a project scope statement was prepared (Appendix B), which was later reviewed by the park, the regional office, and the Hopi. There were no objections to the proposed scope of analysis. The research proceeded and a preliminary report was prepared in the specified time frame. The report that follows is the result of that research. Under other circumstances, such a detailed study might not be warranted; we leave it to the reader to judge.

With completion of the analysis, a whole host of additional problems surfaced in which we had little or no experience or guidance. In phone conversations between Kincaid and the Tribal Preservation Officer, it was determined that the remains should be escorted during the return to Glen Canyon, not merely shipped there. It was also agreed that the method of transport should be documented and that a presentation would be made to the tribal elders concerning the significance of the analysis. It was further agreed that a suitable place, near the original location of the burial, would be found for reburial.

The remains were flown to Glen Canyon on March 4, 1991, by Calabrese and Archeologist Steve Dominguez. The pros-

pect of transporting the burial by post or commercial shipper would have been repugnant to all parties concerned in the matter. Some difficulty was encountered in selecting a suitable location for reburial, as secluded locales in national recreation areas are not always easy to locate. It was necessary to select a location where the remains were not likely to suffer future disturbance and/or loss due to erosion or vandalism. These problems were overcome, however; the presentation to the tribal elders was made on March 6, 1991, and the child was reburied in a suitable location on the following day.

Although study and reburial of this particular burial were completed to the satisfaction of all parties involved, it should be emphasized that there is no mechanism in existing federal law that clearly establishes policy and procedure to be followed in unmarked burial discovery situations, or fiscal responsibility for study and disposition of remains. In this instance, it is fortuitous that many individuals, including National Park Service managers and scientists as well as the Hopi Tribal Preservation Officer and elders, had an interest in historic preservation and worked together to resolve the administrative details and cultural concerns. The analysis and reburial were successfully accomplished. This report would not have happened without the intervention and cooperation of all parties involved. In particular, the analysis would not have been possible without an understanding of our objectives by the Hopi tribal elders.

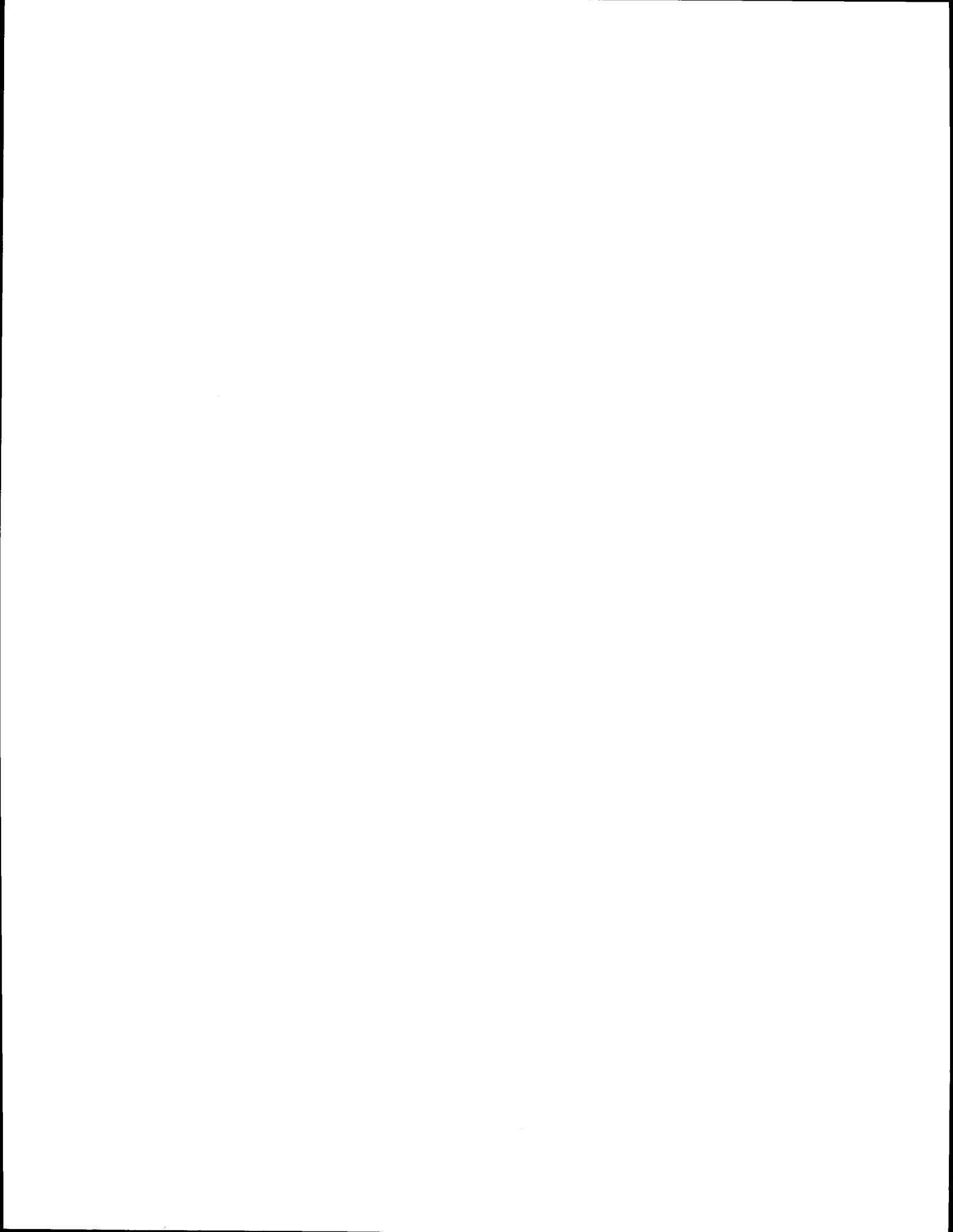
It is apparent from the burial evidence that a family from the distant past took great

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care, love, and tenderness in laying this child to rest for eternity, most probably with the belief that the child was beginning a journey into a new world. The child was provided with the clothing, food, and utensils necessary for travels through the afterlife. What was unknown to that family at that time was that the child's journey would be interrupted inadvertently some 800 years later. Nor could they have known that the burial would survive to the present time preserved well enough to provide us with a window to that past time; to provide a glimpse not only of the personal

loss of their loved one but also a view of aspects of their past lifeway. We have availed ourselves of the opportunity to view what we could through that window into the past. The resulting report may seem technical and it may raise more questions than it answers, but it does increase our understanding of those who came before us on this land. That child has now been sent on to continue his journey into the future. Perhaps there is yet more to tell. We are thankful for what we have learned, and believe that we and the Hopi of today have gained significantly in that process.

F. A. Calabrese  
Chris Kincaid



## NATURAL ENVIRONMENT

The site is at the edge of the pool line of Lake Powell, formed by the Glen Canyon Dam. This dam is located approximately 45 miles downstream from the confluence of the Colorado and the San Juan Rivers. The resulting pool floods over 180 miles of the Colorado River Valley and about 40 miles of the San Juan River Valley.

### PHYSIOGRAPHY

Dan Canyon is a small south-flowing tributary of Moqui Canyon, which in turn is a tributary of the Colorado River. This is at the northwest edge of the San Juan Triangle area (Figure 1). The San Juan Triangle is bounded by the Colorado River on the northwest, the San Juan River on the south, and the east edge of the Grand Gulch Plateau on the east. The Red Rock Plateau occupies the area adjacent to the east bank of the Colorado River (Figure 2). On the west slope of the Red Rock Plateau there are a number of roughly parallel, west- to northwest-flowing tributaries that have characteristics similar to Moqui Canyon such as elevation, size, and area drained. These tributaries include Lake Canyon, Forgotten Canyon, Red Canyon, and White Canyon. This is an area of flat, bare-rock canyon country. To the west, across the Colorado River the terrain is similar. The Grand Gulch Plateau is to the east of the Red Rock Plateau, and to the northeast are Elk Ridge and the Abajo Mountains.

### GEOLOGY

This area is within the Canyon Lands Section of the Colorado Plateau physiographic province defined by Hunt (1974:278). Bedrock consists of Chinle, Wingate, Kayenta, and Navajo formation sandstones, conglomerates, and siltstones. Overall, this province is comprised of an extensive sandstone and siltstone plain that has been highly dissected by several major rivers, the Colorado, San Juan, and Escalante, and more than 100 smaller tributaries (Gregory and Moore 1931).

Many of the tributaries are narrow, vertical- or steep-walled and deeply entrenched, while others, like Moqui Canyon, are more open. The tributaries are generally separated by long, narrow plateaus and cliff-bound mesas. Laccolithic mountains, such as the Navajo and Henry mountains, rise above this sandstone plain. Topography around the Glen Canyon area is extremely rugged, with vertical relief as great as 2200 m in less than 13 km.

Hack (1942) emphasized the importance of the sediment transport and storage cycle for modern Hopi and for prehistoric horticulture. Sediments originate in bedrock sources, and between transport episodes are generally stored in dunes and in drainages (see Figures 2 and 3). Areas of aeolian transported sand deposited on mesa tops and canyon rims, or deposited above impermeable

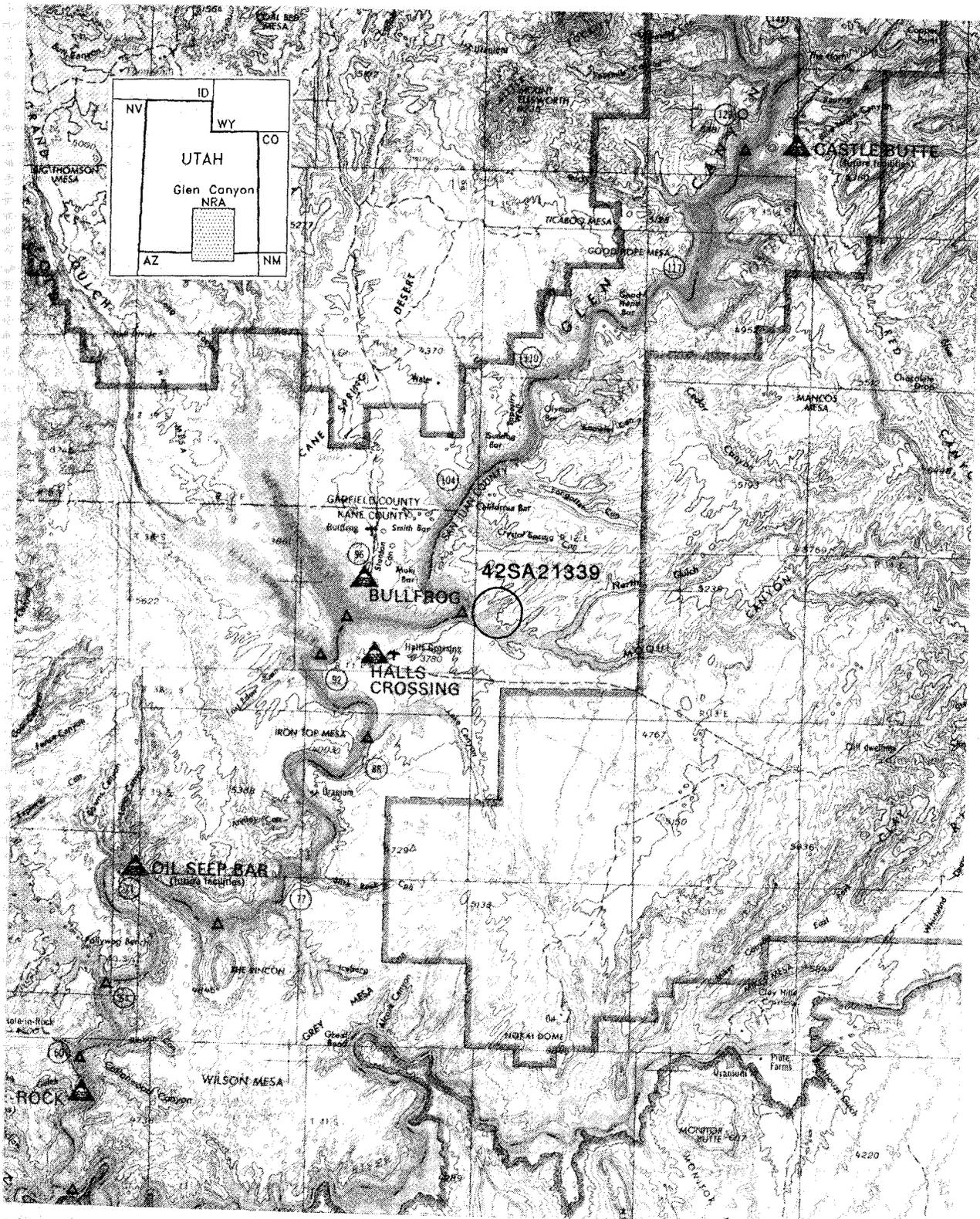


Figure 1. Map of the West slope of the Red Rock Plateau and burial location.

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Figure 2. Aerial photo of the West slope of the Red Rock Plateau looking east over the Colorado River.

soil units, were often sites where water collected and were utilized as fields. Deposition was increased in these areas by construction of brush windbreaks. Deposits of colluvial and alluvial sands within drainages slowed runoff and evaporation of water which collected from large areas, and could provide reliable soil moisture for farming.

### TEMPERATURE AND MOISTURE

Areas in and around the project area range from semi-arid, to cool desert and desert woodland. Winters tend to be cold. Summers are hot and have very little cloud cover. Mean annual temperature ranges from 8-17 degrees C (Flowers 1959; Gregory and Moore 1931).

Mean annual precipitation can be as little as about 15 cm at Lees Ferry (957 m) in the lowlands to as much as 35 cm at Monticello (2153 m) in the highlands. Rainfall tends to be biseasonal, with the wettest periods in late summer-early fall and winter. Drier conditions extend from March or April until July, and occur again in November (Cooley et al. 1969; Gregory 1916). In most of the area the Colorado and San Juan rivers are the main sources of water. Water is available less reliably and in smaller quantities from seasonal runoff, and the seeps and springs that are common in the canyons.

### ENVIRONMENTAL ZONES

In this area vegetation is controlled primarily by groundwater. Within 18 miles of

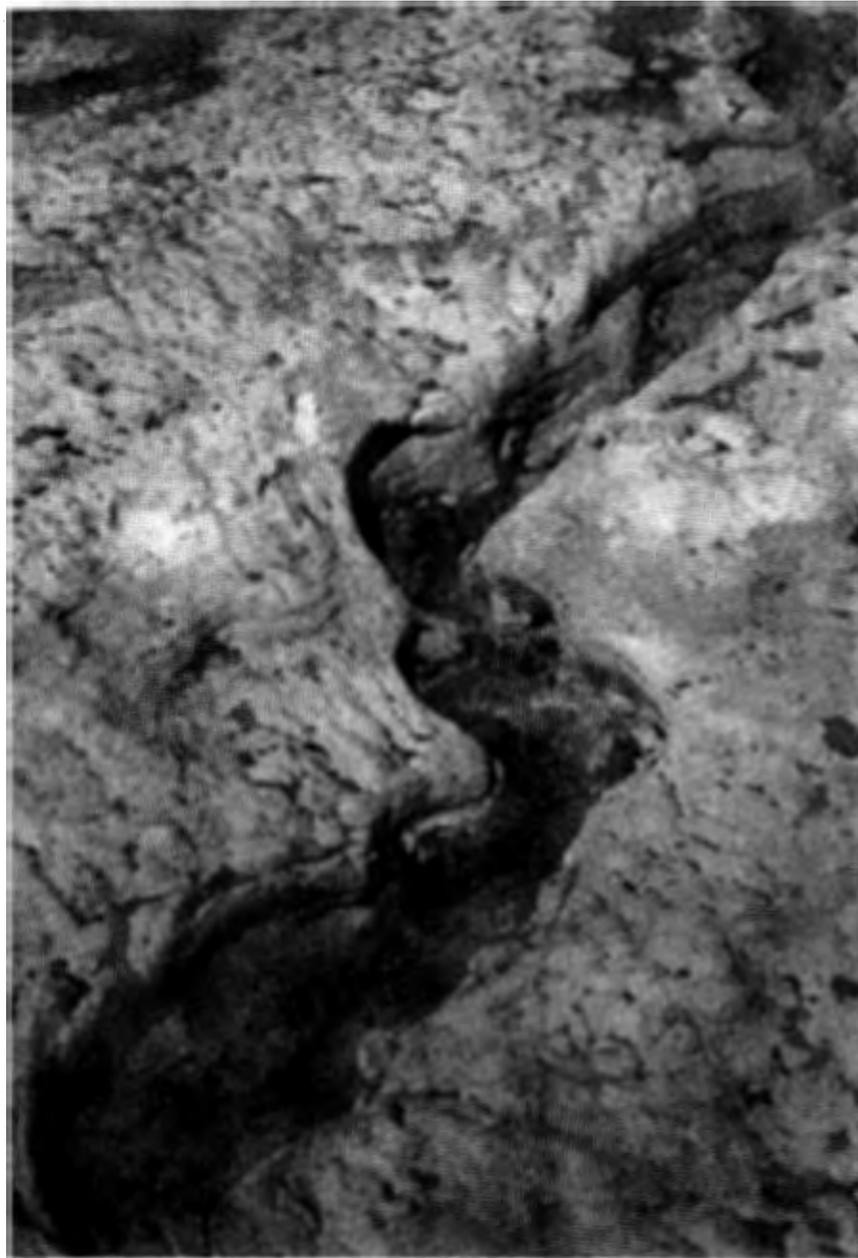


Figure 3. Aerial photo of typical canyon.

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Dan Canyon it ranges from shrublands of the Upper Sonoran to spruce-alpine fir forest of the Hudsonian Life Zone (Gaines 1957, 1960). The site is in Turner's (1982) Great Basin Desertscrub biome.

The area around Glen Canyon can be subdivided into three zones: the highlands, the uplands, and the lowlands or canyons (Tipps 1987). Although this division is based primarily on physiographic features, each zone has distinctive vegetation, climate, and hydrology. The lowlands consist of the Colorado River Canyon and tributary canyons and occupy areas between approximately 3600 and 4500 ft in elevation. The uplands include the dry, non-wooded, sand and slickrock benchlands or "platforms" which separate the canyons and the dry upper reaches of the tributary canyons. They lie between approximately 4200 and 5500 ft in elevation. The highlands generally lie above 5200 ft and include the highland masses such as the Red Rock Plateau, Cedar Mesa, and Elk Ridge.

The canyons are entrenched into the Chinle, Wingate, Navajo, Kayenta, and Entrada formations. In these areas mean annual temperature is high (roughly 14-17 degrees C) and mean annual precipitation is low (roughly 15 cm) (Tipps 1987). Water from seeps and springs in the Navajo and other formations (Cooley 1958) is generally reliable during all seasons. Most of the tributaries are intermittent or ephemeral and generally flow only following rainfall or during spring runoff. Some of the larger tributaries are perennial near their mouths where the water table intersects the surface (Cooley 1965; Cooley et al. 1969).

Due to the abundance of water in this zone, primary productivity and habitat diversity are higher than in other areas. Upper portions of this zone are often rocky and are similar to habitats of the uplands. In lower portions where groundwater is more available the phreatophytes and perennial herbs and shrubs of the Lower/Upper Sonoran are common. Willow (*Salix* spp.), sedge (*Carex* spp.), reed (*Phragmites* sp.), cattail (*Typha* spp.), cottonwood (*Populus fremontii*), and tri-lobed squawbush (*Rhus trilobata*) dominate along water courses and near seeps and springs. Saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), Mormon tea (*Ephedra* spp.), blackbrush (*Coleogyne ramosissima*), Indian rice grass (*Oryzopsis hymenoides*), sunflower (*Helianthus* spp.), and other xerophytic shrubs and annuals occupy drier areas (Flowers 1959:37-51). These diverse habitats also support a wide variety of animals (Woodbury 1965), including a large diversity of reptiles, birds, small mammals (especially larger rodents, such as rock squirrels), and large mammals (including foxes, coyotes, mule deer, and, prehistorically, big-horn sheep).

The Navajo, Kayenta, and Wingate formations are exposed in the uplands. These form large expanses of rolling sandstone outcrops with discontinuous cover by low sand dunes, large sand sheets, and Pleistocene terraces containing flakeable cobbles of various materials. Gravel terraces also cover portions of the low mesas and buttes scattered throughout this large zone. It is crossed by several deeply entrenched drainages. The uplands are hotter and drier than the canyons. Due to the paucity of topographical

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features, such as alcoves, overhangs, canyon walls, and tall vegetation these areas are exposed to wind and sun. Water is available only briefly after precipitation, or from a limited number of seeps, springs, and pot-holes.

Upland vegetation includes many desert scrub species that are capable of surviving on sparse precipitation for most of their water. Common elements include blackbrush, Mormon tea, saltbush, shadscale, Indian rice grass, sunflower, snakeweed (*Gutierrezia* spp.), yucca (*Yucca* spp.), cactus (*Opuntia* spp.) and buckwheat (*Eriogonum* spp.). In the upland area surrounding the site, ground cover ranges from 50 to 0 percent, and averages less than 10 percent.

Although vegetation is generally low and sparse in upland communities, there appear to be differences in the primary productivity and production of edible plants among habitats. In habitats on terrace-edges and high-gradient cutslopes the soils are coarser and rockier. These habitats are dominated by perennials which produce very little that is edible to humans, especially snakeweed and yucca, and few edible forbs and grasses. On low-gradient cutslopes and drainages soil textures are finer, with less rock. A wider variety of edible forbs and grasses grow in these habitats, such as ricegrass (*Oryzopsis*), sunflower (*Helianthus*), pepper grass (*Lepidium*), and sego lily (*Calochortus*).

In the past, faunal resources probably included antelope (*Antilocapra*) and small game such as jackrabbit (*Lepus* spp.), cottontail (*Sylvilagus* spp.), and a variety of rodents.

In the highlands effective moisture is greater; the mean annual precipitation is higher (roughly 30-35 cm) and the mean annual temperature (8.2-9.1 degrees C) is lower than the uplands and lowlands.

The highlands have a greater diversity and larger populations of animal life than the uplands and lowlands (Ambler et al. 1964). In these areas the diversity of plant resources is lower, but primary productivity is high. In the lower portions vegetation consists mostly of pinyon-juniper woodland, and at higher elevations, of pinyon pine and Douglas-fir forests (Hicks 1969:A32).

## PALEOENVIRONMENT

Although the paleoenvironment of the area has not been thoroughly investigated, relevant information has been acquired in other portions of the Southwest. Richmond (1962) identified a series of neoglacial advances in the nearby LaSalle Mountains which may correlate with paleoenvironmental events in lower elevations of this region. Knox (1983) implies that the timing of alluvial events in the Southwest matches the paleoclimatic sequence of Bryson et al. (1970), but notes that responses of Southwestern drainages to climate change are dissimilar to those of other regions. Baker (1983) identified several large-scale environmental changes that correlate among various portions of the Southwest, but asserts that the biotic diversity caused by the varied topography of the region has posed problems in interpretation and correlation of local events.

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Paleoenvironmental sequences have been interpreted for several nearby portions of the Colorado Plateau. For example, Karlstrom (1988), Hevly (1988), and Dean (1988) have examined paleoclimate and paleohydrology from the Late Archaic through the Late Prehistoric on Black Mesa. In areas to the east Peterson (1988) has investigated paleoclimate in the Dolores Archeological Program area, Davis (1985) on White Mesa, Lindsay (1981) at Westwater Canyon, and Matson et al. (1988) on Cedar Mesa. Results from these investigations are in general agreement on timing of events and cultural processes. To the north at Cowboy Cave, Spaulding and Peterson (1980) and Lindsay (1980) have investigated late Pleistocene through late Holocene environments. Although pollen recovery was poor in some portions of the column, results are consistent with the sequence of Bryson et al. (1970).

There have been few studies specific to the area. Lance (1963) investigated the alluvial sequence of Lake and Moqui Canyon, and found them generally consistent with Hack (1942) and Cooley (1962), but did not find conclusive evidence regarding post-Jeddito erosion. In more recent studies personnel of the Center for Quaternary Studies NAU (Agenbroad and Mead 1986) have investigated the paleoclimatic and alluvial sequences of the nearby Bowns Canyon/Bechan Cave area, as well as sequences of areas around Canyonlands.

There is general agreement among results from investigations in nearby areas that indicate large scale climatic changes during PII-PIII times, that it was a period of fluctu-

ating precipitation and population movements (e.g., Dean et al. 1985; Peterson 1988). Due to the widespread nature of the observed effects it is assumed that they are applicable over the west slope of the Red Rock Plateau.

It appears that the PII occupation, up to the mid-1100s, occurred during a favorable period. For example, results by Dean et al. (1985) working on Black Mesa, Fritts et al. (1965) on Mesa Verde, Peterson (1988) in the Dolores area, and Geib, Ambler, and Callahan (eds. 1985) in the Navajo Mountain area all show higher effective moisture during this period. Lindsay (1981) sees conditions during this period as favorable to plants dependent upon summer rainfall in the area around Westwater Canyon. Dean et al. (1985) see it as a period of low temporal variability in precipitation and a period of alluviation and rising groundwater levels. In nearby Bowns' Canyon, Agenbroad and Mead (1986) have identified a period of aeolian deposition which lasts from BMII until early PIII, and a period of alluviation which corresponds with Hack's (1942) Tsegi Alluvium.

Attempting to explain the apparent abandonment of the Red Rock Plateau during the late 1100s, Lipe (1970) cites the tree ring indices from Mesa Verde of Fritts et al. (1965). However, Geib, Fairley, and Ambler (1986) disagree that the area had been abandoned, and cite the occupation of nearby areas. They suggest that this apparent abandonment is an artifact of a shift in areas farmed (Geib, Fairley, and Ambler 1986:21).

Consistencies in the results of the investigators cited above indicate the 1200s

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were a drier period. Results of Dean et al. (1985), Fritts et al. (1965), Peterson (1988), and Geib, Ambler, and Callahan (eds. 1985), all show lower effective moisture during this period. Lindsay (1981) sees higher winter moisture and cooler conditions around Westwater Canyon. Dean et al. (1985) identify it as a period of high temporal variability in precipitation, and erosion and dropping groundwater levels. Agenbroad and Mead (1986) have identified an erosional event which corresponds with Hack's (1942) Tsegi-Naha erosion.

The severity and extent of these climatic shifts imply changes in groundwater levels, in the systems of fluvial and aeolian sedimentary exchange, and in the horticultural potentials of land in and around the Red Rock Plateau. For example, Hack (1942), Karlstrom (1988), and Agenbroad and Mead (1986) have identified contemporaneous erosional episodes which occurred during late PIII. However, Lipe (1970) says there is no evidence for loss of horticultural land in Moqui Canyon due to climatic change. Lipe (1967a:66) equates Lance's (1963) banded alluvium with Hack's (1942) Tsegi Formation. Lipe notes sedimentological changes in the upper portions of the alluvial section (Lipe 1967a:66) which buried PIII architecture, but he points out that there is no clear evidence for Hack's (1942) Tsegi-Naha erosional episode. Overall, direct evidence regarding impacts to horticultural land in Moqui Canyon is currently inconclusive.

Cultural adjustments in nearby areas are consistent with the interpretations of decreased effective moisture. Lindsay (1969) has identified Tsegi Phase changes in settle-

ment location, size, and organization, as well as probable intensification of agriculture (e.g., water control systems). Stewart and Donnelly (1943) discuss contemporaneous terrace systems on the southern slopes of Navajo Mountain. Lindsay et al. (1968) and Lindsay (1961, 1969) describe field systems in Cha, Desha, and Lower Paiute Canyons north and northeast of Navajo Mountain. Dean and Robinson (1977) show that the Navajo Mountain area is more favorable for agriculture than others, and it is likely that this accounts for the concentration of population and intensification of agriculture in the area at this time.

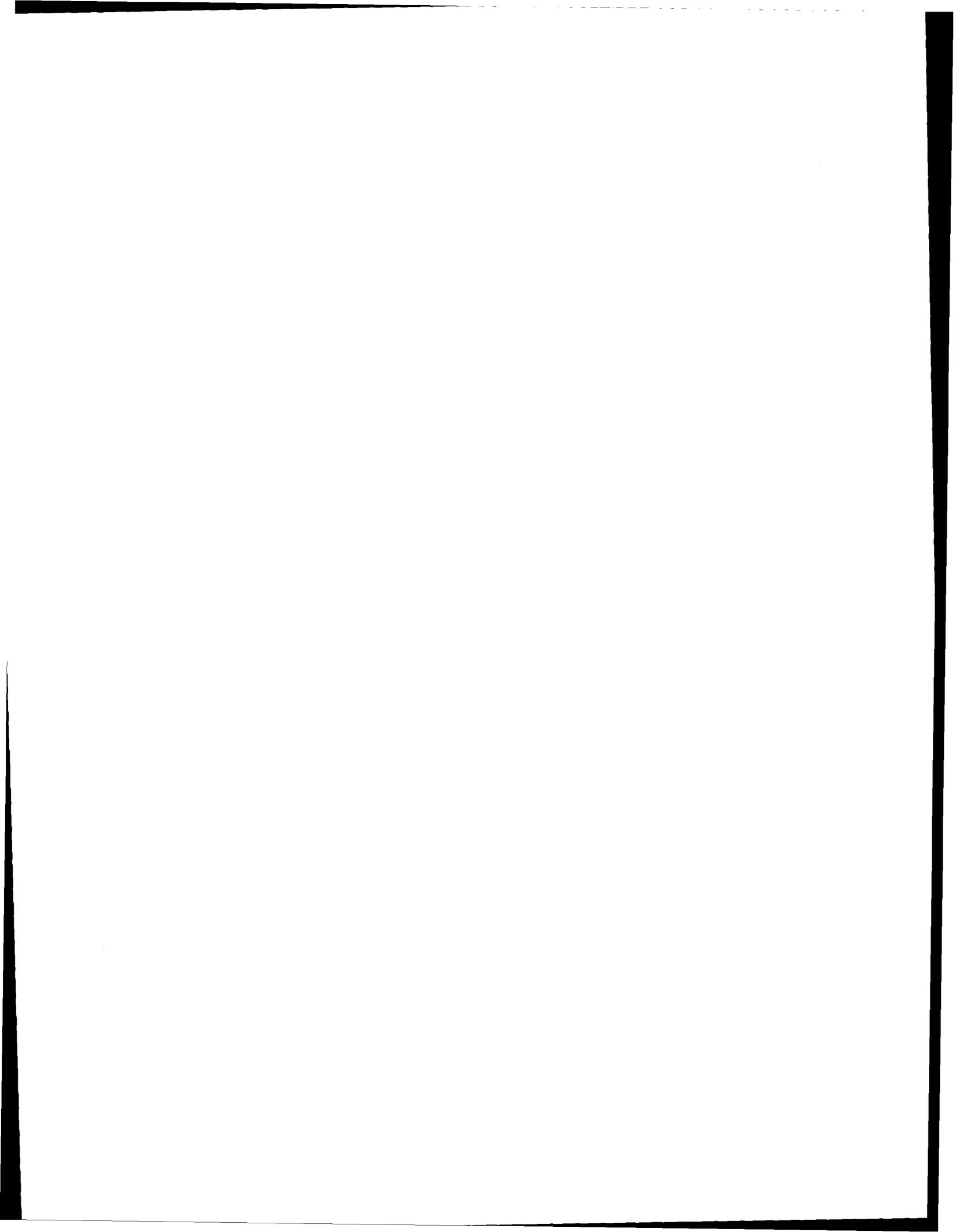
Geib, Ambler and Callahan (eds. 1985:496) discuss the decline in relative representation of domesticates, during late PIII. They see this intensification not as result of increasing reliance on the domesticates but rather as manifestation of efforts to enlarge "... the anthropogenic ecosystem and increase the reliability of the plant foods from this system during a time of less favorable climatic conditions and population growth...."

Biogeographic events which accompanied this paleoclimatic event appear to have encouraged greater use of wild plants. Investigations of domesticates indicate that corn, beans, squash, and cotton were all grown in this area, and were common (Bye 1978, 1979, 1980a, 1980b). Coprolite studies (Fry 1976) indicate common dietary use of all those domesticates during much of the Anasazi occupation. However, investigations in areas south of the San Juan River indicate increases in frequency of use of ruderals and other wild plants during the late PIII (Geib,

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Ambler and Callahan, eds. 1985; Heath and Schroedl 1989). It is likely that use of the sandy uplands increased during this time. Ramaley (1939) has discussed the high diversity of wild plants, including edible plants, associated with unstable aeolian sands in other regions. Ricegrass is associated with dry sandy soils, and probably increased in frequency during this drier period. Rice grass was a resource commonly acquired from these areas (Liestman 1986). Tipps (1987) identified a number of sites apparently created by plant processing in areas to the west, and stressed the importance of the use of upland areas in resource procurement.

There are many aspects of paleoenvironmental conditions which remain unknown. This includes information regarding changes in temperature and precipitation, particularly with regard to changes in seasonal timing of critical events (e.g., last and first frosts, late summer rains), and the reliability with which critical events occurred. The rates, frequencies, magnitudes, and duration of disruptions may eventually be interpreted from dendrochronologic sequences and other proxy data. An accurate chronology of those disruptive events will be crucial in identification of consequential changes in the quantities, spacing, reliability, and timing of resources.



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### PREVIOUS RESEARCH IN THE AREA

During the Upper Colorado River Basin Salvage Archeology Program (UCRBSAP) a large number of preconstruction investigations were conducted in the park. The results of these have been summarized by Jennings (1966). In subsequent years investigations have gathered additional information and further synthesized archeological data for block surveys and for excavations around the park (e.g., Bremer and Geib 1987; Geib, Bungart, and Fairley 1987; Geib, Fairley, and Bungart 1986). The state of research and the cultural sequence for the park have been most recently summarized in Geib, Fairley, and Ambler (1986). There have been no large-scale integrating studies of the past social, economic, and technological systems, especially for the upland areas above the pool line (Geib, Fairley, and Ambler 1986). In past years, research on paleoenvironments has been limited, and has mostly concentrated on chronostratigraphy (e.g., Lance 1963). In recent years more inclusive research on this subject has been initiated by the University of Northern Arizona (Agenbroad and Mead 1986).

Data specific to the cultural history around Moqui Canyon was collected during the UCRBSAP and later investigations, as summarized below. Lipe's (1970) syntheses of Anasazi cultural history in Red Rock Plateau, specifically covers the area around Moqui Canyon and provides the best summary to date.

A number of earlier archeologists such as Clayton Wetherill, Neil Judd, and the Bernheimer Expedition passed through this area and were aware of the Anasazi occupation of Moqui Canyon (Day 1963). A number of BMII burials was collected by Bernheimer, but little other investigation was conducted. During Glen Canyon preconstruction (UCRBSAP) surveys, a total of 100 sites of various affiliations was identified (Day 1963; Fowler 1959a, 1959b, 1960, 1961; Lipe et al. 1960a). A total of 23 was recorded in nearby Lake Canyon (Fowler 1959b). An additional seven were recorded in Moqui Canyon (Schroedl 1976) during a later survey of Moqui Canyon and Lake Canyon. A large number of other Anasazi sites have been recorded during work in the Defiance House area, approximately four miles northwest (Schroedl 1981), and in Forgotten Canyon (Fowler 1959b), approximately four miles to the north.

A number of sites in and near Moqui Canyon has been excavated. In 1959 three sites were excavated in Moqui Canyon (Lipe et al. 1960a); in 1961 nine sites were excavated (Sharrock et al. 1963); and in 1962 an aceramic site of unknown affiliation, 42SA369, was partially excavated (Sharrock 1964). In addition, five sites were excavated in nearby Forgotten Canyon and the Defiance House area (Lipe et al. 1960a). In 1960 twenty sites were excavated in Lake Canyon (Sharrock et al. 1961).

In all, surveys have identified at least 65 Anasazi sites in the townships occupied by

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Moqui Canyon (MWAC 1989) and twelve have been excavated to some extent. Affiliations include BMII, PII, and PIII (Fowler 1959b, Lister 1959). Some potential PIV ceramics, including Jeddito Yellow Ware and Awatobi Yellow Ware, were collected in Moqui Canyon and the surrounding area (Lister 1959), but these represent only brief, seasonal occupation (Fowler 1959b).

Several reports have been written which concern economic or technological issues specific to the area. Cutler (1966) and Bye (1978, 1980) have investigated domesticates (corn, beans, squash, cotton, and others) from various portions of the park, including this area. Weder (1977) has examined some aspects of tool production on lithic materials from Moqui Canyon.

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Paleoindian, Archaic, and Protohistoric materials have been observed in and around the area (e.g., Geib, Fairley, and Ambler 1986; Hauck 1979a, 1979b; Lindsay et al. 1968; Schroedl 1976, 1979; Tipps 1983, 1984, 1987). However, due to the affiliation of the burial, this cultural history summary emphasizes the Anasazi, and particularly the PII to PIII sequence. Other background information regarding the cultural sequence of the area is available in Jennings (1966), Lindsay et al. (1968), Lipe (1967), Schroedl (1976), and others.

Most of the materials in the Glen Canyon National Recreation Area (GCNRA) are Anasazi (Geib, Fairley, and Ambler 1986). Basketmaker II localities (pre A.D. 1 - 600/

700) were common in the area, and several site clusters have been investigated in the area around Dan Canyon (Lipe 1967, 1970). Additional information regarding the BMII occupation of the area is available from Adams et al. (1961), Lindsay et al. (1968), Lipe (1960, 1967, 1970), and Long (1966). Basketmaker III (A.D. 600 - 800) is not common in this area (Lipe 1967, 1983). Basketmaker III sites in the area include several recorded along the tributaries of Navajo Canyon (Miller and Breternitz 1958a, 1958b). Pueblo I (A.D. 800 - 1000) is probably absent from the area (Geib, Fairley, and Ambler 1986). The only well-documented Pueblo I sites in the area are those along Navajo Canyon (Miller and Breternitz 1958a, 1958b) and at the southern end of Piute Mesa (Stein 1966).

Based on data from the Glen Canyon Project (Adams et al., 1961; Fowler 1959a; Lipe 1960, 1967, 1970; Lister 1959; Long 1966), Tipps (1987:14) notes that: (1) some portions of the Glen Canyon area were never intensively utilized, (2) different areas were occupied at different times, and (3) different areas were occupied in different intensities. This is probably due to a variety of factors, including high topographic relief, variability in moisture received in different drainages and in different parts of drainages, variability in types and depths of sediments, and consequent differences in hydrology and economic potentials.

The communities of the west slope of Red Rock Plateau were near the edge of the Anasazi area. Surveys to the northwest of the Colorado River have yielded relatively little material diagnostic of Anasazi occupation (e.g., Christenson 1983; Geib and Bremer

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1988; Suhm 1959). It appears that the PII-PIII use that did occur was infrequent, short in duration, seasonal, involved little or no agriculture, and occurred most frequently in canyon areas near the river (Geib and Bremer 1988; Geib, Fairley, and Bungart 1986).

Areas southeast of the Colorado River, including the Red Rock Plateau (Lipe 1970), were more heavily utilized. This was occupied intermittently during PII through PIII times, with an early PIII hiatus (Lipe 1967, 1970). The Pueblo II to Early Pueblo III (A.D., 1100 to 1150) period is referred to by Lipe (1970) as Klethla Phase. The Late Pueblo III (A.D., 1210 to 1260) is referred to as Horsefly Hollow Phase (Lipe 1970). During these times, several clusters of habitation sites were occupied in the west-slope drainages of the Red Rock Plateau, in Red Canyon, White Canyon, Forgotten Canyon, Lake Canyon, Moqui Canyon, and Wilson Canyon, as well as the upper portions of the plateau (Lipe 1970). No large sites or structural sites occur in the upland areas between the canyons. However, Tipps (1987:18) states that "the uplands were also an important aspect of the Puebloan seasonal round, providing small game, seeds, greens and roots, particularly in the late winter and early spring when stored food supplies had been exhausted."

In the lowlands, the habitation sites usually occur in canyons containing arable alluvium, alcoves, and sources of water (Lipe 1970; Tipps 1987). Extensive trash deposits and ceremonial architecture are rare. Most of the sites contain a limited range of artifact types, which implies a restricted range of activities at most sites. Lipe (1970) sees these restricted assemblages as evidence of activi-

ties specialized by site. Storage facilities and masonry surface rooms suggest storage of horticultural products and probably gathered wild resources. Highland sites are generally larger, more formalized jacal and masonry pueblos that contain storage, habitation and specialized work areas, kivas, and extensive trash middens. Most contain a full range of domestic artifacts and were probably occupied year-round (Ambler et al. 1964; Lindsay et al. 1968; Stein 1966).

Both Kayenta and Mesa Verde Anasazi influence are represented in the Red Rock Plateau area (Geib, Fairley, and Ambler 1986; Lipe 1970), and ceramics from both areas are common in the settlements of the east-bank tributaries. The relative contributions from the two areas differ from PII to PIII times. Klethla Phase sites have yielded more Kayenta ceramics (Lipe 1970). Horsefly Hollow sites have yielded Kayenta and Mesa Verde ceramics in roughly equal frequencies (Lipe 1970).

### Klethla Phase Occupation

The Klethla Phase corresponds to a period of conditions favorable to agriculture in other areas (e.g., Peterson 1988) and expansion of Anasazi ranges (e.g., Dean et al. 1985). Lipe (1970) sees this as part of a general movement of Kayenta people into the Glen Canyon area as a whole, including the Kaiparowitz Plateau, Cummings Mesa, and the southeast edge of the Aquarius Plateau. The apparent abandonment which occurred about A.D. 1150 is contemporaneous with a sharp population decline in this area. Lipe (1970) sees this as a result of decreased precipitation in the late 1100s.

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Alternatively, Geib, Fairley, and Ambler (1986) suggest this apparent abandonment is an artifact of a shift in areas cultivated, from the middle reaches of tributaries to pockets of cultivable land adjacent to the main rivers.

During the Klethla Phase on the Red Rock Plateau, only areas with large patches of arable land were occupied. Narrower canyons, such as Wilson and Slickrock, show no evidence of occupation. Residential units were small. All Klethla sites in the west-slope drainages have few surface structures, and only one pithouse and possibly three kivas have been identified among them. More extensive building occurred in other areas, including Upper Castle Wash and Upper Glen Canyon (Lipe 1970). At 42SA701 an elaborate reservoir and system of ditches was built to irrigate plots with springwater, but only two small rooms were found associated with it (Sharrock et al. 1961). In comparison with the Horsefly Hollow sites, storage structures are rare among Klethla Phase remains, but large campsites are common (Lipe 1970).

Overall, Lipe (1970) sees a large total population and great dependence on more productive agriculture, but small units of co-residence. These units probably consisted of single nuclear families, or small groups of two or three families, which lived in open camps as often as in structures. Lipe suggests they are young people unable to secure suitable farming land in their home areas. There is some evidence of formation of larger groups and of mechanisms for integrating several minimal residential units (e.g., the water control facilities at 42SA701). The few kivas identified did not appear to be associated

with particular groups of residential structures, and possibly served to integrate groupings larger than the household.

In this assessment Lipe has assumed year-round residence, but admits it is possible that these sites are actually seasonally used facilities of groups associated with sites in the highlands (Lipe 1970:119). Among the evidence which potentially supports this he cites the high frequency of pottery with paucity of grinding tools at several important sites (Lipe 1970:120). However, he points out that large, well-built communities are the exception in most of the Anasazi range and generally occur in highly favorable areas. He further asserts that the attributes discussed previously are more characteristic of Kayenta settlement.

### Horsefly Hollow Phase Occupation

Following a 50- to 60-year period of decreased population, population again increased in the southeastern part of Glen Canyon Basin. In particular, the number and size of sites on Cummings Mesa increased (Ambler, Lindsay, and Stein 1964). Occupation also intensified in the highland areas of Lower Glen Canyon late in the period (Ambler, Fairley, and Geib 1983; Ambler, Lindsay, and Stein 1964). At this time the Red Rock Plateau was repopulated, with the highest population occurring during the early and middle 1200s (Lipe 1970). However, the western part of Glen Canyon Basin, including the Kaiparowitz Plateau and the Aquarius Plateau remained unoccupied. Lipe (1970:122) attributes reoccupation to the end of the 1100s drought, loss of farming areas at

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upper elevations during the cool neo-Pacific climatic episode, loss of farmland due to arroyo-cutting, and/or population increase in the Navajo Mountain area.

This occupation appears to result from an influx from both the Kayenta and Mesa Verde areas. Ceramics from both are common in all areas of the San Juan Triangle. However, Kayenta ceramic types are more common to the south and west, while Mesa Verde ceramic types are more common in northern and eastern sites. The Horsefly Hollow Phase was named after a site in Lake Canyon which bore equal frequencies of each (Lipe 1970:123).

Horsefly Hollow Phase occupation was heavy in all the areas occupied previously in Klethla Phase, but also occurred in areas not previously occupied during the Klethla Phase. These areas include narrower, deeper, and less accessible canyons (Lipe 1970), where cultivable areas tend to be smaller, more dispersed, and more prone to flooding. This tends to support contentions that this is a period of maximum population, and fullest possible use was made of land resources (Lipe 1970).

Compared with Klethla Phase sites, Horsefly Hollow Phase sites tend to be located more often in protected, elevated places; to have more structures with more use of masonry; to have more kivas; to have more storage facilities; and to show more functional differentiation among sites. Lipe (1970) has asserted that the sample from which these inferences are made is adequate, and that these attributes are not an artifact of site loss due to alluviation and erosion.

Lipe (1970) identifies six site clusters on the Red Rock Plateau, each of which may have comprised a community. These include Wilson-Slickrock-Alcove Canyons, Moqui Canyon, Forgotten Canyon, Upper Glen Canyon, Upper Castle Wash, and Lake Canyon.

The Moqui Canyon site cluster is similar to and possibly related to the Wilson Slickrock-Alcove cluster and the Forgotten Canyon cluster. The sites in these clusters usually have a small assemblage, consisting of ceramics, grinding tools, hammerstones, and flaked lithics, which varies among the sites. The most common site type is the small residential pueblo, with structures either isolated or standing in small groups, usually along a narrow ledge or above a talus slope. Usually these have one to five living rooms with a firepit and/or mealing bin(s); a small courtyard or open work area with fireplace, and sometimes mealing bin(s) and/or loom anchors; usually a kiva; several rooms without roofs, but occasionally with a hearth or other floor features; and several well-built masonry storage structures in a variety of sizes and shapes. The small size of the sites suggests these were occupied by only several nuclear families or a small extended family, or, in the smallest sites, by a single nuclear family (Lipe 1970).

Although horticulture continued to supply a large portion of the nutrition during the Horsefly Hollow Phase, it is believed that the upland habitats were being extensively utilized for their abundant wild resources (Tipps 1987). In areas to the south, relative representation of domesticates decreased during late PIII (Geib, Ambler, and Callahan, eds., 1985), as discussed earlier.

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The Dan Canyon site appears to be an element of the Late PIII occupation of Moqui Canyon. A number of Horsefly Hollow Phase sites has been identified nearby, and nine of them are less than five miles from the Dan Canyon site. These nine sites include seven with storage and/or residential structures (42SA583, 42SA576, 42SA720, 42SA786, 42SA730, 42SA740, and 42SA729), and two with storage, residential structures, and kivas (42SA585 and 42SA678).

### Late Prehistoric/Protohistoric

The Southern Paiutes probably occupied the Lower Glen Canyon area sometime after A.D. 900 and followed a seasonal round

of hunting and gathering and limited horticulture (Lamb 1958). Diagnostic items often used to define Southern Paiute occupations include Desert Side-notched project points and roughly-made brownware ceramics. These have been identified in several sites around the lower Glen Canyon area (Holmer and Weder 1980; Lister 1959; Sweeney and Euler 1963). The presence of small quantities of Sikyatki, Jeddito, and Awatobi ceramics (Lister 1959; Geib and Bungart 1988) and Hopi-style rock art (Geib and Bungart 1988) constitute evidence for limited use of the area by PIV (Hopi) groups, although these appear to result from short-term and infrequent use of the area (Geib and Bungart 1988).

## RESEARCH CONTEXTS

This section briefly reviews the research potential of the materials based on the data inherent in the material types and their contexts.

### HUMAN REMAINS

Although studies of prehistoric Anasazi diet from coprolites and of disease through skeletal remains are relatively common aspects of archaeological research, rarely have the two approaches been combined in the Four Corners region. The complementary study of coprolites (intestinal contents) and associated skeletons has been done in the lower Pecos of Texas and in the Mimbres area of New Mexico. These studies have provided detailed information regarding prehistoric health care for individuals suffering from specific disease conditions. To date, no such information is available for the Four Corners region.

The find of a subadult burial in Dan Canyon, a tributary of Glen Canyon, provides the opportunity for examining the specific ailments of a young individual and the diet and medicines given to that individual. Skeletal analysis provides a record of disease. Analysis of intestinal contents provides information regarding the foods and medicines provided to the sick immediately prior to death.

### ARTIFACTUAL REMAINS

The assemblage of grave goods was seen as a source of supplementary information regarding the chronology and cultural affiliation, economy and potential external economic ties, and status of the individual. These include the cultural affiliations implied by the diagnostic item, the canteen, as well as chronological implications of the canteen and the textiles.

Information regarding technology and economy includes comparisons of production techniques and/or artifact types to those from other Anasazi sites. Probable origins of materials are viewed as evidence regarding potential external and internal economic relations.

Considered as a whole, the attributes of the assemblage bear implications regarding the status of the individual. This assemblage was compared with the burial assemblages of other individuals of the same age group. The site was also considered in the context of the natural and cultural environments. These remains have been considered in the context of their location within the cultural region, as well as the surrounding settlement types and their dispersal. In particular they are considered in the context of paleoenvironmental change and cultural adjustments to the changing climates.

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### TAPHONOMY

This burial consists of an assemblage of organic materials which were in excellent condition when placed in the primary deposit. Several subsequent events, including long-term dessication, short-term inundation,

and exposure have altered these remains. Consequently, these remains can yield information regarding postdepositional changes due to natural decay, and due to inundation and subsequent exposure. Results may have implications for resource management.

## METHODS

### FIELD PROCEDURES

Field investigations were conducted by Chris Kincaid, Marla Knickrehm, and Steve Luckeson of the Glen Canyon National Recreation Area. Subsequent text which covers field methods and the nature of the site borrows heavily from their notes.

Documentation began with the completion of the Intermountain Antiquities Computer System (IMACS) form and site map. The entire surrounding talus cone was inspected for cultural materials. This yielded only a rock alignment, which is discussed below. Black-and-white and Kodachrome slide photographs were taken of the setting and the site prior to excavation.

A 1-m-x-2-m test unit was placed over the burial clearing and surrounding area. Surface cultural materials (including those found by Ranger Luckeson) were mapped and shown in relation to talus stones and boulders. A catalog of items collected was compiled (Appendix C). Prior to excavation, notes were taken on the surface appearance of each test unit (discussed below).

The burial and associated remains were essentially "floating" in a matrix of loose, dry fill composed almost entirely of aeolian sand. The cultural materials were extremely fragile and easily disturbed, so that even brushes could not be used for exposure. The sand literally had to be blown away from baskets and other fibers which almost disintegrated at the slightest touch. Hundreds of short

sections of split yucca from plaited baskets were loose in the fill. All materials were screened through 1/16-inch mesh, and the contents of all screen "dumps" were saved.

Exposure of the burial was difficult because of the looseness of the fill. Documentation through sketching and photographs was completed at the existing surface and again at approximately 25 cm below the existing surface. At approximately 35 cm below the surface, the soil became fairly damp.

In excavating the burial, no obvious signs of "mummification" were seen, although distinct discoloration and cohesiveness of the soil was visible in specific areas. These areas were noted and fill materials bagged separately when possible. No wraps or fabric were noted during excavation, although fibrous materials were removed later from the screen contents. Several unidentifiable clumps of organic material were also noted and bagged separately.

After excavation, materials were carefully wrapped and removed to park offices in Wahweap. They were not entered into the park museum collection.

### LABORATORY PROCEDURES

Research methods involving visual examination and measurements have been emphasized in order to achieve as complete a documentation of the remains as possible, while staying within the guidelines established

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by the Hopi people. The methods of analysis were non-altering and non-destructive in nature.

### Corporeal Remains

#### *Coprolites*

When found with skeletal or mummified remains, the analysis of mummified intestinal contents can provide dietary information (Fry 1976; Reinhard and Bryant 1991; Reinhard and Hevly 1991; Wakefield and Dellinger 1936), medicinal information (Reinhard et al. 1991; Shafer et al. 1989), and parasitological data (Allison et al. 1974; Callen and Cameron 1960; Ferreira et al. 1983; Horne 1985; Ruffer 1910; Turpin et al. 1986). The techniques for such analysis are derived from established coprolite analysis procedures (Reinhard and Bryant 1991) which incorporate macroscopic analysis of plant and animal remains and microscopic analysis of pollen, phytoliths, and parasite eggs.

These techniques have been applied to coprolites recovered from an Anasazi burial from Dan Canyon. The results of the analysis provide insights into past diet and health, and into the preservation that can be expected of botanical remains after inundation.

Seven coprolites, preserved by desiccation, were found with the burial and represent preserved intestinal contents. The fact that they do represent intestinal contents is verified by the presence of mummified intestinal wall partly covering one of the coprolites. All coprolites are dark colored and granular. One gram fragments of each type were submitted for analysis.

Three coprolites were selected for analysis from 20 recovered from the burial. Past experience has shown that the intestinal contents of mummies can contain evidence of several meals (Reinhard and Hevly 1991). The sampling of the Dan Canyon burial coprolites was done to optimize the chance of sampling several areas of the intestine and therefore several meals. For macroscopic, phytolith, and parasite analysis, 9 grams were taken from coprolite A, 6.5 grams from coprolite B, and 2.5 grams from coprolite C. For pollen analysis, one gram fragments were processed from coprolites A and B and a 2.5 gram sample was taken from coprolite C. The coprolites were taken from what appeared to be morphologically distinct areas to increase the chance of obtaining data on several meals. Coprolites A and B were adhered to each other and clearly were discrete units in the intestinal tract. Coprolite C was smaller than the others and was thought to come from a different portion of the intestine than A and B. The macroscopic, parasite and phytolith analysis, processing and analysis of the coprolites followed these stages: (1) the coprolites were reconstituted in 0.5 percent trisodium phosphate for 48 hours; (2) the coprolites were mechanically desegregated after rehydration; (3) the desegregated residues were screened through a 300 micrometer mesh to separate macroscopic material from microscopic detritus; (4) the macroscopic remains were dried on blotter paper at room temperature and were analyzed after drying; (5) the microscopic residues were concentrated by centrifugation and sedimented in acetic formalin alcohol (AFA). Microscope preparations were then made from these sediments; (6) the preparations

## METHODS

were examined for parasite eggs, hair, mites, fungal spores, and phytoliths.

For pollen analysis, the pollen samples were treated with hydrochloric acid to dissolve carbonates, hydrofluoric acid to dissolve silicates, and a heavy density flotation in zinc bromide (specific gravity 2.0) to separate light particles from heavy particles. The floated remains were then treated with an acetolysis solution to dissolve cellulose, hemicellulose, and chitin. The residue from this process was transferred to glass vials in alcohol and sedimented. The sediments were used to make microscope pollen preparations and a minimum of 200 pollen grains were counted for each specimen to insure statistical validity (Barkley 1934). At the beginning of pollen processing, a *Lycopodium* spore tablet was added to each sample. The tablets each contain 11,200 plus or minus 400 spores. The addition of the spores allows for the quantification of microscopic remains by calculating ratios with the known number of spores added to each gram of material.

The examination of macroscopic sediments was accomplished with a binocular dissecting scope. Identification of seeds was based on a seed comparative collection. Microscopic remains were examined with a compound binocular microscope. The larger microscopic remains were examined for the presence of plant cuticle, seed fragments, phytoliths, and other identifiable objects. The smaller microscopic sediments were examined for parasite eggs.

After the analysis of these three coprolites was completed, the remainder were ex-

amined with a dissecting microscope to determine whether or not all coprolites contained the same components.

### *Skeletal Remains*

Guidelines for the study of human remains have been established in recent years in order to achieve complete and holistic reconstructions prior to reburial, while maintaining compliance with the requests of the living descendants. Twenty-two data collection categories have been established by the Paleopathology Association for analysis of osseous and mummified remains slated for reburial (Table 1). Use of these guidelines will establish uniform standards in osteological analysis and in the process satisfy both the goals of the researcher and descendant. Maximum scientific data was to be collected from the remains, utilizing methods which were non-destructive and non-altering. To insure the recovery of maximum data the above guidelines were followed with respect to the limitations of non-destructive research.

Analysis was carried out on all human skeletal remains recovered from Dan Canyon burial 42SA21339. A single sub-adult individual of undetermined age and sex was represented. The skeletal material displayed fair preservation with slight to moderate taphonomic alterations due to inundation. Limited mummification of soft tissue had occurred in regions of the digestive tract and in small portions of the scalp. The remainder of materials exhibited no mummification, but were covered with a fine sand from the fill matrix.

# DAN CANYON

TABLE 1: Minimal data collection categories as established for reburial analysis by the Paleopathology Association. Osseous and Mummified Remains

Analysis Type	Non-destructive in nature	Completed for Dan Canyon
1. Demographics	yes	yes
2. Growth assessment	yes	yes
3. Skeletal metrics	yes	yes
4. Dental metrics	yes	n.a.
5. Skeletal inventory	yes	yes
6. Harris lines	yes	yes
7. Enamel hypoplasias	yes	yes
8. Nutritional deficiencies	yes	yes
9. Infectious lesions	yes	yes
10. Degenerative conditions	yes	yes
11. Trauma	yes	yes
12. Neoplasms	yes	yes
13. Dental pathology	yes	yes
14. Dental attrition	yes	yes
15. Bone radiography	yes	yes
16. Bone histology	no	no
17. Stable isotopes	no	no
18. Trace elements	no	no
19. Nonmetric genetic markers	yes	yes
20. Postmortem modifications	yes	yes
21. Premortem modifications	yes	yes
22. Biological anomalies	yes	yes

Only non-destructive methods were employed in the analysis of the remains in compliance with the wishes of the Hopi people. Examination through visual and radiographic means provided information as to the age, health, and nutritional status of the individual.

Descriptive analysis entailed a complete documentation of all human bone material recovered from the burial site. A skeletal inventory of each complete bone and bone fragment was compiled, and photographic records of the bone and dental representation were kept.

Age was deduced through macroscopic examination and radiography. Visual esti-

mates of age were based on epiphyseal union of the long bones (Steele and Bramblett 1988), fusion within the vertebral column (Girdany and Golden 1952), and union of the occipital segments in the sub-adult crania (Snow and Luke 1984).

Radiographic images of the maxilla and mandible were taken to allow for more accurate age estimates based on tooth eruption and development. Stages of eruption and calcification were scored according to standards established by Ubelaker (1989) and Moorrees et al. (1963a and 1963b).

Growth was assessed on the basis of long bone measurements following the standard growth charts of Ubelaker (1989). Stat-

## METHODS

ure was determined from the diaphyseal lengths of the femora, tibiae, humeri, radii, and ulnae. Osteometric tools utilized in the analysis included an osteometric board and a large sliding caliper. Correspondence to, or deviations from normal growth rates for the determined age was recorded. Variations related to gender, nutrition, and population make accurate growth standards difficult to ascertain. General estimates, however, were deduced.

Stress assessment was based on the occurrence of growth arrest lines in the long bones of the skeleton, and enamel hypoplastic defects in the dentition. Harris lines appear as radiopaque transverse markers in x-rays of the long bones of the skeleton. Periods of disease and nutritional deficiency followed by resumed growth have been determined as causes of the line formation (Gindhart 1969; Harris 1933). X-rays of the long bones were taken and examined for evidence of these growth disturbances. Enamel hypoplasias, similarly caused by disruptions in growth due to disease and malnutrition, (Goodman 1991) were scored. These disruptions occur in the dentition of an individual when the production of enamel is halted and then resumed. Visual examination and radiography were utilized in the detection of the condition.

Analysis of the remains for pathological conditions was conducted through macroscopic examination of the bone, microscopic examination involving the use of a dissecting microscope, and radiography. Conditions related to trauma, infection, and disease were scored for. Particular emphasis was placed on the detection of *cribra orbi-*

*talia* and porotic hyperostosis, conditions common among Anasazi sub-adult crania of debatable etiology (Steinbock 1976; Walker 1985).

Examination of culturally induced changes which may have altered the skeletal remains in shape or form were analyzed as to the specific degree of bone modification.

Effects of inundation on the skeletal taphonomy were assessed with respect to warpage, preservation, and internal and external changes in bone composition. Visual examination, measurement, and radiography were used.

### Artifactual Remains

#### *Lithic*

These include three flakes and one broken pendant. Information recovered includes material types, production techniques, and functional categories. Analysis includes: (1) measurement and description, visual examination and measurement of standard landmarks with calipers; material typing by visual examination only; and (2) photography, both black-and-white and color photo records.

#### *Ceramics*

This consists of a single vessel. Information recovered includes ceramic ware and type for chronology and affiliation, material types, construction and finishing techniques. Functional categories of analysis were: (1) measurement and description, including visual examination and measurement with

## DAN CANYON

calipers, and material typing by visual examination only; (2) photography, both black-and-white and color photo records; and (3) phytolith and pollen wash of distilled water over small area of vessel, then microscopic examination.

### *Botanical*

Vegetal remains include fiber and wood artifacts, food, non-artifactual charcoal, and incidental products of decomposition. These yielded information regarding chronology, production techniques, material types, ethnobotany, economy, and post-burial conditions (taphonomy).

*Macrobotanical remains.* A 200-millimeter (178 grams) subsample from the midden was removed from the plant remains and weighed. The plant remains were then processed through a series of screens of various sizes, which included 1/4 in, 1/8 in, 1/16 in, and 300 micrometer mesh. The remains were dry screened because of the excellent preservation of plant remains in unconsolidated matrices. With such preservation, it is unnecessary to float the samples. Soil passing through all screens was collected and the macroscopic remains were sorted and identified.

Sorting of all remains (the midden and other areas) was done by material type (i.e., *Juniperus* twig, *Oryzopsis* seeds, etc.). In addition to this, each material type was counted or weighed in order to determine the abundance of each plant present at the site. The smallest of the remains were sorted, identified, and counted with the use of a dissecting microscope.

The macroscopic remains were identified by consulting published texts (Elmore 1976; Martin and Barkley 1961; Stubben-dieck, Hatch, and Hirsch 1986), as well as by comparing remains to specimens curated by the Department of Anthropology, University of Nebraska (UNL). Also, some problematical faunal remains were examined by Dr. Karl J. Reinhard (Dept. of Anthropology, UNL), Rob Bozell (Nebraska State Historical Society), and Ken Cannon (Midwest Archaeological Center, National Park Service). These are listed in the appropriate section.

*Phytolith analysis.* During macroanalysis of materials recovered from the Dan Canyon burial, some plant materials were unrecognizable. It was determined that phytolith recovery from these materials would greatly enhance identification of organic materials associated with the burial. Phytoliths are silicified crystals that are formed in plant cells, cell walls, and intercellular spaces. Because phytoliths conform to the different shaped cells produced by different plants, they have taxonomic importance in identifying plants to family, genus, and occasionally to species level. This application is especially useful when plant material, recovered from archeological sites, is unidentifiable during macroanalysis.

Three different organic materials were selected for phytolith processing, based on empirical observations. The first sample, from DC-17, had a grainy, platy appearance and contained large amounts of incorporated sand grains. The second sample, also selected from DC-17, contained woven plant fibers in a matrix of organic material and

## METHODS

sand. The third sample was taken from DC-18. It appeared orange in color and grainy in texture. When rehydrated and examined under a microscope, small interlaced fibers were observed in the material.

Each sample was placed separately into glass beakers. The organic material was digested using hydrogen peroxide 50 percent and potassium dichromate. The remaining inorganic material and supernatant were poured into 12 ml test tubes and centrifuged on high for several minutes. The supernatant was decanted, distilled water was added to the inorganic material, and it was centrifuged again. This process was repeated once more to neutralize any residual chemicals. One to two drops of inorganic material from each sample were pipetted onto a glass slide and the water allowed to evaporate. One drop of paramount solution was applied to the material and then covered with a glass cover slip. Each sample was observed under a light microscope at 400X to identify any phytoliths present.

*Fiber artifacts.* These consist of fragments from two to four baskets, fragments from one or two sandals, fragments from two unknown objects made of twined textiles, and a large number of disarticulated fragments from the screen. Analysis included: (1) measurement and description including visual examination, and measurement with calipers and goniometer; (2) photography both black-and-white and color photo records; (3) rehydration samples from two specimens were soaked in trisodium phosphate, subjected to microscopic examination, dried, and all materials returned; (4) phytolith examination treat-

ment of a small sample of fibers for separation of phytoliths, then microscopic examination.

*Wood artifacts.* These consist of two spoons and an unidentified worked wood object. Analysis consisted of: (1) measurement and description including visual examination and measurement with calipers, taxonomic identification by visual examination only; and (2) photography both black-and-white and color photo records.

*Food.* A mass of tan to orange organic material was recovered from beneath the individual. It appears to be the remains of a bag of meal or a mash. Analysis consisted of: (1) description including visual examination; (2) rehydration samples from two specimens were soaked in trisodium phosphate and subjected to microscopic examination; (3) phytolith examination treatment of a small sample for separation of phytoliths, microscopic examination; and (4) pollen extraction as described above.

*Non-artifactual charcoal.* Approximately two grams of charcoal from unworked wood was recovered from the fill of the grave. Pieces larger than 5 mm were submitted for identification. It is assumed that this material is approximately contemporaneous to the burial, and it was submitted for C-14 dating.

### *Faunal*

This includes several non-human bones, and incidental inclusions of insect remains due to decomposition.

## DAN CANYON

*Non-human bones.* Several non-human bones were recovered from the burial. Analysis included taxonomic identification by visual examination only.

*Possible hide bag.* No evidence was observed regarding this item. The only information comes from field notes.

*Incidental inclusions.* These consist of insect larval and/or pupal remains for taphonomic and paleoenvironmental information. Taxonomic identification by visual examination was attempted, but the remains were insufficient for identification.

### *Impacts of analysis*

The majority of procedures involved only visual examination, measurement, and photography. The human bones were X-rayed. These are non-intrusive and destroyed no materials.

Rehydration was performed on two samples of textile and 5 grams (0.18 oz) of fecal material. This procedure is minimally intrusive, in that it involves returning materials to a state similar to that at the time of burial, but involves no destruction of material, and can be reversed.

Phytolith analysis was performed on two small samples of textile and on a distilled water wash from the vessel. Pollen analysis was performed on the lighter fraction floated from the coprolite sample, and on a sample from the "meal." This involves separation of the organic portion of the sample and microscopic examination of the remainder. All materials from the samples were returned.

Radiocarbon analysis was performed on non-artifactual wood charcoal which was included in the fill and on disarticulated basketry fragments collected from the screened materials.

## SITE DESCRIPTION

### SITE AND SETTING

The site is located 1800 m west of the Colorado River, 1600 m up Dan Canyon from its confluence with Moqui Canyon. It is on top of a talus cone at the base of a high overhanging sandstone wall (see Figure 4) with an aspect of 330 degrees. Dimensions are 25 m SW-NE by 4 m SE-NW, with a total surface area of approximately 90 sq m (Figure 5).

The talus cone lies at an elevation of 3670 ft, approximately 200 ft above the floor of Dan Canyon prior to the inundation of Lake Powell. The burial was probably first inundated sometime between 1978 and 1980, and was under water continuously for almost 10 years until its exposure sometime in 1989, when lake levels began dropping to their current level of approximately 3645 ft.

Currently no vegetation grows on the site. Vegetal debris was observed on the site. However, it is probable that this material was transported by the lake. The soil consists of fine to medium aeolian sand mixed with gravel to boulder-sized angular sandstone clasts derived from the wall.

This site included two features, the burial and a single-course wall alignment located against the cliff face approximately 15 meters northeast of the burial (Figure 5). This alignment is considered to be a possible granary. No artifacts were observed, other than those directly associated with the burial.

### THE BURIAL

The burial was in a small area cleared of talus debris located immediately against the cliff face (Figure 6). It measured 54 cm NS x 78 cm EW, and was surrounded by large talus boulders ranging in height from 35 cm to 50 cm, making access to the burial extremely difficult during excavation. The setting was completely open; there was no noticeable evidence of walls, masonry, or other purposeful arrangement or alteration of the talus materials other than clearing.

It is estimated that the burial was originally covered with up to 25 cm of fill prior to inundation. The presence of this fill prevented the deposition of silt on the cliff wall during the period of inundation. When the fill was removed, presumably by the receding lake waters, a dark, silt-less "ghost" outline of the fill level was visible above the burial.

Remains, artifacts, and a partial outline were visible on the surface prior to excavation. In Unit 1 basketry remains outlined a roughly rectangular area directly abutting the alcove wall and measuring 75 cm NS x 30 cm EW. In the southern 45 cm of this area, the sandy fill covering this basketry was distinctly discolored, being light beige in contrast with the bright pink hue of the adjacent sandy fill, possibly due to increased organic content. The northern half of Unit 1 was completely covered with rubble, which was not removed during the excavation. The southeast quad-

## DAN CANYON

rant contained fine aeolian sand with large rocky inclusions. The fill was devoid of charcoal and other organic or cultural material, and was not discolored. The southwest quadrant contained fragments of basketry (Figures 7 and 8). One tarsal bone (DC-7, as listed in Appendix C) was visible on the surface near the midpoint of the western unit boundary.

Additional materials were visible in Unit 2. The north half and the southwest quadrant of this unit were filled with sterile rubble. The southeast quadrant contained basketry remnants, as well as a single sherd (DC-2) belonging to the jar collected by Ranger Luckeson. Also visible on the surface were two teeth (DC-3), three skull fragments (DC-4, DC-11, DC-12), two vertebrae (DC-5 and DC-6), basketry remnants, and a patella (DC-8).

The burial consisted of a single skeleton with associated materials. The body was interred lying on the left side in a flexed position, and facing away from the vertical cliff face. This is shown in Figure 9, a composite map of the skeleton and grave goods.

A Tsegi Orangeware canteen was near the head (DC-17). One plaited basket was also near or over the head (DC-14), one was over the body (DC-12), and one or two were at the feet (DC-13). The two wooden spoons found on the surface (SL-9 and SL-10) may have originated from the basket(s) near the feet.

From the fill directly above the burial the following were recovered: a microcline pendant (DC-15); the remains of an open-weave net of fine fiber (DC-18); squash seeds (DC-18); twined textile fragments (DC-11); a finely plaited child's sandal (DC-10); an unidentified circular wooden object ("whorl", DC-9); a bird bone (DC-21); two small waste flakes and a utilized flake (DC-16); and miscellaneous macrobotanical remains (DC-22 and DC-26).

Directly underneath the thoracic portion of the burial was found what may have been a hide pouch, bound with cordage and containing approximately three cups of Indian rice grass seeds (DC-19). This cache was apparently placed in a small space between the large boulders which formed the "floor" of the burial place. It was surrounded by sterile sand. Excavation terminated upon exposure of these boulders.

The skeleton was found to be in exceptionally good condition and, except for that portion near the surface, complete. Missing bones included the right pelvis and an undetermined number of carpal and tarsal bones. While the loss of some carpal and tarsal bones was not surprising, because they were exposed on the surface, the missing pelvic bones indicate that wave action may have disturbed the lower portion of the burial fairly substantially. Before excavation, an approximately 20 cm drop was noted along the 75 cm of cliff face between the head and the pelvic areas.



Figure 4. Site overview photo, looking south. Burial is at right side.

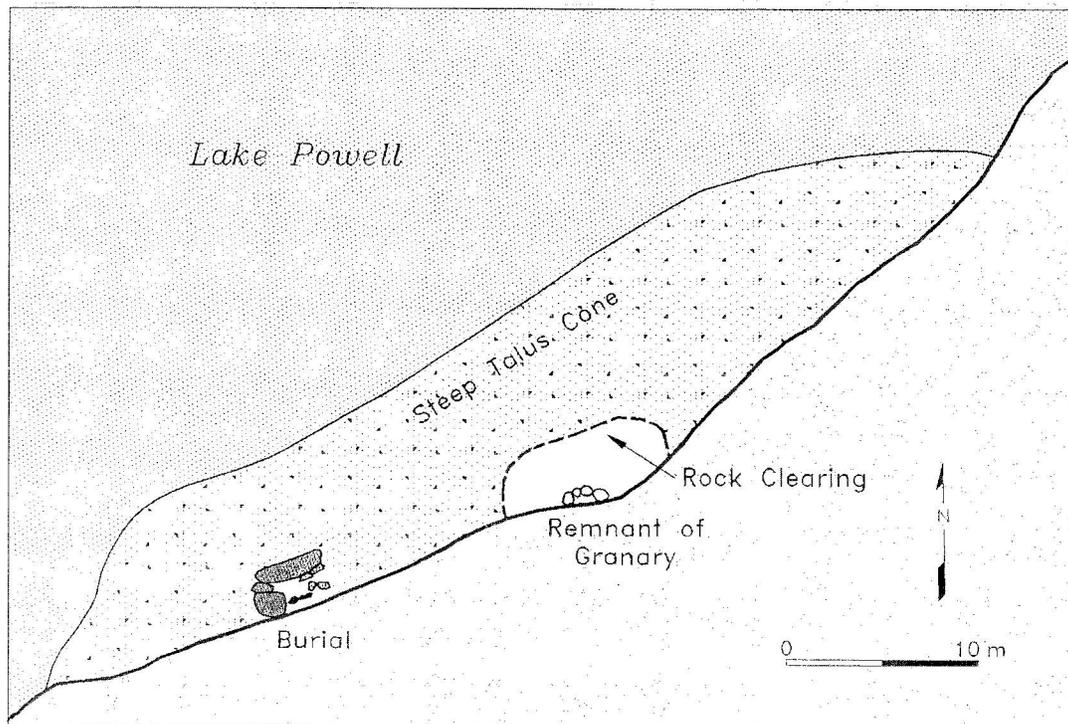


Figure 5. Site map.



Figure 6. Photo toward burial clearing.

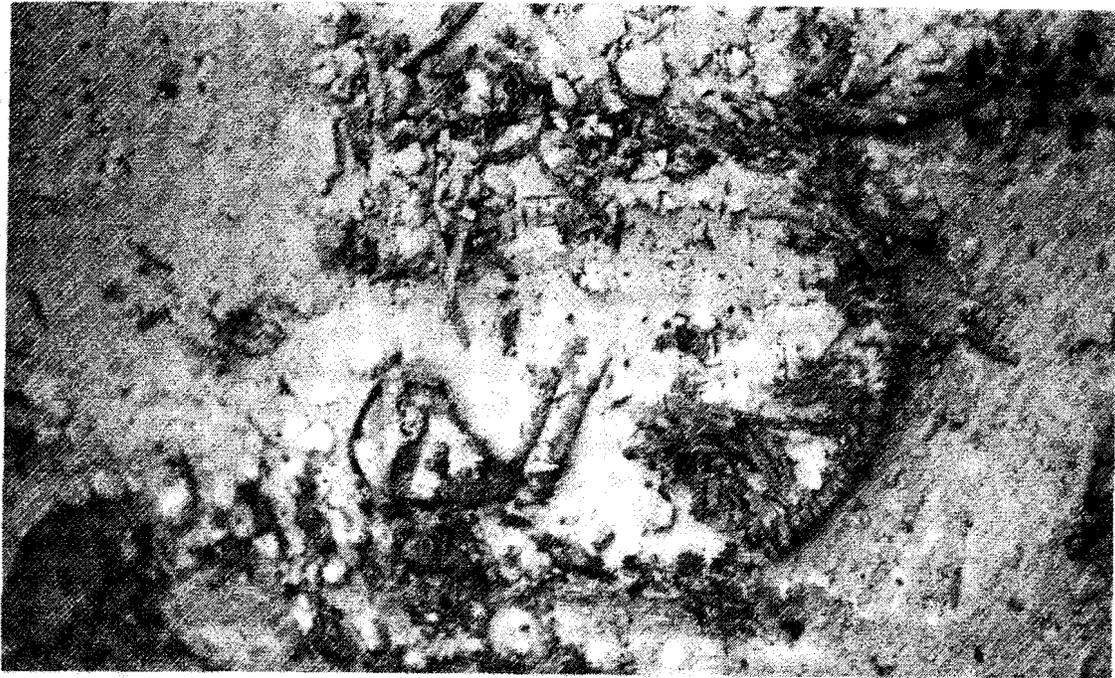


Figure 7. Photo of Basket 2 during excavation.

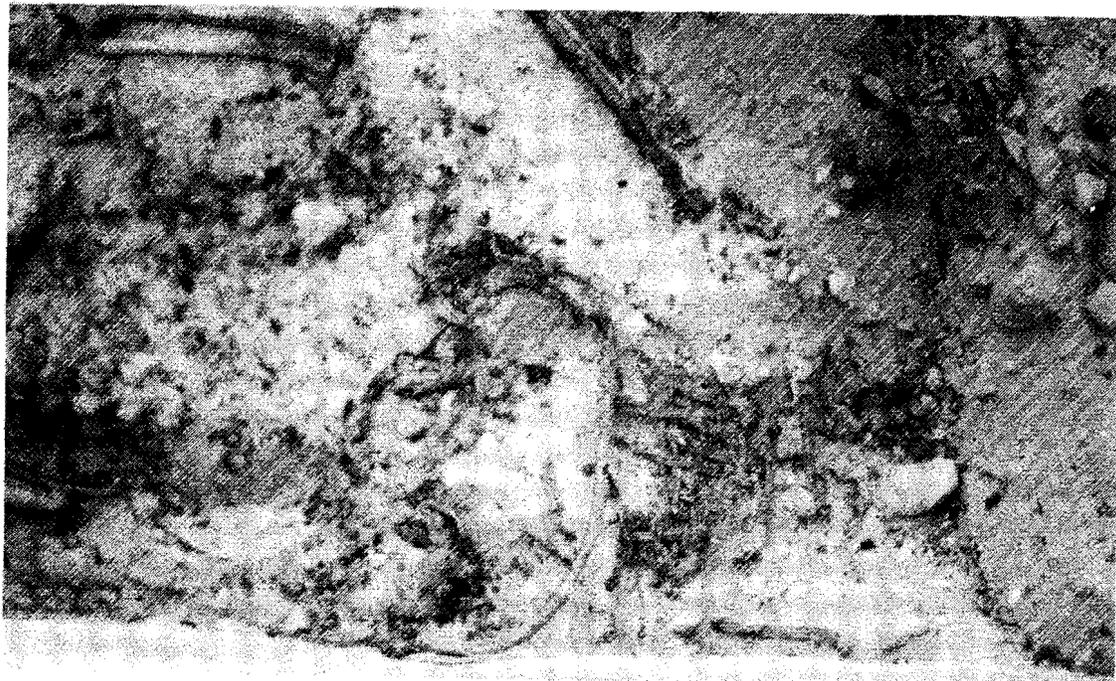


Figure 8. Photo of Basket 3 during excavation.

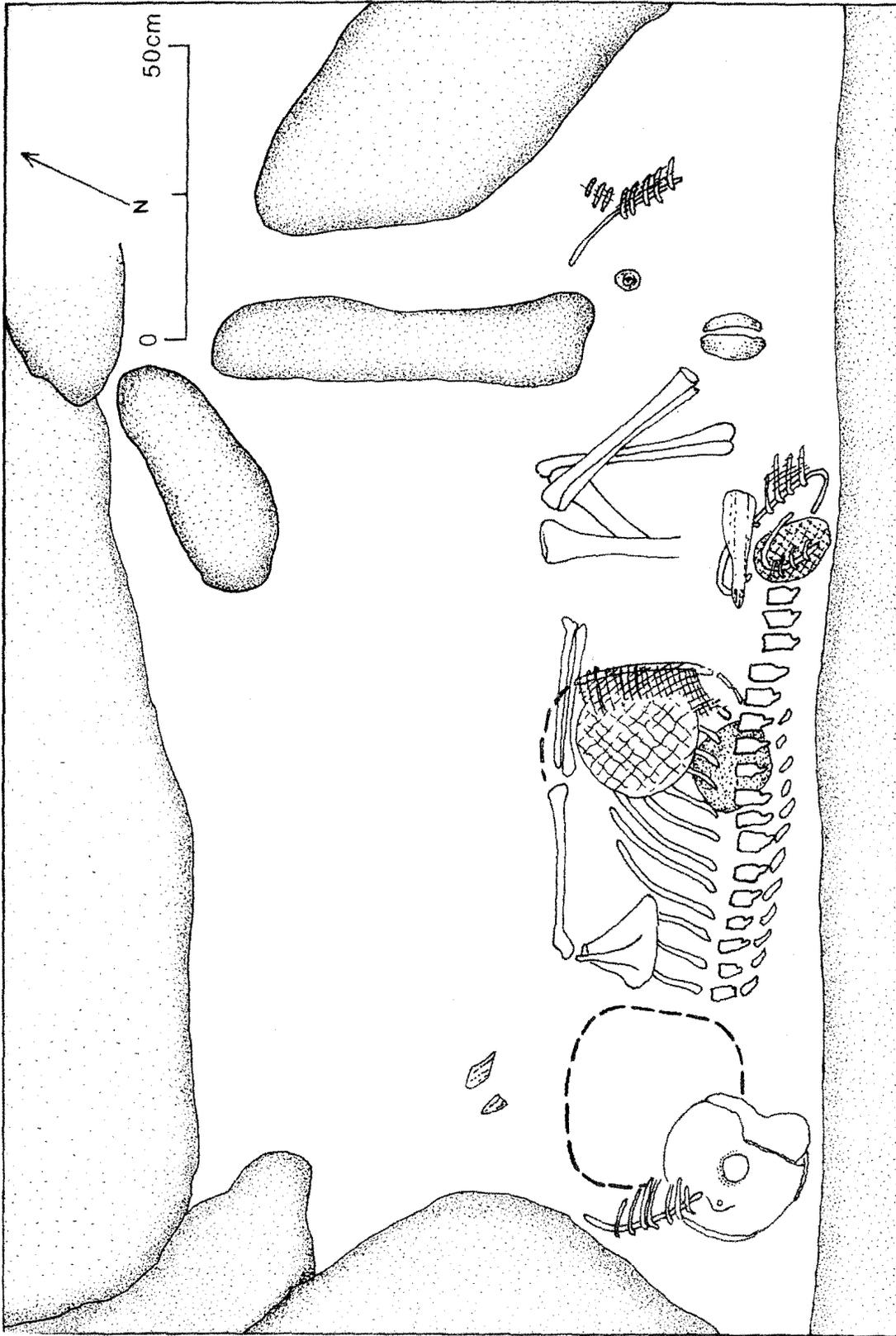


Figure 9. Composite map of burial.

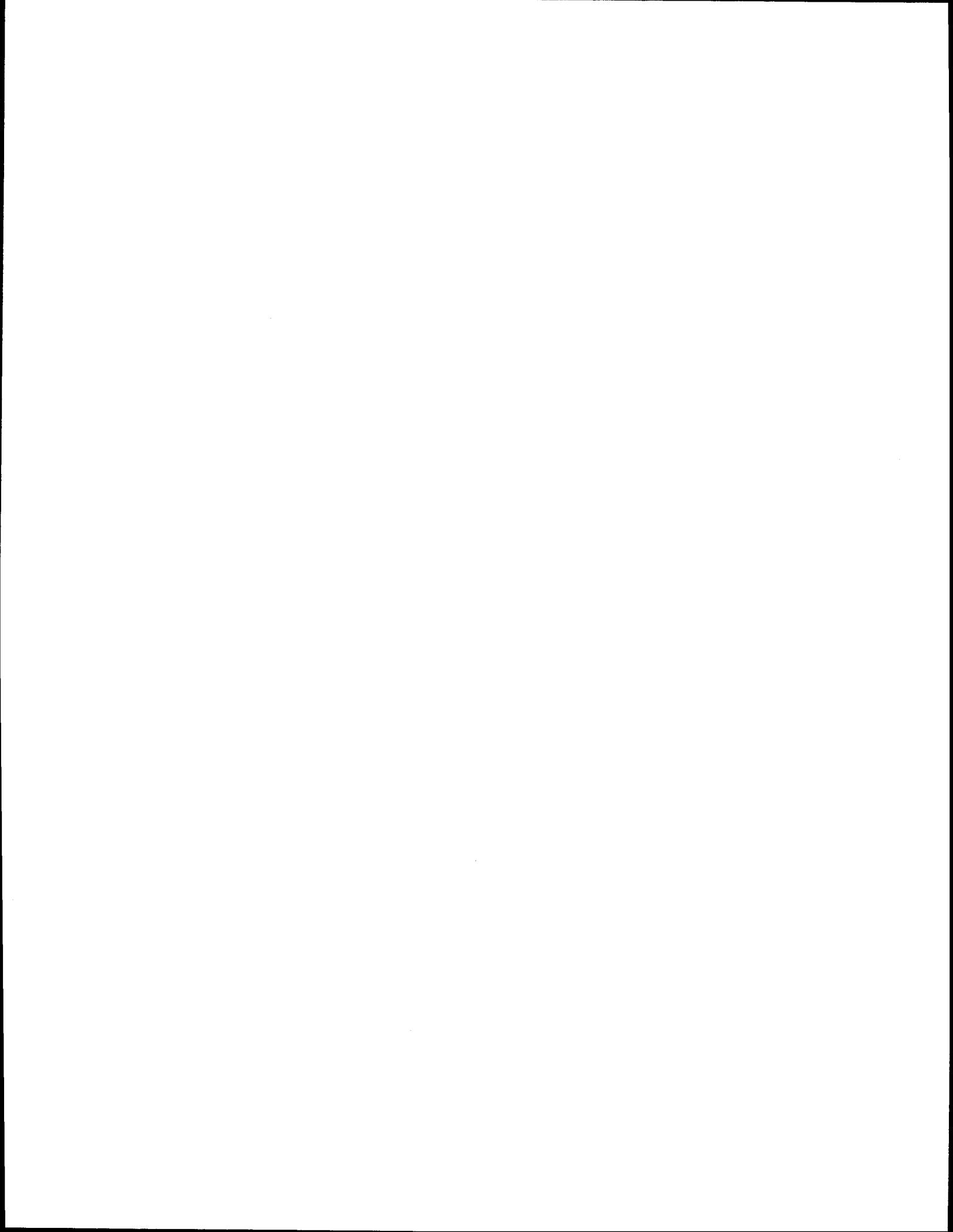
## DATING AND AFFILIATION

The affiliations and dating implied by the artifacts are not consistent with the dates from C-14 analyses. However, it is likely that the materials tested had been contaminated, and that the dates suggested by diagnostic characteristics are more accurate. As discussed below, the ceramic type of the canteen and the production methods of the basketry and sandals suggest that 42SA21339 is a late PIII burial, suggesting dates in a range of 740 to 690 B.P. (Lipe 1970).

C-14 analysis of charcoal collected from the matrix yielded a date of  $1300 \pm 110$  B.P. (Beta 42661), at least 450 years too early for Horsefly Hollow occupation. Several explanations can be advanced to explain this discrepancy. It is possible that this charcoal was not truly associated with the burial, and was incidentally mixed in the matrix; or that this was a result of burning old wood. Analysis of yucca basket fragments yielded a date of  $1120 \pm 110$  B.P. (Beta 42344), at least 270 years too early for Horsefly Hollow occupation. The association of the yucca fragments is indisputable, and the sample size was adequate. The possibility that these early dates were due to growth on soil rich in old calcium carbonate was discarded as unlikely to occur in both cases. The possibility that the samples were contaminated by groundwater was discarded due to the absence of formations bearing fossil fuels in the area of the site. It is also unlikely that these samples represent older "curated" materials.

The most likely reason for this discrepancy is contamination by hydrocarbons (spilled oil and gas) polluting Lake Powell. Saturated hydrocarbons within the water could soak into submerged materials for long periods, or floating hydrocarbons could quickly contaminate materials being exposed at the surface. At least one incident of leakage from a gas storage tank has occurred at Bullfrog. Alternatively, a smaller spill from a boat near the site could contaminate materials being exposed by wave action.

It appears that a similar incident occurred previously. The Rock Creek Site (Nickens, Reed, and Metzger 1986) had also been inundated, then falling lake levels exposed human bone and artifacts. Excavation yielded three individuals in direct association with artifacts diagnostic of Basketmaker II (BMII) affiliation. Dates from two C-14 samples were both too early. The earliest one was from charcoal contained in the fill,  $8660 \pm 80$  B.P. This discrepancy may be due to intrusion of the burials into earlier deposits. The second date,  $2420 \pm 100$  B.P., was probably soft tissue from Burial 1. The authors note that this date is also early for BMII, and suggest that either this period began earlier than previously believed or that the date had been skewed by some agent related to inundation (Nickens, Reed, and Metzger 1986:251).



## HUMAN REMAINS

### COPROLITES

No evidence of parasitism was found, even after repeated examination of three preparations from each coprolite. Thus, it is unlikely that this individual was parasitized by reproductive stages of intestinal worms. No evidence of lice or mites was found. Phytoliths were not abundant, if present at all. The majority of microscopic remains, screened from the macroscopic debris, was composed of tiny seed fragments apparently derived from grinding. The microscopic morphology of these fragments was comparable to the surface of the seeds isolated in the macroscopic debris, which suggests the microscopic seed fragments were derived from the grinding of grass seeds.

The pollen grain per gram calculations for the three coprolites are as follows: 23,800 for sample A, 49,500 for sample B, and 19,900 for sample C. The vast majority of the pollen was derived from uncultivated grass (family Poaceae) (Table 2 and Figure 10). *Ephedra* (Mormon tea) pollen was also present (Figure 10), along with trace amounts of *Pinus* (pine) and *Artemisia* (sage brush). Pollen aggregates were noted for Poaceae and *Ephedra* pollen (Table 3).

Macroscopic remains consisted exclusively of ground grass (Poaceae) seed. The seed is so finely ground that it is impossible to identify with certainty the species from which it is derived, although it is comparable to *Oryzopsis* (Indian rice grass). The ground seed composed 7.8 grams by weight of the 9

gram sample from coprolite A, 6 grams of the 6.5 grams from coprolite B, and 2.2 grams of the 2.3 grams from coprolite C.

Gross examination of the remaining 17 coprolites indicated that all were composed of ground grass. No other type of plant remains was present. This contrasts strongly with the frequencies presented in Table 4, which are all Fremont or Anasazi coprolites. All show a high degree of diversity in taxa represented, and none have high percentages of *Oryzopsis* present.

### SKELETAL REMAINS

The human skeletal material was determined to be that of a single sub-adult individual. An age of approximately 3 to 4 years at time of death was determined through the combination of osseous and dental characteristics listed in Table 5. Lack of epiphyseal union in the long bones, intermediate stages of union in the occipital bone of the crania, and beginning fusion of the cervical and lumbar vertebrae, place the individual within the range of 3 to 5 years old using post-cranial remains. Dental growth and eruption patterns exhibited in the x-rays (Figure 11) confirm that death occurred approximately between the third and fourth year.

#### Evidence of Stress

Abnormalities in the growth of the child were not apparent in the long bone measurements or cortical thickness of the

# DAN CANYON

Table 2: Pollen counts from coprolites. First number is the direct count, second number is a percentage expression of the count.

Taxon	Sample A	Sample B	Sample C	Combined
Poaceae	184/92%	201/94%	184/92%	569/93%
Poaceae (torn)	12/ 6	6/ 3	9/ 4.5	27/ 4
<i>Ephedra</i>	4/ 2	2/ 1	4/ 2	10/ 1.5
<i>Pinus</i>		2/ 1	1/ 1.5	3/ 0.5
<i>Artemisia</i>		1/ 0.5		1/ trace
Cheno Am			2/ 1	2/ trace
Total Pollen	200	212	200	612
<i>Lycopodium</i>	94	48	45	
Pollen/gram	23,800	49,500	19,900	

Table 3: Pollen aggregates found in coprolites. Each number in parentheses indicates one aggregate. The number in parentheses indicates the quantity of pollen grains in the aggregate.

Taxon	Sample A	Sample B	Sample C
Poaceae		(3) (8)	(6) (8) (4)
<i>Ephedra</i>	(2)		

## Dan Canyon Intestinal Contents

### Pollen Spectra from Coprolites

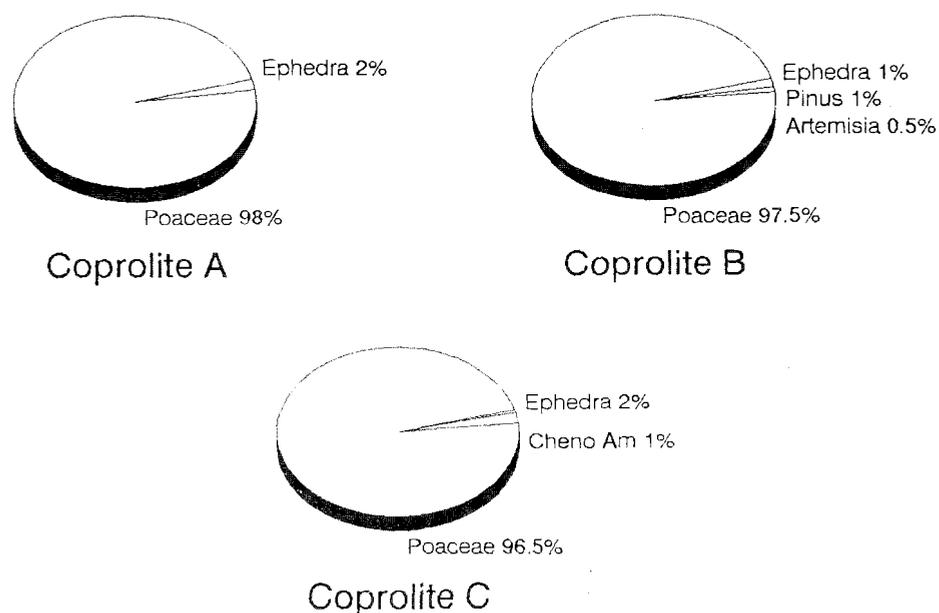


Figure 10. Frequencies of pollen in the coprolites.

## HUMAN REMAINS

Table 4: Presence/absence data for macrobotanical remains from Anasazi and Fremont Culture coprolites expressed as percentages (from Reinhard 1988).

Taxa	CCF	GCF	GCA	TPC	AH	IH
<i>Allium</i>					2	
<i>Amaranthus</i>		60	33	8	10	
<i>Amelanchier</i>		20				
<i>Artemisia</i>		10				
Asteraceae	38	30	27			
<i>Atriplex</i>				4	1	
Cactaceae					42	50
<i>Celtis</i>			17			19
<i>Chenopodium</i>		50	53	40	4	
Cheno Am	44			12		
<i>Cleome</i>			17	12	16	
<i>Cryptantha</i>			3			
<i>Cucurbita</i>		90	67	20	29	
<i>Descurainaea</i>				9		
<i>Elymus</i>	13				1	
<i>Ephedra</i>			3			
<i>Equisetum</i>		10			7	
<i>Gossypium</i>			30		18	25
<i>Helianthus</i>				20	4	19
<i>Juniperus</i>		10		20		
<i>Lepidium</i>	6	10	17	8	1	56
<i>Opuntia</i>		60	53	24	12	
<i>Oryzopsis</i>			17		2	31
<i>Panicum</i>					1	6
<i>Phaseolus</i>		10		4	1	25
<i>Physalis</i>						
<i>Pinus</i>	6		3	12	29	
Poaceae		40	47	12	1	6
<i>Polygonum</i>			3			
<i>Portulaca</i>			7	20	21	6
<i>Scirpus</i>	6	10	3			
<i>Solanum</i>				4		
<i>Sporobolus</i>	75				1	19
<i>Vitis</i>					2	
<i>Yucca</i>		20		4	1	
<i>Zea</i>	44	30	60	96	91	63

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Table 4: Concluded.

	H.H.	S.H.	C.C.	S.R.
<i>Amaranthus</i>	9	8	2	5
<i>Artemisia</i>	2	3		
<i>Atriplex</i>	18			
<i>Chenopodium</i>	11	30		13
<i>Cleome</i>	5	8		1
<i>Corispermum</i>		3		
<i>Cucurbita</i>	20	35		4
<i>Cycloloma</i>				1
<i>Descurainia</i>			9	
<i>Echinocereus</i>				1
<i>Eriogonum</i>	2			
<i>Helianthus</i>	2	3	4	
<i>Juniperus</i>		3		
<i>Opuntia</i>	25	51		1
<i>Oryzopsis</i>	4	5	2	
<i>Phaseolus</i>	18	8		10
<i>Physalis</i>	27	22		1
<i>Pinus</i>	13	27	23	5
Poaceae	2	5		
<i>Portulaca</i>	18	24	15	5
<i>Prunus</i>	4	5		
<i>Rhus</i>		8		21
<i>Shepherdia</i>	5			
<i>Solanum</i>			2	
<i>Sporobolus</i>			4	
<i>Zea</i>	100	76		37

Explanation:

CCF= Clyde's Cavern Fremont (n=16)  
 GCF= Glen Canyon Fremont (n=10)  
 GCA= Glen Canyon Anasazi (n=30)  
 TPC= Turkey Pen Cave (n=25)  
 AH= Antelope House (n=90)  
 IH= Inscription House (n=16)  
 H.H.= Hoy House (n=56)  
 S.H.= Step House (n=37)  
 C.C.= Chaco Canyon (n=47)  
 S.S.= Salmon Ruin (n=112)

## HUMAN REMAINS

bone. Stature, determined by femoral, humeral, radial, and ulnar diaphyseal length, corresponded with standard growth estimates for a 2.5- to 3.5-year old sub-adult (Table 6). Due to the variation of growth rates between populations and even within racial groups, this estimate of stature is considered within the range of a 3- to 4-year old prehistoric Native American child, who will tend to reflect lower rates than historic or living children from whom the standards are formed. Measurements of cortical thickness taken from radiographs of the femur also indicated normal development.

Visual examination, microscopic examination involving a dissecting microscope, and radiographic images of the dentition revealed normal development patterns, without evidence of enamel hypoplasias or dental pathology.

The radiographs of the long bones produced the only evidence of stress. Five Harris lines, either completely or partially, traverse the distal portions of the left and right femora, the proximal portions of the left and right tibiae, and the distal ends of the

radii (Figure 12). Additional pronounced lipping on the proximal and distal ends of the indicated bones may suggest a final, and probably more severe episode of stress.

### Pathology

The skeletal remains failed to display any signs of cribra orbitalia, porotic hyperostosis, infectious lesions or trauma related conditions. An indentation of the left parietal and temporal region of the crania (Figure 13) was initially thought to be evidence of a traumatic blow to the head of the child. Further examination determined the indentation to be a postmortem occurrence. Culturally induced changes of the bone are evident in the occipital flattening of the crania. Additional alterations of the bone are primarily confined to the left side of the individual and are natural occurrences due to inundation rather than cultural or pathological remodeling. Damage to the cranium was limited to an indentation on the left parietal and temporal region of the skull. The left ribs displayed medial curvature. The ilium, ischium, and pubis of the left innominate were not recovered during excavation.

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Table 5. Estimation of Age.

	Bone examined	Age range
Epiphyseal union	long bones	less than 10
Fusion of vertebrae	cervical/lumbar	3 to 5
Cranial union	occipital	3 to 4
Dental growth		3 to 4
Estimated age		3 to 4

Table 6. Long bone measurements of the Dan Canyon individual and the standard growth estimates of Ubelaker (1989).

	Dan Canyon Individual	Standard Growth Rate	Related Age
Humerus	141 mm.	118.0-157.0	2.5-3.5
Ulna	118 mm.	100.0-129.5	2.5-3.5
Radius	107 mm.	93.5-119.0	2.5-3.5
Femur	190 mm.	155.0-215.0	2.5-3.5
Tibia	156 mm.	127.0-184.0	2.5-3.5
Fibula	154 mm.	124.0-182.0	2.5-3.5



Figure 11. Radiographs of dentition. a. mandible, b. left portion of the maxilla, c. right portion of the maxilla.

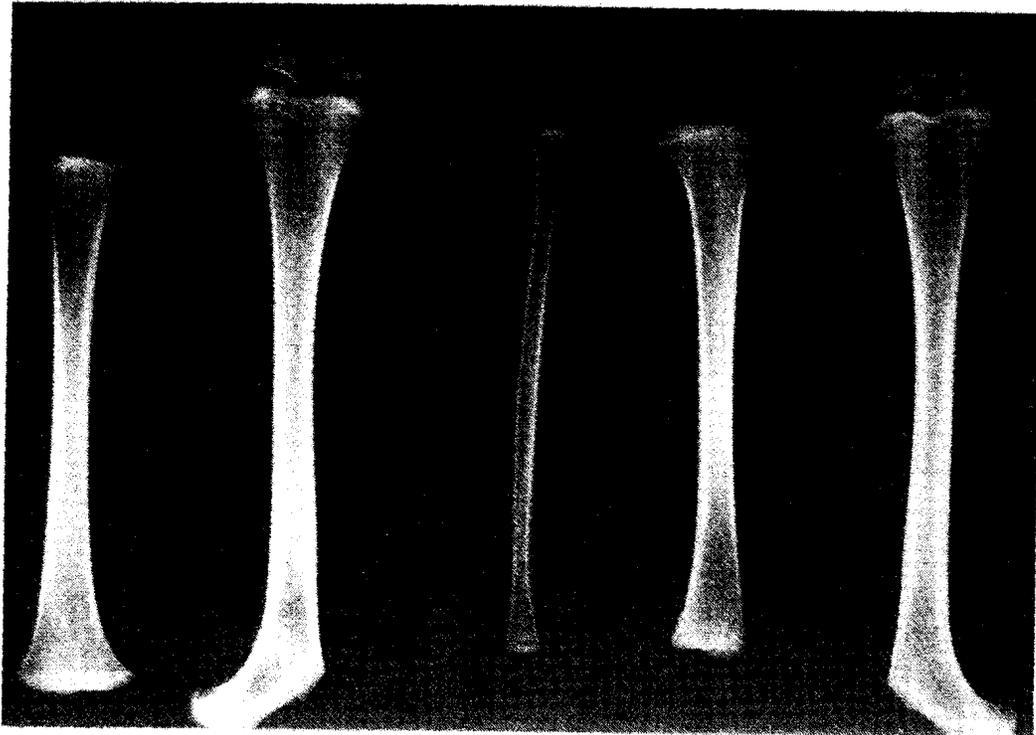


Figure 12. Radiographs of the femora, tibiae, and radii exhibiting transverse growth arrest lines (Harris lines).



Figure 13. Indentation on the left parietal and temporal region of the crania caused by warpage during inundation.

## MATERIAL CULTURE

### LITHICS

Lithic materials include a small assemblage of flaked items and a microcline (Amazon Stone) pendant.

#### Flaked stone

This category included two pieces of debitage and one utilized or retouched flake (catalog # DC-16). No provenience can be assigned to these items, and their relationship to the burial cannot be discerned. Although it is possible that the utilized/retouched flake is an intentional inclusion, it is not likely that the debitage are burial goods. It is likely that these are incidental inclusions of unrelated materials, or resulted indirectly from maintenance work on digging implements.

#### *Debitage*

One retouch or thinning flake has no cortex, five dorsal scars, faceted platform surface, and a high longitudinal curvature. Also evident is a step termination or bending-fracture. This flake is of an orange/white mottled chalcedony.

L = 4.0, W = 2.6, T = 0.7 mm

One retouch or thinning flake has no cortex, four dorsal scars, a faceted platform surface, and a high longitudinal curvature. Also evident is step termination or bending-fracture. It is of chalcedony that is speckled black in white matrix.

L = 4.4, W = 3.6, T = 0.5 mm

### *Tools*

One decortication flake fragment with retouch or use-damage (Figure 14) was recovered. Approximately 50 percent of the dorsal surface has an abraded (water-rolled) cortex, and six dorsal scars cover the remainder. The ventral surface has a pronounced bulb with small point of force application. The flake is straight in longitudinal axis. A line of flake scars running along the lateral margin was severed by a large bending fracture. The maximum dimension of the scars is 2.5 mm. The material is mottled beige, gray, and salmon fossilized palmwood. Maximum edge angle = 80 degrees, minimum = 52 degrees.

L = 33.7, W = 20.9, T = 5.6 mm

#### Ground stone

This category includes a single pendant (catalog # DC-15). No provenience can be assigned to this item.

#### *Pendant*

The pendant is one small piece of ground and drilled microcline (Figure 14) with two ground planar surfaces which are nearly parallel (5 degrees from parallel). Striations run at 20 to 42 degrees from the longitudinal axis. Both sides are smoothed, one is lightly polished. The edges are partly rounded, with slight faceting. Striations on the edges are 20 to 24 degrees to the longitudinal axis. It has been drilled in several stages, with ap-

## DAN CANYON

proximately 80 percent drilled from one side. It was started with a large shallow cone, then drilled deeply with a narrower bit (see Figure 14), and finished from the other side with a larger shallow cone. The proximal end has been severed from the body, breaking across the perforation.

The material is aquamarine to white microcline (Amazon Stone). The planar ground surfaces are parallel to the natural crystal planes or fissures, and it appears that these natural planes of weakness were utilized in production of this item. Microcline is common in felsic intrusives, such as those in the Rocky Mountains to the east. This material may have been acquired through trade, or from natural sources such as the Colorado River gravels or deposits eroded from the ancestral Rocky Mountains.

### CERAMICS

A total of 13 sherds was collected from in situ or from the screen. The majority of these have been refitted to a nearly complete vessel, and the remaining two sherds appear to have derived from this vessel.

Seed jar (catalog #SL-13,14,15,16,17; DC-17,2)

This is a nearly complete, misfired redware vessel (Figure 15). Nearly the entire upper portion of the vessel has been reduced, while part of the base and part of one side have been oxidized in patches. Where reduced, the slipped areas tend to be blacker than the paste, and redder than the paste where oxidized. The exterior color varies

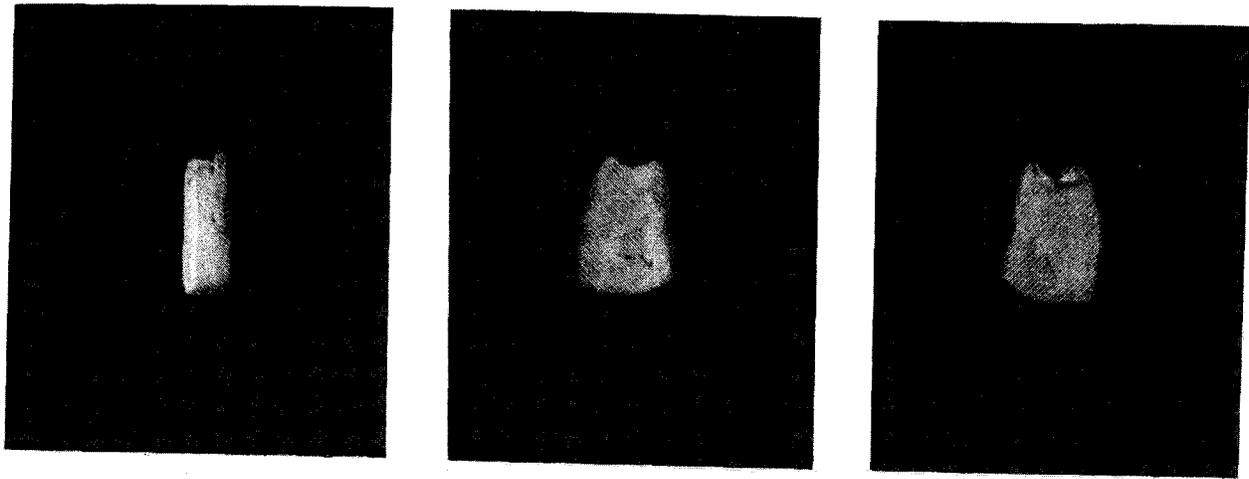
from 10R4/8 to 10R5/6 in the oxidized portions, and is 5YR3/1 to 5YR4/1 in the reduced portions. The interior color is 10R6/1 to 10R5/1.

The core color is light reddish gray, 10R6/1, but oxidized red, 10R5/8, penetrates up to 2 mm into the core. No carbon streak is visible. Temper is fine to medium-grained sherd and sand, and paste texture is medium. Fracture is granular to slightly platy. Hardness is medium.

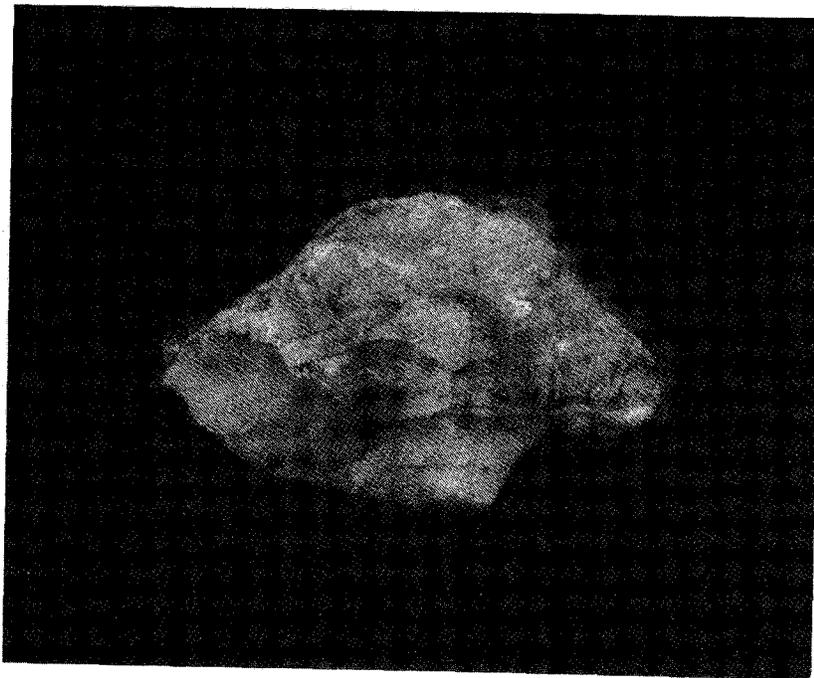
As shown by features visible on the interior surface, this vessel was constructed by coil-and-scrape method. Remnants of coils that are 8 to 13 mm wide and fingerprints are visible in the upper 5 to 7 cm of the curved wall, where the aperture became too small to allow easy working of the interior surface. The lower 17 to 15 cm of the 22 cm long arc of the vessel wall bear marks from scraping.

The vessel form is globular, with a conical "neck" rising to a constricted aperture. Dimensions are as follows: circumference = 54 cm; maximum diameter = 17.1 cm; minimum diameter = 16.5 cm; height = 15.4 cm; mean diameter of mouth = 43.2 (sd = 0.8); maximum = 44.13; minimum = 41.8; mean body thickness = 4.1 mm (sd = 0.6); maximum = 5.0 mm; minimum = 3.4. The "neck" has a slight convex curve up to the rim. The rim is rounded in cross section, and is thickened to the interior and slightly to the exterior. Mean rim thickness = 6.6 mm (sd = 0.7); maximum = 7.3; minimum = 5.5.

Two lugs are located 6 cm below the rim, and were apparently applied immedi-



a



b

Figure 14. Lithic artifacts. a. Microcline pendant (Specimen DC-15), b. Flake, possibly utilized (Specimen DC-16a).

## MATERIAL CULTURE

ately before the constricted upper portion of the vessel was constructed. Each lug is approximately 3 cm wide, 2 cm thick, and protrudes 1.7 cm out of the exterior surface. The interior surface bears scraped-over lumps where these were applied. Both lugs were perforated while the paste was wet. Perforations are 6.7 - 7.4 mm x 4.1 - 4.4 mm. The base of the vessel is very slightly flattened across an area 3.5 cm in diameter, and has a slight dimple.

The exterior surface has been incompletely smoothed and lightly stone polished. The surface is crazed, but no striations or streaks from polishing are visible. The surface is slightly uneven and temper protrudes infrequently. There are several scrapes on the exterior and the base appears to be slightly eroded by use.

Slip was applied over the upper one-half to two-thirds of the vessel. The lower edge of the slipped area is very uneven. Slip was applied with a coarse-fiber brush possibly 1.5 cm wide, moving downward in a clockwise spiral.

This item is similar to Tusayan Black-on-Red in the vessel form and form of decoration (Colton 1956). However, this vessel is unique, as the paint appears to be a white mineral or slip, rather than a black mineral or carbon paint. Several attributes of the paint indicate that this paint is not carbon paint accidentally reduced to white during misfiring. The paint is white not only over the reduced area but also over the oxidized areas. The edges of painted areas are abrupt, as seen on mineral paints, rather than clouded, as often seen on carbon paints. Much of the paint was

thinly applied, but thicker residues of white matte pigment are visible on some portions of the design. In these portions the pigment obscures the underlying surface form, while the underlying surface form is visible on areas where the pigment has been eroded. The surface was not polished over the paint.

Geib (personal communication, 1990) considers this vessel to be anomalous. He states that

"The design style is common during late PII (ca. A.D. 1080-1150), being contemporaneous with Sosi and Dogozhi B/W, but it continues to be used during PIII, except that the exteriors of jars and bowls are not entirely slipped as before — jars are generally 2/3-1/2 slipped (bottom portion unslipped) ... Colton (1956) created the type Dogozhi Polychrome for this type of vessel decoration, but now such vessels are normally classified as Tusayan B/R, with perhaps 'late variety' as a qualifier. The fact that the [Dan Canyon Burial] jar is ca. 1/2 slipped indicates that it was a PIII production, not PII. Given that the design was executed in white strongly suggests that it postdates A.D. 1250. The use of white pigment for Tsegi Orange Ware decoration (Kiet Siel Polychrome and Kayenta Polychrome) does not occur until the advent of Kayenta B/W and is considered a diagnostic of the Tsegi Phase."

The lower third of the interior of the canteen was coated with a thin layer of residue. A wash was performed on a small portion to obtain pollen and phytolith data. Examination of the residue revealed that it was a layer of well-sorted, very small grains of clean sand. The only phytoliths present were

## DAN CANYON

tracheids. The wash was inadequate for pollen recovery.

These results suggest that the pot was exposed to lake wave action during a period when the burial was eroding from its original context. The sand and phytoliths were probably deposited in the ceramic pot during this erosional process.

### MACROBOTANICAL

#### Fiber/textile items, unknown

##### *Twined textile (catalog # DC-11)*

Most of this item has been broken into fragments less than 20 mm long, few fragments remain articulated, and most are coated with an unidentified organic material (Figure 16). Consequently it is difficult to discern the type of textile and the type of object from which this specimen is derived. It appears that it was constructed of cordage of two distinct sizes. The smaller cordage is a 2-ply Z-twist which ranges from 1.7 to <3 mm in diameter. The angle of twist varies from 25 to 30 degrees, and twist varies from 1.6 to 3.7 per cm. The larger cordage is 4-ply S-twist cable-laid (S/Z), which ranges from 3.0 to 3.8 mm in diameter. The angle of twist varies from 13 to 40 degrees, and twist varies from 0.5 to 1.2 per cm.

The few articulations that could be observed suggest that the smaller cordage comprised the warp, and the larger was twined onto this, moving in an S-twist. The warp is engaged by every half twist of weft, with a spacing of 3.4 to 4.0 mm. Close spacing of the

weft could be observed in two specimens. In 8.5 mm of this specimen there were either four or five weft cords, giving a spacing of 2.1 to 1.7 mm per weft. It could not be discerned whether this was simple or diagonal twining. Other portions suggest open twining. No center or decorative elements could be discerned in these fragments. The specimen pictured in Figure 16 may be a selvage fragment, and resembles Adovasio's simple selvage (1977:figure 43)

Several methods were employed to discern the material from which this was manufactured. Much of this specimen was coated with sand adhering to a thick unidentified coat of organic material. When dry the material appears to be a coarse fiber with highly coherent vascular bundles. Portions of the coating material were removed during rehydration. In this form the plies appeared to consist of fine pliable fibers. Microscopic examination disclosed the presence of very little epidermis. That which was present could only be discerned as Poaceae. Additional materials included fungal spores (report in prep.), and unidentifiable fly or beetle parts (Bret Radcliffe, personal communication, 1990).

Overall this item was produced from cordage of two different thicknesses twisted at highly variable angles and variable twist-lengths of two or four plies of an unknown coarse-fibered material with inconsistent thickness. It was twined with the thicker four-ply weft cordage moving in an S-pattern over the thinner warp cordage to produce a closed or intermittently open-twined object of unknown type. Due to the extreme fragmentation of this specimen, additional comparisons

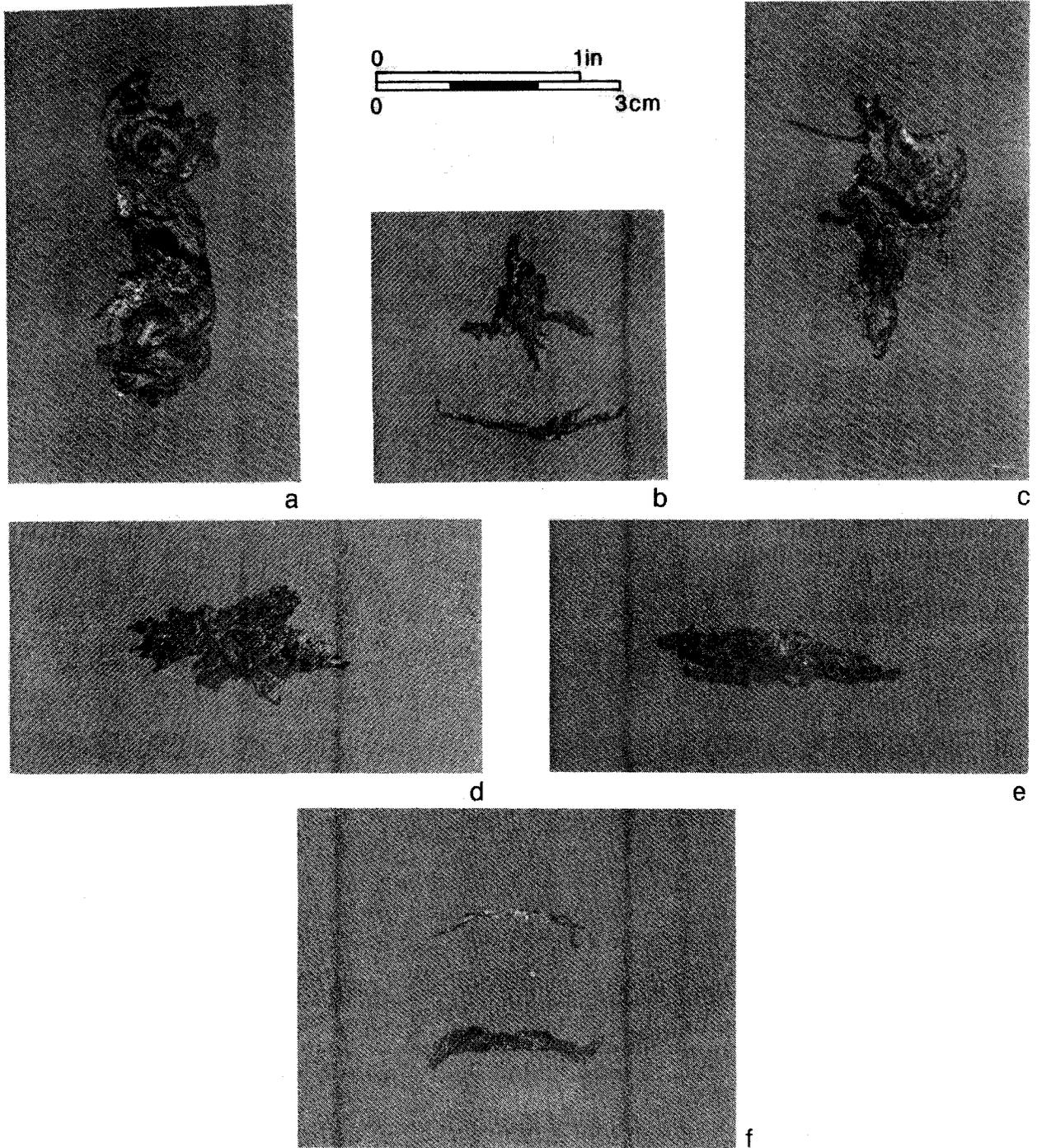


Figure 16. Photos of twined textiles. a. Fragment of coarse open-twined textile (Specimen DC-11), b. Fragments of fine open-twined textile (Specimen DC-11), showing cross of twining, c. and d. Large articulated fragments of coarse open-twined textile (Specimen DC-11), showing thick weft cordage, e. Large articulated fragments of fine twined textile (Specimen DC-18), showing thin cordage, and f. Samples of disarticulated cordage (Specimen DC-18, top; Specimen DC-11, bottom).

## DAN CANYON

with other artifacts are difficult. The construction method is common among Anasazi textiles (e.g., Adovasio 1977; Morris and Burgh 1941).

### *Twined textile (catalog # DC-18)*

Field notes state that this

"...consists of several squash seeds and what appear to be cohesive masses of 2-strand twist fiber, together with many small separated fiber twists. The squash seeds and masses were found together, as though the squash had been placed intact over the fiber item (possibly a net?), and the decayed squash material caused the fiber item to congeal into a cohesive mass. The separated two-strand twists were removed from the screen, and are presumed to be associated because of the similarity of material and manufacture. A single section (boxed separately) was preserved in which the actual weave of the 'net' was still intact."

Almost all of these elements have been broken into fragments less than 31 mm long; few remain articulated, and most are coated with organic material (Figure 16). Consequently it is difficult to discern the type of textile and the type of object from which this specimen is derived. It appears that it was constructed of cordage of two distinct sizes. The smaller cordage is a 2-ply Z-twist which ranges from 0.6 to 0.8 mm in diameter. The angle of twist varies from 13 to 30 degrees, and twist varies from 4.3 to 2.6 per cm. The larger cordage is a 2-ply Z-twist which ranges from 1.0 to 1.8 mm in diameter. The angle of twist varies from 11 to 50 degrees, and twist varies from 2.9 to 1.8 per 10 cm.

The few articulations that could be observed suggest that the smaller cordage comprised the warp, and the larger was twined onto this, moving in a Z-twist. The warp is engaged by every second twist of weft, and has a spacing of 3.4 to 4.0 mm. Close spacing of the weft could be observed in a single specimen. In 8.5 mm of this specimen there were either four or five weft cords, giving a spacing of 2.1 to 1.7 mm per weft. It could not be discerned whether this was simple or diagonal twining. Other portions suggest open twining. No selvage, center, or decorative elements could be discerned in these fragments.

Several methods were employed in order to discern the material from which this was manufactured, including rehydration and phytolith extraction. When dry, the material appears to be a coarse fiber with highly coherent vascular bundles. A sample of this material was rehydrated. In this form the plies appeared to consist of fine pliable fibers. Microscopic examination disclosed the presence of very little epidermis.

Three distinct phytolith types were identified in samples from the platy and fibrous material from the DC-18 specimen. These phytolith types included plates, trichomes, and trapezoids as described and illustrated by Brown (1984). All shapes are produced by plants in the Gramineae (grass) family. A distinction also can be made to determine if the material that composed these two samples was C3 or C4 grasses. As described by Brown, grasses that contain the C3 carbon pathway only produce trapezoid, plate, and trichome shaped phytoliths. All grasses of this type are in the subfamily *Pooideae*.

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Grasses that possess the C4 carbon pathway produce not only the above mentioned shaped phytoliths, but also bilobates, saddle, and cross-shaped phytoliths. These grasses are categorized in other grass subfamilies. Therefore, based on the presence (or lack) of specific phytolith assemblages observed, it can be concluded that the DC-18 organic material was a C3 grass within the subfamily *Pooideae*.

Due to the extreme fragmentation of this specimen, comparisons with other artifact descriptions in the literature are difficult.

A number of other materials was present in this specimen, including large quantities of fine charcoal, an unidentified gray organic material which adhered to the textile (pitch?), squash seeds, an orange organic material which resembles meal (see Food Related Materials, Specimen 24), fungal spores (report in prep.), and unidentifiable fly or beetle parts (Bret Radcliffe, personal communication, 1990).

### Fiber/Textile Items, identified

#### *Cordage*

One small loosely knotted piece of yucca cordage was recovered from specimen DC-22.

#### *Sandal(s) (catalog # DC-10)*

Fragments from one or two plaited yucca sandal(s) (Figure 17), similar to Morris' (1980) Type 3, Kidder and Guernsey's (1919) Type Ia2, or Magers' (1986) Fine-

Plaited were recovered from the area near the feet. This type of sandal is most frequently associated with PIII remains (Magers 1986). Fragments of one or two heel cups are present, and the toe(s) may have been rounded.

This specimen was plaited with untreated yucca which varied from 1.5 to 4.5 mm in width, and averaged 2.9 (sd = 0.7) over 16 measurements. Four measurements across articulated fragments gave an average width of 27.5 mm (sd = 1.1) per ten elements.

The weave is a 2/2 twill, with no shifts or decorative elements visible in the fragments, and the maximum crossing angle equals 83 degrees. The selvage is a 90-degree-self, with each element skipping three other elements to engage after turning. This pattern is similar to that shown by Osborne (1980:Figure 393).

Two fragments are from portions of one or two heel-cups which had an unusual additional element woven at the back. Figure 18a is an idealization of the figure-8 pattern woven at the back or outside of the cups. Figure 18b shows this construction in cross-section. This knotting is 6 to 8 mm wide. Figure 18c is a detail of the pattern on the inside of the larger heel-cup fragment, and shows the shifts which formed the right-angle turn of the heel-cup. Left-moving elements were turned right at approximately 120 degrees, carried over one to three of the right-moving elements, then the rhythm shifted to 1/1. The exact relationship of this portion to the figure-8 knotting at the back cannot be discerned without dissection, and consequently is unknown. However, it appears that the

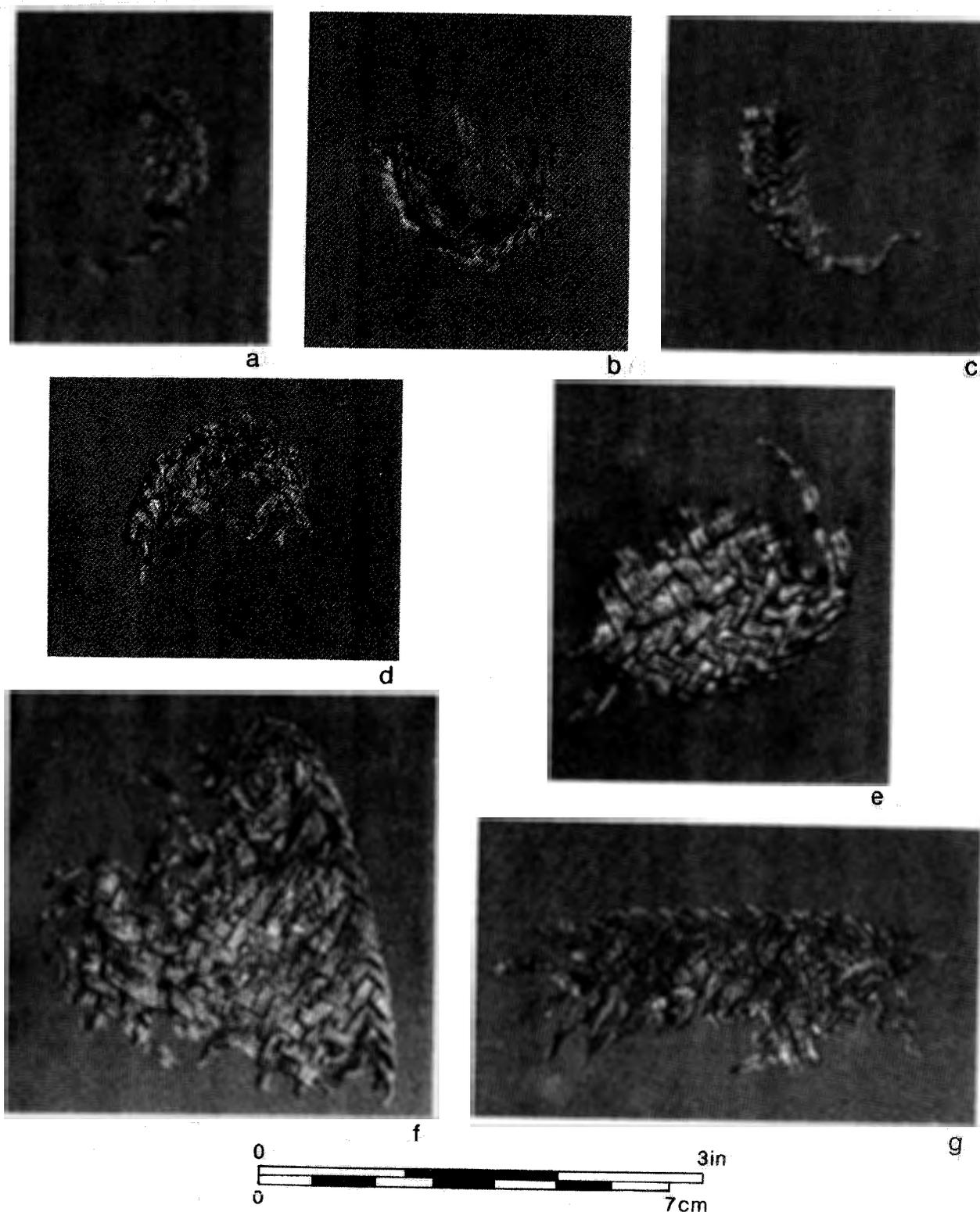


Figure 17. Fragments of plaited sandal(s) (Specimen DC-10). a. and b. Heel-cup fragments, upper surface, c. and d. Heel-cup fragments, lower surface, e., f., and g. Fragments of sole.

2X Actual Size

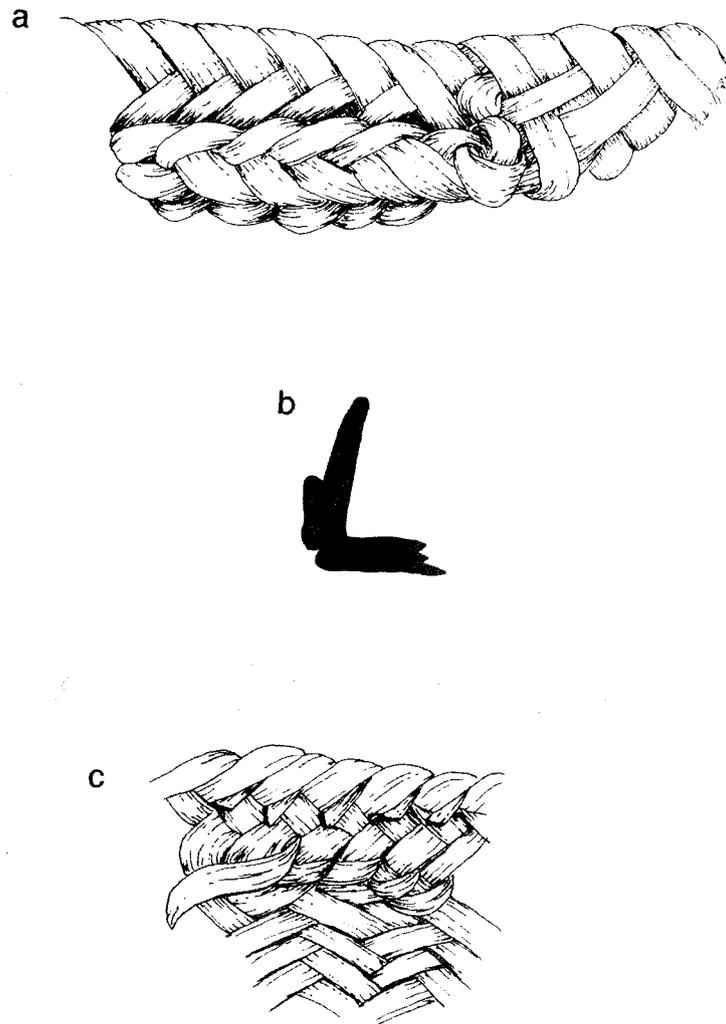


Figure 18. Plaited sandal, pattern and construction of heel-cup. a. Posterior or outer view of heel-cup, b. Cross section of heel-cup (Note additional element at posterior), and c. Anterior or inner view of heel-cup.

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moving ends were carried up over the 90-degree self-selvage of the cup toward the outside, where they were engaged in the figure-8 knots at the back. They were then tucked through the cup, toward the inside, and trimmed at the inside surface.

There appear to be a number of worn yucca leaves, especially at the base of one of the heel-cups. It appears that these sandals were not prepared specially for the burial.

The fragments range up to 7 cm in maximum dimension. There are approximately 17 cm of selvage present from the sole of the sandal(s), and 8 cm from the heel-cup(s). Geib's (1990) approximations of 8 to 9 cm wide by 14 to 15 cm long for the complete item(s) seem appropriate.

### *Baskets*

Remains from two to four plaited yucca ring baskets were recovered. It appears that at least one had been placed adjacent and posterior to the pelvis, one at the lower thoracic area, and possibly one near the head. Other fragments were scattered on the surface. The absence of coiled basketry and the fact that all of the baskets are plaited ring baskets is consistent with a PIII association (Adovasio and Gunn 1980).

*Basket remains (catalog # DC-14).* Fragments from the plaited ring baskets(s) include plaited yucca and disarticulated yucca strips and fragments of willow withes (no photographs). Included is an additional fragment of wood that shows no evidence of cultural modification. This probably is not

from a basket, but may be driftwood which was incidentally included. Also recovered was one small fragment of 2/2 twill plaiting (4 cm x 4 cm). No shifts or decorative elements are present. Angles of intersections range from 85 to 90 degrees.

The yucca is untreated. No cutmarks, splitting, or scraping are visible. Widths of loose yucca elements range from 2.9 to 7.1 mm and average 4.5 mm. The distance measured across six articulated elements is 27 mm.

The ring material includes several fragments which total 102.4 cm in length. This is enough for a ring of 29 to 31 cm in diameter, but it is not known whether all of the fragments are from one item. The ring material appears to have been altered little. No cutmarks or abrasion are visible, and bark remains on approximately 20 percent of the material. Portions without bark may have peeled naturally. Diameters range from 4.0 to 7.0 mm. There were no intact selvage remains with this specimen.

*Basket 2 (catalog # DC-12).* These fragments are from a plaited ring basket and include plaited yucca with selvage and ring (Figure 19). A portion of 2/2 twill plaiting (10 cm x 12 cm) is present. No shifts or decorative elements are present. Angles of intersections range from 82 to 90 degrees.

The yucca is untreated. No cutmarks, splitting or scraping are visible. Widths of loose yucca elements range from 3.2 to 6.2 mm and average 5.0 mm. The distance measured across twelve articulated elements is 60.0 mm.

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The ring fragment is 16 cm in length. The ring material appears to have been altered little. No cutmarks or abrasion are visible, but no bark remains on the material. Diameter of the withe is 6.6 mm in area where it is exposed.

There are 13 cm of 180-degree self-selva intact on this specimen (see Figures 19 and 20). The selva cord consists of untreated yucca approximately 3 mm in width which moves in a Z-twist. This cord engages four elements (two pairs) where intersections with the ring are near 90 degrees, and two elements (one pair) where intersections are near 45 degrees. Selva wraps range from 0.6 to 1.2 cm in width, and average 1.0 cm in width. The curvature of the ring fragment suggests a diameter of approximately 30 cm.

*Basket 3 (catalog # DC-13).* These fragments are from plaited ring baskets(s) and include plaited yucca and disarticulated yucca strips and fragments of willow withes (Figure 21). One small fragment of 2/2 twill plaiting is still tightly articulated (2.5 cm x 3.0 cm), and several fragments approximately 5 cm x 6 cm are loosely articulated. No shifts or decorative elements are present. Angles of intersections on the tightly articulated fragment are 88 degrees.

The yucca is untreated. No cutmarks, splitting or scraping are visible. Widths of loose yucca elements range from 3.1 mm to 5.9 mm and average 4.5 mm. The distance measured across six articulated elements is 20 mm.

The ring material includes fragments which total 115.8 cm in length. This is enough

for a ring of 34 cm to 36 cm in diameter, but it is not known whether all withe fragments are from one item. The ring material appears to have been altered little. No abrasion is visible, and bark remains on most of the material, but it appears that several small branches were cut from the withe. Diameters range from 3.3 mm to 6.2 mm. There were no intact selva remains with this specimen.

### *Wood*

Wood items included two spoons, and several items of unknown function and relationship to the burial, including a small hollowed knot (referred to as a "whorl"), five unburned fragments, and 92 pieces of charred wood and charcoal.

*Spoon (catalog # SL-9).* This is comprised of fragments from a small bowl-shaped object (Figure 22) with a rounded rim and with probable remnants of a handle at one end. It is made from cottonwood.

Production surfaces crosscut the wood grain at the distal and the proximal ends (see Figures 22 and 23a). Knots from smaller branches are visible, especially at lateral portions. No striations from abrasion or cut marks are visible on the surfaces. The spoon was possibly formed by charring and abrasion. Charred areas are visible on many portions of the surface. Charring is also visible on the break surfaces at depths up to 1.5 mm.

The spoon appears to have been produced from interior wood at least 60 mm in diameter. The probable method of production is that a cylinder of wood was cut from

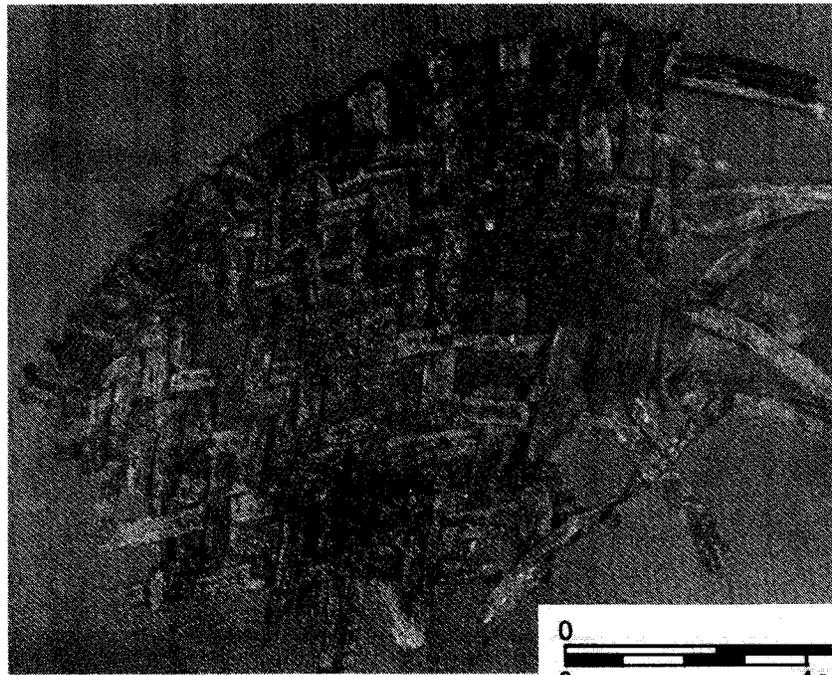


Figure 19. Basket 2 (Specimen DC-12).

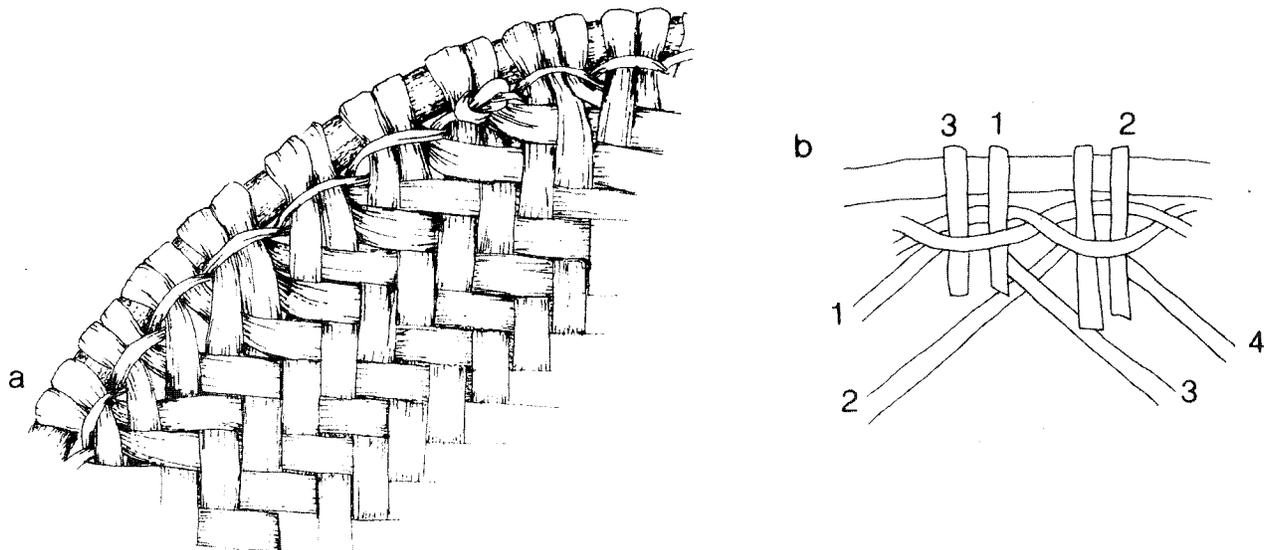
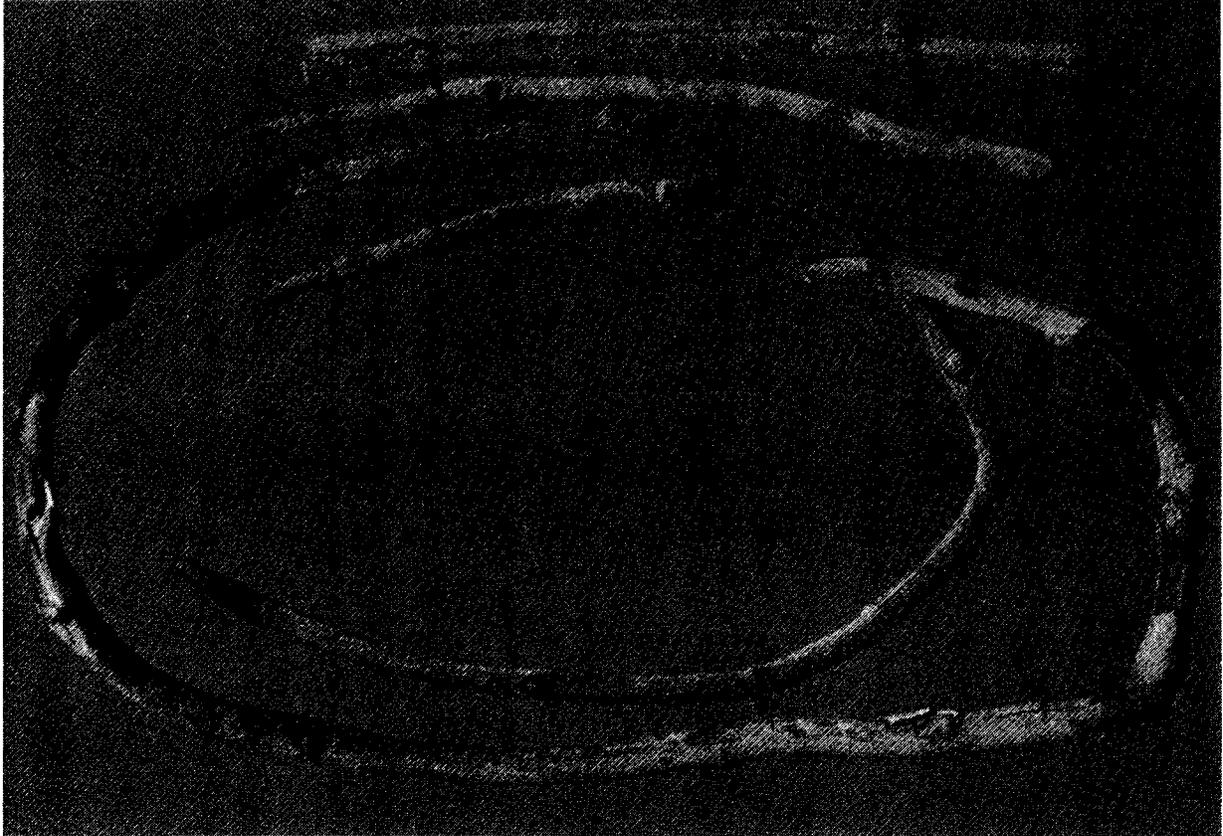
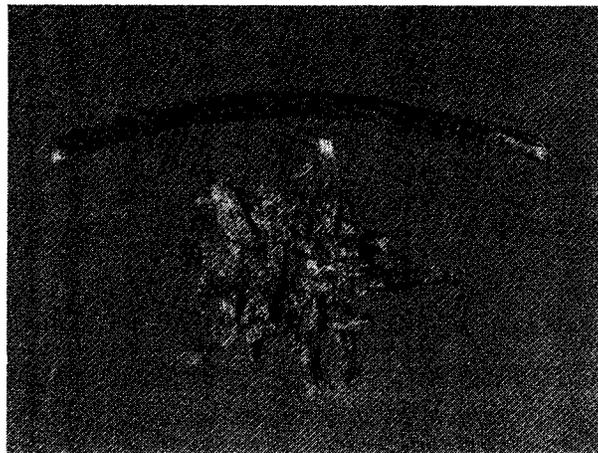


Figure 20. Basket 2, pattern and selvage. a. Pattern and selvage, upper surface, b. Selvage pattern viewed from below.



a

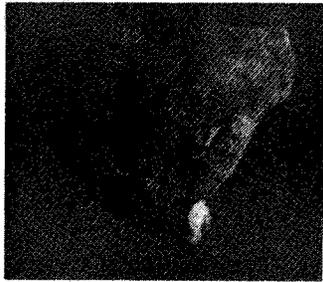


b

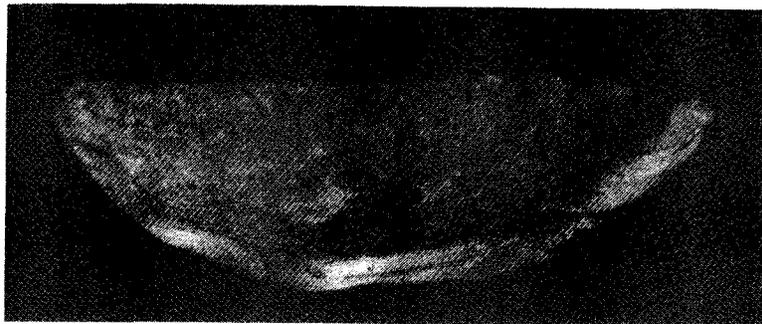
Figure 21. Basket 3 (DC-13). a. Rim fragments. b. Rim fragment (top) and articulated fragment (bottom).



a



b



c



Figure 22. Spoon. (Specimen SL-9). a. Top view, b. End view, and c. Sectional view.

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branch and then split (figures 23a and b). Alternatively, a branch may have been split lengthwise while breaking it from a tree. The object was possibly rough cut to shape with the outer portion shaped by alternating burning and abrasion.

Dimensions are: overall length of fragment = 85.9 mm; width overall approximately 57 to 61 mm; wall thickness varies from 4.2 to 7.7 mm; length of bowl interior < 75.3 mm; width of bowl interior < 48.5 mm; maximum depth of bowl > 22 mm.

Although cottonwood artifacts, including spoons, are common in the literature, little information is available for comparison.

*Spoon (catalog # SL-10)*. This spoon is comprised of fragments from a small bowl-shaped or scoop-shaped object (Figure 24) with remnants of a handle at one end. It is made from cottonwood. The lateral portions of the rim of the bowl are missing and the proximal end of the handle is deeply charred.

Production surfaces crosscut the wood grain very little (see Figure 23c and d). No knots are visible, but the juncture of the bowl and handle may consist of a knot. Surfaces have been partially decayed and no striations from abrasion or cut marks are visible on them. The only charred areas visible on the surface are at the proximal end of the handle, and it is possible that this item was used to stir coals during cooking, etc. Very few of the surfaces crosscut the grain of the wood. These areas are on the ventral surface, at the juncture of the bowl and handle; and at the distal end of the bowl, on the dorsal surface.

This specimen was possibly formed by splintering a branch from a larger branch or from the base of a shrub (Figure 23d). It was produced without charring and with minimal cross-cutting of the wood grain.

Dimensions are: overall length = 128.6 mm; overall width = 46.6 mm; maximum thickness (at base of handle) = 23.7 mm; length of bowl exterior = 81.1 mm; length of bowl interior = 70.0 mm; width at base of handle = 23.7 mm. The maximum depth of the bowl was 7 mm, and possibly is as great as 15 on a complete item.

Although cottonwood artifacts, including spoons, are common in the literature, little information is available for comparison.

*"Whorl" (catalog # DC-9)*. This item consists of a small, spiral-grained cottonwood knot, hollowed and formed to approximately a hemisphere (Figure 25). It has cracked and broken along the spiral grain. Although fragmented, nearly all pieces are present. Deformation due to desiccation prevents an exact fitting of the fragments. In addition, due to splitting and deformation, the form of the rim is difficult to assess. It appears to taper to a thickness of 1 mm - 2 mm and to be slightly rounded. No cultural adherents were observed on the surface, only sand and mold.

Production surfaces generally follow the wood grain, and little crosscutting was observed. No cut marks or striations from abrasion are visible on the surface. Along the edges of break surfaces charring is visible on both the inner and the outer surfaces. A

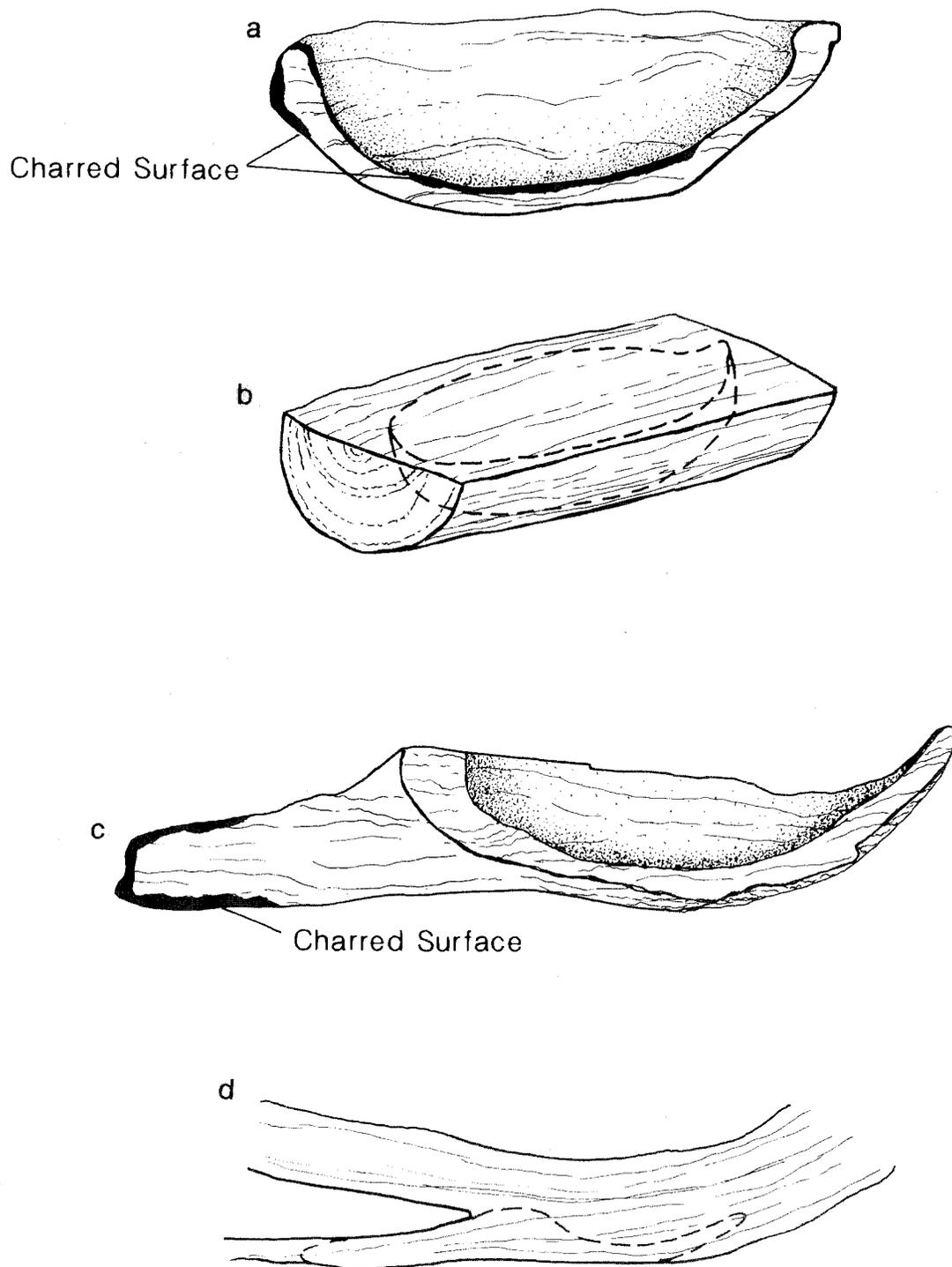
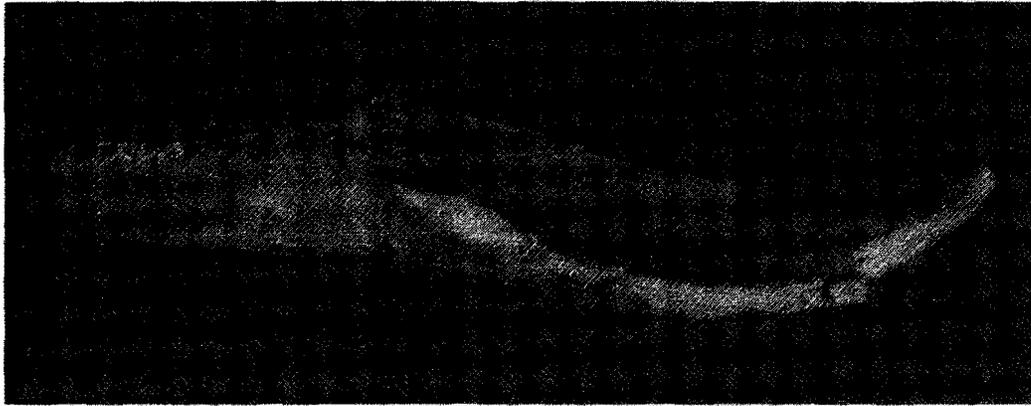
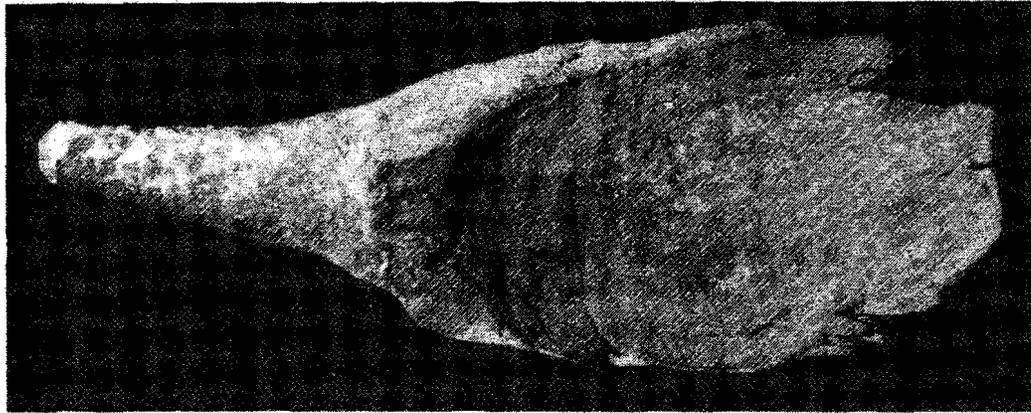


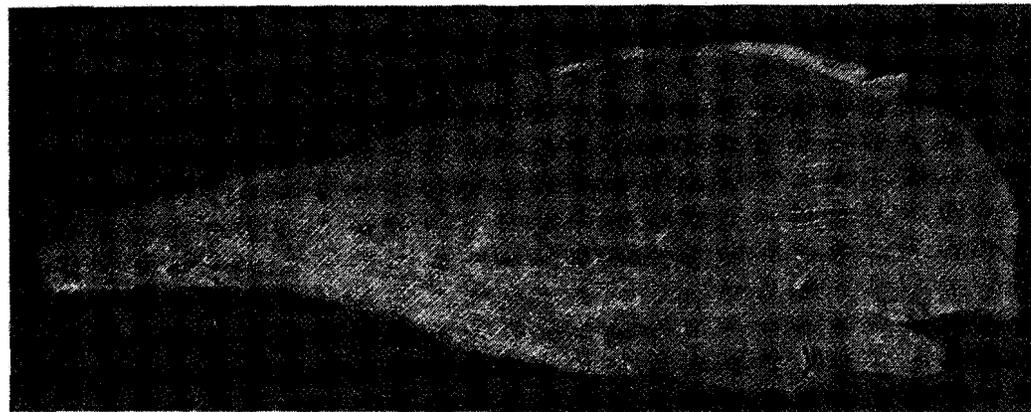
Figure 23. Spoons, methods of construction. a. Specimen SL-9 in cross section (Note direction of wood grain), b. Reconstructed origin of specimen SL-9, c. Specimen SL-10 in cross section (Note direction of wood grain), and d. Reconstructed origin of Specimen SL-10.



a



b



c

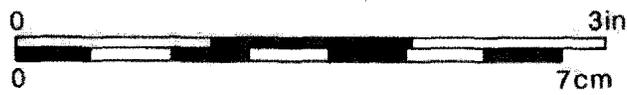


Figure 24. Spoon (Specimen SL-10). a. Side view, b. Top view, and c. Bottom view.

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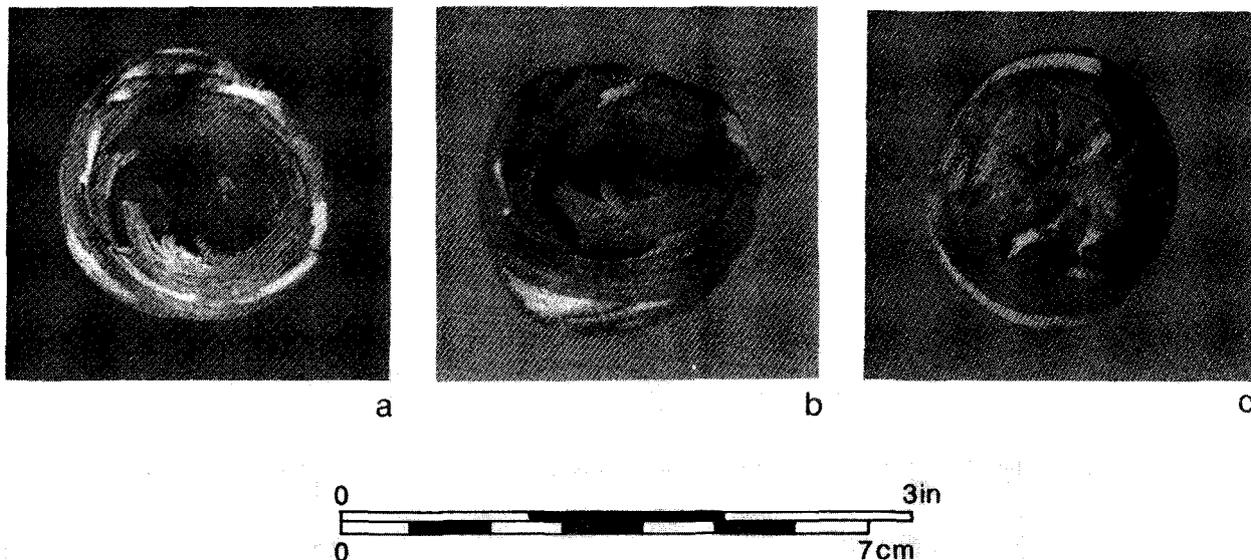


Figure 25. Whorl (Specimen DC-9). a. Top view, b. Oblique view, and c. Bottom view.

greater portion of the charred portion has been removed from the outer surface, which is lighter in color and is generally 0.2 mm in thickness. Charring on the inner surface is darker and thicker, 0.5 mm to 1.0 mm, indicating removal of less of the charred portion of this surface. It appears that this object was formed by charring of the inner and the outer surfaces, followed by light abrasion to remove the resulting charcoal.

Dimensions are: diameter = 32 mm to 36 mm; height approximately 26 mm; thickness at base = 8 mm; thickness at midheight = 3.5 mm; thickness at rim = 1.0 mm to 1.5 mm. No comparable items were observed in the literature.

### *Wood and charcoal fragments*

*Charcoal.* Specimens DC-4 and DC-23 consist of charcoal fragments which were recovered from the screen. Their origin is unknown, as there was no evidence of ash stain or burned rock in the fill. Small bits of charcoal were also common throughout specimens DC-18, DC-22, DC-25, DC-26, and DC-27.

*Unworked wood fragments.* Specimen DC-26 included four twigs which may be *Celtis*. A small fragment of *Juniperus* wood was recovered from DC-22. One twig of *Juniperus* and one twig of an unknown woody species were recovered from DC-27.

## MATERIAL CULTURE

Food remains

### *Cheno-am (unknown species)*

A single unidentified seed was recovered from specimen DC-27.

### *Grass (Poaceae)*

One unidentifiable fiber of grass was recovered from DC-18, from DC-27, from DC-22, and from DC-25.

### *Hackberry (Celtis)*

One seed was found in specimen DC-25.

### *Pinyon seeds (Pinus edulis)*

Four fragments of these were found in the possible contents of Basket 3 (specimen DC-26). Three additional fragments were recovered from DC-23.

### *Ricegrass seeds (Oryzopsis hymenoides)*

Approximately 1/4 liter of these were excavated from the area (specimen DC-19). Excavators believe these had been enclosed in a hide pouch. An additional 130 seeds were found in specimen DC-18, and 175 seeds were found in specimen DC-27.

Three separated groups of *Oryzopsis* (both the rachis and loose seeds) were weighed because of the enormous amounts of seeds available in each. The weights are as follows: 28 grams (mainly rachis), 10.5 grams (mainly loose seeds), and 33.6 grams (includes both rachis and loose seeds). Most of these seeds

were charred, probably as a result of food preparation. Some of these also had hardened dirt adhering to them.

### *Squash seeds (Cucurbita sp.)*

Fifteen complete and 30 fragmentary seeds of *Cucurbita pepo* were recovered from specimen DC-18 (see also *Twined textile*, [catalog #DC-18]). Some of these seeds were charred, probably as a result of food preparation.

### *Sumac (Rhus sp.)*

A single seed of *Rhus trilobata* was recovered from specimen DC-27.

### *Tule (Scirpus)*

Four fragments of *Scirpus* epidermis were recovered from DC-18 and one from DC-22.

### *Unknown*

Several specimens of an unidentifiable material were collected, SL-11 and DC-24, adding to approximately 1/8 liter in volume. These were collected on different dates, but it is believed they are the same material. It consists of a tan to yellow-orange material which resembles a highly processed meal or a mash. It has congealed and crumbles to a granular to platey material. Only common windblown background types of pollen (pine, low-spine composites, *Quercus*, and *Ephedra*) were observed in this. Just three diagnostic phytoliths were observed in this material. These included one plate and two trichrome silicates from a grass. Due to the paucity of

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phytoliths in the sample, it is believed that the three diagnostic phytoliths represent contaminants from the surrounding soil. Silicified tracheids were in abundance, but these are produced in all vascular plants. They possess no distinguishing characteristics for identifying plants. The organic material from the DC-24 sample remains unknown. Based on the color of the material and the presence of squash seeds in the burial, it is possible that this sample is pulp from a squash.

A single leaf fragment of an unknown dicot was recovered from DC-22 and one was recovered from DC-25.

### FAUNAL REMAINS

#### Bone

For specimen DC-21 the field notes state that this:

"... consists of several fragments of unidentified bird bone which were recovered from the screen. Although they were not seen during excavation and their exact origin is unknown, it is considered virtually certain that they were buried in the fill with the other items."

Nine unidentifiable mammal or bird bones were found in DC-21. All are very

fragile and appear to be fetal/neonatal. One is a right proximal femur of a possible small carnivore (neonatal).

Specimen DC-27 yielded unidentifiable bone fragments (some of which were charred), and the macrobotanical remains listed above.

#### Leather

The field notes state that during the excavation of specimen DC-19, the ricegrass seeds appeared to be enclosed in the remains of a hide pouch. While these seeds were being examined under a dissecting microscope in the lab no remains of the pouch could be identified. The material of this pouch was later described as resembling friable gray felt (Chris Kincaid, personal communication, 1991).

#### Feathers

A single unidentified feather was included with the twined textile and macrobotanical remains from DC-18.

#### Insects

Unidentifiable insect casings were recovered from specimens DC-18 and DC-25.

## CONCLUSIONS

### ENVIRONMENT

This site is located in the San Juan Triangle area of the Colorado Plateau. It is on a tributary of Moqui Canyon, on the west slope of the Red Rock Plateau, an extremely arid area which Lipe (1970) considers marginal for the Anasazi. Bedrock consists of flat-lying sedimentary formations with many rockshelters, and much flakable lithic material in Pleistocene terraces. In spite of the extreme aridity and low productivity there is a high diversity of edible biota available. This is in large part due to the relief of the area and consequential diversity of habitats. These form three distinct zones: canyon lowlands, intervening uplands, and highlands. The uplands are extremely dry and have patches of aeolian deposited soils. Most of the available water in the area occurs in springs or is collected over large areas of bare rock and is trapped by the sandy soils of the canyons. Canyons formed a favorable habitat for Anasazi farming, and all structural sites occur within canyon areas with water. Although there was little occupation of intervening uplands between canyons, the uplands were probably a source of wild foods, and a number of campsites have been recorded in these areas. The highlands were areas of more reliable precipitation, but were more prone to early- and late-growing season frosts.

The construction and decoration of the canteen (Geib, personal communication, 1990) and the absence of coiled basketry (Magers 1986) suggest that this was a late PIII burial. Results of the C-14 samples were

dismissed, due to probable contamination. The late PIII is a time of population movements out of areas to the east and south. The Red Rock Plateau is very near the west edge of the Anasazi range, and is in an area of late PIII Kayenta and Mesa Verde Anasazi overlap.

Lipe (1970) has described a number of contemporaneous site clusters in the drainages of the Red Rock Plateau, which he views as widely dispersed communities. This includes a comparatively extensive community in Moqui Canyon. The sites are small and dispersed, usually with one to seven structures. Although these have a variety of features, including storage structures, hearths, mealing bins, and loom anchors, variations among the features represented at these sites suggest differentiation in site function. Several sites have kivas, and it is likely that these functioned to integrate the dispersed residential localities. Relationships of this cluster to upland sites are not understood.

The burial is adjacent to a small storage structure, and is within five miles of a number of contemporaneous sites, including seven with storage and/or residential structures, and two with kivas.

Prior investigations of paleoclimate indicate the PIII was a period of declining precipitation and the end of a major period of alluviation. Although large-scale erosion occurred in surrounding areas, there is no conclusive evidence for it in Moqui Canyon. The impacts of these changes on horticulture

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have not been adequately evaluated. There may have been an associated increase in ruderals, and investigations in nearby areas suggest that use of these plants increased.

### BURIAL ASSEMBLAGE

None of the materials identified in the assemblage was necessarily exogenous, and no necessary relationships to other areas are implied by any of these materials. In particular there are no items which were necessarily traded, or items usually considered to represent "high status." None of the production techniques observed were atypical of the Anasazi. All show relatively little investment in production and, excepting the canteen, little effort at decoration. Several items bear evidence of prior use. The canteen has worn areas on its base, and several scrapes. The sandal(s) has worn spots at the base of the heel-cup(s) and on other unidentifiable portions. One spoon shows evidence of being used to stir fires. It is safe to assume that these items had been used in daily life, and that none were produced especially for burial. This is possibly true of the other materials, excepting the food.

Comparisons of the grave goods with those included with burials of other individuals in the range of 0 to 12 years imply that the Dan Canyon child enjoyed approximately average status (assuming that quantities and types of grave goods equate to status).

Nonperishable materials recovered with individuals in this age-range from areas just south of the San Juan River include 0 to

4 ceramic vessels, and 0 to 1 piece of jewelry (summarized from Crotty 1983:28, Figure 10). An average of 1.6 nonperishable items was recovered with each of the 15 children in this table (Crotty 1983:28). In addition, the basketry, food, and other perishables buried with this child are similar to those recovered from other Anasazi burials in protected sites (e.g., Nickens et al. 1986; Reiley 1969; Reiley and Birkby 1975; Schroedl 1976, 1981; Sharrock et al. 1963). Overall, these comparisons suggest the Dan Canyon individual may have been a somewhat "typical" child who experienced "typical" treatment. The grave goods indicate extensive efforts to provide the child with equipment and food necessary for after-life, despite nutritional shortages, and imply that this individual was well cared for. This is important in considering the health of this child and the circumstances of its death.

### COPROLITES

The macroscopic data indicate that the coprolites were composed of ground grass seeds. Gross examination of all coprolites indicates that ground grass seed was the sole macroscopic component of all coprolites. The fact that there is this uniformity between all coprolites suggests that the intestine was full of this material which in turn suggests that several meals of grass seed were eaten before death.

The pollen data also indicate consumption of grass before death. Between 92 percent and 94 percent of the pollen recovered from the coprolites was from small, non-cultivated grasses. The fact that large pollen

## CONCLUSION

aggregates were recovered indicates that this pollen had a dietary source and probably was adherent to the grass seeds. Bryant and Morris (1986) note that maize pollen adheres to maize kernel and is torn during the grinding process. Thus torn maize pollen is indicative of a food containing processed kernels. Many torn grass pollen were noted in the pollen counts from the Dan Canyon burial. The damage to the grains is similar to that Bryant and Morris describe. Thus, it is suggested that the torn grass pollen grains indicate that the grass grains were adherent to the grass seeds and some were torn when the seeds were ground.

A very low amount of background pollen derived from pine trees, sagebrush, and cheno-ams is present in the coprolites. The low and inconsistent showing of these pollen types in the coprolite is noteworthy. Normally, coprolites deposited during the pollination seasons (late spring, summer, and early fall), contain substantial amounts of background pollen. For the Colorado Plateau, this background pollen should consist primarily of grass, low spine composite, and cheno-am types with lower amounts of pine, juniper, oak, and sagebrush types. The lack of background pollen indicates that the coprolites were formed during the cold season when plants are not actively pollinating.

The pollen counts contain consistent but small amounts of *Ephedra* pollen. *Ephedra* was a common medicinal plant and *Ephedra* pollen has been recovered from several coprolites from the Southwest in quantities that indicate prehistoric medicinal consumption of *Ephedra* tea (Reinhard et al. 1991).

Although, the amount of *Ephedra* pollen in the Dan Canyon burial is low, it still is likely that this pollen is derived from an aqueous concoction of *Ephedra* foliage (a tea) that was administered to the ailing child for medicinal purposes. Normally, small amounts of *Ephedra* pollen would not be interpreted as having a cultural source since *Ephedra* is sometimes a normal constituent of pollen rain, although on the Colorado Plateau it is a relatively minor constituent. The fact that the *Ephedra* pollen is present in the near absence of other environmental types and that clumps of *Ephedra* pollen were observed (Table 2) suggests that the pollen is of a cultural source and is probably reflective of prehistoric pharmaceutical behavior.

## DIET AND DEATH

The coprolite data can address the final meals, time of death, and causes of death for the Dan Canyon burial. The time of death, as indicated by the pollen spectrum, is in winter or early spring. With respect to the final meals of this individual, it is noteworthy that there was an absence of cultigens in the colon. Anasazi coprolites in general usually contain *Zea mays* remains, *Phaseolis* remains or evidence of non-cultivated spices such as *Cleome*. However, Glen Canyon diet deviates from dietary patterns of other Anasazi areas such as Canyon de Chelly, Mesa Verde, the Grand Gulch, Chaco Canyon, and the San Juan River (Minnis 1989; Reinhard 1988) which typically show a high consumption of cultigens. However, maize plays a less important role in Glen Canyon diet in comparison to *Gossypium* (cotton) and *Cucurbita* (squash)

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as represented by coprolites (Reinhard 1988; Table 3). Thus, although the burial diet is unusual in the absence of cultigens with Anasazi coprolites in general, a lack of cultigens is not unusual for coprolites from Glen Canyon.

The coprolites from the Dan Canyon burial are unusual in the monotony of plant foods present. As indicated in Table 3, eighteen plant foods have been documented from Glen Canyon coprolites. Glen Canyon coprolites typically contain a mixture of several of these plant foods (Fry 1976). The Dan Canyon coprolites are therefore noteworthy in their lack of diversity. It is very likely that the lack of diversity of plant foods represented by the Dan Canyon intestinal contents reflects a period of low food diversity. Since the child died in winter, the intestinal contents could reflect a winter diet which characteristically is low in food diversity.

Certain causes of death can be ruled out by the coprolite data. No evidence of parasitism was found, so it is unlikely that parasitic worms were present in the child's intestinal tract at time of death. Therefore, helminth parasitism did not contribute to death. The fact the intestine is full indicates that diarrhea was not a problem at the time of death; one can rule out this as a cause of death.

Thus, the coprolites indicate that the child had a monotonous diet of ground grass seed preceding death. It is probable that this culinary monotony was dictated by the range of wintertime restriction of the diversity of available plant foods. Medicinal *Ephedra* tea

was probably administered to the sick child which resulted in the introduction of *Ephedra* pollen into the intestinal tract. The near lack of background pollen types typical of the Colorado Plateau pollen rain indicates that the child died in the cold season of the year. Finally, the lack of parasites and the full intestine indicates that intestinal disease did not contribute to the death of the child.

## SKELETAL REMAINS

High mortality rates for children 2 to 5 years of age are frequently documented in demographic profiles of both prehistoric and historic populations. For Anasazi children, morbidity and mortality has been associated with anemia (El-Najjar et al. 1976), parasitism (Walker 1985), and bacterial dysentery (Kent 1986). The analysis of the Dan Canyon burial and associated intestinal remains can be used to address these possibilities.

Anemia among Anasazi has been cited as a major life-threatening problem as evidenced by porotic hyperostosis (El-Najjar et al. 1976). El-Najjar identified prevalences as high as 88 percent for certain Anasazi subadult skeletal series. In the case of the Dan Canyon burial, no evidence of porotic hyperostosis is present. Consequently, we can rule out the possibility of anemia as a cause of death.

Kent (1986) offers an alternative hypothesis for the etiology of porotic hyperostosis. Kent postulates that dysentery of bacterial or parasitic nature is a major cause of morbidity and mortality of Anasazi children. As pointed out in the discussion of the Dan

## CONCLUSION

Canyon burial coprolites, the intestinal tract was apparently full at death which eliminates the possibility that dysentery contributed to the death of the child.

Parasitic disease is cited by Walker as a potential health threat for Anasazi. Finds of dangerous parasites in Anasazi sites by Reinhard (1990) heighten this possibility. However, there is no evidence of parasitic disease present in the coprolites.

Infectious disease of a systemic nature affecting bone and dentition has also been discussed and demonstrated in Anasazi populations (Martin, Goodman, and Armelagos 1985). However, the absence of periosteal bone reaction and enamel hypoplasias in the Dan Canyon burial eliminate consideration of chronic infection as a cause of death.

What then, could have been the cause of death for the Dan Canyon child? Evidence present in the skeletal remains of the Dan Canyon child suggests mild, but regular periods of instability in the diet resulting in short interruptions in growth. The Harris lines suggest that the child suffered from seasonal, or periodic stresses related to diet. The presence of five growth arrest lines would suggest that these stresses were frequent. We suggest that the growth arrest lines are evidence of repeated stresses that lowered the vitality of the child such that he or she became increasingly susceptible to infectious disease or star-

vation. The coprolite evidence indicates that the child died in winter. Winter is typically a time of maximum nutritional stress for horticultural people. We infer that the death was facilitated by a weakened constitution stressed beyond capability by winter nutritional inadequacy.

The absence of additional markers of nutritional stress or disease may prove more helpful than their presence in the reconstruction of the death of the child. No evidence of cribra orbitalia or protic hyperostosis indicates the individual did not suffer from anemia during its lifetime. The lack of enamel hypoplastic defects in the child's dentition suggests that long periods of severe stress were not experienced by the individual except, perhaps in the final days before death. Relatively normal stature estimations and normal cortical thickness provide further evidence that stress did not severely disrupt growth and development.

A combination of these indicators would seem to suggest that the Dan Canyon child was subject to regular insults of minor to moderate levels of stress related perhaps to nutritional deficiency brought about in an environment experiencing degradation and decreased productivity. Results of the Dan Canyon research reflect the susceptibility of young Anasazi children to stress in a tenuous environment.



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## APPENDIX A



IN REPLY  
REFER TO:

H2215

United States Department of the Interior  
NATIONAL PARK SERVICE  
Glen Canyon National Recreation Area  
Box 1507  
Page, Arizona 86040



SEP 14 1990

Memorandum

To: Chief, Midwest Archeological Center

From: Superintendent, Glen Canyon National Recreation Area

Subject: Transmittal of Dan Canyon burial materials for study

Under separate cover, we are transmitting to your office materials removed from the Dan Canyon burial (42SA21339) for documentation and reporting. It is our understanding, you have arranged for the completion of this project utilizing funds from the Midwest Archeological Center (MWAC). Please accept our thanks for your willingness to assume this cost. Without your assistance, these exceptional materials would not receive appropriate study and their information would be lost.

As you know, we have been consulting with Leigh Jenkins, of the Hopi Tribe, for the past several months. Both the tribe and this park, agree that all materials recovered from the burial should be reinterred at a suitable location within the park. On August 29, 1990, Mr. Jenkins agreed that limited study of the materials could take place with certain stipulations in effect. These include:

1. All materials must be ready for reinterment, i.e., returned to Glen Canyon National Recreation Area, by February 1, 1991. Please notify us as far in advance as possible when the study is finished and we can assist in arranging for their return transportation to the park. Needless to say, the utmost precautions should be taken to prevent their inadvertent loss or damage; we have not entered these items into the park's museum collection.
2. The scope of the study should focus on documentation, rather than destructive analysis, especially where skeletal remains or other human remains are concerned. Under no circumstances should human remains be altered or destroyed for analytical purposes; however, measurements and visual examination are acceptable. The collection of associated materials conveyed with the human remains may receive more intensive documentation, but should be returned essentially intact.
3. In five months, we plan to meet with the Hopis to discuss consultation and protocol, and draw up procedures for situations such as this. You are invited to participate in this meeting. We have agreed to provide them with a draft or preliminary report for the project at that time; if this is not possible, please let us know. Also, we have agreed to provide them an opportunity to review and comment on the document prior to its release.

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All specimens, as well as original documents, photographs and other records pertaining to this burial which were collected by my staff are being conveyed to you. After you have received these materials, we will contact you concerning the preparation of the project scope and design for the project. If any questions arise concerning the interpretation of these materials, or the content of this memorandum, please contact Chris Kincaid, Park Archeologist, on FTS 761-3150 for clarification.

Again, thank you for your assistance with this project.

  
John O. Lancaster

APPENDIX B

PROJECT SCOPE AND DESIGN

Revised 04/23/90  
Utah Proj. No.  
(call 801-533-7093)

**ROCKY MOUNTAIN REGION**  
**ARCHEOLOGICAL PROJECT SCOPE AND PROJECT DESIGN**  
**PARK - GLEN CANYON NATIONAL RECREATION AREA**  
**DATE - NOVEMBER 30, 1990**

PROJECT SCOPE

- I. **Park:** Glen Canyon National Recreation Area Construction or Planning Project  
Package No.: N/A
  
- II. **Archeological Project Title:** Dan Canyon Burial
  
- III. **Purpose of proposed archeological project:** To document PIII Anasazi remains and burial goods removed in emergency excavation prior to reburial.
  
- IV. **Coordination personnel:**
  - A. Park: Chris Kincaid
  - B. Regional office: Adrienne Anderson
  - C. Midwest Archeological Center: Steve Dominguez

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### V. **Compliance:**

- A. **Native American consultation:** The director of the Hopi Cultural Program, Lee Jenkins, was consulted by Chris Kincaid. On August 29, 1990 Mr. Jenkins agreed that limited study of the materials could be conducted with the stipulations outlined in the attached memorandum.
- B. **Section 106:** This process is the responsibility of the park.

**VI. Location and areal limits of the project:** The materials were removed during emergency excavation of a burial in Dan Canyon, on the Colorado River arm of Lake Powell. All materials were removed from a 1 x 2 m excavation within a rock overhang.

**VII. Work to be performed:** Nondestructive documentation of collected materials, completion of report.

### VIII. **Expected products:**

- A. Project Summary/Small Project Report: N/A
- B. Determinations of Eligibility documentation/National Register Nomination Form: N/A
- C. Draft Final Report: February 1, 1991
- D. Final Report: May 15, 1991
  - 1. Archeological Site Forms N/A
  - 2. Area Surveyed maps N/A
  - 3. Site location maps N/A
- E. Updated CSI: N/A
- F. ANCS catalog records for artifactual material and archived project records: N/A

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PROJECT DESIGN

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**XI. Archeological personnel:**

- A. Project supervisor: Steve Dominguez
- B. Field supervisor: Chris Kincaid

**X. Description of proposed archeological project:**

Both human and cultural remains were recovered from the burial, 42SA21339. Preliminary examination suggests that this child was a member of a late PIII Anasazi group, with average status within the group. The location of the burial is near the edge of the area occupied by Anasazi during late PIII and this area was abandoned shortly after. Investigations in nearby areas indicate that this was a period of environmental degradation, and suggest that Anasazi populations may have experienced periods of nutritional stress or other consequential forms of physiological stress. Studies of both prehistoric populations and living populations suggest that a number of methods were employed to support individuals through periods of stress, and to promote the well being of the group. This burial can provide much unique and important information regarding the economic, dietary, and health care systems, and the general health of the population.

These issues can be addressed using a variety of data, including paleopathological, chronological, technological, social, and economic information. Several theoretic considerations will be briefly reviewed in the following text. In subsequent text the methods to be used for recovery of data from the various material types will be emphasized. Potential impacts of these procedures are discussed at the end of this section.

A report will be produced which presents that data and integrates it with the issues discussed above. This report will be submitted to both the Hopi and professional archeologists for review prior to publication.

**Theoretic considerations:**

Although study of prehistoric Anasazi diet from coprolites and of disease through skeletal remains are relatively common aspects of archaeological research, rarely have the two approaches been combined in the Four Corners region. The complementary study of

## DAN CANYON

coprolites (intestinal contents) and associated skeletons has been done in the lower Pecos of Texas and in the Mimbres area of New Mexico. These studies have provided detailed information regarding prehistoric health care for individuals suffering from specific disease conditions. To date, no such information is available for the Four Corners region.

The find of a subadult burial in Dan Canyon, a tributary of Glen Canyon, provides the opportunity for examining the specific ailments of a young individual and the diet and medicines given to that individual. Skeletal analysis provides a record of disease. Analysis of intestinal contents provides information regarding the foods and medicines provided to the sick immediately prior to death.

Preliminary comparison of burial goods with the Dan Canyon child and other burials in the area indicates that the child is not exceptional with respect to burial furniture. It is therefore assumed that the individual represents the norm of the population with respect to status. Consequently, findings regarding food, medicine and disease can be generalized to the health care system applied to most individuals. Furthermore, preliminary dating criteria suggest that the burial dates to a time of regional ecological stress immediately prior to abandonment. Examination of the burial will show the impact of environmental stress on the individual in this portion of the Anasazi region.

### **Materials and methods:**

Research methods involving visual examination and measurements have been emphasized in order to achieve as complete a documentation of the remains as possible while staying within the guidelines established by the Hopi people. The materials and methods of analysis will be non-altering and non-destructive in nature.

**Human remains:** These include a nearly complete skeleton of a child approximately 4.5 to 5 years in age and coprolites.

Analysis of this individual will focus on study of both of these components. Information to be recovered includes age at death, pathologies and injuries, periods of growth-inhibiting stress, general dietary information, and taphonomic changes to the skeleton. Study of the remains has maintained a focus of non-destructive analysis, both in macroscopic and microscopic techniques. Data recovery will involve the following techniques:

#### 1. Skeletal Inventory

A complete documentation of all bone material recovered from the burial site will be compiled. This will include the identification of each bone and bone fragment in order to deduce the number of individuals within the burial and the presence of any non-human

## APPENDIX

remains. This is done through visual examination and evaluation of the remains. Black-and-white photo records will be kept.

### 2. Growth assessment and long bone measurement

Measurement of the long bones (femora, tibiae, ulnae, radii, and humeri) will be taken in order to determine deviations or correspondence with the standard growth estimates for the assigned age, population and time period. Osteometric tools to be utilized in the analysis include an osteometric board and a large sliding caliper. Both instruments are useful in evaluating the distance from the proximal to distal ends of the long bones mentioned. By accurately measuring the long bones with the osteometric instrumentation estimation of stature can be obtained.

### 3. Age determination

The age of the represented individual(s) will be deduced through the examination of epiphiseal closure, dental eruption, and radiography of the maxilla and mandible. The appearance and fusion of growth centers of bone occur in different areas of the human body at different ages. The evaluation of the areas of epiphiseal closure can thus help form a pattern of age determination by scoring the presence and degree of fusion within a particular bone. Both the crania and postcranial remains exhibit differing periods of fusion and both must be examined in order to determine an accurate appraisal of age. Dental eruption will similarly be used in the evaluation of age. Visual examination and the scoring of the presence or absence of deciduous and/or permanent dentition will be used. Radiographic images of the maxilla and mandible which show the internal development of the non-erupted dentition will be taken. Scoring the degree of growth of the non-erupted dentition in addition to the teeth already erupted, provides a very accurate appraisal of age.

### 4. Stress Assessment by examination of the dentition

Both gross and microscopic examination will be conducted in order to determine the presence or absence of stress indicators known as enamel hypoplasias. These occur when the production of dentin and/or enamel is halted or altered, and are indicated by the presence of lines which horizontally traverse the dentition of the effected individual.

### 5. Pathological study

Pathological study of the remains will include gross examination of the bone in order to detect incidences of trauma, the remodeling and reshaping of bone due to periosteal inflammation, and the deformation of the bone indicative of disease or nutritional deficiency. Utilization of a high-powered microscope in the microscopic examination of the remains will be used to detect minute alterations of the bone. Radiography of the remains is to be done, and will allow an even more in-depth analysis of pathological alterations which may present themselves. Harris lines, or transverse lines evident on the long bones which indicate periods of bone growth alteration due to periods of stress will be recorded. The cortical thickness, also

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an indicator of nutritional stress or disease, will also be evaluated through radiographic means of analysis.

### 6. Examination of culturally-induced changes, i.e. cradleboard deformation

Cultural practices which may have influenced the skeletal remains in shape or form will be analyzed as to the specific degree of modification to the bone. This will be determined through visual examination and measurement.

### 7. Effects of inundation on the skeletal taphonomy

Gross examination of the remains will be used to determine the degree, and pattern of bone warpage and preservation. Radiography will also be useful in interpreting both the external and the internal modifications of bone which result through inundation.

### 8. Trace element analysis

Study of diet can be accomplished through trace element analysis of bone. Trace elements such as strontium, sulphur and nitrogen indicate specific food types consumed in prehistory. Previously, such analysis has been destructive in that small samples of bone had to be removed and destroyed for analysis. Now, non-destructive surficial analysis of the bone is possible due to the combination of an ICP-MS (inductively coupled plasma mass spectrometer) and laser ablation unit. The laser ablation unit strikes the surface of the study material to liberate ions for elemental analysis. This results in no alteration of the integrity of the bone and no visible change in the surface. The area of focus of the laser is a diameter equal to 0.02 millimeters (the width of a human hair). The ICP-MS facility in the Department of Geology, University of Nebraska - Lincoln is one of 3 in the nation to incorporate a laser ablation unit. This type of study has never before been applied to archaeological material and will represent technological advance in archaeological method that could be further applied to future sample to reconstruct diet and disease in the Four Corners area.

### 9. Coprolite analysis

This typically includes several types of analysis. Macroscopic analysis focuses on seeds, plant epidermis, animal bone and scale. Microscopic analysis focuses on dietary pollen, parasite remains, mites, fungal spores, hair and phytoliths. The analysis will begin with rehydration of 5 gm (0.18 ounces) of coprolite followed by screening of macroscopic remains. The macroscopic remains are dried and studied with a low-power microscope. The microscopic remains are first examined for parasite eggs. Then the microscopic remains are separated: lighter components such as pollen, spores and hair are floated from the heavier components, the phytoliths. The pollen will be separated by dissolution of the remainder of this small sample, and examined by microscope. This process separates components, but does not destroy them. Components can be recombined and returned.

## APPENDIX

**Lithic:** These include three flakes and one broken pendant. Information to be recovered includes material types, production techniques, functional categories.

1. Measurement and description. Includes visual examination and measurement of standard landmarks with calipers. Material typing by visual examination only.
2. Photography. Both black-and-white and color photo records.

**Ceramics:** This includes a single vessel. Information to be recovered includes ceramic ware and type for chronology and affiliation, material types, construction and finishing techniques, functional categories.

1. Measurement and description. Includes visual examination and measurement with calipers. Material typing by visual examination only
2. Photography. Both black-and-white and color photo records.
3. Phytolith wash. Wash of distilled water over small area of vessel, then hydration of resulting sample for microscopic examination.

**Botanical:** Vegetal remains included fiber and wood artifacts, food, non-artifactual charcoal, and incidental products of decomposition. These will yield information regarding chronology, production techniques, material types, ethnobotany, economy, and post-burial conditions (taphonomy).

**Fiber artifacts:** These consist of fragments from two to four baskets, fragments from one or two sandals, fragments from two unknown objects made of twined textiles.

1. Measurement and description. Includes visual examination, and measurement with calipers and goniometer.
2. Photography. Both black-and-white and color photo records.
3. Rehydration. Samples from two specimens will be soaked in trisodium phosphate, subjected to microscopic examination, dried and all materials returned.
4. Phytolith examination. Treatment of a small sample of fibers for separation of phytoliths, then microscopic examination.

**Wood artifacts:** These consist of two spoons, and an unidentified worked wood object.

1. Measurement and description. Includes visual examination and measurement with calipers. Taxonomic identification by visual examination only.
2. Photography. Both black-and-white and color photo records.

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**Food:** A mass of tan to orange organic material which bears impressions of a soft-textile or hide container was recovered from beneath the individual. It appears to be the remains of a bag of meal or pollen (see possible hide bag).

1. Description. Includes visual examination
2. Rehydration. Samples from two specimens will be soaked in trisodium phosphate, subjected to microscopic examination.
3. Phytolith examination. Treatment of a small sample for separation of phytoliths, microscopic examination.
4. Pollen extraction as described above.

**Nonartifactual charcoal:** Approximately two grams of charcoal from unworked wood was recovered from the fill of the grave. It is assumed that this material is approximately contemporaneous to the burial. Since it appears to consist of incidental non-artifactual inclusions, it will be submitted for C14 dating.

**Faunal:** This includes several non-human bones, impressions from a possible hide-bag in food remains, and incidental inclusions due to decomposition.

**Non-human bones:** Several non-human bones were recovered from the burial.

1. Measurement and description. Includes visual examination and measurement with calipers. Taxonomic identification by visual examination only.
2. Photography. Both black-and-white and color photo records.

**Possible hide bag:** This consists of impressions in meal or pollen resembling the stitching and wrinkles of some fabric (see Food Remains). The absence of vegetal fibers suggests that this consisted of hide.

1. Measurement and description. Includes visual examination and measurement of textile impressions with calipers.

**Incidental inclusions:** These consist of insect larval and/or pupal remains for taphonomic and paleoenvironmental information.

1. Measurement and description. Includes visual examination. Taxonomic identification by visual identification only.
2. Photography

## APPENDIX

### **Potential impacts of analysis:**

The majority of procedures will involve visual examination, measurement, and photography. The human bones will be X-rayed. These are non-intrusive and will destroy no materials.

Rehydration will be performed on two samples of textile and 5 grams (0.18 oz) of fecal material. This procedure is minimally intrusive, in that it involves returning materials to a state similar to that at the time of burial, but involves no destruction of material, and can be reversed.

Phytolith analysis will be performed on two small samples of textile and on a distilled water wash from the vessel. Pollen analysis will be performed on the lighter fraction floated from the coprolite sample, and on a sample from the "meal". This involves separation of the organic portion of the sample and microscopic examination of the remainder. All materials from the samples will be returned.

The use of the ICP-MS (inductively coupled plasma mass spectrometer) and laser ablation unit will affect an area less than 0.02 millimeters in diameter (less than the diameter of a human hair).

Radiocarbon analysis will be performed on non-artifactual wood charcoal which was included in the fill. This is the only destructive procedure which will be performed on materials from the Dan Canyon Burial.

XI. National Register of Historic Places Information: All archeological materials have been removed from the site. Consequently it has been determined ineligible for the NRHP, as defined in Section D4 of the criteria for the National Register of Historic Places.

XII. File search results and previous archeological investigations in the project area:

A number of earlier archeologists passed through this area and were aware of the Anasazi occupation of Moqui Canyon (Day 1963), a number of BMII burials were collected but little other investigation was conducted. Most archeological work was performed during Glen Canyon preconstruction (Upper Colorado River Basin Salvage Archeology Program) and subsequent park service investigations.

A total of 100 sites of various affiliations were identified during preconstruction surveys (Day 1963, Fowler 1959a, 1959b, 1960, 1961, Lipe et al 1960). An additional seven were recorded in 1976 (Schroedl 1976) during an additional survey of Moqui Canyon and Lake

## DAN CANYON

Canyon. A large number of other Anasazi sites have been recorded during work in in the Defiance House area, approximately four miles north (Schroedl 1981), and in Forgotten Canyon (Fowler 1959b).

A number of sites in and near to Moqui Canyon have been excavated. In 1959 three sites were excavated in Moqui Canyon (Lipe et al 1960), in 1961 nine sites were excavated (Sharrock et al 1963), and in 1962 an aceramic site of unknown affiliation, 42SA369, was partially excavated (Sharrock 1964). In addition, five sites were excavated in nearby Forgotten Canyon and the Defiance House area (Lipe et al 1960). In 1960 twenty sites were excavated in Lake Canyon (Sharrock et al 1961).

In all, surveys have identified at least 65 Anasazi sites in the the townships occupied by Moqui Canyon (National Park Service Cultural Sites Inventory) and twelve have been excavated to some extent. Affiliations include BMII, PII, and PIII (Fowler 1959b, Lister 1959). Some potential PIV ceramics, including Jeddito Yellow Ware and Awatobi Yellow Ware , were collected in Moqui Canyon and the surrounding area (Lister 1959), but these represent only brief, seasonal occupation (Fowler 1959b).

XIII. Collections management and conservation: All materials will be returned to the Hopi Tribe for reburial.

XIV. Project schedule target dates:

- A. Fieldwork dates: N/A
- B. Project summary/Small project report: N/A
- C. Completion of analysis: 12/30/90
- D. Completion of curatorial tasks (cataloging, storing to NPS standards): N/A
- E. Submittal of Determination of Eligibility for sites located to Rocky Mountain Regional Office: N/A
- F. Updating computerized CSI and archeological base map: N/A
- G. Draft of final report for review to be submitted to Rocky Mountain Regional Office by: 2/1/91
- H. Final report to be submitted by: 6/1/91

## APPENDIX

### XV. REFERENCES CITED:

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1964 *1962 Excavations, Glen Canyon Area*. University of Utah Anthropological Papers No. 73, Glen Canyon Series No. 25. Salt Lake City.

Sharrock, F.W., K.M. Anderson, D.D. Fowler, D.S. Dibble

1961 *1960 Excavations, Glen Canyon Area*. University of Utah Anthropological Papers No. 52, Glen Canyon Series No. 14. Salt Lake City.

Sharrock, F.W., K.C. Day, and D.S. Dibble

1963 *1961 Excavations, Glen Canyon Area*. University of Utah Anthropological Papers No. 63, Glen Canyon Series No. 18. Salt Lake City.

### XVI. Project budget (address budget categories):

#### A. Personnel compensation and benefits:

- |   |     |
|---|-----|
| 1. Fieldwork:   | N/A |
| 2. Laboratory analysis                                |     |
| 3. Curation (conservation, cataloging, storage)       | N/A |
| 4. Report preparation (includes National Register)    |     |
| 5. CSI update (arch. base map, computerized database) | N/A |

#### B. Travel and transportation:

#### C. Transportation of things:

#### D. Printing and reproduction:

#### E. Services to other agencies:

#### F. Supplies and other materials:

#### G. Equipment:

#### H. Admin. and support services:

TOTAL

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\$5,000

## APPENDIX

### APPENDIX C

#### CATALOG OF MATERIALS AS RECORDED IN THE FIELD

##### Dan Canyon Burial Summary of Collected Materials

##### I. Materials collected by Ranger Steve Luckeson on 6/17/90

###### SURFACE PROVENIENCE

- SL-1 = Skull fragment (parietal and occipital bones)
- SL-2 = Skull fragment (frontal and zygomatic bones)
- SL-3 = Maxilla fragment
- SL-4 = right temporal
- SL-5 = mandible
- SL-6 = left temporal
- SL-7 = maxilla fragment
- SL-8 = vertebra
- SL-9 = wooden spoon (2 pieces)
- SL-10 = wooden spoon (complete)
- SL-11 = wood fragment (collected on 6/19/90)
- SL-12 = two vertebrae
- SL-13, 14, 15, 16, 17 = Sherds from seed jar

##### II. Materials collected by Chris Kincaid on 6/19/90

###### SURFACE PROVENIENCE:

- DC-1 = Unidentified tooth
- DC-2 = sherd
- DC-3 = 2 teeth
- DC-4 = Skull fragment and possible wood fragment
- DC-5 = vertebra
- DC-6 = vertebra
- DC-7 = tarsal bone
- DC-8 = Patella

###### SUBSURFACE PROVENIENCE:

- DC-9 = unmodified wooden whorl, possible toy?, recovered from vicinity of Basket 4
- DC-10 = mat fragments, found beneath basket 3
- DC-11 = possible sandal fragments, recovered from screen
- DC-12 = fragments from basket 2
- DC-13 = fragments from basket 3
- DC-14 = unidentified basket remains (3 trays) removed from fill

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- DC-15 = possible turquoise pendant, no provenience
- DC-16 = three flaked stone fragments, one tertiary, two micro flakes no provenience
- DC-17 = general number for seed jar
- DC-18 = twisted two-strand cord fragments, associated squash seeds, and unidentified clumps of scordage, 3 trays, associated with the lower thoracic portion of burial
- DC-19 = Remains of hide pouch (?) containing cache of Indian Rice Grass seeds, located below burial (3 containers)
- DC-20 = dark organic clump
- DC-21 = bird bone fragments, no provenience
- DC-22 = miscellaneous macrobotanical remains, including 4 pinyon seeds, possible squash peduncle, possible corn husk remains, no provenience
- DC-23 = small charcoal fragments
- DC-24 = possible wood fragments, recovered from surface in scattered fragments

## REPORT CERTIFICATION

I certify that "The Dan Canyon Burial, 42SA21339, A PIII Burial  
in Glen Canyon National Recreation Area: by Steve Dominguez et al.

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



Regional Director

6/22/92

Date

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### Classification Key Words:

**"Available"**--Making the report available to the public meets the criteria of 43 CFR 7.18(a)(1).

**"Available (deletions)"**--Making the report available with selected information on site locations and/or site characteristics deleted meets the criteria of 43 CFR 7.18(a)(1). A list of pages, maps, paragraphs, etc. that must be deleted for each report in this category is attached.

**"Not Available"**--Making the report available does not meet the criteria of 43 CFR (a)(1).

