ARCHEOLOGICAL INVESTIGATIONS AT SITE 42SA20286, CANYONLANDS NATIONAL PARK, UTAH

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Technical Report No. 36

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

1994

ABSTRACT

Site 42SA20286 is an open lithic scatter located on the west bank of Salt Creek in the Needles District of Canyonlands National Park, Utah. The site is considered eligible for nomination to the National Register of Historic Places by consensus with the Utah State Historic Preservation Officer. In September 1989, subsurface investigations were conducted in and near areas of the site to be impacted by bridge construction.

Three geomorphic units were identified within the site and can be differentiated by depositional conditions. The lowest unit cannot be reliably dated. A single radiocarbon sample from the middle unit tentatively places it within the Neoglacial or Late Archaic. The uppermost unit and surface deposits appear to contain Anasazi components. Culturally derived materials consist of flaked lithics, bone, and charcoal.

The lithic assemblage indicates dependence on a limited set of formal tools augmented by expedient items produced with local materials. Stratigraphic changes in the lithic assemblage suggest chronological shifts in use, technology, and group range.

The faunal assemblage indicates use of small vertebrates, especially mammals. Macrobotanical specimens included *Celtis* seed coats and fragments of an unidentifiable burned seed coat. No features were identified in or near the area investigated.

Although results indicate the presence of significant archeological deposits on portions of this site, none were located in the area of direct impact. As a consequence, the sample recovered during these investigations is considered an adequate sample of the area directly impacted by construction.

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INTRODUCTION

From September 18 to 29, 1989, field investigations were conducted at an archeological site to be impacted by construction of the Highway 211 bridge over Salt Creek (Utah Project No. U-89-NA-210n) in Needles District of Canyonlands National Park, Utah (Figure 1). The purpose of archeological work at site 42SA20286 was to evaluate the composition, extent, and integrity of cultural remains within the construction area (Figure 2) and to mitigate impacts.

Site 42SA20286 consists of a large scatter of lithic tools and flakes on a terrace above Salt Creek and is bisected by Highway 211 (Figure 3). It was determined eligible for the National Register of Historic Places by consensus with the Utah State Historic Preservation Office because of its size and its location in the Salt Creek Archeological District Expansion Area. Construction of a road detour on the north side of the existing road and removal of a large boulder from the south side impacted the site after these investigations.

Located on a low Cedar Mesa Formation sandstone outcrop on the west bank of the floodplain of Salt Creek, the site was originally recorded by the cultural resources management firm P-III Associates, Salt Lake City, from whom no published information is available at the time of this writing. The total surface area is approximately 73,000 sq m. Sand dunes (Figure 4) cover part of the area on and around the outcrop, which is surrounded by alluvial terrace deposits. Flaked lithic materials are found on the surface of, and eroding out of, both alluvial and aeolian deposits and are also found scattered across bare rock. Five artifact concentrations are visible, two of which were probably contiguous prior to bisection by Highway 211. One possible Rosegate point was recorded, which would suggest use in at least the period A.D. 300 to 1300 (Holmer 1986).

Investigations conducted in 1989 included mapping, shovel testing, test excavation, and surface collection within and near the areas of planned direct impact (Figures 5 and 6). The nature of these investigations was conditioned by the lack of features or stratigraphically discernible occupation levels, and by the absence of significant geomorphic or paleo-environmental data within the area to be directly impacted. However, significant surface and subsurface deposits were observed on the site near the areas of planned impact.

It is believed that the data recovered from the investigated portion of the site constitute an adequate sample of the area disturbed by construction of the Salt Creek Bridge. It is recommended that the mapping, shovel testing, test excavation, and surface collection in and around the direct impact area be considered to constitute mitigation of loss of data due to construction activities. This portion of the site was marked with flagging tape and clearance recommended for construction within those boundaries.

The Rocky Mountain Regional Archeologist required that testing and data recovery proceed concurrently. Subsurface investigations conducted in the fall of 1989 constituted both testing and data recovery for this mitigative effort. As a consequence, our limited, prior knowledge of conditions and materials from these deposits was based on the information initially recorded by the contractor, P-III Associates, and on observations of surface conditions made in subsequent separate visits by Susan Vetter and Steve Dominguez of the Midwest Archeological Center. The research design for subsurface investigations was necessarily general and constructed to cover a wide range of potential contingencies.

Due to the types of data recovered, the analyses conducted for this report focused on stratigraphic correlation of soil and geomorphic units, identification of paleoenvironmental conditions, and the characterization of lithic systems and chronologic change within lithic systems. A large portion of these deposits cannot be reliably assigned to specific cultures or paleoenvironmental events. As a consequence, the components of the sequence proposed here should not be viewed as proven inferences but as hypotheses for testing in subsequent investigations in the region.

This project was coordinated by Douglas D. Scott. The field director was Steve Dominguez, and the field crew included Jay Satterfield and Roxanne Gissler. Dennis Danielson processed constant volume (CV) samples and encoded the flaked lithic and mapping data. Molluscs were analyzed by Bill Wayne of the University of Nebraska, Lincoln. Steve Dominguez integrated the data and wrote the text. All artifacts and field records are curated at the Midwest Archeological Center, National Park Service, Lincoln, Nebraska.

Overview of Results

Subsurface investigations consisted of 11 shovel probes, and a total of 14.7 cu m excavated in seven 1-x-2-m test units. Surface materials were collected over an area of 1,090 sq m. Material recovered included 59 flaked lithics from the surface and 668 from subsurface investigations. In addition, one radiocarbon sample and 107 CV samples were collected. From the 44 CV samples processed, 15 macrobotanical specimens, 36 identifiable fragmentary or whole snail shells, and 33 pieces of bone were recovered.

Data from soils, bone taphonomy, and the molluscan fauna suggest that several shifts in available moisture occurred during the period when these deposits were accumulating. Three depositional environments were identified in the deposits investigated — aeolian, high-energy overbank, and low-energy overbank. Based on these factors the seven natural soil units/levels that were discovered (Natural Levels I to VII) were grouped into three geomorphic strata (Strata A, B, and C). Unfortunately, dating of levels and strata are dependent upon a single radiocarbon sample from Stratum B, which yielded a 2490 ± 210 B.P. date (see *Dating*, p. 25). Stratum B is coeval with Richmond's (1962) Neoglacial Lower Gold Basin, Agenbroad and Elder's (1986) T_{4b} from upper Salt Creek and T_{2b} from the Bechan Cave area, and Hack's (1942) Tsegi alluvium a. The age assignments of the geomorphic units above and below Stratum B are based on the inferred depositional conditions matched with paleoenvironmental events and are only tentative. The upper unit, Stratum A, may be coeval with a period of aeolian deposition that occurred between about 1500 and 750 B.P. in the Bechan Cave area (Agenbroad and Elder 1986). Stratum C lies conformably below Stratum B and may immediately precede the deposition of Stratum B.

Cultural materials occurred in varying densities at depths up to 1.1 m below the present surface. No features were observed on the site. Datable materials were absent or very thinly dispersed, and no diagnostic artifacts were observed. The suggested dates for these deposits place them in late Middle or Late Archaic to Late Prehistoric (possibly Anasazi) times. Flaked lithic assemblage attributes suggest dependence upon a set of formal tools, especially bifaces, that were transported and maintained. They were augmented by expedient items produced with local materials and infrequently transported. Stratigraphic changes in lithic assemblages suggest that production of formal tools increased in relative frequency through time and that foraging ranges enlarged with increase in available moisture.

ENVIRONMENT

Canyonlands National Park is located near the center of the Colorado Plateau region, and covers much of the area surrounding the confluence of the Colorado River and the Green River. It occupies elevations from as low as 3,880 ft within the entrenched canyon of the Colorado River to over 7,000 ft in the plateaus to the south. The project covers a very small area on one site on the middle portion of Salt Creek, at 4,880 ft in elevation.

Bedrock throughout this portion of the Colorado River Basin consists of Permian to Cretaceous sediments which were originally flat-lying. These were faulted and uplifted subsequent to the Mesozoic; current drainage patterns were established by the Miocene (Hunt 1956). Subsequent dissection of bedrock created mesas, cuestas, and pediments, and produced a series of cut-and-fill episodes, of which remnants can be found in some drainages and basins.

This area lies in the rain shadow between the Rocky Mountains and Sierra Nevadas. Only a small portion of the moisture in the air masses from the west and east reaches the area and falls as precipitation. Average annual precipitation is less than 25 cm. Humidity is low and evaporation rates are high. Most of the park lies between 4,600 and 7,200 ft. Summers are hot and winters cold, as typically found in continental interior regions (Hunt 1956).

Due to the low precipitation, most soils are poorly developed, low in organic content, and formed on various aeolian, colluvial, alluvial, and residual parent materials.

This area is in the Great Basin Desertscrub Biome (Turner 1982). A variety of desert vegetation communities are present in and around the project area. Pinyon/juniper woodlands tend to occupy rockier soils, while soils of finer textures may bear communities dominated by desert shrubs and grasses. Cottonwoods and other deciduous trees dominate riparian habitats. Vegetation is very open. Ground visibility varies from 50 to 95 percent and averages around 90 percent.

In spite of the severity of the environment, the faunal communities are quite diverse. The species richness of the mammals is largely due to the taxonomic diversity of the smaller animals such as rodents and bats.

Water is available from potholes, springs, and drainages. Potholes are dispersed over bedrock outcrops, and can occur anywhere. Smaller potholes may have water from spring through summer, while supplies in larger potholes can last until much later in the year. Seeps and springs occur in many portions of the Cedar Mesa Formation, and can form seasonally reliable sources. Squaw Creek and the lower portions of Salt Creek run intermittently, but water is usually available in marshes or below the alluvial sands.

Areas 6 to 15 miles to the east and south include uplands and mountains. The uplands are formed on the erosionally resistant Navajo Formation and Wingate Formation. These uplands include Hatch Point and Hart Point, and other areas as far east as La Sal Junction. The uplands range in elevation from 6,000 to nearly 7,000 feet. Much of this area is covered with sand sheets, but it includes frequent exposures of Navajo Formation with remnants and lag gravels from the Summerville Formation. Currently there is little water available, most of it occurring in small intermittent drainages with little or no riparian habitat. Other biotic communities are similar to those in the park. The Abajo (Blue) Mountains lie to the south, range up to 11,445 feet in elevation, and are an area of greater moisture and biotic productivity.

BACKGROUND INFORMATION

Culture History

The culture history of Canyonlands is not yet well defined. Results of previous investigations suggest that the local sequence conforms to that proposed by Anderson (1978) for the region. Research by Sharrock (1966) suggests that Archaic groups, Mesa Verde Anasazi, Kayenta Anasazi, Fremont, Paiute, Ute, and Navajo utilized the areas within the park, while the regional sequence developed by authors such as Jennings (1978) suggests that Paleoindian groups had used the area as well. More recently, Tipps and Hewitt (1989) report additional evidence for occupation by Archaic and Mesa Verde Anasazi groups, as well as evidence suggesting some use of the area by Fremont.

Paleoindian groups were the first to use the area, ca. 10,000 – 6000 B.C. Related materials have been found in the area around the park, including Clovis, Folsom, and Plano points (Copeland and Fike 1988; Nickens 1982) and camps (Davis 1985a; Davis and Brown 1986). To date, three Clovis points have been found within the park. Two were recovered from Horse Canyon in the Maze District (Adrienne Anderson, personal communication 1989). The third was found at the base of Squaw Butte, approximately a mile west of 42SA20286 (Agenbroad, personal communication 1990).

The subsequent Archaic period (ca. 7000 B.C. – A.D. 500) has been subdivided into three shorter periods. The dating for these periods varies to some extent by area and by author. The dates used here are consistent with Holmer (1978): Early Archaic (7000 – 4200 B.C.), Middle Archaic (4200 – 1700 B.C.), and Late Archaic (1700 B.C. – A.D. 500). Archaic materials are numerous, both in the surrounding region and within the park. Cowboy Cave (Jennings 1980) is a large excavated site near the park that yielded a culture sequence longer than 8,700 years. Other evidence of Archaic occupation includes Barrier Canyon–style rock art panels (Schaafsma 1971) and surface remains in Maze District (Lucius 1976). In the Needles District, Archaic points at 42SA8489 and 42SA2116 (Dominguez 1988) and a radiocarbon date of 3710 ± 230 B.P. at 42SA20309 (Beta 34978) provide dating criteria for coeval geomorphic units in sites near 42SA20286. A number of Archaic points were recorded in the Needles District by Tipps and Hewitt (1989), and many radiocarbon dates on samples from sites near 42SA20286 are within the range of the Archaic period (Tipps, personal communication 1990).

The Late Prehistoric (A.D. 300 – 1300) is represented by Anasazi materials and possibly by Fremont materials as well. The majority of sites recorded in the park and in the Needles District have been attributed to the Anasazi (Anderson 1978), and a large number have been recorded (e.g., Griffin 1984; Hogan et al. 1975; Losee and Lucius 1975; Osborn et al. 1986; Sharrock 1966). Reinhard (1986) has identified Kayenta Anasazi ceramic types among sherds from Lavender Canyon, but the circumstances of their occurrence there are unknown. The architectural style seen in the Needles District is reminiscent of Kayenta. However, Tipps and Hewitt (1989) believe that these remains result from Mesa Verde Anasazi occupation. They assert that the ceramic designs, temper, and paste all indicate Mesa Verde affiliation, and that the Kayenta-like architectural styles are due to site function rather than affiliation.

Data suggest that the Fremont used the area infrequently, if at all. Fremont use of the area has been inferred mainly through the presence of Fremont-style rock art and ceramics (Lucius 1976; Rudy 1955; Sharrock 1966). In a survey of the Devil's Lane area, Tipps and Hewitt (1989) did assign one component to Fremont affiliation, based on the presence of two Southern San Rafael Fremont–style anthropomorphs. However, Noxon and Marcus (1982; 1985) and Sharrock (1966) have asserted that the presence of Fremont rock art styles may be due to borrowing by Anasazi.

Tipps and Hewitt (1989) have refined the information regarding Late Prehistoric use of the Needles District. Limited Basketmaker III to Pueblo I use and Pueblo I to Pueblo II use of the region are suggested by a number of sherds and projectile points from the Devil's Lane area. Consistent with Sharrock's (1966) inferences, they conclude that the majority of materials indicate use by late Pueblo II to Pueblo III groups.

There is little evidence for use of the park by Protohistoric groups (A.D. 1300 – 1850) such as Ute and Navajo. Their presence has been proposed by Sharrock (1966), based upon a possible collapsed hogan. Their presence was also proposed by Lucius (1976), based upon rock art panels. No other evidence of protohistoric use of the area has been documented. This paucity of evidence is consistent with Steward's (1938) assertion that this region was sparsely inhabited in Protohistoric times.

Historic use of the park has involved mainly mining, ranching, and tourism. Copious evidence of the latter is visible.

Previous Archeological Investigations

Previous archeological surveys in the immediate area of the proposed construction have been conducted by Sharrock (1966), Marwitt (1970), Lindsay and Madsen (1973), Hartley (1980), Tipps and Hewitt (1989), and Dominguez (1988). The area proposed for construction was surveyed in 1988 by P-III Associates (site forms were provided, but no further information is available). No previous testing has been performed on 42SA20286. Dominguez (1988) directed testing of four sites that are 0.6 to 2.0 km from 42SA20286. These bear information relevant to several large-scale geomorphic events discussed in the section Stratigraphy, Geomorphology, Paleoenvironment (pp. 21-32).

RESEARCH CONTEXTS

This section defines the general research contexts for investigations at 42SA20286, lists specific research questions, and also lists the types of data to be collected to answer each question. Due to the lack of prior testing, the research design was based on surface evidence of geomorphological features and cultural remains at 42SA20286. This evidence was necessarily general, so the design was constructed to cover a range of potential issues.

Research Orientations

The 1989 investigations were approached with three general goals: to determine the extent and nature of cultural deposits, to determine the procedures necessary for conducting mitigation efforts, and to collect data relevant to the prehistory of the region. Overall, investigations were oriented toward recovery and interpretation of data pertinent to paleoenvironmental events and cultural processes. The influence of environment in the structuring of both synchronic and diachronic cultural processes is stressed. Meeting these goals involved several tasks:

(1) determining the presence and extent of datable deposits and assigning archeological units to a chronological framework.

(2) identifying geomorphic events that acted in the formation of the site and determining the timing of these geomorphic events.

(3) recovering or recording ecofactual materials or the attributes thereof that are associated with datable deposits and determining processes responsible for their presence.

(4) recording and/or recovering manifestations of human activities, including features (hearths, concentrations, storage pits, etc.) and portable materials (flaked lithics, ground stone, ceramics, faunal remains).

(5) integrating information derived from geomorphic and ecofactual data with information on adaptations (technologic and economic attributes) in order to examine past human responses to paleoenvironmental change.

(6) integrating the data and interpretations with data and interpretations from other sites within the region, and elucidating or reconciling similarities and differences in results.

Specific Research Questions

Paleoenvironments and Geomorphological Processes

A. What landforms and geomorphic environments have influenced the development of archeological deposits on the site?

The data used to address this issue include surface observations of landforms and subsurface examination of sediments.

B. What major geomorphic changes have occurred on the site over the datable period of occupation?

Several forms of data were sought, including surface observations of landforms, sedimentological information regarding changes in size sorting and bedforms (changes in transport mechanisms), pedological information regarding soil horizon development, and absolute and/or relative dating criteria for geomorphic units.

C. How do these changes relate to geomorphic events within the floodplain of Salt Creek? How do these respond to the existing system of fluvial and aeolian sedimentary exchange?

Data used to address this consist of surface observations of landforms and sediment source areas, a geomorphic sequence for the site, and comparative data for the Salt Creek drainage derived from sources such as Agenbroad and Elder (1986).

D. What gross climatic patterns are implied by the geomorphology on the site? What do these imply about paleoenvironmental conditions, and are these implications consistent with other lines of evidence?

Optimal data would consist of identifiable and datable sequences of cut-and-fill episodes, with sediments resulting from discernible processes and in identifiable sedimentary environments.

E. How have aggradation and erosional cycles affected the preservation of cultural resources? Have substantial portions of the record been lost or obscured?

Optimally, data would be derived from dated sedimentary units of known extent, within both conformable and nonconformable boundaries and within the limits of the site.

F. What gross climatic patterns are implied by the ecofacts recorded on the site?

Optimally, data used to address this issue should include taphonomic information from faunal materials (conditions of ground surface), identifiable elements from naturally occurring molluscs (proxy data for climatic conditions), identifiable elements from naturally occurring vertebrates (proxy data for climatic conditions), and plant macrofossils (must be assessed by archeological context for inclusion in cultural or ecofactual materials to be proxy data for climatic conditions). This also includes absolute and/or relative dating criteria for geomorphic units and correlations with paleoenvironmental events identified elsewhere.

Chronology and Cultural Affiliations

A. What were the times of occupation?

Optimally, data would come from materials suitable for absolute dating and from diagnostic artifacts, especially diagnostic artifacts in association with materials suitable for absolute dating.

B. To what areas or cultures are these related?

Necessary data include diagnostic artifacts with known affiliations and/or areal distributions.

Technological Resources and Technology

A. What geologic resources are available in the region around the park, and how are they distributed? Do they bear distinctive attributes that allow identification? Which lithic resources were utilized and in what ways?

Necessary data include field observations and published data regarding the sources in the area around the park, including the materials available and whether they are unique and identifiable, the distances they occur from the site, and their associations with potential biotic resource zones.

B. Given the material sources in the region, how did stone tool procurement and production systems operate? What types of materials were procured, and how were they transported, utilized, and discarded? What is the relationship among the "formal" tool and "expedient" tool systems with respect to resource distributions?

Data should include a variety of attributes from assemblages consisting of cores, debitage, and tools collected from various archeological contexts within the site, and considered in relation to material types and sources.

C. How do these patterns differ with each period or affiliation represented at the site? Can changes in technology be related to changes in settlement or subsistence practices?

Necessary data would derive from assemblages consisting of cores, debitage, and tools collected from various archeological contexts, as well as dating criteria for assemblages.

Subsistence, Economy, and Adaptation

A. Plant resources: What do macrobotanical specimens imply about economic activities on the site?

Optimally, data would derive from macrobotanical remains which bear definite signs of processing or which are believed to have been utilized as food resources, or from pollen of economically important plants derived from samples which have been collected from identifiable features or activity areas.

B. Faunal resources: Are there changes in relative frequencies of large versus small animals? Have there been significant, environmentally caused changes in availability of prey?

Optimally, data would derive from faunal remains with reliable signs of human use or processing, including cut marks, burning, systematic element selection, or some forms of breakage. Patterns of butchering and transport visible in faunal remains should be identified and compared among chronological associations.

C. Have paleoenvironmental shifts been of sufficient magnitude to alter economic patterns seen in the assemblages?

Optimally, data would consist of statistically significant changes in cultural assemblages in association with evidence of well-defined paleoenvironmental events, and/or evidence for hiatuses in the site or local sequence.

Settlement

A. What season(s) of occupations is (are) implied by plant remains and other site attributes?

Optimal data would derive from plant macrofossils and pollen of plants with well-defined phenologies collected from activity areas or features, or with definite signs of processing.

B. Binford (1979; 1982), Shott (1986), Osborn and Hartley (1984), and others have attempted to define relationships between tool assemblages, environmental attributes, and settlement organization. What form of settlement organization is predicted by tool assemblage composition and organization?

Necessary data would derive from large samples of lithic assemblages, including cores, debitage, and tools produced from both exogenous and local materials, in datable contexts. Ideally these would be contrasted with assemblages from other areas and other affiliations.

Cultural Interactions: Contact, Transition Zones, and Trade

A. What materials can be recognized as originating in other areas, and in what forms and quantities do these occur on the site? What do these imply about relationships to nearby sites? To distant sites?

The optimal data to address this issue would derive from exogenous materials that can reliably be associated with a source and with information on procurement and discard. Additional data would come from large numbers of materials less reliably associated with sources.

METHODS AND FIELD INVESTIGATIONS

During the 1989 fieldwork, the methods of data recovery and analysis described in the first part of this chapter were employed to meet the goals listed in the previous chapter. The specific quantities and the areas to which these were applied are described in the last section of this chapter. Although artifact category definitions might properly be considered "methods," these have been included with the assemblage descriptions in the Cultural Materials chapter to allow easier access to the reader (pp. 33-41).

Data Recovery

Three forms of information were anticipated: 1) artifacts and ecofactual materials, 2) vertical (diachronic) distributions of these, and 3) horizontal distributions. Recovery of each form of information is briefly described below.

Several forms of artifacts and ecofactual materials were anticipated. These are discussed in the context of collection and sampling procedures. Processing is discussed below in *Laboratory Procedures*.

The following materials were to be collected: flaked lithics, including debitage and cores; all faunal materials, both naturally deposited and culturally deposited; and all plant macrofossils.

The following types of samples were recovered: radiocarbon (general-level sample only) and constant volume samples for flotation (one liter from each 10-cm level of each horizontal provenience unit). No features were observed, and consequently no bulk soil or pollen samples were collected.

Various forms of information were collected for interpretation of vertical (diachronic) distributions, including cultural sequences and paleoenvironmental change. Specific characteristics bearing on this topic are sedimentological (changes in parent materials and bedforms), pedological (soil horizon development), and differentiation of cultural materials.

The first two of these characteristics were recorded as they are interpreted in the field, including texture (by manual or "spit" testing), color (Munsell), structure (strength and form), bedform, biotic alterations, and geomorphic context within the site. The third, differentiation of cultural materials, is necessarily based on both laboratory results and field observations of patterns of change across a stratigraphic section, especially changes in the contents of natural units. All of these types of information were recorded in the form of profiles, notes, and photographs.

The area of our investigations does not provide a good sample of horizontal artifact distributions. As a consequence, little cultural and paleoenvironmental information could be recovered from horizontal distributions of cultural materials or other attributes across contemporaneous surfaces. Other than the grid, only one form of horizontal recording was employed, the site map, which included all defined areas, test units, horizontally oriented cultural units, natural boundaries and breaks, and recent disturbances.

Field Procedures

Investigations proceeded in the following sequence: identification of areal extent of surface materials; identification of geomorphic units and areas they cover; identification of relationships between surface artifacts and geomorphology, and assessment of the potential for the presence of subsurface materials; identification of direct impact areas to be tested; testing; and identification of relationships between geomorphic events and subsurface materials. The procedures used are discussed below.

Description of FS Numbering System

The format of the Field Specimen (FS) numbers is designed to preserve horizontal and vertical provenience information. This functions as a check on locational information and also allows rapid data manipulation by computer. A complete FS number includes four forms of information separated by decimal points: 1) the Smithsonian site number; 2) a designation number for the horizontal unit (excavation unit, shovel probe, or surface location); 3) a designation for the vertical unit (arbitrary 10-cm level); and 4) the bag number. For example, an artifact from this site may have the number "42SA20286.6.6.2."

The first nine characters are the site number. Following the first decimal is the horizontal location number, "6." Horizontal location numbers were assigned to the individual test or excavation units in the order in which they were opened, and each corresponds to a grid location. Surface-collected materials each received a unique horizontal location number matched to the grid location in the transit book and on the bag.

Following the second decimal is the vertical location, by increment of 10 cm. Surface materials receive a vertical location of "0," materials from 0-10 cmbs receive a vertical location of "1," materials from 10-20 cmbs receive a vertical location of "2," etc.

The number following the third decimal is the bag number. Bag numbers for artifacts are assigned for each individual artifact type. For example, several pieces of debitage may receive a single bag and single bag number, while other flaked lithic items of other artifact classes may receive individual bags and numbers. Bag numbers for samples receive specific codes.

When discussed in the text the FS number will not include the site number. The bag number will also be excluded except when relevent to a specific artifact or group of artifacts. However, when labeled on an artifact or entered in the catalog an FS number will include all four pieces of information.

Surface Distributions

Artifacts within 80 m of the road in the eastern half of the site were flagged in order to discern surface distributions. East-west baselines were laid out both to the south and to the north of the existing road. Artifacts and concentrations up to 60 m from the road were mapped. Modern features and significant geomorphic features around the areas of proposed construction were mapped. Photographs were taken of the site and artifact concentrations. All artifacts within 5 m of the impact area were collected and piece plotted.

Testing: Shovel Probes and Excavation Units (Test Units)

Distribution patterns of cultural materials were assessed in relationship to the areas to be impacted and to geomorphic features. Areas subject to impact were examined for the presence of cultural materials and for conditions indicating that aeolian or alluvial deposition had occurred. Locations with either or both of those conditions were tested for buried cultural materials.

Shovel probes consisted of circular pits approximately 40 cm in diameter which were dug in 30-cm intervals to bedrock or to 90-100 cmbs. All materials were screened in 1/4-in mesh. Limited soil information was recorded for each probe. These were dug in areas where it was suspected that subsurface artifacts were present (based on surface distributions) and where it was suspected that soil depths were greater (based upon landform).

Excavation (test) units consisted of 1-x-2-m squares located on a true north-south grid. Each unit was dug in 10-cm intervals on the existing ground contour. Excavation units were excavated to bedrock or through at least one sterile level. Some were dug to greater depths to obtain geomorphologic information. Constant volume samples were collected from each level. Radiocarbon samples and macrobotanical samples were collected from several buried soil horizons. Detailed profiles of soil and cultural horizons were drawn, and profiled walls were photographed. The majority of the excavation units were dug in areas where shovel probes had indicated the presence of subsurface artifacts and deeper soil, while several were dug in shallower soil in areas that would be most impacted by construction.

Laboratory Procedures

Preliminary Processing

Chipped-stone items were washed. Bone was brushed. All items were bagged with the original field label and a new label. Only the tools were inscribed with site numbers and field specimen numbers. Debitage and bones were not directly labeled.

Samples

Absolute dating and ancillary studies (analysis of molluscs) were performed by specialists. Radiocarbon samples were dried and stored in foil.

Constant volume samples were processed in-house. Each sample was placed in a cylindrical container of 12-cm diameter and 30-cm height. Water was run into the container at constant rate and soil peds were gently broken. The light fraction floated over the barrier into a 841-micron mesh screen. Both light and heavy fractions were dried and saved. These were picked for all lithic, faunal, and botanical remains under a 15-power binocular microscope.

Encoding and Analysis

Quantifiable data from field records and data from materials analyzed in-house were entered on dBASE, which creates ASCII-based files that can be translated to the Automated National Catalog System (ANCS). The choices of variables encoded and the specific statistical procedures were influenced by the types and sizes of assemblages recovered.

Analyses of the flaked lithic assemblages were oriented toward identifying material use patterns, chronological variations in those patterns, implications for technological organization (as discussed by Binford 1979), and chronological changes in organization. Specifically these include the areas from which materials had been transported (to the extent that the source areas of individual materials could be identified), and differences in assemblage attributes for the different material types, including the artifact categories and dimensions in which they occurred, and the categories and sizes of reductive debris which resulted from continued manufacture and maintenance.

The variables recorded for debitage include provenience, maximum dimension, thickness, material type, category, and type of cortex (if present). The variables recorded for tools and cores include provenience, length, width, thickness, edge type, artifact category, material type, cortex type, maximum edge angle, and minimum edge angle. Although definitions of the lithic material and artifact categories used in analysis might legitimately be discussed in this portion of the text, the definitions are given in the Cultural Materials chapter, which describes the artifacts and lithic material types (pp. 33-41).

Analyses of faunal material were oriented toward identification of taphonomic conditions, the relationship of the site to the natural biotic communities in the area, and technological and economic activities as well as chronological changes in those activities.

Variables recorded from the molluscs included provenience and taxon. Variables recorded from vertebrates include provenience, taxon (to the highest level allowed by the nature of the specimen), element, side, portion (if fragmentary), and weathering stage as defined by Behrensmeyer (1978).

Attributes of the overall site assemblage were examined in relationship to the local abiotic and biotic contexts. Spatial patterns of material distributions and patterns of artifact associations were not examined, due to the sizes of the assemblages from the three stratigraphic units.

Areas Investigated

The road alignment cuts through the approximate middle of the site on an east-west line. Construction plans were provided by the Federal Highways Administration (Project PRA CANY 10(2) NEEDLES ENTR. RD), and NPS personnel participated in making slight revisions (Fox 1989). Construction was to affect several areas on the east side and a strip along the north side of the existing road. There were three areas to be affected outside the existing disturbed area:

(a) A large piece of bedrock approximately 10 x 33 m in size which lies to the south side of the road was to be blasted and replaced as riprap against the bank formed by its removal. This would remove approximately 300 sq m of existing ground surface.

(b) Traffic would be detoured to the north of the existing road during construction. This involved disturbance of 180 to 600 sq m of existing ground surface, of which approximately 400 sq m does not appear to have been previously disturbed by earth-moving activities.

(c) Fences totaling 500 feet in length would be installed to prevent movement of equipment over portions of this and another site.

A zone of 480 to over 650 sq m was to be affected by the construction activities summarized above. Various phases of investigations were conducted in and around this zone (Figure 3). Artifacts up to 80 m from the road in the east half of the site were flagged, and artifact concentrations up to 60 m from the road were mapped. Subsurface tests were conducted within the direct impact areas on the east, and up to seven meters outside of this area. Artifacts up to three meters outside of the direct impact areas were surface collected.

Description of Investigations

Surface artifact distributions were examined in relationship to visible geomorphic units, and mapping and collection proceeded as previously described.

Prior to departure, all portions of the proposed impact area were determined to bear no significant subsurface deposits. All artifactual and ecofactual materials on the entire surface of the impact area and a buffer zone of 5 m were collected and provenienced by polar grid using a theodolite. This process covered a surface area of 1,100 sq m and yielded a total of

59 flaked lithic items. Most of this area consists of a 5-m-wide strip along the margin of the highway. Consequently, an artifact distribution map was not prepared.

All of the subsurface excavations were within the areas to be impacted by road cuts and removal of the rock from the creek bank. These were consequently concentrated at the east side of the site, along the existing creek bank, and up to the dunes at the top of the outcrop (Figure 4). Initially, excavation units were located in areas that appeared to have deep sedimentary deposits within artifact concentrations. Later, excavation unit locations were chosen to give equal representation to all parts of the disturbance area, but they were weighted toward deeper deposits.

A total of 14 sq m was test excavated in 1-x-2-m excavation or test units (Figure 4). Eleven shovel probes were scattered throughout the site, covering 1.4 sq m. These two techniques tested 1.8 to 2.3 percent of the proposed disturbance area. A total of 107 constant volume samples were collected, of which 44 were processed. Data recorded during these subsurface investigations are summarized in Appendix A. Results of analysis are discussed in the following text.

STRATIGRAPHY, GEOMORPHOLOGY, PALEOENVIRONMENT

The first part of this chapter describes the geomorphology and stratigraphy of the site, including surface characteristics, profile descriptions from subsurface investigations, and dating and correlation of units, and proposes depositional and biotic environments associated with each geomorphic unit. The second portion examines evidence regarding the biotic environment, including macrobotanical materials, molluscs, and faunal materials.

Surface Description

Site 42SA20286 is located in the NW 1/4 of the NE 1/4 of Section 20, T30S R20E, on the Salt Lake Meridian. It is situated on the west bank of Salt Creek in the Needles District of Canyonlands National Park, Utah. The site is part of the terrace system along the left bank of Salt Creek.

The site is in a stretch of Salt Creek in which the gradient decreases and potential channel width decreases, both attributes creating good conditions for large-scale sedimentation. From the 1,830-m contour to the 1,500-m contour, the upper Salt Creek drainage covers a distance of 30.4 km and falls at a gradient of 1.09 percent in canyons that are approximately 200 meters in width in most areas. Nearer to the site, between the 1,510-m and the 1,475-m contour, the creek covers a distance of 7.3 km, and the gradient decreases to 0.48 percent. This decline in gradient decreases the energy of stream flow, allowing sediments to drop from transport.

In the area 1.5 miles upstream from the site the creek is no longer confined by the canyon, and the limits of the drainage increase to 300 m and exceed 600 m in many areas. In the area immediately upstream from the site, sediments cover an area more than 700 meters in width. At the location of the site the outcrops of bedrock on both the west and the east side of the creek constrict the area the channel can occupy to 340 meters. The terraces on the east and southeast side of the site have formed within, and upstream from, this constriction.

Overall, this part of the Salt Creek drainage forms a concave-concave slope. Within the site itself the existing slopes are convex to concave in the horizontal axis and convex to concave in the vertical axis, allowing sedimentation to occur in many portions of the site.

Sediments

Much of the cultural material is either on a bedrock terrace or on and within alluvial and aeolian deposits overlying a bedrock erosional terrace. The southern, eastern, and northeast sides are at the level of the lowest existing terrace system. This terrace system is as yet undated but may be coeval with Middle Archaic occupations (Agenbroad, personal communication 1990). The sedimentary deposits surround much of the sandstone outcrop and cover at least the lower portions of the east side of the site. They appear to result from marsh, overbank, channel, and aeolian depositional environments. These may be coeval with the deep sand fills that are found to the west on sites 42SA20309, 42SA8489, 42SA8488, and 42SA2116.

Most of the sediments observed on the surface of the site are medium-grained sand, but discontinuous lenses of sandy loam to silty clay are found. Except for areas immediately above bedrock, the rock fraction is very low and consists of gravel- to pebble-sized subangular to angular clasts of sandstone.

Vegetation and Ground Cover

On-site vegetation is comprised primarily of Indian rice grass and greasewood. Additional elements include snakeweed, senecio, yucca, etc. Ground visibility varies from 50 to 95 percent. Adjacent areas within the creek bed are occupied by extremely dense stands of tamarisk with cattail, sedge, willow, and a diverse group of forbs and grasses.

Profiles and Stratigraphy

Relevant stratigraphic information recorded in the shovel probes and excavation units shown in Figure 4 has been summarized in Figure 7 and Figure 8. Profile notes from excavation units and notes from shovel probes are presented in Appendix A. Unit G is the only excavation unit in which all stratigraphic levels were present, and though thicknesses of these levels varied across the site, their general characteristics were fairly constant. Consequently the profile from Unit G is the only profile presented in detail in this text (Figure 7).

In the subsequent text, several depositional processes are proposed that may be responsible for the deposits investigated. A number of cut-and-fill episodes are recorded in the stratigraphy of the area under study, and at least five natural units can be recognized in the deposits. As previously stated, the absence of diagnostic materials and the thinly dispersed charcoal preclude precise dating of these units. However, these natural units were recognized in most of the shovel probes and excavation units, and could be correlated across the site (see *Intrasite Correlations of Units*, p. 24).

Environments and Profile Development

Three factors were recognized that influenced development of the observed units: energy of sediment transport to location, average soil moisture, and the variability of soil moisture. These are manifested in several soil profile attributes, as described in *Profiles and Stratigraphy*, above. Sediment types are related to the type of transport process and the energy involved, as well as to the surface morphology and vegetation at the area of deposition. Average moisture conditions are responsible for development of soil color (grays). Seasonal variability of moisture is probably the factor responsible for variability of soil color (mottling).

The depositional environments suggested by sediments observed within the test pits are similar to many of those suggested for the surrounding area, including aeolian and overbank/channel deposition in high-energy environments and overbank deposition in low-energy environments, i.e., slow water deposition associated with moderately dense or very dense vegetation.

The difference between aeolian deposits and high-energy overbank and channel deposits was not always discernible due to the homogeneity of parent materials in this area: well-sorted, fine- to medium-grained sand, usually unbedded, compacted, and unstructured to weakly structured. The recent dunes on top of the terraces appear to have no cultural materials. Older aeolian/channel/overbank deposits in lower areas have cultural materials that are thick in some places, absent in others. None of these deposits showed evidence of soil horizon development, and further distinctions are not necessary in this discussion.

Low energy overbank deposits with consistent soil moisture, possibly developed in a riparian setting with dense vegetation, are characterized by dark red sandy silt to silty clay and are moderately structured to very structured. Cultural materials are present.

Low-energy overbank deposits with seasonally variable moisture are characterized by red, medium-grained, weakly structured sand mottled with dark red sandy silt to silty clay, often with very structured peds, sometimes thinly lensed. Artifacts occur in varying densities, often thick. Charcoal is thinly distributed throughout.

The general characteristics and proposed environment for each of the *natural levels* identified during excavation are summarized here:

Level I. Dune, existing surface, low moisture. Loose, well-sorted sand, very low rock fraction, no bedding visible.

Level II. Dune, low moisture. Compacted, well-sorted sand, very low rock fraction, no bedding visible.

Level III. Dune, high-energy overbank or channel, unknown moisture conditions. Compacted, well-sorted sand, very low rock fraction, no bedding visible.

Level IV. Low-energy overbank, moist soil. Dark unbedded medium sand with very dark mottles of clayey and silty sand.

Level V. Low-energy overbank with seasonally variable moisture conditions. Unbedded medium sand with mottles of clayey and silty sand, similar to IV, but lighter color and lower density of mottling.

Level VI. Low-energy overbank with moist soil. Unbedded, mottled clayey sand to silty clay, dark (up to 2.5YR4/6). Forms a thin, discontinuous lens within Level V. Similar lenses are present in other portions of Level V.

Level VII. Low-energy overbank with moist soil. Lies over bedrock in portions of unit, but not completely excavated. Very structured, silty sand, unbedded.

Intrasite Correlation of Units

The levels described above could be identified in test units throughout the area tested. Figure 8 shows the profiles and the shovel probe information plotted by surface elevation. Levels with darker color and higher clay and silt content have been shaded. At least one cut and several fill episodes are visible.

Levels IV and VII were easily recognizable in a large number of the test units. Together these result in at least three relatively flat-bedded natural levels which can be traced over most of the site, Levels IV, VII, and the intermediate Level V. Overall, the sediments and artifact densities of Levels IV and VII are suggestive of several periods with slow sedimentation rates, high groundwater, denser vegetation, and high relative density of use by humans. Intermediate Levels V and VI suggest a period of more rapid sedimentation or more variable moisture levels or both.

Levels IV through VII are absent in some test units. The units where they are absent tend to be either further east or located on the upper dune area. It appears that part of the deposits were eroded from the east, the side which lies toward the creek; in Excavation Unit G (Figure 7), the boundary which lies between Levels III and IV appears to be a cutbank which records removal of part of Level IV. It is not known what unit(s) lay above Level IV at that time or if this defined the ground surface at that time. This erosional event probably removed all of Levels IV, V, VI, and VII from some of the units and probably truncated them to a remnant of Level VII in Stratum C (Figure 8; see next page for strata definitions).

Other units where Levels IV - VII are missing are near the tops of the existing dunes, in Shovel Probes 8, 9, 10, and 11 (Figure 8). It is not known whether alluvial or aeolian erosion has removed them or if they simply did not extend to these locations.

The mechanisms and environments of subsequent fill cannot easily be discerned. These are possibly dune or overbank deposits. At least one fill event, and possibly two, occurred subsequent to that erosional event. These are represented by Level III, overbank and/or dune deposits, and Levels II and I, probable dunes. These levels bear a lower density of cultural materials than the lower levels. These subsequent fill events cannot be dated with the materials collected. Correlations of the levels and geomorphic events with other sites are discussed in *Extrasite Correlations and Paleoenvironmental Implications* (pp. 29-32).

Dating

One radiocarbon sample was recovered during the project and processed for dating. It came from Stratum B (Level IV) and yielded a radiocarbon age of 2490 ± 210 B.P. (Beta-33710; wood charcoal; $\delta^{13}C$ undetermined). The two-sigma calibrated date range is 1110 to 50 B.C. (intercepts at 760, 680, 650, and 550) using Stuiver and Reimer's (1993) calibration program and 20-year data sets.

The charcoal was sparsely distributed throughout approximately 15 vertical centimeters within Stratum B but did not derive from a discrete feature. It was collected from the upper portion of level 70-80 cmbs to the upper portion of 80-90 cmbs in Excavation Unit 185N/322E and Excavation Unit 185N/323E (Excavation Unit G). This was hand-picked by trowel from the excavation unit and from the screen.

Natural Levels, Field Specimen Numbers, and Strata

Differences between natural levels are subtle. Changes in color and structure caused by moisture changes can be as great or greater than changes caused by differences in soil types, and variations in texture are often slight. During excavation, natural units were often recognized after the fact. As a consequence, collected materials are not originally provenienced by natural unit, and must be related back to these units. The fact that materials collected from arbitrary levels dug on contour may have some mixing among natural levels is recognized. Appendix B shows natural units that correspond to field specimen numbers, and accounts for associations among natural units.

These natural units were lumped into three groups on the basis of buried soil horizon sequences and the proposed environmental conditions. During analysis, materials from these seven levels were lumped into Stratum A, "undifferentiated aeolian and high-energy overbank and channel," consisting of Levels I, II, and III; Stratum B, "moist low energy," consisting of Level IV; and Stratum C, "variable moisture, low energy," consisting of Levels V, VI, and VII.

Macrobotanical Materials

A total of 58 specimens were recovered from 44 constant volume samples. Of those, only the 16 specimens listed in Table 1 were considered to be non-intrusive. Botanical materials were considered to be intrusive only if they were obviously new and bore no evidence of cultural alteration. All others were considered to have been potentially deposited by natural means or by cultural means. The intrusive specimens are listed at the end of Table 1.

None of the items considered to be nonintrusive bore any evidence of cultural alteration, i.e., none were burned or mechanically altered. Contexts in which these specimens were found gave no additional clues as to whether these were culturally deposited. Most specimens are fragments of seeds of *Celtis* sp. All 13 of these specimens were recovered from CV samples taken from probable marsh and lower deposits (Stratum B and Stratum C). These were absent in the upper levels. Although ethnobotanical records (e.g., Elmore 1944; Whiting 1939) indicate that *Celtis* sp. (hackberry) seeds were eaten by various historic Native American groups, it is not known whether their presence is due to natural or cultural processes.

In addition, there are two fragments of an unidentifiable seed coat (Reinhard, personal communication 1989) from Stratum B. These may have resulted from economic activities, but their significance cannot be assessed with existing information.

Molluscs, by Bill Wayne, Department of Geology, University of Nebraska, Lincoln

A total of 36 identifiable specimens of snails were recovered from 44 CV samples. Out of 38 vials, 14 contained only unidentifiable fragments, and many of the specimens had to be considered only tentatively identified because they were broken.

All specimens are terrestrial gastropods; no aquatic or semi-aquatic forms are represented. The 36 specimens identified to species included 9 taxa, most of which are fairly widespread in both geographic distribution and ecological requirements. The species distribution by stratum is shown in Table 2. Most of the species are pupillids, which can be recognized if the apertural whorl is complete, and several were identified in this way. Two whole specimens of *Vallonia cyclophorella* were found, and so all broken and immature specimens of *Vallonia* were identified as the same species.

All gastropods live in protected areas and can survive only limited desiccation. For that reason, even those that seem to be able to survive hot summers in semi-arid regions live beneath stones, pieces of wood, or at the bases of plants, where they are inactive on sunny days, but they emerge at night to feed, when humidity is higher and temperature is lower. Typical habitats in the desert include floodplain surfaces, where vegetation is likely to be more abundant; around the margins of springs; and on shaded slopes, where the microclimates are more suitable for their survival. Appendix C includes notes on the taxa in this assemblage.

Both the topographic setting along Salt Creek and the sediments examined in excavation units indicate that these snails were collected from floodplain accumulations. It is not certain whether they originally lived there, because storm runoff commonly washes shells from higher slopes onto floodplains, where they may be buried along with individuals that were living on that surface.

Stratum C, the lowest sedimentary unit, yielded remains of 8 taxa of gastropods. Although all of the taxa are regarded as drought tolerant, two of them, *Gastrocopta pilsbryana* and *Vallonia cyclophorella*, are widely distributed at higher elevations in the mountains of southwestern U.S. Two others, *Pupoides albilabris* and *Hawaiia minuscula*, are common in regions that are cooler and moister, although they can tolerate dry conditions if they have some cover. The presence of these species suggests greater effective moisture in the region when the sediments from which they were recovered were deposited, sometime prior to 2500 B.P. Undoubtedly this location was more moist than it is today, and it is likely this site was part of an active floodplain. However, this evidence does not confirm that this location was a marsh.

The dated bed, Stratum B, yielded mostly broken fragments of shells and a few bones of small vertebrates. The only identifiable snails were broken specimens of *Vallonia*, which inhabits moist microclimates and is common at higher altitudes in mountains, where it is found in forested areas.

The uppermost sediments, Stratum A, contain fewer snails than do those in the basal material. The presence of a few snail shells in the samples suggests that these sediments are floodplain overbank materials or slope colluvium sources rather than dune sand. Alternatively, these deposits of sediments and shells may have been deposited in dune deposits derived from nearby floodplain or slope sources. If this site was the floodplain of an aggrading stream at the time and place these sediments accumulated, the ecologic requirements of all the snails found in these samples would have been met.

Vertebrates

A total of 33 bone fragments were collected, 26 from CV samples and 7 from screening. Raw data recorded from these is in Appendix D.

Elements and Taxonomy

All specimens were extremely small, and most were too fragmented to be identifiable. The unidentifiable bones include 7 unknown irregular, 3 unknown flat, 12 unknown long (shaft fragments), 1 unknown alveolar, and 1 unknown tooth. The 9 identifiable fragments include 1 femur, 1 vertebra, 2 ribs, 1 squamosal, 1 maxilla, 1 mandible, 1 cheek tooth, and 1 incisor.

The majority of the specimens could not be identified beyond a very general level. Of these, 14 were recorded as unknown microverts, 1 as amphibian, 1 as Serpentes, 1 as mammal (unknown size class), 12 as unknown small mammal, 3 as rodent, and 1 as *Sylvilagus* sp. (Table 3). The single amphibian specimen consists of a humerus from an individual approximately the size of a wood toad. The specimen of Squamata consists of a vertebral fragment from a small snake. One of the rodent specimens is an I1/, left, possibly from *Neotoma* sp. *Sylvilagus* is represented by a left mandible fragment with deciduous M/123 and permanent P/3 erupted (Voorhies, personal communication 1990). No other information could be discerned regarding developmental stages.

Taphonomy

Excepting one loose I1/, all specimens were broken to some degree. Mechanisms responsible for breakage could not be discerned. At least 12 specimens were broken while the bone was green, which may have resulted from hunting or predation, while the remaining breakage may have resulted from trampling of dry bone and from weathering. It is quite likely that a substantial portion can be attributed to processing of small mammals by humans, as 9 (27.3 percent) were burned to some degree. However, it is also possible that naturally occurring fragments were incidentally rather than intentionally burned. All of the burned fragments consist of either unknown microvert or small mammal. Insufficient numbers of identifiable elements preclude assessment of patterns of either carnivore breakage or human processing.

Weathering stages were recorded and interpreted using the criteria defined by Behrensmeyer (1978). Of all 33 specimens, only two had differential weathering (FS 22.8.1 with Stages 2 and 1, and FS 22.9.9 with 4 and 1). The remaining 31 had an even distribution of weathering, even on specimens with more advanced weathering stages. This suggests that materials in these deposits were constantly churned as they accreted. Weathering stage distributions by arbitrary level are shown in Table 4. Specimens with multiple stages were entered on the table with the highest stage number. Because of the low number of specimens distributed through a large number of proveniences, little can be discerned in the frequency distribution across individual arbitrary units. The frequency distribution across the totals at the bottom can be considered to represent average conditions in these units. This distribution shows an uneven distribution, with a larger portion of the specimens in lower stages of weathering.

When they are analyzed according to the groups previously described (Strata A, B, and C), differences in the weathering stage distributions are discernible (Table 5). Specimens in Stratum C (Levels V, VI, and VII) are more restricted to Stage 1, with only two items of higher stages. This type of distribution is frequently associated with rapidly accumulating sediments, where bone is preserved in a lower stage of weathering. Specimens in Level IV have a more even distribution across the weathering stages. This type of distribution is frequently associated with more slowly accumulating sediments with few or no large filling episodes, where the accreting bone assemblage remains exposed. Although the majority of the sediments investigated were from Levels I, II, and III, only three bone specimens were recovered from these strata. This may be due to rapid sedimentation or destruction of bone in these overbank and/or dune deposits.

Summary

This assemblage derives from a minimum of four small vertebrates: one unknown amphibian (probably toad), one unknown Serpentes (snake), one unknown rodent, and one individual of *Sylvilagus* sp. The taxonomic level at which these could be identified precludes recovery of specific information regarding habitat type; toads, snakes, rodents, and cottontails occupy a variety of habitats.

There was no definite evidence of human use identified on any of these remains, no butchering marks or definite signs of crushing. However, nine bone fragments were burned, possibly prior to breakage. It is possible but unlikely that these were incidentally burned in the substrate below hearths or natural fires.

Weathering stage distributions suggest changes in the depositional environments that are consistent with information inferred from the soil characteristics. Stage distributions in the lowest stratum, Stratum C, tend to be earlier stages, suggesting rapid sedimentation. Stages in the middle stratum, Stratum B, are more evenly distributed across the stages, suggesting longer exposure on the surface and slower sedimentation. The small size of the sample recovered from the upper stratum, Stratum A, may be due to either rapid sedimentation or to rapid bone destruction. Due to the small sample the significance of dissimilarities among the levels was not statistically tested.

Extrasite Correlations and Paleoenvironmental Implications

Prior Investigations Outside of the Needles District

Although little is known about Quaternary stratigraphy and paleoenvironmental sequences in the park, some relevant information has been acquired in other portions of the Southwest. Richmond (1962) has identified a series of Neoglacial advances in the nearby La Sal Mountains which may correlate with events in the park. Knox (1984) 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) identifies 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.

Paleoenvironmental sequences have been interpreted for several areas in this portion of the Colorado Plateau. For example, Karlstrom (1988), Hevly (1988), and Dean (1988) have examined paleoenvironmental conditions from the Late Archaic through the Late Prehistoric on Black Mesa in northern Arizona. Paleoenvironments during a similar range of time have also been investigated on Cedar Mesa (Matson et al. 1988) in southeastern Utah, in the Dolores Archeological Program area (Peterson 1988) in southwestern Colorado, and on White Mesa (Davis 1985b) in southeastern Utah. Results from these are in general agreement on the timing of events and cultural processes. In the area near Bechan Cave, Agenbroad (1986) has identified an alluvial sequence very similar to that identified by Hack (1942).

In an area south of the Abajo Mountains, Betancourt (1984) investigated large-scale Late Pleistocene to mid-Holocene changes in vegetation zones, but gave little detail relevant to the temporal limits of this study. Closer to the park, 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).

Within the park, Cummings (1989) investigated both natural and culturally deposited botanical remains on the Island-in-the-Sky. This study identified a number of both wild and domesticated plants that were economically used. It also concluded that although the environment in the area was marginal for agriculture, corn was probably grown on the Island-in-the-Sky.

Prior Investigations in the Needles District

In order to establish contexts of the deposits investigated at 42SA20286, discussion of prior paleoenvironmental investigations will concentrate on periods immediately prior to and coeval with events at that site. Investigation of stratigraphic sequences in the Salt Creek drainage have been initiated only in recent years, and little is known about the middle and lower reaches of the drainage. A brief review of the chronological and geomorphic information collected identifies several useful points regarding the alluvial sequence and paleoenvironmental conditions.

Radiocarbon samples from alluvial terraces in upper Salt Creek, in areas approximately 12 miles to the south, have yielded dates that range from 8680 ± 120 to 175 ± 25 years B.P. (Agenbroad 1986). Agenbroad (1986; 1991) has posited the occurrence of a series of cut-and-fill episodes that affected the upper portions of Salt Creek, and it is likely that these affected the middle portions as well. It appears that these events have affected the preservation or at least the visibility of remains from all periods, especially those of Paleoindian and Early Archaic occupations.

The evidence which has been collected to date from the terraces in the middle portion of Salt Creek indicates the occurrence of several cut-and-fill episodes which directly impacted events at 42SA20286. An erosional event of unknown date formed the channel in which the deposits in this study were formed. A limiting date for this erosion is implied by a radiocarbon date of ca. 4500 B.P. from a hearth at a site near the top of a nearby terrace (Agenbroad, personal communication 1989). This date is within the period of a fill episode in upper portions of Salt Creek (Agenbroad and Elder 1986; Agenbroad 1991). Due to the position of this hearth higher in the terraces than later-dated deposits, it is necessary that at least one erosional episode occurred within the ensuing 1,800 years prior to the fill event at 42SA20286. The dating of this event is unknown, but Agenbroad (1991) identified a major erosional episode ca. 3800 B.P. in upper Salt Creek, and it is possible that this is coeval with the event which affected the lower portion of the drainage.

Subsequent alluviation in that erosional channel formed the lower levels at 42SA20286, and apparently affected a larger area. Radiocarbon dates of hearths near the top of, and on deposits on, an extensive terrace 0.6 to 1.6 km to the north and northwest indicate that much of the sediment in these younger deposits accumulated prior to approximately 2650 B.P. (Tipps, personal communication 1989).

Radiocarbon dates from hearths near the surface of the terrace date to the time range of approximately 2650 to 2200 B.P. (Tipps personal communication 1990). This indicates that deposition was slow or non-existent, and that this surface was relatively stable through this period (Agenbroad, personal communication 1992). This is coeval with Richmond's (1962) Lower Gold Basin of the Neoglacial, a period of glacial advance and stasis associated with a decline in average temperatures, increased alluviation, and possibly an increase in precipitation. These conditions suggest increased effective moisture for surrounding areas as well.

Agenbroad (1991) shows four subsequent erosional episodes for the upper Salt Creek drainage, but their relationships to conditions in the middle Salt Creek drainage are unknown. At least one erosional episode affected the middle drainage, as shown by a cutbank visible in Stratum B of Excavation Unit G at 42SA20286. This stratum yielded an uncalibrated radiocarbon date of 2490 ± 210 B.P. (1110 – 50 cal B.C.), while a sample from lower within a cutbank in younger alluvial deposits on site 42SA20615 yielded a date of 1790 ± 90 B.P. (Agenbroad, personal communication 1989). The dates for these sediments suggest the occurrence of an intervening erosional event. Subsequent episodes of erosion and aggradation may be evident in younger deposits at 42SA20286 and other nearby sites, but this cannot be assessed with existing information.

Aeolian deposits can be found overlying both bedrock and the colluvial sands discussed previously. The deposits at 42SA20286 probably date later than the erosional episode at 1790 B.P. A period of aeolian deposition which lasted from ca. 1500 to 800 B.P. is shown in the sequence for the Bechan Cave area (Agenbroad 1986), and dune deposits which postdate 2200 B.P. have been observed on the terraces north of 42SA20286 (Agenbroad, personal communication 1992).

Correlation of Strata at Site 42SA20286

Most of the deposits investigated at 42SA20286 can only be dated relative to the single radiocarbon sample (2490 ± 210 B.P., 1110 – 50 cal B.C.). These deposits appear to represent only the last 2500+ years of the local sequence.

The lowest unit, Stratum C, is mottled dark red soil with lenses of silt and clay mixed with lenses of sand, and it appears to result from conditions intermittently fluctuating between marshy and dry. Its color seems to indicate a higher deposition rate than that implied by conditions in Stratum B. The bone weathering stage distribution indicates a burial rate faster than that in Stratum B.

Stratum C is overlain conformably by Stratum B. The boundary between these two units is based on increased frequency of the silt/clay lenses, darker color, and more consistent color distribution in Stratum B. It appears that these units represent a relatively continuous deposition, with rates of deposition decreasing toward the upper boundary of Stratum B. It is unlikely that differences between Stratum B and Stratum C are due to Stratum B constituting an A horizon for the entire column of Stratum B and Stratum C. The frequency of silt and clay lenses are higher within the entirety of Stratum B, suggesting a change in depositional environment to less turbulent conditions in that upper unit.

Stratum B is a dark soil unit with many lenses of silt and clay. It has darker and more consistent color, and seems to result from a long period of consistently moist soil conditions and slower deposition rates than those seen in Stratum C. The bone weathering distribution indicates slower burial rates than Stratum C. Overall, these suggest that Stratum B represents a relatively stable surface. The radiocarbon dating falls within the range of dates from the previously described stable surface of the terrace to the north, and it is likely that this makes up a portion of that terrace system.

At the east end of the excavation unit, the upper surface of Stratum B is interrupted by a small erosional surface which appears to be a portion of a buried cutbank of the creek. The position of this cut is consistent with the erosion suggested by the absence of Stratum C and Stratum B in other excavation units at the east side of the site. The erosional event recorded by this cannot be dated with the data collected here. However, this may be related to the erosional event subsequent to 1790 B.P. that was discussed above.

Stratum A was disconformably deposited over Stratum B. Stratum A is light colored sand with little or no silt and clay, which appears to have resulted from overbank and aeolian deposition. No soil horizon development was detected and deposition was probably fast, and dry average soil conditions are implied. The weathering stages of the few bone specimens collected from this unit are consistent with fast deposition. This unit may correlate with the period of aeolian activity which Agenbroad and Elder (1986) shows occurring between ca. 1500 and 800 B.P.

Although the molluscan assemblage is small and no conclusions can be drawn from them, the environmental conditions implied by this assemblage are completely consistent with those correlations. The molluscs from Stratum C include species which are associated with mountainous habitats; Stratum B includes species associated with cooler, moister habitats. These are consistent with the suggestion that these deposits accreted during cooler conditions associated with the Neoglacial. Stratum A yielded a limited assemblage which included only molluscs with generalized habitat needs and which are common in the area today.

CULTURAL MATERIALS

The first part of this chapter is a brief descriptive overview of the cultural materials and artifact type definitions, with descriptive statistics for each artifact type. The second part describes the lithic materials and examines patterns in material selection, reduction, and transport. In the last portion of this chapter, stratigraphic changes in lithic material transport and reduction are examined.

Assemblage Overview

During these investigations 727 flaked lithic items were collected, including 544 pieces of macrodebitage, 8 bifaces, 5 cores, 6 retouched or utilized flakes, and 164 pieces of microdebitage.

The debitage, which included a diverse group of flakes, probably from tool and core reduction, is discussed in the section *Definitions and Descriptive Statistics of Artifact Categories* (pp. 36-41). The assemblage is dominated by the local red to yellow chert which originates in the Cedar Mesa Formation (49.5 percent), but Summerville chalcedony comprises a surprisingly large portion (32.3 percent). Other materials were collected in smaller quantities, including a chalcedony which compares favorably to that from the White Rim Formation, other chalcedonies of unknown sources, and quartzites of unknown source. Definitions, sources, and use of these materials are discussed further in the section *Material Type Definitions* (pp. 34-36).

On the surface, flakes and tools were observed scattered over a large, irregularly shaped area of approximately 56,000 sq m (375 m NE-SW x 225 m SE-NW). There are a large number of artifacts, and they are intermittently dense. Cultural materials are deeply buried in some places, but no diagnostics were found, and no spatial patterns could be discerned in subsurface investigations.

No evidence of features was observed on the surface or in test pits. The location of the "hearth" noted during original recording of the site was identified by the Park Archeologist, and the area was searched. No evidence of this feature was found. A number of small patches of buried dark soil horizons exposed by erosion were closely examined. However, no charcoal, ash, or oxidized sand was observed in these patches, and it is likely that one of these had been mistaken for a hearth.

Slightly more than one gram of charcoal was collected from a volume of 0.5 cu m (2+ levels from a 1-x-2-m test pit). Nine pieces of bone and 15 macrobotanical specimens were recovered from screening and from CV samples. These were discussed in the previous chapter.

Only a very small percentage of entire site was sampled. The total surface area collected, 1,090 sq m, is 1.5 percent of the total site area (approximately 73,000 sq m). Total excavated volume is 14.7 cu m, which comprises an unknown percentage of the buried materials. Total surface area with subsurface investigation is 0.02 percent of surface area. With this sample, statistical analysis of spatial distribution is not feasible.

Excluding microdebitage, a total of 563 items was collected from the small area sampled. Although this is probably less than 1 percent of the entire assemblage, this is a number sufficiently large to allow statistical testing of some assemblage attributes. It is not known whether this constitutes a representative sample of the full assemblage that exists on the site.

Raw Materials and Sources

The types used in the text are defined below. During initial encoding, a larger number of material subtypes were defined which express the range of variation in the materials observed. However, for subsequent analysis and data presentation these subtypes were grouped into a smaller number of types which were constructed to reflect the probable geologic source of the raw material. As a consequence, due to the inclusion of multiple subtypes within one category, the types defined here obscure the true range of variation.

Material types found in and near the project area derive from a number of sources. Several sources are known within the park and in the region around the park (Tipps and Hewitt 1989). Only two items bore abraded cortex. Based on the presence of weathered cortex on 83 percent of the items which bear cortex, it is surmised that a large fraction of the materials were from primary context in bedrock sources, or came from materials transported by alluvial processes only a very small distance from their original context.

The only nearby source occurs in outcrops of the Cedar Mesa Formation, including one which is 0.7 mile to the east and one which is 1 mile to the west. Other materials are necessarily exogenous (for the purposes of this study exogenous materials are those for which there are no known sources within 6 miles). These include Summerville chalcedony, a chalcedony which compares favorably to White Rim chalcedony, quartzite from unknown sources, and other materials. These are described further in the following text.

Material Type Definitions

Divisions between metamorphosed sediments (quartzite) and siliceous precipitates were based on the structure visible under 15x magnification. Most items were determined to consist of metamorphosed sand grains and matrix (quartzite) or of a sedimentary precipitate with a micro- or cryptocrystalline mass (chert or chalcedony). The distinction between chert and chalcedony was based simply on the degree of transparency: items which were opaque to an edge ca. 0.5 mm thick were assigned to chert, those on which light was transmitted through greater thicknesses were assigned to chalcedony. These definitions were useful for the purposes of this archeological study but may not withstand rigorous geological scrutiny.

Chert

This was the most common material, numbering 371 items or 51.0 percent of the entire assemblage. A total of 308 pieces of chert debitage, 13 chert tools, and 50 pieces of chert microdebitage were recorded. Divisions among these were based on colors and color patterns, inclusions (dendrites, speckling, banding, clouding, crystal pockets), and crystal size (crypto- or microcrystalline).

Cedar Mesa Chert. This includes homogeneous brown to red/brown to red, cream, and gray/tan mottled chert. Total of 367 (50.5 percent). Grades from poor to excellent. Bedrock sources are widespread in the Needles and other districts of the park. The nearest known is one mile to the west, at the east side of Squaw Butte (site 42SA2116). On the basis of the presence of unabraded or "bedrock" cortex on specimens it is surmised that a large fraction of the materials were from the bedrock sources. Unaltered materials at the nearby source occur in pieces up to 20 cm in maximum dimension. The quality of these materials is quite variable, but a fair portion of them appear to be of adequate quality for production of bifaces.

Unnamed Chert. Black to dark-brown with lighter brown pockets and black flecking. Total of 4 (0.6 percent). Source: Unknown.

Chalcedonies

These numbered 340 items and constituted 46.8 percent of the entire assemblage. These included 226 pieces of chalcedony debitage, 6 chalcedony tools, and 108 pieces of chalcedony microdebitage. Divisions among these were based on color and color patterns, inclusions (dendrites, speckling, banding, clouding, crystal pockets), and crystal size (crypto- or microcrystalline).

Summerville Formation Chalcedony. Gray with blue or orange/tan mottling, slightly translucent to transparent, cryptocrystalline to microcrystalline. Occasional black speckling. Total of 185 (25.4 percent). Source: Similar to materials from the Summerville Formation. These can be found as large lag cobbles on top of outcrops of the Navajo Formation. They occur in portions of the uplands to the east of the park, especially to the north of Photographers Point and north of La Sal Junction.

White Rim Formation Chalcedony. Pink to lavender (some amber) with red dendrites, cryptocrystalline. Total of 52 (7.2 percent). Source: These compare favorably to materials collected from the White Rim Formation (Susan Vetter and Alan Osborn, personal communication 1990). The formation outcrops below the White Rim of the Island-in-the-Sky and also in the Maze District. Although the source(s) of this material is uncertain, this material is referred to here as White Rim chalcedony.

Unnamed Chalcedony. Clear to yellow or orange, with or without inclusions. Total of 53 (7.3 percent). Source: Unknown.

Quartzites

Unnamed Quartzite. Fine-grained to coarse-grained, well metamorphosed to moderately metamorphosed. Source: Unknown. These numbered only 16 items, comprising 2.2 percent of the entire assemblage, including 10 pieces of quartzite debitage, no quartzite tools, and 6 pieces of quartzite microdebitage. Due to very large number of types, color was not considered. Divisions are based on grain size, size sorting, the consistency of the components of sand, and breakage across grains (degree of metamorphosis). Overall, the sources of these are unknown, but it is likely that they have been procured from the Colorado River or from outcrops of the Morrison Formation.

Summary of Material Types

Observations by Tipps and Hewitt (1989) and by this author indicate sources of moderate to high quality material within one mile, as well as other sources of moderate to high quality within less than thirty miles. Materials that appear to be from these sources occur in varying frequencies within the assemblage. The assemblage contains much local material of moderate to good quality, but a surprisingly high proportion of the assemblage is exogenous material. This high frequency of exogenous material is possibly related to quality, areas used in economic activities, functional/morphological requirements, and beginning sizes and forms at sources. These issues are covered further in the following section.

Definitions and Descriptive Statistics of Artifact Categories

Prior to definition of the flaked lithic categories, several terms should be defined:

Intentional modification: At least one flake initiated subsequent to detachment of item, i.e., not a dorsal or platform preparation scar.

Unintentional modification: Wear or unpatterned damage, trampling. Snap or bending fractures.

Thinning: Flakes directed across the thickest portion of an item.

Shaping: Flakes that remove a portion of an edge but do not remove thicker portions of an item.

Cortex, weathering: Shows signs of chemical decay of material, no mechanical removal; is often flaky, scaly, or powdery.

Cortex, abraded: Shows signs of mechanical removal of material, rounding, pitting, polishing, etc.

Debitage

The debitage category includes all flakes which bear no evidence of post-detachment alterations due to either intentional modifications or utilization. Variables recorded for these include material type, reductive stage, maximum dimension, thickness, cortex type, and completeness. Most of the items recorded fall in this category. This large sample has allowed several aspects of material use to be examined.

Reductive stage distributions bear information regarding technological applications of various material types and regarding adjustments to the accessibility of lithic resources. Several authors (Sullivan and Rosen 1985) have objected to the use of stage-based debitage classifications due to difficulties in the application of definitions, and would prefer use of "interpretation-free" schemes. However, the utility and validity of such schemes remain unproven (Amick and Mauldin 1989; Ensor and Roemer 1989). In this study, assignments of categories were based on morphological characteristics that are usually associated with the different flaking tasks, from decortication to core reduction to tool production. While flakes cannot be categorized by reductive process with complete accuracy, they can be assigned to one of four major categories which result from three generalized reductive processes and which tend to have the characteristics described below. In order to insure consistency in categorization, all of the flaked lithics were encoded by a single individual.

Microdebitage. This includes all products of flaking that are less than 2 mm in maximum dimension. A total of 164 pieces of microdebitage were recorded. Of these, 50 (30.5 percent) are chert, 108 (65.9 percent) chalcedony, and 6 quartzite (3.7 percent).

Macrodebitage. This includes all debitage items that are larger than 2 mm in maximum dimension. A total of 544 pieces of macrodebitage were collected. This includes the categories discussed below.

Shatter. Angular fragments without recognizable flake or core features such as platform, initiation point, bulb, or well-defined ripples.

A total of 4 pieces of shatter were recorded. Of these, 2 are chert, 1 chalcedony, and 1 quartzite. These average 13.9 mm (sd = 3.4) in maximum dimension and 7.2 mm (sd = 3.5) in thickness.

Decortication Flake. Any piece of debitage with cortex covering more than 30 percent of the dorsal surface is a decortication flake. Associated with early core reduction: removal of weathered material and shaping of platform and working faces.

A total of 6 decortication flakes were recorded. Of these, 5 (83.3 percent) are chert, 0 chalcedony, and 1 (16.7 percent) quartzite. These average 18.1 mm (sd = 8.8) in maximum dimension and 6.5 mm (sd = 4.7) in thickness.

Interior Flake. Flakes with less than 30 percent cortex are classified as *interior*. Two forms are defined for interior flakes: Interior I, which tend to be produced during core reduction, and Interior II, which tend to be produced during tool thinning and shaping. The two interior flake categories are defined below.

Core Reduction Flake, or Interior I. Tend to be straight in longitudinal axis, thicker, have a higher dorsal-face-to-platform angle, less platform preparation, fewer dorsal scars, higher average thickness-to-width ratio (> 0.2), larger average surface area, and less dispersed bulb. Produced in earlier stages of manufacture.

A total of 166 Interior I flakes were recorded. Of these, 111 (66.9 percent) are chert, 54 (32.5 percent) chalcedony, and 1 quartzite (0.6 percent). These average 16.8 mm (sd = 7.1) in maximum dimension and 3.1 mm (sd = 1.5) in thickness.

Tool Reduction Flake, or Interior II. Tend to be curved in longitudinal axis, thinner, have lower dorsal-face-to-platform angle, more careful platform preparation, more dorsal scars, lower average thickness-to-width ratio (< 0.2), smaller average surface area, and more dispersed bulb. These are produced in later stages of manufacture.

A total of 301 Interior II flakes were recorded. Of these, 174 (57.8 percent) are chert, 127 (42.2 percent) chalcedony, and 0 quartzite. These average 13.2 mm (sd = 5.2) in maximum dimension and 1.8 mm (sd = 0.8) in thickness.

Tools and Cores

These are defined as any flaked lithic item believed to be intentionally altered for use, or intentionally altered to yield another usable item, or an item incidentally altered by use, including the presence of edge crushing, rounding, and striations, as well as patterned retouch. This includes flakes with post-detachment alterations, cobbles altered for use, and cores. The specific criteria are listed with each type. Only 19 tools and cores were collected, as described below.

Core. A nucleus from which flakes of a usable size have been removed. May include tools that were incidentally used as core as well. Three types of cores/tools were identified, based on size, initial shape of the cobble, and resulting morphology.

Core Tools. Usually unpatterned, irregular flaking with deep scars and highly variable edge angles. Edges may or may not be regular or normalized (Ahler 1981).

Only one was collected (FS 22.4.1; Figure 9a), a multiple-direction core with flake scars from use, platform preparation, or retouch along one margin. It is a gray chalcedony with pink mottling and gray speckles, Summerville Formation chalcedony. Its length = 54.1 mm, width = 29.7 mm, and thickness = 18.9 mm.

Core, Small. Less than approx. 60 cc. Possibly expended. A total of three of these were recorded (FS 22.5.2, 23.0.27, 23.0.24; Figure 9b, 9c, 9d). All of these are the red/tan, locally available Cedar Mesa Formation chert. Lengths ranged from 39.9 to 55.4 mm, with a mean of 47.1. Widths ranged from 26.1 to 43.0 mm, with a mean of 35.9. Thickness ranged from 23.8 to 43.8 mm, with a mean of 30.5.

Core or Core/Chopper. Greater than approximately 60 cc. Cores/choppers have one or more well-defined edges, with damage consisting of small-scale edge crushing and rounding.

Only one of these was collected (FS 23.0.28; Figure 9e), a multidirectional core from which large blocky spalls had been removed. It was made from the local tan/red Cedar Mesa Formation chert. Its length = 71.1 mm, width = 48.0 mm, and thickness = 57.9 mm.

Retouched and Utilized Flake. A flake with modifications that affect only the shape, angle, and sharpness of an edge(s), and do not alter any other characteristics of the object.

Unretouched and Utilized Interior I Flake. Interior I flake that has small (less than 1.5 mm maximum length) unpatterned or random flake scars. Discerned from obviously trampled items by lack of large "clam-shell" scars and regularity (Ahler 1981) of edge.

A total of three of these were collected. One of these (FS 23.0.16; Figure 10f) is gray chalcedony (Summerville Formation chalcedony, one (FS 23.0.25; Figure 10b) the local tan/red Cedar Mesa Formation chert, and one (FS 23.0.29; Figure 10c) mottled brown/red-brown Cedar Mesa Formation chert. Lengths ranged from 32.3 to 66.0 mm, with a mean of 43.7. Widths ranged from 15.3 to 44.9 mm, with a mean of 27.1. Thickness ranged from 4.9 to 12.8 mm, with a mean of 7.9.

Unretouched and Utilized Interior II Flake. Interior II flake which has small (less than 1.5 mm maximum length) unpatterned or random flake scars. Discerned from obviously trampled items by lack of large "clam-shell" scars and regularity (Ahler 1981) of edge. Only one of these was collected (FS 21.4.2; Figure 10d), a large bifacial thinning flake with very regular retouch or use scars along two margins. It was made from the local tan/red Cedar Mesa Formation chert. Its length = 50.7 mm, width = 40.2 mm, and thickness = 5.6 mm.

Retouched Interior II Flake. Interior II flake which has patterned flake scars larger than 1.5 mm maximum length. Discerned from obviously trampled items by size and control of flaking, by lack of large "clam-shell" scars, and by regularity (Ahler 1981) of edge.

Only one of these was collected (FS 11.8.2; Figure 10e), a distal fragment of a large bifacial thinning flake with very regular bifacial retouch. It was made from the local tan/red Cedar Mesa Formation chert. Length = 12.7 mm, width = 39.1 mm, and thickness = 3.3 mm.

Blade. Flake with length/width ratio greater than 2; often with high dorsal ridge angle, roughly parallel edges, roughly parallel flake scars, or lamellar flaking. There are no implications regarding formal blade technologies intended in this definition.

End-retouched Blade. Blade with regular, patterned flake scars larger than 1.5 mm maximum length that produces either a "regular" or a "normalized" edge (Ahler 1981).

Only one of these was collected (FS 21.1.1; Figure 10a), a small blade with parallel edges and single dorsal ridge, derived from bifacial thinning or multidirectional core. Proximal end has been severed. A portion of the distal end bears possible unifacial retouch. It was made from the local tan/red Cedar Mesa Formation chert. Length = 29.9 mm, width = 14.3 mm, and thickness = 3.4 mm.

Bifaces

This category includes any flaked lithic item bearing flakes initiated from contiguous portions of the margin and onto opposing surfaces of the item. A total of eight bifaces were collected. Excluding points and bifacial cores, three types of bifaces were defined on the basis of the degree of control over flaking and the resulting thinness. It is likely that these divisions are artificial and that these items actually represent a continuum of reduction.

Biface, Thick, Type 2. Unpatterned, large bifacial flaking. Scars do not necessarily cross thickest portion of item. Possibly served both as tools and as cores.

A total of three of these were collected. One (FS 15.9.3; Figure 11a) is an end fragment of light gray chalcedony mottled with tan-orange (Summerville Formation chalcedony), with length = 10.3 mm, width = 13.4 mm, and thickness = 5.9 mm. The two others are made from the local tan/red Cedar Mesa chert. One (FS 23.0.23; Figure 11h) appears to be a reworked end fragment with length = 45.2 mm, width = 31.3 mm, and thickness = 10.6 mm. The other (FS 15.9.2; Figure 11g) is complete and appears to be a point preform on which thinning could not be completed because of a group of hinge fractures on one surface. Length = 52.2 mm, width = 31.3 mm, and thickness = 11.4 mm. Surfaces are waxy, but none of these bear any evidence of heat treatment.

Biface, Thick, Type 1. Unpatterned, large thinning flake scars, not regular in size or direction. Most scars cross thickest portion of item, but it is not well thinned; maximum thickness to width ratio is greater than 0.3 and less than 0.4.

A total of three of these were collected. Two are made from the local tan/red Cedar Mesa chert. Of those, one (FS 19.6.1; Figure 11c) is an edge fragment with length = 9.9 mm, width = 23.9 mm, and thickness = 6.4 mm. The other (FS 23.0.26; Figure 11e) is pointed, probably a distal fragment, with length = 28.0 mm, width = 22.8 mm, and thickness = 5.7 mm. The third (FS 23.0.33; Figure 11d) is blue-gray chalcedony with red dendrites (White Rim chalcedony), an edge fragment with length = 18.5 mm, width = 14.6 mm, and thickness = 11.6 mm. Surfaces are waxy, but none show evidence of heat treatment.

Biface, Thin. Bears well-controlled bifacial thinning flakes of regular size and direction. Well thinned, maximum thickness/width ratio is less than 0.3. Possibly knives.

Two of these were collected. Neither is complete. One is pointed and may be a distal fragment, and one is a round-based proximal portion. Both of the breaks are slightly diagonal, and could have occurred during maintenance or use. The basal fragment is white to blue-gray chalcedony (Summerville Formation chalcedony; FS 22.4.2; Figure 11f). The length of this fragment = 38.4 mm, width = 33.6 mm, and thickness = 6.6 mm. The other is a pink chalcedony with red dendrites (White Rim chalcedony; FS 11.0.2; Figure 11b). The length of this fragment = 5.0 mm , width = 11.7 mm, thickness = 3.4 mm. Both have been well thinned, and the more complete specimen has thickness/width ratio = 0.20. Both have matte to waxy surfaces, and neither displays any evidence of heat treatment.

ARTIFACT ASSEMBLAGE MATERIAL USE PATTERNS

The artifacts and the inferred reductive strategies show responses to lithic material availability and quality. Based upon the sample recovered, the material procurement and reduction strategies appear to be dependent mainly upon maintenance of a set of high-quality items for transport, especially bifaces, biface cores, and projectile points. These were augmented by unretouched and retouched flake tools produced and discarded in an expedient fashion. Artifact sizes are reflective of material type and probable source area. The types of artifacts of the various materials also reflect material availability — cores and expedient tools tend to consist of local materials, while formal or curated tools consist of a mix of exogenous and local materials.

Local materials were often discarded at early stages of reduction. Decortication flakes are not common, but are most frequent among the local material. Interior I flakes tend to be of local materials, and differences in flake type frequencies among material types are statistically significant. However, based on artifact types and edge angle measurements, the end products of the materials appear to be approximately the same types of items and used for the same purposes. These attributes are discussed further in the following section.

Material use patterns were examined by comparing size, variability of sizes, ratios of thickness/maximum dimension, reductive tasks applied, frequency of cortex, and tool edge angles of items of the different material types. Significant associations among nominal variables were tested by chi-square analysis. Differences in means of continuous variables (e.g., length, thickness, edge angles) among various nominal categories (e.g., material type, flake and tool types, stratigraphic units) were tested by analysis of variance (ANOVA). Both tests were run on Statistical Package for the Social Sciences (SPSSPC, Version 4.0.1).

Material Use Patterns in Debitage

The distribution of reductive stage by material for debitage is shown in Table 6. Reductive stages are as defined in the previous text. The overall assemblage is dominated by Interior II flakes, which constitute 62.1 percent, while Interior I flakes constitute 35.8 percent, decortication 1.2 percent, and shatter 1.0 percent. The high frequency of Interior II flakes suggests that the overall focus of flaking activities at this site was on reduction of tools or bifacial cores.

In spite of the proximity of a material source in Cedar Mesa Formation outcrops, there is a surprisingly low number of decortication flakes and Interior I flakes, which are generally associated with procurement activities. Even among Cedar Mesa chert items, the relative frequencies of items probably related to core reduction—decortication flakes and Interior I flakes—are low, comprising only 1.7 percent and 39.1 percent respectively. Instead, Interior II flakes constitute the majority (58.3 percent) among the chert items. In comparison with exogenous materials, this relative frequency is slightly lower than the relative frequency of the chalcedony Interior II flakes (69.0 percent). Differences in these were not tested with the frequency distribution in Table 6 due to the number of low-expectation cells. Instead, the chi-square and expected values were calculated for frequencies of Interior I and Interior II flakes by chert and chalcedony only. This test gave a chi-square of 32.06, df = 1, significance = 0.00, indicating a significant difference in the frequencies of the two flakes types between these two material types.

Among the chalcedony items, Interior I flakes make up 30.5 percent, which suggests a high frequency of core reduction on these transported materials when compared with 40.7 percent Interior I flakes for locally available chert. This is not consistent with expectations for relative frequencies of these items among transported materials.

Overall, the similarities between the assemblages of local chert and exogenous chalcedony with respect to flake-type frequencies suggest that the organization of, and the trends within, each assemblage were similar. In addition, the fact that so little initial core decortication and shaping was performed on the site with the locally available material suggests that there was a considerable separation between economic activities performed on the site and procurement activities. Other attributes, including dimensions, tend to support both of these assertions, as discussed below.

In contrast, quartzite is represented by materials that should be construed as early reductive stage products: three Interior I flakes, one decortication flake, and one piece of shatter. This type distribution is consistent with the attributes such as cortex, dimensions, relative thickness, and variability of dimensions, which are discussed below, and suggests that this was a low-quality, infrequently procured material.

Additional factors of material use can be seen by comparing the means, the standard deviations, and the coefficients of variability of both the maximum dimension and the thickness of debitage (Table 7). Results of ANOVA suggest that differences are significant, but due to disparity in sample sizes this test cannot be accepted as statistically valid. Average maximum dimension of chert debitage is greater than averages for both chalcedony and quartzite. This result is consistent with expectations for size differences among exogenous and local materials. Average dimensions of transported items should be lower than those of items of locally available materials and should be less variable. Values for average thickness are inconsistent with the expectation of decreased dimensions among transported items (Table 7). Although the average thicknesses of the chalcedony items are lower than averages for chert, as expected, the averages for quartzite items are higher and more variable. This suggests that quartzite was subjected to much less controlled processing, probably due to the lower quality of the material.

Differences in dimensions among the various material types show patterns consistent with the differences observed in dimensions of the reductive stages. That is, the local materials not only have larger average dimensions, but these materials also have greater relative frequencies of early-stage flake types. This fact is due to the difference in the average dimensions of the various flake types (Table 8). Results of ANOVA suggest that the differences are significant, but due to disparity in sample sizes this test cannot be accepted as statistically valid. With the exception of shatter, the mean dimensions and the degree of variability decrease with the advance through the reductive sequence.

Differences in dimensions among the three material types (Table 7) and differences in dimensions among debitage types (Table 8) suggest that flakes of these various types were being reduced at different sizes or that material type dimensions were influenced by the presence of different proportions of the various flake types. This is summarized in Table 9, which shows average dimension by material type of selected reductive stages for chert and chalcedony debitage only (due to the small amount of quartzite debitage). Average dimensions of the earlier stage Interior I flakes are significantly larger than those of the later stage Interior II flakes. Conversely, dimensions of the two material types are slightly, but not significantly, different. Therefore, differences in the average dimensions of the two material types result from the different reductive stage distributions of these two materials, rather than from different size distributions between material types within each artifact type.

The previous discussion has shown that there are significant variations in flake dimensions, including thickness. Flake thickness is not only influenced by maximum dimension, but is also influenced by flaking tasks and material quality, with greater relative thickness associated with less controlled tasks and lower material quality. Table 10 shows average ratio of macrodebitage thickness/maximum dimension by material type. Values for chert and chalcedony are quite similar, 0.16, while quartzite has a high value of 0.23. Again, this suggests that the chert and chalcedony items are being reduced in a similar way. Ratios for these two material types are compared separately in Table 11. The ANOVA shows no significant difference in their relative thicknesses. This suggests that the flaking processes are similar, although the resulting debitage pieces are of different dimensions.

The degree of variability in maximum dimension and in thickness gives some indication of the consistency of reduction processes and the degree of control over processes. These were compared using the coefficient of variability (cov = standard deviation/mean), as shown in Tables 9, 10, and 11. Values for chert and chalcedony items are very similar, while values for quartzite items are higher. Similarities among the values for chert and chalcedony are consistent with the assertion that the technological organization for each of these materials was similar. The higher degree of variability for quartzite items suggests that they were subjected to a flaking process less consistent in size than the two other materials were.

Table 12 shows frequency of cortex by material type among the macrodebitage. In spite of the proximity of a source area, this attribute was very infrequent, occurring on only eight, or 1.5 percent of all macrodebitage. Except for one quartzite flake, all of these are chert and potentially local. None is present on known exogenous materials. The majority of the cortex on the chert is from chemical weathering, while a smaller portion appears abraded. Chert with both types of cortex is available near the site.

Additional attributes of this lithic system can be discerned from the relative frequencies with which microdebitage, macrodebitage, and tools of the various material types occur

(Table 13a). The largest portion of the collected assemblage consists of macrodebitage (544, or 74.8 percent). The second largest portion is microdebitage (164 items, or 22.6 percent), and the smallest consists of tools and cores (19 items, or 2.6 percent).

The low microdebitage frequencies reported here are a product of the sampling method. Of the macrodebitage and tools, 63 specimens were collected from a surface area of 1,090 sq m, and 432 from a volume of approximately 14.7 cu m. All 164 specimens of microdebitage and 68 pieces of macrodebitage were collected from constant volume samples over a total volume of 0.05 cu m, or only 0.3 percent of the excavated volume. Given this ratio, the actual frequency of microdebitage should be approximately 16,400 items. It is believed that these 164 items constitute an adequate sample of the microdebitage, but the low frequency with which it occurs in some provenience units will limit some comparisons. The additional 68 flakes (ranging between 2 and 6 mm recovered from the 0.05 cu m of constant volume samples) suggest that a large number of items were missed with the 1/4-inch mesh.

Departures from expected frequencies (Table 13a) suggest several additional attributes of the overall flaked lithic system. Departures among tools are substantial. The larger frequencies of all cores, expedient tools, and finished tools among local materials, and the smaller numbers among exogenous materials are consistent with expectations for differences between local and exogenous materials. However, these dissimilarities were not subjected to statistical testing.

Departures from expected values among microdebitage and macrodebitage are also substantial. A large departure occurs among the quartzite debitage, but the size of this sample and the small expected numbers make this difficult to assess.

Chert and chalcedony occur in sufficiently large numbers to test, and a chi-square was calculated for frequencies of the micro- and macrodebitage between these two material types (Table 13b). The test yielded a statistically significant difference (df = 1; chi-square = 32.05; significance = 0.00; n = 692). The potentially local chert items have 40 percent fewer pieces of microdebitage than predicted on this table, while the exogenous chalcedony has 40 percent more than predicted. Platform preparation for either core or tool reduction is the most common known source of microdebitage. This suggests that, on the average, the exogenous chalcedony items were subjected to more frequent or more intense platform preparation than were the potentially local chert items. Subsequent discussion of attributes of the tools gives evidence consistent with this observation.

Material Use Patterns in Tools

A total of 19 cores and tools were collected from excavation and from the surface. Of these, 13 (68.4 percent) are Cedar Mesa Formation chert, 4 (21.1 percent) are Summerville chalcedony, and 2 (10.5 percent) are White Rim chalcedony. Table 14 summarizes the information in the section *Definitions and Descriptive Statistics of Artifact Categories* (pp. 36-41) and shows tool/core type by material type. Figure 12 shows all tools and cores arranged by position in the reductive sequence and separated by proposed source area. This figure shows several dissimilarities that appear to result from the relative proximities of the source areas and material availability. It also shows several similarities among the assemblages derived from the different source areas that support the contention that the lithic technology is dependent upon a limited set of curated tools that were transported and replaced where possible, and consisted mainly of bifaces.

In Figure 12, cores consist mostly of Cedar Mesa chert, although one Summerville chalcedony core is also present. Frequencies of utilized and retouched flakes show a similar pattern. These observations are consistent with the flake type frequencies for the various material types, where Interior I flakes are more frequent among the local materials and less frequent among exogenous. In contrast, the formal or curated tool assemblages from the different sources are quite similar. All specimens are bifaces of similar types, and they occur in more nearly equal proportions. The major difference in the formal assemblages is in the dimensions at which these items were discarded; exogenous items have been reduced to a smaller size prior to discard.

Overall, all of the tools and cores show dissimilarities in dimensions at discard. Although the sample is small, this difference is visible in the relative sizes of the items in Figure 12. Mean sizes of all tools and cores from the various sources are dissimilar (Table 15). Much of the variability seen in Table 15 is due to the mixing of artifact types, which occur in different proportions. Comparisons among only the eight bifaces suggest that there are dissimilarities in discard dimensions of materials from the different sources. For bifaces of Cedar Mesa chert, average L = 33.8 (sd = 18.4), W = 29.2 (sd = 7.4), T = 8.5 (sd = 2.9); for Summerville chalcedony, L = 24.3 (sd = 19.9), W = 23.5 (sd = 14.2), T = 6.2 (sd = 0.5); for White Rim chalcedony, L= 11.8 (sd = 9.5), W = 13.1 (sd = 2.1), T = 7.5 (sd = 5.8). These differences are consistent with the patterns seen in dimensions of the debitage.

There appear to be no significant differences among average edge angles for the three material types (Table 16). However, this set of averages includes all types of tools, and compares items of dissimilar function. Most tool types contain insufficient numbers to statistically test differences in edge angles within a single tool type. However, an ANOVA was run on the edge angles of the four bifaces of Cedar Mesa chert (average maximum angle = 60.8, sd = 25.0; average minimum angle = 43.2, sd = 21.4) and four bifaces of Summerville and White Rim chalcedony together (average maximum angle = 62.8, sd = 29.0; average minimum angle = 46.5, sd = 20.8). The ANOVA for the differences in average maximum angles yielded a significance of 0.75 (F = 0.10, df = 1), while the ANOVA for the differences in average minimum angles yielded a significance of 0.75 (F = 0.10, df = 1). Although this is a small sample, the probable similarities in the edge angles support the contention that elements of the formal tool assemblages fulfilled similar functions.

Summary of Material Use Patterns

This stage of analysis describes the attributes of the entire assemblage without regard to chronological changes, and describes gross patterns for all lithics. Of all debitage, 358 items (50.6 percent) are chert and are possibly procured from local sources. Exogenous materials include 334 (47.2 percent) chalcedony items and 16 (2.3 percent) quartzite specimens. This material type distribution shows use of nearly equal portions of local and exogenous materials and suggests frequent use of surrounding upland areas in foraging.

Few items of debitage are from the lowest stages of core preparation and reduction — shatter comprises only 1.0 percent and decortication flakes 1.2 percent. The paucity of items deriving from core preparation indicates that materials were prepared to some degree prior to transport to the site and suggests a separation between material procurement activities and the economic activities conducted at or from the site. In addition, the major portion of debitage made up of is Interior II flakes (62.1 percent) rather than Interior I flakes (35.8 percent), suggesting that tool reduction and maintenance activities played a greater role in technological and economic activities at the site than did core reduction and tool manufacture.

A number of differences were observed in the ways in which the different material types were reduced. Locally available chert items are most frequent, with a total of 315 macro items (302 pieces of debitage, 4 cores, and 9 tools). Debitage type distributions suggest that chert was often subjected to tool reduction processes, especially thinning; but the variability in debitage and tool dimensions also implies that it was used in many types of items.

Chalcedony is common, with a total of 214 macro items (210 pieces of debitage, 1 core, and 3 tools). Among the items of this material, Interior I flakes represent a very high proportion, 69.0 percent, suggesting frequent thinning activities. This interpretation is consistent with expectations for reductive activities performed on transported materials.

Although the tool assemblage is small, it appears to have consisted mostly of bifaces and probably projectile points, augmented by additional expedient elements where local materials allowed production. It appears that chert and chalcedony were used for manufacture of similar items with similar functions. Thickness/maximum dimension ratios for Interior II flakes for these two materials are not significantly different. The dimensions of chert and chalcedony Interior II flakes are not significantly different. The maximum and minimum edge angles for both material types are not significantly different. These facts suggest that these materials were reduced and used in very similar ways — probably a result of the similarity between the chert and chalcedony in flaking and use. However, the observed similarity between the attributes of the transported assemblage and the assemblage produced with locally available material does not meet the expectation that transported items would have smaller mean dimensions and that artifact type distributions would include a higher proportion of items from later reductive stages. The relative and absolute frequencies of chert and chalcedony thinning flakes are surprisingly close, considering that one is a transported material.

The quartzite assemblage is dissimilar to the chert and chalcedony assemblages. Quartzite items have smaller maximum dimensions and larger thicknesses, and consist predominantly of early-stage flake types with less necessary control and higher concomitant thickness to maximum dimension ratio. These attributes, which indicate that quartzite is less easily controlled in flaking, may be related to the low frequency with which it is represented in the assemblage, and to the low frequency with which it occurs in this area.

STRATIGRAPHIC DISTRIBUTION OF ARTIFACTS

An insufficient area was excavated to allow analysis of horizontal distribution. Consequently, only the stratigraphic distribution has been analyzed. This section compares materials from Stratum C, deposits with variable moisture; Stratum B, marsh deposits; and Stratum A, undifferentiated overbank and dune deposits. Although a total of 635 items were assigned to these three stratigraphic units, they may not constitute representative samples of materials from the two lower stratigraphic units.

Several changes in the lithic assemblages were identified among stratigraphic units that are consistent with other forms of data. These changes include variations in the frequencies with which different reductive activities were performed, the raw materials used, and the manner in which the raw materials were reduced. Due to the probable inadequacy of the sample, these changes will be presented only as hypotheses for subsequent work.

The Sample

Among the 635 items assigned to the three stratigraphic units, 96 were assigned to Stratum C, 228 to Stratum B, and 311 to Stratum A. Materials from each of these stratigraphic units make up an assemblage sufficiently large to perform statistical tests. However, these materials came from only seven 1-x-2-m excavation units; while Stratum A occurred in all units, Strata B and C were represented in only a few of these (Appendix B). It is possible that the assemblages from these excavation units represent only a small portion of the raw material types or reductive activities contained in any or all of the stratigraphic units. Casual examination of raw artifact frequency distributions among the individual excavation units (Tables 17, 18, and 19) discloses some degree of spatial variability in Strata A, B, and C. Tables of material type frequencies and reductive activities (not presented) also show substantial spatial variability among excavation units.

Due to the large number of low-frequency cells, these were not subjected to statistical tests for significance. This spatial variability indicates a possibility that these excavation units have sampled dissimilar portions of the various levels, and consequently, the assemblages are not considered adequate samples. However, these data and preliminary interpretations are presented here because they are consistent with several other lines of evidence. They also help to develop hypotheses for further research.

Proposed Chronological Variation in Lithic Technology

Observations concerning chronological variation are based on comparisons of reductive activities, material types, and ways in which material types were reduced in the different levels among the three major stratigraphic units: Strata A, B, and C.

Reductive Activities

Frequencies of flake types are shown in Table 20. As discussed previously, overall frequencies suggest that in spite of the proximity of a material source the majority of activities involved tool reduction (Interior II flakes: 62.0 percent). Core reduction was less common (Interior I flakes: 35.9 percent), and decortication rare (decortication flakes: 1.2 percent).

The frequencies of flakes types collected from these stratigraphic units do indicate deviations from those average conditions. The assemblages collected from each stratigraphic unit all have very low frequencies of shatter and decortication flakes that deviate little from expected values. In contrast, observed frequencies of Interior I and Interior II flakes deviate substantially from expected values. Due to the large number of low frequency cells in Table 20, expected values and chi-square were recalculated for the Interior I and Interior II flake columns alone. This test yielded a statistically significant difference in Interior I and Interior II flake frequencies (chi-square = 6.25; df = 2; significance = 0.04) among the three stratigraphic units. In the lowest unit the percentages of Interior I flakes and Interior II flakes are nearly equal. In the subsequent upper units this frequency shifts, with an increasing portion of the assemblages composed of Interior II flakes.

Values for the diversity measure H show a small change in flake type diversity that is consistent with the changes noted above. For general discussions of H, H_{max}, J, and related statistics, the reader should consult such works as Leonard and Jones (1989), Osborn et al. (1993), and references cited by them. The diversity measure H was calculated for flake types from each stratigraphic unit. The measure for evenness is the value for H divided by the maximum possible value for H, which is represented by H_{max}. All stratigraphic units had four flake types represented, so that $H_{max} = 1.39$. Values for H and J show overall moderate values for evenness and a slight decline in diversity through time. The highest values are for the bottom level, Stratum C, with H = 0.83 and J = 0.60. These values are lower in Stratum B, with H = 0.75 and J = 0.54, where Interior II flakes increase in relative frequency. The minimum values are for Stratum A, with H = 0.74 and J = 0.53, where Interior II flakes make up nearly two thirds of the assemblage.

Material Types

Evidence for stratigraphic change is found in the material type frequencies for *all* flaked stone artifacts, including microdebitage, macrodebitage, cores, and tools, which show statistically significant differences (chi-square = 27.1, df = 4, significance = 0.00; table not presented). However, only material type frequencies and the resulting chi-square statistics for macrodebitage, cores, and tools are presented in this section. The reason for this is that frequencies of microdebitage are greatly dependent upon performance of platform preparation, and changes in platform preparation affect microdebitage frequencies.

Microdebitage frequencies are considered later in the context of reductive activities performed in the individual stratigraphic units. The purpose of presenting material type frequencies is to give counts of individual items and individual fracture events performed on items of different material types. The use of tools, cores, and macrodebitage gives a more accurate count. Material type frequencies among these items are shown in Table 21. As shown at the bottom of the table, the differences among the levels are statistically significant. Material type frequencies are briefly reviewed below, and implications for material procurement and reduction are expanded in the subsequent section.

Quartzite is low in frequency in all units. This material is present only in the lower units, each of which has higher frequencies of core reduction than expected. The absence of quartzite from Stratum A and the deviation from the expected frequency cannot be interpreted, since the sample size is so small.

The most common materials in all units are chert and chalcedony. Among all levels combined, the exogenous material, chalcedony, is less frequent than the local material, chert, consistent with expectations for exogenous and local materials. A chi-square test of chert and chalcedony alone shows significant differences in frequencies of these materials among the three strata (chi-square = 14.19; df = 2; p = 0.00).

In Stratum C, the high frequency of chert, 66.2 percent, and the corresponding low frequency of chalcedony, 25.4 percent, may be related to the lower emphasis on tool reduction. The collected assemblage has large numbers of local materials subjected to core reduction, and lesser numbers of exogenous items which were more frequently subjected to tool reduction.

In Stratum A, there is a slightly higher frequency of chalcedony, 39.8 percent, but chert is still the most frequent material, with 60.2 percent. The assemblage from this stratigraphic unit has resulted mainly from tool reduction activities on both local and exogenous materials.

The assemblage collected from Stratum B has a high frequency of chalcedony items, and large deviations from expected values. In this unit chert makes up only 45.7 percent of the assemblage, and chalcedony 51.8 percent.

Values for measures of diversity and evenness of material types were calculated from the material type frequencies at the finest level of division (Table 22), rather than from the collapsed categories shown in Table 21. Values for the diversity and evenness of source use were calculated from proportions of items deriving from probable sources of the identified materials. Sources of quartzite are unknown. It is likely that the nearest source is the Colorado River, so all of these materials were assigned a single source. Other materials are known to derive from multiple sources (e.g., Summerville chalcedony) but were assigned a source number of one, due to the difficulty of discerning separate sources.

The Stratum A assemblage, which has 60.2 percent potentially local material and no quartzite, has the lowest number of material types and the lowest diversity. The assemblage from Stratum B, which bears 54.2 percent exogenous materials, has the highest value for diversity and the largest number of material types. The assemblage from Stratum C has quartzite but also has the lowest frequency of exogenous materials (33.9 percent). The value for this unit is slightly higher than that for Stratum A. The numbers of material types recorded are dissimilar; the greater number of types in Stratum B, the lowest number in Stratum A. When materials types are grouped by potential source a similar pattern appears, with a substantially higher value for the assemblage from Stratum B.

The values for evenness, J, do not vary substantially. These range from 0.70 to 0.73. This similarity in values for evenness indicates that the variation seen in the diversity of assemblages results from changes in the *number* of material types incorporated into assemblages, rather than changes in the relative frequencies with which different material types were incorporated. This suggests that although the number of source areas contacted varied, the manner in which materials were incorporated from them did not.

The results of the diversity measures also have implications regarding the validity of the observed differences among the stratigraphic units. Both n and H are values that can increase proportionally with sample size. Consequently it is expected that these values would be higher for the assemblage from Stratum A, due to its larger size. This is not the case, and the fact that these values are higher in the stratigraphic units represented in fewer pits and with lower total frequencies argues for the validity of observed differences in flake type and material type.

Little change was detected in the average dimensions of chert flakes, while several dimensions of chalcedony flakes were found to vary. The meaning of these statistically significant changes in average dimensions of the Interior I and Interior II flakes is difficult to assess. Chert Interior II flakes do not change in dimensions (Tables 23 and 24). Chert Interior I flakes increase in mean thickness in Stratum B. This increase is not matched by a corresponding change in thickness of chalcedony Interior I flakes, but the significance of this is unknown.

Mean dimensions of chalcedony flakes do change significantly. The maximum dimension of chalcedony Interior I flakes is significantly smaller in Stratum B. There is also a small but insignificant decrease in the mean thickness in this unit. Chalcedony Interior I flakes from Stratum C were not subjected to ANOVA due to the small sample size, but their means are similar to those from Stratum A.

Similarly, chalcedony Interior II flakes from Stratum C were not included in the ANOVA because of the disparity in the sample size from that stratum. Results of this test show no significant difference in thickness of chalcedony Interior II flakes between Stratum A and Stratum B, but there is a significant difference between the maximum dimensions. Although no ANOVA was run on the Stratum C flakes, it is likely that they do vary significantly. Overall, it appears that chalcedony Interior II flakes are smaller than chert Interior flakes II in Stratum C, but they increase in size to approximately the same dimensions as the chert Interior II flakes in Stratum A. It is possible that this change is related to the increasing frequency of Interior II flakes through the section, i.e., related to the increasing use of bifacial thinning.

Summary of Chronological Changes

Overall, there is declining evenness in flake type distribution as the proportion of Interior II flakes increases. This suggests an increase in the frequency of production of thinned tools. Unfortunately, too few tools were recovered from buried deposits to be able to assess this interpretation.

Several changes were detected in the types of material used. Quartzite was never common, but there is a possible decline in use of quartzite, and it may be significant that this material is missing from the large, well-represented Stratum A assemblage. A larger sample is needed to assess this. The lowest level, Stratum C, has a high number of material types, but it has lowest frequency of all exogenous materials, suggesting less frequent use of the uplands and more frequent use of areas with Cedar Mesa outcrops. The greatest frequency of exogenous materials and greatest number of material types were found in the middle unit, Stratum B, where the Summerville chalcedony found in the arid uplands becomes very common. The lowest number and diversity of material types was found in Stratum A, possibly indicating decreased range use. This is consistent with expectations for a horticultural group such as the Anasazi, from whom these deposits may have been derived.

The dimensions of flakes made from locally available chert do not vary substantially; only the thickness of chert flakes is significantly greater in Stratum B. However, the average dimensions of exogenous (chalcedony) flakes do vary substantially through time; all dimensions of chalcedony show significant variation, except in thickness of Interior I flakes. An increasing relative frequency of thinning activities may be indicated by this change in debitage.

Descriptions of Assemblages from Individual Strata

In the following section the overall assemblage characteristics of each stratigraphic unit are discussed. It is acknowledged that the assemblages of Stratum B and Stratum C may not be adequate, but consistencies among several lines of evidence support these interpretations, and they are presented for later testing.

Stratum C

Ninety-six items were recovered from this stratigraphic unit. It is not known whether the sample is representative, but its size allowed some statistical comparisons to be made within the assemblage and with the other two stratigraphic units.

This assemblage bore the lowest frequency of exogenous materials, since mostly local materials were used. A total of 11 material types were identified. Of all artifacts, 52 items (54.2 percent) are of locally available Cedar Mesa chert, while 44 items (45.8 percent) are of other materials and are necessarily exogenous. The only substantial deviations from expected values for frequency of source use are in the low values for "chalcedony-unknown," "other," and the high value for "Cedar Mesa Formation-local." Quartzite, infrequent in all units, occurs in its highest percentage in this unit (n = 7). However, due to its low representation in all units, the significance of this cannot be assessed. Although there are few necessarily exogenous materials represented, there are nonetheless many material types and sources, indicating frequent use of locally available materials. Evenness of material types is similar to eveness from the other units. Material type diversity is moderate.

The low frequency of shatter and decortication flakes is an attribute shared with Strata A and B, indicating that early-stage core preparation activities were infrequent and that items were transported to the site in at least a partially prepared state. Material procurement activities at nearby sources were quite separate from the economic activities performed at 42SA20286. The Stratum C assemblage is dissimilar to the other two, due to nearly even distribution between debitage suggestive of core reduction and debitage suggestive of tool reduction: 50.0 percent are shatter, decortication, or Interior I, while 50.0 percent are Interior II. This distribution implies similar frequencies of core and tool reduction flake events.

Reductive stage distributions for the various material types are dissimilar, suggesting differential treatment of the exogenous and locally available materials. Table 25 shows flake type by material type for chert and chalcedony. Due to the low frequencies, the material type "quartzite" and the debitage types "shatter" and "decortication" were not included. This table shows large deviations from expected frequencies. Chert occurs as Interior I flakes more frequently and as Interior II flakes less frequently than expected. The converse is true of chalcedony. These occur more frequently as Interior II flakes and less frequently as Interior I flakes than expected. The chi-square of 9.14 indicates a 0.003 probability that this distribution has occurred by chance.

It is possible that the presence of quartzite is related to the greater frequency of core reduction observed in this unit. The quartzite materials all consist of earlier stage items, which require less control over flaking. In addition, the coefficient of variability for dimensions of all of the quartzite items from this site is substantially higher than values for chert and chalcedony.

Although the two material types were subjected to different flaking tasks, there were no significant differences in the sizes of the flakes that resulted from this reduction. Among the Interior I flakes, chalcedony and chert are not significantly different in dimensions (Table 26). Among the Interior II flakes, chalcedony items are slightly, but not significantly, smaller.

Table 27 shows relative frequencies of chert and chalcedony microdebitage for Stratum C. Due to the small number of quartzite microdebitage (one), this material was not included in the table. Among the chalcedony items, the observed frequency of microdebitage is high, while the observed frequency is low among chert. The value for chi-square indicates that these are statistically significant differences. This is consistent with the results for microdebitage frequencies for all levels.

Overall, this assemblage has a relatively even material type distribution across a large number of types. Locally available chert dominates this assemblage, and there is a low percentage of exogenous materials. There is very little shatter and very few decortication flakes. It appears that materials brought to the site from all sources had been previously prepared to some extent. All flake types are evenly distributed between types that suggest core reduction and types that suggest tool reduction. With the exception of quartzite, the exogenous materials have been subjected to tool reduction more frequently than locally available materials, but the resulting debitage is not substantially different in size. This suggests that similar products were manufactured from local and exogenous materials, and that the reductive activities applied to them mainly varied in frequency.

Stratum B

A total of 228 items were collected from this unit, which has the highest diversity of material types and largest number of probable sources. It is likely that at least seven material sources are represented in this assemblage. The value for material type diversity, $H = 1.81$, is the highest value for all three stratigraphic units. This high value can be attributed to a high degree of evenness ($J = 0.73$) and high number of types ($n = 12$). Some quartzite is present in low numbers.

The frequency of locally available chert is lower than the expected value, while exogenous chalcedony is more frequent than expected (Table 28). Several types of change in organization could be responsible for this high frequency, but increased use of the uplands provides the simplest explanation and links together several facts. The majority of this exogenous material appears to be from the Summerville Formation. The nearest known sources for Summerville chalcedony are in the uplands to the east of the overlook. These uplands are currently quite arid. The presence of high frequencies of this material and the presence of characteristics indicative of greater moisture during the formation of this level suggest more frequent use of these uplands during this time.

The value for the evenness of the flake type distribution decreased to a value intermediate between Stratum C and Stratum A. The percentage of Interior II flakes increased to 56.0 percent, suggesting an increase in the production of thinned tools. Again, the low frequency of shatter and decortication flakes is an attribute shared with Stratum A and Stratum C. This attribute indicates that early-stage core preparation activities were infrequent. It further suggests that items were transported to the site in at least a partially prepared state, and that material procurement activities at nearby sources were quite separate from the economic activities performed at 42SA20286.

There is a slight decrease in flake type diversity from Stratum C to Stratum B. This is due to decreased evenness in the distribution, because the number of types does not change. Among all debitage, shatter numbers 1 item (0.7 percent); decortication, 1 (0.7 percent); Interior I, 59 (39.1 percent); and Interior II, 90 (59.6 percent). In contrast with the preceding (lower) units, these frequencies suggest an increase in frequency of thinning activities.

This assemblage is dissimilar to the others in the manner in which exogenous and potentially local materials have been reduced. Contrary to expectations, the exogenous materials have approximately the same percentage of Interior I (core reduction) flakes as do the potentially local materials (Table 28).

With the very small number of tools and cores recovered from these units it is difficult to assess the reason for this similarity in flake type frequencies for the two material types. This similarity does not necessarily indicate that the two groups of materials were being reduced or used in a similar fashion, and the average dimensions of the two flake types argue against this. Table 29 shows two flake dimensions of Interior I and Interior II flakes by material type, excluding the less common quartzite flakes. Among the Interior I flakes, chert flakes are significantly larger. Among Interior II flakes, chalcedony flakes are significantly smaller in maximum dimension, but not in thickness. These dissimilarities in dimensions are consistent with expectations for differences between exogenous and local materials.

Table 30 shows relative frequencies of chert and chalcedony microdebitage for Stratum B. Due to the small number of quartzite microdebitage (three), this material was not included on this table. Among the chalcedony items, the observed frequency of microdebitage is high, while the observed frequency is low among chert. The value for chi-square indicates that these are statistically significant differences consistent with the results for microdebitage frequencies for all levels.

Overall, this assemblage has a relatively even material type distribution across a high number of types. Exogenous chalcedony comprises the major portion of this assemblage, but there is a large percentage of locally available materials. There is very little shatter and very few decortication flakes, and it appears that materials brought to the site from all sources had been previously prepared to some extent. The flake type distribution is dominated by Interior II flakes, which suggests more frequent tool reduction than in the preceding stratigraphic unit. With the exception of quartzite, the exogenous materials occur in a flake type distribution similar to that of locally available material, suggesting these have been subjected to similar reductive tasks. However, the resulting debitage is significantly different in size, with exogenous materials smaller than locally available materials.

Stratum A

A total of 324 items were collected from this unit. Surprisingly, the material type distribution of Stratum A is less diverse than the other levels, as shown on Table 22, in spite of an even distribution. This lower diversity is due to the presence of a low number of material types (nine). The majority of artifacts are of locally available chert (189, or 60.8 percent). Quartzites are absent from the macro-artifacts. It is not known whether this absence is due to material selection based on reductive activities or due to limited use of areas with quartzites. Given the low frequencies of exogenous materials and the decrease in core reduction, both explanations are possible.

Of the three levels, Stratum A has the highest frequency of Interior II flakes (65.8 percent), the lowest frequency of Interior I flakes (31.9 percent), and the least even flake type distribution. These facts suggest that reductive activities concentrated on tool reduction. Again, the very low frequency of shatter and of decortication suggests that materials were transported to the site in a partially prepared state.

Table 31 shows the frequencies of chert and chalcedony Interior I and Interior II flakes. Although the number of chalcedony Interior I flakes is 53 percent of the number of chert Interior I flakes, the number of chalcedony Interior II flakes is 82 percent of the number of chert Interior II flakes. This difference is reflected in the expected frequencies and the results of the chi-square test, and suggests that chalcedony items were subjected to bifacial thinning and other tool reduction tasks in a higher percentage of cases than were chert items.

Although it appears that chert was more frequently subjected to core reduction than was chalcedony, the size distributions of these material types suggest that the products were similar at least in dimension. As shown in Table 32, the mean dimensions for chert and chalcedony Interior I flakes and Interior II flakes from Stratum A are not significantly different.

Although the mean dimensions of chert Interior II flakes do not vary significantly through time, the mean dimensions for chalcedony Interior II flakes were highest in Stratum A. Due to this increase in dimensions of chalcedony Interior II flakes, the mean dimensions for chert and chalcedony Interior II flakes are not significantly different. Chert and chalcedony Interior I flakes are also quite similar in size.

Table 33 shows relative frequencies of chert and chalcedony microdebitage for Stratum A. Due to the small number of quartzite microdebitage (two), this material category is not included in this table. Among the chalcedony items, the observed frequency of microdebitage is high, while the observed frequency is low among chert items. The value for chi-square indicates that these are statistically significant differences. This is consistent with the results for microdebitage frequencies for all levels.

Overall, reductive activities appear to be concentrated on bifacial reduction of a low diversity of material types, mostly locally available materials. Although exogenous materials were more frequently subjected to tool reduction, the dimensions of debitage from local and transported items were similar, and it is likely that the products were also similar.

DISCUSSION

The broad goal of the research conducted for this project was to examine human responses to paleoenvironmental changes. The first section of this chapter provides a background of paleoenvironmental conditions during the period of development of the deposits at 42SA20286. This first section presents much unsynthesized information for two reasons: 1) little is known about paleoenvironmental events in this area, and 2) the primary goal of this project is interpretation of archeological remains. The following sections synthesize information regarding the archeological remains and the cultural contexts in which they were deposited. The structure of this chapter follows the research design.

Paleoenvironments and Geomorphological Processes

This section constructs a sequence of paleoenviromental conditions which may have influenced human activities. Probable conditions for this sequence are first constructed through sedimentological and pedological data. They are then compared to paleoenvironmental events in nearby areas and to information gained from the biotic remains.

The site is in a good position to provide both paleoenvironmental and archeological information for this portion of the Salt Creek drainage. This is due to the fortunate coincidence that this location constitutes a source of water and food, and is located in a good depositional environment. The location is good for both large-scale alluvial deposition and aeolian deposition. It is an area where the gradient of Salt Creek decreases from 1.09 to 0.48 percent, and the area over which the channel can move becomes constricted by sandstone outcrops to a width of 340 m. The terraces at the east and southeast sides of the site have formed within, and upstream from, this constriction. Such areas of heavy and rapid deposition of sand can also act as good sources for aeolian sediments.

The substrate of the site is a bedrock sandstone outcrop overlain by a set of alluvial terraces and dunes. These deposits form part of the terraces discussed below. The geomorphic environments believed to be responsible for these deposits include low-energy overbank in moderate to dense vegetation, high-energy overbank, and dunes with at least one erosional event recorded. No soil horizon development was observed in the high-energy overbank and dune deposits. Soil horizon development in the low-energy overbank deposits indicated periods of consistent soil moisture, as well as periods of variable soil moisture. These deposits and changes in depositional environments have been provisionally correlated with other events.

The sequence of alluvial and other paleoenvironmental events in the middle portions of Salt Creek is not currently well known, but a partial sequence has been previously constructed in this report. The sequence sets the deposits of 42SA20286 in a context of events prior to and coeval with the sequence observed there. Several late Quaternary sequences for nearby areas were cited in previous text, and these provide some structure to the sequence constructed here.

The sequence can be summarized as follows. The sediments at the east side of 42SA20286 occupy a channel which was eroded later than 4500 B.P. This may be coeval with an erosional event in upper Salt Creek dated to approximately 3900 B.P. Most of the fill accreted prior to 2650 B.P., as dated by the earliest known hearth near the surface of a nearby terrace. Accretion of stratum C is probably coeval with this episode.

The upper surface of that nearby terrace was relatively stable in the period of approximately 2650 to 2200 B.P. The date of 2490 ± 210 B.P. from Stratum B at 42SA20286 falls within this period of stability, and is coeval with the Lower Gold Basin period. The Lower Gold Basin period involved decreased temperatures, alluviation, and possibly increased precipitation (Richmond 1962). The presence of increased effective moisture in the Salt Creek drainage as well is suggested by the soil development and molluscan fauna of Stratum B.

The Stratum A fill postdates a period of erosion that is visible as a cutbank in the profile of Excavation Unit G. The cutbank may be coeval to an erosional event in upper Salt Creek which postdates 1790 B.P. The fill of Stratum A consists of undifferentiable aeolian/alluvial deposits and may be associated with an episode of aeolian deposition from 1500 to 800 B.P. (Agenbroad 1986). Pedological, malacological, and taphonomic data are consistent with this sequence.

Stratum C is a mottled dark red sand with lenses of silt and clay and appears to have resulted from low-energy overbank deposition and intermittently moist soil conditions. The lighter color and the bone weathering stage distributions suggest that burial rates were faster than in Stratum B.

Stratum B conformably overlies Stratum C. The boundary is defined by an increase in smaller sedimentary particles and pockets of these, an increase in darkness of the color, and a decrease in the degree of color mottling in Stratum B.

Stratum B is a soil unit with many lenses of silt and clay and a relatively consistent dark red color. The change in mottling and texture indicates that the color difference between Stratum B and Stratum C is probably not due to A horizon development over these strata. Instead, it is likely that the discernible differences result from a decrease in sedimentation rate and in the energy of sediment transport. The color seems to result from more consistently moist soil conditions and slower deposition rates, an interpretation supported by bone weathering stage distributions.

Due to the presence of a cutbank in Stratum B, Stratum A lies disconformably over Stratum B. The location of this cutbank is consistent with erosion suggested by the absence of Stratum C and Stratum B in other excavation units at the east side of the site. The erosional event recorded by this cannot be dated directly with the data collected here. However, this may be related to the erosional event dated after 1790 B.P. discussed above.

Stratum A is light colored sand with little or no silt and clay, and appears to derive from overbank and aeolian deposition. Dry soil conditions or fast deposition are implied by the absence of soil horizon development. Although the data are sparse, the bone weathering stage distribution suggests that deposition was rapid.

Overall, Stratum C and Stratum B appear to correlate with Hack's (1942) Tsegi alluvium a, and with Agenbroad and Elder's (1986) T_{4b} in the upper Salt Creek and T_{2b} in Bown's Canyon. Accumulation of these units may have been coeval with a Neoglacial advance (Richmond's [1962] Lower Gold Basin), suggesting deposition during a cooler and/or moister period. The eastern portion of these units was cut by an erosional event which has not been dated, but may have occurred after ca. 1790 B.P. Stratum A consists of undifferentiated aeolian and overbank deposits that may correlate with Agenbroad and Elder's (1986) aeolian component, which dates between ca. 1500 and ca. 750 B.P.

No direct evidence regarding sedimentary exchange was observed. The site undoubtedly received alluvial sediments out of the upper reaches of the Salt Creek drainage. These have probably been exchanged by aeolian and alluvial processes acting between the creek and dunes. A minimal portion was derived from decay of bedrock.

Temporal correlations as well as the characteristics of the mollusc assemblage suggest that these deposits accumulated during moister and/or cooler conditions than exist now or during the accumulation of Stratum A. Specimens of molluscs associated with cooler, moister conditions were recovered from Stratum B and Stratum C, while the assemblage of Stratum A may indicate drier conditions.

It is not known whether the presence of *Celtis* sp. seeds in Stratum B and Stratum C are due to cultural or natural processes. Due to the possibility that these were transported to the site, their presence gives no reliable information regarding past edaphic conditions. Due to the general taxonomic level to which most of the vertebrate assemblage could be identified, no paleoenvironmental information could be obtained from this assemblage.

Chronology and Cultural Affiliations

Information was sought regarding the chronology of occupation and the affiliations of occupants, but the data recovered were limited. Only one diagnostic item was recorded on the site by the original investigators. This was a possible Rosegate point, suggesting at least Late Prehistoric use of the site, probably by Pueblo II to Pueblo III Anasazi. This artifact could not be relocated during this investigation.

The only chronological data recovered during testing came from a single radiocarbon sample, which yielded a general-level date of 1110 – 50 cal B.C. for Stratum B, as discussed previously. Due to the absence of a discernible unconformity between Stratum C and Stratum B, it is suspected that materials from the stratigraphically lower Stratum C are either Middle or Late Archaic. Materials from the upper stratum have been referred to in this report as "undifferentiated later." However, due to the suspected dating of the erosion after 1790 B.P. this stratum probably contains Pueblo III Anasazi and/or other Late Prehistoric materials, and possibly some Late Archaic materials.

Technological Resources and Technology

The purpose of this phase of analysis is to characterize patterns of lithic material procurement, reduction, and transport, as well as chronological changes therein. This includes identification of general source areas and assignment of collected materials to them. Assemblages from each source area are characterized by size and artifact type, as well as the degree of diversity in the variables considered. Changes in assemblage attributes through time were examined with regard to assemblage structure, material use, and material transport.

Chert is available at site 42SA2116 and in many other areas in the Needles District (Tipps and Hewitt 1989). Much of this occurs in the form of chert deriving from lenses within the Cedar Mesa Formation. This material can be found on many sites in all stages of reduction, including sites in areas to which it had to be transported, such as 42SA20286. The nearest sources are 0.7 mile to the east and one mile to the southwest.

Sources of other materials are known to exist around and in the park. These include chalcedony from the White Rim Formation and Summerville chalcedony, which can be found in the uplands to the east as lag cobbles above the Navajo Formation. The quartzite might come from the Morrison Formation, which outcrops to the north near Moab, or from the Colorado River. Additional types of chalcedony and chert were observed which derived from undetermined sources.

It appears that most of the materials, even locally available materials, were at least partially reduced prior to transport to the site. This prior preparation suggests separation of procurement activities from economic activities at the site. Even among the local materials, there was a high percentage of Interior II flakes, suggesting that activities involved tool reduction and maintenance.

Approximately half of the material (50.6 percent by count) is of locally available chert. Exogenous materials comprise the rest, including 47.2 percent chalcedony and 2.3 percent quartzite. In spite of the quality of local materials, there is a high frequency of exogenous materials, which suggests frequent use of the upland and other undetermined areas.

Differences in the attributes of the debitage of different material types suggest differences in the ways they were reduced at the site. These differences can be attributed to the difference in availability between chert and chalcedony, and to the low quality of the quartzites.

As expected, most decortication flakes are of locally available chert. Interior I flakes, which are generally associated with earlier stages, especially with core reduction activities, consist most frequently of the locally available chert. Among both the chert and chalcedony there is a large percentage of Interior II flakes, which are generally associated with tool reduction.

The quartzite items were all lower-stage flake types, low in maximum dimension and highly variable in thickness, with high thickness to maximum dimension ratio. Therefore this material was infrequently procured and was subjected to flaking processes which required little control.

It appears that chert and chalcedony were utilized in very similar ways to meet needs for formal, transported tools, while immediate on-site (expedient) needs for tools were met by use of local chert. However, considering the close proximity of the source, the local materials had low frequencies of Interior I flakes. It is likely that the high percentage of Interior II flakes of local chert represent production for replacement of formal tools for use in the area and for transport elsewhere. The high percentage of Interior II flakes of transported chalcedony appears to result from maintenance on tools utilized in the area. The absence of significant difference in the dimensions (thickness, maximum dimension, and thickness/maximum dimension ratios) of the debitage of the two material types supports the contention that the materials were used in a similar fashion. The higher percentage of chalcedony microdebitage suggests that this material was subjected to greater relative frequency of platform preparation.

In addition, similarities in the tool assemblages of the various material types suggest that these materials fulfilled similar functions in the formal tool kit, and that differences in the assemblages of the different material types can be attributed to attrition through use and maintenance, rather than differential use. "Formal" tools collected during this project consist solely of bifaces, but the tool kit apparently included projectile points as well (due to the projectile point recorded on the site form). Most of the "expedient" tools were made from the locally available Cedar Mesa chert, as were four out of five cores. Differences among the dimensions of artifacts made from the various materials which derive from different distances show the effects of attrition as items were used and maintained. The small dimensions of the single transported core also appear to be the result of this process of attrition. For comparisons among all artifact types, or comparisons among bifaces only, there were no statistically significant differences discerned in edge angles among the material types.

Comparisons among the three strata yielded statistically significant differences in the raw materials and the artifacts. These differences have implications regarding chronological changes in technology and the areas used for foraging.

Stratigraphic changes in frequencies of flake categories show statistically significant increases in relative frequency of Interior II flakes through time, suggesting increasing use of thinned tools. An insufficient number of tools was collected to address this issue with comparative data.

Variations observed among material types may be related to changes in technology or changes in the areas used for economic activities. Quartzite is most frequent in Stratum C and absent in Stratum A. It is possible that this is related to the increased frequency of bifacial reduction implied by attributes of this later assemblage. However, due to the low frequency with which this material occurs, this issue will require further examination with a larger sample.

Statistically significant changes in the relative frequencies of chert and chalcedony may indicate shifts in range use. Stratum A has higher frequencies of chert than expected. This unit has an even material type distribution, but the lowest value for diversity due to the small number of material types incorporated into the assemblage. This difference may be due either to decreased use of the uplands due to aridity or decreased range size due to increased sedentism. Although these "undifferentiated later" deposits cannot be reliably assigned to any affiliation or time, it is likely that the majority of materials were discarded by Pueblo II or Pueblo III Anasazi. Assignment of these deposits to semisedentary groups could explain the low diversity of materials in this assemblage. Alternatively, this lower diversity may be related to decreased use of the uplands during a period of drier conditions.

Stratum B has the lowest frequency of chert, but the highest frequency of exogenous materials, almost all of which is chalcedony. Stratum B also has the highest value for material type diversity, due to the high number of type categories and the evenness of their frequency distribution. This suggests more frequent use of the uplands around the park during this period. Other forms of data suggest that this assemblage was deposited during a moist period, and it is likely that these currently arid uplands had more available water or more biotic resources during this period.

Stratum C has the lowest relative frequencies of exogenous materials, and the local chert is most frequent, giving the stratum a low measure for evenness. These deposits appeared to have been deposited during a period slightly less moist or a period with higher sedimentation rates than seen in Stratum B. It is possible that ranges were somewhat restricted during this period.

Subsistence, Economy, and Adaptation

The purpose of this analysis is to place the culturally derived biotic remains recovered in this investigation in a context of subsistence, and to identify chronological changes in their use. Directly applicable data are limited.

Little subsistence information can be discerned from the macrobotanical remains recovered. *Celtis* sp. seeds were associated with dense cultural materials. Although all are broken, there is no additional evidence that suggests these were processed or otherwise utilized by humans. They may have been growing on the site and utilized due to their proximity, they may have been included in the deposits due to natural processes, or they may have transported from other areas. The fragment of a single burned seed coat recovered from the site was not identifiable (Reinhard, personal communication 1990). This may have derived from processing of edible seeds or may have been accidentally burned by some other agent.

Insufficient faunal remains were recovered to address issues regarding types of prey or processing. The faunal assemblage included only 33 small vertebrates, most of which are small mammals. These included many burned specimens, all of which were too fragmentary to allow identification.

Types of fuel used and relationships to biotic communities were considered, but data recovered were inadequate to address this. Although it was sufficiently common to get a general-level date, the charcoal did not occur in features. The purposes or the contexts of the fire(s) which produced the charcoal could not be ascertained, and data regarding the type of wood was deemed superfluous.

Limited data were recovered that are directly relevant to examining specific biogeographic changes which would have altered economic patterns. However, as discussed previously, statistically significant changes in material types represented in the flaked lithic assemblages suggest that foraging areas were affected by changes in moisture and/or temperature. These are indicated by variations in the frequencies of materials from uplands. Other changes in the lithic assemblages were detected that may be related to adjustments of the system, but the available data cannot be interpreted in regard to this issue.

Settlement and Spatial Organization

This phase of analysis addresses relationships of site location to potential biotic resource zones and season(s) of occupations implied by biotic remains and other site attributes.

Currently, information regarding past biotic community distributions in this area is limited. Examination of potential biotic resource zones must depend upon several indirect lines of evidence and necessarily focuses on general resource types implied by existing and past edaphic conditions. Several lines of evidence suggest that during at least part of the Late Archaic the areas around the site were more consistently moist than at the present. Observations on current vegetation communities and their distributions suggest that edible plants such as *Typha, Scirpus, Phragmites, Equisetum*, and others may have been available within the drainage. Vegetation up on the outcrop may have included *Celtis, Pinus edulis, Oryzopsis, Ephedra*, and others. Confirmation of the presence or the use of these will require further research.

No good chronological controls exist for the upper deposits, and there was probably much variation in conditions throughout the period of deposition. During the periods with much aeolian activity there was probably a variety of ruderals available in the dunes, such as *Amaranthus, Chenopodium, Helianthus, Oryzopsis,* and *Cirsium*.

No information regarding seasonality can be recovered from the biotic remains. The phenology of *Celtis* gives no information, because use by the occupants cannot be ascertained with existing information.

The research design specified that a number of additional issues regarding settlement, intrasite distributions, and cultural affiliation should be investigated. However, due to the small area investigated, the paucity of datable or diagnostic materials, and the absence of comparable data from past research these studies could not be pursued. In particular, models that address the relationships between tool assemblage composition, environmental attributes, and settlement organization, such as those suggested by Whallon (1973), Binford (1982), Shott (1986), and Osborn and Hartley (1984), were not explored due to lack of an adequate sample or adequate comparative data from other investigations.

Cultural Interactions: External Contacts and Trade

This applies to materials which can be recognized as having originated from distances greater than 50 miles. The forms and frequencies in which these occur on the site bear implications regarding relationships to both nearby and distant sites. However, no materials were observed which were necessarily procured from distances greater than 50 miles, and no diagnostic artifacts were recovered.

CONCLUSIONS

Management

The areas that were to be disturbed by planned construction are described above in *Areas Investigated* (p. 19) and shown in Figure 3. Results of the 1989 investigations indicate that it is unlikely that any of the areas in the proposed direct impact area bear significant subsurface deposits that require further excavation, and the excavations performed during this phase are considered to be adequate mitigation for the proposed direct impact area. However, it is very likely that undisturbed cultural deposits are present within the terrace deposits to the north and south of the direct impact area.

No clearance was given for construction on sensitive portions of the site. The eastern boundary of these areas was flagged with red tape tied on shrubs. No ground-disturbing activities were allowed to the west of this boundary. An alternative road alignment was flagged by MWAC personnel, using blue and green tape tied on shrubs. This alignment crosses through a corner of the site that has a very thin scatter of flaked lithics and appears to have no buried deposits, as judged by slope morphology and attributes of the rock fraction of the soil. The site was avoided by using the flagged alternative alignment.

This site is within the proposed Salt Creek Archeological District Expansion Area, and is determined to be eligible for the National Register of Historic Places by consensus with the State Historic Preservation Office (SHPO). Its size, the diversity of the materials observed here, and the probability that buried and datable deposits exist in uninvestigated portions indicate that this site may yield significant data regarding the prehistoric sequence of the park. Overall, the site can yield data relevant to understanding the groups that occupied the park and the surrounding region, as well as information regarding prehistoric technologies, adaptive systems, and settlement patterns. Currently, data on those issues are quite limited. Consequently this site constitutes an important addition to the archeological resources of the park. Efforts should be made to protect the uninvestigated portions of this site.

Research

In addition to 11 shovel probes, a total of 14.7 cu m were excavated in a 14-sq-m area, and surface materials were collected over an area of 1,100 sq m. Material collected included 59 flaked lithics from the surface and 668 from subsurface investigations. These also included 15 macrobotanical specimens, 36 identifiable fragmentary or whole snail shells, 33 pieces of bone, and one radiocarbon sample.

Analysis focused on stratigraphic correlation of soil and geomorphic units, identification of paleoenvironments, and characterization of lithic systems and chronologic change in lithic systems. Because a large portion of these deposits cannot be reliably assigned to specific cultures or paleoenvironmental events, the proposed sequence is considered to comprise a set of hypotheses for testing in subsequent investigations in the region.

Three depositional environments were identified, including aeolian, high-energy overbank, and low-energy overbank. Soil horizon attributes indicate significant changes in soil moisture. From seven individual stratigraphic units three geomorphic units were identified. Unfortunately, dating of these is dependent upon a single radiocarbon sample which yielded a date of 2490 ± 210 B.P. (calibrated date range approximately 1110 – 50 B.C.; see *Dating*, p. 25). The dated unit (Stratum B) is coeval with Agenbroad and Elder's (1986) T_{4b} from upper Salt Creek and T_{2b} from the Bechan Cave area, and Hack's (1942) Tsegi alluvium a, and is included within Richmond's (1962) Neoglacial Lower Gold Basin. Richmond's radiocarbon date of 2800 ± 200 B.P. has a calibrated two-sigma date range of approximately 1450 – 400 B.C. (Stuiver and Reimer 1993). The upper unit (Stratum A) may be coeval with a period of aeolian deposition that occurred between ca. 1500 and 750 B.P. in the Bechan Cave area (Agenbroad 1986).

Data from soils, bone taphonomy, and molluscan fauna suggest that several shifts in available moisture occurred during the period when these deposits were accumulating. Conditions include an intermittently moist riparian environment in Stratum C, a more consistently moist riparian environment in Stratum B, and a drier environment with undifferentiable overbank and aeolian deposits in Stratum A. These apparent shifts in available moisture appear to be associated with changes in areas used, as shown in stratigraphic changes in the lithics assemblage.

Cultural materials occurred in variable densities at depths up to 1.1 m. No features or diagnostic materials were observed. Datable materials were absent or very thinly dispersed, and no diagnostic artifacts were observed. It appears that these remains result from use by late Middle Archaic or Late Archaic Anasazi groups. Culturally derived materials consist of flaked lithics, bone, charcoal, and one burned seed. Burned specimens in the faunal assemblage indicate use of at least small vertebrates, especially mammals. Macrobotanical specimens included fragments of a single unidentifiable burned seed coat. The origins and significance of this and of seed coats of *Celtis* which were recovered cannot be assessed.

Flaked lithic assemblage attributes suggest dependence upon a set of "formal" tools, especially bifaces, that were transported and maintained, and augmented by "expedient" items produced with local materials and infrequently transported.

Chronological changes in lithic technologies indicate several shifts in range use and/or technology. Statistically significant shifts in material types and type diversity values for lithic materials in Stratum B suggest that use of the uplands north and/or east of the park during this portion of the Neoglacial was more intensive or more frequent than during the periods associated with Stratum A or Stratum C. This may be due to increased water or biotic resources in those areas at that time. Materials from Stratum C suggest use of a smaller area during the previous period. Materials from Stratum A are low in diversity and suggest infrequent use of sources of exogenous materials.

Changes in other assemblage attributes indicate a trend in reductive technology through time. This is visible in a statistically significant change in flake types that shows increased frequencies of flakes associated with later stages of reduction, suggesting an increased dependence on thinned tools.

No effort has been made to assign this site to some functional "site type." The area of subsurface investigations included only a very small portion of the site, and the presence or absence of diagnostic attributes (e.g., Tipps and Hewitt 1989) cannot be determined. In addition, no comparisons can be made with other investigations, since for this area there are insufficient extant data regarding the nature of artifact assemblages and chronologic and spatial variation to make a functional "site type" assignment for 42SA20286 on the basis of its lithic assemblage.

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Table 1. Distribution of non-intrusive seed coat fragments by field specimen number and by natural level, with notes on intrusive macrobotanical specimens.

FS	Level	Number	Taxon	Alteration
11.5.9	V	2	*Celtis* sp.	
11.6.9	VII	1	*Celtis* sp.	
11.7.9	VII	3	*Celtis* sp.	1 burned
12.8.9	VII	1	*Celtis* sp.	
12.9.9	VII	3	*Celtis* sp.	
12.10.9	VII	3	*Celtis* sp.	
21.7.9	VII	2	unidentified	burned
22.4.9	IV	1	*Celtis* sp.	

Intrusive macrobotanical specimens: 11.1.9 (Level II), unidentified terminal bud; 11.8.9 (Level VII), 36 unidentified seeds, not processed and not known to be a taxon economically important to aboriginal groups, probably insect cache; 20.7.9 (Level IV), 6 large, unprocessed seeds, *Chenopodium* sp., appear to be recent, probably insect cache.

Table 2. Stratigraphic distribution of snails.

Stratum A	
	Pupoides hordaceous *Gastrocopta pilsbryana* *G.* cf. *G. riograndensis* *Vallonia* sp. Succineid fragments
Stratum B	
	Vallonia + pupillid and other fragments
Stratum C	
	Gastrocopta cristata *G. pellucida* *G. pilsbryana* *Hawaiia minuscula* *Pupoides albilabris* *P. hordaceous* *Vallonia cyclophorella* Succineid fragments

Table 3. Vertebrate taxa by stratum.

Taxon	Stratum A, Levels I,II,III	Stratum B, Level IV	Stratum C, Levels V,VI,VII	Total
Unknown Microvert	1	6	7	14
Amphibian	-	1	-	1
Serpentes	-	1	-	1
Mammal	-	1	-	1
Small Mammal	-	9	3	12
Rodent	1	2	-	3
Sylvilagus	1	-	-	1
Total	3	20	10	33

Table 4. Weathering stage distribution by arbitrary levels.

Horizontal Unit	Arbitrary Level	Weathering Stage 1	2	3	4	5	Total
21, 22	7	4	1	-	-	-	5
	8	1	4	1	-	-	6
	9	2	4	1	2	-	9
	10	1	-	1	-	-	2
	11	4	-	-	1	-	5
	12	3	-	-	-	-	3
2	2	-	1	-	-	-	1
	6	-	1	-	-	-	1
12	4	1	-	-	-	-	1
Total		16	11	3	3	0	33

Table 5. Weathering stage distribution by strata in FS 21 and 22 (Excavation Unit G).

Stratum	Weathering Stage 1	2	3	4	5	Total
A	1	2	-	-	-	3
B	7	9	2	2	-	20
C	8	-	1	1	-	10
Total	16	11	3	3	0	33

Table 6. Macrodebitage reductive stage by material type.

	Chert	Chalcedony	Quartzite	Total	Key
Shatter	3	1	1	5	observed
	(2.9)	(2.0)	(0.0)		(expected)
	1.0	0.5	20.0	1.0	column %
Decortication	5	0	1	6	observed
	(3.5)	(2.4)	(0.1)		(expected)
	1.7	0.0	20.0	1.2	column %
Interior I	118	64	3	185	observed
	(108.1)	(75.1)	(1.8)		(expected)
	39.1	30.5	60.0	35.8	column %
Interior II	176	145	0	321	observed
	(187.5)	(130.4)	(3.1)		(expected)
	58.3	69.0	0.0	62.1	column %
Total	302	210	5	517	
Percent	58.4	40.6	1.0		

No chi-square calculated; cells with EF < 5 = 8 out of 12, or 66.7%, which is more than the 25% maximum allowed for valid chi-square.

Table 7. Dimensions (mm) by material type of all macrodebitage.

Material, Measure	Mean	Standard Deviation	Coefficient of Variability	n
Chert				
Maximum Dimension	14.8	8.3	0.56	308
Thickness	2.4	1.7	0.71	
Chalcedony				
Maximum Dimension	11.9	6.4	0.54	226
Thickness	2.1	1.2	0.57	
Quartzite				
Maximum Dimension	6.3	4.9	0.78	10
Thickness	2.6	2.9	1.11	

For average maximum dimension of all material types $F = 13.70$, $p = .00$, $df = 2$; for average thickness of all material types $F = 7.86$, $p = .03$, $df = 2$; for average maximum dimension of chert and chalcedony only $F = 4.37$, $p = .04$, $df = 2$; for average thickness of chert and chalcedony $F = 4.24$, $p = .04$, $df = 2$.

Table 8. Dimensions (mm) by reductive stages.

Stage, Measure	Mean	Standard Deviation	Coefficient of Variability	n
Shatter				
Maximum Dimension	13.9	3.4	0.24	5
Thickness	7.2	3.5	0.49	
Decortication				
Maximum Dimension	18.1	8.8	0.49	6
Thickness	6.5	4.7	0.72	
Interior I				
Maximum Dimension	16.8	7.1	0.42	185
Thickness	3.1	1.5	0.48	
Interior II				
Maximum Dimension	13.2	5.2	0.39	321
Thickness	1.8	0.8	0.44	

For average maximum dimension by flake type for all material types $F = 13.66$, $p = .00$, $df = 3$; for average thickness by flake type for all material types $F = 89.73$, $p = .00$, $df = 3$.

Table 9. Dimensions (mm) by material type of selected reductive stages for chert and chalcedony.

Material	Mean	Standard Deviation	Coefficient of Variability	n
Interior I[1]				
Chert				
Maximum Dimension	16.9	7.1	0.42	118
Thickness	3.1	1.4	0.45	
Chalcedony				
Maximum Dimension	15.2	7.6	0.50	64
Thickness	3.0	1.6	0.53	
Interior II[2]				
Chert				
Maximum Dimension	13.6	6.3	0.46	176
Thickness	1.8	1.0	0.56	
Chalcedony				
Maximum Dimension	12.5	4.6	0.37	
Thickness	1.7	1.1	0.65	145

[1]For average maximum dimension $F = 2.26$, $p = 0.13$, $df = 1$, n = 182; for average thickness $F = 0.23$, $p = 0.64$, $df = 1$, n = 182.

[2]For average maximum dimension $F = 2.60$, $p = 0.11$, $df = 1$, n = 321; for average thickness $F = 0.10$; $p = 0.76$, $df = 1$, n = 321.

Table 10. Average ratio of macrodebitage thickness to maximum dimension by material type.

Material	Ratio	Standard Deviation	Coefficient of Variability	n
Chert	0.16	0.08	0.50	302
Chalcedony	0.16	0.07	0.44	210
Quartzite	0.23	0.11	0.49	5

Table 11. Average ratio of thickness to maximum dimension by material type for selected reductive stages.

Material	Ratio	Standard Deviation	Coefficient of Variability	n
Interior I[1]				
Chert	0.19	0.08	0.42	118
Chalcedony	0.20	0.09	0.45	64
Interior II[2]				
Chert	0.13	0.05	0.39	176
Chalcedony	0.14	0.06	0.43	145

[1] $F = 0.69$, $p = 0.41$, $df = 1$, n = 182.

[2] $F = 2.02$, $p = 0.16$, $df = 1$, n = 321.

Table 12. Presence of cortex by material type for macrodebitage.

Material	Cortex: Absent	Cortex: Abraded	Cortex: Weathering	Total	Key
Chert	301 56.2	2 100.0	5 83.3	308	observed column %
Chalcedony	226 42.2	0 0.0	0 0.0	226	observed column %
Quartzite	9 1.7	0 0.0	1 16.7	10	observed column %
Total Percent	536 98.5	2 0.4	6 1.1	544 100	

No χ^2 calculated, cells with EF < 5 = 4 out of 6, or 66.7%, which is more than the 25% maximum allowed for valid chi-square.

Table 13a. Frequencies of microdebitage, macrodebitage, and tools by material types.

Material	Micro-debitage	Macro-debitage	Tools	Key	Total	Macrodeb. to Tool Ratio
Chert	50	308	13	observed	371	23.7
	(83.7)	(277.6)	(9.7)	(expected)		
	13.5	83.0	3.5	row %	51.0	
Chalcedony	108	226	6	observed	340	37.7
	(76.7)	(254.4)	(8.9)	(expected)		
	31.8	66.5	1.8	row %	46.8	
Quartzite	6	10	0	observed	16	-
	(3.6)	(12.0)	(0.4)	(expected)		
	37.5	62.5	0.0	row %	2.2	
Total	164	544	19		727	
Percent	22.6	74.8	2.6		100	

Table 13b. Chert and chalcedony microdebitage frequencies.

	Chert	Chalcedony	Total	Key
Microdebitage	50	108	158	total
	(81.7)	(76.3)		(expected)
	14.0	32.3	22.8	percent
Macrodebitage	308	226	534	total
	(276.3)	(257.7)		(expected)
	86.0	67.7	77.2	percent
Total	358	334	692	
Percent	51.7	48.3	100	

Table 14. Distribution of tool type by material type.

Material	Tool Type: Cores	Utilized Interior I	Retouched Flakes & Utilized Interior II	Bifaces	Total (Percent)
Cedar Mesa Chert	4 (80.0)	2 (66.7)	3 (100.0)	4 (50.0)	13 (68.4)
Summerville Chalcedony	1 (20.0)	1 (33.3)	0 (0.0)	2 (25.0)	4 (21.1)
White Rim Chalcedony	0 (0.0)	0 (0.0)	0 (0.0)	2 (25.0)	2 (10.5)
Total Percent	5 (26.3)	3 (15.8)	3 (15.8)	8 (42.1)	19 (100.0)

Table 15. Means and standard deviations (SD) for tool and core dimensions by material type.

Material	Length		Width		Thickness		n
	Mean	SD	Mean	SD	Mean	SD	
Cedar Mesa Chert	33.8	18.9	28.9	11.8	8.5	2.9	13
Summerville Chalcedony	24.3	19.9	30.4	13.0	6.2	0.5	4
White Rim Chalcedony	11.8	9.53	13.1	2.1	7.5	5.8	2

Table 16. Means and standard deviations (SD) for edge angles by material type.

Material	Maximum		Minimum		n
	Mean	SD	Mean	SD	
Cedar Mesa Chert	60.8	25.0	43.2	21.4	13
Summerville Chalcedony	65.8	31.4	45.0	20.8	4
White Rim Chalcedony	57.0	33.9	49.5	29.0	2

Table 17. Frequencies of artifact classes by excavation unit in Levels I, II, III; Stratum A.

Excavation Unit	Artifact Class: Micro-debitage	Macro-debitage	Tools, Cores	Total
A	SNP	5	0	5
B	SNP	54	0	54
C	SNP	4	0	4
D	SNP	25	0	25
E	1	5	1	7
F	SNP	1	0	1
G	60	95	2	157
Surface Collection	SNP	49	9	58
Total	61	238	12	311

SNP = samples not processed.

Table 18. Frequencies of artifact classes by excavation unit in Level IV; Stratum B.

Excavation Unit	Artifact Class: Micro-debitage	Macro-debitage	Tools, Cores	Total
E	5	3	0	8
G	59	158	3	220
Total	64	161	3	228

Table 19. Frequencies of artifact classes by excavation unit in Levels V, VI, VII; Stratum C.

Excavation Unit	Artifact Class: Micro-debitage	Macro-debitage	Tools, Cores	Total
Unit C	SNP	4	0	4
Unit E	10	51	1	62
Unit G	15	15	0	30
Total	25	70	1	96

SNP = samples not processed.

Table 20. Distribution of macrodebitage flake type by stratigraphic unit.

Stratum	Shatter	Decort.	Interior I	Interior II	Total	Key
A	3	4	95	196	298	observed
	(2.9)	(3.5)	(106.9)	(184.7)		(expected)
	1.0	1.3	31.9	65.8		percent
B	1	1	59	90	151	observed
	(1.5)	(1.8)	(54.2)	(93.6)		(expected)
	0.7	0.7	39.1	59.6		percent
C	1	1	30	32	64	observed
	(0.6)	(0.7)	(23.0)	(39.7)		(expected)
	1.6	1.6	46.9	50.0		percent
Total	5	6	184	318	513	
Percent	1.0	1.2	35.9	62.0		

Table 21. Distribution of material type by stratigraphic unit for macrodebitage, cores, and tools.

Stratum	Chert	Chalcedony	Quartzite	Total	Key
A	195	129	0	324	observed
	(183.7)	(134.5)	(5.8)		(expected)
	60.2	39.8	0.0		percent
B	75	85	4	164	observed
	(93.0)	(68.1)	(2.9)		(expected)
	45.7	51.8	2.4		percent
C	47	18	6	71	observed
	(40.3)	(29.5)	(1.3)		(expected)
	66.2	25.4	8.5		percent
Total	317	232	10	559	
Percent	56.7	41.5	1.8	100	

χ^2 = 38.0, p = 0.00, df = 4. Cells with E.F. < 5 = 2 of 9, or 22.2 %.

Table 22. Diversity and evenness measures for material types and sources.

Stratum	Material Type	Source Area	Key
A	1.60	1.17	diversity (H)
	0.73	0.60	evenness (J)
	9	7	richness (n)
B	1.81	1.31	diversity (H)
	0.73	0.67	evenness (J)
	12	7	richness (n)
C	1.67	1.15	diversity (H)
	0.70	0.64	evenness (J)
	11	6	richness (n)

Table 23. Mean dimensions of Interior I flakes by stratum and by material type.

Stratum	Maximum Dimension Mean	Maximum Dimension SD	Thickness Mean	Thickness SD	n
Chert Interior I Flakes[1]					
A	16.3	6.5	2.9	1.1	63
B	18.4	8.6	3.8	1.9	27
C	16.9	6.9	2.7	1.4	24
Chalcedony Interior I Flakes[2]					
A	16.7	6.9	3.1	1.5	29
B	12.9	6.7	2.7	1.6	26
C	15.7	16.3	2.7	1.6	4

[1]For maximum dimension $F = 0.82$, $p = 0.44$, $df = 2$; for thickness $F = 5.19$, $p = 0.001$, $df = 2$.

[2]Strata A and B only: for maximum dimension $F = 4.28$, $p = 0.04$, $df = 1$; for thickness $F = 0.72$, $p = 0.40$, $df = 1$.

Table 24. Mean dimensions of Interior II flakes by stratum and by material type.

Stratum	Maximum Dimension Mean	Maximum Dimension SD	Thickness Mean	Thickness SD	n
Chert Interior II Flakes[1]					
A	13.3	6.0	1.7	0.9	110
B	13.8	5.6	1.9	0.9	44
C	14.6	9.5	2.0	1.3	19
Chalcedony Interior II Flakes[2]					
A	13.0	5.0	1.7	0.7	86
B	10.9	4.4	1.7	0.8	46
C	8.9	4.5	1.3	0.3	13

[1]For maximum dimension $F = 0.32$, $p = 0.73$, $df = 2$; for thickness $F = 1.14$, $p = 0.32$, $df = 2$.

[2]Strata A and B only: for maximum dimension $F = 5.86$, $p = 0.02$, $df = 1$; for thickness $F = 0.40$; $p = 0.52$, $df = 1$.

Table 25. Macrodebitage flake type by material type in Stratum C.

Material	Flake Type: Interior I	Interior II	Total	Key
Chert	25	19	44	observed
	(18.3)	(25.7)		(expected)
	56.8	43.2		percent
Chalcedony	5	23	28	observed
	(11.7)	(16.3)		(expected)
	17.9	82.1		percent
Total	30	42	72	
Percent	41.7	58.3		

χ^2 = 9.14; p = 0.003, df = 1.

Table 26. Interior I and Interior II flake dimensions in Stratum C.

Type	Maximum Dimension Mean	Maximum Dimension SD	Thickness Mean	Thickness SD	n
Interior I Flakes[1]					
Chert	16.9	6.9	2.7	1.4	24
Chalcedony	15.7	16.3	3.1	3.3	4
Interior II Flakes[2]					
Chert	12.6	3.8	1.8	1.0	18
Chalcedony	11.1	3.5	1.3	0.3	9

[1]No ANOVA run due to small sample size.

[2]For maximum dimension $F = 0.91$, $p = 0.35$, $df = 1$; for thickness $F = 2.14$, $p = 0.16$, $df = 1$.

Table 27. Microdebitage frequencies for chert and chalcedony in Stratum C.

	Material Type			
	Chert	Chalcedony	Total	Key
Microdebitage	5 (14.0) 20.8	19 (10.0) 79.2	24	observed (expected) percent
Macrodebitage and Tools	47 (38.0) 72.3	18 (27.0) 27.7	65	observed (expected) percent
Total Percent	52 58.4	37 41.6	89 100.0	

$\chi^2 = 19.12$, $p = 0.00$, $df = 1$.

Table 28. Macrodebitage flake type by material type in Stratum B.

Material	Flake Type: Interior I	Interior II	Total	Key
Chert	36	48	84	observed
	(36.9)	(47.1)		(expected)
	42.9	57.1		percent
Chalcedony	48	59	107	observed
	(47.1)	(59.9)		(expected)
	44.9	55.1		percent
Total	84	107	191	
Percent	44.0	56.0	100.0	

$\chi^2 = 0.02$, $p = 0.90$, $df = 1$.

Table 29. Average dimensions of chert and chalcedony Interior flakes in Stratum B.

	Maximum Dimension		Thickness		
	Mean	SD	Mean	SD	n
Interior I[1]					
Chert	18.4	(8.7)	3.8	(1.9)	27
Chalcedony	12.9	(6.7)	2.7	(1.6)	26
Interior II[2]					
Chert	13.8	(5.6)	1.9	(0.9)	44
Chalcedony	11.3	(4.2)	1.7	(0.8)	44

[1]*For maximum dimension* $F = 6.67$, $p = 0.013$, $df = 1$; for thickness $F = 5.22$, $p = 0.027$, $df = 1$.

[2]*For maximum dimension* $F = 1.29$, $p = 0.26$, $df = 1$.

Table 30. Microdebitage frequencies for chert and chalcedony in Stratum B.

	Material Type			
	Chert	Chalcedony	Total	
Microdebitage	21	40	61	observed
	(26.5)	(34.5)		(expected)
	34.4	65.6		percent
Macrodebitage and Tools	75	85	160	observed
	(69.5)	(90.5)		(expected)
	46.9	53.1		percent
Total	96	125	221	
Percent	43.4	56.6	100.0	

$\chi^2 = 2.79$, $p = 0.095$, $df = 1$.

Table 31. Distribution of macrodebitage flake type by material type in Stratum A.

Material	Flake Type			
	Interior I	Interior II	Total	
Chert	68	115	183	observed
	(60.8)	(122.2)		(expected)
	37.2	62.8		percent
Chalcedony	36	94	130	observed
	(43.2)	(86.8)		(expected)
	27.7	72.3		percent
Total	104	209	313	
Percent	33.2	66.8	100.0	

$\chi^2 = 3.07$, $p = 0.08$, $df = 1$.

Table 32. Means and standard deviations (SD) for dimensions of Interior I and Interior II flakes in Stratum A.

Material	Maximum Dimension		Thickness		n
	Mean	SD	Mean	SD	
Interior I Flakes[1]					
Chert	16.3	(6.5)	2.9	1.1	68
Chalcedony	16.7	(6.9)	3.1	1.6	36
Interior II Flakes[2]					
Chert	13.3	(6.0)	1.7	0.9	115
Chalcedony	13.3	(4.8)	1.7	0.7	94

[1]For maximum dimension $F = 0.077$, $p = 0.78$, $df = 1$; for thickness $F = 0.42$, $p = 0.52$, $df = 1$.

[2]For maximum dimension $F = 0.010$, $p = 0.92$, $df = 1$; for thickness $F = 0.000$, $p = 0.98$, $df = 1$.

Table 33. Microdebitage frequencies for chert and chalcedony in Stratum A.

	Material Type			
	Chert	Chalcedony	Total	
Microdebitage	24 (40.3) 32.9	49 (32.7) 67.1	73	observed (expected) percent
Macrodebitage and Tools	195 (178.7) 60.2	129 (145.3) 39.8	324	observed (expected) percent
Total	219	178	397	
Percent	55.2	44.8	100.0	

$\chi^2 = 17.96$, $p = 0.00$, $df = 1$.

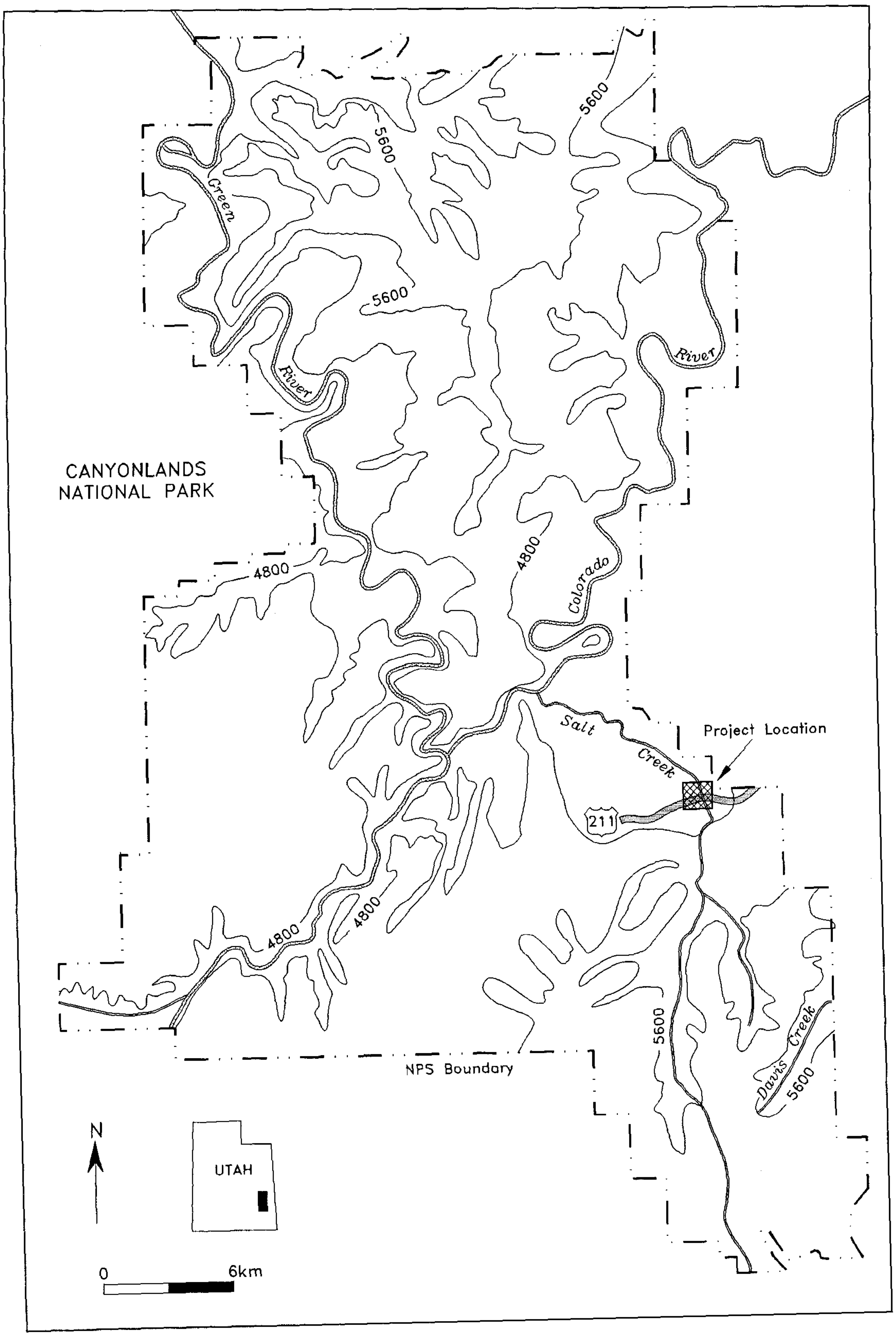


Figure 1. Project location.

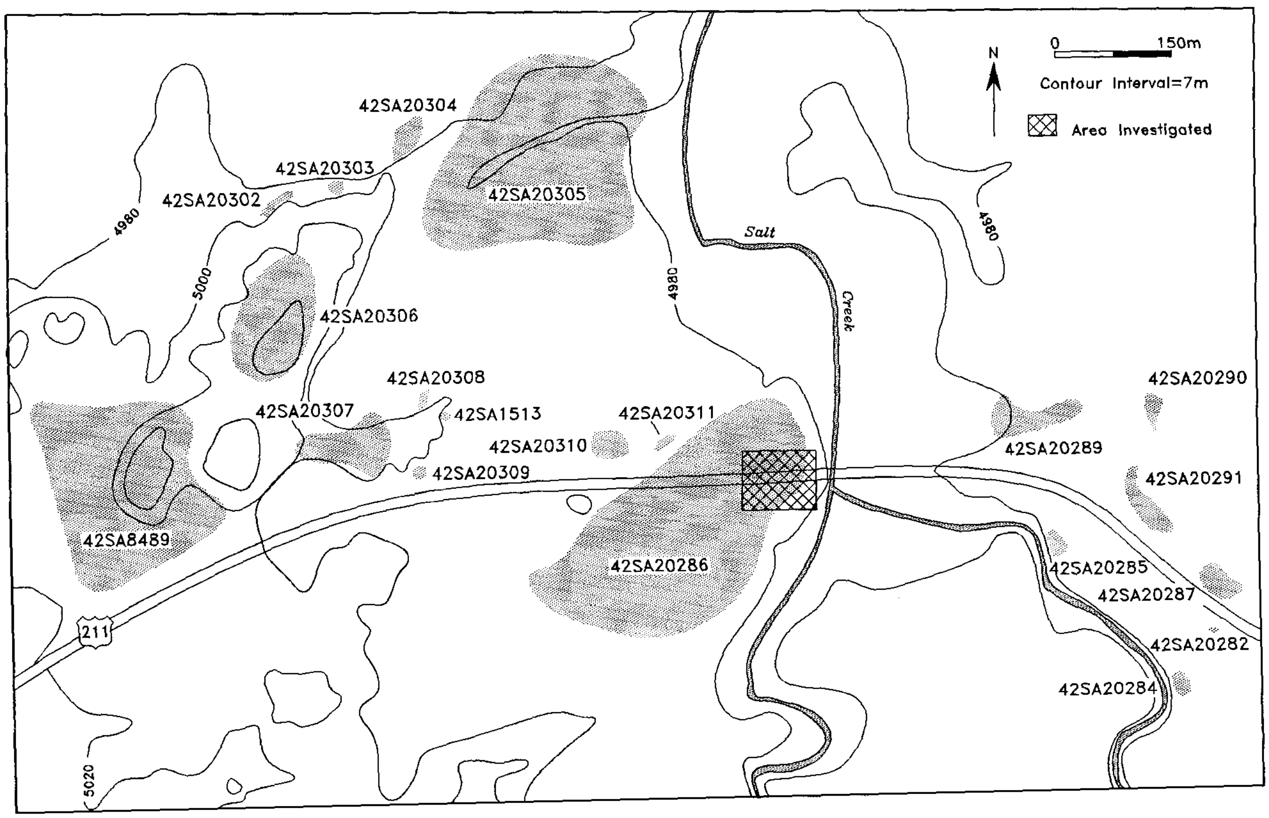


Figure 2. Location of site 42SA20286.

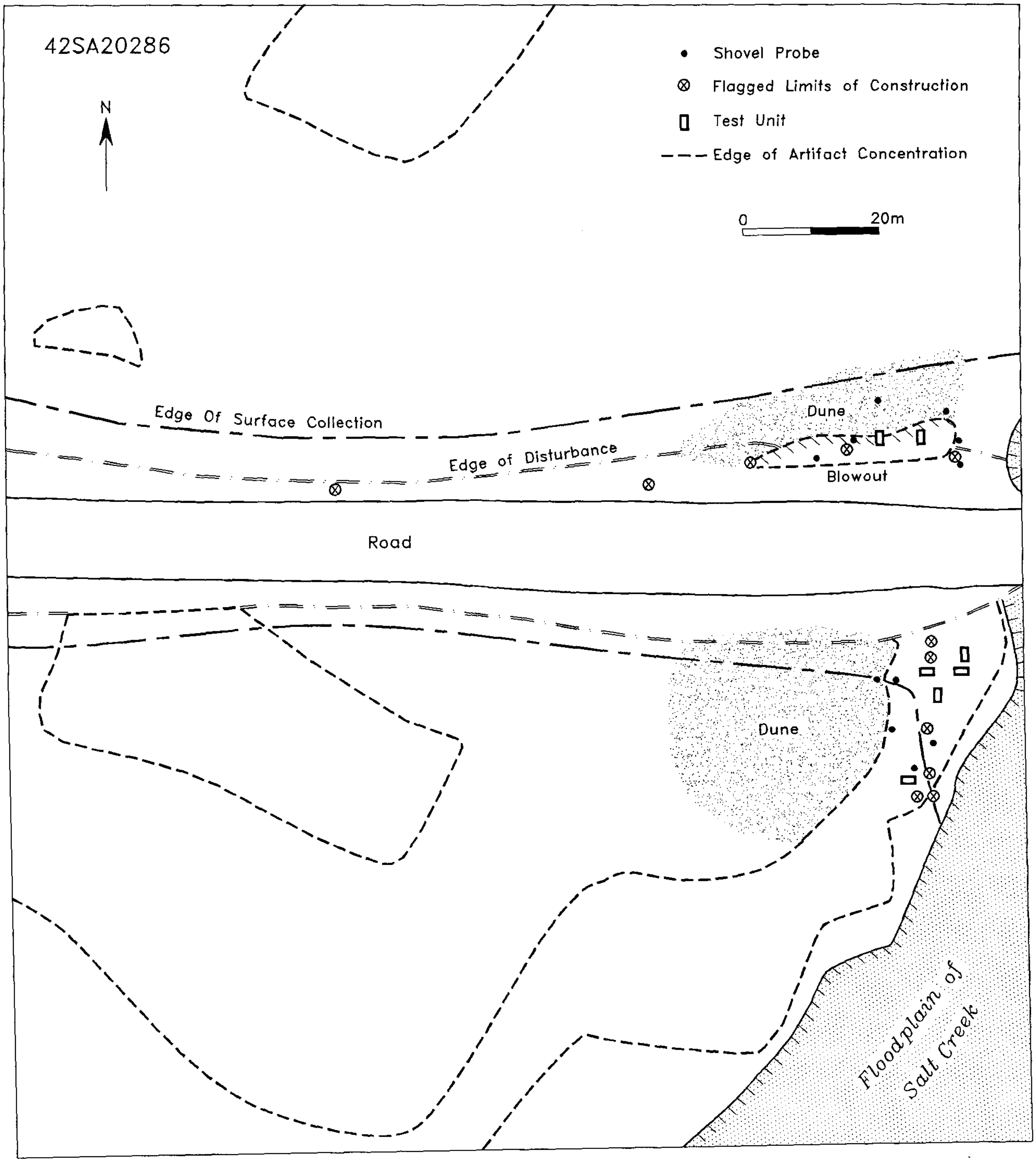


Figure 3. Map of areas investigated.

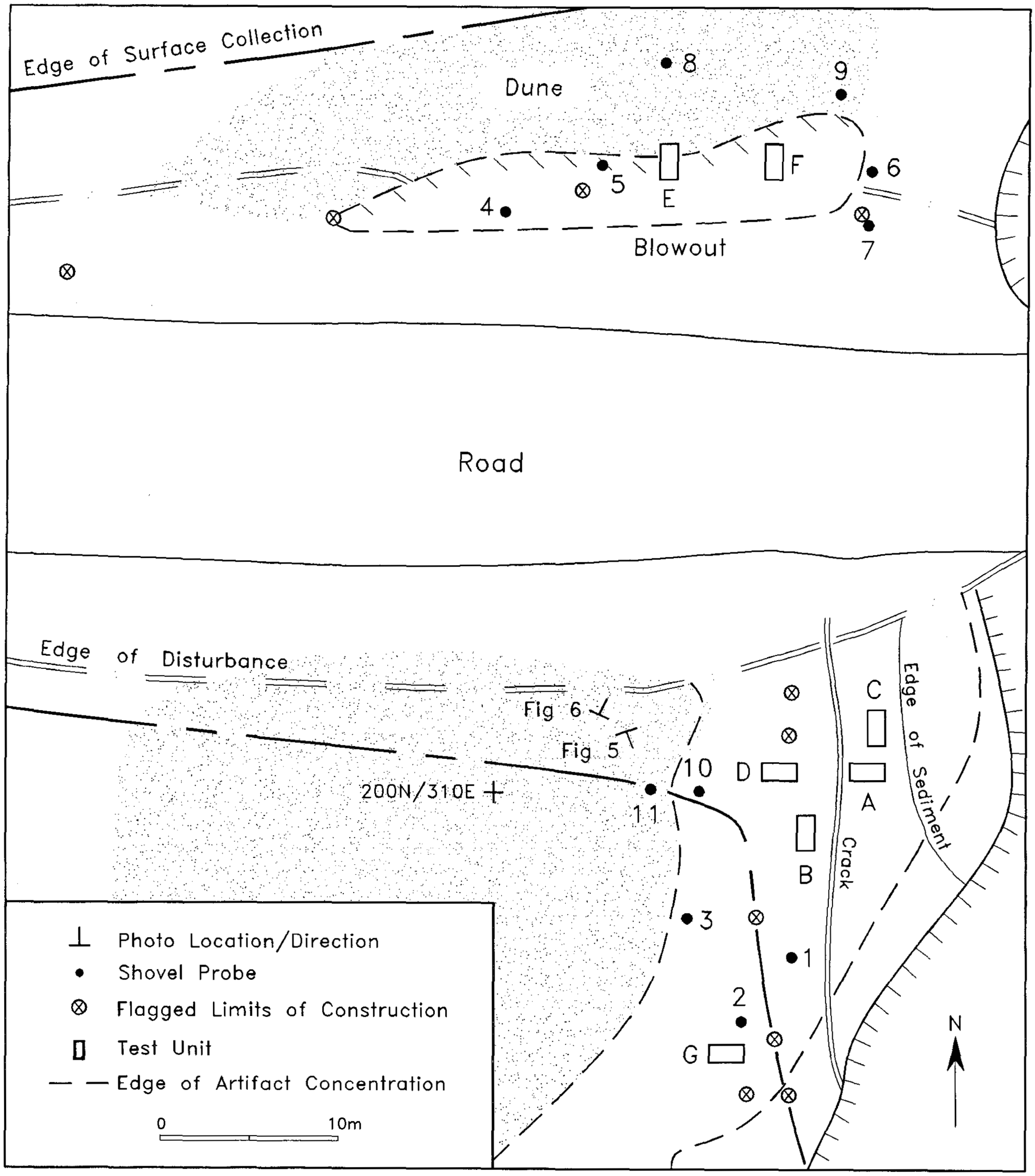
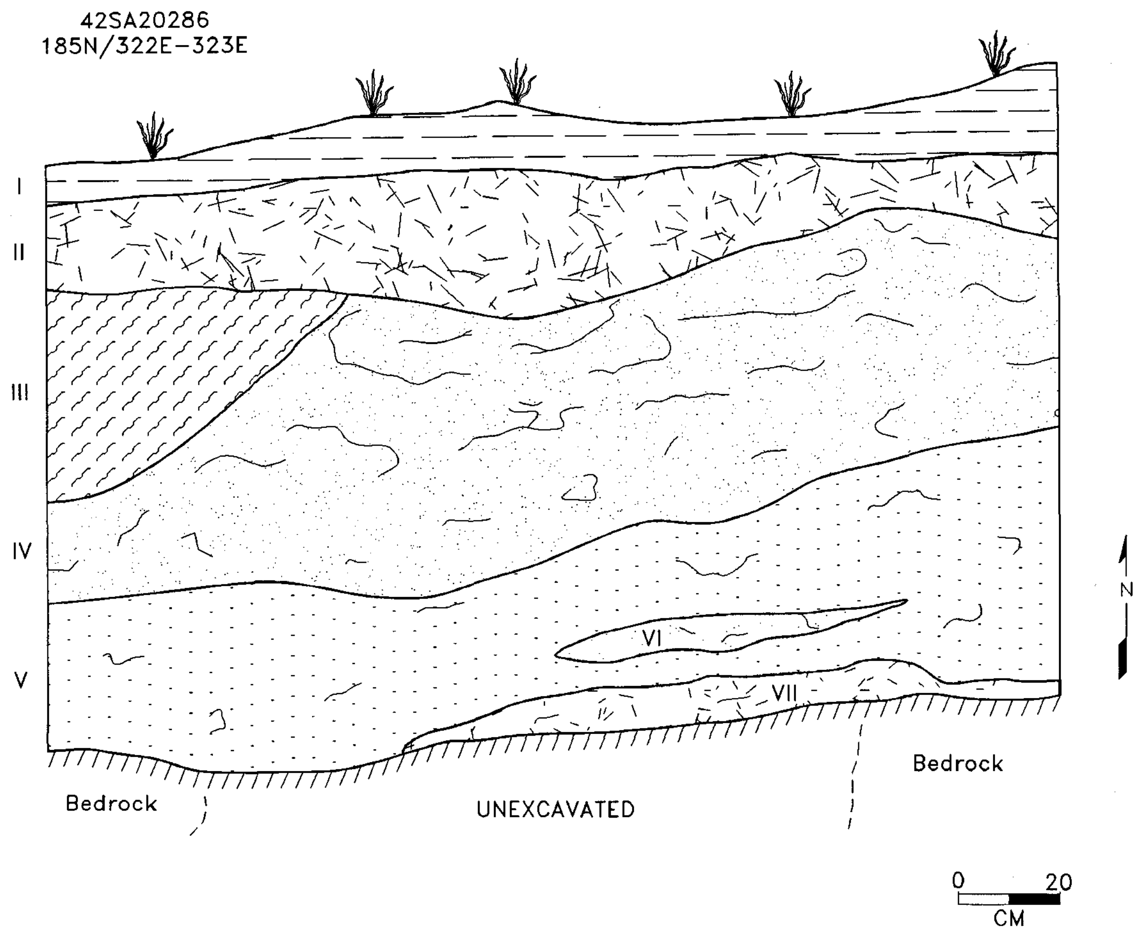


Figure 4. Map of subsurface investigations.

Figure 5. Overview of the site, looking south from road.

Figure 6. Overview of the site, looking north across road.



I 2.5YR4/6, loose to compacted medium sand (nonsticky, nonplastic, gritty), with occasional slightly structured ped. Rock fraction << 1% gravel–sized ss clasts. No bedding visible. Roots, surface trampling. Lower boundary is 0.2 to 0 cm wide, abrupt, clear.

II 2.5YR3/6, slightly structured medium sand (very slightly sticky, nonplastic, gritty). Rock fraction << 1% gravel and pebbled–sized ss clasts. No bedding visible. Fewer roots. Grades to 2.5YR4/6 at bottom. Lower boundary indistinct, 1–5 cm.

III 2.5YR4/6, slightly structured medium sand (nonsticky, nonplastic, gritty). Rock fraction << 1% gravel to pebble–sized ss clasts. No bedding visible. Rodent activity. Lower boundary indistinct, but 1 cm across.

IV 2.5YR4/6, slightly structured medium sand (very slightly structured nonplastic, gritty). Rock fraction << 1% gravel to pebble–sized ss clasts. No bedding visible. Charcoal layer 0.01 to 1 cm across. Rodent activity. Lower boundary indistinct and consists of darker, harder mottling. Layer mottled with lenses of 10YR 3/4, structured to very structured medium to clayey sand (very slightly sticky to sticky, nonplastic to very plastic, gritty to smooth). Lenses are highly irregular and 0.2 to 1 cm thick. Mottling constitutes ca. 50% of volume.

V 2.5YR4/6, slightly structured medium sand (very slightly structured, nonplastic, gritty). Rock fraction << 1% gravel to pebbled–sized ss clasts. No bedding visible. Rodent activity. Mottling decreases in volume to ca. 5–10%.

VI 2.5YR3/4, clayey sand to clayey silt, (plastic to very plastic, sticky, smooth to slightly gritty). No rock fraction. No bedding visible. Boundaries indistinct, abrupt, ca. 1 cm lenses small and discontinuous, 0.1 to 1 cm thick. Mottles to 2.5YR4/6.

VII 2.5YR3/4, very structured, fine grit sand (plastic, slightly sticky). Rock fraction << 1% gravel–sized ss clasts. Not bedding visible. No disturbances. Lower boundary not known.

Figure 7. Profile, 185N322E (Excavation Unit G).

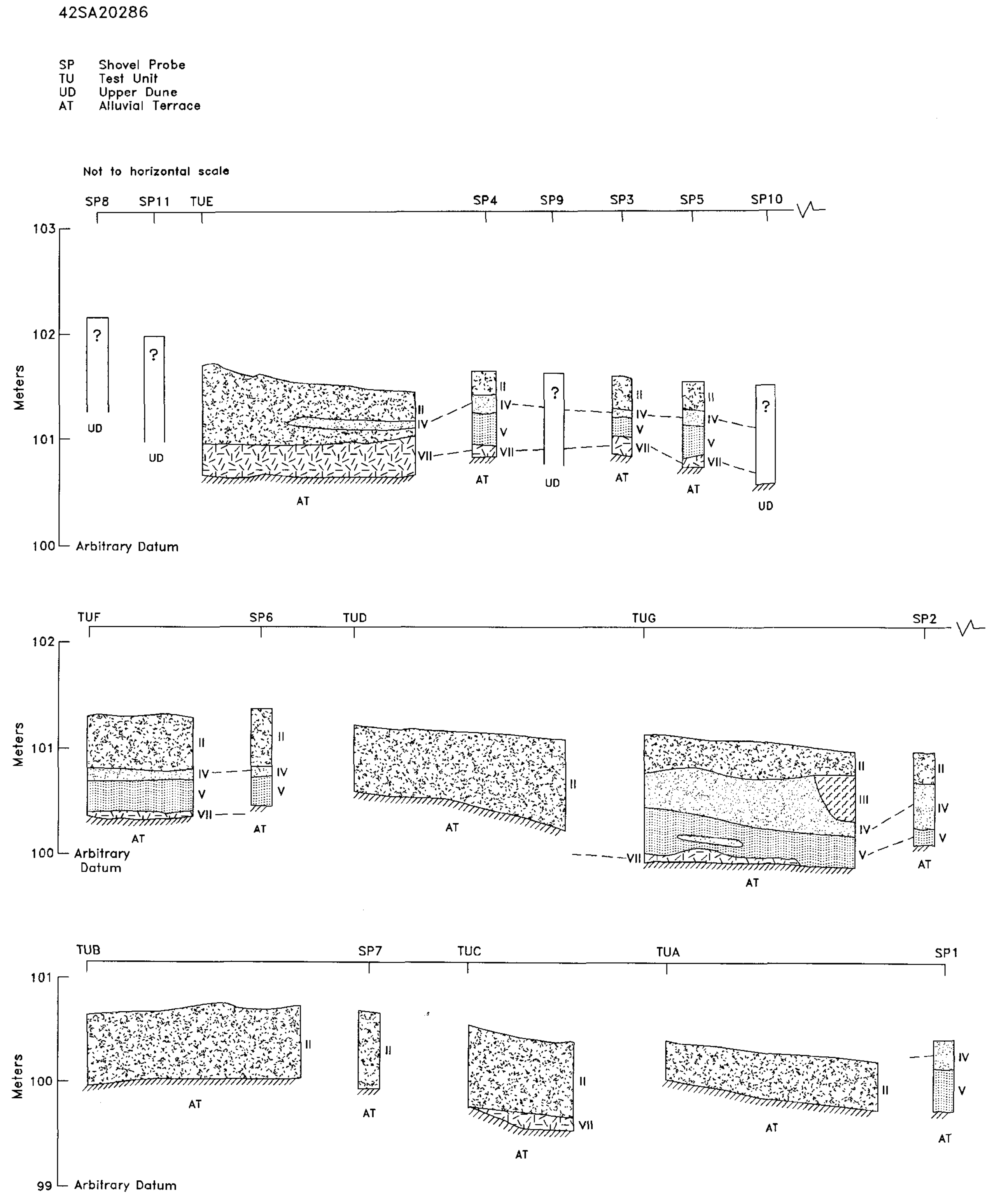


Figure 8. Stratigraphic correlations among excavation units and shovel probes.

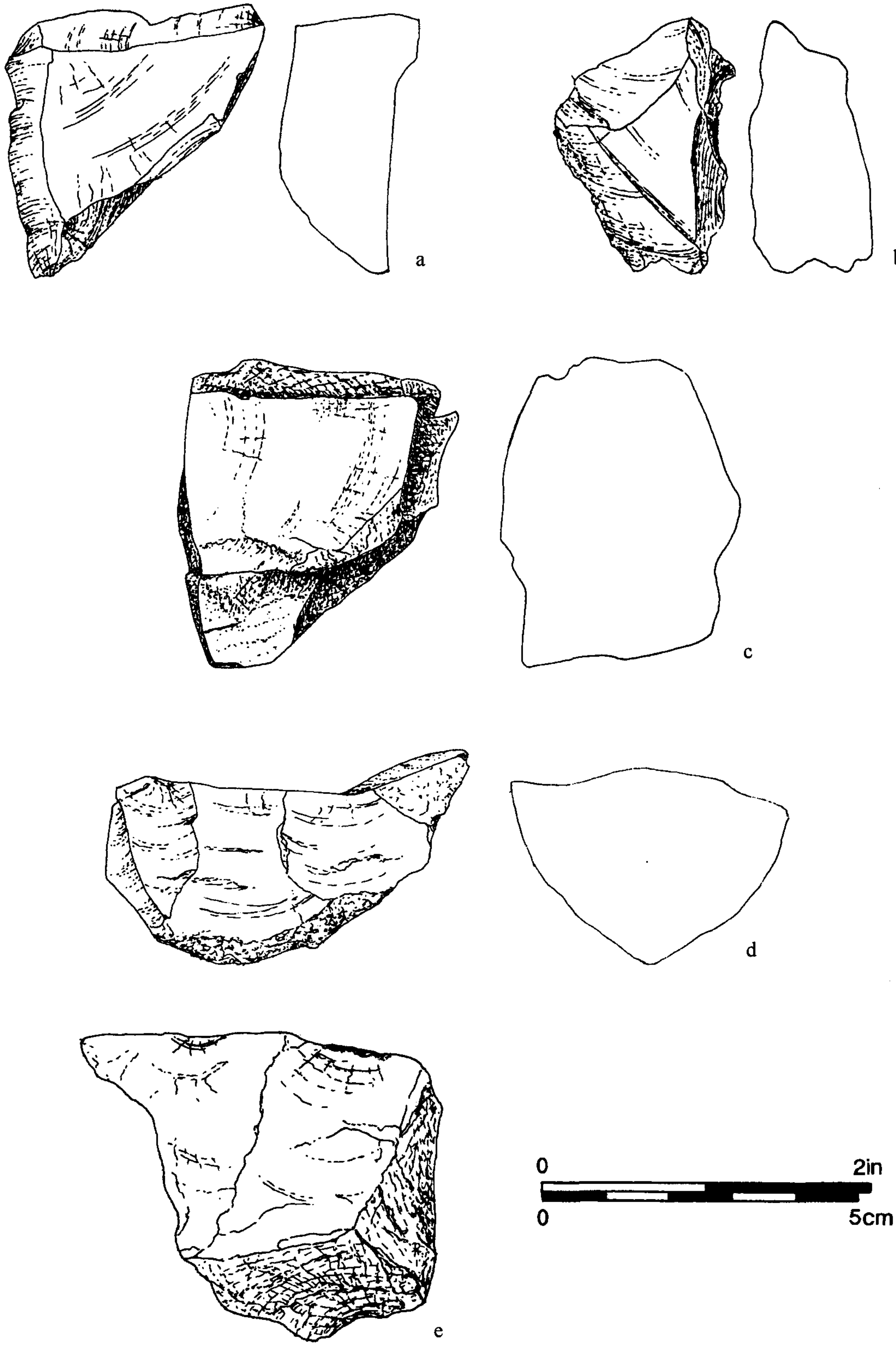


Figure 9. Cores: (a) FS42SA22.4.1; (b) FS42SA22.5.2; (c) FS42SA23.0.27; (d)FS42SA23.0.24; (e)FS42SA23.0.28

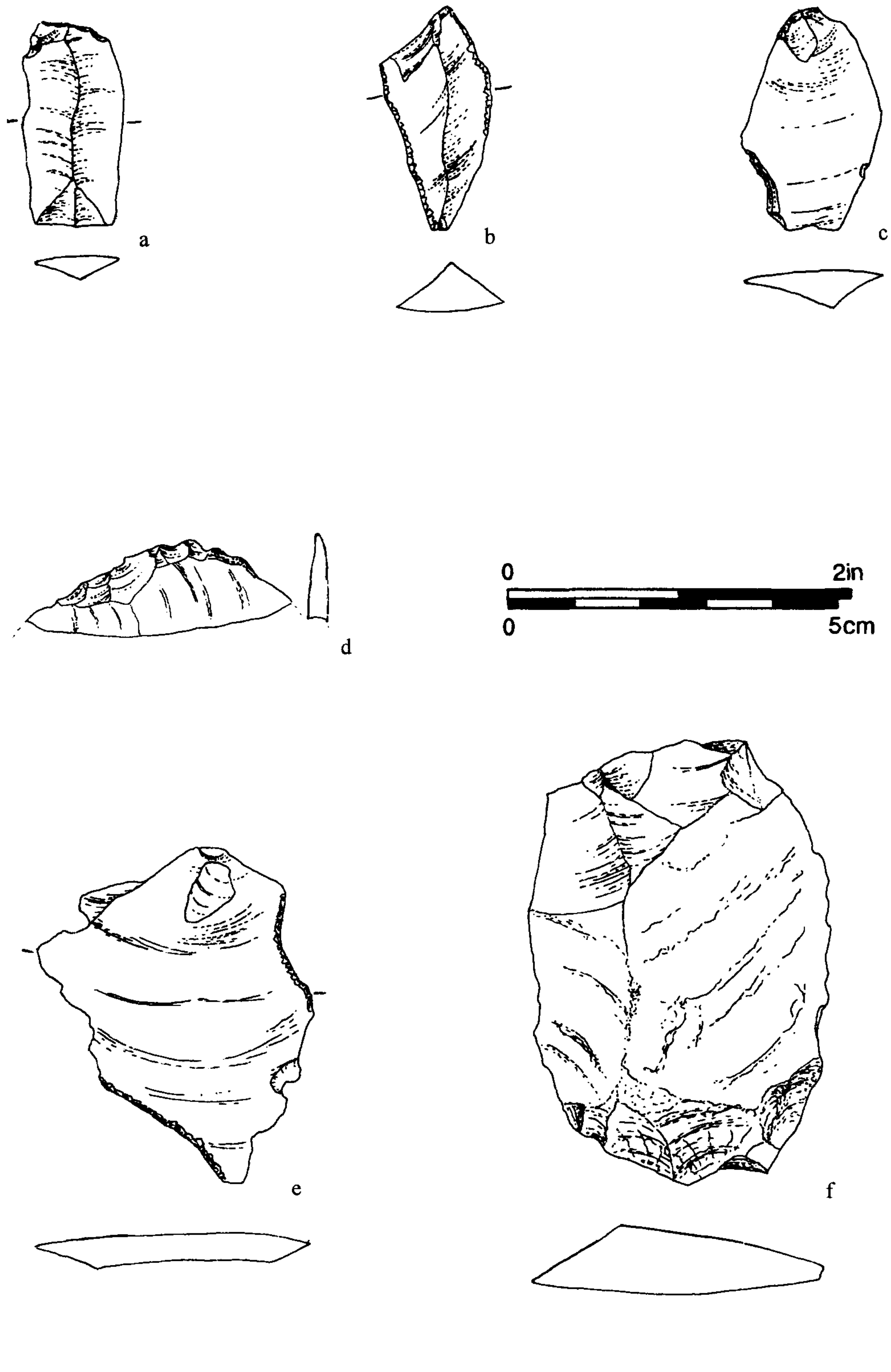


Figure 10. Utilized and retouched flakes: (a) FS42SA21.1.1; (b) FS42SA23.0.25; (c) FS42SA23.0.29; (d) FS42SA21.4.2; (e) FS42SA11.8.2; (f) FS42SA23.0.16

Figure 11. Bifaces: (a) FS42SA15.9.3; (b) FS42SA11.0.2; (c) FS42SA19.6.1; (d) FS42SA23.0.33; (e)FS42SA23.0.26; (f) FS42SA22.4.2; (g) FS42SA15.9.2; (h) FS42SA23.0.23

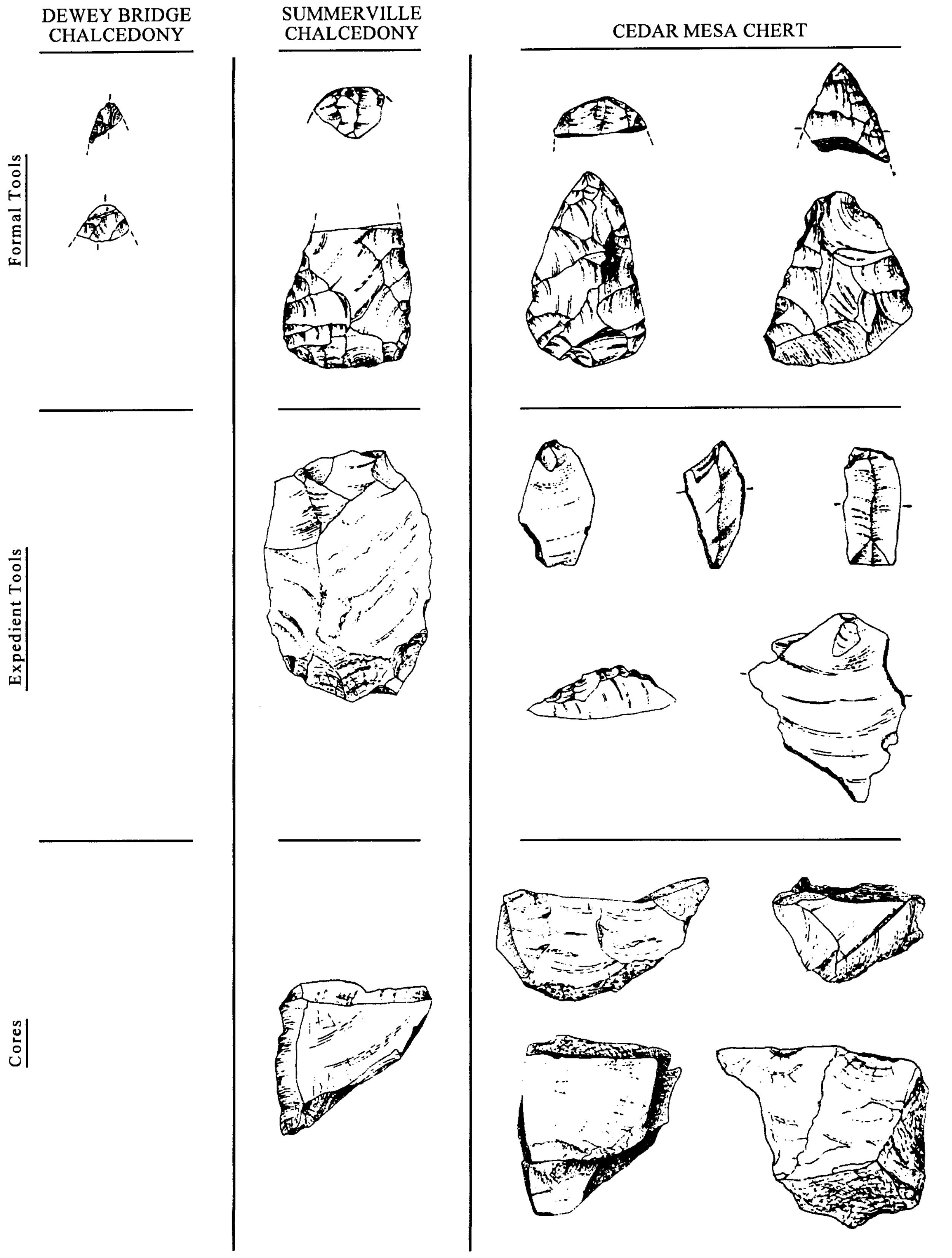


Figure 12. Tools and cores arranged by material type.

APPENDIX A

SOIL PROFILES AND PIT SUMMARIES

Test Pit Summaries and Excavation Unit Soil Profile Descriptions

Excavation Unit A; 201N/330E: 0.5 m downhill from crack, 3 m west from edge of sand. Oriented E-W.

- Within concentration of artifacts.
- Maximum depth = 50 cmbs, on bedrock.
- Maximum 4 flakes in 0-10 cmbs, decreasing to 0 in 20-30.

Profile notes:

I. 2.5YR5/6, loose, unconsolidated, medium-grained sand with very little silt (nonsticky, nonplastic, gritty), with << 1% gravel-sized SS clasts, a few SS pebbles. No bedding visible. Some roots.

II. 2.5YR5/6, consolidated, unstructured sand (nonsticky, nonplastic, gritty), with << 1% gravel-sized SS clasts. No bedding visible. Some very small roots and rodent activity.

Excavation Unit B; 199N/327E: 0.5 m uphill from crack. Oriented N-S.

- Within concentration of artifacts.
- Maximum depth = 80 cm, on bedrock.
- Total of 54 flakes from test pit; maximum was 16 in 10-20 cmbs; 2 flakes in 70-80 cmbs.

Profile notes:

I. 2.5YR4/6, nonsticky, nonplastic, gritty sand with some silt, < 2% gravel SS clasts. No bedding visible. No disturbances noted.

II. 2.5YR4/6, consolidated and weakly structured, gritty sand with some silt. Rock fraction < 1% SS clasts. No bedding visible. Some very small roots throughout soil.

Excavation Unit C; 203N/331E: 0.5 m downhill from crack, 2 m west of edge of sand deposit. Oriented N-S.

- Within concentration of artifacts.
- Maximum depth = 74 cm, on bedrock.
- 8 flakes, 1 per level, except 2 in 40-50 cmbs, and 0 in 60-BR.

Profile notes:

I. 2.5YR4/6, loose, medium-grained sand with some silt, with no rock fraction. No bedding visible. Root disturbance. Abrupt 1-cm boundary.

II. 2.5YR4/6, consolidated, unstructured, medium-grained sand with undulating beds, with no rock fraction. Beds of alternating fine- to medium-grained sand (medium-grained 2.5YR5/4, fine-grained 2.5YR4/6). Undulating beds all approximately 2.5YR4/6. One rodent burrow. Abrupt 1-cm boundary.

III. 2.5YR4/6, consolidated, unstructured fine- to medium-grained sand, with no rock fraction. No bedding visible. Insect and rodent tunnels. Level grades to weakly structured at bottom. Boundary varies 1-2 cm.

IV. 10YR4/6, structured to well-structured massive sand with some clay and silt, with no rock fraction. No bedding visible. Insect casts. Has decaying SS areas of 5YR5/2.

Excavation Unit D; 201N/325E: 1.5 m uphill from crack. Oriented E-W.
- Within concentration of artifacts.
- Maximum depth = 73 cm, on bedrock.
- Total of 25 flakes, maximum of 6 in 30-40 cmbs, 0 in 60-BR. Some charcoal.

Profile notes:

I. 2.5YR4/6, nonstructured, slightly silty sand (slightly sticky, nonplastic, gritty), with < 1% SS gravel-sized clasts. No bedding visible. No disturbances observed.

II. 2.5YR4/6, nonstructured, slightly silty sand (slightly sticky, nonplastic, gritty), with no rock fraction. No bedding visible. Small roots with some larger decayed roots (0.5 to 1 cm dia.). Soil grades from moist to dry, and nonstructured to very slightly structured.

III. 2.5YR4/6, nonstructured, slightly silty sand (slightly sticky, nonplastic, gritty), no rock fraction. No bedding visible. Small roots throughout. Mottled with 2.5YR3/6, slightly structured extremely hard compacted area.

Excavation Unit E; 235N/319E: In deflated dune on top of terrace deposits on north side of road. Oriented N-S.
- Within concentration of artifacts.
- Maximum depth = 120 cm, on bedrock.
- Total of 48 flakes, 1-4 per level, but 16 in 60-70 cmbs, 10 in 80-90, 2 in 90-BR. Charcoal.

Profile notes:

I. 2.5YR4/6, very loose, nonstructured, medium-grained sand with some silt (nonsticky, nonplastic), with < 1% gravel-sized SS clasts. No bedding visible. No disturbances noted.

II. 2.5YR4/6, loose, nonstructured, medium-grained sand (nonplastic), no rock fraction. No bedding visible. No disturbances. Grades to slightly sticky, very slightly plastic sand with silt, and more moist.

III. 2.5YR4/6, nonstructured, medium sand with silt (nonsticky, nonplastic), no rock fraction noted. No bedding visible. No disturbances. Mottled with 2.5YR3/6 clayey sand with structure (slightly sticky, very slightly plastic), moist.

IV. 5YR4/6, structured caliche layer, slightly less sandy (nonplastic), with no rock fraction. No bedding visible. Charcoal staining evident. Soil very hard. Ant and root activity. Level grades to slightly more structured, pockets of plastic and slightly sticky, clayey silt.

V. 2.5YR3/6, slightly structured, sandy silt, very little to no clayey material (nonplastic, nonsticky), with no rock fraction. No bedding visible. Probable charcoal staining. Rodent and root disturbance.

Excavation Unit F; 235N/325E: In deflated dune on top of terrace deposits on north side of road. Oriented N-S.

- Within concentration of artifacts.
- Maximum depth = 109 cm, on bedrock.
- One flake in 10-20 cmbs.

Profile notes:

I. 2.5YR4/6, loose to very slightly structured, medium-grained sand, with no rock fraction. No bedding visible. Root activity (up to 0.5 cm in dia.).

II. 2.5YR4/6, very slightly structured medium grained sand, << 1% gravel-sized SS clasts. No bedding visible. Root activity up to 0.3 cm diameter.

III. 2.5YR4/6, slightly structured sand with some silt and clay, with << 1% gravel-sized SS clasts. No bedding visible. Root disturbance, up to 0.3 cm diameter. Soil mottled with 2.5YR3/6.

IV. 2.5YR4/6, slightly structured, medium-grained sand, with << 1% gravel-sized SS clasts. No bedding visible. Insect casts and rodent burrow disturbances. Grades to 2.5YR3/6, structured, medium-grained sand with fewer gravel-sized SS clasts, but several pebble-sized SS clasts.

V. 2.5YR3/6, structured, medium-grained sand with some clay (slightly sticky), with several gravel- to pebble-sized SS clasts. No bedding visible. Disturbance includes rodent burrow and insect casts.

Excavation Unit G; 185N/322E: On terrace deposits southwest of crack. Oriented E-W.
- Within concentration of artifacts.
- Maximum depth = 120, in soil; uneven bedrock surface.
- Total of 235 flakes, 2 tool fragments, 1 biface, 1 core fragment, 6 bone fragments; highest flake count in 0-10 cmbs, 37 items; and in 30-40 cmbs, 36 flakes + 3 tool fragments.
- One radiocarbon sample of 0.1 g, wood charcoal, collected from 15 vertical cm. Dated to 2490 ± 210 B.P.

Profile Notes:

I. 2.5YR4/6, loose to compacted medium sand (nonsticky, nonplastic, gritty), with occasional slightly structured peds. Rock fraction << 1% gravel-sized SS clasts. No bedding visible. Roots, surface trampling. Lower boundary is 0.2 to 0 cm wide, abrupt, clear.

II. 2.5YR3/6, slightly structured medium sand (very slightly sticky, nonplastic, gritty). Rock fraction << 1% gravel and pebble-sized SS clasts. No bedding visible. Fewer roots. Grades to 2.5YR4/6 at bottom. Lower boundary indistinct, 1 - 5 cm.

III. 2.5YR4/6, slightly structured medium sand (nonsticky, nonplastic, gritty). Rock fraction << 1% gravel to pebble-sized SS clasts. No bedding visible. Rodent activity. Lower boundary indistinct, but 1 cm across.

IV. 2.5YR4/6, slightly structured medium sand (very slightly structured, nonplastic, gritty). Rock fraction << 1% gravel- to pebble-sized SS clasts. No bedding visible. Charcoal layer 0.01 to 1 cm. across. Rodent activity. Lower boundary indistinct and consists of loss of darker, harder mottling. Layer mottled with lenses of 10YR3/4, structured to very structured medium to clayey sand (very slightly sticky to sticky, nonplastic to very plastic, gritty to smooth). Lenses are highly irregular and 0.2 to 1 cm thick. Mottling constitutes ca. 50% of volume.

V. 2.5YR4/6, slightly structured medium sand (very slightly structured, nonplastic, gritty). Rock fraction << 1% gravel- to pebble-sized SS clasts. No bedding visible. Rodent activity. Mottling decreases in volume to ca. 5-10%.

VI. 2.5YR3/4, clayey sand to clayey silt, (plastic to very plastic, sticky, smooth to slightly gritty). No rock fraction. No bedding visible. Boundaries indistinct, abrupt, ca. 1 cm. Lenses small and discontinuous, 0.1 to 1 cm. thick. Mottles to 2.5YR4/6.

VII. 2.5YR3/4, very structured, fine-grit sand (plastic, slightly sticky). Rock fraction << 1% gravel-sized SS clasts. No bedding visible. No disturbances. Lower boundary not known.

Shovel Probes

SP-1; 191N/326E: 1.5 m west of crack.
- In artifact concentration.
- Hit bedrock at 70 cmbs.
- 1 flake in 0-30 cmbs; 2 flakes in 30-70.

Soil: Changes from loose sand at top to structured at 10 cmbs. From 10 to 30 cm soil is slightly browner and fairly hard. Below 30 cm soil color changes back to original brown.

SP-2; 187N/323E: 4 m west of south end of crack.
- In concentration.
- Hit bedrock at 90 cmbs.
- 6 flakes in 0-30 cmbs; 7 in 30-60; 13 flakes, 1 biface in 60-bedrock.

Soil: Upper 7 cm is loose red-tan sand, below this level the soil is compacted. At 50-55 cm becomes structured, slightly browner. At 75-80 soil less compact (softens). Charcoal flecks present from 30 cm to bedrock.

SP-3; 194N/320E: 7 m west of crack.
- Above concentration, at edge of dune.
- Dug to 100 cmbs, no bedrock.
- 3 flakes in 0-30 cmbs; 1 in 30-60; 0 in 60-90; 1 in 90-100.

Soil: Loose red sand to 7 cm then becomes compacted. Below 30 cm soil becomes structured to 40 cm then loose. Soil hardens again at 75 cm and mottled. Grades to clayey silt.

SP-4; 233N/310E: In deflated dune over terrace on north side of road.
- At west end of concentration.
- Hit bedrock at 80 cmbs.
- No artifacts.

Soil: Soil becomes structured to well-structured clayey silt at 20 cm. Grades to a slightly structured fine sand at 40 cm. At 60 cm soil grades to very loose sand with lens of less structured clayey silt.

SP-5; 235N/315E: At boundary between deflated area and artifact concentration.
- North edge of concentration.

- Hit bedrock at 80 cmbs.
- 1 flake in 30-60 cmbs.

Soil: Loose sand to 13 cm, becomes compact to 25 cm, then picked up thin discontinuous pockets of red/brown clayey silt, structured to weakly structured, alternating with red/tan fine sand to 30 cm. Grades to weakly structured red/tan sand from 50 cm to 70 cm. Discontinuous lens of structured clayey silt from 70 to 75 cm.

SP-6; 232N/331E: At east end of deflated area, by creek bank.
- No surface artifacts, in definite impact area.
- Dug to 90 cmbs, homogeneous sand.
- No artifacts.

Soil: Loose sand to 15 cm, grading to compact, very slightly structured, changes to slightly structured ca. 60 cm.

SP-7; 232N/331E: At east end of deflated area, by creek bank.
- No surface artifacts, in definite impact area.
- Hit bedrock at 73 cmbs.
- No artifacts.

Soil: Loose sand to 20 cm, grading to slightly structured medium sand, slightly moist.

SP-8; 241N/319E: Near crest of dune on north side of road.
- No surface artifacts.
- Dug to 100 cmbs.
- 3 flakes in 60-100.

Soil: Loose sand to 15 cm, grading to compacted medium sand. Becoming weakly structured at 55 cm, grading to more structured ca. 70-75 cm. At 80 cm soil becomes structured. A few SS clasts appear at 70 cm.

SP-9; 240N/329E: Near crest of dune on north side of road.
- No surface artifacts.
- Dug to 90 cmbs, homogeneous sand.
- No artifacts.

Soil: Loose medium-grained sand to 10 cm, grading to compact below 20 cm. Weakly structured ca. 55-60 cm.

SP-10; 200N/321E: Near edge of dune.
- At uphill side of artifact concentration.
- Hit bedrock at 90 cmbs.
- 2 flakes in 0-30 cmbs; 5 flakes in 30-60; 1 flake in 60-90.

Soil: Loose sand to ca. 12 cm, then grades to compact with structure to 30 cm. Becomes weakly structured to ca. 60 cm. Grades to slightly structured to bedrock. A few pebble-sized SS clasts between 60-90 cm.

SP-11; 200N/318E: On dune.
- Uphill from concentration.
- Dug to 100 cmbs.
- No artifacts.

Soil: Loose to slightly structured sand with alkali flecks to 60 cm, grading to 2.5YR3/4, very structured, very plastic, sticky. At 80 cm soil changes to a structured medium/fine-grained sand.

APPENDIX B

LEVEL ASSIGNMENTS FOR FIELD SPECIMEN NUMBERS

Excavation Unit A

Grid 201N/330E

FS	Level
1.1	I - II
1.2	II
1.3	II
1.4	II

Grid 201N/331E

FS	Level
2.1	I - II
2.2	II
2.3	II
2.4	II

Excavation Unit B

Grid 199N/327E

FS	Level
3.1	I - II
3.2	II
3.3	II
3.4	II
3.5	II
3.6	II

Grid 198N/327E

FS	Level
4.1	I - II
4.2	II
4.3	II
4.4	II
4.5	II
4.6	II

Excavation Unit C

Grid 203N/331E

FS	Level
5.1	I - II
5.2	II
5.3	II
5.4	II
5.5	II
5.6	VII
5.7	VII

Grid 204N/331E

FS	Level
6.1	I - II
6.2	II
6.3	II
6.4	II
6.5	VII
6.6	VII
6.7	VII

Excavation Unit D

Grid 201N/325E

FS	Level
7.1	I - II
7.2	II
7.3	II
7.4	II
7.5	II
7.6	II
7.7	II

Grid 201N/326E

FS	Level
8.1	I - II
8.2	II
8.3	II
8.4	II
8.5	II
8.6	II
8.7	II

Excavation Unit E

Grid 235N/319E

FS	Level
11.1	I - II
11.2	II
11.3	II
11.4	IV - V
11.5	V
11.6	V - VII
11.7	VII
11.8	VII
11.9	VII

Grid 236N/319E

FS	Level
12.1	I - II
12.1	II
12.3	II - IV
12.4	II - IV
12.5	IV - V
12.6	IV - V
12.7	V - VII
12.8	V - VII
12.9	VII
12.10	VII
12.11	VII

Excavation Unit F

Grid 235N/325E

FS	Level
13.1	I - II
13.2	II
13.3	II
13.4	II

Grid 236N/325E

FS	Level
20.1	I - II
20.1	II
20.3	II
20.4	II
20.5	II
20.6	II
20.7	IV
20.8	V
20.9	V
20.10	V
20.11	VII

Excavation Unit G

Grid 185N/323E

FS	Level
21.1	I
21.2	II
21.3	II, III
21.4	II, III
21.5	III, IV
21.6	III, IV
21.7	III, IV
21.8	IV
21.9	IV
21.10	V
21.11	V
21.12	V, VII

Grid 185N/322E

FS	Level
22.1	I
22.2	I, II
22.3	II, IV
22.4	II, IV
22.5	IV
22.6	IV
22.7	IV
22.8	IV, V
22.9	IV, V
22.10	V
22.11	V, VI
22.12	V, VII

Shovel Probe 1, 191N/326E

FS	Level	FS	Level
14.1	IV	14.4	V
14.2	IV	14.5	V
14.3	IV	14.6	V
		14.7	V

Shovel Probe 2, 187N/323E

FS	Level	FS	Level
15.1	II	15.5	IV
15.2	II	15.6	IV
15.3	II	15.7	IV
15.4	IV	15.8	V

Shovel Probe 3, 194N/320E

FS	Level	FS	Level
16.1	II	16.4	V
16.2	II	16.5	V
16.3	II	16.6	V
		16.7	VII

Shovel Probe 5, 235N/315E

FS	Level	FS	Level
17.1	II	17.4	IV
17.2	II	17.5	V
17.3	II	17.6	V
		17.7	V

Shovel Probe 8, 241N/319E: 18.1 to 18.9 = Level I (undifferentiated recent fill)

Shovel Probe 10, 200N/321E: 19.1 to 19.9 = Level I (undifferentiated recent fill)

Note: No Field Specimen numbers were assigned to Shovel Probes 4, 6, 7, 9, and 11 because no artifacts were found in these units.

APPENDIX C

NOTES ON IDENTIFIED MOLLUSC SPECIES

Valloniidae

Vallonia cyclophorella (Sterki). Fourteen specimens, 2 whole, remainder broken or immature (7.9.9, 9.9.9, 11.9.9, 12.1.9, 20.1.9, 21.4.9, 22.5.9 - one specimen; 11.4.9 - two specimens). Beneath bark, logs, stones; most widely distributed *Vallonia* in the mountain states, 6,800-11,000 ft., in Arizona, New Mexico, Nevada (Taylor 1960:94).

Zonitidae

Hawaiia minuscula (Binney). Three specimens(21.11.9 - two specimens; 12.9.9 - one specimen). Drought resistant, under logs, sticks, stones, and in clumps of grass, both upland and floodplain; widely distributed in North America, also Hawaii, Japan.

Succinidae

Fragments found in three samples, not identifiable except to family.

Pupillidae

Gastrocopta cf. *G. cristata* (Pilsbry and Vanatta). One specimen, incomplete, aperture only (22.12.9). Drought resistant, sheltered areas, but woodland not needed; valleys, dry washes, where vegetation provides some cover; widely distributed in Southern Great Plains (Leonard, 1959:180; Taylor and Hibbard 1955; Getz and Hibbard 1965; Pierce 1987).

Gastrocopta cf. *G. pellucida hordeacella* (Pilsbry). Four specimens, one with aperture only (11.7.9, 11.8.9, 11.9.9). Drought resistant; colonies small, in open areas near shrubs in Kansas. Leonard 1959:180-181; Pierce 1987).

Gastrocopta cf. *G. pellucida parvidens* (Sterki). Four specimens, broken, apertures only (11.5.9, 11.6.9, 12.8.9) [I'm not certain that hordeacella and parvidens are really distinct taxa--]

Gastrocopta cf. *G. pilsbryana* (Sterki). Four specimens observed, (21.1.9, 21.3.9, 21.10.9, 22.12.9). Common in the mountains in the south parts of Arizona, New Mexico.

Gastrocopta cf. *G. riograndensis* (Pilsbry and Vanatta). One broken specimen, aperture only (21.3.9)

Pupoides albilabris (Adams). One specimen (11.7.9). Can tolerate a wide range of conditions, including high summer temperatures; lives at bases of woody plants and even short grass. Widespread in eastern North America, westward to the Dakotas, to Arizona, and Mexico (Hibbard and Taylor 1960:129; Branson et al. 1962).

Pupoides hordaceous (Gabb) Four specimens, 3 the apertural whorl only (11.1.9, 20.1.9, 21.2.9, 22.8.9). Arid foothills, plateaus; NE limit is southern Nevada, SW Colorado. (Pilsbry 1948).

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APPENDIX D

VERTEBRATES

FS 12.4.9
Taxon: Unknown, microvert
Element: Unknown, long bone
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.7.9
Taxon: Unknown, microvert
Element: Unknown, long bone
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident
Human alteration: Burned
Weathering stage and sides: 1, all

FS: 21.7.9
Taxon: Unknown, microvert
Element: Unknown, long bone
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident
Human alteration: Burned
Weathering stage and sides: 1, all

FS: 21.7.9
Taxon: Squamata
Element: Vertebral fragment
Side: R
Portion: Half of centrum, lateral process, and neural arch

Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.7.9
Taxon: Unknown, microvert
Element: Unknown, flat bone
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.9.9
Taxon: Unknown, small mammal
Element: Tooth fragment, unknown
Side: Unknown
Portion: Unknown, enamel w/dentin
Development stage: Unknown
Break types: Unknown
Carnivore or rodent alteration: None evident
Human alteration: Burned
Weathering stage and sides: 1, all

FS: 21.9.9
Taxon: Unknown, microvert
Element: Unknown, irregular bone
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.9.9
Taxon: Unknown, microvert
Element: Unknown, irregular
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 2, all

FS: 21.10.9
Taxon: Unknown, microvert
Element: Unknown, irregular
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.11.9
Taxon: Unknown, microvert
Element: Unknown, long
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: Rodent gnawed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.11.9
Taxon: Unknown, microvert
Element: Unknown, irregular
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident

Human alteration: None evident
Weathering stage and sides: 1, all

FS: 21.12.9
Taxon: Unknown, microvert
Element: Unknown, irregular
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 22.8.9
Taxon: Rodent
Element: Cheek tooth, five fragments
Side: Unknown
Portion: Enamel and dentin
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: None evident
Weathering stage and sides: 3, all

FS: 22.8.9
Taxon: Microvert
Element: Unknown, long
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 22.8.9
Taxon: Small mammal
Element: Unknown, long
Side: Unknown

Portion: Shaft
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: Charred
Weathering stage and sides: 2, all

FS: 22.8.9
Taxon: Small mammal
Element: Unknown, flat
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: Charred
Weathering stage and sides: 2, all

FS: 22.9.9
Taxon: Small mammal
Element: Unknown, flat
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 2, all

FS: 22.9.9
Taxon: Small mammal
Element: Unknown, long
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: None evident
Weathering stage and sides: 4, all

FS 22.9.9
Taxon: Small mammal

Element: Unknown, alveolus
Side: Unknown
Portion: Unknown
Development state: Unknown, erupted
Break types: Unknown
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 3, all

FS: 22.9.9
Taxon: Small mammal
Element: Possibly rib
Side: Unknown
Portion: Proximal, w/margins missing
Development stage: Unknown
Break types: Unknown
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, 4 opposite

FS: 22.9.9
Taxon: Small mammal
Element: Rib
Side: Unknown
Portion: Proximal
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 2, all

FS: 22.10.9
Taxon: Small mammal
Element: Unknown, long
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Unknown
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 3, all

FS 22.11.9
Taxon: Microvert
Element: Irregular, unknown
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Unknown
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 4, all

FS: 22.11.9
Taxon: Microvert
Element: Unknown, irregular bone
Side: Unknown
Portion: Unknown
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident
Human alteration: Burned
Weathering stage and sides: 1, all

FS: 22.11.9
Taxon: Microvert
Element: Unknown, long bone
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 1, all

FS: 22.12.9
Taxon: Small mammal
Element: Unknown, long bone
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident
Human alteration: Charred
Weathering stage and sides: 1, all

FS: 22.12.9
Taxon: Small mammal
Element: Unknown, long bone
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: Charred
Weathering stage and sides: 1, all

FS: 2.2.2
Taxon: Sylvilagus
Element: Mandible
Side: L
Portion: missing angle and ascending ramus
Development stage: Juvenile, permanent P/3 and deciduous M/123
Break types: Unknown
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 2, all

FS: 2.6.1
Taxon: Rodent (possibly *Neotoma*)
Element: Incisor I1/
Side: L
Portion: Whole
Development stage: Unknown
Breat types: None
Carnivore or rodent alteration: None evident
Human alteration: None evident
Weathering stage and sides: 2, all

FS: 21.9.1
Taxon: Mammal
Element: Unknown, long bone
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Green
Carnivore or rodent alteration: None evident
Human alteration: Slightly charred
Weathering stage and sides: 2, all

FS: 22.7.1
Taxon: amphibian, approx size of R.M. toad
Element: Femur
Side: Unknown
Portion: Shaft
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: None evident
Human alteration: None evident
Weathering stage and sides: 2, all

FS: 22.8.1
Taxon: Small mammal, probably rodent
Element: Squamosal
Side: R
Portion: Margins partly missing
Development stage: Unknown
Break types: Dry
Carnivore or rodent alteration: Unknown
Human alteration: None evident
Weathering stage and sides: 2, 1 opposite

FS: 22.8.1
Taxon: Rodent (medium-sized)
Element: Maxilla
Side: Both
Portion: Rostrum
Development stage: Unknown
Break types: Unknown
Carnivore or rodent alteration: Unknown, possibly crushed
Human alteration: None evident
Weathering stage and sides: 2, all

REPORT CERTIFICATION

I certify that "Archeological Investigations at Site 42SA20286, Canyonlands National Park, Utah" by Steve Dominguez

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

available.

William W. Schenk
Regional Director

8/15/94
Date

Classification Key Words:

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