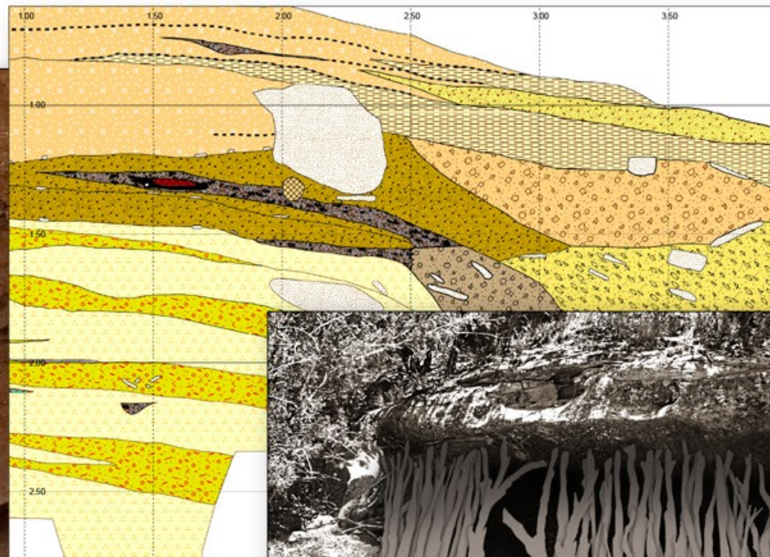
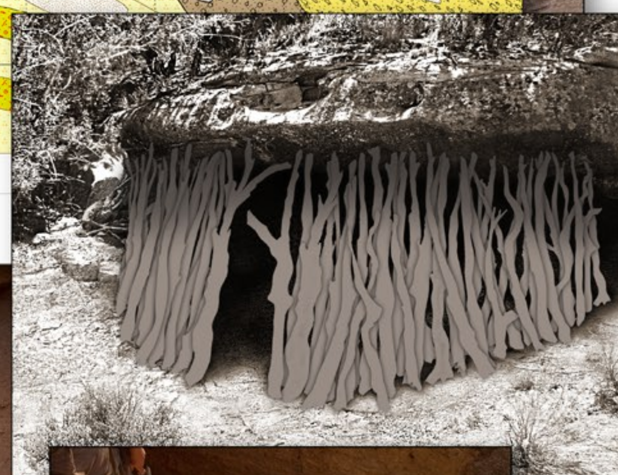
Archaeological Investigations at the McClane Rockshelter 5GF741 Garfield County, Colorado





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Rhino Energy and
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Private Contributors

BLM ARPA Cultural Resource Use Permit #C-67009

DARG

July 2013

Dominguez Anthropological Research Group

ARCHAEOLOGICAL INVESTIGATIONS
AT THE
MCCLANE ROCKSHELTER
5GF741
GARFIELD COUNTY, COLORADO

BLMCRIR 15811-02
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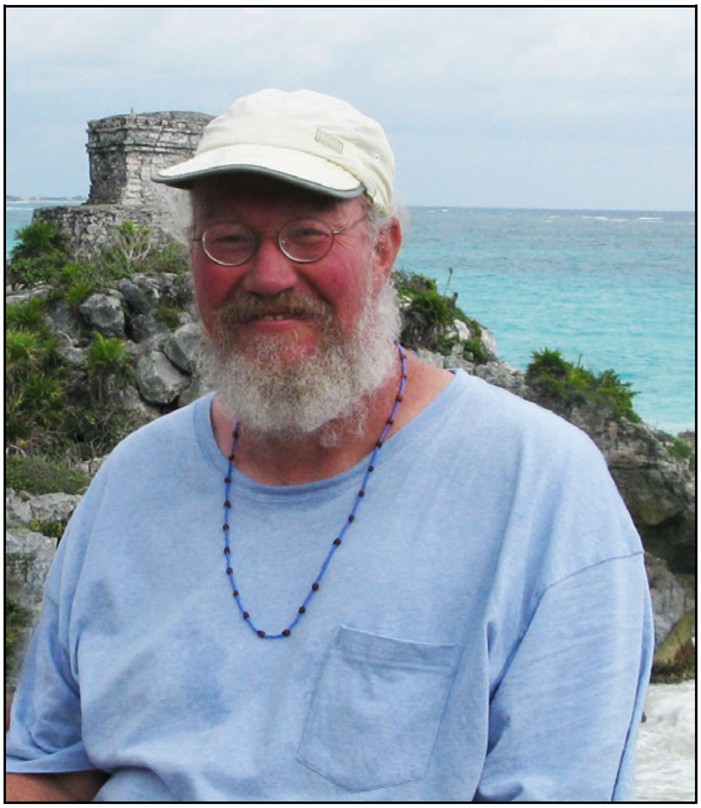

This report is dedicated in memory of James C. Miller.

1955 – 2012

Abstract

Dominguez Anthropological Research Group, by means of a research grant from History Colorado State Historical Fund and contributions from Rhino Energy and Grand River Institute, conducted an archaeological investigation of the McClane Rockshelter, an overhang located in East Salt Creek Canyon of Garfield County, Colorado, about 17 miles north of Loma. The project entailed the excavation of 10.5 square meters within and on the perimeter of the overhang. Cultural deposits ranging in age from about 4200 to 300 years ago were encountered, primarily in four cultural levels. McKean Complex is represented in the two lowest stratigraphic units, which contained three occupation levels dating between ca. 4200-3000 BP. Those levels exhibited characteristics of house pit structures found in open sites by the arrangement of thermal and storage features within the rockshelter. Winter occupation is suspected for these three earliest habitations, which were likely facilitated by the construction of a pole or brush wall around the perimeter of the overhang ledge. Later use of the shelter was apparently limited to short-term camping, probably during seasonal migrations typical of the Archaic Lifeway. Paleoenvironmental evidence provided by analyses of the stratified deposits and the presence of *Oreohelix* gastropods corresponded to regional Holocene Paleoclimatic Variations described by James C. Miller.

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CHAPTER 1

Project Background, Design and Scope of Work

The cultural components of site 5GF741 are contained in deposits in a rock shelter or overhang located on the east side of the deeply dissected Salt Creek valley north of Loma, Colorado, and near the McClane Coal Mine entrance (Figure 1.1; Plates 1.1 and 1.2). The site was originally discovered in 1980 during a pedestrian survey of the mine site and initially tested in 2009 by Grand River Institute (GRI), Grand Junction, Colorado. Testing was conducted to determine the presence of subsurface cultural material and cultural components dating to approximately 1300 and 2750 radiocarbon years before present (RCYBP). GRI later excavated a backhoe trench in front of the shelter in 2010, with assistance from the McClane Mine, and exposed three to four meters of deposits, indicating the deposits in the shelter proper were likely much deeper than previously thought. The sum of the evidence obtained by the end of 2010 culminated in the current project's excavations which started on 1 June 2011. In addition to the evaluation of cultural deposits contained in the shelter deposits, a secondary goal was to recover environmental data to illuminate the past climates in western Colorado.

Site 5GF741 is potentially threatened over the next few years by development of a coal mine in its immediate vicinity through possible runoff, placement of gob piles, and disturbance of its local terrain. Although the site was being avoided by construction activity, Rhino Energy, owner of the the McClane Canyon Mine offered to advance matching funds for a grant to excavate the site and preserve it through data retrieval. Accordingly, after project approval by the Grand Junction Office of the Bureau of Land Mangement, application was made by Dominguez Anthropological Research Group (DARG) to the Colorado Historical Society State Historical Fund (SHF) for a Competitive Grant, which was approved in 2010. Subsequently, Contract #2010-02-029 between DARG and SHF was fully authorized and signed for the State of Colorado on 21 July 2010 by Edward C. Nichols, President.

DARG is a 501(c)(3) non-profit corporation established in 2003 to serve as a catalyst for innovative and collaborative archaeological and anthropological research, preservation, and education in the northern Colorado Plateau. Functioning as a consortium of research associates and technical advisors, DARG's operational focus is to coordinate research, raise and administer funding, and manage projects that advance our shared values and mission. DARG receives funding from the State Historical Fund (SHF), various offices of the Colorado Bureau of Land Management (BLM), and through private contributors. Several of DARG's larger projects include the Colorado Wickiup Project, the Radiocarbon Database Project, the Ute Ethnohistory Project, the Colorado Rock Art Database Project, and the Northwest Colorado Paleoindian Project. DARG operates under BLM ARPA Cultural Resource Use Permit #C-67009. Lead participants and key staff for this project were: Co-Principal Investigators: Michael Berry and Carl Conner; Project Geoarchaeologist: James Miller; Project Coordinator: Richard Ott; Principal Staff: Courtney Groff, Carl McIntyre, and Michael Brown.

[redacted]

Figure 1.1. Landscape setting of 5GF741; plan oblique view southwest (Google Earth 2013).

Plate 1.1. Site overview of excavation setting and mine office.

Plate 1.2. Site overview of excavation setting.

Location of Project

[redacted]

Research Background

Site 5GF741 is a sheltered camp with two overhangs. It was first discovered in 1980, and was officially evaluated as needs data in 1982. Site testing was required to make a final determination of eligibility. Subsequent relocation and testing for evaluation of 5GF741 occurred in April of 2009, in association with a Class III cultural resource inventory for the purpose of surveying lands to be directly affected by mining construction. The project resulted in the testing of two northwest-facing rock shelters within 5GF741: Shelters #1 and #2. Shelter #1 located on a ledge above and southeast of #2 originally contained juniper bark matting, and #2, located on the valley floor below and northwest of Shelter #1, was believed to contain substantial soil deposits. Sandstone beds exposed in the lower parts of both overhangs are acting as aquifers, and the formation of the overhangs is in large part a result of seepage along bedding planes, which weakens the chemical cement of the rock, and subsequent deflation. In both the lower and upper overhangs, secondary anhydrite has precipitated via dehydration of soluble (or "complexed") gypsum at the seep outlets.

A 50cm wide trench was excavated into each of the shelters (Figure 1.3). These were centrally placed and laid out perpendicular to the shelters' back walls. Excavations within the rock shelters were conducted using trowels, brushes, and brooms. Soils removed from there were sifted through 1/8" mesh shaker screens in search of cultural materials. In the upper shelter (#1) a 3.4m long trench was excavated to bedrock, which occurred between 0-18cm and amounted to the removal of about 0.2 cubic meters. No cultural deposits were recovered from Shelter #1.

In the lower shelter (#2) a 5.0m long trench was excavated to a maximum depth of 70cm, which amounted to the removal of about 1.75 cubic meters (Figure 1.4). Cultural deposits were encountered in Shelter #2 starting about 15cm below present ground surface (pgs). Deposits there were found to be more complex because of the alluvial fan related to the bedrock channel immediately north of the site. Two wedge-shaped deposits occupy the rear of the shelter and were formed by exfoliation when the seep or aquifer was most active. Strata VI and VII compose the most recent wedge, and an earlier, possibly middle Holocene wedge, is represented by strata II and IIa. The surface deposit, Stratum VIII, is a recent aeolian sheet. Radiocarbon data was secured from Strata III (thermal Feature 1) and IIa and sent to Beta Analytic, Inc. of Miami, Florida, for aging. Their conventional radiocarbon ages of 2730 ±40 BP (Beta-259175) and 1320±40 BP (Beta-259173), respectively, provide indications of the potential for the remaining undated contexts of the soil deposits.

[redacted]

Figure 1.2. Location map for 5GF741.

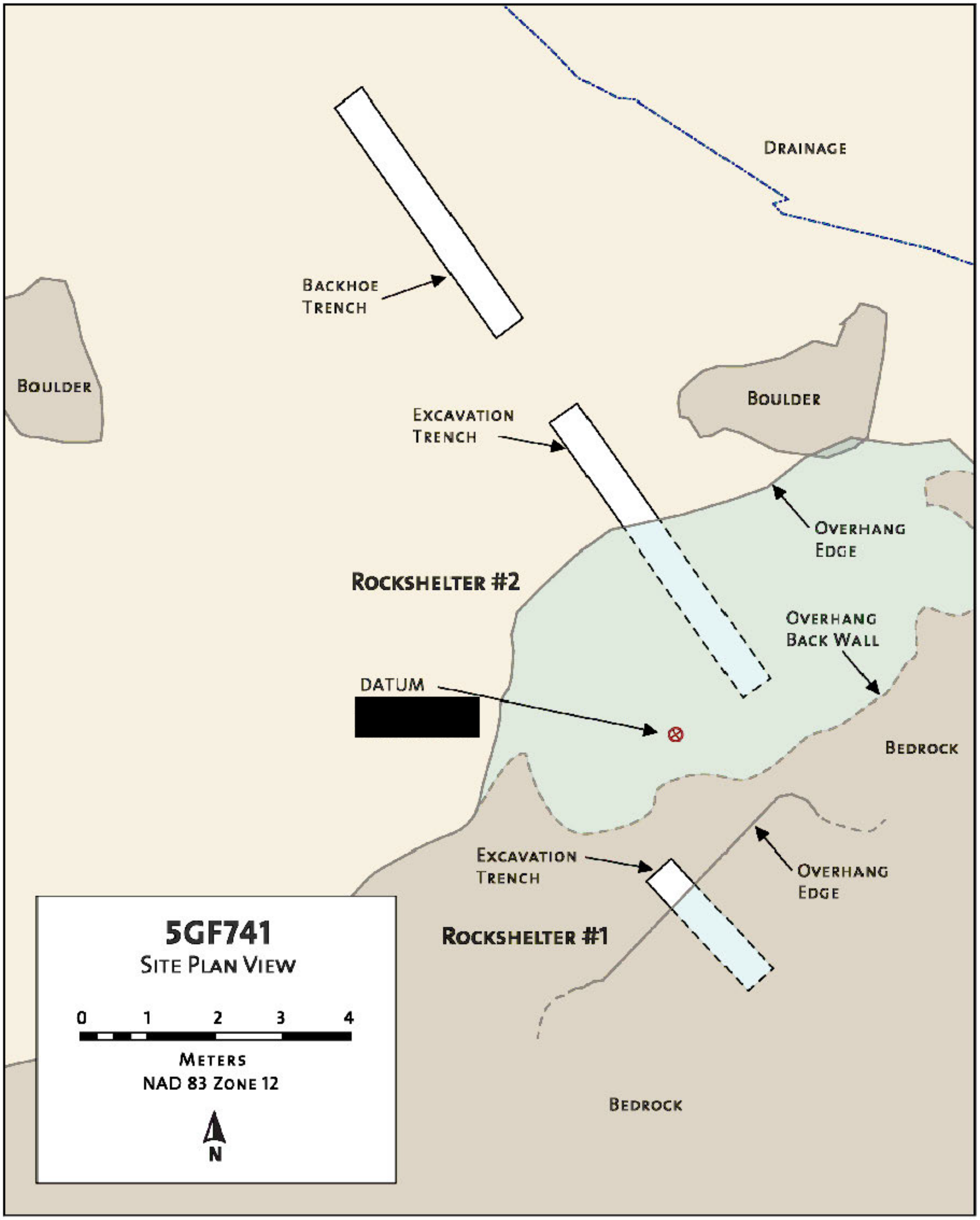


Figure 1.3. Distribution of excavations during the 2009 testing of Shelters #1 and #2, and the backhoe test of 2010.

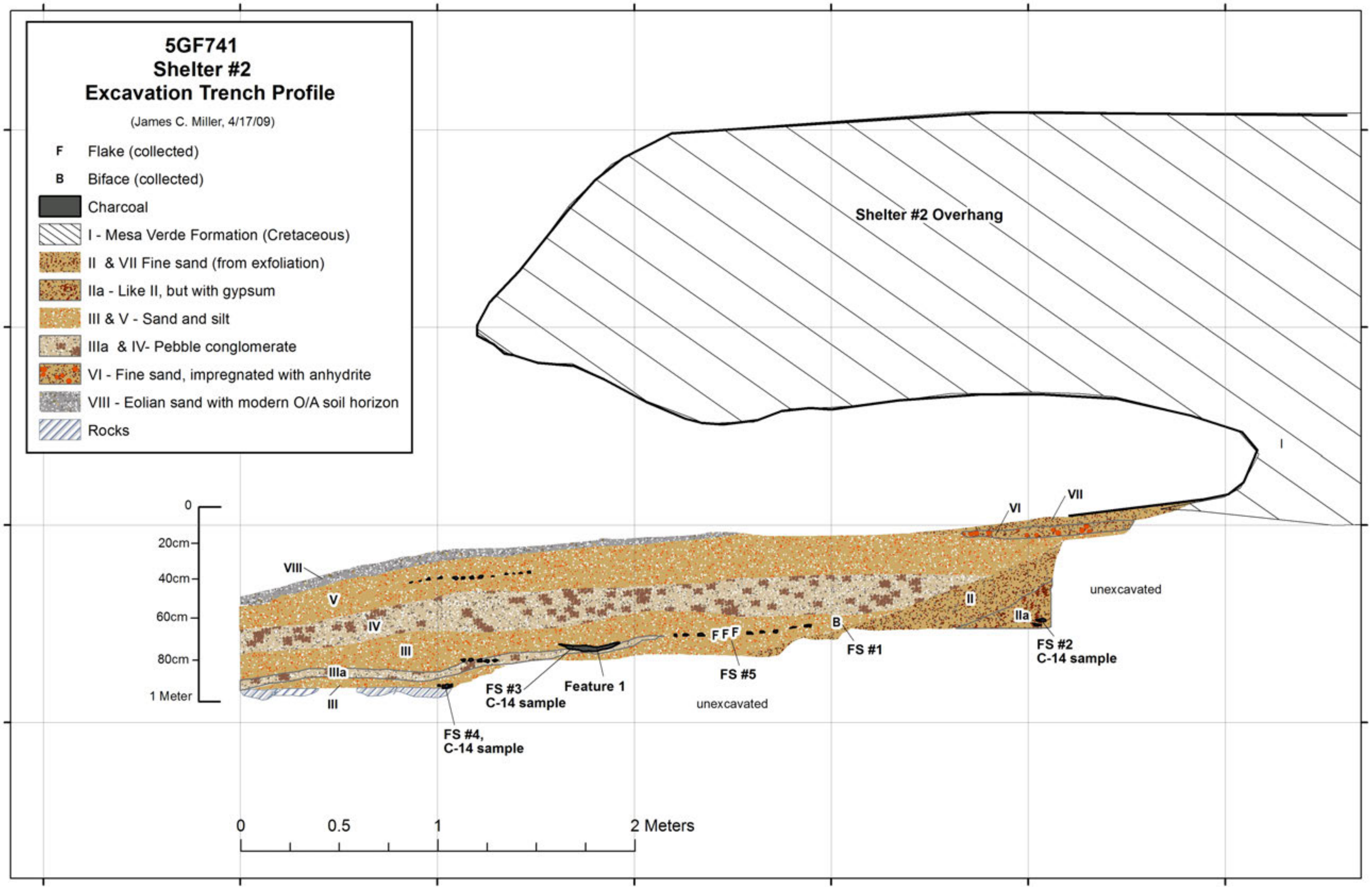


Figure 1.4. Shelter #2, 2009 profile showing the 5.0m long trench excavated to a maximum depth of 70cm.

After hand excavations were completed for both shelters, the BLM felt that in order to make a determination of the site's geomorphology and assess its potential depth of cultural deposits, a backhoe trench was needed. Accordingly, a 1.0m wide trench was dug two meters beyond the northwest end of the hand-excavated trench in Shelter #2 and extended northwest for approximately 4.5 meters. The trench exposed suspected cultural remains in stratified deposits to a depth of approximately 3.2 meters, and the deposits appeared to continue, but trenching was halted for safety concerns. Below the surface deposits, the stratigraphy in Shelter #2 and in the machine trench outside is comprised of a series of deposits alternating between conglomerates (e.g., IIIa and IV) and mixed alluvial and aeolian deposits (strata III and V). Conglomerates are identified by the largest clast size, such as boulder, cobble, pebble, granule, etc., and the intervening units as poorly sorted silt and sand. (No strata numbers are assigned to strata subjacent to Stratum IIIa in the machine trench.) The fine clastic units are mixed loess, alluvium and colluvium.

In summary, the State Historical Preservation Officer (SHPO) concurred with management recommendations for the protection and excavation of 5GF741 because a sequence of paleo-environmental and cultural data, dating to the Early Holocene or Late Pleistocene, can be obtained from Shelter #2.

Research Design

Site 5GF741 Shelter #2 is significant on several levels. First, it has stratified deposits that are ideal for paleo-environmental studies because of their changing sedimentological character and chemical conditions, and second, the fact that they are bracketed by at least eight layers with suspected cultural carbon deposits. Alternating coarse and fine strata provide the primary evidence of shifting climates and deposition. Deposit geochemistry overall favors the preservation of pollen and opal phytoliths. Pollen is destroyed by oxidation and phytolyths by alkaline pH. Higher oxidation products of iron-hematite and magnetite-are not present, and secondary calcite is limited; again factors which suggest a favorable preservation environment exists for pollen and phytoliths. This setting is a rare occurrence and controlled excavation was expected to yield significant data in the reconstruction of paleo-environments. More specifically, this project was to provide a well-dated baseline sequence of environmental change during the Formative, Archaic and possibly Paleoindian Eras for future archaeological research in the region. This and similar such excavations will construct a reliable scientific foundation for the assessment of archeological resources and for preservation planning by land management agencies.

The field work was designed to fully document the paleo-environmental and cultural stratigraphy of the site through intensive excavation. This was to include the removal by hand excavation of approximately 100 cubic meters of deposits at the mouth of and within the interior of Shelter #2.

Laboratory analysis and report preparation included an interpretation of the recorded documentation and field data, preparation of OAHP Reevaluation form, and the preparation of interim and final reports. Work performed under this grant was designed to adhere to OAHP standards and that documentation adheres to the following guidelines:

> A research design for prehistoric cultural resources' mitigation projects can be divided into three basic parts. The first consists of archaeological and environmental data recovery and description. Excavated artifactual and architectural data form the base from which temporal information is acquired (from 14C samples, artifact seriation, possibly dendrochronology and cross-dating) and technological perimeters are defined. Paleo-environmental data are derived from the excavation and recovery of pollen, macrofloral and faunal remains, which are compared with the present-day environmental and species data.
>
> The second part of any investigation requires the synthesis and interpretation of the recovered archaeological materials. Here, the cultural affiliation of a site's occupants is determined and contextual concerns (such as the identification of spatial and temporal variability and functions of artifactual and architectural classes) are examined.
>
> The final stage of analysis involves further synthesis and leads to the formation of a diachronic, cultural/ecological model. The adaptive strategies--as reflected by changes and continuity in subsistence, technology, settlement, land use, social organization, and external relations patterns--of the prehistoric occupants of the site are compared and contrasted to the regional data base.

All collected artifacts and auxiliary samples will be permanently curated at the Museum of Western Colorado in Grand Junction as part of DARG's permit.

EXCAVATION PROCEDURES/SCOPE OF WORK

The field and analytic methods were selected to meet the maximum data recovery requirements of the research design. It was anticipated that data recovery would fully preserve significant data from the site; but if further excavation was deemed necessary, a plan was to be developed and submitted to BLM and the State Historic Preservation Officer for approval.

Data recovery was based on the excavation of 1m x 1m test units set in a layout of a 4m x 6m surface block to encompass the previous test trench. Work at the site was begun with the preparation of a surface map. A datum was established and test units were oriented to the original testing grid and plotted on the base maps. Grid squares were referenced from their southwest corner.

Hand tools were used to excavate the 1m x 1m units. Excavation proceeded in 5cm levels in unstratified deposits, along stratigraphic levels if they were well defined, and by feature outline. Sterile levels were established by excavation to bedrock or an additional 30cm. All soil was processed through 1/8th-inch screen except for collected soil, pollen, flotation, and radiocarbon samples. Hearth contents that were not collected as samples were sifted through 1/16th-inch screen.

All artifacts were collected. Perishables, chipped-stone and ground-stone tools found in-situ were referenced to the control corner and bagged separately. These materials, and features, were point-plotted and referenced to the datum. Other artifacts and ancillary specimens were bagged in aggregate, and labeled by unit and level, or feature and level. Soils, flotation, pollen, carbon and obsidian samples were collected as warranted. Finally, features were photographed, and plan/profile views drawn.

In the laboratory, artifacts were sorted according to a classificatory scheme including perishables and chipped and groundstone categories. Potential perishables were to include basketry, cordage, certain macro-botanical samples, etc. Chipped stone categories included projectile points, other bifaces, unifaces, flake and blade tools, hammerstones, cores, and debitage (primary, secondary, interior, shatter). Groundstone categories included manos (grinding stones), metates (nether milling stones), and other groundstone. Macro-floral flotation samples and faunal samples were processed and analyzed in house, while pollen, carbon and obsidian were processed by outside laboratories.

Project findings are documented in this Cultural Resource Data Retrieval Report; and, the artifacts, written records and photographs will be curated at the Museum of Western Colorado. Data retrieved by the excavations will also be disseminated through public forums.

CHAPTER 2

Environmental Setting, Geomorphology, and Paloeclimate Data

The following provides a discussion of the modern environmental setting, an assessment of the environment from an archaeological perspective, geomorphology of the local area, and a paleoclimate summary based on the area's late Quaternary stratigraphy.

Geology and Physiography

The project area is situated on the south end of the Douglas Creek Arch, a major geological subdivision of northwest Colorado. It separates the Uinta Basin on the west from the Piceance Basin on the east. This structural arch, consisting primarily of highly dissected Cretaceous and Tertiary rocks, began as a north-south upwarp that formed during the Late Jurassic but never stood very high. The Arch is roughly bounded on the south by the Book Cliffs, which form the north side of the Grand Valley and continue well into Utah, and the Carbonera Sag, a minor feature of the Piceance Basin downwarp (Young and Young 1977).

The study area lies within the Book Cliffs/Roan Cliffs of the Canyonlands section of the Colorado Plateau. The Book Cliffs are a linear series of south-facing, steep escarpments which have been carved by the Colorado River and rise to heights of 1500 to 2000 feet above the northern edge of the Grand Valley floor. North of the Book Cliffs rise the Roan Cliffs, an equally rugged expanse of south-facing cliffs composed of the Tertiary-age Green River Formation (lower part) and the Wasatch Formation. The steep Book Cliffs reveal the buff and grey sandstones and grey shales of the Sego Sandstone and the buff sandstones, grey shales, and coal beds of the Mount Garfield formation (Cashion 1973). Upper Cretaceous sediments occur south of the study area, deposited by the once extant Mancos Sea. Shoreline sands and muds, shallow water marine muds, and various floodplain sediments were deposited as the sea transgressed and regressed (Young and Young 1977). The bottom of East Salt Creek canyon exhibits modern alluvium deposits. Springs and seeps are commonly found where impermeable rock layers are encountered or fractures lead water to the surface. The largest concentration of springs is found in the Cretaceous Hunter Canyon Formation of the Mesa Verde Group in the Book Cliffs. Many other springs and seeps are located in the Book Cliffs region: in the Mount Garfield Formation, the Green River Formation and the Wasatch Formation.

Numerous steep-walled intermittent drainages are characteristic of the Book Cliffs. Those near the site flow into East Salt Creek, a permanent drainage, and southward into the Colorado River. The subject site lies at the base of the slope of a mountainous ridge at the edge of the first terrace bench east of East Salt Creek, north of Munger Creek. Characteristic of the Book Cliffs, deep alluvial deposits fill the canyons of the main streams and their tributaries. Depth of fill in East Salt Creek is estimated to be as much as twenty meters, but generally only about half that depth is exposed at any one place. Since the arroyo exposures give but a limited view of the deposits in cross-section, very little is actually known about cultural exploitation of the flood plains and environs here. Recent loess cover and alluvial fan deposition on the valley flanks further complicate the issue.

FLORAL RESOURCES

The elevation of 5GF741 is 5470 feet, which falls within the Upper Sonoran zone. Vegetation is primarily thick sagebrush and greasewood in the bottomland that is bordered by juniper woodland along slopes and cliff edges and in the small drainage bottoms where soils are rocky and shallow. A riparian vegetation community dominated by broad-leaf cottonwood trees is present along East Salt Creek.

The Book Cliffs/Roan Plateau exhibit the following modern plant zones, as described by Young and Young (1968:36) for the slopes of Grand Mesa: 1) a spruce-alpine fir dominated Subalpine Zone (ca. 9500-11,500 feet – below treeline and receives 30 to 35 inches of precipitation a year); 2) an aspen dominated Montane Zone mixed with Douglas fir in the higher elevations and Gambel oak along the lower elevations, often mixed with low sage parks (ca. 8200-9500 feet and receives precipitation from about 25 to 30 inches); 3) an oak-brush dominated Transitional Zone with occasional stands of Ponderosa Pine (ca. 6500-8200 feet with an annual precipitation range of 18 to 26 inches); 4) an Upper Sonoran Zone that is dominated by pinyon pine and juniper (generally ca. 5500-6500 feet; annual precipitation range of 12 to 20 inches), and by sagebrush, shadscale, rabbitbrush, cacti and yuccas in its lower reaches (ca. 4350-5500 feet with an annual precipitation range of 8 to 14 inches); and 5) a Riparian Zone along drainage corridors comprised of cottonwood trees, willows, and occasionally aspens, spruce and other, typically higher elevation species. Mixing of vegetation communities occur between these zones.

The site occurs at the border of the pinyon-juniper community with the saltbrush-grasslands. Pinyon-juniper woodlands occur throughout the Southwest on foothills, low mountains, mesas, and plateaus between elevations of 4500 and 7500 ft. Pinyon pines dominate at higher elevations and junipers at lower. This woodland type has communities that vary widely not only by dominant tree species by also by the makeup of their understories, which may either be sparse or occur with well-developed stands of shrubs and herbaceous vegetation. The determining factor in the composition of the woodland is elevation, although limitations are also imposed by aspect, slope, longitude, latitude, landform, geologic substrate and fire history. Their elevation distributions are usually dictated by negative temperature regimes on their upper and lower edges. When they border a western valley that experiences inversions, they are usually confined to a thermal belt above that valley's inversions and below the colder upslope elevations (Evans 1988:2-3).

FAUNAL RESOURCES

In general, the canyons of the Book Cliffs provide range for mule deer, elk and antelope, and attract the predatory mountain lion as well. Of the large mammals inhabiting the area, mule deer are the most numerous and most frequently observed. Grazing the high slopes and meadows of the higher elevations in summer, these ungulates move to lower elevations when temperatures drop. Nearly all of the lower slopes (those below 7300 feet) of East Salt Creek provide suitable winter range. Although most of the mule deer population follows a migrational pattern, occasional small groups browse the area year round.

Other large mammals present include elk, bighorn sheep, pronghorn, black bear, and mountain lion. Most of the elk herds summer in the thick spruce-fir forests atop the higher elevations and winter on the lower slopes bordering the permanent water sources. It is more than probable that, prehistorically, both the elk and deer summer range extended below that of present populations, but overgrazing by domestic livestock has depleted the native grasses such that sufficient lower elevation summer range no longer exists. Desert bighorn sheep are rarely seen in the area, but generally occur in the sandstone canyons along the river corridors. The black bear population density in and around the study area is estimated to be a bear per two square miles (Burkhard and Lytle 1978:128). Its range extends from the Grand Valley's surrounding high peaks to the river bottoms. Historically, the grizzly bear has been recorded as well, but the black bear is the only bear species present in the area today (ibid.). Mountain lion territory is essentially coincident with that of the black bear, although its numbers in and around the study area are estimated to be considerably fewer. In summer, the lions are dispersed fairly evenly; in winter, they tend to concentrate around deer and elk wintering grounds (ibid: 135).

Sufficient habitat exists in the surrounding area for a wide range of small mammals, including insectivores, carnivores, herbivores and omnivores. Among the insectivores are the masked shrew, the wandering shrew, and the water shrew, all of which are generally found above 7000 feet. Both migratory and non-migratory bats occur in the area and roost in old buildings, hollow trees, rock crevices, and caves. Carnivorous small mammals include the coyote and bobcat (both of which are found throughout the study area), the raccoon (which is common near water sources), and a variety of furbearers: the ringtail, marten, ermine, longtail weasel, ferret, mink, badger, striped skunk, spotted skunk, and grey fox. Except for the marten, ermine, and mink, which tend to be high elevation dwellers, these furbearing mammals may be present in any of the vegetation communities, although they usually gravitate toward water sources. Rodents common at higher elevations include the golden mantled squirrel, red squirrel, pocket gopher, bushy tail woodrat, mountain and longtail vole, and the western jumping mouse. The prairie dog, Apache pocket mouse, and house mouse are more frequent at lower elevations where soils are sandier. Rodents found throughout the area are the marmot, rock squirrel, least chipmunk, Colorado chipmunk, harvest mouse, canyon mouse, deer mouse, pinyon mouse, and porcupine. The beaver and muskrat are inhabitants of riparian environments both along the rivers and higher elevation streams. Hares and rabbits (lagomorphs) constitute a large portion of the small mammal population of the study area. The desert cottontail and whitetail jackrabbit are seen at the lower elevations, while the snowshoe hare and mountain cottontail are more prevalent above 6,500 feet. The small rodents and lagomorphs of the area are important prey species for the diurnal predators of the area (Burkhard and Lytle 1978).

Avian species known in the area include migrant and resident waterfowl, raptors, upland game birds, and a variety of smaller nongame birds and songbirds. Along the Colorado River, harbored in its sloughs and marshes, are many waterfowl species, including the Canada goose and numerous duck-like birds: mallard, gadwall, pintail, green winged teal, blue winged teal, cinnamon teal, American wigeon, northern shoveler, ringnecked duck, redhead, canvasback, lesser scaup, common goldeneye, Barrow's goldeneye, bufflehead, ruddy duck, common merganser, and redbreasted merganser (Burkhard and Lytle 1978). The most common of the resident waterfowl are the mallard and the green winged teal, while the most common of the migrant species is the common goldeneye which regularly winters between Glenwood Springs and Grand Junction. Raptors reported in the vicinity include the turkey vulture, redtailed and other hawks, golden and bald eagles, prairie and peregrine falcons, the American kestrel (most common of the raptors), and several owl species. These raptors prey on the abundant small mammals and aquatic resources available. The most common game birds identified locally by the Colorado Division of Wildlife are the bandtailed pigeon, mourning dove, blue grouse, turkey, ringnecked pheasant, and chukar. The last two are introduced species (ibid.).

A plentiful source of amphibians and reptiles (toads and frogs, snakes and lizards, and fish) is provided by the habitat associated with rivers and their tributaries. Species of native fish include the humpback sucker, speckled dace, bluehead sucker, carp, mottled sculpin, and brown trout (Archer et al. 1985).

MODERN CLIMATE

Presently, the region is characterized as having a steppe-type climate. The low elevations are host to a cool semiarid climate where temperatures can drop to -10 degrees F during the winters and summer temperatures often reach over 100 degrees F; there is a maximum of 160 frost free days and the annual precipitation is about 12 inches. The surrounding higher elevations are characterized as cooler and moister. On the Roan Plateau at 8000 feet, the average annual rainfall is 25.66 inches and the average annual temperature is 35.5° F. (Union Oil Company:182, Tables K.1.5 and K.1.7). Temperatures have varied between -20 degrees F in winter and 90 degrees F in summer with a frost free seasonal range of 70 to 100 days.

The climate of the Grand Valley is similar to that of most intermountain areas west of the Continental Divide in its aridity, wide range of daily temperatures, high percentage of bright sunny days, and high evaporation rate (Knobel 1955). In this semiarid, cool desert environment, winters tend to be mild and summers hot and dry and render the area an attractive place to live year round. Over the Colorado River watershed (east of the Grand

Valley), precipitation is recorded on an average of nearly 60 percent of the days. However, 50 percent of the annual precipitation occurs on only 16 percent of the days having precipitation. Winter precipitation is derived from stratus-type clouds associated with large-scale frontal systems, whereas localized cumulus-type clouds produce most summer precipitation. Table 2.1 summarizes the climatic averages in the Grand Valley between 1900 and 2010.

Month	Max. Temp. (F)	Min. Temp. (F)	Total Precip. (in.)	Total SnowFall (in.)	Snow Depth (in.)
Jan	36.5	15.9	0.60	6.0	1
Feb	44.6	23.3	0.57	3.8	1
Mar	55.1	31.2	0.82	3.0	0
Apr	65.2	39.2	0.79	0.9	0
May	75.6	48.2	0.79	0.1	0
Jun	86.9	57.2	0.45	0.0	0
Jul	92.9	64.1	0.60	0.0	0
Aug	89.5	62.0	0.99	0.0	0
Sep	80.6	53.0	0.96	0.0	0
Oct	67.3	41.0	0.91	0.4	0
Nov	51.3	28.3	0.63	2.3	0
Dec	38.8	18.5	0.59	5.1	1
Annual	65.3	40.2	8.70	21.6	0

Table 2.1 Monthly climate summary for the Grand Valley from AD 1900-2010 (Western Regional Climate Center, wrcc@dri.edu). [Period of Record : 1/ 1/1900 to 7/31/2010. Percent of possible observations for period of record: Max. Temp.: 99.9% Min. Temp.: 99.9% Precipitation: 99.9% Snowfall: 99.9% Snow Depth: 99.8%]

Aside from very local climatic variations within the valley, depending partly on elevation, aspect, and local exposure, climatic conditions in Grand Junction are probably comparable to that of the site area. Grand Junction is situated at an elevation of 4,593 feet and, in general, is relatively warm during summer months and cold during winter months. As elevations increase in surrounding terrain, temperatures tend to decrease and precipitation increases. The highest elevations may receive up to 40 inches of precipitation per year. Over the winter months, snow accumulates above 8,000 feet without completely melting until spring.

The Colorado River enters the extreme eastern end of the Grand Valley through a deep canyon that tends to stabilize air currents through the valley. During the day, air currents generally move up the slopes that confine the valley at its eastern end; at night, a downslope pattern prevails. This air drainage affords a more limited range in daily temperature and less danger of frost in the proximity of Palisade than elsewhere in the valley (Knobel 1955). Winds in the spring and summer months average 8-9 mph. Wind is generally negligible during the winter dry season.

ARCHAEOLOGICAL ASSESSMENT OF THE SURROUNDING ENVIRONMENT

Due to the higher degree of relief in the surrounding area, there is a patterned distribution of vegetation types based on the elevation, slope, and aspect. There are eight major vegetation communities identified surrounding the subject site which are generally subdivided by highland, ridge slopes, and lowland designations. In the highlands are aspen, sagebrush, and mixed mountain brush communities. The steep mountain slope communities are differentiated by aspect. Those that face north and northeast have tall brush and shrubs that form a canopy cover of 80% or more of the slope. Tall shrubs are also found on the south and west-facing slopes, but there is a sparse understory. The lower elevations exhibit pinyon-juniper forest, big sagebrush-greasewood, and riparian communities.

These had varying degrees of usefulness to aboriginal populations, and to the large mammals that they hunted, depending on the season of the year. For example, deer and elk find the thick, mixed-brush communities on the northern slopes more attractive during late spring through fall because of the copiousness of the mountain mahogany/serviceberry community. Browse is better for them on the south slopes during the winter months, but the sparse understory there precludes heavy usage, so during the winter months large mammals rely mainly on the lowland sagebrush-grassland communities. Of the communities represented nearby, the lowland sagebrush and riparian communities have the highest number of edible plants for the prehistoric human populations.

O'Connell (1975:22) stated that grass seeds were probably the most important summer food resource for prehistoric collectors and may have provided a basis for the development of semi-sedentary or sedentary lifestyles during extended moist periods or times of reliable summer precipitation. Fortunately for the hunter-gather is that many of the seed-bearing forbs and grasses cross-cut several environmental zones (between 4500 ft and 9000 ft). Important in the prehistoric settlement/subsistence pattern of a particular area is that minor fluctuations in effective moisture would have little effect on the vertical displacement of the less sensitive floral communities (species such as juniper, greasewood, saltbush, and sagebrush), but would greatly affect both the number and variety of grasses and forbs. An increase in effective moisture would have caused an expansion of the grasslands and an increase in the carrying capacity of the valleys for hunter-gatherers and the large game they hunted. During cooler/wetter periods, the increased availability of this narrow range of plant foods at lower elevations probably reduced the need for extended seasonal migration to higher elevations.

The warmer/drier episodes would certainly have required the hunter-gatherer to be seasonally migratory--to exploit the higher elevations for seeds in the summer.

In general, prehistoric site density in the higher elevations of the Roan Plateau/Book Cliffs is relatively low. Campsites when found usually have access to permanent water, and/or have strategic topographical positioning. The upland sites usually exhibit artifacts related to resource procurement activities and are characteristically smaller (LaPoint et al. 1981:4-67 through 4-91; and Conner and Langdon 1983:44-45). Site types encountered are most often open camps, open architectural sites, lithic scatters, and isolated finds.

Lower elevation sites often occur in sheltered areas along tributary canyons near their convergence with the main drainages. The lowland sites exhibit greater feature frequencies and variability, and often involve rock shelters and rock art. Notably, all of the sites on the Roan Plateau contain low numbers of artifacts, including very limited numbers of debitage, bifacial tools and expedient tools. This suggests conservation, curation, and reuse of flaked stone tools in an area where tool material sources are limited.

In addition, lowland sites tend to be situated in the pinyon-juniper vegetation community in greater frequencies than is suggested by the relative proportion of the pinyon-juniper to other vegetation communities. The sites in the uplands are distributed proportionally to the size of the vegetation communities, with the mountain shrub and sagebrush communities exhibiting the highest site density.

Too little is known of the age of the sites to make any definitive statements. The distribution of site ages based on projectile points and ceramics is generally the same as portrayed in Reed and Metcalf (1999), but the lack of absolute dating precludes any conclusions in this area. Lithic scatters exhibit a smaller site size than open camps in both the lowland and upland settings. Isolated finds are distributed across a wider range of slopes than lithic scatters or open camps.

East Salt Creek was used prehistorically as an access route from the Grand Valley region (to the south) to the eastern portion of the Uintah Basin (via West Douglas Creek north of Douglas Pass). Numerous trails leading north from East and West Salt Creeks into Uinta Ute country were reported by Ute informants to Gunnison, an early railroad surveyor (Hibbets et al. 1979). The presence of Fremont, Ute and Shoshone rock art along the Salt Creek drainages substantiates the use of these trails.

CHAPTER 3

PAST CLIMATES IN WESTERN COLORADO

INTRODUCTION

Understanding past climates in western Colorado is a continuing process, hampered by a paucity of current environmental studies. Few sites with potential climatic data have been excavated in the region and the necessary detailed environmental studies have seldom been undertaken. Some palynological studies have been accomplished, but these samples typically have been taken to evaluate economic plant use rather than environmental change. As a result the generally accepted paleoenvironmental model for the area is a blend of environmental histories established for surrounding areas. These consist of various archaeological and geological studies since the 1950s that have provided a useful number of radiocarbon dates and deposit descriptions that define the regional depositional history and, by extension, local paleoclimates.

The surface deposits that are most important for archaeology are predominantly alluvial and aeolian; other types of deposits are only incidentally important, although the evolution of deposits in pinyon-juniper woodlands is of special interest. Every drainage in the Book Cliffs/Roan Plateau area has channel and overbank deposition of some kind in most if not all of their parts, and aeolian deposits — chiefly loess — are ubiquitous and cover nearly every surface, especially modern alluvial plains. Depths of the deposits vary. Depths of alluvial deposits are regulated by the amount of sediment available for transport in a drainage basin and the amount of water available to shuttle sediment downstream; deep alluvium suggests a drainage has insufficient surface flow to remove sediment contributed to its system. The depths of aeolian deposits vary with topography and type of vegetation but cover extensive areas, hence the appellations “blanket” or “sheet” deposits.

In the Uncompahgre Uplift, Hunt (in Wormington and Lister 1956) completed an important early study on deposits at the Taylor site and associated alluvial deposits on East Creek in Unaweep Canyon. Jones et al. (2010) conducted a later study and provided dates for alluvial and other deposits in Gibbler Gulch, a tributary of East Creek. Three other studies in the Uncompahgre Uplift provide dates from alluvial and other deposits: Scott (Scott et al. 2001) provides a summary of radiocarbon dates on alluvial deposits that are for the most part confined to No Thoroughfare Creek. Aslan and Hayden (2008) provide a few dates from Dolores River alluvium, and Aslan (2005) gives a number of dates from Seiber Canyon alluvium and other deposits there.

Indian Creek, south of Whitewater, Colorado, has been investigated episodically since the 1970s. Bob Patten (n.d) of the USGS compiled an early record of the deposits and associated cultural remains that were exposed in the upper reaches, practically at the base of the long slope rising to Grand Mesa. Horn et al. (1987) and Lamm (1987) completed excavations and obtained numerous radiocarbon dates and accurate profiles on segments of the lower reaches of the creek. This work was conducted during planning and construction of the Ute Power Company's San Juan to Rifle transmission line. More recently, Miller (2010) completed a preliminary geoarchaeological assessment of Indian Creek deposits, provided additional radiocarbon dates, and described the alluvial and aeolian depositional units.

Recent excavations and salvage work by Grand River Institute, Grand Junction, Colorado, associated with the Collbran Pipeline project has so far provided the best dates for the loess deposits from the middle and late Holocene (Conner et al. in progress). Farther east of the study area, along the Colorado-Eagle river corridors, several sites have contributed dates from alluvial and aeolian deposits. Excavations at site 5GF1323, a few miles northeast of Battlement Mesa, Colorado (Miller and Smith 2010), and at the McHatten Reservoir Site (5EA909), a few miles southwest of Eagle, Colorado (Metcalf et al. 2010), display parts of the Late Pleistocene and early Holocene loess sequence as well as later loess deposits. Deposits on both are dated primarily with diagnostic artifacts spanning the Paleoindian through Late Prehistoric and Formative periods. Two dates from alluvial deposits in tributaries of the Colorado River come from sites near the towns of McCoy (Aslan n.d.) and Wolcott (Miller et al. 2009), Colorado.

Three geoarchaeological studies have contributed to our paleoclimatic knowledge in the immediate area. A geoarchaeological summary for the Red Cliff Mine project is presented in Conner et al. (2006a) and details an area at the base of the Book Cliffs north of Loma, Colorado. A second study conducted by McIntyre and Miller (2010), focuses on an area below the Book Cliffs north and west of the Grand Junction, Colorado, airport. The third study was carried out in connection with excavations at 5ME15398 (Miller et al. 2011b). Conner et al. (2006a), cited above, originally recorded the site. Conner et al. (2006a) provides one C-14 date from loess, but no dates were obtained in the other studies. However, the deposits described in these reports are correlated to dated deposits in this study.

Douglas Creek has been the focus of various studies. Womack (1975) completed the first geological study and interest persisted because of the apparent rapid rate of down cutting in the 20th Century (e.g., Womack and Schumm 1977). Hayden et al. (2008) reported on a brief study conducted for a seniors' project in geology at Mesa State College and reports two radiocarbon results. Miller and Nelson (2010) conducted a study within the confines of the Canyon Pintado National Historic District in the middle reaches of Douglas Creek that focused on alluvial and, secondarily, aeolian deposits. Archaeological excavations on various sites in the district by Creasman (1981) and Hauck (1993) provide useful dates on the loess deposits on the highest terrace of Douglas Creek while Arthur (1983) and Baker (1992) provide dates obtained from tributary alluvium.

THE EFFECTS OF CLIMATE ON ALLUVIAL AND AEOLIAN SYSTEMS

Many studies since the 1950's have sought to elucidate the connection between climate variability and depositional cycles, but the associations have not always been clear because of the nature of the data or assumptions of the investigators. The following narrative is intended to illuminate some of the important studies leading to the interpretations offered below.

The Effects of Climate on Alluvial Deposition and Erosion

The first evaluation of Quaternary geology in western Colorado was completed by Charles Hunt (in Wormington and Lister 1956) who identified three main alluvial deposits on East Creek in Unaweep Canyon during excavations on the Taylor Site in Cactus Park. In the same period, Leopold and Miller (1954) conducted the first important study describing Quaternary alluvium in eastern Wyoming and named the two Holocene alluvial units the Kaycee and Lightning formations which correlate to the first and third deposits in Hunt. Less than a decade later Glenn Scott (1963, 1965) conducted studies along part of the Front Range in eastern Colorado and labeled the alluvial units there Pre-Piney Creek, Piney Creek and Post-Piney Creek. These units are essentially the same as Hunt's three units and the first and third units are again equivalent to Kaycee and Lighting formations of Leopold and Miller (1954). Years later, C. Vance Haynes (1968) compiled the first regional correlation of alluvial and some aeolian deposits using radiocarbon dates obtained from archaeological sites across the Great Basin, Rocky Mountains and Plains; the modern version is little changed from the original (e.g., see Haynes 2009). Knox (1983) was the first to attempt a country-wide correlation of alluvial deposition and erosion in the contiguous United States. Knox noted that the timing of deposition and erosion was synchronous across most areas of the contiguous forty-eight states, but parts of the mountain west appeared out of sync.

In these studies there is an assumption that many of the responses on river systems — episodic erosion and deposition — are climate caused, although other factors sometimes play a role. Tectonic activity can add terraces and changing land use patterns such as grazing, sod-busting, chaining to make new grassland, building dams, and realigning drainages can create new deposits altogether. Kirk Bryan (1925) formulated the hypothesis that alluvial deposition occurs in cool, moist climatic periods and alluvial systems downcut in warm, dry climatic periods. Modern adherents of the Bryan theory modify this by shifting the erosion associated to arid intervals to the period of transition to a cool period. Modern adherents also suggest that lower water tables during warm, dry climate intervals are a factor initiating incision. However, the evidence cited for lowered ground water is in Quaternary alluvial deposits acting as local aquifers and downcutting is causing the observed ground water lowering, not vice versa.

E. Huntington (1914) advocated the converse — deposition is associated with warm, dry climate periods, and incision to cool, moist climate periods — and is better supported by multi-regional evidence (see Knox 1983). This approach has a firmer mathematical and statistical basis and addresses factors such as stream power and work, capacity and competence, the effects of ground water or lack thereof, and the redistribution of sediment. Several studies provide important clues. Hadley and Schumm (1961) conducted a multi-year study during the 1950s drought and observed that most reaches of most drainages in their study area were depositing rather than stripping sediment in the interval. They also found that the effects of individual storms was limited to shuttling sediment a short distance downstream before the surface water was lost to unconsolidated alluvium exposed in the channel bottoms.

In a longer study, Wolman and Miller (1960) documented erosion and deposition through annual cycles and determined the frequency of moderate flows in an alluvial system during the wetter times of the year was more important for channel formation and widening than single heavy precipitation events in the drier parts of the year as assumed by the Bryan hypothesis. They also noted that single heavy, precipitation events tend to affect only small segments of a drainage system and, like Hadley and Schumm (1961), observed that sediment was shuttled only a short distance downstream before surface water was lost. Wolman (1959) earlier determined that pre-wetted deposits, especially those affected by frost action, erode more easily; this also suggests increased erosion in the wetter times of the year. Following a similar line of discovery, Rumsby and Macklin (1994) expanded the time scale and determined that channel incision in the Tyne Basin in northern England occurred because of a higher frequency of larger floods during cool, moist climates, ostensibly because a higher frequency of moderate scale flows.

Headward erosion and nick point formation is also tied to ameliorating conditions. Nick point migration accelerates with increased interflow (Miller 1992). Ground water effluence at the base of unconsolidated deposits weakens the support for drier, overlying deposits and causes collapse; this is perceived as upstream migration. Surface flow plays no significant role in forming a nick point or causing its migration in an upstream direction; however, it does break up and remove loose material below the nick point in combination with ground water effluence.

The conclusions from various studies suggest increased erosion in cooler, wetter intervals, but there is firm evidence exposed in the region's Late Quaternary deposits that strongly supports the Huntington model, i.e., the nearly coeval deposition of early Holocene, Kaycee equivalent alluvium and the formation of the major aeolian sand seas. Many important archaeological sites in the western states are contained in lower Kaycee equivalent alluvial deposits and date to about 10,000 BP (e.g., Haynes 1968, 2009; Frison 1978, 1991; Davis 1989; Miller 1992, 1993; Haynes et al. 1998; Kornfeld 1998; Surovell et al. 2005). Locally, both Hunt (in Wormington and Lister 1956) and Jones et al. (2010) report Pleistocene faunal remains at the base of the equivalent deposits on East and No Thoroughfare Creeks, respectively. Jones et al. (2010) and Aslan (2005) report dates of over 9600 BP from alluvium in on No Thoroughfare Creek and Seiber Canyon that are consistent with dates from lower Kaycee equivalent deposits.

The upper Kaycee equivalent surface (or terrace in many places) is more difficult to date accurately, chiefly because the Kaycee surface in many places was a surface for thousands of years—up to 7500 years in extreme cases. Early Archaic, Late Paleoindian and Foothill-Mountain projectile points (e.g., Frison and Stanford 1982; Miller 1995; Miller et al. 1993) and ^{14}C dates (summarized in Miller 2010) indicate that the end of deposition of Kaycee equivalent alluvium was generally around 7500 BP. The youngest date from Kaycee-equivalent deposits in the region, around 7100 BP, comes from Indian Creek, south of Whitewater, Colorado.

Ahlbrandt (1973), Gaylord (1983), Ahlbrandt and Freyberger (1980) and Ahlbrandt et al. (1983) document the beginning of major aeolian sand sea formation around 10,000 BP. The sand seas and dune deposits remained active until 6500 BP (Miller 1992, 2010). Gaylord (1983) documented a shift from high angle foreset bedding to low angle foreset bedding in aeolian deposits in the Ferris-Lost Soldier dune field around 6400 BP, signaling the end of dune activity there. An equally obvious contradiction of the Bryan model, which states alluvial deposition occurs in cool-moist intervals, is the massive dissection during the Ice Age.

The Effects of Sediment Availability on Alluvial Deposition

Fill in alluvial valleys sometimes looks entirely different from one drainage to another, although the sequences are actually similar. The critical factors are the volumes of water and sediment available to any system. There is a sharp contrast between drainages like Douglas Creek, which is sediment choked in the upper reaches (Miller and Nelson 2010), and Indian Creek (Miller 2010), Leach Creek and Persigo Wash (McIntyre and Miller 2010) in Mesa County, Colorado, which are more sediment starved. Sediment choked drainages normally have stacked sequences that include all three major depositional units while sediment starved drainages normally have inset terraces and in most places display only two of the three major deposits, namely the equivalents of the Kaycee and Lightning formations (after Leopold and Miller 1954).

In sediment choked streams (but also in constricted valleys), the middle unit is normally stacked on top of Kaycee equivalent deposits in the upper and middle reaches, for example from the highlands to the basin margins, while an inset sequence is formed in the lower reaches in the interior basins. Douglas Creek displays this character. The middle Holocene unit overlies Kaycee equivalent deposits where Douglas Creek enters the Canyon Pintado National Historic District but are inset between terraces formed of Kaycee equivalent deposits when it exits the district over ten miles to the north (Miller and Nelson 2010). The depth of the Kaycee equivalent deposits is unknown in the upper reaches, but Bauer et al. (2008) report about 20m of sand and silt strata below the present channel in one place within the Canyon Pintado National Historic District, all of which is probably Kaycee equivalent alluvium. Deposits of Pleistocene age are estimated to be much deeper (Miller and Nelson 2010). Farther north, near Rangely, Colorado, the stratigraphic sequence is reduced to Kaycee and Lightning equivalent deposits, and the latter are inset.

In contrast, the upper reaches of Leach Creek and Persigo Wash, near the Grand Junction airport, have less sediment and the middle unit on both drainages is inset between terraces formed by Kaycee equivalent deposits (McIntyre and Miller 2010). On Indian Creek, south of Whitewater, Colorado, the thickness of the middle unit varies and it is alternately inset and stacked because of changes in channel geometry. Channel geometry alters the character of alluvial deposition along the course of a drainage. Channel restrictions favor deposition upstream of the restrictions, while deposition diminishes downstream of the restrictions (e.g., Andrews 1979). A constriction of valley width at the wind gap in the middle reaches of Indian Creek resulted in thicker deposits upstream of the constriction and thinner deposits downstream. In narrow canyons, stacked sequences are more common at least in part because of narrow channel geometries. Kaycee equivalent alluvium in Indian Creek is up to 4.0m thick (Miller 2010, unpublished notes). West of the Grand Junction airport, Kaycee equivalent deposits in Leach Creek and Persigo Wash are about 4.0 and 2.0m thick, respectively.

The depositional sequence in Horse Thief Canyon on V Road, south of the Debeque, Colorado exit on east bound Interstate 70 displays the alluvial depositional sequence and usual variation up- and downstream. Driving up the canyon 0.9mi from the intersection of the Frontage Road and V Road, is the first creek crossing, only Kaycee with overlying loess and Lightning equivalent overbank deposits are present downstream. Greasewood dominates from just before the crossing to 1.3mi up the road because of the alkaline nature of Kaycee equivalent deposits near the surface. Parts of the middle Holocene unit are inset in parts in the lower reach, but between 1.3 and 1.5mi, the middle unit has filled the middle Holocene incision to about the same level as the older Kaycee equivalent deposits on the flanks of the canyon. Greasewood still dominates where Kaycee equivalent deposits are close to the surface on the flanks, but sagebrush dominates in the less alkaline middle Holocene deposits filling the middle Holocene incision. From 1.5 to 2.7mi from the intersection of the frontage and V roads, the middle unit is stacked on Kaycee equivalent deposits and sagebrush dominates in most areas. The second crossing is 2.7mi from the intersection, where the main channel turns east or left, and the road veers to follow a winding tributary. The Kaycee equivalent and stacked middle unit are visible upstream in the main channel from the second crossing, but the tributary is mostly a bedrock channel with some middle Holocene or Lightning equivalent deposits inside. Through the whole distance to the second crossing at 2.7mi and continuing upstream on the main channel, Lightning equivalent deposits are confined to the channel bottom or in thin overbank deposits capping the bordering, higher terraces.

The three main depositional units — from oldest to youngest, Kaycee equivalent, the unnamed middle unit, and Lightning equivalent alluviums — represent “pulses” of sediment released in warm/dry climatic periods after prolonged weathering in highland areas. The volume of sediment in each pulse is proportional to the duration of the previous period of weathering (Miller 2010). The greatest volume of sediment was released after the end of the late glacial, most derived from sediment stored in the mantle of the Pleistocene soil for the previous 15,000 years. Much of this sediment remains in the valleys today. These are Kaycee equivalent deposits. The type section for Kaycee formation is on the middle fork of the Powder River near Kaycee, Wyoming.

The second sediment pulse was generated after the middle Holocene amelioration, a temperature rather than moisture controlled glacial (Miller 2005, 2010), but as indicated above, it is restricted to the upper reaches of many drainages. The third pulse, released in the late Holocene, with additions after the Little Ice Age, are the equivalents of Leopold and Miller's Lightning Formation. The type section for Lightning Formation is on Lightning Creek, a tributary of the Cheyenne River in eastern Wyoming. The volume of sediment related to the latter two pulses is much less compared to the release at the end of the late glacial, and the volume of the middle pulse is greater than the volume of the third.

From the discussion above, it is clear that the surface gradients of the three deposits are not equal. While the surface gradients on the Kaycee and Lightning equivalent deposits are sub-parallel, the surface gradient of the middle unit is steeper. This relationship is present on many streams in the Rocky Mountains and bordering areas (Miller 1997, Miller and Nelson 2010, Miller 2010). Hunt noted that the equivalent unit on East Creek in Unaweep Canyon in western Colorado had attributes of an alluvial fan when referring to the steeper gradient (in Wormington and Lister 1956).

Certain provenance areas are more productive and lend to the formation of deep Late Quaternary alluvial deposits. Green River Formation (Eocene) exposed at Douglas Pass north of Loma, Colorado, weathers easily and is prone to mass wasting — slide and slump features and pistol-grip trees caused by slope creep abound on both sides of the pass. The branches of Salt Creek, a tributary of the Colorado River, drain the south side of the pass and the branches of Douglas Creek drain the north side. Both creeks feature deep alluvial sequences. Green River Formation has a similar effect in other areas. Green River Formation in the Piceance Basin also produces a great volume of sediment (Conner et al. 2006a); Corral Gulch, for example has over ten meters of middle Holocene alluvium and Lightning equivalent overbank deposits. Buckhorn Draw on the dip slope of White Mountain (actually an escarpment), just west of Rock Springs, Wyoming, is another sediment choked drainage with Green River Formation throughout the provenance area (Miller 1988). Again in contrast, Leach Creek and Persigo Wash near the Grand Junction airport and Indian Creek south of Whitewater, Colorado, have much less sediment available. Resistant caprock in the provenance areas of both drainages limit erosion of softer rock units such as the Mancos (Cretaceous) and Green River (Eocene) formations, and thus limit sediment contributions from those sources.

Variations of stacked sequences effected by productive provenance areas are seen on many other drainages in the west, especially where those drainages exit highland areas. Two important archaeological sites in Wyoming — the Hell Gap Site in the Hartville Uplift in the east (Haynes 2009) and the Medicine Lodge Creek Site in the Bighorn Basin (Finley 2007) — display stacked sequences. On the Plains, drainages in the U. S. Army's Fort Carson-Pinyon

Canyon maneuver area west of Pueblo, Colorado (Jackson and Schuldenrein 1985), and drainages including the Belle Fourche River in the eastern Powder River Basin on the South Dakota-Wyoming border (Albanese 1990) have stacked sequences. Locally, deposits in No Thoroughfare Canyon (Scott et al. 2001), Little Dolores River (Aslan and Hayden 2008), Gibbler Gulch (Jones et al. 2010), and Sieber Canyon (Aslan 2005), all draining parts of the Uncompahgre Uplift, display stacked sequences.

PLEISTOCENE DISSECTION, HOLOCENE INCISION AND AVULSION

In the discussion above, three main depositional units are identified. These alternated with, were preceded by, or in some cases, were contemporaneous with periods of downcutting or erosion in the last 13,000 years. Most if not all drainages went through significant downcutting during the Ice Age, carved channels deep into bedrock and lined them with coarse, typically boulder-sized gravel. This type of downcutting is referred to as dissection below. Dissection operates on a scale of tens of thousands of years.

After the Ice Age, particularly between about 10,000 BP until as late as 7100 BP, the typically braided Kaycee equivalent alluvium was deposited in bedrock channels formed by Pleistocene dissection. In the middle Holocene, between 6500 and 4500 BP there is more downcutting, here referred to as the middle Holocene incision. This incision is the most dramatic period of down cutting in the last 10,000 years. Rejuvenated flow in most drainages approached but did not exceed flow conditions of the Late Glacial. In relatively thin Kaycee equivalent deposits, such as those reported at Leach Creek, Persigo Draw, and Indian Creek, incision exposed late glacial gravel and because it was unable to move the gravel, erosion was redirected laterally, causing valley widening. This is also true for many trunk drainages like the Colorado River, where only scattered remnants of the Kaycee equivalent deposits remain. The Kaycee equivalent deposits in sediment choked drainages were similarly incised, but many times the depth of incision never reached Late Glacial gravel. Much of the evidence on these drainages remains buried, but is often indicated by recovery of occasional older dated samples (e.g., Jackson and Schulderein 1985, Aslan 2005).

Coarse, typically cobble-sized gravel preserved in the middle Holocene incisions in Kaycee equivalent deposits indicate peak flow conditions around 5000 to 4500 BP. After 4500, fine clastics of the middle alluvial unit begin deposition. A subsequent incision in the late Holocene, between 2800 and 1500 BP removed part of the middle unit, and in sediment starved systems, removed most of the middle unit (if it was ever deposited). On sediment choked drainages, evidence of this late Holocene incision is fleeting, and in some drainages, such as Corral Gulch in the Piceance Basin, the alluvial deposits after 4500 years ago appear to be a continuous series. Compared to dissection, incision in the Holocene operates on the scale of thousands of years.

Finally, avulsion is the normal reworking of sediment in a valley over the course of hundreds of years, and includes alternating deposition and erosion effected by short-term climate cycles, seasonal variability and even single heavy precipitation events. This type of rework is described by Wolman and Miller (1960), Hadley and Schumm (1961) and Andrews (1979). It has the effect of shuttling sediment downstream. Miller and Nelson (2010) consider the post AD1900 down cutting on Douglas Creek avulsion, the reworking sediment released before and after the Little Ice Age.

The Effects of Climate Change on Aeolian Deposition and Erosion

Aeolian deposits are normally associated with extremely arid climates, and indeed any thought of a desert region conjures the images of interminable, rolling dunes stretching to the horizon. In semi-arid and southern temperate areas, aeolian processes are always active, at least seasonally, but phytogenic aeolian deposits — loess deposits — are the rule rather than the exception before 10,000 or 9500 BP and after 6500 BP. Associated to cooler-moister climatic intervals when the general surface is better stabilized by vegetation supported by increased stored pore waters, the source of fine clastic materials is probably limited to sediment deflated from new alluvial channel and overbank deposits exposed and dried during low flow periods, i.e., in the dry season. Increased stored pore water enhances vegetal growth, and vegetal growth serves as a stabilizing agent and at the same time increases surface roughness with respect to the wind. Increased growth and alterations in surface roughness serve to entrap aeolian sediments. Loss of vegetation and consequent reduction of surface roughness leads to deflation in the same deposits. Scrub oak, common on the northern slopes of Grand and Battlement mesas, traps significant volumes of new loess presently and display the thickest late Holocene loess sequences in the area.

Phytogenic aeolian deposits — typically loess, i.e., wind blown silt and fine sand — are ubiquitous in the general area. There are six loess deposits dating from the Late Pleistocene to the present day; cultural materials are associated with the last five. The first is Late Pleistocene in age and is restricted to highland areas or the upper terraces of the Colorado River. The other five are usually present although the late Pleistocene-early Holocene sheet, second in the series, is difficult to identify in many cases. Loess deposits — sheet or blanket, drift and shadow deposits — accumulate during cooler-moister climatic intervals and the accumulation is facilitated by vegetal cover. Pollen and a few phytolith studies on numerous sites in loess deposits in the mountain west, including Colorado, indicate fine clastic accumulation is a character of cooler-moister intervals (data are summarized in Miller 1992, 2010). Unconformities separating individual loess deposits are miniature serir deposits identified by coarse sediment particles. Serirs are formed by deflation but enhanced by frost heave in the second and third phytogenic deposits. During drought conditions, loess deposits lose moisture and the vegetation that anchors the loess diminishes. Reduction of vegetal cover accelerates deflation (see Tomanek and Hulett 1968). Loess deposits in the area have been going through a cycle of deflation in the recent past.

The cycle of deposition and deflation in phytogenic aeolian deposits in semi-arid areas follows a regular pattern. Slow, gradual accumulation takes place during ameliorating conditions. Deflation follows in the transition to warmer, drier climates and continues at an accelerated pace during the peak of arid conditions (see Tomanek and Hulett 1968). In many deposits, subsurface horizons like soil illuvial horizons or geochemical weathering zones prove to be almost impervious to deflation alone and form a resistant deposit that is only gradually worn away by deflation and the affects of direct precipitation (Miller 1992). During deflation, the coarse fraction or saltating load is concentrated on top of the stripped, resistant illuvial or geochemical weathering horizon. The concentration of the coarse fraction forms a small-scale serir or desert pavement-like deposit which eventually "armors" the surface and further impedes deflation, again by increasing surface roughness. These thin, coarse deposits are serirs, but also unconformities, and are the only real stratigraphic contacts or breaks in aeolian sheet, shadow and drift deposits. Most commonly, a serir or unconformity in profile represents a lacuna — implying erosion, and missing strata and time — rather than a hiatus which describes a period of non-deposition.

The driest period in the late Quaternary was in the early Holocene. Ahlbrandt (1973), Gaylord (1983), Ahlbrandt and Freyberger (1980) and Ahlbrandt et al. (1983) document the beginning of aeolian sand sea formation around 10,000 BP on the Plains and in some Rocky Mountain basins. Finlay and Casper (Frison 1974) are both bison kill sites in early aeolian deposits about 9500 BP. The sand seas and dune deposits were active until 6500 BP (Miller 1992, 2010). Gaylord (1983) documented a shift from high angle foreset bedding to low angle foreset bedding in aeolian deposits in the Ferris-Lost Soldier dune field, essentially a shift from dunes to phytogenic aeolian deposits, i.e., shadows and sheets, around 6400 BP.

LATE QUATERNARY ALLUVIAL AND AEOLIAN DEPOSITS

Alluvial and aeolian deposits are most important for archaeology in the western Colorado. Deposits in rock shelters, although important, are not considered below, but a brief discussion of deposits in pinyon-juniper forest is included.

Late Quaternary Alluvial Deposits

There are four alluvial deposits that can be associated with cultural material; Late Glacial or Pleistocene gravel, the early Holocene Kaycee equivalent alluvium, the unnamed middle to late Holocene alluvial unit, and the late Holocene Lightning equivalent alluvium. Each has a suite of traits that positively identify them. The chronology of the alluvial and aeolian deposits in the area is detailed in a later part, but dates of deposits are included in the following narrative for completeness and as an introduction for what follows.

Late Pleistocene alluvial deposits consist of coarse lag deposits, typically coarser than any sediment contributed by alluvial processes anytime since the Pleistocene. In deposits that act as aquifers, ferrihydrite (like rust) and the manganese oxide minerals birnessite and pyrolucite (black, soot-like minerals) are present. Pleistocene lag deposits are typically associated with red and green, and gleyed clays. The red and green color is from the oxidation-reduction state of iron, while gleying is a result of gibbsite formation in acid, anoxic conditions. These deposits are frequently associated with thin, centimeter-thick, so called A-C soils distinguished by thin, dark A horizons, that frequently display soft sediment deformation features (e.g., incompetent bedding and flasure structure). The depths of the deposits are unknown. Miller and Nelson (2010) estimated the depth of dissection in the Douglas Creek valley at various points between 30 and 50m; as much as half could be Pleistocene gravel. These deposits are generally older than 10,000 BP. Estimates of depth of dissection on Kannah Creek, south of Whitewater (Miller unpublished field notes), and Corral Gulch, in the Piceance Basin (Conner et al. 2006a) are about the same.

The end of the last ice advance occurred about 15,000 BP or a little later in the Southern Rocky Mountains (e.g., Madole 1986), and shows progressively younger dates farther north. The change of capacity and competence marking the end on Dry Piney Creek in the Wyoming Overthrust Belt dated at 13,600 BP (Miller 1997) and still farther north, a similar change in competence and capacity is recorded around 12,000 BP at Indian Creek in the Elkhorn Mountains of western Montana (Miller 1992). The retreat of the Wisconsin ice sheet from the northern plains also presents a timed withdrawal. The last major advance into Iowa occurred between 14,000 and 13,500 BP, and successive but progressively less extensive re-advances took place around 12,300, 11,700, and 9900 BP (Clayton and Moran 1982).

The early Holocene Kaycee equivalent alluvium was the first Holocene deposition, the relic of the first pulse of sediment released from highland areas. The large volume of sediment was derived from sediment formerly stored in the Late Pleistocene soil. Small relicts or “islands” of lower B (or E) and C horizons of the late Pleistocene soil are commonly preserved, the rest was stripped and redeposited in the valleys and rills where much of it has remained since. Braided or anastomosing in character, it comprises the bulk of the visible alluvial deposits preserved in ephemeral and low energy perennial systems. Normally, exposures form vertical walls and exhibit columnar structure reminiscent of columnar jointing on the edge of basalt flows. The deposit is heavily mineralized with secondary calcite and sometimes gypsum (especially where ground water effuses from marine rocks), formation of goethite and limonite, and new clay mineral formation. In western Colorado it is often described as mottled, but the mottling is a result of oxidation-reduction reactions facilitated by high ground water through time and is not restricted to Kaycee equivalent deposits alone.

Thickness of Kaycee equivalent alluvial deposits ranges from 2.0 to 10.0m in and around the study area. Persigo Wash exhibits a 2.0m thick deposit, while on Leach and Indian creeks, the thickness of Kaycee equivalent deposits varies from 2.0 to 4.0m (McIntyre and Miller 2010; Miller 2010). Scott et al. (2001) estimate the depth of the “lower calcareous part” of alluvial deposits in No Thoroughfare Canyon — the Kaycee equivalent — as less than 10m thick. Jones et al. (2010) reports no deposits that can confidently be labeled a Kaycee equivalent in Gibbler Gulch (the dates are not old enough), but Hunt (in Wormington and Lister 1956) discusses a “compact, clayey and limey” unit on East Creek in Cactus Park (near where Gibbler Gulch flows into East Creek), the Kaycee equivalent there, and Scott et al.

(2001) report a date of over 8000 BP in Cactus Park. The Kaycee equivalent deposit near the Taylor site is about 4.0m thick (this deposit was probably dated by Scott et al. 2001). Womack's (1975) stratum A and Miller and Nelson's stratum II are the Kaycee equivalent deposits on Douglas Creek. Aslan (2005) in Seiber Canyon and Aslan and Hayden (2008) on the Dolores River treat the stacked sequence containing Kaycee equivalent (at least at Seiber Canyon), middle Holocene alluvium, Lightning equivalent overbank deposits, and late Holocene loess deposits as one map unit and, apparently, consider the sequence as continual, without major interruption. On the Dolores river, the lower part of Qt2 is described as reddish-beige silty sand and the upper part, dark brown clayey-silt, but it is unclear from the minimal descriptions if the lower deposit is Kaycee equivalent or middle Holocene alluvium; the two dates provided suggest the latter.

Erosion in the middle Holocene amelioration incised Kaycee equivalent deposits, typically to the depth of the Late Pleistocene lag deposits. Erosion in the interval was not sufficient to remove or modify the Pleistocene gravel and once the gravel was exposed, streams began a cycle of valley widening, undercutting the braided alluvium and forming vertical walls. Cementation of these early alluvial deposits started with incision and was accomplished via advection or evaporative pumping. Water tables lowered in response to incision and calcite and other soluble mineral matter precipitated on continually lowering advection fronts. Most of the deposits dating from about 6500 to after 4500 BP are lag deposits formed during high flow conditions (Horn et al. 1987; Aslan and Hayden 2008; Hayden et al. 2008; Aslan 2005).

Around 4500 to 4000 BP, the middle Holocene amelioration subsided and a second period of alluvial deposition began. The sediment release was much less and probably abated with the exposure of the middle Holocene mineralized zone, which was produced by in place weathering fostered by stored pore or vadose water during the amelioration. To reiterate, most of the middle Holocene deposits were left on a steeper gradient in the upper reaches, overlie early Holocene alluvium in the upstream reaches, form inset terraces as far as it persists downstream, and are frequently missing before streams reach very far into the basin interiors. In sediment starved systems, the middle unit is absent altogether.

Thickness of the middle Holocene unit on Douglas Creek (unit B in Womack 1975 and unit III in Miller and Nelson 2010) is up to 6m; Hayden et al. (2008) suggest a similar depth. Thickness of the unit is variable on Indian Creek. In the upper reaches where Indian Creek leaves the Pleistocene fan and forms a channel on the south edge of the valley, an inset deposit about 1.5m thick rests between Kaycee equivalent deposits about 3m thick (Miller 2010, unpublished notes). The Horn et al. (1987) excavations on the San Juan to Rifle power line on the lower reaches exposed about 3m of middle Holocene alluvium. The lower half was a channel deposit active in the middle Holocene amelioration and the upper half, fill of the middle unit. At another exposure 50m south of the excavations, about 1.0m of middle Holocene alluvium overlies Kaycee equivalent alluvium. Thickness of the middle unit is limited north and west of the Grand Junction airport (McIntyre and Miller 2010). Drainage fill near McCoy, Colorado, was as much as 3.0m thick (see Aslan n.d.). Aslan (2005) and Aslan and Hayden (2008) include the middle Holocene unit in the Qt2 map unit at Seiber Canyon and on the Dolores River so thickness of the middle Holocene alluvium is not known.

Another period of incision occurred in the late Holocene sometime between 2500 and 1500 BP. The evidence of incision is fleeting in sediment choked streams since re-incision followed the path of least resistance and re-excavated the arroyos originally formed in the middle Holocene. Also, deposition after 1500 was interrupted and partly re-incised during the Little Ice Age (ca. 600 to 150 radiocarbon years ago). As a result, the middle Holocene unit and the in-channel vertical accretion alluvium of the Lightning equivalent deposit appear continuous or nearly so in sediment choked drainages. Corral Gulch in the Piceance Basin has over ten meters of post middle Holocene alluvial deposits — Green River Formation is again the source of massive volumes of sediment.

Lightning Formation equivalents are always represented by sand and finer deposits in channel bottoms and thin silt and clay overbank deposits on modern terrace surfaces. The oldest date for these deposits is late Holocene, but again, on sediment choked drainages, the Lightning equivalent deposits appear continuous or nearly so with the middle Holocene Unit.

Late Quaternary Aeolian Deposits

Aeolian deposits are ubiquitous and exhibit a regular stratigraphic expression throughout western Colorado and elsewhere (Miller 2010). For the most part, these deposits consist of sheet and shadow deposits, although a few clay dune cores have been noted (e.g., Conner et al. 2006b, Miller 2010). It should be noted that sheet flow alluvium is always a component of loess deposits. Long term stabilization of these deposits is due to stored pore water, which accelerates in-place or syngenetic weathering of mineral grains, and enhances the vitality of the living soil. Sheet and shadow deposits are phytogenic, meaning their growth and stabilization in the long term is a consequence of vegetal growth and water storage during cool-moist intervals. It is important to stress that the accumulation of phytogenic deposits, although they are aeolian in nature, is a process that proceeds in cooler, moister environments. They are best classified as loess based on grain size (i.e., fine sand and silt) and massive soil structure (as defined by Brewer 1976).

There are six phytogenic deposits, and a period of dune formation. The oldest deposit is Late Pleistocene loess, a phytogenic deposit accumulated during the glacial period. Parts of the loess — sometimes many meters thick — are preserved on benches and terraces on the flanks of Grand and Battlement mesas, including the Late Pleistocene and higher terraces along the Colorado River. Similar deposits are preserved in Middle Park, in north central Colorado, and the Hartville Uplift in eastern Wyoming, to name a few, and it is equivalent to the Peoria loess on the Plains. It is best recognized by a yellow color where the Late Pleistocene soil is absent (the color is caused by iron oxy-hydroxides), but especially because of secondary mica and sulfide minerals such as pyrite, bornite and chalcopyrite. The loess is preserved at site 5GF1323 (Miller et al. 2009) on the north slope of Battlement Mesa east of the town of the same name, at site GF109 near Una Bridge on the Colorado River, and at site 5ME15398 (Miller et al. 2011b) north of Loma, Colorado. Sometimes the B and C horizons of the Late Pleistocene soil are preserved in limited areas; the lower B or eluvial horizon is normally red because of hematite formation while the C horizon is almost white due to secondary calcite content. Preserved fragments are reported in small exposures on the flanks of Battlement Mesa (Conner et al. 2006c), at Indian Creek (Miller 2010), and near the Grand Junction airport (McIntyre and Miller 2010). Camel bones were discovered on the top of the lower B horizon at a paleontological locality on the Collbran pipeline which follows the Sunny Side Road between Collbran and Debeque, Colorado (Conner et al. in progress.).

The first period of deflation took place in the so called Clovis Drought (after Haynes 1991), and a subsequent loess deposition is coeval with the Younger Dryas. The second phytogenic deposit spans the Pleistocene-Holocene boundary, but is thin and intermittently preserved. Consistent but discontinuous exposures are present in the upper reaches of Indian Creek, south of Whitewater, Colorado, and spotty remnants are scattered along the base of the Book Cliffs (Conner et al. 2006c, McIntyre and Miller 2010, Miller et al. 2011b). Both site 5GF1323 near Battlement Mesa, Colorado, and the McHatten Reservoir Site (5EA909) near Eagle, Colorado, have partially preserved deposits of the period. The poor preservation is due to aridity and deflation in the early Holocene, but the fact that any is preserved at all is largely because of frost heave during the Younger Dryas. Frost heaved pebbles and small cobbles (up to about 15cm in size) armored part of the deposit and increased surface roughness limited deflation. The cobbles identify the top of the preserved portions of the loess. Lack of coarse particles from provenance eliminates the obvious evidence and this is one reason there are few frost heaved particles on top of Late Pleistocene loess.

The period of early Holocene aridity and dune formation is poorly represented in the surrounding area. The Grand Valley offers good terrain for the development of dunes, however the major sediment producers — Green River (Eocene) and Mancos (Cretaceous) formations have mostly clay and silt and is poor source material for dunes. Clay dune cores (also called dissipation features) are relicts of the period. Sand-sized clay fragments were originally deposited in moving aeolian deposits and the provenance clay altered and dissipated under sub-aerial weathering. Two dissipated dune features were recorded by Conner et al. (2006a) in association with a small playa and more have been identified in the upper reaches of Indian Creek (Miller 2010). At Indian Creek, clay dune cores or dissipation features are located in the western part of the government section in the upper reaches, east of the wind gap or constriction in the valley. The hummocky nature of Salt Creek north of Loma and Mack, Colorado, and west of the area described in Conner et al. (2006a), is partially due to aeolian deposits formed in the early Holocene. The isolated remnants of clay dune cores are up to 0.5m thick and the latest formed are preserved on top of Kaycee equivalent alluvium on broad alluvial valleys occupied by ephemeral streams. In loess deposits, this period is represented by an unconformity or a centimeters-thick layer of coarser, poorly sorted deposits formed by deflation and sheet flow alluvial erosion, technically an unconformity.

Four phytogenic aeolian deposits were deposited after about 6500 BP, separated by unconformities and identified by the alterations caused by in-place weathering and soil formation. The middle Holocene loess (and the one formed during the Younger Dryas) exhibit the greatest degree of weathering and accumulation of secondary minerals. The middle Holocene loess was deposited and both were weathered in-place during the middle Holocene amelioration. The middle Holocene loess normally makes up half to two-thirds of the total thickness of the post 6500 loess deposits. The three late Holocene loesses are imperfectly preserved, thin sheets and shadows deposited during cooler-moister intervals between 2800 and 2200, 1800 and 1000, and between 600 and about 150 BP.

The deposits are identified and separated by secondary minerals and soil structure. The middle Holocene loess deposit tends to shrink when drying and forms desiccation cracks, and when re-wetted, the cracks close up because of clay swelling. These characteristics identify a higher percentage of smectite in middle Holocene loess deposits, and also lend to the formation of prismatic soil structure. The structure is enhanced by secondary calcite produced by in-place weathering or accumulated via airfall and has a pale yellow color because of the calcite and secondary iron oxy-hydroxide minerals goethite and limonite. The deposit was also effected by frost heave and displays small, prism- and plate-shaped pebbles that exhibit long axes perpendicular to the bedding planes (see Tabor 1929 for factors affecting frost heave) and mineral rinds formed by mineral exclusion during ice formation (see Dever 1992). The upper contact or unconformity is armored because of a combination of deflation and frost heave that concentrated rocks on the surface.

The middle Holocene loess has broad exposure in the GJRA and is commonly 1.0-1.5m thick (e.g., at site 5GF1323 along Indian Creek and on the benches south of the Colorado River), but thinner on the north side. At site 5GF1323, the middle Holocene loess is underlain by an unconformity representing the early Holocene droughts, which in turn is underlain by the latest Pleistocene-early Holocene loess which contained a Foothill-Mountain tradition component. A Middle Archaic McKean lanceolate point was recovered from the top of the unit and confirms the age of the deposit (Miller and Smith 2010). About 30 to 40cm is the maximum thickness along the base of the Book Cliffs, near the Grand Junction airport (McIntyre and Miller 2010) and at 5ME15398 north of Loma (Miller et al. 2011b). Loess deposits on the upper terrace of Douglas Creek include 20-30cm of late Holocene loess deposits, most belonging to the second and third late Holocene loess (data are summarized in Miller and Nelson 2010), otherwise loess and alluvium is inter-bedded. Womack (1975) noted aeolian deposits between his alluvial units A and B on Douglas Creek, the equivalents of alluvial strata II and III in Miller and Nelson (2010), which are the Kaycee equivalent and middle Holocene alluvial units respectively. These aeolian deposits are middle Holocene loess deposits for the most part.

Late Holocene loess deposits have more illite, the common marine clay derived from Mancos Formation (Cretaceous). Soil structure in the upper three loess deposits varies with increased weathering. The first late Holocene loess normally exhibits a strong blocky structure; the second, a weak blocky or platy structure; and the third or latest, a platy or crumb structure, or no structure at all. In general, secondary smectite and calcite increases with depth, but never equal the quantity of the same secondary minerals in the middle Holocene loess. The expression of structure depends on a certain amount of clay from provenance, and the expression is diminished where source clay is less abundant. The thickness of each of the late Holocene loess sheet deposits varies from a few centimeters to a maximum of about 20 to 30cm. Deposits in shadow areas are deeper.

Correlation of Alluvial and Aeolian Deposits

The correlation of erosion and deposition in the alluvial and aeolian systems is implied by the dates of the deposits (discussed fully in a later part), but a quick summary is appropriate for clarification. During cooler-moister intervals, alluvial channels are downcutting and have increased power reflected by coarser deposition in incised channels, and phytogenic loess deposits are stabilized and slowly accumulating. During warmer-drier periods, deflation in loess deposits (or the general surface as was the case in the early Holocene) coincides with fine clastic deposition filling incisions. Massive early Holocene alluvial deposition correlates to active aeolian processes and sand sea formation, and many small, early Holocene dune fields derived provenance material from sediment choked drainages (Miller 1992).

A Synopsis of Late Quaternary Geologic History in the Region

Based on an analysis of the area's late Quaternary stratigraphy, the geologic history of the last 15,000 years follows this general scenario. Late Pleistocene dissection scoured channels during the Late Glacial and deposited thick sequences of large, boulder-sized, gravel in most drainages. About 13,000 BP the glaciers were retreating and capacity and competence decreased. The period 13,000 to 11,000 BP is identified by Haynes (1991) as the Clovis drought. In areas dominated by aeolian processes, deflation occurs.

The Younger Dryas, the last gasp of the glacial period, takes place around Folsom times. Drainages are rejuvenated and the late Pleistocene-early Holocene loess is deposited. Between 10,000 and 6500 BP, the long drought hits (interrupted once around 8500 BP, coincident with archaeologically defined Pryor Stemmed occupations). Aeolian sand seas form in Colorado, Wyoming and Nebraska and drainages throughout the mountain west are choked with sediment and become braided; these are Kaycee equivalent deposits. Dunes form in places in western Colorado and are later preserved as clay dune cores, but Kaycee equivalent deposits varying from a few to several meters in thickness are ubiquitous in the nearby Grand Valley. The Pleistocene extinctions take place early in this interval and Paleoindian big game hunters are replaced by Archaic hunter-gatherers.

Cooling temperatures between 6500 and about 4500 BP sustained the middle Holocene incision. Capacity and competence increased, but not to the levels achieved during the Late Glacial. As a consequence, when incision exposed Late Glacial gravel, stream power was insufficient to erode the gravel and a cycle of channel widening was initiated in most drainages. Away from drainages, the middle Holocene loess accumulated. After about 4500 BP, warming temperatures led to erosion of the loess by 3500 to 4000 radiocarbon years ago as well as the deposition of the middle Holocene alluvium. House pits were in wide use in the Rocky Mountains, Wyoming Basin, and Colorado Plateau in the interval, suggesting more sedentary populations; Yarmony Site in Eagle County and site 5ME16789 near Battlement Mesa are local examples. McKean Complex is well represented in western Colorado during the latter part of the interval and the period of transition to warmer climates that followed.

Droughts in the late Holocene are best dated by periods of erosion, i.e., lacunas, identified by unconformities in loess deposits. Erosion in loess took place between 3500 and 2800, 2200 and 1800, and 1000 and 600 BP, and again in the last 150 years or so. The first interval coincides with the Middle to Late Archaic transition and the third interval coincides with the Medieval drought in Europe. In the alluvial system, deposition of the middle alluvium ended after the first arid interval, usually by 2500 BP. The first of Lightning equivalent alluvium is deposited during the second arid interval, starting as early as 2500 BP. As the suggested dates imply, the two deposits are nearly continuous and appear this way in sediment choked drainages, but on other ephemeral and small perennial streams, the deposits are more easily separated.

CHRONOLOGY OF LATE QUATERNARY ALLUVIAL DEPOSITS IN THE REGION

There are sufficient ^{14}C dates from alluvial deposits in western Colorado to suggest a chronology for alluvial deposits since the end of the Ice Age (Table 3.1). These include: dates from Douglas Creek (Creasman 1981, Baker 1992, Hauck 1993, Hayden et al. 2008); No Thoroughfare Canyon in the Colorado National Monument (plus odd dates obtained from Red Canyon and Cactus Park; Scott et al. 2001); Sieber Canyon in McInnis Canyons National Conservation Area (Aslan 2005); the Dolores River in the Uncompaghre uplift (Aslan and Hayden 2008); an unnamed drainage west of McCoy, Colorado (Aslan n.d.); Indian Creek, south of Grand Junction, Colorado, (Horn et al. 1987; Lamm 1987, Miller 2010), from Gibbler Gulch, near Cactus Park (Jones at al. 2010), and another unnamed drainage at site 5ME16789 on the west flank of Battlement Mesa (Conner et al. in progress).

Dates obtained from Kaycee equivalent deposits are few but consistently older than 6500 BP. A gravel deposit in the bottom of Sieber Canyon dated to 9610±40 BP (Aslan 2005), another in No Thoroughfare Canyon dated to 9190±90 BP (Scott et al. 2001). Scott et al. also report a date of 8600±60 in Cactus Park obtained from a sample 2m below the surface but offer no other description. The youngest date from the top of the Kaycee equivalent deposit, 7110±50, comes from Indian Creek (Miller 2010). Extinct Pleistocene fauna have been reported from the base of the Kaycee equivalent alluvium in East Creek by Hunt (in Wormington and Lister 1956) and on No Thoroughfare Creek by Scott et al. (2001). These dates and findings are consistent with Kaycee equivalent alluvium elsewhere. Lower Kaycee equivalent alluvial deposits date to around 10,000 BP (e.g., Haynes 1968, 2009; Frison 1978,

Table 3.1. Radiocarbon dates from the region.

Description	BP	Sigma	Lab No.	Site No.	Reference	Location	Comment
Kaycee equivalent ⇓	7110	50	Beta 252923	5ME699	Miller 2010	Indian Creek	minimum age of deposit
	8600	60	W2169		Scott et al. 2001	Cactus Park	2m below surface
	9190	90	W1736		Scott et al. 2001	No Thoroughfare Canyon	gravel at base
	9610	40	**		Aslan 2005	Sieber Canyon	gravel at base
Misc. Alluvium ⇓	5170	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	5940	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect. GG
	2580	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
Middle unit ⇓	2940	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3030	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3060	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3150	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3310	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3340	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3350	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3490	40	**		Aslan and Hayden 2008	Little Dolores River	base of unit
	3590	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3840	50	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	3910	*	**		Hayden et al. 2008	Douglas Creek	base of unit
	4110	70	Beta 184864	5EA2145	Aslan n.d.	Unnamed creek, McCoy, CO	near base of unit

Description	BP	Sigma	Lab No.	Site No.	Reference	Location	Comment
	4150	80	Beta 12619	5ME1373	Horn et al. 1987, Lamm 1987	Indian Creek	lower part of unit
	4170	220	Beta 12631	5ME1373	Horn et al. 1987	Indian Creek	middle unit
	4300-4000	*	**		Hayden et al. 2008	Douglas Creek	base of unit
	4300	80	Beta 12629	5ME1373	Horn et al. 1987	Indian Creek	middle unit
	4450	140	Beta 12621	5ME1373	Horn et al. 1987	Indian Creek	middle unit
	4460	160	Beta 12617	5ME1373	Horn et al. 1987	Indian Creek	middle unit
	4580	100	Beta 12630	5ME1373	Horn et al. 1987, Lamm 1987	Indian Creek	lower part of unit
	4840	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
Gravel at base of middle unit ⇓	3850	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect. GG
	4640	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect. GG
	4790	60	**		Aslan 2005	Sieber Canyon	gravel overlying bedrock
	4900	50	W2443		Scott et al. 2001	No Thoroughfare Canyon	base of unit
	4990	110	Beta 12618	5ME1373	Horn et al. 1987	Indian Creek	above basal gravel
	5030	50	**		Aslan and Hayden 2008	Little Dolores River	base of unit
	5060	60	W2444		Scott et al. 2001	No Thoroughfare Canyon	base of unit
	5380	50	W2442		Scott et al. 2001	No Thoroughfare Canyon	middle of exposure
	6880	60	**		Aslan 2005	Sieber Canyon	gravel overlying bedrock

Description	BP	Sigma	Lab No.	Site No.	Reference	Location	Comment
Lightning equivalent ⇓	120	40	**		Jones et al. 2010	Gibbler Gulch	Qt1, sect. CH
	140	40	**		Aslan and Hayden 2008	Little Dolores River	lowest terrace
	140	40	**		Aslan 2005	Sieber Canyon	lowest terrace
	220	40	**		Jones et al. 2010	Gibbler Gulch	Qt1, sect. CH
	480	40	**		Aslan and Hayden 2008	Little Dolores River	upper part of terrace
	590	50	**		Aslan 2005	Sieber Canyon	upper part of terrace
	610	40	**		Aslan and Hayden 2008	Little Dolores River	lowest terrace
	630	40	**		Aslan 2005	Sieber Canyon	lowest terrace
	830	100	Beta 54578	5RB3339	Baker 1992	Douglas Creek	1m below surface
	980	50	Beta 56585	5RB3498	Hauck 1993	Douglas Creek	upper 10-20cm of deposits
	1010	50	Beta 56589	5RB3498	Hauck 1993	Douglas Creek	upper 10-20cm of deposits
	1100	100	Beta 6098	5RB2445	Arthur 1983	Douglas Creek	2m below surface
	1150	50	W4246	5RB726	Creasman 1981	Douglas Creek	flood plain
	1280	50	W1734***		Scott et al. 2001	No Thoroughfare Canyon	upper 2m of deposit
	1290	50	Beta 56591	5RB3499	Hauck 1993	Douglas Creek	in open trench
	1300	50	W4249	5RB726	Creasman 1981	Douglas Creek	flood plain
	1300	50	Beta 56588	5RB3499	Hauck 1993	Douglas Creek	in open trench
	1380	80	Beta 56592	5RB3498	Hauck 1993	Douglas Creek	upper 10-20cm of deposits
	1390	40	**		Aslan and Hayden 2008	Little Dolores River	upper 10-20cm of deposits

Description	BP	Sigma	Lab No.	Site No.	Reference	Location	Comment
	1630	90	Beta 56593	5RB3498	Hauck 1993	Douglas Creek	upper 10-20cm of deposits
	1645	65	UGa2420	5RB726	Creasman 1981	Douglas Creek	flood plain
	1760	275	UGa2424	5RB726	Creasman 1981	Douglas Creek	flood plain
	1900	60	Beta 54579	5RB3339	Baker 1992	Douglas Creek	1m below surface
	1970	50	W1734		Scott et al. 2001	No Thoroughfare Canyon	upper 2m of deposit
	2100	40	**		Aslan and Hayden 2008	Little Dolores River	gravel overlying bedrock
Surface of Kaycee equivalent ⇓	3400	60	Beta 12625	5ME1373	Horn et al. 1987	Indian Creek	1 of 5 ages in ~15cm of deposits
	3590	110	Beta 12633	5ME1373	Horn et al. 1987	Indian Creek	1 of 5 ages in ~15cm of deposits
	3800	40	Beta 242812	5ME699	Miller 2010	Indian Creek	overlain by colluvium
	3980	60	Beta 12628	5ME1373	Horn et al. 1987	Indian Creek	1 of 5 ages in ~15cm of deposits
	4040	70	Beta 12622	5ME1373	Horn et al. 1987	Indian Creek	1 of 5 ages in ~15cm of deposits
	4560	70	Beta 12623	5ME1373	Horn et al. 1987	Indian Creek	1 of 5 ages in ~15cm of deposits
	7110	50	Beta 252923	5ME699	Miller 2010	Indian Creek	overlain by sheet flow alluvium
Mixed loess & sheet flow alluvium ⇓	370	40	Beta	5ME16097	GRI, in prep.	Collbran pipeline	3rd late Holocene loess
	500	40	Beta 267655	5ME113	GRI, in prep.	Collbran pipeline	2nd/3rd late Holocene loess
	950	50	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR

Description	BP	Sigma	Lab No.	Site No.	Reference	Location	Comment
	1140	40	Beta 248413	5ME699	Miller 2010	Indian Creek	min. age of 2nd late Qh loess deflation
	1230	40	Beta 249414	5ME699	Miller 2010	Indian Creek	upper part of 2nd late Holocene loess
	1300	60	Beta 267640	5ME16102	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1330	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	1450	60	Beta 267651	5ME16971	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1480	40	Beta 267652	5ME16971	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1520	60	Beta 267638	5ME16102	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1530	60	Beta 267644	5ME16129	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1630	70	Beta 267643	5ME16129	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1720	40	Beta 267635	5ME113	GRI, in prep.	Collbran pipeline	2nd late Holocene loess
	1770	40	**		Jones et al. 2010	Gibbler Gulch	Qt?, sect. TR
	1980	40	Beta 267646	5ME16549	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	1980	60	Beta 267631	5GF4337	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	1990	40	Beta 267634	5GF4351	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2020	50	Beta 267633	5GF4337	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	2060	60	Beta 267636	5ME948	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	2100	60	Beta 267630	5GF4337	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	2110	80	Beta 12614	5ME1373	Horn et al. 1987	Indian Creek	top of 1st late Holocene loess
	2130	90	Beta 267650	5ME16783	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2190	40	Beta 267654	5ME16859	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part

Description	BP	Sigma	Lab No.	Site No.	Reference	Location	Comment
	2200	40	Beta 267645	5ME16134	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2210	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect. GG
	2220	60	Beta 267641	5ME16105	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2230	60	Beta 267632	5GF4337	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	2240	50	Beta 267642	5ME16105	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2340	60	Beta 263483	5ME16784	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2370	40	W2073		Scott et al. 2001	Red Canyon	1.5m below surface
	2380	80	Beta 267629	5GF4337	GRI, in prep.	Collbran pipeline	1st late Holocene loess, upper part
	2380	40	**		Aslan 2005	Sieber Canyon	upper part of terrace
	2400	40	Beta 267648	5ME16785	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2480	60	Beta 267647	5ME16785	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2490	40	**		Jones et al. 2010	Gibbler Gulch	Qt2, sect.PR
	2590	50	Beta 267639	5ME16102	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2620	70	Beta 267653	5ME16858	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2750	40	Beta 248411	5ME699	Miller 2010	Indian Creek	base of 1st late Holocene loess
	2760	70	Beta 263484	5ME16786	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2790	40	Beta 267649	5ME16715	GRI, in prep.	Collbran pipeline	1st late Holocene loess
	2970	40	Beta 267656	5ME16716	GRI, in prep.	Collbran pipeline	contact of middle/1st late Holocene loess
	3210	100	Beta 12620	5ME1373	Horn et al. 1987	Indian Creek	min. age of late/mid Qh loess deflation
	3680	40	Beta 267637	5ME16097	GRI, in prep.	Collbran pipeline	middle Holocene loess
	4600	40	Beta 263487	5ME16789	GRI, in prep.	Collbran pipeline	middle Holocene loess
	5810	40	Beta 263485	5ME16789	GRI, in prep.	Collbran pipeline	middle Holocene loess
	5990	40	Beta 263486	5ME16789	GRI, in prep.	Collbran pipeline	middle Holocene loess

1991; Davis 1989; Miller 1992, 1993; Haynes et al. 1998; Kornfeld 1998; Surovell et al. 2005). Upper Kaycee equivalent deposits contain Early Archaic or Late Paleoindian and Foothill Mountain projectile points (e.g., Frison and Stanford 1982; Miller 1995; Miller et al. 1993) and ^{14}C dates (summarized in Miller 2010), and indicate that the end of deposition of Kaycee equivalent alluvium was generally around 7500 BP. The youngest date in upper Kaycee equivalent deposits is about 7100 BP from Indian Creek, south of Whitewater, Colorado.

Incision of Kaycee equivalent deposits in the middle Holocene produced gravel deposits. In inset deposits, the gravel from middle Holocene rejuvenation mingles almost imperceptibly with Late Glacial Gravel, but in stacked sequences. Gravel deposits mark the depth of erosion before deposition of the middle Holocene alluvium refilled the incision partially or completely. Dates on Seiber Canyon that Aslan (2005) calls "basal" dates of 4790±60 and 6880±60 BP are in gravel overlying bedrock and are typical of rejuvenation phases; the younger date is probably associated to middle Holocene rejuvenation. The broader implication of these dates is that older deposits were stripped in some reaches of Sieber and other canyons during the middle Holocene amelioration.

A date of 4990±110 comes from the base of "high energy" alluvium in a channel incised in older alluvium on Indian Creek (Horn et al. 1987) and equivalent deposits in No Thoroughfare Canyon have three "basal" dates between 5060±60 and 4900±50 BP, and a fourth date of 5380±50 BP in the middle, out of sequence (Scott et al. 2001). These probably mark the bottom of the middle Holocene deposits. Hayden et al. (2008) report calendar dates 4300-4000 and 3910 years ago (unfortunately, conventional ^{14}C dates are not reported by Hayden et al.) at the base of the middle unit on Douglas Creek, which are at least close, and Aslan and Hayden (2008) report dates of 5030±50 and 3490±40 BP in their lower Qt2 deposit, near bedrock on the Dolores River. Fourteen ^{14}C dates obtained at Gibbler Gulch by Jones et al. (2010) from the Qt2 terrace range between 5940 and 2580 BP and most of these are probably from the middle Holocene unit; five later dates from the deposits below the Qt2 surface range from 2490 to 950 BP and are loess and alluvium overlying the middle unit. At Indian Creek, south of Whitewater, a series of six dates between 4150±80 and 4580±100 BP are from the lower part of the middle unit (Horn et al. 1987; Lamm 1987). Fill in an unnamed drainage west of McCoy, Colorado, had a date near the base of 4110 BP (Aslan n.d.), and fill derived from slope wash in a former Pleistocene drainage at site 5ME16789 began accumulating after 4600 BP (Conner et al. in progress). The end of deposition is between 3000 and 2500 BP; the deposits (and other surfaces at the time) are almost always overlain by late Holocene loess deposits that routinely date to 2800 BP or less.

Aslan and Hayden (2008) report two 1390±40 BP dates and a 480±40 BP date from the upper part of the Qt2 deposits along the Little Dolores River, and the upper part of Aslan's (2005) Qt2 deposits in Sieber Canyon have seven dates ranging from 2380±40 to 590±50 BP. These dates are obtained from mixed loess and alluvial deposits although not identified as such. Scott et al. (2001) report dates of 1950±50 and 1280±50 BP in the upper 2.0m of No

Thoroughfare Canyon deposits, and a 2370±40 BP date 1.5m below the surface in Red Canyon. Jones et al. (2010) report five dates ranging from 2490 to 950 BP on Gibbler Gulch in the upper part of the Qt2 deposit; these are from mixed loess and alluvium. Creasman (1981) excavated two sites in loess on Douglas Creek; one of these, the Brady Site (5RB726), was on the flood plain of Douglas Creek south of Rangely, Colorado, and produced four radiocarbon dates in the upper 30-40cm ranging from 1150±50 to 1760±275 BP. Hauck (1993) reports on two sites in the upper reaches of Douglas Creek that are also contained in the mixed loess and alluvium. At 5RB3498, three hearth features in the upper 20-30cm of the mixed deposits dated between 980±50 and 1630±90 BP. Two ^{14}C dates obtained from a feature in the same deposits at 5RB3499 are 1300±50 and 1290±50 BP. Arthur (1983; cited in Baker 1992) produced a radiocarbon assay on a salvaged hearth feature at site 5RB2445 that dated to 1100±100 BP and Baker (1992) completed radiocarbon assays on archaeological features at site 5RB3339 nearby and returned two dates of 1900±60 and 830±100 BP, the former about 2m below the present surface, and the latter about a meter below the present surface. There is a much heavier alluvial component derived from a Douglas Creek tributary in deposits considered in the Arthur and Baker reports.

To summarize the two preceding paragraphs, the oldest date of fill above middle Holocene gravel is about 4500 BP and the oldest date of deposits overlying middle Holocene alluvium is about 3000 to 2500 BP. These dates bracket the deposition of middle Holocene alluvium in the surrounding area. Gravel deposits associated with the middle Holocene amelioration or rejuvenation date from after 7000 to about 4500 BP.

Lightning equivalent deposits normally date after 2800 BP in inset channels and Lightning equivalent overbank deposits are mixed with loess on the flood plains. The Qt1 deposits identified by Aslan (2005) in Sieber Canyon are Lightning equivalent deposits and produced four dates ranging from 140±40 and 630±40 BP. In Qt1 deposits along the Little Dolores River, four dates were obtained ranging between 140±40 and 610±40 BP (Aslan and Hayden 2008). A fifth date of 2100±40 BP was produced from gravel overlying bedrock but was discarded by the authors; it is probably a good date and represents Lightning equivalent deposits. Two dates of 120 and 220 BP were reported by Jones et al. (2010) on Gibbler Gulch from Qt1 deposits, the partial equivalent of Lightning Formation. Lightning equivalent alluvium is still being deposited.

Miller (2010) summarizes the depositional histories of 60 alluvial valleys in a multi-state area based on reported ^{14}C dates or *in situ* diagnostic artifacts for chronological control. Miller completed 18 of the studies and visited most of the other locations. The specific studies were mostly concentrated in Colorado and Wyoming (22 each), but others are in Nebraska (5), Montana and North Dakota (3 each), South Dakota and Kansas (2 each), and Texas (1). The dates of alluvial deposits near the rockshelter are consistent with dates suggested for the equivalent deposits over a large region. Late Glacial gravel is older that 10,000 BP. Kaycee equivalent alluvium was deposited between 10,000 and 7000 BP, and the middle

Holocene alluvium, between 4500 and 2500 BP. Lightning equivalent alluvium began deposition after 2500 BP and continues today.

Avulsion in the 19th and 20th Centuries

Many drainages were filled with sediment in the 1800s and underwent down cutting since the turn of the 19th and 20th centuries. Miller and Nelson (2010) refer to this episode of downcutting as a product of avulsion, the normal reworking of sediment dumped into the alluvial system after transition to a warmer, drier climate following the Little Ice Age. The post AD1882 incision and intermittent deposition on Douglas Creek is a good example of the process. The recent downcutting was researched in some detail by Womack (1975) using journals, interviews, aerial photographs, and tree-ring data, and his work was supplemented by observations by Miller and Nelson (2010).

Womack identified as many as seven inset cut terraces with new deposits in places along Douglas Creek, but nowhere was the number consistent — a fact confirmed by Miller and Nelson. All apparently formed after AD1900 based on oral and written records from early explorers, notably Escalante, and local residents. Womack indicates no significant downcutting occurred on Douglas Creek before AD1900, despite the fact that Soil Conservation Service records from the Meeker, Colorado, (cited in Womack 1975) that show 27,000 cattle were brought in during AD1885. Apparently, overgrazing had no immediate effect; an informant indicated that Douglas Creek could be crossed almost anywhere with a horse and buggy (cited in Womack 1975). Miller and Nelson (2010) suggest the episodic erosion along Douglas Creek since AD1900 is related to short term climate cycles rather than changes in land use.

Chronology of Late Quaternary Aeolian Deposits in the Region

The most important series of ^{14}C dates obtained from loess deposits in the region come from the Collbran Pipeline project (Conner et al. in progress). Dates and diagnostic artifacts from about 20 sites span the middle and late Holocene, from about 6000 BP to the present. The largest number of these sites were contained in mixed late Holocene loess and sheet wash (or sheet flow) alluvium less than 3000 radiocarbon years old and were uncovered during surface blading. The rest were contained in middle Holocene loess and mixed alluvium, or on the contact between middle and late Holocene deposits, and were exposed during trench excavations.

Other sites contributing to the aeolian chronology include 5GF1323 (Miller and Smith 2010) near Battlement Mesa; it has only one date from the late Pleistocene, but *in situ* diagnostic artifacts from Foothill-Mountain, McKean Complex and Late Prehistoric/ Formative components date the deposits. The McHatten Reservoir site (5EA909; Metcalf et al. 2010) near Eagle, Colorado, produced a few dates, but the deposits are otherwise dated with diagnostic artifacts as well. Site 5ME15398 north of Loma (Miller et al. 2011b) and 5ME12585 (Martin et al. 2006) contribute dates or associated diagnostics. Dates obtained from middle Holocene and later loess deposits are available from Indian Creek (Horn et al. 1987, Miller and Smith 2010). Creasman (1981), Hauck (1993), Scott et al. (2001), Aslan and Hayden (2008), and Aslan (2005) provide additional dates from loess deposits.

The Late Pleistocene loess was deposited during the Late Glacial and was initially deflated or otherwise eroded after the end of the Ice Age, ca. 13,000 BP, in the so called Clovis drought (Haynes 1991). Remnants of the Pleistocene soil are partially preserved on top of the Late Pleistocene loess and other deposits; locally, relics are identified near the Grand Junction airport (McIntyre and Miller 2010), on Battlement Mesa (Conner et al. 2006c; Miller and Smith 2010), at Indian Creek, south of Whitewater (Miller 2010), and north of Loma (Conner et al. 2006b; Miller et al. 2011b).

The late Pleistocene-early Holocene loess, a phytogenic sheet deposit, is widespread but poorly dated. Pryor Stemmed and Late Paleoindian projectile points come from its upper contact at Indian Creek, and two Foothill Mountain projectile points were recovered near the contact at 5GF1323. Pryor Stemmed points from 5ME15398 north of Loma are likely from the same deposit there. Dates on the deposit in western Wyoming are 9650 and 9560 BP (Miller and Bower 1986, Miller and James 1986). At site 5GF109 near Una Bridge, the well sorted Late Pleistocene loess grades almost imperceptibly into later loess deposits. Lack of coarse sediment particles from provenance at the latter site make the actual contacts difficult to define.

The deposits in the arid early Holocene are limited. The clay dune cores from the interval are undated, but a major unconformity marks the period of aridity in other deposits at 5GF1323, 5GF109, 5ME12825, 5ME15398, and other sites. More significant aeolian and mixed sheet flow alluvial deposits collected in natural sediment traps at 5ME16789 and McHatten Reservoir (5EA909) stabilized about 6000 BP (the dates obtained are 5990 and 5910, respectively).

After surface stabilization, the accumulation of the middle Holocene loess continued until sometime before 3200 on Indian Creek (Miller 2010); a 3800 BP date also comes from the deposit there. Six dates from deposits overlying Kaycee equivalent deposits on Indian Creek range from 4560 to 3400 BP; most are from the middle Holocene loess. Archaeological features that produced dates of 3680, 4600 and 5810 BP on the Collbran pipeline are also contained in the deposit (Conner et al. in progress).

There are three late Holocene, phytogenic loess sheet deposits. On the Collbran pipeline, the upper two sheets contain fewer dated occupations (represented by eight ^{14}C dates from five sites) because surface deflation turned hearth features into thermally altered rock scatters or thin reworked ash and charcoal stains or layers.

Archaeological components in the first late Holocene loess deposit are better preserved because of cementation of the deposits that contain them, although many cultural features show evidence they were deflated to some degree before burial or during later erosional episodes. Twenty dates from the first late Holocene loess from 14 sites on the Collbran pipeline range between 2790 and 1980 BP (Conner et al. in progress). Two dates from a deposit at Indian Creek are 2750 and 2110 BP (Miller 2010).

Less well preserved, seven hearth features in the second loess sheet range from 1720 to 1320 BP and date components on sites 5ME113, 5ME16102, 5ME16129, and 5ME16791 on the Collbran pipeline. Two dates from the upper part of the deposit at Indian Creek are 1230 and 1140 BP. Undated, poorly preserved features on sites 5GF4352, 5ME16114, 5ME16548, 5ME16691, 5ME16787, and 5ME16857 were in unconsolidated loess and are also less than 2000 years old. A Late Archaic projectile point found on the surface of 5ME16782 points to deflation of the upper two late Holocene loess deposits and part of the first late Holocene loess deposit as well. Large lithic scatters on sites 5ME16133 and 5ME16860, a large midden on site 5ME16117, and a mix of lithic and historic materials at site 5ME16790 probably all date to the last several centuries. Only one feature at 5ME113 on the Collbran pipeline produced a date in the third late Holocene loess, around 500 BP. Five dates from upper Qt2 deposits in Gibbler Gulch range from 2490 to 950 BP and were obtained from the late Holocene loesses and mixed alluvial deposits.

Three gaps in the radiocarbon record after 6500 radiocarbon years ago mark periods of erosion between 2970-2790 BP, 1980-1720 BP, 1300-500 BP, and on the Collbran pipeline. More accurate dates (summarized in Miller 2010). For periods of erosion (deflation) are from 3500-2800 BP, 2200-1800 BP, and 1100-600 BP. Interestingly, Jones et al. (2010) record charcoal layers in Gibbler Gulch they believe are evidence of natural fires, but the radiocarbon frequency curve exactly mimics the cultural radiocarbon frequency curve for the Collbran pipeline.

Climate Summary

Geologic evidence can identify changes in climate within a scale of hundreds of years, but lacks precision when compared to tree-ring data. The sequence of deposition and erosion is easy to see, but dating the sequence with radiocarbon dates obtained mostly from cultural features presents its own challenges. Furthermore, although the changes due to climate change are visible in the stratigraphic record, the boundary conditions that favor deflation over deposition in loess deposits or trigger fine clastic deposition in alluvial valleys are not precisely known. Nevertheless, a coarse summary of climate based on alluvium and aeolian deposition can be suggested (Figure 3.1).

The end of glacial conditions came around 13,000 BP. An early drought, called the Clovis drought by Haynes (1991), caused erosion and is associated with most of the Pleistocene extinctions. Glacial conditions returned in the Younger Dryas between 11,000

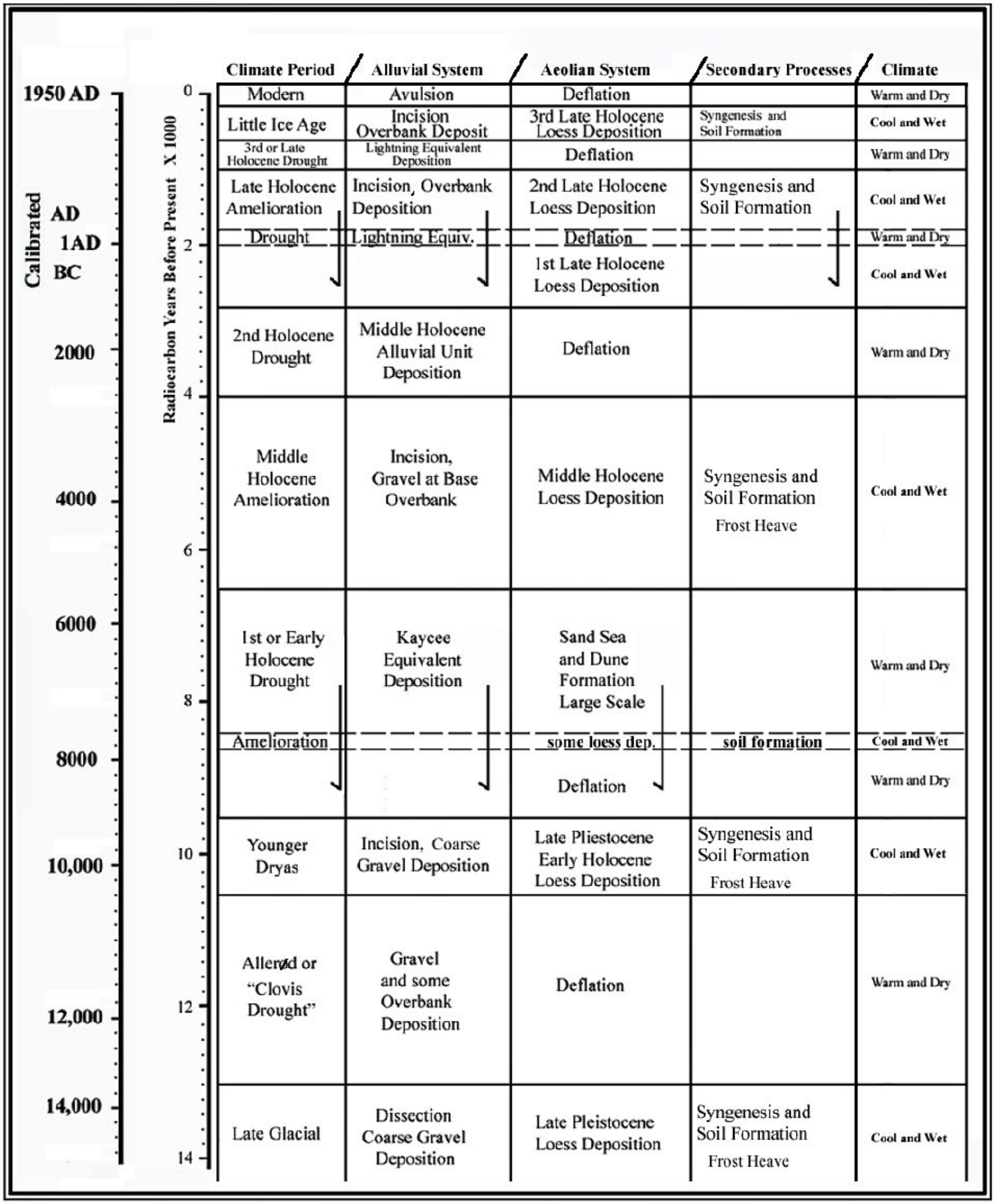


Figure 3.1 Holocene Paleoclimatic Variation.

and about 9500 BP. Severe drought in the early Holocene lasted from 9500 to 6500 radiocarbon years ago, interrupted once around 8500 BP, which coincides with Pryor Stemmed. After 6500, climate ameliorated. Conditions between 6500 and 4500 BP approached but did not exceed conditions during the Late Glacial; changing plant communities, frost heave, geochemical or in-place weathering, and lake levels all point to cooler conditions. Droughts interrupted the generally cooler-moister conditions after 6500 BP, with major periods of drought identified between 600 to 1100, 1800 to 2200, and 2800 to 3500 BP. After about 150 years ago, conditions caused deflation and alluvial deposits shifted in fits and starts downstream.

CHAPTER 4

MIDDLE ARCHAIC, LATE ARCHAIC AND LATE PREHISTORIC OCCUPATION OF THE WESTERN SLOPE

The Western Slope of Colorado has been occupied at different times and places throughout the Holocene epoch. However, site 5GF741 was demonstrably utilized only in three discrete periods; the Middle Archaic, the Late Archaic, and the Late Prehistoric. As such, the site represents a relatively small fraction of the complex culture history of the region. Absent are the Paleo-Indian and Early Archaic portions of the record. So too are the Early Agricultural and Formative cultures. Early Agricultural Period sites were coeval, in part, with the early portion of the Late Archaic occupation. And the Formative period (Anasazi and Fremont) was coeval with the last portion of the Late Archaic, terminating at roughly the same time. The temporal relationships of the various cultures are shown in Figure 4.1. Labels executed in black represent cultures in evidence at 5GF741. Those labeled in blue are Western Slope cultures that did not utilize the site (or, at least, there was no evidence of such occupation). While there undoubtedly was significant interaction among coeval cultures, we will only summarize the current knowledge for the three occupations attested to by the scant cultural evidence recovered from 5GF741 (see chapters on Excavation and Conclusions). The cultural and temporal periods not covered herein have been treated in detail in Conner et al. (2011) and Reed and Metcalf (1999).

MIDDLE ARCHAIC

Evidence of Western Slope occupation during the Middle Archaic Period, ca. 5000-2500 BP, from excavation data greatly expands in comparison to any preceding period. The Middle Archaic roughly corresponds to a cool moist period in the second half of Millers' Middle Holocene Amelioration (see Chapter 2). It is evidenced by a wide variety of projectile point styles covering large regions of the Intermountain West, with the greatest influences coming from the Great Basin and the Wyoming Basin. The occurrence at several sites of radiocarbon dates from this period on multi-component sites suggests that subsistence and settlement strategies were indeed logistically organized on ecological economic zones that radiated out from a household residential base. In fact, this adaptation had become so well established that what may have once been simple household residential bases had now become true base camps, which later metamorphosed into localities that were repeatedly and systematically re-occupied. This is demonstrated in several sites which contain multiple radiocarbon dates from this period, including: Debeque Rockshelter (5ME82); the Taylor Site (5ME97); the Indian Creek Site (5ME1373); TZ Shelter 1 (5ME4828); the Rapid Creek Site (5ME4971); and the Turkey Tailfeather Site (5ME11465). It is especially evident at the Indian Creek Site where the architectural remains of three shallow house pits were identified. House pits also occur at 5ME16784 and 5ME16786, dated 2340±60 BP and 2760±70 BP, respectively.

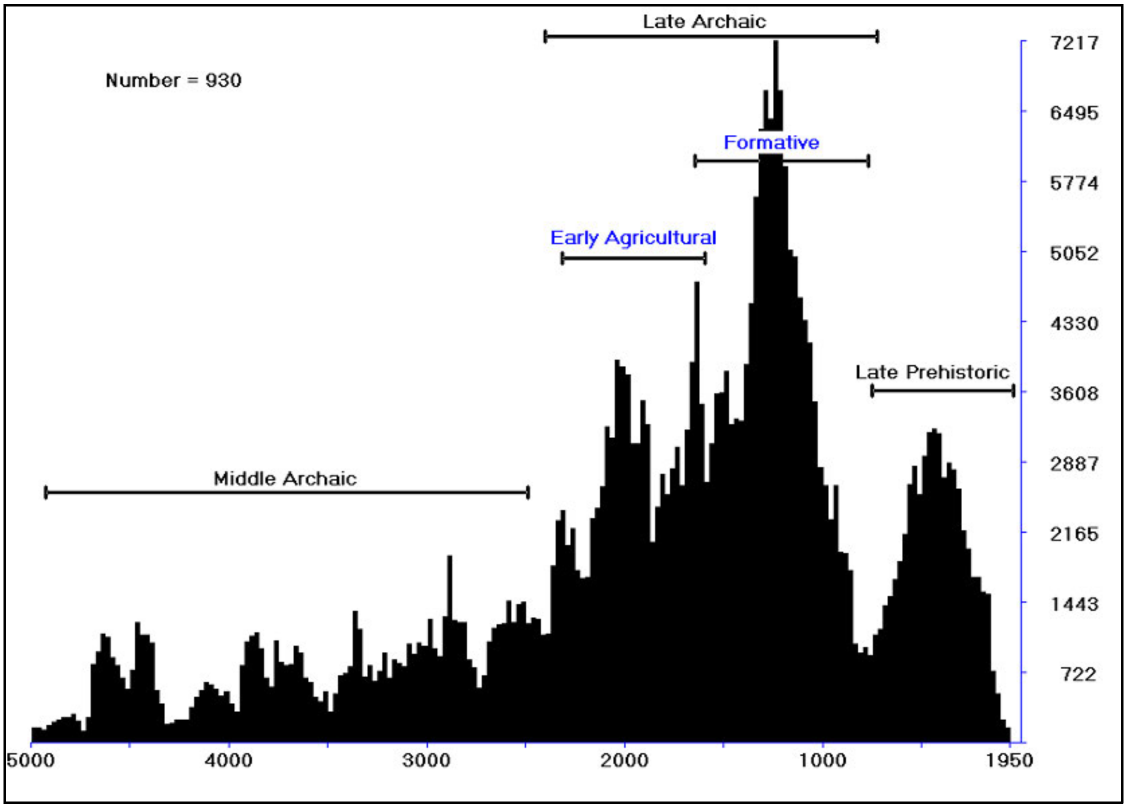


Figure 4.1. Histogram of Radiocarbon Dates from the Western Slope.

The Middle Archaic roughly corresponds with latter portion of the Neoglacial period, which exhibited an overall increase in effective moisture and cooler temperatures. On the Colorado Plateau, these conditions were conducive to the expansion of the pinyon pine forest northward from New Mexico into central Colorado and eastern Utah by around 4150 BP (Berry and Berry, 1986). With the advent of these more favorable environmental conditions, a shift by the aboriginal populations down to the middle and lower elevation levels would have been comfortably feasible (Figure 3.2).

By about 3400 BP, the pinyon forest again expands northward with pinyon and juniper trees present in the canyon bottoms and washes.

Climatic fluctuations occurred during this period and two distinct dry episodes are recorded by Petersen (1981) for the La Plata Mountains and by Chen and Associates for the Battlement Mesa area (Conner and Langdon 1987:3-17). Data supporting the first dry episode is derived from excavations conducted in the Alkali Creek Basin (located just north of the Gunnison Basin) and reported by Markgraf and Scott (1981). Their study indicates the presence of a montane pine forest at an elevation of 9,000 feet until ca. 4550 BP. The environmental model prepared for Battlement Mesa Community shows an accumulation of windblown silts ca. 4550 BP (at the end of an extended, increasingly dry episode of the Neoglacial period) and again ca. 2500 BP.

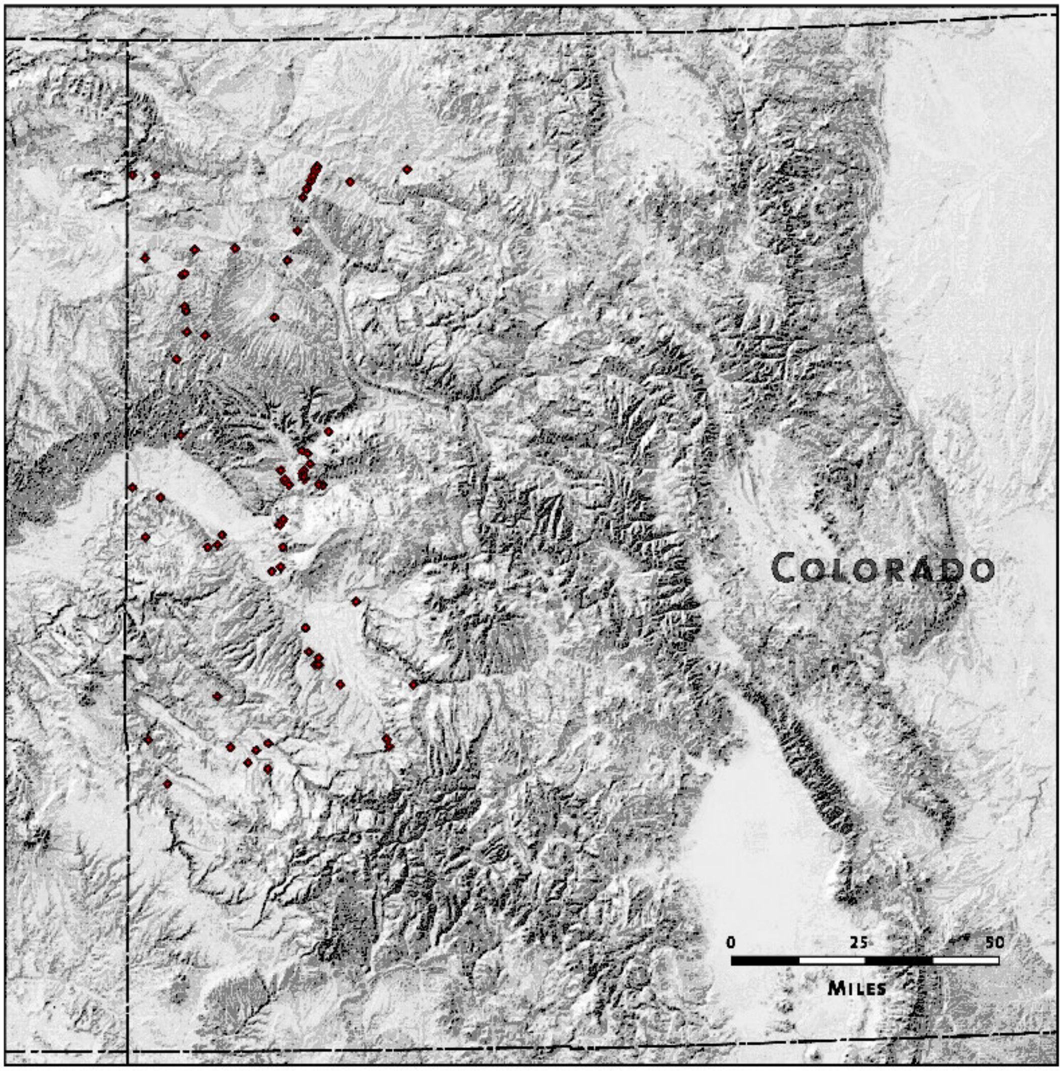


Figure 4.2. Distribution of Middle Archaic Sites on the Western Slope.

Between 4300 and 4000 BP, the increased moisture allowed the pinyon pine to expand northward from New Mexico into central Colorado and eastern Utah, and it became a major component of the La Plata Mountains in southwestern Colorado. By about 3400 BP, pinyon/juniper forest is present in the canyon bottoms and washes of the Colorado Plateau. This period exhibits stabilization of dune fields and reversion to sagebrush steppe of much of the area covered in desert shrub communities. Consequently, increased game populations and a wider variety of edible plants were available to the human populations at lower elevations.

The Middle Archaic is distinguished on the basis of increased variability in material culture. Reed and Metcalf (1999:79) also suggest that this period is characterized by less sedentisim in settlement patterns and perhaps greater seasonality in the use of higher elevations. Archaeological evidence for this patterned seasonal transhumance is found in the remains of shallow basin structures and their associated artifacts identified from this period at the Indian Creek Site near Whitewater (Horn et al. 1987) and in the Gunnison Basin at Curecanti Reservoir (Euler and Stiger 1981; Jones 1986).

Another set of synthetic temporal units used to describe the various Archaic stage manifestations is the phase sequence developed principally from excavations within eastern Utah by Schroedl (1976) for the northern Colorado Plateau. For the Western Slope, Buckles (1971) developed a synthetic phase sequence for the Archaic of the Uncompahgre Plateau. Neither set fits well with the other, except for the period between about 5150 BP and 3150 BP, where both researchers recognized changes in the projectile point types. This resulted in the creation of three phase sequences for each. Whereas Schroedl was able to arrange his three phases (Late Castle Valley, Early Green River, Late Green River) in sequential order based upon multiple radiocarbon dates and deeply stratified deposits containing different frequencies of projectile point types, Buckles had only two radiocarbon dates and a multiplicity of projectile point types from poorly stratified and mixed deposits. Consequently, he created three overlapping, nearly coeval phase sequences (Monitor Mesa, Shavano, and Robideau).

This same 2000 year span also corresponds with the San Jose and Armijo phases identified by Irwin-Williams (1973) for the Oshara Tradition, and the projectile point types present in Buckle's Uncompahgre Complex represent many of the types found in both the sequences posited by Schroedl and Irwin-Williams. Accordingly, the multiplicity of projectile point types evident in the Uncompahgre Complex may be a manifestation of the frontier and boundary effects between the northern and southern Colorado Plateau typologies.

There also appears to have been sporadic contact with Plains Middle Archaic groups as defined by Frison (1978) and evidenced by diagnostic artifacts associated with the McKean Techno-complex. Again, such finds indicate that there was frontier contact between highly mobile bands of hunters and gatherers during the Middle Archaic Period due to improved climatic conditions, which provided opportunities for exploration. It may well be that there are no fixed or well-defined boundaries present and that all the groups are generally operating in an open, free interaction zone within West-central Colorado.

Several diagnostic Middle Archaic projectile point types have been defined. McKean Lanceolate points, of the McKean Complex, date from after 5000 BP to as late as 3000 BP (Frison 1991:89) on the Plains and somewhat more recently on the Western Slope. A similar point type has been identified by Buckles (1971:164,165) in the Uncompahgre area. Buckles suggests that the most complete specimen within Type 39 of the Uncompahgre Complex resembles a McKean Point; however, "the specimen is heavily ground which is not a McKean Point characteristic and it has oblique parallel flaking which, although not well executed, is not a characteristic of McKean Points either" (Buckles 1971:164).

In addition, Reed and Metcalf (1999:85) note that: "Stemmed points include a variety of styles ranging from contracting stem points generally subsumed under Gypsum, Elko

Contracting Stem, and Gatecliff Contracting Stem categories; stemmed indented base points (Lister 1953), including Duncan-Hanna McKean variants; and a wide range of unnamed points with straight to convex to distinctly rounded bases."

Contracting stem points from the Great Basin and northern Colorado Plateau have temporal distributions ranging from about 4000 BP to 1500 BP (Holmer 1986:105). Stemmed indented base points such as the Duncan and Hanna of the McKean Complex roughly date from 4000 to 3000 BP (Frison 1991:24). Reed and Metcalf (1999:85) obtained dates of 4600 to 3200 BP for the Duncan and Hanna points in the Yampa Valley. It may be that the stemmed points graded into corner-notched points, obscuring the boundaries between these two broad categories. However, Davis and Keyser (1999:251) propose that the three McKean complex point types functioned within a multiple weapons system involving the atlatl and thrusting spear: Duncan-Hanna points were atlatl darts while McKean Lanceolates, and possibly Mallory points, were used on thrusting spears. Projectile point morphology, breakage and rejuvenation data, and analogies from prehistoric rock art and ethnographic sources, were used to develop and support this hypothesis.

Side-notched points exhibit variable morphological attributes ranging from straight to convex to concave basal edges and/or straight to convex blade edges. Notches vary from shallow to deep and can either be situated near the base of the point (low notches) or higher on the blade (high notches). Pronounced basal indentations or basal notching of side-notched points in the area is rare; however, basally indented, side-notched points are well recognized on the Northern Plains and constitute a cultural complex known as Oxbow. In general, side-notched points tend to predate 3000 BP. Examples of side-notched points indicative of the Archaic include: Elko Side-notched, Bitteroot, Northern Side-notched, Hawken, Mallory and Mt. Albion types.

Corner-notched points, primarily Elko corner-notched, occur in some frequency but the temporal range is broad and poorly controlled. Thus, they are not of particular diagnostic utility.

Important in the understanding of the Archaic Era in western Colorado is that it exploited multiple biotic zones based upon changes in elevation: the desert shrub (<4600 ft.), the pinyon-juniper belt (4600 - 6500 ft.), the pine-oak belt (6500 - 8000 ft.), the fir-aspen belt (8000 - 9500 ft.), and the spruce-fir belt (9500 - 10,500 ft.). The occurrence of storage and habitation structures within some of the biotic zones of the region have been documented.

Notable is the Yarmony site, which contained two pithouses that dated to the Early Archaic Period. The occupation of House 1 dated 7131±67 BP and House 2 dated 6884±83 BP (Metcalf and Black 1991:57). This site is in the pine-oak belt at an elevation of 7140 feet. Other Early and Middle Archaic period sites with structural features are also found at altitudes of 8000 feet or more in Colorado. What apparently were pole and mud structures have been found both in the Curecanti National Recreation Area near Gunnison and the Windy Gap site near Granby. Radiocarbon dates of between 8000 to 3300 BP from the Curecanti sites compare well with Windy Gap's dates of 7960 to 3750 BP (Cassells 1983:73-80). Nearer to the McClane Rockshelter, three basin shaped, roughly circular depressions approximately 3m in diameter and 25cm deep were identified at the Indian Creek Site, 5ME1373, located southeast of Grand Junction (Horn et al. 1987). The features were determined to be evidence of pole and brush structures with peripheral and centrally located post holes and no internal hearths. Though they were not radiocarbon dated, they were stratigraphically dated to the middle of the Archaic Era.

LATE ARCHAIC

The Late Archaic (2500-650 BP), as noted earlier, was coeval with both the Early Agricultural and Formative occupations of the Western Slope. In combination, these three cultural entities represent a significant increase in the number of sites and, by inference, population density. The level of interaction or degree of symbiosis between hunter-gatherers and farming groups is yet to be determined. What is clear is that Late Archaic adaptive strategies reached a pinnacle of intensification. Such intensification is reflected in heightened processing of seeds and other lower rate-of-return resources, cultigen manipulation, and evidence of a shift to the bow and arrow. The Archaic lifeway likely continued as a successful strategy for hunter-gatherer groups until 650 BP; a date coincident with the onset of the "Great Drought" over much of the Southwest and the northern Colorado Plateau. The same drought led to the abandonment of the region by Formative period populations.

The Late Archaic period witnessed population increase from the outset, peaking at 1250 BP. The Turkey Tailfeather Site, the Indian Creek Site, Debeque Rockshelter, the Taylor Site; and the TZ Shelter Site continued to be favored localities. Projectile point styles indicate influences from the Great Basin and the Wyoming Basin, as well as contacts with the Southwest. Figure 4.3 shows the distribution of Late Archaic and Formative sites on the Western Slope.

The initial portion of the Late Archaic Period appears to consist primarily of climatic conditions somewhat similar to the present with periodic fluctuations between cooler and wetter, cooler and drier, or hotter and drier conditions, depending upon geographic location. The same seasonal patterns of floral and faunal exploitation probably continued much as they had during the Middle Archaic Period. However, uncertainty caused by the fluctuating environmental conditions, coupled with increasing population densities coincident with Formative development, may have led to changes in social organization and a greater necessity to define group territories and home ranges. This may have been due to pressures from outside groups trying to relocate as a result of adverse environmental conditions in other areas. But, it appears that at various times, ecological niches in the different biotic zones provided conditions stable enough for the maintenance of a sedentary or semi-sedentary lifestyle.

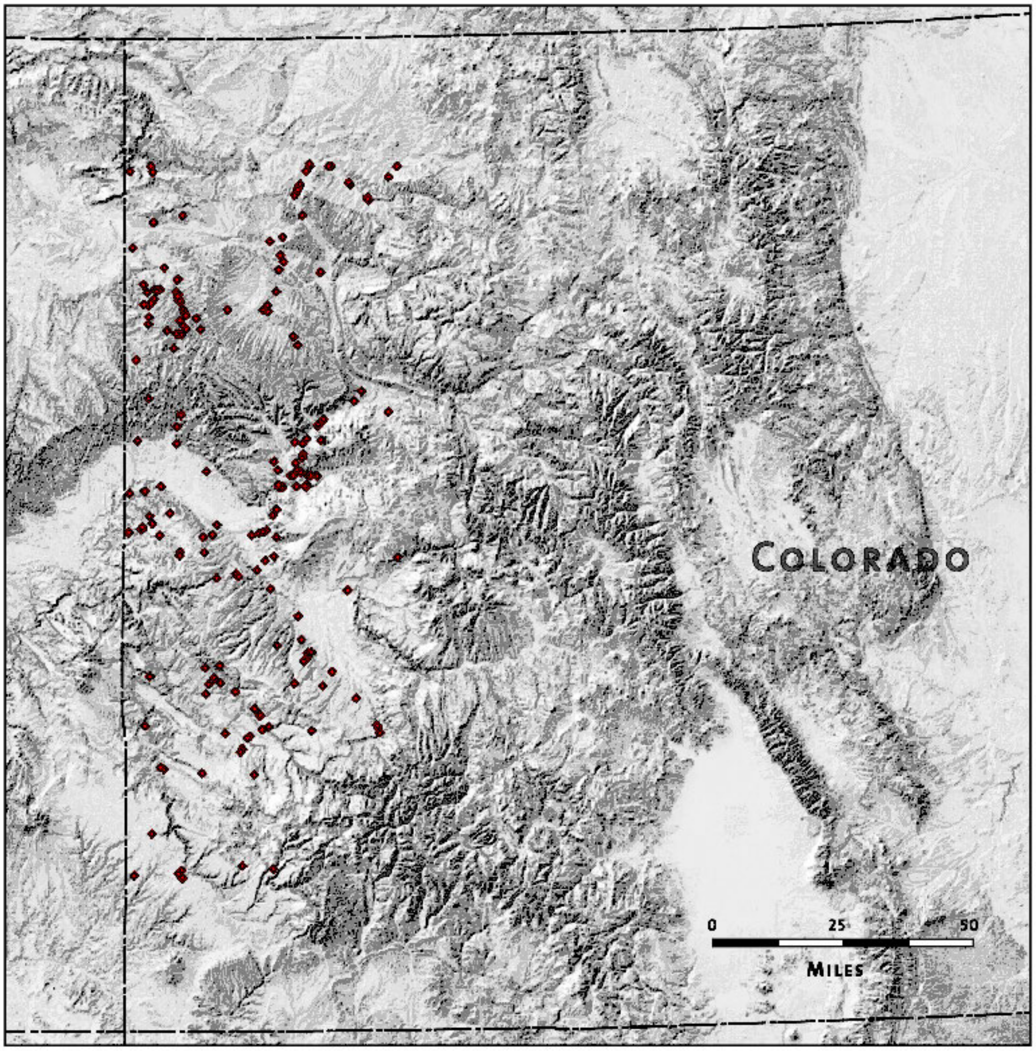


Figure 4.3. Distribution of Late Archaic and Formative Era Sites on the Western Slope.

Three sites in west-central Colorado that roughly date to the beginning of the Late Archaic period contained structural remains. Colorado Department of Highways archaeologists found linear, low-walled (10-40 cm) surface structures and a burial site, 5EA128, near Dotsero. Nothing was recorded within the structures; however, a burial found in an adjacent crevice yielded a C-14 date of 2910±55 BP (Hand and Gooding 1980).

A pithouse excavated at 5GF126, the Kewclaw Site, in the townsite of Battlement Mesa, had a roughly circular floor four meters in diameter, a central hearth, and walls that rose abruptly 30 to 60 centimeters. The walls showed evidence of having been smoothed with water or mud glazed. Eight small, shallow holes around and within the pithouse and a single large hole at the center of the floor implied the presence of a superstructure, presumably constructed of wooden poles. This site dated 2770±60 BP and may be a cultural relative of the Dotsero burial site (Conner and Langdon 1987:7.44).

The Sisyphus Rockshelter, located just north of the Colorado River and east of the town of Debeque, contained the ruins of a structural feature within the overhang of Late Archaic origin and dating 2410±70 BP. Uncovered were remains of a sandstone slab-lined, rectangular floor and three stone foundation walls assumed to be a habitation structure (Gooding and Shields 1985:56).

One final aspect of importance during this critical period concerns the introduction or development of the bow and arrow, a major technological innovation over the preceding atlatl and dart. Exactly when this change occurred is controversial, but the majority of the available data indicate ca. 1650 BP.

LATE PREHISTORIC PERIOD

The dissipation of the Late Archaic and Formative cultures coincident with the drought of 650 BP was followed by the influx of new people from the western and central Great Basin. The newcomers are referred to as the Numic speakers of the Uto-Aztecan language phylum (Smith 1974:10). Their appearance in the Fremont territory of Utah by ca. 750 BP is indicated by finds of Shoshone pottery mixed with the upper strata of Fremont artifacts in numerous cave sites (Jennings 1978:235). Aikens and Witherspoon (1986) have proposed a model that includes an environmentally induced extinction of non-Numic inhabitants and an expansion of Numic foragers that occupied the Great Basin for at least 5000 years. They contend that the Numic were coexisting with non-Numic foragers and horticulturalists during the Formative period when the regional climates were relatively warm and wet. During times of aridity, non-Numic farmers and wetlands foragers would have abandoned optimal areas, which, in turn, were re-occupied by Central Numic foragers. Similarly, Simms (1986, 1990) suggests that Numic speaking foragers may have coexisted with Fremont farmer-foragers throughout the Formative Stage, and Jorgensen (1994:85) using linguistic and ethnographic data placed the Numic spread at about 2000 years ago.

The Numic Speakers brought to the Colorado Plateau a change in subsistence pattern. According to Bettinger and Baumhoff (1982:496-500), the Numic Speakers concentrated more heavily on small seed gathering and the hunting of large game over shorter distances, and thus exploited a smaller catchment. The technology for small seed gathering and processing was more advanced than was known to pre-Numic peoples and allowed support of larger populations. This strategy brought economic pressure to bear upon groups who did not practice it. Thus, the subsistence pattern that had been followed throughout the Archaic Period and altered slightly by the Fremont horticulturalists was supplanted entirely by the Numic scheme of procurement. Such a strategy was probably born of the needs created by changing climatic conditions and/or by increased population densities in the southwestern Great Basin (Bettinger and Baumhoff 1982:496-500).

The Numic expansion began in earnest beginning about 600 years ago with the onset of the Little Ice Age (Petersen 1981). Cooler temperatures affected the growing of corn and the horticulturalists retreated to the south. The broad spectrum hunting and gathering of the Numic maintained itself as a successful adaptation. In the archaeological record for the period after 650 BP, Desert side-notched and Cottonwood Triangular projectile points predominate. Post ca. 550 BP marks the appearance of Uncompahgre Brown Ware ceramics. Though once thought to date back into the Formative Period, luminescence dates on sherds from sites within the study area and adjacent regions indicate the appearance of Uncompahgre Brown Ware generally postdates that time. Reed, et al. (2001:41-9) provide additional luminescence dates that generally support this observation, though an early date of 650 BP cannot be ruled out.

A variety of floral and faunal items were used by the Numic speakers. Textiles (basketry and other woven items) were made from squaw-bush, willow, and juniper bark (Smith 1974:91). Seeds and pinyon nuts were processed for food using grinding and milling stones. Other floral resources collected seasonally were serviceberry, chokecherry, currant, raspberry, elderberry, wild rose, sego lily, wild onion, and wild carrot. The hunting and trapping of rodents, deer, mountain sheep, elk, and bison are illustrated in the rock art (Conner and Ott 1978).

One of the most prominent features of Historic Ute sites is the wickiup and it is likely that similar structures were used in the Late Prehistoric period as well. There exists evidence from numerous archaeological investigations that have taken place in Colorado and elsewhere that habitations and shelters have been manufactured for thousands of years with wooden superstructures incorporated into their construction (Stiger 2005: personal communication; Metcalf and Black 1991; Conner and Langdon 1987; Cassells 2003). It is likely that a significant percentage of prehistoric campsites included temporary shelters. This is based on the premise that, in all temperate and harsh-weather regions of the world shelters were necessary for human survival, or at minimum highly desirable. Binford (1990) surveyed housing among the world's foragers (hunters and gatherers) and found that some form of shelter is constructed whenever a foraging group stops, even for a short time. There are no known cases among modern hunter-gatherers where shelter is not fabricated in residential sites (or anywhere hunter-gatherers plan to sleep), regardless of the expected occupational duration, and only in rare instances are sites of any kind produced by hunter-gatherers where no shelter is provided for the occupants (Binford 1990).

Although many of the sites categorized as aboriginal "open architectural" in the OAHP database contain wickiups or brush shelters, all forms of extant wooden and brush features are of interest in terms of categorizing sites as being of Historic Ute affiliation. It is from the early historic and ethnographic records of the then-living native peoples, the photographs and illustrations that accompany them, and the archaeological documentation of the abandoned habitations and camp sites in the times since, that provide us with much of the data from which to formulate definitions and descriptions of wickiups and other forms of ephemeral architecture and perishable features, as found within the western United States. Figure 4.4 shows the distribution of Late Prehistoric sites on the Western Slope.

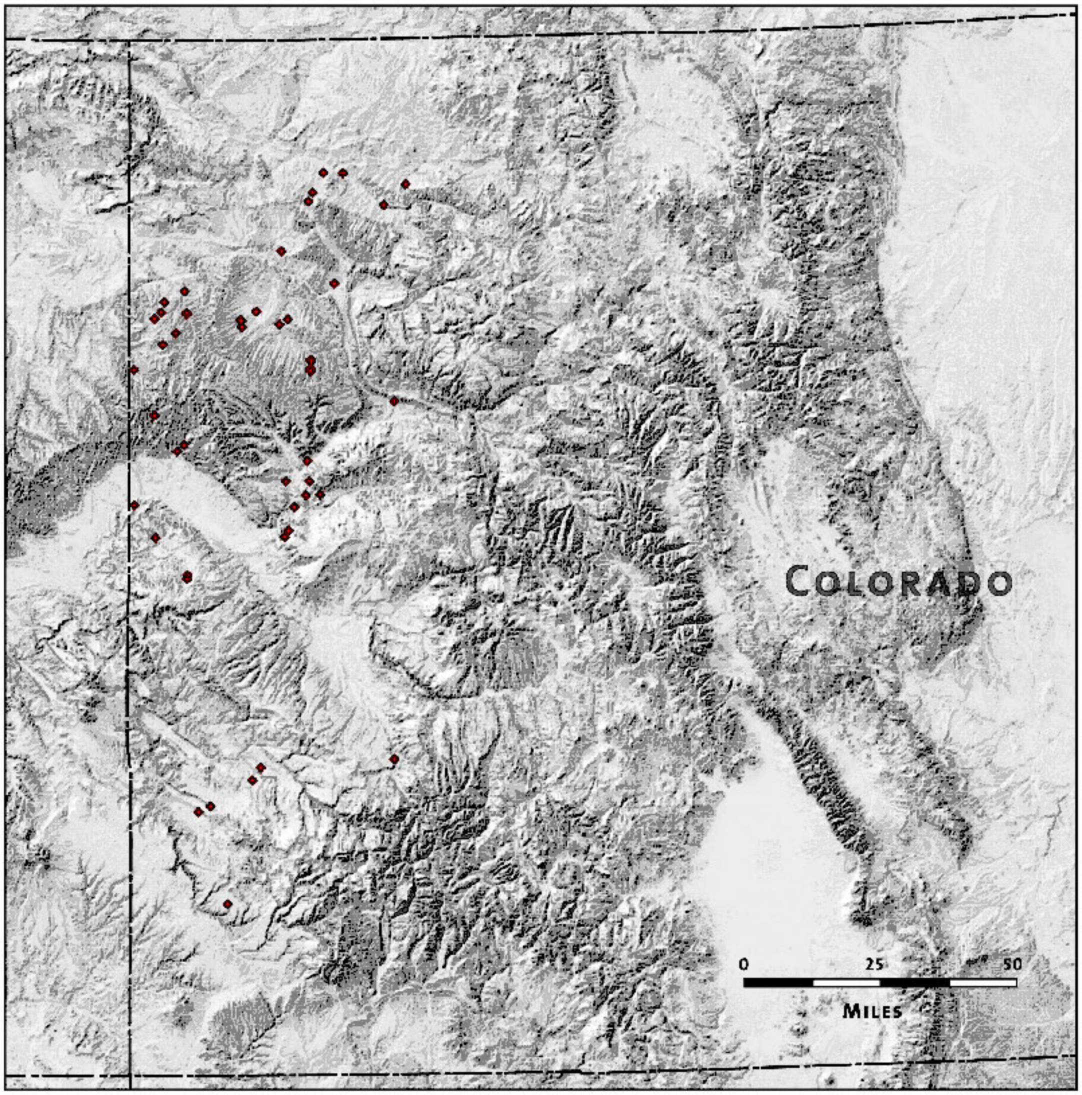


Figure 4.4. Distribution of Late Prehistoric Sites on the Western Slope.

CHAPTER 5

EXCAVATION METHODS AND RESULTS

METHODS

At the beginning of the 2011 excavation, a temporary datum was established by driving a rebar 10 centimeters west of the south end of the test trench and a baseline was set perpendicular. A main datum was established at a later date by drilling a rebar into the back wall of the shelter approximately one meter SSW of the temporary datum. A meridian was placed one meter west of the rebar and the first four 1x1 meter units were set having the west walls on the meridian line. The grid began at the intersection of the baseline and meridian; the southeast corner of unit X0,Y0. Three more units were opened parallel to the old test trench leaving a 10 centimeter balk on both sides of the trench, which was later removed. Three units parallel the east side of the trench and were offset due to the angle of the back wall of the rock shelter and one unit (X2.5,Y0.5) was pushed east to further define components. Unit X3,Y-0.5 was opened in the back southwest corner to further examine the deposits along with the back extension of the overhang into a small alcove with a possible slab-lined storage feature. The depth of the unit floors range from 1.74 meters in X2.5,Y0.5 and half of unit X0,Y1 was taken down to 3.4 meters in search for possible Paleo-Indian components. The plan map for excavation is shown in Figure 5.1. Approximately 10.5 square meters were opened, which represents approximately two-thirds of the area (~15 square meters) under the overhang.

Excavations within the rock shelter were conducted using trowels, brushes, whisk brooms and rock picks particularly when dealing with the back wall and lower deposits. Sediment was removed in arbitrary ten centimeter levels and was sifted through a 1/8th inch hardware cloth in search of cultural materials.

When a feature was identified it was cross-sectioned by removing and bagging half of the fill to identify strata and find living floors. Once complete, the remaining half of the feature fill was collected and brought back to the lab for flotation analysis.

Feature fill was processed by adding the fill to a plastic tub filled with tap water and slowly stirring to transport lighter materials to the top and out through a tube at the top of the tub. The materials were run through a 1/16th inch mesh net, rinsed and the remaining particles were then air dried, and sorted for further analysis.

Pollen and sediment samples were collected within every stratum from what was thought to be the Pleistocene to modern surface from the west wall of unit X0,Y1. Sample boundaries were based on unconformities, which represent drought, and ranged from 2-5cm in height. Pollen samples were taken from between 64-256cm below datum and averaged 302

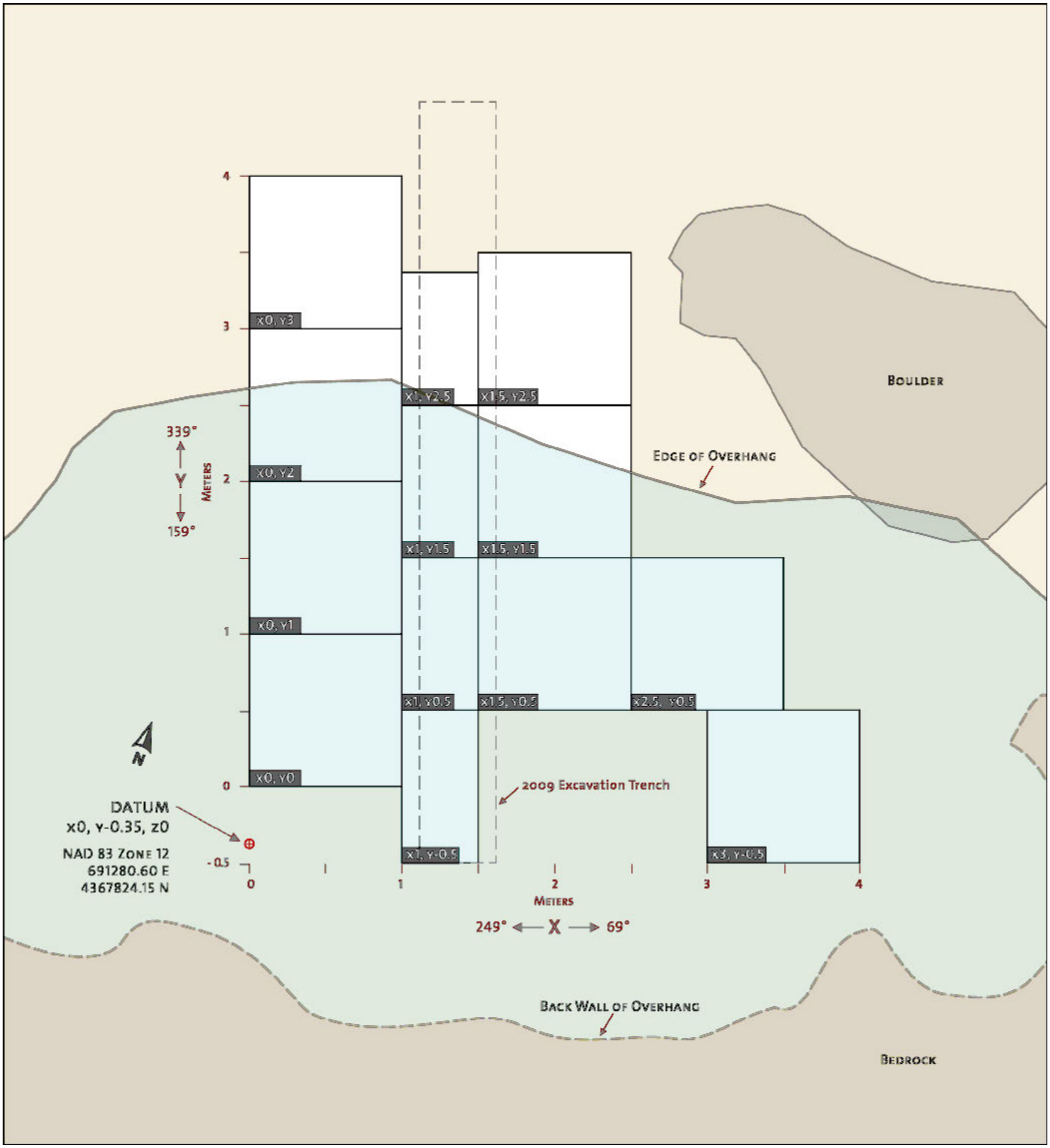


Figure 5.1. Schematic plan view of 2011 excavation units in relation to Shelter #2, 5GF741.

grams in weight. Sediment samples were taken from between 64-263cm below datum averaged 285 grams in weight. A pollen wash was done in the laboratory at Grand River Institute and then sent to the University of Utah, RED Lab for analysis (results p. 5-27). Sediments were examined under a microscope to determine roundness and sphericity, and to better characterize the deposits a Munsell color (wet and dry) was also documented.

Radiocarbon samples were collected using metal tweezers and stored in aluminum foil to prevent contamination. Some samples were taken directly from feature fill float samples. Sample sizes ranged from 2-30 grams. Samples were analyzed by Beta Analytic, Inc.

Twelve 25x25x10cm water screening samples were collected from unit X0, Y1 between the depths of 150-280cm below datum. Samples were sorted through two 1/16th inch mesh screens using a hose, while remaining particles were dried and analyzed under a microscope to classify micro flakes, invertebrates, macro-botanical specimen and bone.

SITE FORMATION PROCESSES AND DEPOSITIONAL CHARACTERISTICS

The depth of deposits within the overhang are known to be about 3.0 meters. The deposits formed via colluvial, alluvial sheet wash, aeolian, geo-chemical, and biological (including human) processes. Colluvial deposits include roof fall, fine-grained sluff generated by mineral precipitation at the rock-atmosphere interface, and drip line debris cascading from the slope above the overhang. Alluvial sheet wash (also called slope wash) is contributed to the shelter from flanking slopes. Aeolian deposits are loess. Geochemistry has altered the lower deposits to a significant extent and in large part is responsible for the formation of the overhang. Finally, biological processes, especially cultural occupation, has had a lasting effect.

Sediment samples were collected from a column in a section of the X0, Y1.5-2.5 profile (Figure 5.2). These were processed and described by James Miller and Carl MyIntyre. Table 5.1 provides a summary of the analyses, which was used to describe the following depositional characteristics of the site.

The lower deposits are colluvial with some sheet wash alluvial deposits. The colluvial elements include roof fall and fine sand and coarse silt sluff caused by geochemical processes (explained below) while the alluvial elements are sheet flow alluvium. The lowermost deposits are suspected of being late Pleistocene in age based on the presence of rhizome and root casts, calcified root tubules, and geochemistry. These deposits are largely unbedded.

The next series of deposits are dominated by sheet wash alluvial processes and range upward to about a meter in thickness. These deposits are considered Late Pleistocene and early Holocene in age, relic of the transition from waning glacial conditions to early Holocene drought when slope instability released massive volumes of sediment into alluvial valleys

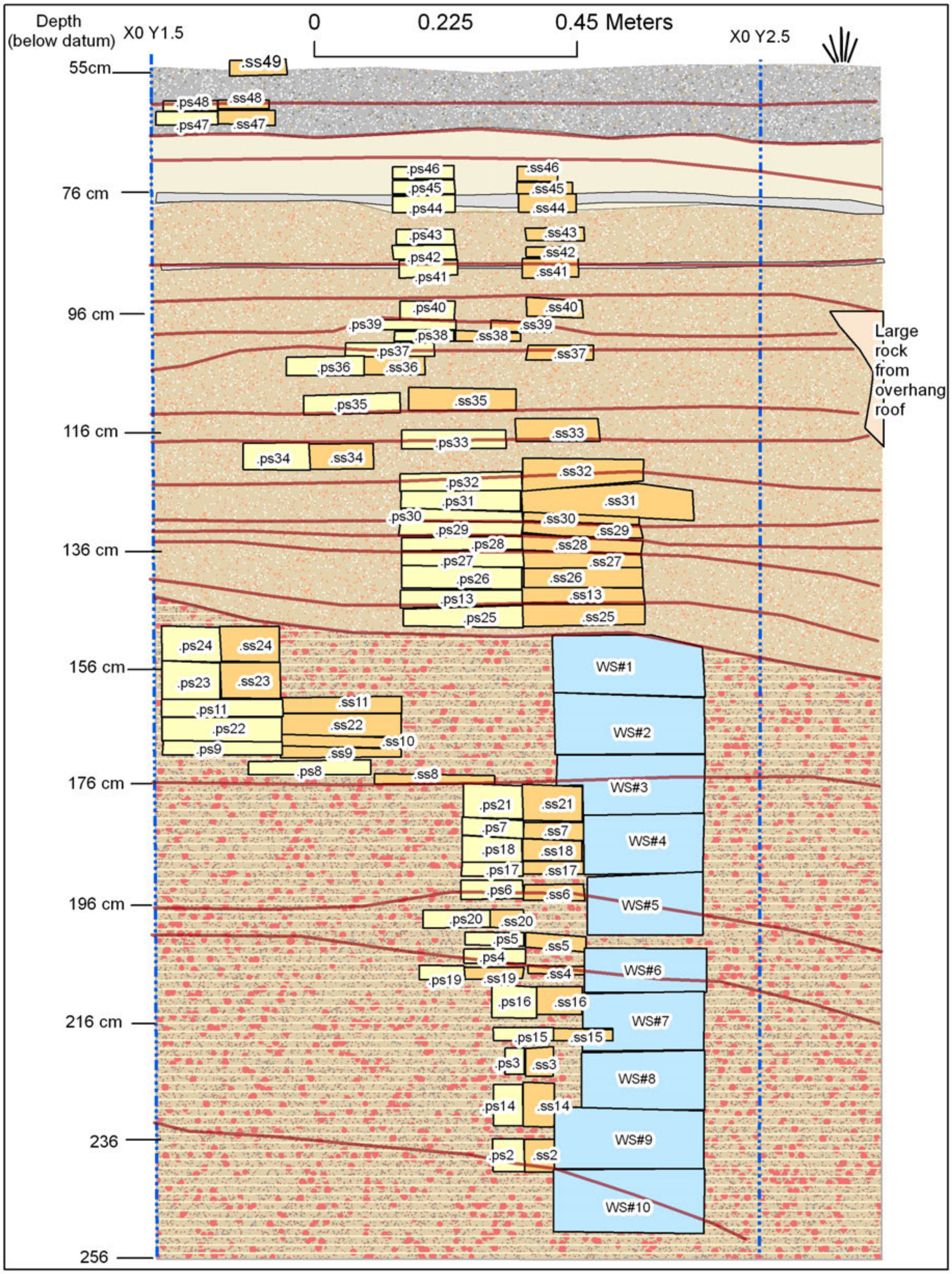


Figure 5.2. Profile showing the locations of sediment (ss), pollen (ps), and water (ws) samples taken from the X0, Y1.5-2.5 profile.

Plate 5.1. X0 wall during sediment, pollen and water screen sampling.

Table 5.1. Sediment sample analyses results for 5GF741. Depth is measured from below permanent datum. Strata is based upon geologic stratigraphy not cultural stratigraphy. [Ang. = angularity; Sph. = sphericity; pH = lower number is more acidic, higher number is more alkaline.]

Sample No.	Grid Unit	Depth	Strata	Ang.	Sph.	Munsell Dry	Munsell Wet	pH	Conductivity mmhos
.ss49	x0, y0.8 to y1.6 (from far back of SW corner)	Surface (roof fall)	VIII	2.5	2.5	2.5y 7/6	2.5y 5/6	7.8	Unavailable
.ss48	x0, y0.8 to y1.6	64-68cm	VIII	3.5	2.5	2.5y 7/4	2.5y 5/4	7.5	40
.ss47	x0, y0.8 to y1.6	68-72cm	VIII	2.5	2.5	2.5y 7/4	2.5y 5/4	7.3	38
.ss46	x0, y0.8 to y1.6	71-74cm	II	3.5	2.5	2.5y 6/4	2.5y 4/2	7.5	32
.ss45	x0, y0.8 to y1.6	72-76cm	II	2.5	2.5	2.5y 6/4	2.5y 4/4	7.3	23
.ss44	x0, y0.8 to y1.6	76-82cm	II	1.5	2.5	2.5y 6/4	2.5y 4/4	8.1	28
.ss43	x0, y0.8 to y1.6	80-83cm	III	2.5	2.5	2.5y 6/4	2.5y 4/4	7.9	29
.ss42	x0, y0.8 to y1.6	89-93cm	III	1.5	2.5	2.5y 6/4	2.5y 4/4	7.1	27
.ss41	x0, y0.8 to y1.6	88-94cm	III	1.5	2.5	2.5y 6/4	2.5y 4/4	7.6	28
.ss40	x0, y0.8 to y1.6	92-98cm	III	2.5	2.5	2.5y 6/4	2.5y 4/4	8.4	25
.ss39	x0, y0.8 to y1.6	99-112cm	III	2.5	-2.5	2.5y 7/4	2.5y 5/6	7.5	27
.ss38	x0, y0.8 to y1.6	100-106cm	III	3.5	2.5	2.5y 7/4	2.5y 5/6	6.7	29
.ss37	x0, y0.8 to y1.6	106-110cm	III	2.5	2.5	2.5y 7/4	2.5y 5/6	7.0	25
.ss36	x0, y0.8 to y1.6	101-108cm	III	3.5	2.5	2.5y 6/4	2.5y 4/4	7.6	37
.ss35	x0, y0.8 to y1.6	107-115cm	III	2.5	2.5	2.5y 6/4	2.5y 4/4	7.4	35

Sample No.	Grid Unit	Depth	Strata	Ang.	Sph.	Munsell Dry	Munsell Wet	pH	Conductivity mmhos
.ss33	x0, y0.8 to y1.6	114-118cm	III	3.5	2.5	2.5y 7/4	2.5y 5/4	7.8	34
.ss34	x0, y0.8 to y1.6	120-125cm	III	2.5	2.5	2.5y 7/4	2.5y 5/4	6.9	41
.ss32	x0, y0.8 to y1.6	120-122cm	III	2.5	2.5	2.5y 6/4	2.5y 4/4	7.5	36
.ss31	x0, y0.8 to y1.6	125-131cm	III	3.5	2.5	2.5y 6/4	2.5y 4/4	8.2	37
.ss30	x0, y0.8 to y1.6	130-132cm	III	2.5	2.5	2.5y 6/2	2.5y 4/2	8.2	41
.ss29	x0, y0.8 to y1.6	132-134cm	III	1.5	2.5	2.5y 7/4	2.5y 5/4	8.5	41
.ss28	x0, y0.8 to y1.6	134-136cm	III	2.5	2.5	2.5y 7/4	2.5y 5/4	8.3	36
.ss27	x0, y0.8 to y1.6	136-139cm	III	3.5	2.5	2.5y 7/4	2.5y 4/4	7.0	36
.ss26	x0, y0.8 to y1.6	139-143cm	III	1.5	-2.5	2.5y 7/4	2.5y 5/4	7.1	38
.ss13	x0, y0.8 to y1.6	143-146cm	VI	2.5	2.5	2.5y 6/4	2.5y 4/4	7.9	40
.ss25	x0, y0.8 to y1.6	146-149cm	III	2.5	4.5	2.5y 6/6	2.5y 4/4	7.2	38
.ss12	x0, y0.8 to y1.6	149-151cm	VI	2.5	2.5	2.5y 6/4	2.5y 4/4	6.8	37
.ss24	x0, y0.8 to y1.6	149-155cm	VI	1.5	2.5	2.5y 6/6	2.5y 4/4	8.2	45
.ss23	x0, y0.8 to y1.6	155-161cm	VI	2.5	2.5	2.5y 6/6	2.5y 4/4	7.9	42
.ss11	x0, y0.8 to y1.6	161-163cm	VI	1.5	2.5	2.5y 6/6	2.5y 4/4	7.6	44
.ss22	x0, y0.8 to y1.6	164-168cm	VI	2.5	2.5	2.5y 6/6	2.5y 4/4	7.2	49
.ss10	x0, y0.8 to y1.6	172-174cm	VI	1.5	2.5	2.5y 6/6	2.5y 4/4	6.6	41
.ss9	x0, y0.8 to y1.6	168-171cm	VI	1.5	2.5	2.5y 6/6	2.5y 4/4	7.3	45
.ss8	x0, y0.8 to y1.6	175-176cm	VI	2.5	2.5	2.5y 7/6	2.5y 5/6	8.4	47

Sample No.	Grid Unit	Depth	Strata	Ang.	Sph.	Munsell Dry	Munsell Wet	pH	Conductivity mmhos
.ss21	x0, y0.8 to y1.6	176-182cm	VI	2.5	2.5	2.5y 7/6	5/62.5y	8.1	43
.ss7	x0, y0.8 to y1.6	183-185cm	VI	3.5	-2.5	2.5y 7/6	2.5y 5/6	8.4	48
.ss18	x0, y0.8 to y1.6	185-189cm	VI	3.5	2.5	2.5y 7/4	2.5y 5/4	7.8	41
.ss17	x0, y0.8 to y1.6	188-190cm	VI	2.5	2.5	2.5y 7/6	2.5y 5/6	7.7	47
.ss6	x0, y0.8 to y1.6	193-196cm	VI	2.5	2.5	2.5y 7/6	2.5y 5/6	8.0	53
.ss20	x0, y0.8 to y1.6	197-200cm	VI	2.5	4.5	2.5y 7/6	2.5y 5/6	8.0	68
.ss5	x0, y0.8 to y1.6	201-204cm	VI	4.5	-2.5	2.5y 5/6	2.5y 7/6	8.3	58
.ss19	x0, y0.8 to y1.6	207-209cm	VI	1.5	2.5	2.5y 7/4	2.5y 5/4	7.7	58
.ss4	x0, y0.8 to y1.6	207-209cm	VI	2.5	4.5	2.5y 7/6	2.5y 5/6	8.5	63
.ss16	x0, y0.8 to y1.6	210-215cm	VI	2.5	4.5	2.5y 6/4	4/42.5y	7.8	62
.ss15	x0, y0.8 to y1.6	217-219cm	VI	1.5	2.5	2.5y 7/4	2.5y 5/4	7.8	68
.ss3	x0, y0.8 to y1.6	219-224cm	VI	2.5	-2.5	2.5y 5/4	2.5y 7/4	8.1	69
.ss14	x0, y0.8 to y1.6	227-234cm	VI	1.5	2.5	2.5y 7/4	2.5y 5/4	7.8	89
.ss2	x0, y0.8 to y1.6	237-241cm	VI	3.5	4.5	2.5y 7/6	2.5y 5/6	8.1	95
.ss1	x0, y0.8 to y1.6	256-263cm (bottom of profile)	VI	2.5	2.5	2.5y 7/6	2.5y 5/6	8.2	121

where much of the sediment is still stored today. These deposits are geochemically modified by groundwater effluence from a local aquifer within the shelter (see below) and interbed with angular, boulder-sized drip line deposits below the edge of the overhang and exterior of the shelter proper.

Overlying the sheet flow alluvial deposits is a series of loess deposits, also up to a meter in thickness, that represent the middle and late Holocene ameliorations. These strata are aged radiometrically and with diagnostic artifacts. The loess deposits interbed with roof fall and fine grained sluff in the back of the overhang and less coarse (cobble-sized) drip line debris below the shelter edge and exterior of the shelter. Increased drip line debris is associated with minor periods of drought and related to slope instability during those periods.

The uppermost deposits include further sheet wash alluvial and loess deposits associated with the droughts that occurred before and after the Little Ice Age. The sheet wash deposits are up to 30cm in depth in one side of the shelter while the loess is 5cm to 10cm thick and interbeds with roof fall and fine grained sluff in the back of the shelter.

The geochemical elements of the site formation processes have had varying effects. The shelter was formed by precipitation of mineral matter at the rock-atmosphere interface. Roof fall and fine grained sluff are a direct result of gypsum, anhydrite (the anhydrous polymorph of gypsum), and calcite. The minerals are transmitted through the local aquifer in a complexed form rather than in a solid mineral phase. When the minerals precipitate close to the rock face, expansion at the interface forms scabs as well as fine-grained sluff which contribute to the deposits inside the shelter, particularly in the back of the shelter.

Aquifer effluence in the bottom of the shelter has chemically altered the lower deposits. Iron sulfides (chiefly pyrite) and disseminated reduced iron (creating a greenish cast to the deltaic sandstone of the rock face in fresh fractures) formed in acidic, reducing conditions in the Cretaceous are weathered to iron oxy-hydroxide minerals in the Quaternary deposits. The formation of ferrihydrite, goethite, limonite, hematite, and small amounts of magnetite, not to mention pyrolusite and/or birnessite (manganese oxides) and ferroan calcite, indicate alkaline, oxidizing conditions in the late Quaternary. The formation of iron and manganese oxides and hxdroxides, the production of sulfate from sulfide, and the precipitation of gypsum, anhydrite and the forms of calcite all suggest that the groundwater effusing from the back of the shelter is recharged by meteoric water in a local aquifer and is somewhat responsive to climate change. Overall, the oxidation increases with depth.

The major part of the chemical modification in the lower deposits occurred during the end of the middle Holocene amelioration. Evidence for this is the plastic deformation of the lower sheet wash alluvial strata caused by the detachment and fall of an approximately two-ton, oblong boulder from the edge of the shelter overhang after the end of the middle Holocene amelioration.

The overall climate can be summarized as cool and moist at the end of the Pleistocene and warm and dry during the early Holocene concurrent with the deposition of the lower sheet flow alluvial deposits. The middle Holocene loess represents a cooler, moister climate envelope while evidence of a late drought and the Little Ice Age loess cap the deposits.

STRATIGRAPHY

Site formation processes exhibited in the array of interbedded deposits were contributed by aeolian, sheet wash alluvial, colluvial, geochemical, and biological factors. However, the deposition is largely controlled by position within the shelter. For instance, some forms of alluviation do not have sufficient energy to deposit far within the shelter whereas aeolian deposition is not well preserved outside of the shelter. Sediment also accumulates from the bedrock from which the shelter is formed as carbonates and sulphates that slough off sediment grains from the back wall. In addition, large sandstone roof scabs fall from the ceiling. In general, though, the deposits appear climate driven and thus reflect climate change in the latest Pleistocene and Holocene. Early Holocene drought conditions are eventually followed by the middle Holocene amelioration, and finally variable climate conditions in the Late Holocene.

The stratigraphic profile from the rockshelter is well preserved and complicated (Figures 5.3, 5.4, 5.5 and Plates 5.2, 5.3, 5.4). Units II, III, IV, V, VI and VII correspond to the first Holocene Drought, Middle Holocene Amelioration, and the three cycles of drought and amelioration in the late Holocene respectively. Erosional unconformities were identified by either changes in sediment grain size or a distinct accumulation of coarser grained sediments on a thin continuous horizon. Most of the unconformities have an accumulation of smaller roof scabs on the erosional surface.

UNIT I

The Mesa Verde Formation (Cretaceous) forms the shelter overhang and is designated Unit I. The formation is primarily derived from fluvial and lacustrine environments as well as swamp deposits of coal and organic rich mudstones. These succeeding fluvial and marginal marine facies of sandstone and shale formed as a result of the regression of the Western Interior Seaway which locally deposited the marine derived Mancos Shale.

UNIT II

Unit II can be complexly divided into numerous subunits. For simplification, these subunits were not used in all of the stratigraphic profiles. Subunits IIAi through IIAiii are thick aeolian loess deposits that interfinger with alluvial IIBii and IICii. One additional subunit, IIAig, was described as being part of subunit IIAi but it is heavily impregnated with gypsum. This amount of gypsum in only seen proximal to the back wall and is related to groundwater flow through the permeable sandstone of the shelter.

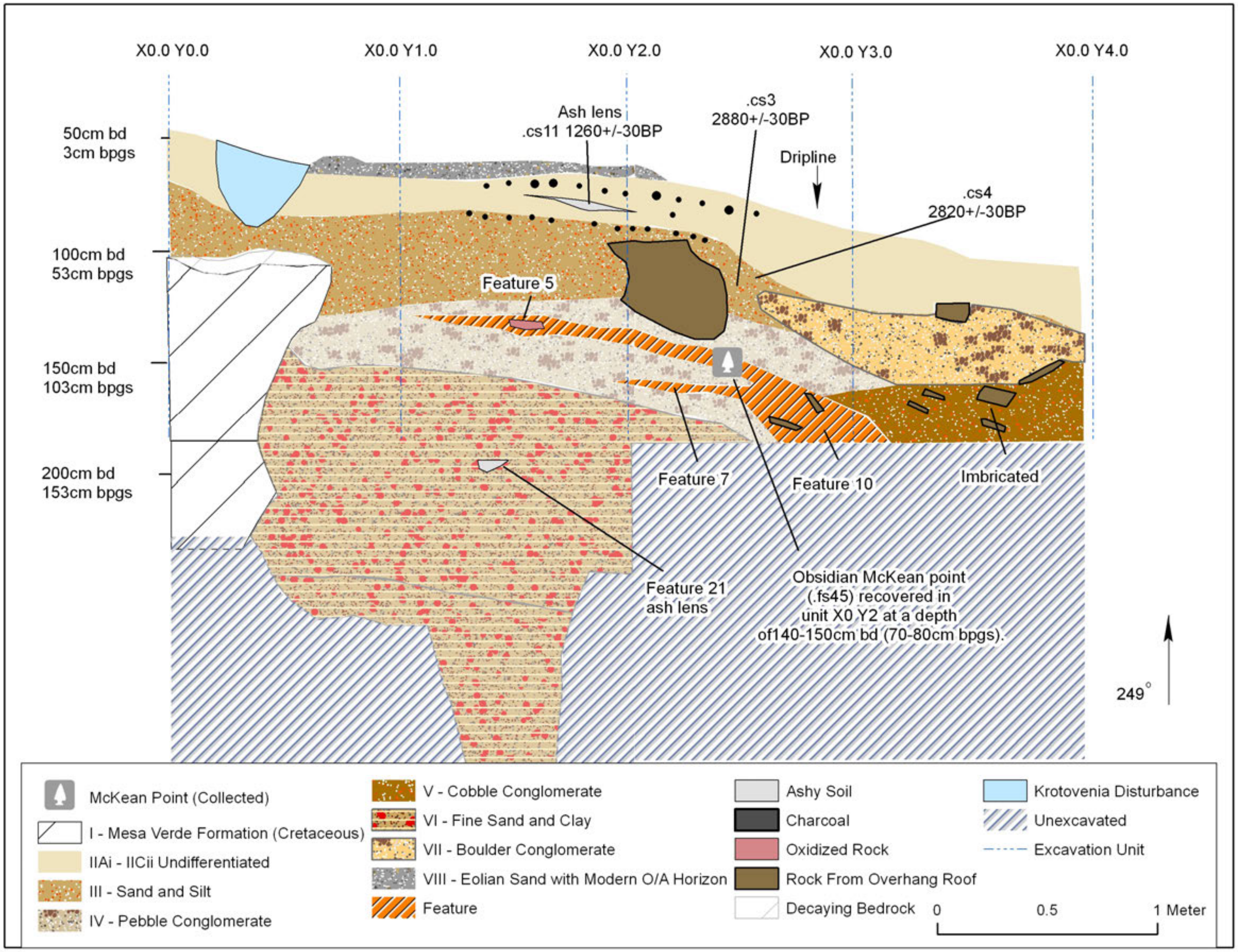


Figure 5.3. Profile of the southwest wall (Y coordinate) at X0 showing associated dates and diagnostic for the cultural levels.

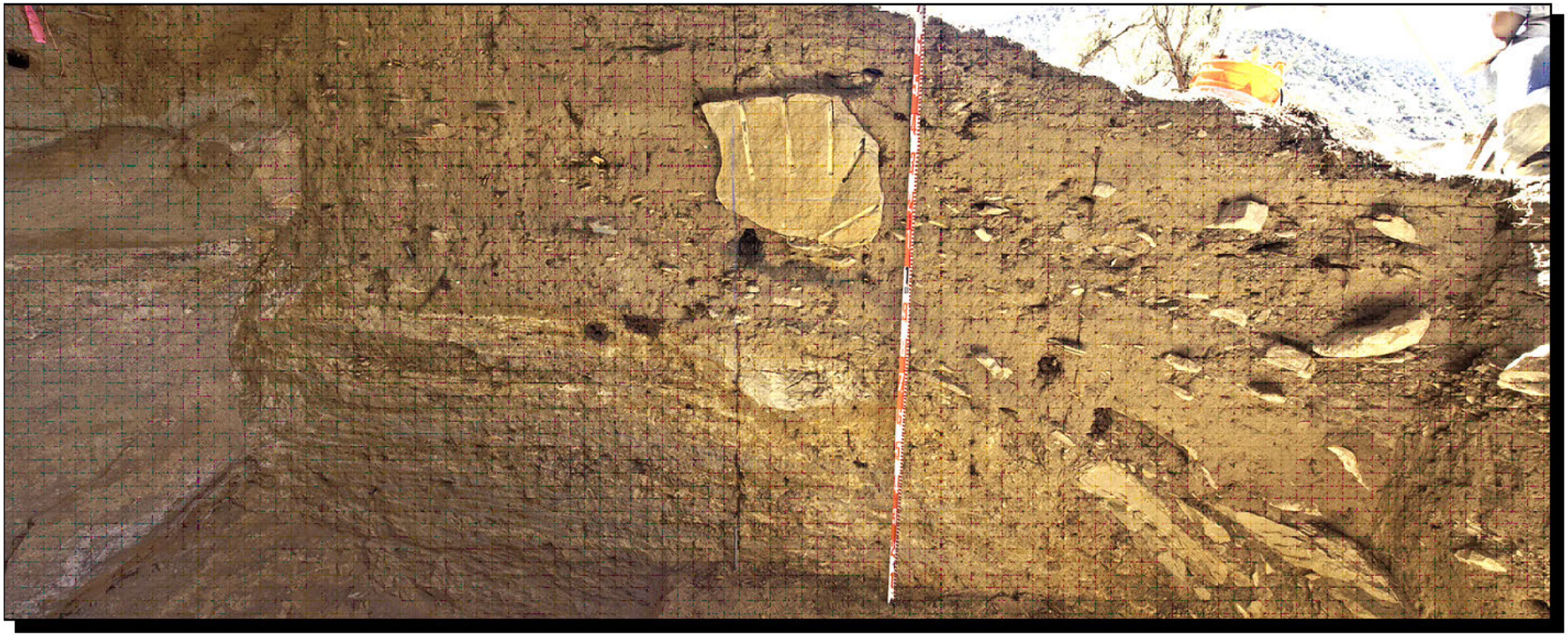


Plate 5.2. Photo of profile of the southwest wall (Y coordinate) at X0.

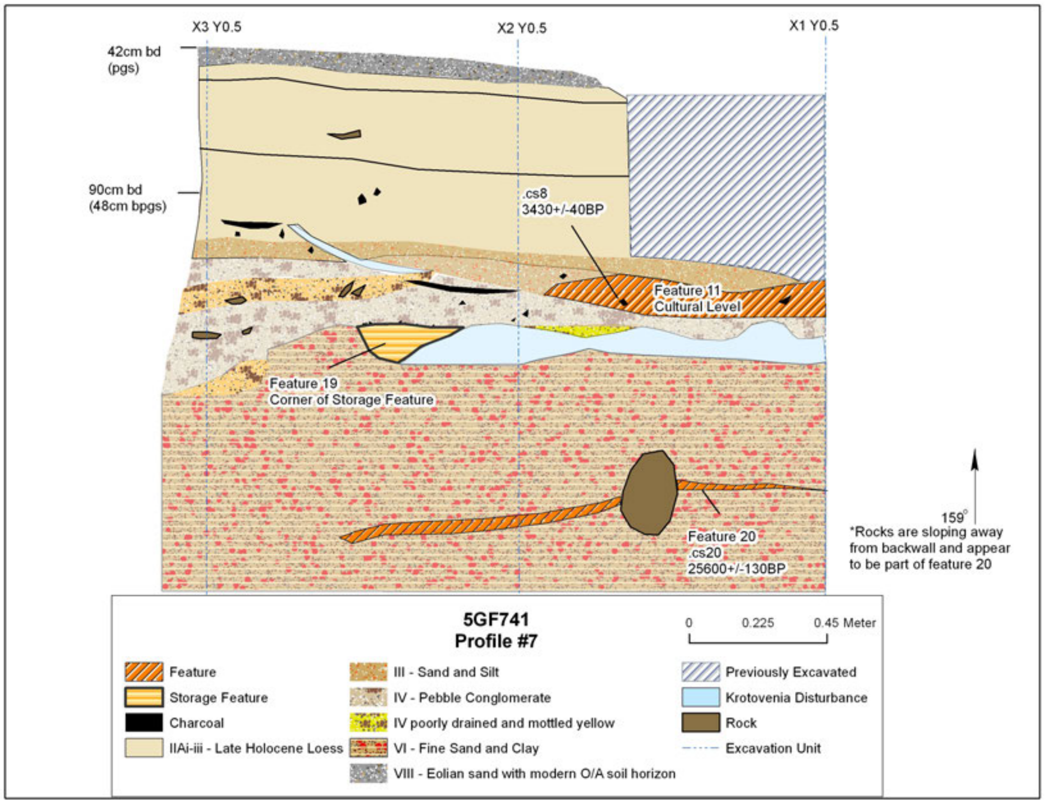


Figure 5.4. Profile of Y0.5 (southeast) wall.

Plate 5.3. View of Y0.5 (southeast) wall. Meter stick is located at the X2 Y0.5 grid corner.

Figure 5.5. Profile of X2.5 (East) wall of unit X1.5 Y0.5.

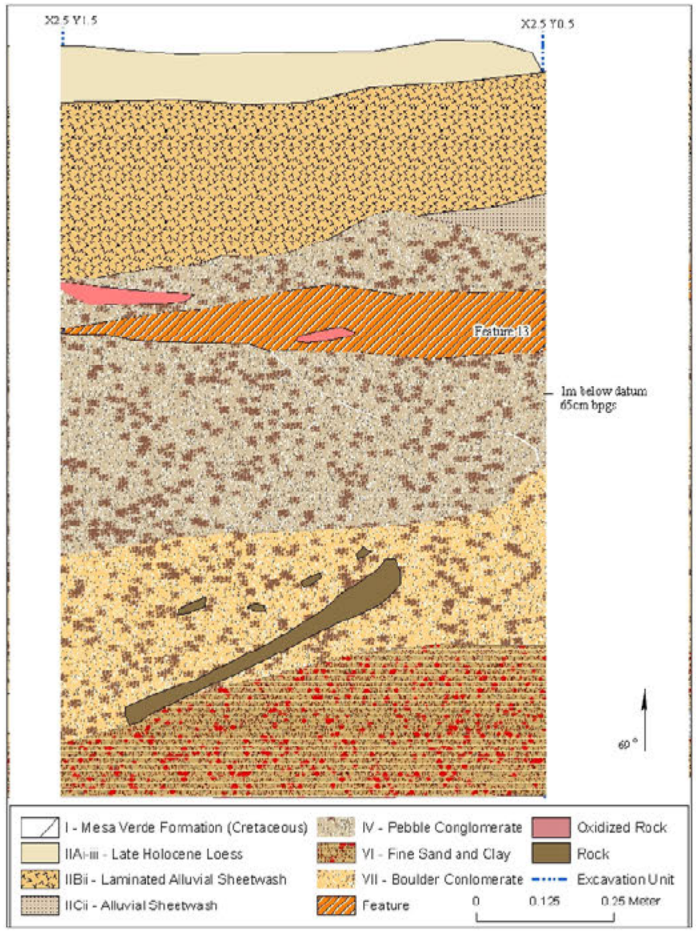


Plate 5.4. View of east wall of unit X1.5 Y0.5. Note Feature 5 in bottom-left near trowel.

Aeolian subunits IIAi though IIAiii are dominant in the rockshelter above 1.25m below datum. These three subunits form a 1.0m thick wedge of loess that increases in thickness towards the back wall. One distinct erosional unconformity is present between IIAi and ii and three paraconformities between IIAii and iii.

Aeolian processes deposit sediment due to the back wall creating a turbulent wind break. This decreases carrying capacity and competence causing grains to no longer be entrained. Additional slough is created from the back wall and roof of the shelter as anhydrite forms on the surface of the bedrock. Anhydrite formation imparts a pore pressure on individual grains in the bedrock sandstone.

Subunit IIBii consists of two periods of prolonged alluvial sheetwash. These deposits have good laminations and consist of loess and silt sized particles. The lowest deposit persists far into the shelter before pinching out into the aeolian loess. The upper IIBii ends at the opening of the shelter just before the dripline. The lower of the two laminated alluvial deposits were supplied with water and sediment from the dripline while upper unit was not influenced by the dripline other than by constraint.

Between the upper and lower IIBii is another alluvial subunit IICii. There is little difference between these alluvial subunits other than IICii is not laminated. There is slightly finer to medium grained sand within IICii suggesting a sheetflow depositional sequence. The lack of lamination indicates more rapid deposition of the subunit in either singular or few catastrophic events. IICii is also constrained outside of the dripline and pinches out at the entrance of the shelter. The alluvium is bound above and below by the aeolian Subunit IIAii. IIBii and IICii are not exposed on the immediate surface. Much of the material (Unit VIII) above these subunits was removed and screened for ease of excavation.

UNIT III

Unit III overlies IV, V and VI. It is similar to V in that they are both alluvial, have similar colors, and are moderately indurated. Unit III lacks the imbrication that V has and contains a larger fraction of fines. The maximum grain size in Unit III is cobble-size, but they are very sparse in abundance. This unit is mostly silt and sand sized particles and the larger clasts are matrix supported. Unlike V this unit is an alluvial channel that has eroded into IV and partially into V. Unit III forms a convex erosional surface with Unit IV, further indicating that it is part of a small alluvial channel.

UNIT IV

Unit IV is a mix of aeolian loess and the accretionary wedge forming below the dripline. The unit begins at the back wall at a depth of approximately 1.30m below datum and extends to 3.10m from the back wall at a depth of 1.35m below datum. The shape of this unit is important as it determines that the dripline is controlling much of the deposition. The unit dips towards the back of the shelter indicating that the majority of the deposition is directly under the dripline. This type of deposition creates abundant fine grained loess but a comparable fraction of coarse pebble sized grains. Roof scabs falling from the dripline and shelter ceiling are bladed, sub-angular, pebble sized clasts that are concentrated on erosional unconformities. This unit has some bioturbation; notably one large rodent hole directly under the dripline. IV contains darker lenses than the other units because it eroded into and effectively mixed multiple charcoal features with dripline and debris flow material. Unit III has eroded into this wedge limiting the interpretation outside of the shelter.

UNIT V

Unit V is similar to VII in grain size and sorting but it has a distinct difference in color, shape, and depositional environment. V lacks carbon from features and is a more tan-brown color. Clasts are bladed and appear to be more abundant in the fine to medium sized cobbles. V is well imbricated suggesting an alluvial deposition consistent with a braided stream deposit in an alluvial fan. The imbrication indicates that flow is trending towards the entrance of the rockshelter. Cross sections are oblique to the direction of imbrication and actual current flow direction cannot be determined. From the modern drainage proximal to the shelter it could be suggested that flows began parallel and slightly towards the opening of the shelter. The apex of the fan would have been located more to the north and west of the shelter. It is also important to note the shape of the top of this unit is concave. Alluvial stream channels are often flat or convex upper surface; fan and landslide deposits are concave in cross section. As the channel evolved it migrated down slope or north away from the opening of the shelter. For this reason we see an alluvial unit similar to V at this period. Further excavation to the north would potentially strengthen this hypothesis as this is the most likely direction that the channel migrated.

UNIT VI

The lowest stratigraphic unit (Unit VI) in the shelter measured from 1.40m below datum to approximately 3.20m below datum. The bottom contact of Unit VI was not identified at 3.20m and it is likely that distinct Pleistocene aged deposits would be found deeper. The unit begins to dip steeply just outside of the dripline and becomes part of the alluvial sheetwash and colluvium dominant system approximately 4.00m from the back of the shelter. Excavation of the unit as it exits the shelter ceased at 3.50m from the back wall at a depth of 2.44m below datum.

Unit VI consists of two interfingering types of deposition. The first is a very well indurated aeolian loess and fine sand deposit. Grain size ranges from clay to fine sand and sorting is moderate. This loess is the most weathered with an abundance of secondary mica growth and several bands of iron oxidation. Groundwater flow from the bedrock into this deposit is noticeable in oxidation bands and an increase in cementation proximal to the back wall.

The second interfingering deposition of unit VI is similar to the first in weathering and oxidation but was deposited by sheet wash alluvium and rills entering the rockshelter. The alluvium is poorly sorted and ranges from fine sand to pebble sized grains. Clasts are sub-angular and include roof scabs from the shelter ceiling. Iron oxidation is more concentrated in the alluvium due to the increased porosity groundwater flow. There is a small amount of anhydrite impregnated into the alluvial deposits that is not present in the loess.

Four small lenses of organic material were found in Unit VI. The material was not identifiable and appeared as millimeter sized oxidized organics and some root material. Some charcoal was collected from the larger of the lenses. Two of these accumulations are associated with the alluvial lenses and the other four are within the finer grained loess. Of those proximal to the alluvium at 2.00m below datum and 2.30m below datum one appears to be floated on the surface of the sheetwash and the lower appears to have been covered by the alluvium. The other two at 1.94m and 2.15m below datum are within the loess. The upper is a thin lens and the lower is thicker and denser with organics. Both lenses appear to be culturally rather than naturally deposited.

UNIT VII

Unit VII is similar to a debris flow or land slide that is contemporaneous with Unit IV. Very large boulders with concavity that matches that of the roof surface on the dripline are located within this unit, but they are not within the proximity of the dripline deposition. It is most likely that these boulders migrated outside of the shelter in debris flows. Unit VII is poorly sorted and grain sizes range from silt to boulder sized clasts. Clasts are matrix supported and have no signs of imbrication.

Units IV, V and VII have similar formation to Unit VI in that the deposition is controlled by the location of the dripline and stream power of the alluvium outside of the dripline.

UNIT VIII

The uppermost unit (Unit VIII) is a modern O/A Horizon mixed with recent aeolian deposits. The unit is few centimeters thick at most and is thickest near the center of the shelter. Windblown fine sand and silt contributes to a smaller fraction of the unit compared to the organics which are also deposited by aeolian processes. A very small percentage of bladed, pebble sized roof scabs are present within Unit VIII.

STRATIGRAPHIC AGE AND CLIMATE CORRELATION

Unit VI was deposited during a period of widespread drought between 12,000 BP and 6500 BP. This period of deposition is synchronous with alluvium described by Leopold and Miller (1954). Leopold and Miller (1954) referred to the largest early Holocene alluvial stratum as the Kaycee Formation. The deposition of this stratum is coincident with the migration of the aeolian sand seas, as dune and Pleistocene soil destabilization provides the available sediments to fill drainage systems. Warming temperatures, decreased precipitation, lower water table, and decreased stream power allow the deposition of the Kaycee equivalent alluvium in the Pleistocene dissection by no later than 9500 BP (Miller et al. 2011a). This same destabilization provided the material needed for deposition within the rockshelter. Given that this is the most prolonged period of destabilization since the beginning of the Holocene the Kaycee equivalent deposition of alluvial or aeolian nature are usually the most prominent strata.

The aeolian sand sea activations at the beginning of the Holocene are important to understanding the nature of the modern drainage systems yet there is considerable discrepancy as to the timing and duration of this event. Ahlbrandt and Freyberger (1980) as well as Ahlbrandt et al. (1983) indicate this activation occurred near 10,000 BP. Haynes (1991) suggests this activation is concurrent with an earlier drought sometime between 11,000 and 12,000 BP.

The increased weathering evident in elevated secondary mica and hematite accumulations indicate extended periods of exposure. These units are cemented due to weathering to a degree many times greater than the successive units above. A regional amelioration and soil forming event occurring approximately 8300 BP may be identifiable in the thin organic accumulations and prominent alluvial deposits within these units (Miller et al. 2011a). Sulfide mineralization of pyrites and iron hydroxides indicate weathering concurrent with sediments older than Holocene aged deposition. No sulfide minerals were identifiable in Unit VI but one radiocarbon sample was dated at nearly 25,600 BP. Sulfide minerals are highly susceptible to groundwater migration especially in slightly acidic solutions. The presence of hematite indicates that these environments are more oxidizing than reducing and suggest solutions in which pyrites are relatively soluble, but this is purely speculation based on the absence of sulfide minerals.

Units IV, V and VII formed during a period of widespread alluvial incision and aeolian phytogenic stabilization between 6500 and 4000 BP. The aeolian phytogenic deposits throughout the region begin stabilizing with the end of the sand sea migrations at 6500 BP (Miller 1992, 2010) but can begin forming as late as 6000 BP (Miller 2010). Aeolian sheets regionally preserved are the latest Pleistocene/early Holocene sheet, middle Holocene sheet, first and second late Holocene sheets, and the Little Ice Age sheet. Identified sheets nearly 20 miles from the shelter at Persigo Wash appear to have all of the aforementioned deposits. The early and middle Holocene sheets have undergone considerable weathering and have significant cementation due to smectite and calcite accumulation (Miller 2010). Other indications of these two sheets are the presence of oxy-hydroxide and sulfide minerals (Miller and Nelson 2010). The early Holocene sheet ceased deposition with the activation of true dunes between 12,000 and 10,000 BP. The middle Holocene sheet age would be consistent with the alluvial incisional period after the deposition of the Kaycee equivalent and prior to the deposition of the middle Holocene unnamed unit between 6500 and 4000 BP (Miller 2010).

Unit IV is representative of the middle Holocene aeolian sheet stabilization. During ameliorating conditions increased precipitation on relatively steep slopes like those proximal to the shelter resulted in incisional events indicative of Unit VII. The relatively large fraction of coarse material in Units V and VII suggests that finer grained materials are stabilized by phytogenic means.

After the middle Holocene amelioration, the next successive temperature shift allowing for the second depositional event within alluvial drainage systems began and ended sometime between 4000 and 2800 BP (Miller 2010, Miller et al. 2011a). The deposit can occur either within an incision of Kaycee equivalent alluvium, referred to as an inset deposit, or on top of the Kaycee, otherwise known as a stacked deposit. Given that this deposit can be present within an incision of Kaycee equivalent alluvium or on top of the Kaycee deposition there is a possibility of confusion during interpretation. This may lend some explanation for the fact that this unit is unnamed. Lack of a name leaves us in this study, and many others, to refer to this stratum as the middle Holocene unnamed unit. Leopold and Miller (1954) described the same terrace as the middle Holocene "unnamed unit" and referred to it as the Moorcroft terrace.

The unnamed unit was not identified in the study area because a thorough investigation of the alluvial units near the shelter was not conducted. In the drainage west of the shelter it would be best to look for the unnamed unit on point bars with a high degree of sinuosity as these would be least susceptible to erosion and avulsion. Unit III does fit into the same time period of deposition as the middle Holocene unnamed unit. Grain size of Unit III is consistent with the capacity and competence of middle Holocene alluvium in drainages located in the Grand Valley region. Mineralization of Unit III is considerably greater than that of Subunits IIBii and IICii which is consistent with the estimated 1200 additional years during which the middle Holocene deposits would have been susceptible to weathering.

The upper aeolian deposits, Subunits IIAi through IIAiii, are representative of the latest three Holocene aeolian soil formations and syngenesis. The later Holocene sheets have undergone little weathering resulting in poor cementation and few secondary minerals. Miller (2010) provides general ages for the three later Holocene sheets the first late Holocene sheet being deposited between 2800 and 2200 BP, the second late Holocene sheet between 1800 and 1000 BP, and the Little Ice Age sheet between 500 and 300 BP. Miller and Nelson (2010) record ages for the first sheet between 2750 and 2110 BP at Indian Creek and between 2790 and 1980 BP on the Colbran pipeline. They also show dates on the upper contact of the second sheet ranging between 1230 and 1140 BP at Indian creek and seven dates from the Colbran pipeline ranging between 1720 and 1300 BP. One date from the Colbran pipeline was 500 BP for the Little Ice Age (Miller and Nelson 2010).

Subunit IIAi is the first late Holocene sheet. Subunit IIAii is the 2nd late Holocene sheet and IIAiii would have formed during the majority of the Little Ice Age. Between the three subunits are distinct unconformities identifying periods of regional drought contemporaneous with alluvial deposition and soil deflation. From 2200 to 1800 BP the unconformity between Subunits IIAi and IIAii formed. From 1000 to 500 BP the unconformity between IIAii and IIAiii formed.

The unconformities are small deflation surfaces forming synchronous with the alluvial deposition. The deflation of the late Holocene aeolian sheets is the source of sediment filling the alluvial valleys (Miller 2010). The third alluvial deposition occurring during the late Holocene after 1000 BP, continuing until the Little Ice Age near 500 BP represents the unconformity between Subunits IIAii and IIAiii (Miller 2010). Like the middle Holocene alluvium, these subunits can also occur as inset or stacked deposits. In the study area this alluvial deposit is easily identifiable as an inset terrace within the late Holocene incision. Leopold and Miller (1954) name this small terrace the Lightening Formation for where it was first described on Lightening Creek in Wyoming. This formation is smaller than both the Kaycee equivalent and the unnamed middle Holocene unit. The Lightening alluvium often resembles the modern alluvial fill and can only be distinguished by a small terrace that the modern channel has incised (Leopold and Miller 1954).

Climatic Indications in the Deposition of *Oreohelix* Gastropods

Numerous specimens of Oreohelix spp., a common forest dwelling gastropod in western Colorado, have been recovered from the deposits. Two species are present in Colorado, but they cannot be identified with hard parts alone. The gastropods are present in the deposits above the early Holocene sheet flow alluvial deposits, indicating their range shifted to lower elevations in cooler, moister climates. Similar gastropods recovered from middle Holocene loess deposits at sites 5ME12825, 5ME16786 and 5ME16789 indicate a species shift to lower elevations during cooler, moister intervals.

Presence of Oreohelix spp. snails in the rockshelter strata indicate alternating wet and dry periods; ameliorating conditions are beneficial to Oreohelix populations and drought conditions negatively impact them. In Unit IV, only two Oreohelix shells were found in excavation. Units IV, V, and VII yielded seven Oreohelix shells collectively. A total of seven Oreohelix were also found in Subunit IIAi, and 12 were found in Subunits IIAii, IIBii, and IICii. On the surface and within Subunit IIAiii, three shells were found. Unit III yielded none.

As Units VI and III had the lowest number of Oreohelix shells, they represent periods of drier conditions near and within the rockshelter. The middle aeolian Subunit IIAii alone yielded five Oreohelix, and when added to the seven found in Subunits IIBii and IICii, demonstrates significant evidence for these units forming during ameliorating conditions.

The abundances of Oreohelix snails correlate with the climate model described in

Chapter 3 (see Figure 3.1, p. 3-30). Those deposits with few snails represent the largest droughts in the Holocene. The majority of snails were found in the aeolian deposits formed during ameliorating conditions.

RADIOCARBON DATING

As described above, geomorphological evidence demonstrates deposition throughout the full sweep of the Holocene. However, the utility of the radiocarbon record for this site is relatively limited for two reasons: 1) poor preservation of perishable remains, especially in the lower levels and 2) the difficulty of assigning the samples recovered to specific stratigraphic units. The former is not unusual for shelters where deposits have been exposed to the elements over the millennia. The latter is attributable to the complexity of the stratigraphy and thinning, dipping and increasing homogeneity of strata near the shelter drip line where some of the samples were recovered. There was also the factor of bioturbation which can result in vertical movement of charcoal from its original context. Despite these limitations, radiocarbon and artifact correlated dates of occupations were derived from the stratified deposits.

Table 5.2 is a listing of the radiocarbon results. The provenience column represents our best estimate of stratigraphic association. The culture column is, with two exceptions (as discussed later in this section), based on comparative data from the surrounding area rather than diagnostic artifacts because of the paucity of artifacts recovered.

Table 5.2. Radiocarbon Dates from 5GF741.

Lab Number	Provenience	Culture	δ13C	Conventional 14C	Material
Beta-312257	NA	NA	-25.5 ‰	111.4 ± 0.3 pMC	Intrusive Root
Beta-304087	Unit IV	NA (root burn)	-21.1 ‰	400 ± 30 BP	Charcoal
Beta-316336	Unit IV	NA (root burn)	-20.9 ‰	450 ± 30 BP	Charcoal
Beta-259174	Unit IV/VII	NA (root burn)	-20.7 ‰	490 ± 40 BP	Charcoal
Beta-304083	Unit IV	NA (root burn)	-21.9 ‰	480 ± 30 BP	Charcoal
Beta-316337	Unit IV	NA (root burn)	-21.0 ‰	800 ± 30 BP	Charcoal
Beta-259176	Unit II	Late Archaic/ Formative	-22.2 ‰	930 ± 40 BP	Charcoal
Beta-304085	Unit II	Late Archaic/ Early Formative	-20.7 ‰	1260 ± 30 BP	Charcoal
Beta-259173	Unit II	Late Archaic/ Early Formative	-20.5 ‰	1320 ± 40 BP	Charcoal
Beta-259175	Unit III	Late Archaic	-20.4 ‰	2730 ± 40 BP	Charcoal
Beta-304082	Unit III	Late Archaic	-22.3 ‰	2820 ± 30 BP	Charcoal
Beta-304081	Unit III	Late Archaic	-20.7 ‰	2880 ± 30 BP	Charcoal
Beta-304086	Unit III	Late-Middle Archaic	-20.9 ‰	3020 ± 30 BP	Charcoal
Beta-304084	Unit III	Middle Archaic	-21.1 ‰	3430 ± 40 BP	Charcoal
Beta-304088	Unit VI	Paleo-Indian (?)	-24.3 ‰	25600 ± 130 BP	Organic Matter

These dates were plotted on an idealized stratigraphy of the site's deposits in Figure 5.6. Figure 5.7 shows the temporal relationships of cultures in the region as compared with those found in 5GF741.

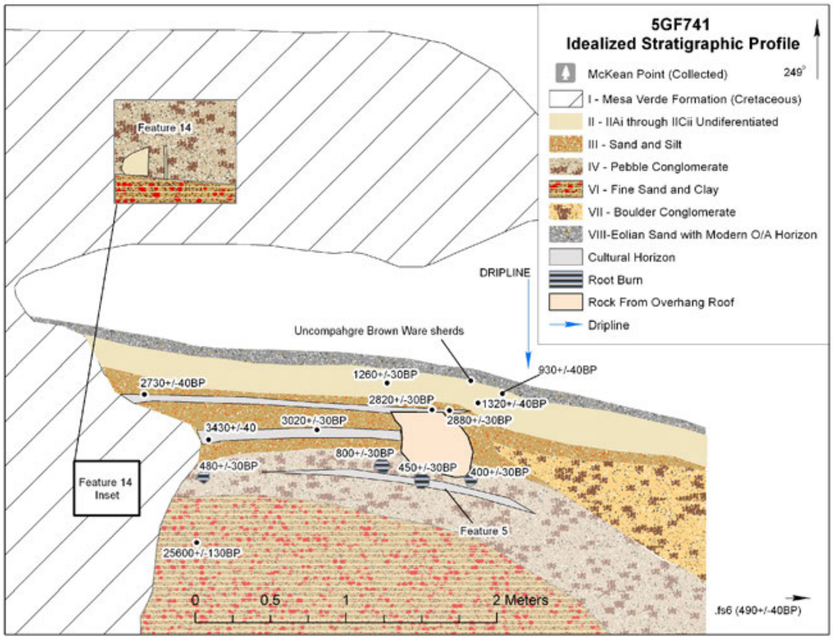


Figure 5.6 Radiocarbon dates and diagnostic artifacts plotted on an idealized stratigraphy of the site's deposits.

The samples that dated ca. 400-500 were found to be out of context in Unit IV and by their appearance in the profiles were determined to be root burns. When those dates were averaged the surface burn was found to occur 455±32 BP. The 800 ± 30 BP date was also determined to be out of context in Unit IV and likely derived from a root burn.

The dates for the root burns were compared with Paleoenvironmental models for the southern Colorado Plateaus, and found to correspond to periods of low ground water

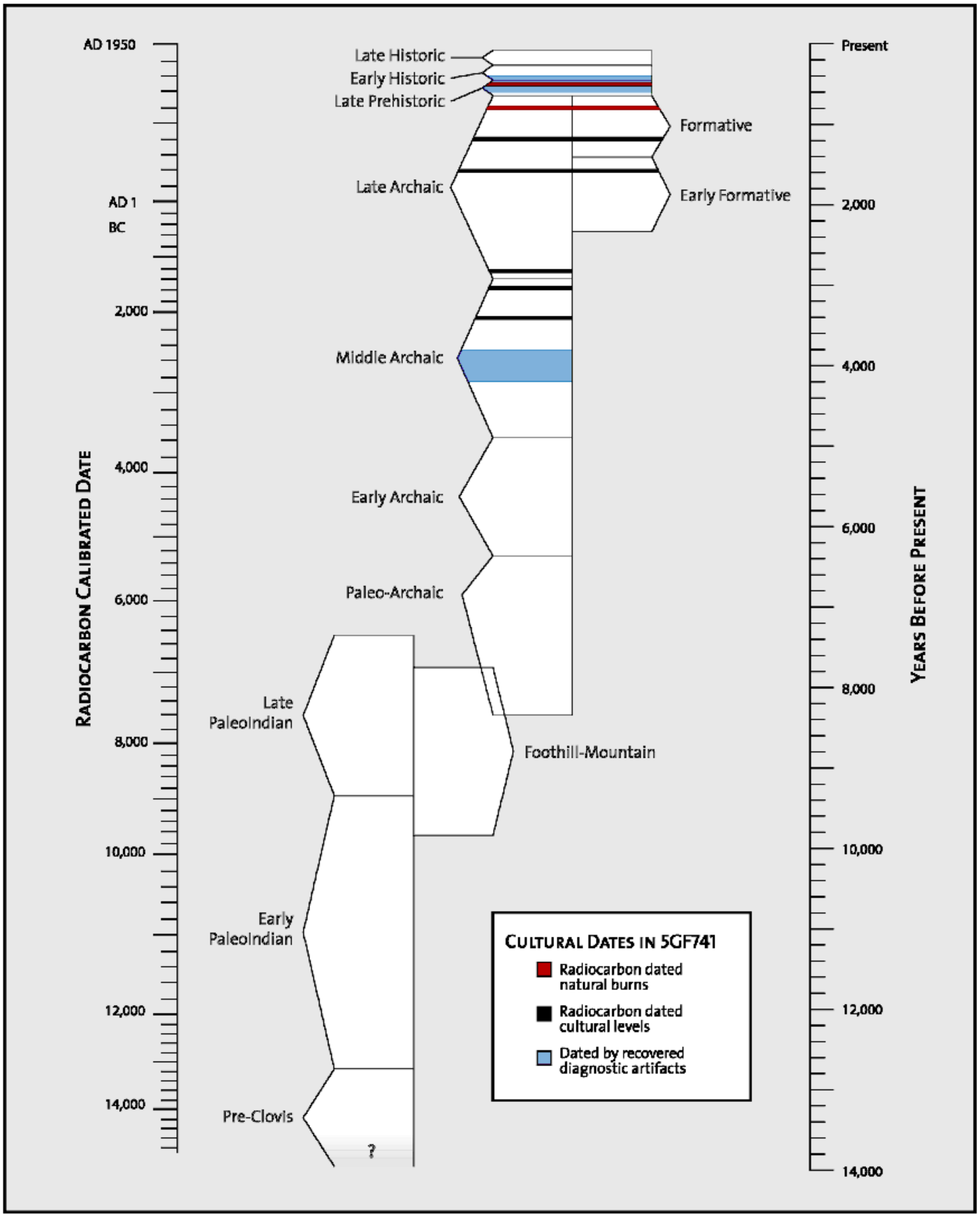


Figure 5.7. Temporal relationships of cultures in the region as compared with those found in 5GF741 shown in colored blocks.

availability in the past 2000 years and likely a time of widespread natural burns. The Dean et al. 1985 model provides a correlation with cultural episodes in areas such as southwestern Colorado, where such is by and large also subject to tree-ring dating (Figure 5.8). Similarly, the Palmer Drought Severity Index (PSDI), which illustrates the paleoclimatic variation for Northwest Colorado (Palmer 1965; Alley 1984), also shows a significant period of drought at that time (Figure 5.9). The PDSI employs precipitation, temperature and the Available Water Content (AWC) of soil types to assess agricultural potential on an annualized basis (Palmer 1965; Alley 1984). When the modern instrumental record is calibrated with available tree-ring indices the PDSI for specific regions can be extended to prehistoric times. Edward R. Cook of the Lamont-Doherty Earth Observatory recalibrated the PDSI for 1825 annually for resolved grid points for North America (Berry and Benson personal communication with Cook, 2007). The relevant node (Number 117) for northwestern Colorado is depicted in Figure 5.9, averaged to decadal means. Drought conditions are indicated in red for negative departures greater than 1-sigma. Radiocarbon dates are expressed both as BP and calibrated AD/BC for purposes of comparison to the charts included in this section.

Radiocarbon dates were not secured for the organic surface layer (Unit VIII). However it produced two fragments of Uncompahgre Brown Ware ceramics. Post ca. 1350 AD (ca. 600 BP) marks the appearance of Uncompahgre Brown Ware ceramics in the region. Though once thought to date back into the Formative Period, luminescence dates on sherds from sites in the local area and adjacent regions indicate the appearance of Uncompahgre Brown Ware generally postdates that time [5ME4970, 1508-1644 AD; 5ME16097, 1400-1520 AD; 5GF620, 1450-1528 AD; 5RB144, 1510-1590 AD; and 5RB2929, 1470-1530 AD]. Reed, et al. (2001:41-9) provides additional luminescence dates that generally support this observation, though an early date of 1300 AD cannot be ruled out. The date cluster represented by the Uncompahgre Brown Ware is assigned to the Late Prehistoric/Early Historic period. At the time, no groups other than the Numic speakers have been identified with this period on the Western Slope. Their occupation occurred during the Little Ice Age (see Figure 3.1, p. 3-30).

Three dates have a post-AD 1, Late Archaic or Formative cultural association. The most recent is 930±40 BP or ca. AD 1070 and may be designated [late] Formative; and, the two older dates (1260±30 BP and 1320±40 BP) an Early Formative affiliation. When averaged older two produce a date of 1290±35 BP or ca. AD 710. Both the AD 1070 and AD 710 dates occur during periods of relatively high effective moisture in the Southwest and in Northwest Colorado according to Dean et al. 1985 (Figure 5.8). Their classification as Late Archaic is based on the lack of any indications of maize at this site. Reed and Gebauer (2004) propose that the Formative be subdivided into two distinct periods: Early Formative (ca. 400 BC - AD 750) and Formative (ca. AD 750 - 1300) – the early period emphasizing the appearance of maize farming in the region, and the latter, the technological development of ceramics that allowed farming communities to create secure storage for maize. Accordingly, these two dates may be classified as Formative, but with the caveat that the camp was used during foraging forays.

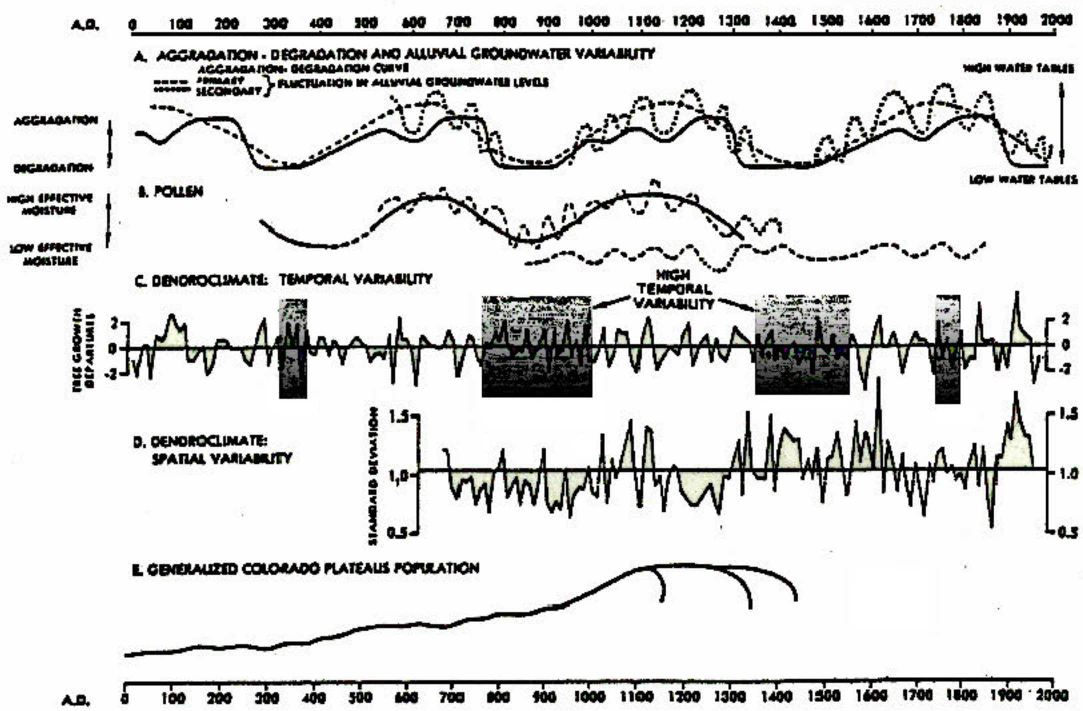
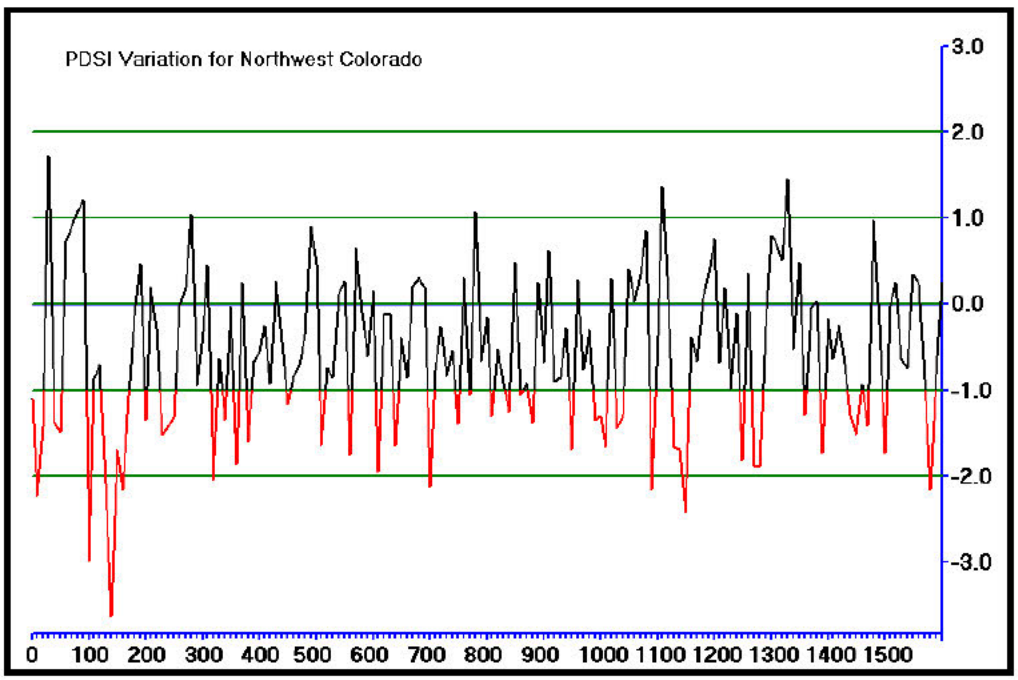


Figure 1. Environmental and demographic variability on the southern Colorado Plateaus, A.D. 1–1970. A, hydrologic fluctuations and floodplain aggradation-degradation. B, primary (solid) and secondary (dashed) fluctuations in effective moisture as indicated by pollen data. C, decadal tree growth departures in standard deviation units. D, spatial variability in dendroclimate. E, relative population trends, A.D. 1–1450.

Figure 5.8. Paleoenvironmental model for the southern Colorado Plateaus reproduced from Dean et al., 1985:541, Figure 1.

Figure 5.9. PDSI for Northwestern Colorado from 1-1600 AD. Annual data decadally averaged (Berry and Benson personal communication with Cook, 2007).



Four dates (2730±40 BP, 2820±30 BP, 2880±30 BP, 3020±30 BP) occur during the transition period between the Late and Middle Archaic. The three more recent dates fall within the temporal range of two sites located south of the Colorado River between De Beque and Battlement Mesa that contained pithouses: 5GF126, 2770±60 BP (Conner and Langdon 1987:7-44); and, 5ME16786, 2760±70 BP (Beta-303007) (Conner et al. in progress). Similarly, a large, alcove overhang site, 5ME17953 (Conner et al. 2012) that contains the remains of low-walled masonry architecture dating ca. 1260-1460 BC (conventional radiocarbon age of 3100±50 BP [Beta-290972]) is temporally comparative to the 3020±30 BP, ca. 1216-1372 BC, of the McClane Rockshelter.

The oldest date obtained from charcoal at the site is 3430±40 BP, or ca. 1775 BC, which falls within the latter part of the Middle Archaic. It and the previous four occur within Stratigraphic Unit III. This date also falls within the range for McKean Complex dating ca. 4700-3100 BP, as Frison (1991:98-101) reports. Unit III is an alluvial deposit occurring during Miller's Second Holocene Drought dating ca. 4000-2800 BP (see Figure 3.1, p. 3-30).

Below the dated Stratigraphic Unit III, a McKean Lanceolate point was found in association with a large ashstain in Stratigraphic Unit IV. At the Signal Butte site in western Nebraska, Lanceolate points were found in association with Mallory-type side-notched points in dated levels from 4550-4170 BP [ca. 3360-2700 BC] (Frison 1991:101). The 4500 BP date was derived from a fire pit associated with the two point types and a bison kill. The approximate date span indicated for this cultural level is supported by the characteristics of the Unit IV deposits. They are resultant from aeolian loess, debris flow and alluviation, which are consistent with deposition during Miller's Middle Holocene Amelioration from 6500-4000 BP, a relatively cool, moist era (see Figure 3.1, p. 3-30).

None of the strata below Stratigraphic Unit IV have been reliably dated and assigned a cultural affiliation. The earliest date 25600±130 BP (Beta-304088) from Unit VI has been given a tentative cultural affiliation of Paleoindian. However, it was not associated with any cultural material or features and likely represents a late Pleistocene natural occurrence of organic matter. The strata below Unit IV corresponds to the deposition of the Kaycee Formation during the Allerod or "Clovis" drought beginning after 12,000 BP and interrupted by the cool-wet Younger Dryas prior to 10,000 BP. Following higher in the strata is a continuation of Kaycee Formation development during Miller's Early Holocene drought and terminating by 6500 BP (see Figure 3.1, p. 3-30).

PALYNOLOGY

The palynological report prepared by the RED Laboratory, University of Utah is included below. The authors note that “Pollen preservation below 150cm BPGS in the stratigraphic column is too poor to support analysis.” This problem has also been cited as a limiting factor for radiocarbon sample preservation. The effects are analogous in that only a small portion of the 11,000 years of Holocene deposition evident in the shelter are represented by the perishable evidence of pollen and in situ charcoal. This seems to have been more problematical for the former than the latter as indicated by the palynologists conclusion that:

> Pollen analysis suggests that at the time of occupation climatic conditions at the site were stable and similar to the present day, and the flora is similar except for an increase in shrubby taxa.

Clearly, there were major climatic swings during the occupational history of the shelter as indicated by both the geomorphology and the episodic nature of human presence as demonstrated by the tripartite clustering of radiocarbon dates. It seems evident that the analyzed preserved pollen represents the past 4000 years of periodic occupations of the site.

RESULTS OF POLLEN SAMPLE ANALYSIS

(Extracted from RED Laboratory Report)

It is well known that Native Americans utilized many plant taxa found on the landscape (Behre, 1986; Fowler, 1986; Moerman, 1998). The Records of Environment and Disturbance (RED) Lab pollen reports will limit the general classification of Ethnobotanically Significant Taxa (EST) to plants that were most likely utilized as food resources. Because there are many other possible vegetative resources for native peoples (fuel, building, basket-making, etc.) in addition to the general EST category, reference to any taxa present in aggregate form (clumps of multiple pollen grains of the same taxa) in the pollen samples will be made in the discussion section of the report, as pollen aggregates are also indicative of human use. Pollen aggregates tend to be more common in archaeological settings because plants may have been processed by humans before the pollen was completely mature. The occurrence of a large number of aggregates or a large number of grains in an aggregate in prehistoric samples may indicate that these plants were processed by humans (Martin, 1963; Behre, 1986 and 1988; Matson, 1991; Moerman, 1998). In addition, in archaeological studies the presence of insect pollinated taxa is especially indicative of humans bringing these plants onto a site for processing and use. Whereas the pollen of wind pollinated plant species makes up the vast majority of ‘pollen rain’ and is therefore common in sediments, the pollen morphology of insect pollinated plant species is designed to cling onto insects foraging in flowers, making it much less common in sediments. Thus, reference to pollen from insect pollinated taxa present in the pollen samples will also be made in the discussion section of the report.

Methods of Pollen Analyses

Sub-samples of $1cm^3$ were processed for pollen analysis following the methods of Faegri et al. (1989), with the following modifications to address issues that arose with high silica and high charcoal/organic content. Silicates were reduced by applying two hydrofluoric acid treatments to each sub-sample, and a certain fraction of the charcoal and organic content was removed by nitexing (screening) those samples that required it.

All of the pollen samples were stained with safranin stain and preserved in silicone oil. To ensure good representation of the taxa present, a minimum of 300 terrestrial pollen grains or 300 introduced *Lycopodium* tracers per sample was counted with a light microscope at 500X. Samples with low pollen preservation were counted using no fewer than five horizontal transects evenly spaced across the height of the cover slip to ensure complete coverage of the sample. Raw pollen count data for each of the three sites is included in the attached Excel files. Table 5.3 is a comprehensive list of the Latin and common names of the pollen taxa identified and counted in the samples from the three sites.

The software program Tilia® Version 1.7.16 (Grimm© 1991-2011) was used to graph pollen percentages. Pollen percentage is the percentage each pollen taxon comprises of the total number of grains counted for a specific sample. Unknown, deteriorated, and obscured pollen grains are included in the pollen total used to calculate percentages. Deteriorated grains are those that could be identified as being pollen, but preservation was too poor for further identification.

Table 5.3. Latin and common names of pollen taxa identified from site 5GF741.

Ethnobotanically Significant Taxa (EST)	
Amaranthaceae*	Amaranth Family
Asteraceae	Sunflower Family
Ambrosia, Asteraceae	ragweed
Cactaceae	Cactus Family
Cirsium, Asteraceae	Thistle
Malvaceae	Mallow Family
Mirabilis, Nyctaginaceae	four o'clock, Four O'Clock Family
Nyctaginaceae	Four O'Clock Family
Rosaceae	Rose Family
Taraxacum type, Asteraceae	dandelion

Herbaceous	
Brassicaceae	Mustard Family
Caryophyllaceae	Pink Family
Fabaceae	Bean Family
Poaceae	Grass Family
Polygonaceae	Buckwheat Family
Shrubs	
Artemisia, Asteraceae	sagebrush
Ephedra, Ephedraceae	Mormon tea, Ephedra Family
Sarcobatus, Sarcobataceae	greasewood, Greasewood Family
Trees	
Alnus, Betulaceae	alder, Birch Family
Betulaceae	Birch Family
Carya, Juglandaceae	pecan, Walnut Family
Celtis, Ulmaceae	hackberry, Elm Family
Cupressaceae	juniper, Cypress Family
Picea, Pinaceae	spruce, Pine Family
Trees	
Pinus, Pinaceae	pine (likely pinyon), Pine Family
Quercus, Fagaceae	oak, Beech Family
Salix, Salicaceae	willow, Willow Family
Ulmus, Ulmaceae	elm, Elm Family
Unidentifiable	
Typha/*Sparganium*, Typhaceae/Sparganiaceae	cattail/burreed,Cattail Family/Bur-reed Family grains too similar to differentiate Family
Rose/Oak	grains too similar to differentiate Family
unk/det/obs	unknown/deteriorated/obscured
Categories outside of pollen counts	
Lycopodium	spore – introduced tracer

Results of Pollen Analyses

Fifty pollen samples, including 47 samples beginning at 5cm BPGS (below present ground surface) and ending at 214cm BPGS from a stratigraphic column, one control sample from the modern surface taken in the vicinity of the rock shelters near the road, and two pollen washes from artifacts recovered during excavation were processed and analyzed for site 5GF741. The focus of the analyses was for the radiocarbon and comparatively dated cultural levels in the top 95cm of the shelter's deposits. Results are presented in the following pollen aggregate data table (Table 5.4) and Tilia diagrams (Figures 5.10-5.14).

In the Figure 5.10 diagram showing the upper part of the stratigraphic column, pollen types are expressed as percentages except for total grains and *Lycopodium*, which are actual counts. Dots represent presence in the case of a low number of grains (less than 3%), which otherwise would not show up clearly on the diagram. All samples analyzed yielded pollen, although preservation was very poor below 90cm. With the exception of the upper few centimeters, the record above 90cm is generally stable. Dominant taxa are Amaranthaceae and Cupressaceae. *Pinus* (likely pinyon) is mostly below 20%, indicating that pinyon was sparse on the landscape. Above 90cm, unk/det/obs grains are generally below 20%. In approximately the top 10cm of the profile *Sarcobatus*, Rosaceae, Rose/Oak, *Quercus* and *Salix* percentages increase, while Cupressaceae and *Ephedra* decline. *Typha*/*Sparganium* appears in the record at about 20cm. Asteraceae, *Mirabilis* (Nyctaginaceae), Malvaceae, and *Taraxacum* type, all insect pollinated EST, were present in samples above 90cm.

Figure 5.11 diagram shows percentages of pollen types from the stratigraphic column that yielded aggregates (clumps of multiple pollen grains of the same taxa). Total grains and *Lycopodium* are plotted as actual counts. Following the percentage column for each taxon is a column indicating, with a dot, the presence of one or more aggregates (p-aggr) for that taxon by sample. The next column is a plot of the number of aggregates (#aggr) in that sample for that taxon. See Table 5.4 for the complete tally of the number of aggregates and the number of grains in each aggregate, by sample, for this site. *Sarcobatus* aggregates increase toward the top as *Sarcobatus* percentage increases. The number of Amaranthaceae aggregates is generally high, with four of the samples containing enough aggregates to show as peaks in the #agg column, something rarely seen in modern surface samples. The surface/control sample is plotted on this figure to show naturally occurring aggregates.

Figure 5.12 diagram, plotted as a histogram to a depth of 65cm, was created in order to effectively compare results from the surface/control sample to the results from the upper sediments of the stratigraphic column. The surface/control sample was assigned an artificial depth of 62cm in order to plot it. Pollen types are expressed as percentages except for total grains and *Lycopodium*, which are actual counts. The surface/control pollen sample is very similar to the topmost samples analyzed of the stratigraphic column.

Table 5.4. Site 5GF741 pollen aggregate data.

Sample/Depth cm BPGS	Taxon	Number of aggregates	Number of grains/aggregate
surface near road (control sample)	Amaranthaceae	1	4
	Artemisia	1	~8
	Asteraceae	1	3
	Sarcobatus	2	2, 2
PS-48/4-8	Amaranthaceae	2	2, 3
	Cupressaceae	1	4
	Poaceae	1	2
	Sarcobatus	1	2
PS-47/8-12	Amaranthaceae	1	2
	Sarcobatus	2	4, 3
PS-46/11-14	Amaranthaceae	7	4, 2, 5, 3, 3, 2, 4
	Cupressaceae	1	4
PS-45/12-16	Amaranthaceae	2	4, 2
	Artemisia	1	>10
	Cupressaceae	3	2, 3, 2
PS-43/19-22	Amaranthaceae	1	2
	Cupressaceae	1	2
PS-42/29-33	Amaranthaceae	1	2
	Artemisia	1	~8
	Cupressaceae	2	3, 5
	Sarcobatus	1	2
PS-41/24-34	Amaranthaceae	2	3, 4
	Cupressaceae	1	3
	unk/det/obs	1	2
PS-40/32-38	Amaranthaceae	2	2, 2
	Cupressaceae	1	3
PS-38/40-46	Amaranthaceae	2	2, 2
	Cupressaceae	1	2
PS-36/41-48	Amaranthaceae	1	2
PS-39/39-52	Amaranthaceae	2	3, ~10
	Asteraceae	1	4
	Malvaceae	1	4
PS-37/44-52	*Pinus*	1	4
	Sarcobatus	1	2
PS-35/49-55	Amaranthaceae	2	4, 3
	Cupressaceae	2	2, 5
	unk/det/obs	1	5
PS-33/50-56	Amaranthaceae	1	4
	unk/det/obs	2	2, 2

Table 5.4. (Continued.)

Sample/Depth cm BPGS	Taxon	Number of aggregates	Number of grains/aggregate
FS-109/50-60	Amaranthaceae	1	2
(pollen wash)	Cupressaceae	1	2
PS-34/60-65	Amaranthaceae	1	3
	Artemisia	1	2
	Cupressaceae	1	5
FS-95/65	Amaranthaceae	2	2, ~6
(pollen wash)	*Artemisia*	1	4
	Cupressaceae	1	4
PS-32/63-66	Amaranthaceae	3	2, 4, 2
	Cupressaceae	1	4
	Pinus	1	2
PS-31/66-69	Amaranthaceae	1	2
	Cupressaceae	1	3
	unk/det/obs	1	2
PS-30/70-72	Amaranthaceae	1	4
	Ambrosia	1	3
	unk/det/obs	1	2
PS-29/72-74	Amaranthaceae	1	>6
	Asteraceae	1	>12
	Cupressaceae	2	2, 4
PS-28/74-76	Amaranthaceae	1	2
	Cupressaceae	1	3
	unk/det/obs	1	~8
PS-27/76-79	Cupressaceae	1	4
PS-26/79-83	Amaranthaceae	1	2
	Cupressaceae	1	3
	Sarcobatus	1	2
PS-13/83-85.5	Amaranthaceae	1	>10
	Cupressaceae	1	4
PS-25/86-89	Amaranthaceae	4	2, 2, 3, 2
PS-12/89-90.5	Amaranthaceae	5	3, 2, 2, 2, 2
	Asteraceae	1	3
	Poaceae	1	3
PS-24/89-95	*Sarcobatus*	1	2

0

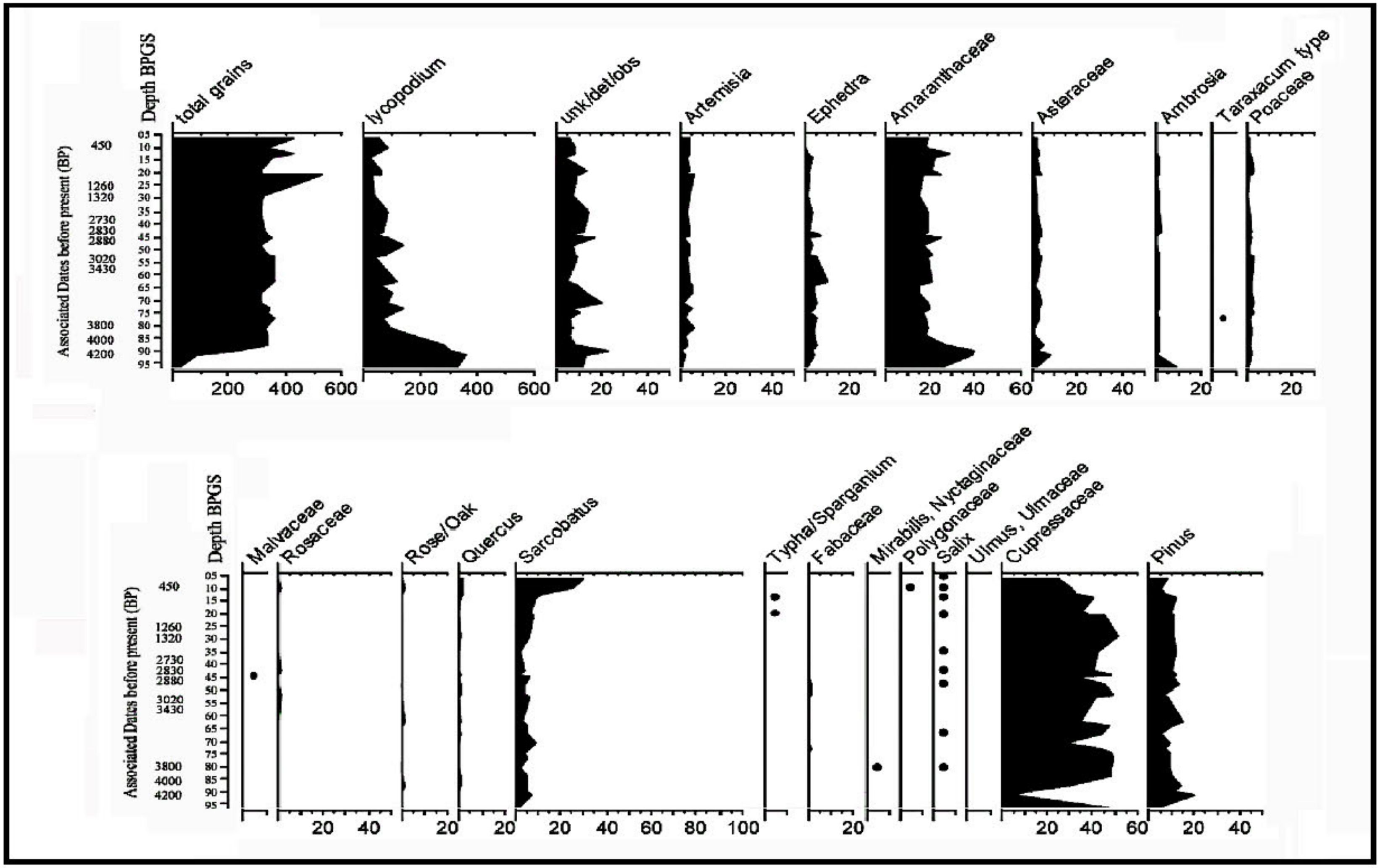


Figure 5.10. Stratigraphic column from a northwest facing rock shelter. Pollen types are expressed as percentages except for total grains and Lycopodium, which are actual counts. Dot = less than 3%.

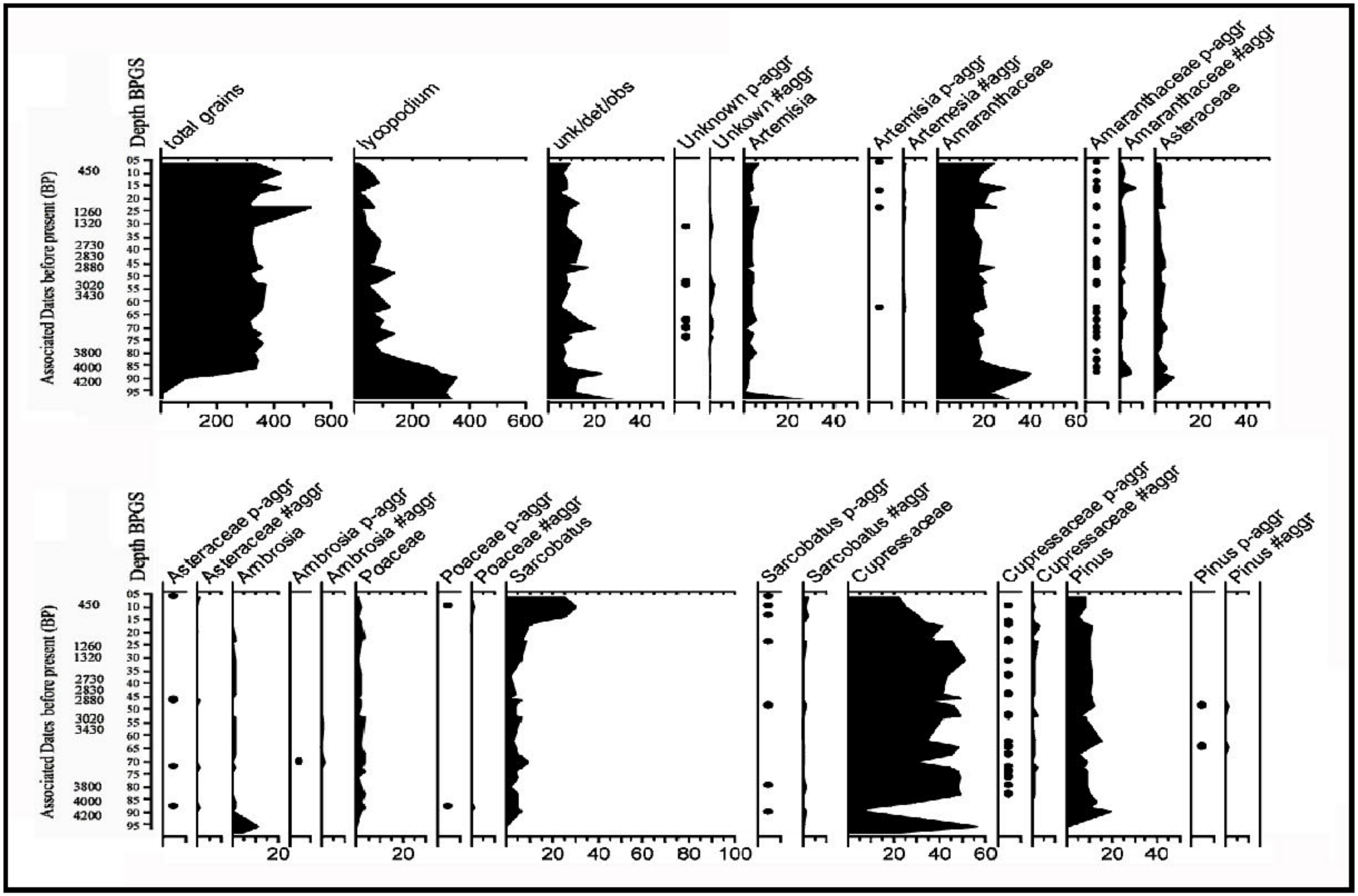


Figure 5.11. Stratigraphic column from a northwest facing rock shelter. Only taxa which were found in aggregate form are graphed. Pollen types are expressed as percentages except for total grains, Lycopodium, and #aggr, which are actual counts. Dot = presence.

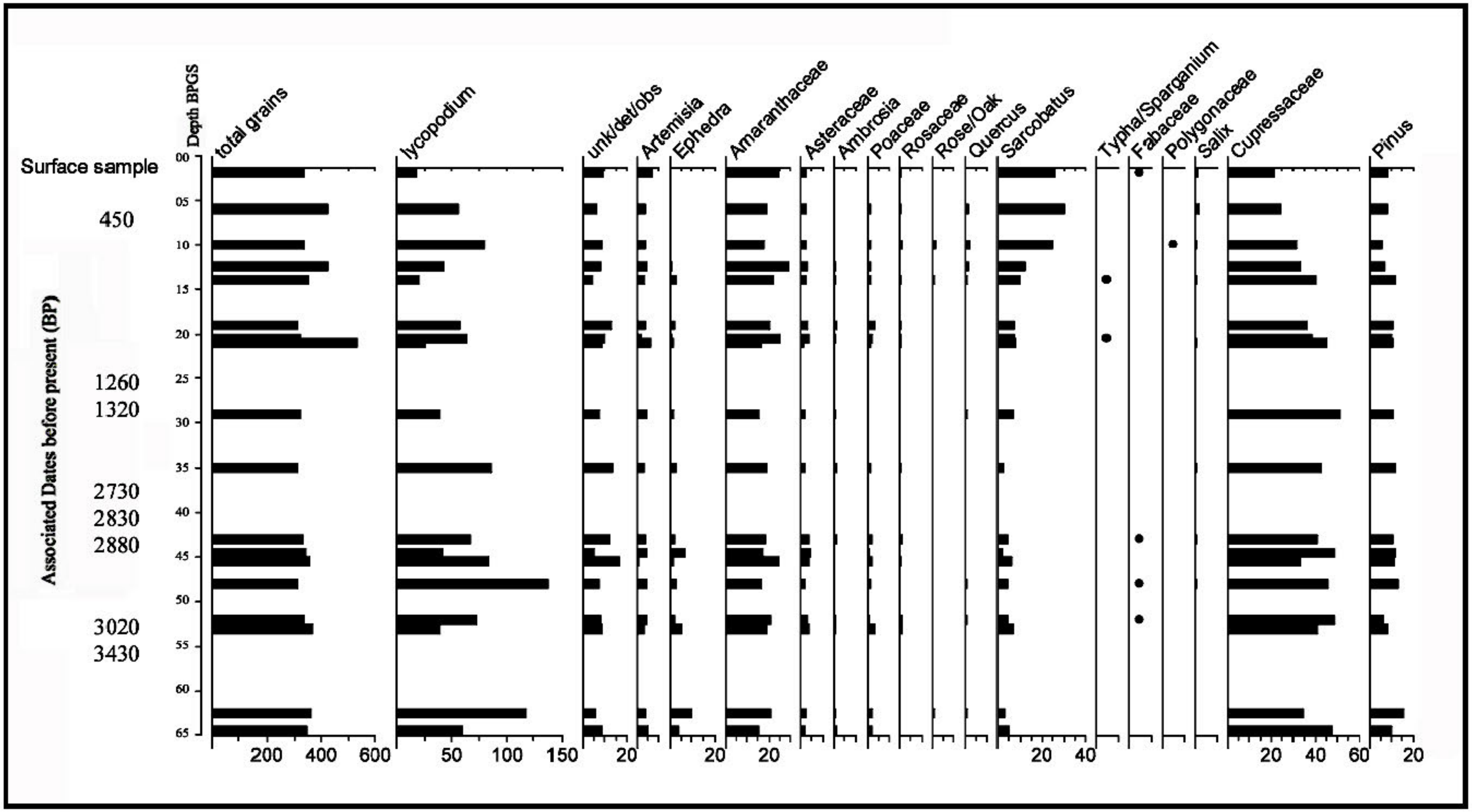


Figure 5.12. Stratigraphic column from a northwest facing rock shelter. Surface sample and stratigraphic column samples down to 65cm depth plotted as a histogram. Pollen types are expressed as percentages except for total grains and Lycopodium, which are actual counts. Dot = less than 3%.

Figure 5.13 shows the pollen wash data from possible comal FS-109, 50-60cm BPGS, plotted as a histogram showing percentages of pollen types, except total grains and *Lycopodium*, which are plotted as actual counts. Dots represent presence in the case of a low number of grains (less than 1%), which otherwise would not show up clearly on the diagram. Aggregate data is represented as in Figure 5.8. The wash yielded less variety of pollen taxa and similar aggregate data to a sediment sample at 50-56cm BPGS (PS-33) (see Table 5.4).

Figure 5.14 shows the pollen wash data from comal FS-95, 65cm BPGS, plotted as a histogram showing percentages of pollen types, except total grains and *Lycopodium*, which are plotted as actual counts. Dots represent presence in the case of a low number of grains (less than 1%), which otherwise would not show up clearly on the diagram. Aggregate data are represented as in Figure 5.8. The wash yielded very similar data, including aggregates of the same taxa (some with more grains per aggregate), to sediment samples at 60-65cm BPGS (PS-34) and 63-66cm BPGS (PS-32) (see Table 5.4).

Conclusions of Pollen Analyses

The high occurrence of *Amaranthaceae* and the continual presence of *Asteraceae* in the samples are used to support the assertion that the site was utilized by humans, along with the presence of other plant taxa known to be used by native peoples for food or other resources, namely *Artemisia, Mirabilis, Malvaceae, Rosaceae, Taraxacum* type, and *Typha/Sparganium*.

Investigations of prehistoric cultures and geoclimatic and bioclimatic conditions on the Colorado Plateau indicate that cultural and demographic change coincided with environmental fluctuations (Euler et al. 1979:1089). Using information gathered from Black Mesa, Mesa Verde, Navajo Reservoir, and Canyon de Chelly, Euler et al. concluded that prehistoric Puebloan populations moved to higher elevations or down along major drainages during dry periods. In wetter times, these people moved into the canyonlands and other low areas, where surface water supplies are normally scant during dry times (ibid:1097-1098).

Fluctuations in effective moisture vary and are cyclic. Minor fluctuations, although they have little effect on the vertical displacement of less sensitive floral communities or species such as juniper, greasewood, saltbush, and sagebrush, greatly affect both the number and variety of grasses and forbs that are available. An increase in effective moisture would have caused an expansion of the grasslands and an increase in the carrying capacity of the valleys for early man and the large game he hunted. O'Connell (1975:22) stated that grass seeds were probably the most important summer food resource for prehistoric collectors and may have provided a basis for the development of semi-sedentary or sedentary lifestyles during extended moist periods or times of reliable summer precipitation.

Dry periods of long duration generally result in the upward vertical displacement of montane vegetation and pinyon pine forestation; in the valleys, greasewood-saltbush

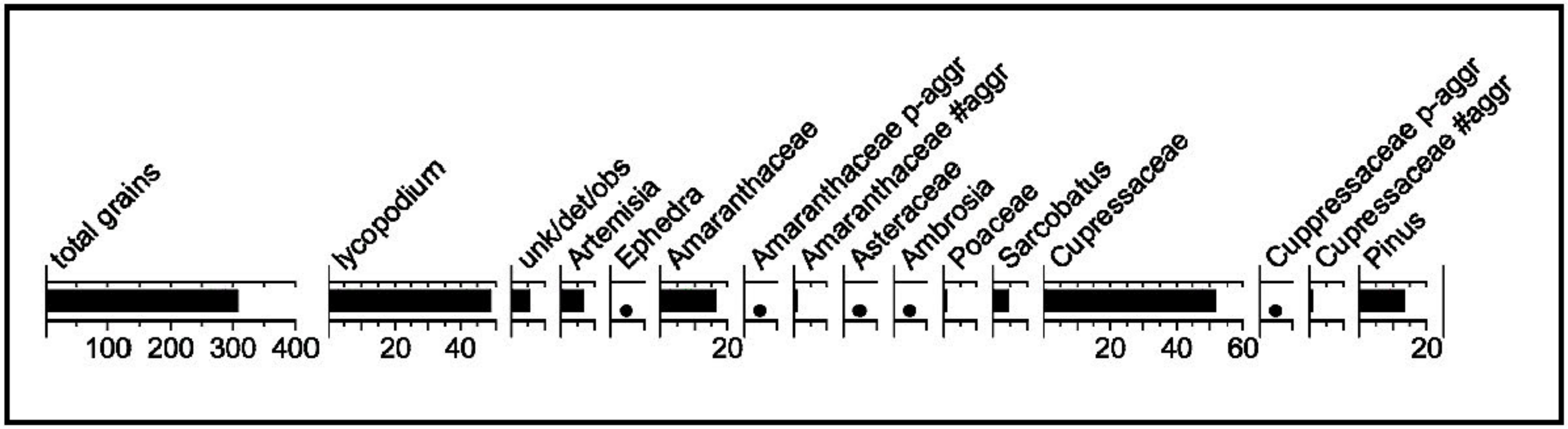


Figure 5.13. Pollen wash on possible comal (FS-109), 50-60cm bpgs, plotted as a histogram. Pollen types are expressed as percentages except for total grains, Lycopodium, and #aggr, which are actual counts. Dot for p-aggr = presence; dot for pollen type = less than 1%.

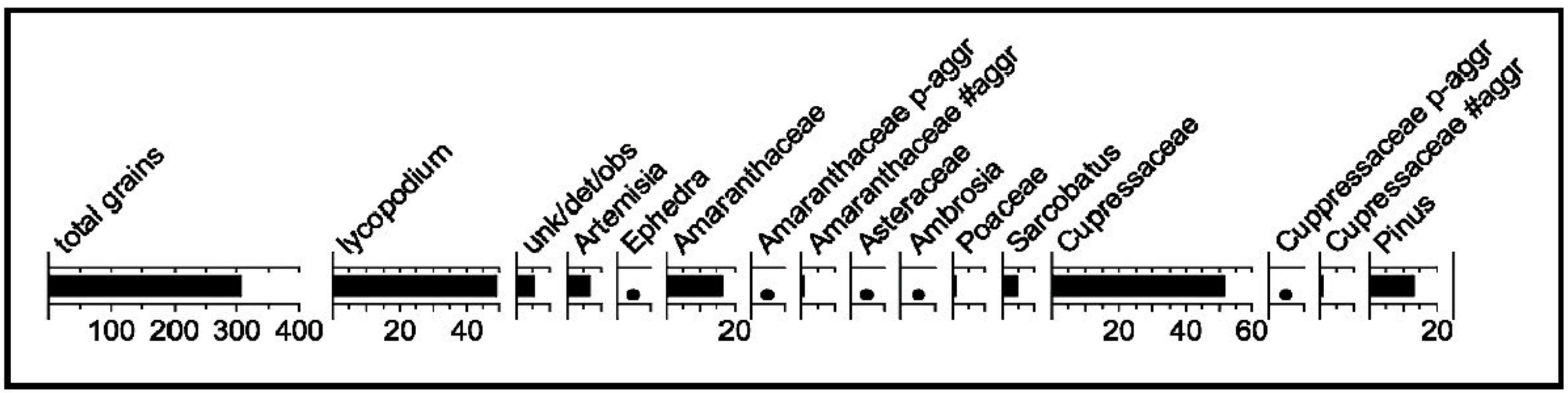


Figure 5.14. Comal pollen wash (FS-95), 65cm bpgs, plotted as a histogram. Pollen types are expressed as percentages except for total grains, Lycopodium, and #aggr, which are actual counts. Dot for p-aggr = presence; dot for pollen type = less than 1%.

communities spread and encroach upon sagebrush-floral communities. Extreme shifts in vegetation show up in the pollen record. One of the best indicators of such changes is the contrasting pollen counts of pinyon and juniper: warmer, drier periods are marked by in-creased juniper pollen, while cooler, moister periods are represented by a higher percentage of pine pollen (Euler et al. 1979:1095).

The seed-bearing forbs and grasses on which the prehistoric people of the Book Cliffs/Roan Plateau are thought to have depended cross-cut several environmental zones (between 4500 ft and 9000 ft) in this area and are very sensitive to effective moisture. During wet periods, the availability of this narrow range of plant foods at lower elevations in the summer may have obviated seasonal migration. Drier episodes would have required the hunter-gatherer to be seasonally migratory--to exploit the higher elevations for seeds in the summer and the lower elevations (where the food gathering period is extended) in late fall to early spring. Natural shelters, such as rockshelters, would have better served a transient people during drier times. Extremely dry periods would have pushed the migratory cycle into higher elevations altogether (above 7000') and may even have allowed territorial permanence there. Thus, times of greatest movement of populations probably occurred during transitional, moderately dry episodes.

SUMMARY OF MACROBOTANICAL ANALYSES

During the course of the excavation, macrobotanical specimens were collected as found and sediment samples were obtained from feature fill to be floated separately. Unburned pinyon nut hulls were collected from within every cultural level, but several other varieties of botanical species were of note in Cultural Levels I through IV (Table 5.5).

Cultural Level I had several pinyon nut hulls, none of which exhibit any evidence of burning. Unburned juniper berries were also of note in this level, but no features were sampled for floatation. In Cultural Level II, Features 3 and 17 were sampled. Both features yielded unburned goosefoot (*Chenopodium album*) seeds, while juniper (*Juniperus communis*) and burned goosefoot seeds were found in Feature 3 fill.

Unburned true grass (*Poaceae)*, goosefoot, and knotweed (*Polygonum arenastrum)* seeds, and a possible burned buckwheat (*Eriogonum sp.)* seed were found within Feature 11 fill that occurred in Cultural Level III. Fill from Feature 19 in this level was collected and analyzed, but did not yield any specimens. Cultural Level IV had the highest yield of botanical specimens and species. Features 4, 5, 6, 7, 8, 13, 14, 16 and 21 were sampled within level IV. Botanical specimens within Feature 4 include: unburned goosefoot seeds, an undetermined goosefoot species seed, an unburned foxtail (*Setaria sp.*) seed, an unburned cheatgrass (*Brome sp.*) glume, an unburned knotweed seed, a juniper seed, and an unburned wheatgrass (*Agropyron sp.*) glume. Burned goosefoot seeds and unburned juniper seeds were found in Features 5, 13 and 16.

Table 5.5. Summary listing of recovered macrobotanical specimens by Cultural Levels (as defined in Chapter 6).

ARTIFACTS COLLECTED: MACROBOTANICALS					
FS/SS#	**UNIT**	**LEVEL BELOW DATUM**	**CULTURAL LEVEL**	**FEATURE ASSOCIATION**	**FLOTATION RESULTS**
.fs35	X0Y3	50-60cm	I	None	Unburned pine nut hulls
.fs75	X1.6Y0.5	50-60cm	I	None	Unburned pine nut hulls
.fs21	X0Y0	60-70cm	I	None	Unburned pine nut hulls
.fs47	X0Y3	110-120cm	I	None	Unburned pine nut hulls
.fs77	X0Y3	170-180cm	I	None	Unburned juniper berries
.fs68	X0Y3	180-190cm	I	None	Unburned pine nut hull
.ss3	X0Y0 E ½	100-120cm	II	Feature 3 fill	Burned goosefoot seeds juniper seed Unburned goosefoot seeds
.ss4	X0Y0 E ½	100-120cm	II	Feature 3 fill	
.ss5	X0Y0 E ½	100-120cm	II	Feature 3 fill	
.ss6	X0Y0 W ½ (2 bags)	100-120cm	II	Feature 3 fill	
.ss33	X1.5Y2.5	90-100cm	II	Feature 17 fill	Unburned goosefoot seeds
.fs32	X0Y0	90-100cm	II	None	Unburned pine nut hull
.fs31	X0Y0	80-90cm	II	None	Unburned pine nut hulls

ARTIFACTS COLLECTED: MACROBOTANICALS					
FS/SS#	**UNIT**	**LEVEL BELOW DATUM**	**CULTURAL LEVEL**	**FEATURE ASSOCIATION**	**FLOTATION RESULTS**
.ss15	X1.5Y0.5	100cm	III	Feature 11 fill	Possible burned buckwheat Unburned grass (*Poaceae)* seed Unburned goosefoot seeds Unburned knotweed seeds
.ss16	X1.5Y0.5	100cm	III	Feature 11 fill	
.ss18	X1.5Y0.5	110-120cm	III	Feature 11 fill	
.ss19	X1.5Y0.5	110-120cm	III	Feature 11 fill	
.ss20	X1.5Y0.5	110-120cm	III	Feature 11 fill	
.ss21	X1.5Y0.5	110-120cm	III	Feature 11 fill	
.ss22	X1.5Y0.5	120-130cm	III	Feature 11 fill	
.ss23	X1.5Y0.5	120-130cm	III	Feature 11 fill	
.ss41	X2.5Y0.5	150-152cm	III	Feature 19 fill	None
.ss42	X2.5Y0.5	150-152cm	III	Feature 19 fill	
.ss43	X2.5Y0.5	150-152cm	III	Feature 19 fill	
.fs40	X0Y0	100-120cm	III	None	Unburned pine nut hull
.ss1	X0Y0	110-120cm	IV	Feature 4 fill	Unburned goosefoot seeds Unknown goosefoot species seed Unburned foxtail seed Unburned cheatgrass glume Unburned knotweed seed Unburned juniper seed Unburned wheatgrass glume
.ss2	X0Y0	110-120cm	IV	Feature 4 fill	
.ss10	X0Y1 NW ½	130-150cm	IV	Feature 5 fill	Vitrified pine sap Burned goosefoot seed Unburned juniper seed
.ss11	X0Y1	130-150cm	IV	Feature 5 fill	

ARTIFACTS COLLECTED: MACROBOTANICALS					
FS/SS#	**UNIT**	**LEVEL BELOW DATUM**	**CULTURAL LEVEL**	**FEATURE ASSOCIATION**	**FLOTATION RESULTS**
.ss40	X1Y1	130-150cm	IV	Feature 5 fill	Vitrified pine sap Burned goosefoot seed Unburned juniper seed
.ss30	X1Y1.5	130-150cm	IV	Feature 5 fill	
.ss31	X1Y1.5	130-150cm	IV	Feature 5 fill	
.ss32	X1Y1.5	130-150cm	IV	Feature 5 fill	
.ss7	X0Y2	160-170cm	IV	Feature 6 fill	Burned Indian ricegrass seeds
.ss8	X0Y2	160-170cm	IV	Feature 6 fill	
.ss9	X0Y2	160-170cm	IV	Feature 6 fill	
.ss12	X0Y1	150-153cm	IV	Feature 7 fill	Unburned goosefoot seeds
.ss13	X0Y1	158cm	IV	Feature 8 fill	Vitrified pine sap
.ss14	X0Y1	150-158cm	IV	Feature 8 fill	
.ss24	X2.5Y0.5	75-80cm	IV	Feature 13 fill	Burned goosefoot seeds Unburned juniper seeds
.ss25	X2.5Y0.5	75-80cm	IV	Feature 13 fill	
.ss26	X2.5Y0.5	75-80cm	IV	Feature 13 fill	
.ss28	X2.5Y0.5	75-80cm	IV	Feature 13 fill	
.ss27	X1Y2.5 (2 bags)	120-130cm	IV	Feature 14 fill	None
.ss29	X1.5Y1.5	120-130cm	IV	Feature 14 fill	None
.ss38	X1.5Y2.5	120cm	IV	Feature 14 fill	None
.ss39	X1.5Y2.5	120-130cm	IV	Feature 14 fill	None

Artifacts Collected: Macrobotanicals					
FS/SS#	**UNIT**	**LEVEL BELOW DATUM**	**CULTURAL LEVEL**	**FEATURE ASSOCIATION**	**FLOTATION RESULTS**
.ss34	X3 Y-0.5	117-134cm	IV	Feature 16 fill	Burned goosefoot seeds Unburned cactus seeds Unburned goosefoot seeds
.ss35	X3 Y-0.5	117-134cm	IV	Feature 16 fill	
.ss36	X3 Y-0.5	117-134cm	IV	Feature 16 fill	
.ss37	X3 Y-0.5	117-134cm	IV	Feature 16 fill	
.ss44	X1Y2.5	200cm	IV	Feature 21 fill	None
.fs44	X0Y2 N ½	110-120cm	IV	None	Unburned pine nut hull
.fs49	X0 Y1	130-150cm	IV	None	Unburned pine nut hull
.fs73	X0Y0	140-150cm	IV	None	Possible unburned juniper seed half

Vitrified pine sap was of note in Features 5 and 8 and unburned cactus (*Cactaceae*) seeds were found in Feature 16 fill. Burned Indian ricegrass (*Oryzopsis hymenoides*) seeds were found only in Feature 6. There were no macrobotanical specimens found in Features 14 and 21. An unburned possible juniper seed was collected within Cultural Level IV at 140-150cm below datum.

With the exception of Cultural Level I, goosefoot seeds are the most prominent species found within the shelter, while Indian ricegrass and cactus seeds were only noted once, within level IV.

SUMMARY OF ARTIFACT ANALYSES

The following section discusses lithic material types that have been found on sites in west central Colorado. The types of artifacts found in 5GF741 and their relative cultural level positions are described thereafter.

The terminology used here has its basis in the geologic literature and is fully elucidated in Miller (1992), however, other descriptive names are applied to these rocks. For instance, translucent opalitic chert is commonly called chalcedony. Chalcedony is a crypto-crystalline rock, indicating a concealed or hidden crystal habit (albeit viewable in cross-polarizing light), and forms in hydrothermal or geothermal settings while opalitic chert forms in surface environments, usually in water during fluctuating pH conditions. Opal, by definition, contains a small amount of water and has a Moh's hardness in the range of 6.5 as opposed to 7.0 for true chalcedony. It should be noted, however, that after opalitic chert is deeply buried and affected by geothermal heating, vugs or fractures in the rock are usually filled with chalcedony.

Opalitic chert is variegated and translucent to some degree, even in thick samples. Miocene opalitic chert ranges in color from almost clear to milky gray to white (often referred to as chalcedony), and brown to red; formed in shallow, ephemeral lakes; and almost always contains ostracodes (clam shrimp) and stromatolitic (i.e. algal) banding. "Local" sources include Troublesome and Browns Park formations (Miocene), east and north, respectively, from the Steamboat Mesa area, but a useful secondary source exists in nearby river gravel, in the present bed or in terraces. The primary opalitic chert of the northern Uncompahgre Plateau comes from Burro Canyon Formation (Jurassic-Cretaceous); it is white to cream, yellow, and pink to red in color, and co-occurs as interbeds with the orthoquartzite and porcellanite from the same formation. There are numerous sources of this material in the Uncompahgre Uplift.

Other names are commonly applied to opalitic chert types. "Pumpkin" chert, an orange-to-red chert with manganese dendrites is usually derived from Mississippian, Pennsylvanian and Permian rocks. A local type is imported from quarries in the Morgan

Formation located along the Yampa River. Similarly, "pidgeon blood" chert is white or clear opalitic chert with blebs of hematite and probably ferrihydrite and is formed in karst in Paleozoic limestones, but also in Miocene playa lakes. The name "root beer" chert is often applied to any dark brown chert formed in terrestrial environments in perennial and ephemeral lakes or, less commonly, during subaerial erosion of limestone over hundreds of millions of years. A type regionally observed has been identified in quarries found in Sand Wash Basin. "Jasper" is applied to any red, orange or yellow chert, but is more specifically spherulitic felsite which originates in rhyolite source rocks such as those found on the Flat Tops and Grand Mesa. Banded opalitic chert from the Green River Formation (Eocene) is referred to as "tiger" or "shavetail" chert and was formed on the bed of lakes Gosuite and Uinta. The material is usually dark brown or black with tan banding, and inclusive invertebrates, especially ostracodes, are commonly replaced by light blue opalitic chert or chalcedony. The banding represents lake varves – alternating opalitic chert and porcellanite – representing clastic deposition during monsoons (porcellanite) and silica precipitation in the dry season during deposition.

Knife River Flint or KRF from Golden Valley Formation (Eocene) in western North Dakota is also opalitic chert that has been identified in Protohistoric artifact collections as far south as the Uncompahgre Plateau (Conner et al. 2007:22). A local source is also found near Crawford in west-central Colorado. It is identified by numerous palm leaf or frond fragments, the latter identified by parallel veins where voids are left by loss of the organics that are filled with chalcedony. Miller and Larson (1990) presents a series of photographs of KRF taken at high magnification under cross-polarizing light where the chalcedony crystal habit is clearly contrasted with the surrounding amorphous opalitic chert.

Orthoquartzite and porcellanite are silica cemented clastic rocks, the former sandstone and the latter mudstone (i.e., siltstone or claystone). Mesozoic clastic rocks are identifiable by mineral composition which is almost exclusively quartz and black chert grains due to prolonged rework and transport. Many Mesozoic orthoquartzites exhibit authigenic chalcedony filling interstices and voids, and quartz grains and silica cement have been altered to high refractive quartz by a combination of heat and pressure in diagenesis. Light-colored orthoquartzites are described as "salt and pepper" with black chert grains being the "pepper." *Sucrosic* is another term applied to these rocks, describing reflected light from facets on fractured quartz and other mineral grains.

Most of these rocks have distinct characters useful in identification. Dakota Formation (Cretaceous) is commonly light colored, typically "salt and pepper" and sucrosic; related Burro Canyon Formation (Jurassic-Cretaceous) orthoquartzite is variegated, ranging from tan to cream to red and green. Also, Burro Canyon Formation green porcellanite was used as tool stone in many areas, and tools of this material have been observed throughout the region. Cloverly Formation (Cretaceous) is chiefly identified by quartz overgrowths on clastic grains and even colors, ranging from gray to tan to red to purple. Morrison Formation (Jurassic) porcellanite contains fossil roots and rhizomes, and fucoids (worm burrows) associated to a fossil soil, and mottling related to exsolution of iron oxy-hydroxides.

Dakota Formation has many exposures in the Uncompahgre Uplift. Morrison Formation is consistently exposed along the north side of the uplift, along the Redlands fault which marks the geologic boundary between the Grand Valley and the Uncompahgre Uplift, but no specific quarry or procurement areas are known by the author. Cloverly Formation is exposed in the western Plains area, around the Black Hills and Hartville uplifts in eastern Wyoming and overlies Morrison Formation there.

Obsidian is commonly called volcanic glass because it is found in "obsidian flows" within the margins of rhyolitic lava flows. The obsidian flows are a phenomenon where felsic lava extruded from a volcano cools rapidly with minimum crystal growth, a result of the presence of a high silica content which induces a high viscosity and polymerization degree to the lava. This material is a hard and brittle substance that fractures with very sharp edges, and was used by Native Americans as primarily cutting tools and projectile points. Because it is volcanic, it has a particular chemical signature that can be identified by its source; hence the term "sourcing" of obsidian. Obsidian is found on many sites in the region and is derived from sources primarily found in Idaho, Wyoming, New Mexico, and Utah.

SUMMARY OF COLLECTED ARTIFACTS BY CULTURAL LEVELS

Table 5.6 summarizes the analyses of all recovered artifactual material. Appendix A contains a list of collected artifacts that will be curated at the Museum of Western Colorado, a BLM designated curation facility. [Note: Cultural Levels are defined in Chapter 6.]

The greatest density of cultural artifacts was collected in Cultural Level IV. The chipped stone assemblage consisted of: 14 flakes, one utilized flake, one piece of angular shatter, and one obsidian McKean complex projectile point. A small comal fragment and a pocket of red ochre were also collected. Debitage materials consist mostly of a reddish-brown porcellanite. Local coal seam contacts within the Green River Formation are probable procurement areas for such material. The source of the obsidian was found to be Malad, near southern Idaho. Three flakes were found to be of opalitic chert from the Burro Canyon Formation, and one porcellanite also from the Burro Canyon Formation. The small comal fragment is likely of local Dakota Formation sandstone.

The McKean Lanceolate projectile point was sent to the Northwest Research Obsidian Studies Laboratory, Corvallis, Oregon for sourcing, and was analyzed using X-ray fluorescence (XRF) trace element characterization. This process is a method that is *nondestructive*, accurately measures trace element concentrations in obsidian, and has been shown to have the greatest overall success in "fingerprinting" obsidian sources (Harbottle 1982; Rapp 1985; Williams-Thorpe 1995; Glascock et al. 1998; and, Herz and Garrison 1998). The source identified for this projectile point was Malad, which is located in the southeast portion of Idaho.

Table 5.6. Summary of analyses of artifact materials recovered from 5GF741.

Artifacts Collected: Chipped Stone								
FS #	**Unit**	**Level Below Datum (BD)**	**Cultural Level**	**Artifact**	**Oxidation-Use Ware-Retouch**	**Material**	**Source**	**Dimensions**
12	X0Y0	60cm	I	possible flake		porcellanite	Green River Fm	1.5x1.6x5.5mm
25	X0Y0	70-80cm	I	flake		quartzite	Unknown	1.7x4.3x7.3mm
28	X0Y0	70-80cm	I	possible flake		porcellanite	Green River Fm	14.8x4.7x7.5mm
84	X1.6Y 0.5	90-100cm	II	flake	useware	porcellanite	Green River Fm	45.1x21.5x12.5
59	X0Y1	107.5cm	II	flake		ostracodal chert	Golden Valley Fm	3.0x2.5x9.1mm
22	X0Y1	70-80cm	III	possible flake		mudstone	Cretaceous shale	0.9x3.1x9.3mm
43	X0Y0	114cm	III	chert core		chert	Burro Canyon Fm	23.7x13.1x2.5mm
64	X1Y1	115cm	III	flake fragment		opalitic chert	Summerville Fm	15.7x5.7x5.5mm
36	X0Y0	110-120cm	III	Projectile Point Midsection (possible fragment of a Roubideau Phase Type 24, Uncompahgre Complex)		quartzite	Proterozoic quartzite	10.9x8.6x4.7mm
1	2009	130-140cm	III	tertiary bifacial thinning flake	overstep	opalitic chert	Green River Fm	14.1x7.8x0.9mm
5	2009	130-140cm	III	Biface	polymodal	opalitic chert	Green River Fm	blade edges 25.2 & 4.9mm; max width 24.8mm; max thickness 5.8mm

Artifacts Collected: Chipped Stone								
FS #	**Unit**	**Level Below Datum (BD)**	**Cultural Level**	**Artifact**	**Oxidation-Use Ware-Retouch**	**Material**	**Source**	**Dimensions**
2	2009	130-140cm	III	tertiary bifacial thinning flake	overstep	opalitic chert	Green River Fm	13.6x7.2x1.4mm
	2009	130-140cm	III	tertiary bifacial thinning flake	fragment	opalitic chert	Green River Fm	9.5x6.8x1.1mm
69	X0Y1	132cm	IV	shatter		porcellanite	Green River Fm	30.6x8.8x1.1mm
70	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	18.2x9.9x0.4mm
	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	21.2x19.9x5.9mm
	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	21.5x12.4x3.0mm
	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	24.4x11.7x4.1mm
	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	13.2x10.9x2.9mm
	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	9.9x6.5x2.6mm
	X0Y1	131cm	IV	flake fragment		porcellanite	Green River Fm	4.4x7.2x2.2mm
45	X0Y2	135cm	IV	Projectile Point (McKean Lanceolate)		obsidian	Malad SE Idaho	39.3x8.1x6.4
89	X1Y1.5	135cm	IV	flake		porcellanite	Green River Fm	32.0x19.8x4.2mm
79	X0Y3	130-150cm	IV	flake	useware	porcellanite	Green River Fm	25.6x3.7x4.4mm
107	X1Y1.5	147cm	IV	pressure flake fragment	no cortex	porcellanite	Green River Fm	6.3x1.5x8.9mm
74	X0Y1	152cm	IV	flake fragment		porcellanite	Green River Fm	4.5x0.1x7.1mm
61	X0Y2	150-160cm	IV	flake		opalitic chert	Burro Canyon Fm	0.1x3.3x9.0mm

Artifacts Collected: Chipped Stone								
FS #	**Unit**	**Level Below Datum (BD)**	**Cultural Level**	**Artifact**	**Oxidation-Use Ware-Retouch**	**Material**	**Source**	**Dimensions**
80	X0Y1	150-160cm	IV	flake		opalitic chert	Burro Canyon Fm	2.0x4.2x9.1mm
87	X0Y1	135-165cm	IV	flake fragment		opalitic chert	Burro Canyon Fm	0.1x2.5x8.2mm
90	X0Y0	190-200cm	VI	broken waterworn pebble		quartzite	Dakota Fm	15.0x15.6x18.0mm
110	X1.5 Y1.5	130-140cm	IV	pressure flake frag	no cortex	porcellanite	Burro Canyon Fm	18.2x11.2x7.7mm
108	X0Y1	250-260cm	VI	possible flake fragment	shatter chunk	opalitic chert	Burro Canyon Fm	0.5x1.9x8.2mm
WS 1	X0Y1. 41.7	150-160cm	VI	possible microflake frag	no cortex	opalitic chert	Burro Canyon Fm	3.6x1.8x0.7mm
WS 5	X0Y1. 41.7	190-200cm	VI	possible microflake frag	faceted on one surface	quartzite	Dakota Fm	6.1x4.7x1.4mm
WS 8	X0Y1. 41.7	220-230cm	VI	possible microflake frag		porcellanite	Dakota Fm	4.0x3.4x0.8mm
WS 9	X0Y1. 41.7	240-250cm	VI	possible microflake frag	no cortex	porcellanite	Dakota Fm	2.7x2.5x0.8mm

Artifacts Collected: Groundstone Site:5GF741							
FS#	**UNIT**	**LEVEL BD**	**CULTURAL LEVEL**	**ARTIFACT**	**MATERIAL**	**SOURCE**	**DIMENSIONS**
72	X0Y1	145cm	IV	Comal frag	sandstone	Dakota Fm	5.34x4.47x1.49cm
95	X1.5Y 0.5	125cm	III	Comal fragment	sandstone	Dakota Fm	15.4x12.2x1.33cm
109	X1.5Y 2.5	110-120cm	III	metate frag	sandstone	Dakota Fm	23.5x13x3.72cm

Artifacts Collected: Ceramics Site:5GF741					
FS#	**UNIT**	**LEVEL**	**ARTIFACT**	**MATERIAL**	**DIMENSIONS**
6	X0 Y2	70cm	2 pottery sherds	Uncompahgre Brown Ware	12.4x12.1x3.1mm 11.5x6.6x3.2mm

Artifacts Collected: Other						
FS#	**UNIT**	**LEVEL**	**CULTURAL LEVEL**	**ARTIFACT**	**MATERIAL**	**DIMENSIONS**
4	X0 Y1	60-70cm	I	red ochre	hematite	3.0x2.9x6.1mm
55	X0 Y1	83cm	II	red ochre	hematite	5.7x5.6x2.0mm
112	X2.5 Y0.5	154cm	IV	red ochre	hematite	fragmented; 13 grams

Although Cultural Level III had a low density of artifacts, it did have a large artifactual diversity. Five flakes, one biface, one core and a projectile point fragment constitute the chipped stone assemblage while groundstone consisted of a comal fragment and a metate fragment. Both groundstone artifacts are of Dakota Formation sandstone. Lithic materials are varied; three of the flakes are of a Green River Formation chert, one flake of Summerville Formation chert, one possible mudstone flake, a core of Burro Canyon chert and a projectile point midsection of a pink orthoquartzite. The quartzite is similar to a Proterozoic quartzite known to occur in South Dakota and the mudstone flake is likely of local Cretaceous shale.

Cultural levels I and II only yielded five flakes collectively. One flake of Golden Valley Formation ostracodal chert and one utilized flake of Green River porcellanite were collected from level II. A red ochre chunk was also collected from this level. The chipped stone assemblage of Cultural Level I consisted of two Green River Formation porcellanite flakes and one quartzite flake of unknown origin. A red ochre chunk was collected from level I as well.

Two sherds of Uncompahgre Brown Wear recovered from upper aeolian and organic deposits represent a Numic speaking occupation.

VERTEBRATE REMAINS

All the vertebrate remains recovered from the shelter are from the last thousand years of deposits and include a fetal artiodactyl (probably Bos); bear phalange; lagomorph rib; a vertebra and proximal rib end, possible from a carnivore (coyote?); an unidentified ilium from a newborn mammal; and rodent remains, including a squirrel maxillary. The lagomorph rib has marks that may have resulted from rodent gnawing.

CHAPTER 6

ARCHAEOLOGICAL INTERPRETATIONS

The research design prescribed excavation by $1m^2$ grid units and documentation by 5-10cm levels based on a datum plane. These procedures were used to individually document cultural features (Appendix B: OAHP Site Form). In the laboratory, the discrete cultural layers were identified by the analyses of the radiocarbon data, comparative dating of collected diagnostic artifacts, and designation of stratigraphic units. The following section discusses the findings based on those associations, and discusses the cultural levels from lowest to highest following the stratigraphic units.

CULTURAL LEVEL IV MIDDLE ARCHAIC

This cultural level (CL-IV) corresponds with Stratigraphic Unit IV (Figure 6.1). It contained a McKean Lanceolate point (Plate 6.1) of the McKean Complex, which dates after 5000 BP to as late as 3000 BP on the Plains. At the Signal Butte site in western Nebraska, McKean Lanceolate points were found in association with Mallory-type side-notched points in dated levels from 4550-4170 BP (Frison 1991:89). Considering that the oldest radiocarbon date from Stratigraphic Unit III is 3430±40 BP (Beta-304084), it is likely that the date range for CL-IV is 4200 and 3800 BP. The comparative dating of the Lanceolate point and confirmation by stratigraphic unit clearly establishes the temporal association of this cultural level.

Plate 6.1. McKean Lanceolate projectile point, CL-IV.

CL-IV contains two, vertically separated, ash lenses (Features 5 and 7) within the shelter that converge at the dripline into a single expression, and continue as such as the deposits dip to the northwest outside the overhang. These lenses have a radius of approximately three meters from the back of the shelter and extend downslope about 2m past the dripline. The two lenses within the shelter most likely represent separate occupations during the 4200-3800 BP time period, but could date as early as 4500 BP.

The surface of the cultural deposits occur about 1.6m below the ceiling of the shelter, and the covered floor at this level is about $10m^2$. The height and floor space provided by the shelter would allow a relatively comfortable living area for eight or more people. The floor of this living area exhibits a low artifact count, as would be expected from an habitation area. [See identification of shelter floors in the Bustos Wickiup Site in eastern Nevada (Simms 1989:2).] Importantly, this level contains several features including a storage cist and one small thermal feature that was initially interpreted by the excavators as a possible post hole. Feature 8, the thermal feature is located in the southwest portion of and about midway in the shelter. It is 20cm in diameter, clearly defined and excavated into the floor

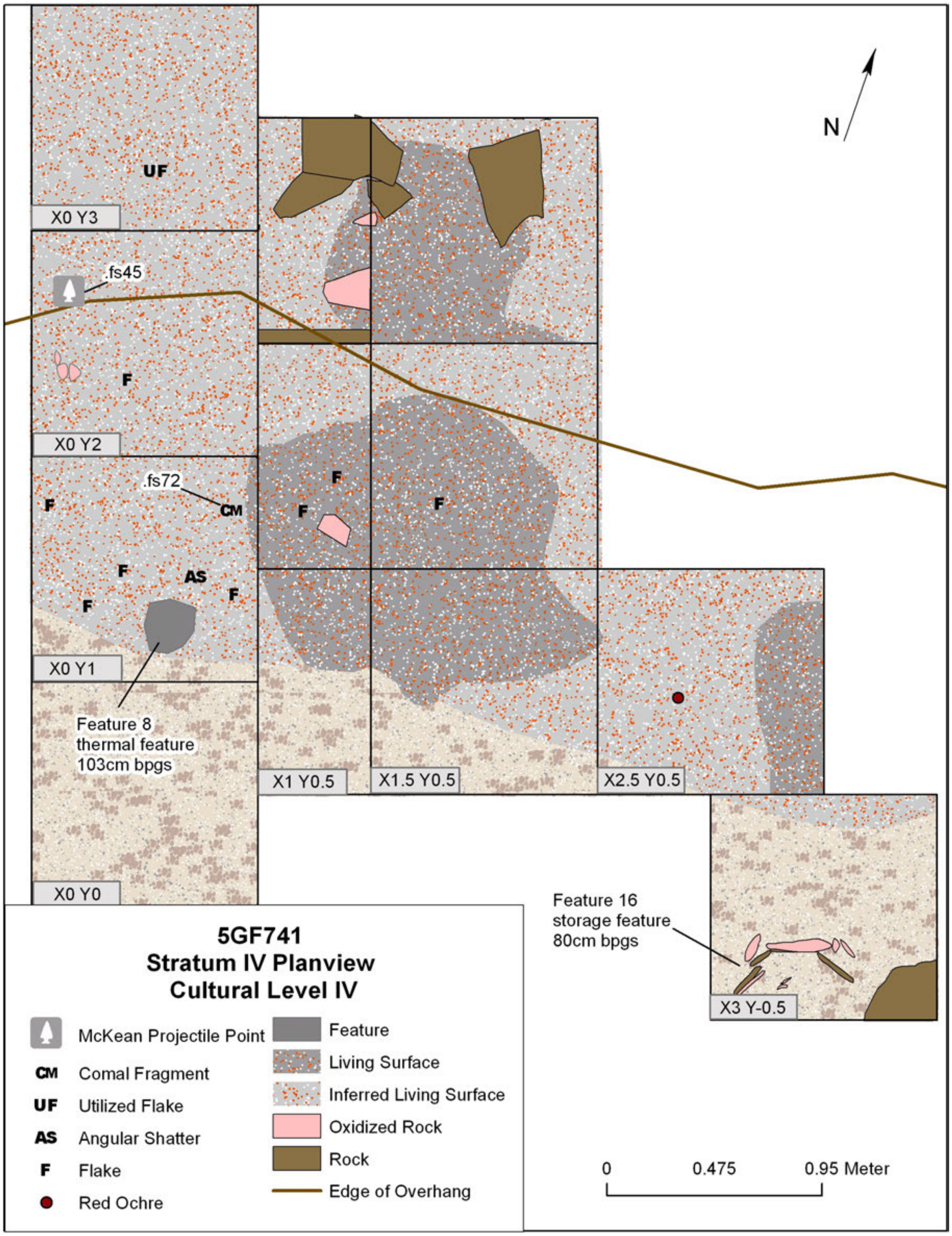


Figure 6.1. Composite of plan views and profiles illustrating features and artifacts of Cultural Level IV.

to a depth of 5cm (Figure 6.2; Plate 6.2). In cross-section, it exhibits a clear rind of oxidized soil, which implies that it contained a hot fire for an extended period. The color and penetration of the oxidation is also an indication of climatic conditions that are ameliorating and wet, which correlates with the end of the Middle Holocene amelioration (6500-4000 BP) and beginning of the 2nd Holocene Drought (4000-2800 BP) [see Figure 3.1, p. 3-30]. In the proximate 2m area to the north and northwest of this feature were ash-stained soils – within and outside the overhang – which probably represent clean-out deposits from the feature.

The storage cist (Feature 16) was found in the northeast corner of the shelter near the back wall. It was dug into the lower portion of Stratigraphic Unit IV (117cm below datum), and the top was near the same level as the top ash lense of CL-IV (Figure 6.3; Plate 6.3). It is slab-lined type that had four slabs relatively *in-sit*u and a scatter of five other slabs and/or fragments (all of sandstone). Five of the slabs exhibit thermal alteration. The largest (in place) upright slab measures roughly 25x20x3cm. The diameter of this feature was estimated to be 50cm and, based on the largest slab, the estimated depth was 25cm.

CULTURAL LEVEL III   MIDDLE ARCHAIC

This cultural level (CL-III) occurs in the lower portion of Stratigraphic Unit III, which has a average thickness of 40cm within the shelter (Figure 6.4). Two dates (3430±40 BP [Beta-304084] and 3020±30 BP [Beta-304086]) were obtained from there and bracket the cultural level. Based on the broad range of projected dates for McKean Complex of 5000 to 3000 BP, CL-III could be culturally related, as is CL-IV.

This level is defined by Features 11, 18 and 19. Feature 11 is an ashstain that averaged about 10cm thick and covered most of the floor of the shelter. Since two radiocarbon samples produced dates stratigraphically corresponding to the bottom and top of the ashstained soil layer, Feature 11 probably represents the compressed floors of two occupations. This cultural level also contained two large storage cists, unlined pits that – based on their stratigraphic levels – relate to the separate dates of occupation. Both are located in the back and northeast quadrant of the shelter. Storage feature 18 is slightly lower in the stratigraphy, at the contact between SU-III and SU-IV, and thus likely related to the 3430±40 BP date (Figure 6.5). It measures approximately 40cm deep and 60cm in diameter at the top. During its construction by the Archaic inhabitants, the south portion of Feature 16 (CL-IV) was disturbed. Storage feature 19 is located about 0.5 meter northwest of 18 (Figure 6.4). In profile, it appears as a bell-shaped or jar-shaped pit. It measures about 40cm deep, 20cm in diameter at the top and bottom, and about 40 cm in diameter for its maximum central diameter (Figure 6.6). It is slightly higher in SU-III, and is close to the same level as the radiocarbon date 3020±30 BP.

The 3020±30 BP date was recovered from a deposit near a scatter of fire-cracked and

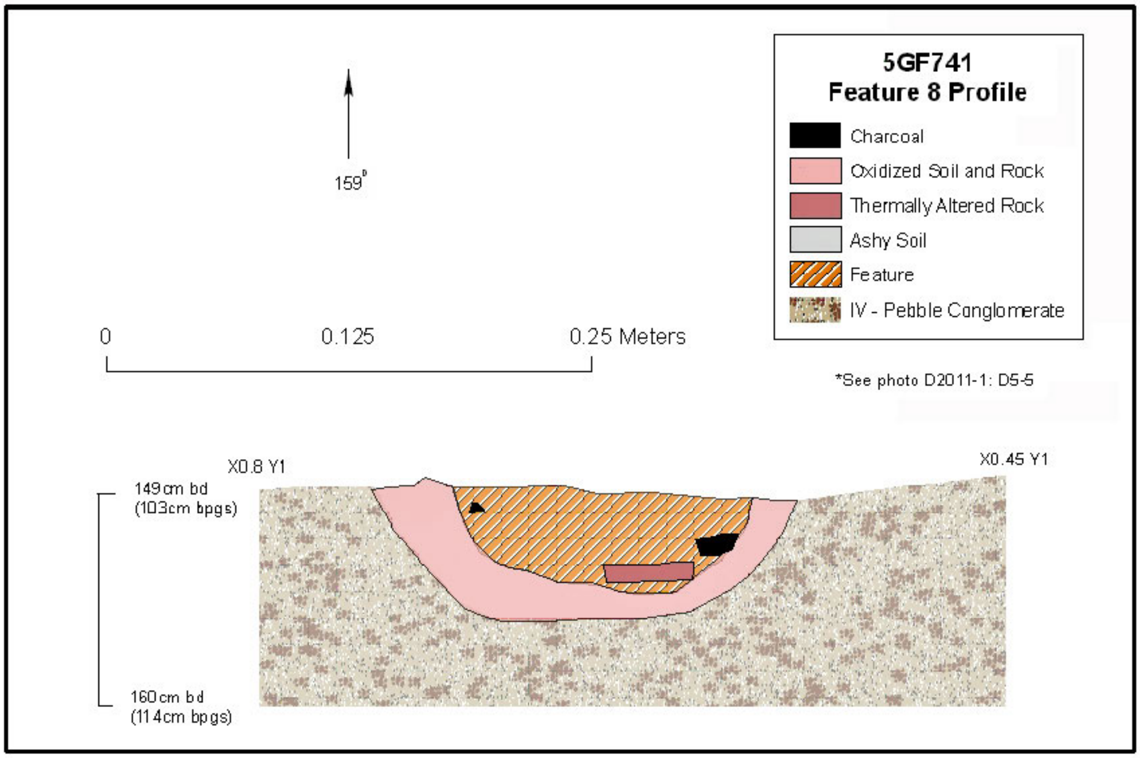


Figure 6.2. Feature 8 profile.

Plate 6.2. Plan view photograph of Feature 8.

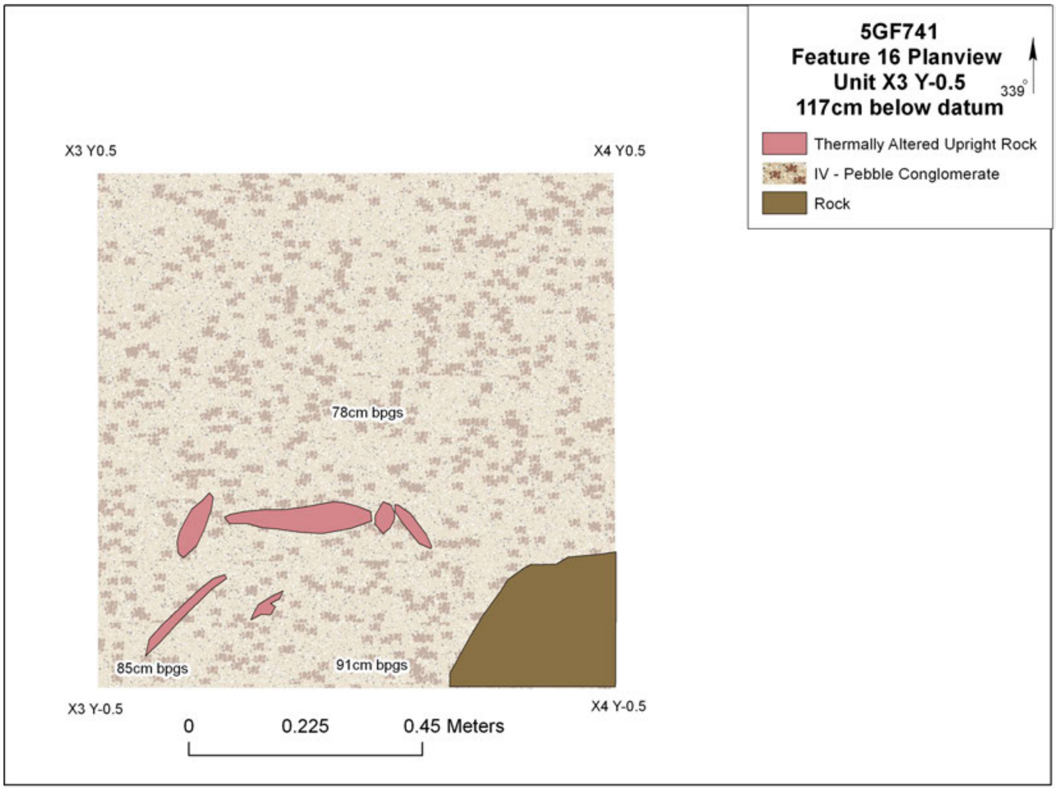
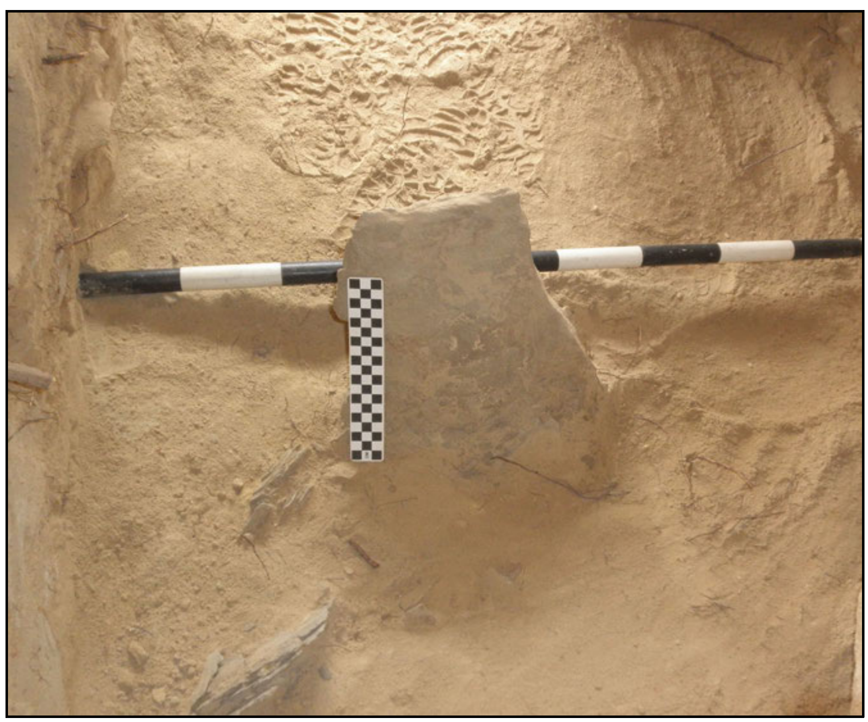


Figure 6.3. Plan view of Feature 16, a slab-lined storage pit.

Plate 6.3. Photograph of the largest slab of Feature 16, a slab-lined storage pit.



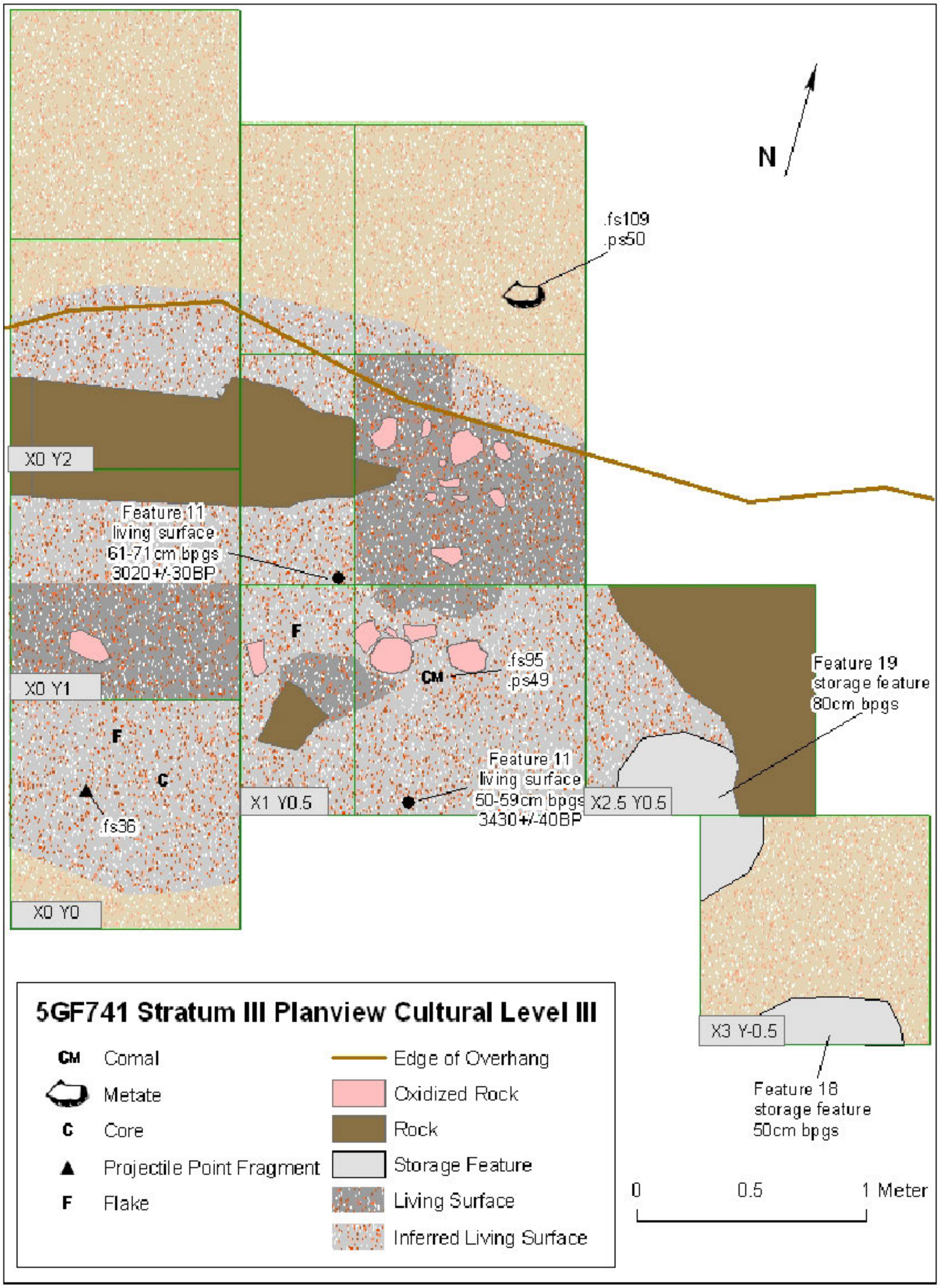


Figure 6.4. Composite of plan views and profiles illustrating features and artifacts of Cultural Level III.

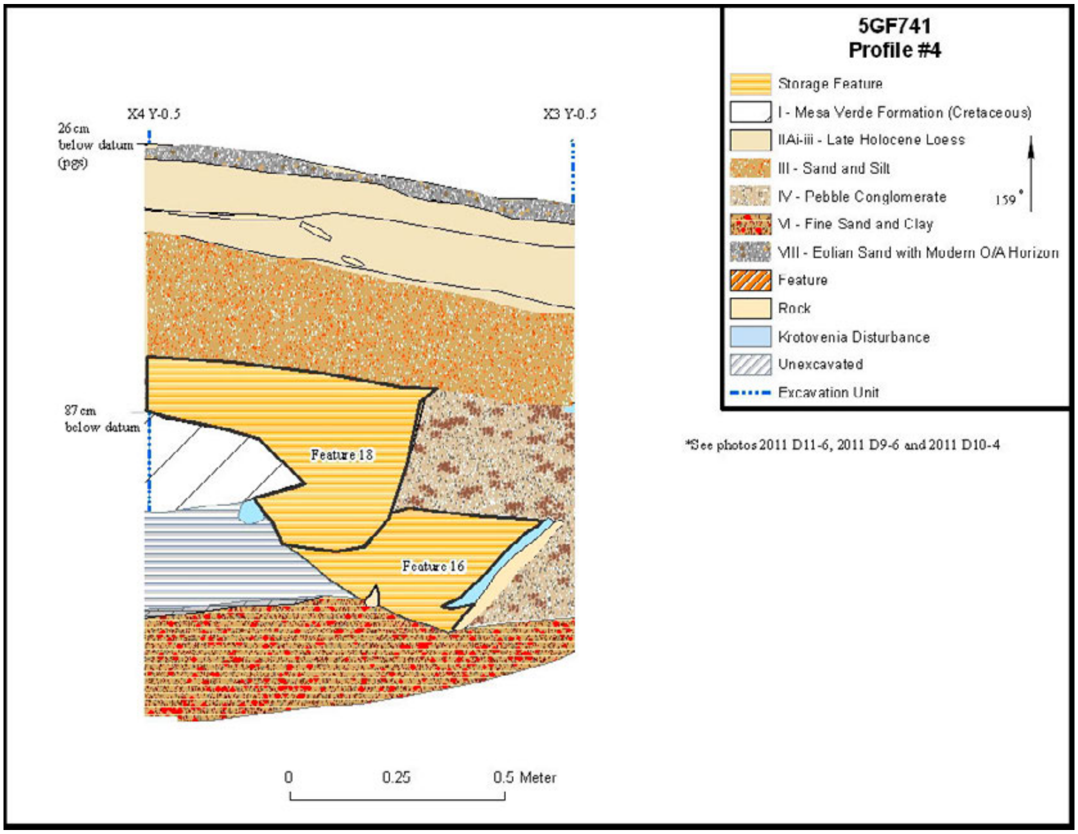


Figure 6.5. Profile showing stratigraphic relationship of Feature 18 CL-III, an unlined storage pit, in relation to Feature 16 CL-IV.

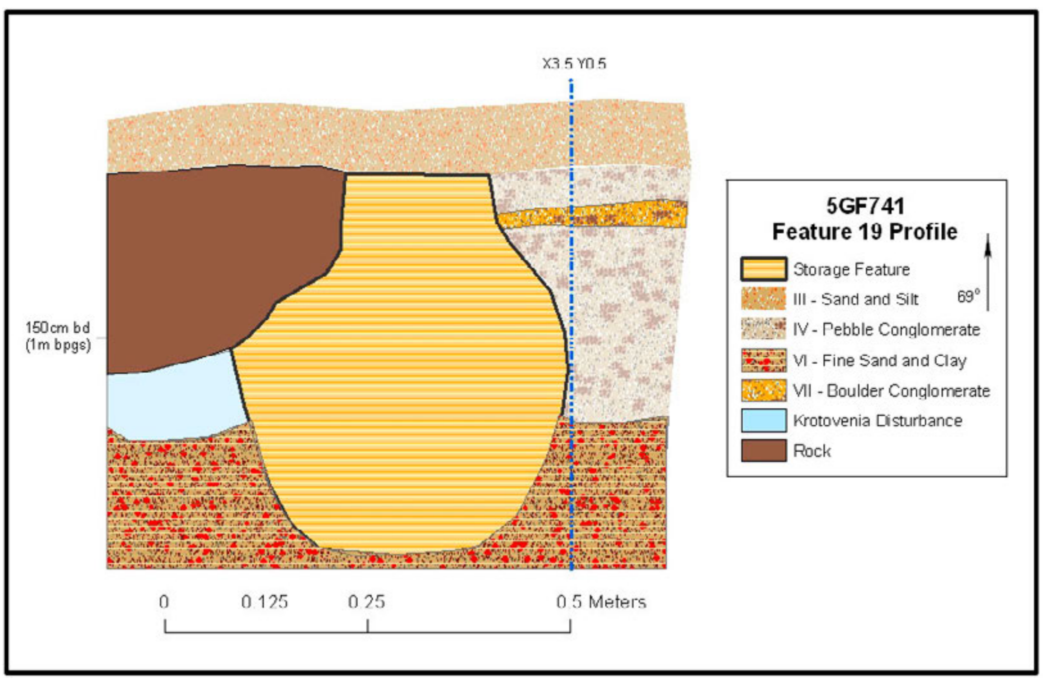
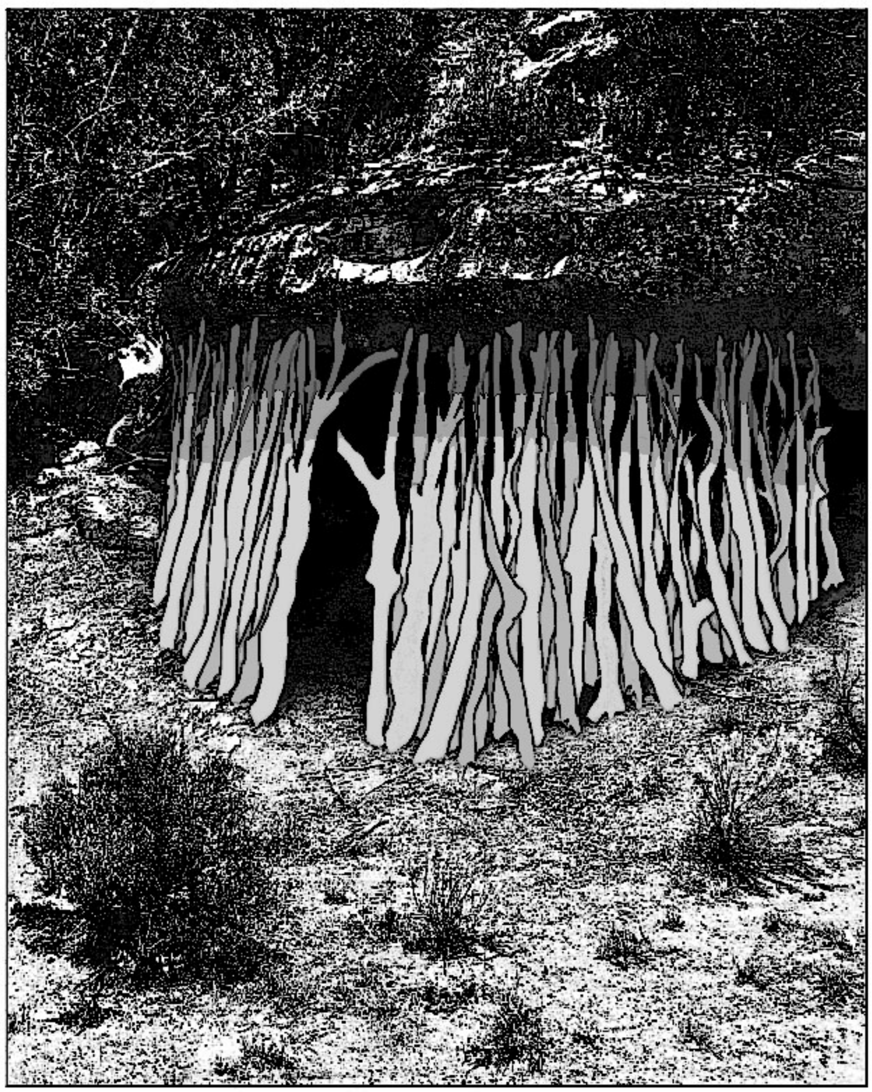


Figure 6.6. Profile showing Feature 19, an unlined, bell-shaped storage pit in CL-III.

altered rocks (FCR) near the top of the 10cm deep cultural deposits – ash-staining that occurs across the floor. This floor level is about 1.4m (~4ft 8in) below the ceiling of the shelter. In the vicinity of the FCR scatter, were a couple flakes, a core, a comal fragment, and a projectile point midsection. A metate fragment was recovered from outside the dripline of the shelter. Between the occupations of CL-IV and CL-III, a large segment of the ledge that forms the roof collapsed onto the floor of CL-IV. It measured about 2m long by 50cm wide and is 45cm thick. It lay parallel to the back of the shelter and about 50cm within the dripline. It had a flat top and could have functioned as a bench or work area for the occupants.

CL-III characteristically resembles CL-IV. Based on the presence of the storage units in each of these levels, the shelter-centered positioning of the thermal features, and the height of the roof during those periods, the shelter was likely used for winter habitations and was probably enclosed with a wall of wood poles leaned against the overhang's ledge. An artist's interpretation of this concept is shown in Figure 6.7.

Figure 6.7. Artist's rendering of possible pole wall superstructure that enclosed the McClane Rockshelter during occupations of Cultural Levels III and IV.



CULTURAL LEVEL II LATE ARCHAIC

Three dates (2880±30 BP [Beta-304081], 2820±30 BP [Beta-304082] and 2730±40 BP [Beta-259175]), and were derived from thermal features or charcoal lenses higher in SU-III than CL-III (Figure 6.8). Thermal features 3 and17 were also recorded in this level. Interestingly, the features and lenses that contained charcoal dated to this level were not set near the center of the shelter, rather just inside the dripline or at the back. There were no associated storage features with this level and it is probable that occupation activities were related to short-term camping for resource procurement.

CULTURAL LEVEL I LATE ARCHAIC/FORMATIVE

Three dates define this cultural level: 1320±40 BP [Beta-259173], 1260±30 BP [Beta-304085], and 930±40 BP [Beta-259176], as well (Figure 6.9). The thermal feature dating 1320±40 BP was found just in front of the dripline – outside but near the center of the overhang. As discussed earlier, this position in relation to the overhang suggests that no structural feature is present and use of the shelter was for short-term camping. The ash and charcoal lens dating 1260±30 BP was found near the center of the overhang. Based on the previous indications, this may be indicative of a winter occupation and a possible structural feature to enclose the shelter at this time, but no storage features were recorded with this level. The 930±40 BP date was derived from a charcoal lens just outside the dripline and near the center of the overhang, which again is suggestive of short-term camping in the shelter.

Two Uncompahgre Brown Ware sherds were found mixed in the surface layer of the shelter. The presence of these sherds suggest another cultural level dating to the Late Prehistoric/Early Historic period on the surface of the site, but later use by domestics animals completely disturbed that layer. Luminescence dates on Uncompahgre Brown Ware sherds from sites in northwest Colorado indicate the appearance of Uncompahgre Brown Ware about 650 BP and the termination of use by ca. 300 BP (see Chapter 5, p. 5-4).

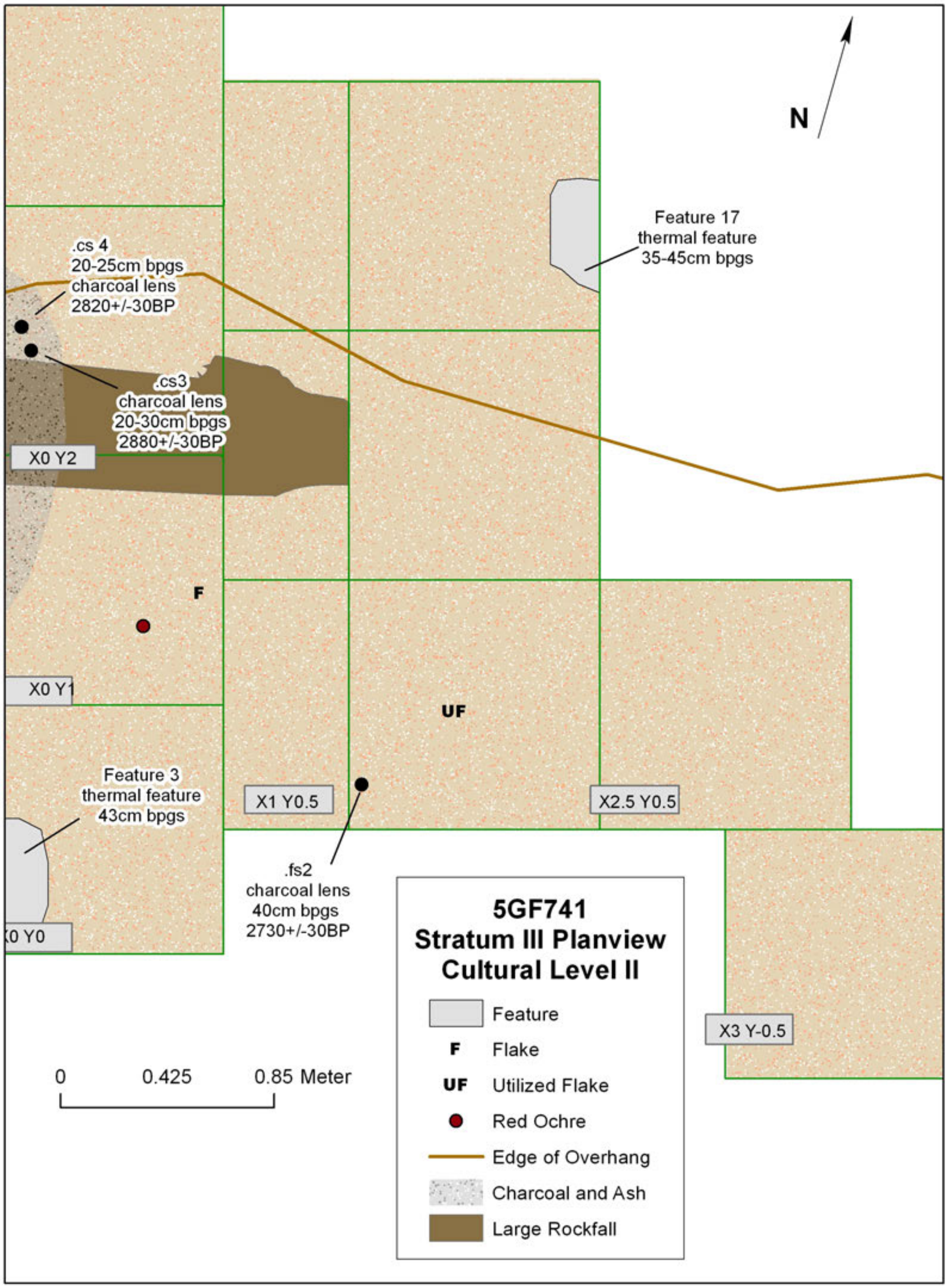


Figure 6.8. Composite of plan views and profiles illustrating features and artifacts of Cultural Level II.

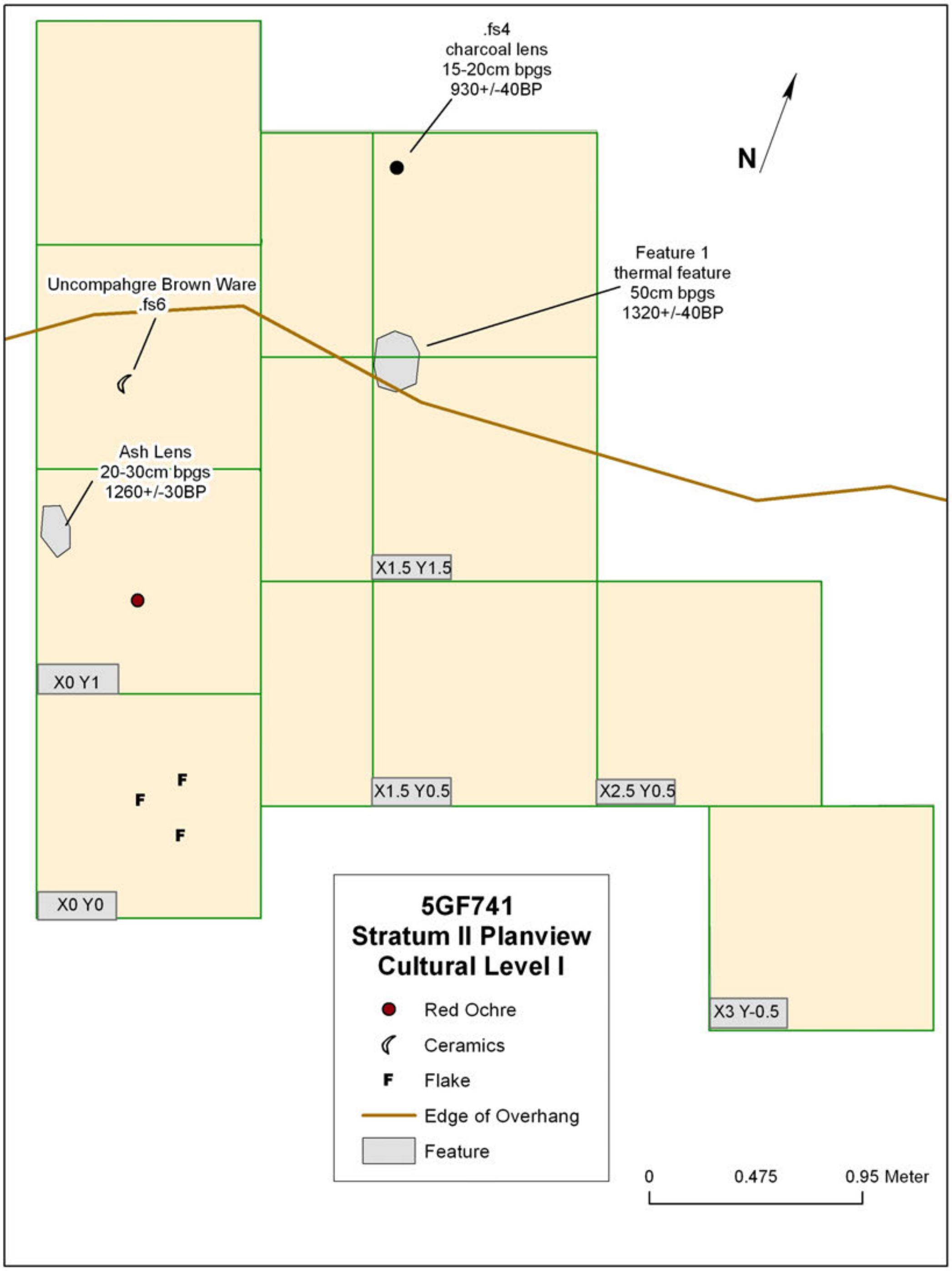


Figure 6.9. Composite of plan views and profiles illustrating features and artifacts of Cultural Level I.

COMPARISON WITH THE SISYPHUS ROCKSHELTER

The results of the excavations at the McClane Rockshelter can be directly compared to those of Sisyphus Shelter (5GF110), Area C (Gooding and Sheilds 1985). The comparison was undertaken because their excavation is the only one for the region that has recorded a slablined habitation floor within an overhang. Additionally, Sisyphus Shelter has nearly a parallel cultural/temporal span of occupation (Table 6.1.) Accordingly, this comparison is made to emphasize the use of rockshelters at various times and especially by McKean Complex groups as primary winter habitation structures – an overhang shelter augmented by the construction of internal features or that of pole and/or brush walls around the perimeter. Notably, two other sites have been recorded in west central Colorado that have wooden features that create habitation within a rockshelter or along a cliff face: 5ME901, the Bella site; and, 5DT222, the Black Canyon Ramada. These two date to the Late Prehistoric and Historic periods respectively.

Table 6.1. Comparison of temporal data derived from radiocarbon analyses and comparative diagnostics from the Sisyphus Shelter (Gooding and Sheilds 1985:33-34) and the McClane Rockshelter.

Cultural/Temporal Period	**Chronometric Data**	
	Sisyphus Shelter, 5GF110	McClane Rockshelter, 5GF741
Late Prehistoric - Early Numic	520 ± 55 BP	Uncompahgre Brown Ware
Late Archaic/Formative and Early Formative	1210 ± 50 BP	930 ± 40 BP 1260 ± 30 BP 1320 ± 40 BP
Late Archaic	2100 ± 55 BP 2410 ± 70 BP	2730 ± 40 BP 2820 ± 30 BP 2880 ± 30 BP
McKean Complex	3240 ± 75 BP 3480 ± 160 BP 3620 ± 95 BP 3660 ± 80 BP 3780 ± 80 BP 4130 ± 85 BP 4130 ± 125 BP 4400 ± 95 BP	3020 ± 30 BP 3430 ± 40 BP McKean Lanceolate

The Sisyphus Shelter contained evidence of a floor and low wall of a habitation structure (Feature 9, Cultural Level VII). It was dated 2410±70 BP, and described as a:

> ...rectangular slab--lined habitation within the shelter... Sandstone "foundation" walls were constructed to enclose three sides... [with] one wall placed across the front of the shelter and two side walls extended toward the back wall... Dimensions of the structure were 2.5m x 3.5m with the long axis of the habitation running the length of the shelter. All that remained of the feature was the floor and a lower portion of the west wall. The structure was shallow and saucer-shaped in profile (deepest in the middle and rising slightly to the edges)... [and] was laid on a prepared surface that was excavated into Levels VI, V and I. The slabs of the feature flooring varied from two to five centimeters thick. The slabs were neither trimmed nor prepared and were not laid in the prepared depression in any patterned manner. The edges appeared to be built up with several slab courses... Two features described as "adobe" puddles (Features 3 and 5) and two hearth features (Features 8 and 16) were subfeatures of Feature 9... The "puddled adobe" features, appeared as pure clay discolorations... The distance from the floor of the habitation to the ceiling of the overhang varied from 1.3 to 1.5 meters. Neither roof beams nor superstructure were encountered during excavation. Also, there was no evidence of logs laid in place to suggest cribbing of the walls. [However], the disturbance and cultural mixing of the levels and the disintegration of most of the fibrous remains [and] precluded any solid evidence of postholes (Gooding and Sheilds 1985:54,56).

The report indicated that storage pits and hearth features were found in Cultural Level VII. A tool cache was recovered from Feature 16, a storage pit located slightly under the southwest corner of the Feature 9. It measured 38cm in diameter by 44cm deep (ibid.:42). A second, Feature 10, was found near the back of the shelter and measured 31cm in diameter and 17cm deep. Two basin hearth features (6 and 8) were found in this level, but were slightly, stratigraphically above Feature 9 and apparently not directly associated. Their measurements ranged from 36-47cm in diameter and 6-9cm deep. As well, an interesting thermal feature was found built into one of the side walls of Feature 9.

Level IV defines the McKean Complex occupation of Sisyphus Shelter and probably of west-central Colorado. Six dates (Table 6.1) bracket the period from 4400±95 BP to 3240±75 BP. The oldest, 4400±95 BP, was derived from the "interface deposit at the bottom of Level IV." This level contained Features 12, 17, 19, 21-25, 27 and 29. These features were characterized as a boulder surface hearth (12; 3240±75 BP), a slab-lined basin hearth (17), a simple basin hearth (19), an outline of stones with reflector with basin hearth (21; 3480±160 BP), an outline of stones with reflector with surface hearth (27), a cluster of stones with basin hearth (23), an outline of stones with basin hearth (29), and three post molds (22, 24 and 25) that may have been constructed to hold a tripod. The dated features (12 and 21) were stratigraphically high in Level IV, so the remaining features were "generally dated in the 4400-4000 BP range."

Gooding further summarizes the radiocarbon dating related to the McKean level:

> Samples dating 3620±95 BP, 3660±80 BP and 3780±80 BP were retrieved from the lower portions of Level IV where Level III is indicated only as a set of lenses. They are believed to be indicative of an occupation period. Three samples, 4130±85 BP, 4130±125 BP and 4400±95 BP are believed to represent the earliest occupation of the rockshelter. It is important to note that the 4400 year date is contact with Level II, keeping in mind that Level III is a discontinuous level (ibid.:38).

Notably, Feature 21 – a basin hearth with an outline of stones and a reflector that was dated 3480±160 BP – was found on the same stratigraphic plane as and adjacent to Feature 9, the slab-lined floor dating 2410±70 BP. As stated in the report: "The slab-lined floor was laid on a prepared surface that was excavated into Levels VI, V and I" (ibid.:54). Based on the plan and profile illustrations (ibid.: 25, 46), the subfloor of Feature 9 appears to have been excavated into cultural Level IV as well – damaging Feature 16, a large unlined storage pit. The authors' profile of Feature 10 (ibid.:52) illustrates a dish-shaped ash level below Feature 9, which means that Feature 9 was probably constructed by simply laying sandstone slabs over a living floor relating to Feature 21 and dating 3480±160 BP. Feature 16 then becomes a part of those that define one of the McKean Complex cultural levels – one that contains the floor of a structure directly comparable to ones identified in CL-IV and CL-III of 5GF741. Notably, and in support of this hypothesis, Feature 18 of 5GF741 CL-III (dating 3430 ± 40 BP), is a large unlined storage pit of basically the same size as Feature 16, 5GF110.

The dates of 2100±55 BP and 2410±70 BP, 5GF110, do not have a corresponding representation in 5GF741. Nor does the date of 930±40 BP from 5GF741 have a parallel temporal date in 5GF110. However, the 1210±50 BP date from Sisyphus roughly corresponds to the 1260±30 BP occupation of McClane, and the Early Numic (Late Prehistoric) temporal period represented by the Uncompahgre Brown Ware diagnostic from McClane corresponds with the 520±55 BP occupation of Sisyphus.

SETTLEMENT/SUBSISTENCE/SEASONALITY

Importantly, 5GF741 is located along a recorded trail route: 5GF4377.s1, a segment of the East Salt Creek Canyon Trail (Conner et al. 2009). It is situated on the east side of the canyon, on the slope above the McClane Rockshelter. The trail generally follows the ridge slope about 20 feet from the valley floor. This trail was likely part of the "Loma to Rangely" wagon road built in 1884, but which fell out of use by 1909. Numerous prehistoric sites have been recorded along the same route and it is likely that prior to development as a road by EuroAmericans, the route was used by the Native Americans.

In general, the overall pattern of prehistoric sites identified previously in this elevation range of west central Colorado include numerous sheltered and open camps that were occupied seasonally during the late fall to early spring. Tributary creeks of the Colorado River, both permanent and ephemeral, similar to those found nearby this site, were the focal points of these occupations. Their migrations to and from the lower and higher elevations is attested to by the rock art panels and surface archaeological materials located in overhangs along the drainages and on the terraces within their canyons.

This particular overhang was selected by the occupants not only because of its size, but also its environmental setting. Camps located at lower elevations near the corridors of the main drainages were supported by the exploitation of a variety of environmental zones and the diverse biotopes within the surrounding ten or more kilometers. The riparian in canyons along the main creeks, the sagebrush grasslands, the pinyon-juniper forest, and the berry-producing shrub communities situated on the slopes of the higher elevations would have provided a wide range of seasonal and year-round resources. This site is situated at the edge-environment of two separate and important plant communities – the pinyon/juniper forest and the open sage flats – from which to harvest: wood for fuel and shelters; roots, nuts, berries, and grasses for food; and, plants for medicinal purposes.

Models used to predict the general locations of archaeological sites in west central Colorado have suggested the importance of several geographic and environmental variables (Burgess, et al. 1980; Lutz, et al. 1979). In general, they have pointed to strong correlations between site locations and/or site types and vegetational communities, elevation, distance to water, and topographic setting such as site slope and aspect.

One of the first predictive models in the region and one pertinent to the this project was developed by Grady (1980). His study, conducted in the Piceance Basin, emphasized an ecological approach that focused on the spatial relationships between human occupations, plant communities, and mule deer populations. Grady set up a series of ten testable hypotheses that correlated distance to water, slope, aspect, distribution of soils, and the nature and distribution of the vegetation communities to the subsistence requirements of both humans and mule deer. The variables were then examined on three levels: a point-pattern analysis, an analysis of the correlation between site location and specific factors within the immediate environment, and a site catchment analysis.

An upland study area and a lowland study area were identified. In the upland area the majority of sites were found in the big sage-grassland vegetation community, followed by the grassland and the mixed mountain shrubland communities, respectively. In the lowland area, the majority of the sites were found in the pinyon-juniper vegetation community followed by the big sage-grasslands and the riparian communities, respectively. The site catchment analysis in the upland area indicated that sites were located to maximize access to the summer range of the mule deer, while a similar analysis in the lowland area indicated that sites were located to maximize access to the pinyon nuts and berry resources while still maintaining contact with mule deer during the fall and winter. Both of these analyses underscore the importance of knowing the behavior and migration routes of local mule deer populations.

In short, Grady found that variables such as water, slope, and aspect are important predictive variables in the upland settings, while pinyon-juniper, water, slope and aspect are important predictive variables in lowland situations. The upland catchment analysis indicates a 2:1 site location preference for areas with high mule deer forage values (which further suggests the presence of prehistoric hunting and processing sites), while the lowland catchment analysis suggests that site locations are predicted by foodstuffs that are directly exploitable by humans (which further predicts the presence of gathering and processing sites). Soils did not appear to be a factor in either the upland or lowland situations.

Grady then compared his data to ethnographic accounts (e.g. Smith 1974) of hunting situations, hunting techniques, butchering and meat processing techniques, and pinyon nut harvest and preparation. According to Grady (1980:242) camp location decisions were based upon the location of the most profitable resources at a given time of the year, proximity to water, proximity to neighbors, slope, aspect and topography.

Another model posited by Horn et al. (1987) demonstrated that the location of sites was influenced by features of the natural environment and provided some base line data on both a synchronic and diachronic level. Their investigations involved an examination of site function, cultural affiliation and chronology, and settlement/subsistence shifts relative to elevation, proximity to water, and vegetation zone. Their results for the Archaic lifeway generally parallel those of Grady (1980) and, importantly, they suggest that ecotones (edges between pinyon-juniper, sagebrush/grassland communities and drainage basins, and other micro-environments within larger vegetative communities) be modeled.

Unfortunately, no direct determination of the site's occupants'vegetal-based subsistence can be made from the pollen and macrobotanical samples. Despite this, founded on archaeological evidence from Protohistoric Era sites throughout the Basin/Plateau, the availability of floral resources including grass and forb seeds, berries, and pinyon nuts, also influenced the establishment of short-term camps (Simms 1989). The best summary of the types of plants exploited by populations that practiced the Archaic lifeway on the Northern Colorado Plateau are listed by Lewis (1994:28-29) in his description of the types of plants gathered by the Ute women:

> "Ute women gathered and utilized many edible seeds, plants, and roots in their physical environment. Pine nuts were a staple, parched in baskets with hot coals and stored whole or as ground meal for winter use. The women mixed the meal with water to form small meal balls or boiled it into mush. Women gathered wheat grass (Agropyron), bentgrass (Agrostis), bluegrass (Poa), needle grass (Stipa), and June grass (Koeleria), and seeds from lamb's-quarter (Chenopodium), sunflowers, and amaranth, among others, which they stored whole or parched and ground into flour. The people ate raspberries, strawberries, gooseberries, serviceberries, currants, buffalo berries, rose and juniper berries in season or dried and cached them in baskets underground. Chokecherries (Prunus), molded and dried into round cakes for winter

use, were a particularly important fruit resource. Women gathered numerous roots, including yampa (Perideridia), camas (Camassia), sego lily (Calochortus), tule, valerian, and yucca, as well as seasonal greens and thistles, cactus leaves and fruit, and some acorns. Women also collected and processed vegetal fibers for baskets, cordage, and clothing. Ute men gathered native tobacco (Nicotiana) and numerous other plants valued for their medicinal or ceremonial power."

That the Utes were exploiting these plant resources in this portion of the Northern Colorado Plateau is attested to by the 4 September 1776 record of the Dominguez-Escalante Expedition. While traveling near the present day town of Plateau City located on Plateau Creek (south of the Sunnyside area, about 2.0 miles west of Collbran), the group:

> "...passed through a section of piñon growth, and came upon a sagebrush stretch where three Yuta women with a child were preparing the small fruits they had picked for their sustenance in the arroyos and rivulets hereabouts. We went over to talk to them, and right away they offered us their fruits, which were chokecherry, gooseberry, lemita, and some of this year's piñon nuts. The gooseberry which grows in these parts is very sour on the bush, but when already exposed to the sun, as these Yuta women had it, it has a very delicious sweet-sour taste" (Chavez and Warner 1976:43-44).

A study by O'Neil (1993:241) showed that the highest frequency of prehistoric/ protohistoric open camps in the region occur in the pinyon-juniper zone. During the winter months, their establishment at the lowest extent of the forest but above valley bottoms may have been to alleviate the effects of winter cold air inversions. The strongest expression of this phenomenon occurs from mid-December through January, although the frequency of temperature inversions is dynamic and highly variable based on yearly snow and cloud cover. Importantly, when the cold air gets trapped in valleys, there is a layer above it that can be several hundred feet thick where air temperatures can be up to 30 F warmer. During colder periods, such as the Little Ice Age, this factor was likely an important consideration in settlement patterns. The rockshelter of 5GF741 is at the optimum elevation – the contact with the pinyon/juniper forest – to reduce the effects of cold air inversions.

TECHNOLOGY

In its surface and subsurface deposits, this site exhibited a density of artifacts similar to wickiup sites, which frequently is well below 0.1 item per square meter. Importantly, the site displayed a pattern of low-density but high assemblage diversity. Activities represented by the artifact assemblage are typical of those associated with both short-term camping and household residences, which amounted to cooking and tool refurbishing in the vicinity of the thermal features.

The lithic tools are made of materials common in the local formations of the Northern

Uncompahgre Plateau (located about 10 miles to the south), and are composed primarily of porcellanites and a few cherts. The presence of shatter from core reduction indicates that the occupants were arriving with raw materials from quarry sites or collections from river gravels for the quick preparation of expedient tools. The exception is the recovery of an obsidian projectile point, which indicates extra-regional trading activities by the McKean Complex group or long range travel to the quarry in Malad, Idaho.

SUMMARY

As noted, diagnostic cultural remains at the site were scant and the assigned cultural affiliations are based on radiocarbon data and inference from diagnostics. Figure 6.10 juxtaposes the radiocarbon histogram for the Western Slope (Chapter 4, Figure 4.1) with a histogram of the dates from 5GF741.

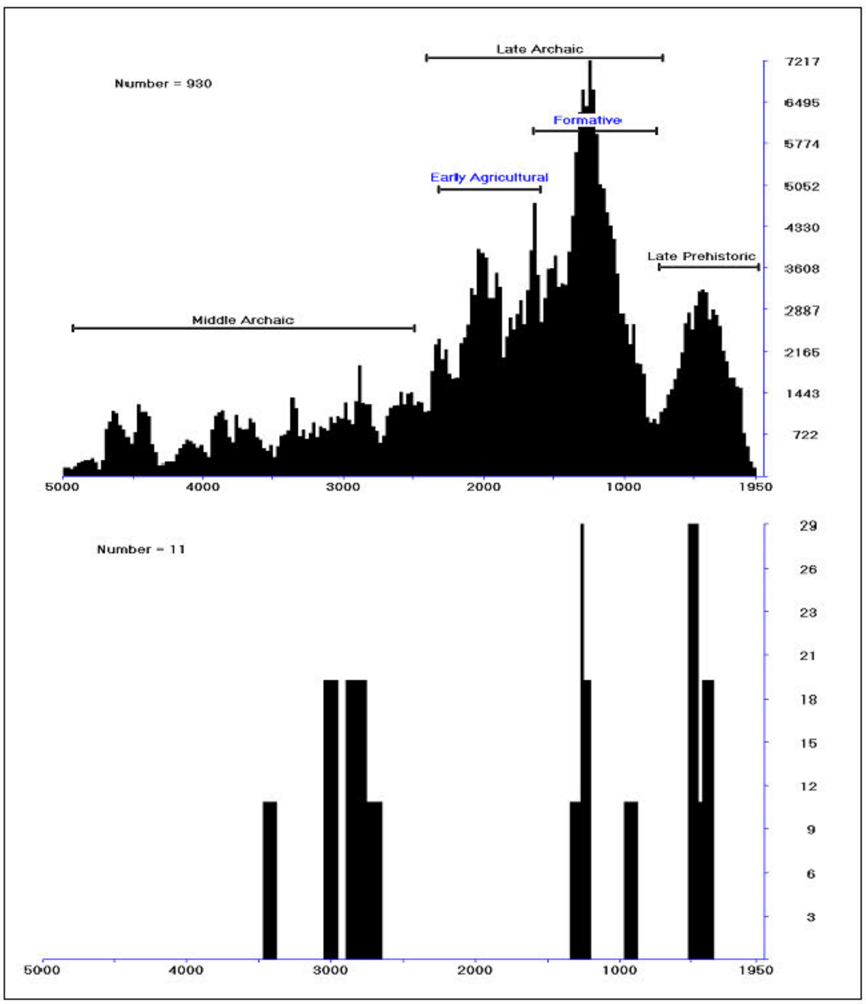


Figure 6.10. Radiocarbon histogram for the Western Slope juxtaposed with a histogram of the dates from 5GF741.

The lowest cultural level was stratigraphically and comparatively dated by the presence of the McKean Lanceolate projectile, which temporally places this occupation ca. 4200-3800 BP. This period falls within the Middle Holocene Amelioration, a cool, moist climate for which there is abundant evidence of occupation in the region. The first cluster of radiocarbon dates from 3400-2700 BP fall within the Middle-Late Archaic period of the Western Slope, a time bracketed by Miller's Second Holocene drought.

The second cluster of dates from 1300-800 BP occur in the Late Archaic and/or Formative period. No artifacts diagnostic of either cultural tradition were recovered. We have tentatively assigned this 5GF741 component to Late Archaic on the absence of Formative ceramics or cultigens. This occupation occurred during Miller's Late Holocene Amelioration.

The third and final date cluster from 500-400 BP is assigned to the Late Prehistoric period, and based on the origin of the dates, which are from burned roots, indicates an extensive dry episode. Relative to these date was the recovery of two Uncompahgre Brown Ware sherds that have a relative temporal span of 600-300 BP. No groups other than the Numic speakers have been identified with this period on the Western Slope. The occupation between 600-300 BP occurred during the onset of the Little Ice Age.

Cultural levels were identified. Based on the distribution of thermal and storage features, certain inferences can be made about utilization of the rockshelter over time. The three oldest occupations (ca. 4000 BP, 3400 BP, and 3000 BP) that occurred in CL-IV and CL-III indicate use of the shelter similar to the open, shallow-basin, architectural features (house pits) previously recorded in the region. The overhang during those periods had a roof clearance between 1.4 and 1.6 meters, which is comparable to that of Sisyphus Shelters' internal house features dating to the Late (ca. 2400 BP) and possibly the Middle Archaic (ca. 3400 BP) occupations.

In addition, within the McClane Rockshelter, thermal features recorded for the three oldest dated occupations were centrally located and storage features were present at the back of the shelter. If the shelter were used during the winter, it is easy to imagine that a pole and/or brush wall was built around the perimeter of the overhang ledge to help retain heat. Taken together the storage structures, a centrally placed hearth feature, a pole or brush surround, and a 10 square meter enclosed floor would infer use of the shelter as a winter base camp for as many as 8-10 people. Another centrally placed thermal feature from CL-I (dating ca 1230 BP) may also be an indication that a wood surround was built during this time but no storage features or other indications of such are present. Notably, all the other thermal features were placed either at the dripline or the back of the shelter, a strategy that would heat the shelter without a wood surround structure, which in turn indicates short-term stays during somewhat warmer periods of the year.

CHAPTER 7

REFERENCES

Ahlbrandt, Thomas S.
1973 Sand Dunes, Geomorphology and Geology, Killpecker Creek Area, Northern Sweetwater County, Wyoming. Ph.D. dissertation (geology), University of Wyoming, Laramie.

Ahlbrandt, Thomas S. and Steven G. Freyberger
1980 Eolian deposits in the Nebraska Sand Hills. In *Geologic and Paleontologic Studies of the Nebraska Sand Hills*: *Geological Survey Professional Paper* No. 1120A, pp. 1-24, U.S. Government Printing Office, Washington D.C.

Ahlbrandt, Thomas S., James B. Swinehart, and David G. Maroney
1983 The Dynamic Holocene Dune Fields of the Great Plains and Rocky Mountain Basins, U.S.A. In *Aeolian Sediments and Processes*, edited by M.E. Brookfield and Thomas S. Ahlbrandt, pp. 379-406. Elsevier Science, Amsterdam.

Aikens, C. Melvin and Younger T. Witherspoon
1986 Great Basin Numic Prehistory: Linguistics, Archaeology and Environment. In Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings, edited by Carol J. Condie and Don D. Fowler, pp. 7-20. *University of Utah Anthropological Papers* No. 110, Salt Lake City.

Albanese, John P.
1990 *Geoarchaeology of the eastern Powder River Basin.* Ms on file, with the Wyoming State Historic Preservation Office, Cultural Records Division, Laramie, Wyoming.

Alley, William M.
1984 The Palmer Drought Severity Index: Limitations and Assumptions. *Journal of Climate and Applied Meteorology* 23:1100-11009.

Andrews, E.D.
1979 *Scour and fill in a stream channel, East Fork River, Western Wyoming.* USGS Professional Paper 1117. US Government Printing Office, Washtington, D.C.

Archer, D. L., L. R. Kaeding, B. D. Burdick, and C. W. McAda.
1985 A study of the endangered fishes of the upper Colorado River. Final Report. U.S. Fish and Wildlife Service, Grand Junction .

Arthur, Christopher

1983 *Final Report on the Archaeological Monitoring of the Northwest Pipeline Corporation's Trunk "D" Pipeline in the Canyon Pintado Historic District*. Cultural Resource Management Report 9, Archaeological Services of Western Wyoming College, Rock Springs.

Aslan, Andres

2005 *Alluvial History and Geoarchaeology of Seiber Canyon, McInnis Canyons National Conservation Area, Mesa County, Colorado.* Prepared by the Department of Physical and Environmental Sciences, Mesa State College. Ms on file, BLM Grand Junction Field Office.

n.d. *Environmental Analysis of the McCoy Archaeological Site, Eagle County, Western Colorado.* Prepared by Department of Physical and Environmental Sciences, Mesa State College. Ms on file, BLM Colorado River Valley Field Office, Silt.

Aslan, Andres and Anne Hayden

2008 *Holocene Alluvial History of the Little Dolores River Valley, McInnis Canyons National Conservation Area, Mesa County, Colorado.* Ms on file, BLM Grand Junction Field Office.

Baker, Steven G.

1992 *An Archaeological Monitor of the Crow Canyon Water Crossing Reconstruction, Canyon Pintado National Historic District, Rio Blanco County, Colorado.* Prepared by Centuries Research for Fina Oil and Chemical Co., Rangely. Ms on file, BLM White River Field Office, Meeker.

Bauer, Andrew P., Trevor N. Hoyles, and Alan Snider

2008 *Geotechnical Engineering Services and Horizontal Directional Drilling Design, Colorado Hub Connection Project, Douglas Creek HDD Crossing, Rio Blanco County, Colorado.* Prepared by GeoEngineers for Williams Northwest Pipeline Co. Copies available from GeoEngineers, Portland, Oregon.

Behre, Karl-Ernst

1986 *Anthropogenic Indicators in Pollen Diagrams.* A.A. Balkema, Boston.

1988 The role of man in European Vegetation history. In *Vegetation History*, edited by B. Huntley and T. Webb, pp. 633-673. Kluwer Academic, Dordrecht, South Holland, Netherlands.

Berry, Michael S. and Larry V. Benson
2008 The Role of Prehistoric Climate Change in Anasazi Stage Transitions. Paper presented at the 2008 joint annual meeting of the Geological Society of America, Houston.

Berry, Claudia F. and Michael S. Berry
1986 Chronological and Conceptual Models of the Southwestern Archaic. In *Anthropology of the Desert West*, ed. by Carol G. Condie and Don D. Fowler, pp. 255-327. University of Utah Anthropological Papers No. 110. Salt Lake City.

Bettinger, Robert L. and Martin A. Baumhoff
1982 The Numic Spread: Great Basin Cultures in competition. *American Antiquity* 47(3):485-503.

Binford, Lewis R.
1990 Mobility, Housing, and Environment: A Comparative Study. *Journal of Anthropological Research*, Vol. 46, No. 2 (Summer, 1990), pp. 119-152.

Brewer, R.
1976 *Fabric and Mineral Analysis of Soils*. Krieger Publishing, Huntington.

Bryan, Kirk
1925 Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest. *Science* 62:338-344.

Buckles, William G.
1971 *The Uncompahgre Complex: Historic Ute Archaeology and Prehistoric Archaeology on the Uncompahgre Plateau in West Central Colorado*. Ph.D. dissertation, Department of Anthropology, University of Colorado. University Microfilms, Ann Arbor.

Burgess, Robert J. with K. L. Kvamme, P. R. Nickens, A. D. Reed, and G. C. Tucker, Jr.
1980 Class II Cultural Resource Inventory of the Glenwood Springs Resource Area, Grand Junction District, Colorado. Nickens and Associates, Montrose, CO. Ms on file at the BLM Colorado River Valley Field Office, Silt.

Burkhard, Walter T. and Thomas A. Lytle
1978 Final Report for Fish and Wildlife Resource Analysis of the West Divide Project. Colorado Division of Wildlife, Grand Junction.

Cashion, W.B.
1973 Geologic and structure map of the Grand Junction quadrangle, Colorado and Utah: US Geological Survey Miscellaneous Geologic Investigations I-736.

Cassells, E. Steve
2003 *Tracing the Past: Archaeology Along the Rocky Mountain Expansion Loop Pipeline*. Alpine Archaeological Consultants, Inc., Montrose.

Chavez, Fray Angelico (translator), and Ted J. Warner (editor)
1976 *The Domínguez-Escalante Journal: Their Expedition Through Colorado, Utah, Arizona, and New Mexico in 1776*. Brigham Young University Press, Provo.

Clayton, Lee, and Stephen R. Moran
1982 Chronology of Late Wisconsin Glaciation in Middle North America. *Quaternary Science Reviews* 1:55-82.

Conner, Carl E., Nicole Darnell, Barbara J. Davenport and Dakota Smith
In progress *Cultural Resource Monitoring Project for the Collbran Pipeline Project in Garfield and Mesa Counties, Colorado for EPCO.* Prepared by Grand River Institute for the Bureau of Land Management, Grand Junction Field Office and the White River Field Office of the U.S. Forest Service.

Conner, Carl E., Nicole Darnell, Brian O'Neil, Richard Ott, Curtis Martin, Dakota Kramer, James C. Miller, Barbara Davenport, Sally Cole, Jim Keyser, Claudia F. Berry, and Michael S. Berry (ed.)
2011 *Class I Cultural Resource Overview for the Grand Junction Field Office of the Bureau of Land Management*. Prepared by Grand River Institute. Prepared for Bureau of Land Management Grand Junction Field Office. Ms on file, the Bureau of Land Management Grand Junction Field Office.

Conner, Carl E. and Danni L. Langdon
1983 *Cultural Resources Inventory of the Parachute Creek Shale Oil Program, Phase II.* Prepared by Grand River Institute. Prepared for Union Oil Company of California, Parachute, Colorado. Ms on file, Office of Archaeology and Historic Preservation, Denver.

1987 *Battlement Mesa Community Cultural Resources Study.* Prepared by Grand River Institute. Ms on file, Colorado Historical Society Office of Archaeology and Historic Preservation, Denver.

Conner, Carl E. and James C. Miller, Nicole Darnell, and Barbara Davenport
2007 Report for the Class III cultural resources inventory for the proposed Wagon Park Hazardous Fuels Reduction Project (Phase I) in Mesa County, Colorado, BLM Report No. 1107-08. Ms on file, Bureau of Land Management Grand Junction Field Office.

Conner, Carl E., James C. Miller, and Barbara J. Davenport
2009 *Report of Preliminary Findings for a Class III Cultural Resource Inventory of a Proposed Area of Disturbance and the Re-evaluation of Site 5GF741, in Garfield County, Colorado, for McClane Canyon Mine, LLC.* Prepared by Grand River Institute. Prepared for McClane Canyon Mine, LLC. Ms. on file the Bureau of Land Management, Grand Junction Field Office, Grand Junction.

Conner, Carl E., James C. Miller, Barbara Davenport, and Nicole Darnell
2006a *2006 Mahogany Research Project: A Class III Cultural Resource Inventory of Five Tracts Consisting of 2570 Acres on Private Lands in Rio Blanco County, Colorado.* Prepared by Grand River Institute. Prepared for Norwest Corps, Salt Lake City, Utah, representing Shell Frontier Oil & Gas, Inc. Copies available from Grand River Institute, Grand Junction.

Conner, Carl E., Jim Miller and Nicole Darnell
2006c Class III Cultural Resources Inventory Report for Three Block Acreages within the South Parachute GAP Domain in Garfield County, Colorado, for Williams Production RMT. Ms on file, BLM Colorado River Valley Field Office, Silt.

Conner, Carl E., James C. Miller, Nicole Darnell, and Barbara J. Davenport
2006b *Class III Cultural Resource Inventory Report for the Proposed Red Cliff Mine Project in Garfield and Mesa Counties, Colorado*. Prepared by Grand River Institute. Prepared for CAM Colorado, LLC. Ms on file, Bureau of Land Management Grand Junction Field Office.

Conner, Carl E. and Richard W. Ott
1978 *Petroglyphs and pictographs of the Grand Junction District, Volume I.* Prepared by Grand River Institute. Ms on file, the Bureau of Land Management Grand Junction Field Office.

Conner, Carl E., Richard W. Ott and Holly Shelton
2012 Cultural Resource Site Assessment of 5ME16710 and 5ME17953 conducted for the Bureau of Land Management Grand Junction Field Office. Ms on file, BLM Grand Junction.

Creasman, Steven D.
1981 Archaeological Investigations in the Canyon Pintado Historic District. Rio Blanco County, Colorado. Master's thesis (anthropology), Colorado State University, Fort Collins.

Davis, Jonathan O.
1989 *Archaeological Paleoenvironments of the Southwestern Division, U.S. Army Corps of Engineers*. Arkansas Archaeological Survey Technical Paper No. 8, Fayetteville, Arkansas.

Davis, C. M., and J. D. Keyser
1999 McKean Complex Projectile Point Typology and Function in the Pine Parklands. *Plains Anthropologist* 44:251-270.

Dean, Jeffery S.; R. C. Euler; G. J. Gumerman; F. Plog; R. H. Hevly; and T. N.V. Karlstrom
1985 Human behavior, demography and paleoenvironment on the Colorado Plateau. *American Antiquity* 50(3):537-554.

Dever, L., C. Martin, M. A. Courty, and P. Vochier
1992 Geochemistry and isotopes of secondary calcite precipitated by freezing. In *Water-Rock Interaction, Volume I: Low Temperature Environments*. Edited by Y. K. Kharaka and A. S. Maest. A.A. Balkema, Rotterdam, South Holland, Netherlands.

Euler R. Thomas and Mark A. Stiger
1981 *1978 test excavations at five archaeological sites in Curecanti National Recreation Area, Intermountain Colorado.* Ms on file, the National Park Service-Midwest Archaeological Center, Lincoln.

Evans, Raymond A.
1988 Management of Pinyon-Juniper Woodlands. *General Technical Report INT-249*. US Department of Agriculture, Forest Service Research Station, Ogden, Utah.

Faegri, K.P., Kaland, E., Kzywinski, K.
1989 *Textbook of Pollen Analysis*. Wiley, New York.

Finley, Judson
2007 Stratigraphy, Sedimentology, and Geomorphology. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 131-152. Clovis Press, Avon.

Fowler, C.S.
1986 Subsistence. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 64-97. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor, Smithsonian Institution, Washington D.C.

Frison, George C.
1974 *The Casper Site: A Hell Gap bison kill on the High Plains.* 2nd Ed. Academic Press, New York.

1978 *Prehistoric Hunters of the High Plains.* 1st ed. Academic Press, San Diego.

1991 *Prehistoric Hunters of the High Plains.* 2nd ed. Academic Press, New York.

Frison, George C., and Dennis J. Stanford
1982 *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains*. Academic Press, New York.

Gaylord, David R.
1983 Recent Aeolian Activity and Paleoclimates Fluctuations in the Ferris-Lost Soldier Area, South-Central Wyoming. Ph.D. dissertation (geology), University of Wyoming, Laramie.

Glascock, Michael D., Geoffrey E. Brasswell, and Robert H. Cobean
1998 A Systematic Approach to Obsidian Source Characterization. In *Archaeological Obsidian Studies: Method and Theory*, edited by M. Steven Shackley, pp. 15-65. Advances in Archaeological and Museum Science Series. Plenum Publishing Co., New York, New York.

Gooding, John and William L. Shields
1985 *Sisyphus Shelter.* Bureau of Land Management Cultural Resources Series No.18. Bureau of Land Management, Denver.

Grady, James
1980 Environmental Factors in Archaeological Site Locations, Piceance Basin, Colorado. *Cultural Resources Series No. 9*. Bureau of Land Management, Denver.

Hadley, R. F., and S. A. Schumm
1961 *Sediment sources and drainage basin characteristics in upper Cheyenne River Basin*. United States Geological Survey Water Supply Paper 1531, pp. 137-198.

Hand, O.D. and John Gooding
1980 Excavations at Dotsero, 5EA128. *Southwestern Lore* 46:25-35.

Harbottle, Garman
1982 Chemical Characterization in Archaeology. In *Contexts for Prehistoric Exchange*, edited by Jonathon E. Ericson and Timothy K. Earle, pp. 13-51. Academic Press, New York.

Hauck, F. Richard
1993 *Archaeological Excavations (1988-1992) in the Douglas Creek-Texas Mountain Locality of Rio Blanco County, Colorado.* Prepared by Archaeological-Environmental Research Corporation, Bountiful Utah. Prepared for Conoco, Inc.

Hayden, Anne, Andres Aslan and Paul Hanson
2008 Douglas Creek Revisited—Evidence for Climate Driven Arroyo Incision in Western Colorado. Joint Meeting of the Geological Society of America, Soil Science Society of America, American Society of Agronomy, Crop Science Society of America, Gulf Coast Association of Geological Societies with the Gulf Coast Section of SEPM, Houston, Texas. Geological Society of America Abstracts with Program 40:6:464.

Haynes, C. Vance
1968 Geochronology of Late Quaternary alluvium. In *Means of correlation in Quaternary successions*, edited by R. B. Morrison and H. E. Wright, pp. 591-631. Contribution 121, Program in Geochronology, University of Arizona, Tuscon.

Haynes, C. Vance
1991 Geoarchaeological and Paleohydrological Evidence for Clovis-age Drought in North America and its Bearing on Extinction. *Quaternary Research* 35:438-450.

2009 Geochronology. In *Hell Gap, a Stratified Paleoindian Campsite at the edge of the Rockies*, edited by Mary Lou Larson, Marcel Kornfeld and George C. Frison, pp.39-52. University of Utah, Salt Lake City.

Haynes, C. Vance, Michael McFaul, R. H. Brunswig, and K. D. Hopkins
1998 Kersey-Kuner Terrace Investigations at Dent and Bernhardt Sites, Colorado. *Geoarchaeology* 13(2):201-218.

Herz, Norman and Ervan G. Garrison
1998 *Geological Methods for Archaeology*. Oxford University Press, New York.

Hibbets, Barry N., and James Grady, Judith Halasi, Hannah Huse, Frank W. Eddy
1979 *West Central Colorado Coal Leases, Final Report. Vol. I, Settlement Analysis*. Prepared by Archaeological Associates, Inc. Ms on file, the Bureau of Land Management Grand Junction Field Office, Grand Junction.

Holmer, Richard N.
1986 Common Projectile Points of the Intermountain West. In *Anthropology of the Desert West,* ed. by Carol G. Condie and Don D. Fowler, pp. 91-115. University of Utah Anthropological Papers No. 110. Salt Lake City.

Horn, Jonathan C., Alan D. Reed and Stan A. McDonald
1987 *Archaeological Investigations at the Indian Creek Site, 5ME1373: A stratified Archaic Site in Mesa County, Colorado.* Prepared by Nickens and Associates. Ms. on file the BLM Grand Junction Field Office.

Huntington, E.
1914 The Climate Factor as Illustrated in Arid America. *Carnegie Institute Publication* 192:22-28.

Irwin-Williams, Cynthia
1973 The Oshara Tradition: Origins of the Anasazi Culture. *Contributions in Anthropology* 5(1). Eastern New Mexico University, Portales.

Jackson, H. E., and J. Schuldenrein
1985 Geomorphology II: Late Quaternary Stratigraphy and the Arroyo Systems in the Fort Carson-Pinyon Canyon Site Region. In *Geomorphological Investigations at the US Army Fort Carson-Pinyon Canyon Maneuver Site, Las Animas County, Colorado,* pp.101-201. Ms on file, with National Park Service Rocky Mountain Region, Denver.

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

Jones, Bruce A.
1986 The Curecanti Archaeological Project: 1981 investigations in Curecanti National Recreation Area, Colorado. *Midwest Archaeological Center Occasional Studies in Anthropology* No. 14, National Park Service, Midwest Archaeological Center, Lincoln.

Jones, L. S., M. Rosenburg, M. Del Mar Figueroa, K. McKee, B. Haravitch, and J. Hunter
2010 Holocene Valley Floor Deposition and Incision in a Small Drainage Basin in Western Colorado, USA. *Quaternary Research* 74:199-206.

Jorgensen, Joseph G.
1994 Synchronic Relations Among Environment, Language and Culture as Clues to the Numic Expansion. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by David B. Madsen and David Rhode, pp. 84-102. University of Utah Press, Salt Lake City.

Knobel, E. W.
1955 *Soil survey of the Grand Junction area, Colorado.* US Soil Conservation Service, Washington D.C.

Knox, J. C.
1983 Responses of river systems to Holocene climates. In *Late Quaternary environments of the United States, Volume 2, The Holocene*, edited by H. E. Wright, pp. 26-41. University of Minnesota, Minneapolis.

Kornfeld, Marcel
1998 *Early Prehistory of Middle Park: the 1997 Project and Summary of Paleoindian Archaeology*. Technical Report 15a, Department of Anthropology, University of Wyoming, Laramie.

Lamm, Nancy B.
1987 Geology of 5ME1373, the Indian Creek Site, Appendix A. In *Archaeological Investigations at the Indian Creek Site, 5ME1337: A Stratified Archaic Site in Mesa County, CO.,* edited by J. C. Horn, A. D. Reed, and S. A. McDonald. Ms on file, Office of Archaeology and Historic Preservation, Denver.

LaPoint, Halcyon, Brian Aivazian, and Sherry Smith
1981 *Cultural resources inventory baseline report for the Clear Creek Property, Garfield County, Colorado.* Prepared by Laboratory of Public Archaeology, Colorado State University, Fort Collins.

Leopold, Luna and John P. Miller
1954 A postglacial chronology for some alluvial valleys in Wyoming. *Geological Survey Water-Supply Paper,* No. 1261, U.S. Government Printing Office, Washington D.C.

Lewis, David Rich
1994 *Neither Wolf Nor Dog: American Indians, Environment and Agrarian Change*. Oxford University Press.

Lister, Robert H.
1953 The Stemmed Indented Base Point, a Possible Horizon Marker. *American Antiquity* 18:264–265.

Lutz, Bruce J., with William J. Hunt, Jr. and Cheryl Muceus
1979 A Cultural Resource Management Survey within the Eagle Planning Unit, Colorado. *Office of Public and Contract Archaeology, Vol. 1, No. 1*., University of Northern Colorado. Ms on file, BLM Colorado River Valley Field Office, Silt.

Madole, R. F.
1986 Lake Devlin and Pinedale Glacial History, Front Range, Colorado. *Quaternary Research* 25:43-54.

Markgraf, Vera and Louis Scott
1981 Lower timberline in central Colorado during the past 15,000 years. *Geology* 9:231-234.

Martin, Paul S.
1963 *The Last 10,000 years. A Fossil Pollen Record of the American Southwest.* University of Arizona Press, Tuscon.

Martin, Curtis, James C. Miller, Carl E. Conner, and Nicole Darnell
2006 *Archaeological Investigations at 5ME12825 in Mesa County, Colorado.* Prepared by Grand River Institute. Prepared for EnCana Oil and Gas (USA), Parachute. Ms on file, BLM Grand Junction Field Office.

Matson, Richard G.
1991 *The Origins of Southwestern Agriculture.* The University of Arizona Press, Tucson.

McIntyre, Carl, and James C. Miller
2010 *Late Quaternary Alluvial Deposits and Geoarchaeology of the Mancos Shale Foot Hills Area South of the Book Cliffs, Grand Junction, Colorado.* Prepared by Dominguez Anthropological Research Group, Grand Junction, Colorado. Prepared for the BLM Grand Junction Field Office.

Metcalf, Michael D. and Kevin D. Black
1991 Archaeological Excavations at the Yarmony Pit House Site, Eagle County, Colorado. Colorado Bureau of Land Management Cultural Resource Series #31, Lakewood.

Metcalf, Michael D., James C. Miller, Jeannie Borreson Lee and Jenny Stahl
2010 *An Archaeological Assessment of 5EA909, the McHatten Reservoir Site, Eagle County, Colorado.* Prepared by Metcalf Archaeological Consultants. Prepared for the BLM Colorado Valley Field Office, Silt, and Dominguez Archaeological Research Group, Grand Junction.

Miller, James C.

1988 *Geoarcheological Investigations on Three Sites in the Central Green River Basin, Sweetwater County, Wyoming, with Reference to an Integrated Aeolian/Alluvial Depositional Model for the Western Wyoming Basin*. Geological Investigations 2, Western Wyoming College Archaeological Services, Rock Springs.

1992 Geology in Archaeology: Geology, Paleoclimates, and Archaeology in the Western Wyoming Basin. Master's Thesis, Department of Anthropology, University of Wyoming, Laramie.

1993 Geology of Sites 39PN972, 39PN974, 39PN975, and 39PN976, Pennington County, South Dakota. In *Results of Archaeological Investigations at 39PN972, 39PN974, 39PN975, and 39PN976, Pennington County, South Dakota*, edited by T. K. Larson and D. M. Penny. Ms on file, USDA Forest Service, Black Hills National Forest, Custer.

1995 Geologic Studies. In *Results of the 1994 Archaeological Investigations at 32MN395, Montrail County, North Dakota,* edited by T. K. Larson and D. M. Penny. Ms on file, North Dakota Department of Transportation, Bismarck.

1997 Geoarchaeological Analysis, Appendix F. In Archaeological Data Recovery at the Harrower Site (48SU867): Labarge Natural Gas Project, Volume 2: Prehistoric Mitigation, by K. W. Thompson. *Cultural Resource Management Report 24, Volume 2: Prehistoric Mitigation*. Western Wyoming College Archaeological Services, Rock Springs.

2010 *Preliminary Report of Geoarchaeology Investigations at Indian Creek, Mesa County, Colorado.* Prepared by Dominguez Anthropological Research Group. Ms on file, the BLM Grand Junction Field Office.

Miller James C., and Patrick W. Bower

1986 *Results of the Exxon Labarge Project Trunkline Trench Inspection, Lincoln and Sublette Counties, Wyoming.* Ms on file, Western Wyoming College Archaeological Services, Rock Springs.

Miller, James C., Michael Brown, and Courtney Groff

2011b *Report on the 2009 Test Excavations At Prehistoric Site 5ME15398 Mesa County, Colorado, and The Aeolian Depositional Sequence in Western Colorado*. Prepared by Dominguez Anthropological Research Group for the State Historical Fund Grant SHF09-AS007. Ms on file, BLM Grand Junction Field Office.

Miller James C., and Julie James
1986 Salvage excavations on 48LN1678 and 48LN1679, Exxon Road Hollow Unit 12. Ms on file, Archaeological Services of Western Wyoming College, Rock Springs.

Miller, James C. and Thomas K. Larson
1990 Knife River Flint Studies, Part I, Geological and Physical Characterization. In: *Highway 22 Project: Archaeological Excavations at 32DU178 and 32DU179, Dunn County, North Dakota*, edited by T. K. Larson and D. M. Penny. Larson-Tibesar Associates, Laramie.

Miller, James C., Thomas K. Larson, and Dori M. Penny
1993 Results of an intensive cultural resource inventory of selected parcels within the Platte River Resource Area. Ms on file, BLM Platte River Field Office, Cheyenne.

Miller, James C., Michele Nelson, Carl McIntyre and Courtney Groff
2011a Past Environments in Western Colorado. In *Class I Cultural Resource Overview for the Grand Junction Field Office of the Bureau of Land Management*, edited by Michael S. Berry. Ms on file, BLM Grand Junction Field Office.

Miller, James C. and Michele Nelson
2010 *Late Quaternary Alluvial Deposits and Geoarchaeology of Douglas Creek Within Canyon Pintado National Historical District as Part of Northwest Pipeline's Colorado Hub Connection Project, Rio Blanco County, Colorado.* Ms on file, BLM White River Field Office, Meeker.

Miller, James C., and Dakota N. Smith
2010 *Report on the 2009 Excavations at Prehistoric Site 5GF1323, Garfield County, Colorado*. Ms on file, BLM Colorado River Valley Field Office, Silt.

Miller, James C., Dakota N. Smith, and Carl E. Conner
2009 *Testing and Evaluation of the Bocco Mountain Bison Ceremonial Site (5EA2742), Eagle County, Colorado.* Ms on file, BLM Colorado River Valley Field Office, Silt.

Moerman, Daniel E.
1998. *Native American Ethnobotany*. Timber Press, Portland.

O'Connell, James F.
1975 The Prehistory of Surprise Valley. *Anthropological Papers No. 4*, Bellena Press. Ramona, California.

O'Neil, Brian
1993 The Archaeology of the Grand Junction Resource Area: Crossroads to the Colorado Plateau and the Southern Rocky Mountains. A Class I Overview. Ms on file at the BLM Grand Junction Field Office.

Palmer, Wayne C.
1965 Meteorological Drought. *Research Paper No. 45*, U.S. Weather Bureau. [NOAA Library and Information Services Division, Washington, D.C.]

Patten, Bob (compiler)
n.d. An early record of the deposits and associated cultural remains in Indian Creek at the base of Grand Mesa, Mesa County, Colorado. Prepared for the USGS Central Region Offices, Denver Federal Center. Ms on file, BLM Grand Junction Field Office.

Petersen, Kenneth L.
1981 10,000 years of change reconstructed from fossil pollen, La Plata Mountains, southwestern Colorado. Unpublished Ph.D. dissertation, Department of Anthropology, Washington State University.

Rapp, George, Jr.
1985 The Provenience of Artifactual Raw Materials. In *Archaeological Geology*, edited by George Rapp, Jr. and John A. Gifford, pp. 353-375. Yale University Press, New Haven.

Reed, Alan D. and Rachel Gebauer
2004 *A research design and context for prehistoric cultural resources in the Uncompahgre Plateau Archaeological Projects Study Area, Western Colorado.* Ms on file, BLM Grand Junction Field Office.

Reed, Alan D., and R.A. Greubel, S.M. Kalasz, J.C. Horn, J.D. Cater, and K. Redman
2001 Synthesis of Project Data, Vol. 7, Chapter 41, In *The Trans Colorado Natural Gas Pipeline Archaeological Data Recovery Project, Western Colorado and Northwestern New Mexico.* Ms on file, BLM Grand Junction Field Office.

Reed, Alan D. and Michael D. Metcalf
1999 *Colorado Prehistory: A Context for the Northern Colorado River Basin*. Colorado Council of Professional Archaeologists, Boulder.

Rumsby, Barbara T., and Mark G. Macklin
1994 Channel and flood plain response to recent abrupt climate change: The Tyne Basin, Northern England; *Earth Surface Processes and Landforms* 19:499-515.

Schroedl, Alan R.
1976 *The Archaic of the Northern Colorado Plateau.* Ph.D. Dissertation. University of Utah. University Microfilms, Ann Arbor.

Scott, Glenn R.
1963 Bedrock Geology of the Kassler Quadrangle, Colorado. In *Geology of the Kassler Quadrangle, Jefferson and Douglas Counties, Colorado: U.S. Geological Survey Professional Paper, 421-B:71.* US Government Printing Office, Washington, D.C.

1965 Nonglacial Quaternary Geology of the Southern and Middle Rocky Mountains. *The Quaternary of the United States,* edited by H. E. Wright and D. G. Frey, pp. 243-254. Princeton University Press.

Scott, Robert B., Anne E. Harding, William C. Hood, Rex D. Cole, Richard V. Livaccari, James B. Johnson, and Robert P. Dickerson
2001 *Geologic Map of Colorado National Monument and Adjacent Areas, Mesa County, Colorado.* US Geological Survey Geologic Investigations Series I-2740. U.S. Government Printing Office, Washington, D.C.

Smith, Anne M.
1974 *Ethnography of the Northern Utes.* Museum of New Mexico Papers in Anthropology No. 17. Albuquerque.

Simms, Steven R.
1986 New Evidence for Fremont Adaptive Diversity. *Journal of California and Great Basin Anthropology* 8(2):204-216.

1989 The Structure of the Bustos Wickiup Site, Eastern Nevada. *Journal of California and Great Basin Anthropology* 11 (1), pp. 2-34.

1990 Fremont Transitions. *Utah Archaeology* 3(1):1-18.

Surovell, Todd A., N. M. Waguespack, J. H. Mayer, M. Kornfeld, and George C. Frison
2005 Shallow Site Archaeology: Artifact Dispersal, Stratigraphy, and Radiocarbon Dating at the Barger Gulch Locality B Folsom site, Middle Park, Colorado. *Geoarchaeology* 20:6:627-649.

Tabor, S.
1929 Frost Heaving. *Journal of Geology* 37:428-461.

Tomanek, G. W., and G. K. Hulett
1968 Effects of historical droughts on grassland vegetation in the central Great Plains. In *Pleistocene and Recent Environments of the Central Great Plains*, edited by W. Dort, Jr., and J. K. Jones, Jr. Special Publication 3, Department of Geology, University of Kansas, Lawrence.

Union Oil Company, Energy Mining Division
1982 Colorado Mined Land Reclamation Board Permit Application. Phase II: Parachute Creek Shale Oil Program. Volumes VI and VII. Union Oil Company of California, Parachute.

Western Regional Climate Center
2010 wrcc@dri.edu.

Williams-Thorpe, Olwyn
1995 Obsidian in the Mediterranean and the Near East: A Provenancing Success Story. *Archaeometry* 37:217-248.

Wolman, M. G.
1959 Factors influencing erosion of a cohesive riverbank: *American Journal of Science* 257:204-216.

Wolman, M. G., and J. P. Miller
1960 Magnitude and frequency of forces in geomorphic processes; *Journal of Geology* 60(1):54-74.

Womack, Wesley Raymond
1975 Erosional History of Douglas Creek, Northwestern Colorado. Master's thesis (geology), Colorado State University, Fort Collins.

Womack, Wesley R., and Stanley A. Schumm
1977 Terraces of Douglas Creek, Northwest Colorado: An Example of Episodic Erosion. *Geology* 5:72-76.

Wormington, H. Marie and Robert H. Lister
1956 Archaeological Investigations on the Uncompahgre Plateau in Colorado. Denver of Museum of Natural History Proceedings No. 2. Denver.

Young, Robert G. and Joann W. Young
1968 *Geology and Wildflowers of Grand Mesa.* Wheelwright Press, Ltd.

1977 *Colorado West, Land of Geology and Wildflowers.* Wheelwright Press, Ltd.

PERSONAL COMMUNICATIONS

Edward Cook, 2007, Lamont-Doherty Earth Observatory (as presented in Berry and Benson 2008)

Mark Stiger, 2005, Professor Western State Colorado University

APPENDIX A: LIST OF ARTIFACTS CURATED AT THE MUSEUM OF WESTERN COLORADO

(BLM and OAHP copies)

APPENDIX B: OAHP SITE FORM
(BLM and OAHP copies)