Chimney Rock Stabilization Project

Chimney Rock Great House (5AA83)

Archuleta County, CO

University of Colorado at Boulder

Chimney Rock Stabilization Project

Chimney Rock Great House (5AA83)

Archuleta County, CO

SJNF# 11-076

Prepared by:

Brenda K. Todd

Submitted By:

Dr. Stephen H. Lekson (PI)

University of Colorado at Boulder

Natural History Museum

UCB 218

Boulder, CO 80309-0218

August 13, 2011

Prepared for:

USDA San Juan National Forest, Pagosa District; Chimney Rock Interpretive Association (CRIA); University of Colorado at Boulder

Permit#: COL538

Abstract

Chimney Rock Pueblo (5AA83) is an L-shaped Chaco-style great house consisting of approximately 30-35 ground floor rooms, several potential second story rooms, two kivas, a plaza and a court. The pueblo is located at an elevation of 7600 feet on a narrow triangular ridge crest southwest of two natural sandstone pillars. The site is the centerpiece of the Chimney Rock Archeological Area, administered by USDA Forest Service, San Juan National Forest, Pagosa District, with the assistance of the Chimney Rock Interpretive Association (CRIA). The Chimney Rock Archaeological Area is located 27 km west of Pagosa Springs in southwestern Colorado.

Limited fill reduction and test excavation was necessitated by stabilization issues at the site. Rooms 6 and 8 were completely excavated earlier in the 20th century, while rooms 5 and 7 had not been excavated, leading to large load differentials on fragile prehistoric walls and moisture movement through walls from unexcavated to excavated rooms. Stabilization plans (Hovezak 2007) called for fill reduction or complete excavation of Rooms 5 and 7. Discussions among the University of Colorado (CU), the USDA Forest Service, and CRIA developed a program of fill reduction and limited testing in rooms 5 and 7 (as specified in CRIA-CU contract and USDA Forest Service ARPA permits to the University of Colorado).

The University of Colorado reduced fill in both Rooms 5 and 7 by approximately 60 cm to satisfy preservation requirements. A test unit in the southwest quadrant of each room was excavated below room floors to bedrock. These units revealed original architecture, wood for dendrochronological dating, and an assemblage indicative of both local and Chacoan influences. The Great House was likely constructed by individuals from Chaco Canyon with detailed architectural knowledge. Dendrochronological dates support Eddy's inference of a roofing event in A.D. 1093, and offer tantalizing hints of a possible earlier construction event at Chimney Rock Great House.

This material is based upon work assisted by a grant from the Department of Interior, National Park Service. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of

Interior. The Colorado State Historic Fund, Gates Family Foundation, Tourism Cares for Tomorrow and Chimney Rock Interpretive Association also provided funding for this work.

Table of Contents

List of Figures

List of Tables

Introduction

Chimney Rock Pueblo is located on the upper mesa of a northeast to southwest trending flat-topped narrow ridge or mesa. The upper mesa, at an elevation of 7,600 feet, is connected to the lower mesa, at an elevation of 7,400 feet, by a narrow causeway. The name "Chimney Rock" is derived from the two dramatic natural pillars of rock at the northeast end of the mesa. The smaller pillar located further from the great house is "Chimney Rock," while the larger and closer pillar is known as "Companion Rock." Jeancon (1922) estimated that the L-shaped pueblo consisted of 35 ground floor rooms, with some indications of a second story, and two kivas. Further mapping work completed by the University of Colorado at Boulder and Woods Canyon Archaeological Consultants, Inc., has shown that the site consists of approximately 30 ground floor rooms, 2 kivas, 15 ancillary or buttress rooms surrounding the east kiva, and several possible second story rooms north of the east kiva (Figure 1).

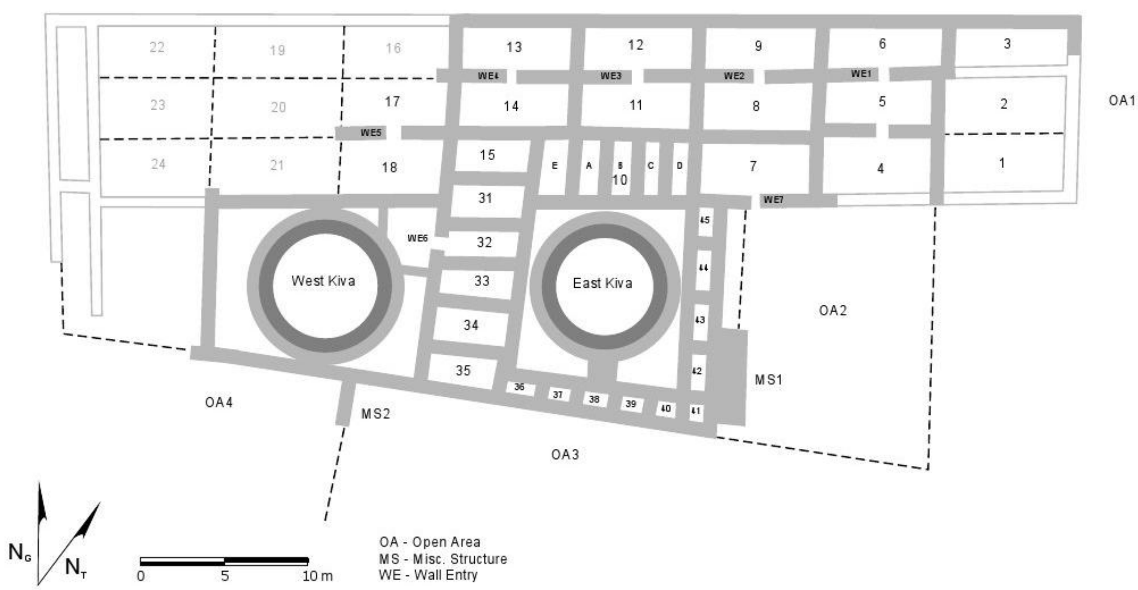


Figure 1. Chimney Rock Great House (5AA83). In progress base map derived from Frank Eddy's 1972 map as annotated by Steve Lekson 2009. Drafted by Jason Chuipka, Woods Canyon Archaeological Consultants, Inc. Chimney Rock Interpretive Association's Preservation.

The Chimney Rock Pueblo is constructed of regularly coursed sandstone masonry, very similar to that observed in Chaco Canyon, 150 km to the southwest (Eddy 1977:32). Chaco Canyon was the 11th and early 12th century center of what is known variously as the Chacoan Regional System (Crown and Judge 1991), the Chaco Rituality (Yoffee 2001) and the Chaco World (Lekson 2006). The extent of the Chaco Region is determined by the distribution of prehistoric roads, great houses, great kivas or combinations of those structures (Lekson 1991; Mills 2002:67-68; Kantner and Kintigh 2006:155). Estimates for the ultimate size of the Chacoan World vary, but range from the entire San Juan Basin and surrounding uplands, or approximately 65,000 square kilometers (Cordell 1997:305-306) to an area of about 120,000 square kilometers including the San Juan Basin, the surrounding uplands in northwestern New Mexico, northeastern Arizona, southeastern Utah, and southwestern Colorado (Lekson 1996:82; Lekson 2006:9).

Approximately two hundred outlying great houses have been identified, located in southwestern Colorado, New Mexico, Utah and Arizona (Kantner 2004:102, Lekson 2006:14). Chimney Rock is the northeastern-most of these outlying great houses and was connected to Chaco Canyon by the line-of-site passing through Huerfano Mesa (Freeman, Bliss and Thompson 1996). Chimney Rock is also unique in respects to many other prominent outliers, including Aztec Ruins, in that it was abandoned in the early to mid 12th century and does not have later 13th century component. This historical singularity is inherently interesting; but it also allows study of the 12th century occupation without the complications introduced by later components.

Previous Research at Chimney Rock

The first major research at Chimney Rock was undertaken in 1921. This project was sponsored by the State Historical and Natural History Society of Colorado (now the Colorado Historical Society) in partnership with the University of Denver (Eddy 1977:2; Lister 1993:9-26). J. A. Jeancon directed the project. Excavations took place at the Chimney Rock Pueblo (5AA83), the Guardhouse (5AA84) located on the neck of the mesa accessing the main pueblo, the Causeway Site (5AA85), and sites near the Pargin and Harlan Ranches located on the benches on the east side of the Piedra River (Jeancon 1922). During this field season at the Chimney Rock Pueblo, five rooms (6, 9, 10, 11, 12) were completely excavated and two other rooms (3 and 34) were partially excavated. The East Kiva was 80% excavated and the corner spaces in the rectangle surrounding the kiva were cleared. Six small rooms interpreted as storage areas (38, 39, 40, 42, and 43) just outside of the East Kiva were excavated (Jeancon 1922; Eddy 1977:32-33; Eddy 2004:24).

Further excavations were carried out in 1922, this time under the direction of Frank H.H. Roberts, a student during the previous field season of 1921. During this field season, rooms 31-35, the West Kiva, and the spaces around the kiva (two of which were labeled 1-A and 2-A [Jeancon and Roberts 1924:Figure 7], the other spaces remain unlabeled) were fully excavated (Jeancon and Roberts 1924; Eddy 1977:33; Eddy 2004:24). Unfortunately, no backfilling was completed after these excavations, leaving the site open to the ravages of weather, looting, and vandalism for the next 50 years (Eddy 1977:33; Lister 1993:27).

In 1970, 1971, and 1972, a University of Colorado team lead by Dr. Frank Eddy completed a project comprising both survey around and excavation in and around Chimney Rock Pueblo under a contract with the U.S. Forest Service (Eddy 1977, Eddy 2004). This work identified 91 sites (interpreted by Eddy [1977] to be equivalent to the 108 sites reported by Jeancon [1922]), and completed excavations in sites 5AA83, 5AA86, 5AA88, and 5AA92 (Eddy 1977). Based on the distinctive architecture, unusual settlement pattern, and ceramic industry, Eddy identified a new and distinct archaeological taxon that he termed the "Chimney Rock Phase," dated between A.D. 925 and 1125 (Eddy 1977:3). Eddy (2004:26) later slightly revised the dates of the Chimney Rock Phase to fall between A.D. 1000 and 1125.

The goals of Eddy's excavations were to "clear a room and test a kiva in preparation for wall stabilization and eventual ruins display" (Eddy 2004:26). Eddy also wanted to obtain samples for dendrochronological dating, a technique not in existence during the 1920s excavations, and to recover pottery to create a chronological sequence (2004:27). The crew excavated Room 8, a small area of unexcavated fill on the north side of the East Kiva, tested outside of the building to the south and east of the East Kiva, and tested of a trash deposit (Eddy 1977; Eddy 2004:28).

Eddy was successful in his goal of obtaining samples for dendrochronological dating. Ninety wood specimens were collected during the course of excavations. Fourteen of these were duplicates, and of the 76 remaining specimens, 47 were dateable. Forty-one of the specimens were from Room 8. Of these, 26 dated to A.D. 1093, with the remaining dates coming in between A.D. 1066 and 1092 (Eddy 1977:43). Of the 26 samples dated to A.D. 1093, 13 have an "r" suffix, indicating that the outermost ring is continuous around the log that is present and therefore may represent cutting dates; one specimen has an "rB" suffix indicating a continuous outer ring with bark on the portion of the sample present and a definite cutting date; and two samples have a "c" meaning that the last ring is constant around the circumference and is likely a cutting date; and one sample has a "cB" suffix meaning that the outer ring is constant and bark is present, indicating a definite cutting date. Therefore, 17 of the samples dating to A.D. 1093 provide strong evidence that trees were being harvested to roof room 8 during the summer of that year. There were no cutting dates prior to or after A.D 1093, indicating that beams were not salvaged and the room was not re-roofed (Eddy 1977:44). The remaining six samples were from the East Kiva. A single of A.D. 1076r from a ponderosa pine pole taken from the horizontal ventilator tunnel next to the vertical ventilator shaft has been interpreted as dating the construction of the earlier phase kiva (Eddy 1977:44). The other five dates from the kiva were recovered from the roof of the upper, later kiva. Only one of these five samples had a continuous outer ring, indicating a cutting date of A.D. 1093r (Eddy 1977:46).

Eddy also did some work outside of the pueblo in 1971 in an attempt to identify court, plaza and midden locations. This work resulted in the definition of the East Court, an elevated surface located between the two arms of the L-shaped great house Eddy (1977:39). The court was an intentionally constructed surface comprised of "a mottled and horizontally banded light yellow and gray clay loam" atop occupational debris that had accumulated outside the pueblo during its construction (Eddy 1977:43). A bench or banquette, interpreted by Eddy as a location to sit during ceremonial activities or for resting during the day was defined along the exposed east wall of the pueblo. The South Plaza, consisting of a mud plaster paving of an unknown extent outside the south wall of the building was identified as well. This plaza appears to have been constructed directly on top of the bedrock surface (Eddy 1977: 40). A trash deposit along the base of the cliff on the very steep north side of the great house was examined. The deposit was found to consist of a "charcoal-stained soil mixed with pottery, stone and bone artifacts" (Eddy

1977:41). Eddy found no evidence of calcined human remains reported by Jeancon (1922) (Eddy 1977:41).

After the completion of the final University of Colorado at Boulder field season, the Chimney Rock Archaeological Area was closed for a period of 12 years between 1973 and 1985 because it was feared that visitation to the site would disturb nesting peregrine falcons (Eddy 2004:47). The site was re-opened in 1985 and very limited research was initiated in 1988. Some of the projects included research at communities within the High Mesa Group and along the Piedra River just outside of the Chimney Rock Archaeological Area; aerial photography; archaeoastronomical investigations; and materials sourcing for feather holders and obsidian (Eddy 2004:48-50).

Throughout the nearly one hundred years that archaeologists have been aware of Chimney Rock, there have been a diversity of interpretations of the site. However, there is one common theme present in most, if not all, of these interpretations: a clear connection to Chaco Canyon. The following paragraphs briefly summarize the main theories proposed for the great house.

Jeancon, the first archaeologist to work at the site, interpreted Chimney Rock as defensive, noting that the trail, "would constitute a fairly good defense, as the enemy in attacking would have to surmount this rise and would suffer from precarious footing in the climb which would necessarily retard his progress" (1922:13). He also saw the guardhouse, which literally blocks the only entrance from the lower mesa to the main pueblo of Chimney Rock above as a defensive structure (Jeancon 1922). Jeancon was impressed with the imposing structure of the two story Chimney Rock Pueblo and by the beauty and craftsmanship of the masonry; he saw similarities to Chaco Canyon (Jeancon 1922:14, 16).

Based on the exceptional parallels in architectural planning, masonry styles, and kiva construction at Chimney Rock and at Chaco, Eddy (1977) suggested that Chimney Rock was built by male priests from Chaco who possessed detailed cultural and religious knowledge. Based on the relative lack of Chacoan pottery at Chimney Rock, Eddy posited that women (presumed to be potters) from Chaco had not been a part of this colonization. Parker (2004) adds an interesting additional interpretation. Based on petrographic analyses of 225 sherds, Parker

(2004) found that while Gallup Black-on-white (associated with Chaco) made up only 9.5% of the ceramics found at the site, a local imitation of Chacoan pottery that used Chacoan sherds as temper made up 56% of the total pottery at the site. That is, sherds from the south were ground up for temper in locally made imitation Chacoan pottery. This evidence provides a strong indication of a Chacoan presence on the high mesa.

Building on the defensive nature of Chimney Rock first observed by Jeancon (1922), Wilcox (1993; 2004) posited that the pueblo functioned as a fortress where warrior-priests could collect tribute from local populations and provide protection from any threats to Chaco coming from the northeast. Tucker (2004) sees a much less significant connection to Chaco Canyon than do many other researchers. In his estimation, Chimney Rock developed over a period of two centuries due to reactions to natural and cultural forces and was constructed by a local elite population and not a Chacoan elite population (contra Eddy 1977; 2004). In this scenario, Chimney Rock develops trading relationships and ritual connections to Chaco Canyon only very late in its history, ultimately becoming a northeastern port of trade. In a similar vein, Kane (2004) interpreted Chimney Rock as a “lumber-camp” where trees would have been floated down the Piedra River to the San Juan River and then carried to Chaco. Chimney Rock may have also supplied dried meat from large game animals to Chaco. Bradley (2004) used colonial Spanish missions as an analog to explain Chimney Rock and other outliers. In this framework, Chaco was a theocracy that dispatched missionaries to indigenous populations. “Missionaries” would have lived in the outlying great houses and gained greater prestige due their Chacoan connections, manifest by Chimney Rock's similarities with the great houses of Chaco Canyon. Roney (2004) saw Chimney Rock as an outlier participating in the Regional System in the same ways as other Chacoan outliers and as a direct product of Chacoan people. In Roney’s (2004) estimation, Chimney Rock may have decided to participate in the Chaco system due to the ritual significance of the double chimneys and the economic importance of timber and other resources.

Malville’s (2004) interpretation of Chimney Rock as an astronomical observatory is partially based on tree ring dates provided by Eddy (1977) that correspond with the major lunar standstill each 18.6 years. Further, from the vantage point of the great house, the moon can be viewed rising spectacularly between the two stone spires. Malville (2004) argues that much of the power of ritual specialists within Chaco was esoteric in nature and may have included astronomical observations from Chimney Rock. The A.D. 1076 and 1093 dates derived from Eddy's excavations fall on years in which lunar standstills occurred. Malville has inferred that this coincidence in cutting dates and lunar standstills demonstrates a significant ceremonial nature to the site (2004). Chimney Rock Great House as an astronomical observatory is currently the dominant interpretation of the site, and our research design sought to further evaluate this theory through the recovery of dendrochronological samples.

Current Threats to the Site

The primary threat to the site is natural deterioration of walls exposed in past excavations due to exposure to the elements including precipitation, freeze/thaw action, and sometimes heavy snow loads (Hovezak 2007). These weather and high altitude related factors have resulted in collapse and/or bulge of basal and mid-wall veneer (Hovezak 2007). Fill differentials in adjacent rooms is a major threat to site preservation. This problem is especially apparent in Room 8, fully excavated by Eddy (1977), where fill differentials in rooms 5 and 7 are nearly two meters above the floor level of Room 8. There are also impacts from vegetation and visitation (Hovezak 2007).

Nature of Anticipated Disturbance

No further disturbance to the site is anticipated. The fill reduction and limited test excavations described in this report were completed in anticipation of stabilization and preservation activities at the site.

Description of Archaeological Field Operations

Archaeological field operations were conducted by personnel from the University of Colorado in cooperation with Woods Canyon Archaeological Consultants. The Principal Investigator was Dr. Stephen H. Lekson, and the Project Director was Brenda Todd. Crew members were upper level graduate students from the University of Colorado. Crew Chief, Jason Chuipka was contracted from Woods Canyon Archaeological Consultants, Inc. due to his expertise in the archaeology of the area. Fieldwork was conducted between June 1, 2009 and July 3, 2009.

Plans for professional and public dissemination of information include: poster and paper presentations at professional meetings such as the Society for American Archaeology Annual Meeting, the biannual Southwest Symposium, and the Pecos Conference; publication in professional journals such as *Kiva: The Journal of Southwestern Anthropology and History,* and *American Antiquity;* thorough discussion in Todd's Ph.D. dissertation; public lectures for the Chimney Rock Interpretive Association; and museum-quality panel for display at CRIA visitor's cabin.

Environment

General Topographic Features and Geology

The Chimney Rock Great House (5AA83) is located atop the Chimney Rock Mesa. The mesa dips steeply from the northeast to the southwest and ranges from 6600' to 7600' in elevation. There are two primary sections of the Chimney Rock Mesa: a smaller triangular upper mesa at 7600' in elevation where the great house is located; and the larger lower mesa where the largest proportion of prehistoric inhabitants lived. The two sections of the mesa are connected by a narrow causeway. The Chimney Rock Ravine bisects the lower mesa and drains the upper mesa to the Piedra River during heavy summer storms (Eddy 1977:1).

The uppermost layer of the Chimney Rock Mesa is composed of Pictured Cliff sandstone (Wood, Kelley, and MacAlpin 1948). Underlying the more resistant Pictured Cliff sandstone are beds of Lewis shales and clays that may have been important sources of building material and clay for the prehistoric inhabitants of the area (Eddy 1977:1). Chimney Rock gets its name from two free-standing stone pillars: the larger and higher Chimney Rock at an elevation of 7,903' and the lower Companion Chimney (Eddy 1977:1).

Soils

The soils in the immediate vicinity of the Great House are shallow, rocky, and ill-suited to farming activities (Chuipka 2010:5). The talus slopes surrounding the Great House are very steep, making farming impossible. Due to these factors, it is likely that farming was carried out in other locations, most likely on the pediment colluvial soils at the base of the mesa in the Stollsteimer Valley (Eddy 1977:9)

Hydrology

There are no running water sources or springs in the immediate vicinity of the Great House. The Chimney Rock Ravine only runs after rare summer storms. In the summer months, the closest sources of drinking water are from perennial streams in the valley below: 2.4 km to Stollsteimer Creek; 1.6 km to Devils Creek; and 2 km to the Piedra River. In the winter, snowpack on the mesa would have provided plentiful water for drinking and other household uses (Eddy 1977:9-10). The Piedra River, ultimately draining to the San Juan River to the south, would have been the most important water source for inhabitants of the Chimney Rock area (Hovezak et al. 2002:17; Adams and Peterson 1999:22).

Flora

The dominant biotic community in the Upper San Juan-Piedra drainage, where Chimney Rock is located, is the pine-douglas-fir forest. There are smaller locales dominated by spruce-fir forest, and pinyon-juniper woodland. Some sagebrush-saltbush communities are located in the lower Los Pinos and Piedra River Valleys (Adams and Peterson 1999:20). The vegetation in the vicinity of the Great House and other sites in the High Mesa Group can be characterized as pine-douglas fir forest.

The prehistoric environment was likely much like the current environment, with a few exceptions (Eddy 1977:10, 62). A pollen study carried out in 1971 showed periodic decreases in tree pollen and increases in grass pollen between A.D. 950 and 1100. This variation may have been caused by forest fires or clearing of trees by humans. In either case, it would have resulted in more food resources for elk, deer and rabbits. Additionally, there are overall lower rates of tree pollen in the prehistoric past than there are today, indicating that prehistoric forest cover was more sparse (Eddy 1977:64). Prehistoric pollen and wood types identified include Ponderosa pine, Douglas fir, True fir, Juniper, Aspen, maize, beeweed, prickly pear cactus, cattail, and members of the parsley and *Leguminosae* families (Eddy 1977:64-65).

Common plants in the vicinity include Indian ricegrass (*Stipa hymenoides*), western wheatgrass (*Agropyron smithii*), dropseed grass (*Sporobolus*), and Junegrass (*Koeleria*). Sagegrush, Gambel oak (*Quercus gambelii*),rabbitbrush, saltbush, skunkbush (*Rhus aromatica*), serviceberry (*Amelanchier*), mountain mahogany (*Cercocarpus*), and yucca (*Yucca*), and prickly pear and hedgehog cacti (Chuipka et al 2010:8).

Fauna

Animal life is abundant and includes a wide variety of large mammals such as elk, mule deer, jack rabbits, desert cottontail, squirrels, porcupines, beavers, prairie dogs, woodrats, and pocket gophers. Birds, including turkey, songbirds, jays, raptors, and crows, would have also provided a potential food source for prehistoric inhabitants (Eddy 1977:62; Chuipka 2010:9). Prehistorically, grizzly bears and wolves were present, but these species no longer inhabit the area surrounding Chimney Rock (Chuipka 2010: 9).

Land Use Patterns

The distribution of sites in the High Mesa Group, of which Chimney Rock Great House is a component, is dictated by the dramatic topography of the mesa. The sites are situated between the edge of the mesa and the Chimney Rock Ravine, up the causeway and then to the upper mesa before the deeply eroded saddle separating the great house form the stone chimneys (Eddy 1977:9). Eddy (1977:9) recorded 16 sites within .16 square miles representing a site density of 100 sites per square mile in the High Mesa Group. During the Chimney Rock Phase (A.D. 1050-1150) the prehistoric inhabitants show a marked preference for high locations atop the mesas versus living closer to potential farmland lower in the valley (Eddy 1977:9; Chuipka et al. 2010: 105). This can be contrasted with a preference for lower elevations during the preceding century (Chuipka et al. 2010:105).

Environmental Constraints

The primary environmental constraints at the Chimney Rock Great House are its high elevation, sheer cliffs on three of four sides of the site, and exposure to the elements. These factors all contribute to deterioration requiring stabilization at the site. Of the cultural remains at Chimney

Rock, the architecture of the great house has been most heavily impacted by the factors discussed above. The contents of the rooms excavated in this project were fairly well protected and preserved. No oppressive environmental constraints were encountered during the completion of fieldwork. The weather was fortuitous and work progressed smoothly.

Paleoenvironment

The paleoenvironment at Chimney Rock was very similar to the environment encountered today with a few exceptions. First, grizzly bear and wolf do not currently live in the Chimney Rock vicinity. Next, pollen studies conducted in the 1970s indicate that the area may have been slightly more xeric during the Chimney Rock occupation (Eddy 1977:64). While a direct climatic interpretation derived from tree ring data was not possible due to the young nature of the assemblage, the tree ring laboratory indicated that based upon the species present, the climate may have been slightly more mesic than presently (Eddy 1977:65). Eddy explains the discrepancy between the pollen data and the wood identifications by positing that overall rainfall may have been less than today, but most of it occurred in the winter in the form of snowpack. This moisture would have been of most benefit to trees because less evaporation occurs in the winter time (Eddy 1977:66).

The Chimney Rock area is generally characterized by a bi-seasonal moisture pattern, with precipitation in the winter months and erratic summer thunderstorms between July and September (Adams and Peterson 1999:23). This bi-seasonal moisture pattern can be further contextualized within larger weather patterns, including the Medieval Warm Period (A.D. 800-1200) and the Little Ice Age (A.D. 1250 to 1850) (Adams and Peterson 1999:41). Peterson (1994) notes that the initial Puebloan florescence coincides with the Medieval Warm Period, while the eventual decline of Puebloan societies in the southwest coincides with the Little Ice Age.

Benson et al. (2007) identify three severe droughts in the western United States in the 10th, 11th, and 12th centuries. These weather patterns correspond to major population movements. The first major drought (A.D. 990-1060) may have compelled some Ancestral Puebloans to move out of Chaco Canyon and north to the San Juan River area. A subsequent drought, between A.D. 1135 and 1170, may have spurred the abandonment of many great houses, perhaps including Chimney Rock. The final major drought (A.D. 1276-1297) may have been a contributing factor to the ultimate depopulation of the Four-Corners Region (Benson et al. 2007:343-344).

Culture History and Previous Work

The following summary of the culture history of the Chimney Rock Region begins with a description of the culture history of the Chaco Region of which Chimney Rock is a component and then traces through time the results of the projects completed in the more immediate Chimney Rock region, including the Animas, Piedra, and Pine River drainages and the benches and mesas surrounding Chimney Rock.

Chaco Canyon Chronology and Culture History

A brief discussion of the chronology and culture history of Chaco Canyon and of the Chaco Region is necessary to contextualize Chimney Rock Pueblo. As noted by Lipe, Varien, and Wilshusen (1999:289), “Understanding Chaco and its influences/interactions with the rest of the Southwest is perhaps the most important and far-reaching research problem in the archaeology of this region.” Since 1890, many, many excavations have taken place within the Canyon and much has been written about this prehistoric society. The following summarized chronology and culture history is a result of more than a century of research in and around the canyon.

The relevant chronology within Chaco Canyon has been divided into three phases: the Early Bonito phase (850-1040 A.D.), the Classic Bonito phase (1040-1100 A.D.), and the Late Bonito phase (1100-1140 A.D) (Lekson 2006:6). In the mid-800s, or the Early Bonito phase, Chaco Canyon inhabitants began to construct great houses, an architectural form never seen before in the region. These “great houses” were differentiated from other puebloan constructions based on their possession of one or more of the following features: larger relative building size, greater labor investment, multistoried construction, symmetry of layout, large-scale foundation units that indicate planning, core and veneer masonry, and banded masonry (Mills 2002:89-90; Judge 1991:27-28). Between A.D. 1040 and 1100, the Classic Bonito phase, isolated great kivas and formally constructed "trash" mounds became a component of the Chacoan architectural repertoire (Judge 1991:25). Then, in the early A.D. 1100s, or the Late Bonito phase, great house construction slowed considerably, and only very small-scale additions and remodeling projects were carried out on existing great houses. The architects of the canyon began to build a new kind of great house, more compact and efficiently constructed, labeled "McElmo" by Vivian and Mathews (1965). Large building projects outside of Chaco Canyon proper were also underway during the Bonito phase. These communities are known as "Chacoan Outliers" and are typically made up of a great house surrounded by smaller pueblo structures, and often have associated great kivas and roads (Marshall et al. 1979:331; Lekson 2006:14). Chimney Rock is one of these large building projects.

After about A.D. 1125, during the late Bonito Phase, construction within Chaco Canyon ceased and quantities of finished goods filtering into the canyon decreased (Kantner 2004:127-128). Based on the fact that the last known cutting date is A.D. 1132, some argue that Chaco Canyon was largely depopulated by A.D. 1140 (Judge 1991:27). A.D. 1150 is often noted as the conventional end of the identifiable "Chaco Phenomenon." The canyon may have been largely devoid of inhabitants at the end of the 12^{th} century, and then reoccupied during the A.D. 1200s. Then, like the rest of the Four-Corners region, Chaco was abandoned by the beginning of the 14^{th} century (Cameron and Toll 2001:10).

Chimney Rock Region Previous Work, Chronology, and Culture History

After the initial work completed by State Historical and Natural History Society of Colorado (now the Colorado Historical Society) in partnership with the University of Denver in 1921 and 1922, no further excavation was carried out in 1923 due to lack of funding. Instead, Frank H. H. Roberts, a student who had worked with Jeancon in 1921 and directed field operations in 1922, was charged with completing a survey of the Piedra and Pine River Valleys south of Highway 160. Roberts' survey revealed that the benches and hills surrounding Chimney Rock and south of Highway 160 had been thickly populated during what he thought were the Pueblo I and early Pueblo II time periods (See Chuipka et al. 2010 for a revised perspective). Indeed, thirty villages were recorded on Stollsteimer Mesa. (Roberts 1925; Eddy 1977; Eddy 2004). The survey activities were continued in 1924, and again, were lead by Roberts. This survey included locations along the San Juan River south to Rosa, New Mexico. Roberts also carried out three weeks of test excavations on Stollsteimer Mesa during 1924 (Roberts 1930).

In 1925, Jeancon returned for one final field season in the area, conducting excavations at the Harlan Ranch near the Piedra River (Roberts 1930:17). No research was completed in the area during 1926 and 1927. In 1928, Roberts, now at the Smithsonian Institution, returned and completed excavations of Pueblo I and early Pueblo II sites on Stollsteimer Mesa (Roberts 1930). These excavations resulted in the definition of the Piedra Phase Unit between A.D. 850 and 950 (Eddy 1966: 492-499).

The Museum of New Mexico completed a series of site survey and excavations along the San Juan River, now Navajo Reservoir, between 1958 and 1963 (Dittert, Hester, and Eddy 1961; Eddy 1972). Pueblo I and Pueblo II sites were recorded during this research. The Ancestral Puebloan cultural patterns identified through this work were labeled: Los Pinos (Basketmaker II - A.D. 1-400), Sambrito (Basketmaker III A.D. 400-700), Rosa (Early Pueblo I - A.D. 700-850), and Arboles (Pueblo II - A.D. 950-1000) (Eddy 1966: 472-484). Basketmaker II sites are typically identified based on the presence of maize and lack of pottery; Basketmaker III settlements are characterized by pithouses, stone and ceramic artifacts; Pueblo I sites are typified by large, aggregated villages; Pueblo II is characterized by Prudden unit pueblos, great kivas, and widely dispersed homesteads (Chuipka et al. 2010:48; 57-58; 65; 99-100).

In 1969, 1970, and 1973 under a contract with the Southern Ute Tribe, the University of Colorado surveyed approximately 45,000 acres on the Southern Ute Reservation, to the east of the Navajo Reservation District, along the San Juan River and towards Pagosa Springs. The survey recorded 226 sites in the Rosa, Piedra, and Arboles Phase, representing the time periods between A.D. 700 and 1050 (Eddy 2004:25-26).

In 2008 and 2009, Woods Canyon Archaeological Consultants, Inc. completed the Northern San Juan Settlement Survey and testing project in La Plata and Archuleta counties in southwestern Colorado. The project area included 148,000 acres between Durango, CO and Chimney Rock. The goals of the project were to "1) *Clarify the archaeological record for this area from the Paleoindian through Protohistoric periods*, and 2) *to develop a cultural resource management* *plan to better evaluate, manage, and protect these resources".* This work was organized around three major river drainages: the Animas River; the Piedra River; and the Pine River (Chuipka et al. 2010: 1)

Survey and testing of the Animas River drainage revealed sparse evidence for Paleoindian, Archaic, and Basketmaker II presence on the landscape; no evidence for Basketmaker III, strong evidence for Pueblo I; no evidence for Pueblo II, Pueblo III, and Navajo; and sparse evidence for Ute occupation. Survey and testing along the Pine River drainage revealed sparse evidence for Paleoindian, Archaic, and Basketmaker II occupation; no Basketmaker III; widely spaced, single unit Pueblo I habitations pre A.D. 850 and two villages post-A.D. 850; no Pueblo II sites; Pueblo III hunting camps; two Navajo settlements, and no Ute presence. Survey and testing of the Piedra River Drainage revealed sparse evidence for Paleoindian, Archaic, and Basketmaker II; no Basketmaker III sites; a few small Pueblo I sites; Pueblo II occupation centered around Chimney Rock; and no Pueblo III sites; numerous Navajo sites; and no Ute sites (Chuipka et al. 2010).

Previous Work in the Project Area

Previous work conducted at Chimney Rock Great House (5AA83) has been summarized in the *Introduction*, so this portion of the report will focus on research completed at other sites within the Chimney Rock Archaeological Area.

Two major rounds of study have been undertaken in what is now the Chimney Rock Archaeological Area, the first in the 1920s, and the second in the 1970s. The first major research at the site was undertaken in 1921. This project, directed by J. A. Jeancon and discussed above completed work at the Guardhouse (5AA84) located on the neck of the mesa accessing the main pueblo, the Causeway Site (5AA85), and other sites on the benches below Chimney Rock along the Piedra River, in addition to work at the Great House (Jeancon 1922).

The next major research was conducted at a number of sites within the Chimney Rock Archaeological Area by Frank Eddy in the 1970s. In 1970 and 1971, Eddy completely excavated Mound 3 of the Parking Lot Site (5AA86). The Parking Lot Site consists of three linked circular masonry rooms (Rooms 2, 3 and 4) backed by two rectangular masonry rooms (Rooms 1 and 6)

(Eddy 1977:50). Eddy (1977; 2004) determined that the site was contemporary with the great house above, but that the architecture was substantially different. Eddy also examined a series of what he termed "crater-shaped mounds" at sites 5AA86, 5AA88, and 5AA92 (Eddy 1977:4). The mounds ranged from 1.5' to 6' in height, are circular in plan, with a 1.5' to 3' central depression. Eddy interpreted the rooms to be the remains of circular, thick-walled masonry domestic rooms, with central fireplaces, ventilator systems and flat roofs constructed from logs and mud. One particularly large crater mound, with a diameter of 30-40' at 5AA88 was determined to be analogous to great kivas associated with the Chacoan system (Eddy 1977:4).

Eddy also defined seven groups of sites within the Chimney Rock Archaeological Area. The first is the "High Mesa Site Group" consisting of 16 sites, including Chimney Rock Pueblo (5AA83), the Guard House (5AA84), the Parking Lot Site (5AA86), and (5AA88), and Mound 3 of 5AA92 that was destroyed during the construction of the parking lot (Eddy 1977:7). The "East Slope Group" is located on the east slope of the Chimney Rock Mesa and consists of five residential sites and 7 non-architectural sites (Eddy 1977:10). The "Stollsteimer Group" is located on the southeastern tip of the Chimney Rock Mesa and consists of nine permanent residences and 6 other non-architectural sites that may have been camps or workshops (Eddy 1977:12). The "Chimney Rock Ravine Group" is located along the southern rim of the Chimney Rock Ravine and consists of five architectural habitation sites and three non-architectural temporary camps (Eddy 1977:13). The "Pyramid Mountain Group" is located on the extreme southwestern corner of the Chimney Rock Mesa and consists of two large sites: the Village site (5AA129) and 5AA130 (Eddy 1977:15). The "Southern Piedra Group" consists of six architectural sites and one workshop on the Piedra River along the southwestern edge of the Chimney Rock Mesa (Eddy 1977:16). The "Northern Piedra Group" is a group of 14 sites comprised of 70 buildings located at the confluence of the Piedra River and Devil's Creek. This group of sites is one of the two largest site groups, the other being the High Mesa Site Group, and may have actually housed more people than the High Mesa Site Group (Eddy 1977:17). Eddy interprets all of these sites to be representative of the 11^{th} century community and components of the Chimney Rock Phase (1977:22).

The Guard House (5AA84) has been examined on three different occasions. First, in 1921, J.A. Jeancon outlined the circular, one room building and gave it its name. Jeancon interpreted the structure as serving to control access across the causeway to the great house above (1922). In 1970, Eddy again examined the site to evaluate the possibilities for ruin display. Due to the sparse remnants of the guardhouse, Eddy recommended against displaying the site to the public (Eddy 1977). In 1988, Fort Lewis College conducted a summer field school at 5AA84. These excavations examined the ventilator, and the northeast curve of the wall and identified a hard-packed clay floor and some intact portion of the original wall (Eddy 2004: 50-51). In 1989, excavations were completed for trail mitigations in the Chimney Rock Archaeological Area (Charles 1989).

Historic Research

No historic research, beyond history of archaeological fieldwork, was necessary for this project.

Statement of Objectives/Research Design

Excavations at Chimney Rock Great House (5AA83) addressed fill reduction for stabilization needs and limited testing.   To this end, fill was reduced in Rooms 5 and 7 by at least 50 cm from modern ground surface to equalize load differentials on prehistoric wall fabric (as specified by Hovezak 2007). One quarter of each room was then excavated to bedrock to provide data on the nature of room fill and to address three research questions. First, was the Chimney Rock Pueblo built in a single planned construction effort in A.D. 1076 and then re-roofed in A.D. 1093 in correspondence with major lunar standstills?   Next, how does Chimney Rock Great House relate to the surrounding community? Lastly, how does Chimney Rock Great House relate to the larger Chacoan World?

Presently, the dominant interpretation of Chimney Rock Great House hinges on a possible connection to major lunar standstills. Both the construction and role of Chimney Rock Pueblo in the larger Chaco Region have been interpreted based upon a single cutting date of A.D. 1076 from the East Kiva ventilator, and seventeen definite or likely cutting dates of A.D. 1093 from Room 8. Both A.D. 1076 and A.D. 1093 correspond with major lunar standstills, when the moon rises between the massive pillars of Chimney Rock and Companion Rock, just east of the pueblo. Eddy (1977:46, 50) contends that the pueblo was constructed in a single, planned event in A.D. 1076 by Chacoan priest-colonists, and then re-roofed in A.D. 1093. Malville (2004) adds to Eddy's interpretation, arguing that Chimney Rock was an astronomical observatory, built and sited to purposefully correspond to major lunar standstills to bolster the esoteric knowledge and power of the priests of Chaco Canyon 150 km to the south. Obviously, these interpretations are specific to Chimney Rock and its particular setting.

Archaeologists looking at the larger Chacoan region focus upon defining the relationships between Chaco Canyon and the outlying great houses, and the relationships between outlying great houses and their respective local communities (Reed 2008; Cameron 2009, Kantner 2003, Van Dyke 1999, 2003). Stylistic similarities in architecture and artifacts have long been noted between Chaco Canyon and sites throughout the San Juan Basin. The relationships between these sites and Chaco Canyon have been much debated with many attempts to develop a single explanatory framework for all of the sites that "look" similar to Chaco. Two basic models have emerged: "export" or "emulation." An "emulation" is thought to be a local copy of Chaco style architecture and artifacts, whereas an export is considered to be indicative of direct Chacoan influence, i.e. Chacoan masons actually constructing an outlying great house. This approach assumes that there is a suite of low visibility technological characteristics in architecture and artifacts that only Chacoan people could be aware of. Therefore, if an outlying site and its assemblage possess these subtle characteristics, it is likely a direct export of Chaco Canyon. If, on the other hand, the site displays more superficial or obvious traits that could be visible to the casual observer, it is determined to be an emulation created by locals who wanted to manufacture a connection to Chaco Canyon.

Eddy (1977) concluded that Chimney Rock was a colony built by Chacoan priests—an "export." More recently, archaeologists have postulated that perhaps outliers like Chimney Rock were more likely emulations of Chaco Canyon (Reed 2008, Cameron 2009). A careful examination of wall construction and other artifact classes such as pottery informs on this debate. For example, "hidden" construction characteristics found to be similar or identical to those at Chaco would be an indication of export, while more superficial similarities would be indicative of emulation.

This excavation was designed to examine these architectural and artifactual traits and to establish firm dates for Chimney Rock, thereby helping to place the site in time and space in reference to Chaco and to the surrounding community.

Field/Lab Methods

Field Methods

The University of Colorado completed fill reduction and limited testing in two adjacent rooms, 5 and 7. Room 5 is east and Room 7 is south of Room 8 excavated by Dr. Frank Eddy in the early 1970s (Eddy 1977). These rooms were previously unexcavated. Partial excavation was needed in Rooms 5 and 7 because they share walls with rooms that had been excavated and now stand open, resulting in uneven loads on and moisture movement through the prehistoric walls. Excavation methodology reflected stabilization plans (Hovezak 2007), but also addressed the research questions (above) through the recovery of wood samples for dating, pottery for analysis and original architecture for comparison to other Chacoan structures and to the surrounding community.

First, fill reduction was addressed. The draft stabilization plan (Hovezak 2007) indicated that the fill in Rooms 5 and 7 needed to be reduced by at least 50 cm. Each room was subdivided into quadrants. Work commenced June 1, 2009 in the NE quadrant of Room 5 and in the NW quadrant of Room 7. Fill reduction was undertaken in these initial quadrants with the removal of three 20 cm arbitrary levels that were completely screened. Virtually no artifacts were recovered, and it became clear that a significant portion of the upper fill in each room consisted exclusively of wall fall and sparse, re-deposited cultural material. Therefore, fill to 60 cm below modern ground surface was removed from the three remaining quadrants in each room and every third wheelbarrow was screened. Rocks from the first quadrant excavated to 60 cm below modern ground surface in each room were cairned for volume measurement, but rocks from the other three quadrants were not because they would not represent a controlled sample.

Fill reduction was completed in weeks 1 and 2 (June 1, 2009 – June 11, 2009). As detailed in the CRIA-CU contract and USDA Forest Service ARPA permit, limited tests were then placed in one quadrant of each room to bedrock. After consultation with USDA Forest Service, the SW quadrant of each room was chosen for these tests. One of the primary reasons that the SW quadrants were chosen in both rooms was the potential for doors in the south walls of each room. These quadrants were excavated using a combination of arbitrary levels and natural stratigraphic levels. Test excavations and backfilling in Rooms 5 and 7 took place June 11, 2009 to July 1st, 2009.

Each room utilized two vertical datum points: Room 5 began work utilizing Datum 5, and when the excavations became too deep for accurate measurements to be taken, measurements were taken from datum 7A. Datum 5 was located just outside the northeast corner of Room 5, and Datum 7A was located just outside the northeast corner of Room 7. Datum 7A is 110 cm below datum 5A. Room 7 began work utilizing datum 7A, and then shifted to 7B. Datum 7B is approximately 103 cm below 7A and was located immediately north of the southwest quadrant within Room 7 (Table 1).

Table 1. Datum spatial relationships.

Datum	Relationship
Datum 5	
Datum 7A	110 cm below 5
Datum 7B	103 cm below 7A; 213 cm below 5A

Room excavations were documented using forms and systems developed by Crow Canyon Archaeological Center (2001). Crow Canyon uses a Provenience Designation system in which every unit of space that is investigated in a site is assigned a sequential number or Point Designation (PD) number. Noteworthy artifacts are assigned a Point Location (PL) number (Crow Canyon Archaeological Center 2001). Horizontal control was provided by quadrants defined relative to room walls (mapped by the Historic American Building Survey; LaRocque 1989). Each provenience designation and PL artifact will be discussed in more detail in the Results portion of this report.

One floor surface was identified in Room 5 at approximately 250 cm below datum 5 and 140 cm below datum 7A (Figure 9). In Room 5, burned roof materials occurred in lenses. These lenses were thick, possibly Aeolian strata. Room 5 was nearly devoid of artifacts above the floor surface, with the exception of a grizzly bear jaw. Subfloor excavations in this room yielded a significantly higher density of artifacts than work above the floor. A large lithic biface, animal bone, and a small amount of pottery were recovered from subfloor contexts. There were two features in the bedrock beneath the southwest quadrant of Room 5: a hearth hollowed out of the bedrock; and an unburned basin.

Two floors were identified in Room 7, the uppermost at approximately 300 cm below datum 7A, or 197 below datum 7B (Figures 22 and 27). The lower floor surface in Room 7 was approximately 3 cm below the upper floor surface. The ceiling of the room appears to have been heavily burned before collapsing directly onto the uppermost floor surface. Approximately 150 ears of burned corn, several potentially reconstructible partial pots, an elk antler, and a complete pot built into the floor were recovered. A considerable amount of faunal material was recovered from subfloor deposits. The southwest quadrant of Room 7 was excavated to bedrock, and unlike Room 5, the bedrock below the room was featureless.

The bedrock beneath both rooms was about 15-20 cm below the floor surfaces. The exact depth of fill between floor and bedrock is variable due to the natural slope of the surface of Chimney Rock Mesa. Wood samples for dendrochronological dating were recovered from both rooms. Deposits in each room are discussed in detail in the *Results* section of this report.

The great house is oriented northeast by southwest, but Eddy (1977:34) used a nominal directional designation. In order to maintain consistency with previous work, we chose to adopt Eddy’s nominal directions, designating the walls with doorways in Rooms 5 and 7 as south, and the walls opposite these doors as north. This convention is reflected in Figures 1 and 2. Arrows in photos designate nominal north.

One quarter inch screen was used for screening fill. The entire first quadrant in each room removed for fill reduction purposes was screened. Not all fill removed from rooms was screened based upon observations gained from excavating the first quadrant of each room. Decisions regarding screening were made on a case by case basis determined by previous experience and close attention to fill being removed. Screening practices for specific proveniences will be discussed in the upcoming pages.

Students from the School of Mines also completed geophysical investigations on the western half of the pueblo in an effort to verify the presence of walls initially mapped by J.A. Jeancon in the early 20th century, but no longer visible. The results of this work were positive, and it is likely that walls exist in the locations where Jeancon (1922) initially mapped them. This work is described in Appendix I.

Lab Methods

Materials recovered from Chimney Rock Great House were analyzed by the most appropriate individual or institution for each artifact category. The following paragraphs describe the analysts and their respective laboratories or institutions.

Chipped stone material was analyzed by Jakob Sedig from the University of Colorado (Appendix A).

Groundstone artifacts were identified and analyzed by Brenda Todd from the University of Colorado (Appendix B).

Faunal material was analyzed by Brigit Burbank under the supervision of Dr. Robert Muir from the Department of Archaeology at Simon Fraser University in British Columbia, Canada (Appendix C).

Corn sourcing studies were completed by Dr. Larry Benson of the United States Geological Survey (USGS) with the assistance of University of Colorado Graduate Student, Kellam Throgmorton (Appendix D).

Archaeobotanical materials, included charred plants and corn, were analyzed by Dr. Karen Adams. Dr. Adams is an archaeobotanist and research consultant of Crow Canyon Archaeological Center (Appendix E).

Wood samples for tree ring dating were processed by the Laboratory of Tree Ring Research in Tucson, AZ. This laboratory is the primary dendrochronology source in the United States (Appendix F).

Four samples for radiocarbon dating were processed. Two samples from Room 7 were processed by the Keck Carbon Cycle AMS Facility, Earth System Science Department, University of California, Irvine. , and two samples from Room 5 were processed by BetaAnalytic (Appendix G).

Ceramics were analyzed by C. Dean Wilson, Director of the Pottery Analysis Laboratory at the New Mexico Office of Archaeological Studies (Appendix H).

Geophysical investigations were completed by advanced students at the Colorado School of Mines (Appendix I).

For specific laboratory methods, see artifact analysis appendices.

Storage of Materials

As defined in the ARPA Permit and CU/CRIA contract, all materials and photographs recovered and produced during this excavation will be curated at the Anasazi Heritage Center operated by the Bureau of Land Management near Dolores, CO.

Results

The University of Colorado completed fill reduction and limited testing in rooms 5 and 7. Four excavation units were placed in each room (Figure 2). The following pages will summarize the methods and results of these units.

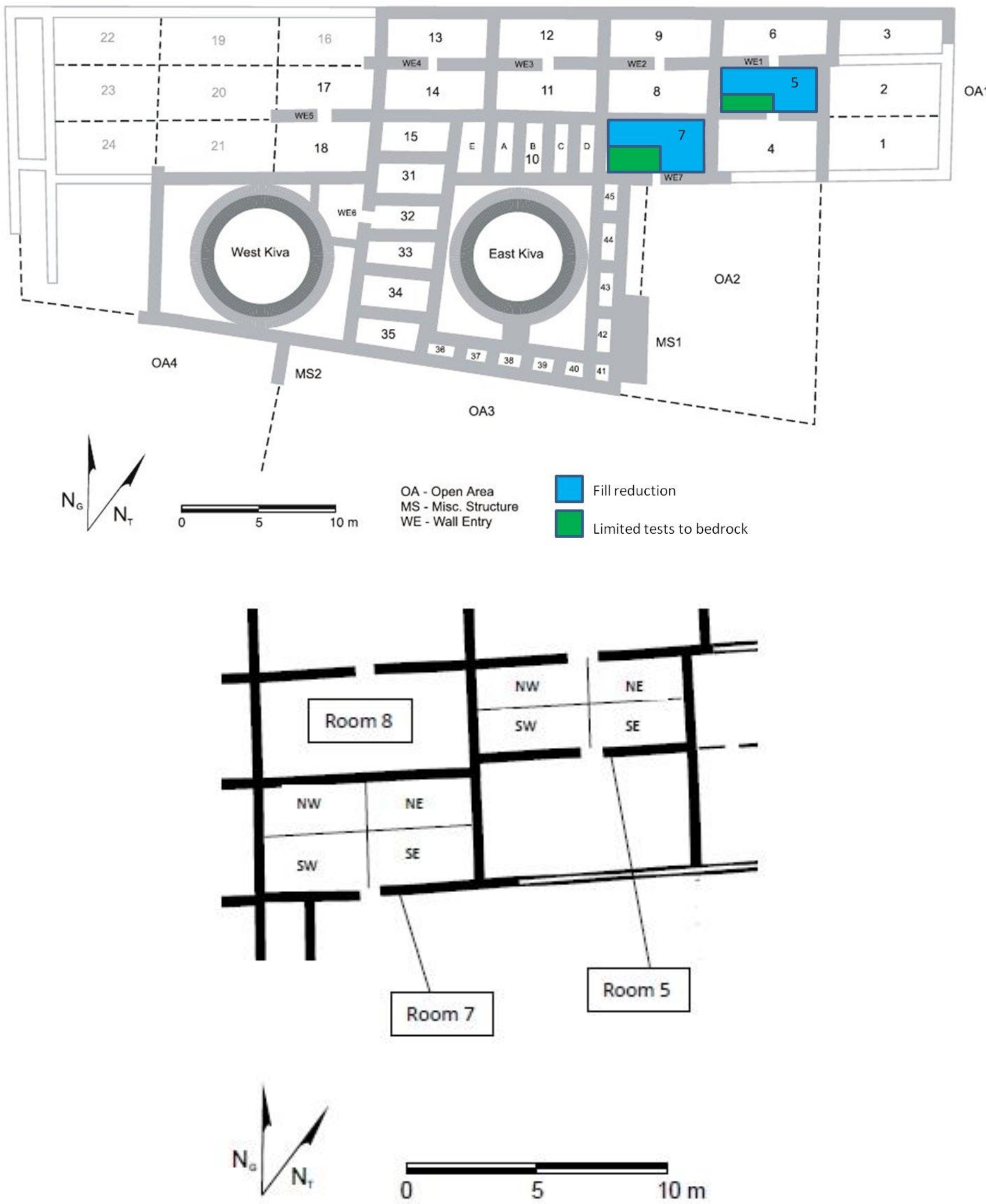


Figure 2. Location of excavations (top) and detail of location of excavations (bottom). Top map adapted from in progress base map derived from Frank Eddy's 1972 map as annotated by Steve Lekson 2009. Drafted by Jason Chuipka, Woods Canyon Archaeological Consultants, Inc. *Chimney Rock Interpretive Association's Preservation and Reconstruction Project (#2009-01-039).* Bottom map adapted by Brenda K. Todd from map digitized and drafted by Jason Chuipka, from Eddy 1977:Figure 12 and maps of pueblo revised by Woods Canyon Archaeological Consultants, Inc.

Room 5 Fill Level Reduction

The goal of fill reduction activities in Room 5 was to reduce fill in the room to within one meter of the fill in the rooms immediately adjacent to the room. We determined that a minimum of 50 cm of fill needed to be removed to accomplish this goal.

Northeast Quadrant

Work in room 5 commenced in the northeast quadrant of the room. The modern ground surface exhibited no signs of disturbance, and further excavations did not reveal any indications of previous excavation. Fill was removed in four arbitrary, approximately 20 cm levels: Stratum 1, Levels 1, 2, 3, and 4 (Table 2 and Figure 4). The fill was dark yellowish brown silty loamy sand. The fill in this room sloped with the northeast corner being approximately 90 cm higher in elevation than the northwest corner. This resulted in the removal of uneven or partial levels, especially in those closest to the modern ground surface. Fill in the NE quadrant was reduced to 118 cm b.d. 5. The fill removed is interpreted as naturally deposited post-occupational fill. Small inclusions of burned rock, burned adobe, and charred vegetal material were found throughout levels 1-4. In the last excavated level in this quadrant, 98-118 cm b.d. 5, rock inclusions became larger and were likely wall-fall. All fill from this quadrant was screened. Very few artifacts were recovered, with the exception of one sherd, one faunal bone, and one flake of chipped stone.

Table 2. Room 5 Northeast Quadrant Strata and Levels. Depths provided are for corners of quadrant.

Stratum/Level	Description	Depth Below Datum 5 (cm)
Modern Ground Surface	Aeolian/Natural	NE 38; SE 44; SW 84; NW 129
Stratum 1 Level 1	Aeolian/Natural/Wall Fall	NE 58; SE68; SW 84; NW 129
Stratum 1 Level 2	Aeolian/Natural/Wall Fall	NE 78; SE 78; SW 84; NW 129
Stratum 1 Level 3	Aeolian/Natural/Wall Fall	NE 98; SE 98; SW 102; NW 129
Stratum 1 Level 4	Aeolian/Natural/Wall Fall	NE 118; SE 118; SW 118: NW 129

Northwest Quadrant

After finishing fill reduction activities in the northeast quadrant, attention was shifted to the northwest quadrant in order to provide a continuous profile across the axis of the room. Approximately 60 cm was removed from the northwest quadrant of room 5 to take the level of the fill to 118 cm b.d. 5. This 60 cm was taken out as one level due to the fact that the previously excavated northeast and southwest quadrants were nearly devoid of artifacts (Table 3 and Figure 4). Every third wheelbarrow was screened. The soil in this level consisted of yellowish/reddish silty sandy loam with a high concentration of eroded and cobble sandstone rocks with some mottling of burned adobe and calcium carbonate. No artifacts were recovered. Less consolidated soil nearest the north wall may be indicative of trenching activity, likely a result of stabilization efforts at some point in the past. This level is interpreted as a mixture of natural fill with the uppermost levels of wall fall.

Table 3. Room 5 Northwest Quadrant Strata and Levels. Depths provided for corners of quadrant.

Stratum/Level	Description	Depth Below Datum 5 (cm)
Modern Ground Surface	Aeolian/Natural	NE 132; SE 86; SW 96; NW 84
Stratum 1 Level 1	Aeolian/Natural/Wall Fall	NE 118; SE 118; SW 118; NW 118

Southwest Quadrant

The modern ground surface of the southwest quadrant was much lower than the northeast corner of the northeast quadrant. Therefore, only one 20 cm level was removed to bring the fill to 118 cm b.d. 5, the level required for fill reduction needs (Table 5 and Figures 6,7, and 13). Every third wheelbarrow of this level was screened. The fill from this level was about a 50/50 mix of rock debris and sediments. The fill was dark yellowish brown silty loamy sand. One course of the south wall of the room was uncovered in the excavation of this stratum and a doorway was discovered in the south wall of the room. A small soil change along the western wall indicated a narrow, shallow trench, approximately 25 cm wide was dug next to the wall for repair and stabilization work at some point in the past, and later refilled (Figure 3). Like the uppermost 60 cm of the northeast and northwest quadrants, this level was composed of wall fall and soil from post-occupational natural processes.

Figure 3. View from above of possible stabilization related trench along the west wall of the southwest quadrant of Room 5. Note slight soil color change along wall in upper 1/3 of photo.

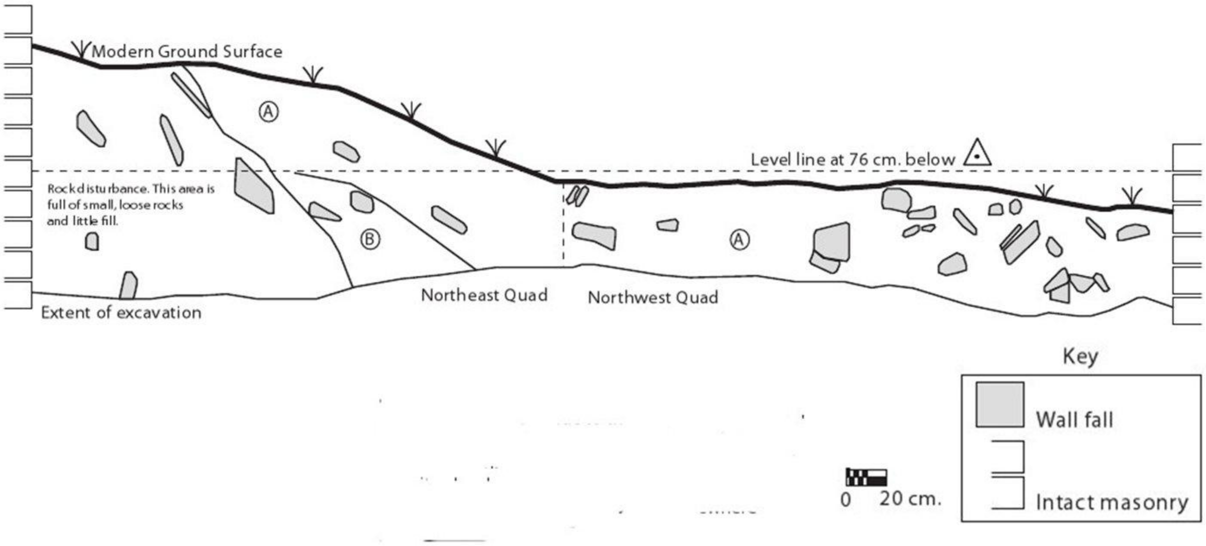


Figure 4. Room 5, composite profile of Northeast and Northwest Quadrants, facing south.

Southeast Quadrant

The fill in the southeast quadrant was removed in a single stratum to bring the fill level to 118 cm b.d. 5 and level with the other three quadrants (Table 4). The topmost portion of the stratum consisted of yellowish sandy loam, partially disturbed by rodents and roots. Nearest the north/south wall on the east side of the quadrant, the soil was less compacted, and filled with sandstone spalls, large rock, and small, eroded sandstone rock. This appeared to be a dump for detritus from 1970s stabilization or Room 8 excavations. This detritus decreased near the bottom of the stratum and appeared to be intact deposits once again. A series of large worked and faced stones were fallen inward atop one another in a line along the eastern 1/3 of the room (Figure 5). These stones were not a wall and were likely an episode of collapse. The middle of the unit had a lens of burned material that appeared to represent a post-abandonment ephemeral episode. This burn episode was atop intact deposits of yellowish sandy loam mottled with calcium carbonate. This level is interpreted as mixed fill, post abandonment natural deposits with an intrusive pit along the east ½ of the quadrant, a natural burned lens, and intact natural deposits along the west wall.

Figure 5. Room 5, Southeast Quadrant, series of large, worked stones fallen in to the room visible behind mug board and underneath meter stick.

Table 4. Room 5 Southeast Quadrant Strata and Levels. Depths provided for corners of quadrant.

Stratum/Level	Description	Depth Below Datum 5 (cm)
Modern Ground Surface	Aeolian/Natural	NE 50; SE 57; SW 104; NW 89
Stratum 1 Level 1	Aeolian/Natural/Wall Fall	NE 117; SE 118; SW 122; NW 118

Room 5 Test Excavations

Limited testing in the southwest quadrant of Room 5 was carried out after the completion of fill level reduction activities. This quadrant was chosen in part to further define the door and south wall of the room. Five strata, three features, and two surfaces were defined in this quadrant (Figures 7, 9, 10, 11, 12 and Table 5). Point located artifacts from Room 5 are reported at the end of strata and excavation discussions because they were recorded on a single map for all proveniences.

Figure 6. Room 5, Southwest Quadrant modern ground surface.

Figure 7. Room 5, Southwest Quadrant. End of fill level reduction and beginning of limited test excavations.

Table 5. Southwest Quadrant Strata and Levels. Depths provided for corners where relevant. Measurements were taken from Datum 7A beginning in Stratum 1, Level 2.

Stratum/Level	Description	Depth Below Datum 5/Datum 7A
Modern Ground Surface	Aeolian	NE 85; SE 107; SW 98; NW 90 (5)
Stratum 1 Level 1	Aeolian/Wall Fall	118 (5)
Stratum 1 Level 2	Aeolian/Wall Fall	178 (5) /68 (7A)
Stratum 2 Level 1	Aeolian/Wall Fall/Roof Fall	88 (7A)
Stratum 2 Level 2	Aeolian/Wall Fall/Roof Fall	108 (7A)
Stratum 3 Level 1	Aeolian/Wall Fall/Roof Fall	128 (7A)
Stratum 3 Level 2	Aeolian/Wall Fall/Roof Fall	138 (7A)
Surface 1	Thick adobe floor surface	148 (7A)
Stratum 4	Subfloor fill, caps bedrock	176 (7A), split by Stratum 5
Stratum 5 Level 1	Aeolian laminate	148 – 157 (7A); cuts stratum 4
Feature 1 (Full Cut)	Fire Pit in Bedrock	155 (top) – 164 (bottom) (7A)
Surface 2	Bedrock	Slopes from 176 (E) to 148 (W)
Feature 2 (Full Cut)	Pit in Bedrock	157 (top) – 176 (bottom) (7A)
Feature 3 (Doorway)	In south wall of room	88 (sill) (7A)

Excavation below that required for fill reduction commenced with Stratum 1 Level 2. This level is approximately 60 cm between 118 cm and 178 cm b.d. 5. In this level, excavators began to take elevations from datum 7A, which is 110 cm b.d. 5. Every third wheelbarrow of fill was screened. This level consisted of silty sandy loam with heavy concentrations of rock, and mottling from adobe, charred vegetal material, and caliche. The soil was relatively unconsolidated with large voids under rocks. Artifact density was negligible and rocks ranged from sandstone spalls to large shaped and pecked stones over 25 cm in length. The doorway in the south wall of the quadrant was further defined and the fill immediately in front of the door had higher concentrations of clay, adobe, and mottling. A series of large, rectangular stones was found immediately in front of the door (Figure 8). These stones are mostly angled downward and toward the center of the room. Stratum 1 Level 2 was interpreted as wall fall that is perhaps mixed with the upper levels of roof fall. Measurements of door sills in this room and the two adjacent rooms indicate that Room 5 floor and door levels were approximately 1 meter higher than adjacent rooms to the west. Near the end of this level, excavators began to encounter higher frequencies of burned material and wood. This change warranted the designation of a new stratum.

Figure 8. Room 5 Southwest Quadrant, end of Stratum 1 Level 2. Large rocks (wall fall) visible immediately inside door in upper left of photo.

Stratum 2 Level 1 in the southwest quadrant of room 5 is a 20 cm level, 68-88 cm b.d. 7A. This stratum consisted of significantly more distinguishable reddish soil with heavy mottling from charred vegetal material, caliche, and adobe. Pockets of adobe, both burned and unburned, were present. Artifact density remained sparse. Wood in this level was rotted, friable, partially burned outside shells of wooden beams. A two-handed mano fragment, faunal bone, beam-impressed adobe, and charred material from unsalvageable beams were recovered. This level sloped from west down to east (the interior of the room). Heavy concentrations of masonry rocks, both worked and un-worked and up to 30 cm in length were present. This level is interpreted as a mixture of wall fall and roof fall.

Stratum 2 Level 2 of the southwest quadrant of Room 5 was a 20 cm level between 88 and 108 cm below datum 7A. This level consisted of pockets of heavily mottled sandy loam, silty clay, and clayey loam. Masonry rubble was present, but size and density decreased. Artifacts recovered include a mano, faunal bone, 1 sherd, 1 Narbona Pass chert flake, and basalt and possibly Brushy Basin Chert heat treated chipped stone. This stratum was a continuation of a mixed wall fall/roof fall layer where wall collapse was mixed with the final stages of roof fall.

There were pockets of caliche, burned and unburned adobe, and burned vegetal material.   There were laminations from wind and water, likely from the period after the roof had collapsed but prior to the collapse of the wall. These laminations were cut by rock collapse, but were present throughout the eastern portion of the unit. Excavators noted that the southern wall of the room had been burned. The rock in the wall was reddened, but otherwise appeared to be in good condition. The amount of rock/wall fall decreased and the amount of unsalvageable dendrochronology samples increased. The highly fragmentary beams appear to be oriented from the northeast to the southwest. Due to these changes, the next level excavated was designated as a different stratum.

Stratum 3 Level 1 was a 20 cm level 108-128 cm b.d. 7A. This level is the 20 cm immediately above the 10 cm on the floor. This level consisted of heavily mottled mixture of hard packed silty sandy soil with abundant chunks of burned and partially burned wood beams, charred vegetal material, ash, burned and unburned adobe, and caliche. Artifact density remained low with some black on white and corrugated pottery, faunal remains (including a grizzly bear mandible), impressed adobe, wood samples for dendrochronological dating, chipped stone, and groundstone. Nineteen wood samples for dendrochronological dating, a flat shaped slab, and the grizzly bear jaw were point located in this level (Table 6 and Figure 14). Rock density decreased markedly. Stratum 3 was nearly devoid of sandstone. Plaster was present on both the east/west and north/south walls. Preservation of the plaster was best on the east/west wall in the center between the corner and the doorway. Plaster continued below Stratum 3 Level 1. There was an area of compaction present under the door composed of an undulating gray area marked by with rootlets; this compacted area was approximately 40 x 30 cm in size and extended downward to the floor. Much of the roof fall sits immediately atop or just above the floor.

Stratum 3, Level 2 was a nominal 10 cm level between about 128 and 138 cm b.d. 7A. This was the primary fill immediately atop an apparent use surface (Surface 1).   Stratum 3 Level 2 was a continuation of Stratum 3 Level 1 and consisted of clayey sandy loam with significant concentrations of burned wood, adobe, burned adobe and ash. One pot sherd and 5 wood samples for dendrochronological dating were point located (Table 7, Figure 14). These wood samples were just above the floor. This layer appeared to be secondary roof fall deposits mixed with Aeolian deposits. There were very few rocks in the fill. Stratum 3, levels 1 and 2 suggest that the room was filled in multiple episodes with several occurrences of burned material sitting directly on the floor.

Surface 1 (Figure 9) was an approximately 10 cm level between 138 and 148 cm b.d. 7A. Initially, this surface was characterized by yellowish compacted sand that “pops off” and did not appear to be prepared with any sort of plaster or adobe cap. Some burned material, including wood and sandstone spalls, was compacted into the surface. Further excavation revealed the surface to be a roughly 10 cm thick prepared layer that detaches immediately above a heavily mottled layer (Stratum 4 Level 1). This surface was approximately 59 cm below the sill of the door in the south wall of the room, and 138 cm below datum 7A. Immediately under the doorway was a hump of compacted gray soil, first observed in Stratum 3 Level 1, that appeared to be directly on the yellow use surface, but also appeared to have been a use surface itself. A single sherd was associated with the floor.

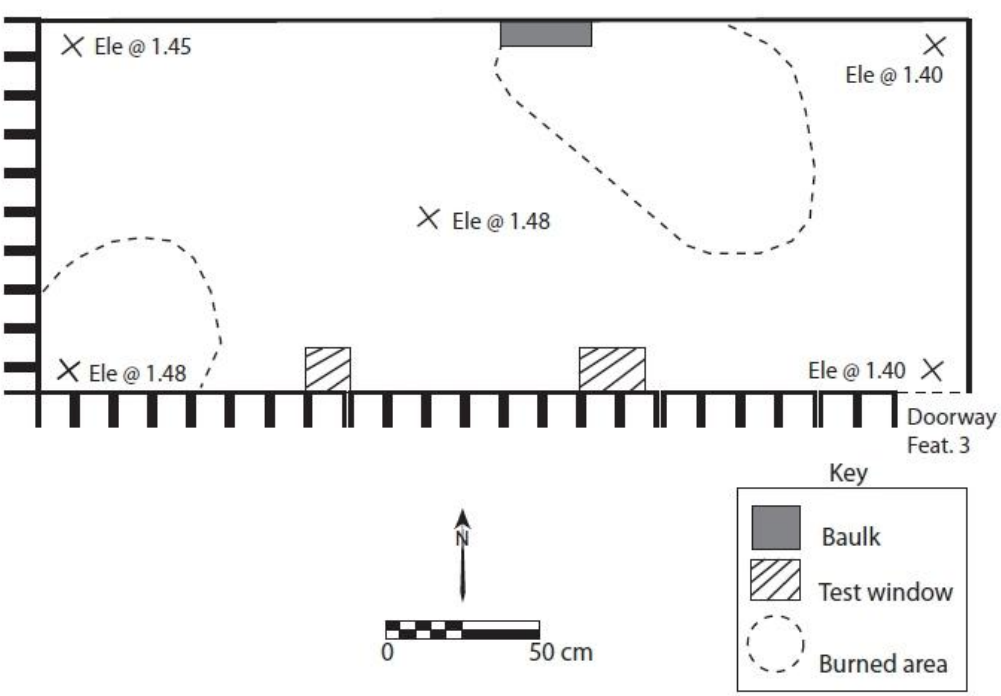


Figure 9. Room 5, Southwest Quadrant Surface 1 plan view.

Stratum 4 began as a 50 x 50 cm test unit that cut into Surface 1 1.5 cm east of the southwest corner of the quadrant. Stratum 4 was split by Stratum 5, a lens between two layers of Stratum 4, in the western portion of the unit. Stratum 4 was between 140 and 176 cm below datum 7A and included the cultural fill immediately below Surface 1 and immediately above bedrock and modified bedrock (Surface 2, Feature 1, and Feature 2). This stratum included the material that capped the two features in the bedrock. This stratum consisted of yellowish red mottled clayey sandy loam. There were relatively few rock inclusions, excepting eroded or exfoliating bedrock, and the sediment was heavily mottled with charred vegetal material, ash and caliche. Artifact density was moderate, though much greater than encountered in levels above surface 1. Artifacts included animal bone, pottery, a hammerstone, a biface, and a projectile point. The stone biface was point located to this provenience (Table 8 and Figure 14). Stratum 4 was a layer of culturally deposited material that was a mixture of defacto fill from nearby occupation activities as well as natural deposits that accumulated against the N/S wall in the western portion of the unit. It leveled the floor (surface 1) above bedrock, which sloped from east to west.

Stratum 5 was an approximately 10 cm thick layer of yellow silty clayey sand that sat on top of heavily mottled loamy, sandy clay that is on top of bedrock. This stratum ended between 149 and 156 cm below datum 7A and constituted a lens between two layers of Stratum 4 in the western portion of the unit. Stratum 5 was a distinct, looser, yellow layer that was 10 cm thick against the north/south wall in the west end of the unit and pinched off as it moved towards the east. It extended approximately 80-85 cm from the north/south wall towards the east where it was subsumed by Stratum 4. There were some artifacts including faunal bone, undecorated pottery and chipped stone. Rock inclusions were comprised of eroded sandstone bedrock fragments. Stratum 5 was clearly visible in the north profile wall and sat in between a section of Stratum 4. While there was some cultural fill in this stratum, it appeared that this layer was either a wind or water natural laminate that rested against the north/south wall.

Surface 2, the bedrock underlying room 5, slopes upward approximately 25 cm from west to east and is 148 cm b.d. 7A in the eastern portion of the unit and 174 cm b.d. 7A in the western portion of the room (Figures 10 and 11). The bedrock is eroded sandstone, and the uppermost layers are spalling off. This bedrock appeared to have been an extramural space prior to the construction of room 5. Two features are present in the bedrock. Feature 1 was a hearth excavated out of the bedrock, and Feature 2 was a pit cleared into the eroding bedrock. One ceramic sherd was point located to this provenience (Table 10 and Figure 14).

Feature 1, a shallow, round, basin-shaped hearth, was cut into the bedrock underlying room 5 (Figures 10 and 11). The fire pit is 58 x 50 x 10 cm in size and was excavated as a unit. The bedrock and surrounding soil were thermally altered. Ash from the final use of this feature was left in situ. No large chunks of charred vegetal material or unburned wood were present.

Feature 2 is a round, flat-bottomed pit 58 x 40 x 27 cm in size, cut into the bedrock underlying Room 5 (Figures 10 and 11). This pit was partially capped by sandstone spalls but was defined by loose sediments. The pit was constructed by removing eroded sandstone from the bedrock and is an inverted truncated cone in shape. One flake and a number of charred vegetal samples were recovered from this pit. Feature 2 may have been an extramural pecked rock basin. The function of this pit is unclear, but similar pits in the Chimney Rock Archaeological Area may have been used as astronomical markers.

Figure 10. Room 5, Southwest Quadrant. View of bedrock beneath Room 5. Feature 1 (hearth) is visible to the left of the meter stick and Feature 2 (pit) is visible to the right.

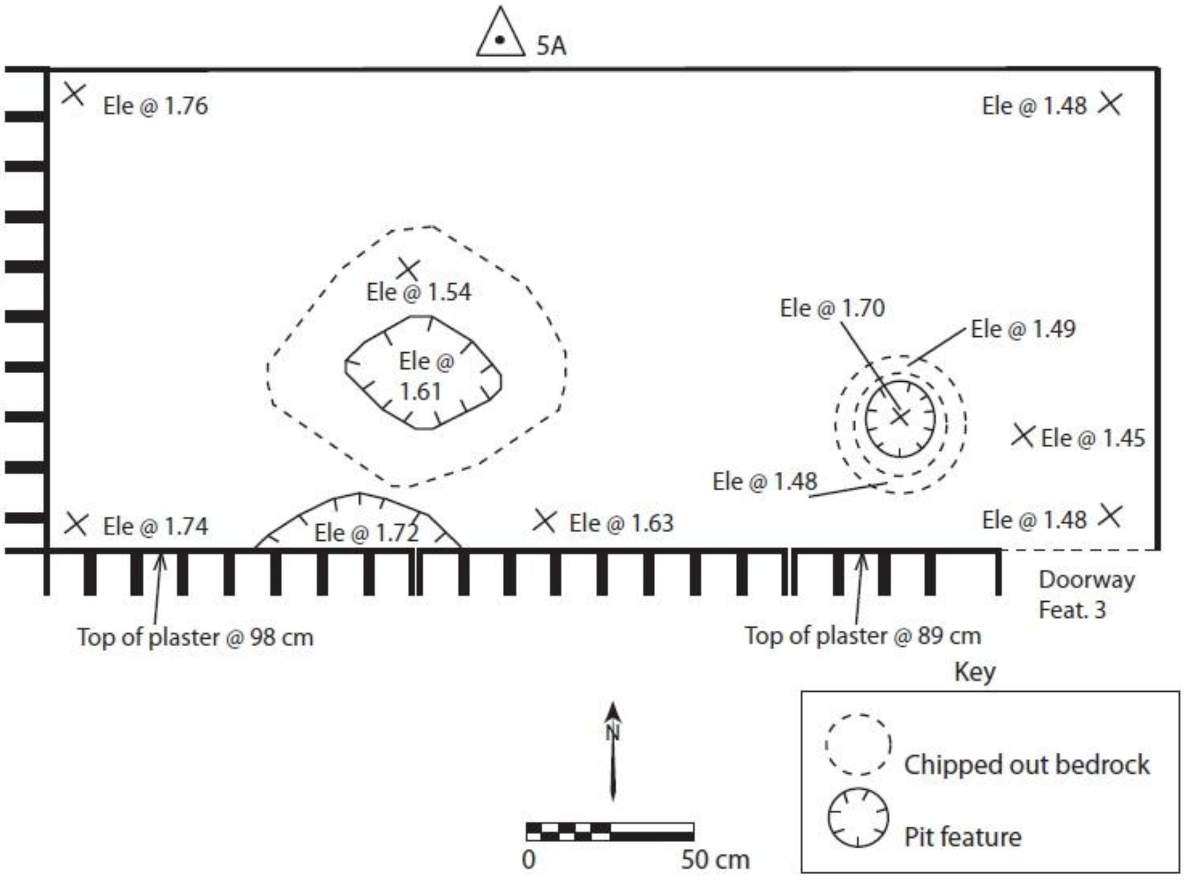


Figure 11. Room 5, Southwest Quadrant. Surface 2 final plan view.

A doorway, feature 3, was documented in the south wall of Room 5 (Figure 12). The door is 60 cm wide x 63 cm high and is about 63 cm in width (width of the wall). This feature was exposed during the normal course of excavation of the southwest quadrant of Room 5. The door appears to have been constructed as an original component of the east west running south wall of the room. It is delineated by shaped, pecked masonry, is rectangular in shape, and sits atop a long, thin slab sill. The sill is approximately 60 cm above Surface 1. The upper portion of the doorway has collapsed along with the east-west running south wall. The main pathway through the site runs immediately south of the door and wall and may have contributed to the deterioration of this feature.

Figure 12. Room 5, Feature 3. Doorway in south wall.

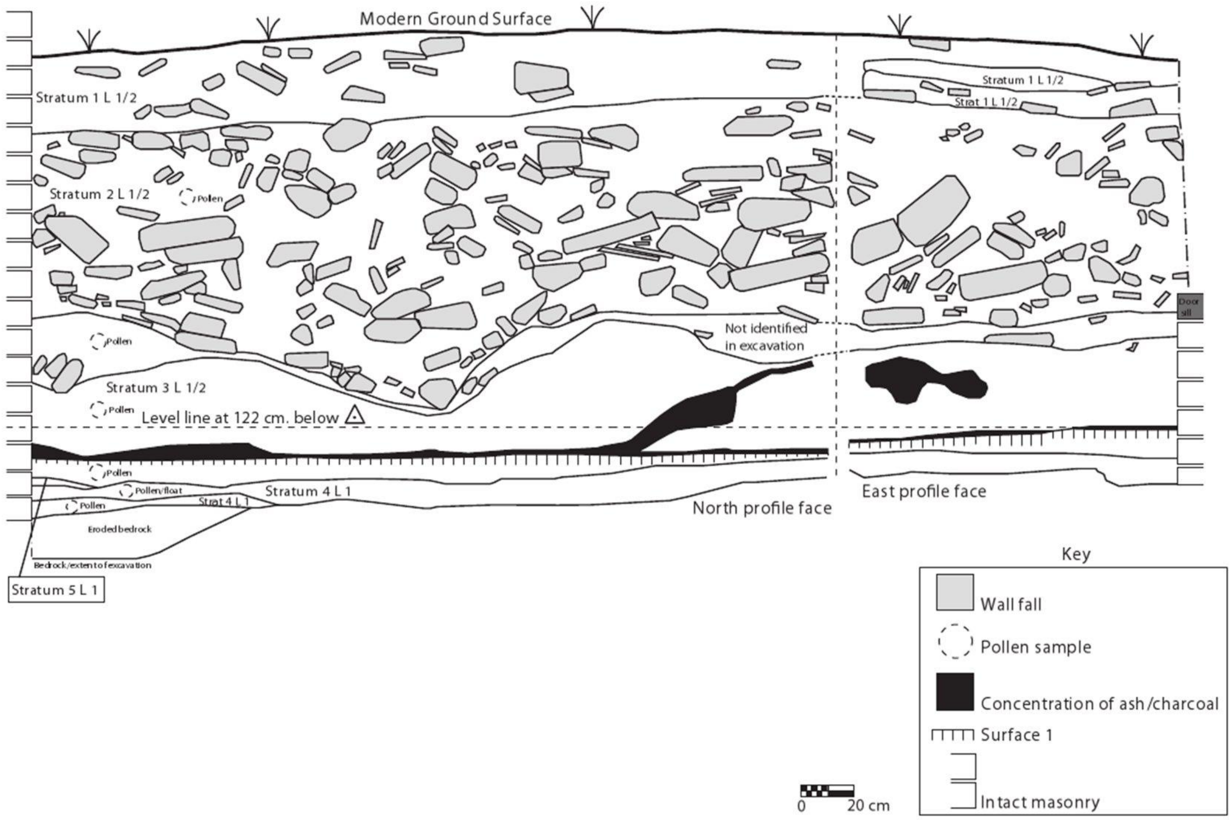


Figure 13. Room 5, composite profile of north and east faces of the Southwest Quadrant.

Room 5 Point Located Artifacts

A total of thirty artifacts were point located in the southwest quadrant of room 5. The tables and map that follows describe these artifacts.

Table 6. Point Located (PL) Artifacts from Stratum 3 Level 1

PL Number	Artifact Class	Elevation b.d. 7A
1	Dendro Sample	110
2	Dendro Sample	112
3	Dendro Sample	114
4	Dendro Sample	107
5	Dendro Sample	107
6	Dendro Sample	107
7	Dendro Sample	108
8	Dendro Sample	114
9	Dendro Sample	109

10	Dendro Sample	114
11	Dendro Sample	115
12	Dendro Sample	115
13	Dendro Sample	112
14	Dendro Sample	118
15	Dendro Sample	126
16	Flat, shaped slab	118
17	Dendro Sample	121
18	Faunal Bone (jaw)	128
19	Dendro Sample	131
20	Dendro Sample	127
21	Dendro Sample	127

Table 7. Point Located (PL) Artifacts from Stratum 3 Level 2.

PL Number	Artifact Class	Elevation b.d. 7A
22	Dendro Sample	135
23	Dendro Sample	130
24	Ceramic	134
25	Dendro Sample	134
26	Dendro Sample	134
27	Dendro Sample	133

Table 8. Point Located (PL) Artifacts from Stratum 4 Level 1.

PL Number	Artifact Class	Elevation b.d. 7A
28	Lithic (Biface/Knife)	161

Table 9. Point Located (PL) Artifacts from Stratum 5 Level 1.

PL Number	Artifact Class	Elevation b.d. 7A
29	Flotation	151

Table 10. Point Located (PL) Artifacts from Surface 2.

PL Number	Artifact Class	Elevation b.d. 7A
30	Ceramic	152

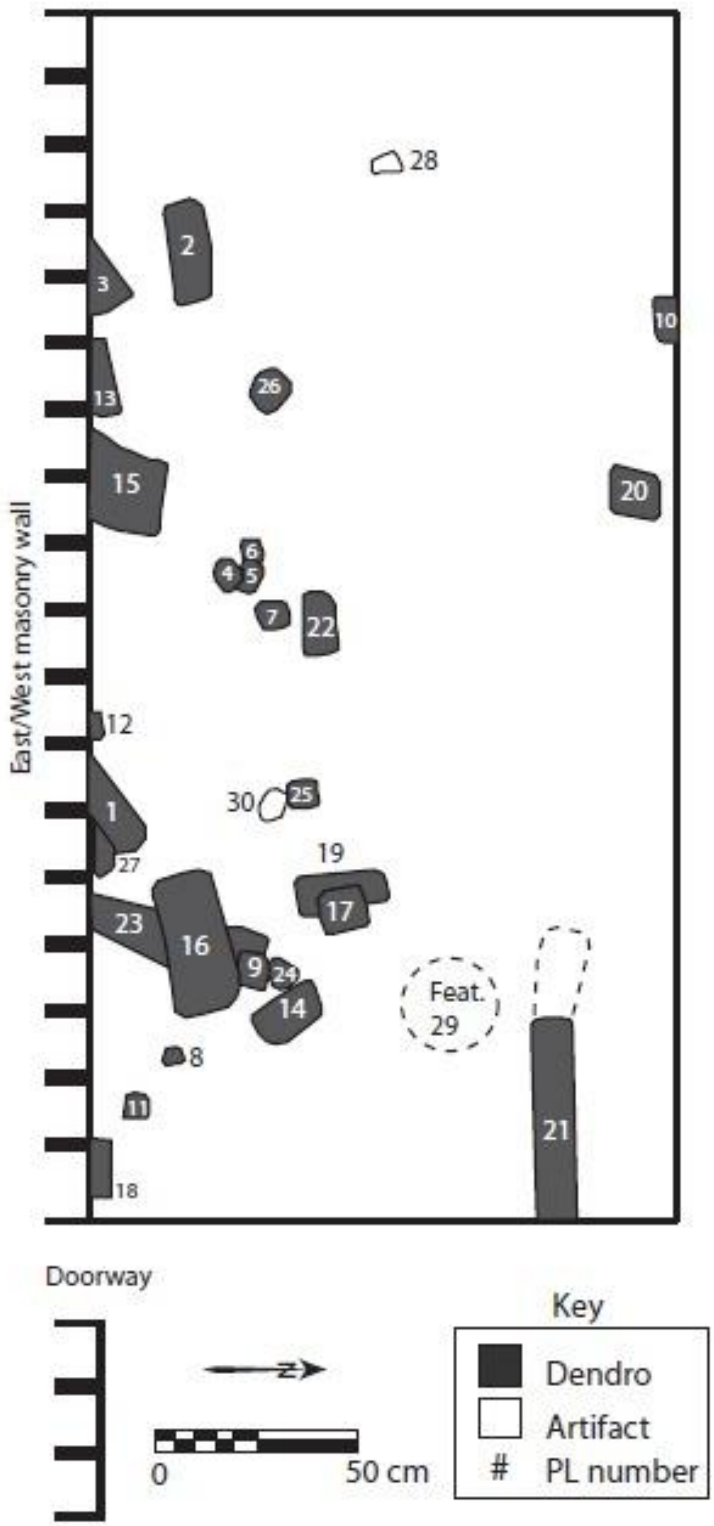


Figure 14. Room 5, Southwest Quadrant point located artifacts.

Room 7 Fill Level Reduction

Northwest Quadrant

Fill level reduction activities in Room 7 commenced in the northwest quadrant. The goal of this fill reduction was to reduce fill by approximately 60 cm to 120 cm below datum 7A. The modern ground surface was sparsely vegetated with cheat grass and the soil was compacted rocky loam. The modern visitor trail ran directly through this quadrant (Figure 15). The elevations of the corners and center of the modern ground were relatively level, unlike in Room 5. The modern ground surface is interpreted as modern and post-occupation mixed fill. The uppermost 60 cm of fill were removed in one Stratum comprised of three 20 cm levels (Table 11 and Figure 17). All excavated fill was screened.

Figure 15. Room 7, modern ground surface looking west. Modern visitor trail ran from southwest to northeast corners of the room.

Stratum 1 Level 1 was the fill from the upper 20 cm of Room 7, bound by the north and west walls of the room and the quadrant unit. This level was 62-86 cm below datum 7A. The fill was a mix of relatively clean, brown silty loam and loam with burned jacal, flecks of charred vegetal material, and a few artifacts. Rocks were common throughout, but most were small (30 x 20 x 5 cm). Stratum 1 Level 2 was the second arbitrary 20 cm level in the uppermost fill of the room, between 80 and 100 cm below datum 7A. The fill was mostly a dark brown loam with moderate amounts of charred vegetal material and rock. Burned daub fragments were also common. A few sherds were the only artifacts recovered. Both Level 1 and Level 2 were comprised of post-occupation, and possibly modern, mixed fill. Charred vegetal material, rock and adobe fragments in these levels may be a result of Eddy's excavations in Room 8 directly north of room 7 in the 1970s.

Stratum 1 Level 3 was an arbitrary 20 cm level excavated to a depth of 120 cm b.d. 7A. Rocks were intact and 30 x 20 x 10 cm in size on average, or were fire-cracked and less than 10 cm across. The majority of the intact stones sloped towards the south. Earth stained by charred vegetal material was present in discrete locations. Each stain was approximately 8 cm in diameter. This charred material was likely indicative of some mixing with roof collapse material below or charred and burned beam remains retained in upper portions of wall segments. Stratum 1 Level 3 was interpreted as wall fall and was probably not mixed with any backdirt from previous excavations conducted by Eddy or Jeancon. One mano fragment was recovered.

Looser soil was present along the north wall of Room 7 and possibly along the west wall. This soil change is quite obvious in the east profile of the unit. Aerial photos from Eddy's excavations indicate that sometime after the excavations were completed, a stabilization crew trenched around the walls of room 7 and stabilized the masonry with cement. The disturbance was confined to a 50 cm wide strip approximately 40 cm deep along the north and west wall (Figures 16 and 17).

Figure 16. Room 7, detail of trench around west wall. Note slab of stone nearest wall (right) with a different orientation than other stones in room fill.

Table 11. Northwest Quadrant Strata and Levels. Depths given for corners of quadrant as relevant.

Stratum/Level	Description	Depth Below Datum 7A (cm)
Modern Ground Surface	Aeolian/Natural	NE 62; SE 67; SW 72; NW 70
Stratum 1 Level 1	Aeolian/Wall Fall (Eddy's backdirt?)	80
Stratum 1 Level 2	Aeolian/Wall Fall (Eddy's backdirt?)	100
Stratum 1 Level 3	Aeolian/Wall Fall (Eddy's backdirt?)	120

Southwest Quadrant

After reducing the fill by 60 cm in the northwest quadrant of room 7 (to a depth of 120 cm below datum 7A), excavations proceeded in the southwest quadrant. The modern ground surface had light vegetation and was a mix of post-occupational and modern fill. The visitor trail went through this quadrant from the southwest to the northeast and there was no evidence of previous excavation. The southwest quadrant was relatively level, with the fill slightly higher in only the southeast corner of the unit. Stratum 1 Level 1 extended from 70-120 cm below datum 7A. Since the northwest quadrant was nearly devoid of artifacts, the top 60 cm was removed in a single level to take this quadrant to the same level as the NW quadrant, which was excavated to

120 cm below datum 7A (For Complete Summary of Strata and Levels See Table 14). Every third wheelbarrow of fill was screened. The upper fill contained a circular modern/historic fire circle with oxidized soil and flecks of charred vegetal material. The soil in this level was a dark brown silty clay loam. Artifacts from this level included 2 corrugated sherds and some pieces of rodent bones. A considerable amount of sandstone wall fall was removed from this level. The sediment in this unit indicated that the south wall likely fell first, followed by the north wall. These layers were not separately designated, but were observed during excavation. This level was interpreted as post-occupational fill and wall fall.

Northeast Quadrant

The ground surface of the northeast quadrant was post-occupational fill likely associated with wall collapse, and modern fill associated with wall stabilization. The trail entered the room in the northeast corner of this quadrant. There was little vegetation on the surface and a few rocks poked through the loamy topsoil. The modern ground surface was relatively level, with the southwest corner being slightly higher than the other corners. Fill was reduced in one level due to the paucity of artifacts in previously excavated quadrants. Stratum 1 Level 1 was 60-70 cm taken as a full cut and every third wheelbarrow of fill was screened for artifacts to take the quadrant level to 120 cm b.d. 7A (Table 12 and Figure 17). The fill contained a single flake and was moderately compact sandy loam with frequent flecks of charred vegetal material, some small charred wood fragments, and a large amount of masonry rock. Some of the rock was thoroughly burned, but most was unburned. A trench, approximately the width of a shovel was found to continue eastward from the northwest quadrant of the room. This trench was probably excavated in the 1970s along the Room 7/8 wall to examine fill and/or masonry. The trench ended above 120 cm b.d. 7A.

Table 12. Northeast Quadrant depths below datum 7A. Depths for corners of quadrant provided as relevant.

Stratum/Level	Description	Depth Below Datum 7A (cm)
Modern Ground Surface	Aeolian/Natural	NE 45; SE 49; SW 67; NW 61
Stratum 1 Level 1	Aeolian/Wall Fall (Eddy's backdirt?)	120

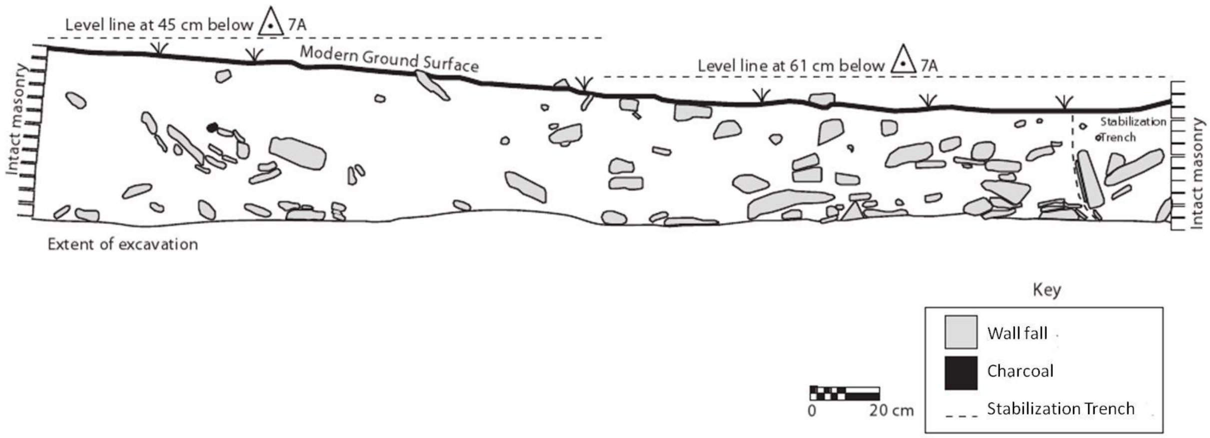


Figure 17. Room 7, composite profile of south face of Northeast and Northwest Quadrants.

Southeast Quadrant

There was sparse vegetation, mostly grasses, on the modern ground surface of the southeast quadrant of Room 7, and the soil was rocky loam. This was most likely post-occupational fill mixed with modern fill. There was no evidence of prior excavation. The elevation of the modern ground surface sloped upward in the southwest corner of this quadrant. Fill was removed in one cut due to the low artifact densities and little stratum differentiation in the previously excavated northwest quadrant of Room 7. Stratum 1 Level 1 was 60-70 cm of fill from the modern ground surface to 120 cm b.d. 7A (Table 13). Some charred vegetal material staining in the fill began to emerge in the south half of the quadrant. Wall fall was present throughout the unit. Concrete was present in the east wall of the unit to the base of this level, but there was little evidence of a trench

Table 13. Room 7, Southeast Quadrant strata and depth below datum 7A. Depths for corners of quadrant provided as relevant.

Stratum/Level	Description	Depth Below Datum 7A
Modern Ground Surface	Aeolian/Natural	NE 49; SE 66; SW 95; NW 65
Stratum 1 Level 1	Aeolian/Wall Fall (Eddy's backdirt?)	120

Room 7 Limited Testing

As in Room 5, the southwest quadrant of Room 7 was chosen for limited testing to bedrock with the goal of further defining the door in the south wall of the room. Excavations revealed six strata, four surfaces, and six features (Table 14).

Table 14. Room 7, Southwest Quadrant Strata and Levels. Depths for quadrant corners provided as relevant. Depth Measurements taken from Datum 7B starting in Stratum 1, Level 2.

Stratum/Level	Description	Depth Below Datum 7A/7B
Modern Ground Surface	Aeolian/Natural	NE 70; SE 94; SW 74; NW 72
Stratum 1 Level 1	Aeolian/Wall Fall (Eddy's backdirt?)	120 (7A)/16 (7B)
Stratum 1 Level 2	Aeolian/Wall Fall (Eddy's backdirt?)	78 (7B hereafter)
Stratum 1 Level 3	Aeolian/Wall Fall (Eddy's backdirt?)	112
Stratum 2 Level 1	Burned Roof Fall	132
Stratum 2 Level 2	Burned Roof Fall	148
Stratum 2 Level 3	Burned Roof Fall	158
Surface 1	Floor Surface	158
Feature 1 (Full Cut of North ½)	Refuse Deposit	141 (top) – 155 (bottom)
Feature 1 (Stratum 1, South ½)	Refuse Deposit	141 (top – 145 (bottom)
Feature 1 (Stratum 2, South ½)	Refuse Deposit	145 (top) – 149 (bottom)
Feature 2 (Pot Set Into Floor)	Corrugated Vessel	158 (top) – 188 (bottom)
Stratum 3 Level 1	Yellow sand on top of Surface 2	160 – 163
Stratum 4 Level 1	Ashy cultural fill on top of Surface 2	162-165
Surface 2	Compacted, gray floor surface	160
Stratum 5	Cultural and construction fill	163
Surface 3	Unprepared surface	178
Feature 3	Doorway in South Wall	133 (sill)
Feature 4 Full cut of South ½	Hearth	160 (top) – 163 (bottom)
Feature 5 (Pot Rest)	Pot Rest	160 (top) – 163 (bottom)
Feature 6	Footer Trench	188 - 214
Stratum 6	Natural Sediments a top mesa	176
Surface 4	Bedrock	NE 177; SE 176; SW 214, NW 205

Test excavation of the southwest quadrant of Room 7 began with Stratum 1 Level 2 as Stratum 1 Level 1 was discussed in the *Fill Level Reduction,* above. Stratum 1 Level 2 was the first level in the southwest quadrant of Room 7 below the fill level reduction of approximately 50 cm of overburden. This was an arbitrary 60 cm level to a depth of 78 cm b.d. 7B. This large level was removed based on the dearth of artifacts encountered in previous levels of wall fall and in an effort to expeditiously remove wall fall and achieve our test excavation goals. Datum 7B is 103 cm b.d. 7A. Every third wheelbarrow was screened, despite previous experience indicating that few, if any, artifacts would be recovered in strata dominated by wall fall because we wanted to closely monitor fill to determine if the screening strategy needed to be changed. The fill was darkly stained with some charred vegetal fragments and contained abundant masonry rock. Most rocks were small to medium sized, about 20 x 20 x 5 cm, with a few large slabs. No artifacts were recovered. Stratum 1 Level 2 was interpreted as upper, post-occupational fill. Some evidence suggests that the fill along the west wall was disturbed, probably during stabilization in the 1970s.

Stratum 1 Level 3 was the second arbitrary level in the southwest quadrant of Room 7 below the 50-60 cm fill reduction and was also removed as a full cut. Every third wheelbarrow was screened because the fill was identical to that is Stratum 1 Level 2. This stratum was 76-128 cm below datum 7B. This level ended at the top of burned roof/wall fall. This fill was identical to that in Stratum 1 Level 2 as it was composed of stained silty loam and rock in nearly equal volumes. Flecks of charred vegetal material were common, as were small oxidized fragments of burned adobe and rock. A single black-on-white sherd was recovered. Stratum 1 Level 3 was the base of post-occupation fill in the SW ¼ of room 7. It was undisturbed and made up of material that filled the room soon after the roof burned and collapsed. Burned plaster was intact along the south wall at the bottom of this level.

Due to the increase in oxidation, burning, and frequency of roofing debris, a new stratum was designated. Stratum 2 Level 1 is the first level of burned wall fall and was an approximately 20 cm level between 112 – 132 cm b.d. 7B. Oxidation of the tan-brown fill suggests the burned roof collapsed while hot and the closing material differentially burned. No large beams were encountered in this level, only chunks of probable secondary timbers. Larger pieces protruded from the Stratum 2 Level 2. Three wood samples for dendrochronological dating were point located to this level (Table 15, Figure 20). The irregular surface of Stratum 2 was leveled to facilitate excavation of subsequent levels within this stratum. The fill consisted of mottled and mixed sediments and rubble. The sandy silt matrix contained moderate amounts of charred vegetal flecking and chunks. Patches of oxidation and staining were present. There were some small fragments of beam impressed adobe.

Level 2 of Stratum 2 was a 15 cm level extending 130-148 cm b.d. 7B and was the heart of the burned roof-fall material. This level was comprised of burned beams, closing material, adobe, and rock with only a few artifacts. However, there was a large concentration of burned macrobotanical materials in the southeastern portion of the unit (near the door). This deposit contained dozens of corn cobs, some of which retained their cob ends and husks, suggesting that they were shucked and tied together in a bundle (Figures 18, 19, and 21). The position of the corn suggests that it was in the roof of Room 7, possibly hanging from the ceiling beams. Also found in this deposit was a variety of narrow charred materials that are either parts of boughs or pieces of shrubs (e.g. mountain mahogany, serviceberry). Some charred elements also appear to be sagebrush. This debris may represent roof closing material, or alternatively, fuel used to ignite Room 7 at abandonment. Also found in this area was a large, naturally shed, elk antler fragment. Faunal bone and flaked stone were present in very low number (fewer than 5). Twenty-four wood samples for dendrochronological dating, 12 botanical samples, 2 ceramic sherds, 4 faunal bones, and 1 piece of groundstone were point-located to this provenience (Table 16, Figures 20 and 21).

The timbers from this dense level of burned roofing material ranged in length from 5 to 20 cm, and were generally parallel to the long axis of the room (east-west). While not particularly large, the larger elements appear to represent primary roof beams. Rather than very large beams such as those seen at other Great Houses, the roof of Room 7 was built of medium-sized timbers no larger than 20 cm in diameter. The secondary timbers appear to have been smaller (5-10 cm). The roof-fall was jumbled, and the orientation of all these beams is not entirely clear. No herring-bone pattern (like Jeancon 1922: Plate XVII) was found. Instead, the secondary beams (and some smaller dimension material) may have been more simply arranged to cover the primary timbers and support an earthen cap. No charred splints (like those in some Chacoan roofs) were found.

Stratum 2 of Level 2 in Room 7 ended at a depth of 147 cm below datum 7B in the SW quadrant of Room 7. This was an arbitrary break so that the 10 cm of fill above the floor surface could be excavated independently.

Figure 18. Close-up of burned corn and botanical material on floor of Room 7.

Figure 19. Corn husk knot from floor of Room 7.

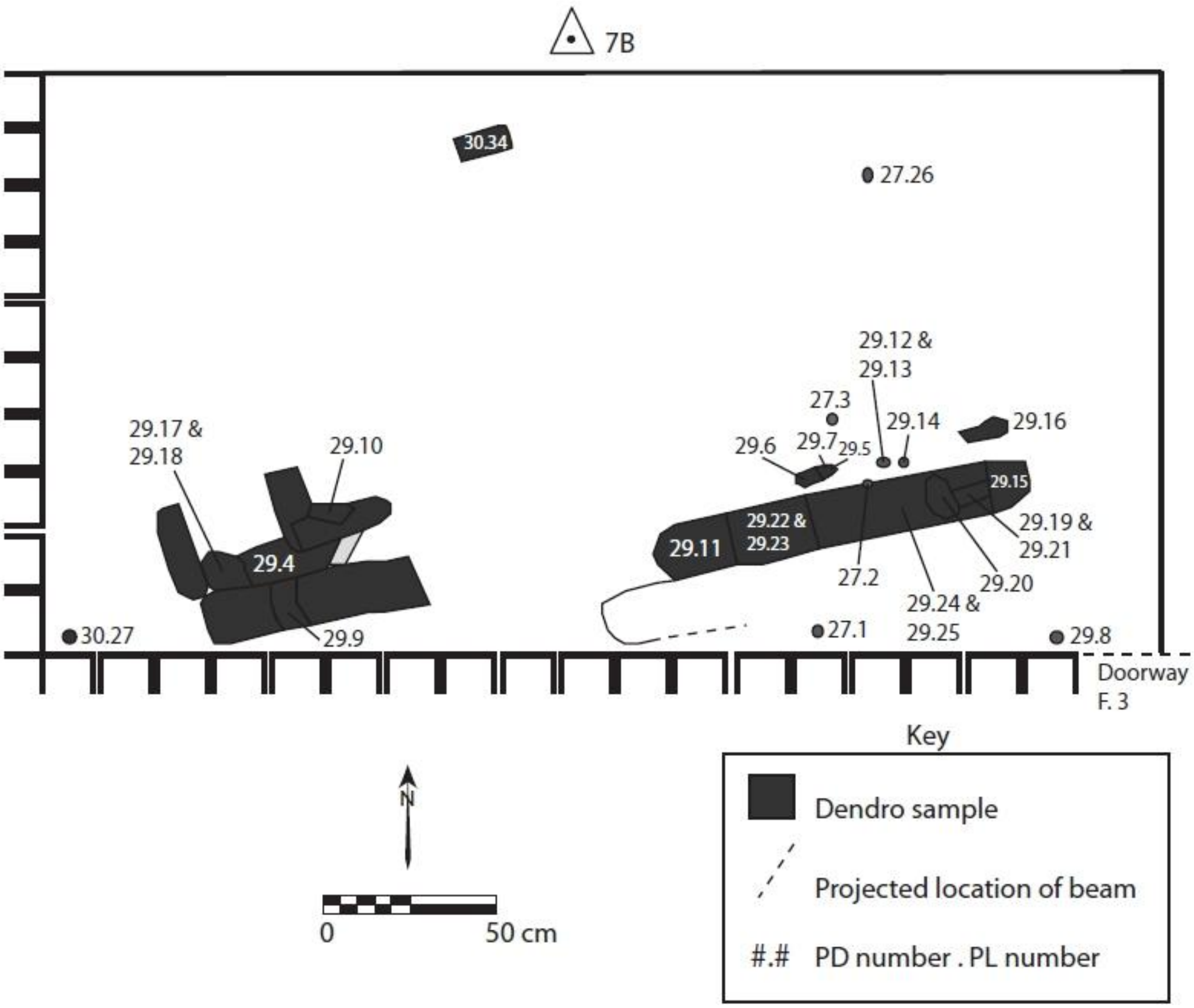


Figure 20. Room 7, Southwest Quadrant upper roof fall PL map. PD 27 is Stratum 2 Level 1, PD 29 is Stratum 2 Level2, and PD 30 is Stratum 2 Level 3.

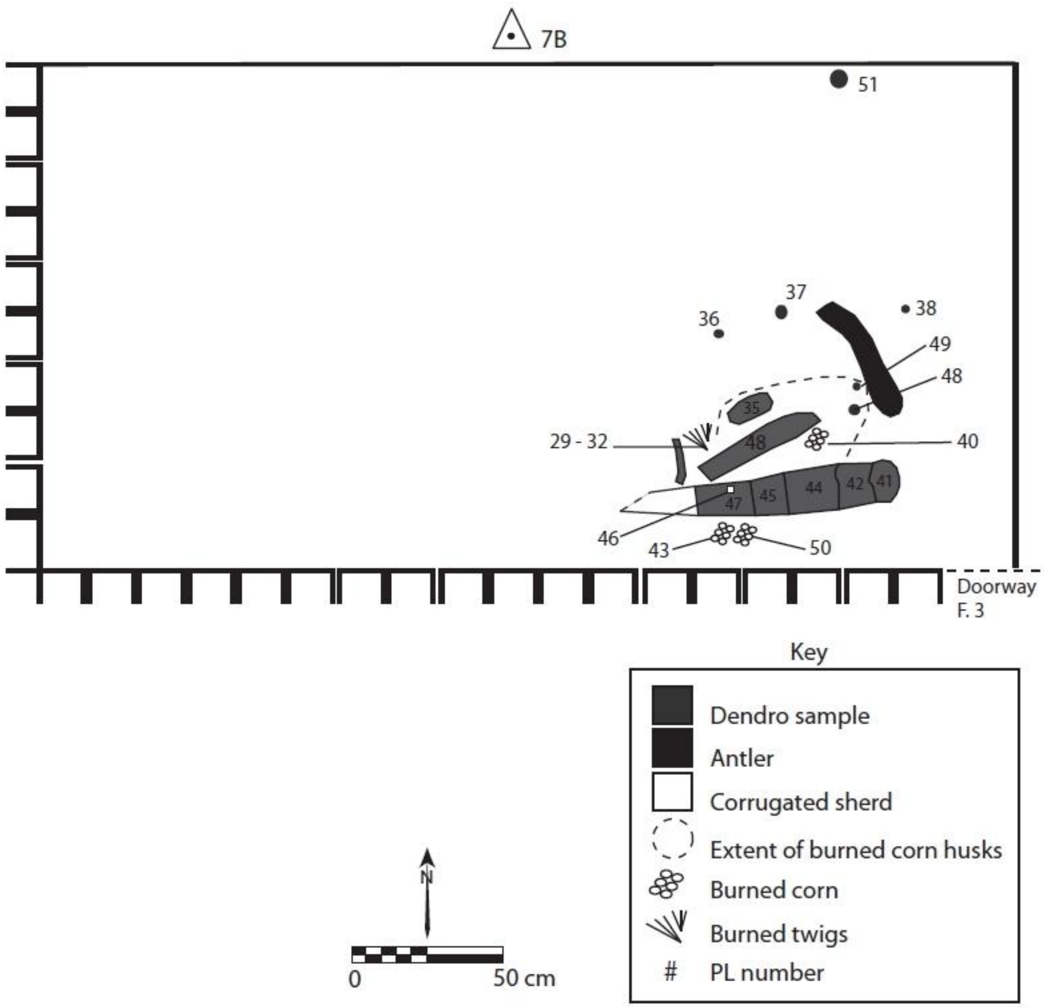


Figure 21. Room 7, Southwest Quadrant lower roof fall PL map.

Table 15. Point Located (PL) Artifacts from Stratum 2 Level 1.

PL Number	Artifact Class	Elevation b.d. 7B
1	Dendro Sample	130
2	Dendro Sample	130
3	Dendro Sample	128

Table 16. Point Located (PL) Artifacts from Stratum 2 Level 2.

PL Number	Artifact Class	Elevation b.d. 7B
4	Dendro Sample	148
5	Dendro Sample	145
6	Dendro Sample	145
7	Botanical Sample	146

8	Dendro Sample	147
9	Dendro Sample	146
10	Dendro Sample	140
11	Dendro Sample	146
12	Botanical Sample	145
13	Botanical Sample	145
14	Botanical Sample	145
15	Dendro Sample	132
16	Dendro Sample	136
17	Dendro Sample	151
18	Dendro Sample	151
19	Dendro Sample	138
20	Dendro Sample	139
21	Dendro Sample	140
22	Dendro Sample	142
23	Dendro Sample	142
24	Dendro Sample	136
25	Dendro Sample	136
26	Dendro Sample	147
28	Ceramic	146
29	Botanical Sample (Corn Boxes A, B, C, D)	152
30	Botanical Sample	152
31	Botanical Sample	152
32	Botanical Sample	152
35	Faunal Bone	150
36	Lithic	150
37	Faunal Bone	148
38	Faunal Bone	140
39	Botanical Sample	141
40	Botanical Sample	147
41	Dendro Sample	141
42	Dendro Sample	141
43	Lithic	149
44	Dendro Sample	142
45	Dendro Sample	143
46	Dendro Sample	146
47	Botanical Sample	147
48	Ceramic	149
49	Faunal Bone	149
50	Botanical Sample	145
51	Groundstone	137

Table 17. Point Located (PL) Artifacts from Stratum 2 Level 3.

PL Number	Artifact Class	Elevation b.d. 7B
27	Botanical Sample	154
33	Ceramic	155
34	Dendro Sample	155

Stratum 2 Level 3 was a 10 cm level between 147 and 157 cm b.d. 7B and was the floor fill of the SW quadrant of Room 7. It was comprised of burned roof fall directly on the floor surface 1. This fill was identical to Stratum 2 Level 2; both were burned roof fall composed of charred beams and some rock. Pockets of yellow closing material were found in the SW corner of the room. There were many more artifacts in this lower level of roof fall than in the upper roof fall. Some of these artifacts may have been in contact with the floor at the time of site abandonment and some of the artifacts recovered may have been in the roof of structure 7 when it burned. Three artifacts including a ceramic sherd, a botanical sample, and a wood sample for dendrochronological dating were point located to this provenience (Table 17 and Figure 20).

Surface 1 (Figure 22) was the uppermost floor surface in the southwest quadrant of Room 7. This floor was a sooted, use-compacted surface of sterile yellow sand between 157 cm and 159 cm below datum 7B. Two features (Feature 1 and Feature 2) were defined on Surface 1. Feature 1 was a refuse deposit on floor surface 1, and Feature 2 was a vessel in the floor. The surface is the latest floor surface in the SW quadrant of Room 7 as evidence by burned roof fall (Stratum 2) resting on top of it. A total of 25 artifacts were point-provenienced to Surface 1, including two corrugated vessels (Table 18, Figure 22). Other sherds, both plain and black on white may represent partial vessels.

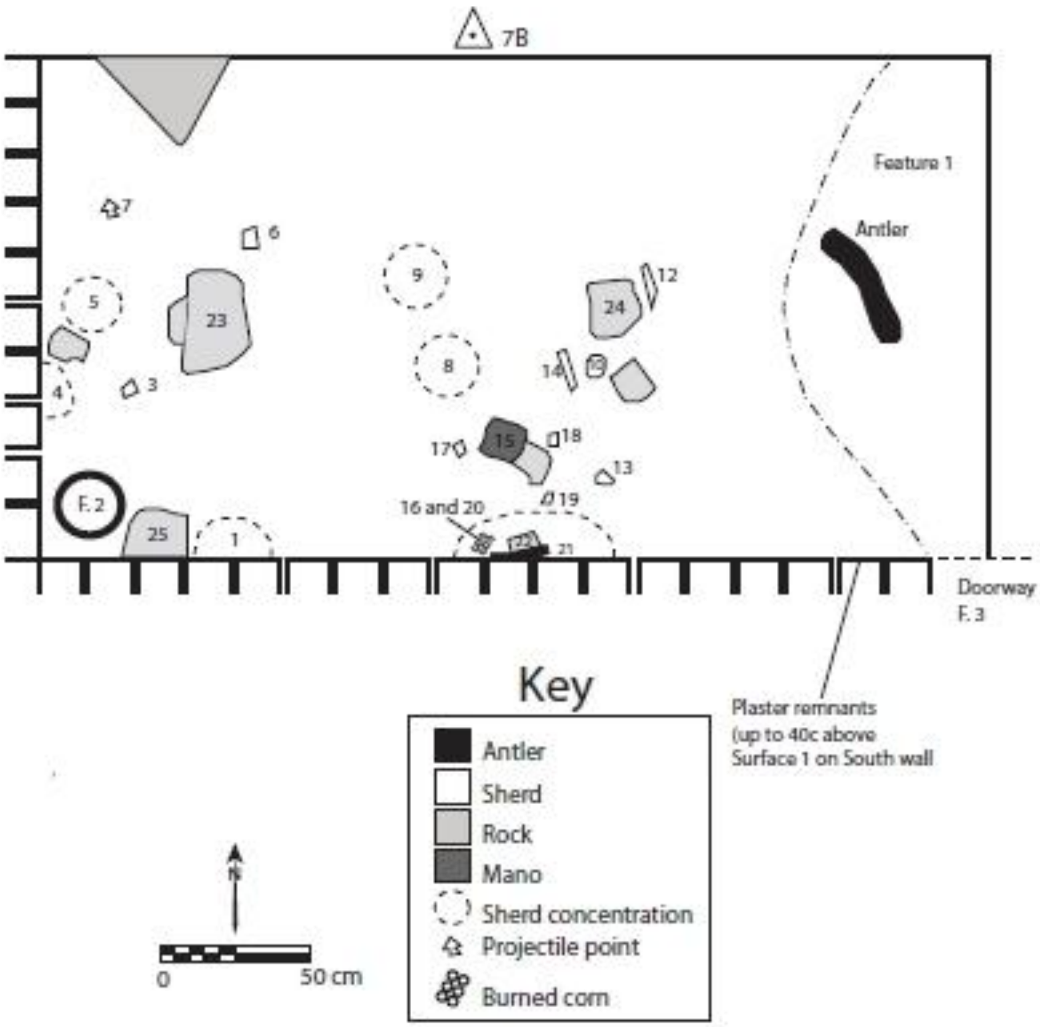


Figure 22. Room 7, Southwest Quadrant Surface 1 plan view and PL map.

Table 18. Point located artifacts associated with Surface 1.

Point Location Number	Artifact Class	Elevation b.d. 7B
1	Ceramic	160
2	Ceramic	155
3	Ceramic	157
4	Ceramic	157
5	Ceramic	157
6	Ceramic	157
7	Lithic	156
8	Ceramic	160
9	Ceramic	161
10	Ceramic	155
11	Ceramic	154

12	Faunal Bone	155
13	Ceramic	154
14	Faunal Bone	154
15	Mano	156
16	Ceramic	157
17	Ceramic	157
18	Ceramic	157
19	Ceramic	157
20	Botanical Sample	153
21	Faunal Bone (Antler)	150
22	Groundstone	156
23	Pollen Sample	156
24	Pollen Sample	156
25	Pollen Sample	155

Feature 1 (Figures 22 and 23) was a refuse deposit on Surface 1 and was located in the southeast portion of the quadrant, nearest the door. The feature was designated because it was beneath the roof fall and corn, contained a higher density of pottery and faunal bones, and was a light mound on top of surface 1. This feature was the result of two discrete dumping events. The uppermost layer was a small stratum, approximately 3 cm thick at 141-145 below datum 7B. This stratum was bounded by the quadrant wall on the east, pinches out to the west and is approximately 25 x 25 cm. The fill was tan in color, contained charred vegetal fragments, a few sherds and some faunal remains. This level represents a single dumping episode of the Feature 1 rubbish pile and may have contained secondary refuse from other areas of the site. Stratum 2 of Feature 1 was approximately 4 cm thick, 145-149 cm below datum 7B. This layer was bounded by the east wall of the SW quadrant and pinches out on top of Stratum 3. The fill is dark, ashy, and contains ceramic sherds and faunal bones. Stratum 2 of Feature 1 covered approximately a 50 x 45 cm area. This stratum is interpreted as the initial dumping episode of Feature 1, containing secondary refuse from other areas of the site (Figures 23 and 35).

Figure 23 Room 7, Feature 1 (refuse deposit) profile view.

Feature 2 (Figures 22, 24, and 25) was a corrugated vessel set into Surface 1. Surface 1 was constructed at the same time that the vessel was placed into the floor. There was no evidence of a pit being excavated into Surface 1. The base of the vessel was coincident with Surface 3. This vessel is 35 cm in height and 20 cm in width at the top orifice. The contents of the jar were left intact for removal in a lab setting and the entire vessel was removed intact. The jar was located in the southwest corner of the room, and the orifice of the jar would have been open to Surface 1. The surface of the jar was fire blackened prior to becoming a part of the floor and was likely a storage vessel. The bottom of the vessel is 188 cm b.d. 7B, atop Surface 3.

Figure 24. Feature 2, pot installed concurrently with Surface 1. Note that the orifice of the pot is flush with Surface 1.

Figure 25. Feature 2, almost completely excavated.

Stratum 3 was a thin layer of yellow sand 160-163 cm below datum 7B introduced by the prehistoric inhabitants of Chimney Rock Great House to create a clean floor layer on top of the cultural fill of stratum 4 and on top of Surface 3 in places. Stratum 3 was approximately 3 cm thick in the western ½ of the quadrant and 1 cm or discontinuous in the eastern ½ of the quadrant.

Stratum 4 was a layer of ashy cultural fill which accumulated on surface 2 and appears to come from Feature 4. Feature 4 (described below) was a basin-shaped, informally prepared hearth with at least 10 phases of use. Stratum 4 was about 3 cm thick 161-165 cm b.d. 7B and was only present in the eastern 2/3 of the SW quadrant of Room 7.

Surface 2 (Figure 27) was approximately 160 cm below datum 7B (and 3 cm below Surface 1) and was the earliest occupation surface in Room 7. It was composed of compacted gray soil with inclusions of clay. The surface was under fill used to level and construct Surface 1. A single black-on-white sherd and a charcoal sample were point located to this surface. Two features (Features 4 and 5), a hearth and a pot rest, were associated with this surface (Figures 26, 27, 28, and 29).

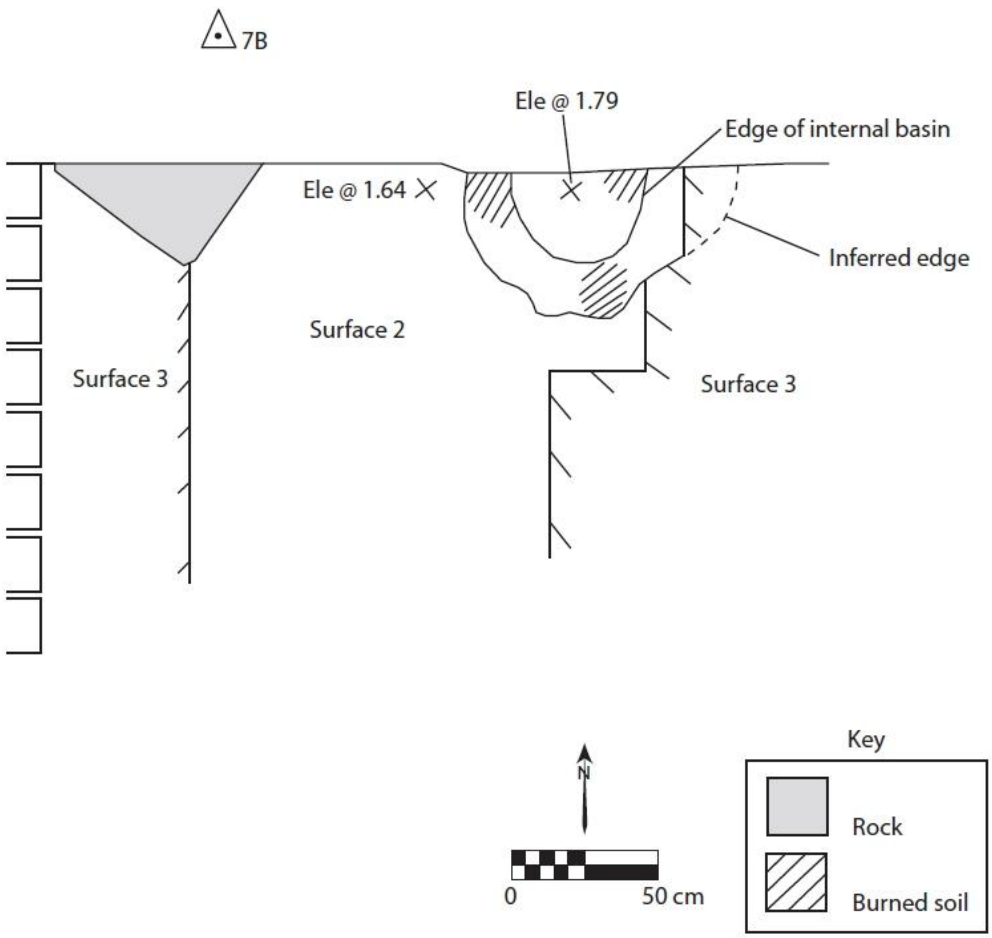


Figure 26. Room 7, Feature 4, hearth.

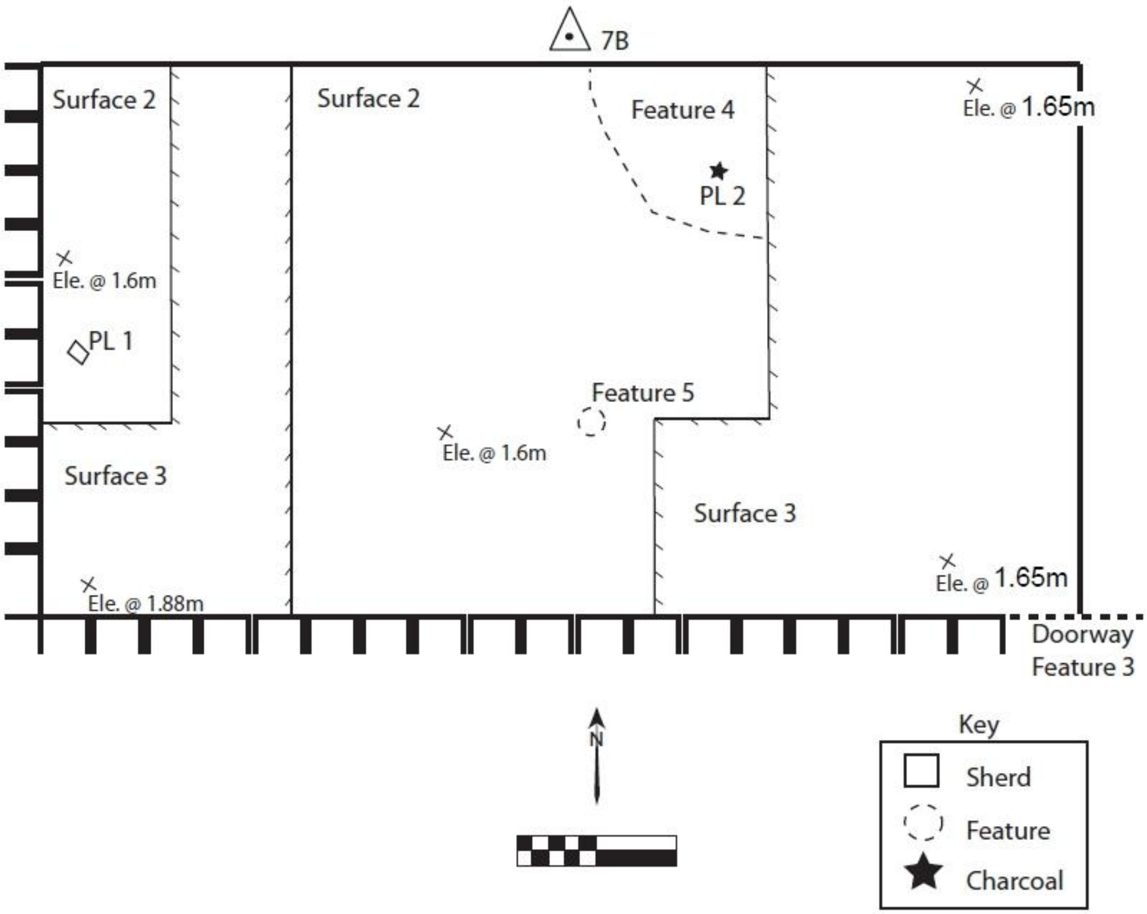


Figure 27. Room 7, Southwest Quadrant Surface 2 plan view and PL map. Also includes portions of Surface 3.

Table 19. Point Located (PL) Artifacts from Surface 2 and Feature 4 - Hearth in Surface 2

PL Number	Artifact Class	Elevation b.d. 7B
1	Ceramic	160
2	Charcoal from Feature Fill	179

Stratum 5 was an approximately 15 cm level 163-178 cm below datum 7B. This level consisted of a thick layer of tan sandy clay loam-like fill. The fill contained a few small rocks, pockets of sand and pockets of clay. The clay was prevalent in the lower 1/3 of stratum 5 and especially towards the south wall. Feature 4 (a hearth) and Feature 5 (a pot rest) were excavated into Stratum 5. Stratum 5 was likely construction fill laid over Surface 3 (described below) to create a flat floor for Room 7. Patches of clay and large mammal bones in the lower portion of Stratum

5 fill may have been associated with the construction of Room 7. The fill was mottled in places, suggesting that material was deposited from a variety of locations.

Feature 4 was a hearth (Figures 26 and 28). The portion of the hearth visible to excavators was 90 cm long, 48 cm wide, and 18 cm deep. The heart extended into the unexcavated northwest quadrant of the unit and is inferred to have been 90 x 90 x 18 cm in size prehistorically. The hearth was basin-shaped and somewhat prepared with at least two phases of use, including the application of a clay lining. The edges of the hearth were not clearly defined, suggesting that it was located in a high traffic area during its use. The hearth was prehistorically excavated into Stratum 5.

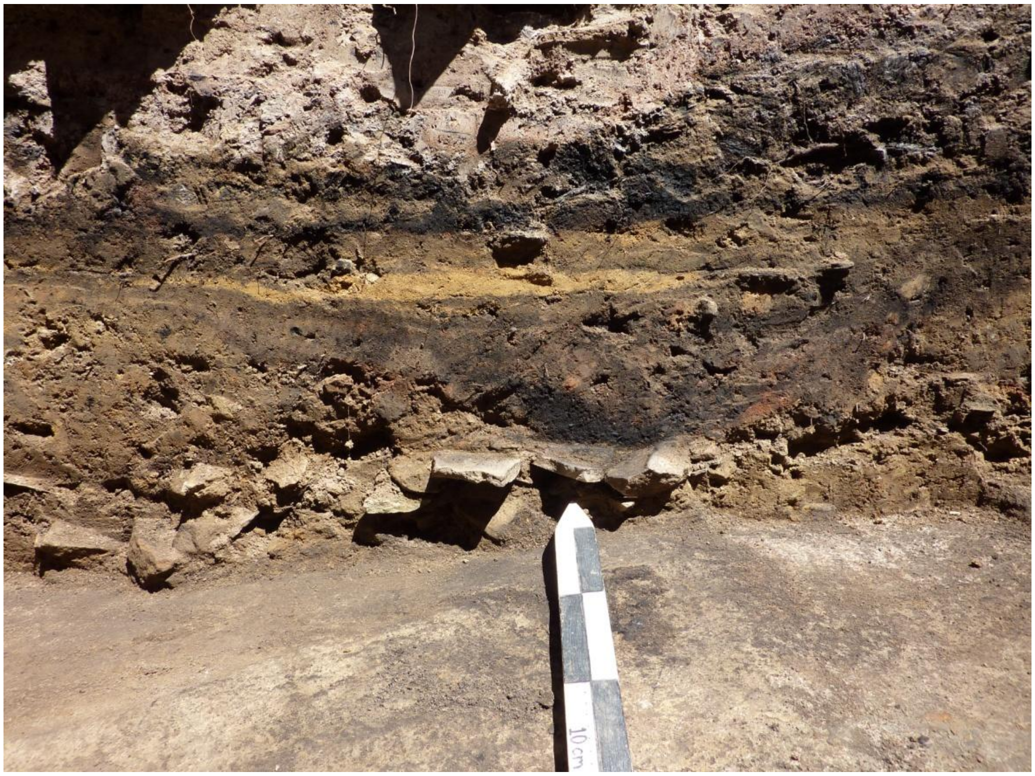


Figure 28. Room 7, profile of Feature 4, hearth.

Feature 5 was a pot rest 160 cm b.d. 7B (Figures 29 and 27). The dimensions of the pot rest were 20 cm by 20 cm and it was circular in shape. Feature 5 was identified on Surface 2 and underneath Stratum 4. The pot rest was only 3 cm in depth and was filled with yellow sand most likely from Stratum 3. Feature 5 was likely associated with Feature 4, a hearth. This pot rest was likely used during the occupation of Surface 2 and buried when Surface 1 was constructed on top.

Figure 29. Room 7, Feature 5, partially excavated pot rest.

Surface 3 (Figures 27 and 30) covered the entire area of the quadrant and sloped from east to west, paralleling the natural slope of the bedrock. Elevations b.d. 7B in the eastern portion of the quadrant were 169 cm and 165 cm, and in the western portion of the quadrant 189 cm and 188 cm. Stratum 5 came off of Surface 3, but surface 3 does not appear to have been prepared. Surface 3 was interpreted as the top of natural sediments on top of the Chimney Rock Mesa. This interpretation is supported by a footer trench (Feature 6, Figures 30 and 31) excavated into Surface 3 along the western wall of the quadrant. A similar surface does not appear to have been present beneath Room 5. It is possible that the bedrock was naturally exposed prior to the construction of that room.

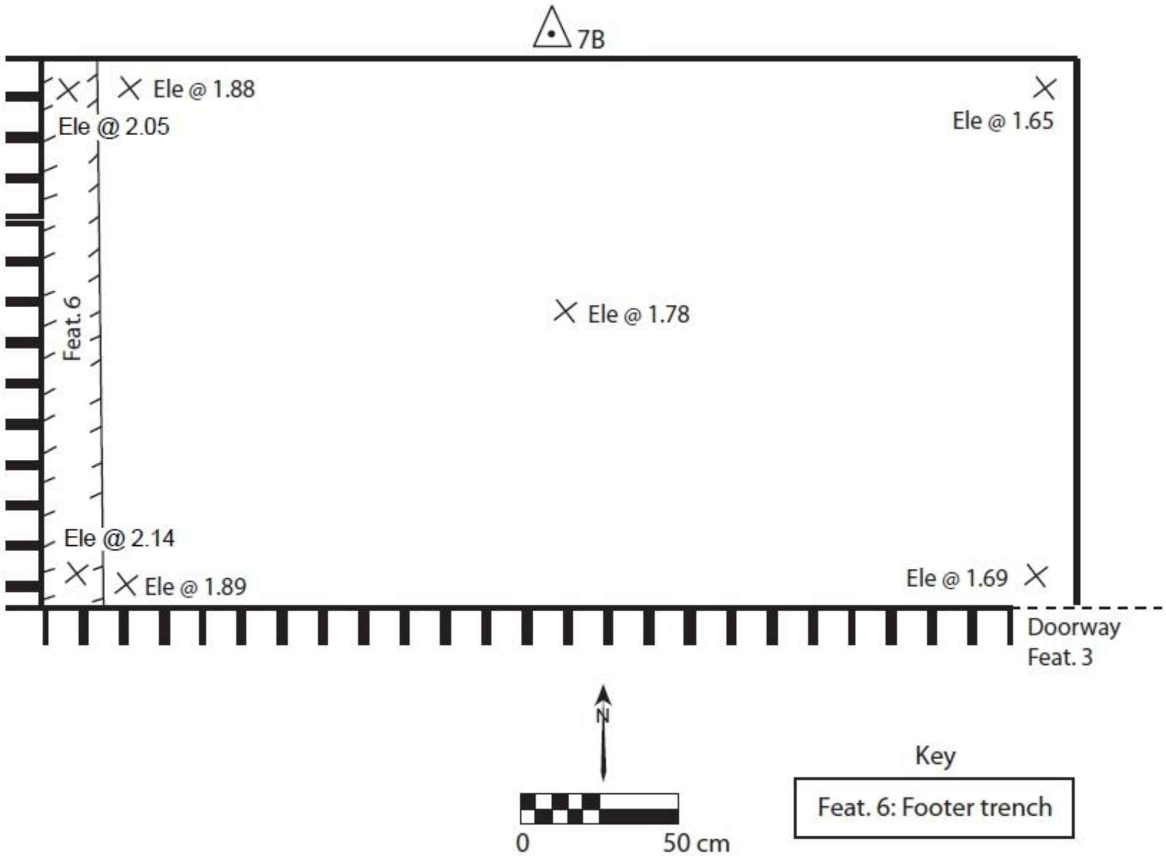


Figure 30. Room 7, Southwest Quadrant Surface 3 plan view.

Figure 31. Room 7, Feature 6, footer trench excavated for the construction of the west wall of the room.

Stratum 6 was the natural sediments atop the bedrock of Chimney Rock Mesa. The top of this level was Surface 3, the likely ground surface at the time of site occupation. The stratum 6 sediment was moderately compact clay-loam with sparse charred vegetal flaking and some artifacts. There was a footer trench (Feature 6) in this stratum along the wall in the western portion of the SW quadrant of room 7. This suggests that this deposit was present at the time that the pueblo was built. There is no footer trench along the south wall that abuts the west wall of Room 7. The south wall was built on top of Stratum 6, without being set on the bedrock. Stratum 6 is an approximately 10 cm level from 165 cm – 176 cm below datum 7B. The footer trench (Feature 6) extended from 188 cm -205 cm below datum 7B in the northernmost portion excavated, and 189 cm – to 214 cm below datum in the southernmost portion excavated. The dimensions of the footer trench were 150 cm long x 16 cm wide x 20 cm in depth. The trench likely continues into the northwest quadrant of room 7, and the depth was somewhat variable due to the natural slope of the bedrock. Feature 6 was identified on Surface 3 and was a narrow trench excavated into the prehistoric ground surface in order to place a foundation for the west wall. A few flakes, some faunal bone, and charred vegetal material were removed from the upper cm of this trench fill.

Surface 4 (Figure 32) is the bedrock beneath the great house and has no features (like those in the bedrock beneath Room 5) to indicate that it was used as an occupation surface. The bedrock sloped from 176-214 cm b.d. 7B from the east to the west. The bedrock was not modified and forms the top of the Chimney Rock Mesa. It was overlain by 10-20 cm of natural sediment (Stratum 6). When the great house was constructed, the west wall of Room 7 was constructed on the bedrock, while the south wall was constructed on top of Stratum 6.

Figure 32. Room 7, Surface 4, bedrock beneath Room 7.

The doorway in the south wall of Room 7 was designated Feature 3 (Figure 33). Only the western portion of the doorway was exposed within the excavated area of the southwest quadrant of Room 7. Approximately one quarter of the door was visible. The sill of the door is approximately 12 cm above the level of Surface 1, the latest floor in Room 7. The door is plaza facing, but does not appear to have been T-shaped. Only the lower 90 cm of the doorway are preserved due to wall collapse soon after the room burned. The upper portion of the doorway was reconstructed, likely during stabilization activities in the 1970s, in an effort to make it suitable for exhibit. The stabilization efforts make the original dimensions of the door very difficult to ascertain. The width of the door is inferred to be 77 cm, the height of the remaining prehistoric door structure is 80 cm, while the stabilizing cap makes the door 167 cm in height. The Feature 1 trash deposit is immediately north of the doorway, inside of Room 7.

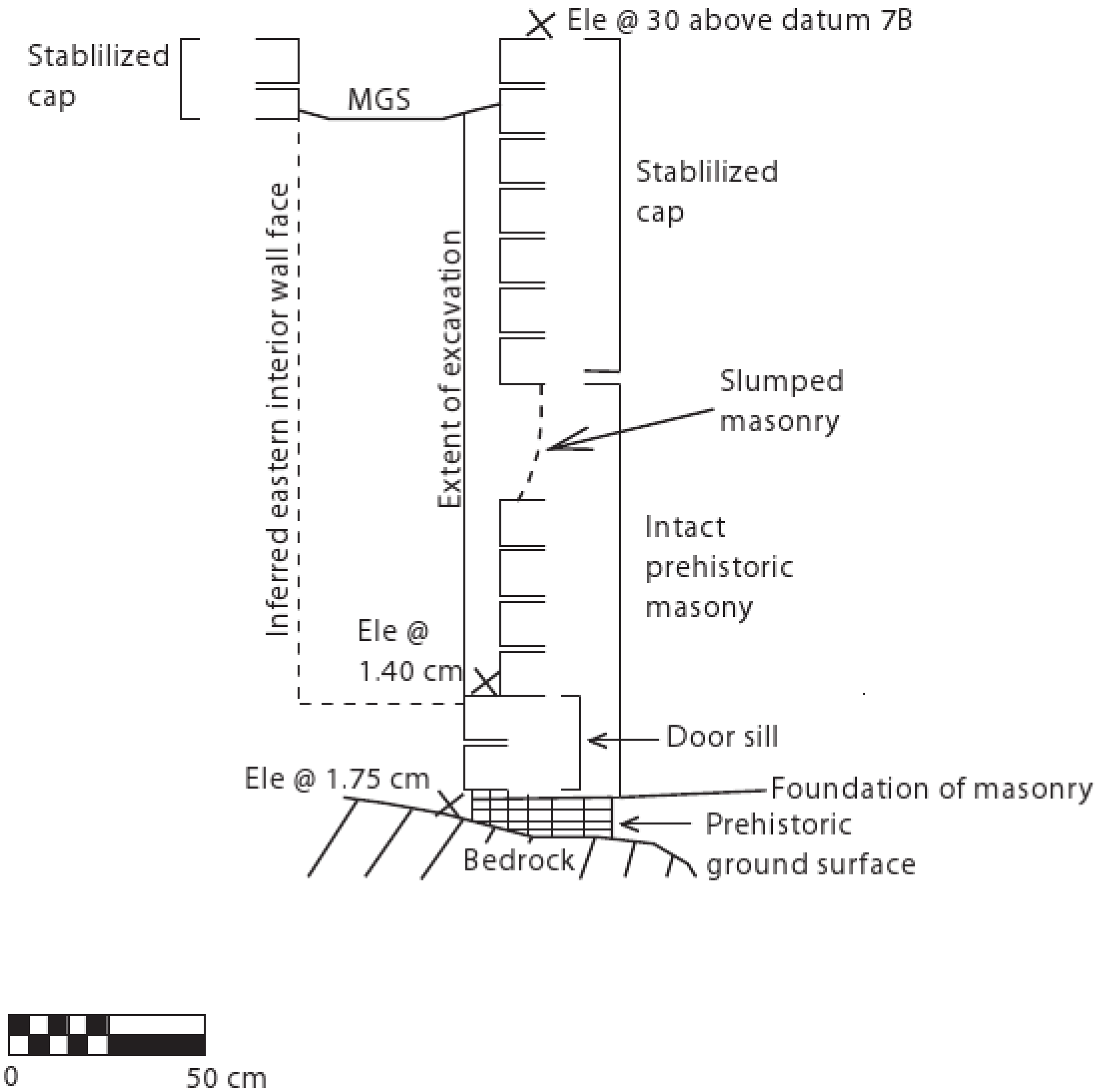


Figure 33. Room 7, Feature 3, doorway in south wall. Looking south.

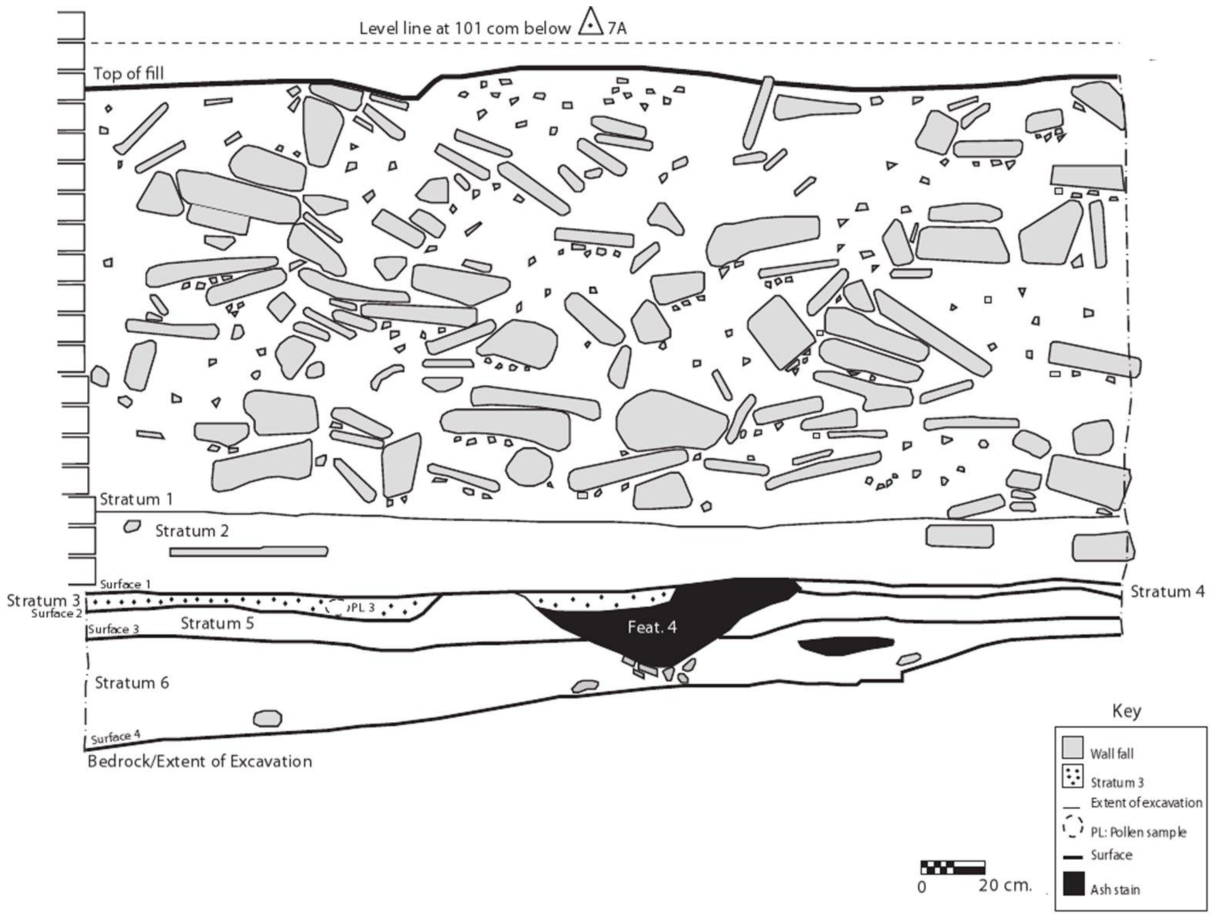


Figure 34. Room 7, Profile of north face of Southwest Quadrant.

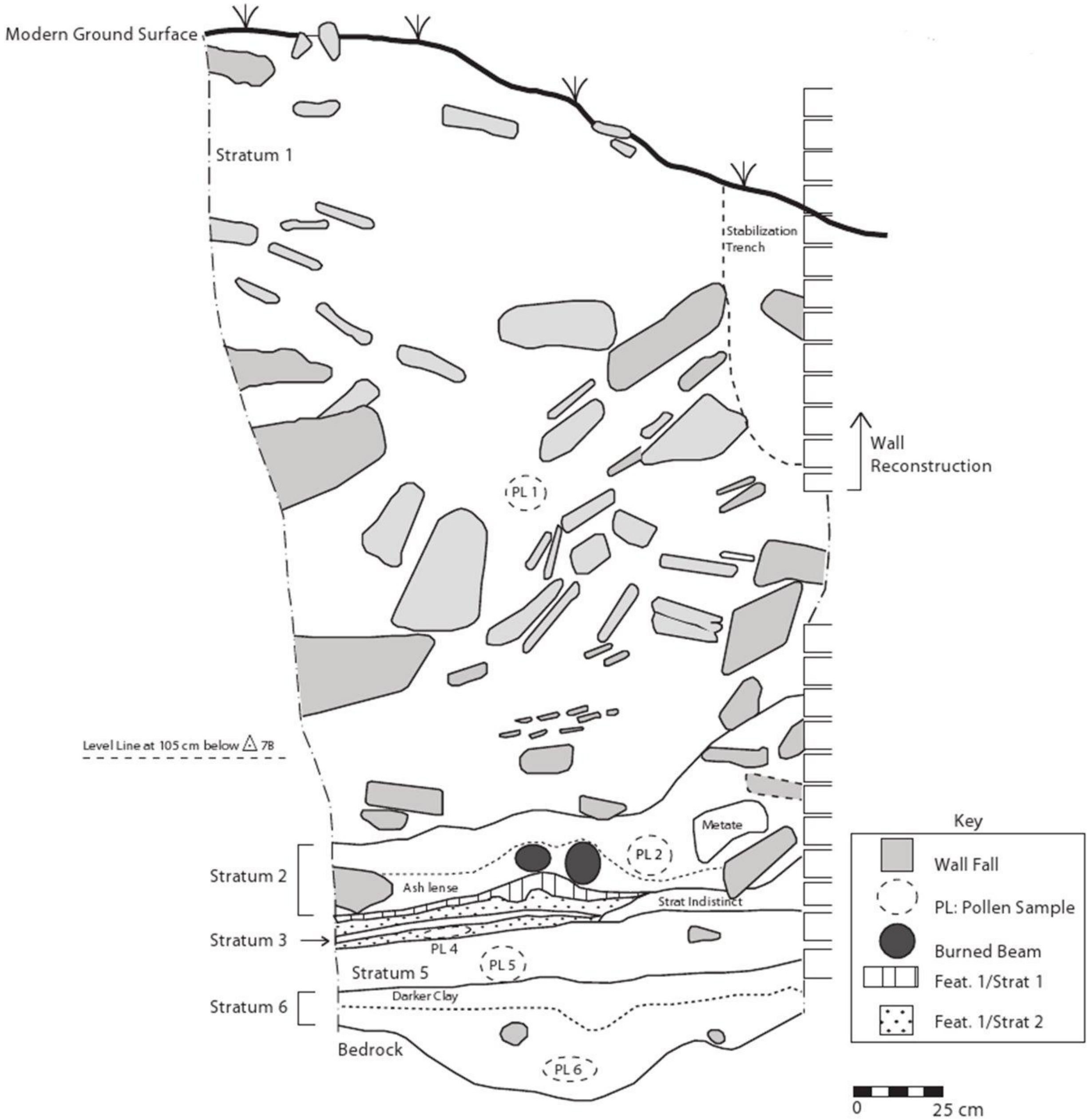


Figure 35. Room 7, east face profile of Southwest Quadrant.

Results of Artifact Analysis

The following pages summarize the results of the analyses of individual classes of artifacts. For complete analysis reports, see Appendices.

Chipped Stone

Analysis of chipped stone (Appendix A) from Chimney Rock Great House was completed during the fall of 2009 by Jakob Sedig, project crew member and University of Colorado graduate student. Fifty-four pieces of chipped stone were recovered from Rooms 5 and 7 during fill reduction activities and limited testing. Each piece of chipped stone was classified into one of the following three categories: debitage, flake tool, or formal tool. Only four formal tools, including three projectile points and one biface, were identified in this assemblage. Material types were also identified, using the Warren Code System (Warren 1967).

Twenty-three pieces of chipped stone were recovered from Room 5. Ten were classified as debris/shatter, 3 as broken flakes, 5 as flake fragments, 2 as utilized flakes, and 1 piece as a modified flake. The two formal tools identified include a broken orthoquartzite projectile point and a finely made biface. Fifteen distinct types of raw material were identified in the assemblage, with the most common raw material type being local cherts and siltstones. The 15 distinct types of raw material can be consolidated into 8 broad categories that include local cherts, siltstones, basalts, quartzites, Burro Canyon Orthoquartzites, Narbona Pass chert, and unidentifiable material. The majority of flake fragments, broken flakes, and utilized and modified flakes were recovered from contexts on or above the floor, indicating that most lithic reduction activities associated with the room happened after the construction of Room 5. The biface was recovered from sub-floor contexts and was manufactured from an exotic stone type, Alibates chert from Texas. Since no debitage of Alibates chert was found at Chimney Rock, it is likely that the tool was manufactured elsewhere and transported to the site as a finished piece. Interestingly, the only other tool from this room, a projectile point, was also found in subfloor contexts.

Thirty one pieces of chipped stone were recovered from Room 7. Eleven of these were categorized as debris/shatter, 1 as a broken flake, 3 were flake fragments, 4 were complete flakes, 9 were utilized flakes, 2 were formal tools (chalcedony projectile points), and 1 was a spent core. Thirteen types of raw material were present in the room and these can be grouped into 8 broad categories: local cherts, siltstones, undifferentiated clays, basalts, quartzites, red jasper, Narbona Pass chert, and unidentifiable material.

While the sample size is too small to infer a great deal about chipped stone at Chimney Rock Great House, a few patterns can be noted. No correlation between chipped stone material type and chipped stone type (debitage, flake tool, formal tool) or chipped stone type and provenience was noted in either Room 5 or Room 7. Most of the chipped stone in both rooms was classified as debris/shatter. Like Room 5, material types in Room 7 were dominated by local cherts and siltstones. Unlike Room 5, complete flakes and flakes with cortex present were found in Room 7. This is suggestive of different stages of lithic reduction being completed in each of the two rooms: earlier, hard hammer reduction in Room 7 and later, soft-hammer reduction in Room 5. The biface and two of the projectile points were likely manufactured elsewhere and transported to the site based upon the lack of debitage of the same material type as these particular tools. Other expedient tools (not recovered), were likely made and used on the site. Three pieces of Narbona Pass chert, a non-local material type originating in the Chuska Mountains, were recovered from the rooms. Narbona Pass chert is found more frequently in Chaco Canyon between A.D. 1050 and 1100, so it is not surprising that it be recovered at Chimney Rock, an outlying Chacoan great house. Cameron (2001:85) notes that Narbona Pass Chert "may have had value beyond the utilitarian", possibly valued as a gift, or as a minor tribute. No evidence for specialized tool manufacture was noted.

Groundstone

Basic groundstone identification and analysis was completed by one of the authors (Appendix B). Only fifteen different groundstone specimens were recovered from Rooms 5 and 7. Much of the recovered groundstone appears to be from secondary depositional contexts, with a very few exceptions.

Nine groundstone artifacts were recovered from Room 7. Two small, unidentifiable pieces of groundstone were found in the upper fill of the room. Pieces of a fairly large metate (41x22x8 cm) were removed from Stratum 2 Level 2 of Room 7, the heart of the burned roof material. The metate may have been stored in or on top of the roof. Two pieces of groundstone were point located to floor Surface 1. These include a broken piece of a smooth, shaped slab and a portion of a large two-handed mano (16x11x4 cm). There was some burning on the broken end of the mano. One indeterminate piece of groundstone was recovered from the three centimeters of yellow sand found on top of Surface 3 in places. One shaped disc, likely a pot lid was recovered from Stratum 5, the construction fill laid on top of Surface 3 to create a flat floor surface for the room. This fill was mottled, and likely from a variety of different sources. Two pieces of groundstone were recovered from Stratum 6, the natural sediments atop Chimney Rock Mesa. These pieces include a one-handed mano and a circular shaped stone, likely a pot lid.

Six groundstone artifacts were recovered from Room 5. A hammerstone, two incomplete pieces of a heavily used mano, and a one handed mano were found in upper room fill dominated by wall fall and Aeolian deposits. A piece of a broken one-handed mano and a smooth shaped stone slab were recovered from Stratum 3 Level 1, approximately 30 cm above the only floor surface in the room. One hammerstone was recovered from Stratum 4, the cultural fill immediately below Surface 1.

Fauna

Faunal analysis (Appendix C) was completed by Brigit Burbank, a student at Simon Fraser University, under the supervision of Dr. Robert Muir during the Fall of 2009. Five hundred and ninety-four fragments of bone, teeth, antler, and ossified cartilage were recovered from Rooms 5 and 7. Three hundred and sixty-one fragments could be confidently identified as belonging to 19 different taxonomic categories. The categories range from the general (i.e. small mammals) to the more specific (i.e. porcupine, vole, wood rat). The assemblage is dominated by the medium mammal category, but it is possible that some larger mammals are simply so fragmentary that they appear to be medium mammals. Larger mammals, including artiodactyls and grizzly bear, and birds were also identified in the assemblage.

Two hundred and twenty two of the 594 fragments were assigned to the medium mammal category, 71 of the fragments were assigned to the artiodactyls taxon, and 38 were assigned to the cervid taxon. The cervid taxon is likely overrepresented because it consists of 38 antler fragments that probably originate from a single set of antlers. A grizzly bear mandible with teeth was identified. The remaining 15 taxonomic categories, all represented by 6 fragments or fewer, include various small, medium, and large birds, rodents, canis sp., elk, and deer.

Some comparisons can be made between faunal remains recovered from Eddy's excavations (analyzed by Harris 1977), and those recovered in 2009. Both assemblages are dominated by artiodactyls, contain immature artiodactyls, porcupine, and all of the taxa identified in the 2009 assemblage were also identified in Eddy's assemblage. Neither assemblage has many bird bones. Eddy's assemblage included some taxa not identified in the 2009 assemblage: these include grouse, bobcat, mountain lion, beaver, muskrat, and otter. Rodents and lagomorphs are more abundant in the earlier assemblage as well. These disparities are likely due to differences in sample size and the fact that Eddy's collection included a considerable amount of surface material.

While the faunal assemblage recovered in 2009 is too small to draw conclusions about diet, seasonality or function of the structures, some broad trends were defined. Like the inhabitants of other Chacoan great houses, the inhabitants of Chimney Rock consumed mostly deer and antelope (Plog 1997: 109). The lack of bird remains is likely indicative of an active choice to not consume birds. It is also unlikely that birds such as turkeys and macaws were being raised or traded at Chimney Rock. The most surprising find in the faunal collection was the mandible of a grizzly bear. The mandible was almost completely intact and nearly all the teeth could be refitted. Bears may have been of ritual importance at Chimney Rock, as indicated by a small bear effigy recovered from the guardhouse and a bear paw petroglyph recovered in the vicinity of the great house (Malville 2004:7).

Strontium Analysis of Corn

Corn recovered from Room 7 was subjected to strontium (SR) analysis (Appendix D) by Dr. Larry Benson of the United States Geological Survey with the assistance of Kellam Throgmorton, project crew member and University of Colorado graduate student. Strontium analysis is used to determine the ultimate source of organic materials. Strontium isotopes occur naturally in surface sediments and in soil water. Plants that are grown in an area with a given

87SR/86Sr isotope ratio will acquire that isotope signature through the intake of water (Benson 2010: 622).

Burned corn suitable for strontium analysis was recovered from the floor of Room 7. Dr. Karen Adams (Appendix E) analyzed ethnobotanical materials from Chimney Rock and determined that the corn from Room 7 was representative of two land races. Samples from both land races were tested for their strontium signatures. Rabbitbrush growing in three separate locations surrounding the great house were collected to determine the strontium isotope signature of the local area. Rabbitbrush is a good indicator species for locales where corn could have been grown because it has similar growing requirements.

All but one of the cobs analyzed had elevated aluminum (Al) values, suggesting some level of mineral contamination. The cobs were not cleaned prior to analysis because they appeared to be free of mineral material and the cleaning process can sometimes be detrimental to strontium analysis. The rabbitbrush samples also had elevated Al values despite appearing clean.

Despite the minor mineral contamination issues, the 87Sr/86Sr results cluster and correlate best with themselves and not with the Al values. The maize samples tested are also within the range exhibited by the rabbitbrush collected in the immediate area. The 87Sr/86Sr values of the archaeological cobs range from 0.710014 to 0.710170 (with an average error of 0.0000115), while the rabbitbrush values range from 0.710082 to 0.711259 (with an average error of 0.0000093). This suggests that the corn recovered at Chimney Rock Pueblo was grown locally in the valley below the site. There is no significant difference in the strontium ratios of the two distinct types of corn analyzed. While there are a number of other potential sources for the maize based on previously published strontium data, the presence of delicate and easily destroyed parts of the maize plant lend credence to our interpretation that the Chimney Rock maize was grown locally.

Archaeobotanical Analysis

Dr. Karen Adams completed an analysis of archaeobotanical materials (Appendix E) recovered from Chimney Rock during the summer and fall of 2009. Thirty-seven macrobotanical samples and 11 flotation samples were analyzed.

At least fourteen different taxa/parts were identified in the flotation samples from Rooms 5 and 7. These include: sagebrush, mountain mahogany, cheno-am, conifer, juniper, pine, pinyon, ponderosa, cottonwood, chokecherry, Douglas fir, bitterbrush, oak, rose family, and maize. All of these were charred and are assumed to have been burned by the prehispanic inhabitants of Chimney Rock Great House.

Of the thirty-seven macrobotanical samples analyzed, domesticated maize (*Zea mays)* was the most ubiquitous, and therefore likely of great importance to the prehistoric residents of Chimney Rock Great House. Further, the diversity of maize parts present in the sample indicates that the food source was being grown near the pueblo. The density of maize was most notable in Room 7 where a pile of ear segments/fragments, some with kernels attached, and left over maize cob segments/fragments and shanks were stored or discarded within the pueblo. The majority of the remaining macrobotanical samples are most probably remains of roofing material in Room 7. Charred fragments of juniper, Douglas fir, ponderosa pine, and pinyon were present and were likely roof construction elements. Mountain mahogany, bitterbrush, and sagebrush may have been used as closing materials above the primary and secondary beam layers of the roof. In Room 7, short cigar-shaped maize cob segments with 10 rows of kernels were found in association with the latest floor surface (Surface 1). Fragments of Douglas fir, likely used as fuel, were found associated with a hearth (Feature 4) associated with an earlier floor. Most of the macrobotanical material from Room 5 was from a mixture of Aeolian, natural, and wall fall/roof fall deposits. Two samples from roof fall above the floor contain some of the same woody plant taxa/parts thought to be part of the Structure 7 roof, indicative of consistent choices in construction materials. Three charred maize kernels with pop/flint endosperm were preserved on the thick adobe floor of Room 5.

Flotation samples yielded evidence of the use of other wild plant resources as food by the residents of the pueblo. Cheno-am seeds could have been harvested from goosefoot or pigweed plants that came up as weeds within maize fields. Chokecherry seeds indicate the harvest of chokecherries from trees in riparian areas. Pinyon pine cones present in the flotation samples may indicate the use of pinyon nuts as occasional food resources, or may simply be the result of inadvertent entry on wood.

Observations of maize ears, cobs, kernels, and shanks suggest the presence of two landraces grown by prehistoric farmers. Cigar-shaped ear/cob specimens, kernels with husk striations, and an average kernel row number of 12 along with the presence of pop and flint kernels within the assemblage are indicative of maize similar to Chapalote or Basketmaker. Maize with gradual ear/cob taper, possible flour kernels, relatively large shanks, and 14 or 16 rows of kernels are similar to historic Rio Grande Pueblos large-eared flour maize land races. However, the Chimney Rock maize is not nearly as large as the Rio Grande maize.

Some inferences about seasonality can be made. Chokecherries are harvested in the early summer, and Cheno-ams can be gathered in the mid-summer through early fall. Maize is harvested in the late summer or early fall. Agricultural activities, such as field preparation, planting, and husking and drying corn can take place over much of the year. The plant record offers no indication for or against year round occupation of Chimney Rock.

Dendrochronology

Fifty-six wood samples were collected for dendrochronological analysis. Twelve total dates were returned, seven from Room 7 and five from Room 5 (Appendix F). A short explanation of the symbols used in the following tables is provided here and in Appendix F. This information is taken directly from the Laboratory of Tree Ring Research website: (http://www.ltrr.arizona.edu/archaeology/explsymbols.pdf).

The symbols associated with inside dates are: p, no pith ring present; and +/-, the innermost ring is not the pith ring and an absolute date cannot be assigned to it. A ring count is involved.

The symbols associated with the outside dates are: B, bark present; L, a characteristic surface patination and smoothness, which develops on beams stripped of bark, is present; vv, there is no way of estimating how far the last ring is from the true outside; +, one or more rings may be missing near the end of the ring series whose presence or absence cannot be determined because the specimen does not extend far enough to provide an adequate check; ++ a ring count is necessary due to the fact that beyond a certain point the specimen could not be dated. The symbols B, G, L indicate cutting dates in order of decreasing confidence unless + or ++ is also present.

Table 20. Dendrochronological information for Room 5.

Laboratory of Tree Ring Research Specimen Number	Chimney Rock Field Number (PD-PL)	Species Identification	Inside Date/Outside Date
CRE-259	32-26	Ponderosa Pine	957-1024vv
CRE-260	32-27	Ponderosa Pine	931+-- 1018+LB comp
CRE-261	28-14	Douglas Fir	1038p – 1082vv
CRE-262	28-19	Douglas Fir	1051 – 1079vv
CRE-265	28-8	Juniper	964 – 1011L comp

In Room 5 (Table 20), all wood samples were recovered from the 30 cm directly on top of the floor. The A.D. 1018+LB comp near cutting date (harvested anytime between A.D. 1018 and 1021) and the A.D. 1011 L comp cutting date are surprising because they are much earlier than any other dates yet recovered from the great house. Interestingly, A.D. 1018 is a year in which a major lunar standstill occurred and A.D. 1011 is a year in which a minor lunar standstill occurred. These early dates may be indicative of a few different possibilities. First, the great house may have been built much earlier than originally thought. The fact that the early wood samples have been stripped of their bark indicates that the wood was not old wood collected from the ground surface and integrated into the great house. The structure may have been constructed early in the 11th century and ritually renewed during the major lunar standstill event, thus explaining the A.D. 1076 and 1093 tree ring dates. Or, the architects who built the great house may have salvaged wood from an earlier structure atop Chimney Rock Mesa that was built at the same time as major and minor lunar standstill events. Either way, it would seem that the choice of wood was not random. And, these dates indicate human activity on Chimney Rock Mesa earlier than previously thought.

Table 21. Dendrochronological information for Room 7.

Laboratory of Tree Ring Research Specimen Number	Chimney Rock Field Number (PD-PL)	Species Identification	Inside Date/Outside Date
CRE-252	29-44	Douglas Fir	1025p – 1070+LB comp
CRE253	29-18	Douglas Fir	1062 – 1091 +vv
CRE-254	29-17	Ponderosa Pine	1008p – 1055+vv
CRE-255	29-10	Douglas Fir	1047 – 1080+vv
CRE-256	29-4	Douglas Fir	1006 – 1053vv
CRE-257	29-21	Douglas Fir	1054 – 1093+LB comp
CRE-258	29-22	Douglas Fir	1067 – 1093+LB comp

In Room 7 (Table 21), all wood samples came from the heart of the burned material within the room. The single A.D. 1070+LB comp and two A.D. 1093+LB comp dates are near cutting dates, meaning they could have been cut anytime between A.D. 1070 and 1073 or A.D 1093 and 1096, respectively. The A.D. 1093 dates are consistent with Eddy's dating of Room 8 and postulation that a work group was out cutting beams for the final roofing episode of the pueblo. Unlike Eddy's dating of Room 8, there are pre-1093 cutting dates from Room 7 indicating that some roofing material from previous construction events may have been retained during the activities circa A.D. 1093. Also of note is the fact that A.D. 1093 is a year in which a major lunar standstill occurred, and that the major lunar standstill phenomena is observable at Chimney Rock for a period of several years each cycle.

Radiocarbon Dating

Four radiocarbon dates were processed as a component of our research (Appendix G). Two of these were from the corn on the floor of Room 7, and two were from the hearth (Feature 1) in the bedrock below Room 5.

The two dates from Room 5 are 930 +/- 40 B.P. and 970 +/- 40 B.P. At one sigma confidence level (68% probability) these dates are A.D. 1030-1160 and A.D. 1020-1140. At two sigma confidence level (95% probability) these dates are A.D. 1020-1210 and A.D. 1000-1160.

The two dates from Room 7 are 955 +/- 20 B.P. and 960 +/- 20 B.P. At one sigma confidence level (68% probability) these dates are A.D. 1028-1149 and A.D. 1026-1148. At a two sigma confidence level (95% probability) these dates are A.D. 1023-1154 and A.D. 1021-1154.

The dates in the two rooms are not significantly different from one another, and unfortunately do not add a great deal of specificity to our understanding of Chimney Rock Great House. The dates do indicate that the great house was constructed and in use during the Chaco era. They also indicate that the Chacoan inhabitants of the pueblo were likely the first and last to use the structure.

Ceramic Analysis

Ceramics from Chimney Rock Great House were analyzed by Dr. C. Dean Wilson (Appendix H). One thousand twenty-nine sherds were recovered, 999 from Room 7 and 30 from Room 5. The majority of the gray and white ware sherds examined from Rooms 5 and 7 had andesite/diorite temper, and are similar to that occurring in sites across much of the San Juan region. Pottery with quartz sand, trachyte, or sherd temper was also identified. Most sherds recovered from Chimney Rock Pueblo exhibit coiled or corrugated treatments over the entire surface underlying the fillet along the rim. This is typical of the majority of gray ware pottery produced in Anasazi country between A.D. 1000 and 1300. Seventy-seven percent of the pottery examined from Rooms 5 and 7 was assigned to San Juan gray ware types. The majority of sherds (79.5%) from this site are gray utility ware, with 20.4% being white wares. While most (64.3%) of the white ware sherds appear to have derived from bowls, a significant frequency (33%) are from jars. Other white ware vessel forms noted include a handed dipper. This assemblage appears to be functionally similar to those noted at other Late Pueblo II sites in areas to the south and west, with the possible exception of a higher frequency of gray ware cooking jars

A few sherds were assigned to Rosa Gray and Payan Corrugated, both types defined for the Upper San Juan tradition. A small number of sherds from a few vessels were assigned to Arboles Black-on-white, but in general assignments to this type were limited to the most distinct sherds. A very small number of sherds decorated with a diffuse organic paint were assigned to Indeterminate Organic Paint. Cibola gray wares are very difficult to distinguish from sand tempered gray wares produced in other areas of the Southwest, and were seldom recognized during the present study. A single Unpainted White Mountain Red Ware sherd was identified.

The distribution of both gray and white ware types from both Rooms 5 and 7 are indicative of an occupation during the very late part of the Pueblo II period. The overall distribution of types noted in the current study is similar, if not identical to those documented by Eddy (1977). Some of the most notable similarities include Mancos Black-on-white as the dominant white ware, and overall dominance of corrugated gray ware. Further, most of the decorated white and utility gray ware pottery from Chimney Rock Pueblo was assigned to Northern San Juan types, and a low frequency of pottery assigned to types defined for the Chaco tradition was assigned in both studies.

Ceramic distributions noted at Chimney Rock support both a time of occupation and level of interaction consistent with a Chaco outlier. As is the case for other northern Chaco outliers, these assemblages contain a combination of types reflecting local production of San Juan types and types produced in the Chaco and Chuska regions to the south.

Geophysics

Students from the Colorado School of Mines completed geophysical investigations on the western portion of the site to identify evidence for the presence of walls originally mapped by Jeancon (1922), but no longer visible. The results of geophysical investigations were positive, with strong evidence for previously mapped walls below the ground surface (Appendix I).

Artifact Lists

The following tables (Tables 22-30) summarize the artifacts recovered from Room 5 and 7. "PD" stands for "Provenience Designation" and "PL" for "Point Location." See the *Field Methods* portion of this report for more information on methods used to record the excavations.

Table 22. Flotation Samples.

Room	PD	PL	Bag Date	Provenience
7	NA	NA	6/3/09	Stratum 1, Levels 1-3
7	NA	NA	No Date	Stratum 1, Levels 1-3
7	NA	NA	No Date	Stratum 1
7	49	NA	6/24/09	Stratum 5
7	49	NA	6/24/09	Stratum 5
7	53	NA	6/23/09	Feature 4, South ½
7	47	NA	6/22/09	Feature 4
7	47	NA	6/22/09	Stratum 4
5	2, 13	NA	6/3/09	NE Quadrant, Stratum 1, Levels 1-2
5	2/13	NA	6/3/09	NE Quadrant, Stratum 1, Levels 1-2
5	35	29	6/23/09	Stratum 4
5	45	NA	6/23/09	Surface 2, Feature 2
5	41	NA	6/22/09	Stratum 4, Feature 1
5	35	NA	6/30/09	Stratum 4
7	56	NA	6/24/09	Stratum 6, Full Cut
7	38	NA	6/22/09	South ½ Feature 1

Table 23. Pollen Samples.

Room	PD	PL	Bag Date	Provenience
7	56	NA	6/29/09	Stratum 6
7	46	NA	6/29/09	Stratum 3
7	27,29,30	NA	6/29/09	Stratum 2
7	47	NA	6/29/09	Stratum 4
7	49	NA	6/29/09	Stratum 5
7	12,24,26	NA	6/29/09	Stratum 1
7	31	23	6/22/09	Surface 1
7	31	25	6/22/09	Surface 1
7	31	24	6/22/09	Surface 1
5	23	NA	6/30/09	Stratum 2, Level 2
5	28	NA	6/30/09	Stratum 2, Level 2
5	32	NA	6/30/09	Stratum 3, Level 1-2
5	40	NA	6/30/09	Stratum 5, Level 1
5	35	NA	6/30/09	Stratum 4, Level 1
5	34	NA	6/30/09	Surface 1
5	35	NA	6/30/09	Stratum 4, Level 1

Table 24. Botanical Samples.

Room	PD	PL	Bag Date	Provenience
7	29	30	6/18/09	Stratum 2 Level 2
7	29	39	6/18/09	Stratum 2 Level 2
7	29	47	6/18/09	Stratum 2 Level 2
7	29	29 Box A	6/17/09	Stratum 2 Level 2
7	29	40 Box A	6/17/09	Stratum 2 Level 2
7	29	40 Box B	6/17/09	Stratum 2 Level 2
7	29	40 Box C	6/17/09	Stratum 2 Level 2
7	29	NA	6/17/09	Stratum 2 Level 2
5	22	NA	6/9/09	Stratum 1 Level 2
7	29	12	6/16/09	Stratum 2 Level 2
7	31	20	6/18/09	Surface 1
7	29	NA	6/17/09	Stratum 2 Level 2
7	29	29 Box B	6/17/09	Stratum 2 Level 2
7	29	29 Box C	6/17/09	Stratum 2 Level 2
7	29	29 Box D	6/17/09	Stratum 2 Level 2
5	34	NA	6/18/09	Surface 1
5	45	NA	6/18/09	Feature 2 (Full Cut)
5	35	NA	6/22/09	Stratum 4 Level 1
5	25	NA	6/11/09	Stratum 2 Level 2
5	22	NA	6/8/09	Stratum 1 Level 2
7	53	2	6/23/09	Feature 4 Full cut of South ½
7	29	50 (1 of 3	6/18/09	Stratum 2 Level 2
7	29	50 (2 of 3	6/18/09	Stratum 2 Level 2
7	29	50 (3 of 3	6/18/09	Stratum 2 Level 2
7	29	NA	6/18/09	Stratum 2 Level 2
5	32	NA	6/17/09	Stratum 3 Level 2
5	28	NA	6/15/09	Stratum 3 Level 1
5	32	NA	6/18/09	Stratum 3 Level 2
7	NA	NA	No Date	General vegetal sample
5	25	NA	6/11/09	Stratum 2 Level 2
5	23	NA	6/9/09	Stratum 2 Level 1
5	23	NA	6/9/09	Stratum 2 Level 1
7	29	NA	No Date	Stratum 2 Level 2
7	29	29.7	6/15/09	Stratum 2 Level 2
7	29	13	6/16/09	Stratum 2 Level 2

Table 25. Ceramics.

Room	PD	PL	Bag Date	Provenience
7	31	17	6/18/09	Surface 1
5	43	30	6/23/09	Surface 2
7	31	10	6/17/09	Surface 1
7	31	9	6/18/09	Surface 1
7	31	NA	6/23/09	Surface 1
7	31	3	6/17/09	Surface 1
7	29	NA	6/16/09	Stratum 2 Level 2
7	47	NA	6/24/09	Stratum 4 Level 1
7	31	8	6/17/09	Surface 1
5	35	NA	6/18/09	Stratum 4 Level 1
7	31	4	6/17/09	Surface 1
7	31	5	6/17/09	Surface 1
7	31	18	6/18/09	Surface 1
7	56	NA	6/25/09	Stratum 6
5	32	NA	6/17/09	Stratum 3 Level 2
7	48	1	6/24/09	Surface 2
5	25	NA	6/15/09	Stratum 2 Level 2
7	31	13	6/17/09	Surface 1
7	30	33	6/17/09	Stratum 2 Level 3
5	34	NA	6/18/09	Surface 1
7	33	NA	6/23/09	Feature 1 (Full Cut of North ½)
5	40	NA	6/22/09	Stratum 5 Level 1
5	32	24	6/17/09	Stratum 3 Level 2
7	53	NA	6/23/09	Feature 4 Full cut of South ½
7	46	NA	6/23/09	Stratum 3 Level 1
7	42	NA	6/22/09	Stratum 3 Level 1 (Includes Strata 3-5; PDs 46, 47, 49)
7	49	NA	6/24/09	Stratum 5
7	36	NA	6/18/09	Feature 1 (Stratum 1, South ½)
7	29	48	6/18/09	Stratum 2 Level 2
7	6	NA	6/1/09	Stratum 1 Level 1
7	31	2	6/17/09	Surface 1
5	28	NA	6/15/09	Stratum 3 Level 1
7	31	9	6/17/09	Surface 1
7	12	NA	6/4/09	Stratum 1 Level 1
7	26	NA	6/11/09	Stratum 1 Level 3
7	14	NA	6/2/09	Stratum 1 Level 2
7	31	6	6/17/09	Surface 1
7	31	11	6/17/09	Surface 1
7	29	28	6/17/09	Stratum 2 Level 2
7	31	16	6/18/09	Surface 1
7	30	NA	6/17/09	Stratum 2 Level 3

7	33	NA	6/18/09	Feature 1 (Full Cut of North ½)
7	37	NA	6/18/09	Feature 1 (Stratum 2, South ½)
5	15	NA	6/1/09	Stratum 1 Level 3
5	35/40	NA	6/22/09	Stratum 4 Level 1/ Stratum 5 Level 1
7	31	1	6/17/09	Surface 1

Table 26. Dendrochronology Samples.

Room	PD	PL	Bag Date	Provenience
7	30	34	6/17/09	Stratum 2 Level 3
7	29	44	6/17/09	Stratum 2 Level 2
7	29	45	6/17/09	Stratum 2 Level 2
7	29	41	6/17/09	Stratum 2 Level 2
5	32	26	6/17/09	Stratum 3 Level 2
7	29	42	6/17/09	Stratum 2 Level 2
5	32	27	6/18/09	Stratum 3 Level 2
5	32	22	6/17/09	Stratum 3 Level 2
7	30	27	6/17/09	Stratum 2 Level 3
5	32	25	6/17/09	Stratum 3 Level 2
7	29	15	6/17/09	Stratum 2 Level 2
7	29	18	6/16/09	Stratum 2 Level 2
7	29	26	6/16/09	Stratum 2 Level 2
5	23	NA	6/9/09	Stratum 2 Level 1
7	29	19	6/16/09	Stratum 2 Level 2
7	29	17	6/16/09	Stratum 2 Level 2
7	29	20	6/16/09	Stratum 2 Level 2
5	28	14	6/16/09	Stratum 3 Level 1
5	28	19	6/16/09	Stratum 3 Level 1
7	29	10	6/16/09	Stratum 2 Level 2
5	25	NA	6/11/09	Stratum 2 Level 2
5	28	15	6/16/09	Stratum 3 Level 1
7	29	4	6/15/09	Stratum 2 Level 2
5	28	20	6/17/09	Stratum 3 Level 1
5	32	21	6/17/09	Stratum 3 Level 2
5	28	21	6/17/09	Stratum 3 Level 1
7	29	21	6/16/09	Stratum 2 Level 2
7	29	46	6/17/09	Stratum 2 Level 2
7	29	22	6/16/09	Stratum 2 Level 2
7	29	11	6/16/09	Stratum 2 Level 2
5	28	17	6/16/09	Stratum 3 Level 1
7	29	6	6/15/09	Stratum 2 Level 2
7	29	NA	6/16/09	Stratum 2 Level 2
5	28	13	6/16/09	Stratum 3 Level 1
5	28	12	6/16/09	Stratum 3 Level 1
7	29	24	6/16/09	Stratum 2 Level 2

7	27	3	6/15/09	Stratum 2 Level 1
7	27	1	6/15/09	Stratum 2 Level 1
7	29	16	6/16/09	Stratum 2 Level 2
7	29	5	6/15/09	Stratum 2 Level 2
5	28	1	6/15/09	Stratum 3 Level 1
7	29	25	6/16/09	Stratum 2 Level 2
7	29	9	6/15/09	Stratum 2 Level 2
7	29	23	6/16/09	Stratum 2 Level 2
5	28	8	6/15/09	Stratum 3 Level 1
5	28	7	6/15/09	Stratum 3 Level 1
5	28	11	6/15/09	Stratum 3 Level 1
5	28	6	6/15/09	Stratum 3 Level 1
7	29	8	6/15/09	Stratum 2 Level 2
7	27	2	6/15/09	Stratum 2 Level 1
5	28	10	6/15/09	Stratum 3 Level 1
5	28	5	6/15/09	Stratum 3 Level 1
5	28	3	6/15/09	Stratum 3 Level 1
5	28	2	6/15/09	Stratum 3 Level 1
5	28	4	6/15/09	Stratum 3 Level 1
5	28	9	6/15/09	Stratum 3 Level 1

Table 27. Miscellaneous.

Room	PD	Bag Date	Contents	Provenience
7	8	6/9/09	Bullet Shell	Stratum 1 Level 1
5	3	6/8/09	Glass	Modern Ground Surface

Table 28. Adobe Fragments.

Room	PD	Bag Date	Provenience
7	29	6/15/09	Stratum 2 Level 2
5	28	6/16/09	Stratum 3 Level 1
5	28	6/15/09	Stratum 3 Level 1
5	28	6/15/09	Stratum 3 Level 1
5	23	6/9/09	Stratum 2 Level 1

Table 29. Faunal Bone.

Room	PD	PL	Bag Date	Provenience
7	42	NA	6/22/09	Stratum 3 Level 1 (Includes Strata 3-5; PDs 46, 47, 49)
7	31	14	6/17/09	Surface 1
7	47	NA	6/24/09	Stratum 4 Level 1
7	29	NA	6/16/09	Stratum 2 Level 2
7	31	NA	6/23/09	Surface 1
7	12	NA	6/4/09	Stratum 1 Level 1
7	49	NA	6/23/09	Stratum 5
7	33	NA	6/18/09	Feature 1 (Full Cut of North ½)
7	56	NA	6/25/09	Stratum 6
7	46	NA	6/23/09	Stratum 3 Level 1
7	6	NA	6/1/09	Stratum 1 Level 1
7	37	NA	6/18/09	Feature 1 (Stratum 2, South ½)
5	15	NA	6/1/09	Stratum 1 Level 3
5	23	NA	6/9/09	Stratum 2 Level 1
7	36	NA	6/18/09	Feature 1 (Stratum 1, South ½)
5	28	NA	6/17/09	Stratum 3 Level 1
5	40	NA	6/22/09	Stratum 5 Level 1
7	29	35	6/17/09	Stratum 2 Level 2
5	32	NA	6/17/09	Stratum 3 Level 2
5	13	NA	6/17/09	Stratum 1 Level 2
7	55	NA	6/25/09	Feature 6
7	29	37	6/17/09	Stratum 2 Level 2
7	53	NA	6/23/09	Feature 4 Full cut of South ½
7	31	NA	6/23/09	Surface 1
7	30	NA	6/17/09	Stratum 2 Level 3
7	31	12	6/17/09	Surface 1
7	30	NA	6/17/09	Stratum 2 Level 3
7	24	NA	6/18/09	Stratum 1 Level 2
7	29	NA	6/18/09	Stratum 2 Level 2
7	29	49	6/18/09	Stratum 2 Level 2
5	25	NA	6/11/09	Stratum 2 Level 2
5	28	NA	6/19/09	Stratum 3 Level 1
7	33	NA	6/23/09	Feature 1 (Full Cut of North ½)
5	35/40	NA	6/22/09	Stratum 4 Level 1/ Stratum 5 Level 1
7	31	NA	6/18/09	Surface 1
5	28	NA	6/16/09	Stratum 3 Level 1

Table 30. Lithics.

Room	PD	PL	Bag Date	Provenience
7	47	NA	6/24/09	Stratum 4 Level 1
7	42	NA	6/22/09	Stratum 3 Level 1 (Includes Strata 3-5; PDs 46, 47, 49)
7	49	NA	6/24/09	Stratum 5
5	45	NA	6/23/09	Feature 2 (Full Cut)
5	22	NA	6/8/09	Stratum 1 Level 2
5	28	NA	6/17/09	Stratum 3 Level 1
7	33	NA	6/18/09	Feature 1 (Full Cut of North ½)
5	34	NA	6/18/09	Surface 1
7	10	NA	6/8/09	Stratum 1 Level 1
7	29	43	6/17/09	Stratum 2 Level 2
5	40	NA	6/22/09	Stratum 5 Level 1
7	46	NA	6/23/09	Stratum 3 Level 1
5	25	NA	6/11/09	Stratum 2 Level 2
5	15	NA	6/1/09	Stratum 1 Level 3
5	21	NA	6/3/09	Stratum 1 Level 1
7	29	NA	6/18/09	Stratum 2 Level 2
7	16	NA	6/2/09	Stratum 1 Level 3
5	35	NA	6/18/09	Stratum 4 Level 1
5	28	NA	6/16/09	Stratum 3 Level 1
7	49	NA	6/24/09	Stratum 5
5	17	NA	6/2/09	Stratum 1 Level 4
7	29	36	6/17/09	Stratum 2 Level 2
7	56	NA	6/24/09	Stratum 6
5	25	NA	6/11/09	Stratum 2 Level 2
7	31	22	6/18/09	Surface 1
7	56	1	6/25/09	Stratum 6
7	31	15	6/18/09	Surface 1
7	6	NA	6/1/09	Stratum 1 Level 1
7	33	51	6/23/09	Feature 1 (Full Cut of North ½)
7	31	7	6/17/09	Surface 1
7	55	NA	6/25/09	Feature 6
5	40	NA	6/23/09	Stratum 5 Level 1
7	29	NA	6/22/09	Stratum 2 Level 2
7	46	NA	6/29/09	Stratum 3 Level 1
5	28	16	6/16/09	Stratum 3 Level 1
7	37	NA	6/22/09	Feature 1 (Stratum 2, South ½)
5	23	NA	6/9/09	Stratum 2 Level 1
7	35	NA	6/18/09	Stratum 4 Level 1

Field Conditions

Field conditions were remarkably pleasant and did not require any modifications to initial excavation plans. Results were not affected by field conditions.

Evaluation of Research

The primary goal of this project was preservation of Chimney Rock Great House. Stabilization studies (Hovezak 2007) indicated that fill levels in Rooms 5 and 7 needed to be reduced to within 1 meter of the fill levels in adjacent rooms to reduce stress on ancient walls. To accomplish this, approximately 60 cm of fill was removed from both Rooms 5 and 7. This amounts to about 12.6 cubic meters of fill.

Other research questions focused on the chronology of the construction of Chimney Rock Great House and its relationship to Chaco Canyon. Radiocarbon dates from the uppermost floor surface of Room 7 and from subfloor deposits of Room 5 fall between A.D. 1000 and 1210 at a 2 sigma confidence level. This radiocarbon dating places Chimney Rock firmly in the era of Chacoan influence. Near cutting dates of A.D. 1093 from Room 7 further support Eddy's (1977) contention that the site was roofed (or reroofed) in or around that year. An intriguing early cutting date of A.D. 1011 and a near cutting date of A.D. 1018 from Room 5 hint at a possible earlier construction for the great house, or at the very least of the re-use of "special" wood. The tree ring dates also strengthen the connection between Chimney Rock and astronomical events: a minor lunar standstill occurred in A.D. 1011, and a major lunar standstill occurred in both A.D. 1018 and 1093.

Next, what was the relationship between Chimney Rock, Chaco Canyon, and the local community? This question will be addressed in much greater depth in Todd's dissertation where Chimney Rock will be compared with the nearby Ravine Site, the Bluff Great House and Corral Canyon Site in Utah, and Pueblo Alto and 29SJ 627 in Chaco Canyon, but a few preliminary statements can be made here. The original architecture of Chimney Rock Great House revealed during the course of excavations fits comfortably into Chaco Type II. The ceramic assemblage indicates a mix of local and Chacoan types. The lithic assemblage is dominated by local materials, but does contain Narbona Pass Chert, frequently associated with Chaco Canyon between A.D. 1050 and 1100. Strontium analysis shows that corn was likely being grown in the Piedra River Valley below Chimney Rock. These lines of evidence indicate close connections to Chaco Canyon and that Chimney Rock was likely constructed by individuals from the Canyon with detailed architectural knowledge. In terms of the local community, even the most cursory examination of architectural styles indicates stark differences between the Great House and the surrounding habitations. Very likely, there was a small local population in the area prior to the construction of the great house. This population greatly increased during the tenure of the great house, with an influx of people who retained their traditional architectural practices.

Site Evaluation and Recommendation

Chimney Rock Great House (5AA83) was listed on the National Register of Historic Places on August 25, 1970.

Summary and Conclusions

Archaeologists from the University of Colorado at Boulder completed fill reduction and limited testing activities at Chimney Rock Great House (5AA83) June 1-July 3, 2009. Fill reduction was needed in Rooms 5 and 7 to reduce stress on prehistoric walls. Approximate 60 cm of fill was removed from each room to accomplish preservation goals.

Limited testing in the southwest quadrant of each room was completed. Test excavations went below the floor surfaces in each room to bedrock. The research questions and results of these tests are discussed in greater depth above and in the appendices. In sum, Chimney Rock Great House appears to have been constructed by individuals from Chaco Canyon with considerable knowledge of Chacoan architectural practices. As would be expected from an outlying site at a significant distance from Chaco Canyon, the artifact assemblage consists of a mix of local and Chacoan materials.

Dendrochronological dates both support existing understanding of the great house and inspire more questions. Could the great house have been constructed much earlier than previously thought, in the early eleventh century? Or, were the architects of the great house reusing "special" wood harvested in astronomically significant years? The recovery of more wood samples from different locations of the great house could inform upon these questions.

References Cited

Adams, Karen R. and Kenneth Lee Peterson
1999 Environment. In *Colorado Prehistory: A Context for the Southern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp. 14-50. Colorado Council of Professional Archaeologists.

Benson, L.V., Berry, M.S., Jolie, E.A., Spangler, J.D., Stahle, D.W., and Hattori, E.M.,
2007 Possible impacts of early-11th-, middle-12th- and late-13th-century droughts on western Native Americans and the Mississippian Cahokians: Quaternary Science Reviews, v. 26, p. 336-350.

Bradley, Bruce
2004 Wallace Ruin and Chacoan Missions. . In *Chimney Rock: The Ultimate Outlier*, edited by J. McKim Malville, pp. 115-122. Lexington Books, Lanham.

Cameron, Catherine
2001 Pink Chert, Projectile Points, and the Chacoan Regional System. *American Antiquity* 66(1):79-102.

2008 *Chaco and After in the Northern San Juan: Excavations at the Bluff Great House.* University of Arizona Press, Tucson.

Cameron, Catherine M. and H. Wolcott Toll
2001 Deciphering the Organization of Production in Chaco Canyon. *American Antiquity* 66(1): 5-13.

Charles, Mona C.
1991 *Chimney Rock Barrier Free Trail Mitigation.* Powderhorn Research for the USDA San Juan National Forest.

Chuipka, Jason P., Richard Wilshusen, and Jerry Fetterman
2010 *The Northern San Juan Basin Settlement Survey Project, Archuleta and La Plata Counties, Colorado: Context and Research Design (SJNF #09-013/SJFO #09-017*). Prepared for the USFS and BLM, San Juan Public Lands, Durango, CO and the Chimney Rock Interpretive Association, Pagosa Springs, CO by Woods Canyon Archaeological Consultants, Inc., Yellow Jacket, CO

Cordell, Linda
1997 *Archaeology of the Southwest.* Second Edition. Academic Press, San Diego.

Crow Canyon Archaeological Center

2001 *The Crow Canyon Archaeological Center Field Manual* [HTML Title].Available: http://www.crowcanyon.org/fieldmanual. Date of use: June 2009.

Crown, Patricia L. and W. James Judge

1991 Introduction. In *Chaco and Hohokam Prehistoric Regional Systems in the American Southwest,* edited by Patricia L. Crown and W. James Judge, pp. 1-9, School of American Research Press, Santa Fe.

Dittert, Alfred E. Jr., J.J. Hester, and F.W. Eddy

1961 *An Archaeological Survey of the Navajo Reservoir District, Northwestern New Mexico.* The School of American Research and the Museum of New Mexico, Monographs 23, Santa Fe.

Eddy, Frank W.

1966 Prehistory in the Navajo Reservoir District, Northwestern New Mexico. Museum of New Mexico, Papers in Anthropology, No. 15, Parts I and II, Museum of New Mexico Press, Santa Fe.

1977 *Archaeological Investigations at Chimney Rock Mesa: 1970-1972*. Memoirs of the Colorado Archaeological Society 1. Boulder, Colorado

2004 Past and Present Research at Chimney Rock. In *Chimney Rock: The Ultimate Outlier*, edited by J. McKim Malville, pp. 23-50. Lexington Books, Lanham.

Freeman, Katherine, Robert Bliss, and Jennifer Thompson

1996 Visual Communication between Chimney Rock and Chaco Canyon. Paper presented at the Oxford V Conference on Archaeoastronomy, Santa Fe, NM August 3-13.

Hovezak, Timothy

2007 *Condition Assessment and Stabilization Recommendations for Three Archeological Sites in Chimney Rock Archaeological Area, San Juan National Forest, Archuleta County Colorado.* Submitted by Archaeological Site Conservation Program, Division of Research and Resource Management, Mesa Verde National Park to the U.S. Forest Service, San Juan National Forest.

Hovezak, Timothy D., Leslie M. Sesler, and Steven L. Fuller

2002 *Archaeological Investigations in the Fruitland Project Area: Late Archaic, Basketmaker, Pueblo I, and Navajo Sites in New Mexico*. Volume I: Introductory Chapters and Synthesis. La Plata Archaeological Consultants Research Papers No. 4, Dolores, CO.

Jeancon, Jean Allard
1922 Archaeological Research in the Northeastern San Juan Basin of Colorado During the Summer of 1921. The State History Society of Colorado and the University of Denver, Denver.

Jeancon, Jean Allard and Frank H.H. Roberts, Jr.
1924 Further Archaeological Research in the Northeastern San Juan Basin of Colorado, During the Summer of 1922. *Colorado Magazine* 1(2): 65-70, 1(3): 108-118.

Judge, W. James
1991 Chaco Prehistory and the Regional System. In *Chaco and Hohokam Prehistoric Regional Systems in the American Southwest,* edited by Patricia L. Crown and W. James Judge, pp. 11-30, School of American Research Press, Santa Fe.

Kane, Allen E.
2004 Chimney Rock: An Ancient Logging Town? In *Chimney Rock: The Ultimate Outlier,* edited by J. McKim Malville, pp. 99-114. Lexington Books, Lanham.

Kantner, John
2004 *Ancient Puebloan Southwest.* Cambridge University Press, Cambridge, UK.

Kantner, John, and Keith Kintigh
2006 The Chaco World. In *The Archaeology of Chaco Canyon: An Eleventh Century Pueblo Regional Center,* edited by Stephen H. Lekson, pp. 153-188. School of American Research Press, Santa Fe.

LaRocque, J.M.
1989 Ruin 5AA83, Historic American Building Survey, National Park Service.

Lekson, Stephen H.
1991 Settlement Pattern and the Chaco Region. In *Chaco and Hohokam: Prehistoric Regional Systems in the American Southwest,* edited by P. L. Crown and W. J. Judge, pp. 31–55. School of American Research Press, Santa Fe, New Mexico.

1996 Scale and Process in the American Southwest. In, *Interpreting Southwestern Diversity: Underlying Principles and Overarching Patterns,* Anthropological Research Papers, No. 48, edited by Fish, P.R., and Reid, J.J., pp. 81-86, Arizona State University, Tempe.

2004 Foreword. In *Chimney Rock: The Ultimate Outlier,* edited by J. McKim Malville, pp. vii-ix. Lexington Books, Lanham.

2006 Chaco Matters: An Introduction. In *The Archaeology of Chaco Canyon,* edited by Stephen H. Lekson, pp. 3-44. School of American Research Press, Santa Fe.

Lipe, William D., Mark D. Varien, and Richard H. Wilshusen, eds.
1999 *Colorado Prehistory: A Context for the Southern Colorado River Basin.* Colorado Council of Professional Archaeologists.

Lister, Florence C.
1993 *In the Shadow of the Rocks: Archaeology of the Chimney Rock District in Southern Colorado.* University Press of Colorado, Niwot.

Malville, J. McKim
2004 Ceremony and Astronomy at Chimney Rock. . In *Chimney Rock: The Ultimate Outlier,* edited by J. McKim Malville, pp. 131-150. Lexington Books, Lanham.

Marshall, Michael P., John R. Stein, Richard W. Loose and Judith E. Novotny
1979 *Anasazi Communities of the San Juan Basin*. State Historic Preservation Bureau, Santa Fe.

Mills, Barbara
2002 Recent Research on Chaco: Changing Views on Economy, Ritual, and Society. *Journal o f Archaeological Research* 10(1):65-117.

Ortman, Scott G., Erin L. Baxter, Carole L. Graham, G. Robin Lyle, Lew W. Matis, Jamie A. Merewether, R. David Satterwhite, and Jonathan D. Till
2005 *The Crow Canyon Archaeological Center Laboratory Manual, Version 1*. Electronic Resource. www.crowcanyon.org. Accessed 5/10/2008. Crow Canyon Archaeological Center, Cortez, CO.

Parker, Douglas R.
2004 Petrographic Analysis of Chimney Rock Ceramics. In *Chimney Rock: The Ultimate Outlier,* edited by J. McKim Malville, pp. 73-88. Lexington Books, Lanham.

Petersen, Kenneth Lee

1994 A Warm and Wet Little Climatic Optimum and a Cold and Dry Little Ice Age in the Southern Rocky Mountains, U.S.A. In *Climatic Change (*26): 243-369.

Reed, Paul ed.

2008 *Chaco's Northern Prodigies: Salmon, Aztec, and the Ascendancy of the Middle San Juan Region after AD 1100.* University of Utah Press, Salt Lake City.

Roberts, Frank H. H., Jr.

1925 Report on Archaeological Reconnaissance in Southwestern Colorado in the Summer of 1923. *Colorado Magazine 2: 1-80.*

1930 Early Pueblo Ruins in the Piedra District, Southwestern Colorado. *Bureau of American Ethnology Bulletin* 96.

Roney, John R.

2004 Bonito-style Greathouses. In *Chimney Rock: The Ultimate Outlier,* edited by J. McKim Malville, pp. 123-130. Lexington Books, Lanham.

Sullivan, Alan P. and Kenneth C. Rozen

1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50(4): 755-779.

Tucker, Gordon C. Jr.

2004 Chimney Rock as a Chacoan Port-of-Trade. In *Chimney Rock: The Ultimate Outlier,* edited by J. McKim Malville, pp. 89-98. Lexington Books, Lanham

Van Dyke, Ruth

1999 The Chaco Connection: Evaluating Bonito Style Architecture in Outlier Communities. *Journal of Anthropological Archaeology* 18(4):471-506.

2003 Bounding Chaco. *Kiva* 69(2):117-139.

Vivian, Gordon and Tom W. Mathews

1965 *Kin Kletso: A Pueblo III Community in Chaco Canyon, New Mexico.* Southwest Monuments Association, Technical Series 6, Part 1, Globe.

Warren, A.H.

1967 Chapter IV: Petrographic Analysis of Pottery and Lithics. In *An Archaeological*

Survey of the Chuska Valley and the Chaco Plateau New Mexico, edited by Arthur H. Harris, James Schoenwetter, and A.H. Warren, pp. 104-134. Museum of New Mexico Research Records no.4. Museum of New Mexico Press, Santa Fe.

Wilcox, D.R.

1993 The Evolution of a Chacoan Polity. In *The Chimney Rock Archaeological Symposium*, edited by J.M. Malville and G. Matlock, pp. 76-90. USDA Forest Service General Technical Report RM-227, Fort Collins, Colorado.

2004 The Evolution of the Chacoan Polity. In *Chimney Rock: The Ultimate Outlier*, edited by J. McKim Malville, pp. 163-186. Lexington Books, Lanham.

Wood, G. H., V. C. Kelley, and A. J. MacAlpin

1948 Geology of the southern part of Archuleta County, Colorado. United States Geological Survey Oil and Gas Investigations, Preliminary Map 81.

Yoffee, Norman

2001 The Chaco "rituality" revisited. In *Chaco Society and Polity*, edited by L.S. Cordell, W.J. Judge, and J. Piper, pp. 63-78, Special Publication 4, New Mexico Archaeological Council, Albuquerque.

Appendix A

Chipped Stone Analysis

Jakob Sedig

Analysis of Chipped Stone from Fill Level Reduction at Chimney Rock Summer 2009

Jakob Sedig

Methods

54 pieces of chipped stone were recovered from fill reduction in Rooms 5 and 7 of Chimney Rock Pueblo during the summer of 2009. Analysis of the chipped stone was conducted in the fall of 2009 and is presented in this report. This section outlines the methods used in the analysis of the chipped stone. I begin by describing the methods of stone tool analysis used, which are largely derived from Crow Canyon's (2005) system of chipped stone analysis and Sullivan and Rozen's (1985) method of debitage analysis. I then move to a discussion of chipped stone raw material identification, based on the system developed by A.H. Warren (1967).

Analysis of chipped stone from Chimney Rock Rooms 5 and 7 began by classifying each piece as debitage, a flake tool, or a formal tool. For this project, debitage is defined as any piece of chipped stone removed from a core and not used as a tool. Any piece of chipped stone classified as debitage was then determined whether to be debris (shatter), defined as any angular piece of stone lacking a bulb of percussion and a single interior surface, or a flake. Debitage identified as a flake was then classified as a complete flake, broken flake, or flake fragment. Following Sullivan and Rozen (1985), complete flakes have a bulb of percussion, single interior surface, and intact margins; broken flakes have a bulb of percussion, single interior surface, but lack intact margins; and flake fragments have a single interior surface, but no bulb of percussion. According to Sullivan and Rozen (1985), stages of stone tool production can be identified by examining the proportion of cores, complete flakes, broken flakes, and flake fragments present in a given area.

Chipped stone from Chimney Rock not identified as debitage was classified as either a flake tool (often referred to as expedient) or formal tool. Only four formal tools- three projectile points and one biface- were recovered from summer 2009 excavations (Figures 2, 3, 5, and 6). Following Crow Canyon's (2005) system, two types of flake tools were identified in this lithic analysis. Modified flakes are flakes that had at least one edge intentionally altered to create a simple tool for cutting, scraping, or slicing.

Utilized flakes were also used for these purposes, but no effort was put into preparing the edge. Flakes were examined under a binocular microscope at 10-30x magnifications to determine if unmodified edges were utilized.

Each piece of chipped stone, regardless of whether it was classified as debitage, a flake tool, or a formal tool, was assigned a raw material type using the Warren Code System (Warren 1967). Warren originally identified raw materials within an 110,000-acre area of the Navajo Indian Irrigation Project in northwest New Mexico and assigned each specific type a unique code; additional sources have been added to the original list since. Raw material of the Chimney Rock chipped stone collection was determined by comparing color, texture, and grain of the specimens to a Warren Code type collection held at the University of Colorado-Boulder.

Basic metric data was also recorded for each piece of chipped stone analyzed in this project. These include length, defined as the maximum distance of the longest axis of a flake, width, the distance of the axis perpendicular to this, and thickness. The research methods used in this analysis are meant to help elucidate how chipped stone was used at Chimney Rock pueblo.

Data

This section will provide data on the chipped stone recovered from Rooms 5 and 7 of Chimney Rock pueblo during summer 2009 fill reduction. Raw data for the chipped stone of each room can be found in Appendices 1 and 2. I will begin by reviewing the chipped stone from each room separately, and then move to a discussion of all the chipped stone in synthesis.

Room 5

23 pieces of chipped stone were recovered from Room 5 of Chimney Rock pueblo during summer 2009 fill reduction. Of these 23 artifacts, 10 were identified as debris/shatter, 3 as broken flakes, 5 as flake fragments, 2 as utilized flakes, and 1 piece as a modified flake. The 2 formal tools present included a broken projectile point (Figure 2) and a finely made biface (Figure 3). The chipped stone from Room 5 consists of 15 distinct types of raw material, the most common being local cherts and siltstones. These 15

distinct types can be grouped into 8 broad categories including: local cherts, siltstones, basalts, quartzites, Burro Canyon Orthoquartzites, Narbona Pass chert, and unidentifiable materials (Figure 1).

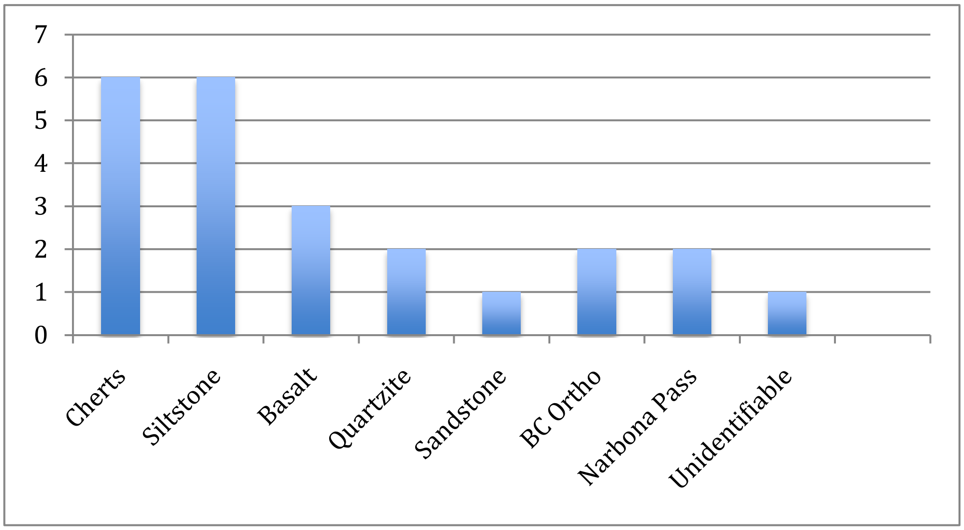


Figure 1. Room 5 Raw Material Distribution.

Figure 2. Orthoquartzite projectile point fragment recovered from Room 5.

Figure 3. Biface (possible Alibates chert) recovered from Room 5.

Table 1. Room 5 Raw Material/Chipped Stone Types.

	Debris/ Shatter	Broken Flake	Flake Fragment	Complete Flake	Utilized Flake	Modified Flake	Formal tool
Cherts	3	1	0	0	1	1	0
Siltstone	3	2	0	0	1	0	0
Basalt	2	0	1	0	0	0	0
Quartzite	0	0	2	0	0	0	0
Sandstone	1	0	0	0	0	0	0
BC Ortho	0	0	1	0	0	0	1
Narbona Pass	1	0	1	0	0	0	0
Unidentifiable	0	0	0	0	0	0	1

There appears to be no correlation between lithic material type and chipped stone type (debitage, flake tool, or formal tool) (Table 1); small sample size may have something to do with this. Additionally, utilized flakes, modified flakes, and formal tools, save for the biface, which will be discussed below, were constructed from a raw material also present as debitage in the collection, indicating that these tools were made and used on site.

Due to a small sample size, patterns in distribution of chipped stone within the stratigraphy of Room 5 remain somewhat ambiguous. However, some trends are apparent. Except for one broken flake in a subfloor pit-feature, all broken flakes, flake fragments, utilized and modified flakes were recovered from contexts on or above the floor (Table 2), indicating that the most intensive lithic reduction associated with Room 5 occurred after its completion. Yet debris/shatter was found above and below the floor in Room 5. This demonstrates that the reductive lithic activities associated with Room 5 were not limited to one particular point in time.

Table 2. Room 5 Chipped Stone Distribution.

	Debris/ Shatter	Broken Flake	Flake Fragment	Utilized Flake	Modified Flake	Formal tool
Wall/Roof Fall	2	1	3	2	0	0
Floor/Surface	3	1	2	0	1	0
Subfloor	5	0	0	0	0	2
Subfloor Pit	0	1	0	0	0	0

Special discussion is warranted for the biface recovered from in Room 5. The biface, along with the three projectile points from the site, constitute the only formal tools in the 2009 chipped stone collection. The biface was constructed from a material that is not part of the Warren Code type collection held at the University of Colorado-Boulder, thus it most likely comes from a non-local source, perhaps Alibates chert from Texas. No other piece of chipped stone is of this material; this suggests that the biface most likely was imported to the site as a finished tool. Use-wear on the edges of the biface indicates it was utilized as a knife or scrapper. Both the projectile point and the biface from Room 5 were found in sub-floor contexts near the west wall. This is intriguing, as most of the debitage was recovered from the floor or layers above it. Unique raw material, provenience, and fine construction of the biface all indicate to the author that it made as special deposit prior to the completion of the floor of Room 5.

To summarize, the small sample size from Room 5 makes any delineation in chipped stone patterns difficult. What is apparent is that local raw materials were reduced on site. No piece of chipped stone from Room 5 had cortex present; this indicates that raw material may have primarily reduced in another area and secondary/bifacial thinning occurred here. However, as a large portion of the chipped stone was recovered from mixed wall fall/roof fall deposits, it is difficult to determine whether these reduction processes occurred in Room 5 or somewhere else, and then was deposited as trash.

Room 7

31 pieces of chipped stone were recovered from Room 7 during summer 2009 fill reduction at Chimney Rock Pueblo. Of these, 11 pieces were debris/shatter, 1 was a broken flake, 3 were flake fragments, 4 were complete flakes, 9 were utilized flakes, 2 were formal tools (chalcedony projectile points) (Figures 5 and 6), and 1 piece was a spent core. 13 distinct types of raw material were present in Room 7. These can be grouped into 8 general groups composed of: local cherts, siltstones, undifferentiated clays, basalts and quartzites, red jasper, Narbona Pass chert, and unidentifiable material (Figure 4). Like Room 5, local cherts and silstones dominate the chipped stone assemblage from Room 7.

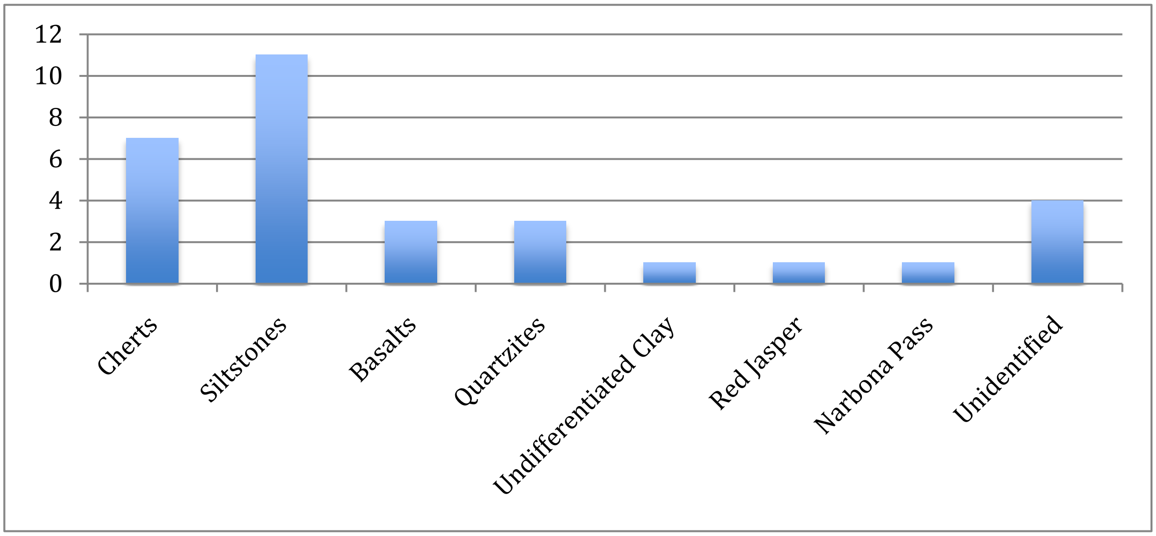


Figure 4. Room 7 Raw Material Distribution.

Like Room 5, there appears to be little correlation between raw material and chipped stone type (Table 3), or chipped stone type and provenience within the room's stratigraphy (Table 4). Once again, small sample size may have something to do with this. Despite this, there are a few interesting depositional patterns. 5 of the 11 pieces of siltstone recovered from the site came from PD 49, a cultural/construction fill below Surface 2. 4 pieces were debris/shatter; the other piece was a flake fragment. This debitage most likely came from a piece of chipped stone being shaped into a tool.

Figure 5. Chalcedony projectile point recovered from Room 7.

Figure 6. Chalcedony projectile point recovered from Room 7.

Table 3. Room 7 Raw Material/Chipped Stone Types

	Debris/ Shatter	Broken Flake	Flake Fragment	Complete Flake	Utilized Flake	Modified Flake	Core	Formal Tool
Chert	2	0	0	1	2	0	0	0
Siltstone	5	0	1	2	3	0	0	0
Undiff. Clay	1	0	0	0	0	0	0	0
Basalt	0	0	1	0	2	0	0	0
Quartzite	2	1	0	0	0	0	0	0
Chalcedony	0	0	0	0	0	0	0	2
Red Jasper	0	0	0	0	1	0	0	0
Narbona Pass Chert	0	0	1	0	0	0	0	0
Unidentifiable	1	0	0	1	1	0	1	0

Table 4. Room 7 Chipped Stone Distribution.

	Debris/ Shatter	Broken Flake	Flake Fragment	Complete Flake	Utilized Flake	Modified Flake	Core	Formal Tools
Wall Fall/Roof Fall	0	0	0	1	2	0	0	0
Refuse Deposit	1	0	0	2	1	0	0	1
Mixed Deposit	2	0	1	1	3	0	1	0
Surface 1	0	0	0	0	0	0	0	1
Sandy Lens Above Surface 2	3	0	0	0	0	0	0	0
Ashy Fill Above Surface 2	1	1	1	0	0	0	0	0
Sub-surface Cultural/ Construction Fill	4	0	1	0	2	0	0	0
Footer Trench	0	0	0	0	1	0	0	0

Also similar to Room 5, the majority of the chipped stone from Room 7 was classified as debris/shatter. However, there are aspects of the chipped stone collection from Room 7 that distinguish it from Room 5. Unlike Room 5, complete flakes and flakes with cortex on them were recovered from Room 7. Nine of the 31 (29%) pieces of chipped stone had cortex present. This, along with the presence of complete flakes, suggests that different stages of the lithic reduction processes are represented in the two rooms. The presence of a core, complete flakes, and cortex indicates that earlier, hard-hammer reduction is represented in Room 7. The chipped stone collection from Room 5, containing no pieces with cortex, no complete flakes, and more broken flakes and flake fragments may have been a result of later, soft-hammer reduction.

Discussion

This section will discuss the Chimney Rock chipped stone collection from summer 2009 excavations as a whole. Although only 54 pieces of chipped stone were excavated, some general trends and patterns are evident.

The inhabitants of Chimney Rock Pueblo used a wide variety of local raw materials, especially cherts and siltstones, to produce stone tools. Like most Southwestern stone tools, these were expedient, informal flake tools. The unmodified, sharp edges of flakes were used when a cutting or scraping tool was required. Only 4 "formal" tools were recovered from summer 2009 fill reduction; one of these, the biface, I argue was deposited as some sort of special object prior to the completion of Room 5. The other 3 are projectile points. What is most intriguing about these tools that of the 4 of them, 3 were constructed from material not recovered as debitage during summer 2009 fill reduction (the biface, and 2 projectile points made of chalcedony). Once again, this indicates that these formal tools were being imported to Chimney Rock as completed objects. Cameron (2001:79) notes a similar pattern with chipped stone from Chaco Canyon.

Formal tools, however, were not the only chipped stone imported to Chimney Rock. 3 pieces of Narbona Pass chert- a pink, lustrous chert with a source in the Chuska Mountains- were recovered during summer 2009 fill reduction. Cameron (2001:85) has previously noted the significance of this material within the Chaco Regional System, postulating that it "may have had value beyond the utilitarian", possibly valued as a gift, or as a minor tribute. Like Chaco Canyon (Cameron 2001:80), the majority of the chipped stone recovered during the summer of 2009 at Chimney Rock was gathered from sources within 5-20 km of the site. However, Cameron (2001:85) notes that from A.D. 1050-1100 the non-local Narbona Pass chert becomes more common in Chaco Canyon. It was during this time that Chimney Rock was founded and occupied, so it should come as no surprise that 3 pieces of Narbona Pass chert were uncovered at this Chacoan outlier.

The chipped stone recovered from Rooms 5 and 7 at Chimney Rock during summer 2009 fill reduction provides no evidence for specialization or intensive tool production. Chipped stone of various material types was recovered from multiple contexts. Most likely, the majority of the chipped stone collection represents standard, utilitarian use; people created simple, informal tools from readily available local materials when they needed. Yet some chipped stone was special, serving a function outside of utilitarian: the biface, finely flaked projectile points made from non-local materials, and Narbona pass chert all support this argument. This chipped stone data, along with analysis of other material culture recovered from summer 2009 fill reduction at Chimney Rock can help shed light on the lives of the people who inhabited this unique site.

References Cited

Cameron, Catherine
2001 Pink Chert, Projectile Points, and the Chacoan Regional System. *American Antiquity* 66(1):79-102.

Ortman, Scott G., Erin L. Baxter, Carole L. Graham, G. Robin Lyle, Lew W. Matis, Jamie A. Merewether, R. David Satterwhite, and Jonathan D. Till
2005 *The Crow Canyon Archaeological Center Laboratory Manual, Version 1*. Electronic Resource. www.crowcanyon.org. Accessed 5/10/2008. Crow Canyon Archaeological Center, Cortez, CO.

Sullivan, Alan P. and Kenneth C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50(4): 755-779.

Warren, A.H.
1967 Chapter IV: Petrographic Analysis of Pottery and Lithics. In *An Archaeological Survey of the Chuska Valley and the Chaco Plateau New Mexico*, edited by Arthur H. Harris, James Schoenwetter, and A.H. Warren, pp. 104-134. Museum of New Mexico Research Records no.4. Museum of New Mexico Press, Santa Fe.

Appendix 1. Room 5 Chipped Stone Debitage

PD#	Raw Material Type	Cortex?	Debitage	Debitage Type	Utilized Flake	Modified Flake	Maximum Length (cm)	Maximum Width (cm)	Maximum Thickness (cm)	Description
15	1011 Fossiliferous Chert	None	Yes	Broken Flake			1.09	0.79	0.16	Very small bifacial thinning flake
21	2251 Siltstone	None	Yes	Debris/Shatter			1.69	1.36	0.48	Debris/Shatter
21	1080 Narbona Pass	None	Yes	Debris/Shatter			2.26	1.25	0.84	Narbona, but debris/shatter
22	Brown Siltstone	None			X		2.82	2.74	0.77	Debris/Shatter, but edges have been utilized
25	3400 Basalt	None	Yes	Flake Fragment			1.87	2.37	0.41	Flake Fragment, no use-wear
25	1080 Narbona Pass	None	Yes	Flake Fragment			2.22	1.41	0.31	Flake Fragment, no use-wear
25	1040 Brushy Basin Heat treated?	None			X		2.39	1.45	2.22	Small, complete flake, edges have use
28	4063 Quartzite	None	yes	Flake Fragment			3.86	2.86	0.83	Flake fragment, not utilized
34	2260 Siltstone	None	Yes	Broken Flake			2.03	1.39	0.4	Small, unused broken flake
34	1040 Brushy Basin Heat treated?	None	Yes	Debris/Shatter			2	1.34	0.43	Piece of debris/shatter
34	1040 Brushy Basin Heat treated?	None	Yes	Debris/Shatter			1.17	0.82	0.31	Piece of debris/shatter
34	2000 Series, grey with black fleck inclusions Sandstone	None	Yes	Debris/Shatter			3.5	1.99	1.04	Piece of debris/shatter
34	4062 Quartzite	None	Yes	Flake Fragment			4.1	2.52	0.51	Broken flake, minor use-wear

Appendix 1. Room 5 Chipped Stone Debitage, cont'd.

PD#	Raw Material Type	Cortex?	Debitage	Debitage Type	Utilized Flake	Modified Flake	Maximum Length (cm)	Maximum Width (cm)	Maximum Thickness (cm)	Description
34	2245 Burro Canyon orthoquartzite	None	Yes	Flake Fragment			1.26	0.78	0.14	Small, broken flake. No use-wear
34	1011 Fossiliferous Chert	None				X	2.56	1.79	0.65	Small, thick, modified flake. Edges have been retouched
40	1050 Chert	None	Yes	Debris			0.87	1.01	0.4	Piece of debris/shatter
40	2250 Siltstone	None	Yes	Debris			3.08	1.93	1.38	Piece of debris/shatter
40	2250 Siltstone	None	Yes	Debris			2.96	0.97	0.35	Piece of debris/shatter
40	3400 Basalt	None	Yes	Debris			3.61	2.36	1.45	Piece of debris/shatter
40	3400 Basalt	None	Yes	Debris			2.27	1.33	0.42	Piece of debris/shatter
45	2552 Siltstone	None	Yes	Broken Flake			2.05	1.38	0.43	Broken Flake, no use-wear

Appendix 1. Room 5 Chipped Stone Formal Tools

PD#	Raw Material Type	Cortex?	Tool Type	Maximum Length (cm)	Maximum Width (cm)	Maximum Thickness (cm)	Use Wear	Description
35	2245 Burro Canyon orthoquartzite	None	Projectile Point	2.08	1.3	0.3	None	Chaco cornered notched point. Distal half is broken off. Thin, nicely made
40	Alibate? Not local	None	Biface	7.42	5	0.92	Yes	Bifacial tool, made from raw material analyist is unfamiliar with. Material is carmel brown in color, with white veins. Tip is white, while majority is caramel colored. Tool has been used, use-wear on edges.

Appendix 2. Room 7 Chipped Stone Debitage

PD#	Raw Material Type	Cortex?	Debitage	Debitage Type	Utilized Flake	Maximum Length (cm)	Maximum Width (cm)	Maximum Thickness (cm)	Description
10	Unidentifiable	Yes	Yes	Complete Flake		4.68	1.97	0.65	Complete flake that shows no evidence of use-wear. Dorsal side is cortex. Raw material type most similar to 1552 in texture, but not color
29	1060 Red Jasper	None			X	3.49	3.67	0.78	This is an unmodified flake that has use-wear on the edges
33	1040 Brushy Basin Chert	none	yes	Complete Flake		2.19	1.65	0.28	Complete flake, unused
33	2264 Siltstone	Yes	Yes	Complete Flake		3.14	2.62	1.15	Complete, unused primary flake
33	1040 Brushy Basin Chert	Yes	Yes	debris/shatter		1.48	1.18	0.58	Small piece of debris/shatter
37	3400 Basalt	Yes			X	6.15	4.5	2.12	Large primary flake, but utilized. Edges have use-wear
42	2261 Morrison Siltstone	Yes	Yes	Complete Flake		1.64	1.57	0.38	Small complete flake, no evidence of use-wear
42	Unidentifiable	none	Yes	Core		5.59	3.73	1.47	Spent Core
42	1421 Chert	none	Yes	Debris		1.63	0.66	0.13	Small piece of debris/shatter
42	4064 Quartzite	none	yes	Debris		5.25	2.79	0.84	Piece of debris/shatter
42	3400 Basalt	None		Flake Fragment		2.52	1.92	0.62	Flake fragment, minor use-wear on edge.
42	1011 Fossiliferous Chert	None			X	3.21	1.03	0.4	Bladelette like flake, edges have use-wear, tip crushing
42	2261 Morrison Siltstone	None			X	4.03	3.94	0.8	Complete flake with utilized edge
42	Unidentifiable	None			X	5.1	3.65	1.04	Large Flake fragment, proximal end has use-wear. Brown in color, most similar to mudstone in grain.
46	2500 Undifferentiated Clay	None	yes	Debris		2.9	2.08	0.52	Piece of debris/shatter

Appendix 2. Room 7 Chipped Stone Debitage, Cont'd.

PD#	Raw Material Type	Cortex?	Debitage	Debitage Type	Utilized Flake	Maximum Length (cm)	Maximum Width (cm)	Maximum Thickness (cm)	Description
46	2261 Morrison Siltstone	Yes	Yes	Debris		2.62	1.78	0.59	Piece of debris/shatter
46	4062 Quartzite	none	Yes	Debris		4.55	3.06	1.24	Piece of debris/shatter
46	1080 Narbona Pass	None	Yes	Flake Fragment		2.64	1.64	0.43	Flake fragment, not utilized
47	4062 Quartzite	none	Yes	Broken Flake		2.41	1.54	0.45	Small, broken flake. No evidence of use
47	Unidentifiable	Yes	Yes	Debris		5.55	4.18	1.43	Large piece of debris shatter/spall
49	2261 Morrison Siltstone	None	Yes	Debris		2.65	0.98	0.7	Piece of debris/shatter
49	2261 Morrison Siltstone	none	yes	Debris		6.43	4.07	2.93	Large piece of debris shatter/spall
49	2261 Morrison Siltstone	yes	yes	Debris		4.82	2.98	0.99	Debris with cortext present on over 50% of surface
49	2261 Morrison Siltstone	None	yes	Debris		3.4	2.34	1.12	Piece of debris/shatter
49	2261 Morrison Siltstone	None	Yes	Flake Fragment		2.14	1.75	0.42	Flake fragment, not utilized
49	1011 Fossiliferous Chert	None			X	3.9	4.07	1.38	Large, thick, complete flake with use along edges
49	3400 Basalt	None			X	4.69	3.23	0.7	Complete flake, utilized. Use wear on edges.
55	2264 Siltstone	None	Yes		X	4.51	3.61	1.68	Chunk of debris/shatter, edges have use-wear
29 PL :	2264 Siltstone	Yes			X	5.93	5.28	1.48	Large primary flake, but utilized. Edges have use-wear

Appendix 2. Room 7 Chipped Stone Formal Tools

PD#	PL#	Raw Material Type	Cortex	Tool Type	Maximum Length (cm)	Maximum Width (cm)	Maximum Thickness (cm)	Use Wear	Description
33	51	1090 Chalcedony	None	Projectile Point	2.18	1.12	0.26	None	Bifacially flaked, thin point. Base is missing.
31	7	1090 Chalcedony	None	Projectile Point	1.74	1.11	0.31	None	Small, dorsally flaked Chaco corner notched point. No use-wear, nicely made

Appendix B

Groundstone Analysis

Brenda Kaye Todd

Groundstone from Chimney Rock Great House (5AA83)

Brenda K. Todd, M.A.

University of Colorado, Boulder

Basic groundstone identification and analysis of materials recovered from Rooms 5 and 7 of Chimney Rock Great House (5AA83) was completed according to the guidelines defined in *The Crow Canyon Archaeological Center Laboratory Manual, Version 1* (2005). Artifact types were identified and measured. Only fifteen different groundstone specimens were recovered from Rooms 5 and 7. Much of the recovered groundstone appears to be from secondary depositional contexts, with a very few exceptions.

Nine groundstone artifacts were recovered from Room 7 (Table 1). Two small, unidentifiable pieces of groundstone were found in the upper fill of the room. Pieces of a fairly large metate (41x22x8 cm) were removed from Stratum 2 Level 2 of Room 7, the heart of the burned roof material. The metate may have been stored in or on top of the roof. Two pieces of groundstone were point located to floor Surface 1. These include a broken piece of a smooth, shaped slab and a portion of a large two-handed mano (16x11x4 cm). There was some burning on the broken end of the mano. One indeterminate piece of groundstone was recovered from the three centimeters of yellow sand found on top of Surface 3 in places. One shaped disc, likely a pot lid was recovered from Stratum 5, the construction fill laid on top of Surface 3 to create a flat floor surface for the room. This fill was mottled, and likely from a variety of different sources. Two pieces of groundstone were recovered from Stratum 6, the natural sediments atop Chimney Rock Mesa. These pieces include a one-handed mano and a circular shaped stone, likely a pot lid.

Six groundstone artifacts were recovered from Room 5 (Table 2). A hammerstone, two incomplete pieces of a heavily used mano, and a one handed mano were found in upper room fill dominated by wall fall and Aeolian deposits. A piece of a broken one-handed mano and a smooth shaped stone slab were recovered from Stratum 3 Level 1, approximately 30 cm above the only floor surface in the room. The slab is 40x20x1.5 cm and shaped by a combination of grinding and pecking. The slab was likely an architectural element or component of the roof that was deposited in fill as the room collapsed. One hammerstone was recovered from Stratum 4, the cultural fill immediately below Surface 1.

Table 1. Groundstone artifacts recovered from Room 7.

Room	PD	PL	Date	Provenience	Description
7	16	NA	6/2/09	Stratum 1 Level 3	2 small pieces of unidentifiable groundstone; 3x3x2 cm; 3x3x1 cm
7	29	NA	6/18/09	Stratum 2 Level 2	Unidentifiable groundstone fragment,burned; 8x13x2 cm
7	29	NA	6/22/09	Stratum 2 Level 2	Metate;30x22x8 cm; light use wear
7	29	NA	6/29/09	Stratum 2 Level 2	Large piece of metate above; 11x20x8 cm
7	29	NA	6/22/09	Stratum 2 Level 2	5 metate fragments from metate above
7	31	22	6/18/09	Surface 1	Broken piece of smoothed stone slab; 16x8x1 cm
7	31	15	6/18/09	Surface 1	Portion of large 2-handed mano; 16x11x4cm; some burning on broken end
7	46	NA	6/29/09	Stratum 3	Indeterminate fragment; 8x5x4 cm
7	49	NA	6/24/09	Stratum 5	Shaped disc, maybe a pot lid, 9 cm in diameter
7	56	NA	6/25/09	Stratum 6	1 handed mano; 16x8x3 cm
7	56	NA	6/24/09	Stratum 6	Oblong shaped disc, maybe a pot lid? 9x7x1 cm

Table 2. Groundstone artifacts recovered from Room 5.

Room	PD	PL	Date	Provenience	Description
5	17	NA	6/2/09	Stratum 1 Level 4	Hammerstone; 7x7x4 cm
5	23	NA	6/9/09	Stratum 2 Level 1	2 pieces of a heavily used mano. Incomplete, impossible to determine original size. 9x8x3 cm; 9x11x2 cm
5	25	NA	6/11/09	Stratum 2 Level 2	Small 1 handed mano; 12x8x3 cm
5	28	NA	6/16/09	Stratum 3 Level 1	Broken piece of one-handed mano, 8x6x2 cm
5	28	16	6/16/09	Stratum 3 Level 1	Smooth stone slab. 41x20x1.5 cm
5	35	NA	6/18/09	Stratum 4	Hammerstone; 7x7x2 cm

References Cited

Crow Canyon Archaeological Center

2005 *The Crow Canyon Archaeological Center Laboratory Manual, Version 1* [HTML Title].Available: http://www.crowcanyon.org/ResearchReports/LabManual/LaboratoryManual.pdf. Date of use: October 2010.

Appendix C

Faunal Analysis

Brigit Burbank

Faunal Remains Report Site 5AA83

Introduction

This report presents the analysis of the faunal remains collected from Chimney Rock Pueblo (Site 5AA83) during the summer of 2009. A brief description of Chimney Rock Pueblo including its ceremonial significance, the surrounding region, and status as a Chacoan outlier are given so the reader may place this site and its significance within the broader realm of Southwestern archaeology. The methodology and analytical procedures are discussed as are the taxa represented in the assemblage. This report also discusses the origins of the assemblage, considering specifically the natural and cultural forces responsible for creating and affecting the assemblage. Previous excavations at site 5AA83 are discussed as they provide a more full understanding of the site and some of the conclusions that other analysts have drawn based on similar faunal collections. A discussion regarding the faunal connections between Chimney Rock and Chaco Canyon as well as the significance of the bear mandible found on the site. The report closes with some concluding remarks regarding the site and the excavations at 5AA83.

Chimney Rock Pueblo

The faunal remains presented in this report came from site 5AA83, commonly referred to as Chimney Rock Pueblo. Chimney Rock Pueblo is located in the San Juan Basin in Southern Colorado (Lekson 2006: 262). The site is located on an isolated part of what is called the High Mesa. Chimney Rock Pueblo shares the High Mesa with a number of other structures collectively called the High Mesa Group, but the architecture of the structures differ significantly from the great house on 5AA83. These surrounding structures are all now mounds of rubble that were most likely above ground buildings of an oval or circular shape (Malville 2004: 24). These structures appear quite similar to Largo-Gallina communities (Malville 2004: 108) that are found in northwest New Mexico (Mackey & Holbrook 1978: 29). Essentially, the great house on site 5AA83 is unique in the area, and this is often used in theories that label Chimney Rock a Chacoan outlier.

Excavations at Chimney Rock during the early 1970s lead archaeologists to pinpoint the initial construction of the Chimney Rock Pueblo and the smaller structures that surround it to around 1076 with an approximate date of the abandonment around 1125 AD (Malville 2004: 26). There have been only three major excavations at the Chimney Rock Pueblo site 5AA83 including 2009. The first excavation took place in the summer of 1921. Excavators lead by Jean Jeancon fully excavated Rooms 6, 9, 10, 11, 12 as well as Rooms 38-43. The East Kiva, room 3 and a feature labeled Number 24 were also partially excavated (Malville 2004: 24). It appears that Jeancon's main goal in the excavation of Chimney Rock was to investigate the different types of architecture so he has done little more than mention the existence of faunal remains in a number of structures (Jeancon et al. 1922). The next excavations were conducted during the summers between 1970 and 1972 and lead by Frank Eddy (Eddy 1977). The section entitled intra-site comparison will explain further the outcomes of Eddy's excavations and their relevance to the current faunal remains recovered from site 5AA83.

Chimney Rock Pueblo is often identified as a Chacoan outlier because its architecture is incredibly similar to Chaco great houses and the pueblo was built and occupied during the same time period as Chaco Canyon. There can be no denying that Chimney Rock Pueblo bears a notable resemblance to Chaco great houses, but initially, Chimney Rock Pueblo was classified as a local phenomenon. When discussing the pueblos and the architectural features like the kivas found on a few high mesa sites, Jeancon states in his report, "That the whole culture is a local development can hardly be questioned, even taking into consideration the small amount of information at our disposal at this time" (Jeancon et al. 1922: 20). Also, author Gordon Tucker leans toward the idea that Chimney Rock Pueblo was probably a response by the local elites to changing environmental conditions as it helped them strengthen their power over the surrounding community. He does also accept that Chimney Rock could have been the result of a "site-unit intrusion", a phenomenon produced by Chacoan elites travelling to Chimney Rock and colonizing the high mesa after fleeing social upheaval in Chaco Canyon (Malville 2004: 89). However, Malville, Lekson and many others accept that there was probably some type of relationship between Chaco Canyon and Chimney Rock. Malville discusses the Chaco pottery discovered at site 5AA83 that was probably a result of trading with Chaco Canyon (Malville 2004: 86). The abundance of artifacts called feather holders found only at Chimney Rock, Chaco Canyon and Wallace Ruin, another outlier pointing towards a strong connection with Chaco Canyon. Lekson cites these feather holders as evidence of his proposed "political-prestige economy" that existed between Chaco Canyon and its outliers (Lekson 1999: 52). Lekson is a strong proponent of classifying Chimney Rock Pueblo as an outlier stating in his book *The Chaco Meridian*, "In the context of its local archaeology, Chimney Rock sticks out like a sore thumb. Chimney Rock is tidy and huge and very Chacoan; the community looks like somebody stepped in a unit pueblo and tracked it all over Stollsteimer Mesa (fig. 2.11). If ever there was a smoking gun outlier, it's Chimney Rock" (Lekson 1999: 38).

Chimney Rock is associated with a great deal of ceremonialism surrounding astronomical events. The twin towers site to the east of Chimney Rock Pueblo is thought to be the site of ceremonial fires that marked the summer and winter solstices. The fire pit between the two towers also marks the position where the moon will rise every 18.6 years (Malville 2004: 11). This event is known as a lunar standstill and archaeologists have dated the potential construction dates at Chimney Rock Pueblo to around the same time as the major lunar standstills (Mathien 1995: 180). It is likely that these astronomical events had a profound impact on the ceremonial practices of the Chimney Rock inhabitants.

Methodology

Identifications were made largely using the Simon Fraser University reference collection as well as a number of published osteological guides including *Teeth* by Simon Hillson (2005) and *Mammalian Osteo-Archaeology* by Miles Gilbert (1973). Weekly meetings with the analyst's supervisor, Bob Muir, also played a major role in the identification process. The analyst used Jon Driver's system for faunal analysis outlined in his "Manual for Description of Vertebrate Remains" (Driver 2006) in order to make the report comparable to faunal assemblage data derived from other Pueblo sites in the San Juan Basin, particularly those published by Crow Canyon Archaeological Center. The analyst recorded the taxonomic category, element, part, side, epiphyseal fusion, breakage type, any evident modifications to the bone, and the length and thickness of each fragment. The analyst attempted to reconstruct several elements including the patella of a large artiodactyl as well as the left and right sides of a bear mandible and the accompanying teeth. The fragments were glued together along breakage lines that were probably the result of post depositional taphonomic processes and excavation procedures. These elements were able to provide more information after reconstruction including the location of teeth and a more specific taxonomic determination for both the patella and the mandible.

The methods of this particular analysis deviated slightly from the criteria outlined in Driver's (2006) Manual in that fragments were assigned to the medium mammal category (MMA) even when they could not be identified as belonging to a certain element. In this analysis, the medium mammal category encompassed fragments of bones that appeared to have the same dimensions, (i.e. thickness, shape) as mammal long bones even if a specific element could not be determined. The analyst felt that even if bones were not assigned to a specific element, it would still be possible to rule out the reptile, bird or fish categories for a number of fragments that seemed to bear strong similarities to mammalian long bones. This category was also used for fragments that could be identified as a certain element, but were not diagnostic enough to be assigned a more specific designation.

Due to the small number of fragments that could be identified to relatively specific taxa, the analyst has not attempted to calculate MNI ore other estimates of absolute or relative abundance as there simply are not enough data to allow for meaningful calculations. Instead, only the number of fragments (NISP) that could be assigned to each taxonomic category is presented (see Table 1).

The excavation at 5AA83 was carried out in two particular rooms: Room 5 and Room 7. Faunal remains were collected from the southwest quadrant of each room after fill reduction efforts had removed the top 60 cm of earth from the contemporary ground surface. The excavators dug through the fill to about 15-20 cm below the room floors and stopped upon hitting bedrock (Todd 2009: 3-4).

Represented Taxa

The assemblage yielded a total of 594 fragments of bone, teeth, antler, and ossified cartilage. The remains that could be confidently identified include 361 fragments, which were distributed over 19 different taxonomic categories (see Table 1, below). These categories range from general identifications such as small mammals to more specific taxonomic designations like porcupine, vole, and wood rat. Medium-sized mammals dominate the assemblage with "Medium Mammal" being the most common taxon. Amongst the more specific taxonomic categories artiodactyls are most common, and it is likely that a majority of the remains identified as "Medium Mammal" are highly fragmented artiodactyls remains, though other animals that fall within this size class (e.g., canis sp. and large rodent) are also potentially represented. Larger mammals were also identified, incorporating several taxonomic groups: large mammals, large artiodactyl and grizzly bear. Bird remains of varying sizes were also identified, but a more specific determination other than the relative sizes small, medium and large was not possible as the remains were quite fragmentary and/or non-diagnostic. As many the of the remains were highly fragmentary, there are a number of quantitative biases that are worth discussing when examining the fragments counts for each of the more common taxa.

The medium mammal category is the most well represented taxonomic category in the assemblage with a total of 222 of the 594 fragments. This taxon is largely represented by ribs, vertebral fragments, and fragments resembling long bones, many of which contained spiral fractures. This category is definitely subject to quantitative bias as its highly fragmentary nature makes it subject to overrepresentation.

The second largest category is the medium artiodactyl taxon, which constitutes 71 of the 594 fragments and is largely represented by fragmented ribs, vertebrae, carpals and tarsals as well as a left and right mandible from a fetal individual. Based on the presence of both mature and immature artiodactyl remains, it is evident that at least two individuals are represented.

The cervid taxon makes up 38 of the 594 fragments in the assemblage, but this is a gross overrepresentation of the actual number of elements represented. The cervid taxon was assigned to 38 antler fragments and it is probable that most of these fragments represent a single set of antlers, which are most likely deer as they are not as large as elk or moose. Almost all of these fragments were found in the same provenience and contained the same blackened quality that was the result of burning.

A mandible of a grizzly bear complete with teeth was identified, this specimen was initially highly fragmented, but for the purposes of positive identification, was reconstructed (as mentioned above), and is thus treated as a single specimen in the catalogue, and collectively have an NISP value of 1.

The remaining 15 taxonomic categories include various small, medium, and large birds, rodents, canis sp., elk and deer. These categories are represented by 6 fragments or fewer with most of the remaining taxa being represented by 1 or 2 fragments. This has made it impractical to calculate MNI or other useful calculations like skeletal element frequency.

Origins of the Assemblage

Understanding the nature of the origins of the assemblage is integral to developing and understanding of the assemblage. During the excavations at Chimney Rock Mesa, by Frank Eddy from 1970-1972, archaeologists analyzing faunal material concluded that the room fill was likely the result of cultural processes. The analyst states in his report that , “Many of the bones, for example, show evidences of association with man (burns, cuts, shaping) and thus definitely are derived from the aboriginal habitation” (Harris 1977: 73). Furthermore the relatively high quantity of bones that are associated with the site are seen as evidence of human activity as there is no obvious natural explanation for the accumulation of these bones other than cultural processes. Statistical analyses also helped Harris confirm that there was not a distinct difference between the occupational and post-occupational faunal material.

Similarly, a number of modifications that point towards a cultural origin for the 2009 assemblage were observed. Spiral fractures were observed on 58 specimens (primarily artiodactyl and Medium Mammal remains) and a number of specimens (n=82) were burned. These latter remains were mostly found in the context of strata with burnt roof fill so it is unclear whether this burning is the result of natural or cultural agents. Only two bone fragments (both medium-sized mammal) displayed what appeared to be human produced cut marks and one antler fragment was clearly shaped and modified culturally. This latter artifact is small in size being only about 3.5 cm long and about 1 cm thick. The antler has been shaped into a cylindrical rod with a rounded top and a notch had been taken from one side of the rounded top, forming a shape that resembles the lingual view of a mammalian incisor. While the few rodent remains recovered, and perhaps even some of the bird remains that were identified may be the result of natural deposition, it is likely that this assemblage was largely the result of cultural deposition.

Comparisons to Past Excavations at 5AA83

Faunal remains recovered from Eddy's excavations of Chimney Rock Mesa (including 5AA83 and several other designated sites), were analysed and reported by Harris (1977). While Harris unfortunately provides only MNI data, some striking similarities are evident. Both assemblages are dominated by artiodactyls remains and all of the taxa identified amongst the 2009 assemblage were also identified amongst the previously collected remains. Furthermore, both assemblages happen to contain remains of immature artiodactyls. The 2009 assemblage contains two fetal artiodactyl mandibles while Harris reports 'fawns' being present amongst his assemblage. Together these remains indicate early to late spring hunting of deer. Both assemblages also contained antler remains, and in both cases the antlers were so fragmented most of them could only be identified as cervid (Harris 1977: 76). Unfortunately, the degree of fragmentation precludes determination of the maturity of the antlers or whether they had been shed or were removed from the skulls of animals. Other similarities include a significant lack of bird bones and the existence of porcupine in both collections. The porcupine remains found during the 1970s excavations, however, show evidence of cut marks and burning that associate their acquisition with human activity, while the three porcupine specimens found in the 2009 collection show no signs of cultural modification, but have all display carnivore damage (tooth marks).

The remains collected by Eddy include a variety of taxa that were not identified amongst the 2009 assemblage. This is not surprising given that the excavations were far more extensive and the assemblage much larger. These taxa include grouse, bobcat, mountain lion, beaver, muskrat, and otter; the latter three of which were taken to indicate possible hunting trips in surrounding river valleys (Harris 1977: 73). Rodents and lagomorphs (rabbits) are also somewhat more abundant amongst Eddy's assemblage, however this again is likely due to differences in sample size and the fact that Eddy's collection included a considerable amount of surface material.

Discussion

The faunal assemblage collected during the 2009 excavation at site 5AA83 is too small to draw any broad conclusions about diet, seasonality or function of the structures; however, it does seem to support a number of recognized trends that have already been established. Chaco great house inhabitants are reported to yield faunal remains largely consisting of deer and antelope unlike inhabitants of smaller Chacoan sites (Plog 1997: 109). This fits well with the faunal remains found at Chimney Rock Pueblo as there are numerous deer related taxa displayed at 5AA83 including medium artiodactyls, artiodactyls, cervid and odocoileus. Harris also found that around 55% of the remains from 5AA83 were classified as artiodactyls (1977: 73).

As noted by Harris (1977: 74) and supported by this analysis there is a distinct lack of bird remains at Chimney Rock. It is unlikely that this lack of bird remains is indicative of a depreciated bird population in the surrounding area, so it probably reflects an active choice not to consume birds (Harris 1977: 76), and suggests that the inhabitants of Chimney Rock were not actively engaged in raising or trading of live Turkeys or Macaws, though this does not necessarily preclude trade and use of the feathers of these animals.

Perhaps the most remarkable find was the mandible of a grizzly bear. After reconstruction, it was clear that the mandible was almost completely intact and nearly all teeth could be fitted back into their original sockets. It is likely that bears held a ceremonial significance at least for the Chimney Rock inhabitants. A small bear effigy made of pottery was found in the Guard House, a structure found on the upper mesa (Malville 2004: 7). This symbolic figurine is probably a reflection of the ceremonial importance of bear and perhaps the mandible also served a ceremonial purpose. The mandible was found amongst other burned material including wood and adobe (Todd 2009: 15) so the question becomes then whether these remains were burned in a natural or cultural context; and if cultural, whether the burning was intentional or not. It is possible that the fire was associated with a ceremonial context as fires were lit on the tower site adjacent to Chimney Rock Pueblo during the lunar standstills (Malville 2004: 11). Another possibility is the structure was intentionally burnt upon abandonment, with the bear remains stored amongst the roof beams, or intentionally discarded in the fire.

Conclusions

The faunal remains from this site have allowed some potential connections between Chimney Rock Pueblo and Chaco Canyon. This is important as the concept of a Chacoan outlier and the nature of its connection to Chaco Canyon is still a disputed concept (Lekson 1999: 32). Sampling biases due to limited spatial representation preclude strong statements about the site or mesa locality as a whole, however, when paired with previous faunal remains (Harris 1977) it appears as if the assemblage has provided a sample that is actually consistent with other larger samples from the locality . Although these faunal remains may not be able to provide significant conclusions, this result was probably expected by the excavators and archaeologists involved in the 2009 excavations. The goals of the project were mainly focused around fill reduction, which was needed to stabilize the walls of the pueblo structure.

Table 1: Number of identified specimen (NISP) data for site 5AA83, 2009 excavations.

Class/Order	Taxon	Common Name	Rm 5	Rm 7	Total
Aves	Small Bird	Smaller than Robin		1	1
	Medium Bird	Robin to Mallard sized	1		1
	Large Bird	Larger than Mallard		1	1
Rodentia	*Microtus* sp.	Vole	1		1
	Neotoma sp.	Wood Rat	1		1
	Erethizon dorsatum	Porcupine	1	2	3
	Large Rodent	Beaver, Porcupine, Marmot		1	1
Carnivora	*Canis* sp.	Coyote, Dog, Wolf	1		1
	Ursus arctos horribilis	Grizzly Bear	2		2
	Small Carnivore	Smaller than fox		1	1
Artiodactyla	*Odocoileus* sp.	Deer (mule or white-tailed)	2	4	6
	Cervus elaphus	Wapiti (elk)		2	2
	Cervid	Deer, Elk , Moose		38	38
	Medium Artiodactyl	Deer-sized artiodactyl	7	64	71
	Large Artiodactyl	Elk, Moose, Bison, Cattle		2	2
	Artiodactyl	Even-toed Ungulates		2	2
Misc. Mammal	Small Mammal	Smaller than dog		2	2
	Medium Mammal	Dog to deer sized	31	191	222
	Large Mammal	Larger than deer		3	3
Unidentified			97	136	233
		Grand Totals:	144	445	594

References

Chimney Rock Interpretive Association, Inc.
2009 *Chimney Rock Archaeological Area*. <www.chimneyrockco.org/standstill_intronew.htm>

Driver, Jonathan C.
2006 Manual for Description of Vertebrate Remains. Crow Canyon Archaeological Center (8): 1-32.

Eddy, Frank
1977 *Archaeological Investigations at Chimney Rock Mesa: 1970-1972*. Colorado: Colorado Archaeological Society.

Gilbert, Miles
1973 *Mammalian Osteo-Archaeology*. Missouri Archaeological Society: Columbia.

Harris, Arthur
1977 "Faunal Remains From Chimney Rock Mesa." Appendix A, pp. 73-76, in *Archaeological Investigations at Chimney Rock Mesa: 1970-1972*, By Frank Eddy. Colorado: Colorado Archaeological Society.

Hillson, Simon
2005 *Teeth.* Cambridge University Press: Cambridge.

Jeancon, Jean
1922 *Archaeological Research in the Northeastern San Juan Basin of Colorado During the Summer of 1921*. University of Denver Press: Colorado.

Lekson, Stephen
1999 *The Chaco Meridian: Centers of Political Power in the Ancient Southwest.* Sage Publications: London.

Plog, Stephen
1997 *Ancient Peoples of the American Southwest.* Thames and Hudson: London.

Mackey, James and Sally Holbrook
1978 Environmental Reconstruction and the Abandonment of the Largo-Gallina Area, New Mexico. *Journal of Field Archaeology* (5): 29-49.

Malville, McKim
2004 *Chaco Canyon: the ultimate outlier.* Lexington Books: Lanham.

Appendix D

Strontium Analysis of Corn

Kellam Throgmorton

Strontium Isotope Analysis of Corn Recovered from Chimney Rock Great House (5AA83)

Kellam Throgmorton
University of Colorado, Boulder
July 16, 2010

Strontium Isotope Analysis

Strontium isotopes within organically-derived materials have proven useful in determining the ultimate source of archaeological remains. The technique has most notably been used on human teeth and bone, but the same principle can be similarly applied to other organic materials, such as maize. Strontium analysis relies on the variation across space of ratios of the stable isotope 86Sr and the radioactive isotope 87Sr, which is produced by the radioactive decay of Rubidium 87. Strontium isotopes occur naturally in surface sediments, and soil water in contact with these sediments takes on the ratio of the mineral isotopes contained within (Benson 2010, 622). Plants that are growing within a sediment exhibiting a given 87Sr/86Sr isotope ratio will acquire that isotope ratio signature through the intake of soil water. This ratio remains constant within the plant after it dies as long as it is preserved in some manner, such as through desiccation or carbonization by combustion.

Recent research has used strontium isotope analysis to determine the source locations for archaeological maize recovered from a number of places around the American Southwest (Benson et al 2003; 2006; 2009). Other archaeological information supporting possible relationships between the recovery location and potential source of the maize is frequently brought to bear, for strontium isotope ratios from different regions can overlap. For example, archaeological maize samples obtained from Chaco Canyon and radiocarbon dated to the 12th century could have originated in any of five regions based on isotope ratio results. However, the Middle San Juan region was chosen as the likeliest source because it was clearly occupied during the period when the corn cobs were deposited (other areas were not), and sites within the Middle San Juan have demonstrable links with Chaco Canyon. (Benson 2010).

The identification of a source location requires that the strontium isotope ratio of the potential source be known; this can be accomplished either through directly sampling the soils and creating a synthetic soil-water or through collecting an indicator plant from a potential source and processing it to determine its strontium isotope ratio. Benson (2010:625) has shown that creating synthetic soil-water may release strontium that is not biologically available to plants, and thus it may be better to acquire strontium ratios from plants grown within a potential source soil.

Background to the Current Study

In the summer of 2009, the University of Colorado was asked to undertake the reduction of fill levels at Chimney Rock Pueblo, an 11th-12th century Ancestral Puebloan habitation that is considered to be a great house with links to Chaco Canyon. Since archaeological material would likely be encountered, fill was reduced in measured levels. A quarter of each room was excavated to bedrock for data recovery purposes.

Within Room 7--a plaza fronting first story room of Chimney Rock Pueblo--the grid southwest quarter of the room was excavated to bedrock. The roof of Room 7 had been burned and collapsed, which preserved material beneath the roof-fall. Near the door of Room 7, better airflow had more completely carbonized organic remains such as roof timbers and an elk antler, as well as maize which had been tied by a braided husk to the ceiling of the room. An additional quantity of maize may have been stored in a jar either hanging from the ceiling or placed on the floor near the wall--this jar was smashed by the falling roof beams but the cobs and ears contained within were preserved by being completely carbonized in the fire that consumed the roof of Room 7.

The recovery of the charred cobs and ears presented an opportunity to determine if they had been grown locally or imported from another location, potentially Chaco Canyon. Dr. Larry Benson of the United States Geological Survey in Boulder, Colorado is a leading researcher in the sourcing of archaeological maize specimens using strontium isotope analysis, and he agreed to process and analyze the Chimney Rock maize in the Taylor Laboratory at the USGS in Boulder.

Methods

Upon discovery, the charred maize was excavated with plastic implements to minimize potential metal contamination. The cobs and ears recovered in Room 7 were carefully boxed and a number of them delivered to Dr. Karen Adams who determined that there were two distinct cob morphologies, suggesting that two landraces of maize were represented in the sample. One of these morphologies is somewhat cigar-shaped and resembles Chapolote or Basketmaker varieties of maize; the other tapers from the apex to the butt and resembles a number of historic maize varieties (Adams 2010, 15). Dr. Adams shipped a selection six cobs and two ears (all charred; see Table 1) to the USGS for strontium analysis.

In order to determine the strontium isotope signature of the valley below the Chimney Rock site, we acquired samples of rabbitbrush growing in three separate locations within the valley. Rabbitbrush is a good indicator species of locations where corn could have been potentially grown in prehistory because it has similar growing requirements. The three rabbitbrush samples were brought back to the USGS in Boulder and placed in a freezer for storage.

Procedures for cleaning archaeologically recovered corn cobs are detailed in Benson et al (2010). The essential quandary in processing cobs for strontium analysis is that the same acids used to clean the cobs of mineral contaminant-containing dirt are powerful enough that they can remove too much strontium from the organic sample for an isotope ratio to be measurable. The procedures developed by Benson and others at the Taylor Lab seeks to maximize the removal of contaminating silicates and carbonates but minimize the organic sample's exposure to cleansing agents that may alter isotope ratios. The reason for the concern with mineral contaminants--particularly aluminosilicate minerals--is that Sr can substitute for K, Na, or Ca in a number of common minerals, and thus the isotope analysis may analyze the mineral, not the organic sample (Benson 2010, 626).

In this case, we decided that the eight archaeological cobs and ears appeared visually free from dirt, and that they could be processed, ashed, and analyzed without a lengthy cleaning process. The rabbitbrush samples were treated in a similar manner, but first needed to be processed and homogenized.

Rabbitbrush Processing Procedure

1. The first step involved initial processing of the rabbitbrush into small, homogenous samples. The plant stalks were removed approximately 2-3cm above the stem and root portion of the plant

on the assumption that dirt contamination would be highest near the interface with the ground. Half the plant specimen was bagged, and replaced in the freezer as an archive sample. The leaves of the remaining half were removed from the stalk, and both the stalk and leaves were cut with a ceramic knife into 1 cm long segments. The leaf and stalk segments were then combined into a homogenous pile so that all parts of the plant (aside from the root) would be present in any single sample. It was noted during this procedure that all the rabbitbrush samples had mold on them, but this was not thought to affect the outcome of the procedure.

2. In the second step, the rabbitbrush samples were freeze-dried. The cut and homogenized plant parts were placed in small teflon vials, which were placed in the freezer with a filter over the vial opening rather than a cap. This was to facilitate quicker freezing of the samples. After approximately 1.5 hours the samples were deemed sufficiently frozen, and were removed from the freezer and the teflon vials were placed in a large glass jar. The glass jar was attached to a lyophilizer, which established a vacuum within the jar and removed all the frozen moisture from the samples (which still have only filters over their openings, not caps). The rabbitbrush samples were left on the lyophilizer for approximately 40 hours until completely desiccated.

3. The third step involved further homogenization of the rabbitbrush, weighing, and ashing in a muffle furnace. Two acrylic ball bearings were placed in each teflon vial of rabbitbrush sample, and the vials were placed on a shaker for 25 minutes to homogenize the samples. The leafy portions were easily reduced to a powder, but the stalk portions were more resistant and some retained their original character. The samples were removed from the teflon vials, weighed, and then placed in a platinum crucible. The crucibles were placed in a muffle furnace and the samples ashed at 500 degrees Celsius for approximately 72 hours. When removed, it was observed that the leafy material had ashed completely to a powder, whereas the un-homogenized stalks had ashed, but retained their shape. However, it was decided that the stalks were sufficiently ashed to move to the next step.

4. In the final step prior to analysis, the ashed rabbitbrush samples were treated to remove any residual mineral contaminants and concentrated in solution. After removing the samples from

the muffle furnace, the ashed rabbitbrush was removed from the platinum crucibles using deionized water and placed in teflon vials. 1.77g of HCl and 0.5ml HNO3 was added to the vials, which were then placed on a sand bath to reduce the samples to dryness. A treatment of 2ml of HNO3 was then added and the samples placed back on the sand bath and reduced to dryness a second time. A final treatment of 2ml of HNO3 was added to the samples, which were placed on the sand bath and reduced to dryness a third time. This was the final processing step prior to analysis.

Archaeological Corn Cob Processing

1. The archaeological cobs and ears were cut in two halves with a ceramic knife, and then the halves were split down the middle. Two quarters of each cob or ear were archived at the USGS facility in Boulder for future reference. The remaining half of the sample was broken into small chunks, weighed, and placed in a platinum crucible. The samples were then ashed in a muffle furnace for 72 hours at 500 degrees Celsius. A control sample of corn bran was also placed in a platinum crucible and ashed along with the archaeological corn.

2. The ashed samples were removed from the muffle furnace and the remaining material was transferred to Teflon vials using deionized water. The archaeological maize and corn bran samples were then cleaned with the same sequence and volumes of HNO3 and HCl as are related in Step 4 of the rabbitbrush processing section.

Trace Metals Analysis for Aluminum

In order to check for potential contamination, the rabbitbrush and archaeological cobs and ears were analyzed for the presence of aluminum. As mentioned above, strontium can substitute for a number of other metals in aluminosilicate minerals, so high values of aluminum in a sample can be an indication that the sample was not adequately cleaned prior to analysis, and that the strontium isotope ratios may not be indicative of the organic portion of the sample. One ml of HNO3 was added to all samples, which were then diluted with 100 ml of DI in a volumetric flask. Inductively coupled plasma-atomic emission spectrometry (ICP-AES) was performed on the samples using a Perkin-Elmer Optima 3300 DV instrument to make trace-metals determinations for strontium and aluminum. The diluted samples are introduced into the plasma torch of the instrument using direct pneumatic nebulization. The plasma excites the atoms in the nebulized sample, causing the atoms to emit radiation indicative of their respective elements. The concentrations of the trace elements in question (in this case strontium and aluminum) can then be measured as a ration of the total sample volume. The results of this analysis are presented in Table 2.

Strontium Analysis of Archaeological Corn

After processing at the USGS facility in Boulder, the archaeological cob and rabbitbrush samples were analyzed for strontium isotope ratios by Dr. Emily Verplanck in Dr. Lang Farmer's laboratory at the University of Colorado, Boulder. A Finnigan-MAT 261 thermal-ionization mass spectrometer in 4-collector static mode was used to determine the ratios of 87Sr to 86Sr.

Results

The results of the strontium isotope analysis are contained in Table 2. As can be seen, all of the samples except for KA42 cob1 have elevated Al values suggesting some level of mineral contamination. Based on previous results, a cleaned cob with little contamination can be expected to have below 50 ug/g Al (Benson et al. 2010:87, Fig 4), while most of the Chimney Rock cobs and ears contain Al values in excess of 200. Cleaning is a process that runs the risk of removing too much Sr to measure the isotope ratios, so we had decided that based on the fact the cobs and ears were visually very clean that extensive cleaning with HCl and HNO3 was not necessary. Even greater levels of Al are observed in the rabbitbrush samples, suggesting that they too, while visually clean, should have undergone the cleaning process. Clearly, it is probably best to treat all archaeological samples as dirty and subject them to the cleaning process described in Benson et al. (2010).

However, the 87Sr/86Sr results cluster rather nicely, and correlate best with themselves and not with the Al values. Moreover, the archaeological maize samples are within the range exhibited by the rabbitbrush collected in the valley below Chimney Rock Pueblo. The 87Sr/86Sr values of the archaeological cobs range from 0.710014 to 0.710170 (with an average error of 0.0000115), while the rabbitbrush values range from 0.710082 to 0.711259 (with an average error of 0.0000093). That the isotope ratios of the archaeological corn overlaps with the isotope ratios of the rabbitbrush grown on local soils strongly suggests that the corn recovered at Chimney Rock Pueblo was grown locally in the valley below the site. There is no discernible difference in strontium ratio between the two distinct cob morphologies present.

Discussion

Published strontium isotope values of soil exist for a number of locations around the northern Southwest (Benson 2010:628, Fig. 5). A look at Figure 5 in Benson (2010) shows that the Chimney Rock cobs Sr isotope values are within the range represented by sample cobs from Gallo Cliff Dwelling, Chetro Ketl, and Pueblo Bonito. In addition, the Chimney Rock cobs also overlap with soil samples from the Nutria and Pescado areas at Zuni, the Defiance Plateau, and the Middle San Juan region in northwest New Mexico. Two Chimney Rock cobs have been dated by mass spectrometer to AD 1105 +_ 16 and AD 1106 +_15 (Calibrated dates, 1 sigma: Keck Carbon Cycle AMS Facility, UC Irvine). During this time period, all of the other potential source areas supported Ancestral Puebloan populations. The Zuni area supported populations from as early as the AD 900s, with a significant increase around AD 1100 (Kintigh et al 2004). The Defiance Plateau contained at least seven Chacoan great houses whose occupations overlap with the Chimney Rock cob dates, as well as countless numbers of small pueblos (Dennis Gilpin, personal communication 2010). Along the Middle San Juan, Salmon Ruin's initial occupation dates from AD 1090-1120, and construction at Aztec West began around AD 1100 with a major construction episode from AD 1105-1125 (Paul Reed, personal communication 2010).

While none of these three areas can be ruled out as candidate maize donors, the Middle San Juan region is by far the closest to the Chimney Rock area and is thus the strongest alternative source of the cobs recovered at Chimney Rock Pueblo. A high ridge to the south of Aztec and Salmon ruins is positioned such that it is the only necessary intermediate point in a line-of-site between Pueblo Alto above Chaco Canyon and Chimney Rock Pueblo. Any travel between Chaco Canyon and Chimney Rock Pueblo would by necessity have to pass through the Middle San Juan region. Regardless, there is no reason to doubt that the archaeological cobs recovered at

Chimney Rock Pueblo were grown in the area immediately surrounding the pueblo; while rather high in elevation and likely subject to cold air drainage, the area had played host to Pueblo I period populations three centuries before and maize production was clearly feasible. In addition, Dr. Adams noted that the variety of charred maize parts recovered, such as ears, husks and shanks, is evidence that the maize was probably not transported any great distance to Chimney Rock (Adams, 2010, 8). The most likely explanation is that the charred ears and cobs recovered from Room 7 at Chimney Rock Pueblo were grown in the valley immediately below, and carried to the pueblo for processing and storage.

Summary and Conclusions

Charred maize recovered from Room 7 of Chimney Rock Pueblo was analyzed to determine whether it was grown locally or imported. Although visually clean, and therefore not subjected to acid cleansing, the eight maize samples showed elevated levels of aluminum which indicates contamination from surrounding sediments post-depositionally. In the future, it might be best to treat all archaeological samples as dirty, until proven clean. Regardless, the strontium ratio of eight cobs and ears matches the ratio of rabbitbrush samples collected from the valley below the pueblo, suggesting that the maize was indeed grown locally. While there are a number of other potential sources for the maize based on previously published strontium data, the presence of delicate and easily destroyed parts of the maize plant lend credence to our interpretation that the Chimney Rock maize was grown locally.

<u>Bibliography</u>

Adams, Karen
2010 Chimney Rock Pueblo (5AA83) Archaeobotanical Analysis. Report submitted May 27, 2010.

Benson, Larry
2010 Who Provided Maize to Chaco Canyon After the Mid-12th-Century Drought? Journal of Archaeological Science (37):621-629.

Benson, Larry et al.
2010 The Cleaning of Burned and Contaminated Archaeological Maize Prior to 87Sr/86Sr Analysis. Journal of Archaeological Science (37):84-91.

Benson, Larry, Cordell, L, Vincent, K, Taylor, H, Stein, J, Farmer, G L, Futa, K
2003 Ancient Maize from Chacoan Great Houses: Where Was it Grown? Proceedings of the National Academy of Sciences of the United States of America 100, 13111-13115.

Benson, Larry, Stein, J, Taylor, H, Friedman, R, Windes, T
2006 The Agricultural Productivity of Chaco Canyon and the Source(s) of pre-Hispanic Maize found in Pueblo Bonito. In Staller, J, Tykot, R, Benz, B (Eds.) Histories of Maize: Multidisciplinary Approaches to the Prehistory, Biogeography, Domestication, and Evolution of Maize. Elsevier/Academic Press, Amsterdam, pp. 289-314.

Benson, Larry, Stein, J, Taylor, H
2009 Possible Sources of Archaeological Maize Found in Chaco Canyon and Aztec Ruin, New Mexico. Journal of Archaeological Science 36, 387-407.

Kintigh, Keith, Glowacki, D, Huntley, D
2004 Long-term Settlement History and the Emergence of Towns in the Zuni Area. American Antiquity 69:432-456.

TABLE 1. Cobs selected for strontium analysis.		
LAB ID	Field ID	Shape
37080	KA18-29 cob01	g
37081	KA17-40 cob01	unknown
37082	KA17-40 cob02	c
37084	KA26-50 ear05	g
37085	KA27-40 cob02	c
37086	KA42-50 cob01	unknown
37087	KA42-50 cob02	not determinable
37088	KA42-50 ear01	c

(c=cigar-shaped, g=gradual taper. See Adams 2010: Tables 6 and 7)

TABLE 2. Results of Strontium Analysis.

Lab ID	FieldID	Site	AVE Al mg/L	STDDEV Al mg/L	AVE Al ug/g	AVE Sr mg/L	STDDEV Sr mg/L	AVE Sr ug/g	Ashed Wt g	ParentID	87/86	err
37080	KA18 cob1	Chimney Rx	8.88	0.19	262	5.62	0.13	165.40	3.3967	36950	0.710014	0.000014
37081	KA17 cob1	Chimney Rx	4.61	0.04	249	2.26	0.03	121.96	1.852	36948	0.710118	0.000008
37082	KA17 cob2	Chimney Rx	3.53	0.02	486	0.869	0.005	119.77	0.7257	36949	0.710162	0.000009
37084	KA26 ear5	Chimney Rx	3.55	0.00	217	3.62	0.01	221.48	1.6328	36951	0.710129	0.000014
37085	KA27 cob2	Chimney Rx	5.49	0.13	222	1.47	0.04	59.55	2.4701	36952	0.710170	0.000014
37086	KA42 cob1	Chimney Rx	2.28	0.02	90	2.22	0.02	87.65	2.5326	36953	0.710115	0.000011
37087	KA42 cob2	Chimney Rx	12.8	0.2	476	3.14	0.05	116.99	2.6818	36954	0.710132	0.000011
37088	KA42 ear1	Chimney Rx	4.16	0.16	444	3.29	0.14	351.61	0.9356	36955	0.710119	0.000011
37090	RB-1	Rabbit Brush Chimney Rx	19.1	0.4	1213	0.452	0.011	28.70	1.5747	37015	0.710082	0.000011
37091	RB-2	Rabbit Brush Chimney Rx	15.7	0.2	937	0.898	0.008	53.59	1.676	37016	0.711359	0.000010
37092	RB-3	Rabbit Brush Chimney Rx	6.04	0.08	303	0.679	0.010	34.07	1.9927	37017	0.710405	0.000007

(From Larry Benson)

Appendix E

Archaeobotanical Analysis

Karen R. Adams

Chimney Rock Pueblo (5AA83) Archaeobotanical Analysis

May 27, 2010

Karen R. Adams, PhD
Archaeobotanical Consultant
2837 E. Beverly Dr.
Tucson, AZ 85716-5716

Submitted to:
Brenda K. Todd
218 UCB
University of Colorado
Boulder, CO 80309-0218

Partial maize (*Zea mays*) ear with husks and shank still attached, excavated from within a burned layer of roof fall in Room 7.

List of Figures

List of Tables

Table 10. Charred whole and nearly whole maize *(Zea mays)* shank segments from Room 7 (PD 29).

Table 11. Overview of charred/partially charred plant taxa/part(s) within macrobotanical and flotation samples, arranged in order of ubiquity (presence) for all samples examined.

Introduction

Chimney Rock Pueblo (5AA83) in southwestern Colorado is located at approximately 7,600 feet elevation atop Chimney Rock mesa within the San Juan National Forest. The site is situated within the Rocky Mountain (Petran) and Montane Conifer Forests, dominated by ponderosa pine (*Pinus ponderosa*) trees at the lower elevations, and by a mixed conifer forest of Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), limber pine (*Pinus flexilis*), and aspen (*Populus tremuloides*) trees at higher elevations (Pase and Brown 1982:43-48). Even within lower elevations, these cold-adapted trees favor canyons and north-facing slopes. A variety of species of evergreen oaks (*Quercus* spp.) also grow in the region. To the southwest of Chimney Rock, the Great Basin Conifer Woodland (Brown 1982:52-57) supports an additional suite of trees and shrubs, including pinyon (*Pinus edulis*), various junipers (*Juniperus scopulorum*, *J. osteosperma*), mountain mahogany (*Cercocarpus* spp.), and bitterbrush (*Purshia tridentata*). Cottonwood (*Populus*) and willow (*Salix*) trees can be found lining riparian areas, such as the Piedra River and its smaller tributaries.

Archaeologists excavating portions of Rooms 5 and 7 of Chimney Rock Pueblo encountered a diverse and well-preserved collection of charred archaeological plant materials. The bulk of these remains were collected during excavation by hand-picking them from site deposits and boxing them for storage/analysis. In addition, a number of site sediment samples were systematically acquired for water processing to capture smaller plant remains generally invisible to the naked eye.

Methods

The two types of archaeological plant samples collected during excavation of Chimney Rock Pueblo both provide information regarding subsistence and non-subsistence resources of importance to ancient communities. "Macrobotanical" samples include those larger plant parts that are easily recognized and collected directly from site sediment or archaeological screens. In contrast, smaller plant parts such as seeds and other tiny reproductive parts are difficult to recognize during excavation. Such "microfossils" are retrieved within site sediment samples routinely collected for flotation processing, and for a range of other processing methods focused on acquiring pollen grains, phytoliths, and starch grains. The best archaeobotanical interpretations rely on both the larger macrobotanical samples and the smaller plant parts to reveal a balanced view of ancient plant use. This report includes analysis data from 37 macrobotanical samples and 11 flotation samples (Table 1).

Macrobotanical Samples. Each box of macrobotanical materials was opened and spread out on lab trays or tables, so that all items were visible. Specimens were sorted into groups of the separate plant taxa/part(s) recognized. Each taxon/part group was then counted and the condition of specimens noted. All specimens were examined under a Zeiss binocular microscope at magnifications ranging from 8x to 50x, and identified in comparison to an extensive Colorado Plateau collection of comparative plant materials backed by herbarium voucher specimens deposited in the University of Arizona Herbarium.

Particular attention was devoted to maize (*Zea mays*) remains. For each sample, charred maize parts were separated into a number of categories and counts made of: (a) maize ear segments; (b) maize cob segments and cob fragments; (c) maize kernels; and (d) maize shanks. An ear segment has at least some kernels still attached, and the ear is complete around the circumference for a portion of its length. A cob segment is a broken piece of cob that is also complete around the circumference. Ear and cob segments can include the apex, base, and/or middle portions of an ear. Some of the Chimney Rock Pueblo specimens were whole, having both the apex and the base (butt) near the shank, which attaches the ear to the main stem of the plant. Others appeared to be nearly whole, missing the apex or the base. Broken segments are clearly missing some unknown portion of their original length.

The whole and nearly whole maize ear and cob segments were further analyzed for metric and non-metric data. These specimens have the greatest potential for providing useful information about the diversity of types or landraces of maize present within the collection. Data gathered included: number of kernel rows, ear/cob taper, cross-section shape, length (cm), diameter at the midpoint of the specimen (cm), diameter at the butt (cm), cupule width (mm), cupule depth (mm), and presence of a shank. A cupule is a small pocket of a cob that formerly held two kernels. The following data were gathered on kernels attached to an ear: kernel length (mm), width (mm), thickness (mm), shape, endosperm type, and the presence/absence of husk striations. If a shank was present, data gathered included diameter (cm) at the butt, length (cm), number of nodes (locations where husks were attached), and presence/absence of attached husks.

Two of these observed traits of particular importance are kernel row number and cupule width. These two traits have been recorded on archaeological maize for decades, and represent standard data for comparison to other collections (Adams 1994). Row number appears to be a stable genetic trait unaffected by moisture available during the growing season (Adams et al. 1999), and is not affected if the ear or cob shrinks during charring. Other traits, such as the nature of the shank (large, small) at the base of the ear or cob, and the general ear/cob taper (gradual from butt to tip; sharp from butt to tip; cigar-shaped, narrow at the top and the bottom) are important, as are the general shape and endosperm type of the kernels (Adams 1994). The overall length and size of the ears also proved extremely useful in defining major morphological categories of 20th century maize landraces (Adams et al. 2006; Martínez and Adams 2008), although charring is known to affect these two traits significantly (Adams 1994).

Flotation Samples. Flotation samples are sediment samples from which plant remains are extracted in the laboratory using a water-separation technique (Bohrer and Adams 1977). The flotation samples discussed here represent both excavated Chimney Rock Pueblo structures. The samples were processed via a water separation technique that allows a “light fraction”, composed of buoyant plant specimens that float on the surface of water, to be skimmed off, dried, and then examined. Flotation samples were typically 1 liter in size. For every flotation sample, the “heavy fraction” that sank during processing was also dried and bagged up. Heavy fractions are primarily composed of rocks and clay chunks, but can also include water logged plant specimens, tiny bone fragments, lithic flakes, beads, and ceramic sherds.

Prior to analysis, each light fraction was passed through a series of USGS Standard graduated sieves with mesh sizes of 4.0 mm, 2.0 mm, 1.0 mm and 0.5 mm. Material from each size fraction was examined separately under a binocular microscope ranging from 8x-50x in magnification. Subdividing material into size fractions allows for the use of a constant focal depth while examining each fraction. The larger fractions were examined first, because larger and more easily recognized plant parts sometimes provide clues for the identification of smaller remains. Material that passed through the 0.5 mm sieve was not analyzed; this fraction is assumed to consist primarily of nonorganic silt, unidentifiable organics, and small fragments of specimens that were likely recognized in the larger size fractions. Heavy fractions were examined to check for artifacts and organic remains.

Charred reproductive and non-reproductive plant parts were removed from the samples and segregated into separate vials. Reproductive plant parts can include seeds, fruits, flowers, grass grains and embryos, achenes, nutshell fragments, pieces of maize cobs, etc. Non-reproductive plant materials can include wood fragments, small twigs, juniper scale leaves, pine bark scales and needles, spines, etc. Charred plant remains within archaeological contexts are considered more likely than uncharred specimens to be related to human activities (Pearsall 1989:224-226). Explanations for the presence of charred seeds unrelated to human behavior include natural seed rain into prehistoric cooking, heating, or other fires, and infiltration of seeds burned by wildfires and deposited into the soil matrix (Pearsall 1989:224-226, Minnis 1981); such scenarios may be relatively uncommon. Uncharred specimens generally owe their presence to post-occupational intrusion into archaeological sites.

Charred reproductive parts were identified to the most specific taxonomic category possible, in conjunction with use of a modern comparative collections and referral to published seed identification guides (Adams and Murray 2004; Bohrer and Adams 1976; Egginton 1921; Martin and Barkley 1961). The term "Cheno-am" is utilized here to describe seeds that are so similar in appearance they that might belong to either the genus *Chenopodium* (goosefoot) or *Amaranthus* (pigweed).

Charred fragments of wood within the macrobotanical and flotation samples were identified in the following manner. For each flotation sample, 20 charred wood pieces were selected from the >4.0 mm size fraction. However, if fewer than 20 pieces were present in that size fraction, then pieces from the 2.0-4.0 mm size fraction were included. For each macrobotanical sample, 20 pieces were selected from among the larger specimens available. All charred wood fragments were chosen non-randomly on the basis of appearance, in order to identify as many different wood types as possible within each sample, aiming to understand the diversity of wood types utilized in the past. To facilitate identification, charred wood fragments were snapped for a clear cross-section view, and examined under 8X to 50X magnification. Each piece was identified to the most specific taxonomic category possible via the use of modern comparative collections and published wood identification guides (Adams and Murray 2004; Hoadley 1990; Minnis 1987).

Results.

At least thirteen different plant taxa/parts were identified within the Chimney Rock samples examined (Table 2). All plant parts were charred or partially charred, and are assumed to have become so due to actions of people occupying the Pueblo during the pre-Hispanic period. Use of the word "type" following a taxonomic identification indicates that the specimens compare well in anatomical and morphological features to the taxon/taxa named, but that they might also represent other plants that have characteristics within the range of the taxon/taxa cited. This conservative approach acknowledges the similarity in appearance of the parts of various plants, especially for archaeological specimens that have been carbonized and damaged. For ease of use, this chapter indicates "type" only in Table 2, but the word is implied in all text and tables. Criteria of identification of most of the taxa and parts reported here have been published elsewhere (Adams and Murray 2004). Ethnographic literature relevant to the American Southwest (Castetter 1935; Yanovsky 1936; and summarized in Rainey and Adams 2004), and previous summaries of the Southwestern U. S. archaeobotanical record (Adams 1988; Adams and Fish 2006; Huckell and Toll 2004) all provide substantial evidence for use of these plants through time.

Macrobotanical Samples. The charred and partially charred macrobotanical specimens provide evidence relevant to both subsistence and non-subsistence resources (Table 3). Data arranged in this and following tables consider the ubiquity (presence) to indicate some level of use of the taxa/parts recovered. The more often a plant was gathered and utilized, the more often it might become part of the archaeological record in a variety of locations within the Pueblo. Based on ubiquity, the record reveals the importance of domesticated maize (*Zea mays*), whose parts were identified most often in the 37 macrobotanical samples submitted for examination. The ubiquity of maize in nearly half of the macrobotanical samples underscores the value of this domesticated crop. The diversity of maize parts that preserved suggests that maize fields were located within walking distance of the Pueblo, close enough that ears, shanks, and husks/leaves were transported into the community. The maize evidence was most notable in Room 7. A number of ear segments/fragments still had some kernels attached. Left over maize cob segments/fragments and shanks appear to have also been discarded within the Pueblo, and all may have served a secondary purpose as a fuel or tinder source. The association of maize remains with a major layer of burned roof fall in Room 7 suggests that empty cobs had either been piled on top of the roof, or were within the structure when the roof burned and fell in.

Most non-maize macrobotanical evidence likely represents roofing layers. Charred wood fragments of juniper (*Juniperus*), Douglas fir (*Pseudotsuga*), ponderosa pine (*Pinus ponderosa*) and pinyon (*Pinus edulis*) trees (Figures 1a-1d) indicate these conifer trees provided construction elements. Mountain mahogany (*Cercocarpus*) twigs (Figures 1e-1f), and those of bitterbrush (*Purshia*) and sagebrush (*Artemisia*) shrubs could have been used as closing materials above the viga and latilla layers. The mountain mahogany twigs ranged up to 10 cm in length and up to 2.0 cm in width, and appeared to represent less than 10 years of annual growth. The bitterbrush twigs were of similar dimensions, averaging between 10-20 annual rings. This consistency in width suggests a deliberate search for twigs within a reasonably narrow size range. A number of branches with 3-needle fascicles (bundles of needles) and the internal needle anatomy (Figure 2) characteristic of ponderosa pine (Harlow 1931) probably represent roof closing materials or some other need.

At the base of Room 7 above the bedrock, a number of surfaces and associated features were uncovered. Macrobotanical plant specimens associated with the latest floor surface (Surface 1) included a short cigar-shaped maize cob segment having 10 rows of kernels. A hearth (Feature 4) associated with an earlier floor surface (Surface 2) preserved fragments of charred Douglas fir wood, suggesting a fuel resource. Additional evidence within flotation samples from the base of Room 7 will be discussed below.

The majority of macrobotanical samples within Room 5 came from a mixture of aeolian, natural, and wall fall/roof fall deposits. Two samples from roof fall above a use surface contain a subset of the woody plant taxa/part(s) associated with the Room 7 roof, indicating similar choices in construction elements. Three charred maize kernels with pop/flint endosperm preserved on a thick adobe floor surface. Possibly these kernels were associated with use of the floor, or were deposited after the structure was no longer occupied.

Flotation Samples. Charred plant specimens preserved within flotation samples provide additional insight into plant use at Chimney Rock Pueblo (Table 4). The ubiquity of many of the same types of wood and twigs as in the macrobotanical samples supplements the story of wood use. However, a few new wood types have preserved, expanding the list of woody resources to include oak (*Quercus*), some members of the rose family (Rosaceae), and cottonwood and willow (*Populus/Salix*) trees. The very specific locations of the flotation samples (two pits in Room 5 and a number of cultural features near the bottom of Room 7) may in part explain these additional taxa. The flotation samples may include wood gathered as fuels and for making tools, as well as for roofing materials. A flotation sample from a sub-floor corrugated jar (Feature 2) associated with the latest floor surface (Surface 2) in Room 7 was filled with sandstone fragments intermixed with charred pinyon, ponderosa, juniper and Douglas fir wood fragments. It is most likely that collapsing walls and charred roof elements entered this empty sub-floor jar following its original use(s) for cooking and/or storage.

Chimney Rock Pueblo occupants were clearly dependent on maize. However, they also utilized Cheno-am seeds, representing either goosefoot (*Chenopodium*) and/or pigweed (*Amaranthus*) plants, both likely to have occupied agricultural fields as weeds. The presence of domesticated maize and the weeds of maize fields together suggest a heavy reliance on agricultural endeavors. The only other evidence of a wild food was the presence of a charred chokecherry (*Prunus serotina*) seed fragment within the hearth (Feature 4) associated with an early floor surface (Surface 2) in Room 7, where Douglas fir wood was burned as fuel (see macrobotanical evidence above). Some of the charred

Cheno-am seeds were also recovered within this hearth, and other Cheno-am seeds preserved in association with natural sediments at the very base of Room 7 cultural fill.

Maize. Macrobotanical and flotation samples contained a broad range of charred maize parts, the bulk of them preserved within a thick layer of burned roof fall within Room 7 (Table 5). The following discussions of ears, cobs, kernels, shanks, and husks/leaves serve to generally characterize the maize at Chimney Rock Pueblo. The reader is cautioned that charring may well have affected the overall size dimensions of some parts, by either shrinkage or expansion. Cobs tend to shrink notably when burned (Adams 1994; Martínez and Adams 2008), sometimes up to 60%, depending on the cob trait examined (Hildebrand 1994). Ears do not appear to shrink as much, partly because their attached kernels impede size changes. Kernels may expand when moisture inside turns to steam and exerts outward pressure; this is essentially what happens when pop kernels are heated. Kernels appear to remain their original size under conditions of very gradual heating and cooling (Adams in press). Kernels may also shrink or fracture, especially those with soft interior flour endosperm that is easily subjected to external forces.

Ears and cobs. Six whole/nearly whole ear segments preserved with kernels still attached (Figure 3a). Examine of these specimens (Table 6) and 19 whole/nearly whole cob segments (Table 7) indicate the Chimney Rock Pueblo maize averaged 12 rows of kernels (Figure 3b), ranging between 8 and 18 rows. A single tiny ear segment with 18 rows was unusual and possibly aberrant. Maize appeared to be of two general shapes: those ears/cobs that gradually tapered from a narrow top (apex) to a wider base (butt), and those that were cigar-shaped and tapered at both the apex and the butt. Whole and nearly whole ear and cob segments were sometimes as long as 11.5 cm. Although not always the case, those specimens with a gradual taper were generally equal or narrower in diameter at the mid-point in comparison to their diameter at the butt. In contrast, specimens with a cigar shape were always narrower at the butt and the apex than at their mid-point. Although complete around their circumference for only a portion of their length, a relatively large sample of broken maize ear (N=18) and cob (N=71) segments displayed similar metric traits (Table 8). No specimens had grooves between rows or row pairing.

Kernels. Whole mature kernels still attached to ears were examined in detail. Metric measurements indicate these kernels averaged 4.1 mm in length, 3.6 mm in width, and 3.0 mm in thickness (Table 9). Generally for maize, because kernels are arranged around a 360 degree circumference (the cob), those kernels on ears having eight kernel rows tend to be wider than long, and those on ears having higher kernel rows (e.g. 14 or 16 rows) tend to be longer than wide. Ears with 10 or 12 rows of kernels tend to have kernels of more nearly equal length and width dimensions. Round kernels often form when incomplete pollination kernels on an ear allows room for some of them to expand outward into adjacent un-used space on the cob, rather than be tightly constrained by adjacent kernels. Irregularly shaped kernels that are isodiametric are representative of an ancient/extant maize landrace known as Chapalote, with kernels arranged on the cob in a mosaic pattern, rather like overlapping tiles on a roof (Adams 1994:297). The major endosperm varieties of maize kernels (flour, flint, pop, dent, sweet) help characterize indigenous maize landraces, and each offers unique qualities of interest to subsistence farmers (Adams et al. 2006). The endosperm types observed in Chimney Rock Pueblo include flour? (Figure 3c), pop (Figure 3d), flint, and pop/flint (Table 9). Criteria for distinguishing these endosperm types in modern (Adams et al. 2006) and charred (Doebley and Bohrer 1983:33) kernels were relied upon. No kernels displayed a dent in the kernel top, typical of true dent maize, nor were any kernels thought to represent the wrinkled types indicative of sweet corn (Adams et al. 2006). When the ear husks so tightly enclose the ear during kernel maturation that the husks leave visible parallel striations (imprints of fibro-vascular bundles characteristic of the monocotyledon group of plants that maize belongs to) on the kernels (Figure 3e), that trait is restricted to Chapalote and a limited number of additional landraces (Adams et al. 2006). Quite a few of the kernels appeared hollow and/or immature, suggesting the ears were harvested prior to kernel maturation (Figure 3f).

Kernel color, deriving from more than one tissue layer, is very important in characterizing historic landraces of maize, serving to impart information on when to plant, where to plant, culinary traits, etc. (Adams 1994; Bohrer 1994). Maize kernel color is also extremely important to Native American ritual and ceremonial life (Bohrer 1994). Yet the Chimney Rock maize kernels, black from charring, impart no color information at all, characteristic of charred maize from most Southwestern U.S. archaeological sites that are not protected within shelters, overhangs, caves, etc.

Shanks. Archaeologists recovered over seventy well-preserved charred maize shanks from Room 7. Shanks (Figure 4a) are the short stalks that attach each ear to the main stem of the maize plants. Most shanks were characterized as segments, defined as being complete around the circumference for at least a portion of their length; only two were shank fragments. Eighteen whole and nearly whole segments averaged 1.6 cm in diameter at the butt (where the ear was formerly attached), and 4.5 cm in length (Table 10). Over fifty additional broken shanks also averaged 1.6 cm in diameter at the butt. Their shorter average length (1.9 cm) is understandable for broken specimens. A few shanks attached to cobs/ears were notably wide at the attachment point, as wide as the cob butt; others were much smaller and narrower where they attached (Figure 4b). In cross-section view, the shanks all have the characteristic monocotyledon anatomy of fibro-vascular bundles scattered throughout the tissue (Figures 4c-4d).

Chimney Rock Pueblo shanks averaged 4.8 nodes per shank. A node is a location where a husk was once attached and wrapped up and around the ear for protection. Some of the shanks actually had their fragile husks still attached; on one specimen the attached husks were bent back, typical of what happens when a farmer pulls the husks back to break an ear free from the shank. The smaller average number of nodes on the broken specimens (2.8) is clearly due to having incomplete segments to evaluate.

Husks/leaves. A limited number of maize husks and or leaves were identified in Room 7. Some husks were still attached to the ear (Figure 4e). Once removed from the plant, maize leaves and husks both provide long, flexible, relatively strong materials for use in daily life. The husks are essentially leaves that are wrapped around ears to provide protection during development. Although use of maize husks is common in the historic record of the American Southwest, leaves presumably also offer useable raw materials; when separated from maize plants, husks and leaves are difficult to distinguish from each other, especially when tied in a knot and burned (Figure 4f).

Evidence for more than one maize landrace. There is enough variability in maize at Chimney Rock Pueblo to assess if more than one landrace was being grown by farmers. Multiple types of endosperm (flour?, pop, fling, and pop/flint) were identified, which among historic groups could represent different maize landraces which conservative farmers would grow out in isolated fields to prevent extensive cross-pollination (Adams 1994; Adams et al. 2006). The recognition of two cob morphologies supports this interpretation. Maize ears/cobs that gradually taper from the apex to the butt represent a wide range of historic maize landraces, in contrast to cobs that are cigar-shaped and taper at the apex and the butt, typical of Chapalote type maize and of some pre-Hispanic Basketmaker maize (Adams, 1994). The imprints of husk striations on kernels are also typical of Chapalote and Basketmaker types of maize, and occur only rarely in other landraces (Adams 1994; Adams et al. 2006).

The nature of the shank where it attaches to the cob is also informative about maize landraces. Broad shanks typically found on large ears of historic Native American flour maize landraces contrast with smaller shanks that are characteristic of smaller-eared maize grown in the Sonoran Desert, northern Mexico, and elsewhere. These two distinctive morphological shank forms are present in the Chimney Rock Pueblo collections (Figure 5).

The complete suite of maize parts suggests the presence of at least two maize landraces. The evidence seems to be distributed within different layers of the roof fall in Room 7. Those ear/cob specimens with a gradual taper clearly outnumber the cigar-shaped specimens. But the cigar-shape ear/cobs, the striations on some kernels, plus the presence of pop and pop/flint kernels within the assemblage, definitely suggest maize similar to Chapalote and/or Basketmaker. Chapalote is characterized as having “12-14 rows of small, cigar-shaped ears; globular (isodiametric) popcorn or flint kernels often marked with striations” (Adams 1994:277), which would generally fit some of the Chimney Rock Pueblo evidence. The remaining Chimney Rock maize, averaging 12 kernel rows, has a gradual taper to the cob/ear, and represents a diversity of kernel endosperm types. However a few of the cobs have shanks that are relatively large where they attached to the ear; larger ears typically require larger shanks for support. This, when coupled with the possible presence of flour? kernels and some ears/cobs with 14-16 kernel rows, suggests some Chimney Rock ears were smaller but generally similar to maize landraces of historic Rio Grande Pueblos having large flour kernel ears with large shanks and row numbers averaging 14 or higher (Adams et al. 2006).

Maize in Room 7. The majority of maize parts that preserved within Room 7 were cob segments and fragments, suggesting these were left-over after kernel removal. The limited number of ears with kernels still attached displayed some variability. Some of these ears had sunken in/collapsed kernels indicative of immaturity, and may have been discarded. Such a practice would only be reasonable if food stress were not prevailing at the time. Severe food stress may not have been a problem at Chimney Rock Pueblo, or the maize cobs associated with Room 7 would likely have been eaten, as has been the custom in the historic era (Hill 1938). Of course, it is always possible the empty cobs and immature ears were being kept on/in Room 7 as an eventual food, prior to the burning event.

Other ears within Room 7 contained mature kernels. Historic groups on the Colorado Plateau store corn as ears, with kernels still attached, organized by kernel color and endosperm type. Often ears are carefully arranged in stacks within storage structures, in such a way that air can circulate around the maize and reduce chances of fungal damage. Other times ears are braided together and hung from the roof rafters. Possibly these Chimney Rock specimens represent the last remaining ears from a harvest that was gradually being consumed over the winter/spring. In the pre-Hispanic period it is thought that “seed corn” for a future planting was generally stored as loose kernels in small specialized ceramic “seed jars”, however it cannot be ruled out that kernels for a future planting were not also stored as complete ears, possibly also braided together and hung from the rafters.

Discussion

An overview of the Chimney Rock Pueblo macrobotanical and flotation results reveals a focus on maize agriculture (Table 11). A diversity of maize parts preserved more often than any other subsistence resource. The majority of maize specimens likely represent discard of cobs/shanks/husks following removal of kernels from the ears. A limited number of ears with kernels still attached suggests maize in storage as food or possibly for future planting. The presence of such a wide variety of maize parts implies maize fields were located within reasonable walking distance of the community.

Within flotation samples most likely to capture evidence of smaller wild food resources, the only non-maize evidence to preserve includes limited Cheno-am and chokecherry seeds. The Cheno-am seeds could easily have been harvested from goosefoot and/or pigweed plants that came up as weeds in maize fields. The chokecherry seed suggests harvest of the sweet fruit from trees located within riparian habitats. The presence of pinyon cone evidence in a single sample could derive from inadvertent entry of the cone on wood, or of occasional interest in pinyon nuts as a food resource.

Metric and non-metric observations on maize ears, cobs, kernels, and shanks suggest at least two landraces were grown by Chimney Rock farmers. The cigar-shaped ear/cob specimens, kernels with husk striations across the top, and an average kernel row number of 12, coupled with the presence of pop and pop/flint kernels within the assemblage, suggest maize similar to Chapalote and/or Basketmaker. Other Chimney Rock maize specimens with a gradual ear/cob taper, possible flour kernels, relatively large shanks, and 14 or 16 rows of kernels, bear some resemblance to historic Rio Grande Pueblo large-eared flour maize landraces, except the Chimney Rock Pueblo specimens are not nearly as large.

The relatively high numbers of maize cob segments and fragments within the Chimney Rock archaeobotanical assemblage suggests most of the kernels had been removed, likely for consumption during the months following harvest. Some ears with immature kernels may have been discarded as inedible, and if so argue against intense food stress. Other ears with mature kernels may represent the last of a harvest, suggesting at least some food was still available when Room 7 burned. Possibly some of these ears represented seed stock for future planting.

Roofing materials are well-represented in the plant record. Juniper, pinyon, and Douglas fir roofing timbers were preferred, most likely as vigas. Smaller branches may have been utilized as latillas. These trees may also have provided fuel and wood for tools and other needs. Oak was also carried in often. Twigs of mountain mahogany, sagebrush, and bitterbrush may have been utilized as closing layers during roof construction.

Occasionally people gathered wood of rose family shrubs, and cottonwood/willow and ponderosa pine trees. Branches with bundles of ponderosa pine needles were carried into the Pueblo for some purpose, possibly roof closing layers.

The seasons that plant parts are available give some indication of when people formerly occupied or visited landscapes, with the exception of wood, which can be gathered in any season throughout the calendar year. However, because groups often store foods for future use, it becomes harder to link season of availability with season of use (Adams and Bohrer 1998). The chokecherry seed indicates harvest of a resource in the early summer, and the Cheno-am seeds suggest presence in the area sometime in the mid-summer through fall period when these weedy plants produce edible seeds. Maize is ready for harvest in late summer or early fall. However, agricultural activities can take place over much of a calendar year, starting with field preparation during the late winter months and ending following harvest, husking, and drying of the maize crop for storage in the fall. The plant record is generally mute regarding the likelihood of year-round occupation, and offers no evidence for or against this possibility.

Acknowledgments

The author greatly appreciates the significant assistance provided by Judy van Roggen Paterson during analysis of the Chimney Rock Pueblo macrobotanical samples. Judy was especially helpful with data gathering/entry and photography. Crow Canyon Archaeological Center in Cortez, CO kindly furnished laboratory facilities for the macrobotanical sample analysis during the summer of 2009.

References Cited

Adams, Karen R.
1988 The Ethnobotany and Phenology of Plants in and Adjacent to Two Riparian Habitats in Southeastern Arizona. PhD dissertation, Ecology and Evolutionary Biology Department, University of Arizona. University Microfilms, 716 pages.

Adams, Karen R.
1994 A Regional Synthesis of *Zea mays* in the Prehistoric American Southwest. In *Corn and Culture in the Prehistoric New World*, pp. 273-302. Sissel Johannessen and Christine A. Hastorf, editors, Westview Press.

Adams, Karen R.
In press. Charred plant remains. In *The Duval Mine Road Site*: *Rincon Phase Subsistence and Settlement in the Middle Santa Cruz, Sahuarita*, *Arizona*. Logan Simpson Design Technical Reports in Prehistory 3. Robert B. Niely, ed. Tempe, AZ: Logan Simpson Design, Inc.

Adams, Karen R. and Vorsila L. Bohrer
1998 Archaeobotanical Indicators of Seasonality: Examples from Arid Southwestern United States. In *Seasonality and Sedentism. Archaeological Perspectives from Old and New World Sites*. T.R. Rocek and O. Bar-Yosef, editors. Peabody Museum Bull. 6, Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, MA.

Adams, Karen R. and Suzanne K. Fish
2006 Southwest Plants. In *Handbook of North American Indians*, Vol. III, Environment, Origins, and Population, pp.292-312. Douglas Ubelaker, volume editor; Bruce D. Smith, associate editor. Smithsonian Press.

Adams, Karen R., Cathryn M. Meegan, Scott G. Ortman, R. Emerson Howell, Lindsay C. Werth, Deborah A. Muenchrath, Michael K. O'Neill, and Candice A.C. Gardner.
2006 MAÍS (Maize of American Indigenous Societies) Southwest: Ear Descriptions and Traits that Distinguish 27 Morphologically Distinct Groups of 123 Historic USDA Maize (*Zea mays* L. ssp. *mays*) Accessions and Data Relevant to Archaeological Subsistence Models. Manuscript on file, http://farmingtonsc.nmsu.edu.

Adams, Karen R, Deborah A. Muenchrath and Dylan M. Schwindt
1999 Moisture Effects on the Morphology of Ears, Cobs and Kernels of a North American Maize (*Zea mays* L.) Cultivar, and Implications for the Interpretation of Archaeological Maize. *Journal of Archaeological Science* 26:483-496.

Adams, Karen R. and Shawn S. Murray
2004 *Identification Criteria for Plant Remains Recovered from Archaeological Sites in the Central Mesa Verde Region* [HTML Title.] Available: http://www.crowcanyon.org/PlantID. Date of use: 20 May 2010.

Bohrer, Vorsila L.

1994 Maize in Middle American and Southwestern United States Agricultural Traditions. In *Corn and Culture in the Prehistoric New World*, pp. 469-512. Sissel Johannessen and Christine A. Hastorf, editors, Westview Press.

Bohrer, Vorsila L. and Karen R. Adams
1976 Guide to Learning Prehistoric Seed Remains from Salmon Ruin, New Mexico. Unpublished manuscript on file, Crow Canyon Archaeological Center, Cortez, Colorado.

Bohrer, Vorsila L. and Karen R. Adams
1977 *Ethnobotanical Techniques and Approaches at Salmon Ruin, New Mexico*. Contributions in Anthropology, Vol. 8, No. 1, Eastern New Mexico University, Portales.

Brown, David E.
1982 Great Basin Conifer Woodland. In *Biotic Communities of the American Southwest–United States and Mexico*, David E. Brown, editor. Desert Plants Vol. 4 (1-4):52-57.

Castetter, Edward F.
1935 Uncultivated Native Plants Used as Sources of Food. *Ethnobiological Studies in the American Southwest 1*: Biological Series 4(1). University of New Mexico Bulletin, Whole Number 266. Albuquerque.

Doebley, John and Vorsila L. Bohrer
1983 Maize variability and cultural selection at Salmon Ruin, New Mexico. *The Kiva* 49(1-2):19-37.

Egginton, George
1921 *Colorado Weed Seeds*. Bulletin No. 260, Agricultural Experiment Station, Fort Collins, Colorado.

Harlow, W. M.
1931 *The Identification of the Pines of the United States, Native and Introduced, by Needle Structure*. Technical Publication No. 23. Bulletin of the New York State College of Forestry, Syracuse University.

Hildebrand, Lisa
1994 Shrinkage of *Zea mays* cobs during charring. Manuscript on file, Crow Canyon Archaeological Center, Cortez, CO.

Hill, W. W.
1938 The Agricultural and Hunting Methods of the Navajo Indians. *Yale University Publications in Anthropology*, No. 18. Yale University Press, New Haven, Connecticut.

Hoadley, R. B.
1990 *Identifying Wood: Accurate Results with simple Tools*. Taunton Press, Newton, Connecticut.

Huckell, Lisa W. and Mollie S. Toll
2004 Wild Plant Use in the North American Southwest. In *People and Plants in Ancient Western North America*. Paul E. Minnis, ed. Pp. 37-114. Smithsonian Books, Washington, D.C.

Martin, Alexander C. and William D. Barkley
1961 *Seed Identification Manual*. University of California Press, Berkeley.

Martínez, Natalia and Karen R. Adams
2008 Archaeological Maize: A Reassessment of Traits Relevant to Distinguishing Varieties". 73rd Annual Meeting, Society for American Archaeology, Vancouver, BC, Canada.

Minnis, Paul E.
1981 Seeds in Archaeological Sites: Sources and Some Interpretive Problems. *American Antiquity* 46:143-152.

Minnis, Paul E.
1987 Identification of Wood from Archaeological Sites in the American Southwest: I: Key to Gymnosperms. *Journal of Archaeological Science* 14:121-131.

Pase, Charles P., and David E. Brown
1982 Rocky Mountain (Petran) and Madrean Montane Conifer Forests. In *Biotic Communities of the American Southwest–United States and Mexico*, David E. Brown, editor. Desert Plants Vol. 4 (1-4):43-48.

Pearsall, Deborah M.
1989 *Paleoethnobotany: A Handbook of Procedures.* Academic Press, San Diego.

Rainey, Katharine D. and Karen R. Adams
2004 *Plant Use by Native Peoples of the American Southwest: Ethnographic Identification* [HTML Title]. Available: http://www.crowcanyon.org/ plantuses. Date of use: 20 May, 2010.

Yanovsky, Elias
1936 Food Plants of the North American Indians. *U. S. Department of Agriculture. Miscellaneous Publications 237*. Washington: U. S. Government Printing Office.

Figure 1. Cross-section (transverse) views of charred wood specimens of trees utilized as roofing elements and for other daily needs. (a) juniper (*Juniperus*) from Room 5 roof fall; (b) Douglas fir (*Pseudotsuga*) from Room 7 hearth Feat. 4; (c) ponderosa pine (*Pinus ponderosa*) from Room 5 roof fall above a use surface; (d) pinyon (*Pinus edulis*) and (e-f) mountain mahogany (*Cercocarpus*) twigs from the burned roof layer in Room 7. All photographed at 50x magnification except for (e). At the cross-section view, the size and placement of the resin canals distinguishes Douglas fir (smaller, associated with latewood) from ponderosa pine (larger, likely to be located throughout the ring) wood.

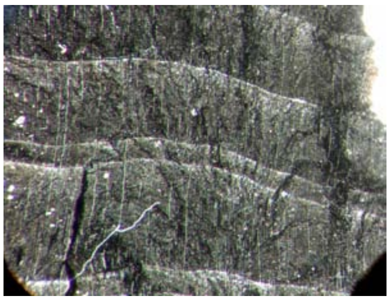
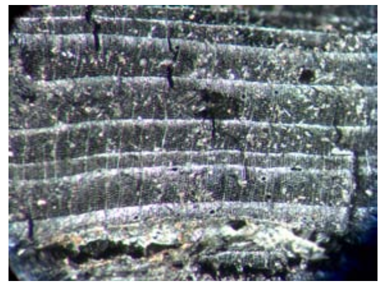
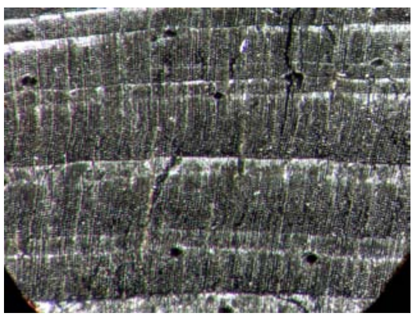
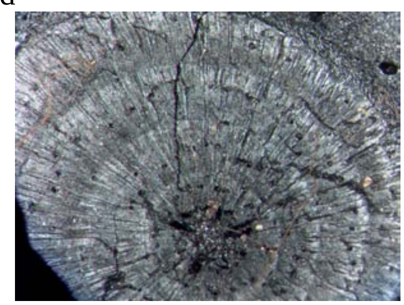
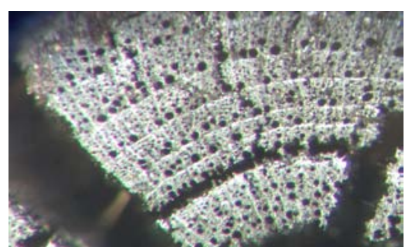
a 	b 
c 	d 
e 	f 

Figure 2. Charred ponderosa pine (*Pinus ponderosa*) branches containing needle fascicles (bundles) from within the burned roof fall layer in Room 7. (a) View of branches with attached bundles; (b) close-up view of base of needle fascicles on a branch; (c) cross-section (transverse) view of a single needle fascicle showing three distinct needles arranged within the bundle; (d) cross section view of three single needles, showing the typical anatomy of ponderosa pine needles with resin canals at the outside edges, and how the needles flatten a bit once detached from a fascicle.

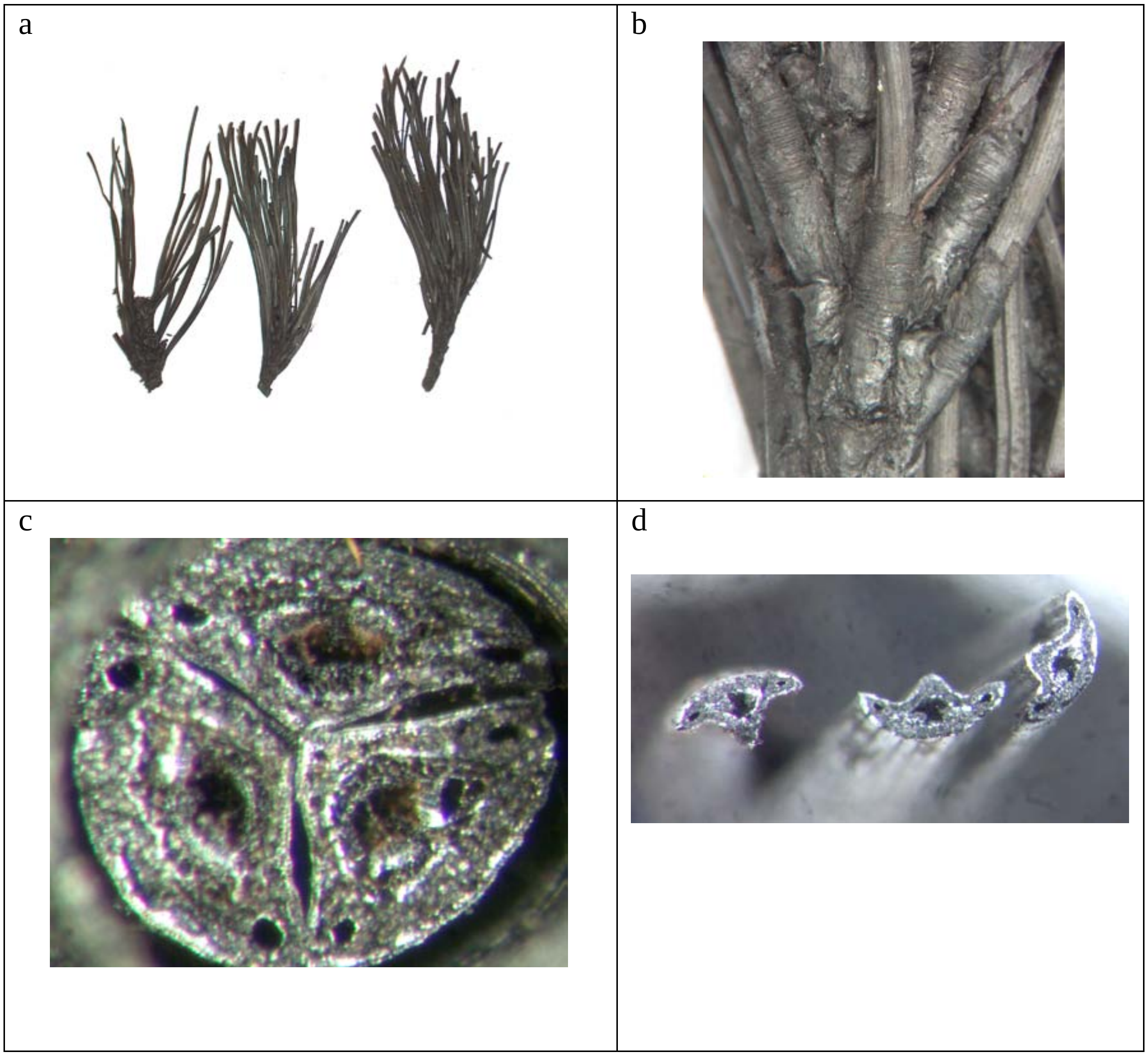


Figure 3. Charred maize (*Zea mays*) parts, all from the burned roof fall layer within Room 7. (a) Ear with mature kernels still attached, photographed through a macro lens; (b) cross-section (transverse) view of a 12-rowed maize cob segment, at 8x magnification; (c) interior view of a maize kernel (center of photo) with possible flour endosperm characterized by a porous and light-reflective surface, at 32x magnification; (d) interior view of two halves of a maize kernel with pop endosperm characterized by a very fine-grained non-porous and non light reflective surface, at 50x magnification; (e) kernel with striations across the top, at 50x magnification; (f) ear with sunken-in and hollow immature kernels, at 8x magnification.

Figure 4. Additional charred maize (*Zea mays*) parts, all from the burned roof layer within Room 7. (a) Variety of shanks, photographed through a macro lens; (b) two cob segments, one attached to a narrow shank (left) and one to a broad shank (right), photographed through a macro lens; (c) cross-section (transverse) view of a shank, revealing the monocotyledon anatomy, at 12x magnification; (d) same specimen as in (c), showing the distinctive monocotyledon fibro-vascular bundles (light reflective ovals), at 50x magnification; (e) ear with husks still attached, at 8x magnification; and (f) husks/leaves tied into a knot, photographed through a macro lens.

Figure 5. Two charred maize (*Zea mays*) ear segments and their attached shanks from within the burned roof layer within Room 7, photographed though a macro lens. These are representative of two possible landraces of maize grown by Chimney Rock Pueblo farmers. The broken cob segment on the left displays a gradually tapering cob attached to a relatively broad and sturdy shank, similar but not identical to the large-eared, large-shanked flour maize landraces of historic Rio Grande Pueblo communities. The nearly whole cob segment on the right tapers at the apex and tapers a bit at the base, and is attached to a smaller and narrower shank, more characteristic of Chapalote and Basketmaker maize, typical of historic southern Arizona and ancient Basketmaker Period farmers, respectively.

Table 1. Macrobotanical (M) and Flotation (F) samples from Chimney Rock Pueblo. PD = Provenience Designation, PL = Point Location, and KA No. = arbitrarily assigned number to track macrobotanical samples. PNS = Pit Not further Specified.

Room	PD	PL	Stratum	Level	KA No.	Context	Feature No.	Sample Type
Rm 5	22		1	2	KA33	aeolian/natural/wall fall		M
Rm 5	22		1	2	KA31	aeolian/natural/wall fall		M
Rm 5	23		2	1	KA47	mixed wall fall and roof fall		M
Rm 5	23		2	1	KA53	mixed wall fall and roof fall		M
Rm 5	25		2	2	KA30	aeolian/wall fall/roof fall		M
Rm 5	25		2	2	KA48	aeolian/wall fall/roof fall		M
Rm 5	28		3	1	KA51	aeolian/wall fall/roof fall		M
Rm 5	32		3	2	KA45	roof fall above use surface		M
Rm 5	32		3	2	KA50	roof fall above use surface		M
Rm 5	34				KA37	thick adobe floor surface		M
Rm 5	35		4	1	KA36	cultural fill between bedrock and Surface 1		M
Rm 5	40	29	5	1		aeolian laminate		F
Rm 5	41		4			firepit in bedrock	1	F
Rm 5	45					pit in bedrock	PNS #2	F
Rm 5	45				KA34	pit in bedrock	PNS #2	M
Rm 7	53	2			KA32	hearth excavated into Surface 2	4	M
Rm 7					KA52	general charcoal		M
Rm 7	29		2	2	KA22	burned roof fall		M
Rm 7	29		2	2	KA23	burned roof fall		M
Rm 7	29		2	2	KA40	burned roof fall		M
Rm 7	29		2	2	KA41	burned roof fall		M
Rm 7	29		2	2	KA44	burned roof fall		M
Rm 7	29	12	2	2	KA35	burned roof fall		M
Rm 7	29	13	2	2	KA54	burned roof fall		M
Rm 7	29	14	2	2	KA49	burned roof fall		M
Rm 7	29	29	2	2	KA18	burned roof fall		M
Rm 7	29	29	2	2	KA19	burned roof fall		M
Rm 7	29	29	2	2	KA20	burned roof fall		M
Rm 7	29	29	2	2	KA21	burned roof fall		M
Rm 7	29	30	2	2	KA24	burned roof fall		M
Rm 7	29	39	2	2	KA29	burned roof fall		M
Rm 7	29	32	2	2	KA38	burned roof fall		M
Rm 7	29	40	2	2	KA17	burned roof fall		M
Rm 7	29	40	2	2	KA27	burned roof fall		M
Rm 7	29	40	2	2	KA28	burned roof fall		M
Rm 7	29	50	2	2	KA26	burned roof fall		M
Rm 7	29	50	2	2	KA42	burned roof fall		M
Rm 7	29	50	2	2	KA43	burned roof fall		M
Rm 7	29	7?	2	2	KA46	burned roof fall		M
Rm 7	31	20			KA39	Surface 1, uppermost floor		M
Rm 7	38		3			secondary refuse deposit on Surface 1	1	F
Rm 7	45					sub-floor corrugated jar used for cooking, then storage	2	F
Rm 7	47		4			ashy cultural fill on top of Surface 2		F
Rm 7	47		4			ashy cultural fill on top of Surface 2		F
Rm 7	49		5			cultural and conRmuction fill		F
Rm 7	49		5			cultural and conRmuction fill		F
Rm 7	53					hearth	4	F
Rm 7	56		6			natural sediments on mesa top		F

Table 2. Plant taxa/parts recovered within macrobotanical and flotation samples from Chimney Rock Pueblo.

Taxon	Common Name	Part(s)	Condition
Artemisia type	sagebrush	twig, wood	charred
Cercocarpus type	mountain mahogany	twig, wood	charred
Cheno-am	cheno-am	seed	charred
Conifer type	conifer	wood	charred
Juniperus type	juniper	wood	charred, partially charred
Pinus type	pine	wood	charred, partially charred
Pinus edulis type	pinyon	twig, wood	charred, partially charred
Pinus edulis type	pinyon	cone fragmemt	charred
Pinus ponderosa type	ponderosa pine	branch, needle fascicle, wood	charred
Populus/Salix type	cottonwood/willow	wood	charred
Prunus serotina type	chokecherry	seed fragment	charred
Pseudotsuga type	Douglas fir	wood	charred
Purshia type	bitterbrush	twig	charred
Quercus type	oak	wood	charred
Rosaceae type	rose family	wood	charred
Zea mays	maize, corn	cupule, cob segment, cob fragment, ear segment, ear fragment, husk/leaf, kernel, kernel fragment, shank segment, shank fragment	charred

Table 3. Distribution of charred/partially charred plant taxa/part(s) within macrobotanical samples, arranged in order of ubiquity (presence) for all samples examined.

	Room Number =	5	7		Totals
	Number of Samples =	12	25		37
Taxon	Part	No. of samples containing the taxon/part			
Zea mays	cob segment, cob fragment		16		16
Zea mays	shank segment		16		16
Zea mays	kernel/kernel fragment	1	8		9
Zea mays	ear segment, ear fragment		9		9
Juniperus	wood	7	1		8
Cercocarpus	twig	1	7		8
Pinus edulis	wood	5	1		6
Pseudotsuga	wood	5	1		6
Zea mays	husk/leaf		4		4
Pinus	wood	3	1		4
Purshia	twig		2		2
Artemisia	twig		1		1
Pinus ponderosa	wood	1			1
Pinus edulis	cone fragmemt		1		1
Pinus edulis	twig		1		1
Pinus ponderosa	branch		1		1
Pinus ponderosa	needle fascicles		1		1
Pinus	wood		1		1

Table 4. Distribution of charred/partially charred plant taxa/part(s) within flotation samples, arranged in order of ubiquity (presence) for all samples examined.

	Room Number =	5	7		Totals
	Number of Samples =	3	8		11
Taxon	Part	No. of samples containing the taxon/part			
Quercus	wood	2	7		9
Juniperus	wood	1	7		8
Pinus edulis	wood	1	6		7
Pseudotsuga	wood	1	5		6
Zea mays	cupule	1	5		6
Zea mays	kernel/kernel fragment	2	3		5
Cercocarpus	wood	1	4		5
Rosaceae	wood		5		5
Populus/Salix	wood	1	3		4
Artemisia	twig	1	1		2
Cheno-am	seed		2		2
Pinus ponderosa	wood		1		1
Prunus serotina	seed fragment		1		1

Table 5. Charred maize parts recovered from macrobotanical (M) and flotation (F) samples from Rooms 5 and 7.

		Room				
		5		7		
	Sample Type	M	F	M	F	
		Number of specimens				
Part	Condition					Notes
cob segment	whole			10		
"	nearly whole			9		
"	broken			71		additional specimens badly degraded
cob fragment	broken			97		not analyzed
cupules	whole		5		17	loose in flotation samples
ear segment	whole			1		
"	nearly whole			5		
"	broken			18		
ear fragment	broken			1		
husk/leaf	sections			21+		includes 2 knots
"	"			10+		
kernel	whole	3				pop/flint endosperm
"			3			flour? endosperm
"				21		some likely pop; many appear immature, hollow
"	fragment		12	3	5	
shank	whole			17		
"	nearly whole			1		
"	broken			53		

Table 6. Charred whole (w) and nearly whole (nw) maize *(Zea mays)* ear segments from Room 7 (PD 29). Ear taper from apex to base (butt) is gradual (g) or cigar-shaped (c). Cross section is elliptical (e) or round (r).

PL No.	Spec. No.	Whole/ Broken	Taper	Cross-section	No. of rows	Row Pairs	Row Grooves	Length (cm)	Diam. (cm) Mid	Diam. (cm) Butt	Cupule Width (mm)	Cupule Depth (mm)	Kernels Present	Shank Present	Notes
29	ear01	nw	-	e	12	no	no	7.5	2.7				yes	no	
29	ear02	nw	-	e	10	yes	yes	8.8	2		8	4.5	yes	no	kernels look immature, wrinkled/ collapsed
50	ear02	nw	-	r	12	no	no	7.5	1.7	1.2	4	2	yes	yes	husk still attached
50	ear04	w	-	r	18	no	no	2.7	1.2	1.1	3	2	yes	yes	rows twisted, ear is tiny
50	ear05	nw	g	e	10	no	no	10	2	2.2			yes	yes	
50	ear01	nw	c	e	14	no	no	4.7	2.2	1.6	3	2	yes	yes	

Table 7. Charred whole (w) and nearly whole (nw) maize (*Zea mays*) cob segments from Room 7 (PD 29). Cob taper from apex to base (butt) is gradual (g) or cigar-shaped (c). Cross section is elliptical (e) or round (r).

PL No.	Spec. No.	Whole/ Broken	Taper	Cross-section	No. of rows	Length (cm)	Diam. (cm) Mid	Diam. (cm) Butt	Shank Present	Notes
40	cob02	w	c	e	10	7.5	1.2	1	yes	
29	cob01	w	g	e	8	11	1.7	2.1	yes	just an edge of shank
29	cob01	w	g	e	12	9.5	1.8	2	yes	
29	cob02	nw	g	r	12	8.5	1.6	1.7	yes	
29	cob01	w	g	e	14	11.5	2	2	yes	
29	cob02	nw	g	r	10	10.5	2	1.8	yes	
29	cob03	w	g	e	12	10	1.7	1.5	yes	
29	cob01	w	g	e	10	11.5	1.8	1.8	yes	shank barely present
29	cob03	nw	g	e	12	10	1.8	2	yes	
29	cob04	nw	g	r	10	9.5	1.5	1.3	yes	
29	cob05	nw	g	e	14	10	1.5			
50	cob02	w			12	8.5	1.7	1.8		
50	cob04	w	g		10	10	1.5	1.5		
50	cob05	w			12	8.2	1.2	2		
50	cob09	nw	g		14	10.7	1.8	2.1		
40	cob02	nw	c	e	12	8.5	2	1.4		
40	cob03	nw		e	12	11	2			
50	cob04	nw	g	e	12	9	1.7	1.8	yes	
50	cob10	w	g	e	12	8.5	1.7	1.7	yes	

Table 8. Summary data on charred whole (w), nearly whole (nw), and broken (b) maize cob and ear segments from Room 7 (PD 29 and PD 31).

	Ear segments			Cob segments	
Condition =	w and nw	b		w and nw	b
No. of specimens =	6	18		19	71
Trait					
row number					
mean	12.7	12		11.6	12
median	12	12		12	12
range	10 - 18	8 - 16		8 - 14	8 - 16
taper	g and c	g and c		g and c	g and c
mean length	6.9 cm	4.6 cm		9.7 cm	4.7 cm
mean diameter at mid point	2.0 cm	2.0 cm		1.7 cm	1.9 cm
mean diameter at butt	1.5 cm	2.0 cm		1.7 cm	2.1 cm
mean cupule width	4.5 mm	4.0 mm		-	-

Table 9. Traits of whole charred maize *(Zea mays)* kernels from Room 7 (PD 29). Kernal shapes, top view, kernels still attached to the ear: round (r), wider in the horizontal dimension than in the vertical dimension (w), longer in the vertical dimension than in the horizontal dimension (l), or irregular (i). Husk striations are imprintations of parallel monocotyledon fibro-vascular bundles across the kernel surface.

PL No.	Spec. No.	Length (mm)	Width (mm)	Thickness (mm)	Shape	Endosperm	Husk Striations	Notes
40	ear01					hollow		immature
40	ear02	5	5	3	w	flour?	possible	
40	ear03							collapsed/ immature
40	ear04	4	5	2.5	w	flour?	possible	
40	ear05	5	4	4		flour?	possible	some are round
29	ear01	6	5.5	3.5	w	pop/flint	possible	
29	ear02					hollow		
29	ear03	4	3	2.5	r	hollow		
29	ear03					hollow		
50	ear01	5	4	4	r	pop/flint	possible	
50	ear02				r			2 kernels only
50	ear04	2	1.5	1.5	r	hollow	possible	
50	ear05	5	4.5	4.5	r		yes	
40	ear01	5	4	3.5	irr	flour?		
40	ear02	5	4	3	irr	flour?		
	ear01	4	5	4	w	pop/flint		
	ear02				r			
50	ear01	4	3	3	r	pop/flint	yes	more likely pop, not porous
50	ear01	0.6	0.6	0.5	r	flint	yes	
50	ear02	2.5	1.5	1.5	r			most are hollow
14	ear01	4	4	4	r	pop/flint	possible	

Table 10. Charred whole and nearly whole maize *(Zea mays)* shank segments from Room 7 (PD 29). Nodes are locations along the shank where a husk was attached; husks wrap around the ear for protection.

PL No.	Spec. No.	Diam. (cm) Butt	Length (cm)	Nodes	Notes
40	cob02	0.7	1.5	3	
29	ear03	1.8		5	
29	shank01	1.4	4.2	6	husks attached
30	shank01	1.2	3.3	5	husks attached
30	shank04	1.7	4.4	5	husks attached
30	shank05	1.3	4.9	5	husks attached
50	ear01	2.3	5	5	husks attached
50	ear03				husks attached, some bent back
50	shank01	1.7	4.7	5	husks attached
40	cob01	2		4	
40	shank01	2.8		3	
40	shank02	1.3		5	
40	shank03	1.3		3	
39	shank01	1.1	5.5	5	
12	shank01	1.3	6.5	5	in 2 pieces
50	shank01	2.2	5.5	6	
50	shank02	1.6	3.8	6	
50	shank03	1.3	5.2	6	

Table 11. Overview of charred/partially charred plant taxa/part(s) within macrobotanical and flotation samples, arranged in order of ubiquity (presence) for all samples examined.

	Room Number =	5		7			
	Sample type =	Macrobotanical	Flotation	Macrobotanical	Flotation		Totals
	Number of Samples =	12	3	25	8		48
Taxon	Part	No. of samples containing the taxon/part					
Juniperus	wood	7	1	1	7		16
Zea mays	cob segment, cob fragment			16			16
Zea mays	shank segment			16			16
Zea mays	kernel/kernel fragment	1	2	8	3		14
Pinus edulis	wood	5	1	1	6		13
Pseudotsuga	wood	5	1	1	5		12
Zea mays	ear segment, ear fragment			9			9
Quercus	wood		2		7		9
Cercocarpus	twig	1		7			8
Zea mays	cupule		1		5		5
Cercocarpus	wood		1		4		5
Rosaceae	wood				5		5
Zea mays	husk/leaf			4			4
Pinus	wood	3		1			4
Populus/Salix	wood		1		3		4
Artemisia	twig		1	1	1		3
Cheno-am	seed				2		2
Pinus ponderosa	wood	1			1		2
Purshia	twig			2			2
Conifer	wood	1					1
Pinus edulis	cone fragment			1			1
Pinus edulis	twig			1			1
Pinus ponderosa	branch			1			1
Pinus ponderosa	needle fascicles			1			1
Pinus	wood			1			1
Prunus serotina	seed fragment				1		1

Appendix F

Dendrochronology

Laboratory of Tree Ring Research

Chimney Rock Pueblo				10-Jul-2010	
LTRR Sample #	Field Sample #	Species	Provenience	Inside Date	Outside Date
CRE-252	29-44	DF		1025p	1070+LB comp
	29-45			same as CRE-252	
	29-41			same as CRE-252	
	29-42			same as CRE-252	
	28-15			same as CRE-252	
	29-46			same as CRE-252	
CRE-253	29-18	DF		1062	1091+vv
CRE-254	29-17	PP		1008p	1055+vv
CRE-255	29-10	DF		1047	1080+vv
CRE-256	29-4	DF		1006	1053vv
CRE-257	29-21	DF		1054	1093+LB comp
CRE-258	29-22	Df		1067	1093+LB comp
CRE-259	32-26	PP		957	1024vv
CRE-260	32-27	PP		931+-	1018+LB comp
CRE-261	28-14	DF		1038p	1082vv
CRE-262	28-19	DF		1051	1079vv
CRE-263	28-15	PP		No Date	
CRE-264	28-12	PP		No Date	
CRE-265	28-8	JUN		964	1011L comp
CRE-266	28-7	PP		No Date	
CRE-267	28-6	PP		No Date	
CRE-268	29-5			No Date	
Cre-269	28-4			No Date	

SITE: Chimney Rock Pueblo ACCESSION # A-1922
Species ID by JAP Date: 7/11/2010

FS #	DF	PP	PNN	JUN	S/F	POP	QUER	NON-CON	COMMENT
30-34		1							
29-26		1							
29-19	1								
29-20	1								
23-(none)		1							
29-11	1								
29-6		1							
29- (none)		1							
29-24		1							
29-16	1								
29-5		1							
29-25	1								
29-9	1								
29-23	1								
29-8		1							
32-22	1								
32-25	1								
32-21	1								
30-27									"corn cob"
28-20	1								
28-21		1							
28-17	1								
28-13	1								
28-1	1								
28-11	1								
28-10				1					
28-3	1								
28-2	1								
28-9	1								
27-2		1							
27-3		1							
27-1		1							
29-11	1								
25-(none)		1							

LABORATORY OF TREE-RING RESEARCH
ARCHAEOLOGICAL RESEARCH

EXPLANATION OF SYMBOLS

The symbols used with the inside date are:

- year – no pith ring present
- p – pith ring present
- fp – the curvature of the inside ring indicates that it is far from the pith
- ±p – pith ring present, but due to the difficult nature of the ring series near the center of the specimen, an exact date cannot be assigned to it. The date is obtained by counting back from the earliest dated ring.
- ± – the innermost ring is not the pith ring and an absolute date cannot be assigned to it. A ring count is involved.

The symbols used with the outside date are:

- B – bark present
- G – beetle galleries are present on the surface of the specimen
- L – a characteristic surface patination and smoothness, which develops on beams stripped of bark, is present
- c – the outermost ring is continuous around the full circumference of the specimen. This symbol is used only if a full section is present
- r – less than a full section is present, but the outermost ring is continuous around available circumference
- v – a subjective judgment that, although there is no direct evidence of the true outside on the specimen, the date is within a very few years of being a cutting date
- vv – there is no way of estimating how far the last ring is from the true outside
- \+ – one or more rings may be missing near the end of the ring series whose presence or absence cannot be determined because the specimen does not extend far enough to provide an adequate check
- ++ – a ring count is necessary due to the fact that beyond a certain point the specimen could not be dated

The symbols, B, G, L, c and r indicate cutting dates in order of decreasing confidence, unless a + or ++ is also present.

The symbols L, G, and B may be used in any combination with each other or with the other symbols except v and vv. The r and c symbols are mutually exclusive, but may be used with L, G, B, + and ++. The v and vv are also mutually exclusive and may be used with the + and ++. The + and ++ are mutually exclusive but may be used in combination with all the other symbols.

Appendix G

Radiocarbon Dating

Keck Carbon Cycle AMS Facility and UC Irvine and Beta Analytic Radiocarbon Dating Laboratory

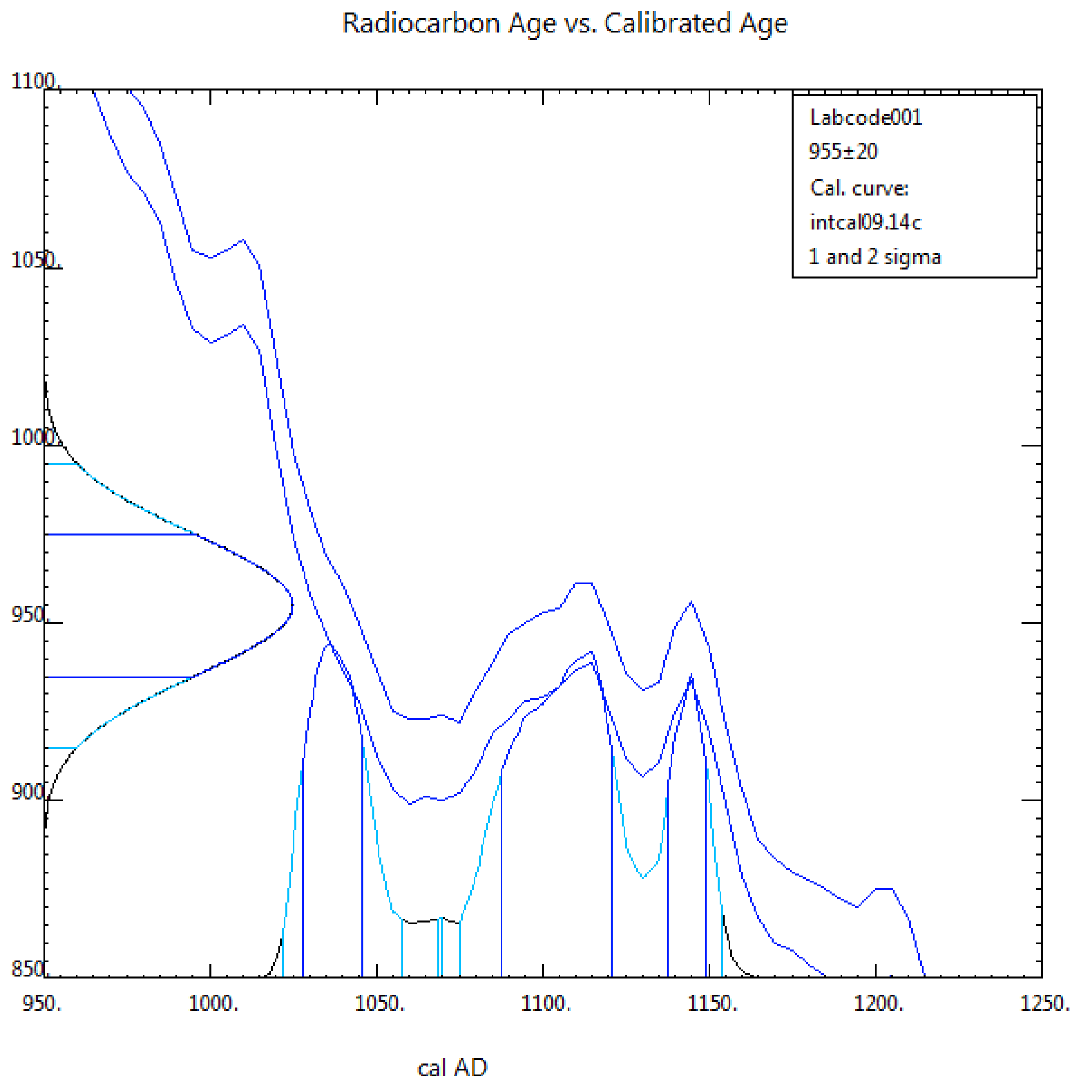


Figure 1. Calibration curve for radiocarbon sample from Room 7 (Corn lying atop Surface 1). Processed by the Keck Carbon Cycle AMS Facility, Earth System Science Department, University of California, Irvine.

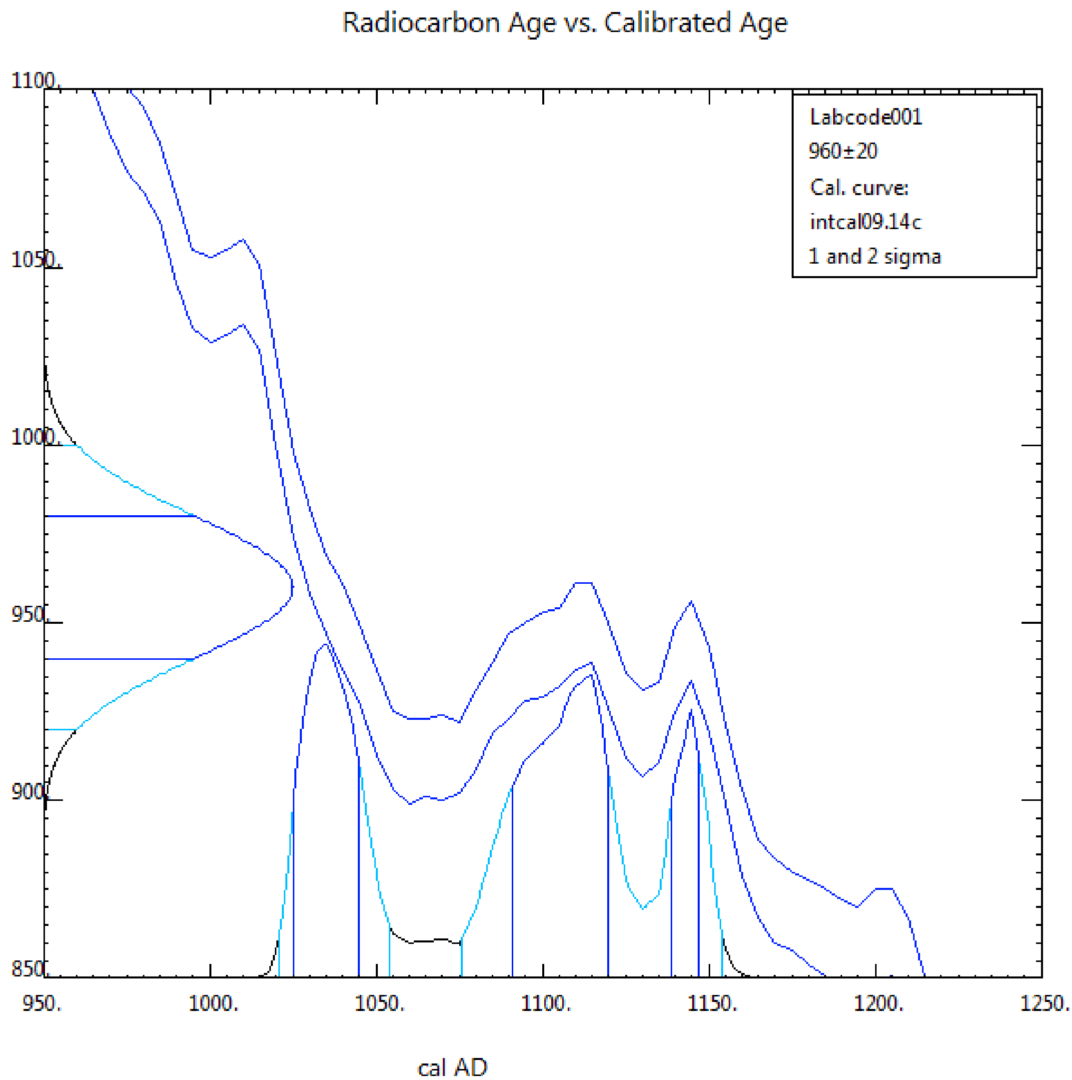


Figure 2. Calibration curve for radiocarbon sample from Room 7 (Corn lying atop Surface 1). Processed by the Keck Carbon Cycle AMS Facility, Earth System Science Department, University of California, Irvine.

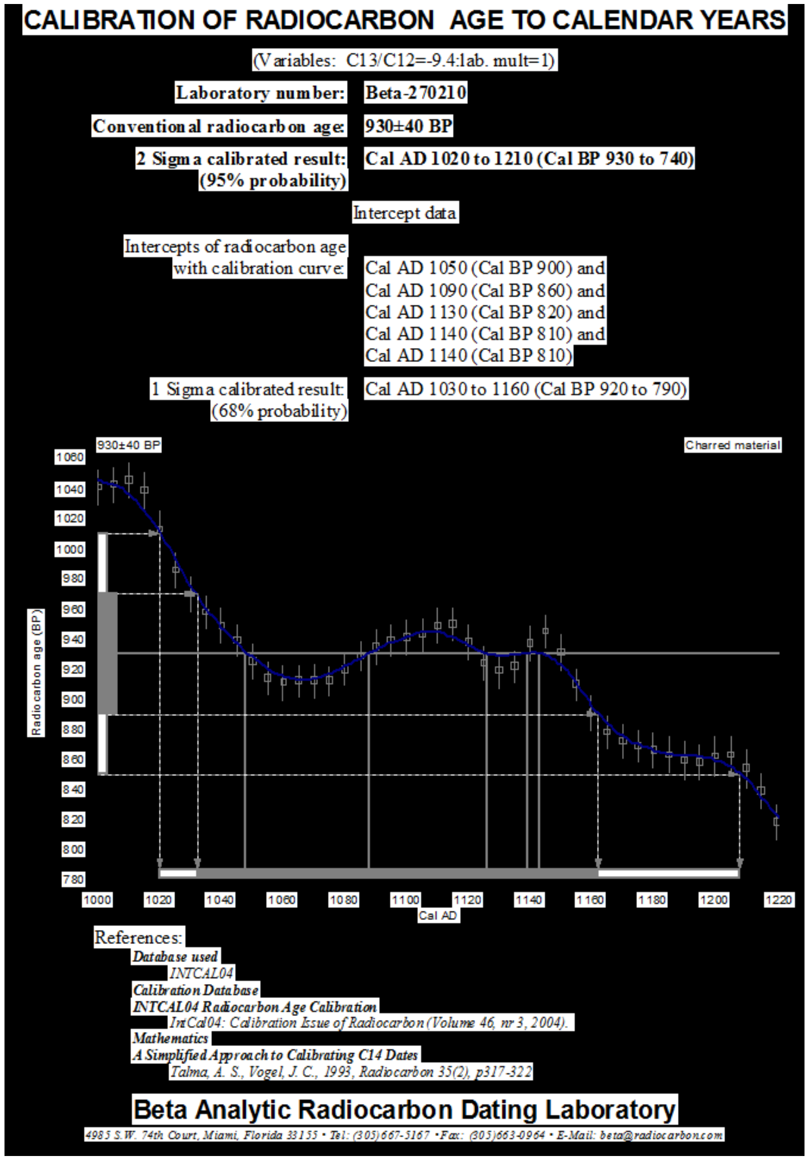


Figure 3. Calibration curve for radiocarbon sample from Room 5 (Feature 1, hearth in bedrock below the room). Processed by the Beta Analytic Radiocarbon Dating Laboratory.

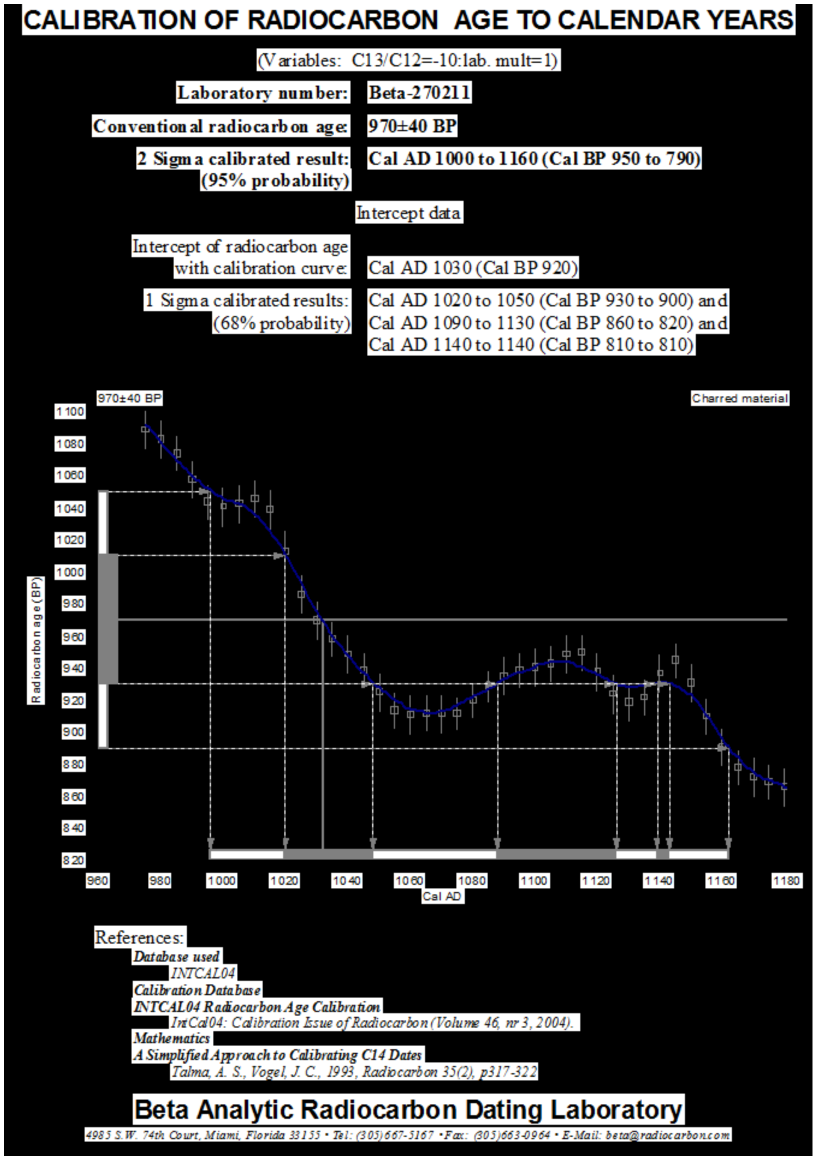


Figure 4. Calibration curve for radiocarbon sample from Room 5 (Feature 1, hearth in bedrock below the room). Processed by the Beta Analytic Radiocarbon Dating Laboratory.

Appendix H

Ceramic Analysis

C. Dean Wilson

Chimney Rock Pueblo (5AA83) Ceramic Analysis

September 5, 2010

C. Dean Wilson
Director, Pottery Analysis Laboratory
New Mexico Office of Archaeological Studies
Santa Fe, NM 87501

List of Figures

List of Tables

This report briefly discusses data resulting from the analysis of 1029 sherds at Chimney Rock Pueblo, and includes 30 sherds from Room 5 and 999 sherds from Room 7. Categories used during this analysis provide for the examination of a variety of issues including the assignment of ceramic dates to various components as well as the examination of trends relating to the area of origin, associated technology, manufacture, production, decoration, and use of pottery vessels at Chimney Rock Pueblo. In order to examine various patterns, a range of ceramic data was recorded in form of both attribute classes and ceramic type categories.

During this analysis, pottery from provenances, exhibiting a unique combination of traits, was separated into different groups. Information about the combination of traits noted for pottery assigned to a particular provenance was recorded on a distinct data line. Each data line was assigned to consecutive catalogue numbers. Sherds assigned to a particular grouping were placed into a separate bag along with a small slip of paper recording the associated site, provenience designation, and catalogue number. Other information recorded for each data line included the ceramic type, descriptive attribute codes, count, and weight. These procedures allow for the matching of sherds with data lines recorded, that may be necessary to locate items for data editing and future analyses.

Descriptive Attributes

Attribute classes recorded during the present study include temper, paint type, surface manipulation, modification, and vessel form.

Temper

Temper categories refer to characteristics noted in aplastic particles in paste clay. Temper analysis involved examining freshly broken sherd surfaces through a binocular microscope. Such characterizations are limited, although broad temper categories can be recognized based on combinations of color, shape, fracture, and sheen of associated of particles.

Temper was assigned an andesite/diorite category based on the presence of crushed igneous porphyries that could have derived from the andesite or diorite. This temper is in most of the gray and white ware sherds examined during this study, and is similar to that occurring in sites across much of the San Juan region. Surveys along the Piedra River near Chimney Rock seem to indicate the common occurrence of water worn andesite cobbles along the river banks and flood plain (Parker 2004). Although areal variations in the crushed igneous rock employed most likely exist, they were not distinguished here. This temper category is characterized primarily by angular to sub-angular lithic particles that are clear to white. Small, black, often rod-shaped crystals are present, and may occur individually outside or within the larger particles.

Quartz Sand is rounded or sub-rounded, with well-sorted moderate to large sand grains. These grains are transparent, white, or gray. This temper is common in ceramics produced throughout most of the Kayenta and Cibola region, although it may be present in pottery produced in certain areas of the Mesa Verde region (Wilson and Blinman 1995). It is likely that some of the temper assigned to this category during this study may be similar to that classified by Parker (2004) as arcose, and some of the material he assigned to that group may have been classified here as andesite/diorite given the range of weathering noted in temper assigned to that group. Fine sand particles bound together in a matrix were classified as fine sandstone.

Trachyte consists of highly reflective, angular to sub-angular green, gray, or black particles. These are very crystalline or sugary in appearance, and exhibit little variability. This temper reflects the use of distinctive igneous rock sources by potters in the Chuska region in northwestern New Mexico although given the occurrence of basalt sources in areas of the Upper San Juan, it is possible that closer sources may have sometimes been utilized.

Sherd refers to the use of crushed potsherds as temper, and consists of angular particles that are relatively small and are usually white, buff, gray, or orange. These are easily distinguished from rock tempers by their dull non-reflective appearance. Small, reflective lithic particles may occur inside or outside the sherd fragments. In some cases, fairly large particles occur along with a crushed sherd and may indicate that both crushed rock and sherd particles were added. If both sherd particles and distinctive rock fragments occur together, the combination of the two temper categories was recorded together. Similar conventions were used to note combinations of sherd and sand and sherd and trachyte particles.

Pigment

Pigment categories were identified based on the presence, surface characteristics, and color of painted decorations. Most pigments were divided into organic (or carbon) and mineral pigment groups based on previously described characteristics (Shepard 1963). The presence, type, and color of paint pigments were recorded for all sherds examined. Pottery without evidence of painted decorations was simply placed into a not-tempered or none category. Mineral paint refers to ground minerals such as iron oxides used as pigments. These decorations are applied as powdered compounds, usually along with an organic binder. Mineral pigment represents a distinct physical layer, and rests on the vessel surface. Such pigments are usually thick enough to exhibit visible relief. Mineral pigments usually obscure surface polish and irregularities. Organic paint refers to the use of vegetal pigment only. Organic paint is soaked into rather than deposited on the vessel surface. Thus, streaks and polish are often visible through the paint. The painted surface is generally lustrous, depending on the degree of surface polishing. The pigment may be gray, black, bluish, and occasionally orange in color. The edges of the painted designs are often fuzzy and indistinct.

Surface Manipulation

Attributes relating to surface manipulations reflect the presence and type of surface texture, polish, and slip treatments, and were recorded for both interior and exterior vessel surfaces. Categories identified during the present study include plain unpolished, plain polished, polished with white slip, polished with red slip, plain scored, surface missing, clapboard, indented corrugated, plain corrugated, smeared indented corrugated, wide neck banded, plain corrugated, smeared indented corrugated, wide neck banded wiped, plain indented corrugated, alternating fillet indented corrugated, patterned corrugated, and Payan style corrugated.

Vessel Form

Observations about sherd shape and surface manipulation provide clues concerning the use of the vessels from which they derived. Vessel form classification is usually dependant on sherd size, manipulation, and vessel portion. It is usually possible to assign rim sherds to more specific categories than body sherds. Categories identified during the present study include indeterminate, bowl rim, bowl body, jar neck, jar rim, and dipper with a handle.

Modification

Modification refers to evidence of post firing alteration including abrasion, drilling, chipping, or spalling. Data concerning such treatments provides information about use, repair, and shaping of sherds and vessels. Modification categories recorded during the present study include none, drill hole complete, and beveled edge.

Design Motifs

Distinct stylistic motifs or combination of motifs noted were also recorded. Categories recorded include wide hachure, fine hachure, wide parallel lines, thin parallel lines, triangles, checkered, criss - cross hachure, squiggle line, dots, hachure and thin lines, scroll, and ticked lines.

Ceramic Type Categories

All sherds analyzed were also assigned to ceramic type categories based on combinations of traits with spatial, functional, and temporal implications. The assignment of types was based on a series of decisions that involved first the recognition of associated ceramic tradition, ware, and finally to specific type names. The determination of associated ceramic tradition involved the separation of sherds into broad groups indicative of postulated area of origin or "cultural" association. Pottery was placed into ceramic traditions based on characteristics of temper, paste, and paint of pottery known to have been produced in various regions. Next, sherds were assigned to ware groups, including gray, white, red wares, based on technological attributes, surface characteristics and form. Finally, they were assigned to ceramic types based on temporally sensitive painted styles or textured treatments.

Ceramic traditions generally correspond to long recognized regions of the Southwest (Kidder 1924; Colton 1939). During the present study, types belonging to a number of Anasazi regional traditions were identified including those assigned to the Northern San Juan, Upper San Juan, Cibola and Chuska tradition. Table 1 notes distribution of types assigned to various ceramic traditions and ware groups.

Northern and Upper San Juan Tradition Types

The great majority of pottery examined during the present analysis exhibit combinations of pastes, manipulations, styles and other traits commonly noted in types defined for either the Northern San Juan or Upper San Juan pottery traditions. Ceramics associated with these two regional traditions, are during some periods very distinct, and during other periods are extremely similar to each other (Wilson and Blinman 1995). For example Rosa Black-on-white, which was produced over wide areas of the Upper San Juan region during the Early Pueblo I period, seems to have been distinct from contemporaneous decorated forms produced over much of the Northern San Juan region. In contrast, the characteristics of Piedra Black-on-white from Late Pueblo I contexts from sites in both regions appears to be extremely similar if not identical to each other.

Assemblages dating to the Pueblo II period in areas such a Chimney Rock appears to reflect an interesting and variable combination of regional pottery forms with, some closely resembling contemporaneous pottery types defined for the Northern San Juan (or Mesa Verde) region to the west, and other pottery reflecting distinct characteristics of distinct forms produced in the Upper San Juan region. Thus, a combination pottery of probable local manufacture was assigned to a combination of type categories including those previously defined for the Northern San Juan tradition (Abel 1955; Breternitz and others 1974; Brew 1946; Erickson 1998; Hayes and Lancaster 1975; Oppelt 1991; Wilson and Blinman 1995) as well as some distinct forms defined for the Upper San Juan tradition (Blinman and Wilson 1994; Wilson and Blinman 1993; Wilson 2000; 2002). A combination of types defined for these two traditions is used here to document the potential range of variation that reflects both regional and local developments. Categories employed during the present study also reflect a mixture of both formal and informal types. Formal types encompass distinctive design styles or manipulations characteristic of specific types described for particular regional tradition. Formal type names follow the conventions of Colton and Hargrave (1937), consisting of a geographic place name followed by ware or decoration descriptor such as Dolores Corrugated or Mancos Black-on-white. Pottery that lacks style or manipulation traits necessary for assignment to a formal type but may still convey useful information relating to the dating or nature of the ceramic assemblage are assigned to informal types. Informal types are given descriptive names that largely convey the identifying characteristics such as Unpainted Undifferentiated or Indented Corrugated. The use of types defined for both kinds of categories provides for a complete characterization of all the ceramics noted for a particular assemblage.

Ceramics occurring within the Northern San Juan (or Mesa Verde) region were first defined as a distinctive Anasazi ceramic tradition based on the presence of crushed igneous temper (Abel 1955). The igneous rocks include a range of porphyries, usually andesite or diorite. . These rocks are present in situ in laccolithic mountains and dikes and as igneous cobbles in Quaternary alluvial deposits whose drainages include the primary sources. As usually defined, Northern San Juan Region is the northernmost extension of the Anasazi, including large areas of southeastern Utah, southwestern Colorado, and northwestern New Mexico, and includes most of the area drained by the northern tributaries of the San Juan River. The boundary between the Northern San Juan and Upper San Juan is usually placed at about the Animas River. Although the definition of the Northern San Juan region is often linked to the distribution of crushed igneous rock temper, there are several deviations from that pattern. These included widely scattered pockets within this region where sand or crushed sandstone were used as temper. During later periods, sherd temper was used in the production of white wares over much of this region (Abel 1955).

San Juan Gray Ware Types

Gray wares represent the majority of ceramics produced in the San Juan region. Exterior sooting is common and reflects the use of gray ware vessels for cooking. Paste and surface colors of sherds and vessels are extremely variable, ranging from white, gray, and black to red. Dark cores are often present in paste cross section. When exposed to standardized oxidizing conditions, color is quite variable, as significant frequencies of sherds from a given assemblage may fire to white, buff, pink, orange, and red colors. The overwhelming majority of gray wares produced during all periods were tempered with crushed igneous rock. Tempering material is usually coarse, with particles often protruding through the surface.

While the great majority of the pottery examined from Chimney Rock Pueblo exhibited textured treatments common in Pueblo II assemblages throughout the San Juan region, a low frequency exhibited plain surfaces. While the combination of plain surface and crushed rock temper is similar to that noted for Chapin Gray which dominates assemblages associated with the earliest ceramic occupations in the Northern San Region and Piedra Gray and Arboles Gray characteristic of assemblages in the Upper San Juan region dating to the Late Pueblo I and Pueblo II periods, during the present study all plain gray ware sherds were assigned to a series of descriptive categories,

Plain Gray Rim was assigned to plain rim sherds that were large enough to clearly indicate they derived from vessels for which the exterior surface had been completely smoothed as noted for Chapin Gray, Piedra Gray, and Arboles Gray. Given the absence of any other evidence of ceramics dating prior to the Pueblo II period, it is likely the two sherds assigned to this category derived from an Arboles Gray vessel. Indeterminate Plain Rim refers to small rim plain rim sherds that could have been derived from a variety of forms. Plain Gray Body refers to obliterated sherds not belonging to a rim that could have originated from plain vessels as well as the portions of neck banded and/or corrugated neck forms.

.

Many of the plain gray wares identified during this study were probably derived from Mummy Lake Gray which is contemporary with corrugated pottery. Pottery is assigned to this category based on the presence of an everted single rim fillet near the rim with a plain surface directly below. Eversion varies from slightly everted to eversion angles of more than 45 degrees. The rim fillet is usually broad and unmanipulated, and traces of coils have been completely obliterated on the exterior surface of the body, leaving a plain and often rough surface. Vessel forms are restricted to jars. This type is rare in all assemblages but probably dates during the late Pueblo II to Early Pueblo III period, spanning from about 1050-1200 period.

The great majority of sherds from Chimney Rock Pueblo exhibit coiled or corrugated treatments over the entire surface underlying the fillet along the rim which is typical of the great majority of gray ware pottery produced in the Anasazi country from A.D. 1000 to 1300. Since this rim based typological approach explicitly ignores style of corrugated indentations and vessel shape, body sherds from corrugated vessels are not assigned to a specific type. Instead body sherds were assigned to a series of informal descriptive types based on the treatment of the coil. Most of the corrugated sherds display regular spaced indentation along thin clapboarded coils and were assigned to Indented Corrugated. Similar sherds without regularly spaced indentations were assigned to Plain Corrugated. Those with rows exhibiting both kinds of treatments were assigned to Alternating Corrugated. Those with indented corrugation that were highly obliterated were assigned to Smeared Corrugated.

Most formal corrugated types defined for this region are based on projected changes in rim eversion that are thought to have temporal implications. Three distinct corrugated types can be identified by arbitrary subdivision of a continuum of rim eversion from near vertical to extremely everted. Although the correlation is not absolute, this continuum seems to correlate more strongly with time of vessel production than other attributes of corrugated sherds. Mancos Corrugated rims exhibit little or no eversion (less than 30 degrees). They are associated with the earliest corrugated vessels, appearing in small quantities sometime prior to A.D. 930 and become rare after A.D. 1100. Rim sherds exhibiting moderate eversion (approximately 30 to 55 degrees) are assigned to Dolores Corrugated (see figure 1.1 - 1.3). This type is extremely rare prior to A.D. 1050, but becomes more common through the end of the eleventh century, at which time it is the most common corrugated rim type. Corrugated rim sherds showing eversion greater than 55 degrees are classified as Mesa Verde Corrugated. These sherds are extremely rare prior to A.D. 1100, but they increase in frequency to form at least a plurality and usually represent the majority of the corrugated rims at contexts dating after A.D. 1200.

A very small number of sherds were assigned to types defined for the Upper San Juan tradition. Rosa Gray exhibit plain surfaces and sand or quartz temper. Payan Corrugated is a distinctive variety whose manufacture appears to be geographically and temporally restricted within the Upper San Juan region. Indentations on Payan Corrugated are widely spaced and are stacked to create pronounced spiral, angular, or vertical ribs (Siscenti et al. 1963). Rims tend to be vertical, and vessel forms are cooking-storage jars with cylindrical shapes. Although corrugated sherds with similar patterns have been observed in other Anasazi regions, they are extremely rare. In contrast, Payan Corrugated sherds have comprised up to one-third of the gray wares in some Arboles phase sites in the Navajo Reservoir.

San Juan White Ware Types

For most regional traditions of the Northern Anasazi white wares dating to the Pueblo II period are usually easily distinguished from gray ware types by the presence of painted decoration, polish, or slip, as well the common use of sherd temper. The great majority of white wares exhibit combinations of crushed rock recorded here as andesite diorite either by itself or with crushed sherd that appears to represent a more finely crushed version of the temper dominating the associated gray wares.

White ware sherds, which do not display painted decorations distinct enough to be assigned to formally defined Northern San Juan types, were assigned to grouped types. Unpainted white ware sherds were classified as Unpainted Undifferentiated. Those exhibiting indistinct painted designs in mineral paint were assigned to Pueblo II Mineral Paint Undifferentiated.

Sherds exhibiting pastes and styles typical of those noted for Northern San Juan pottery produced during the early span of the Pueblo II period were assigned to Cortez Black-on-white. This type is usually well-polished and commonly exhibits a white crackled slip. Painted decorations were executed in a mineral pigment, and tend to incorporate a number of distinctive design motifs which occur together in moderately complex combinations. These include sequences of thin parallel lines, wavy lines, ticked lines, and rick-rack. Bands may be filled by squiggle hachure, interlocking scrolls, or stepped and ticked triangles. A partitioned or banded layout is often present in which the vessel surface is divided into a series of two to four geometrically opposed sections. Each section consists of similar combinations of design motifs separated by a succession of thin framing lines.

Mancos Black-on-white as often defined encompasses a wide range of design styles and technological variability, often including ranges of styles that may reflect those used to define several types described for other regional traditions. A wide variety of forms are represented including bowls, jars, ollas, and dippers. Designs are executed in mineral pigment, although organic paint is found on examples of forms that seem to be transitional between the late Pueblo II to Pueblo III periods. Design styles are often simple and boldly executed in allover patterns. The design element most commonly associated with Mancos Black-on-white is a series of rectilinear bands filled with diagonal, squiggle, straight, or cross hachure. Other designs noted for Mancos Black-on-white include dots, opposing triangles, radiating triangles, step triangles, checkered triangles, checkered squares, parallel lines and scrolls. Because of the variability of designs noted, Mancos Black-on-white was assigned to a series of varieties based on the presence of particular solid or hatchured motifs. Mancos Black-on-white first appears in the last decades of the tenth century and is the dominant white ware type from A.D. 1000 through about A.D. 1150. Examples of Mancos Black-on-white reflecting the use of similar paint regiments and paste and range of styles are illustrated in figure 3.1 through 3.4).

Given the variations noted in the white wares, it is possible certain local forms may not have always been adequately recognized during the present analysis. In fact, a large number of sherds, many of which appear to be from a single vessel, presented a considerable challenge concerning their assignment to a particular type. This was represented by a number of sherds exhibiting hatchured designs in a very washy pigment (figure 4.1 through 4.4). Examinations of many of the sections of pigments on these sherds seemed to indicate the use of a very washy organic pigment, while other areas appear to contain the remnants of mineral paint, often over a soft paste and light flaky slip. After much struggle and fretting and placing them into one group and then another, I characterized these sherds as containing very washy mineral paint and I assigned them to Mancos Black-on-white. I am still not completely satisfied with either decision, although the struggle involved in making this assignment may be in itself be instructive about the nature of ceramic production in the Chimney Rock District. Mancos Black-on-white found in areas across the San Juan is often a very variable type, and it is common for archaeologist to struggle with assignments on decorated sherds from late Pueblo II period sites. Given this period is represented by a gradual shift, with many intermediate examples to the use of an exclusively organic pigment; it is not surprising that a mixture of pigment recipes are represented in this assemblage. While the documentation of the considerable variability noted in local Pueblo II white ware produced in the Upper San Juan or Chimney Rock District has partially dealt with through the definition of Arboles Black-on-white as examples of distinct forms thought to have developed in the Upper San Juan or Chimney Rock District, the nature of this variability may be such that the variation cannot easily be documented through the use of these two type categories alone.

The difficulty of the assignment of the distinct hatchured forms discussed was partly addressed during the present study by the assignment of "Mancos Black-on-white Wide Hatchured Category" to sherds with wide hatchured designs executed in a similar pigment. All the sherds assigned to this category are very similar, and most of these sherds appear to be from the same vessel. It is possible these sherds are similar if not identical to pottery previously assigned to Chimney Rock Black-on-white, a local variety of Mancos Black-on-white defined by Parker (2004). It was not possible for me to confidently assign the hatchured sherds discussed here to this type given may lack of familiarity with sherds, type collections, or detailed descriptions of sherds assigned to Chimney Rock Black-on-white. This type is described as containing crushed sherd temper from the Chaco area in local clay (Parker 2004). Decorations consist of fine hachure similar to that on Gallup Black-on-white, but described as having been executed in an organic paint. (Parker 2004)

Arboles Black-on-white was defined during investigations by the Navajo Reservoir Project and represents the most common Anasazi decorated type defined for the Arboles phase and essentially represents an areal variety of Mancos Black-on-white (Dittert 1961). Arboles Black-on-white is analogous to Cortez Black-on-white and Mancos Black-on-white of the Northern San Juan region and differs from these types mainly in surface characteristics. Paste color is usually gray to dark gray. Surfaces are usually slightly polished to unpolished, and they are usually covered with a white to buff slip or wash. The slip is often uneven, and unslipped patches may be visible. Arboles Black-on-white is almost always tempered with crushed igneous rock, sometimes occurring with sand, and sherd temper is absent. Designs are almost always executed in mineral paint. Designs are similar to those observed on Cortez Black-on-white and Mancos Black-on-white, but they tend to be simple and sloppy. While a small number of sherds from just a few vessels were assigned to Arboles Black-on-white during this study (figures 5.1 and 5.2), in general assignments to this type were limited to the most distinct examples. This decision is largely based on my previous observations of a great deal of variation in Mancos Black-on-white including slipped and unslipped forms throughout the San Juan region.

A very small number of sherds decorated with a diffuse organic paint were assigned to Indeterminate Organic Paint. One sherd assigned to this category exhibits a tan silty paste, unslipped surface, slight polish and line designs similar to pottery that has been characterized as Bancos Black-on-white or Gallina Black-on-white (figure 6). Such forms represent a very long continuation of distinct and simple styles and forms in organic paint in the southernmost areas of the Upper San Juan area including areas of the Largo Gallina drainage (Hibben 1949). Ceramics exhibiting these characteristics could have originated from an earlier component or they could have originated in the Gallina district to the south that was contemporaneous with the late Pueblo II period.

Cibola Tradition Types

Cibola tradition types include ceramics made over a wide area covering much of the northwestern part of New Mexico, including a very large area encompassing much of the area south of the San Juan River and north of the Mogollon Highlands (Carlson 1970; Franklin 1980; Hawley 1936; Toll and McKenna 1987; Windes 1977). Cibola gray wares are very difficult to distinguish from sand tempered gray wares produced in other areas of the Southwest, and were seldom recognized during the present study. Cibola gray ware types are generally distinguished by the presence of sand, sand and sherd or sherd temper, a light-colored paste, and finely executed hachure designs in mineral paint. Gray wares assigned to this tradition were limited to a single Plain Gray Body sherd.

Red Mesa Black-on-white refers to ceramics exhibiting styles found throughout the northern Anasazi country during the early Pueblo II period with styles equivalent to those described for Cortez Black-on-white Temper may be sand, sherd, or sherd and sand. Designs are similar to those described for Red Mesa Black-on-white. Gallup Black-on-white refers to sherds exhibiting Pueblo II surface manipulation and hatchured designs (figures 7.1 through 7.6). Lines in earlier forms of Gallup Black-on-white tend to be wider spaced than those associated with later forms of this type. Escavada Black-on-white was assigned to sherds exhibiting a range of solid design styles. Definitions of and distinctions between Puerco Black-on-white and Escavada Black-on-white are somewhat confusing and vague. As used here, these categories include the use of a range of solid design styles employed during the later part of the Pueblo II and early Pueblo III periods (figure 8). Design styles often include triangles, parallel lines and chevrons.

White Mountain Red Wares represent a distinctive red ware tradition produced in the westernmost regions of the Colorado Plateau (Carlson 1970). White Mountain red ware types generally exhibit a buff to orange paste covered by a distinct dark red slip. Vessels belonging to this tradition are almost always tempered with crushed sherd fragments. Pottery from Chimney Rock Pueblo assigned to this tradition was limited to a single unpainted sherd classified as Unpainted White Mountain Red Ware.

Chuska Tradition Types

Chuska tradition ceramic types were produced in the Chuska Valley and nearby drainages in parts of Southeast Arizona and Northwest New Mexico (Franklin 1980; Peckham and Wilson 1965; Wilson 1990; Windes 1977). Chuska tradition types are identified by the presence of distinct sanidine basalt (trachyte) temper. In addition Chuska ceramics often contain a bluish gray paste which fires to bright red colors. White wares are often covered with a streaky white slip. Painted decorations are commonly executed in organic paint in contrast to the adjacent Cibola and Mesa Verde traditions. Ceramic type categories previously defined and described for the Chuska tradition (Peckham and Wilson 1965; Wilson 1990; Windes 1977) were employed during the present study. Given the possibility for local trachyte temper sources, it is possible some of the sherds assigned to types in the tradition could have been produced in the Chuska region.

Gray ware with smoothed exteriors was assigned to Bennet Gray. White wares with indistinct designs in mineral paint were assigned to Mineral Painted Undifferentiated. Examples with typical Pueblo II designs in mineral paint were assigned to Taylor Black-on-white (figure 9) while those with hachure designs were assigned to Brimhall Black-on-white.

Examination of Ceramic Trends

Data relating to ceramic distributions noted at Chimney Rock Pueblo may be used to examine a variety of trends and issues. Many of these trends may relate to a combination of influences noted at Chimney Rock Pueblo and surrounding Pueblo II sites including a long sequence of local development as well as interaction with Northern San Juan or Mesa Verde groups to the west along with sudden and dramatic influence from Chaco groups who may have been at least partly responsible for the establishment of the great house at this community.

It has been argued that populations living in areas of the Upper San Juan moved north into Colorado during the Arboles Phase at about A.D. 900 to 1050 (Eddy 1972, 1974; Lister 1993). Habitations associated with this occupation appear to have been small and sparsely settled and mostly consisted of small habitations such as pit structures in lower elevations surrounding Chimney Rock. Ceramic assemblages noted on sites assigned to this phase include simple and distinct painted bowls (Arboles Black-on-white), and distinct corrugated (Arboles Corrugated) and plain gray ware (Arboles Gray) forms.

This phase was thought to have been followed by the Chimney Rock phase which not only included Chimney Rock Pueblo but smaller contemporary "crater houses". These structures tend to be in higher locations along the narrow rock ridges and are thought to have been occupied between A.D. 1075 and 1150 (Eddy 1977). It has been argued that the replacement of pit house by large surface communities which included great houses was the direct result of intrusion and influence by groups from Chaco Canyon (Eddy 2004).

Recent investigations have proposed that many of the sites in lower elevation such as those along the Piedra River Valley assigned to the Arboles phase were in fact contemporaneous with the great house and other settlements on top of Chimney Rock Mesa (Chuipka et al. 2010). In this scenario, many of the sites assigned to the Arboles phase are thought to embody an Upper San Juan orthodoxy reflecting groups coexisting with those who resided in communities in higher elevations after the establishment of the Chaco great house at Chimney Rock. This pattern is reflected by variability in both architecture and ceramics at contemporaneous sites along the Piedra River valley and on nearby mesas which represent both the continuation of earlier patterns noted in the Upper San Juan as well as influences from the Northern San Juan and Chaco regions.

Formal structures such as Chimney Rock Pueblo have often been interpreted as forming part of a larger pattern of construction and control of great houses established in various areas in regions north of Chaco Canyon (Bradley 2004; Irwin Williams and Shelley 1980; Judge 1991; Lekson 1991; McKenna and Toll 1992; P Reed 2006; 2008; Roney 2004; Wilcox 1990). Some studies have interpreted these great houses as having been directly built by and linked to groups in Chaco Canyon while other studies have interpreted these developments as reflecting local expressions of pan-regional developments that occurred in Chaco Canyon and elsewhere. Examinations of ceramics from almost all of these great houses indicate the dominance of locally produced Northern San Juan gray and white wares that are associated with varying frequencies of ceramics types known to have been produced in the Chaco and Chuska region (Franklin 1980; L Reed 2006; Wilson in progress).

The great majority of gray wares at these northern great houses are tempered with relatively large igneous rock fragments, and are almost exclusively represented by corrugated jars. Rim sherds from these jars tend to display an intermediate degree of eversion that result in their classification as Dolores Corrugated. The great majority of white wares from these great houses are tempered with smaller igneous rock fragments often in combinations with crushed sherd fragments. These white wares exhibit a combination of hatchured and solid designs characteristic of Mancos Black-on-white. While the majority of the white wares from these sites are decorated with mineral paint, low frequency exhibit decorations in organic paint, with designs similar to those noted on Mancos Black-on-white. Similar combinations of styles are present in the “intrusive” ceramics assigned to Cibola and Chuska types. The common occurrence of similar combinations of ceramic types and styles in the early components of these great houses indicate most were founded sometime during the late A.D. 1000s and continued to be continuously occupied until at least the early A.D. 1100s. Ceramic distribution also indicates evidence of later occupations or reoccupation at many of these great houses. The consistent occurrence of Chaco pottery and traits in assemblages dominated by local forms of Northern San Juan ceramic types at earlier components may indicate the interaction and possible mixture of local San Juan and Chaco populations at the various great houses.

Mobley Tanaka (1990) notes some areal patterns in pottery for the Chimney Rock area involving sites in both lower and higher elevations that are described as being dominated by a local form of Mancos Black-on-white. Trends noted include the presence of low frequencies of Chaco imports in all sites on the mesa top with fewer Chaco ceramics on lower elevation mesa and riverside sites. The higher frequency of hatched designs on Mancos Black-on-white on the upper mesa as compared to those on the lower mesa and along the river is interpreted as indicating a conscious effort to imitate Chaco designs on local vessels (Mobley Tanaka 1990). This and other patterns are interpreted as indicating that groups that occupied the great house community in the upper mesa did not necessarily originated from Chaco Canyon, but were more strongly influenced by Chaco styles and ties than populations residing in lower communities. The frequency of white ware and corrugated ceramics was also higher at sites on the upper mesa.

Ceramic data documented during the present indicate patterns very similar to those described at other great house communities north of Chaco Canyon, and seem to support models invoking Chaco influences in terms of reflecting the construction of these communities during the same time as other well known Chaco great houses as well as evidence of influences and pottery from areas commonly associated with the Chaco system. Distribution of both gray ware and white ware types indicate that assemblages from all provenances from both Room 5 and 7 at Chimney Rock exhibit similar distributions indicative of an occupation during the very late part of the Pueblo II period (table 1 through 3).

The distribution of types noted here appears to be similar to that observed during previous excavations of Chimney Rock Pueblo by Eddy (1977). It is difficult, however, to fully compare data from this study to that from earlier studies due to some difference in type groupings defined in these studies (Eddy 1977 p 44). Despite the differences in the manner in which these categories were defined, it appears that the overall distribution of types noted in early studies is similar if not identical to those noted here. Similarities include the occurrence of sherds derived from Mancos Black-on-white as the dominant white ware and the overall dominance of corrugated gray ware. The assignment of the great majority of decorated white and utility gray ware pottery from Chimney Rock Pueblo to Northern San Juan types as well as the presence of a low frequency of pottery assigned to types defined for the Chaco tradition is also consistent with the data from this study. The main difference in the data presented here from that noted in Eddy does not seem to reflect so much a difference in an assemblage but in an analysis strategy that attempted to document potential range of variability in both local and intrusive ceramic forms.

The great majority (77%) of the pottery examined during the present study was assigned to San Juan gray ware types, which represent 77% of the pottery types identified during this analysis. The great majority of these gray wares sherds were tempered with similar crushed rock assigned here to andesite/diorite (table 4). Other temper categories recorded for extremely low frequencies of sherds assigned to San Juan gray ware types include sand, sand and andesite/diorite, sherd and sand (table 4). The great majority of gray wares for the sample of sherds subjected to refiring analysis fired to white to buff colors in an oxidizing atmosphere and indicate the use of similar low iron clays in the production of most of these gray wares. The great majority of the gray ware sherds exhibit indented corrugated treatments, although very low frequencies of sherds exhibiting plain corrugated smeared indented and treatments that may be indicative of Payan corrugated. Most of the corrugated rim sherds exhibit intermediate eversion indicative of Dolores Corrugated, which is the prevalent corrugated rim form at sites dating to the late part of the Pueblo II and early part of the Pueblo III period. The presence of very low frequencies of Mummy Lake Gray also supports this dating assignment, and may explain the presence of very low frequencies of plain gray ware body sherds in these assemblages. Thus, distributions of gray ware types are extremely similar to those noted in late Pueblo II sites throughout the San Juan region. The only exceptions are extremely low frequencies of Payan Corrugated and Rosa Gray which reflect some continuation of local technologies. This influence may also be reflected by the presence of two sherds classified here as Plain Gray Rim, but may actually belong to Arboles Gray, which reflect the late production of plain gray vessels in areas of the Upper San Juan region during the Pueblo II period. Extremely low frequencies of gray wares were assigned to Cibola or Chuska types on the basis of temper although this frequency is much lower than that noted for white ware types (tables 1 and 4).

Distributions of white ware types are similar to those noted in almost all Pueblo II sites in the San Juan region. This similarity is illustrated by the dominance and associated characteristics of sherds assigned to Mancos Black-on-white, although the struggle to characterize what seems to be a distinct hatchured form and to distinguish Arboles that stem from unique aspect of these assemblages/. Sherds assigned to Mancos Black-on-white are represented by a fairly even amount of sherds characterized as tempered with andesite diorite (46.4%) and andesite diorite and sherd (43.2%). The great majority of pastes of selected samples of Mancos Black-on-white sherds fired to buff and white colors in an oxidizing atmosphere similar to those noted in gray wares, and may indicate the use of similar clay sources in the production of locally produced white and gray ware vessels. The presence of extremely low frequencies of sherds with characteristics resulting in their assignment to Cortez Black-on-white is also consistent with this dating period. Some continuation of local styles or forms previously discussed are also reflected by sherds exhibiting pastes and designs resulting in their assignment to Arboles Black-on-white and various forms of Mancos Black-on-white. The very few sherds of Arboles Black-on-white subjected to refiring analysis fired to yellow-red colors, and appear to reflect the use of different clay sources in the production of vessels assigned to this type. This contrasts with the similar buff colors recorded for refired examples of Mancos Black-on-white and Cibola white ware types. Criteria used to recognize Arboles Black-on-white during the present study tended to be fairly conservative, given the wide variation in paste and stylistic characteristics commonly noted in Mancos Black-on-white from sites distributed over much of the Northern Anasazi. It is likely then, that the frequency of pottery reflecting characteristics indicative of production in more conservative lowland areas, is higher than that represented by sherds assigned to Arboles Black-on-white during the present study.

Styles noted for San Juan white ware types reflect the wide range of designs noted on Mancos Black-on-white and other white ware types produced during the Late Pueblo II period (table 5). For sherds exhibiting distinct styles, just over half exhibit some form of hachure, most of which were characterized as wide hachure. Other design styles recorded include wide parallel lines, thin parallel lines, triangles, checkerboard, dots, scrolls and ticked lines. Given the common assumption that hatchured designs are closely associated with the Chaco Phenomenon (Judge 1989; Plog 1989; Neitzel 1985; Neitzel and Bishop 1990), the common occurrence of hatchured designs in both local and intrusive ceramics found in the northernmost outliers has often been interpreted as reflecting Chaco influence. Distributions of stylistic motifs during this time may, however, actually reflect horizon styles associated with late Pueblo II communities across several Anasazi regions that extended well beyond Chaco and associated great houses (Toll and others 1992). While the frequency of pottery with hatchured designs at sites dating to this period does tend to be slightly higher in sites which immediately surround Chaco Canyon, they make up as much as half of the pottery from “local” late Pueblo II sites in regions to the north. For example, hatchured ceramics consist of slightly over half of the ceramic at small indigenous sites in the Northern San Juan region dating to the late Pueblo II period (Hayes and Lancaster 1975; Swannack 1969; Toll and others 1993; Wilson 1988; 1995). Thus, the frequency of hatchured designs noted in local white wares from Chimney Rock is similar to that noted for the San Juan region at sites of all kinds, and may simply reflect the wide distribution of this style at communities occupied during the late eleventh and early twelfth century. The common presence of hatchured styles at northern outliers may be more indicative of a time horizon indicative of the period of expansion of great houses into new areas to the north than direct influences by Chacoan migrants or elites. The hachure in the “local” decorate pottery from Chimney Rock is much wider and more poorly than that noted in the intrusive Cibola white ware wares , although these distributions are largely influences by pottery from a small number of vessels,

The presence of some pottery assigned to other regional traditions also indicates potential Chaco influences. Cibola types identified during this analysis are dominated by Gallup Black-on-white along with low frequencies of Escavada and Red Mesa Black-on-white. Gallup Black-on-white is the dominant white wares in assemblages from Chaco Canyon dating the late eleventh and early twelfth century (Toll and McKenna 1997). The presence of Chuska white wares assigned to Taylor and Brimhall Black-on-white is also consistent with an occupation during the late Pueblo II period (Wilson 1989; Windes 1977). While most of the pottery assigned to Chuska types exhibit solid designs, a very high frequency of those assigned to Cibola types exhibit hachure design, most of which exhibit thin closely spaced lines characteristic of much of the Gallup Black-on-white produced in the Chaco Canyon area. While the presence of trachyte temper was used to assign pottery to Chuska types during the present study, it is possible some of this pottery could have originated in production tracts within the Upper San Juan as normally defined. This possibility is indicated by the high frequency of sherds displaying this temper identified in assemblages from sites in the Upper San Juan (Blinman and Wilson 1994; Parker 2004). While pottery exhibiting this temper was assigned to the Chuska tradition pottery, the presence of closer sources of production of such pottery remains a possibility. Some of the examples identified do certainly exhibit pastes that are very similar to types known to have been produced in the Chuska region. The single White Mountain Red Ware sherd, which reflects pottery produced in the Zuni and Little Colorado region, is also consistent with an occupation dating to the late Pueblo II period.

Thus, ceramic distributions noted at Chimney Rock support both a time of occupation and level of interaction consistent with a Chaco outlier. As is the case for other northern Chaco outliers, these assemblages contain a combination of types reflecting local production of San Juan types and types produced in the Chaco and Chuska regions to the south. Archaeologist are still grappling with the development of ceramic analytical strategies and typologies that can best document and convey the nature of dynamics of cultural and economic interactions that occurred at various great houses. Distributions of types and styles identified during this study are extremely similar to those noted at other northern great houses, although many of these characteristics may simply reflect pan-regional styles and influences that are certainly represented at but not limited to Chaco sites or great houses. In addition, a very low frequency of pottery identified may reflect some interaction with more conservative groups in surrounding lowland area that may have continued producing more conservative and localized pottery forms.

Vessel Function

Ceramic data recorded during this analysis also provide clues about the types of activities for which ceramic vessels were used. Many aspects related to vessel use are reflected in ceramic ware distinctions and vessel form categories. Distributions of attributes associated with these categories indicate differences in the use of ceramic vessels at various sites and contexts.

The type of functional interpretations derived from distributions of sherds differs significantly from those based on whole or partially complete vessels. The advantages of sherd-based data is that it is often represented by large samples distributed through a variety of contexts. Sherds, however, represent limited and incomplete samples of the vessels from which they were derived, and often are not recovered from the context where the actual use of the vessel took place.

In many regions of the Northern Southwest, similar functional changes occurred from the earliest ceramic periods into the Pueblo II period. For examples, the total frequency of gray utility ware as compare to white decorated ware gradually declines from the Basketmaker III to Pueblo I to Pueblo II period. For example, at sites scattered over a wide area dating to the Basketmaker III period, gray wares almost always make up more than 90 percent of the total assemblage. This frequency declines during later periods until by the Pueblo II they represent about two thirds, and during the Pueblo III period they consist of just over half of the total ceramics (Wilson and Blinman1993). Another pattern noted in the associated gray ware types includes changes in exterior surface textures (Pierce 2004). While almost all gray ware pottery vessels produced during very early Anasazi occupation periods such as the Basketmaker IIII exhibit plain exterior surfaces, during the early Pueblo I period a high frequency exhibit unobliterated coils near the neck. The portion of vessels with unobliterated surfaces increased, until by the late Pueblo II period almost all jars exhibited corrugated treatments over the entire vessel surface. Neither of these trends extends to regions to the east such as those in areas of the Northern Rio Grande country (Wilson 2003). At sites in these regions dating from A.D. 1000s to 1200, over 90% of the pottery continues to be represented by gray ware jars. In addition, the great majority of the gray ware pottery exhibit unpolished plain exteriors, with very low frequencies represented by those exhibiting neckbanded and even lower frequencies exhibiting corrugated exterior surface treatments.

Functionally related distribution noted here for assemblages from Chimney Rock Pueblo are most similar to those noted for Pueblo II assemblages in the Northern San Juan or Chaco regions in terms of distributions of ceramic ware groups and vessel forms (tables 6 and 7). The majority of sherds from this site represent gray utility ware, which represent 79.5% of the total sherds, with white wares representing 20.4%. The total frequency of gray ware types appear to be slightly higher and that for white wares tends lower than that noted at Late Pueblo II sites in the Northern San Juan region (Wilson and Blinman 1993). As is the case for other Late Pueblo II ceramic assemblages, the overwhelming majority of gray utility ware sherds examined exhibit indented exteriors and appear to have been derived from large mouth cooking/storage forms, with only a single sherd having clearly derived from a bowl. While most (64.3%) of the white ware sherds appear to have derived from bowls, a significant frequency (33 %) are from jars. Other white ware vessel forms noted include a handed dipper.

Thus, these assemblages appear to be functionally similar to those noted at other Late Pueblo II sites in areas to the south and west, with the possible exception of a higher frequency of gray ware cooking jars. This frequency is somewhat similar to those noted for slightly earlier periods, and may indicate an earlier pattern associated with the predominance of cooking. Other studies also indicate that assemblages from potentially contemporaneous communities in lower elevations surrounding Chimney Rock display characteristics similar to late eleventh and early twelfth century noted for other areas along the eastern margins of the Pueblo II. These include a higher frequency of gray wares that are dominated by forms exhibiting plain surfaces. This may indicate that pottery in Chimney Rock reflects a combination of functionally related influences. Influence from Chaco or other areas of the Colorado Plateau are reflected by distributions of wares and gray ware textures noted at Chimney Rock Pueblo where more conservative patterns noted in Pueblo communities in lower areas appear to be more typical of distributions noted for areas of the northeastern margins of the Pueblo Southwest.

While a number of sherds from various sherds appear to reflect sherds belonging to the same vessels, complete vessels appear to be associated with two contexts. Both represent Dolores Corrugated wide mouth jars. One is from Structure 7 PD 45 and is 20 mm in 21 diameter and is about 32 mm in height. The corrugations on this vessel are comparably small and smeared. . It is largely completely, and in a packed box. Most of the vessel exhibits dark areas apparently resulting from sooting although a small area that is lighter gray color of the vessel is exposed on areas on the bottom. It is very likely that this combination of characteristics reflects the use in cooking resulting in sooting of all areas of the vessel except where it rested on the fire. The other vessel is from t Structure 7 PD 31 PL 1 and has not been reconstructed It is 21 mm in diameter and exhibits and alternating and plain corrugations. Given the size of the sherds and completeness this vessel was not reconstructed, Both of these vessels are about the same size and both exhibit similar combinations of highly sooted and lighter areas indicting they were probably used for cooking. No evidence of distinct wear were noted in either vessel. Thus, I would interpret contexts associated with both vessels as reflecting similar activities. that is probably also reflected by the other corrugated pottery which dominates these assemblages.

References Cited

Abel, Leland J.

1955 *Pottery Types of the Southwest: Wares 5A, 10A, 10B, 12A, San Juan Red Ware, Mesa Verde Gray and White Ware, San Juan White Ware*. Museum of Northern Arizona Ceramic Series 3, Flagstaff.

Blinman Eric and C. Dean Wilson

1994 Ceramic Analysis. In *Excavations Along the Arkansas Loop Pipeline Corridor Northwestern New Mexico*, edited by L. Honeycutt and J. Fetterman, pp. 29-1 - 29-15. Woods Canyon Archaeological Consultant Inc., Yellow Jacket, Colorado.

Bradley, Bruce

2004 Wallace Ruin and Chacoan Missions. In *Chimney Rock: The Ultimate Outlie*r, edited by J..M., Malville, pp 115 -122. Lexington Books, Lanham, Maryland.

Breternitz, David A., Arthur H. Rohn, Jr., and Elizabeth A. Morris

1974 *Prehistoric Ceramics of the Mesa Verde Region*. Museum of Northern Arizona Ceramic Series 5. Flagstaff.

Brew, John O.

1946 *Archaeology of Alkali Ridge, Southeastern Utah*. Papers of the Peabody Museum of American Archaeology and Ethnology, 21. Cambridge.

Carlson, Roy L.

1970 *White Mountain Redware; A Pottery Tradition of East-Central Arizona and Western New Mexico*. Anthropological Papers of the University of Arizona No. 19. University of Arizona Press, Tucson.

Chuipka, Jason P., Richard Wilshusen, and Jerry Fetterman

2010 *The Northern San Juan Basin Settlement Survey Project, Archuleta and La Plata Counties, Colorado: Context and Research Design (SJNF #09-013/SJFO #09-017*). Prepared for the USFS and BLM, San Juan Public Lands, Durango, CO and the Chimney Rock Interpretive Association, Pagosa Springs, CO by Woods Canyon Archaeological Consultants, Inc., Yellow Jacket, CO

Colton, Harold S., and Hargrave, Lyndon L.

1937 *Handbook of Northern Arizona Pottery Wares*. Museum of Northern Arizona, Bulletin 11, Flagstaff.

Colton, Harold H.

1939 *Prehistoric Culture Units and Their Relationship in Northern Arizona*. Museum of Northern Arizona, Bulletin No. 17. Flagstaff, Arizona.

Dittert, Alfred E. Jr.
1961 *An Archaeological Survey of the Navajo Reservoir District*. Museum of New Mexico Papers in Anthropology 10. Santa Fe.

Eddy, Frank W.
1972 Culture Ecology and the Prehistory of the Navajo Reservoir District. *Southwestern Lore*, 38 (1 and 2).

1974 Population Dislocation in the Navajo Reservoir District, New Mexico and Colorado. *American Antiquity 39* (1): 75-84.

1977 *Archaeological Investigations at Chimney Rock Mesa: 1970-1972*. Memoirs of the Colorado Archaeological Society 1. The Colorado Archaeological Society, Boulder.

2004 Past and Present Research at Chimney Rock. In *Chimney Rock: The Ultimate Outlie*r, edited by J.M. Malville, pp 115 -122. Lexington Books, Lanham, Maryland.

Erickson, Mary
1998 Ceramic Material Culture. In *The Puebloan Occupation of the Ute Mountain Piedmont*, Volume 6: Material Culture Studies, edited by B.R. Biliman, pp. 3-74. Soil Systems Publications In Archaeology No. 22, Tucson.

Franklin, Hayward H.
1980 Ceramic chronology and culture change at Salmon Ruin. In *Investigations at the Salmon Site: the Structure of Chacoan Society in the Northern Southwest*, edited by C. Irwin-Williams and P.H. Shelley, Volume 2. Report to Funding Agencies, Portales: Eastern New Mexico University.

Hayes, Alden C., and James A. Lancaster
1975 *Badger House Community*. Publications in Archeology 7E, Wetherill Mesa Studies. U.S. Department of the Interior, National Park Service, Washington, D.C.

Hawley, Florence
1936 *Field Manual of Prehistoric Southwestern Pottery Types*. University of New Mexico Bulletin, Anthropology Series, Vol 1, no.4, Albuquerque, New Mexico.

Hibben, Frank
1949 The Pottery of the Gallina Complex. *American Antiquity* 14(3):194-202.

Irwin-Williams, Cynthia, and Phillip H. Shelley (editors)

1980 *Investigations at the Salmon Site: The Structure of Chacoan Society in the Northern Southwest*. Final report to funding agencies. Eastern New Mexico University, Portales.

Judge, W. James

1989 Chaco Canon-San Juan Basin. In Dynamics of Southwest Prehistory, edited by Linda S. Cordell and George J. Gummerman, 209-263. Smithsonian Institution Press. Washington D.C.

1991 Chaco: Current Views of Prehistory and the Regional System. In *Chaco and Hohokam; Prehistoric Regional Systems in the Southwest*, edited by P.L. Crown and W.J. Judge, pp. 11-30. School of American Research Press, Santa Fe.

Kidder, Alfred V.

1924 *An Introduction to the Study of Southwestern Archaeology, with a Preliminary Account of the Excavations at Pecos*. Papers of the Phillips Academy Southwestern Expedition 1.Yale University Press, New Haven..

Lekson, Stephen H.

1991 Settlement Patterns and the Chaco Region. In *Chaco and Hohokam; Prehistoric Regional Systems in the Southwest*, edited by P. L. Crown and W. J. Judge, pp. 31-56. School of American Research Press, Santa Fe.

Lister, Florence C.

1993 In the Shadows of the Rocks; Archaeology of the Chimney Rock District in Southwestern Colorado. University Press of Colorado, Niwot, Colorado.

McKenna, Peter J., and H. Wolcott Toll

1992 Regional Patterns of Great House Development Among the Totah Anasazi. In *Anasazi Regional Organization and the Chaco System*, edited by D. E. Doyel, pp 133-143. Anthropological Papers 5. Maxwell Museum of Anthropology, Albuquerque.

Mobley-Tanaka, Jeanette L.

1990 Prehistoric Community and Community Interaction at Chimney Rock, Colorado. Unpublished Mater's of Arts thesis on file at the University of Colorado.

Neitzel, Jill E.

1985 Regional Styles and Organizational Hierarchies: The View from Chaco

Canyon. Paper presented at the 50th annual meeting of the Society for American Archaeology, Denver.

Neitzel, Jill E., and Ronald L. Bishop
1990 Neutron Activation of Dogoszhi Style Ceramics: Production and Exchange in the Chacoan Regional System. *Kiva* 56(1):67-85.

Oppelt, Norman T.
1991 *Earth, Water and Fire, The Prehistoric Pottery of Mesa Verde*. Johnson Books, Boulder.

Parker, Douglas R
2004 Petrographic Analysis of Chimney Rock Ceramics. In *Chimney Rock: The Ultimate Outlie*r, edited by J.M. Malville, pp 115 -122. Lexington Books, Lanham, Maryland.

Peckham, Stewart and John P. Wilson
1965 Chuska Valley Ceramics. Ms. On file, Museum of New Mexico, Santa Fe.

Pierce, Christopher
1999 Explaining Corrugated Pottery in the American Southwest: An Evolutionary Approach, Unpublished Ph.D. Dissertation, Department of Anthropology, University of Washington, Seattle.

Plog, Stephen
1989 The Sociopolitics of Exchange and Archaeological Research in the Northern Southwest. In Sociopolitical Structure of Prehistoric Southwestern Societies. edited by S. Upham, K.G. Lightfoot, and R.A. Jewett, pp 129-`48, Westview Press, Boulder.

Reed, Paul .
2006 *Thirty-Five Year of Archaeological Research at Salmon Ruin, New Mexico, Volume One: Introduction, Architecture, Chronology, and Conclusions*. Center for Desert Archaeology and Salmon Ruins Museum. Bloomfield New Mexico and Tucson Arizona.

Reed, Lore Stephens
2006 New Research With Ceramic Data from Salmon Pueblo Ruins. In *Thirty-Five Year of Archaeological Research at Salmon Ruin, New Mexico, Volume One: Introduction, Architecture, Chronology, and Conclusions*. pp 583-5-92, Center for Desert Archaeology and Salmon Ruins Museum. Bloomfield New Mexico and Tucson Arizona.

Roney , John R
2004 Bonito-style Great Houses. In *Chimney Rock: The Ultimate Outlie*r, edited

by J.M. Malville, pp 99 -114. Lexington Books, Lanham, Maryland.

Siscenti James V., Alfred E. Dittert, Jr, and Beth Dickey
1963 Excavations at the Railroad Site, LA 4103. In *Pueblo Period in the Piedra River Section, Navajo Reservoir District*, assembled by Alfred E. Dittert Jr. and Frank W. Eddy, pp 80-93. Museum of New Mexico Papers 10. Santa Fe.

Shepard, Anna O.
1963 *Ceramics for the Archaeologist*. Publication 609 of the Carnegie Institution, Washington.

Swannack, Jervis D., Jr.
1969 *Big Juniper House. Archeological Research Series 7-C*. U.S. Department of the Interior, National Park Service, Washington, D.C.

Toll, H. Wolcott, and Peter J. McKenna
1987 The Ceramography of Pueblo Alto. In *Investigations at the Pueblo Alto Complex*, Volume III, Part 1, edited by T.C. Windes and F.J. Mathien, pp. 19-230. National Park Service Publications in Archeology 18F. Santa Fe.

Toll, H. Wolcott, Eric Blinman and C. Dean Wilson
1992 Chaco in the Context of Ceramic regional Systems. In *Anasazi Regional Organizations and the Chaco System*, edited by D.E. Doyel, pp. 147-157. Maxwell Museum of Anthropology Papers 5. Albuquerque.

Wilcox , David R.
1990 The Evolution of the Chacoan Polity. In the Chimney Rock Archaeological Symposium, edited by J.M Malville and D Matlock, pp 765- 90. USDA Forest Service General Technical Report RM-227, Durango, Colorado.

Wilson, C. Dean
1989 Ceramics. In *The Archaeology and Ethnohistory of the Red Rock Valley: A Study of Prehistoric and Historic Land Use in Northeastern Arizona*, edited by B.S. Hildenbrandt, pp 272-477, Zuni Archaeology Program, Report 262, Research Series 3.

1990 Hovenweep Laterals Ceramic Analysis. In Archaeological Excavations of the Hovenweep Lateral, by James N Morris, Prepared for Cultural Resource Program; Bureau of Reclamation, Upper Colorado Region, Salt

Lake City.

1993 Upper San Juan Ceramic Typology. Office of Archaeological Studies Archaeology Notes 80, Santa Fe.

1996 Ceramic Pigment Distributions and Regional Interaction: A Re-examination of Interpretations in Shepard's "Technology of La Plata Pottery". *Kiva* 62 (1) 83-102.

2000 *Ceramic Data and Interpretations for Anasazi Sites, Appendix A*. In Frances Mesa Alternative Treatment Project, compiled by R.H. Wilshusen, T.D. Hovezak, and L.M. Sesler, pp 349-370, La Plata Archaeological Consultants Research Papers No. 3. La Plata Archaeological Consultants, Dolores, Colorado.

2002 Chapter 1: Ceramics. In *Archaeological Investigations in the Fruitland Project Area: Late Archaic, Basketmaker, Pueblo I, and Navajo Sites in Northwestern New Mexico; Volume V: Material Culture, Bioarchaeological and Special Studies*, compiled by T.D. Hovesak and L.M, Sesler, pp 1-48, La Plata Archaeological Consultants Research Papers No. 4. La Plata Archaeological Consultants, Dolores, Colorado.

2003 A Reappraisal of the Nature and Significance of Spatial Distributions of Pottery from Sites in the Northern Southwest. In Anasazi Archaeology at the Millennium; Proceedings of the Sixth Occasional Anasazi Symposium, edited by PF. Reed, pp. 129-136. Center for Desert Archaeology, Tucson.

Wilson, C. Dean

In progress. *Draft La Plata Report.*

Wilson, C. Dean, and Eric Blinman

1995a Ceramic Types of the Mesa Verde Region. In *Archaeological Pottery of Colorado: Ceramic Clues to the Prehistoric and Protohistoric Lives of the State's Native Peoples*, edited by R.H. Brunswig, B. Bradley, and S.M. Chandler. Colorado Council of Archaeologists Occasional Papers 2, Denver.

Windes, Thomas C.

1977 Typology and technology of Anasazi ceramics. In *Settlement and Subsistence Along the Lower Chaco River*, edited by Charles Reher. pp 270-369, University of New Mexico, Albuquerque.

Chimney Rock Great House (5AA83) Ceramic Analysis Figures

Figure 1.1. Dolores Corrugated.

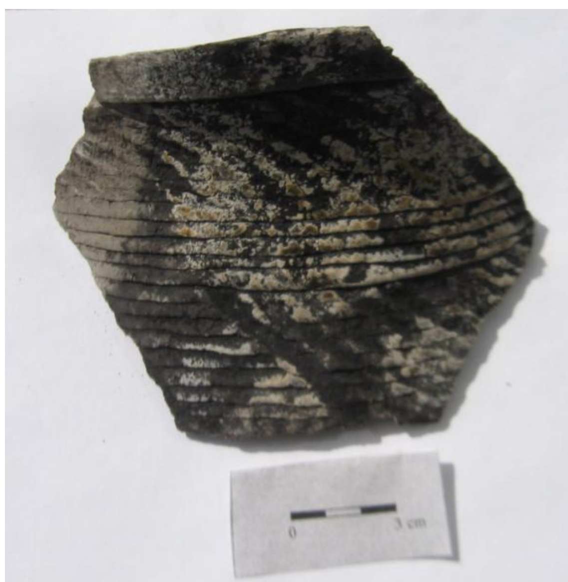


Figure 1.2. Dolores Corrugated.

Figure 1.3. Dolores Corrugated.

Figure 2. Payan Corrugated.

Figure 3.1. Mancos Black-on-white with thick border.

Figure 3.2. Mancos Black-on-white with fine hatchure.

Figure 3.3. Mancos Black-on-white with dots.

Figure 3.4. Mancos Black-on-white checkered.

Figure 4.1. Mancos Black-on-white with wide hatchure.

Figure 4.2. Mancos Black-on-white with wide hatchure.

Figure 4.3. Mancos Black-on-white with wide hatchure.

Figure 4.4. Mancos Black-on-white with wide hatchure.

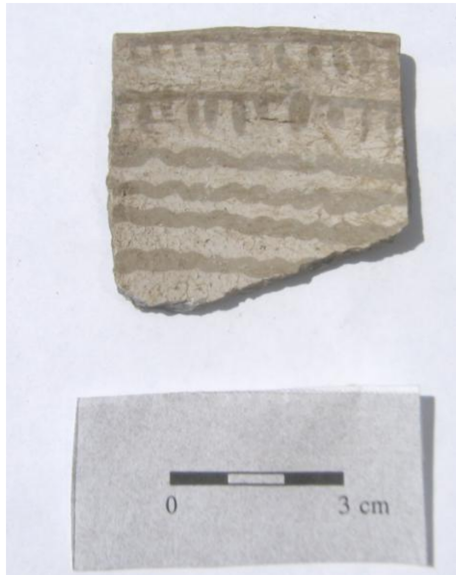


Figure 5.1. Arboles Black-on-white with ticked lines.

Figure 5.2. Arboles Black-on-white with wide lines.

Figure 6. Gallina Black-on-white or Bancos Black-on-white.

Figure 7.1. Gallup Black-on-white with fine hatchure.

Figure 7.2. Gallup Black-on-white with fine hatchure.

Figure 7.3. Gallup Black-on-white with fine hatchure.

Figure 7.4. Gallup Black-on-white with fine hatchure.

Figure 7.5. Gallup Black-on-white with fine hatchure.

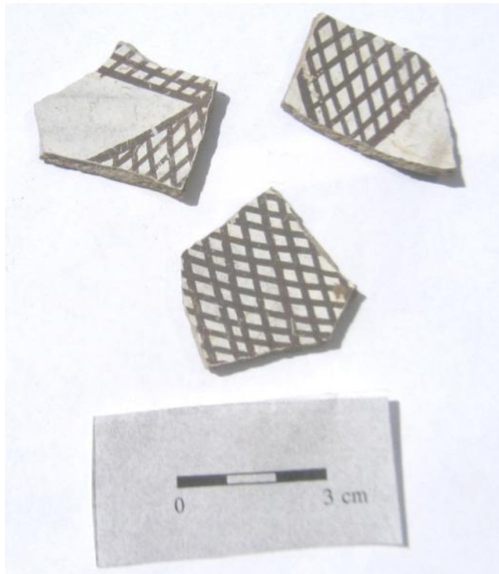


Figure 7.6. Gallup Black-on-white with cross hatchure.

Figure 8. Escavada Black-on-white with triangles.

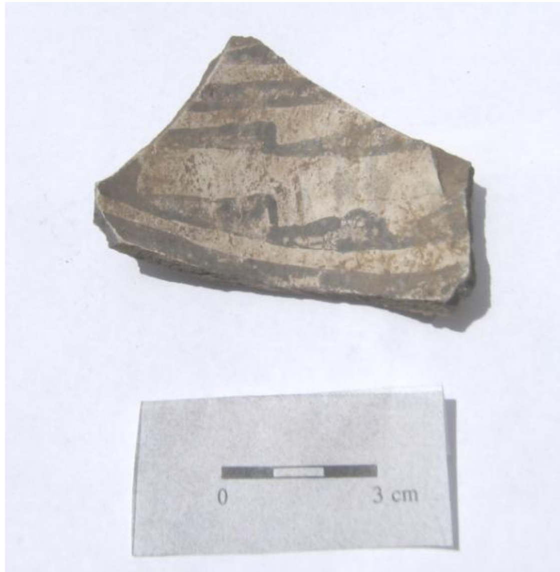


Figure 9. Taylor Black-on-white with triangles.

Table 1 Distribution of Ceramic Types Assigned to Various Traditions

	Date	Frequency	Percent
San Juan or Mesa Verde Gray Ware			
Plain Gray Rim	A.D. 550 to 1050	2	0.2
Indeterminant Plain Rim	A.D. 550 to 1300	16	1.6
Plain Gray Body	A.D. 550 to 1300	30	2.9
Indented Corrugated	A.D. 930 to 1300	685	66.6
Plain Corrugated	A.D. 930 to 1300	5	0.5
Plain Corrugated	A.D. 930 to 1300	5	0.5
Alternating Corrugated	A.D. 930 to 1300	39	3.8
Smeared Indented Corrugated	A.D. 930 to 1300	19	1.8
Payan Corrugated	A.D. 950 to 1100	2	0.2
Mummy Lake Gray	A.D. 1050 to 1200	2	0.2
Mancos Corrugated Rim	A.D. 930 to 1100	4	0.4
Dolores Corrugated Rim	A.D. 1000 to 1250	31	3.0
Rosa Gray	A.D. 700 to 950	1	0.1
San Juan or Mesa Verde White Ware			
Unpainted Undifferentiated	A.D. 900 to 1300	12	1.2
Pueblo II Mineral Paint Undifferentiated	A.D. 900 to 1200	30	2.9
Cortez Black-on-white	A.D. 900 to 1075	3	0.3
Mancos Black-on-white Solid	A.D. 980 to 1200	19	1.8
Arboles Black-on-white	A.D. 900 to 1100	15	1.5
Mancos Black-on-white Hatchured	A.D. 980 to 1200	52	5.1
Mancos Black-on-white solid and hatchured	A.D. 980 to 1200	1	0.1
Indeterminate Organic Paint	A.D. 980 to 1200	5	0.5
Mancos Black-on-white Gallup style	A.D. 980 to 1200	1	0.1
Cibola Gray Ware			
Plain Gray Body	A.D. 550 to 1300	1	0.1
Cibola White Ware			
Mineral Paint Undifferentiated	A.D. 900 to 1200	3	0.3
Red Mesa Black-on-white	A.D. 900 to 1075	2	0.2
Escavada Black-on-white	A.D. 950 to 1160	3	0.3
Gallup Black-on-white	A.D. 960 to 1150	26	2.5
White Mountain Red Ware			
Unpainted White Mountain Red Ware	A.D, 1030 to 1300	1	0.1
Chuska White Ware			
Bennet Gray	A.D. 550 to 1050	2	0.2
Mineral Painted Undiffentiated	A.D. 900 to 1200	1	0.1
Taylor Black-on-white	A.D.900 to 1100	10	1.0
Brimall Black-on-white	A.D. 900 to 1100	1	0.1
Total sherds		1029	100.0

Table 2 Distribution of Types by Proveniences from Room 5

	Provenience									
	Stratum 1 level 3		Stratum 2 level 2		Stratum 3 level 1		Stratum 3 level 2		Surface 1	
	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
San Juan Gray Wares										
Plain Gray Body					1	16.6667				
Indented Corrugated	2.0	100					1.0	50		
Plain Corrugated							1.0	50		
Smeared Indented Corrugated					2	33.3333				
Mancos Corrugated Rim					1	16.6667				
San Juan White Wares										
Pueblo II Mineral Paint Undifferentiated			2	100					1	100
Mancos Black-on-white Solid					1	16.6667				
Indeterminate Organic Paint										
Cibola White Ware										
Plain Gray Body					1	16.6667				
Total	2.0	100	2	100	6	100	2.0	100	1	100

Table 2 Distribution of Types by Proveniences from Room 5, cont'd.

	Stratum 4 level 1		Stratum 5 level 1		Surface 2		Table Total .00	
	Count	Col %	Count	Col %	Count	Col %	Count	Col %
San Juan Gray Wares								
Plain Gray Body	2	14.2857	2	100	1	100	6	20
Indented Corrugated	5	35.7143					8	26.6667
Plain Corrugated							1	3.33333
Smeared Indented Corrugated	2	14.2857					4	13.3333
Mancos Corrugated Rim	1	7.14286					2	6.66667
San Juan White Wares								
Pueblo II Mineral Paint Undifferentiated							3	10
Mancos Black-on-white Solid	1	7.14286					2	6.66667
Indeterminate Organic Paint	3	21.4286					3	10
Cibola White Ware								
Plain Gray Body							1	3.33333
Total	14	100	2	100	1	100	30	100

Table 3 Distribution of Types by Provenience from Room 7

	Stratum 1 level 1		Stratum 1 level 1		Stratum 1 level 2		Stratum 1 level 3		Stratum 2 level 2		Stratum 2 level 3	
	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
San Juan Gray Ware												
Plain Gray Rim												
Indeterminant Plain Rim											1	0.9
Plain Gray Body					3	100					1	0.9
Indented Corrugated	1	20	1	100					13	50.0	66	60.6
Plain Corrugated	1	20										
Plain Corrugated									1	3.8		
Alternating Corrugated												
Smeared Indented Corrugated												
Payan Corrugated												
Mummy Lake Gray											1	0.9
Mancos Corrugated Rim												
Dolores Corrugated Rim											3	2.8
Rosa Brown									1	3.8		
San Juan White Ware												
Unpainted Undifferentiated									2	7.7	1	0.9
Pueblo II Mineral Paint Undifferentiated	2	40							2	7.7	8	7.3
Cortez Black-on-white												
Mancos Black-on-white Solid											2	1.8
Arboles Black-on-white									1	3.8	1	0.9
Mancos Black-on-white Hatchured									4	15.4	24	22.0
Mancos Black-on-white solid and hatchured												
Indeterminate Organic Paint												
Mancos Black-on-white Gallup style												
Cibola White Ware												
Mineral Paint Undifferentiated												
Red Mesa Black-on-white												
Escavada Black-on-white												
Gallup Black-on-white							1	100	1	3.8		
White Mountain Red Ware												
Unpainted White Mountain Red Ware	1	20										
Chuska Gray Ware												
Bennet Gray												
Chuska White Ware												
Mineral Painted Undiffentiated									1	3.8		
Taylor Black-on-white											1	0.9
Brimall Black-on-white												
Total Sherds	5	100	1	100	3	100	1	100	26	100.0	109	100.0

Table 3 Distribution of Types by Provenience from Room 7, cont'd.

		Surface 1 Count	Surface 1 Col %	Feature 1 Count	Feature 1 Col %	Feature 1 Count	Feature 1 Col %	Feature 1 Count	Feature 1 Col %	Stratum 3 - 5 Count
San Juan Gray Ware										
	Plain Gray Rim			1	0.2					
	Indeterminant Plain Rim			3	0.7					
	Plain Gray Body			19	4.7					
	Indented Corrugated			292	71.7	48	52.2	3	60	77
	Plain Corrugated			3	0.7					
	Plain Corrugated			2	0.5					
	Alternating Corrugated			39	9.6					
	Smeared Indented Corrugated			12	2.9					1
	Payan Corrugated			2	0.5					
	Mummy Lake Gray			1	0.2					
	Mancos Corrugated Rim					1	1.1			1
	Dolores Corrugated Rim			15	3.7	2	2.2			1
	Rosa Brown									
San Juan White Ware										
	Unpainted Undifferentiated					7	7.6			
	Pueblo II Mineral Paint Undifferentiated					6	6.5	2	40	3
	Cortez Black-on-white					1	1.1			2
	Mancos Black-on-white Solid			3	0.7	9	9.8			1
	Arboles Black-on-white			6	1.5	2	2.2			6
	Mancos Black-on-white Hatchured			3	0.7	1	1.1			3
	Mancos Black-on-white solid and hatchured									1
	Indeterminate Organic Paint			1	0.2	1	1.1			
	Mancos Black-on-white Gallup style									
Cibola White Ware										
	Mineral Paint Undifferentiated					1	1.1			
	Red Mesa Black-on-white									
	Escavada Black-on-white									2
	Gallup Black-on-white			5	1.2	10	10.9			12
White Mountain Red Ware										
	Unpainted White Mountain Red Ware									
Chuska Gray Ware										
	Bennet Gray									
Chuska White Ware										
	Mineral Painted Undiffentiated									
	Taylor Black-on-white					2	2.2			7
	Brimall Black-on-white					1	1.1			
Total Sherds				407	100.0	92	100.0	5	100	117

Table 3 Distribution of Types by Provenience from Room 7, cont'd.

			Feature 2 full cut		Stratum 3 level 1		Stratum 4		Strat 5	
		Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
San Juan Gray Ware										
	Plain Gray Rim									
	Indeterminant Plain Rim						3	4.2	2	3.3
	Plain Gray Body								1	1.7
	Indented Corrugated	65.8	46	74.2	18	78.3	63	88.7	45	75.0
	Plain Corrugated								1	1.7
	Plain Corrugated									
	Alternating Corrugated									
	Smeared Indented Corrugated	0.9	1	1.6						
	Payan Corrugated									
	Mummy Lake Gray									
	Mancos Corrugated Rim	0.9								
	Dolores Corrugated Rim	0.9			5	21.7	1	1.4	4	6.7
	Rosa Brown									
San Juan White Ware										
	Unpainted Undifferentiated		1	1.6					1	1.7
	Pueblo II Mineral Paint Undifferentiated	2.6	3	4.8					1	1.7
	Cortez Black-on-white	1.7								
	Mancos Black-on-white Solid	0.9							1	1.7
	Arboles Black-on-white	5.1	2	3.2			1	1.4		
	Mancos Black-on-white Hatchured	2.6	2	3.2					1	1.7
	Mancos Black-on-white solid and hatchured	0.9								
	Indeterminate Organic Paint									
	Mancos Black-on-white Gallup style								1	1.7
Cibola White Ware										
	Mineral Paint Undifferentiated								1	1.7
	Red Mesa Black-on-white		2	3.2						
	Escavada Black-on-white	1.7					1	1.4		
	Gallup Black-on-white	10.3	3	4.8			2	2.8	1	1.7
White Mountain Red Ware										
	Unpainted White Mountain Red Ware									
Chuska Gray Ware										
	Bennet Gray		2	3.2						
Chuska White Ware										
	Mineral Painted Undiffentiated									
	Taylor Black-on-white	6.0								
	Brimall Black-on-white									
Total Sherds		100.0	62	100.0	23	100.0	71	100.0	60	100.0

Table 3 Distribution of Types by Provenience from Room 7, cont'd.

		Feature 4 full cut		Stratum 6		Table Total			
		Count	Col %	Count	Col %	Count	Col %		
San Juan Gray Ware									
	Plain Gray Rim	1	6.7					2	0.2
	Indeterminant Plain Rim	7	46.7					16	1.6
	Plain Gray Body							24	2.4
	Indented Corrugated	4	26.7					677	67.8
	Plain Corrugated							5	0.5
	Plain Corrugated					1	100	4	0.4
	Alternating Corrugated							39	3.9
	Smeared Indented Corrugated			1	100			15	1.5
	Payan Corrugated							2	0.2
	Mummy Lake Gray							2	0.2
	Mancos Corrugated Rim							2	0.2
	Dolores Corrugated Rim							31	3.1
	Rosa Brown							1	0.1
San Juan White Ware									
	Unpainted Undifferentiated							12	1.2
	Pueblo II Mineral Paint Undifferentiated							27	2.7
	Cortez Black-on-white							3	0.3
	Mancos Black-on-white Solid	1	6.7					17	1.7
	Arboles Black-on-white	1	6.7					20	2.0
	Mancos Black-on-white Hatchured							38	3.8
	Mancos Black-on-white solid and hatchured							1	0.1
	Indeterminate Organic Paint							2	0.2
	Mancos Black-on-white Gallup style							1	0.1
Cibola White Ware									
	Mineral Paint Undifferentiated	1	6.7					3	0.3
	Red Mesa Black-on-white							2	0.2
	Escavada Black-on-white							3	0.3
	Gallup Black-on-white							35	3.5
White Mountain Red Ware									
	Unpainted White Mountain Red Ware							1	0.1
Chuska Gray Ware									
	Bennet Gray							2	0.2
Chuska White Ware									
	Mineral Painted Undiffentiated							1	0.1
	Taylor Black-on-white							10	1.0
	Brimall Black-on-white							1	0.1
Total Sherds		15	100.0	1	100	1	100	999	100.0

Table 4 Distribution of Temper by Ware Group for All Pottery

	Ware group						Table Total	
	Gray		White		Red			
	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Sand	5	0.6	7	3.3			12	1.2
Andesite or diorite	763	93.3	72	34.3			835	81.1
Sherd and andesite or diorite	2	0.2	67	31.9			69	6.7
Sand and andesite or diorite	4	0.5	1	0.5			5	0.5
Sherd			20	9.5	1	100	21	2.0
Trachyte	2	0.2	4	1.9			6	0.6
Sherd and sand	1	0.1	21	10.0			22	2.1
Large leucocratic rock	40	4.9	9	4.3			49	4.8
Trachyte			7	3.3			7	0.7
Fine sandstone	1	0.1	1	0.5			2	0.2
Trachyte and sherd			1	0.5			1	0.1
Total	818	100.0	210	100.0	1	100	1029	100.0

Table 5 Distribution of Style by Ceramic Tradition for Decorated White Ware Pottery

	San Juan		Cibola		Chuska		Count	Col %
	Count	Col %	Count	Col %	Count	Col %		
wide hatchure	47.0	53.4					47.0	35.9
fine hatchure	5.0	5.7	22.0	71.0	1.0	8.3	28.0	21.4
wide paralllel lines	9.0	10.2			1.0	8.3	10.0	7.6
thin parallel lines	9.0	10.2	3.0	9.7	1.0	8.3	13.0	9.9
triangles	5.0	5.7	1.0	3.2	8.0	66.7	14.0	10.7
checkerboard	4.0	4.5	2.0	6.5			6.0	4.6
criss cross hatchure			3.0	9.7	1.0	8.3	4.0	3.1
suiggle line	2.0	2.3					2.0	1.5
dots	2.0	2.3					2.0	1.5
hatchure and thin lines	2.0	2.3					2.0	1.5
scroll	1.0	1.1					1.0	0.8
ticked lines	2.0	2.3					2.0	1.5
	88.0	100.0	31.0	100.0	12.0	100.0	131.0	100.0

Table 6 Distribution of Associated Tradition and Ware Groups by Room

	Room number				Table Total	
	5 Room		7 Room 7			
	Count	Col %	Count	Col %	Count	Col %
San Juan Gray Ware	21	70.0	771	77.2	792	77.0
San Juan White Ware	8	26.7	156	15.6	164	15.9
Cibola Gray Ware	1	3.3	23	2.3	24	2.3
Cibola White Ware			34	3.4	34	3.3
White Mountain Red Ware			1	0.1	1	0.1
Chuska Gray Ware			3	0.3	2	0.3
Chuska White Ware			11	1.1	11	1.2
Total	30	100.0	999	100.0	1029	100.0

Table 7 Distribution of Vessel Form by Ware Group

	Ware group						Group Total	
	Gray		White		Red		Count	Col %
	Count	Col %	Count	Col %	Count	Col %		
Indeterminate	29	3.5	2	1.0			31	3.0
Bowl rim	1	0.1	30	14.3			31	3.0
Bowl body			105	50.0			105	10.2
Jar neck	103	12.6	3	1.4			106	10.3
Jar rim	60	7.3					60	5.8
Jar body	625	76.4	68	32.4	1	100	694	67.4
Dipper with handle			2	1.0			2	0.2
Total	818	100.0	210	100.0	1	100	1029	100.0

Appendix I

Geophysical Investigations

Sarah G.R. Devriese, Roxanna N. Frary, Michael A. Mitchell

Archaeological investigations using geophysics at the Chimney Rock Great House, Colorado

Sarah G.R. Devriese, Roxanna N. Frary, Michael A. Mitchell
Department of Geophysics, Colorado School of Mines

May 07, 2010

Clients:
Brenda K. Todd, Department of Anthropology, University of Colorado, Boulder
Dr. Wendy Sutton, Archaeologist, Pagosa Springs District, San Juan National Forest

Advisor: Dr. Rich Krahenbuhl

Contents

List of Figures

Executive Summary

In this paper, we present results from a geophysical investigation at the Chimney Rock Great House using magnetics, electromagnetics, gravity and DC resistivity methods middle gradient and dipole-dipole. Our data is focused on a grid southwest of the Great House, where we use geophysics to detect potential buried walls. These walls may be covered by 1 to 3 m of fill as a result of nearby excavations in the 1920s, and should be approximately 0.5 m thick. Using geophysics, we were able to identify several potential targets in the multiple datasets, which are consistent with sketches from earlier archaeological digs. Through our investigations, we have likewise gained a better understanding of the geophysical responses of buried walls at Chimney Rock.

1 Introduction

The Chimney Rock area, which can easily be recognized by the iconic shape of the towering sandstone formations, is located about 20 miles west of Pagosa Springs, CO. The area has at least 7 Native American settlements but our prime interest is the Great House located at one of the highest points. Marked by cliffs on every side, the Great House offers protection and views of the entire valley. Much of the Great House has been excavated throughout the 20th century and a 1920s map of the settlement depicts the structure. However, some of the walls identified on this map (see Figure 1) are not visible at the site.

Our senior design project used geophysical methods to investigate the Great House area. By using geophysics, we learned more about the subsurface and delineate whether or not the proposed buried walls exist. In this project, we used electromagnetics, magnetics, DC resistivity, and gravity to understand the physical properties of the area and to interpret possible wall locations.

This paper describes the entire process, starting with identifying the problem, the best ways to address it, and maximizing the survey grid. We also provide budgets and timelines before describing the data acquisition and processing steps for each method. Following this, we close with interpretations of our results and final conclusions.

2 Archaeological and geological background

Chimney Rock was inhabited by the ancestors of the modern Puebloan tribes from about 950-1100 AD. These ancestral Puebloans were characterized by their subsistence farming regimen, construction of dwellings, production of tools and crafts, use of storage rooms, and integration of cultural structures. This particular settlement is connected to the practice of astronomy. The two pinnacles, Chimney and Companion Rocks, were most likely used for the observation of lunar standstills. Once every 18.6 years, the moon is seen to rise directly between the two rocks.

The first archaeological researcher in this area was Jean Allard Jeancon in the early 1920s. He, along with the Natural History Society of Colorado, conducted several excavations and surveys on the mesa. It was during these excavations that a sketch of the rooms in the Great House was produced. This sketch included several rooms, and two kivas, with more rooms on the western side of the mesa. In 1970, the area was declared a National Historic Site. Minimal archaeological work was done, due to the discovery of the Peregrine Falcon, which is an endangered species, within the area. The site was reopened to the public in the 1980s.

In 2009, researchers at the University of Colorado at Boulder worked to excavate and

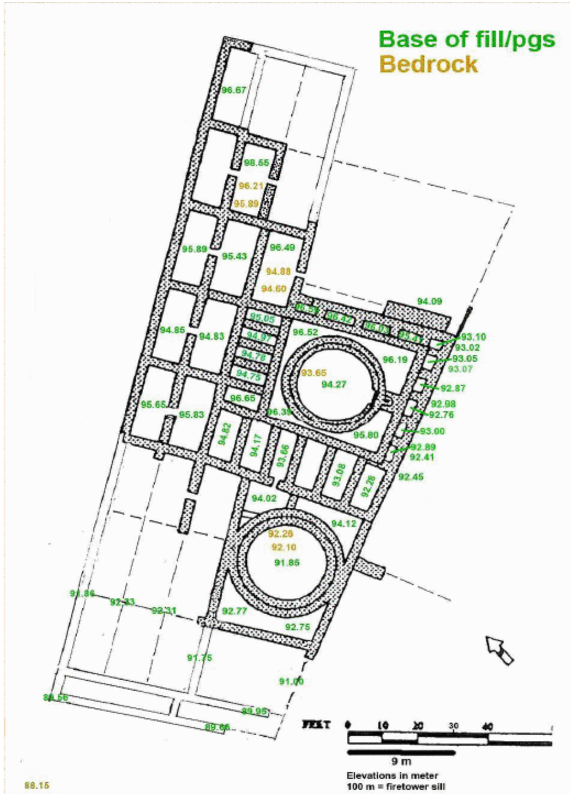


Figure 1: Drawn map of the Great House with excavated walls (thick lines) and proposed walls (thin lines). The goal of this project is to evaluate the presence of these walls.[1]

stabilize a few of the rooms in the Great House. Jeancon's sketch showing rooms on the western side of the mesa prompted the researchers to ask for a geophysical investigation to determine whether these rooms really exist.

The geology of the Chimney Rock area is part of a larger unit called the Mesaverde Group.[3] To the north of Chimney Rock lie the San Juan Mountains. Just south of that mountain range outcrops a section of the Dakota Sandstone, which runs almost perfectly east-west. South of that, is an outcrop of the Mesaverde Group, which pinches out to the east. Chimney Rock is composed of a Cretaceous shoreline deposit, remnant of the ancient sea that used to cover most of Colorado. The rocks in this area look similar to those found at Mesa Verde although they are not the same. The sedimentary cap at Chimney Rock is the Pictured Cliffs Sandstone (about 70-100 million years old) while the dark gray sediments below are Lewis Shale.[4] When looking at the Chimney Rock area, it becomes clear that the sandstone, of which the two chimneys are comprised, is more resistive to erosion than the underlying shale. Over time, these pinnacles will also erode away.

The Native American structures at Chimney Rock were built using the local material. One of the questions we hope to answer is whether we can distinguish between the local rock

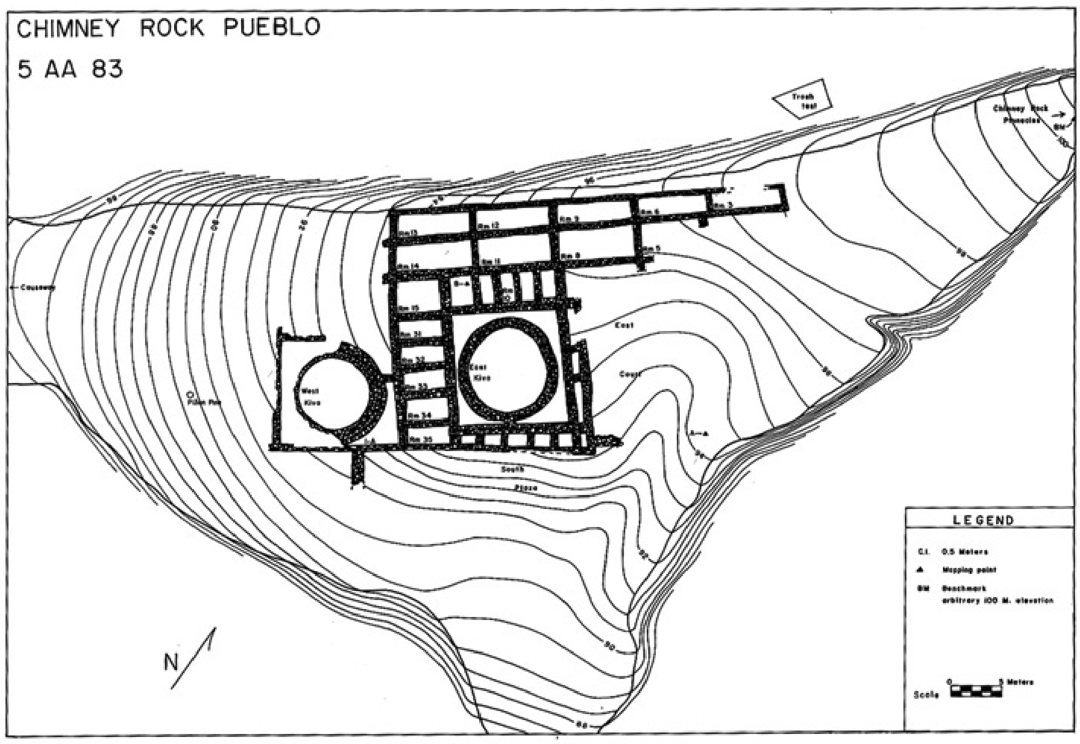


FIGURE 12. Map showing upper mesa and plan of exposed portions of the Chimney Rock Pueblo, 5AA83.

Figure 2: A map showing the topographic changes in our survey area. The map also shows the currently exposed walls at the Chimney Rock Great House. Figure 1 is an adaptation of this original sketch. Note the cliffs that bound our survey area.[2]

Figure 3: Close-up view of a section of wall of the Great House.

Figure 4: A sketch of the Chimney Rock Great House overlaid on an aerial photo. The dotted lines show where walls are predicted and the dark, filled lines show where exposed walls are.

used to build the Great House and the soil that fills and covers the structures.

3 Problem statement

The Chimney Rock Great House is situated on top of a narrow mesa, spanning approximately 40 m by 60 m. The walls were built using local materials and many have been excavated. In this project, we will be addressing a number of questions:

- Are there buried walls next to the Great House?
- Can we locate buried walls utilizing geophysical methods?
- What geophysical methods work best in this area?

Keeping these questions in mind, we can formulate a survey design and decide which methods to use.

4 Design objectives

Figure 5 shows a model of the problem we are addressing. The model shows a buried wall and an exposed wall. The buried wall has rubble zones next to it from partial collapse due

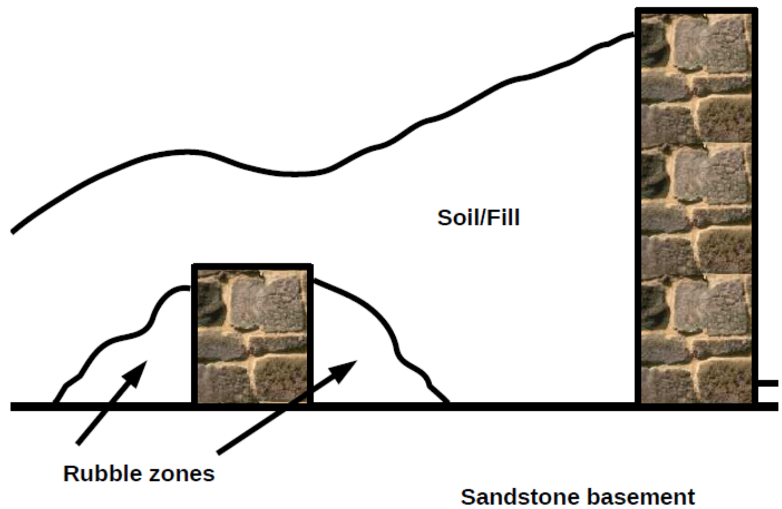


Figure 5: A model of the subsurface at our survey site.

to age. The exposed wall is excavated close to the sandstone basement. The buried wall is underneath soil and/or fill.

5 Decision-making and assessment of approaches

Because of the location and topography of the area of interest, we faced a few challenges in this investigation that influenced our choices of geophysical methods. Figure 4 shows the sketch depicting the exposed walls and the predicted walls overlaid on an aerial photo of our survey area.

5.1 Small location

Because the area of interest is relatively small and has cliffs on either side, our survey grid is severely limited. In terms of collecting data, this means that we cannot have the survey lines run from side to side as there would be no room to turn around to start the next line. This decreases our survey area even more. The survey grid must utilize as much of the space as possible to ensure that the data is collected over the greatest possible surface.

5.2 Half-space assumption

Many of the geophysical methods assume a half-space model, which is a model where the ground extends to infinity in every direction. Extending to infinity is not possible in the real world but we assume that the ground extends well beyond the area of interest. At Chimney Rock, that is not the case since the area of interest is on a small mesa. This means that some of our methods may not provide as useful results as would normally be expected.

5.3 Remote area

We are dealing with a remote location, accessed by a narrow, rocky path. This makes it harder to carry equipment to the site. One major advantage of a remote location, however, is the lack of modern cultural influences (such as power lines and drainage pipes), which can add great amounts of noise to the data.

5.4 Methods

For this project, we considered magnetics and electromagnetics because of how quickly data can be collected with them. We also considered DC resistivity because it can show 3D distributions of resistivity, allowing us to do a 3D inversion. We wanted to do gravity as well, as an experiment, to see whether a density anomaly can be detected over the walls. We also considered GPR because of its strengths in archaeological applications.[5] Seismic methods are not an option because of the survey location.

6 Design solution

During our first trip to Chimney Rock, we were able to come to a design solution that would work best in this area.

6.1 Survey grid

Because of the small and narrow survey area, we created a T-shaped survey grid that encompasses the greatest amount of space as possible (Figure 6).

6.2 Methods

Considering the limitations of the survey area, we decided to use magnetics, electromagnetics, dipole-dipole arrays, middle gradient, and gravity at the Chimney Rock Great House. This decision is partly based on how well these methods worked at Chaco Canyon.[6] We decided not to collect GPR data because of the vegetation and slopes at the survey site.

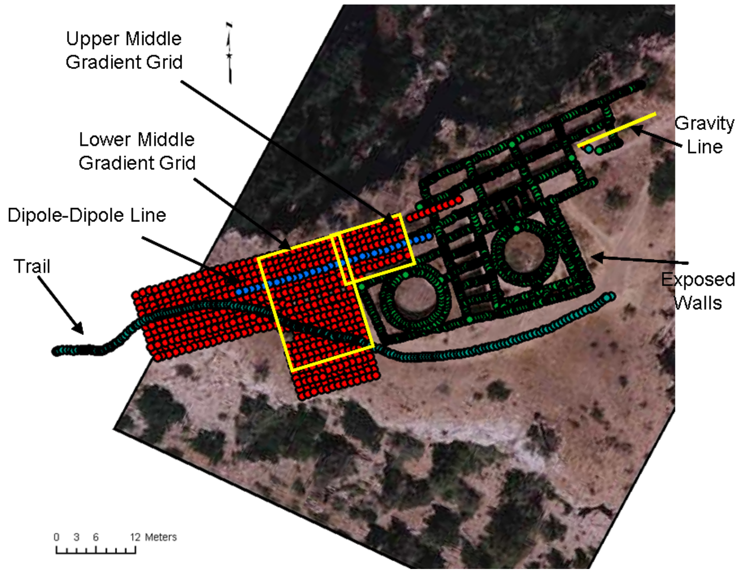


Figure 6: Map showing upper mesa, exposed portions of the Great House, our proposed survey areas, and GPS locations.

6.3 Station spacing

We wanted a station spacing that is as small as possible. For moving surveys, such as electromagnetics and magnetics, the smallest line spacing will be 1 m. For the DC resistivity survey, the station spacing was also 1 m and electrodes were placed at every point. The gravity survey was done with really tight spacing: 0.25 m between stations. GPS points were collected at every station, so every 1 m for the main survey grid and every 0.25 m for the gravity line.

6.4 Implementation plan

The data was collected during Fall 2009's fall break (see the Timeline). During this time, we collected magnetics, electromagnetics, and gravity data. We also did DC middle gradient and 3D dipole-dipole surveys that would cover the survey grid completely. Because of instrument failure, we were only able to do one 2D dipole-dipole survey.

6.5 Deliverables

Over the course of the Fall 2009 and Spring 2010 semesters, we delivered a number of documents to our clients, our advisor, and the Geophysics Department faculty. We submitted a memo to the Geophysics Department to describe our project and what we intend to do. We provided monthly status reports to Dr. Krahenbuhl and Dr. Young to mark our progress over the last two semesters. Before heading to Chimney Rock over Fall Break, we turned in our preliminary proposal for the project to our clients, our advisor, and Dr. Young. At the end of the fall semester, we presented our final proposal and some initial findings to the Geophysics Department.

In the spring semester, we presented an update to our clients and later on to the faculty as well. This report is our final deliverable to our clients and the faculty, and sums up our entire project. This report comes with the ArcGIS database we have created as well as copies of our previous deliverables and field/processing notes. We presented our final results to our clients for help in making archaeological interpretations and later, presented our final results to the faculty.

Although not a part of the requirements for the course, we submitted abstracts to SAGEEP and SEG. We presented a poster at the SAGEEP conference. Copies of the abstracts and poster are included with this report, for we consider these deliverables as well.

6.6 Error analysis, testing, and reliability

To increase our chances of success in this project, we used the Cesium G858 Magnetometer to collect data during our reconnaissance trip to Chimney Rock. The lines were separated by 2 m and the data showed us that collecting magnetic data in this area is indeed a viable option. The magnetic data range was much larger than the instrument error, further supporting this method.

For electromagnetics and magnetics, we collected along two different line orientations: NE-SW and NW-SE. Essentially, these datasets should provide us the same information since orientation minimally affects the data. This also provides us with two datasets, thus providing us with a chance to compare and delineate whether they truly represent the subsurface better. For example, the electromagnetic datasets in the NE-SW and NW-SE directions varied greatly in one area of the survey grid. Knowing that these datasets disagree provides us with more confidence in rejecting one dataset and having more faith in the other. We will expand on this issue later in the report.

For instruments such as the Sting R1 and the Scintrex CG-5 gravimeter, we have error estimates for each measurement. These help to identify the validity of the data, as well as help us to understand the limitations of the data. Because the gravity line was an experimental survey, we forward modeled a simple model to see what the gravity response would be. The forward model showed an anomaly that is close to the instrument noise. This showed that gravity may be possible in this survey area if the measurements are taken very accurately to minimize noise and uncertainty. Despite this possible limitation, we decided to try a micro-gravity survey.

The differential GPS also provided error estimates for each measurement. These were taken into consideration when collecting GPS information. We made sure that each data point was below a certain threshold so that the accuracy of the position information is as good as possible. This still did not guarantee consistency over multiple days, though. By taking a GPS point at the base station at the start of every survey, we were able to correct the GPS datasets so that the base station points are in the same location. We will expand on this correction method later in the report.

6.7 Safety

Because our survey area is located on a mesa, with cliffs on every side, we were extremely cautious. Also, the area contains many cacti as well as tarantulas. The survey grid also had some steep relief. In order to improve the level of safety, we wore high visibility vests, long pants, and hiking boots. We carried a first-aid kit and plenty of water with us in the field. The path to our survey area is very rocky and steep, so we exercised extreme caution when going up to the mesa and when coming down, especially when carrying equipment. We helped one another carry equipment to and from the site to prevent injury and made sure we knew where everyone was at all times. We also made sure to keep all equipment away from the mesa edges and took extra caution when walking near these areas.

6.8 Timeline

This project spanned over two semesters: Fall 2009 and Spring 2010. Overall, the fall semester was dedicated to planning and data collection while we focused on data processing during the spring semester. Dates in bold indicate absolute deadlines. All other dates were meant to keep the project on track throughout the two semesters.

Fall 2009

- **September 25-26:** Initial reconnaissance trip to Chimney Rock
- October 15: Proposal complete
- **October 16-20:** Data collection at Chimney Rock
- **December 7:** Presentation of proposal to faculty and clients
- Winter break: Begin DC inversion and data processing

Spring 2010

- **February 1:** SAGEEP abstract due
- February 5: ArcGIS well under way
- February 12: Magnetics incorporated into ArcGIS
- February 26: EM data and all DC data plotted and processed
- March: Re-evaluation of processed results and redo as needed
- April 1: All processing done
- April 2: Draft of SAGEEP poster done
- **April 7:** SEG abstract due
- April 9: Draft of final paper complete
- **April 12-15:** SAGEEP conference in Keystone, CO
- **April 26:** Final presentation to faculty
- **May 7:** Final report complete

6.9 Division of responsibility and level of effort

For the fall semester, Sarah's responsibility was to communicate with the clients. She also wrote the monthly status reports and the majority of the proposal, as well as other small documents. Michael was in charge of the equipment, including preparing it before our trips and understanding how to run it. Roxanna's responsibility was to help with writing drafts of any documents and to edit them. All three were responsible for collecting data during the reconnaissance and fall break trips.

During the spring semester, Roxanna was responsible for incorporating all the data images, sketches, and aerial pictures into ArcGIS. She has prepared a database for our clients as one of our deliverables. Roxanna also spent time editing the SEG abstract. Michael processed the electromagnetics and the gravity data, calculated apparent resistivity for the dipole-dipole data and inverted it. Sarah calculated apparent resistivity for the middle gradient surveys and created a 3D inverted model of the magnetic data. Sarah also converted the local coordinates for all 2D datasets to GPS coordinates. Michael and Sarah spent time with Dr. Nabighian to further process the data, such as removing heading errors and calculating derivatives. Michael also plotted all the data in Geosoft so that they could be added to the ArcGIS database. Sarah also wrote the spring semester's monthly status reports, the SEG abstract, and a significant portion of the final paper. All members helped with writing and editing the final paper.

6.10 Budgets

For this project, we have two budgets. The class budget shows all the costs we actually had during this project. The real-world budget shows what the estimated costs would be for this type of project if it were contracted to an actual company.

6.10.1 Class budget

- Transportation: 1800 miles (2 trips, 3 cars) @ $2.50/gallon = $335
- SAGEEP conference in April 2010:
  - Abstract fee: $50
  - Student conference fee: 3 * $105 = $315
  - Travel: 240 miles (2 cars) @ $2.50/gallon = $50
  - Hotel: $265 (2 nights)
  - Poster: $75
  - **Total:** $755
- SEG conference in October 2010:
  - Student conference fee: 3 * $25 = $75
  - Hotel: $203/night/room (4 nights, 2 rooms) = $1,624
  - Flights:
    - Sarah (from Vancouver, BC): $525
    - Roxanna (from Reno, NV): $260
    - Michael (from London, England): $730
    - **Total:** $1,515
  - **Total:** $3,214
- **Total:** $4,304

6.10.2 Real-world budget

- Salaries: $100/hour for 3 people
  - Data acquisition: 180 hours
  - Pre-planning: 200 hours
  - Processing: 200 hours
  - **Total:** 580 hours * $100/hour = $58,000
- Travel:
  - Housing: 5 nights for 3 people * $100/night = $500
  - Transportation: 1800 miles (2 trips, 3 cars) @ $2.50/gallon = $335
  - **Total:** $885
- Equipment:[7–9] 7 days
  - Trimble Differential GPS: $75/day + $50/prep = $575
  - Geometrics Cesium G-858 Magnetometer: $100/day + $75/prep = $775
  - Geometrics G-856 Proton Precession Magnetometer: $20/day + $25/prep = $165
  - Geonics EM31-MK2: $75/day + $75/prep = $600
  - Geonics EM38: $35/day + $75/prep = $320
  - AGI SuperSting: $400/day + $400/prep with cables and 56 electrodes = $3,200
  - AGI Sting R1: $175/day + $150/prep with 56 electrodes = $1,375
  - Scintrex CG-5 Gravimeter: $235/day + $250/prep = $1,895
  - **Total:** $8,905
- **Total:** $67,740

7 Data acquisition

7.1 GPS

We collected GPS points at every flag in our survey grid, as well as along the dipole-dipole line and the gravity line. We used the continuous topography option to collect GPS data along the trail through our survey grid and along the tops of the exposed walls. This

Figure 7: Sarah used the magnetometer to collect magnetic data while Roxanna helped call out flag locations.

information provided us with accurate positions for our data as well as further insight into the Great House area for the archaeologists, who were interested in the exact locations of the excavated walls.

7.2 Magnetics

During our reconnaissance trip in September, we collected magnetic data using the Geometrics Cesium Magnetometer and 2 m line spacing. During fall break, we collected magnetic data using the Geometrics Cesium 858 magnetometer with a sample rate of 5 Hz. Line spacing was 1 m and we collected along NE-SW and NW-SE lines. The surveys were collected in a vertical gradient mode, with a top and a bottom sensor. The bottom sensor was approximately 0.37 m above the ground surface and the separation between the two sensors was 0.75 m. For both trips, we used a Geometrics Proton Precession Magnetometer away from our survey grid as a way to monitor changes in the diurnal field so that these can be subtracted from the data. Figure 7 shows Sarah collecting magnetic data. Sarah collected all the magnetic data during the fall break trip and one of the data sets collected during the reconnaissance trip. Michael collected the second data set during the reconnaissance trip. Both made sure to remove all metal objects before collecting data.

7.3 Electromagnetics

Electromagnetic data was collected along NE-SW lines and NW-SE lines with the Geonics EM31-MK2. The line spacing was 1 m and the GPS was synced to the EM31 so position

Figure 8: Leon and Michael collecting electromagnetic data.

information was simultaneously collected for greater accuracy in the location of the data points. Figure 8 shows Michael and Leon collecting electromagnetic data. This required two people because we used the Allegro data collector so the setup required two people to carry all the equipment. This was done for both orientations and both Leon and Michael made sure to remove all metal objects from their persons.

We also attempted to collect electromagnetic data with the Geonics EM-38 but the instrument required constant recalibration. We decided that this was not a viable option in this area, possibly because of the cliff effects.

7.4 DC resistivity

For both DC resistivity survey types, we used the Sting R1. We originally planned to use the SuperSting but we had issues with it in the field. We had tested the SuperSting with many cables, as well as adding salt water to the electrodes, but still had errors from the instrument. Upon returning, we learned that the SuperSting had an internal problem.

7.4.1 Middle gradient

The middle gradient data were collected in two sets: the north-easternmost section had an current electrode spacing of 30 m and the middle section had a current electrode spacing of 36 m. The potential electrodes were spaced at 1 m throughout both grids. This data gives us a map of the resistivity of the area, which complements the dipole-dipole data well. We added salt water to the electrodes to increase coupling.

Figure 9: The gravity survey line.

7.4.2 Dipole-dipole array

A 2D dipole-dipole array was collected along a NE-SW line in the middle of the grid (see Figure 6). The current electrodes were spaced at 1 m and the potential electrodes were also spaced at 1 m. The two sets of electrodes were spaced 1 m from one another along the first profile. Further profiles were collected with the current electrode pair and potential electrode pair spaced at 2 m, 3 m, and 4 m to increase the depth of penetration. Again, we added salt water to the electrodes to increase coupling with the ground. This was especially needed near the southwest end of the line because the sandstone bedrock was much closer to the surface there.

7.5 Gravity

Prior to data collection, we used a forward modeling script provided by CGEM to compute the expected response from a buried wall to try to determine whether or not we would be able to detect a wall in a micro-gravity survey. Using what we felt were conservative estimates for the density contrast between a buried wall, the surrounding fill, and the sandstone bedrock, the wall should produce a small positive gravity anomaly roughly 3 μGal in size. While such an anomaly is pushing the limits of the Scintrex CG-5, and there was a reasonably large chance of this small-amplitude anomaly from the wall being at or below the noise level of our data, we proceeded and collected one 7 m test line over a known buried wall with a station spacing of 0.25 m. Figure 9 shows the setup of the gravity survey line with flags marking each station. The gravity data was collected by Jeff to save time during our data collection trip.

8 Data analysis and integration

8.1 GPS

The GPS data was downloaded after every day that we collected data. The files were converted to text files on the Trimble handheld devices before being transferred to a USB drive. Then, the files were copied onto a computer where they could be plotted in Matlab and ArcGIS.

The magnetics and middle gradient data were collected in local coordinates. Once these data were plotted, they needed to be translated into GPS coordinates. This was simply done using a rotation matrix. The angle of rotation was calculated to be $\theta = 73.6°$. The rotation matrix used this angle as follows:

$$\begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \cos(\theta) \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}, \tag{1}$$

where the left-hand side is a vector with the rotated local x and y coordinates and the right-hand side is composed of the rotation matrix and a vector with the local x and y coordinates.

This equation was used to rotate the data appropriately. To change these coordinates into GPS coordinates, we applied a translation to shift the data to the correct spatial position. This was different for each dataset as the size of the data, represented as a 2D matrix differed for each. The code associated with these calculations is in the Appendix.

Since the GPS rover was mounted over the left shoulder and the Geonics EM31 rested on the right hip, there was approximately a 0.45 m horizontal offset between the two instruments. Since both EM31 datasets were collected with bi-directional lines that were spaced every meter, the GPS positions from every other line were pushed together resulting in very uneven line spacing (Figure 14). To correct for this, we divided the EM31 datasets into individual lines and wrote Matlab code to correct for the horizontal offset of the GPS rover. For each line, the code looks at a window of GPS locations and computes the heading angle θ, with respect to the east-west direction, for each point along the line. The heading angle is used to compute the angle α which decomposed the measured horizontal offset into its proper x and y, or easting and northing, components (Figure 13).

As shown in Figure 13, the angle is calculated by the following equation:

$$\theta = \tan^{-1} \frac{\Delta y}{\Delta x}. \tag{2}$$

Because $\theta + 90° = \alpha$, we calculate the offset that corrects the GPS locations:

$$x_{off} = \cos(\alpha) h_{off} \tag{3}$$

and

$$y_{off} = \sin(\alpha) h_{off}, \tag{4}$$

where h_{off} is the measured horizontal offset, and x_{off} and y_{off} are the easting and northing decompositions of the horizontal offset, respectively. Having corrected the GPS data for each line, the lines are concatenated back into a single data file for each survey and plots were made of the original and corrected GPS data to ensure that the correctional shift was done properly and that the corrected line spacing is relatively uniform.

8.2 Magnetics

After the magnetics data was collected, it was downloaded from the Geometrics Cesium Magnetometer. Similarly, the base station data was also downloaded from the Geometrics Proton Precession Magnetometer. MagMap2000 was used to correct the magnetic data for diurnal changes in the magnetic field over time. After this was done, the magnetic data was gridded to an interval of 0.25 m in both directions. Then, the gridded data was rotated and translated from local coordinates to GPS coordinates using the method described above.

At this point, we realized that the magnetic data had many heading errors and we applied a decorrugation algorithm to remove them. This worked well for the data collected along NE-SW lines but not for the perpendicular data. Because the heading errors overwhelmed the NW-SE magnetic data, we decided not to work with this dataset any longer and to focus on the one dataset that did show non-noisy data. We based this decision on the fact that both datasets should show us the same information for the most part so losing one was not critical for this project. After the decorrugation filter was applied, we upward continued the data by 0.2 m to remove some of the high-frequency content. Figure 10 shows the decorrugated, upward continued magnetic data from the top sensor.

Using this data, we calculated the total horizontal derivative (Figure 11), the reduction to the pole (RTP), and the vertical gradient (Figure 12). The total horizontal gradient data and the reduction to the pole data were calculated with Dr. Nabighian's help and codes. The RTP data is not very different from the magnetic data itself. The total horizontal gradient data shows an increased response close to the exposed walls. This response could be due to both the presence of subsurface walls and possible burning of these walls. There are two notable linear features identified in Figure 11: the first is close to the westernmost

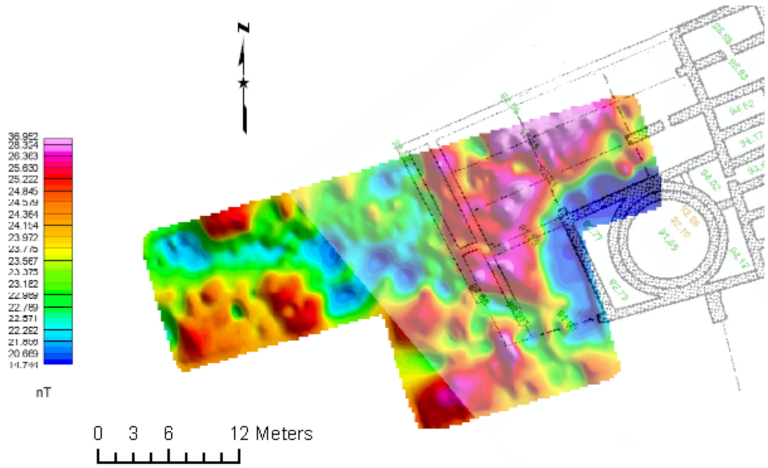


Figure 10: Magnetic data from the top sensor, collected along NE-SW lines. The data shows a magnetic high in the northeast region and marks the outer extent of the Great House. Within the Great House, the magnetic anomaly is significantly higher than outside its proposed boundaries.

wall of the kiva while the second is approximately 10 m west of the first feature and lies directly beneath the westernmost predicted wall in the sketch. These features align with the projected walls in the sketch.

The vertical gradient data was calculated by simply subtracting the top sensor data from the bottom sensor data and normalizing by the distance in between the two sensors. Often this provides a better image of near-surface targets since it minimizes the influence of larger regional trends and better constrains the location of small anomalous targets. This result is shown in Figure 12 and provides greater information on the magnetic response, thus further supporting our conclusions from the other magnetic datasets.

We also calculated terraced data, which breaks the data into little terraces, or steps. This was an alternate way of viewing the data but it did not help interpretations due to the loss of resolution.

We attempted a 3D inversion of the magnetic data but unfortunately did not have sufficient time to create a decent model. The initial inversion results are promising but we used unmasked data and the model seems to focus on areas where the data is highly interpolated. We plan to continue working on this inversion and present final results at the SEG conference, if our abstract is accepted.

8.3 Electromagnetics

Initially, we experienced a great deal of difficulty working with the Geonics EM31 datasets that we collected. After downloading, we were unable to convert the raw binary data files

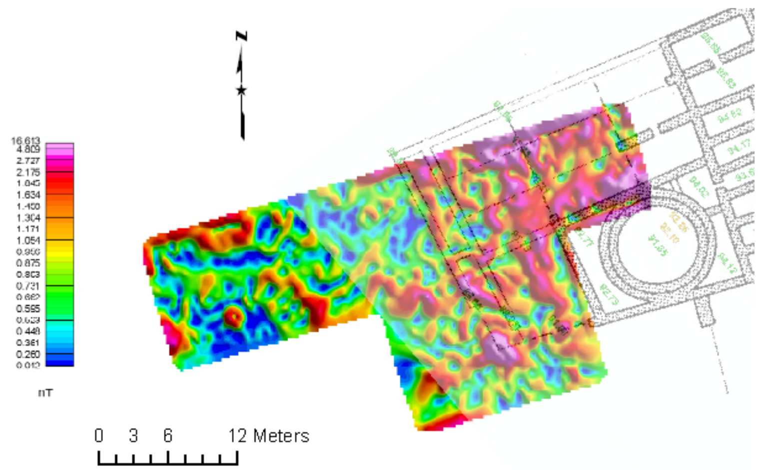


Figure 11: Total horizontal gradient data calculated from the top sensor magnetic data, collected along NE-SW lines. The data shows magnetic highs in regions that correspond to predicted walls and also shows the outermost extent of the Great House.

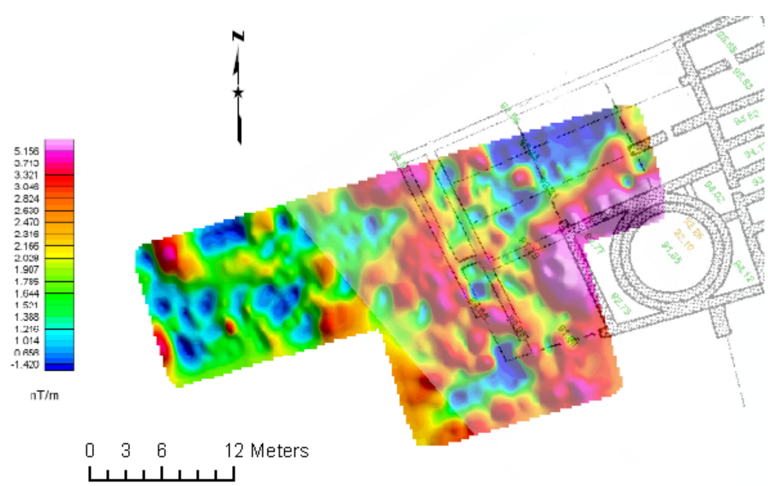


Figure 12: Vertical gradient calculated from the top and bottom sensors of the magnetic data collected along NE-SW lines.

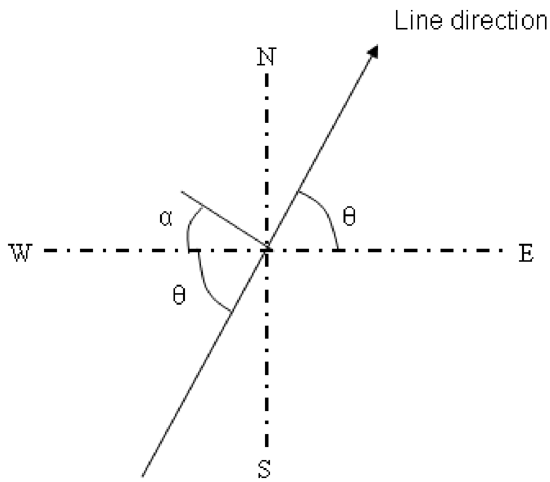


Figure 13: A diagram showing the angles used to decompose the measured horizontal GPS offset into its corresponding easting and northing components.

into ASCII files using the Geonics's software program DAT31W without losing all of the embedded GPS data. After spending several weeks working with these datasets, we contacted Geonics directly and someone in their technical services department was able to extract the data for us and generate usable ASCII data files that contain the GPS position information along with the quadrature and in-phase measurements.

Since the GPS data was collected simultaneously with the EM31 datasets, the GPS horizontal offset from the instrument needed to be corrected before further processing could be done. To do this, we divided the EM31 datasets into their individual lines and wrote some Matlab code which computed the heading of each line and divided the measured horizontal offset into its corresponding x and y direction offsets (Figure 13). Having corrected the GPS data for each line, they were concatenated back into a single data file for each survey for gridding and plotting. Figure 14 shows the change in the location of the EM lines for the NE-SW dataset. As with the magnetic datasets, a gridding interval of 0.25 m was used. The code for these corrections can be found in the Appendix.

Since both datasets contained significant heading errors, we first decorrugated the datasets. This was done by first rotating the datasets by approximately 17° to achieve an east-west grid orientation. The decorrugation algorithm leveled the various lines of the dataset to a uniform level using a wavelength of 2 m. After leveling, the datasets were rotated back to their original orientation. A low-pass filter was applied to remove some of the high-frequency noise in the dataset. Next, we computed the total horizontal gradient to map linear structures and define significant horizontal variations in apparent conductivity and susceptibility. These basic processing steps were applied to the quadrature (apparent conductivity) and

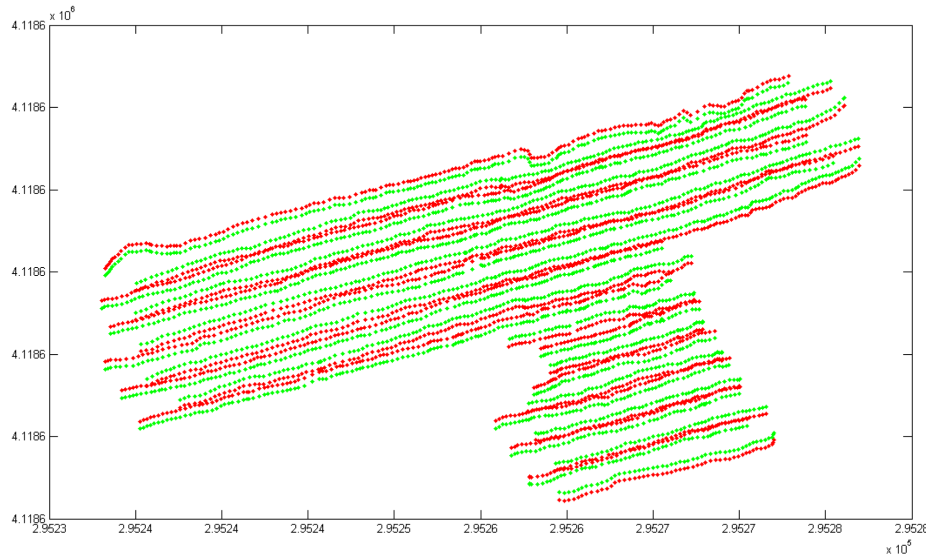


Figure 14: The green marks are the results of the GPS offset correction. The red marks show the GPS locations of the EM lines before the correction was applied.

in-phase (apparent susceptibility) components of both datasets.

We primarily concentrated on the quadrature components since they contained less noise than their corresponding in-phase measurements. A comparison of the quadrature plots of the dataset collected along NE-SW lines and the dataset collected along NW-SE lines showed a good correlation in all regions, except for the upper northeast section of the grid. In this section, the dataset with NW-SE lines showed a region of exceptionally high apparent conductivity (Figure 16). While the orientation of the boom could cause some variations in the two plots due to target coupling differences, we believe that this anomalously conductive region may be due to instrument error.

We were unable to see any features in the NE-SW EM31 dataset, which could have indicated the existence of buried walls. However, we thought that these higher frequency details might merely be hidden by a larger regional trend. To test this hypothesis, we tried to remove the regional field and produce a regional residual plot of the quadrature component. Unfortunately, the regional field was not very large, so its removal did not provide us with further information about our survey area.

8.4 DC resistivity

8.4.1 Middle gradient

The middle gradient data was collected using the Sting R1, so we wrote down the measurements in our field notebook, with the correct orientations and electrode spacings. These

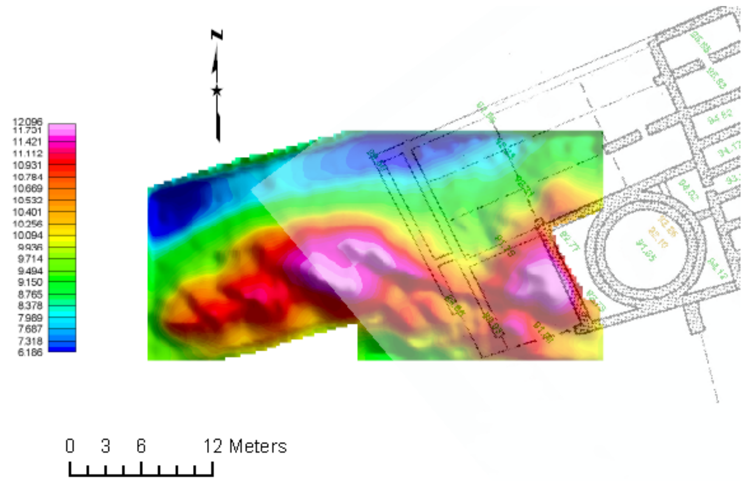


Figure 15: Electromagnetic quadrature data collected along NE-SW lines. The data has been decorrugated to remove heading errors and a smoothing filter was applied to remove some high-frequency content.

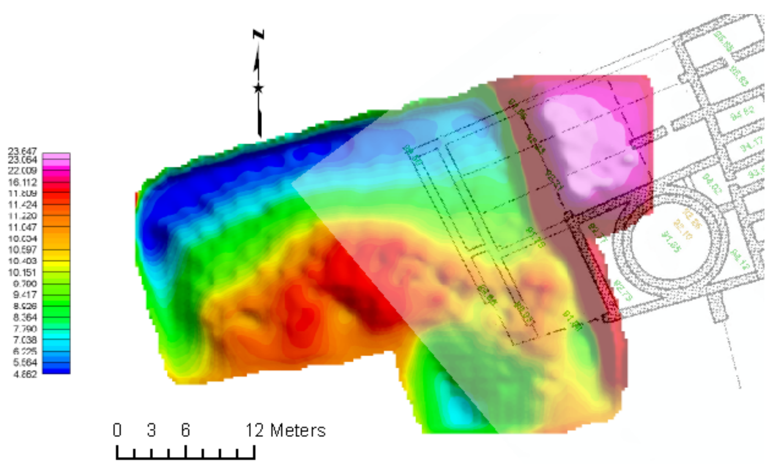


Figure 16: Electromagnetic quadrature data collected along NW-SE lines. The data has been decorrugated to remove heading errors and a smoothing filter was applied to remove some high-frequency noise. Notice the electromagnetic high in the northeast portion of the plot. Because of the amplitude of this feature and its deviation from Figure 15, we question the validity of this dataset.

measurements were copied from the notebook to a spreadsheet so that the apparent resistivity can be calculated from the measured potential. The apparent resistivity was calculated using the following formula:

$$\rho_a = \frac{K\Delta V}{I}, \tag{5}$$

where ρ_a is the apparent resistivity, ΔV is the measured potential, I is the current used, and K is the geometric factor, which is defined as:

$$K = \frac{2\pi}{\frac{1}{R_{AM}} - \frac{1}{R_{AN}} - \frac{1}{R_{BM}} + \frac{1}{R_{BN}}}. \tag{6}$$

The R terms in this equation refer to the distance between the corresponding electrodes. For example, R_{AM} is the distance between the A electrode and the M electrode.

After the measured data was converted to apparent resistivity, two files were created. One file had the local coordinates with the apparent resistivity and the other file had the local coordinates with the potential. The coordinates were rotated and translated into GPS coordinates as described earlier. These files were plotted to show the data. Because we collected two middle gradient surveys that partially overlapped, we combined the two surveys and plotted the combination for both apparent resistivity and potential. Figure 17 shows the potential of the two combined datasets. As in the magnetic data, there is a sharp boundary aligned with the westernmost exposed kiva wall. The feature has a high potential value, which relates to a high resistive value. This interpretation matches the anomaly detected in the inversion results, although we are looking at different locations. The middle gradient data, along with the magnetic data, further supports our interpretation of a wall extending from the westernmost kiva wall.

Middle gradient data that aligned with the dipole-dipole array was used in the inversion of the dipole-dipole data as a further constraint on the model.

8.4.2 Dipole-dipole

Upon returning from the field, the dipole-dipole measurements from the Sting R1 were transferred from the field notebook into a spreadsheet. The raw $\frac{\Delta V}{I}$ measurements were then used to compute the apparent resistivity. The apparent resistivity was computed according to the equations shown in the middle gradient section.

After computing the apparent resistivity values, a pseudo-section was plotted using the midpoint of the electrode positions to determine the x position and depth estimation of the A-N electrode separation (R_{AN}) divided by 3 (Figure 18). While this provides a visual

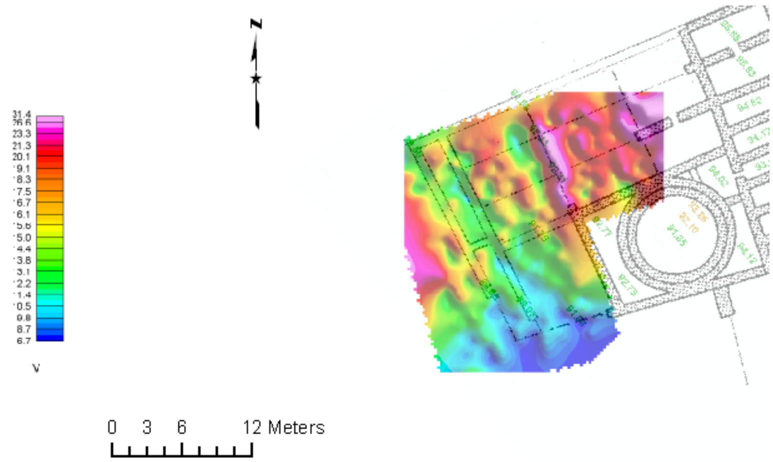


Figure 17: The plot shows the potential for the two middle gradient surveys, which were combined and plotted together. Notice how the extension of the westernmost NW-SE wall of the kiva lies over a high potential feature. This feature corresponds with the expected signature of our model (Figure 5).

representation of the data, it is never good to try to make interpretations from a pseudo-section. To produce an interpretable result, the data was used to create the appropriate input files (a mesh file, a topography file, and an observation file) for the inversion program DCIP2D, which is a 2-D DC/IP inversion code that Dr. Li wrote while at the University of British Columbia. After multiple runs and some alterations to the mesh file, we were able to produce an inversion model which we believe to be reasonable. By creating two different inversion models using radically different reference models, we were able to create a depth of investigation index. This index allowed us to determine which portions of the constructed model were constrained by the data.

Our final inversion result shows a highly resistive region at location $x = 13$ along the line, which correlates well with the predicted westernmost extent of the Great House as shown in the archaeological sketch (Figure 4). As Figure 19 shows, the location of this prospective wall also correlates well with the linear trend in the magnetic data, which we believe defines the westernmost extent of the Great House. The inversion result also supports our initial wall model (Figure 5) since it shows a resistive core, which we interpret to be the buried wall, flanked by two small, more conductive regions, which could represent the unconsolidated rubble zones.

8.5 Gravity

The gravity data was copied from the field notebook and entered into a spreadsheet. In addition to the time, station number, gravity measurement, and standard deviation, precise

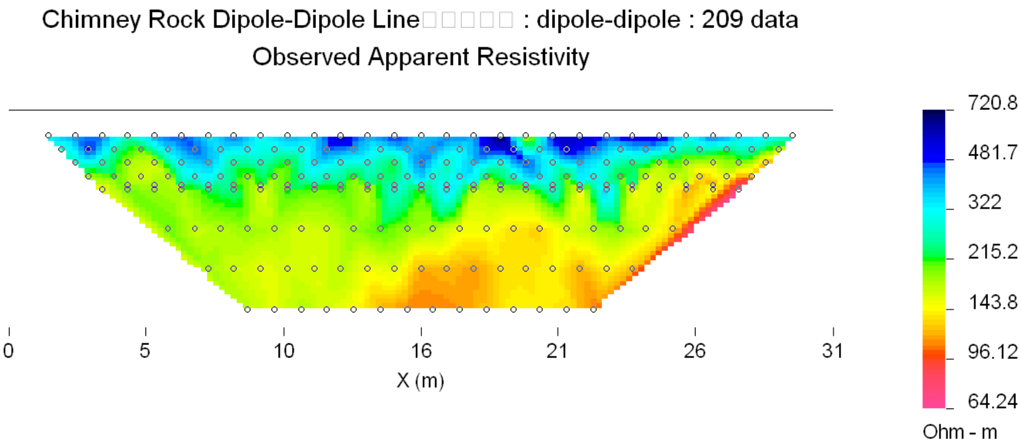


Figure 18: Pseudo-section of the dipole-dipole data.

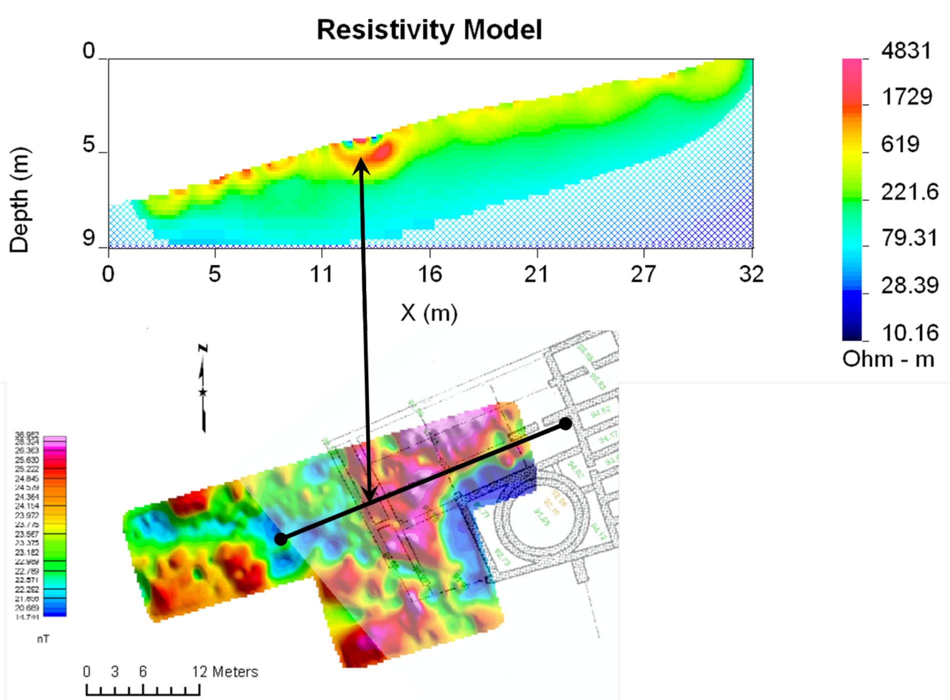


Figure 19: Inversion results of the DC resistivity dipole-dipole data. The large anomaly matches with the smaller linear feature seen in the magnetic total horizontal gradient data (Figure 11), as indicated.

GPS location information for each gravity station was also required, so that the necessary corrections could be applied. Having compiled all of this information, the tidal/drift correction, free air correction, latitude correction, and simple Bouguer correction were applied to calculate the gravity anomaly, which is given by the following equation:

$$\Delta g = g_{measured} + (\Delta g_D - \Delta g_L + \Delta g_{FA} + \Delta g_{SB} + \Delta g_T), \tag{7}$$

where $g_{measured}$ is the measured gravity, Δg_D is the tidal/drift correction, Δg_L is the latitude correction, Δg_{FA} is the free-air correction, Δg_{SB} is the simple Bouguer correction, and Δg_T is the terrain correction. These corrections are described in detail below.

For this dataset, the terrain correction was not computed as a result of the severe complications that the cliffs on either side of the survey line posed. Since there was less than 0.5 m of elevation change across the survey line (Figure 20) and because the survey line was run parallel to the cliff edges of the mesa, we do not believe that ignoring the terrain correction will limit our ability to test the applicability of micro-gravity surveys to similar archaeological problems.

After completing all of the gravity corrections and reducing the measured data to the gravity anomaly, which is a measure of the field due to density variations in the crust and upper mantle, the gravity profile over the wall was plotted (Figure 21).The relatively low gravity anomalies measured from $x = 0$ to 3 m indicates that the room fill inside of the Great House has a signicantly lower density than the material outside of the Great House from roughly $x = 4$ to 7 m. We believe that the increasing gravity anomaly from $x = 4$ to 7m is a result of shallowing sandstone bedrock. While we expect the rubble zones on either side of the buried wall to be less dense than the surrounding fill, the wall itself should be more dense that either the fill or the rubble zones. In this light, the gravity low centered about the wall could be a reasonable response from the rubble zones, but we would still expect to see a positive anomaly centered on the wall. Our inability to detect the buried wall using gravity is most likely a result of instrument error and complications due terrain effects. It is very possible that a micro-gravity survey of this type might prove successful in detecting similar buried walls at other sites where the topography is considerably flatter and more continuous, such as Chaco Canyon.

8.5.1 Tidal/drift correction

Since gravity measurements at the same location will vary over time due to tidal effects and instrument drift, it is necessary to loop back and tie measurements to a designated base station every few hours. These tie points allow the data to be corrected for these effects according to the following equation:

$$\Delta g_D = g_b + (t - t_b)\frac{g_e - g_b}{t_e - t_b} g_1, \tag{8}$$

where t is reading time of a measurement, g_b and g_e are gravity readings at the beginning and end of survey loop, at times t_b and t_e, respectively (mGal), and g_1 is the first base station reading. All gravity values are in mGal and all times are in hours from the start of the survey.

8.5.2 Latitude correction

Since g, the field from the reference spheroid, increases with proximity to the equator, it is necessary to perform a correction to remove possible variations in the measurements that are a result of changes in latitude. This latitude correction is implemented using the following formula:

$$\Delta g_L = 0.001626 \sin(\phi) \cos(\phi) \Delta y, \tag{9}$$

where ϕ is the latitude in degrees, and Δy is local northing in meters from the base station. This correction is positive in the northern hemisphere and negative in the southern hemisphere.

8.5.3 Free-air correction

The free-air correction accounts for the difference between gravity measured at sea level and at the elevation where the measurement is taken, assuming that there is only air between the two. This correction, which accounts for the change in distance from the center of mass of the Earth, is approximated by the following equation:

$$\Delta g_{FA} = 0.3086h, \tag{10}$$

where h is the elevation of the measurement above sea level in meters. This reduces the data to a constant-elevation datum.

8.5.4 Simple Bouguer correction

Unlike the free-air correction, the Bouguer correction accounts for the rock mass between the reference datum (sea level) and each gravity station. It computes the attraction of an infinite slab with a specific density and thickness when correcting for excess material. Bouguer corrections should be subtracted from the observed gravity values for stations above sea level. The general form for this equation is given by the following equation:

$$\Delta g_{SB} = 2\pi\gamma\rho h, \tag{11}$$

where γ is the gravitational constant, ρ is the density of the infinite slab, and h is the thickness of the slab given by the elevation of the measurement above sea level in meters. Assuming an average density of 2.67 $\frac{g}{cm^3}$ this equation simplifies to the following form:

$$\Delta g_{SB} = 0.1119h. \tag{12}$$

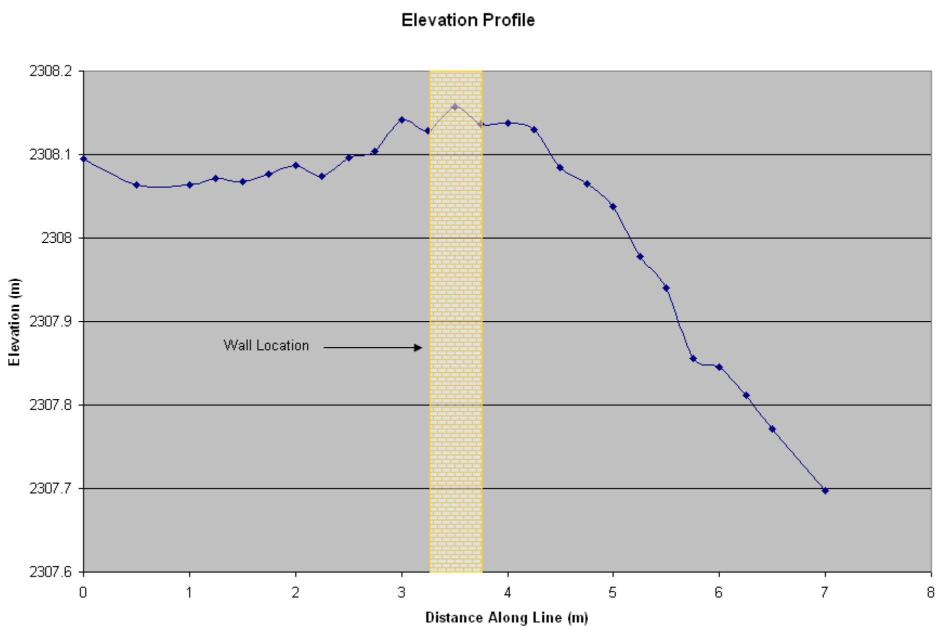


Figure 20: The graph shows the elevation profile along the gravity line. The buried wall marks the high point of the line. It is also important to note the high degree of vertical exaggeration in this graph since there is less than 0.5 m of elevation change from the high to low points.

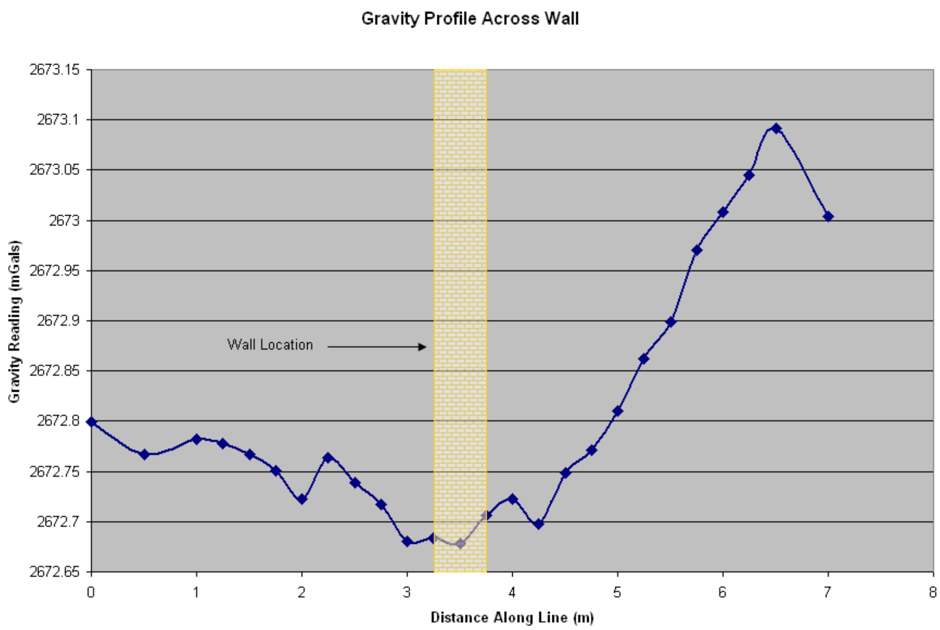


Figure 21: This graph shows the measured gravity anomaly in mGal at each one of the gravity stations. The relatively low gravity readings to the left of the wall are consistent with poorly consolidated room fill, and the increasing anomaly to the right of the wall correlates with the expected response of of the shallowing bedrock away from the wall. However, the wall is not distinguishable within the larger regional trend and noise.

8.6 ArcGIS

We received an aerial photo of the Chimney Rock area from our client, Brenda Todd. This was the basis of the ArcGIS database included with this report. After this photo was georeferenced, the topographic sketch (Figure 2) and the map (Figure 1) were imported into the database and referenced to the aerial photo. Next, all the GPS location data were imported into the database. The result was similar to Figure 6.

After all the magnetic, electromagnetic, and middle gradient data were processed, they were exported as Arc TIFF files using Geosoft and then imported into the ArcGIS database as well. Because they already included coordinates, these files overlaid the aerial photo, sketches, and GPS data well. However, they did include masking as a result of coordinate rotation and translation, and it was necessary to change the background color from white to transparent. Most of the figures in this report were created in ArcGIS (i.e. Figure 10) and provide a reference of the survey area to the data. As a function of ArcGIS, a north arrow and a scale were included in the database and all the figures.

The ArcGIS database is included in this report, and a copy will be given to our client as well. We intend for this database to be used in additional surveys as well as for additional analysis and interpretation.

9 Conclusion

In this report, we discussed the results of an archaeological investigation using several geophysical methods to identify potential buried walls at the Chimney Rock Great House in Colorado. Specifically, we used magnetics, electromagnetics, and two types of DC resistivity surveys. The magnetic data showed linear features that aligned with the predictions from the sketch, and the electromagnetic data provided the regional conductivity trend at Chimney Rock. The dipole-dipole inversion and the middle gradient data narrowed down the signature of potential structures, giving us the ability to further constrain our interpretation. Combining these methods has allowed us to interpret two locations where walls may be buried. These structures have a high magnetic signature and are more resistive than the surrounding fill. The first wall is an extension of the westernmost exposed kiva wall and the second wall is located approximately in the center of the survey grid, parallel to the first wall. Both of these structures align very well with the original sketch depicting possible locations.

10 Recommendations for future work

For future geophysical investigations at the Chimney Rock Great House, the following actions could improve interpretations and solidify our findings. We believe that a 3D dipole-dipole survey will provide additional information about the area. With a 3D survey, a 3D inversion can improve the depth resolution of our targets, further aiding in interpretations and conclusions. We would also expand the survey grid to encompass the area between the Great House and the fire tower since this is where excavations occurred during the summer of 2009. By expanding to this area, more can be learned about the Great House area. We also suggest testing the magnetics and electromagnetics methods over the gravity site to better determine the characteristic signature over a known wall, as was done with the gravity method. This data can further help to constrain the subsurface model and aid in fine-tuning the inversions.

We recommend that future teams also have enough flags for the survey grid since we created extras using tape and wooden skewers. Incidentally, these worked great because the skewers were easier to plant in the ground than plastic flags. Lastly, we highly recommend having extra equipment, such as both the SuperSting and the Sting R1, since problems in the field are bound to occur and can severely limit data collection.

11 Acknowledgments

We would like to thank Dr. Misac Nabighian for his time and input on this project and Dr. Yaoguo Li for his guidance and ideas on inversions. Our sincere thanks goes out to Dr. Steve Lekson for his thoughts regarding archaeological interpretations. We would like to thank Brenda K. Todd for her ideas on the project and being our client. We also thank Dr. Wendy Sutton at the Forest Service in Pagosa Springs, CO and the Chimney Rock Interpretive Association for funding, lodging, and access to the site. We very much appreciate Jeff Shoffner, Leon Foks, and Caitlin Evans for help with data collection in the field. We also offer our thanks to Kris Davis, M. Andy Kass, Kris MacLennan, and the other members of the Consortium for Gravity, Electrical, and Magnetic Studies (CGEM). Finally, we would like to thank Dr. Terry Young and the Department of Geophysics at the Colorado School of Mines for providing equipment and funding for this project.

References

[1] F. W. Eddy, "Sketch," 1977, modified by S. Lekson (2009).

[2] ——, "Archaeological Investigations at Chimney Rock Mesa: 1970-1972," *The Colorado Archaeological Society, Boulder*, 1977, memoir No. 1.

[3] H. Chronic, *Roadside Geology of Colorado.* Missoula, MT: Mountain Press Publishing Company, 2001.

[4] "Chimney rock geology," October 2009. [Online]. Available: http://www.chimneyrockco.org/geologynew.htm

[5] "Ground-penetrating radar," October 2009. [Online]. Available: http://en.wikipedia.org/wiki/Ground-penetrating_radar

[6] C. Martinez, A. Dean, E. Goggin, B. K. Todd, and R. A. Krahenbuhl, "Archaeological investigations of the Court Kiva in Chaco Canyon using geophysical methods," *SEG Expanded Abstract*, October 2009.

[7] (2010, April) Land equipment rental rates: 2009. [Online]. Available: http://www.northwestgeophysics.com/priceList-land.cfm

[8] (2010, April) Geophysical equipment rentals. [Online]. Available: http://www.kdjonesinstruments.com/

[9] (2010, April) Gravity meters product listing. [Online]. Available: http://www.expins.com/rent_category.html?cat=Gravity%20Meters\&max=8\&startAt=1