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A Comparative Study of Earthen Surface Finishes of the Eastern Façade of Open Area J and the Northern Façade of Open Area 26 at Cliff Palace, Mesa Verde National Park, Colorado

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Comments
A thesis in Historic Preservation Presented to the Faculties of the University of Pennsylvania in Partial
Advisor: Frank G. Matero

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Nicole Sylvia Collum

A THESIS
In
Historic Preservation

Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements of the Degree of

A Master of Science in Historic Preservation

2008

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1. Introduction

This thesis examines the exterior architectural surface finishes of the eastern façade of Open Area J, located in the southern end of Cliff Palace and the northern façade of Open Area 26, located in the northern end of Cliff Palace in the Speaker Chief Complex at Mesa Verde National Park. The selection of each site was based on their common incorporation of exterior façades defining an open area and the hypothesis that although Open Area J and Open Area 26 are believed to have been constructed during the same time period, dating to the 1260’s CE., they may be associated with different social groups or may reflect a difference between public (Speaker Chief Complex) and private architectural space. A comparative study of these two open areas considered the similarities and differences between the compositional constituents, formulation and application of the earthen surface finishes found at each site over time.

During this study three primary research objectives were addressed. The first of these includes an analysis and comparison of the primary composition of each finish. This information can suggest possible raw source materials utilized to formulate each earthen finish. The second objective includes the creation of possible decorative schemes over time for each space based on onsite observations and stratigraphic analysis. Lastly this study examined how the relationship of the applied surface finishes in each space might relate to the social or symbolic function of each open area over time.

The general research methodology employed, included the examination of archival research focusing on Chapin Mesa and Cliff Palace. The examination of
previous research conducted at Mesa Verde National Park and the Four Corners Region including: previous architectural finishes studies, geologic surveys, soil surveys and archeological and architectural research. Instrumental and traditional laboratory testing methods utilized in previous earthen architectural studies were also employed during this study based on their relevance and availability. Representative samples from both sites were studied using optical light microscopy, scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS), x-ray diffraction (XRD) and micro-chemical spot testing. The compilation of data gathered both in the field and during laboratory testing provided the information necessary to create a series of decorative finishing schemes for the eastern façade of Open Area J and the northern façade of Open Area 26.

The earthen surface finishes of the eastern façade of Open Area J and the northern façade of Open Area 26 represent two examples of how open spaces within Ancestral Puebloan communities may have been treated in relationship to interior spaces and the unique aspect of open areas and their social function. While a considerable amount of research has been conducted on the interior surface finishes of kivas, little to no research exists on exterior surface finishes of open areas within Ancestral Puebloan communities. This study provides an initial examination of these spaces in terms of their applied surface finishes.
2. Mesa Verde

Mesa Verde National Park is located in the southwestern corner of Colorado in the “Four Corners” region of the American Southwest, encompassing 72,000 acres of land and containing 4,000 known archeological sites, 600 of which have been categorized as “cliff dwellings” or more correctly alcove structures.1 Built within weathered alcoves these structures are in the sandstone canyon walls of the region and serve a range of functions including, storage areas, permanent and temporary domestic structures and ceremonial spaces, plazas, and kivas.2 This architecture displays some of the most well preserved earthen surface finishes and mural paintings in the American Southwest and has attracted visitors, archaeologists and scholars for centuries.3

In 1906, under the authority of President Theodore Roosevelt, Mesa Verde became the first United States National Park created in order to protect and preserve “the works of man” and still remains the only national park in the United States created for that purpose.4 Since its early discovery in the late nineteenth century the preservation and study of the architectural remains have been of paramount importance to the history of the park. In the 1890’s, long before Mesa Verde was designated as a National Park, documentary photographs, and archaeological studies had already been

3 Rose Houk and Raith Marroveccio, eds. Mesa Verde: The First 100 Years. (Golden: Mesa Verde Museum Association and Fulcrum Publishing, 2006), x.
4 Ibid, x.
initiated by the Wetherill brothers, Frederick Chapin and Gustaf Nordenskiöld.\(^5\) Archaeology studies continued throughout the twentieth century and in 1978 Mesa Verde National Park was designated by UNESCO as a World Heritage Site, the first within the United States.

In 1998, despite a long tradition of preservation efforts at Mesa Verde, the National Trust for Historic Places listed the park as one of America’s most endangered historic places.\(^6\) The reason for this listing stemmed from three primary factors: the park’s vulnerability to natural disasters, the questionable condition of archaeological sites not open to the public (back country sites) and visible deterioration of the ancient architectural surface finishes at well-known sites within the park.\(^7\) One program created in order to address the continued deterioration of the earthen surface finishes was C.A.S.P.A.R., The Conservation of Architectural Surface Finishes Program for Archaeological Resources.\(^8\) This program was created and implemented through a collaborative agreement between the Architectural Conservation Laboratory at the University of Pennsylvania and then Intermountain System Support Office-Santa Fe of the National Park Service with funding provided by an American Express Award through the World Monuments Watch and the National Park Service.\(^9\) Work from this program has continued up until today and provides much of the base research for this study.

\(^6\) Ibid 73-75.
\(^7\) Ibid 75.
\(^9\) Ibid.
2.1 Chapin Mesa

Chapin Mesa is the largest and most visited mesa within Mesa Verde National Park, home to 16 mesa top sites, and 7 major cliff dwellings, including: Spruce Tree House, Balcony House, Square Tower House and Cliff Palace. This slender finger-like mesa, ranges in height from 8100 feet above sea level on its north side to 6400 feet above sea level, where the Mancos River intersects, with sandstone canyons of up to 700 feet deep surrounding either side.¹⁰ Chapin Mesa is flanked by Long Mesa and Spruce Canyon on the west and Park Mesa and Soda Canyon on the east. The top of the mesa is blanketed by pinyon-juniper trees, dense brush and periodic Douglas firs, typical of the region and providing the area with its namesake, Mesa Verde, meaning green table in Spanish.

2.2 Cliff Palace

According to local tradition, Cliff Palace was first discovered on Christmas Eve in 1891 by the Wetherill Brothers.\textsuperscript{11} The first published account can be credited to Frederick Chapin who announced Cliff Palace to the scientific world in a presentation to The Appalachian Mountain Club on February 13, 1890. Following Chapin’s publication more descriptions of Cliff Palace were published, the most notable by Dr. W.R. Birdsall

in 1891, Rev. Stephen D. Peet in 1892, Baron Nordenskiöld in 1895, and Dr. Edgar L. Hewett in 1909. The combination of these detailed written accounts and visual documentation of the site catapulted Cliff Palace into the national spotlight. This new interest resulted in the Secretary of the Smithsonian Institute, at the request of the Secretary of the Interior, to launch an excavation and stabilization initiative in 1909 by Jesse Walter Fewkes to preserve and study Cliff Palace.

2.2.2 Physical Description

![Figure 2.2 Cliff Palace, looking south (August 2008)](image)

Figure 2.2 Cliff Palace, looking south (August 2008)

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Cliff Palace is located in a sandstone alcove 200 feet above the floor of Cliff-palace canyon, an offshoot of Cliff Canyon on Chapin Mesa. The entire complex faces southwest looking across towards Sun Temple located on the opposite side of Cliff Canyon. The alcove is set within the upper Cliff House formation, massively bedded sandstone. This site, with its multi-terraced layout and imposing four-story architecture is one of the most impressive cliff dwellings in the American Southwest and the largest at Mesa Verde National Park, containing 141 rooms, 22 kivas and 75 other architectural spaces including: courtyard areas, open areas, and slab structures. Cliff Palace is laid out over three manmade stepped terraces, and is constructed of sandstone masonry units, earthen plaster, and timber roof members. Seventy-five percent of the site is made up of courtyard complexes with room types ranging in function from living quarters, ritual spaces, non-food storage areas, granaries, food preparation areas and perhaps civic needs. This topic of architectural function will be covered in more detail in subsequent chapters.

The sandstone masonry found at Cliff Palace was described by J.W. Fewkes as some of the finest seen in any cliff dwelling North of Mexico with most of the stones being dressed prior to construction. The quality of masonry varies throughout the site, with the most skilled workmanship generally found in the construction of kivas. In terms of technique, the majority of the walls were built with the largest stones at the

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15 Ibid.  
16 Nordby, 2006 111.  
17 Fewkes, 1999 29.  
18 Ibid.
base and decreasing in size toward the upper walls. The stones were laid with an earthen mortar and in some instances a variety of objects have been found embedded within the mortar, including: pottery and wood fragments.¹⁹

Many of the rooms and kivas at Cliff Palace were once covered with earthen plaster, and washes in a variety of colors ranging from white, grey and black to pink, red and yellow. In some cases more elaborate finish schemes remain including applied dados, auras, geometric pattern designs, and handprints. While the best preserved plaster finishes are predominately found on the interiors of rooms and kivas, some impressive exterior plaster finishes still survive. The most remarkable exterior plaster described by Fewkes in 1909 is described on the south façade of what is known today as the Speaker Chief Complex, which will be described in more detail in Chapters 7 and 10.²⁰ The finishes applied to this building were noted for their exceptionally smooth texture in comparison to similar plastered rooms on site.²¹ In terms of technique, it is believed the plaster finishes found at Cliff Palace were applied by hand due to the presence of finger and palm prints still visible in the dried plaster over 700 years later.²² Plastering appears to have been an ongoing practice at Cliff Palace throughout its evolution with multiple layers of different colored finishes visible where remaining areas of plaster have fractured showing multiple plastering campaigns.

Although, archeological research at Cliff Palace has been ongoing since J.W. Fewkes was commissioned in 1909, his description of the construction of the complex and the materials remains the only early work on the site today. This is predominately

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¹⁹ Ibid 29.
²¹ Ibid.
²² Ibid.
because his description and photographs were the most detailed accounts given prior to reconstruction and stabilization on-site. For this reason much of what Fewkes described in 1909 is referred to in this chapter.

2.2.3 Construction Chronology

In the 1990’s extensive archeological research into the morphological evolution of Cliff Palace was undertaken using dendrochronology, essentially tree-ring dating for absolute chronology and construction sequences for relative dating. During this project multiple samples from remaining timber members were taken to create a building timeframe for the complex. It was determined from this that the earliest construction period began between 1190-1191 AD (in the Kiva F area), followed by an extensive building phase between 1240-1244 AD (the area between Room 39, 40 and the Speaker Chief Complex). After this period in 1268-1274 AD the ancient Puebloans undertook an expansion and remodeling campaign to the south (including Kivas L, M, N and E). The last active construction period was found to be 1278-1280 AD and involved construction on Kivas O and R.  

2.3 Archeological Research

2.3.1 Resident Population

The estimated size of the resident community at Cliff Palace has been a subject of debate since the site’s initial study in the early 1900’s. Originally it was believed to have had the largest population within Mesa Verde National Park due to the size of the

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23 Nordby 2001 x
site. However, physical architectural evidence and the availability of natural resources have led archeologists to a different interpretation.

Today it is believed that Cliff Palace was not home to a large permanent resident population but instead housed a small caretaker population of 25-30 households, roughly 100-120 people year round.\textsuperscript{24} This current interpretation is based on the lack of hearths within the site and accessible water resources. Despite the size of Cliff Palace, only 25 of the 141 rooms contained hearths, indicating that only a small portion of the structures contained space that was livable year round.\textsuperscript{25} Although, there are a considerable number of kivas within the site (all of which contain hearths) that could have been used as seasonal spaces for shelter, it is believed that they would have been used temporarily for living purposes.

Additionally, the lack of water resources that would have been needed by a resident community supports the hypothesis that the site housed a small care taker population rather than a large permanent village. The small amount of reservoirs, springs, and seeps that would have been easily available to the occupants of Cliff Palace would not have supported a large permanent population.

Archeologists now believe the remainder of the site could have been inhabited by visitors from nearby communities during part of the year for short periods of time perhaps during religious ceremonies.\textsuperscript{26} During these short periods of visitation kivas could have been used for temporary living quarters if necessary.\textsuperscript{27}

\textsuperscript{24} Ibid v.
\textsuperscript{25} Ibid 7.
\textsuperscript{26} Nordby 2001,7.
\textsuperscript{27} Ibid 110.
2.3.2 Social Division

Cliff Palace is physically divided into two clear sections, separated by a solid wall just south of Speaker Chief House. This physical division of architectural space within the site is currently thought to illustrate a dual social division, for Cliff Palace.\(^{28}\) These social and architectural divisions may represent larger related social groups than those that would traditionally use a single kiva.\(^{29}\) Moieties or in some cases triadic divisions are found both in the Hopi and Zuni cultures today, both of which have ties to the Ancestral Puebloans of Mesa Verde.\(^{30}\)

There are two main areas where the dual division on-site should be clearly visible in terms of accessibility and architectural construction practices. In a dual division society it is expected that residents within each section would have unlimited access to spaces within their section but limited or restricted access to spaces outside their affiliated section.\(^{31}\) Additionally, architectural construction practices may provide insight to an existing dual society. This can be illustrated through architectural symmetry, shared architectural details within village sections, or localized architectural details.\(^{32}\)

At Cliff Palace three distinct architectural indicators have been used to identify a dual division society. A “Moity Demarcation Line” in the form of a stone wall, has been found at Cliff Palace separating the site into two distinct parts. This wall runs from the back of the site along the exterior southwest corner of Room 63, extends across

\(^{28}\) Ibid v.
\(^{29}\) Ibid 107.
\(^{30}\) Ibid 107.
\(^{31}\) Ibid.
\(^{32}\) Nordby 2001, 107.
miscellaneous structure 14 and runs alongside the north eastern side of Room 58 (1). 33
Perhaps the most telling detail found within Cliff Palace illustrating the possible presence of a dual organization society is visible in the last finish campaign of Kiva Q. This kiva, which is located near the demarcation line and just below the Speaker Chief Complex, has been equally divided into two semicircles by the use of two wash colors. 34 The northern banquette side is covered with pink plaster while the southern banquette side is covered with white. 35 These two halves then come together over the eastern wall niche providing a clear illustration of two independent halves.

33 Ibid 108.
34 Ibid 109.
2.3.3 Previous Work On-site

Documentation and stabilization projects at Cliff Palace have been ongoing since the late 1800's, ranging from the production of site plans and photographs to stabilization and repair initiatives.

The earliest documentation project at Cliff Palace was initiated by Gustav Nordenskiold in 1893. This undertaking yielded the first numbering system and comprehensive site map of Cliff Palace.\textsuperscript{36} Although, Nordenskiold’s numbering system was changed by J.W. Fewkes in 1909, his descriptions and site map laid the foundation for Fewkes’ excavation, stabilization, and documentation project.

Until the 1930’s, when the Morse mapping project was initiated, Fewkes’ work remained the most comprehensive to date. During Morse’s project a another site map of Cliff Palace was created, and a standardized system of large format documentation photography was developed by Chester Markley before and after stabilization, supervised by Earle H. Morris and James ‘Al’ Lancaster.\textsuperscript{37} The majority of the work conducted during this project was relegated to the northern end of Cliff Palace, with a specialized focus on the Speaker Chief’s House.\textsuperscript{38}

In 1961 ground water seepage threatened the stability of Cliff Palace resulting in the creation of a drainage tunnel to mitigate any damage. As a result of this project a new map of the site was produced in the mid 1960’s, which included the position of the newly installed drainage tunnel, by someone only known by the initials of L.D.A.\textsuperscript{39}

\textsuperscript{36} Nordby 2001, 3.
\textsuperscript{37} Ibid 4.
\textsuperscript{38} Ibid.
\textsuperscript{39} Ibid 6.
The next set of significant documentation projects at Cliff Palace focused on the study of earthen plaster found throughout the site. In 1986 Constance Silver compiled a comprehensive report on the distribution of plaster throughout Cliff Palace and in 1993 Copeland and Ives picked up where Silver left off creating a comprehensive report describing the plaster designs present onsite.\textsuperscript{40}

In 1995 water seepage threatened Cliff Palace once more, this time through a large crack in the rock face, jeopardizing original plaster work and the overall integrity of Cliff Palace.\textsuperscript{41} Although, the park officials did their best to prevent loss of original architectural fabric, considerable damage occurred in areas of Courtyard Complex J and M. As a result a documentation crew was organized to document in detail Courtyard Complex J and M.

Over the last 115 years four different site maps have been produced (Nordenskiold 1893; Fewkes 1909; Morse 1935; L.C.E. 1965) and one onsite prestabilization report summary (Nordenskiold 1893). One excavation report summary (Fewkes 1909), two comprehensive sets of stabilization notes (Morris, Lancaster, and Fiero; Stabilization Record Collection 5MV625), two comprehensive stabilization reports of all past projects, (Horn 1989; Chandler 1989), one comprehensive documentation report of Courtyard Complex M and J (Nordby 2001), two comprehensive plaster reports (Silver 1986; Copeland and Ives 1993), one earthen conservation finishes report (Rivera 1999), and one conservation site (Fritz 2001).\textsuperscript{42}

\textsuperscript{40} Ibid 7.
\textsuperscript{41} Nordby 2001, 3.
\textsuperscript{42} Ibid 7.
3. Architecture and Social Function

Ancient Puebloan society and its organization was based on rituals and spiritual ceremonies which reinforced a social structure based on kinship and family. According to current anthropological research, historic and contemporary pueblo people are matrilineal (descended through the female line), and matrilineal as an organized household.\textsuperscript{43} If the Ancestral Puebloans did in fact have a matrilineally organized society, it is probable that the wife or mother of a clan (a named group claiming descent from a common ancestor) owned or controlled the family’s home.\textsuperscript{44} It is believed when a man married he moved into his wife’s home or her family’s home while still remaining part of his mother’s clan. However, his children would become part of his wife’s clan (their mother’s clan). While archaeologists cannot be certain whether Ancestral Puebloans lived matrilineally, an interpretation of the architecture of the Ancestral Puebloans provides physical evidence of architectural units that expanded over time to house nuclear families, extended families, lineages, clans and even larger groups that integrated the smaller ones into a cohesive, functioning community.\textsuperscript{45}

3.1 Kiva

The main focus of social activity for residential communities was the kiva, usually a subterranean room covered with a cribbed timber and mud roof that doubled as a public plaza area.\textsuperscript{46} Unlike modern Puebloan society, the kiva in Ancestral Puebloan

\textsuperscript{43} Nordby 2006, 111.
\textsuperscript{44} Ibid.
\textsuperscript{45} Ibid 112.
\textsuperscript{46} Ibid 112.
society probably served both a ceremonial as well as a domestic function where as today kivas are only used for ritual or ceremonial purposes. The organization of specific architectural features within the kiva such as pilasters, banquets, wall niches and the sipapu may have derived from spiritual or social conventions as well as necessitated by utilitarian function.47

The design, style, raw materials, and decorative embellishments may be a reflection of group identity and social traditions. For instance the type of finishes used within one kiva may differ from another depending on the resources available to each family or clan. At Cliff Palace and at comparable ancient puebloan sites throughout the southwest there is a much higher ratio of kivas to domestic structures than what is seen today. This higher percentage of kivas could indicate the representation of more clans within one domestic village or a more complex social organization than what is present today in modern puebloan society.48

### 3.2 Room Suites

Room suites are a set of linked rooms that open onto the open plaza area created by the kiva roof tops. In order to be defined as a “room suite” this set of linked rooms must contain at least one living or habitation room and must front the open plaza area.49 The most common room suite combination found at Mesa Verde is a living or habitation room paired with a single food-storage room or granary.50

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47 Nordby 2006, 112.
48 Ibid.
49 Ibid.
50 Ibid 113.
The two required architectural elements required in order for a room to be labeled as a living or habitation room are the presence of a hearth and the room’s placement opening onto the courtyard. However, other elements that tend to also be present in living rooms but are not required to be defined as such are: a “T” shaped doorway, a ventilation port, (an open space in the wall that resembles a window), and larger square footage.51

Often there are additional smaller rooms present behind living rooms that were most likely used for storage due to the size and nature of their doorways. The doorways to these spaces are rectangular in shape with elevated sills and are considerably smaller than the doorways associated with living rooms. These rooms were most likely used as granaries and food-storage space since they were smaller in size than the living rooms, could be easily sealed with a stone slab or hide, and did not contain a hearth.52

These room suites were probably used exclusively or inhabited by a nuclear family consisting of a mother, father and children. L. Nordby has found that the floor areas of room suites ranged from less than 65 square feet to a little more than 160 square feet.53 Considering this finding it is likely that the families that inhabited these room suites spent much of their social time in the clan kiva and rooftop plaza area.

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51 Nordby 2006, 112.
52 Ibid.
53 Ibid 113.
3.3 Courtyard Complexes

The entire family architectural unit made up of the kiva, its rooftop plaza, and encircling room suites makes up what Mesa Verdecian archaeologists have termed the “courtyard complex.” Typically, courtyard complexes include one to four room suites in addition to singular rooms. At Cliff Palace and other alcove sites within Mesa Verde National Park, the open plaza area within the courtyard complex is sheltered by the overhanging sandstone rock face. This means daily social activities could continue in spite of excessive heat, cold, rain or snow. While room suites were typically utilized by a nuclear family it is believed by archaeologists today that there was a shared utilization of kivas and plazas by extended family members and clans.

The exterior and interior walls of room suites and kivas were often plastered with different colored earthen finishes and geometric designs. Other decorative embellishments that are often found within these complexes are auras, (circular halos that around structure entrances), mud ball imprints, handprints, and dados. The types of embellishment and materials used could be specific to a clan since these spaces are believed to have been the social epicenter for clan activity.

The continued study of the courtyard complex at Mesa Verde has become increasingly important in understanding the organization of social groups within Ancestral Puebloan society. The courtyard complex, considering its intimate utilization by the nuclear and extended family can be viewed as representative architecture for

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54 Ibid.
55 Nordby 2006, 114.
56 Ibid.
57 Ibid.
each different social group or clan providing valuable information as to how different clans may have accessed raw materials and used different colors and symbols, in the formulation and embellishment of architectural space.

3.4 Open Areas

Open Area is a term used to describe the space formed as a result of surrounding architectural features. Although, the term “open area” is relatively new to the archeological lexicon, the observation and study of these places is not. In past years, these spaces have been called, “non-structures”, (Metzger 1989), however because of the lack of specificity in the term many archeologists describe these spaces now as “open areas”. Furthermore, these architectural spaces have been separated into two specific subcategories, courtyards or plazas and work spaces.

Open areas that fall into the courtyard or plaza category are located on top of kiva roofs; they are larger than work spaces and have more finely plastered and worked floors with limited floor or wall features. These plazas are spatially linked to a nearby kiva and serve a similar social gathering function. Open areas are closely linked to the clan or family using the space on a daily basis and tend to exhibit decorative plasters and wall embellishments on spatially related rooms that create the enclosed area. These decorative finishes in these spaces can include: auras, dados, banding, and hand prints.

The other subgroup within the architectural category of open areas is the work area. These spaces tend to be smaller than plazas, include floor and wall utilitarian

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59 Ibid .
60 Ibid .
features used in food preparation or other technological activity. Items that have been commonly found in these spaces include mealing bins, axe-sharpening grooves, awl sharpening grooves, and other modifications to the bedrock floor.\textsuperscript{61} Character defining elements of a work area include no direct affiliation with a kiva, less decorative embellishments, the inclusion of floor utilitarian features, small size, and accessibility by the entire community.\textsuperscript{62}

\textsuperscript{61} Nordby 2001, 14.
\textsuperscript{62} Ibid.
3.5 Civic Architecture

A unique type of architecture separate from the building types that make up the courtyard complex, are “specialized buildings”.63 These buildings are found in large cliff dwelling settlements and are defined by their lack of physical connection to a specific courtyard complex. Specialized buildings range in type from: kivas without encircling rooms, rooms without a kiva near or adjacent to them, as well as specialized meal preparation rooms for grinding corn, towers, great kivas and other individual or “unusual” buildings.64 It is believed that the individual nature of these buildings is indicative of their function as a place of collaboration between clan members and possibly other residents within the community.65

The interpretation of these specialized buildings has proved to be a perplexing task for researchers. Considering the amount of limited sheltered space provided by the sandstone alcove, it seems difficult to pinpoint why the Ancestral Puebloans would have constructed buildings that did not have a clear connection to the clans. Nordby considers these specialized structures, similar to the courtyard complex, as representative of the entire community rather then at the individual clan level.66 Based on this hypothesis, specialized buildings within an alcove community like Cliff Palace would serve to bring the individual clans together, strengthening the bond of the community. At Cliff Palace, there is architectural evidence that supports this hypothesis.

63 Nordby 2006, 115.
64 Ibid 114.
65 Ibid 115.
66 Ibid.
Kiva Q located in the northwest corner of the site has been characterized as a "specialized building" type.\textsuperscript{67}

\textsuperscript{67} Nordby 2006, 115.
4. Earthen Finishes in the Historic Southwest

The most common surface finishes found at Mesa Verde National Park are earthen plasters and washes. Earthen finishes have been utilized in pueblan architecture from the Basketmaker period (400 C.E.) up through the modern pueblo period. This common architectural finish consists of a basic matrix of water and soil and can be embellished through additional applications of colored washes or incised design.

4.1 History of Earthen Finishes at Mesa Verde

Studies of plasters from this period indicate successive layers of plaster indicating a renewal cycle, once existing plasters had either become too deteriorated to serve their insulation function or as ritual application.

In the Developmental Pueblo period, 800-1000 C.E., earthen plasters become more decorative in nature with the addition of designs on plaster surfaces. This new interest in the symbolic and aesthetic in addition to the functional aspects of finishes is evident. Decorative murals applied to the surface of plastered interior and exterior walls became widespread during the Classic Pueblo period, as the Ancestral Puebloans transitioned from pithouse structures to cliff dwellings.

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69 Ibid.
70 Ferguson and Rohn 1987, 6.
Remaining plasters and washes found at alcove sites throughout Mesa Verde National Park exhibit a strong function in defining architectural space through the use of dados, auras, floor bands and wall bands. Each plaster and wash is categorized depending on where it is located on a building.\(^72\)

In terms of interior finishes the most elaborate and intricate earthen finishes tend to be located within kivas, with few exceptions located in rooms. Common designs found within kivas include geometric and animal designs similar to those found on pottery vessels concurrent with the period.\(^73\)

After kivas, richest exterior finishes found at Mesa Verde tend to be located on the exteriors of rooms facing open area plaza areas in courtyard complexes. Archeologists today believe these areas were the focal point in daily Ancestral Puebloan life, which may have resulted in an increased expression of community identity through the use of architectural finishes.\(^74\)

In order to better understand what constitutes the types of earthen plasters and washes used by the Ancestral Puebloans each will be described in terms of the components, preparation and application.

### 4.2 Plasters

The term plaster defines those earthen surface finishes that measure 1mm thick or more. This delineation was determined by the Architectural Conservation Laboratory at the University of Pennsylvania and will be utilized here. Earthen plasters

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\(^72\) Slater 1999, 28.
\(^73\) Ibid 23.
\(^74\) Ibid.
are made up of two primary components, soil and water. Soil refers to a complex matrix of sand, clay and silt as well organic material, if present. Each component within a particular soil provides a fundamental function in creating a successful earthen plaster. Sand and silt provide shrinkage control, texture and color, while clay provides adhesion and acts as the binder between the other soil constituents.

Although, soil and water are the only two components necessary to create a simple earthen plaster, organic and inorganic additives may be utilized to improve the physical or visual properties of a plaster. Organic additives are often added to either increase cohesion or aid in drying and improve tensile strength. In order to increase cohesion, blood, dung, animal glues, or urine may have been added to a plaster matrix while fibrous material like yucca fibers, animal hair or grass would have increased tensile strength and prevent cracking. Inorganic additives are often utilized either to improve a plaster’s set time or provide a specific color. The most common inorganic additives that would have increased durability and improve set time include: calcium carbonate such as chalk or lime. Inorganic additives that were often utilized to provide a specific color to a plaster include: iron, copper, or other minerals.

Despite the ability to utilize inorganic and organic additives to enhance an earthen plaster, the soil matrix provides the majority of the primary physical properties. Manipulation of soil constituents during the formulation process may include physical alteration such as sifting or grinding or selection bias depending on color, texture, plasticity and shrinkage.

75 Slater 1999, 27.
76 Ibid.
The existence of earthen plasters at Mesa Verde National Park, almost 700 years after their application indicate durable plasters that were carefully selected, formulated and applied.

### 4.2.1 Application

Although the specific application process of common plasters is not known in detail, archeologists have a basic idea of the plaster application process based on remaining impressions in the plaster and tools found on site. One specific plaster application identified at Cliff Palace has been termed ‘defacto plaster’. This plaster, also referred to as ‘extruded smooth’, refers to when mortar between joints has been extruded and smoothed out along the sandstone masonry. It is suspected this type of earthen finish was utilized either as filler or leveling coat in instances where masonry walls were uneven. Other basic plaster applications include being smoothed by hand in a circular motion, or the utilization of extraneous pottery shards, stones or yucca leaves.

### 4.3 Washes

The term wash has been defined as thin finishes applied directly on top of masonry units or applied plaster that measure less than 1mm in thickness. This delineation is used by the Architectural Conservation Laboratory at the University of

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77 Silver 1987, 27.
78 Ibid.
79 Slater 1999 28.
Pennsylvania and will be used here. Although, it should be noted that previous studies conducted by Watson Smith defined these finishes as paints rather than washes.80

Washes in contrast to plasters have a much finer particle matrix and are made up of three basic components: a carrier, a colorant and a binder. In the case of Ancestral Puebloan washes, water serves as the carrier, inorganic and organic pigments serve as the colorants and clays most likely served as the binder. Although, organic binders such as blood, urine, or plant gums could have been used as binding agents, the identification of these materials has been extremely difficult and evidence of their presence is not likely to be found after 700 years of exposure.81 The way the three components of a wash work together to create a thin film when dry is through the following process: the binder and carrier serve as the vehicle for the colorant, the carrier provides fluidity allowing easy application, once applied the carrier evaporates leaving a thin film.82 For earthen washes clays and lime tend to work as binders while water disperses the clay and pigment particles onto a dry surface.

In this matrix the colorant plays the most dominant role visually. At Mesa Verde the most common colors utilized at sites around the park include: black, white, brown, orange, pink, yellow and grey. In an extensive pigment study on Ancestral Puebloan plaster and wash samples conducted by Watson Smith in 1952 in his *Kiva Mural Decorations at Awatovi and Kawaika-a*, organic and inorganic pigments were identified. In this study Smith characterized 125 paint samples from the interior kiva walls of Awatovi

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80 Ibid 29.
82 Slater 1999, 30.
and kawaika-a. Each sample was studied using microscopy, spectroscopy and microchemical spot tests in order to identify the key components of the pigments. The following list of pigments summarizes Smith’s findings from his 1952 study.

**Black**: A variety of black pigments were found in the 125 samples analyzed, however this was the only organically derived pigment. The presence of wood fibers was indicative of the utilization of charcoal. Other black pigment samples tested positive for phosphates, and thus were characterized as lamp black, a common pigment characterized as nearly pure carbon resulting from burning organic material.

**White**: The most common components of white pigment samples tested included the presence of kaolin (Al₂O₃·2SiO₂·2H₂O), fine silica sand, chalk, calcium carbonate (CaCO₃) and gypsum (CaSO₄·2H₂O).

**Yellow**: The most dominate mineral sources utilized for yellow pigments include: Goethite (H Fe O₃) and Limonite [Fe₂O₃·n (H₂O)]. These mineral sources can be found in soils and clays native to the Mesa Verde area, with variations in tone and richness as results of additional mineral inclusions and source location.

**Red**: Red pigments were identified in this study as red iron oxide hematite (Fe₂O₃) which is a variety of anhydrous ferric oxide that is nearly free of impurities. Similar to the yellow pigments found it seems varieties in tone and richness have been attributed to impurities found in the hematite utilized.

**Orange**: The formulation of orange pigments was created through the mixture of yellow and red pigments to create an orange hue. In some cases white particles were found that were most likely clay mineral inclusions.

**Pink**: Pink pigments were formulated in a similar manner as orange pigments. In order to create pink the Ancestral Puebloans combined red and white pigments.

**Vermillion**: Although not commonly found at Ancestral Puebloan sites, the creation of a vermillion pigment is speculated to be the result of mixing red ochre with clays that look very similar to cinnabar in color.

**Brown**: The two most common sources of brown pigments were attributed to burnt iron oxide and mixtures of iron oxide and carbon particles.

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84 Ibid 22-24.
Purple: Some of the pigment samples tested by Smith were purple in color. The most dominate component of this pigment was identified as red iron oxide (Fe₂O₃). Although, one sample tested positive for manganese in addition to iron oxide and was most likely a mixture of the two. Other samples tested positive for the inclusion of secondary components including: clay and carbon.

Blue: Although, a relatively rare pigment two blue pigment samples were tested in Smith’s study. Both tested positive for copper carbonate (CuCO₃), most likely originating from azurite minerals. These pigments were bright blue in hue. However, a more commonly found dark blue pigment was present at the sites sampled by Smith and was the result of a mixture of iron, grayish-green in color and iron oxide yellow in color as well as carbon.

Green: Another rare pigment not often seen is green. Two types of green pigments were identified by Smith. The first is brilliant green in color resulting from copper carbonate (CuCO₃) most likely from malachite minerals. The second green pigment found is dull in luster and tested positive for iron, grayish-green in tone and yellow iron oxide and carbon similar to the dull blue pigment found.

Gray: Gray pigments similar to oranges and pinks seem to be a mixture of two common pigments. To create gray the Ancestral Puebloans mixed white and black pigments together.

Unlike binder and carrier identification, pigments from Ancestral Puebloan plasters can be much more easily identified and provide a key element in understanding their utilization of natural resources in the creations of architectural finishes.

4.3.1 Application

Although, little is known about the application process for washes by the Ancestral Puebloans some speculations have been made based on modern puebloan practices and remaining archaeological evidence. What is known for certain is that washes were formulated and applied in their liquid form and once the carrier evaporated a thin film would be created. Remaining yucca impressions and finger prints
in plasters with decorative washes at Mesa Verde today indicate that a thick brush made out of yucca fibers or simple hand application of washes may have been utilized.\(^{85}\)

Another possible application technique could have included the utilization of animal skins to apply washes to walls. This technique possibility is based on modern puebloan practices of using sheepskin mittens to apply washes today.\(^{86}\)

\(^{85}\) Smith 1952, 30-31.

\(^{86}\) Ibid.
5. Natural Resources on Chapin Mesa

Earthen plasters are composed of two primary elements soil and water. Soil constitutes the bulk of the earthen plaster formulation and is made up of a matrix of sand, silt and clay particles. In order to understand the components of the plaster matrices used at Open Area J and Speaker Chief House, it is important to know which natural resources were available to the residents of Cliff Palace to be utilized in the formulation of the plasters found on site. The following sections will address which natural resources were immediately available to the residents of Cliff Palace and could have potentially been used in the formulation of the earthen plasters found at Open Area J and Speaker Chief House.

5.1 Hydrology

The residents of Cliff Palace would have had access to a variety of water resources including precipitation and natural springs and seeps. In a comprehensive water resource study conducted by Arthur Rohn in 1963, many of the ancient manmade water conservation devices on Chapin Mesa were recorded and mapped including: check dams, reservoirs, and ditches. This study noted the location of these manmade constructions in relation to natural springs, streams and seeps in the area in order to better understand which water sources would have been immediately available to each Ancestral Puebloan community.
Figure 5.1 Chapin Mesa Check Dam System (Rohn 1963)
In this study, 39 separate series of check dams were found over 900 individual manmade check dams on Chapin Mesa. These dams are characterized as low sandstone masonry walls located in stream beds and heavy rain run off areas. The process of water collection using the check dam system is as follows, check dams would be built during dry seasons so that when water from heavy rains or snow melt collected in stream beds, water would become trapped behind the masonry dams. Once the water became trapped behind the dam, most of its silt and soil content would be lost either through settlement or through forced passage through small crevices in the check dam. Not only did this system provide the Ancestral Puebloans with fresh water for daily activities, but during this process silt and soil would collect on top of the check dam creating fertile soil for small scale farming.

For the residents of Cliff Palace two check dam systems at the base of Cliff Canyon as well as three small springs and a few seeps would have been immediately available to them as possible water resources for plaster source water as well as possible solid materials.

In addition to the immediate availability of water resources mentioned above there are more abundant water resources located further from Cliff Palace on Chapin Mesa. These resources include Mummy lake (also known today as the Far View Reservoir) and the Farview Ditch. Both of these water sources have been linked to the ruins at Far View. Although, it is less likely these resources were used as frequently as

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87 Rohn 1963, 442.
88 Ibid.
those in the immediate vicinity of Cliff Palace they are still worth noting as a possible water source for plaster formulation.

### 5.2 Geology

Prior to beginning any stratigraphic testing or analysis it is essential to examine the natural geologic resources in the Mesa Verde region that would have been available to the Ancestral Puebloans during the primary period of architectural construction during the 1200’s. This information will provide an understanding of which geologic resources could have been used by the Ancestral Puebloans to formulate the earthen plasters, and washes found on the interior and exterior walls of dwellings found throughout the park.

As cited by Wanek in 1959 and Griffits in 1990, four primary geologic formations all from the Cretaceous period make up the exposed geology visible throughout Mesa Verde National Park. These formations include: the Mancos Formation, Point Lookout Formation, Menefee Formation, and Cliff House Formation.\(^{89}\)

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5.2.1 Mancos Formation

The Mancos Formation makes up the base geologic foundation for the three remaining formations identified above. First described in 1899, this formation consists of inhomogeneous soft gray shale with limy concretions and thin bentonite layers deposited near the base. The bentonite deposits within the Mancos Formation present themselves as thin white plastic lines within the shale on a freshly exposed surface and

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90 Griffits 1990, 43.
turn to a rust orange color upon weathering.\textsuperscript{91} Within the Mancos Formation a fossil zone located 75 feet from the base of the formation approximately 10 feet thick contains fossilized remains of \textit{Pycnodonte newberryi}, a type of oyster as a testament to the nearby seas that once covered the land. More dark shales are present above the fossil zone, with the Greenhorn limestone layer deposited above the successive dark shales. The Greenhorn member is composed of rich fossil deposits with thick limestone beds that give way to limey shales that are capped by thin layers of dark soft and sandy shale.\textsuperscript{92} The Juana Lopez member, composed of two layers of highly fossiliferous sediments is located directly above the Greenhorn member. This layer upon initial inspection appears to be a type of sandstone, however when samples of the sediment is placed in hydrochloric acid the entirety of the sample dissolves, illustrating that in fact this layer is composed of finely grained fragments of shell fossils.\textsuperscript{93} These beds cap the small hills located on the northern side of the park and are rust brown in color.\textsuperscript{94} The remaining components of the Juana Lopez formation consists of yellow-gray sandy shales and shaley sandstone that complete the upper portion of the Mancos Formation.\textsuperscript{95}

\section*{5.2.2 Point Lookout Formation}

Located directly above the Mancos formation is the Point Lookout Formation which is the first of the three geologic formations that make up what has been identified as the Mesaverde group. This geologic formation begins where sandy shale layers give way to thin sandstone layers that transition to massive sandstone units which range in

\textsuperscript{91} Griffits 1990, 43.
\textsuperscript{92} Ibid.
\textsuperscript{93} Ibid 47.
\textsuperscript{94} Ibid.
\textsuperscript{95} Ibid 51.
depth from 30 to 40 feet. These sheets of sandstone protect the Mancos shale layer below and cap the rock cliffs on the north edge of the park. The Point Lookout Formation is distinguished by its dark rust brown color and rich iron concretions dispersed throughout.

5.2.3 Menefee Formation

The bottommost layer of the Menefee Formation located directly above the Point Lookout Formation is composed of thin layers of dark brown and soft black shales with thin layers of burnished coal deposits. These layers are interspersed with sandstone beds from an inch to a foot in thickness with fossilized flora impressions dispersed throughout. The center portion of the Menefee Formation is made up of a series of irregular, crossbedded sandstones interspersed with shaley sandstones and devoid of much of the fossilized flora impressions present in the lower layers. Thin and thick layers of bentonite some as thick as three feet are dispersed throughout the middle section of the Menefee Formation. Deposits of bentonite that have become exposed in areas of the park where they have been exposed to the elements and undergone a weathering process have turned into soft sticky light gray clay. The uppermost layers of the Menefee Formation closely resemble its lowest layer consisting

96 Griffits 1990, 51.
97 Ibid 51-53.
98 Ibid 54.
99 Ibid 53-54.
100 Ibid 56.
101 Ibid.
102 Ibid.
of thin layers of dark brown and soft black shales with thin layers of burnished coal deposits.103

5.2.4 Cliff House Formation

This geologic formation is named after the cliff dwellings built by the Ancestral Puebloans within the sandstone beds of this formation. The Cliff House Formation usually consists of two massive sandstone beds most often buff orange in color, each ranging in size from 100 to 200 feet thick and separated by a thin shale layer between the two.104 On Chapin Mesa, while there are some exceptions, weathered alcoves and niches in the upper portion of the Cliff House Formation is the predominant location used by the Ancestral Puebloans to build their architectural complexes.105 For this reason the Cliff House formation is of particular interest in the study of the earthen plasters and washes found on the walls of Spruce Tree House and Cliff Palace both of which have been constructed within the upper portion of the Cliff House geologic formation.

While Mary Griffits’ Guide to the Geology of Mesa Verde National Park is the seminal geologic text for the Mesa Verde area and has been relied on heavily for this portion of research, it should be noted that a task force assembled in October of 2005 to document and map the surficial geology of Mesa Verde National Park will be publishing new research in this area upon project completion.106

103 Ibid.
104 Griffits 1990, 59.
105 Ibid.
5.3 Soil

Soil is a complex matrix of unconsolidated solid particles created through chemical and physical weathering of parent rocks and can include organic matter. Each soil composition varies depending on the topography, climate, vegetation and parent rock material as well as the amount of time necessary in the creation of the soil. The two most common ways to characterize soils is either according to their particle size or geotechnical classification or their mineralogical composition.

The geotechnical classification of a soil’s components is an assessment of the particle size based on each grain’s diameter. There are four common geotechnical classifications, gravel (60mm-2mm), sand (2mm-60μm), silt (60μm - 2μm) and clay (less than 2μm). Each component plays an important role in utilizing the soil for the creation of an earthen finish. Sand is used as the aggregate of a plaster, increasing compressive strength, controlling shrinkage, creating texture and providing color. Clay on the other hand is utilized as a binder, providing cohesion to the plaster matrix. A soil high in clay tends to be sticky and malleable when wet, allowing it to be easily shaped and molded. Although, clayey soils have good adhesion they tend to crack and shrink during the drying process.

The mineralogical composition of a soil tends to relate to the types of clays included within the soil matrix in addition to any secondary or tertiary rock fragments.

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108 Ibid.
109 Ibid.
110 Ibid 96.
different from the primary parent rock material. For further information on clays see Section 5.4.

Extensive soil surveys were conducted in the Mesa Verde region as part of the soil survey for the greater Cortez area of Colorado including parts of Dolores County, Montezuma County and the Ute Mountain area. These studies were conducted in January of 2008 by the Natural Resources Conservation Service (NRCS). Although, soil information is available for the entire region only, the surveys conducted on Chapin Mesa and the immediate surrounding areas will be discussed in this study as potential source material for the earthen plasters found at Open Area J and the Speaker Chief Complex.

The NRCS found seven different series of soils and rock outcrops in the immediate area of Cliff Palace, including: Park Mesa, Chapin Mesa, Long Mesa and the canyons in between. These different series include: Arabrab-Longburn complex, Longburn, Morefield loam, Sheek-Archuleta, Steephouse-Rock, Tragman-Sheek complex, Wauquie-Dolcan Rock outcrop complex, and Yarts fine sandy loam. Each series was numbered, mapped and categorized according to color, clay content, calcium carbonate percentage, and alkalinity (Appendix A).\textsuperscript{111}

5.3.1 Longburn Series

The Longburn series of soils are well drained soils created in residuum, colluviums and weathered eolian substances originating from sandstone parent rocks in this particular case Cliffhouse sandstone.\textsuperscript{112} These soils are characteristically shallow or

\textsuperscript{112} Ibid.
very shallow in depth and are often found in canyons and mesa tops with a taxonomy typically consisting of a matrix of loamy-skeletal, super-active, and mesic Lithic Haplustalfs.

In this study the Longburn soils were sampled at a range of depths from 0-17 inches in order to classify the series in terms of color and pH. Using the Munsell color classification system for soils the Longburn series were categorized as brown to dark brown with a color range between 7.5YR 3/3, 7.5YR 3/4, 7.5YR 4/4, and 7.5YR 5/4. Overall the pH of the soil ranged from neutral at 7.2 at the top most layers to slightly alkaline measuring 7.4. In general the Longburn soils consisted of 20 to 35% clay, 35% and up of gravel and cobble and 0-5% calcium carbonate.\(^{113}\)

### 5.3.2 Dolcan Series

Similar to Longburn soil, Dolcan soils are usually shallow to very shallow in depth located in canyons and hills. These soils are the products of colluviums and residuum originating from sandstone and shale in this case Morrison shale. The taxonomy of the soil has been further classified as loamy, mixed super active, calcareous, mesic, and shallow Aridic Ustorthents.\(^{114}\)

Like the Longburn series, Dolcan soils were analyzed in terms of color and pH at depth intervals from 0-11 inches. These samples included a range of colors on the Munsell soil color classification system including brown (10YR 5/3, 10YR 4/2 and 10YR 4/3), dark brown (7.5YR 3/2), reddish brown (5YR 4/4) and dark reddish brown (5YR 3/4), with the hue deepening in tone and saturation the closer the samples were taken.

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\(^{114}\) Ibid.
to 11 inches. Overall the Dolcan series of soils is slightly alkaline with a pH ranging from 7.6 to 7.8. Further physical characteristics of Dolcan soils sampled in 1993 include the following make up: a clay content of approximately 18%-35%, a rock fragment content of 5%-35%, and a calcium carbonate content of 0-2%.\textsuperscript{115}

5.3.3 Morefield Series

In contrast to Longburn and Dolcan soils, Morefield soils are very deep and well drained soils created in eolian material originating from sandstone parent rocks. These soils are usually located on mesa tops and are commonly found in the Mesa Verde region. The taxonomic class has been characterized as fine-silty, mixed, super active, mesic Aridic Paleustalfs.\textsuperscript{116} Since the Moorefield series of soils is found in much deeper depths than Longburn or Dolcan soils, samples were taken at intervals from 0-67 inches. Each sample was characterized in terms of color and pH, using the Munsell color system for soil classification the Morefield soils were found to range in color from brown (7.5YR 4/3), to dark brown (7.5YR 3/3) to reddish brown (5YR 5/4, 5YR 4/4) and yellowish red (5YR 4/6).\textsuperscript{117} In terms of alkalinity the Morefield Series varies between neutral with a pH range between 7.0 – 6.8 and slightly alkaline at 7.7-7.8. Other physical characteristics of the Morefield soils in the Mesa Verde region include an overall clay content of 18-35%, a rock fragment content of 0%-10% and a calcium carbonate range of 0-2% at 0-2 in., 3-6% at 2-24 in., and 5-15% at 24-67 in.\textsuperscript{118}

\textsuperscript{116} Ibid.
\textsuperscript{117} Ibid.
\textsuperscript{118} Ibid.
5.3.4 Sheek Series

The Sheek series of soils are similar to Morefield soils exhibiting deep deposited well drained soils. However, unlike the Morefield soils, Sheek soils are created in gravelly, cobbly, and stony colluviums as well as slope alluvium originating from shale and sandstone. Sheek soils similar to those already discussed are commonly found on canyon slopes and hills. The general taxonomy class given to Sheek soils has been broken down in the following categories: loamy-skeletal, mixed, super active, frigid Typic Haplustalfs. Since Sheek soils are found at greater depths samples were taken at intervals between 0-60 inches in order to categorize the range of color and alkalinity. In terms of color Sheek soils were categorized as brown (10YR 5/3, 7.5YR 4/4 and 7.5YR 5/4) and dark brown (10YR 3/3) using the Munsell soil color classification system. Overall pH values for sampled Sheek soils were neutral with the exception of samples taken at 17-27 in. which registered as slightly acidic at 6.5pH, and 43-60 in. which registered as slightly alkaline at 7.4pH. Other characteristics of the Sheek soil series includes an overall clay content of 18-35%, and a rock fragment content of 35-70%.

5.3.5 Tragmon Series

Tragmon soils are well drained soils are found at very deep depths and are created in colluviums, slope alluvium and alluvium from both shale and sandstone. These soils are commonly found on hills, canyons, mesas and alluvial fans. The taxonomic class of Tragmon soils consists of fine-loamy, mixed, super active, frigid Typic

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120 Ibid.
121 Ibid.
Argiustolls.\textsuperscript{122} Since Tragmon soils are found at deep depths samples were taken at intervals ranging from 0-60 inches and categorized in terms of color and pH. In terms of color Tragmon soils range from pale brown (10YR 6/3) brown (10YR 5/3, 10YR 3/3), dark brown (10YR 3/3), light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4), and dark yellowish brown (10YR 4/4) on the Munsell color classification of soils.\textsuperscript{123} Overall the pH of Tragmon soils is neutral with a pH of 7.2 with the exception of soil taken at 48-60 in. with a pH of 7.8.\textsuperscript{124} Other characteristics of Tragmon soils include a clay content of 18-35\% and a rock fragment content of 0-20\% in soils from 0-40 in. and 0-30\% rock fragment content in depths of 40-60 in.\textsuperscript{125}

5.3.6 Wauquie Series

Wauquie soils are well drained soils deposited very deep and are characteristiclly found on mesas, canyons, hills, benches, mountains and alluvial fans. These soils originated from alluvium and colluviums parent material including granite, sandstone and shale.\textsuperscript{126} In terms of taxonomic class Wauquie soils consist of loamy-skeletal, mixed, super active, mesic Aridic Haplustalfs. In order to categorize Wauquie soils in terms of color and pH samples were taken at intervals from 0-65 inches.\textsuperscript{127} Using the Munsell soil color classification system, Wauquie soils range from light reddish brown (5YR 6/4) reddish brown (5YR 5/4, 2.5YR 4/4)) and dark reddish brown (5YR 3/4) with a pH ranging from neutral to slightly alkaline.\textsuperscript{128} Other characteristics of

\textsuperscript{122} Ibid.
\textsuperscript{124} Ibid.
\textsuperscript{125} Ibid.
\textsuperscript{126} Ibid.
\textsuperscript{127} Ibid.
\textsuperscript{128} Ibid.
Wauquie soils include a clay content of 18-35%, a calcium carbonate content of 0-5%, and a rock fragment content of 35%-85%.129

5.3.7 Yarts Series

Yarts soils are well drained soils deposited very deep and originate from eolian material, and alluvium weathered sandstone, quartzite and shale.130 These soils are often found on structural benches, terraces, hills, alluvial flats and fans. In terms of taxonomy, this soil is categorized as coarse-loamy, mixed, super-active, calcareous, mesic Ustic Torriorthents. This soil ranges in color from yellowish red (5YR 5/6), and reddish brown (5YR 4/4) on the Munsell soil color classification system.131 In terms of pH this soil is moderately alkaline registering a pH of 8 to 8.2. Other characteristics of Yarts soils include a clay content of 5-28%, a rock fragment content of 0-15%, and a calcium carbonate content of 1-10%.132

5.4 Clay

Clays can be defined as very fine grained earthy substances that when in contact with a liquid become malleable and plastic.133 On the most basic level clays are formed through the weathering of specific types of silicate rocks containing a considerable amount of alumina.134 The most common of types of silicate rocks that form clays are predominantly those containing micas and feldspars.

130 Ibid.
131 Ibid.
132 Ibid.
134 Ibid 34.
Chemically speaking clays are composed primarily of silica and alumina and usually resemble some combination of the following formula: $2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$.\textsuperscript{135} However, the percentage of water, alumina, and silica vary between each type of clay. Most silicate clays are composed of roughly 39.4% alumina, 46.6% silica and 13.91% water.\textsuperscript{136} However, different clays have different types of atomic structures leading to a range of silica to alumina ratios anywhere between 1:1 to 4:1 or higher.\textsuperscript{137}

Clays are further categorized into two groups, the phylosilicate group and the hydrous-magnesian group, based on their physical structure. The phylosilicate group contains all of the clays that have a layered structure and the hydrous-magnesian group contains all of the clays that have a chain or lath like structure.\textsuperscript{138} The most predominate types of clays that have been found in the Mesa Verde region are from the phylosilicate group and include: kaolinite, smectite, and illite.

### 5.4.1 Kaolinite

Kaolinite clays are characterized by their two layer silica alumina structure and are representative of advanced weathering of the parent material, usually granitic rocks high in feldspar and quartz or micaceous schist.\textsuperscript{139} Chemically speaking kaolinite tends to have high alumina to silica ratios averaging two to one and are commonly expressed in the following formula: $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$. The typical chemical compositional breakdown of kaolinite clays are as follows: 39.4% alumina, 46.6% silica, and 13.9% water. In general this clay is high in alumina with a ratio of two to one with silica.

\textsuperscript{135} Rice 2006, 40.
\textsuperscript{136} Ibid.
\textsuperscript{137} Ibid.
\textsuperscript{138} Ibid 44-45.
\textsuperscript{139} Ibid 45.
Physically speaking kaolinite particles form in two layers of flat hexagonal plates. Typically these plates range in size from moderate to large with a diameter from 0.3 \( \mu \)m to 0.01mm and roughly 0.05\( \mu \)m thick. The distinctive two layer silica alumina structure incorporates a reasonably strong bond, this bond prevents most opportunities for cation subpositions in the structure and because of this kaolinite properties are relatively constant.\(^{140}\)

### 5.4.2 Smectite

Smectite also known as montmorillonite is the first major clay group with characterized by a three layer structure consisting of a center layer of alumina

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\(^{140}\) Rice 2006, 48.
octahedrons loosely bonded between two sheets of silica tetrahedrons. This loosely bonded structure connected at the oxygen atoms of the silica and alumina sheets allows water molecules to easily penetrate the voids between each layer. When water molecules or other elements penetrate the spaces between the silica and alumina sheets it causes the layers to expand and swell or absorb extra ions easily. This property is commonly known as high base exchange.

Smectite clays are created through alteration and weathering of parent rocks high in calcium, magnesium, and iron including basalts and clacic plagioclases or decomposed volcanic ash. These clays are commonly found in the soils and recent sediments of arid regions.

141 Rice 2006, 48.
142 Ibid.
143 Ibid.
Chemically speaking smectites tend to exhibit a higher ratio of silica to alumina approximately 4:1 with a composition of 66.7% silica, 28.3% alumina, and 5% water.\textsuperscript{144} However, one should note that due to the high base exchange property smectites almost always differ in their actual chemical composition when compared to the theoretical breakdown above. The smectite particles are relatively thin and platy do not exhibit a clearly formed hexagonal crystal structure like the kaolinite particles.\textsuperscript{145} The particles

\textsuperscript{144} Rice 2006, 48.
\textsuperscript{145} Rice 2006, 49.
are also significantly smaller in size ranging from 0.05μm to 1μm in diameter.\textsuperscript{146} The small particle size of the smectite particles is responsible for their plastic and sticky nature.

### 5.4.3 Illite

The Illite clay group is the second major category of clays with a three-layer structure. Illite clays are very similar to well-crystallized micas and smectites in structure.\textsuperscript{147} One major difference between illite and smectite clays is the charge deficiency present in illite clays. In Illite approximately one-sixth of silicon is substituted by aluminum, creating a charge deficiency which is usually balanced by potassium (K\textsuperscript{1+}) however in some cases Ca\textsuperscript{2+}, Mg\textsuperscript{2+} or H\textsuperscript{1+} are substituted.\textsuperscript{148} This charge deficiency located on the outer silica layers is the predominate reason for the non-expandable characteristic of illite clays. Similar to smectites illite clay particles form in small thin poorly crystallized plates ranging in diameter from 0.1μm and 0.3μm.
Illite clays are commonly found in marine deposits located offshore or in deep water. However, there is some indication that illite minerals are created through diagenesis, a chemical or physical alteration to sedimentary deposits to rocks. Other ideas to the origin of illite mineral formation point to their creation evolving directly from the weathering and deposition process of these sediments.\textsuperscript{149}

\textsuperscript{149} Rice 2006, 49.
6. Open Area J

Figure 6.1 Courtyard Complex J, Cliff Palace (Nordby 2001)

6.1 General Architectural Description

Open Area J, (Figure 6.1) is located on the southeastern half of Cliff Palace at the social epicenter of Courtyard Complex J and directly above Kiva J (Appendix B). This courtyard space is created through the exterior sandstone masonry walls of the surrounding storage and residential units directly adjacent to Kiva J, measuring 61.9 m² in overall enclosed surface area.
Open Area J has been characterized as a plaza or courtyard and exhibits all of the character defining features of this type of architectural space including embellished surrounding walls, lack of utilitarian floor features and a large surface area. Access to this plaza space could be gained by residents of Courtyard Complex J directly from their living rooms.150 However, non-residents would have accessed the plaza from the roofs of residential units to the west and by ladder from Open Area 30.151 Like many spaces within Cliff Palace, this plaza was constructed in several building periods, the first between the years of 1260-1278 C.E. and the majority of construction to follow in the period between 1270-1278 C.E.152 Relative construction dates for each of the dominate

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150 Nordby 2001, 46.
151 Ibid.
152 Ibid 45.
facades of Open Area J have been deduced from remaining archaeological evidence and
dendrochronology providing vital information to enhance the understanding of this
architectural space.

The northern façade of Open Area J was originally formed by the southern
facades of Storage Rooms 28(1) and 99(2) constructed in 1272-1273 C.E. and Storage
Room 29(1) constructed in 1271-1272 C.E. This section of Open Area J may have
included a portion of the adjacent round tower, Rooms 36(1) and 126(2); however,
archaeologists have hesitated in assigning these rooms to any courtyard complex due to
their location. Although, a narrow walkway exists today connecting the round tower
to Open Area J, it is a modern construction and was not present in archival photos
from the area’s initial excavation.

Evidence of the exterior wall finishing schemes is still present on portions of this
façade that still stand. Remnants of a pink plaster finish applied from the base of Room
28 (1) on the ground floor to the beginning of Room 99(2) on the second floor are still
present. There is no evidence of plaster for Room 99(2) suggesting the room was never
plastered or that its plastered finish has been lost over the years.

The southern façade of Open Area J is made up of the northern exterior walls of
Rooms 21(1), 22(1), 23(1), 97(2) and 98(2). These rooms were all built during the same
relative construction period of 1275-1278 C.E. and range in function from living rooms
(Rooms 21(1)and 23(1)) to storage rooms (Rooms 97(2), and 22(1)) with Room 98(2)

153 Nordby 2001, 45.
154 Ibid 45.
155 Ibid.
156 Ibid 46.
identified as indeterminate in terms of function. Rooms are declared indeterminate if archaeologists are unable to define the social function of the space.

Unlike the northern façade of Open Area J, the southern façade exhibits much more evidence as to its original finish scheme. Although not without some partial loss, it is clear that a pink plastered finish covered the walls of the southern façade from the base of Rooms 21(1), 22(1) and 23(1) on the ground floor to the top of Rooms 97(2) and 98(2) on the second floor. This plastered finish stops right at the sockets of the lower story roof line of Rooms 22(1) and 23(1) visually illustrating the presence of a projecting balcony directly below the doorway of Room 98 (2). From this visual evidence archaeologists believe that while Room 98(2) had a balcony, Room 97(2) did not install one according to the remaining plaster pattern. Additional evidence of decorative embellishments including incised designs and succession of white, gray and pale yellow auras around the doorways of Rooms 21(1), 22(1) and 23(1) are still faintly visible. Because this section of Open Area J has suffered damage from water seepage and poor preservation over the years details of these elements is no longer present.

The eastern façade, also believed to be the earliest section of Open Area J, dates from 1260-1270 C.E. and is made up of the exterior facades of Rooms 25, 26, and 27. These rooms, thought to have been early granaries initially, show evidence of a conversion to living rooms after their initial construction in 1260 C.E. This hypothesis is based on the relatively small size of the rooms and the lack of hearths incorporated into their initial construction plan.

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158 Ibid 46.
159 Ibid.
160 Ibid 46.
In terms of decorative finishes still present on this façade, considerable evidence of the plastered scheme of these rooms still remains. As with the other facades previously discussed, the eastern wall of Open Area J was covered in a pink plaster from the base of Rooms 25, 26, and 27 to the top of the alcove wall. Traces of a darker red plaster along the base may represent the presence of a dado at one time. Similar to the southern façade, the doorways to Rooms 25, 26, and 27 all exhibit the presence of auras. The extant plaster finishes of the eastern façade will be discussed in more detail in Section 6.4.1.

The western side of Open Area J is predominately open; the exteriors of Rooms 18(1), 124(2) and Miscellaneous Structure 1 create a partial enclosure worth noting. Despite the fact that this section of Open Area J is almost entirely open, remnants of a decorative floor band or dado is still visible on the “back” of Miscellaneous Structure 1 illustrating the importance of architectural finishes in this space.\footnote{Nordby 2001, 46.}
Figure 6.3 Evolutionary Development Map of Open Area J (Created by author based on findings by Larry Nordby 2001)
6.2 Open Area J: Eastern Façade

The eastern façade of Open Area J (Figure 6.4), is made up of the exterior walls of Rooms 25, 26, and 27, exhibits some of the most extant earthen plaster finishes for Open Area J. This façade not only displays significant remains of its decorative scheme but it is also considered to be the oldest section of Courtyard Complex J and the most transitional in terms of social function. According to the relative dates provided through dendrochronology, this façade of Open Area J was constructed during the same approximate time frame as the Speaker Chief Complex located on the opposite end of Cliff Palace. In order to better understand the construction practices of the Ancestral Puebloans a detailed analysis of the decorative finishes of Rooms 25, 26, and 27 has been conducted and compared to those of Open Area 25 and 26 of the Speaker Chief.
Complex. This research provides insight into similarities and differences between the general construction process, and decorative plaster campaigns.

6.2.1 Room 25

Room 25 measures a total of 2.03m long on its north south axis, 1.44m in width from east to west, and 2.02m from floor to ceiling, totaling 2.92m² of total enclosed surface area.\textsuperscript{162} Inside Room 25 there is oxidation on the northwest and southwest corners indicating that at one point each of these corners incorporated a hearth. However, considering the size of this unit it is improbable that these two hearths would have existed at the same time. Remnants of the hearth in the southwest corner still remain and a coping most likely surrounded the hearth during its initial construction despite the fact that no permanent evidence of this feature remains. The presence of the hearth in the northwest corner is evident from the oxidation visible, although no physical construction evidence remains.\textsuperscript{163}

Archeologists believe Room 25 was constructed in two stages, the north wall was constructed in two different campaigns and represents one complete stage and the construction of the south and west walls make up the second stage.\textsuperscript{164} The first sector of the north wall exhibits unshaped sandstone masonry blocks with heavily extruded mortar joints embellished with chinking. Although some of the smooth extruded plaster finish that is present on the upper portion of this wall has been attributed to Fewkes’ repair work in 1911, the rest of the wall construction is original.\textsuperscript{165}

\begin{flushright}
\textsuperscript{162} Nordby 2001, 30.
\textsuperscript{163} Ibid 31.
\textsuperscript{164} Ibid 30.
\textsuperscript{165} Nordby 2001, 30.
\end{flushright}
The construction of the south and west walls were conducted at the same time as a single unit. The masonry used to create these walls contains large and unshaped sandstone laid on top of stone slabs.\textsuperscript{166} The mortar used in between the joints is considerable with excess mortar extruded past the joint. Similar to the construction of the north wall, the south and west walls were embellished with chinking stones between the mortar joints. According to the pattern of the stones and the chinking style used in

\textsuperscript{166} Ibid.
the west and south walls, archaeologists today believe these walls were constructed by two masons rather than one.\textsuperscript{167}

The floor of Room 25 has been altered considerably since its initial construction. During the 1995 documentation process broken areas of the plastered floor revealed loose sediment below the original floor. However, the original utilitarian configuration of the floor including hearths and any other household utility installation had been removed long before the documentation process in 1995 and is difficult to deduce outside of the locations of the two corner hearths which can be located from oxidation still visible.\textsuperscript{168}

\textbf{6.2.2 Room 26}

Room 26 measures 1.58m in length from north to south, 1.41m in width from east to west and 1.72m from floor to ceiling totally a total livable surface area of 2.23m\textsuperscript{2}. This room is located north of Room 25 and south of Room 27.\textsuperscript{169} Although, no subfeatures remain in the floor of Room 26 there is evidence of a hearth in the southwest corner from a remaining oxidation plume present just above the floor. However this hearth has long since been buried. Most of the interior north and south walls no longer stand with the exception of Fewkes’ repair work from 1911.

Room 26 was constructed by adding walls to the southwest exterior corner of Room 27; however the joining pattern of these two rooms is not well articulated and is easier identified in plan. Similar to Room 25, excess amounts of mortar are present between the joints, of the masonry walls. Although, chinking is used between the joints

\textsuperscript{167} Nordby 2001, 30.
\textsuperscript{168} Ibid.
\textsuperscript{169} Ibid 31.
it is much more limited than that seen in Room 25. The interior walls of Room 26 were never plastered, exposing the original masonry work that remains. The condition of the sandstone units used to construct the walls of Room 25 appear to have been reused from other areas or previously built structures due to their condition and irregular sooting patterns.\textsuperscript{170}

Figure 6.6 Plan View of Room 26 (Nordby 2001).

The floor of Room 26 is not original and was most likely filled in during Fewkes’ 1911 restoration work. Although, no extant utilitarian floor elements are currently

\textsuperscript{170} Nordby 2001, 31.
visible, soot staining in the southwest corner suggests a hearth that has since been buried in this section of the room. Despite the modest size of this room the presence of a hearth at one time in the southwest corner suggests Room 26 once functioned as a living room.  

6.2.3 Room 27

Room 27 measures 2.70m in length from north to south, 1.70m in width from east to west, and 2.14m from floor to ceiling totally 4.49m² of roofed space. This room appears much as it did following the repair work undertaken by Fewkes in 1911. The room is quadrilateral in shape, with fully constructed walls on the north, south, and west sides with a partially constructed masonry wall located against the back of the alcove. This low rising wall approximately 25-30cm in height is thought to be an important insight to the construction and function of Room 27 illustrating that it may represent an attempt to prevent moisture from entering into the room. This may be indicative of Room 27’s original function as a granary storage room or it could have been utilized as a shelf or architectural bench for its inhabitants.

Similar to Rooms 25, and 26, Room 27 shows signs of a hearth no longer present. In the northwest corner of this unit clear oxidation remains on the interior walls of Room 27 indicating the possible presence of a hearth.

172 Ibid 32.
173 Ibid.
The exterior walls of Room 27 were originally plastered with extant plaster and washes remaining on the surface of the structure. Fractures in the plastered surface finish at the base of Room 27 reveal that the foundation of the west wall is composed in part of upright slabs on top of the bedrock floor. According to the onsite inspection in 1995 it appears the walls of Room 27 were laid out and constructed all at once.\textsuperscript{174}

\textsuperscript{174} Nordby 2001, 32.
6.2.4 Construction Chronology

The eastern façade of Open Area J was studied as part of the overall conditions survey of Cliff Palace by archeologists in 1995. This examination revealed that the northwest corner of Room 25 had a lower bond keyed into Room 26 indicating that Rooms 25, 26, and 27 were laid out at the same construction time and built as a single unit. However, since each unit displays distinct construction stylistic elements and exterior finishes, it is hypothesized that each of the three rooms were finished independently. According to the archeological examination it appears Room 27 was constructed first followed by Room 26 with Room 25 being constructed last. The remaining finishes on Rooms 26 and 27 indicate that these two rooms were completely enclosed prior to the completion of Room 25.

6.3 Previous Work On-site

Prior to on-site investigation of Rooms 25, 26, and 27 all previous stabilization, repair and conservation work for each of the three rooms was recorded and documented as not to confuse alterations to the rooms with original construction or finishing work.

175 Nordby 2001, 32.
176 Ibid.
6.3.1 Room 25

Room 25 was originally labeled as Room 79 by Nordenskiold in 1885; however this designation was changed to Room 25 by Fewkes in 1911 during his excavation of the site.

Although Fewkes provided a very limited description of Room 25, what is known from his account is that the exterior wall of Room 25 was still plastered and the partition wall between Room 25 and 26 had been partially destroyed. Despite some limited areas of loss, the masonry and earthen plaster finishes still remaining on the exterior of Room 25 are original. The only repair undertaken by Fewkes on Room 25 was limited to patching a hole below the doorway to the unit and capping the north partition wall. Both repairs were documented and can be easily identified by remaining archival photographs.\(^{177}\)

Since Fewkes’ repair work in 1911, little conservation work was conducted until 1999 when the Architectural Conservation Laboratory at the University of Pennsylvania documented and conserved remaining plaster finishes following the damage incurred by water seepage into the site in 1995. Although Room 25 was virtually unaffected from water damage as a result of seepage, some conservation work was conducted on its eastern façade. This conservation work included the reattachment of plaster finishes with injection grouting and the consolidation of friable washes and plasters.\(^{178}\)

\(^{177}\) Nordby 2001, 30.
\(^{178}\) Ibid.
6.3.2 Room 26

Room 26 like Room 25 was originally labeled differently by Nordenskiöld as Room 78 prior to 1911 when Fewkes re-designated the room to the number it is known as today, Room 26.\textsuperscript{179} However, during Fewkes’ repair and stabilization effort in 1911, no further description of the condition of Room 26 was recorded outside of the information provided about the interior walls connecting it to Room 25 and its general exterior pink plaster scheme. Unfortunately no further description of decorative architectural finish embellishment was recorded by Fewkes.

The physical repair conducted by Fewkes on Room 26 consisted of the same program given to Room 25. The top of the north and south partition walls were capped and a small hole on the exterior façade was filled and repaired. One further repair was conducted by Fewkes to Room 26 which consisted of a small repair next to the southern side of the doorway to Room 26. Similar to Room 25, Room 26 has seen little additional repair or conservation work since Fewkes’ repair work in 1911. However, after the water damage incurred following seepage problems during 1995, Room 26 underwent the same conservation program as Room 25 conducted by the Architectural Conservation Laboratory at the University of Pennsylvania in 1999.

6.3.3 Room 27

Room 27 like Rooms 25 and 26 was originally designated by Nordenskiöld using a different numbering system and classified as Room 77.\textsuperscript{180} In 1911 this room along with Rooms 25 and 26 was excavated by Fewkes with limited repair conducted to the

\textsuperscript{179} Ibid 31.
\textsuperscript{180} Nordby 2001, 32.
original masonry. Of the repair work undertaken by Fewkes in 1911, two small repair patches are visible on the exterior face of Room 27. Although Fewkes noted that his stabilization team capped the southern wall that had largely fallen, the masonry units that remain appear to be original and not replacement stone.\textsuperscript{181}

In the summer of 2000, the Architectural Conservation Laboratory at the University of Pennsylvania documented and recorded all existing deterioration conditions and remaining surface finishes for the eastern façade of Open Area J, as part of the C.A.S.P.A.R. project. This façade was selected as a top priority for conservation and recording based on the extant surface finishes present, archeological significance and severity of condition.\textsuperscript{182} In 1995 Room 27 of the eastern façade of Open Area J incurred significant damage to its existing surface finishes as a result of water seepage; however Rooms 25 and 26 were not significantly impacted by this event. The conservation plan developed for this façade was to document all remaining surface finishes and treat those finishes in severe condition.

6.4 Onsite Investigation

6.4.1 Extant Surface Finishes

The entire exterior of the eastern façade of Open Area J appears to have been finished with salmon pink plaster in varying thicknesses over the sandstone masonry walls. In areas where the sandstone masonry units used are smaller in size or uneven there is evidence of a thicker plaster layer being applied to level the wall surface.

\textsuperscript{181} Ibid.

Although, the general base plaster for Rooms 25, 26, and 27 appears to be relatively the same pink tone, distinct decorative details are visible on each building façade.

6.4.1.1 Room 25

Room 25 has been repaired at the base of its exterior wall in two different campaigns, one by Fewkes and one by Landcaster as well as one localized patch by Fewkes on the upper north side of the doorway. Despite these localized repair areas, the rest of the masonry and earthen finishes that remain are original and have been recorded onsite.

The majority of the original red plaster on the upper north wall of Room 25 survives almost in its entirety due to the shelter provided by the alcove wall. A clear gray aura surrounds the doorway to this room; however due to a limited amount of fragmented plaster in the area, visual onsite analysis of previous layers was difficult. As a result further analysis using optical microscopy was used to confirm any previous plaster or wash campaigns. At the base of Room 25 fragments of a white wash remain which could be evidence of a dado.

6.4.1.2 Room 26

Similar to Room 25, Room 26 exhibits the presence of an early Fewkes repair at the base of the building; however the remaining masonry and earthen finishing campaigns still visible on the exterior of Room 26 appear to be original and have been examined in the same manner as Room 25. The two main areas of examination for Room 26 are of the base of the building and the doorway.
The area at the base of Room 26 that had not been repaired exhibited fragments of gray wash present on the top most layer indicating the possible presence of a dado. However due to the Fewkes’ repair, the area examined for traces of a dado is located higher than Room 25 and may include traces of aura campaigns as well. In the area examined for the evidence of a dado a number of finishing campaigns were recorded from visible layers in fractured plaster areas. These layers were documented in the following order: layer 1: pale red plaster (2.5YR 6/4), layer 2: pink wash (2.5YR 6/4), layer 3: cream wash (2.5YR 8/2) layer 4: pink wash (2.5 6/4), layer 5: cream wash (2.5YR 8/2) and layer 6: bright red wash (2.5YR 6/8).

The second area examined on the façade of Room 26 included the upper half of the doorway in order to investigate the aura wash chronology. This investigation proved an interesting comparison to the layers found at the base of the doorway. The upper area of Room 26’s doorway provided evidence of five different finishing schemes in the following order: layer 1: light red plaster (7.5YR 6/4), layer 2: soot layer (7.5YR 4/1), layer 3: buff tan wash (7.5YR 6/4), layer 4: soot layer (7.5YR 4/1) and layer 5: white wash (2.5Y 7/1).

Other additional features of Room 26 include an increased amount of plaster on the upper portion of the room used to level out the wall thickness and yellowish pink mortar.

**6.4.1.3 Room 27**

Although, there is a visible repair to the masonry wall directly below the doorway, the rest of the exterior of Room 27 appears to be original. During the onsite analysis of the extant surface finishes of Room 27 seven different plaster colors were
recorded, four different red hues, two different white hues and one yellow hue. These plasters were recorded in layer orientation in relation to the masonry substrate in specific locations on the exterior façade of Room 27 in chronological order.

The base of Room 27 was the first location analyzed in this onsite analysis. At the base of Room 27 traces of white plaster were visible terminating approximately 1 meter above the floor. This white finish could be the remnants of a white dado which continued from Room 27 to Room 23, however this finishing scheme is not present on the facades of Rooms 21 or 22. The first layer of red plaster visible on the exterior of Room 27 in this location continues behind the wall of Room 23 indicating that this plaster campaign was applied prior to the construction of Room 23. Although three other plaster schemes in red and white are present on the exterior of Room 27, they do not continue behind the wall of Room 23 and were most likely applied after Room 23’s construction. To sum up the visual examination of the base of Room 27, five clear plastering campaigns were observed and recorded as follows: layer 1: red (2.5YR 6/4), layer 2: red (2.5YR 6/4), layer 3: white (2.5Y 8/2), layer 4: red (2.5YR 6/4), layer 5: white (2.5Y 8/2).

The doorway to Room 27 shows traces of a yellow wash around the masonry opening most likely the remnants of a yellow aura. Directly above the yellow aura fragments of a yellow wash outside the aura area indicate the possible application of handprints applied in a yellow wash. On top of the yellow wash surrounding the door, fragments of a red wash are visible perhaps indicating a later application of a red aura following the initial yellow aura application. In this localized investigation three key
layers of earthen finishes were recorded in the following order: layer 1: red plaster (7.5YR 8/4), layer 2: yellow wash (10YR 8/3), and layer 3: red wash (2.5YR 6/4).

Other decorative embellishments noted on the façade of Room 27 include the presence of a gray wash on the upper right side of Room 27 that continued from the façade of Room 23. Also in areas where plaster no longer covered the exterior walls of Room 27 the mortar was characterized as gray to tan in color throughout the masonry construction.

6.4.2 Sampling

In 1999 as part of the C.A.S.P.A.R. project, 14 representative samples consisting of original mortars and plasters were taken from the eastern façade of Open Area J by Rynia Fourie and Frank Matero. Each sample was carefully selected based on its location and potential to provide further insight into the decorative program for the eastern façade of Open Area J. These samples were removed by hand and placed in labeled plastic sample bags with their location recorded on a rectified photograph using a permanent marker. Since their initial collection in 1999 these samples have been stored at the Architectural Conservation Laboratory at the University of Pennsylvania.

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183 Matero, Cancino, and Fourie 2002, 11.
7. Speaker Chief Complex

Figure 7.1 Speaker Chief Complex, looking north, (August 2008).

7.1 Architectural Description

Speaker Chief Complex formerly referred to as Speaker Chief Complex is located in the northern half of Cliff Palace directly adjacent to Kiva Q. It is one of the most visually dominating architectural units within Cliff Palace perched upon a boulder and facing west towards Cliff Canyon. This unique three story building complex is composed of Rooms 70(1), 71(1), 72(1), 73(1), and 74(1) on the first story, Rooms 133(2), and 134(2), on the second, and 115(3) and 135(3) on the third story. In addition
to this three story building group, Speaker Chief Complex also has immediate access to
two open areas located directly south of Rooms 71(1) and Room 72(1): Open Area 26,
a very small platform open space and Open Area 25, a larger courtyard area complete
with a hearth in the northeast corner.184

Figure 7.2 Speaker Chief Complex located within Cliff Palace Site Plan (R.G. Milo 1990)

Examination in plan reveals that Rooms 71(1), 72(1), 73(1) and 74(1) are laid
out in a four room quadrilateral plan creating a square with Open Area 45(2) located
above Room 71(1), Rooms 133(2) and 115(3) located above Room 72(1), Open Area
45(2) located above Room 73(1) and Rooms 134(2) and 135(3) located above Room

Preliminary study of the interiors of these rooms reveals that Rooms 71(1) and 74(1) were most likely used as living quarters since each room has a hearth (Appendix B). In Room 71(1) the hearth is located in the southwest corner and in Room 74(1) the hearth is located in the northeast corner. Additional details present in Room 71(1) include an original plastered floor and the presence of a wall niche located directly above the hearth in the northwest corner.\textsuperscript{186}

Although, the social function for rooms 71(1) and 74(1) is fairly clear, the social function of Rooms 72(1) and 73(1) is uncertain. Neither Rooms 72(1) nor 73(1) maintains a hearth or shows evidence of one, indicating these rooms were most likely not used as living quarters. However both rooms exhibit architectural embellishments on their interiors, Room 72(1) has a wall niche located on its north wall and Room 73(1) has wall niches located on its north, south and east walls. The presence of wall niches in each room may indicate that these rooms could have been used for small social gatherings or ceremonial preparation purposes.

Since there is little physical evidence remaining for the units on the second and third floors, their social function has been difficult to determine. The second stories of Rooms 71(1) and 73(1) do not show remains of a roof, roof supports or partition walls and may indicate that these spaces were connected and never roofed. As a result archaeologists have categorized the space above Rooms 71(1) and 73(1) as Open Area 45(2).\textsuperscript{187} This area appears to have been accessible from a doorway on the southwest wall of the second floor. However, it should be noted that the partial exterior wall that remains on the southwest side of Open Area 45(2) was largely rebuilt by Fewkes in

\textsuperscript{185} Nordby 2001.
\textsuperscript{186} Ibid.
\textsuperscript{187} Ibid.
Therefore the location and shape of this opening cannot be determined for certain. Room 133(2) located above Room 72(1) still maintains evidence of a ‘T’ shaped doorway on its southwest wall; however the social function of this room cannot be determined from remaining archeological evidence for Rooms 134(2) and 135(3) above Room 74(1) and Room 115(3).  

Room 70 (1), located southeast of Room 71(1) appears to have been built after Room 71(1) and shares its northwest sandstone masonry corner with Room 71(1). This room does not have a hearth and is believed to have been used for food preparation purposes. This hypothesis is based on the two mealing bins still present in the northeast corner. These bins were used for grinding.

Considering the architectural configuration of Speaker Chief Complex and its juxtaposition with Kiva Q, it has been suggested that this complex may have been built for civic functions. Not only does Speaker Chief Complex create a dominate image within Cliff Palace, but it is also not directly connected to a kiva in terms of physical accessibility, a unique characteristic for this complex not shared by other architectural complexes within the site. Furthermore if Speaker Chief Complex is affiliated with Kiva Q it may provide added evidence for its function as an example of civic architecture. Kiva Q exhibits a unique final plaster scheme, consisting of bichrome walls: a light tan and pink applied to each half of the kiva that come together in the center of a square niche. This scheme is believed to represent dual social organization. Based on this hypothesis Kiva Q may have held special ceremonies that brought the community of

188 Nordby 2001.
189 Ibid.
Cliff Palace together as a whole. Therefore, if Speaker Chief Complex is directly associated with this kiva it too may have served a civic social function.190

7.2 Construction Chronology

Although archaeologists have been unable to date Speaker Chief Complex using tree ring dating, an approximate construction date prior to 1264 C.E. has been assigned by analyzing its surrounding structures.191 Through careful analysis of the masonry construction techniques of Speaker Chief Complex archaeologists believe this is one of the earliest building complexes and was most likely already in place prior to the construction of Room 80(1). Although wood samples from Speaker Chief House all dated to the modern era, archeologists were able to get a tree ring date of 1264C.E. from Room 80(1). If Speaker Chief Complex was in place prior to Room 80(1) it had to have been built prior to 1264C.E.192

While a general approximate date has been assigned to the complex, the individual building evolution of each room that makes up the complex is unclear. Examining Speaker Chief Complex in plan it appears Room 70(1) was built after Room 71(1). Although further building evolution for the complex cannot be deduced without further archeological research including plaster studies.

190 Ibid 109.
Figure 7.3 Hypothetical Construction Development for Speaker Chief Complex.
7.3 Open Area 26: Northern Façade

Figure 7.4 Plan View of Speaker Chief Complex with the Northern Façade of Open Area 26 in Red (Nordby 2001).

Open Area 26 is located directly south of the entrances of Rooms 71(1) and 72(1). The northern façade of this open area is the most dominate of the three, and is composed of the southern facades of Rooms 71(1), 72(1), Open Area 45(2), Rooms 133(2) and 115(3). Although this open area is modest in size, it incorporates the most striking extant exterior surface finishes within the Speaker Chief Complex.

In order to complement the analysis of the surface finishes from the northern façade of Open Area 26, samples from the northern façade of Open Area 25 will also be
included. Open Area 25 is located directly south of Open Area 26 and consists of a small partition wall and the southern façade of Room 70(1). Although Open Area 25 plays a minor role in the overall study of the northern façade of Open Area 26, its proximity to Open Area 26 makes its inclusion important.

Further analysis of these existing earthen plasters and washes provide a valuable comparison to those analyzed from the eastern façade of Open Area J. Each site is thought to have served similar social functions and is believed to have been part of the earliest surviving buildings within Cliff Palace.

7.4 Previous Work On-Site

In 1911 Jesse Walter Fewkes conducted the first stabilization and repair work on the northern façade of Open Area 26, during this project Fewkes’ stabilization team conducted relatively little reconstructive work on northern façade of Open Area 26, with the exception of stabilizing the elevated platforms of Open Area 26 which had been partially destroyed over the years. Fewkes also repaired the top portion of the south facing wall of Room 70 (1). This work was recorded through documentary photographs taken before and after repair.193

Following Fewkes’ work in 1911, the northern façade of Open Area 25 underwent stabilization and repair in 1934. This project was supervised of Earl H. Morris and James “Al” Landcaster and involved stabilizing the base of the Room 71(1).

193 Fewkes 1999, Plate 15).
Small patch repairs were also undertaken in localized areas on the southern façade of Room 70(1).\textsuperscript{194}

\textbf{Figure 7.5} Repairing Crack at the base of Speaker Chief Tower (Markley 1934).

Since the 1930's relatively little conservation or repair work has been conducted to either Open Area 25 or 26 until 2000 when the Architectural Conservation Laboratory at the University of Pennsylvania documented and treated the deteriorating earthen finishes in both areas. This treatment program was lead under the supervision of Frank Matero and involved consolidation and grouting treatments of detached and friable original finishes.\textsuperscript{195}

\textsuperscript{194} Nordby 2001, 4.
\textsuperscript{195} Matero 2002, 64.
7.5 On Site Investigation

7.5.1 Extant Surface Finishes

The northern façade of Open Area 26 exhibits evidence of a salmon pink plaster that once covered the majority of the first floor including Rooms 71(1) and 72(1). At the base of Rooms 71(1) and 72(1), fragments of a white plaster or wash still exist and rise approximately 1 meter before the finish disappears. This white finish may indicate that the southern exterior of Rooms 71(1) and 72(1) may have once had a white dado as part of their decorative program. In addition to the possible presence of a white dado, Room 71(1) exhibits a unique white finish that runs horizontally across its two southern facing windows directly above the room’s entrance. Also fragments of a light pink and gray wash are present around the entrance to Room 71(1) which may indicate the presence of two different aura campaigns: one applied in a pink wash and another applied in a gray wash.

Similar to Room 71(1), Room 72(1) also exhibits fragments of a yellow wash around its entrance indicating that it too may have had an aura around its entrance. Interestingly the western-most side of the southern façade of Room 72(1) appears it may not have been finished. This area is located approximately 1.5m west of the entrance to Room 72(1) and continues west to the end of the building. Also, approximately 1 meter directly below the wooden sockets of Room 72(1) no plaster remains except for fragments located on the west-most portion of Room 72(1). This may also indicate this 1meter strip of exposed masonry may not have been originally plastered. The masonry in this section is very finely laid and is some of the most exceptional seen in the entire site of Cliff Place.
Room 133(2) located directly above Room 72(1) appears to have been covered with a light pink salmon colored plaster (5YR 8/4) similar to the base plaster applied to Rooms 71(1) and 72(1). From initial on site investigation Room 72(1) does not appear to have an aura around its entrance although further investigation would be required to confirm this.

Similar to Room 133(2), Open Area 45(2) also appears to have been covered in a salmon pink plaster (5YR 8/4) originally. However since a large portion of the exterior of Open Area 45(2) was rebuilt by Fewkes in 1911 it is difficult to tell if the exterior room of Open Area 45(2) may have had a more complex scheme.

Directly south of Open Area 26, Open Area 25 appears to exhibit the same salmon pink plaster (5YR 8/4) that most likely covered the majority of the southern exterior of this space. However one notable embellishment visible on the exterior of Room 70(1) is the presence of fragments of a gray wash or plaster near the entrance to Open Area 26 indicating the possible presence of an aura.

### 7.2.5.2 Sampling

In 1999 as part of the C.A.S.P.A.R. project, 15 representative samples from the northern façade of Open Area 26, and 3 representative samples from the northern façade of Open Area 25, were taken by Rynta Fourie and Frank Matero. These samples consisted of original mortars and plasters, each selected based on location and potential to provide further insight into the schemes for these two areas.

The conservation team removed plaster and mortar samples by hand and placed there in labeled plastic sample bags. During this collection process each sample location was recorded both on the plastic sample bags and on a rectified photograph using a
permanent marker to serve as a location key. Since their initial collection in 1999 these samples have been stored at the Architectural Conservation Laboratory at the University of Pennsylvania.
8. Analytical Testing Methodology

Each analytical method included in this chapter is examined in terms of how it can enrich the study of the architectural surface finishes found at Mesa Verde in terms of raw materials, application technique, and the overall finishing schemes applied. In this chapter previous analytical methods proven useful in the study of earthen architectural finishes will be discussed and evaluated for comparison. This examination will cover the following instrumental techniques: optical light microscopy, scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS), and X-ray diffraction (XRD).

Visual analysis using optical light microscopy plays a major role in understanding the individual and overall accumulation of the individual finishes and finishing schemes for each area. Using this technique, the color, stratigraphy, and texture of each sample was noted and recorded on stratigraphic data sheets (Appendix C). From this information the treatment of individual elements and overall schemes was reconstructed for each area over time and is discussed in detail in Chapter 10.

To complement thick cross sectional analysis, thin section examination of representative samples from each space was conducted to provide a complete understanding of the texture of each finish. During this investigation each sample was characterized in terms of their microstructure.

Compositional pigment analysis and identification was conducted through the examination of pigment particle dispersions created from representative samples and compared against the McCrone library of known pigments at the Architectural
Conservation Lab at the University of Pennsylvania. The findings from these observations were then compared to elemental analysis results of similar samples from each site using SEM-EDS and XRD.

Throughout this comparative examination, like colored plasters and washes found at both sites were separated into similar color hues and compared against one another in terms of their micromorphology and compositional make up.

The culmination of this data allowed both for a comparative compositional study of the earthen finishes found at both sites as well as provided the information necessary to produce interpretive conjectural finishing schemes for each space illustrating their transformation over time (See Chapter 10).

### 8.1 Optical Light Microscopy

Optical light microscopy provides the opportunity to examine the physical and optical characteristics of each finish sample. This analysis includes the sequence of layers, layer thickness, color, surface texture, particle size and shape as well as crystalline structure. Through this examination the components of earthen finish matrices can be identified, as well as the sequence of decorative finishing schemes.
8.1.1 Bulk Sample Analysis

Each sample from Open Area J and the Speaker Chief Complex were examined in bulk form using the Leica MZ stereo-binocular microscope. During examination samples were studied from a variety of angles allowing layers to be examined in relation to one another prior to examination in cross section. During this process each distinct plaster and wash layer was classified in terms of color using the Munsell Soil Color Classification System under simulated daylight.

This classification system has become standard practice since the 1960’s providing conservation professionals with an objective color classification system and as such was chosen as a base for the color classification portion of this project.\textsuperscript{196} Furthermore, the Munsell soil classification system was selected based on the shared palette of colors found in natural soils and earthen plasters.

This color classification system is organized on three basic levels: hue, value and chroma. Hue refers to the location of a color on the broad color spectrum and is signified by a combination of letters that each identify a specific color hue family.\textsuperscript{197} In the Munsell soil classification system the following letters are used to describe the three most common hues found in soils: R red, Y yellow, and YR yellow-red. Two additional charts with the heading, Gley were added later for soils ranging in hue from blue, bluish green, green, greenish yellow or purplish blue and are typically, but not always used to describe wetland soils.\textsuperscript{198}

\textsuperscript{197} Ibid.
\textsuperscript{198} Ibid.
The hues within the Munsell soil classification system are further separated into eight categories organized by prefixes ranging between 0 and 10 including: Gley 1, Gley 2, 10 R, 2.5 R, 5 YR, 7.5 YR, 10 YR, 2.5 Y, and 5R. In this organizational system prefix numbers closer to the red end of the spectrum fan out with 0 being closest to the red end of the spectrum and 10 being closest to the purple end of the color spectrum.

Value, makes up the second element included within the Munsell classification system and is defined as the intensity of a color. Lower numbers represent darker colors and higher numbers represent lighter colors within the spectrum. Value is represented by numbers with 0 representing black and 10 representing white.\(^{199}\)

The last component of this system is chroma, defined as the clarity or saturation of a color with 0 representing neutral grays and 10 representing higher saturated colors.\(^{200}\) The complete Munsell classification of a specific color is given in the following order, hue, value, and chroma, so a Munsell listing could look like the following 2.5YR 6/7. In this example 2.5YR represents the hue, 6 represents the value and 7 represents chroma.\(^{201}\)

Color matching was conducted on each representative sample taken from the eastern façade of Open Area J and the northern façade of Open Area 26 and recorded on stratigraphic data sheets created for each sample (Appendix C).

### 8.1.2 Thick Cross Section Analysis

Representative samples from the eastern façade of Open Area J and the northern facades of Open Areas 25 and 26 were embedded in Bioplastic™, a

\(^{199}\) Orton, Tyers and Vince 1999, 136.  
\(^{200}\) Ibid.  
\(^{201}\) Ibid, 137.
proprietary polyester and methacrylate resin polymerized with a methyl ethyl keytone peroxide catalyst.\textsuperscript{202} Once embedded, each sample was cut into sections using a micro-diamond blade fitted for the Buehler Isomet\textsuperscript{TM} on low speed. After being cut, each sample was lightly polished using Buehler polishing felt with stoddard solvent and mounted on a glass slide using Cargille Meltmount\textsuperscript{TM}.

After all of the cross section slides had been prepared, each sample underwent preliminary examination using the Leica MZ 16 stereo-binocular microscope with reflected light. During this process general stratigraphic characteristics were noted, including: the number of layers, thickness of layers, color, and texture. Orientation photomicrographs were taken of each cross section using a Nikon DS-F11 camera in conjunction with NIS Elements BR software and recorded on stratigraphic data sheets (Appendix C).

Following preliminary examination, a more in depth study of each sample's stratigraphy was carried out using the Nikon Optiphot 2-POL compound microscope in reflected light. The same stratigraphic characteristics examined during preliminary examination using the stereomicroscope were studied but at higher magnification. Each finish was then characterized as a plaster or wash using the measurement tool included in the NIS Elements BR software. Since finish layers often vary in thickness, ten points were selected across each layer, measured, and the mode of each layer thickness was recorded for its overall thickness measurement. Any finish layer measuring more than 1mm was classified as a plaster and any finish layer measuring less than 1mm was classified as a wash as per previous studies. These stratigraphic characteristics were

then recorded on the stratigraphic data sheets along with photomicrographs of each sample (Appendix C).

During visual examination it was observed that plaster layers tended to contain more inclusions and large quartz grains, whereas washes tended to contain few coarse grains and were much higher in fine particle content. Although, most of the finishes examined from the eastern façade of Open Area J and the northern facades of Open Areas 25 and 26 were classified as washes according to the 1mm definition, it should be noted that washes close to 1mm in thickness exhibited similar characteristics to those typical of plasters rather than washes.

The texture horizon of each finish layer tended to be relatively well defined with some finish layer horizons intermixed with previous layers. In cases where layer horizons appeared indistinct, it is most likely an indication of wet on wet application of the surface finish or soot deposits mixing with subsequent finish applications. In comparing the general texture of the samples taken from the eastern façade of Open Area J and the northern facades of Open Areas 25 and 26, samples from Open Area J appeared to be rougher in texture with less distinct layer horizons than those from Open Areas 25 and 26. Interestingly the samples taken from Open Area 26 were noticeably smoother in texture with very distinct finish layers.

The overall sequence of layers recorded for each sample from Open Area J and Open Areas 25 and 26 provided the information necessary to produce conjectural design schemes for each space over time, discussed in the Chapter 10.
8.2 Polarized Light Microscopy

Polarized light microscopy is used in compositional analysis in order to identify both organic and inorganic elements in surface finishes based on the elements, optical and physical properties. PLM uses polarized light in order to reveal properties of a sample that would not normally be seen in plain light microscopy.

8.2.1 Pigment Dispersions

Pigment dispersions were made from white and red washes found on the eastern façade of Open Area J and the northern façade of Open Area 26 in the Speaker Chief Complex. A representative sample of each color was selected from both sites for comparative analysis as illustrated in the chart below.

<table>
<thead>
<tr>
<th>Color</th>
<th>Open Area J</th>
<th>Speaker Chief Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>C08</td>
<td>A04</td>
</tr>
<tr>
<td>Red</td>
<td>C11 C07</td>
<td>A04</td>
</tr>
</tbody>
</table>

Figure 8.1 Pigment Dispersion Samples

In order make each dispersion, pigment particles were carefully sampled from the representative finish layer on the bulk sample using a tungsten needle. The gathered particles were then gently placed on a glass slide, dispersed in Cargille Meltmount™ and covered with a circular cover slip. Once all of the pigment dispersions had been prepared the color, morphology, birefringence, and refractive indices of each sample were recorded. Pigment dispersions were then compared within each color category between each site and against known pigments in the McCrone pigment dispersion.

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204 Ibid.
reference library at the Architectural Conservation Laboratory at the University of Pennsylvania.

Samples C08 and A04 were compared to commonly found inorganic white earths and minerals found in the region including calcite (CaCO₃), and gypsum (CaSO₄·2H₂O). Calcite is a mineral found in chalk, limestone and marble. Calcite particles are rombahedral in shape displaying strong biofriengence at a refractive index of 1.66. Gypsum is a naturally occurring calcium sulfate mineral that is tabular rombahedrals in shape, birefringent and has refractive indices greater than 1.66.

Both unknown white pigments sampled from Open Area J and Open Area 26 appeared identical during polarized microscopic investigation. The individual pigment particles of both samples were rhombahedral in shape, displaying distinct birefringence. In order to determine the refractive index for each sample the Becky line test was used. However, rather than displaying a distinct halo during testing the pigment particles of both samples became slightly more illuminated, indicating a refractive index close to or identical to the mounting medium at 1.66. When compared to the known pigments both samples C08 and 04 most resembled whiting in terms of particle shape, birefringence and refractive index.

The unknown red pigment particles taken from samples C07, C11, A04, were compared to common inorganic pigments found in the Mesa Verde region, including: red ochre (FeO₃), red lead (2PbO·PbO₂ or Pb₃O₄), and hematite(α-Fe₂O₃). Red ocher is a

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207 Ibid, 1407.
208 Ibid.
naturally occurring red pigment which attains its red color through the inclusion of iron oxide hematite and is often found in deposits of ilmonite, rutile, feldspars, magnetite and calcite. Pigment particles of red ocher are anhedral in shape, anisotropic with refractive indices greater than 1.66. Red lead also known as lead oxide or minium is a synthetic analogue of the mineral minium. Red lead pigment particles are anomalous in shape, anisotropic and have refractive indices greater than 1.66. Hematite is the naturally occurring form of iron oxide and occurs often in oxidized regions of iron. Pigment particles of hematite are usually conchoidal in shape, anisotropic with refractive indices greater than 1.66.

All three unknown red pigments examined appeared to most closely resemble red ochre. The shape of the particles for each sample were extremely small and relatively round very similar to the known pigment dispersion for red ochre in the McCrone reference library. Following particle shape categorization the Becky line test was conducted and the particles were noted as having a refractive index higher than 1.66. Similar to the known sample for red ochre each unknown sample also displayed birefringence during cross polarized light examination.

8.2.2 Thin Section Analysis

Petrographic thin sections were made for samples C01, C06, C08, A04, and B01 by Leonard Cannone at American Petrographics, Inc. Each of the above samples was selected for petrography based on their stratigraphy, location within each site and

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210 Ibid, 229.
211 Ibid, 183.
color. All of the samples selected for thin section were impregnated with a clear epoxy resin, cut and polished using oil to 30-40 microns thick.

Each sample was viewed in transmitted plain- and cross-polarized light using the Nikon Optiphot 2-POL compound microscope. During examination gain color, shape, distribution, and mineralogy were noted for each sample.

In general both samples from Open Area J and Open Areas 25 and 26 had grains that ranged from sub-angular to sub-rounded in shape with a low percentage of pores visible in the topmost wash and plaster layers. In terms of color samples from both sites tended to contain grains that were white or translucent in color which exhibited strong birefringence in cross polarized light. These grains most resembled calcite and quartz when compared to known minerals in A Color Atlas of Rocks and Minerals in Thin Section. In addition to the translucent and white grains visible in all the samples examined, samples C01, C06 and C08 also contained dark sub-angular to sub-rounded particles in the gray wash layers. These darker particles visibly intermixed with the lighter white and translucent particles could possibly be charcoal or burnt organic material that when mixed create a gray pigment.

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Sample C01 from the eastern façade of Open Area J (Figure 8.2) is a thin gray wash taken from the upper right corner of Room 25. The grains within the gray wash are very fine in texture with few quartz grain inclusions and predominately made up of fine clay/silt particles. The plaster substate of sample C01 contains large sub-angular to sub-rounded particles of quartz grains within a fine clay/silt matrix.
Sample C06 (Figure 8.3), is a gray aura taken from the upper left corner of the entrance to Room 26 from the eastern façade of Open Area J. This sample exhibits a much higher percentage of large quartz grains to silt and clay in its top most wash layer. Similar to sample C01 the grains range in size and shape from sub-angular to sub-rounded and are predominately white or transparent in color with interspersed fine grained brown and black particles.
Sample C08 Figure 8.4) is a gray aura with a thin white wash applied later, taken from just below the opening into Room 27. In general the shape of the grains range from sub-angular to sub-rounded and are predominately white or translucent in color with interspersed light gray and dark brown silt and clay sized particles. However, unlike samples C01 and C06, C08 contains a thin dark brown-black layer of fine grained particles that could be soot naturally deposited and manipulated to create a grey-black finish as previously observed in Kiva Q Cliff Palace.
Figure 8.5 Thin section, A04, Open Area 26 (Speaker Chief Complex), thick red wash (layer 2). (Mag. 100x, plain polarized light).

Sample A04 (Figure 8.5) is a thick red wash taken from the top right corner of Room 72. This sample is similar to the previous samples from Open Area J and contains grains that are sub-angular to sub-rounded in shape. However, sample A04 contains a much higher concentration of fine quartz grains within its topmost wash and is much more well sorted than the samples from Open Area J. Similar to the samples from Open Area J, sample A04 has predominately white or translucent pigmented particles with interspersed dark brown and tan fine silt and clay sized particles dispersed between.
Sample B01 (Figure 8.6), is a gray wash taken from left side of Room 70 in the Speaker Chief Complex. This sample is moderately well sorted with large quartz grains ranging in shape from sub-angular to sub-rounded in shape. Compared to the previous samples discussed, sample B01 has a much higher silt and clay particle size ratio than the others examined from Open Area J or Open Area 26. Additionally, the layer displays irregular inclusions which appear to be organic plant or charcoal fragments. This suggests the grey color may be due to the accidental or intentional addition of soot, probably from hearth ashes, mixed into the wash.
8.3 SEM-EDS

The most common techniques used to examine the clay fraction of earthen materials are electron microscopy and x-ray diffraction.213 Electron microscopy has proven to be beneficial in providing detailed micromorphological information on a much smaller level that cannot be seen using a standard stereomicroscope or polarized compound microscope. Today there are a wide variety of techniques in the field of electron microscopy that can aid in analyzing the micromorphology of an earthen material including: transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDS), electron probe microanalysis (EPMA), and back scatter electron image producer (BSI).214 In each of the above techniques, samples are bombarded with a beam of high energy electrons. When the electrons come into contact with the sample a multitude of signals are created that provides an image of the sample's surface or its elemental composition or both depending on which technique is being used.215

In previous studies conducted by Hall 2007; Ferron 2007; Slater 1999; and Dix 1998 SEM-EDS proved successful in providing key images necessary for micromorphological analysis and elemental compositional analysis of earthen plasters and washes studied at Mesa Verde National Park.

214 Ibid, 32.
8.3.1 Sample Preparation

Representative samples from the eastern façade of Open Area J and the northern facades of Open Areas 25 and 26 were selected for SEM-EDS following examination using the Nikon Optiphot 2-POL microscope. Samples from each site were selected based on color and location.

Samples from the eastern façade of Open Area J (samples C01, C06, C07, and C08), from Open Area 25 (sample B01), and from the northern façade of Open Area 26 (sample A04) were selected for SEM-EDS analysis. Representative white, gray and red plaster and wash samples were chosen to compare possible differences in composition and therefore source materials. Sample C01, a white wash from Open Area J was selected for comparison with sample A04, a white wash from Open Area 26. Similarly the gray wash layers in sample C06 from Open Area J was compared both with sample C08, a thick gray wash from Open Area J and sample 01, a gray wash from Open Area 25. The last set of samples selected for comparison were samples C07, a bright red wash with salmon and buff washes below, from Open Area J and sample A04 from Open Area 26, a thick red wash over an earlier white thick wash.

Each sample cross section selected for SEM-EDS testing was embedded, sectioned and mounted on a circular aluminum stub using black carbon tape. To insure each sample would receive a sufficient charge, carbon tape was also placed along the sides of each cross section connecting the edge of the sample to the base of the aluminum stub. Once each sample had been properly mounted using black carbon tape a gold palladium coating was applied over the entire surface of the sample. This layer of gold palladium provides a conductive coating to stimulate the electrons.
8.3.2 Analysis and Observations

SEM-EDS testing was conducted at the University of Pennsylvania Regional Nanotechnology Facility using a JEOL 6400 scanning electron microscope paired with electron dispersive spectroscopy. All tests were conducted by Doug Yates at 15Kv.

During SEM-EDS testing both individual spectrums and electron dot maps were produced to provide elemental data (Appendix D). Although, spectra were produced for every sample selected for SEM-EDS testing, only those samples with more complex stratigraphies were selected for electron dot mapping in addition to individual spectra. Since electron dot maps provide a visual illustration of the location and concentration of specific elements within each sample, individual layers within the same sample can be compared in relation to each other based on their elemental composition. Samples selected for electron dot mapping include: samples C06, C07, and C08 from the eastern façade of Open Area J, sample B01 from Open Area 25 and sample A04 from Open Area 26.

In all the samples tested three major elemental components were found in significant quantities including: silicon, aluminum, and calcium. Carbon also tended to be found in varying quantities throughout all the samples tested and was most prominent in the gray wash of sample C8 from Open Area J. Sulfur was present in small amounts in the thin gray wash of sample C06 and the brilliant red wash of C07 from Open Area J. However, the gray wash in sample B01(Figure 8.7) from Open Area 25 contained a significantly high percentage of sulfur and calcium indicating this wash was most likely gypsum based. Titanium was also an interesting trace element found in the white wash of sample A04 from Open Area 26. Other trace elements found in varying quantities
throughout all the samples tested included potassium, magnesium, and iron. (For the results of each sample tested consult the SEM-EDS data sheets in Appendix D).

8.4 XRD

X-ray diffraction or XRD is a compositional analysis technique used for analyzing inorganic crystalline compounds. XRD involves firing a monochromatic x-ray beam at a crystalline material and the diffraction pattern produced provides the information necessary to identify the element based on this unique signature. Since this analytical method only works if a material has a crystalline structure it is not suitable for testing amorphous materials. The minimum sample size necessary for using XRD analysis is 10µg.216

This type of test is considered to be non-destructive and has a sensitivity of 5% in identifying materials. Since many pigments originate from inorganic crystalline compounds, XRD is a desirable test used in clay and mineral compositional analysis.217

8.4.1 Sample Preparation

Two sets of samples were selected for XRD testing; one set consisted of soil samples collected from Mesa Verde National Park, and the other set consisted of earthen plasters and washes from Open Area J and Open Areas 25 and 26. The three soil samples taken from Mesa Verde National Park include: Mancos shale, a carbonate rich soil known as caliche, and a prevalent yellow soil (most likely originating from sandstone parent rocks in the area). Prior to XRD testing approximately 4 grams of

216 Derrick, Stulik and James, 1999 1-10.
217 Ibid.
each of the soil samples were sieved. The fines left in the pan for each sample were then
collected, labeled and placed in a plastic sample bags.

Four plaster and wash samples from Open Area J and Open Areas 25 and 26
were also selected for XRD analysis. From Open Area J samples C03, (a yellow aura)
and C11 (a red plaster), were chosen and samples 07 (a white wash) and 13 (a red
plaster) from Open Area 26 were selected. Each layer selected for testing was carefully
removed from the bulk sample using a tungsten needle. Once each layer had been
removed the particles were then further broken down using the edge of a stainless steel
spatula. Each ground sample was then placed on silica wax coated paper prior to
mounting in order to retain as much of the original sample as possible.

After both sets of samples had been properly prepared each sample was then
mounted on circular stainless steel stubs. Using a small brush each sample was carefully
brushed into the center circular cutout of the stainless steel stub and leveled off with a
straight razor. Since the plaster and wash samples selected for testing were
considerably smaller in size, small amorphous glass plates were placed within the center
circular cut out. These plates allowed the plaster and wash samples to sit level during
XRD testing.

8.4.2 Sample Analysis

XRD testing and analysis was conducted at the Earth and Environmental Sciences
Laboratory at the University of Pennsylvania by Professor Gomaa Omar. Each sample
was analyzed using the Philips X’Pert Pro Instrument at 45kV, 40mA.

Once all of the data spectrums had been gathered for all the samples each
spectrum was analyzed using the elemental composition software, X’Pert HighScore.
Using this software, major and minor peaks within each sample spectrum were identified using the known mineral database (Appendix E).

Sample C03, a yellow wash from Open Area J was found to be composed predominately of aragonite (CaCO$_3$), a commonly occurring polymorph of calcium carbonate, making up 85% of its composition. Wollastonite (CaSiO$_3$), a calcium inosilicate (often containing moderate amounts of magnesium, manganese and iron) comprised 12% of the sample and the remaining 12% of the sample was made up of quartz (SiO$_2$).

In comparison to sample C03, sample A04, a white wash from Open Area 26 was analyzed. This sample contained predominately montmorillonite ($\frac{1}{2}$Ca,Na)(Al,Mg,Fe)$_4$(Si,Al)$_8$O$_{20}$(OH)$_4$nH$_2$O), a type of phyllosilicate clay, with moderate amounts of quartz (SiO$_2$), calcite (CaCO$_3$), and wollastonite (CaSiO$_3$). Interestingly with the exception of montmorillonite most of the components of these two samples are similar. Both samples contain quartz and wollastonite, and while aragonite and calcite are different minerals they are both naturally occurring calcium carbonate polymorphs.

Sample C11, a thick red wash, from Open Area J was selected as a representative thick salmon red wash. This sample was predominately made up of quartz (SiO$_2$), with a moderate amount of montmorillonite ($\frac{1}{2}$Ca,Na)(Al,Mg,Fe)$_4$(Si,Al)$_8$O$_{20}$(OH)$_4$nH$_2$O), and trace amounts of albite (NaAlSi$_3$O$_8$) and titanomagnetite (FeO Fe$_2$O$_3$ TiO$_2$), an iron titanium oxide. For comparative analysis sample A13, a thick red wash from Open Area 26 was also selected for XRD analysis. This sample contained primarily quartz and muscovite (KAl$_2$(AlSi$_3$O$_10$)(F,OH)$_2$), a
phyllosilicate mineral composed of aluminum and potassium with trace amounts of albite (NaAlSi$_3$O$_8$) and calcite(CaCO$_3$).

Unlike samples C03 and A07, there are significant differences between these two thick washes. Although both samples contain large amounts of quartz, sample C11 contains 72% while sample 13 only contains 48%. Additionally, neither montmorillonite nor titanomagnetite were found in sample 13 suggesting two distinct sources.
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<th>Location</th>
<th>Sample</th>
<th>Type</th>
<th>Components</th>
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<td>C03</td>
<td>Yellow Wash</td>
<td>85% Aragonite</td>
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*<10% not detected

**Figure 8.7.** XRD Sample Results (Phillips X’Pert Pro XRD Instrument)
8.5 Micro-Chemical Spot Testing for Determination of Pigments

Micro-chemical spot testing was used to confirm the presence of calcium carbonate in the white and light gray finishes found using SEM-EDS and polarized light microscopy. All reactions were observed using the Leica MZ16 stereomicroscope at 115x magnification.

8.5.1 Sample Preparation

Using a tungsten needle pigment particles from sample C08, from Open Area J and sample B01 from Open Area 25 were carefully removed from the light gray washes of each sample and placed on a glass slide. Once the particles were in place a drop of hydrochloric acid was placed on the opposite side of the slide and using a glass needle the particles were carefully moved into the acid and the reaction was observed through the microscope.

5.5.2 Analysis and Observations

Sample C08 produced tiny bubbles when the pigment particles were moved into the hydrochloric acid testing positive for carbonates. A confirmation test for calcium using sulfuric acid was conducted by placing a drop of sulfuric acid on the dissolved pigment particles and placed on a hot plate on low heat. Once the sample was heated it was observed again under the stereomicroscope at 115x magnification; however, no gypsum crystals were observed.

Sample B01 produced a strong reaction creating many tiny bubbles when the pigment particles were moved into the hydrochloric acid, testing positive for
carbonates. The same confirmation test conducted on sample C08 using sulfuric acid was carried out. Following heating, tiny gypsum crystals were formed and observed using the stereomicroscope at 115x magnification, confirming the presence of calcium carbonate.

Figure 8.8 Gypsum crystals, B01, following sulfuric acid micro-chemical spot test (100x Nikon Optophot2-POL)
9. Summary of Analytical Results

9.1 Microstructure/Stratigraphy

The microstructure and stratigraphy of each sample taken from the eastern façade of Open Area J and the northern façade of Open Area 26 were analyzed during microscopic analysis in thick and thin section using plain and cross polarized light.

9.1.1 Eastern Façade of Open Area J

As mentioned previously in Chapter 8, no plasters were found on the eastern façade; all of the earthen finishes examined from this site measured less than 1mm classifying them as washes. However, during this examination there were distinct differences between those washes less than 0.5mm in thickness and those greater than 0.5mm in thickness in terms of grain size distribution and porosity.

Washes measuring less than 0.5mm in thickness from the eastern façade of Open Area J were predominately composed of fine clay sized particles, densely packed together exhibiting good cohesion and few large fissures or pores. Sample C06, unlike the other washes examined from this site did show the presence of large angular quartz grains interspersed within its thin washes, which was atypical. Thicker washes from the eastern façade of Open Area J measuring 0.5 mm or more contained a much higher proportion of larger mineral inclusions most predominately quartz. These larger mineral components made up approximately 60% of each sample with the remaining 40% composed of smaller clay sized particles. The larger mineral inclusions within these thicker wash layers ranged in shape from sub-angular to sub-rounded. These thicker
washes also exhibited good cohesion but were not as densely compacted as the thinner washes from this site and displayed visible pores.

In general the texture of each wash for all of the samples analyzed from Open Area J ranged in texture from moderately rough to moderately wavy. This horizon line between each finish layer and the subsequent layer before it provides a visual image of how each layer, when applied infiltrated the layer before it. Layers with a less distinct horizon line most likely intermixed with the previously applied wash readily. This could have been a result of wet on wet application or the base layer could have suffered surface erosion allowing the newly applied wash to fill in voids of the previous finish creating an indistinct or rougher horizon line between finishes.

During stratigraphic analysis of these samples it is clear the eastern façade of Open Area J underwent several finishing campaigns. The stratigraphies of samples C03, C06, and C08 showed evidence of multiple aura campaigns for each of the three rooms, with Room 26 undergoing the greatest amount of schematic change with four or five possible aura campaigns. Similarly sample C07 provided evidence of cyclical schematic changes to the dado illustrating 4 or 5 possible campaigns. The remainder of the samples examined contained only one or two layers. The information from this examination provided the necessary data to create interpretive schemes of the space as it may have looked throughout its history as discussed in Chapter 10.

9.1.2 Northern Façade of Open Areas 25 and 26

Similar to the surface finishes examined from the eastern façade of Open Area J, few earthen finishes were characterized using plasters using the 1mm definition from the northern façade of Open Area 26. The thin cream white washes from the northern
façade of Open Area 26 exemplified similar physical characteristics to those of Open Area J, being predominately composed of clay sized particles, densely compact with no visible fissures or large pores. However the texture of these washes was much smoother than those found at Open Area J ranging from moderately wavy to smooth. The smoother finish texture visible on samples from this site illustrates a conscious care to create this horizon during application.

Also like the samples examined from Open Area J, there were clear differences between physical characteristics of thick and thin washes. Thicker washes measuring 0.5mm or more had a much higher percentage of larger mineral inclusions, predominately quartz as in Open Area J. In comparing samples from the northern façade of Open Areas 25 and 26 with those from the eastern façade of Open Area J, a much higher proportion of quartz grains within the thicker washes of Open Areas 25 and 26 was found. During analysis it appeared these washes exhibited approximately 70% quartz to 30% smaller clay particles. The grain shape of the quartz grain inclusions appeared much more rounded than those from Open Area J and may indicate they were ground prior to creating the wash formulation. In general thicker washes from these two sites exhibit a higher proportion of larger mineral inclusions than the thinner cream washes found at Open Area 26, are densely compact and illustrate visible pores within the matrix.

Although, only two plaster samples were identified from Open Areas 25 and 26 they exhibit an even higher proportion of larger mineral inclusions, that range in shape from sub-angular to sub-rounded. The matrix of these plasters is more loosely compact with visible pores throughout.
Unlike Open J, Open Areas 25 and 26 underwent few finishing campaigns. After examining the stratigraphy of each sample microscopically it appears these sites underwent only one or two schemes, maintaining the same finishing scheme for years as discussed in Chapter 10.

9.2 Compositional Analysis

9.2.1 Red Plasters and Washes

According to the data collected from XRD analysis the thick red washes and plasters analyzed from Open Area J and Open Area 26 were similar but not identical in composition. Sample C11 analyzed from Open Area J was composed predominately of quartz, with a moderate amount of montmorillonite, and trace amounts of albite and titanomagnetite. While sample A13 from Open Area 26 also contained quartz and calcite, muscovite and calcite were also identified. Additionally, although samples C11 and A13 both contained considerable amounts of quartz, sample C11 contained 72% quartz while sample A13 only contained 48% quartz. These findings suggest that the sources for these finishes were probably different. Similar to previous analyses of earthen finishes conducted at Mesa Verde National Park, the red finishes at both sites were found to contain trace amounts of iron and sulfur was found during SEM-EDS testing. In general the texture of the red plasters from Open Area 26 were much finer and therefore the plasters and washes smoother than those found at Open Area J.

9.2.2 Gray Washes

Gray washes from both from the eastern façade of Open Area J and the northern façade of Open Area 26 were found to be predominately a mixture of calcium
carbonate and burnt organic material. During SEM-EDS testing both samples C06, C08 and B01 were found to contain high amounts of calcium. Through the use of micro-chemical spot testing it was confirmed that the calcium found during SEM-EDS testing was most likely calcium carbonate. Although, none of the data collected during SEM-EDS testing confirmed the presence of carbon as a result of the inclusion of charcoal ash, the examination of samples C06, C08 and B01 in thin section suggest burned organic plant material was added or intermixed in the layers at both sites. However, one distinct difference noted in sample B01 during elemental dot mapping was a considerably higher percentage of sulfur within the gray wash not found in samples C06, or C08 suggesting gypsum.

9.2.3 Cream White Washes

Cream white colored washes from both the eastern façade of Open Area J and the northern façade of Open Area 26 appear to be very similar in composition. Sample A07 was analyzed using XRD and was found to contain predominately montmorillonite, quartz, wollastonite and calcite, confirming previous findings of high portions of clay within the washes. Unfortunately no samples from the eastern façade of Open Area 26 were large enough to conduct XRD analysis. Therefore for comparative analysis between the cream-white washes found at Open Area J and Open Area 26 SEM-EDS elemental dot mapping was conducted for samples C01 and A04. In general both samples contained the same main elements consisting predominately of silicon, aluminum and calcium with trace amounts of potassium and magnesium. However, one interesting elemental inclusion found at Open Area 26 which was not found at Open Area J was trace amounts of titanium in sample A04.
9.2.4 Yellow Washes

Only one yellow wash was found, sample C03, located just left of the entrance to Room 25. This sample showed evidence of a light yellow wash across part of the bulk sample which was confirmed during onsite analysis. Since examination of this finish was difficult to conduct during cross section analysis using reflected light microscopy, a portion of this wash was removed from the bulk sample and tested using XRD analysis. According to results of the analysis, this wash was composed predominately of aragonite with a moderate amount of wollastonite and trace amounts of quartz.
10 Interpretation and Conclusions

10.1 Interpretation of Schemes

Each successive application of earthen finishes to the interior or exterior of a structure is referred to as a scheme. The creation of architectural schemes for the eastern façade of Open Area J and the northern façade of Open Area 26 was based on in-situ observations and microscopic analysis. In general observations made onsite tended to correlate with stratigraphic examination conducted during microscopic analysis. The correlations between decorative features at different locations on each site’s exterior were synchronized within individual schemes from the data collected during microscopic stratigraphic analysis. However due to the size of the samples taken from each site as well as the limited amount of samples obtained from each location, the schemes developed in this chapter are speculative.

10.2 Schemes for the Eastern Façade of Open Area J

Based on observations made in the field and stratigraphic analysis conducted on representative samples taken from the facades of Rooms 25, 26 and 27 it appears Open Area J underwent as many as six different successive finishing schemes.

The only element that remained relatively consistent throughout all six schemes of the eastern façade of Open Area J was a gray ceiling band located at the top of the façade wall. This decorative element was identified from onsite observations and stratigraphic analysis of samples C01 and C09 which both display a light gray finish. Based on their location on the eastern façade, a ceiling band spanning across the top of
all three rooms has been suggested. However, the point at which this finish was applied between scheme 1 and scheme 6 is uncertain. Since there is only one layer of gray wash present on both samples the initial application of this finish cannot be determined. Because the gray wash on both samples C01 and C09 was the exposed layer in the field, it is possible this band may have been applied as early as the second scheme and remained exposed throughout. For this reason it has been included for all of the projected schemes between scheme 2 and 6.

Both the auras and the dado colors for each room on the eastern façade of Open Area J underwent considerable change over time. From the evidence gathered from sample number C07, (taken from the base of the entrance to Room 26) and observations made in the field. it has been speculated that all of the rooms changed dado color schemes in unison. The analysis of sample C07 indicates the eastern façade of Open Area J had four different dado schemes that alternated in color between red and cream beginning in scheme 2.

However, unlike the synchronized changes in dado color, the auras of each room underwent chromatic changes independently from one another. Examination of sample C03 from Room 25 displayed evidence of at least one aura scheme in yellow and according to observations made in the field, a second aura in red.

The center room of Open Area J, Room 26 appears to have had up to five possible aura campaigns according to stratigraphic evidence obtained from samples C06 and C07 as well as onsite observations. The first four campaigns appear to be a light gray wash, followed by a light buff wash, followed by a gray wash, followed by much lighter grayish-white wash. All of these aura campaigns were confirmed both in the field
and in the stratigraphy of sample C06. However, while sample C07 tends to correlate exactly with the field observations for dado schemes of the eastern façade, it does contain a bright red wash located on its topmost layer. Due to the thickness of this wash, its brilliantly rich color and location (just to the right of the door to Room 26), a possible fifth aura campaign in red has been considered in the schemes projected for this room.

Room 27, the southern most room, only showed evidence of two aura finishing campaigns, the first in light gray and the second in a cream white wash.
10.2.1 Open Area J: Scheme 1

The initial scheme of the eastern façade of Open Area J according to stratigraphic analysis of representative samples taken on site was an overall salmon red plaster without any additional decorative embellishments. Rooms 25, 26 and 27 are all believed to have been early graneries based on their modest size and construction, and a simple overall finish free of embellishment may be indicative of such uses.

![Scheme 1 projection for the eastern façade of Open Area J.](image)

**Figure 10.1** Scheme 1 projection for the eastern façade of Open Area J.
10.2.2 Open Area J: Scheme 2

The second scheme for the eastern façade of Open Area J initiates the introduction of additional decorative elements such as a possible gray ceiling band, a red dado and auras around each of the three rooms. In this scheme evidence was found during on site observations and bulk analysis of sample C03, for a yellow aura around the entrance to Room 25. While Room 26 was found to have a dark gray aura according to the stratigraphic analysis of sample C06. Similar to Room 26, Room 27 also was found to have a dark gray aura during this period.

Figure 10.2 Scheme 2 projection for the eastern façade of Open Area J
10.2.3 Open Area J: Scheme 3

The light gray ceiling band remains present in this scheme however, as mentioned previously its initial application within the six schemes is uncertain. The dado is still present in this scheme, however it has changed from a salmon red to cream white in color. The aura for Room 27 has remained light gray, and the aura for Room 26 has changed to a light tan or cream color based on the stratigraphy of sample C06. While the aura for Room 25 has changed from yellow to a salmon red in color. However, it should be noted that the color change for the aura of Room 25 is based on observations made in the field and was unable to be confirmed during further laboratory study of sample C03.

Figure 10.3 Scheme 3 projected for the eastern façade of Open Area J.
10.2.4 Open Area J: Scheme 4

In Scheme 4 the gray ceiling band has remained in place from previous schemes and the auras for Rooms 25 and 27 have remained the same as in Scheme 3. However the aura of Room 26 has reverted back to the same gray colored wash as seen in Scheme 2. The only other change present is the dado that has now become a light salmon red once more as in Scheme 2.

Figure 10.4 Scheme 4 projected for the eastern façade of Open Area J
10.2.5 Open Area J: Scheme 5

Scheme 5 is very similar to Scheme 3, the gray ceiling band remains present, the dado is the same cream white, and the auras for Rooms 25 and 27 remain unchanged. The only alteration visible in this scheme is the application of a light grayish-white aura on top of the previous dark gray aura around the entrance to Room 26.

Figure 10.5 Scheme 5 projected for the eastern façade of Open Area J
10.2.6 Open Area J: Scheme 6A and 6B

Schemes 6A and 6B illustrate the possibility of a change in dado and aura colors for Rooms 26 and 27. In this scheme Room 27 has a light cream white aura, which was visible during onsite analysis and while examining the stratigraphy of sample C08. According to evidence from sample C07 it appears that Room 26 may have had a bright red aura applied last. However, due to the location of this sample it is unclear whether this layer correlates with a change in aura color or dado color. For this reason Scheme 6 is shown two ways. One with a bright red dado, Scheme 6A, and one with a bright red aura for Room 26, Scheme 6B. Since all of the stratigraphies for sample C07 correlate with onsite observations of the sequential dado changes over time, this suggests that Scheme 6A is more probable.
Figure 10.6 Scheme 6A projected for the eastern façade of Open Area J

Figure 10.7 Scheme 6B projected for the eastern façade of Open Area J
10.3 Schemes for the Northern Façade of Open Area 26

According to observations made in the field and stratigraphic analysis of representative samples during microscopic examination, it appears that the northern façade of Open Area 26 had only two different finishing schemes. In general all of the observations made in the field correlated to what was found during stratigraphic analysis.

Unlike Open Area J, Open Area 26 had relatively few changes made to its overall schematic program since the application of its original base salmon red plaster (5YR 8/4). However one unique feature visible on the exterior of Room 72 is its exposed sandstone masonry. Located approximately one foot west of the entrance to Room 72, this exposed masonry spans the entire structure to the western most edge and continues to the eastern most wood socket approximately one foot above the entrance to Room 72.

Evidence of auras around each of the openings to Rooms 71(1), 72(1) and 133(2) are clearly visible. However, it should be noted that while it is believed a third story existed above Room 133 (2), and a second story above Room 71, no schemes were included for these spaces due to a lack of physical evidence. The presence of the third story and walled exterior for Open Area 45 on the projected schemes for the northern façade of Open Area 26 are purely for visual continuity.
10.3.1 Open Area 26: Scheme 1

Similar to the eastern façade of Open Area J, the initial scheme for the northern façade of Open Area 26 consisted of the application of a salmon red plaster. This finish covered the exteriors of Rooms 71(1), 72(1), and 133(2) with the exception of the exposed sandstone masonry on the eastern portion of Room 72 (1).

![Scheme 1 projected for the northern façade of Open Area 26](image)

**Figure 10.8** Scheme 1 projected for the northern façade of Open Area 26
10.3.2 Open Area 26: Scheme 2

Scheme two introduces the application of decorative finish embellishments including the addition of cream white auras around the entrances to Rooms 71(1), 72(1) and the T shaped doorway to Room 133(2). The same cream white auras are also present around the two square openings just above the entrance to Room 71(1) creating a bright cream white band spanning the edges of the room. Examination of samples A01, A02, A06, A07 A09, and A10 during bulk sample analysis all confirmed onsite observations of cream white auras. Although, these washes were visible in cross section, due to their extremely thin application observation of the washes during bulk sample analysis proved to be more advantageous.

Figure 10.9 Scheme 2 projected for the northern façade of Open Area 26
10.4 Conclusion

The comparative study of the eastern façade of Open Area J and the northern façade of Open Area 26 illustrates a distinctly different treatment of the decorative finishing schemes at each site. Despite the fact that both open areas are believed to have been constructed during the same time period, Open Area J underwent significantly more finishing campaigns than the northern façade of Open Area 26. The diverse and more complex nature of the schemes for the eastern façade of Open Area J may illustrate the transformation of the space from the original function of Rooms 25, 26, and 27 as early graneries to their later conversion into small living rooms. Unlike, Open Area 26 in the Speaker Chief Complex, the auras of Rooms 25, 26, and 27 appear to have undergone independent chromatic changes during different schematic periods and at no single point in time does it appear that all three rooms had the same aura color applied to the exterior. If the observations made in the field and from stratigraphic analysis are representative of the chronological changes of the aura colors over time, it appears that the inhabitants of these rooms may have been illustrating an individual expression through the application of different aura colors.

In contrast to the eastern façade of Open Area J, Open Area 26 in the Speaker Chief Complex appears to have had two finishing schemes throughout its lifetime. Unlike Open Area J, Open Area 26 showed only one successive scheme following the initial application of salmon red plaster. The auras applied around the entrances and openings in the masonry walls of Rooms 71(1), 72(1) and 133(2) were all applied in the same cream white wash illustrating continuity between rooms and perhaps room
function. The continued relationship between the finishing treatments of Rooms 71(1), 72(1) and 133(2) could be explained through the hypothesis that these rooms maintained the same social function throughout their history; and earthen finishes applied to these rooms were directly symbolic of their function within Ancestral Puebloan society.

Examination and comparison of the compositional make up of the earthen plasters and washes found at both sites suggests some insight into the raw materials utilized by the Ancestral Puebloans in order to create each surface finish. As stated in Chapter 9, predominately the same basic inorganic constituents were identified in like colored finishes from each site through instrumental analyses; however, some basic differences were noted.

The red plaster from the eastern façade of Open Area J contained a much higher percentage of quartz than that of Open Area 26 clearly illustrating a distinctly different proportion of raw materials. The light gray wash from Open Area 25 analyzed using SEM-EDS contained a significantly larger percentage of sulfur than any of the samples tested from Open Area J indicating it may have been created using a different source material than what was utilized at either Open Area J or Open Area 26.

As noted in previous earthen finishes studies conducted at Mesa Verde calcium carbonate composed the majority of the thinner cream, white and gray washes, consisting of densely packed fine sized clay particles.

The findings of this comparative study of the earthen surface finishes of eastern façade of Open Area J and the northern façade of Open Area 26 provide an interesting first look at how the application of earthen surface
finishes may have directly related to the social function of open areas. However, since little research has been conducted on the analysis and interpretation of open area surface finishes at Cliff Palace or other large cliff dwellings within Mesa Verde National Park, further research on similar spaces is recommended for a more comprehensive understanding of the relationship between decorative finishing schemes and the social function of open areas within Ancestral Puebloan culture.
Appendix A

Chapin Mesa Soil Survey Data
### Map Unit Legend

#### Cortez Area, Colorado, Parts of Dolores and Montezuma Counties (CO671)

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<th>Map Unit Symbol</th>
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<th>Acres in AOI</th>
<th>Percent of AOI</th>
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<tr>
<td>147</td>
<td>Yants fine sandy loam, 1 to 6 percent slopes</td>
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#### Ute Mountain Area, Colorado and New Mexico (CO670)

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<th>Percent of AOI</th>
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<td>66</td>
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<tr>
<td>67</td>
<td>Morefield loam, 3 to 6 percent slopes</td>
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<tr>
<td>122</td>
<td>Waquie-Dolcan-Rock outcrop complex, 25 to 80 percent slopes</td>
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Totals for Area of Interest (AOI) | 4,572.8 | 100.0%

### Chemical Soil Properties—Cortez Area, Colorado, Parts of Dolores and Montezuma Counties

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<th>Salinity</th>
<th>Sodium absorption ratio</th>
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<tr>
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6—Arubala-Longhorn complex, 3 to 15 percent slopes

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69—Longhorn-Rock outcrop complex, 15 to 45 percent slopes

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76—Mosaic field, 1 to 3 percent slopes

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106—Rock outcrop

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### Chemical Soil Properties – Cortez Area, Colorado, Parts of Dolores and Montezuma Counties

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### Chemical Soil Properties – Cortez Area, Colorado, Parts of Dolores and Montezuma Counties

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<th>Soil reaction (pH)</th>
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### Chemical Soil Properties—Ute Mountain Area, Colorado and New Mexico

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### Chemical Soil Properties—Ute Mountain Area, Colorado and New Mexico

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<td>22-60</td>
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<td>Diltam</td>
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<td>5.0-15</td>
<td>7.4-7.8</td>
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<td>10-20</td>
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<td>Rock outcrop</td>
<td>0-60</td>
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Appendix B

Archeological Plans and Conditions Surveys
Open Area J in Plan View, 5MV625 Cliff Palace, Mesa Verde National Park.
Cliff Palace Mapping Project 1998-2001, in Prelude to Tapestries in Stone by Larry V. Nordby
(Mesa Verde National Park Colorado: Mesa Verde National Park Division of Research and Resource Management, 2001)
Conservation of Architectural Surfaces Program for Archaeological Resources: Mesa Verde National Park, CO.

Architectural Conservation Laboratory and Research Center: Graduate Program in Historic Preservation University of Pennsylvania

Project Director: Frank G. Matero

Fall 1998-2001
Conservation of Architectural Surfaces Program for Archaeological Resources: Mesa Verde National Park, CO.
Architectural Conservation Laboratory and Research Center: Graduate Program in Historic Preservation University of Pennsylvania
Project Director: Frank G. Matero
Fall 1998-2001
Conservation of Architectural Surfaces Program for Archaeological Resources: Mesa Verde National Park, CO.
Architectural Conservation Laboratory and Research Center: Graduate Program in Historic Preservation University of Pennsylvania
Project Director: Frank G. Matero
Fall 1998-2001
Appendix C

Sample Schedules, Sample Locations, 
and Stratigraphic Data Sheets
<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Site Structure Sector # Detailed Location</th>
<th>Description</th>
<th>Munsell Color Date of Structure Date Sampled Analysis</th>
</tr>
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<tbody>
<tr>
<td>C01</td>
<td>Open Area J Cliff Palace (5MV625) Room 25 Sector 4</td>
<td>Two feet above doorway Grey smooth finish top right.</td>
<td>Finish: Light gray 2.5Y 7/1 (Gray) Substrate: Pale yellow 2.5Y 8/2</td>
</tr>
<tr>
<td>C02</td>
<td>Open Area J Cliff Palace (5MV625) Room 25 Sector 4</td>
<td>Upper right corner one foot and half above doorway Grey mortar no finish</td>
<td>10 YR 7/2 (Gray)</td>
</tr>
<tr>
<td>C03</td>
<td>Open Area J Cliff Palace (5MV625) Room 25 Sector 8</td>
<td>Right side of doorway Red plaster with traces of yellow aura</td>
<td>Very Pale Brown 10YR 8/3 (Yellow Aura) Pink 7.5 YR 8/4 (Pink plaster substrate)</td>
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<tr>
<td>C04</td>
<td>Open Area J Cliff Palace (5MV625) Room 23 Sector 8</td>
<td>Side wall at height of Room 25 doorway Red plaster, red wash with white</td>
<td>Light gray 2.5Y 7/1 (white wash) Light reddish brown 2.5YR 6/4 (Red plaster layer) Pale yellow 2.5Y 8/2 (Substrate)</td>
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<tr>
<td>C05</td>
<td>Open Area J Cliff Palace (5MV625) Room 23 Sector 12</td>
<td>Lower side wall below the height of the doorway of Room 25 Red plaster</td>
<td>7.5 YR 7/3 (Red) Gray 8/6 (White)</td>
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<tr>
<td>C06</td>
<td>Open Area J Cliff Palace (5MV625) Room 26 Sector 6</td>
<td>Above doorway left hand corner Two chunks, top: dark grey on red plaster</td>
<td>Light gray 2.5Y 7/1 (gray wash) Dark gray 7.5YR 4/1 (soot layer) Light brown 7.5YR 6/4 (substrate)</td>
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<tr>
<td>C07</td>
<td>Open Area J Cliff Palace (5MV625) Room 26 Sector 7</td>
<td>Just below the doorway of Room 26 on the right hand corner Beige orange wash plaster</td>
<td>Light Red 2.5YR 6/6 (red wash) Pale yellow 2.5Y 8/2 (plaster) Light reddish brown 2.5YR 6/4 (Red plaster) Pale yellow 2.5Y 8/2 (Substrate)</td>
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<tr>
<td>C08</td>
<td>Open Area J Cliff Palace (5MV625) Room 27 Sector 5</td>
<td>Just below the center of the doorway to Room 27 White wash with gray aura on red plaster</td>
<td>White 10YR 8/1 (White wash) Gray Clay 1 6/6 (Gray plaster) Reddish Yellow 7.5YR 6/6 (Red Substrate)</td>
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<tr>
<td>C09</td>
<td>Open Area J Cliff Palace (5MV625) Room 26 Sector 6</td>
<td>Two feet left of the doorway to Room 26 Field color: red plaster with a gray wash</td>
<td>Pale Yellow 2.5Y 8/2 (gray wash) Light Brown 7.5YR 6/4 (red wash)</td>
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<tr>
<td>C10</td>
<td>Open Area J Cliff Palace (5MV625) Room 28 Sector 5</td>
<td>Taken at the same height as the doorway of Room 27 Mortar with plaster</td>
<td>Light Brown 7.5YR 6/4 (red plaster) Very Pale Brown 10YR 8/2 (substrate)</td>
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<tr>
<td>C11</td>
<td>Open Area J Cliff Palace (5MV625) West Wall NA</td>
<td>NA</td>
<td>Pink 7.5YR (red field) Very Pale Brown 10YR 8/2 (substrate)</td>
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<tr>
<td>Sample #</td>
<td>Site</td>
<td>Structure</td>
<td>Sector#</td>
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<tr>
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<tr>
<td>A01</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>Open Area 26 North</td>
<td>Sector 3A</td>
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<tr>
<td>A02</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>Open Area 26 North</td>
<td>Sector 3A</td>
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<tr>
<td>A03</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>Open Area 26 North</td>
<td>Sector 3B</td>
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<tr>
<td>A04</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>Open Area 26 North</td>
<td>Sector 3B/2B</td>
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<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>RM 133(2)</td>
<td>Sector 3B</td>
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<td>A06</td>
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<td>RM 71(1)</td>
<td>Sector 2C</td>
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<tr>
<td>A07</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>RM 71(1)</td>
<td>Sector 2C</td>
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<td>A08</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
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<tr>
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<td>RM 72(1)</td>
<td>Sector 1B</td>
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<tr>
<td>A10</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>RM 72(1)</td>
<td>Sector 1B</td>
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<tr>
<td>A11</td>
<td>Speaker Chief House Cliff Palace (5MV625)</td>
<td>RM 71(1)</td>
<td>Sector 1C</td>
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<tr>
<td>Sample #</td>
<td>Site</td>
<td>Structure</td>
<td>Sector#</td>
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<tr>
<td>----------</td>
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<td>--------------------------</td>
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<tr>
<td>A12</td>
<td>Speaker Chief House</td>
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<td>A15</td>
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<td>B02</td>
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<td>Cliff Palace (SMV-625)</td>
<td>Sector 5</td>
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Open Area J East: Sample Location

Note: Samples 04, 05, 09, 11, 13 taken from southern walls
Speaker Chief Complex Open Area 26 North: Sample Location

Site Location of Open Area 26 North, Rooms 71 and 72
Speaker Chief Complex Open Area 25 North: Sample Location
Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<th>Analysis Performed by: Nicole Collum</th>
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<td>Location: Top Right Corner of Room 25</td>
<td>Date Analyzed: February 2008</td>
</tr>
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<td>Camera: Nikon DS-Fi1</td>
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C01 Bulk Sample 20x Mag.
Leica MZ16

C01 Bulk Sample 50x Mag.
Leica MZ16

C01 Cross-Section 50x Mag.
Leica MZ16

C01 Cross-Section at 100x Mag.
Nikon Optiphot2-Pol

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<th>Description</th>
<th>Color</th>
<th>Munsell Color</th>
<th>Thickness (mm)</th>
<th>Texture</th>
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<td>Mortar</td>
<td>Pale Yellow</td>
<td>2.5Y 8/2</td>
<td>N/A</td>
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<tr>
<td>2</td>
<td>Grey Wash</td>
<td>Light Gray</td>
<td>2.5Y 7/1</td>
<td>0.0628mm</td>
<td>Weakly Wavy</td>
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Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<tr>
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<th>Color</th>
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<th>Thickness (mm)</th>
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<td>Yellow Aura</td>
<td>Very Pale Brown</td>
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C03 Bulk Sample 18x Mag. Leica MZ16
C03 Bulk Sample 50x Mag. Leica MZ16
C03 Cross-Section 50x Mag. Leica MZ16
C03 Cross-Section at 115x Mag. Leica MZ16
Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

| Analysis Performed by: Nicole Collum | Type of Illumination: Reflected |
| Sample #: C04 | Date Sampled: August 2001 |
| Location: Side Wall of Room 23 at the Height of Room 25’s Doorway | Date Analyzed: February 2008 |
| Software Used: NIS Elements BR | Camera: Nikon DS-F11 |

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<th>Thickness (mm)</th>
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<td>Mortar</td>
<td>Pale Yellow</td>
<td>2.5Y 8/2</td>
<td>N/A</td>
<td>Slightly Wavy</td>
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<tr>
<td>2</td>
<td>Red Wash</td>
<td>Light Reddish Brown</td>
<td>2.5YR 6/4</td>
<td>0.55792</td>
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<tr>
<td>3</td>
<td>Traces of White Wash</td>
<td>White</td>
<td>2.5Y 8/1</td>
<td>N/A</td>
<td>Fractured / Very Rough</td>
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Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Sample #: C06</td>
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<tr>
<td>Location: Room 26 Above Doorway</td>
<td>Date Analyzed: February 2008</td>
</tr>
<tr>
<td>Upper Left Corner</td>
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<td>Software Used: NIS Elements BR</td>
<td>Camera: Nikon DS-FI1</td>
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<th>Color</th>
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<th>Thickness (mm)</th>
<th>Texture</th>
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<td>Mortar</td>
<td>Light Brown</td>
<td>7.5YR 6/4</td>
<td>N/A</td>
<td>Slightly Rough</td>
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<tr>
<td>2</td>
<td>Soot Layer</td>
<td>Dark Gray</td>
<td>7.5YR 4/1</td>
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<td>3</td>
<td>Buff Wash</td>
<td>Light Brown</td>
<td>7.5YR 6/4</td>
<td>0.12869</td>
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<td>4</td>
<td>Soot Layer</td>
<td>Dark Gray</td>
<td>7.5YR 4/1</td>
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<tr>
<td>5</td>
<td>White Wash</td>
<td>Light Gray</td>
<td>2.5Y 7/1</td>
<td>0.16964</td>
<td>Fractured /Moderately Rough</td>
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Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Sample #: C07</td>
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<tr>
<td>Location: Room 26 Just Below the</td>
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</tr>
<tr>
<td>Doorway Lower Right Corner</td>
<td>Camera: Nikon DS-F11</td>
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<td>Software Used: NIS Elements BR</td>
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![C07 Bulk Sample 30x Mag.](image1)
![C07 Bulk Sample 115x Mag.](image2)
![C07 Cross-Section 50x Mag.](image3)

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<th>Layer</th>
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<th>Texture</th>
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<td>Plaster</td>
<td>Pale Yellow</td>
<td>2.5Y 8/2</td>
<td>N/A</td>
<td>Rough</td>
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<tr>
<td>2</td>
<td>Pink Wash</td>
<td>Light Reddish Brown</td>
<td>2.5YR 6/4</td>
<td>0.61418</td>
<td>Slightly Wavy</td>
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<td>3</td>
<td>Cream Wash</td>
<td>Pale Yellow</td>
<td>2.5Y 8/2</td>
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<tr>
<td>4</td>
<td>Pink Wash</td>
<td>Light Reddish Brown</td>
<td>2.5YR 6/4</td>
<td>0.33145</td>
<td>Wavy</td>
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<tr>
<td>5</td>
<td>Cream Wash</td>
<td>Pale Yellow</td>
<td>2.5Y 8/2</td>
<td>0.17690</td>
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<td>6</td>
<td>Red Wash</td>
<td>Light Red</td>
<td>2.5YR 6/8</td>
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![C07 Cross-Section at 50x Mag.](image4)

Nikon Optiphot2-Pol
Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<th>Analysis Performed by: Nicole Collum</th>
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<td>Location: Room 27 Just Below the</td>
<td>Date Analyzed: February 2008</td>
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<tr>
<td>Center of the Doorway</td>
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<tr>
<td>Software Used: NIS Elements BR</td>
<td>Camera: Nikon DS-F11</td>
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<table>
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<th>Layer</th>
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<th>Thickness (mm)</th>
<th>Texture</th>
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<tr>
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<td>Plaster</td>
<td>Reddish Yellow</td>
<td>5YR 6/6</td>
<td>N/A</td>
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<td>Gray Wash</td>
<td>Gray</td>
<td>Gley 1 6/</td>
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<td>White Wash</td>
<td>White</td>
<td>10YR 8/1</td>
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C08 Bulk Sample 25x Mag.
Leica MZ16

C08 Bulk Sample 50x Mag.
Leica MZ16

C08 Cross-Section 50x Mag.
LEICA MZ16

C08 Cross-Section at 100x Mag.
Nikon Optiphot2-Pol
Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<tr>
<td>Sample #: C09</td>
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<tr>
<td>Location: Room 26 2ft. Left of Doorway</td>
<td>Date Analyzed: February 2008</td>
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<td>10YR 8/3</td>
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<td>White Wash</td>
<td>Light Brown</td>
<td>7.5YR 6/4</td>
<td>N/A</td>
<td>Rough</td>
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C09 Bulk Sample 25x Mag.
Leica MZ16

C09 Bulk Sample 50x Mag.
Leica MZ16

C09 Cross-Section 50x Mag.
Leica MZ16

C09 Cross-Section at 100x Mag.
Nikon Optiphot2-Pol
Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

<table>
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<tr>
<td>Location: Room 28 Taken at the</td>
<td>Date Analyzed: February 2008</td>
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<td>Height of Room 27's Doorway</td>
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<td>Camera: Nikon DS-Fi1</td>
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<td>10YR 8/3</td>
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<td>7.5YR 6/4</td>
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Stratigraphic Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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Analysis Performed by: Nicole Collum
Sample #: C11
Date Sampled: August 2001
Location: West Wall of OAJ
Date Analyzed: February 2008
Software Used: NIS Elements BR
Camera: Nikon DS-Fi1
Stratigraphic Analysis  
Speaker Chief Complex: Cliff Palace  
5MV0625 Mesa Verde National Park  

| Analysis Performed by: Nicole Collum | Type of Illumination: Reflected |
| Sample #: A01 | Date Sampled: August 2001 |
| Location: Open Area 26 North, Right of Room 133(2) Doorway | Date Analyzed: February 2008 |
| Software Used: NIS Elements BR | Camera: Nikon DS-Fi1 |

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<td>2</td>
<td>Pink Wash</td>
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<td>0.62654</td>
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A01 Bulk Sample 63x Mag.  
Leica MZ16

A01 Bulk Sample 115x Mag.  
Leica MZ16

A01 Cross-Section at 50x Mag.  
Leica MZ16

A01 Cross-Section at 50x Mag.  
Nikon Optiphot2-Pol

| 1 |
|---|---|---|---|---|
| 2 |
| 3 |
Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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A02 Bulk Sample 16x Mag.
Leica MZ16

A02 Bulk Sample 50x Mag.
Leica MZ16

A02 Cross-Section 50x Mag.
Leica MZ16

A02 Cross-Section at 100x Mag.
Nikon Optiphot2-Pol
Stratigraphic Analysis  
Speaker Chief Complex: Cliff Palace  
5MV0625 Mesa Verde National Park

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<td>5YR 6/6</td>
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Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Sample #: A04</td>
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<td>Software Used: NIS Elements BR</td>
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<td>10YR 8/3</td>
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<td>4</td>
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Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Location: Open Area 26 North, Above</td>
<td>Date Analyzed: February 2008</td>
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<tr>
<td>Doorway Room 71 First Floor</td>
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A06 Bulk Sample 12.5x Mag. Leica MZ16
A06 Bulk Sample 60x Mag. Leica MZ16
A06 Cross-Section 50x Mag. Leica MZ16
A06 Cross-Section at 100x Mag. Nikon Optiphot2-Pol
Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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<th>Texture</th>
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<td>Pink</td>
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Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Date Analyzed: February 2008</td>
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<td>Software Used: NIS Elements BR</td>
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<td>Pale Yellow</td>
<td>2.5Y 8/3</td>
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A10 Bulk Sample 10x Mag.
Leica MZ16

A10 Bulk Sample 50x Mag.
Leica MZ16

A10 Cross-Section at 100x Mag.
Nikon Optiphot2-Pol

A10 Cross-Section 40x Mag.
Leica MZ16
Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Location: Open Area 26 North, Building 71</td>
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Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

Analysis Performed by: Nicole Collum
Type of Illumination: Reflected
Sample #: A12
Date Sampled: August 2001
Location: Open Area 26 North, Building 72 Below Doorway Left Corner
Date Analyzed: February 2008
Software Used: NIS Elements BR
Camera: Nikon DS-FI1

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Stratigraphic Analysis
Speaker Chief Complex: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Sample #: A13</td>
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<tr>
<td>Location: Open Area 26 North, On the Connecting Wall of Building 71 &amp; 72</td>
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A13 Bulk Sample 16x Mag.
Leica MZ16

A13 Bulk Sample 50x Mag.
Leica MZ16

A13 Cross-Section 63x Mag.
Leica MZ16

A13 Cross-Section at 50x Mag.
Nikon Optiphot2-Pol

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Stratigraphic Analysis
Speaker: Chief House; Cliff Palace
SMV0625 Mesa Verde National Park

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Stratigraphic Analysis
Speaker Chief House: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>10YR 8/3</td>
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B02 Bulk Sample 13x Mag. Leica MZ16
B02 Bulk Sample 50x Mag. Leica MZ16
B02 Cross-Section 40x Mag. Leica MZ16
B02 Cross-Section at 100x Mag. Nikon Optiphot2-Pol
Appendix D

SEM-EDS Data Analysis
**SEM-EDS Analysis**

Open Area J: Cliff Palace  
5MV0625 Mesa Verde National Park

<table>
<thead>
<tr>
<th>Analysis Performed by: Doug Yates</th>
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<tr>
<td>Facility: Penn Regional Nanotechnology Facility</td>
<td>Microscope: JEOL 6400 SEM</td>
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</table>

![Image of electron microscope image with labeled layers and spectrum analysis](image-url)

![Image of spectrum analysis graph](image-url)
SEM-EDS Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<th>Analysis Performed by: Doug Yates</th>
<th>Analysis Performed: SEM-EDS</th>
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<td>Sample #: C06, Elemental Mapping</td>
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</tr>
<tr>
<td>Location: Room 26 Above Doorway</td>
<td>Date Analyzed: April 2008</td>
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<tr>
<td>Upper Left Corner</td>
<td>Facility: Penn Regional Nanotechnology Facility</td>
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<tr>
<td></td>
<td>Microscope: JEOL 6400 SEM</td>
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C06 Cross-Section at 100x Mag.
Nikon Optiphot2-Pol

C06 Cross-Section SEM-EDS
Oxygen

C06 Cross-Section SEM-EDS
Carbon

C06 Cross-Section SEM-EDS
Silicon

C06 Cross-Section SEM-EDS
Calcium

C06 Cross-Section SEM-EDS
Iron

C06 Cross-Section SEM-EDS
Sulfur
SEM-EDS Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

Analysis Performed by: Doug Yates Analysis Performed: SEM-EDS
Sample #: C06, Spectrum 1 Date Sampled: August 2001
Location: Room 26 Above Doorway Date Analyzed: April 2008
Upper Left Corner Facility: Penn Regional Nanotechnology Facility Microscope: JEOL 6400 SEM
SEM-EDS Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<th>Analysis Performed: SEM-EDS</th>
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<td>Facility: Penn Regional Nanotechnology Facility</td>
<td>Microscope: JEOL 6400 SEM</td>
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![Image of analysis results](image_url)

Layer 4

10 μm

Full Scale 26.0/75 keV Current: 14.638 (20.054)

Full Scale 28.075" keV Current: (20.054)
SEM-EDS Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

<table>
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Analysis

Layer 1

100μm 0 Kα1

Full Scale: 29678 cts, Current: 14538 (16 cts)

183
SEM-EDS Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

<table>
<thead>
<tr>
<th>Analysis Performed by: Doug Yates</th>
<th>Analysis Performed: SEM-EDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample #: C07, Elemental Mapping</td>
<td>Date Sampled: August 2001</td>
</tr>
<tr>
<td>Location: Room 26 Below Doorway</td>
<td>Date Analyzed: April 2008</td>
</tr>
<tr>
<td>Lower Right Corner</td>
<td>Microscope: JEOL 6400 SEM</td>
</tr>
</tbody>
</table>

Facility: Penn Regional Nanotechnology Facility

C07 Cross-Section SEM-EDS
Oxygen
Silicon
Calcium
Iron
Sulfur

C07 Cross-Section at 50x Mag.
Nikon Optiphot2-Pol

Si Kα1
C07 Cross-Section SEM-EDS
Silicon

Ca Kα1
C07 Cross-Section SEM-EDS
Calcium

Fe Kα1
C07 Cross-Section SEM-EDS
Iron
SEM-EDS Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Microscope: JEOL 6400 SEM</td>
</tr>
<tr>
<td>Facility: Penn Regional Nanotechnology Facility</td>
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C07 Cross-Section at 50x Mag.
Nikon Optiphot2-Pol

C07 Cross-Section SEM-EDS
Carbon

Si Ka1
C07 Cross-Section SEM-EDS
Silicon

Al Ka1
C07 Cross-Section SEM-EDS
Alumina Mapping

K Ka1
C07 Cross-Section SEM-EDS
Potassium

Fe Ka1
C07 Cross-Section SEM-EDS
Iron

S Ka1
C07 Cross-Section SEM-EDS
Sulfur
**SEM-EDS Analysis**
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

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<th>Analysis Performed: SEM-EDS</th>
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<td>Lower Right Corner</td>
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<td>Microscope: JEOL 6400 SEM</td>
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</table>

![Image](image-url)

**SEM-EDS Analysis**
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

- **Layer 5**
- **Spectrum 1**

![Layer 5 Image]

**Full Scale**: 7250 cts Curves: 13,747 (5 cts)
**SEM-EDS Analysis**  
Open Area J: Cliff Palace  
SMV0625 Mesa Verde National Park

<table>
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<th>Analysis Performed by: Doug Yates</th>
<th>Analysis Performed: SEM-EDS</th>
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<tr>
<td>Sample #: C08, Elemental Mapping</td>
<td>Date Sampled: August 2001</td>
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<td>Location: Open Area J, Room 27, Center Below Doorway</td>
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<td>Microscope: JEOL 6400 SEM</td>
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<table>
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<th><strong>08 Cross-Section SEM-EDS Carbon</strong></th>
<th><strong>C08 Cross-Section SEM-EDS Oxygen</strong></th>
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<tr>
<td><strong>08 Cross-Section SEM-EDS Silicon</strong></td>
<td><strong>08 Cross-Section SEM-EDS Calcium</strong></td>
<td><strong>08 Cross-Section SEM-EDS Iron</strong></td>
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<tr>
<td><strong>08 Cross-Section SEM-EDS Alumina</strong></td>
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SEM-EDS Analysis  
Open Area J: Cliff Palace  
SMV0625 Mesa Verde National Park

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<tr>
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<td>Microscope: JEOL 6400 SEM</td>
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![Layer 2](image1.jpg)

![Spectrum 1](image2.jpg)
SEM-EDS Analysis  
Open Area J: Cliff Palace  
SMV0625 Mesa Verde National Park

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<td>Microscope: JEOL 6400 SEM</td>
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![Image of SEM-EDS analysis results](image-url)

![Image of SEM-EDS analysis results](image-url)
**SEM-EDS Analysis**

**Speaker Chief House: Cliff Palace**
**5MV0625 Mesa Verde National Park**

<table>
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<th>Analysis Performed: SEM-EDS</th>
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<tbody>
<tr>
<td>Sample #: A04, Elemental Mapping</td>
<td>Date Sampled: August 2001</td>
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<tr>
<td>Location: Open Area 26 North, Upper Right Corner of Room 72</td>
<td>Date Analyzed: April 2008</td>
</tr>
<tr>
<td>Facility: Penn Regional Nanotechnology Facility</td>
<td>Microscope: JEOL 6400 SEM</td>
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**Analysis Images:**
- A04 Cross-Section at 50x Mag, Nikon Optiphot2-Pol
- O Kα1 A04 Cross-Section SEM-EDS Oxygen
- Ti Kα1 A04 Cross-Section SEM-EDS Titanium
- Si Kα1 A04 Cross-Section SEM-EDS Silicon
- Ca Kα1 A04 Cross-Section SEM-EDS Calcium
- Fe Kα1 A04 Cross-Section SEM-EDS Iron
SEM-EDS Analysis
Speaker Chief House: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Location: Open Area 26 North, Upper Right Corner of Room 72</td>
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<td>Facility: Penn Regional Nanotechnology Facility</td>
<td>Microscope: JEOL 6400 SEM</td>
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Layer 3

![Electron Image 1]

![Spectrum 1]
Analysis Performed by: Doug Yates  
Sample #: A04, Spectrum 2  
Location: Open Area 26 North, Upper Right Corner of Room 72  
Facility: Penn Regional Nanotechnology Facility  
Analysis Performed: SEM-EDS  
Date Sampled: August 2001  
Date Analyzed: April 2008  
Microscope: JEOL 6400 SEM
SEM-EDS Analysis
Speaker Chief House: Cliff Palace
5MV0625 Mesa Verde National Park

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<td>Sample #: B01, Elemental Mapping</td>
<td>Date Sampled: August 2001</td>
</tr>
<tr>
<td>Location: Open Area 25 North, 1m. from Open Area 26’s entrance</td>
<td>Date Analyzed: April 2008</td>
</tr>
<tr>
<td>Facility: Penn Regional Nanotechnology Facility</td>
<td>Microscope: JEOL 6400 SEM</td>
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B01 Cross-Section at 40x Mag. Leica MZ16

B01 Cross-Section SEM-EDS Carbon

B01 Cross-Section SEM-EDS Oxygen

B01 Cross-Section SEM-EDS Silicon

B01 Cross-Section SEM-EDS Calcium

B01 Cross-Section SEM-EDS Iron

B01 Cross-Section SEM-EDS Alumina

B01 Cross-Section SEM-EDS Sulfur
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<tbody>
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<td>Sample #: B01, Spectrum 1</td>
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<tr>
<td>Location: Open Area 25 North, 1m. from Open Area 26’s entrance</td>
<td>Date Analyzed: April 2008</td>
</tr>
<tr>
<td>Facility: Penn Regional Nanotechnology Facility</td>
<td>Microscope: JEOL 6400 SEM</td>
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**Electron Image 1**

**Spectrum 1**

**Layer 2**

**Spectrum 2**
Appendix E

XRD Data Analysis
XRD Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

Sample Location Type Components
C03 Open Area J Yellow Wash 85% Aragonite
12% Wollastonite
4% Quartz
XRD Analysis
Open Area J: Cliff Palace
5MV0625 Mesa Verde National Park

Sample Location Type Components
C11 Open Area J Thick Red Wash 72% Aragonite 19% Montmorillonite 8% Albite 1% Titanomagnetite
XRD Analysis
Speaker Chief House: Cliff Palace
5MV0625 Mesa Verde National Park

<table>
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<th>Location</th>
<th>Type</th>
<th>Components</th>
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</thead>
<tbody>
<tr>
<td>A07</td>
<td>Open Area 26</td>
<td>Cream Wash</td>
<td>41% Montmorillonite</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>26% Quartz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22% Wollestoneite</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11% Calcite</td>
</tr>
</tbody>
</table>
XRD Analysis
Speaker Chief House: Cliff Palace
5MV0625 Mesa Verde National Park

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Type</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>A13</td>
<td>Open Area 26</td>
<td>Thick Red Wash</td>
<td>49% Quartz, 40% Muscovite, 7% Albite, 4% Calcite</td>
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</tbody>
</table>
XRD Analysis
Soil Analysis
Mesa Verde National Park

Yellow Soil

<table>
<thead>
<tr>
<th>Components</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>51%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>26%</td>
</tr>
<tr>
<td>Dolomite</td>
<td>7%</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>6%</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>5%</td>
</tr>
<tr>
<td>Calcite</td>
<td>5%</td>
</tr>
</tbody>
</table>

Sample Location Type

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location Type</th>
<th>Components</th>
</tr>
</thead>
</table>
| Yellow Soil | Open Area | 51% Quartz  
|           | 26% Muscovite | 7% Dolomite  
|           | 6% Kaolinite | 5% Orthoclase  
|           | 5% Calcite    | |
XRD Analysis
Soil Analysis
Mesa Verde National Park

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Type</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Soil (Caleche)</td>
<td>Open Area 26</td>
<td>Soil</td>
<td>46% Quartz, 42% Calcite, 8% Kaolinite, 4% Magnetite</td>
</tr>
</tbody>
</table>
### XRD Analysis

**Soil Analysis**

**Mesa Verde National Park**

#### Mancos Shale

<table>
<thead>
<tr>
<th>Sample Location Type</th>
<th>Components</th>
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<tbody>
<tr>
<td>Mancos Shale Open Area 26</td>
<td>Soil</td>
</tr>
<tr>
<td></td>
<td>65% Quartz</td>
</tr>
<tr>
<td></td>
<td>22% Albite</td>
</tr>
<tr>
<td></td>
<td>12% Kaolinite</td>
</tr>
<tr>
<td></td>
<td>1% Vermiculite</td>
</tr>
</tbody>
</table>

#### Peak List

- 01-079-1913: Quartz, SiO₂
- 01-080-0885: Albite, Na₄(OH)₂Al₆Si₄O₁₄
- 01-083-1007: Albite 191, Na (Na₂O·SiO₃)
- 01-090-0887: Mica, K₂Al₂Si₃O₈(OH)₂

#### Mancos Shale

![Mancos Shale Pie Chart]

- Quartz: 65%
- Albite: 22%
- Kaolinite: 12%
- Vermiculite: 1%
Appendix F

Data Summary Results and Schemes
## Open Area J Stratigraphic Analysis Summary

<table>
<thead>
<tr>
<th>Room</th>
<th>Sample #</th>
<th>Layer</th>
<th>Finish Type</th>
<th>Color</th>
<th>Sorting</th>
<th>Shape</th>
<th>Cohesion</th>
<th>SEM-EDS</th>
<th>XRD</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 C04</td>
<td>1</td>
<td>mortar</td>
<td>2.5YR 8/2 (pale yellow)</td>
<td>well sorted</td>
<td>sub-angular to sub-rounded</td>
<td>very good (well packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>23 C04</td>
<td>2</td>
<td>thick wash (0.58 mm)</td>
<td>2.5YR 6/4 (light reddish brown)</td>
<td>well sorted</td>
<td>angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>23 C04</td>
<td>3</td>
<td>thin wash</td>
<td>2.5Y 8/1 (white)</td>
<td>poor (predominantly clay sized particles)</td>
<td>rounded to well rounded</td>
<td>poor (very fractured layer)</td>
<td>similar to red ochre</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>23 C11</td>
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<td>mortar</td>
<td>10YR 8/2 (very pale brown)</td>
<td>well sorted</td>
<td>sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>23 C11</td>
<td>2</td>
<td>thin wash (0.13 mm)</td>
<td>7.5YR 8/4 (pink)</td>
<td>well sorted</td>
<td>sub-angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>25 C01</td>
<td>1</td>
<td>mortar</td>
<td>2.5Y 8/2 (pale yellow)</td>
<td>well sorted</td>
<td>sub-angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>quartz</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>25 C01</td>
<td>2</td>
<td>thin wash (0.063 mm)</td>
<td>2.5Y 7/1 (light gray)</td>
<td>poor (predominantly clay sized particles)</td>
<td>sub-rounded to rounded</td>
<td>excellent (densely packed particles)</td>
<td>quartz</td>
<td>Si, Ca, Al</td>
<td>K, Fe, Mg</td>
</tr>
<tr>
<td>25 C03</td>
<td>1</td>
<td>plaster</td>
<td>7.5YR 8/4 (pink)</td>
<td>well graded</td>
<td>sub-angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>25 C03</td>
<td>2</td>
<td>thin wash (aura)</td>
<td>10YR 8/3 (very pale brown)</td>
<td>poor (predominantly clay sized particles)</td>
<td>sub-rounded to rounded</td>
<td>excellent (densely packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</table>

**Instrumental Analysis Findings**

- **SEM-EDS**
  - Primary: N/A
  - Secondary: N/A
  - XRD: N/A

- **XRD**
  - Primary: N/A
  - Secondary: N/A
  - XRD: N/A
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<th>Shape</th>
<th>Cohesion</th>
<th>CPL</th>
<th>SEM-EDS</th>
<th>XRD</th>
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<tr>
<td>26</td>
<td>C06</td>
<td>1</td>
<td>mortar</td>
<td>7.5YR 6/4 (light brown)</td>
<td>well sorted</td>
<td>sub-angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>quartz</td>
<td>Si, Ca, O, Na</td>
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<tr>
<td>26</td>
<td>C07</td>
<td>2</td>
<td>thick wash (aura) (0.107mm)</td>
<td>7.5YR 4/1 (dark gray)</td>
<td>well sorted</td>
<td>sub-angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>quartz, possible charcoal</td>
<td>Ca, Si, O, Mg, Fe</td>
<td>N/A</td>
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<tr>
<td>26</td>
<td>C10</td>
<td>1</td>
<td>mortar</td>
<td>10YR 8/3 (very pale brown)</td>
<td>well sorted</td>
<td>angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>26</td>
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<td>sub-rounded to rounded</td>
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Open Area J Stratigraphic Analysis Summary

Instrumental Analysis Findings

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<th>Finish Type</th>
<th>Color</th>
<th>Sorting</th>
<th>Shape</th>
<th>Cohesion</th>
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<tr>
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<td>mortar</td>
<td>7.5YR 6/4 (light brown)</td>
<td>well sorted</td>
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<td>good (moderately packed particles)</td>
<td>quartz</td>
<td>Si, Ca, O, Na</td>
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<td>sub-angular to sub-rounded</td>
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<td>quartz, possible charcoal</td>
<td>Ca, Si, O, Mg, Fe</td>
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<td>C10</td>
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<td>10YR 8/3 (very pale brown)</td>
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<td>angular to sub-rounded</td>
<td>good (moderately packed particles)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<td>C10</td>
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<td>thick wash (aura) (0.536mm)</td>
<td>7.5YR 6/4 (light brown)</td>
<td>well sorted</td>
<td>sub-rounded to rounded</td>
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## Open Area J Stratigraphic Analysis Summary

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<td>Primary</td>
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<td>27</td>
<td>C08</td>
<td>1</td>
<td>plaster</td>
<td>5YR 6/6 (reddish yellow)</td>
<td>well sorted</td>
<td>sub-angular to sub rounded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>thick wash (aura)</td>
<td>Gley 1 6/ (gray)</td>
<td>well sorted</td>
<td>sub-angular to sub rounded</td>
</tr>
<tr>
<td></td>
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<td>thin wash (aura)</td>
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<tr>
<td>27</td>
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<td>10YR 8/3 (very pale brown)</td>
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</tr>
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<td></td>
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<td>2</td>
<td>thin wash (room band)</td>
<td>7.5YR 6/4 (light brown)</td>
<td>poor (predominately clay sized particles)</td>
<td>well rounded</td>
</tr>
<tr>
<td>Room</td>
<td>Sample #</td>
<td>Layer</td>
<td>Finish Type</td>
<td>Color</td>
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<td>71</td>
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<tr>
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<td>10YR 8/4 (very pale brown)</td>
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<td></td>
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<td>thin wash (&lt;0.02mm)</td>
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<td>10YR 8/4 (very pale brown)</td>
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<td>thick wash (0.818mm)</td>
<td>5YR 7/4 (pink)</td>
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<td>133</td>
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<td>2.5Y 6/4 (pale yellow)</td>
<td>well sorted</td>
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<td>thin wash (&lt;0.062mm)</td>
<td>2.5Y 8/3 (pale yellow)</td>
<td>poor (moderately clay sized particles)</td>
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<td>133</td>
<td>A02</td>
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<td>10YR 8/3 (very pale brown)</td>
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<td></td>
<td></td>
<td>2</td>
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<td>poor (moderately clay sized particles)</td>
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<td>3</td>
<td>thin wash (0.036mm)</td>
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<td>Room</td>
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<td>Layer</td>
<td>Finish Type</td>
<td>Color</td>
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<td>Instrumental Analysis Findings</td>
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<td>70</td>
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<td>thin wash</td>
<td>7.5YR 7/1 (light gray)</td>
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<tr>
<td>70</td>
<td>B02</td>
<td>1</td>
<td>mortar</td>
<td>10YR 8/3 (very pale brown)</td>
<td>fairly well sorted</td>
<td>angular to sub-rounded</td>
</tr>
<tr>
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<td>thin wash</td>
<td>7.5YR 7/4 (pink)</td>
<td>well sorted</td>
<td>sub-rounded to rounded</td>
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### Eastern Façade of Open Area J

<table>
<thead>
<tr>
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<th>Field</th>
<th>Dado</th>
<th>Aura</th>
<th>Room Band</th>
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<tbody>
<tr>
<td>Room 25</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Room 26</td>
<td>Red</td>
<td>N/A</td>
<td>N/A</td>
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**Scheme 2**

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<td>Room 26</td>
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<tr>
<td>Room 27</td>
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**Scheme 3**

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<tr>
<td>Room 25</td>
<td>Red</td>
<td>Cream</td>
<td>Red</td>
<td>Gray</td>
</tr>
<tr>
<td>Room 26</td>
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<td>Buff</td>
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<tr>
<td>Room 27</td>
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**Scheme 4**

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<tbody>
<tr>
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<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Gray</td>
</tr>
<tr>
<td>Room 26</td>
<td>Red</td>
<td>Red</td>
<td>Gray</td>
<td>Gray</td>
</tr>
<tr>
<td>Room 27</td>
<td>Red</td>
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**Scheme 5**

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<tbody>
<tr>
<td>Room 25</td>
<td>Red</td>
<td>Cream</td>
<td>Red</td>
<td>Gray</td>
</tr>
<tr>
<td>Room 26</td>
<td>Red</td>
<td>Cream</td>
<td>White</td>
<td>Gray</td>
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<tr>
<td>Room 27</td>
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**Scheme 6A**

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<td>Red</td>
<td>Gray</td>
</tr>
<tr>
<td>Room 26</td>
<td>Red</td>
<td>Red</td>
<td>White</td>
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</tr>
<tr>
<td>Room 27</td>
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**Scheme 6B**

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<tbody>
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<td>Red</td>
<td>Cream</td>
<td>Red</td>
<td>Gray</td>
</tr>
<tr>
<td>Room 26</td>
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<tr>
<td>Room 27</td>
<td>Red</td>
<td>Cream</td>
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## North Façade of Open Area 26

### Scheme 1

<table>
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<td>Room 71</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<td>Room 72</td>
<td>Red/Exposed Masonry</td>
<td>N/A</td>
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<td>N/A</td>
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<tr>
<td>Room 133</td>
<td>red</td>
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### Scheme 2

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<th>Aura</th>
<th>Room Band</th>
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</thead>
<tbody>
<tr>
<td>Room 71</td>
<td>Red</td>
<td>N/A</td>
<td>Cream</td>
<td>N/A</td>
</tr>
<tr>
<td>Room 72</td>
<td>Red/Exposed Masonry</td>
<td>N/A</td>
<td>Cream</td>
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<tr>
<td>Room 133</td>
<td>Red</td>
<td>N/A</td>
<td>Cream</td>
<td>N/A</td>
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</table>
Appendix G

Materials and Distributors
BUEHLER
41 Waukegan Rd P.O. Box 1
Lake Bluff, IL 60044-1699
847.295.500
800.283.4537
http://www.buehler.com
Isomet Low Speed Saw and polishing supplies

CARGILLE-SACHER LABORATORIES, INC
55 Commerce Rd.
Ceder Grove, NJ 07009
973.239.6633
http://www.cargille.com/index.html
Meltmount used for sample mounting.

FISHER SCIENTIFIC
Liberty Lane
Hampton, NH 03842
800.766.7000
http://www.fishersci.com
All reagent chemicals and other noted laboratory equipment used.

WARD’S NATURAL SCIENCE
PO Box 92912
Rochester, NY 14692-9012
800.962.2660
http://www.wardsci.com
Liquid Bio-plastic polyester resin and peroxide catalyst used for embedding samples.
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