

Excavation and Additional Studies at the Haynie Site (5MT1905) by the Crow Canyon Archaeological Center Annual Progress Report 2024

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Introduction

In 2016, the Crow Canyon Archaeological Center (Crow Canyon, or CCAC) initiated the Northern Chaco Outliers Project (NCOP), a multi-year excavation and laboratory analysis project focused on the Haynie site (5MT1905) in southwestern Colorado (Ryan 2016). This report describes the project background and research objectives and summarizes archaeological work conducted under State of Colorado permit #81256 at the Haynie site in 2024 as well as preliminary results of laboratory analyses.

The Northern Chaco Outliers Project

The Chaco cultural phenomenon was centered in Chaco Canyon, New Mexico and reached its greatest regional influence between A.D. 840 and 1140 (Judge 1979; Judge and Cordell 2006; Lekson 2006, 2015; Plog and Heitman 2010; Reed 2004; Saitta 1997; Sebastian 1992; Van Dyke 2007; Vivian 1990; Ware 2014). Archaeologically, Chaco culture was characterized by the construction of monumental masonry great houses with a preplanned layout, civic architecture such as great kivas and road segments, earthworks, a recognizable stylistic architectural and ceramic style, nonlocal exchange networks, social inequality, and a suite of ritual practices. Between A.D. 1050 and 1140 Chaco-style architecture, landscapes, and settlement patterns expanded across the northern Southwest, appearing in what is now northeastern Arizona, southeastern Utah, and southwestern Colorado (Brown et al. 2013; Cameron 2008; Kantner and Mahoney, eds 2000; Lipe 2006; Ryan 2008; Reed, ed. 2008; Van Dyke 1999). Archaeologists continue debating the level of social, cultural, or political control and influence this expansion represents. The NCOP seeks to understand the impact of Chacoan influence in the northern San Juan region of southwestern Colorado during the Chaco and post-Chaco periods by addressing four interrelated research domains: the role of community centers with public architecture, social stratification, identity formation, and human-environment interaction (Ryan 2016).

The focus of the NCOP is a multi-great house community known as the Lakeview Group. The Lakeview Group includes four great houses and a great kiva within a 1-km radius. Multi-great house communities are a poorly understood facet of the Chaco and post-Chaco periods in the northern San Juan region. Regionally, archaeologists identify multi-great house communities at Aztec Ruins (Brown and Paddock 2011; Lekson 2015; Turner 2015, 2019; Van Dyke 2007), Mitchell Springs (Dove 2014, Lowry Pueblo (Kendrick and Judge 2000), and the Lakeview Group. This concentrated density of known great houses in such close proximity to one another is rare in the northern southwest. Gilpen (2003) states that this density of great houses in this proximity to one another is found in only 1 percent of known great house clusters in the northern southwest. The Haynie site contains the remains of two great house structures within the 5-acre property owned by The Archaeological Conservancy. The Wallace Ruin great house (5MT6970) is located 335 m south of Haynie (Bradley 1988, 1992, 1993, 2010, 2015; Bradley and Bradley 2019, 2020). An additional great house and an associated great kiva are found at the Ida Jean site (5MT4126) (Brisbin and Brisbin 1973), located 859 m west of the Haynie site. Additionally, other great houses are within relatively close proximity (e.g., Jensen great house site).

There is little research examining the relationships between monumental structures within multi-great house communities, and it is not clear how these clusters functioned within the adjacent community. Furthermore, the role of the northern multi-great house communities within the Chaco regional system is uncertain. To address these issues, Crow Canyon archaeologists, in consultation with Crow Canyon's Pueblo Advisory Group, have developed a series of guiding research questions, situated within the four research domains described above (and summarized from Ryan 2016):

- How did the Lakeview group first arise, and how did it develop over time? How did each great house function and what kinds of relationships existed between great houses?
- How was inequality or equality expressed within the Lakeview community?
- Drawing on the communities of practice concept (Lave and Wenger 1991), how did identities unfold within the Lakeview group during the Chaco period (ca. A.D. 1080-1140) and did they change during the post-Chaco period (A.D. 1140-1225)?
- What conditions of possibility (or impossibility) arose during periods of significant environmental change, for example the great drought of A.D. 1130-1180? How was environmental change intertwined with community formation, inequality, and identity?

Crow Canyon researchers designed the NCOP fieldwork and laboratory analyses to utilize environmental and material culture data to address these research questions. This research will contribute to regional archaeological issues—such as the degree of political centralization present within Chaco society—and a suite of broader anthropological questions concerning culture and environment.

To answer these research questions, the NCOP is conducting both fieldwork and laboratory analysis. Crow Canyon's archaeological fieldwork in the Lakeview group focuses on the Haynie site (5MT1905). Staff and participants have conducted site testing excavation, remote sensing, architectural documentation, and artifact analyses at the site since 2016. Laboratory analysis of material excavated from the Haynie site is on-going.

Bruce Bradley has conducted excavations at the nearby Wallace Ruin for over 50 years (Bradley 1988, 1992, 1993, Bradley and Bradley 2019, 2020). Although much of the Ida Jean site has been disturbed, the great kiva is partially intact and some information on the site is available from work conducted in the 1970s (Brisbin and Brisbin 1973). Furthermore, notes, maps, and artifact data exist from previous nonprofessional excavations at the Haynie site and are on file at CCAC. Crow Canyon is integrating these data into a research database to augment new data collected through excavation at Haynie.

Project Area Location and Ownership

The Lakeview Group is in Montezuma County, Colorado, east-northeast of the modern-day town of Cortez (Figure 1). The sites in this group are in the heart of the Mesa Verde archaeological region, north of the Mesa Verde escarpment and near the confluence of Simon Draw and

McElmo Creek. Stinking Springs is a significant nearby drainage and is located southeast of the Lakeview group. The majority of the Haynie site is located on a 5-acre property acquired by The Archaeological Conservancy from the Haynie Ranch, LLC. The easternmost portion of the Haynie site, including a portion of the east great house, is on private land not accessible to Crow Canyon. Bruce and Cindy Bradley own Wallace Ruin and Greenstone Pueblo, a small domestic habitation adjacent to Wallace Ruin. The Ida Jean site, including the great kiva, is on private land not accessible to Crow Canyon.

Environmental Setting

The NCOP study area includes an environment defined by the surrounding drainages and by current agricultural use of the land. Figure 2 shows the locations of sites in the Lakeview group. The Haynie site is located at 1,911 m (6,270 ft) and sits at the toe of a ridge that trends northeast, and just above a shallow broad valley associated with the Simon Draw drainage. The valley broadens just south of the site. The head of Simon Draw is located about 6 km north of the Haynie site and after bordering the Haynie Site it continues south-southwest until feeding into McElmo Creek 4 km southwest of the Haynie site.

The soils of the Simon Draw valley located south of the Haynie and Ida Jean Sites, and upon which Wallace Ruin sits, are predominantly Gladel-Pulpit complex (an eolian loess), and Ramper clay loam (a well-drained eolian loess). According to Van West (1994:162-167), these soils are among those with the greatest agricultural potential in the entire region. Today the undeveloped areas of the valley bottom are plowed and irrigated and produce primarily alfalfa/grass hay. Small, undisturbed areas are present in the valley, and these are typically covered in sagebrush, lesser amounts of greasewood and saltbush, and some riparian vegetation that includes cottonwood, willow, cattails, and sedges. The Chaco-style great houses and the midden deposits at the Haynie site are covered mostly with greasewood, sagebrush, saltbush, and grasses. A series of sandstone canyons and ridges lie north and northwest of the Haynie site and a series of low sandstone ridges flank the valley floor, these ridges support a pinyon-juniper woodland community.

Crow Canyon Excavation, Documentation, and Recording System

In 2009, Dr. Susan Ryan and other Crow Canyon archaeologists established a permanent, primary site datum. Subsequently, based on this datum, Crow Canyon used a total station to establish a grid across the entire Haynie site. The “0,0” origin point is located southwest of the property’s southwest corner; thus, all grid coordinates have a “northing” and “easting” number (e.g., 400N 300E). In 2016, we used a high-resolution TopCon Hifer II High Resolution GPS Geodetic Receiver to obtain more precise coordinates for the primary datum and backsite. For organizational purposes, the Haynie site is divided into Architectural Blocks. For example, the west great house and adjacent units are referred to as “Architectural Block 100.”

Most of Crow Canyon’s excavations at the Haynie site occur within excavation units (EU) of defined size (e.g., 2-x-4-m, 1-x-1-m) oriented to cardinal directions. We refer to Excavation Units by the size of the unit and the coordinate of the southwest corner (e.g., “3-x-2-m unit, 459N 376E”). Field archaeologists choose original unit size and orientation based on the research

needs in the field. Occasionally, the field crew conducted excavations that do not comply neatly with the typical meter grid unit—these are referred to as “Segments” and assigned a number (e.g., Segment 5). We typically use segments to expose partially buried walls, or to extend a grid unit to capture the corner of a room or structure. Table 1 provides a list of all prior and in-progress excavation units at the Haynie site and shows their locations.

During Haynie site excavations, we often place several grid units and/or segments adjacent to one another. Contiguous grid units and segments are characteristically used for exploring structural remains. In suspected midden deposits, Crow Canyon generally excavates random 1-x-1-m sample units. Finally, we often use smaller 1-x-2-m or 2-x-2-m test units to target specific archaeological features identified through remote sensing, pedestrian survey, or archival work (for example, units of this size were used to seek remains of previous mechanically disturbed areas). We refer to clusters of excavation units as “excavation areas” and we assign each excavation area a letter (e.g., Area A, Area B) (Figure 4).

Within excavation units, we excavate depositional strata by natural layers, usually arbitrarily subdividing strata into 10-cm levels to achieve tighter provenience control. Archaeological contexts that represent distinct natural and cultural deposits or construction events are designated a “study unit” or “SU.” The study unit is the key unit of analysis within the Crow Canyon documentation and recording system. There are three types of study unit designation: Arbitrary (ARB), Structure (STR), and Nonstructure (NST). Arbitrary units tend to be deposits with edges that are either difficult to define or are a result of natural processes (e.g., fallen wall debris, or wind and water-laid post-occupational sediments). Structures include both surface structures and subterranean pit structures and kivas. We give each room within a multi-room habitation an individual structure number. This includes surface rooms and superimposed pit structures. Nonstructures typically include “constructed” deposits that are not defined as structures, such as middens and use surfaces. We give each newly defined study unit one of these three designations depending on its origin and assign it a distinct number.

2024 Excavations at the Haynie Site

This section describes major study units investigated by Crow Canyon during 2024. For the location of structures in Block 100, see Figure 3.

Excavation in Area C: A Pueblo I-Pueblo II Roomblock and Midden

Excavations conducted in Area C are described below by study unit. This area continues to be a focus of testing and research and an important component to understanding the Pueblo I period village, as well as the later Pueblo II overlying component.

Structure 1002 and Structure 1036

Minimal work continued in Structure 1002 and Structure 1036 during 2024. Structure 1036 is an earthen-walled pit structure nested within a larger, earthen-walled pit structure (Structure 1002).

Structure 1002 was the original pit structure and was cut into at a later time by Structures 1036, 1003, and 1018. No work was conducted in Structures 1002 or 1018 in the 2024 season. Structure 1003 was completed and backfilled in 2021. In 2023, approximately two dozen floor features were identified in Structure 1036, Surface 1. Seventeen features were excavated in 2023, including a hearth (Feature 1), two adjacent small pits (Features 2 and 3), and multiple other small features that include postholes and paho features. In 2024, five additional features were documented and excavated (Features 18, 19, 20, 21, 22). Features 18, 19, and 20 were paho holes filled with clean sand. Feature 21 was a pit not-specified (PNS) feature measuring 9-x-10-x-3.5-cm. Feature 22 was a post hole filled with post-abandonment sandy sediment containing sparse charcoal flecking. This feature measured 11-x-11-x-1-cm. All features were fully excavated and sediment from within the features was collected for future analysis. In addition to the fill from each feature, additional pollen samples were collected from the floor of Structure 1036. All features and samples collected were from the northern half of the study unit (4-x-1-m 454N 374E).

No new dates were secured for Structure 1036 during the 2024 season. Structure 1036 has not yielded any datable dendrochronology samples, and it appears the roofing beams were recycled prior to depopulation. Pollen and sediment samples were collected for additional analyses. Work will continue in 2025.

No additional work was conducted within Structure 1002 during the 2024 season.

Structures 1026 and 1042, Structure 1052, Arbitrary Unit 171

Much of the 2024 season's focus centered around Structures 1026 and 1042. These study units consist of a set of overlapping rooms belonging to the surface room block immediately north of Structures 1002 and 1036. In past seasons Structure 1026 construction was thought to post-date Structure 1042 a (higher in stratigraphy) . Structure 1042 was designated the room immediately under (and earlier than) Structure 1026. This series of rooms shows evidence of multiple re-use and remodeling episodes resulting in a complex palimpsest of structures, features, and building sequences. Prior to this season, no testing had been conducted within these study units since 2021.

In the 2023 season, pollen analysis results returned evidence of one cotton pollen grain recovered within these units and an inordinate amount of corn pollen grains (Smith 2023; also, in Satterwhite et al. 2023). It was decided to focus on these study units in 2024 to investigate explanations for the extremely high corn pollen quantities in this set of rooms and to clarify the sequence of masonry wall alignments that were previously not exposed enough to definitively assign to either Structure 1026 or Structure 1042. Our testing in 2024 helped clarify these questions.

Arbitrary Unit 171 is the study unit assigned to the upper strata across the northern arching roomblock that includes Structures 1026 and 1042. It is inferred to be moderately-to-heavily disturbed by previous landowners. Testing in 2024 included Structures 1026 and 1042 (3-x-2-m 459N 376E; 1-x-1-m 460.3N 378E; 1.3-x-1-m 459N 378E; and 0.8-x-1-m 461.2N 378E) and revealed, two distinct low masonry wall alignments, inferred to be a grinding area. Structure 1042

is inferred as a likely turkey pen area, including at least two use surfaces (one each for Structures 1026 and 1042). Study unit 462N 376E is immediately north and adjacent to Structures 1026 and 1042 and is designated Structure 1052. No testing or work was conducted in this unit during the 2024 season.

Approximately six whole manos, mano fragments, and one partial metate were located on the southern half of Surface 1 in Structure 1042. This is the area with an extremely high maize pollen grain count (Smith 2023). North of the ground stone, and distinctly dividing the study unit, were a series of post holes assigned to Structure 1042. Adjacent and north of the post hole features (Structure 1042) was evidence of a turkey confinement area in the northern portion of the unit. This evidence includes high quantities of eggshell fragments, high quantities of turkey gizzard stones, white, pungent staining on the floor surface suggesting uric acid staining (from avian excrement), a fragmented corrugated jar, possibly for use as a watering bowl, and a yellowish mounding of possible turkey dung (Feature 3). The eggshell and gizzard stones await processing in the CCAC lab. The potential uric acid-stained sediments and turkey dung deposits were heavily sampled and collected for future analyses. Additional samples were collected for pollen (including control samples), flotation, and mortar analyses. Pending analyses, the inferences of how these structures may have been used in the past are tentative. However, given the multiple lines of evidence that align with previous research on turkey confinement and penning areas (Conrad 2021), the hypothesized use of Structure 1042 appears supported.

As noted above, Structure 1042 contained multiple features. Features 4, 5, 6, 7, were designated Postholes (POS). All four were excavated with all available sediment collected for additional analyses. Feature 1, a Burned Spot (BSP). Features 2 and 9 were designated Pit: Not Further Specified. Feature 3 is mounded turkey dung (Other feature; OTH) with distinct coloration of surrounding sediments (Munsell 5YR 7/2, Pinkish grey). Feature 8, a Wall Other (WOT), is comprised of the melted remains of an adobe wall. Features 6, 8 and 9 are Postholes associated with Feature 3 and appear to be part of the penning barrier (Figures 6 and 7).

Structure 1003

Structure 1003 was completed and backfilled in 2021. However, the archaeomagnetic samples submitted in 2022 were processed by the Museum of New Mexico Office of Archaeological Studies (NM OAS) during the 2024 season (see Appendix E, Jones 2024). Samples from two hearth features (Features 5 and 7) dated, and possibilities range from A.D. 1000 to A.D. 1300, A.D. 1350 to A.D. 1375, and A.D. 1000 to A.D. 1400 for Feature 5. The most acceptable dates for this feature, based on additional lines of evidence including pottery types and radiocarbon dates, best fit with the A.D. 1000 to 1300 date range.

Feature 7 yielded a date range between A.D. 1050 and A.D. 1125, and A.D. 1200 and A.D. 1275. Given pottery typologies, architecture style, dendrochronology dates, along with other lines of evidence, the most acceptable archaeomagnetic date range for this feature is A.D. 1050 to A.D. 1125. See Tables 2 and 3 in Appendix E for a summary.

Arbitrary Units 1135, 1138 and 1106

Arbitrary Units 1135 and 1138 (1-x-1.5-m 458N 359.5E) were test units located adjacent to Structure 1000. Arbitrary Unit 1135 consisted of Stratum 3 and was completed during the 2024

season. Stratum 4 was assigned Arbitrary Unit 1138 and testing of this stratum started prior to the end of the College Field School program. Arbitrary Unit 1138 testing will continue in 2025.

Arbitrary Unit 1106 (1-x-3-m 457N 361E) is immediately east of Arbitrary Unit 1138 and is a study unit designed to test the exterior area adjacent to the masonry wall in Arbitrary Unit 1138. Surface 1 was partially uncovered during the 2024 College Field School and will continue to be uncovered and documented in 2025.

Ten pollen samples, three flotation samples, and one masonry mortar sample were collected from these study units in 2024 for analyses. Testing in both study units will continue during the 2025 field season.

Nonstructure 1082

Nonstructure 1082 is located on the western side of Area C (Figure 4). Aerial photos suggest this portion of the site is a heavily disturbed midden. In addition to the midden being heavily looted prior to the 1960s, in the late 1980s and early 2000s it was further disturbed by mechanical excavations conducted by previous landowners. Despite mechanical disturbance, the western edge of the midden appears to be largely intact and, in 2021, three 1-x-1-m test units (449N 374E, 450N 374E, 451N 374E) were placed to sample remaining midden deposits. In these units, Nonstructure 1082 is much deeper than would be expected given the surrounding topography. In previous seasons it was initially believed there may be some kind of natural topographic anomaly here, possibly a small drainage channel. However, wall fall, construction material, a scarcity of fluvial gravels and deposits, and roof fall within the profile walls suggest the presence of a likely pit structure. One 1-x-1-m unit (449N 374E) was cleaned up of winter slump, otherwise no substantial work was conducted in these units during the 2024 season.

Excavation in Area A:

Structure 1101, Structure 1102, ARB 1136

Structures 1101 and 1102 are the northern and southern east-halves of a partial-masonry surface room that was subdivided into two rooms. Both are associated with a roomblock in the northern portion of Area A (Figure 4). In 2023, excavations exposed Surface 1 of Structure 1101 which included a hearth (Feature 1), an adjacent slab-lined pit (Feature 2), a feature with an undetermined function (Feature 3), and a posthole (Feature 4). During the 2024 season, Feature 1 testing revealed at least three separate remodeling episodes where the coping around the hearth was modified (Features 1, 5, and 6). The different remodeling events were fully excavated and documented. Archaeomagnetic samples were collected from two of the hearth rinds (Features 1 and 5), one in 2023 and one in 2024. These samples await analysis.

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In 2024 excavations primarily focused on testing a potential structure(s) below Structures 1101 and 1102. For both Structure 1101 and 1102, cultural fill was encountered below Surface 1. Arbitrary Unit 1136 (1-x-4-m 431.50N 386.10E) was then assigned to the fill under Surface 1 of Structures 1101 and 1102. Excavators identified the lower fill as roof fall, strongly suggesting

the presence of an earlier structure predating Structures 1101 and 1102. However, no conclusions are definitive at this stage.

Three dendrochronology samples, from the same beam, were collected in the northern portion of Arbitrary Unit 1136 with the goal of dating structures or features below Structures 1101 and 1102. Additionally, sediment samples were collected from this fill and are awaiting macrobotanical processing.

Structure 1102 is the eastern-half of a partial-masonry surface room immediately south of Structure 1101. It was divided from Structure 1101 by a low, masonry east-west wall abutted to the outer, eastern north-south wall of the original larger room. The low dividing wall was removed in 2024. In 2023, Surface 1 of Structure 1102 was fully exposed and documented. One floor feature was partially exposed in the excavation unit, a small pit with an ashy fill (Feature 1). This feature extended under the dividing wall, predating the division of the rooms. It was fully documented during the 2024 season. In 2024, fieldwork focused on subsurface testing below Surface 1 of Structure 1102 (assigned Arbitrary Unit 1136). No features were encountered in the southern portion of Arbitrary Unit 1136.

A rock alignment trending southwest-northeast was partially exposed in the northern portion of Arbitrary Unit 1136; however, not enough was exposed to warrant a feature assignment before this unit was closed for the season. Work will resume in the 2025 season.

Testing in Area D: West Great House Area

Structures 1115/1138

In the late 2000s, a local archaeologist, Joel Brisbin, tested a pit structure (West Ruin Pit Structure 1 in Brisban's notes) located beneath the northeast corner of the west great house. This was designated Structure 1115 by CCAC. Ralph Haynie, a previous landowner, placed a backhoe trench diagonally across the structure and Brisbin documented the profile stratigraphy and a floor surface. His field notes indicate the preservation of burned roof beams laying on the floor and a potentially partially intact hearth. Sherds collected during excavation suggest the pit structure dates to the Pueblo I period.

In 2023, testing focused on removing the redeposited fill from the 2000s backhoe trench (Structure 1115). Crow Canyon's College Field School students conducted this work and re-exposed Surface 1. Within the southeast profile wall of the trench, intact burned roof beams were visible in the profile. In 2024, a 1-x-1-m unit was established adjacent and south of the trench (448.5N 425E) to attain possible datable roofing material for this structure. Multiple largely intact wood samples were collected. These samples were burned and rested immediately above, or directly on, Surface 1. In addition to dendrochronology samples, pollen, sediment, and vegetal roofing material, or closing material, samples were collected. These samples are pending analyses, and the dendrochronology samples will be sent to the Laboratory of Tree-Ring Research in Tucson, Arizona for dating in the winter of 2025.

Unfortunately, a hearth (Structure 1115, Feature 1), noted in Brisban's notes, was too damaged to attempt archaeomagnetic sampling. However, when clearing the bottom of the 2023 trench excavations, it was discovered that cultural fill extended below Surface 1 of Structure 1115. Structure 1115, Surface 1 was thought by Brisban to be the earliest surface. It appears this is not the case. Just prior to closing this unit for the season, the top of a slab-lined feature was discovered below, and predating, Structure 1115, Surface 1. Given the continuation of cultural fill and the presence of a feature predating Structure 1115, the earlier structure was designated Structure 1138 and will be tested during the 2025 field season.

Structure 1126

Hand-drawn maps made by the previous landowner in the mid-1980s depict a large, masonry-lined, subterranean structure northwest of the "paint shop." In 2019, a geophysical survey was conducted in this location. Electrical resistance data suggest a large, circular anomaly was present. In 2021, a backhoe trench (Segment 33) was placed east-west across the anomaly to locate a potential structure and test for a series of rooms thought to be present by a previous landowner. Segment 33 exposed a masonry wall corresponding to the east edge of the circular anomaly. In 2022, a hand trench (Segment 34) followed the wall segment to the north and south, confirming the anomaly was a curved, masonry double-wythe wall. The subterranean structure is a large masonry-lined kiva and designated Structure 1126. Testing began on the interior of this structure in 2023, excavating interior cultural fill and abundant wall fall. However, no further testing has taken place to date.

Testing of Structure 1126 continued in 2024, reaching a stratigraphic level below wall fall. On the east end of the test unit (1-x-4-m 434N 416E) the masonry upper lining wall remains predominantly intact with approximately 1.2 meters of masonry exposed. Additionally, the top of a masonry bench (Feature 1) was exposed in 2024. Testing of the structure's interior has reached what is primarily identified as roof fall. This stratum is thus far absent of any roofing beams, strongly suggesting the recycling of this structure's roofing supports. In the western portion of the study unit, the top of an apparent masonry alignment was exposed just prior to closing the unit for the season. This alignment will be explored further during the 2025 season (Figure 8). A small trowel test suggests that this alignment consists of more than one course.

Block 300 (Middle Area):

Arbitrary Unit 301

The "middle area" of the site, (Block 300) resides between the east and west great houses (Figure 5). Crow Canyon has not previously conducted any formal testing in this area. The area is heavily disturbed from prior landowner excavations with at least three or four crater-like, mechanically excavated depressions measuring up to 2-m-deep.

In 2024, a project for the College Field School was designed and implemented with the intention of determining a baseline date for the Prehispanic use of one area. Surface pottery suggested a mid-to-late Pueblo I period use.

Because of the way the pits were originally excavated by backhoe, the back dirt from the excavations was placed immediately adjacent to the rim of the depressions. The College Field School students tested two back dirt piles (1-x-1-m 444N 456E, 1-x-1-m, 454N 456E) from one depression (Arbitrary Unit 302) to assess the pottery within the back dirt and determine a timeline for the occupation of the assumed pit structures.

Part of the original hypothesis is that the back dirt deposits would be in reverse chronological order, with the older materials higher in the back dirt deposits and the later materials in the lower reaches of the back dirt. However, the back dirt deposits proved to be highly mixed, homogenous, and relatively shallow impeding attempts to tease out chronological strata. Nevertheless, the pottery types identified dated to the late Pueblo I and early Pueblo II periods. Testing in these units was completed in 2024 and they were backfilled at the end of the season.

Four College Field School students conducted the pottery analyses under the supervision of lab staff. From these analyses they produced a poster and presented their research to Crow Canyon staff and volunteers, and at the 2024 Pecos Conference located near Prescott, Arizona (see Appendix B).

Stabilization of the East Great House

In 2024 The Archaeological Conservancy contracted Woods Canyon Archaeological Consultants to conduct stabilization of Structures 200, 201, and 219 (all kivas) and Structure 210 (masonry room) (Figure 10) in the east great house (Diederichs 2024). This work was completed in April 2024. The treatment primarily involved recapping walls and repointing the upper three-to-five courses of masonry (see Appendix D). The standing masonry walls were stabilized to mitigate threatening conditions of unstable and loose stones in structure walls over eight feet in height (Diederichs 2024). For details of methodology, theoretical approach, and detailed descriptions of location of actual stabilized areas in each kiva or room please refer to Diederichs (2024) in Appendix D.

Structure 200

Structure 200, an above-ground, masonry kiva, is located in the northwestern portion of the great house. The north, east, south, and west walls were stabilized with wall caps and repointing where necessary. Additionally, the southern recess and southwest and southeast pilasters required stones to be reset and the addition of cap stones. Diederichs concluded that Structure 200 is structurally unstable and should be considered a high priority for additional treatment in the next two-to-five years. High priority treatments recommended include architectural documentation, plaster conservation, veneer and feature reconstruction and repointing, and/or mitigation through backfilling (Diederichs 2024).

Structure 201

Structure 201, an above-ground, masonry kiva, is located in the southwestern portion of the great house. Prior to the 2024 stabilization, wall caps were in a deteriorated state with pockets of imminent veneer collapse. A 2-m-long and 0.5-m-wide portion of the east interior lining wall collapsed during the winter of 2023-2024 (Diederichs 2024). This resulted in a large hole in the

upper veneer and numerous visibly unstable stones. At the top of the southern recess severe mortar loss was evident. Treatment included the restacking and relaying of loose stones in the east interior lining wall. To complete wall capping, a relaying of one to three courses of stone was required for the southern recess and southeast pilaster.

Diederichs recommends backfilling of Structure 201 to mitigate continued deterioration and erosion of bench tops, mortar loss, and deterioration of the previously-excavated subfloor vent.

Structure 219

Structure 219, an above-ground, masonry kiva, is located in the southeast portion of the great house. It appears this structure is a later addition inserted into a 5-x-5-m square room. No stabilization work has occurred in this kiva since 2018 and the masonry prior to the 2024 treatments has severely deteriorated. Visible cracks appeared in the east and west veneers, the tops of both benches had lost mortar, and a section of the southeast bench veneer had collapsed to grade (Diederichs 2024).

Treatment included resetting all loose stones and the filling in of any holes with new-laid stone. Several top courses of veneer had to be reset and new stone laid to fill in holes. The severe cracks were cleaned out and repacked with stone and mortar to increase tensile strength of the structure's veneer.

Structure 210

Structure 210, a masonry room, is located south of Structure 219 (Appendix D). Very little of this room remains preserved. A portion of the north wall appears to have been removed during occupation to make room for the southern recess of Structure 219. The east and south walls were obliterated by previous landowner's excavations. The majority of the west wall is standing. The cell walls behind this room show evidence of 12th century A.D. backfilling activities during the construction of Structure 210 (to enclose the room space after the addition of Structure 219).

Artifact and Sample Analyses

Lab Analyses

Crow Canyon staff, participants, and volunteers cataloged and analyzed flaked stone, ground stone, pottery, and environmental samples recovered during excavation. This year, participants in the College Field School and internship programs assisted in laboratory analyses. Cataloging and artifact analyses is in progress. To date, the CCAC laboratory has cataloged 15,126 artifacts and samples. Analyses include 42,554 flaked-lithic artifacts, including 821 bifaces, drills, and projectile points. Ceramic analysis includes 103,743 sherds. Ground stone analysis includes 162 pieces of ground stone, and of this total, 17 pieces have been analyzed under a new and more detailed recording system. Ninety-eight tree-ring samples were processed.

The pottery types identified at the Haynie site and tree-ring data indicate a primary use of the village during the early Pueblo I through Pueblo II Periods (A.D. 750–1150). A less

substantial Pueblo III occupation is also evident, though modern disturbances have impacted these deposits significantly.

Special analyses were conducted on a variety of artifact types. For example, Crow Canyon researchers continued to develop the Pueblo II design analysis protocols and dataset. To date, 907 bowl rim sherds from Cortez Black-on-white, Mancos Black-on-white and Pueblo II white painted sherds have been analyzed from the Lakeview community, including 68 sherds from Greenstone Pueblo (5MT6970), 182 sherds from Wallace great house (5MT6970), 105 bowl rim sherds from the Ida Jean site (5MT4126) and 552 from the Haynie site. The preliminary results of these analyses show the potters in the Lakeview community decorated their white ware bowls with similar design styles as seen in the larger region, but the timing and use of distinct designs styles within a common repertoire of design grammars differed from those reported in other areas of the region. A similar analysis has been applied to the 49 Pueblo III white ware bowls in our ongoing analyses of the Pueblo III white wares at the Haynie site. Additional special analyses of the sherds at the Haynie site consisted of the examination and identification of pottery temper of 1,136 white ware and gray ware rim sherds. Analysis identified a total of 458 ornaments including beads, pendants, bracelets, gaming pieces, rings, bone tubes, other modified stone, modified shell, shaped sherds, and other modified bone. This total includes analyses from across the Lakeview group: 110 from the Haynie Site, 269 from the Wallace Site, 69 from the Ida Jean Site, and 10 from Greenstone Pueblo.

Archaeofaunal Analyses

Crow Canyon's Environmental Archaeologist, Jonathan Dombrosky, supervised the analyses of the faunal specimens catalogued as of August 2024. He was assisted by zooarchaeology intern, Chelsea Betts. Three primary topics guided the faunal research in 2024. First, a need to explore the cause of high levels of unidentifiable bone at the Haynie site. The approach for this consisted of comparing all faunal assemblages at other sites in the CCAC database with those from Haynie. A second important topic of research in 2024 was exploring the faunal assemblage, in particular the artiodactyl remains, to test some long-held assumptions regarding large game hunting, specifically mule deer. The analysts estimated mule deer body size to inform on environmental and anthropogenic influences (i.e., overhunting). Third, a spatial distribution model for grass stable carbon isotope ($\delta^{13}\text{C}$) values was employed to predict where Haynie bison bones (n=6) potentially came from on the landscape (Dombrosky et al. 2024). All of these foci continue to expand the understanding of the daily lives of the Haynie community significantly. See Appendix C for the 2024 archaeofaunal report.

Chronometric Dating

Archaeomagnetic Dating

In the 2024 field season, two hearth features were sampled by archaeologist, Kay Barnett for archaeomagnetic dating. These samples were collected from hearths within Structure 1101 (Features 1 and 5). Samples will be sent to the Office of Archaeological Studies in Santa Fe, New Mexico for dating in the future. See Structure 1101 discussions above for details.

Analysis of Earthen Architectural Materials

As of July 2024, 40 mortar samples from Haynie have been collected for additional analyses. Eight of those were collected by Crow Canyon archaeologists, Katharine Williams and Steve Copeland, in the 2024 season and include mortar, plaster, finish plaster layers, and a scratch coat layer. Six of those collected in 2024 were attained from Structure 200 in the east great house. The other two were collected from Structure 1042 and Nonstructure 1132. At the time of this report, all 40 samples have been visually assessed in the lab and described in terms of color, aggregate size, aggregate type, and relative percentage of aggregate by Williams. Twenty-two samples, from the overall sample of 40, were identified for additional analyses. These samples will be sent to Wagner Petrographic in 2025 for thin sectioning, polishing, and for the generation of high-resolution scans for preliminary micromorphological characterization. Once thin sections and high-resolution scans are returned, analysis will continue using an optical microscope, and as needed, thin sections will be taken to the University of New Mexico by Williams for additional scanning electron microscopy and compositional analyses.

The current earthen architecture materials questions of interest are as follows (Williams 2025, personal communication):

- Do recipes change over time? Is this related to a shift in material sources or to a change in production practice (production group), possibly associated with the construction of Chaco style great houses? Is there continuation in practice over time, suggesting continuity in social identity (or at least the rapid sharing and adoption of local building practice)?
- Are there different recipes in contemporaneous architectural contexts?
- Can different practice groups be identified in the earthen materials sampled at the Haynie site?

These questions are generally united by two areas. First, the need to understand whether apparent visual differences in mixes (e.g., color, aggregate type) are connected to time, function, or social unit. Are these differences in earthen mixes associated with different labor practices at a level beyond material choice? Or are they connected to construction sequence (i.e., people building at different times during one occupation period and using different mixes), function (i.e., storage rooms versus living rooms versus repairs), or social unit (e.g., family 1 versus family 2)?

Second, there is a need to understand whether material choices are consistent across the community through time. If so, then apparent changes in material choice might reflect a change in available materials (e.g., red loess is no longer available). Alternatively, it could reflect a change in production knowledge (e.g., the builders do not have information about the availability of some materials).

Osteological Analysis

Four isolated human remains were inadvertently encountered during the 2024 season. They were analyzed in field by osteologist, Kathy Mowrer (Mowrer 2024), and were reinterred in accordance with the CCAC Human Remains Policy developed by the Native American Advisory Group. See Table 2 for details of the remains encountered.

Supplemental Studies

College Field School Baseline Chronology Project

Crow Canyon's 2024 College Field School was sponsored by the National Science Foundation Research Experiences for Undergraduates Site program. Four students—Brandon Yam, Joseph Watts, Adrian Valbuena, and Sam Bosque—completed a research project analyzing the pottery found in two different back dirt piles associated with a single disturbed and mechanically excavated pit structure (Figure 5). The study was conducted in an area between the west and east great houses on the site. This area has seen no formal testing or in-depth analyses by CCAC. This project provided a baseline chronology, based on pottery types, for this probable structure and portion of the village. The authors inferred the pit structure most likely dated to the late Pueblo I to early Pueblo II period (Appendix B).

College Field School Experimental Ground Stone Production Project

Three students from the 2024 College Field School—Alexander Jones, Christopher Manel, and Nico Pace—completed a project on an experimental approach to ground stone analysis that focused on understanding the production of the most common mano and metate forms from the Haynie site. Their study included collecting raw materials, recording the time invested in production of each tool, and a preliminary calculation of the investment necessary for the manufacture of these ground stone forms. Two metates and two manos were produced for this study. Reuven Sinensky, CCAC Laboratory Manager, supervised the project and development of the poster (Appendix B).

Curation Agreement

Crow Canyon entered into an agreement with the Canyons of the Ancients Visitors Center and Museum, located in Dolores, Colorado, for the curation of collected materials from the Haynie site. The Canyons of the Ancients Visitors Center and Museum will take possession of these materials after the completion of fieldwork and analyses as stipulated in the research design for the NCOP (Ryan 2016).

Public Education, The Intern Educational Program, and College Field School

Six school groups, comprised of 82 students and 18 chaperones, visited the Haynie site for educational tours in 2024. In addition, in accordance with the public outreach values adhered to by CCAC, an additional 92 visitors toured Haynie in 2024. Visitors included former interns, community members, fellow researchers, the PaleoWest Foundation Cultural Resource

Management (CRM) Field School, students from Jagiellonian University, The Archaeological Conservancy, a CCAC Cultural Explorations group, and the CCAC Board of Trustees.

There were two, 10-week sessions of the field internship program, each with two interns (Julia Frost, Carly Rusch, Laine Fischer, and Kaeleen Stauffer). In addition, ten students participated in the 2024 National Science Foundation Research Experiences for Undergraduates Site program College Field School and were introduced to intensive hands-on field methods training, pedestrian survey, and laboratory analyses, as well as training in the cultural history of the region, archaeological ethics, and responsible and inclusive research methodologies.

Research Presentations and Public Outreach

Two posters were presented by College Field School students at the 2024 Pecos Conference in the Chino Valley near Prescott, Arizona on data collected or associated with the Haynie site. Four students—Brandon Yam, Joseph Watts, Adrian Valbuena, and Sam Bosque—created a poster (Appendix B) reporting the results of their chronological analysis based on pottery for a portion of the Haynie site previously untested by CCAC. In addition, three students—Alexander Jones, Christopher Manuel, and Nico Pace—presented results of their study on their experimental approach of the production of ground stone, specifically manos and metates, with the idea of understanding the time, energy expenditure, and techniques for producing ground stone in the Four Corners region from the harvest of raw materials to completion of a final, useable product (Appendix B). Additionally, lab intern, Jonah Bullen, co-authored, with the Lab Manager, Reuven Sinensky, a poster on research identifying nightshade macroremains in the northern Southwest, including samples from the Haynie site.

This public outreach and education component continues to be an important and integral part of the research at the Haynie site and remains an integral part of CCAC's mission to educate on, and teach respect of the regional ancestral populations indigenous to the area and the current indigenous community members maintaining ties to the site and region today.

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Figures

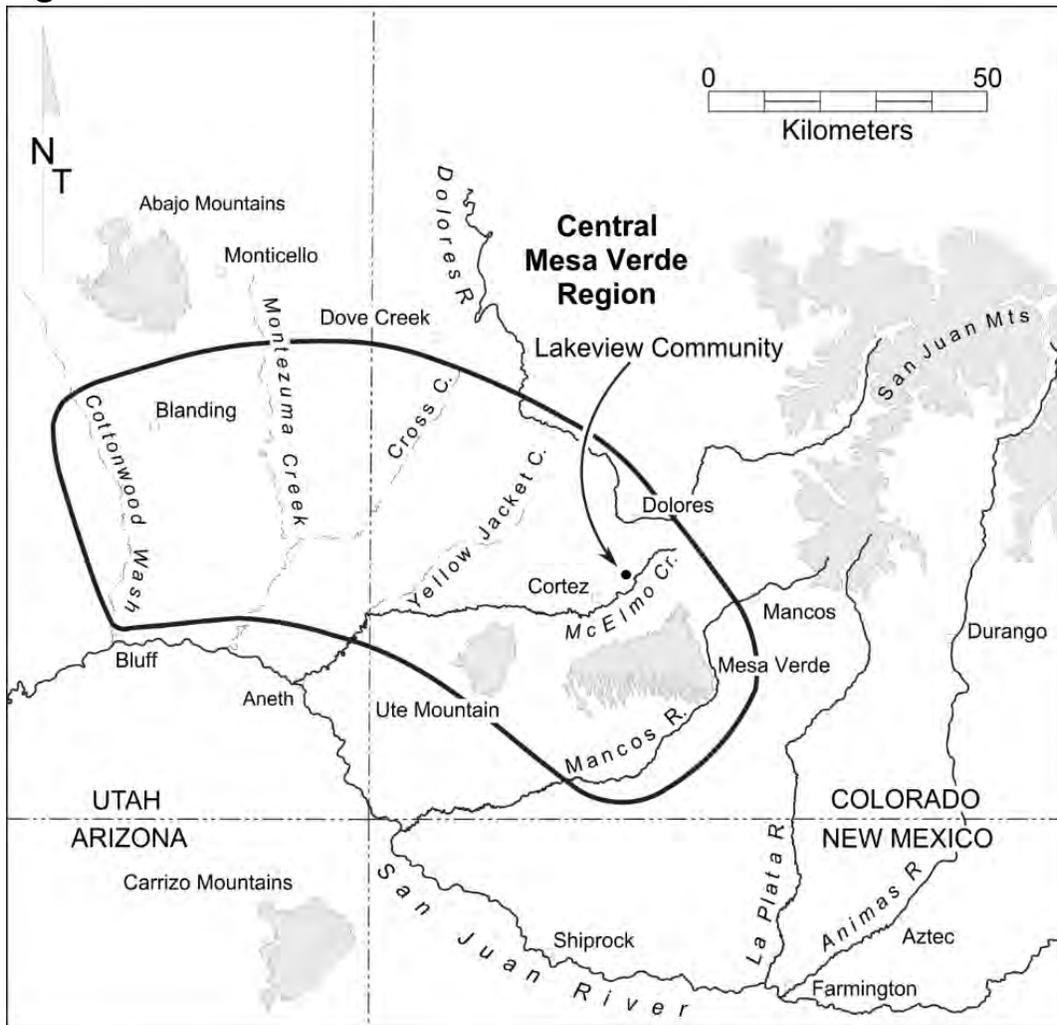


Figure 1. Location of Haynie Site.

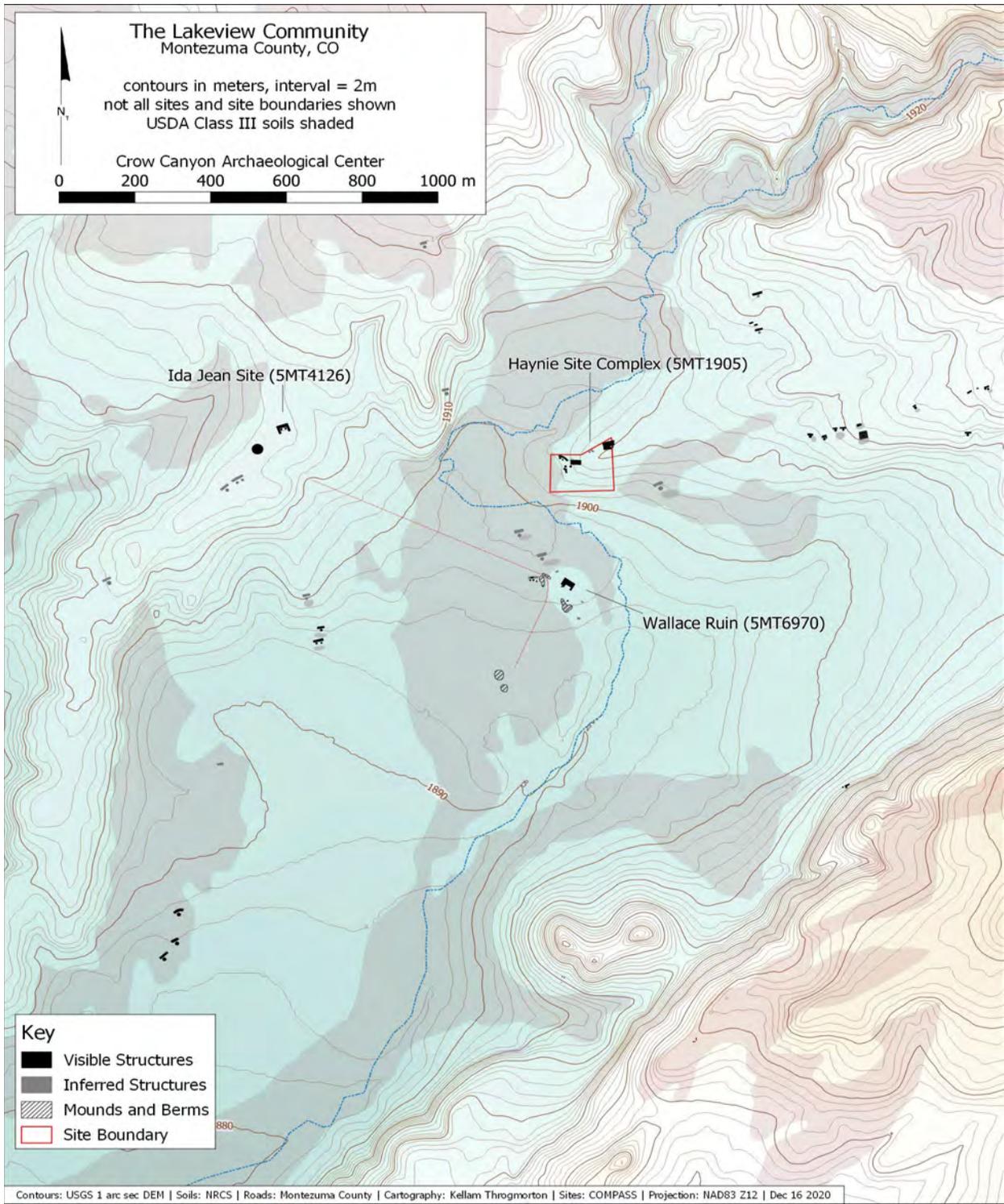


Figure 2. The Lakeview community showing the location of great houses and known or possible habitations.

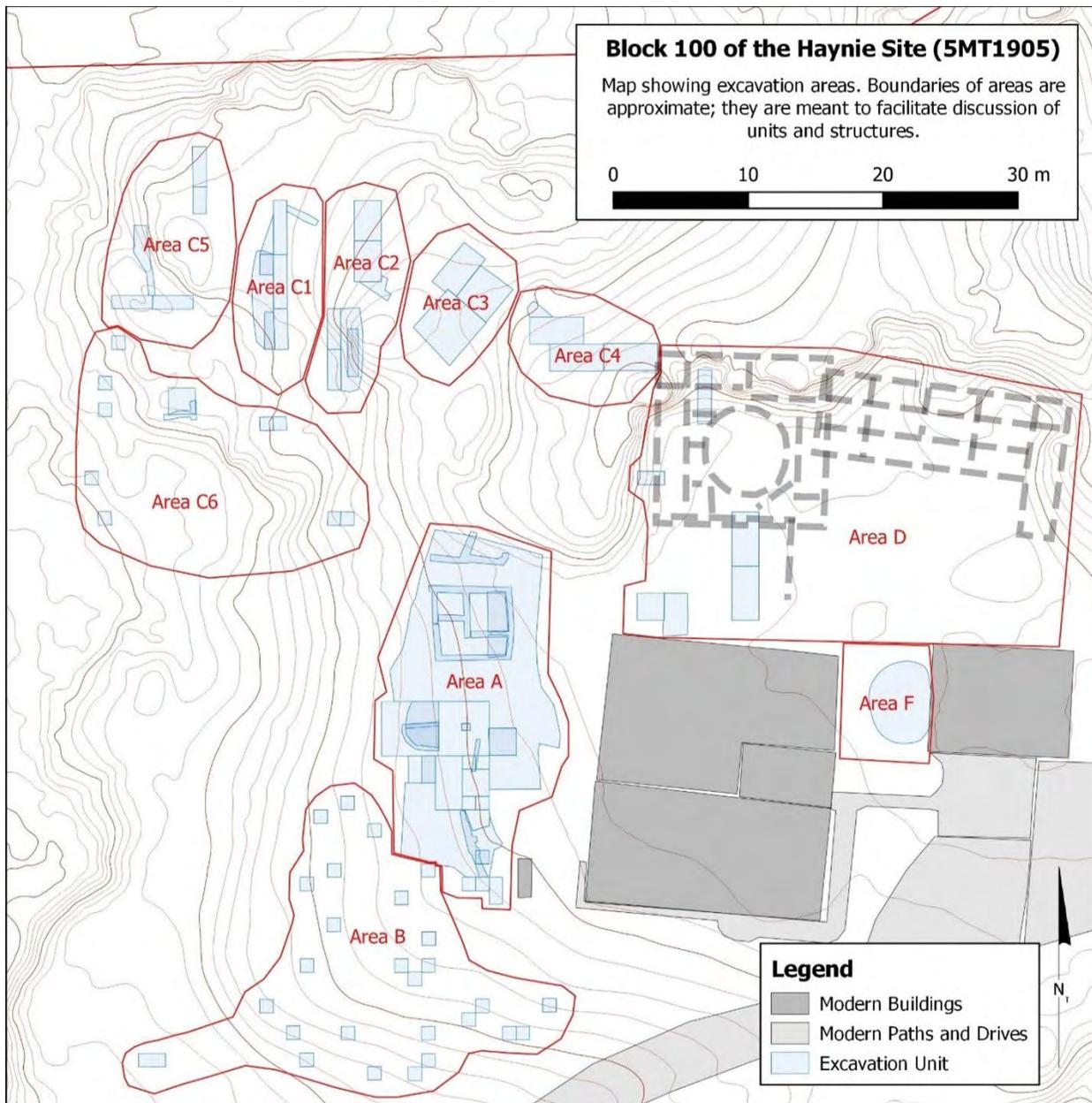


Figure 3. Location of Areas A through F, Haynie Site.

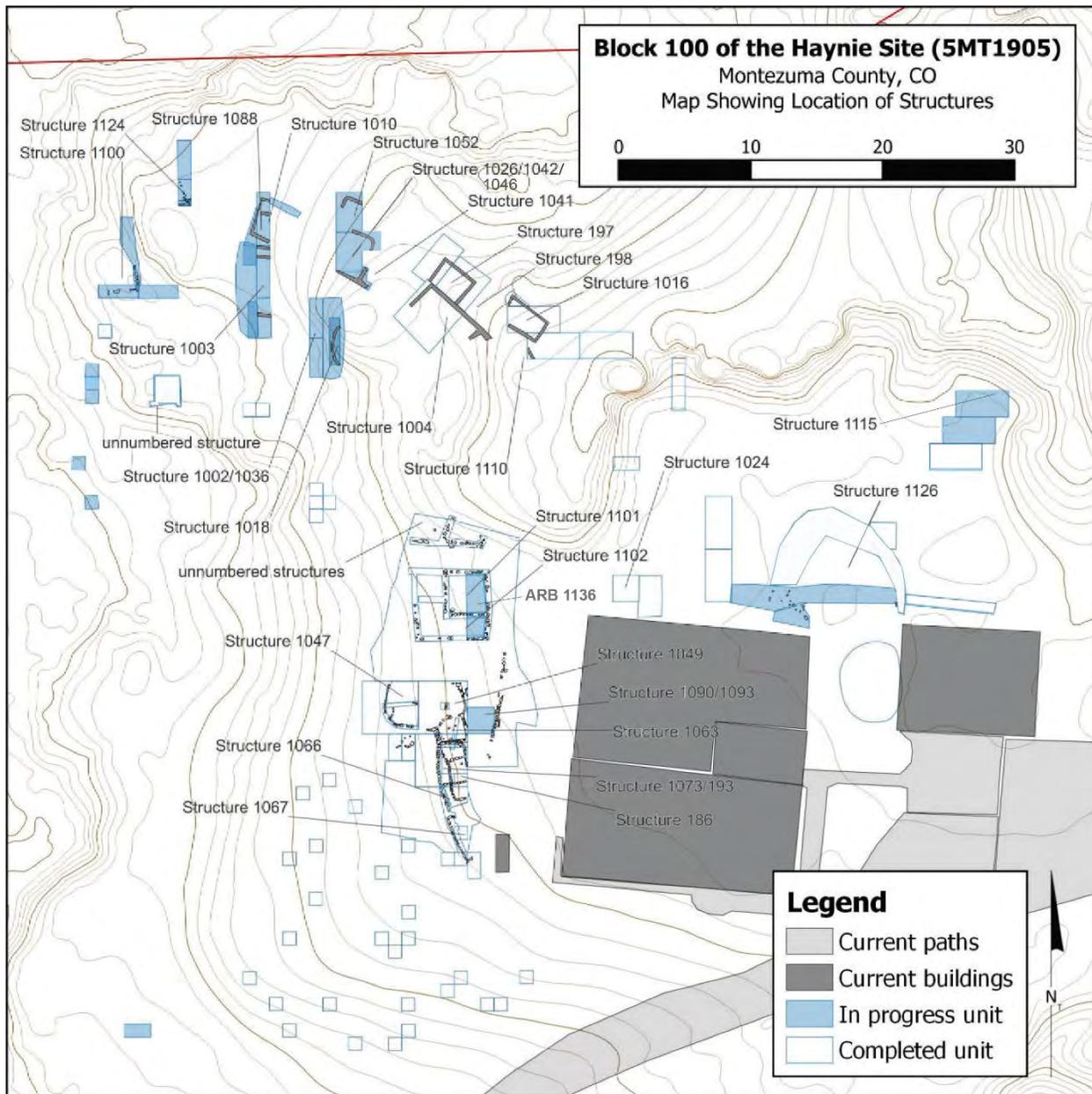


Figure 4. Location of all in- progress excavation units, Haynie site.

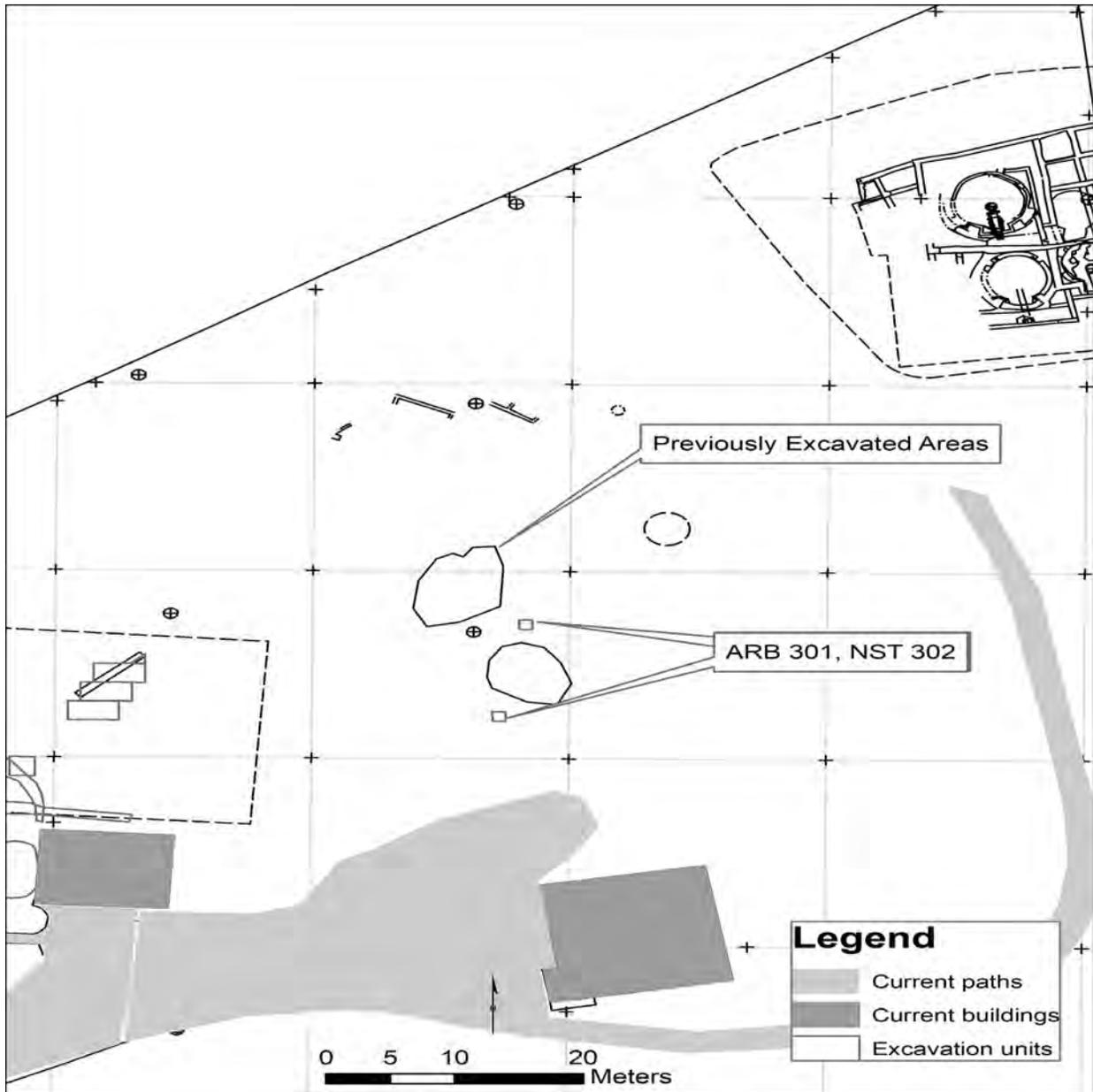


Figure 5. Map of "Middle Area", location of Nonstructure 302 and Arbitrary Unit 301.



Figure 6. Structure 1042/1026, Surface 1, Haynie site. Note yellowish dung mat in northeast corner of the unit, and the white-gray excrement staining in the northwest quadrant.



Figure 7. Structure 1042/1026, Surface 1, Haynie site.



Figure 8. Structure 1126, top of masonry bench in bottom of photo, masonry rock alignment in top of photo.



Figure 9. Structure 1115, Haynie site. Julia Frost, field intern, collects a dendrochronology sample from above Surface 1.

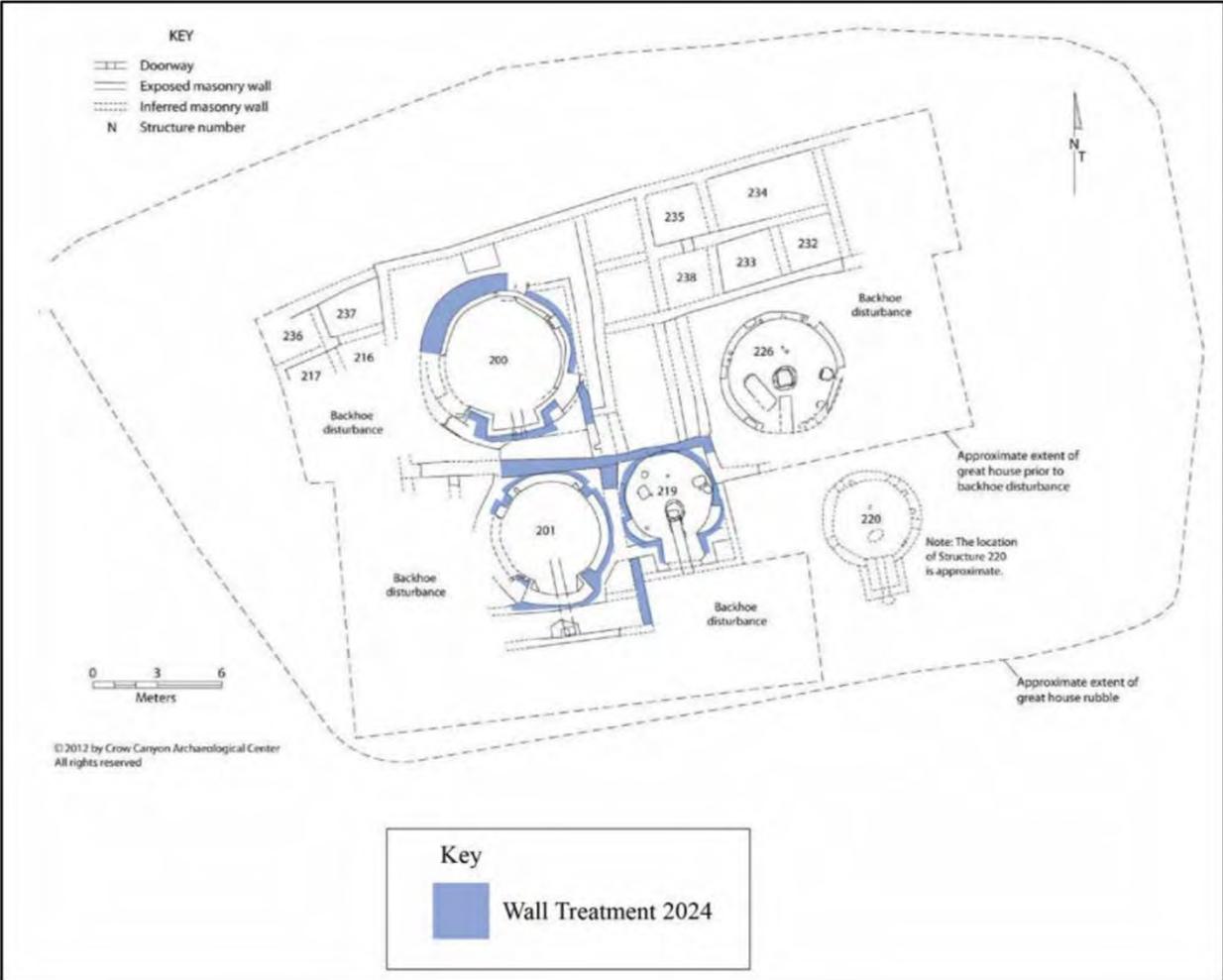


Figure 10. Plan map highlighting 2024 wall treatments at the Haynie site east great house (Diederichs 2024, based on Ryan 2013:663).

Tables

Table 1. List of Excavation Units and Status, Haynie Site

Area	Unit Number	Date Opened	Date Closed	Comments
<i>Excavation Units In Progress</i>				
A	1-x-4-m 431.5N 386.1E	5/20/2024	In Progress	ARB 1136: Unit underneath STRs 1101 and 1102 to test for earlier structure
C1	4-x-1-m 461N 370E	5/29/2108	In Progress	Test trench to investigate rubble north of anomaly identified in remote sensing; walls, structure, surface under STR 1010 Surface 1
C1	Segment 4	10/30/2018	In Progress	Hand trench to identify orientation of wall segment.
C1	Segment 9	6/26/2019	In Progress	Segment to identify corner of structure adjacent to grid unit, STR 1088 (under STR 1010)
C2	3.5-x-1-m 452N 375.5E	5/29/2019	In Progress	Unit expands test trench to expose masonry architecture- STRs 1026/1042 (southeast corner)
C2	3-x-2-m 459N 376E	5/29/2019	In Progress	Test trench to investigate north of anomaly identified during remote sensing. STRs 1026/1042
C2	1.3-x-1-m 459N 378E	8/28/2024	In Progress	Unit expands excavation unit to investigate masonry architecture beyond grid unit; STR 1042
C2	1-x-1-m 460.3N 378E	5/28/2024	In Progress	Unit expands excavation unit to investigate masonry architecture beyond grid unit; STR 1042
C2	0.8-x-1-m 461.2N 378E	9/2/2024	In Progress	Unit expands excavation unit to investigate masonry architecture beyond grid unit; STR 1042
C2	3-x-2-m 462N 376E	9/3/09	In Progress	Expands on test trench to include additional architecture; STR 1057
C2	3-x-1-m 451N 374E	6/1/2017	In Progress	STR 1036: Test trench placed to investigate anomaly identified during remote sensing.
C2	3-x-1-m 454N 374E	6/1/2017	In Progress	STR 1036: Test trench placed to investigate anomaly identified during remote sensing.
C2	Segment 6	5/28/2019	In Progress	Segment is a backhoe cut to step back a deep excavation unit; STRs 1002 and 1036
C2	Segment 11	5/28/2019	In Progress	Placed to identify corner of a structure just outside of grid unit.
C5	1-x-3-m 457N 361E	5/17/2021	In Progress	Test trench to identify wall alignment; NST 1105
C5	1-x-3-m 457N 358E	5/17/2021	In Progress	Test trench to identify wall alignments; STR 1100
C5	1-x-1-m 458N 359.5E	8/31/2021	In Progress	Unit placed to identify a floor surface of Structure 1100; Also, ARB 1135
C5	2-x-1-m 464N 364E	5/17/2021	In Progress	Test trench to identify wall alignments; Structure 1124.
C5	3-x-1-m 466N 364E	5/17/2021	In Progress	Test trench to identify wall alignments
C6	1-x-1-m 449N 357E	5/20/2021	In Progress	Unit placed to test presumed midden deposits; NST 1082
C6	1-x-1-m 450N 357E	5/1/2023	In Progress	Unit placed to test presumed midden deposits
C6	1-x-1-m 451N 357E	5/20/2021	In Progress	Unit placed to test presumed midden deposits
D	Segment 34	5/23/2022	In Progress	Segment established to identify possible wall alignment for pit structure; needs final documentation; this identified the east wall of STR 1126
D	1-x-3-m 434N 416E	7/3/2023	In Progress	This unit placed for interior of pit structure identified by masonry in Segment 34; STR 1126

D	2-x-4-m 446N 422E	4/27/22	In Progress	Unit placed to identify boundaries of Joel Brisban backhoe trench; STR 1115/ STR 1138
D	2-x-4-m 448N 423E	4/27/22	In Progress	Unit placed to identify boundaries of Joel Brisban backhoe trench; STR 1115/ STR 1138
<i>Excavation Units Completed and Closed</i>				
A	1-x-1-m 416N 385E	4/13/2017	7/24/2018	Probability test unit. Unit encountered a PVC leach field pipe. Backfilled.
A	1-x-1-m 420N 385E	9/6/2017	4/31/2021	Sterile identified. Backfilled.
A	4-x-2-m 420N 382E	9/7/2017	10/4/2021	Unit closed after test windows confirmed stratigraphy of deposits. Backfilled.
A	1-x-1-m 420N 384E	4/13/2017	5/5/2021	Probability test unit. Sterile identified. Backfilled.
A	2-x-2-m 421N 384E	5/3/2017	10/5/2021	Sterile identified. Backfilled.
A	2-x-2-m 422N 380E	8/5/2020	10/6/2021	Unit placed to identify ventilator of STR 1047 and replaces 2x1 422N 381E after backhoe stripping. Unit closed after ventilator identified and mapped. Backfilled.
A	2-x-1-m 422N 381E	6/26/2019	7/17/2020	Unit created to explore possible extramural surface and suspected ventilator of STR 1047. Unit closed prior to backhoe stripping and replaced by 2x2 422N 380E. Backfilled.
A	1-x-1-m 423N 385E	4/13/2017	5/6/2021	Probability test unit. Sterile identified. Backfilled.
A	1-x-1-m 423N 384E	5/3/2017	10/29/2020	Sterile identified. Backfilled.
A	4-x-8-m 424N 378E	5/23/2018	11/5/2021	Unit placed to explore anomaly identified during electrical resistivity testing. Sterile identified, testing of STR 1047 completed. Backfilled.
A	1-x-1-m 427N 388E	4/18/2017	10/11/2018	Probability test unit. Unit encountered a PVC leach field pipe. Backfilled.
A	Segment 14	9/17/2020	11/5/2021	Segment created to test western portion of STR 1047. Testing of STR 1047 completed. Backfilled.
A	Segment 22	7/24/2020	11/3/2020	Hand trench to chase walls after backhoe stripping. Segment closed after mapping location of wall segments and structures. Backfilled.
A	Segment 23	7/24/2020	11/3/2020	Segment used for backhoe stripping. Backhoe stripped area closed at end of season. Backfilled.
A	Segment 13	9/17/2020	9/29/2020	Exploratory hand trench in west part of STR 1047 Testing of STR 1047 complete Backfilled.
A	Segment 25	9/24/2020	9/24/2020	Hand trench to identify and map the east wall of STR 1047. Segment closed upon identification of STR 1047 east wall. Backfilled.
A	Segment 21	7/21/2020	7/22/2020	Segment used for backhoe stripping. Backhoe stripped area closed at end of season. Backfilled.
A	Segment 10	8/13/2019	7/7/2020	Hand trench used to identify the south wall of STR 186. Segment 10 closed in 2019 because of human remains. Segment 10 expanded in 2020 to include fill within STR 186 (area with human remains left untouched). Closed on completion of STR 186. Backfilled.
A	STR 1101 E 1/2	9/10/2021	5/20/2024	Unit created to test the east half of STR 1101, then to look for underlying walls. Completed.
A	STR 1102 E 1/2	9/10/2021	5/20/2024	Unit created to test the east half of STR 1102. Completed.
A	2-x-1-m 413N 386E	9/16/2019	7/17/2020	Unit created to expand on adjacent unit after wall segment was found. Deposits overlying architecture were mostly redeposited

				overburden, unit closed prior to backhoe stripping. Backfilled.
A	1-x-1-m 414N 384E	4/13/2017	7/17/2020	Probability test unit. Deposits overlying architecture were mostly redeposited overburden, unit closed prior to backhoe stripping. Backfilled.
A	1-x-1-m 414N 385E	4/13/2017	7/17/2020	Probability test unit. Deposits overlying architecture were mostly redeposited overburden, unit closed prior to backhoe stripping. Backfilled.
B	1-x-1-m 400N 380E	4/17/2017	7/9/2018	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 400N 377E	4/17/2017	9/19/2017	Probability test unit. Bedrock and sterile identified. Backfilled.
B	1-x-1-m 401N 381E	4/17/2017	7/25/2018	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 401N 372E	4/17/2017	7/9/2018	Probability test unit. Bedrock identified. Backfilled.
B	1-x-2-m 401N 360E	5/23/2018	10/31/2024	Unit placed to test deposits at southwest edge of site. Finished unit. Backfilled.
B	1-x-1-m 403N 381E	4/17/2017	8/23/2018	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 403N 375E	4/17/2017	7/26/2018	Probability test unit. Bedrock and sterile identified. Backfilled.
B	1-x-1-m 403N 371E	4/18/2017	7/18/2018	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 403N 387E	4/17/2017	5/7/2018	Probability test unit. Human remains density exceeded limit. Backfilled.
B	1-x-1-m 403N 388E	4/17/2017	5/7/2018	Probability test unit. Human remains density exceeded limit. Backfilled.
B	1-x-1-m 404N 384E	4/17/2017	8/23/2018	Probability test unit. Bedrock and sterile identified. Backfilled.
B	1-x-1-m 405N 385E	4/17/2017	6/19/2019	Probability test unit. Bedrock and sterile identified. Backfilled.
B	1-x-1-m 405N 369E	4/20/2017	6/12/2019	Probability test unit. Large sandstone slabs blocked further progress. Backfilled.
B	1-x-1-m 405N 390E	4/17/2017	8/29/2018	Probability test unit. Large quantity of rodent burrows and potential leach field line. Backfilled.
B	1-x-1-m 407N 380E	4/13/2017	8/28/2019	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 408N 380E	9/9/2019	9/26/2019	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 408N 379E	4/17/2017	8/22/2019	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 408N 381E	4/13/2017	8/22/2019	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 408N 372E	4/20/2017	6/7/2019	Probability test unit. PVC pipe encountered. Backfilled.
B	1-x-1-m 410N 381E	4/13/2017	8/28/2019	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 411N 374E	4/20/2017	10/22/2020	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 413N 379E	4/13/2017	6/3/2019	Probability test unit. PVC pipe encountered. Backfilled.
B	1-x-1-m 414N 372E	4/20/2017	11/3/2020	Probability test unit. Bedrock identified. Backfilled.
B	1-x-1-m 415N 374E	4/20/2017	11/5/2020	Probability test unit. Bedrock identified. Backfilled.
C1	2.75-x-0.65-m 454N 369.35E	5/28/2019	11/8/2022	Unit expands on test trench to expose architecture. Backfilled.

C1	3-x-1-m 454N 370E	6/1/2017	11/8/2022	Test trench placed to investigate anomaly identified during remote sensing. Backfilled.
C1	4-x-1-m 457N 370E	4/21/2017	11/8/2022	Test trench placed to investigate anomaly identified during remote sensing. Backfilled.
C1	1.5-x-1-m 459.5N 369E	5/28/2019	10/04/2022	Unit expands on test trench to expose architecture. Backfilled.
C1	Segment 5	5/28/2019	11/8/2022	The segment is a backhoe cut to step back a deep excavation unit. Backfilled.
C3	Segment 1	5/4/2017	8/16/2018	Segment placed atop a visible masonry surface room. In situ human burial identified in room suite. Backfilled.
C3	Segment 3	4/21/2017	10/18/2017	Segment placed atop a visible masonry surface room. In situ human burial identified in room suite. Backfilled.
C3	Segment 2	6/28/2017	10/5/2017	Segment placed atop a visible masonry surface room. In situ human burial identified in room suite. Backfilled.
C4	2-x-4-m 452.40N 394.50E	4/26/2017	11/9/2021	Unit placed to investigate the foundations of west great house. Undisturbed native sediment identified. Backfilled.
C4	2-x-4-m 452.40N 390.50E	4/26/2017	11/2/2021	Unit placed to investigate the foundations of west great house. Undisturbed native sediment identified. Backfilled.
C4	2-x-4-m 454.40N 389E	7/22/2019	7/27/2021	Unit placed to investigate masonry surface room identified in adjacent unit. Testing of STR 1016 completed. Backfilled.
C4	Segment 12	9/2/2019	9/2/2019	Segment placed to identify corner of structure in adjacent grid unit. Testing of STR 1016 completed. Backfilled.
C5	3-x-1-m 466N 364E	5/17/2021	5/2/2022	Test trench to identify wall alignments. Excavation complete.
C5	Segment 30	7/27/2021	4/18/2023	Hand trench to identify walls of STR 1100. Excavation complete.
C6	1-x-1-m 441N 375E	8/31/2021	9/23/2023	Unit expands on adjacent 1-x-1-m unit after a possible floor surface identified. Excavation complete, awaiting backfill.
C6	1-x-1-m 441N 374E	5/20/2021	9/23/2023	Test unit placed to investigate cultural deposits between Areas A and C suspected to be a midden. Excavation complete, awaiting backfill.
C6	1-x-1-m 442N 374E	5/20/2022	9/23/2023	Unit placed to sample midden deposits identified in adjacent units. Excavation complete, awaiting backfill.
C6	1-x-1-m 441N 357E	5/20/2021	4/21/2023	Unit placed to test presumed midden deposits. Excavation complete, awaiting backfill.
C6	1-x-1-m 444N 356E	5/20/2021	5/17/2023	Unit placed to test presumed midden deposits. Excavation complete, awaiting backfill.
C6	1-x-1-m 448N 370E	8/31/2021	10/15/2023	Placed to expand adjacent unit after possible pitstructure fill identified. Excavation complete, awaiting backfill.
C6	1-x-1-m 448N 369E	5/20/2021	10/15/2023	Unit placed to test presumed midden deposits. Excavation complete, awaiting backfill.
C6	2-x-2-m 449.19N 362.21E	6/30/2021	4/17/2023	Unit placed to investigate several wall segments identified by Segment 28. Excavation complete, awaiting backfill.
C6	1-x-1-m 454N 358E	6/15/2021	11/1/2023	Unit placed to test presumed midden deposits. Excavation complete, awaiting backfill.
C6	Segment 28	5/28/2021	8/5/2021	Segment created to clear overburden from around an exposed wall segment. Placed a grid unit after extent of wall was better defined.

D	2-x-2-m 434N 397E	5/26/2017	10/22/2019	Unit placed to determine whether anything remained of southwest corner of west great house. Testing of STR 1024 completed, undisturbed native sediment identified. Backfilled.
D	4-x-2-m 434N 404E	4/26/2017	10/5/2017	Unit placed to determine whether any foundations remained from west great house. Active leach field encountered. Backfilled.
D	4-x-2-m 438N 404E	4/26/2017	10/23/2017	Unit placed to determine whether any foundations remained from west great house. Active leach field encountered. Backfilled.
D	1-x-2-m 444N 397E	5/26/2017	11/2/2017	Unit placed to determine whether any foundations remained from west great house. Undisturbed native sediment identified. Backfilled.
D	4-x-1-m 448.50N 401.50E	9/20/2018	9/24/2019	Unit placed to determine whether any foundations remained from west great house. Undisturbed native sediment identified. Backfilled.
D	Segment 7	9/2/2019	10/22/2019	Backhoe excavation to step back deep unit. Undisturbed native sediment identified. Backfilled.
D	Segment 33	5/23/2022	10/30/2023	Backhoe trench excavated at end of 2021 to identify structures thought to lie north of the "paint shop." Expanded with mechanical equipment in November 2022. Excavation complete, awaiting backfill.
E	2-x-1-m 388N 410E	5/13/2018	8/29/2020	Unit placed to determine nature of deposits in area south of driveway. Unit was deemed unlikely to reveal cultural deposits without significant expansion on unit. Backfilled.
F	Segment 8	6/3/2019	6/5/2019	Segment created for backhoe stripping atop a possible pit structure identified by auger testing. Gas line encountered. Backfilled.
Block 300	1-x-1-m 444N 456E	5/25/2024	8/10/2024	NST 301 – College Field School backdirt test unit
Block 300	1-x-1-m, 454N 456E	5/25/2024	8/10/2024	NST 301 – College Field School backdirt test unit

Table 2. 2024 Haynie Site Osteological Analysis Results of Isolated Occurrences

Excavation Unit Size and Location	Element	Age Estimate
1-x-1-m 431.5N 386.1E	Fifth metatarsal fragment	Adult (18+ years of age)
1-x-1-m 454N 456E	Long bone fragments	Adult (18+ years of age)
STR 186, Seg 10	Small bone fragments	Indeterminate
1-x-1-m 454 N 456E	Adult molar	Adult (35-45 years of age)

Appendix A – Personnel

Mission Staff

R. David Satterwhite – Field Manager
Steve Copeland – Field Archaeologist
Reuven Sinensky – Laboratory Manager
Jamie Merewether – Collections Manager
Kate Hughes – Laboratory Analyst
Daniel Hampson – Laboratory Analyst
Susan Montgomery – Project Assistant
Rebecca Hammond – American Indian Outreach Manager
Rebecca Renteria – American Indian Initiatives Outreach Coordinator
Jonas Kurronen – Senior Education Manager
Paul Ermigiotti – Educator
Tyson Hughes – Educator
Alicia Benally – Educator
Jon Ghahate – Educator
Jeremy Grundvig – Mission Associate

Research Institute at Crow Canyon Staff

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Grant Coffey – Research Database Manager
Jonathan Dombrosky – Environmental Archaeologist
Katharine Williams – Post Doctoral Scholar in Geospatial Archaeology

IT Support Staff

Robbin Laws – Systems Administrator

Social Media and Outreach

Sarah Payne – Chief Outreach Officer
Emphasis Marketing, LLC. – Marketing and Advertising
Taylor Hasbrouck – Community Outreach Manager

Interns (2024)

Kaeleen Stauffer – Field Intern
Laine Fischer – Field Intern
Julia Frost – Field Intern
Carly Rusche – Field Intern
Chelsea Betts – Zooarchaeology Intern
Jonah Bullen – Laboratory Intern
Logan Ash – Laboratory Intern
Alexandria Roubideaux – Laboratory Intern

Ivan Clow-- Laboratory Intern
Autumn Rose -- Outreach Intern
Annie Kane -- Education Intern
Delancy Griffin -- American Indian Initiatives Intern

Appendix B -College Field School Research Posters

Please See Next Page

Appendix B – College Field School Constructing Chronology of Backdirt at the Haynie Site Project, 2024 Pecos Conference Poster

BACK with THE FILL-TURE

Constructing Chronology of Backdirt at the Haynie Site (5MT1905)

Sam Bosque¹, Adrian Valbuena², Joseph Watts³, and Brandon Yam⁴

I. Introduction

The Haynie site (5MT1905) is a multi-component ancestral village, located northeast of Cortez, CO, and inhabited between A.D. 800 and 1200. It consists of two Pueblo II period (A.D. 750-950) great houses, two Pueblo I period (A.D. 950-1150) room blocks, and a Pueblo III period (A.D. 1150-1300) component (Satterwhite et al. 2023). The site was disturbed by mechanical excavation in the 1980s and 1990s, which led to piles of backdirt scattered throughout the site. The goal of our research is to analyze the cultural deposits disturbed by mechanical excavation in order to reconstruct the chronology of the pit structure between the two great houses (Fig. 1).

Figure 1. Aerial photograph showing locations of east great house, west great house, and location of Test Units 1 and 2.

II. Methods

Two test units were excavated within the backdirt: Test Unit 1 and Test Unit 2 (Figs. 1 & 2). Each 1x1 m test unit was excavated with trowels and picks, then screened with a quarter-inch screen. Test Unit 1 was excavated in one level of 35 cm, and subsequent levels were ~30 cm. Test Unit 2 was excavated in two levels of 40 cm, and subsequent levels were 20 cm.

Pottery Data Scan here

III. Results

- Test Unit 1 was excavated to a depth of approximately 63 cm. Test Unit 2 was excavated to a depth of 100 cm.
- Combined, the units had 126 diagnostic sherds and 843 sherds that were indeterminate either due to being too small or due to a lack of diagnostic features.
- Of the 126 diagnostic sherds, 80 sherds date to Pueblo I and Pueblo II (A.D. 750-1150). Two sherds date to the transitional period between Basketmaker III (A.D. 500-750) and Pueblo I, and 44 dated to the transitional period between Pueblo II and Pueblo III.
- Both Test Units' sherds dated to the Pueblo I and Pueblo II periods (Fig. 3).

Figure 2. LIDAR image showing location of units in relation to the pit structure.

IV. Analysis and Conclusions

Pottery sherds were used solely for dating due to diagnostic characteristics (Ortman et al. 2005). Both Test Units 1 and 2 had sherds dating to the Pueblo I and Pueblo II periods, which is consistent with sherds found elsewhere on the site (Satterwhite et al. 2023). Our analyses indicate this pit structure was likely occupied during the Pueblo I and Pueblo II periods. By examining backdirt, our study demonstrates we can reconstruct chronological assignments of structures based on disturbed contexts. For future research, we recommend following this methodology to reconstruct chronological assignments of a site. We also recommend continuous collaboration with descendant communities on site interpretations.

Acknowledgements

We acknowledge the Pueblo City, Montez, and Cortez, Colorado Projects, which provided us the site access and the shared the National Ancestral Puebloan site data program support. We also thank the Anthropological Community and the staff members at the National Anthropological Archives for their support. We thank the following individuals for their assistance and support: [Logos for The Anthropological Community, New Mexico State University, Hamilton, etc.]

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Appendix B - College Field School Experimental Approach to Ground Stone Analysis, 2024 Pecos Conference Poster

2001: A Ground Stone Odyssey – An Experimental Approach to Ground Stone Analysis

Alexander Jones¹, Christopher Manuel², Nico Pace³ & R. J. Sinensky⁴

¹California State University, Stanislaus, ²University of Arizona, ³Marshall University, ⁴Crow Canyon Archaeological Center

Introduction

- Manos and metates were used by Ancestral Pueblo peoples to process plant foods for millennia, and are still used in Pueblo communities today.
- The time investment necessary to manufacture Ancestral Pueblo grinding tools remains poorly understood by archaeologists.



Fig. 1. Dorsal surface of a mano from the Haynie Site.



Fig. 2. Ventral surface of a mano from the Haynie Site.

The Haynie Site

- An early village (CE 800-950) and great house (CE 950-1200) located in the Central Mesa Verde region.
- Most grinding tools are consistently designed rather than expedient.
- Elongate manos (Figs. 1-2) and ¾ trough metates (Figs. 3-4) are the most common active and passive tools recovered from earlier and later components.



Fig. 3. Plan view of a ¾ trough metate from the Haynie Site.



Fig. 4. Profile view of a ¾ trough metate from the Haynie Site.

Goals

- To better understand the manufacture of the most common mano and metate forms recovered from Haynie.
- To calculate the time investment necessary to manufacture such manos and metates.

Methods

- We collected raw materials for manos and metates from Dove Creek and Dolores River Canyon.
- Igneous cobbles for pecking stones were collected from Mancos Canyon and Dolores River Canyon.
- We measured metric attributes, mass, and the hardness of raw materials and pecking stones pre- and post-manufacture (Table 1).
- The time invested in the manufacture of each tool was recorded in detail.

Table 1. Pre- and Post-Manufacture Experimental Ground Stone Data.

Object Number	Raw Material	Pre/Post Mass (grams)	Pre/Post Length (cm)	Pre/Post Width (cm)	Pre/Post Thickness (cm)	Hardness (1-10)	Trough Depth (cm)	Total Time
Metate 1 (Fig. 5-7)	Dakota Sandstone	42,200/ 37,500	59.0/ 56.0	33.0/ 33.0	13.5/ 13.5	3	0.5	6 hrs, 42 mins
Metate 2 (Fig. 8-9)	Dakota Sandstone	22,040/ 16,100	58.0/ 44.0	28.0/ 28.0	10.0/ 10.0	3	N/A	4 hrs, 18 mins
Metate 3 (Fig. 10-11)	Dakota Sandstone	23,600/ 18,060	53.0/ 51.5	33.0/ 33.0	12.5/ 11.5	3	N/A	1 hr
Mano 1 (Fig. 12-13)	Dakota Sandstone	5,520/ 4,639	26.5/ 20.5	13.5/ 10.0	7.5/ 7.5	3	N/A	2 hrs, 5 mins
Mano 4 (Fig. 14-15)	Dakota Sandstone	5,741/ 5,575	23.5/ 23.5	13.5/ 13.5	9.5/ 9.5	5	N/A	1 hr



Fig. 5. Metate 1 pre-manufacture.



Fig. 6. Metate 1 after 4 hrs and 47 min.



Fig. 7. Metate 1 post-manufacture.



Fig. 8. Metate 2 pre-manufacture.



Fig. 9. Metate 2 post-manufacture.



Fig. 10. Metate 3 pre-manufacture.



Fig. 11. Metate 3 post-manufacture.



Fig. 12. Mano 1 pre-manufacture.



Fig. 13. Mano 1 post-manufacture.



Fig. 14. Mano 4 pre-manufacture.



Fig. 15. Mano 4 post-manufacture.

Conclusions

- Manufacture of manos and metates is physically intense and time consuming.
- Imperfections in raw materials influenced the trajectory of manufacture in unexpected ways.
- A relationship between skill level and efficiency of manufacture was observed.
- Average mass removed per-hour ranged widely from 5,540-166 grams.
- Attempts to shape mano and metate blanks more rapidly resulted in frequent manufacture failures (see Figs. 10-11).
- Harder raw materials required greater time investment to shape (see Table 1 & Figs. 14-15).
- Experimental manufacture of grinding tools gave us a greater appreciation of Ancestral workmanship.

Future Research

Potential areas for future research include:

- Use-wear analyses of pecking stones used specifically for manufacture or maintenance.
- Ethnographic research to better understand mental templates for initial mano and metate designs.
- Use-wear analyses with experimentally produced grinding tools to better understand ancient tool use.
- Time investment necessary to manufacture other types of passive and active grinding tools.
- Use-wear studies to better understand the rates of wear of different raw materials types.

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We acknowledge the Pueblo, Ute, Paiute, Diné, and Jicarilla Apache peoples on whose traditional homelands we work. Our work would not be possible without Indigenous peoples in the past, present, and future. We respectfully recognize, and honor, Ancestral and Descendant Indigenous communities for their contributions to all humankind. We bring light into the darkness of memory that these lands, waters, wildlife, and her descendants hold as a result of policies of removal, genocide, and displacement. We hold the disciplines of anthropology and archaeology and our organization accountable by taking a critical approach to our work that allows for difficult discourse and shifts our efforts to be inclusive, restorative, and just. We also want to thank the National Science Foundation for providing funding for our project and our time at Crow Canyon, and the Crow Canyon Archaeological Center for providing mentorship for this project and funding for college credit. We thank the Archaeological Conservancy for the ability to learn, and to create our project.



Appendix C – 2024 Haynie Site Archaeofaunal Report

Please See Next Page

Year Three of Archaeofaunal Analyses at the Haynie Site (5MT1905)

Jonathan Dombrosky

Chelsea Betts

Steve Wolverton

Susan C. Ryan

December 16, 2024 2:43 PM CST

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1 Introduction

The Crow Canyon Archaeological Center launched the Northern Chaco Outliers Project (NCOP) in 2016 (Ryan 2016) to investigate the Lakeview Community, a cluster of four Chaco period great houses in southwestern Colorado. These great houses are located within three archaeological sites: the Haynie site (5MT1905), Ida Jean (5MT4126), and Wallace Ruin (5MT6970). Over the past eight years, most NCOP fieldwork has focused on the Haynie site, a complex ancestral settlement occupied intermittently from approximately A.D. 800 to 1175 (Throgmorton et al. 2022, 2023). The site features two great houses, a large Pueblo I-II roomblock (A.D. 750-1150), and various other structures and contexts throughout the Pueblo I and III periods (A.D. 750-1280).

Analyzing archaeofaunal remains from the Haynie site is a key component of the Northern Chaco Outliers Project. The first year of archaeofaunal analyses revealed a high degree of bone fragmentation and low identifiability, driven by the shaft fragments of medium-to-large mammals (Dombrosky and Gilmore 2023). The preliminary findings also suggested taxonomic diversity estimates were incomplete and animal diversity was not notably high at Haynie compared to selected other sites. Additionally, we identified rare taxa, including wolf (*Canis lupus*) and bison (*Bison bison*). The wolf specimen was identified using a highly accurate classification model for canid mandibular measurements. In the second year of faunal analyses (Dombrosky and Feldstein 2024), beyond reporting on a whole new year’s worth of identifications, we summarized the contexts that dogs (genus *Canis*) have been recovered from in the central Mesa Verde region and how the Haynie site compares. We found no clear associations with typical descriptive categories for animal internments in the U.S. Southwest, and suggest reconceptualization of how dogs fit into categories of deposition, discard, and offering (*sensu* Monagle and Jones 2020). We also incorporated disturbance contexts into pinpointing the cause of the low faunal identifiability rate at Haynie. We found that disturbance contexts do not strongly influence how identifiable or unidentifiable bone specimens are, further suggesting medium-to-large mammal bone fragmentation could have been driven by the occupants of the Haynie site. Finally, we re-estimated diversity at the site to gauge taxonomic representativeness and compared these estimates to all of the faunal assemblages in the [Crow Canyon Research Database](#). We found—with the addition of new specimens—Haynie had the highest amount of taxonomic diversity compared to other sites in the database, but diversity was not significantly high compared to the other sites.

Here, we report on another year’s worth of faunal identifications, but also provide an in-depth analysis of artiodactyl body size in the central Mesa Verde region (which includes body size

estimates from Haynie site specimens). Body size may be influenced by the amount of hunting on large game populations (also known as harvest pressure). This analysis, led by Crow Canyon Zooarchaeology Intern, Chelsea Betts, offers another important way to test for overhunting of large game through time in the central Mesa Verde region (Section 4). We also provide a new analysis associated with Haynie bison specimens. We model the spatial distribution of grass carbon stable isotope ($\delta^{13}\text{C}$) values (with what is known as an isoscape) to predict where Haynie bison specimens come from on the landscape. Using this approach, we evaluate whether the Haynie bison specimens were traded in from the Plains or if they come from areas closer to site. Additionally, we compare fragmentation at the Haynie site to all other sites in the Crow Canyon Research Database (Section 5). The larger goal here is to document different research avenues associated with the Haynie archaeofauna and the quality of Haynie site identifications produced from May 2024 through August 2024.

2 Materials and Methods

There are four analysts associated with the data described here: Jonathan Dombrosky, Eric Gilmore, Ahna Feldstein, and Chelsea Betts. Jonathan Dombrosky, Environmental Archaeologist at Crow Canyon, has approximately 12 years of experience with archaeofaunal analysis, and he analyzed new specimens associated with this report from May 2022 to August 2024. Eric Gilmore had approximately three years of experience with archaeofaunal analysis, and he analyzed specimens as a Crow Canyon Zooarchaeology Intern in the summer of 2022. Ahna Feldstein had four years of experience with faunal analysis and was an intern from May 2023 to July 2023. Chelsea Betts had over one year of experience with faunal analysis and was an intern from May 2024 to July 2024. Jonathan, Eric, Ahna, and Chelsea are respectively referred to as Analyst 1, Analyst 2, Analyst 3, and Analyst 4 in all subsequent interanalyst comparisons.

The main comparative collection used for the analysis of the Haynie site archaeofauna is housed in Crow Canyon Archaeological Center's Laboratory. Three cottontail (*Sylvilagus* spp.) specimens and one black-tailed jackrabbit (*Lepus californicus*) specimen were loaned from the Laboratory of Zooarchaeology at the University of North Texas. We took specimens that were difficult-to-identify to the Museum of Southwestern Biology's Division of Mammals and Division of Birds located in Albuquerque, New Mexico. Various osteological guides, manuals, atlases, and keys aided identification. Several publications assisted with the identification of mammal remains (Adams and Crabtree 2012; Chavez 2008; Gilbert 1980; Hillson 1986, 1996; Jacobson 2003; Olsen 1964; Smart 2009). Bird remains were identified with other works (Cohen and Serjeantson 1996; Gilbert et al. 1981; Hargrave and Emslie 1979; Olsen 1979), as well as fish, amphibian, and reptile bones (Olsen 1964). Some consulted references helped identify both avian and mammalian remains (Broughton and Miller 2016; Elbroch 2006). Yet other works verified nonhuman from human remains (Baker et al. 2005; France 2009; White et al. 2012).

We followed identification protocols explicitly designed to enhance data quality (Driver 1992, 2011; Wolverton 2013; Wolverton and Nagaoka 2018) and used the coding system by Driver (2006). Briefly, analysts adopted a conservative approach to identifying zooarchaeological specimens at the Haynie site. It is an almost impossible task for analysts to understand how all diagnostic skeletal criteria change through time, among species, within different age classes, between sex, and across geographic areas on a fragment-by-fragment basis. It has been argued identifications become less taxonomically specific when analysts have more experience, greater access to diverse comparative materials, and a specific focus on data quality (Gobalet 2001; Lyman 2002, 2019; Wolverton and Nagaoka 2018). This lack of taxonomic specificity likely increases identification accuracy in situations where assemblages contain an abundance of fragmented remains from closely related taxa.

We use the Number of Identified Specimens (NISP) to report taxonomic abundance, and this quantitative unit is a tally of all archaeofaunal specimens within a given taxonomic classification. NISP is the most basic quantitative unit from which most others are derived, such as the Minimum Number of Individuals (MNI). NISP is preferred because it is often highly correlated with measures like MNI. It is also devoid of errors in additive calculation that plague minimum number units (Grayson 1984; Lyman 2008).

All statistical analyses and figures were produced with R version 4.3.3 (R Core Team 2024). Our statistical analyses are structured with tidyverse packages and syntax (Wickham et al. 2019). All graphs were produced with ggplot2 (Wickham 2010).

3 Identified Taxa

There are 2,440 identifiable and 6,359 unidentifiable specimens to date in the Haynie archaeofaunal assemblage. We have added 249 identifiable and 704 unidentifiable specimens—for a total of 953 specimens—since our last report. Our identification rate is still low at 27.73%, which has mostly gone unchanged. Of all the large faunal assemblages Crow Canyon has analyzed over the years, Haynie currently has the lowest identification rate (Figure 1). Analyst 1 analyzed 60.4% of the assemblage, Analyst 2 analyzed 18.33%, Analyst 3 analyzed 15.07%, and Analyst 4 analyzed 6.19%. There are 4 classes of animals present: Mammalia (mammals), Aves (birds), Actinopterygii (ray-finned fishes), and Reptilia (reptiles). There are four orders of mammals present, seven orders of birds, one order of ray-finned fishes, and one order of reptile. In total, we used 61 identification types (Figure 2).

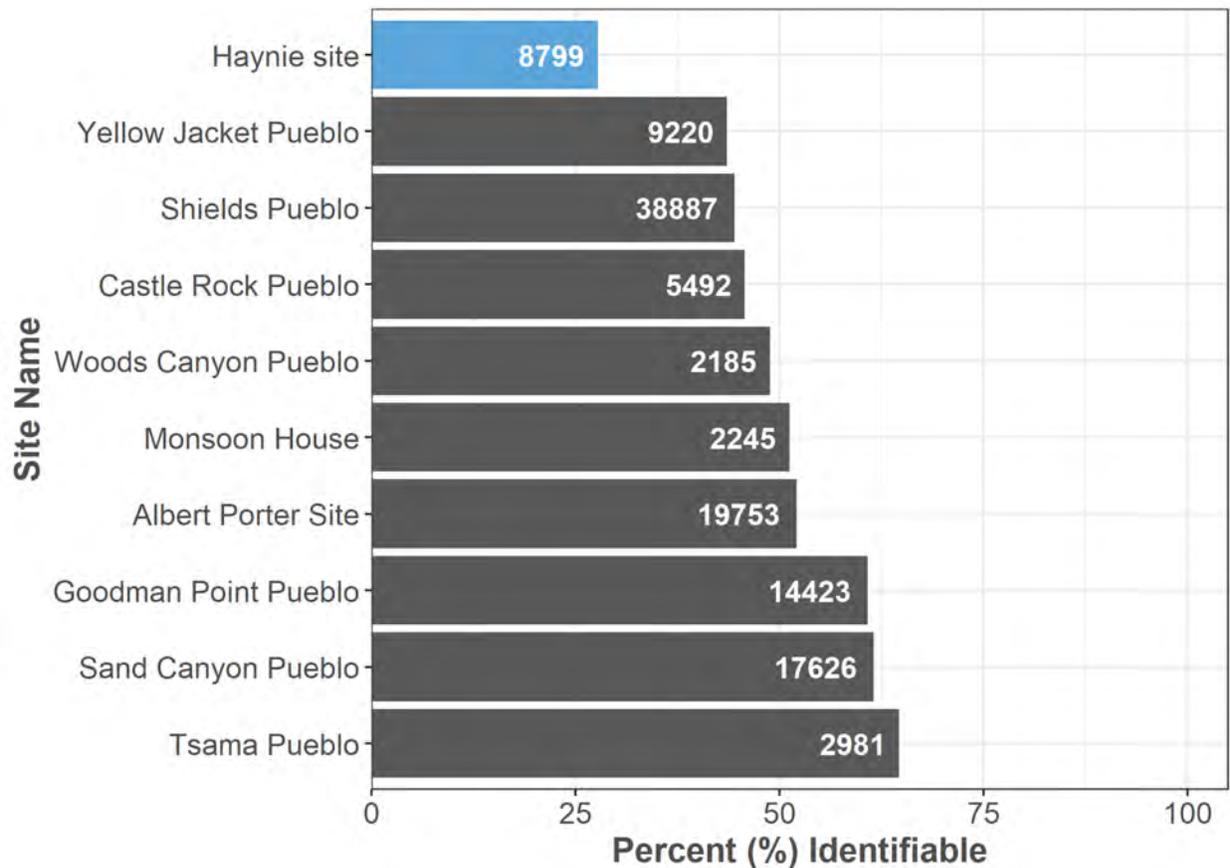


Figure 1: The Haynie site (highlighted in light blue) currently has the lowest identifiability rate of Crow Canyon faunal assemblages that exceed 1,000 Number of Identified Specimens (NISP). Percent Identifiable is the ratio of identifiable specimens to all specimens in a faunal assemblage. Number of Specimen (NSP) values for each site are located within each bar. It currently ranks as the 48th lowest identifiability rate in the entire Crow Canyon Research Database among 52 sites.

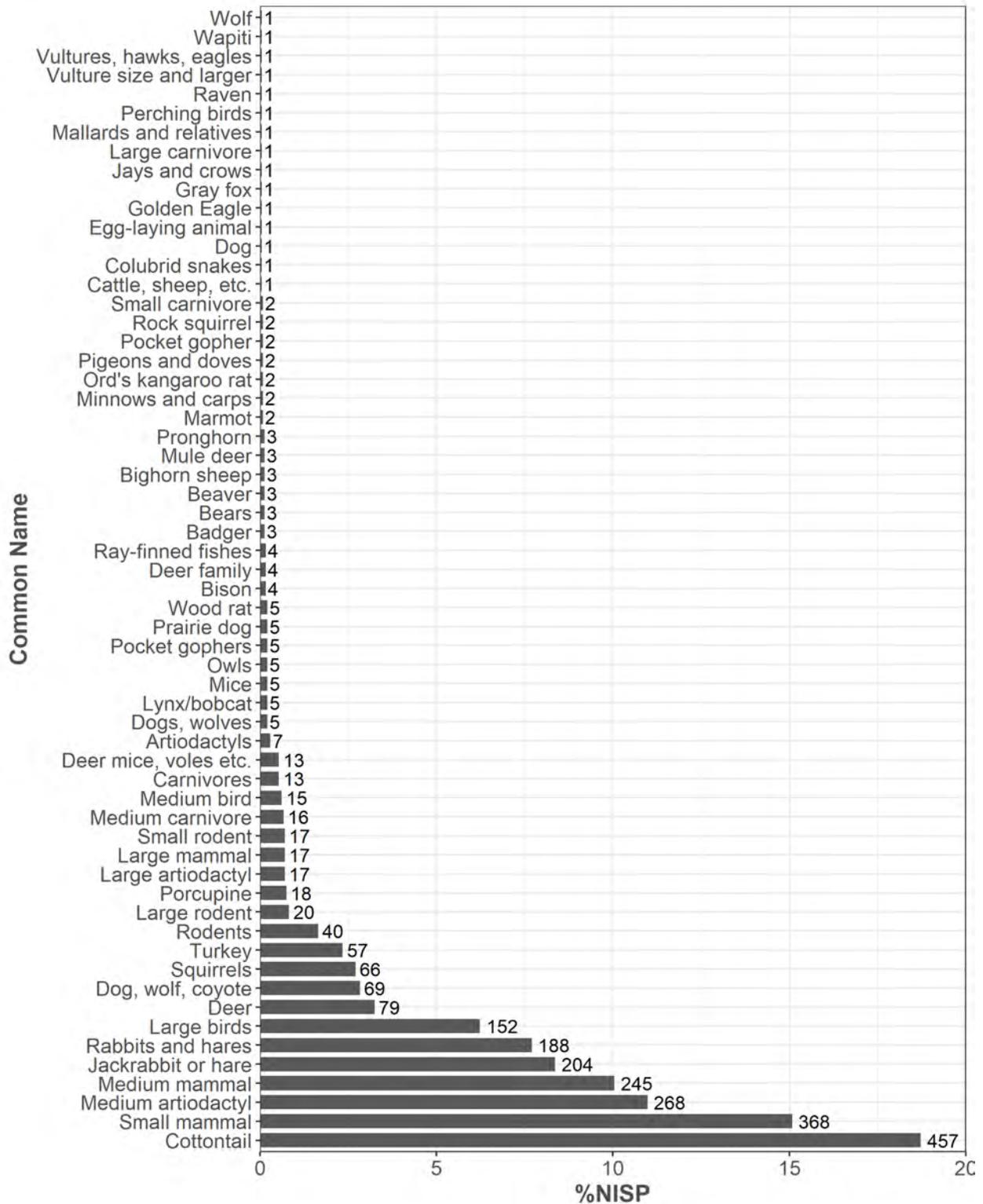


Figure 2: Relative taxonomic abundance at the Haynie site using percent Number of Identified Specimens (%NISP). Raw NISP values are reported next to each bar. Total NISP = 2,440.

3.1 Mammalia (n = 2194)

3.1.1 Lagomorpha (n = 849)

Cottontails (*Sylvilagus* spp.) and jackrabbits (*Lepus* spp.) are the main taxa in the order Lagomorpha recovered from the Haynie site. Lagomorphs are currently the most abundant animals identified, comprising 34.8% of the identified specimens. It has been hypothesized populations of larger-bodied jackrabbits decreased through time in the central Mesa Verde region, and this decrease is likely due to human overhunting (Driver 2002; Ellyson 2014). Thus, the ratio of cottontails to jackrabbits—commonly referred to as the Lagomorph Index—is a basic quantitative unit of general interest in the area, and in western North America in general (Driver and Woiderski 2008). The Lagomorph Index at the Haynie site is 0.69, which indicates a fairly equal relationship between the abundance of cottontails and jackrabbits. Haynie currently has the lowest Lagomorph Index of all the large (greater than 1,000 NISP), central Mesa Verde faunal assemblages in the Crow Canyon Research Database (Figure 3). This number is similar to the Lagomorph Index from some Pueblo II (A.D. 950-1150) components of Shields Pueblo (5MT3807). Shields serves as an important point of comparison—here and in subsequent analyses—considering that it and Haynie both have similar site features (i.e., great houses) and general occupation histories (Rawlings 2006).

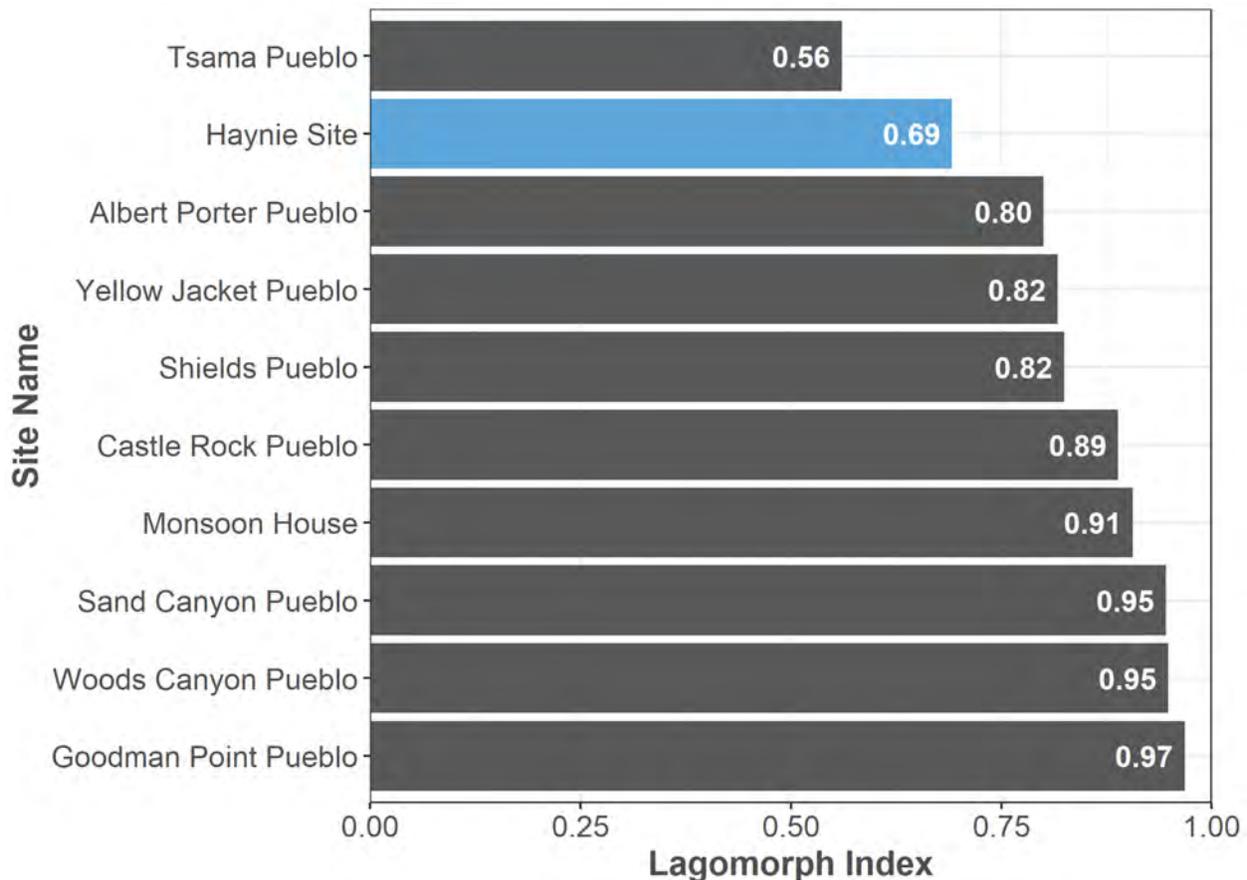


Figure 3: The Lagomorph Index across all faunal assemblages exceeding 1,000 Number of Identified Specimens (NISP) in the Crow Canyon Research Database. Currently, the Haynie site has the lowest Lagomorph Index of all the central Mesa Verde assemblages (Tsama Pueblo is a Pueblo IV period (A.D. 1300-1600) Northern Rio Grande site).

Garden hunting is an important subsistence practice to consider at the Haynie site, and the moderate Lagomorph Index value is interesting in this regard. Researchers argue that higher ratios of cottontails to jackrabbits indicates a higher reliance on garden hunting in the central Mesa Verde region (Driver 2011). What could the more even relationship of cottontail and jackrabbit abundance indicate about garden hunting at the Haynie site? Future work using stable isotope analysis (*sensu* Dombrosky et al. 2023) or tooth microwear might help shed light on whether garden hunting was prevalent at the site, and it also might help describe the relationship between the Lagomorph Index and garden hunting in general.

3.1.2 *Artiodactyla* (n = 390)

Even-toed hoofed animals make up the order Artiodactyla, and they are currently 15.98% of identified specimens recovered from the Haynie site. Substantial zooarchaeological evidence indicates artiodactyls—mostly mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and bighorn sheep (*Ovis canadensis*)—were severely overhunted in the central Mesa Verde region (Badenhorst and Driver 2009). Some models suggest deer populations might have been so low that any observable deer was immediately hunted after A.D. 1000 (Bocinsky et al. 2012). For this reason, the Artiodactyl Index is another basic quantitative unit of general interest in the region and in the larger northern U.S. Southwest. It measures the ratio of large-bodied artiodactyls to small-bodied lagomorphs in an archaeofaunal assemblage (Broughton et al. 2011). The current Artiodactyl Index at Haynie is 0.31. This value may seem somewhat low, but it is high relative to other sites in the central Mesa Verde region. The Haynie site currently has the highest Artiodactyl Index of all the large (exceeding 1,000 NISP) faunal assemblages in the Crow Canyon Research Database, the only exception is a Pueblo IV (A.D. 1300-1600) site from the Northern Rio Grande called Tsama Pueblo (Figure 4).

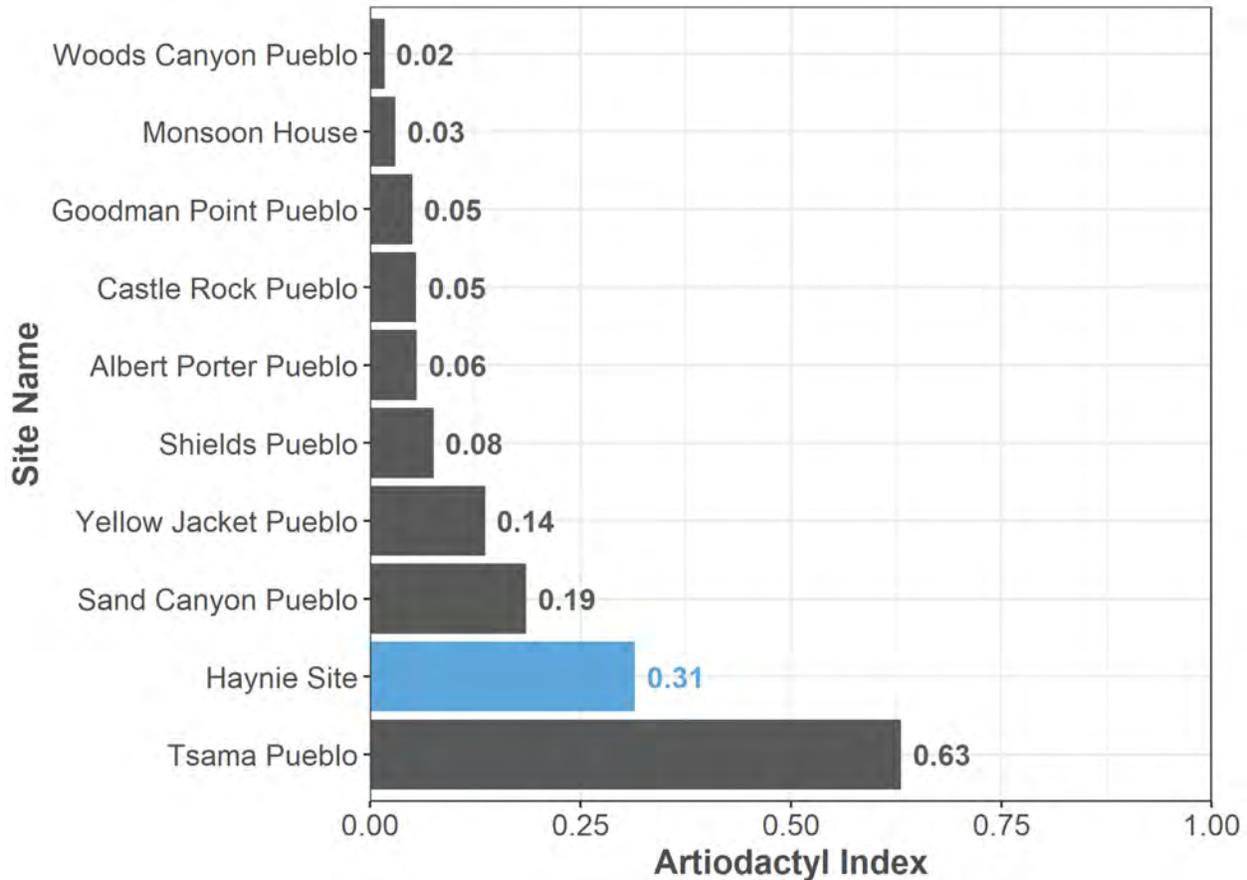


Figure 4: The Artiodactyl Index across all faunal assemblages exceeding 1,000 Number of Identified Specimens (NISP) in the Crow Canyon Research Database. Currently, the Haynie site has the highest Artiodactyl Index of all the central Mesa Verde assemblages (Tsama Pueblo is a Pueblo IV period (A.D. 1300-1600) Northern Rio Grande site).

Large artiodactyls—elk (*Cervus canadensis*) and bison (*Bison bison*)—are also notable parts of the Haynie archaeofaunal assemblage. These specimens comprise 5.64% of artiodactyls. There are currently 4 bison specimens, and Dombrosky and Gilmore (2023) reported on these specimen identifications in detail. Importantly, these specimens do not overlap with each other and represent an MNI of 1.

Dombrosky and Feldstein (2024) reported on radiocarbon dates from the bison specimens to potentially gauge if two or more individual bison were present at the Haynie site. There was almost complete overlap in the 95% calibration date ranges, and two specimens had the same exact conventional radiocarbon age estimation. These results suggest that it is possible all the specimens belong to the same individual. However, given that the calibrated date ranges are around 150 years, it is still possible they could be from two or more individuals. Regardless of how many individuals were present at Haynie, there is another interesting question surrounding these specimens: where did the bison individuals actually come from?

The procurement area for bison is a classic topic of research in Southwest zooarchaeology. The typical question is: were bison hunted locally or were they part of exchange relationships with more mobile Plains groups (*sensu* Speth 1991)? The central Mesa Verde region does not come to mind as typical habitat for massive, roving herds of bison. However, it has been argued that

small bands of these animals migrated through the Colorado Plateau since the late Pleistocene and into the Holocene (Martin et al. 2017). Thus, that bison were procured somewhat closer to the Haynie site than from the plains is a valid question in need of testing. Here, we use stable isotope values to predict where on the landscape Haynie bison specimens fed from before their deaths. We use $\delta^{13}\text{C}$ isoscape models of grasses for this task. Specifically, we rely on a widely used modern isoscape model provided by Cotton et al. (2016) and constructed using bison bone collagen and tooth enamel sampled from museum collections (Figure 5). We also used the raw data from Cotton et al. (2016) and created a new isoscape model that takes elevation into account using the IsoriX package. This newer package has the added benefit of providing statistical predictions for where on the landscape unknown samples derive from.

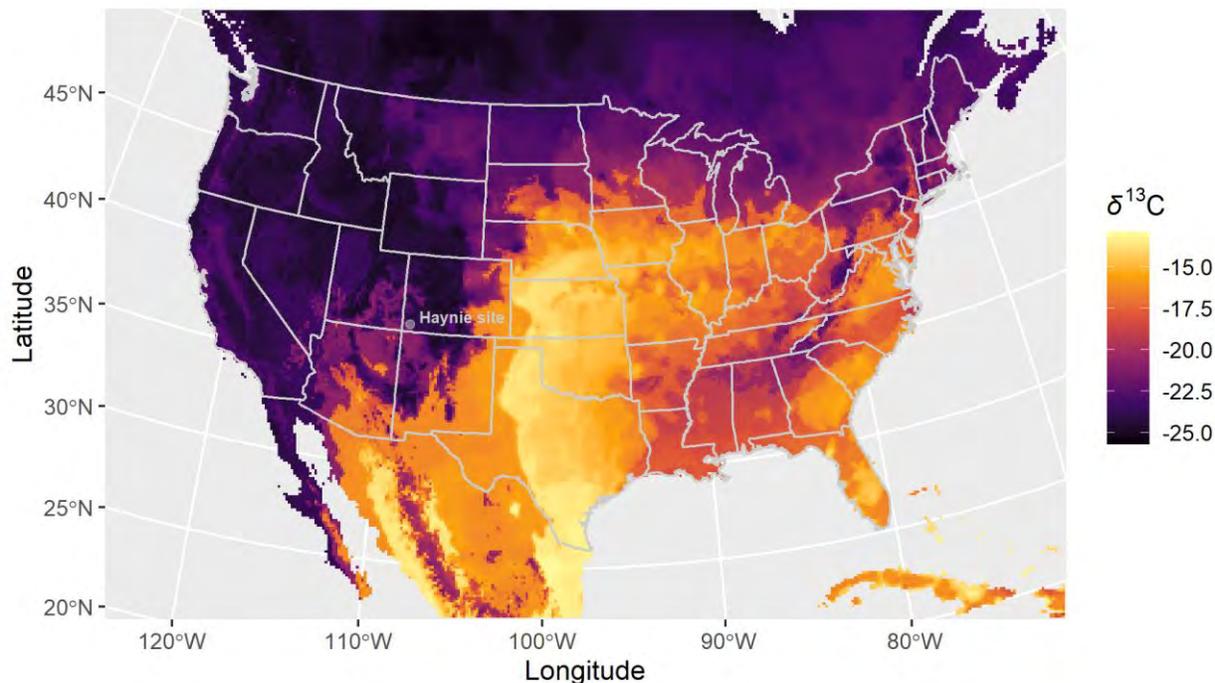


Figure 5: The modern $\delta^{13}\text{C}$ isoscape of grass in North America developed by Cotton et al. (2016).

The five Haynie bison bone collagen specimens' have $\delta^{13}\text{C}$ values ranging from -24.2‰ to -23.0‰. These values have the same Trophic Discrimination Factor (-4.875‰) incorporated that Cotton et al. (2016) used. These $\delta^{13}\text{C}$ values do not occur in the Plains, but are represented in the general Four Corners region where the Haynie site is located (Figure 6). The new isoscape model developed here (Figure 7) also supports this interpretation (Figure 7). It is important to note these models do not provide fine scale resolution for where exactly these specimens occur on the landscape, but it is possible the Haynie specimens could come from higher elevation areas like the La Plata Mountains to the east (Figure 8, Figure 9).

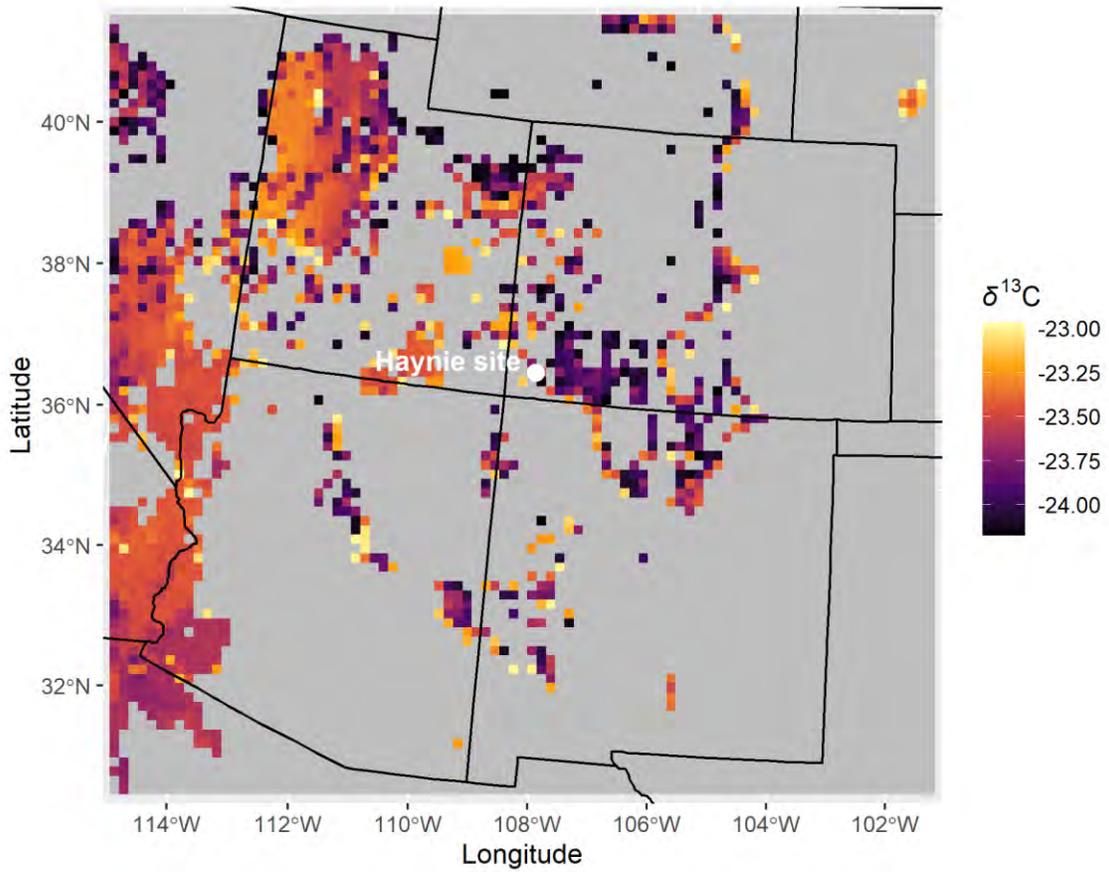


Figure 6: Cotton's (2016) isoscape model zoomed into the four corners region and filtered for only the values that apply to the Haynie bison specimens ($\delta^{13}\text{C} = -24.2\text{‰}$ to -23.0‰).

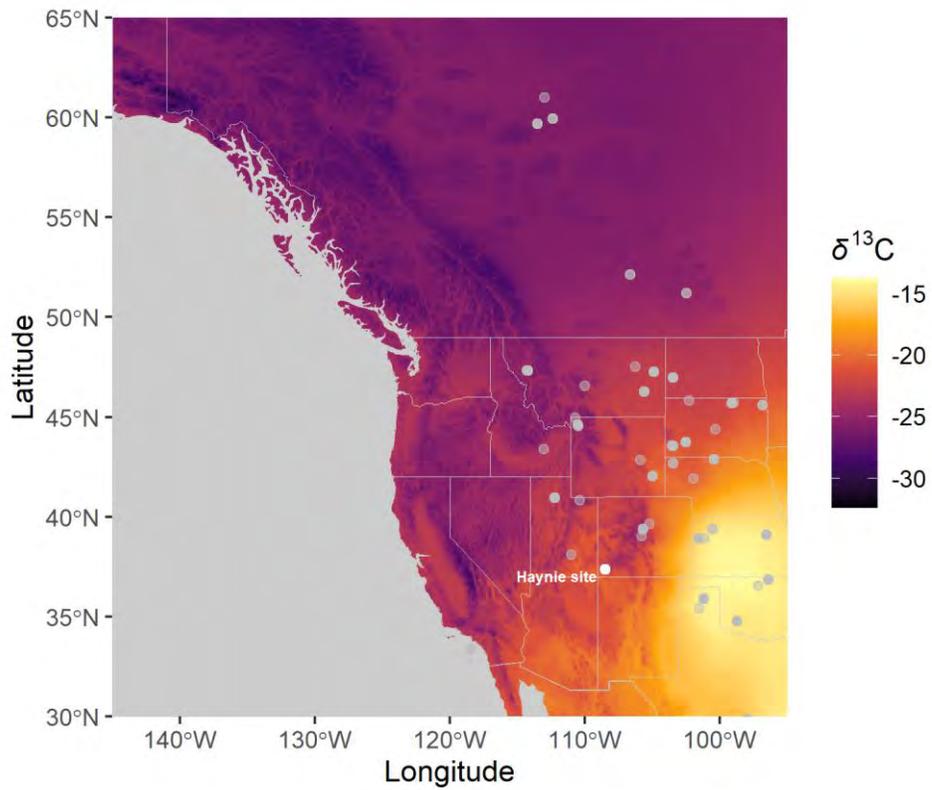


Figure 7: The new isoscape model created here using Cotton's (2016) raw data (gray circles) but re-extrapolating with the Isorix package. The main difference is that the Isorix model incorporates elevation into the isoscape modeling algorithm. The location of the Haynie site is marked by the white circle.

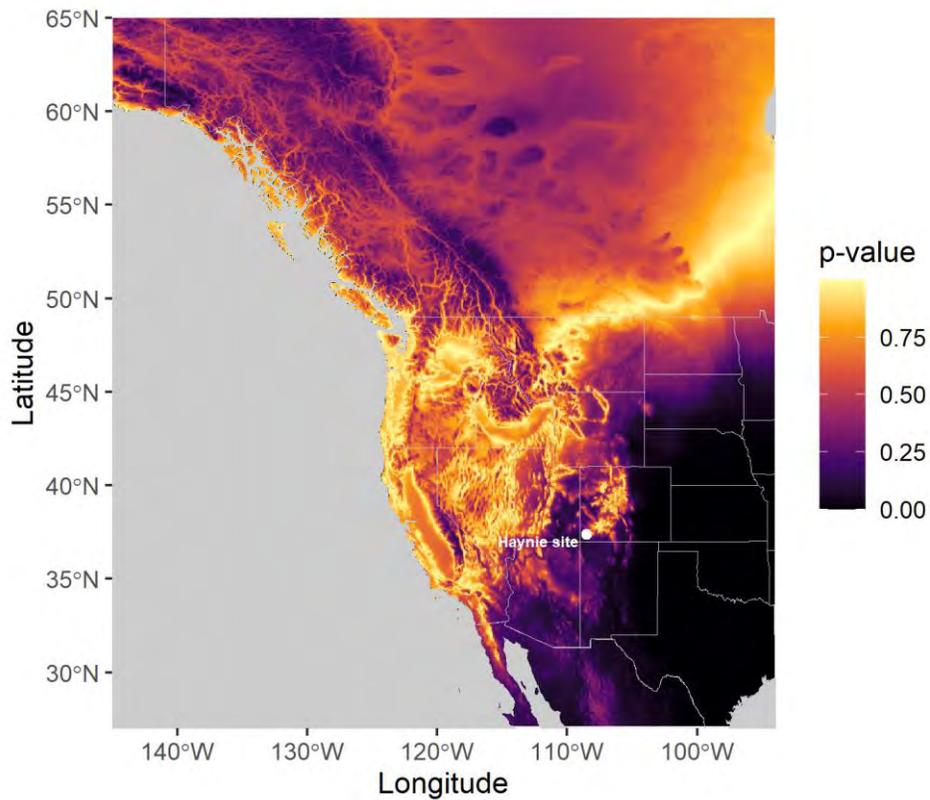


Figure 8: Using the IsoriX isoscape model to predict where Haynie site (marked by the white circle) bison specimens could likely come from. The prediction model here tests where specimens do not come from. Thus, lower p-values (darker areas) indicate where specimens most likely do not derive from. The individual (or individuals) that comprise the Haynie specimens likely did not come from the plains.

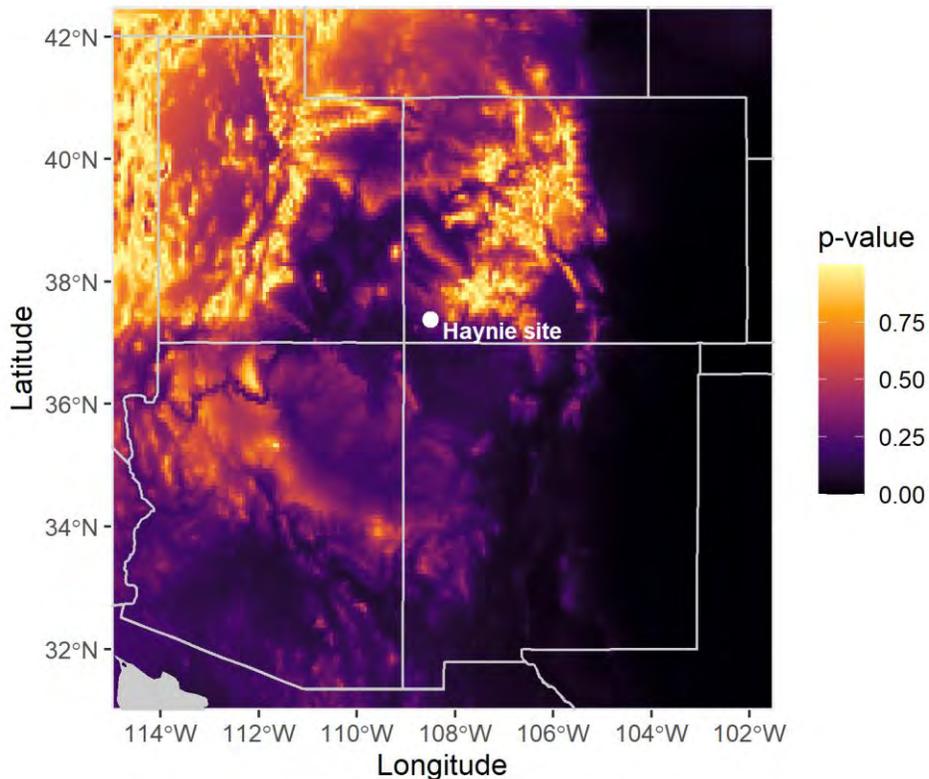


Figure 9: Zooming in on the IsoriX prediction model (Figure 8) to show areas around the Four Corners region where the bison specimens could derive from.

3.1.3 Small Mammal ($n = 368$)

This identification group includes those mammals jackrabbit size and smaller. This non-standard identification includes all small mammal specimens lacking morphological features required for more specific taxonomic levels. Consequentially, it has a high likelihood of incorporating many lagomorph specimens since they are exceedingly abundant in southwestern archaeofaunas. This identification group will be incorporated into final comparisons of size-based abundance indices through time, between areas of the Haynie site, or between sites. The goal will be to gauge the impact this identification group has on final interpretations of the Lagomorph Index.

3.1.4 Medium Mammal ($n = 245$)

Mammals larger than a jackrabbit and up to deer size are considered medium mammals. There is a high probability this identification group incorporates many artiodactyl specimens since they are one of the most common medium mammals in southwestern archaeofaunas. It should be incorporated in sensitivity analyses that rigorously assess final conclusions relying on size-based abundance index values, such as the Artiodactyl Index.

3.1.5 Rodentia ($n = 205$)

Rodents are 8.4% of identified specimens, which is a small component of the overall assemblage. The ratio of sciurids to rodents can help gauge the impact of intrusive species.

Members of the squirrel family (Sciuridae) are notorious intruders of archaeological deposits, especially prairie dogs (*Cynomys* spp.). The majority of prairie dog skeletal fragments are identified to the family level, as it is extremely difficult to skeletally distinguish prairie dogs from ground squirrels. This means Sciuridae identifications have the highest potential for accumulating prairie dog specimens. Indeed, we confirmed that the vast majority of sciurid specimens compare favorably to prairie dogs. Sciurids make up 36.59% ($n = 75$) of the rodent assemblage. Given that rodents comprise a small portion of the overall assemblage, it does not appear that rodent intrusions pose a significant problem for interpretation at the site. We will, however, closely track the taxonomic composition of rodents as the Northern Chaco Outliers Project progresses. Importantly, rodents could have been actively hunted (Badenhorst et al. 2023). One way to disentangle intrusive from non-intrusive rodents is through radiocarbon dating (Guiry et al. 2021). This could prove useful if prairie dog specimens preclude clear interpretation of the Haynie archaeofaunal assemblage in the future.

Large rodents, those larger than a woodrat (*Neotoma* spp.), comprise 20.98% of the total rodents currently identified. Beaver (*Castor canadensis*) and porcupine (*Erethizon dorsatum*) specimens are the most notable. Beavers prefer aquatic habitats while porcupines take refuge in trees along active floodplains (Baker and Hill 2003; Roze and Ilse 2003). The presence of these species might suggest hunting activities focused in riparian habitat close to the site.

3.1.6 Carnivora ($n = 120$)

Carnivores are a small portion of currently identified specimens at the Haynie site (4.92%), but a number of canid specimens were discussed in detail in previous reports (Dombrosky and Gilmore 2023; Dombrosky and Feldstein 2024). There are currently 77 specimens from the family Canidae in the Haynie site fauna. Many of the specimens come from an articulated domestic dog offering and one specimen is a wolf mandible.

3.1.7 Large Mammal ($n = 17$)

The large mammal identification includes mammals larger than deer, and it includes specimens lacking morphological features required for more specific taxonomic levels. It is likely that it could incorporate large artiodactyls like elk and bison specimens. It is recommended it be incorporated in sensitivity analyses that rigorously assess conclusions based on these animals.

3.2 Aves ($n = 238$)

3.2.1 Large Birds ($n = 152$)

Birds larger than a mallard are considered large birds. This identification group is most likely dominated by Turkeys (*Meleagris gallopavo*) as they are one of the most frequent birds recovered from ancestral sites in the region. A high proportion of Turkey specimens are assigned to this group considering there is considerable skeletal morphological overlap between Sandhill Crane (*Grus canadensis*) and Turkey (Hargrave and Emslie 1979). The Crow Canyon comparative collection does not, as of yet, include Sandhill Crane skeletal material. As a result, this group is frequently used as it represents a broader identification category.

3.2.2 Galliformes ($n = 57$)

All Galliformes specimens identified so far in the Haynie assemblage are Turkey, but it is still surprising how few Turkey specimens there seem to be. For instance, Spielmann and Angstadt-Leto (1996) proposed the Turkey Index, which is the ratio of Turkeys to lagomorphs in an assemblage. The current Turkey Index for Haynie is 0.07, which is notably low. However, Driver

(2002) proposed the Modified Turkey Index where the large bird identification group is included in the calculation. The current Modified Turkey Index value for Haynie is 0.20. This value is within the normal range for Pueblo I/Pueblo II period sites in the central Mesa Verde region (Badenhorst and Driver 2009), but it is the lowest Modified Turkey Index for large assemblages in the Crow Canyon Research Database (Figure 10). Also worth noting, there appears to be an abundance of turkey specimens yet to be identified. It is doubtful that this low index value will remain constant as the faunal sample increases. How turkey husbandry was managed at the community-level is an essential future area of research for the Northern Chaco Outliers Project. This line of inquiry is one way to delve deeper into aspects of cooperation and identity at the Lakeview Community.

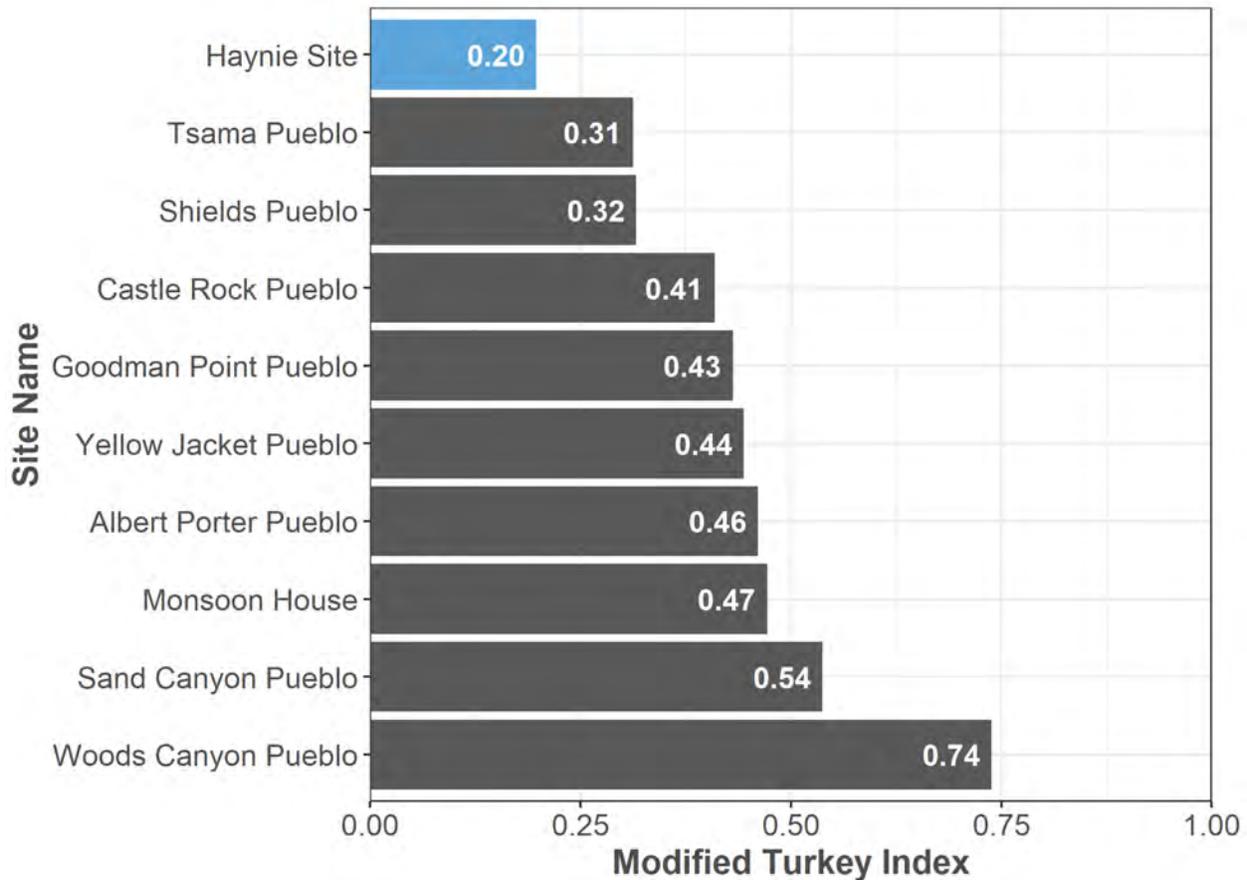


Figure 10: The Modified Turkey Index across all faunal assemblages exceeding 1,000 Number of Identified Specimens (NISP) in the Crow Canyon Research Database. Currently, the Haynie site has the lowest Modified Turkey Index of all the central Mesa Verde assemblages (Tsama Pueblo is a Pueblo IV Northern Rio Grande site).

3.2.3 Medium Birds (n = 15)

Medium birds are considered larger than a robin and the size of a mallard or smaller. It is difficult to attribute the majority of this identification group to a single taxon, as it contains a variety of difficult-to-identify fragmented skeletal parts that could belong to numerous taxa.

3.2.4 *Strigiformes* (n = 5)

The owl specimens identified at the Haynie site are a terminal phalanx, second phalanx, first phalanx, femur, and ulna. Owl feathers are known to have been incorporated into dance paraphernalia and prayer sticks (Ladd 1963). It is, however, important to keep in mind that owls can be active taphonomic agents. Luckily, their signatures are well-known and include the presence of pellets, small mammal remains with little-to-no fragmentation, and visible signs of digestion on specimens (Andrews and Cook 1990; Fernández-Jalvo and Andrews 2016). Owls do not appear to be a taphonomic agent of concern at Haynie (Section 5).

3.2.5 *Accipitriformes* (n = 3)

Accipitriforms are birds of prey active during the day, which include hawks, eagles, vultures, and kites. Two specimens were identified as general members of this order: one general foot phalanx and one terminal phalanx that compared favorably to a Turkey Vulture (*Cathartes aura*). The other specimen was a distal tibiotarsus fragment identified to Golden Eagle (*Aquila chrysaetos*). This specimen was taken to the Museum of Southwestern Biology's Division of Birds and identified with their skeletal comparative collection. It was distinguished from Bald Eagle (*Haliaeetus leucocephalus*) based off the morphology of the supratendinal bridge, which is more convex and more proximally robust in Golden Eagles compared to Bald Eagles. Eagles are acutely significant in Pueblo culture and their feathers are highly valued (Beaglehole 1936; LaZar and Dombrosky 2022; Tyler 1991).

3.2.6 *Passeriformes* (n = 3)

Three passeriform (i.e., song bird) specimens have been identified thus far in the Haynie assemblage: one small fragmented humerus generally identified to the order-level, a tibia fragment identified to Corvidae (the family comprising jays and crows), and one large carpometacarpus identified as Raven (*Corvus corax*).

3.2.7 *Columbiformes* (n = 2)

Pigeons and doves are in the order Columbiformes, and one ulna fragment and one sternum fragment were recovered from Haynie. These specimens are most likely a Mourning Dove (*Zenaida macroura*). An order-level identification was used because the Crow Canyon comparative collection does not include a Band-tailed Pigeon (*Columba fasciata*), which is the only other member in the order Columbiformes to consider in the region.

3.2.8 *Anseriformes* (n = 1)

One complete carpometacarpus was identified to the genus *Anas* spp. (mallards and other relatives) from the Haynie site. While this specimen could likely represent the common mallard (*Anas platyrhynchos*), Hargrave (1965) mentions the likely presence of Mexican Duck (*Anas diazi*) in the Four Corners region in the past. He based this assertion on the recovery of Mexican Duck feathers associated with Tusayan Polychrome sherds from Glen Canyon. The presence of different mallards and ducks is of potential biogeographic significance and the different members of this genus represent difficult-to-separate taxa.

3.3 Actinopterygii (n = 6)

This taxonomic class includes the ray-finned fishes. Six specimens have been identified to this general class: two ribs and three fragmented vertebrae centra (of which two of these specimens can be identified to the order-level, see below). Following Nelson (2006, 35), fish specimens

should no longer be referred to as pisces, as it is an antiquated taxonomic term. Similarly, for fishes of inland North America, the use of osteichthyes should no longer be used (Nelson 2006, 83). This is so for two interrelated reasons. First, this term has been replaced by the Euteleostoma designation. It successfully describes a monophyletic clade that includes tetrapods. Secondly, since Euteleostoma includes tetrapods, it includes lobe-finned fishes (Sarcopterygii). Lobe-finned fishes—like the coelacanth (Actinistia)—are not native fishes in inland North America during the late Holocene (Cloutier and Forey 1991). The use of osteichthyes should be accordingly abandoned. Instead, Actinopterygii (ray-finned fishes) should be used because it is a more accurate class-level designation for archaeofaunas from the U.S. Southwest/Mexican Northwest.

3.3.1 Cypriniformes (n = 2)

This order includes carps, minnows, and suckers, which are common fishes in the aridland streams of the U.S. Southwest (Minckley and Marsh 2009; Sublette et al. 1990). These two specimens are small intact vertebrae. The lateral ridge morphology of centra can be used to identify vertebrae of fishes from U.S. Southwestern archaeofaunas to the order-level. Common orders of fishes found in rivers in the U.S. Southwest include Cypriniformes, Siluriformes, Lepisosteiformes, and Salmoniformes, and each of these orders have distinct vertebral morphology. These specimens are also notably small. It is possible inhabitants of the Haynie site used non-targeted methods to capture fishes, such as seining (Dombrosky et al. 2022). A focus on fishing practices offers a basic way to understand aquatic habitat use associated with the [Simon Draw watershed](#).

3.4 Reptilia (n = 1)

3.4.1 Squamata (n = 1)

One colubrid (family Colubridae) vertebra was identified from Haynie. This specimen was identified to the family-level using Olsen (1964). It likely represents a bullsnake (*Pituophis catenifer sayi*), which is one of the most common colubrids in Cortez, CO. This taxon frequently overwinters in covered archaeological deposits in the Mesa Verde region and could represent intrusive specimens.

3.5 Oviparous Animals (n = 1)

Eggshell specimens were identified as oviparous animals. These specimens are likely from turkey, but a general identification was given because a scanning electron microscope could not be used to assess mammillary cone morphology (Beacham and Durand 2007; Conrad et al. 2016; Lapham et al. 2016). It is possible, though unlikely, that this eggshell could be from a lizard.

4 Mule Deer Body Size Through Time in the Central Mesa Verde Region

One of the largest zooarchaeological questions in the central Mesa Verde region centers on overhunting and resource depletion. The migration of ancestral communities out of the region—during the end of the A.D. 1200s—is thought to be at least partially caused by a reduction in large game (Muir and Driver 2002; Schollmeyer and Driver 2023). The increased use of turkeys and other smaller game (i.e., cottontails and jackrabbits) is also linked to large game resource depression (Muir and Driver 2002; Badenhorst and Driver 2009; Munro 2011; Ellyson et al. 1990; Schollmeyer and Driver 2023). Artiodactyls, such as mule deer, are the preferred taxa of

hunters in the Southwest because of their high caloric return and perhaps even their association with prestige (Schollmeyer and Driver 2023). Overhunting is the current leading explanation of the lack of mule deer in Pueblo III period (A.D. 1150-1280) archaeofaunal assemblages (Muir and Driver 2002; Badenhorst and Driver 2009; Schollmeyer and Driver 2023). However, this interpretation is based on relative abundance data and abundance indices (i.e. the artiodactyl index), which are derived from site-level bone counts (specifically quantified using the Number of Identified Specimens or NISP). While crucial for initial estimations of taxonomic abundance, accurate bone counts are influenced by a multitude of factors. Environmental shifts, human butchery practices, post-depositional processes, overhunting, and many other processes can significantly alter accurate estimations of large game from archaeofaunal assemblages (Lyman 1994). The extent to which each of these processes affected assemblages cannot be confirmed without additional complimentary evidence.

Overhunting remains a hypothesis in the late prehispanic central Mesa Verde region, though multiple strong case studies suggest it occurred (Muir and Driver 2002; Badenhorst and Driver 2009; Schollmeyer and Driver 2023). Multiple lines of evidence, beyond bone counts, should be used to further evaluate this hypothesis. If overhunting is truly the cause of the low relative abundance of mule deer, its signature should also be visible in body size changes and mortality profiles.

The overhunting hypothesis should be rigorously evaluated because the implication that Ancestral peoples were unsustainably using resources is serious. Interpretations like this affect the public perception of Ancestral groups, and as a result, their descendants. One can also extrapolate this hypothesis to imply, on a larger scale, that humans in general cannot avoid unsustainable environmental practices. This section strives to address the question of overhunting through changes in mule deer body size and mortality data, which adds to previous studies and can hopefully create a clearer picture of hunting practices through time and at the end of the Pueblo III period.

4.1 Large Game Body Size and Overhunting

Zooarchaeologists commonly estimate animal body size from archaeofaunal specimens to understand past human hunting strategies, as well as other environmental or climatic factors (Broughton et al. 2011; Dombrosky et al. 2022; Purdue 1987, 1989; Wolverton 2008; Wolverton et al. 2007, 2008, 2009). Deer body size typically tracks with the amount of available food resources in the environment, which is controlled by both anthropogenic and non-anthropogenic factors. Hunting pressure is one anthropogenic factor of particular interest, and this term can be used interchangeably with harvest pressure. Hunting pressure is defined as the degree to which a prey population is thinned by hunting activities (Wolverton 2008). Changes in the degree of harvest pressure can cause changes in food availability and thus body size.

Under the influence of high human hunting pressure, there are fewer individual deer present on the landscape. This results in less competition for food resources among deer. In turn, increased access to food resources translates to the increased body size of individual deer in the population. The population of deer in this scenario is maintained below ecological carrying capacity, which is the total number of organisms that can be supported by an ecosystem over time (Wolverton 2008). The environment can adequately support this population of deer under heavy harvest pressure (and the other organisms in the ecosystem) without strain, which keeps the deer population in a constant state of growth through successive generations (Wolverton 2008; Wolverton et al. 2007, 2008, 2009). Deer populations are higher under the influence of low hunting pressure due to decreased mortality. In this scenario, we would expect to see more individuals present and competing for resources on the landscape. Each individual animal would

have fewer available food resources because the population is pushed above or nearer to carrying capacity. As a result, these deer would obtain a smaller body size through time.

Much research on body size has been done on white-tailed deer specifically because of a trait known as phenotypic plasticity. Phenotypic plasticity is the influence of environmental changes and food availability causing change in an observable trait, such as growth rate (Wolverton 2008). The body sizes of white-tailed deer are sensitive to changes in resource availability, which means the maximum body size of these animals can change within just one generation. Mule deer, which are in the same genus as white-tailed deer, also exhibit variability in this trait. However, mule deer body size does not change as dramatically in relation to food availability because these animals are adapted to tolerate a somewhat less nutritious diet (Staudenmaier et al. 2021). While differences in phenotypic plasticity exist between these two species, we argue that the life history strategies of white-tailed deer represent an accurate general analog to mule deer in the case of the late prehispanic central Mesa Verde region. It is reasonable to expect that changes in harvest pressure and food availability would influence mule deer body size and that such changes should be observable in the paleozoological record.

4.2 Body Size Estimation Methods

To estimate large game body size, Analyst 4 measured 35 medium artiodactyl astragali following Purdue (1989) and Wolverton et al. (2007) (Figure 11). Astragali have been commonly used in past research to estimate body size because they are load-bearing skeletal elements. Their size and shape changes based on the locomotion of the animal. They are also very dense, thus they tend to survive in archaeological contexts.

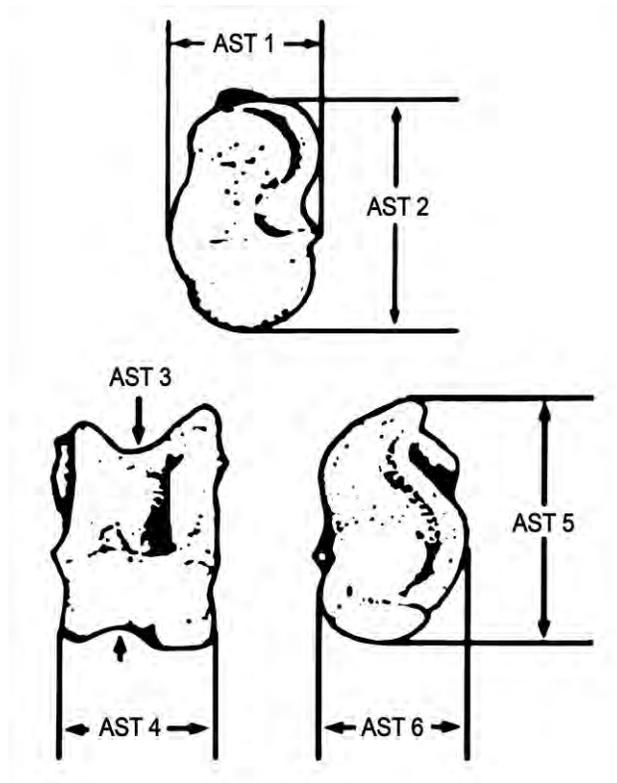


Figure 11: Astragalus measurements to best predict body size. The figure originates from Purdue (1989) and is after Figure 2 in Wolverton et al. (2007).

Our astragali assemblage is comprised of several different sites excavated by Crow Canyon Archaeological Center that span a wide range of time periods. All of these astragali are curated by Canyons of the Ancients Visitor Center and Museum. The astragali were recovered from six different sites: The Dillard site (5MT10647; A.D. 420–725), the Haynie site (5MT1905; A.D. 950–1150), Albert Porter Pueblo (5MT123; A.D. 1050–1300), Yellow Jacket Pueblo (5MT5; A.D. 1050–1300), Sand Canyon Pueblo site (5MT765; A.D. 1150–1300), and Goodman Point Pueblo (5MT604; A.D. 1260–1275).

To understand the change in mule deer body size, we first differentiated between artiodactyl species to confirm specimens were not actually white-tailed deer. The Medium Artiodactyl designation follows Driver’s (2006) CCAC manual and is used when a genus or species cannot be identified using distinct morphological criteria. To simplify this task, Analyst 4 re-identified all astragali based on the CCAC comparative collection along with Lawrence’s (1951) criteria and personal notes by other zooarchaeologists. The goal was to limit inter-analyst variability and sort out possible bighorn sheep and pronghorn antelope. To distinguish mule deer and white-tailed deer, Analyst 4 measured all astragali following Dombrosky and Gilmore (2023) (Fig. 2). We built models using modern white-tailed deer and mule deer astragali with known identifications. We used Linear Discriminant Analysis (LDA) as an engine to distinguish archaeological white-tailed deer and mule deer. Our model confidently predicted the assemblage only included mule deer. The models were 98–100% accurate in discriminating between the two species.

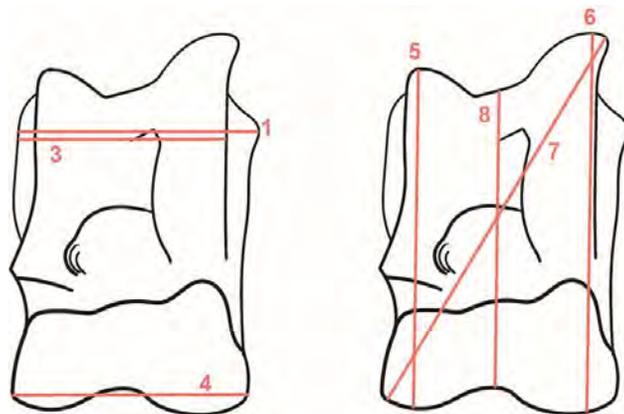


Figure 12: White-tailed deer and mule deer differentiation model measurement sites following Dombrosky and Gilmore (2023).

4.3 Results

One of the most interesting results of our body size measurements is the wide variation in astragali size towards the end of the Pueblo III period, especially at Sand Canyon Pueblo. We expect mule deer to have a larger body size at the end of Pueblo III if harvest pressure had increased to a point where deer populations were pushed below environmental carrying capacity. However, there is a highly diverse range of astragali size present here, which does not provide resolution on the impacts of harvest pressure. To explore our dataset, we fitted a linear model, a curvilinear model, and a multi-curvilinear model (Figure 13) to our astragali measurements. These are three possible interpretations of mule deer body size through time in the central Mesa Verde region.

Various Astragalus Sizes Through Time

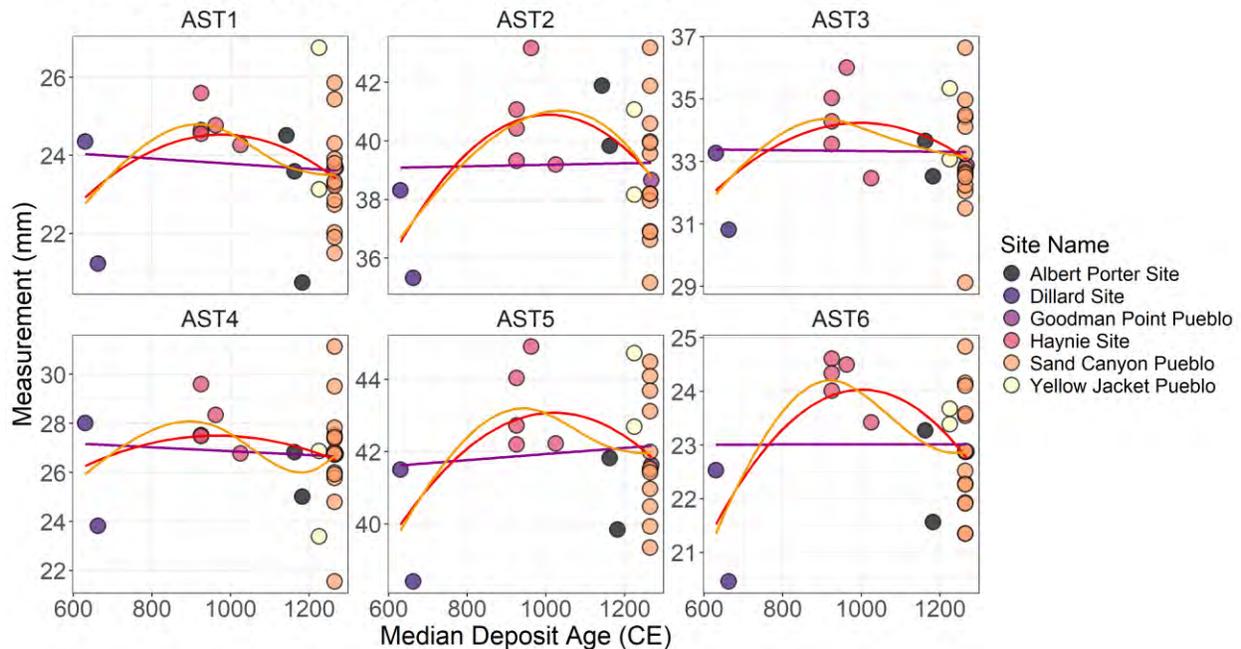


Figure 13: This plot shows astragalus measurements through time at the different Crow Canyon sites and provides linear (dark magenta line), curvilinear (red line), and multi-curvilinear (orange line) models. The curvilinear and multi-curvilinear models are better match patterning through time, but neither fully encompasses the full range of variation in the data. The x-axis represents the median deposit age of the astragali in our assemblage (not every context is represented, and so the entire occupation span of each site is not represented). This is used for general ordering. The y-axis represents the measurement of the astragali in millimeters. The sites are color-coded. Each dot is an astragalus measurement.

In order to contextualize our data, we compared them to archaeological white-tailed deer assemblages from Weitzel (2023) (Figure 14 and Figure 15), and specifically, the Morgan Site. The Morgan Site is a Late Woodland Period site in Connecticut, and it provides an example of sustainable harvest pressure. The white-tailed deer at the site have a large body size because their habitat was anthropogenically expanded. The environmental carrying capacity increased through agricultural land-clearing and controlled burns, causing deer body sizes to grow larger without extreme harvest pressure (Weitzel 2023). Deer generally prefer to live on the edges of the forest, near disturbed land, thus these changes to the landscape increased their access to resources.

Comparison of White-Tailed Deer and Crow Canyon Mule Deer Astragali Sizes

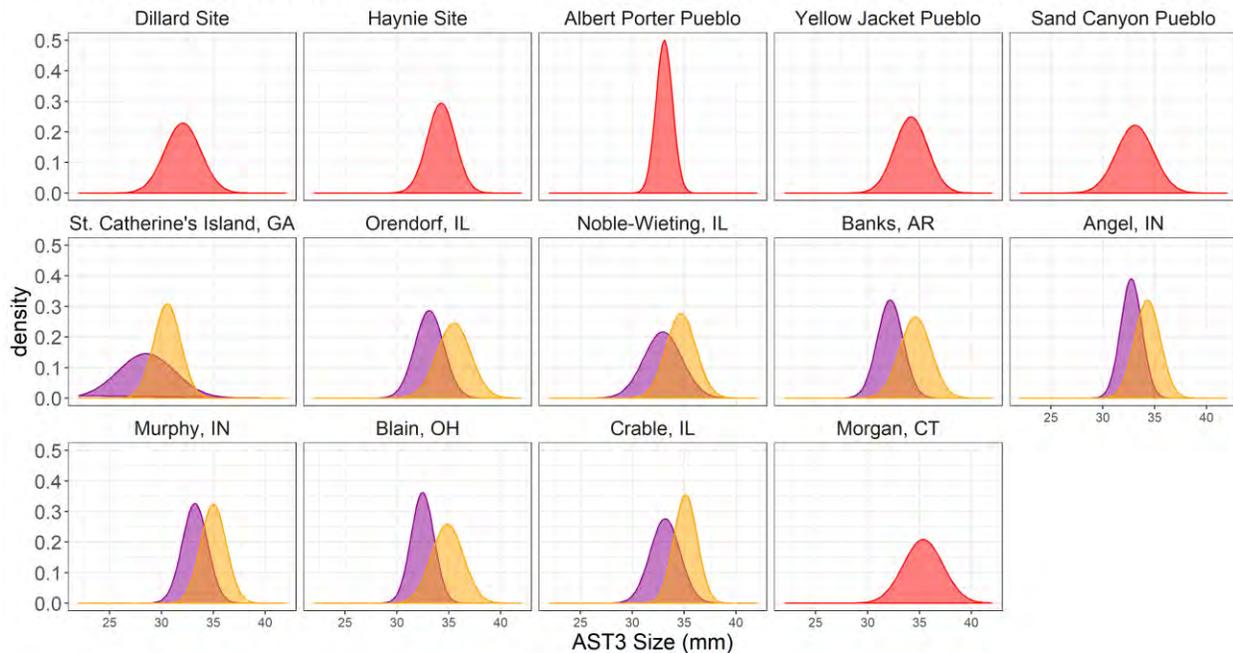


Figure 14: This plot compares the Crow Canyon mule deer astragali measurement distributions (top row) to white-tailed deer measurement distributions from a variety of sites published in Weitzel (2023) (bottom rows). The x-axis represents the AST3 measurement in millimeters. The y-axis provides density estimation. The purple color represents female white-tailed deer astragali and the orange color represents the male white-tailed deer astragali. The red color stands for unknown sex.

Mule deer body sizes at the Crow Canyon sites overlap with, and fall slightly below, the Morgan Site white-tailed deer body sizes (Figure 15). There are a few ways to interpret this pattern. One possibility is body size did not increase around the end of Pueblo III period. The white-tailed deer body size at the Morgan Site roughly plots around where mule deer might plot if the body sizes had increased. Mule deer body sizes tend to be larger than white-tailed deer body sizes, with significant overlap in their size ranges (Staudenmaier et al. 2021). Another interpretation is because there is a significant amount of overlap between mule deer and white-tailed deer astragali sizes here, the size of mule deer at the central Mesa Verde region sites are actually indicative of healthy and resilient deer populations. Yet another possibility is that high ecological productivity of the environment surrounding the Morgan site is causing white-tailed deer to surpass mule deer in body size. Ecological productivity can improve ontogenetic growth rate and increase maximum body size.

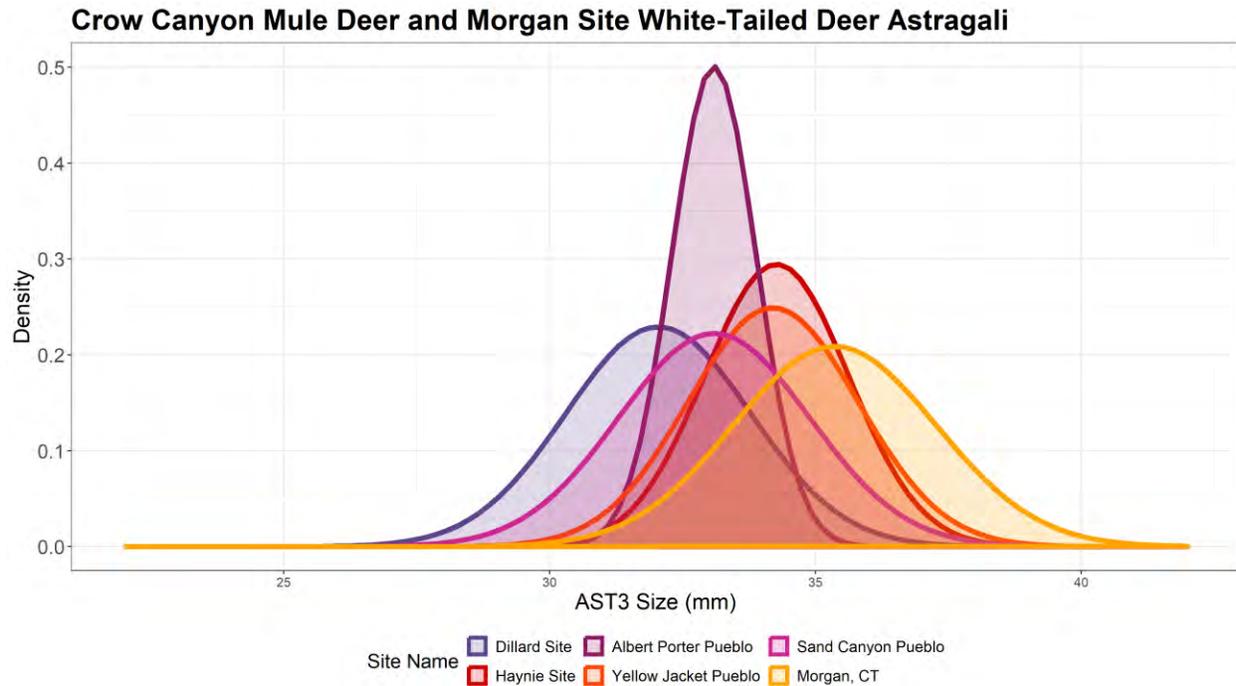


Figure 15: Comparison of Crow Canyon mule deer astragali measurement distributions to white-tailed deer measurement distributions from the Morgan Site published in Weitzel (2023). The x-axis represents the AST3 measurement in millimeters. The y-axis provides density estimation.

Another important line of evidence to consider is the age at which animals died, which is estimated using mortality profiles. Mortality profiles use epiphyseal fusion data to represent the age class of animals at the time of their death. They can be used as an additional method to tease apart factors affecting body size change. Environmental changes and harvest pressure have distinct signatures with some overlap (Wolverton 2008; Wolverton et al. 2008). High harvest pressure (and overhunting) is indicated by an inordinate number of juveniles in the archaeological record. This assumes that energy maximization logic of optimal foraging theory holds true, which postulates the largest individuals with the most amount of meat (and thus energy potential) will be preferentially hunted. Young individuals would have less of an opportunity to get old as the number of larger adult animals dwindle. Low harvest pressure is indicated by a larger presence of older adults in an assemblage. Young individuals would have the chance to grow to older age classes before they are hunted. If there is a clear change in body size, but all age classes in the mortality profile are affected equally, including reduced fertility, that is an indicator of a change in environmental carrying capacity. The quality and quantity of resources available to mothers affect their ability to have young.

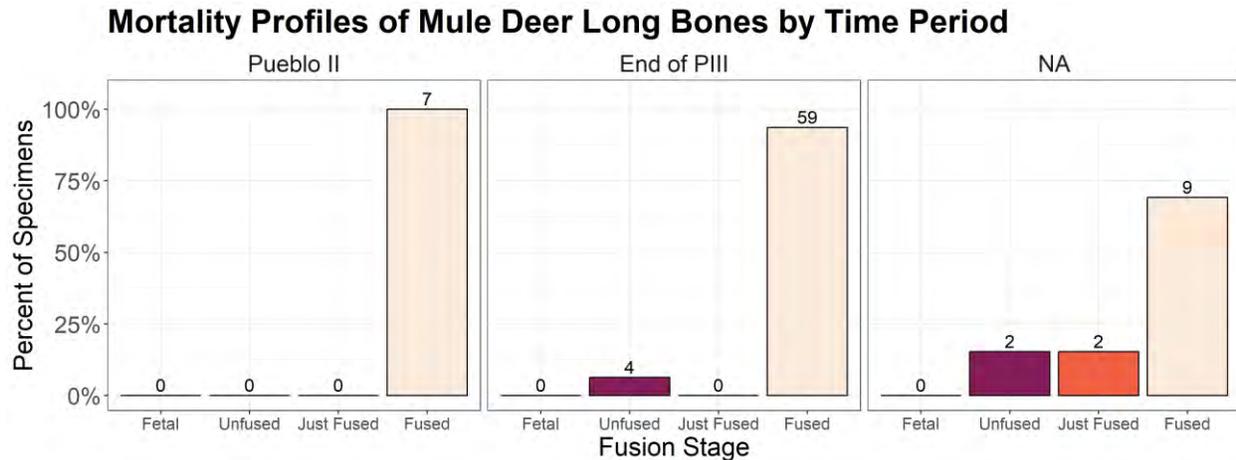


Figure 16: This mortality profile represents deaths in each age category over time. We grouped sites into rough time periods to account for low sample sizes. We calculated time groupings by the median deposit age of the loci in which the astragali were found. Sand Canyon Pueblo, Goodman Point Pueblo, and Yellow Jacket Pueblo represent the “End of PIII” grouping. Albert Porter Pueblo represents “Mid PIII” and the Haynie site represents “Pueblo II”. The x-axis is grouped by degree of epiphyseal fusion, which is a very rough measure of age composition (as opposed to the usual 10 age categories). Sample sizes are listed above the bars.

The substantial number of fused long bones at the end of PIII is a sign harvest pressure in the region may not have been as high as previously thought (Figure 16). Mule deer are seemingly given the chance to reach adulthood before they are hunted. Optimal foraging theory is not the only subsistence model possible, but the purpose of its use here is to question the assumption that overhunting occurred at the end of Pueblo III period. Our models do not provide exact snapshots for what harvest pressure and environmental conditions looked like at the end of Pueblo III. They are simply meant to call for the use of multiple lines of evidence in understanding the nuances of harvest pressure, especially at such a pivotal time in human history.

4.4 Conclusions

Preliminary investigations of several new lines of evidence concerning mule deer at the end of Pueblo III period are inconclusive, but they suggest areas for further consideration and study. The diversity of astragali sizes at PIII sites such as Sand Canyon Pueblo shows there are likely factors outside of harvest pressure at play. Body size does not clearly increase as expected under heavy harvest pressure. The body size of white-tailed deer at the Morgan Site overlaps with and/or surpasses the size of mule deer from the central Mesa Verde region. The Morgan Site is an interesting comparison considering it is located in central Connecticut and argued to have unusually large white-tailed deer that were sustainably hunted. The mortality profiles created here show an abundance of adult individuals at the end of PIII, which is another sign that high harvest pressure may not be the main actor on these assemblages.

Regardless of whether there was truly low or high artiodactyl harvest pressure during the late PIII period in the central Mesa Verde region, our point here is simple: the archaeological picture may not be as clear cut as previously thought. More data must be obtained to accurately identify causes of the patterns found here, as sample size is a concern in the above analysis. In particular, more astragali measurements are needed from PI and PII periods. More accurate

comparisons for archaeological mule deer data should also be developed using modern or archaeological mule deer astragali data with known context and environmental conditions. Future research should be done to create parameters around the sensitivity of mule deer body size to harvest pressure. Most body size models have been created using white-tailed deer. Considering the differences between the diets and morphology of white-tailed deer and mule deer, variation in phenotypic plasticity between these two species should be gauged. Another important thing to understand is how slight differences in the environments surrounding our selected sites can affect body size independently of harvest pressure. Additionally, the consideration of other models beyond optimal foraging theory is also one avenue for future research.

5 Taphonomy

One of the primary taphonomic questions surrounding the Haynie site archaeofauna is: what is causing the large amount of unidentifiable specimens at the site? The last two reports have focused on building predictive models to investigate what taphonomic variables are most associated with unidentifiable specimens. In year one, we found unidentifiable specimens are usually shaft fragments from medium-to-large mammals. In year two, we demonstrated there was an association between unidentifiability and recently disturbed contexts at Haynie, but that this association was of little practical significance (due to low effect size values). Our current hypothesis is medium-to-large mammal processing from Haynie's Ancestral occupants is the primary cause of unidentifiability and recent archaeological deposit disturbance is slightly exaggerating the signal of unidentifiability.

In this report, we step back from predictive modeling, zoom out, and spend time thinking about Haynie from a comparative taphonomic perspective. This last year, we worked to better understand taphonomic variables across the Crow Canyon Research Database. In particular, we focused on bone fragmentation, as it is a common taphonomic variable that effects many archaeofaunal assemblages across the globe. In particular, one of our investigations was to better understand the relationship between fragmentation and deposit type. To do this, we developed a Fragmentation Agency Index (FAI), which is defined as the ratio of percent unidentifiable (%Unidentifiable) to percent whole (%Whole) in an assemblage. %Whole measures extent of bone fragmentation by gauging the number of whole skeletal elements; it is a ratio of the number of whole specimens to the total number of specimens in an assemblage. %Unidentifiable coarsely measures intensity of fragmentation given the smaller fragments are the less identifiable criteria preserves (Cannon 2013). We calculate FAI by dividing fragmentation intensity (%Unidentifiable) by fragmentation extent (%Whole), which simplifies to: the number of unidentifiable specimens divided by the number of whole specimens. A higher FAI indicates a faunal assemblage dominated by more unidentifiable fragments relative to the number of whole specimens, which is what we view as a faunal assemblage with high fragmentation agency. We then calculated FAI for the faunal remains in every Study Unit—or unique area of deposition—in the Crow Canyon Research Database (Figure 17). This provides a way to diagnose deposits with particularly high levels of fragmentation in the central Mesa Verde region. The question now is, how do faunal remains (and their associated deposits) compare to other major sites in the region?

Distribution of Fragmentation Agency Across All Study Units in the Crow Canyon Database (n = 890)

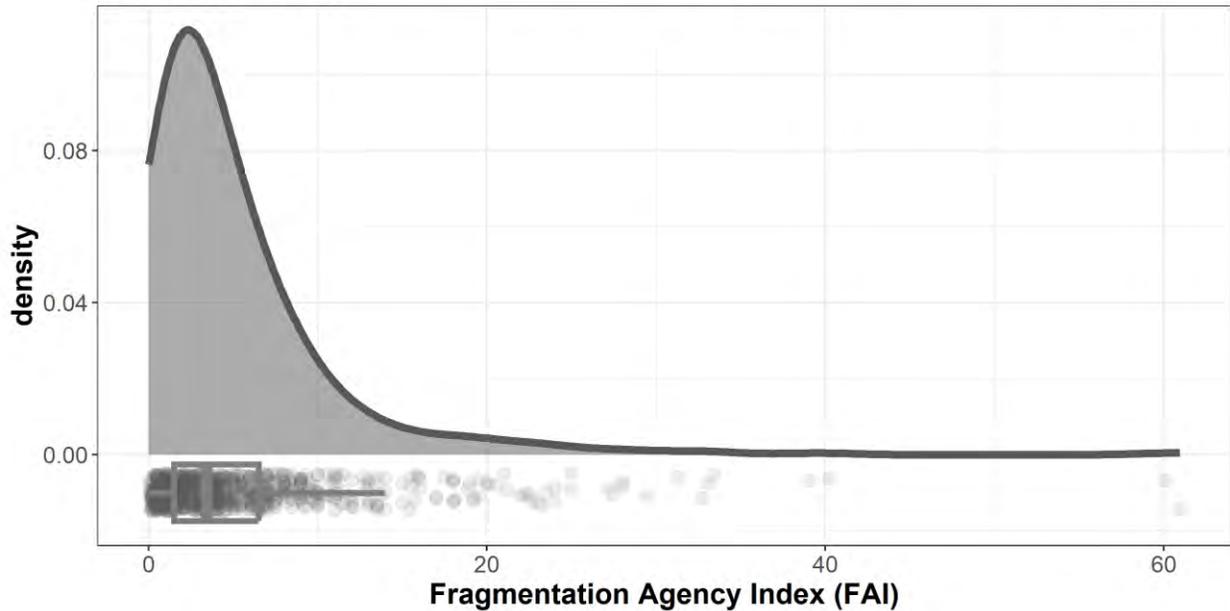


Figure 17: The distribution of the Fragmentation Agency Index (FAI) across all Study Units within the Crow Canyon Research Database. FAI is defined as the number of unidentifiable specimens divided by the number of whole specimens in a Study Unit.

To compare FAI across major archaeological sites in the central Mesa Verde region, we broke down different FAI categories by deposits with different taphonomic potential. We created five different categories to capture taphonomic potential: primary deposits within a structure, secondary or other deposits shielded by a container of some kind (e.g., a structure), recently disturbed deposits (e.g., looter's pits or chained areas), unshielded deposits (e.g., primary midden), or floor deposits. In that order, we term the deposits Structure, Non-Structure (in container), Recently Disturbed, Non-Structure (outside container), and Floor Inside Structure. We also put FAI into categories defined by quantile: below 25 is low, between 25 and 50 is medium-low, between 50 and 75 is medium-high, and higher than 75 is high. Using these grouping criteria, we see that Haynie is distinct from other major Crow Canyon projects in that the majority of faunal samples identified thus far come from Study Units that are recently disturbed with a high level of fragmentation agency (Figure 18). Shields Pueblo has a somewhat similar history of recent disturbance, but a much more even distribution of fragmentation agency across the FAI categories. Additionally, other Crow Canyon projects had a much higher focus of excavation in structures. The fragmentation of archaeofaunal remains identified from Haynie thus far are truly different compared to other sites in the Crow Canyon Research Database.

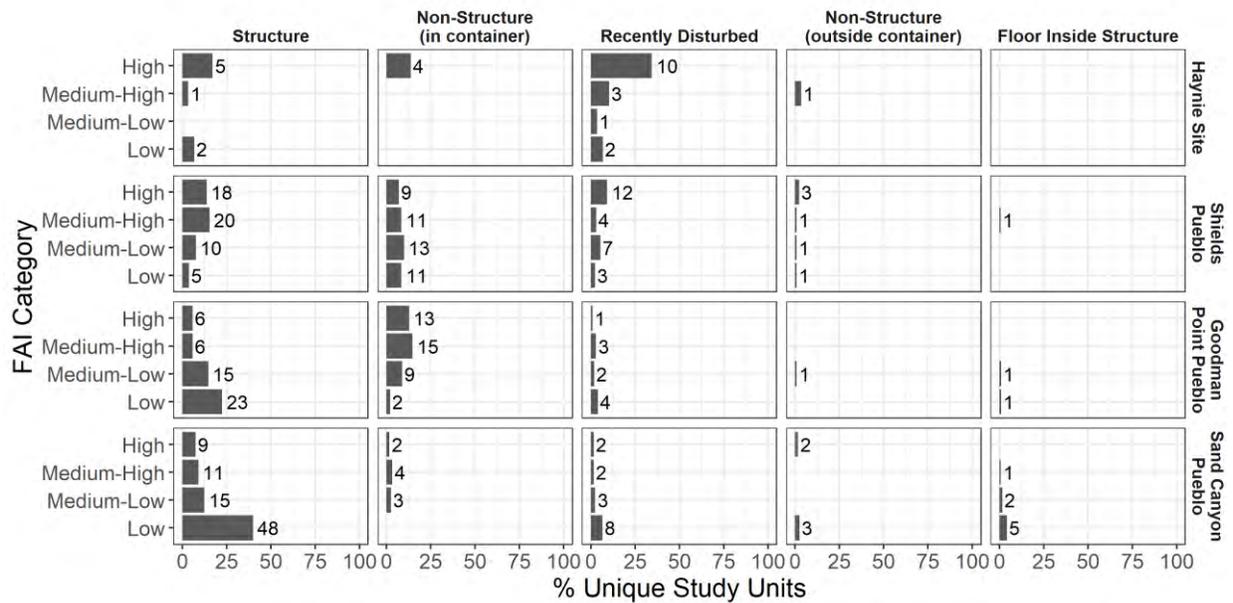


Figure 18: Fragmentation Agency Index (FAI) categorized by quantile (25, 50, 75) and grouped by five different deposit categories that capture taphonomic potential (Structure, Non-Structure (in container), Recently Disturbed, Non-Structure (outside container), and Floor Inside Structure) across four different archaeological sites. Haynie has a distinct fragmentation profile compared to the other sites.

6 Conclusions

This year's faunal report has added three new distinct areas of research associated with the Haynie site archaeofauna. First, we demonstrated—using stable isotope analysis and isoscape modeling—that the bison specimens recovered from the Haynie site do not come from the Plains region. It could be bison were procured closer to the Haynie site, and there are areas in the general Four Corners region that might be good candidates for areas of bison procurement. Second, preliminary evidence suggests mule deer may not have been as extensively overhunted at the end of Pueblo III period as previously thought. We have provided a snapshot of mule deer body size through time, of which Haynie importantly provided PII period samples. We have shown that signals of mule deer body size may not match with times where harvest pressure is thought to be intense. Future research will benefit from focusing on expanding astragali datasets, refining body size models specific to mule deer, and exploring alternative explanations associated with body size (i.e., environmental and/or ecological influences). Finally, to compare bone fragmentation across major archaeological sites in the central Mesa Verde region, we categorized deposits based on taphonomic potential and created an intuitive measure of fragmentation called the Fragmentation Agency Index (FAI). Haynie stands out in that most faunal samples from the site come from recently disturbed contexts with high fragmentation. This is different from other Crow Canyon projects, which typically emphasize excavation in structures and show more evenly distributed FAI patterns. While fragmentation is certainly distinctive at Haynie, additional research is needed to disentangle the cause of the high level of fragmentation.

7 Acknowledgements

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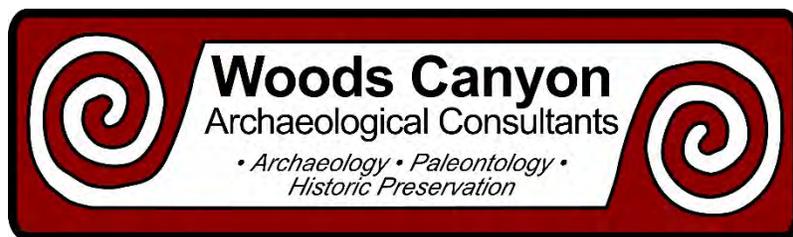
Appendix D – 2024 Haynie Site Stabilization Report

Please See Next Page

**Stabilization of Wall Caps in the East Ruin of the
Haynie Site (5MT1905)
Montezuma County, Colorado (MT.HP.R1)**



April 30, 2024



**Stabilization of Wall Caps in the East Ruin of the Haynie Site
(5MT1905)
Montezuma County, Colorado (MT.HP.R1)**

DRAFT

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ABSTRACT

Standing masonry walls in the East Ruin great house of the Haynie Site (5MT1905) were stabilized to mitigate the safety threat posed by overhead loose stones. This safety threat was initially identified during a condition assessment of the site in 2017. The Archaeological Conservancy purchased the Haynie Site property in 2019 and contracted Woods Canyon Archaeological Consultants to conduct the stabilization treatment in 2024. The Conservancy funded this work through a grant- Haynie Archaeological Site Stabilization Project- from the National Trust for Historic Preservation. Masonry wall caps were stabilized in preparation for testing in the East Ruin great house by Crow Canyon Archaeological Center as part of the Northern Chaco Outliers Project (NCOP). The NCOP is a Crow Canyon research initiative focused on understanding community centers with public architecture during the Chaco and post-Chaco periods (A.D. 100-1280) in the northern San Juan region of southwest Colorado.

Stabilization treatments were implemented between April 1 and April 12, 2024. Four architectural units in the East Ruin of the Haynie Site were treated including Kivas 200, 201, and 219, the second story courtyard walls above each kiva, and the interior west wall of Room 210. In each architectural unit, wall caps were stabilized to mitigate the safety hazard posed by loose stone above head height.

INTRODUCTION

Occupied from A.D. 700-1225, the Haynie site (5MT1905) is an Ancestral Pueblo community center with concentrated habitation and public architecture in Montezuma County, Colorado. The east and west Chacoan great houses at the site are associated with the expansion of Chaco influence into the Mesa Verde region between A.D. 1075-1300, which is an important event in regional history. For its import as a community and Chacoan great house center, the Haynie Site was listed on the National Register of Historic Places under the Great Pueblo Period theme on November 13, 2017.

For the current project, standing masonry walls in the East Ruin great house of the Haynie Site were stabilized to mitigate the safety threat posed by loose stones in walls over eight feet in height. This safety threat was initially identified during a condition assessment of the site in 2017 (Diederichs 2018). The Archaeological Conservancy purchased the Haynie Site property in 2019 and contracted Woods Canyon Archaeological Consultants to conduct the stabilization treatment in 2024. The Conservancy funded this work through a grant (Haynie Archaeological Site Stabilization Project) from the National Trust for Historic Preservation. The architectural wall caps were stabilized in preparation for excavation and mapping in the East Ruin great house by Crow Canyon Archaeological Center as part of the Northern Chaco Outliers Project (NCOP). The NCOP is a Crow Canyon research initiative focused on understanding community centers with public architecture during the Chaco and post-Chaco periods (A.D. 100-1280) in the northern San Juan region of southwest Colorado.

Three standing above ground kivas (Kivas 200, 201, and 219) and Room 210 in the East Ruin of the Haynie Site were treated. Various sections of the masonry were stabilized including the interior upper lining walls, second story kiva courtyard walls above the roof level of each kiva, and the west interior wall of Room 210. In each architectural unit, walls caps were stabilized to mitigate the safety hazard posed by loose stone above head height.

Stabilization treatment was conducted by Woods Canyon Archaeological Consultants, Inc. between April 1 and April 12, 2024. Jason Chuipka served as the Principal Investigator for the project. Architectural Conservator, Shanna Diederichs, was the project lead and was assisted by Staff Archaeologists Cory Breternitz and Grace Albers. Dave Satterwhite and Steve Copeland of Crow Canyon Archaeological Center provided field support and inspected the work. April Brown, Southwest Regional Director of the Archaeological Conservancy, managed the project.

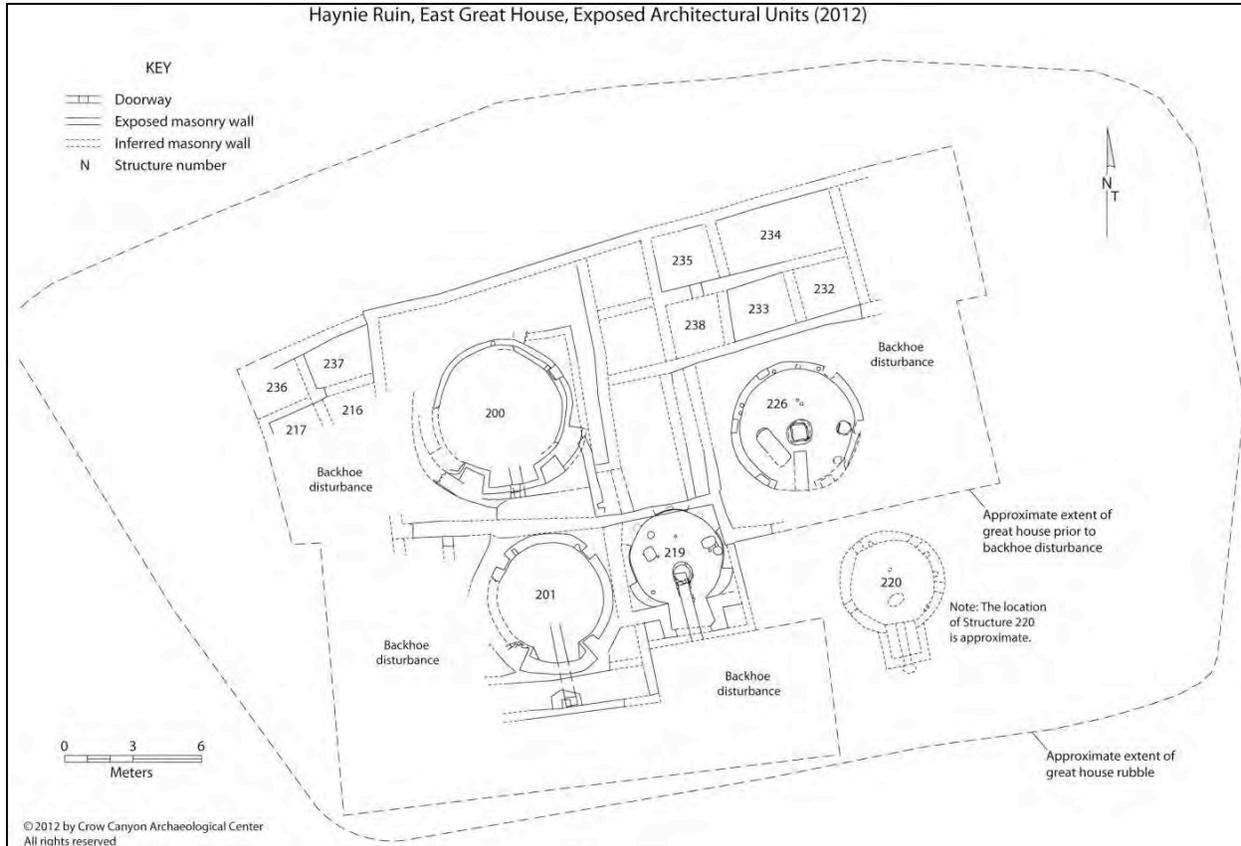


Figure 1. Plan map of the standing architecture at the Haynie Ruin East great house in 2012 (Ryan 2013:663).

This report provides background about the project, a description of methods used during stabilization, and a detailed account of the stabilization treatments to each architectural unit. Photographs from the project with captions can be found in Appendix A.

Project Background

The Northern Chaco Outliers Project (NCOP) is a multi-year research initiative by Crow Canyon Archaeological Center. The NCOP is focused on the Lakeview group—the Haynie site (5MT1905), the Ida Jean site (5MT4126), and Wallace Ruin (5MT6970)—a complex of four Chaco-style great houses and one great kiva within a 1 km radius (Ryan 2016). The site comprises a portion of two Chaco era great houses (West Ruin and East Ruin) with standing architecture and extensive buried earlier occupation deposits.

The Haynie site is the current focus of Crow Canyon’s investigations. The site is located on private property owned by the Archaeological Conservancy, which purchased the property in 2019. This parcel includes all of the West Ruin great house and two thirds of the East Ruin great house. The East Ruin great house is on the eastern boundary of the Archaeological Conservancy property (Figure 1).

Both the East and West Ruin were severely damaged between 1980 and 2015 during extensive amateur excavations. The previous landowners (Ralph and Claudia Haynie) engaged in nonprofessional digging in the ruins with heavy equipment (Ryan 2016). As a result, approximately 85% of the great house architecture was destroyed. In the West Ruin, only the back halves of few rooms survived demolition. In the East Ruin, four kivas and remnants of approximately six rooms were left standing. These once buried walls have been subjected to the elements for at least 30 years and are in various states of deterioration.

Though compromised, the importance of the Haynie site has long been recognized by regional archaeologists (Ryan 2013). Joel Brisbin, a long time Mesa Verde National Park archaeologist, knew Ralph Haynie personally and worked to salvage information and architecture at the site for nearly a decade in the 2000s. Brisbin cleared floor surfaces and mapped features in several of the great house structures (personal com. 2017). He also stabilized much of the standing great house architecture in both the West and East Ruins. He reportedly focused on areas of critical structural instability, often adding support structures such as retaining or abutment walls and capping to most wall tops.

Mr. Brisbin's stabilization mortars are visibly distinct from the original Ancestral Pueblo mortar in the great house walls. First, Mr. Brisbin often imported clean reddish brown loess from other locations in Montezuma County to use as mortar. This loess is much lighter and redder than the original mortar material. Second, Mr. Brisbin reconstituted eroded mortar screened from collapsed architecture in the vicinity and amended it with masonry mortar mix and/or portland cement. Due to the amendments, this reconstituted mortar often has a gray tone and is less permeable than the original mortars used at the site.

In 2017, Crow Canyon conducted a condition assessment of the standing architecture at the Haynie site. The primary objective of the assessment was to identify and prioritize areas in need of stabilization, especially in areas that posed a threat to safety. The architectural value and deterioration scores generated by the condition assessment process were used to prioritize structures for treatment. Structures with high value scores but low condition scores were recommended for stabilization treatment.

During the condition assessment, Crow Canyon solicited the advice of structural engineer Preston Fisher R.P.E. on the stability of the standing architecture at the Haynie site. Mr. Fisher identified six areas with exposed walls high enough to present safety and structural threats. In the west great house he identified the three standing walls of Room 161 and the north and east walls of Room 163. In the east great house he identified the interior masonry faces of Kivas 200, 201, 219 and the kiva perimeter wall on the east side of Kiva 200. Mr. Fisher recommended that qualified personnel assess the structural condition of these walls before excavating or working in their vicinity.

To mitigate these threats and effectively open the site to excavation, structures of high to urgent treatment priority were stabilized in 2018 after they were documented with photography, narrative descriptions, and abutment mapping (Diederichs 2018). Nine structures at East and West Ruin were stabilized. The most common treatment involved the relaying of wall caps to eliminate the danger of loose stone above head height. Often voids in the wall top were filled with new lay stones to seal the cap and several courses below the wall cap were repointed to ensure the stability

of the masonry. Other treatments were focused on creating safe access and egress into and through the structures by stabilizing the footing. Loose rock and rock piles were removed, floor features covered by plywood, and excavation and rodent holes were filled with backdirt.

Only issues that posed a safety threat were addressed during CCAC's stabilization. As a result, numerous material and structural threats were not addressed and most of the structures were still considered moderate to high stabilization priorities. Only issues that posed threats to safety were addressed during CCAC's stabilization. As a result, numerous material and structural threats were not addressed during this intervention and seven of the structures were still considered stabilization priorities. Kiva 200 in the East Ruin great house was deemed the highest priority because several delicate architectural features were actively collapsing. All nine structures were recommended for detailed architectural documentation before they were further stabilized or backfilled.

Since the 2018 stabilization, Crow Canyon has conducted spot capping of loose stones in structures at East Ruin including Kivas 200 and 201 and Room 241. This work was conducted for one week during each of the 2020, 2021, 2022, and 2023 field seasons and integrated into site conservation workshops for Crow Canyon Field Interns (Fladd et al. 2018; Satterwhite et al. 2023; Throgmorton et al. 2023).

Regulatory Setting

Awareness and public concern for the preservation of our national cultural heritage has prompted legislation by federal, state and tribal governments to protect historical, ethnographic, and archaeological cultural resources. Federally funded cultural resource management projects on private land are regulated and authorized by federal legislation and stipulation. These regulatory acts include the Federal Antiquities Act of 1906 (P.L. 59-209); The National Historic Preservation Act of 1966, as amended 1980 and 1992 (P.L. 89-665); The National Environmental Policy Act of 1969 (P.L. 91-194); Executive Order 11593: "Protection and Enhancement of the Cultural Environment", 1971 (36 C.F.R. 8921); The Federal Land Policy and Management Act of 1976 (P.L. 94-579); The Archaeological Resources Protection Act of 1979 (P.L. 95-96); The American Indian Religious Freedom Act of 1979 (P.L. 95-341); and The Native American Graves Protection and Repatriation Act of 1990 (P.L. 101-601). Colorado also mandates cultural resource management on private lands through state legislation such as the Historical, Prehistorical, and Archaeological Resource Act of 1973 (8 CCR 1504-7). Work conducted in conjunction with the current project is intended to comply with the statutes and regulations contained in these laws and codes.

In addition, prehistoric ruins preservation is guided by accepted standards and procedures to ensure that the work is professionally done and is consistent with national goals for historic preservation. While no definitive technical manual for this work has been published, procedural standards for the preservation of cultural resources are governed primarily by the Department of Interior's *Standards for Historic Preservation Projects* (USDI 1985) and *Archaeology and Historic Preservation* (USDI 1983), *United States Forest Service Manual 2300* (1978), *National Park Service Preservation Guidelines-28* [USDI 1981]), and *Ruins Stabilization: A Handbook* (Metzger 1988). Professional standards for archaeological excavation and analysis as well as acceptable qualifications for personnel are defined in the codification of the Archaeological Resources

Protection Act and supplemented by the standards of State Historic Preservation Offices and the National Park Service (NPS-28). Woods Canyon Archaeological Consultants, Inc. is fully aware of the elements of these documents and the work and recommendations reported herein and are in compliance with all of these standards.

METHODOLOGY

The purpose of cultural resource preservation is to arrest or retard deterioration of the structural remains and any associated scientific and cultural deposits including artefactual material. All work done in pursuit of this purpose is oriented toward retaining the original fabric and integrity of the prehistoric or historic remains as exactly as possible. Additionally, the sites or structures must be accessible and safe for scientific use and public enjoyment. Preservation work should not increase rates of erosion, and only such work necessary for structural stability, interpretation, and visitor safety should be done. Ideally, all preservation activities should be reversible, i.e., removable without permanent adverse impact to the resource.

The general approach to the preservation undertaken as part of the current project is consistent with the philosophy of the approach defined above. This approach is also consistent with the current techniques and philosophy used by both federal and state cultural resource management agencies in the region. All efforts were made to blend the repairs with the materials that were already in place.

The Haynie site has been documented in detail. In addition, the site has been included in several archaeological studies over the past decade. The previous recordings were used as baseline information for the condition assessment of extant architecture at the site. Maps, photographs, architectural descriptions, and architectural designations were all referenced when applicable. This report uses the architectural designations and terminology baseline developed by Joel Brisbin and Crow Canyon.

Conservation Treatments

The following conservation methods were employed individually or combined as necessary in response to the structural needs of each architectural unit and the 2017 condition assessment. The basic procedures utilized to accomplish the specific tasks are defined below.

Repointing and Pointing: Pointing is the placement of mortar in the joints of a new-laid or reconstructed wall. Repointing is the replacement of deteriorated, loose, or missing, mortar within the joints of a wet-laid masonry wall. All mortar joints requiring repair at the sites are raked clean of loose material. This process is accomplished with trowels, whiskbrooms and by hand. The vacant mortar joints are then thoroughly wetted for additional cleaning and to prevent the surrounding fabric from drawing excessive moisture out of the stabilization mortar. Water is applied to the joints with spray bottles and whiskbrooms. The stabilization mortar is then introduced to the void by hand or trowel. This new mortar is repeatedly packed into the joint during the curing process to ensure that the voids are completely filled and to prevent cracking of the mortar. Where necessary, small stones are used as spalls to aid in filling large joints. All repointing

mortar is final textured to simulate the surrounding original mortar joints or to achieve a weathered appearance. Repointing at sites will be done only to the degree that structural stability and compatible visual characteristics are achieved.

Relaying: Relaying is the process of replacing a stone in a wet-laid wall in a new bed of mortar where the stone remains in its original location, but some orientation displacement has occurred. Loose and displaced stones within a wall are removed. All loose mortar is removed with a trowel, whiskbroom, and by hand. This process continues until a sound footing is reached. The top course of the intact fabric is moistened and a new bed of mortar is laid down. The stones are wetted and replaced as closely as possible to their original locations atop the new mortar bed and tapped into place by hand or tool handle. Where necessary, spalls are used to aid in filling voids and providing a level platform for the stones. Excessive mortar, which has extruded from around the stones is removed. All mortar is final textured by hand. This technique can also be employed with dry-laid masonry if mortar is not deemed necessary to achieve the desired results.

New laying: New laying involves the addition of stone to a masonry structure that was not originally part of it or is missing from the structure. New laying can be done on either wet-laid or dry-laid fabric and is used discriminately to stabilize the existing masonry. New laying may be performed at the site to support overhanging, unsupported wall sections. Loose fabric is removed from the wall base with whiskbroom and by hand. The wall area is wetted, and a bed of mortar laid down. New stones are wetted and set in the mortar. Stones are built up in a style to simulate the surrounding masonry until the void is repaired. The stones should be new-laid in such a way to avoid areas where water could collect. All excess mortar is removed and the joints final textured by hand. Where necessary, spalls are used to aid in filling voids and provide a level platform for the new-laid stones. The mortar is monitored during the curing process, and all cracks, which develop, are immediately repaired.

New laying also may be performed along wall bases in heavy traffic areas and established paths through the site to provide steps over the wall fabric. A solid footing is obtained by removing debris and laying a bed of backfill material down. Stones are placed on the bed, and shimmed where necessary with leveler spalls. Where necessary, multiple courses of steps may be constructed. The additional courses are placed atop the lower course and leveled where necessary with shim stones. The steps may be dry-laid to create minimal impact on the adjacent fabric and accommodate easy removal if necessary.

Capping: Capping is the action of placing stones (whether they be wet-laid or dry-laid) on the top of the extant architecture. This can be done to add stability to a double stone width wall, which may be separating or to deter water flow and collection through the wall fabric. When employed for the later example these can be called splash stones. In some instances, these splash stones are situated on the wall top so to have an eve slightly overhanging a wall face that is being impacted by water flow. This allows overhead water to drip off of the splash stone without coming in contact with the wall face.

Backfilling and Drainage Contouring: Backfilling is the addition of culturally sterile sediment and/or stone to a structure, to support and protect structural fabric and cultural deposits. Backfilling is used to support wall bases, eliminate differential fill levels, cushion and protect archaeological

deposits from foot or vehicle traffic and the natural elements. Where appropriate, backfilling alone can fully stabilize a site or structure. Drainage contouring is the method of arranging backfill material to encourage moisture and water runoff away from wall bases and out of structures or where necessary, into the center of the structure. Burial or reburial of a structure or feature may be considered a priority action when compatible stabilization materials do not provide adequate stability.

Conservation Materials

The materials used in the structural stabilization of the East Ruin great house at the Haynie Site in 2024 included stone and mortar. Both were sourced locally.

Stone

When possible, displaced and loose stones in the walls were cleaned off and reset in place. To rebuild collapsed sections of masonry, new stone was collected from one of two mounds of previously collected stone piled off the west and south sides of the great house. This displaced construction stone is no longer in archaeological or architectural context and its removal did not alter the integrity or stability of the site.



Figure 2. Photograph of one of two mounds of previously collected stone adjacent to the East Ruin great house used as a source of masonry during stabilization treatment.

Mortar

A critical element to the success of any structural stabilization activity is the development of appropriate mortar. Desirable attributes for stabilization mortar sediment as defined by Metzger (1988) includes:

- Mortars must be durable with good adhesive qualities, able to withstand open weather exposure without excessive discoloration, crumbling, or extensive cracking for prolonged periods.
- Mortars must be consistent with variations in the aboriginal mortars throughout the site and be similar in color, texture, and content to the extent possible given availability and durability constraints.
- Mortars must be moisture resistant to the extent that they dry and wet without excessive expansion and contraction such as those containing illite or kaolinite. Sediments containing the Smectite Group clays should be avoided as they are subject to excessive expansion/contraction, which compromises bonding resulting in poor consolidation and weather resistance.
- Mortars must provide adequate flexibility to withstand seasonal wall movement and settling.
- Mortars must provide good capillary drainage to allow moisture to escape the fabric, preventing interior pooling, which promotes mortar erosion and cracking during freeze/thaw and swell/shrink cycles.
- The mortars should be removable without permanent adverse impact to the resource.

Mortar for the current project is a mix of local sediments, municipal water, and a mortar hardening agent. Under Crow Canyon's direction, sediments used in the mortar were collected from two contexts: 1) original and previous stabilization mortar eroding from the caps of masonry walls under repair and 2) from a backdirt pile associated with Ralph Haynie's excavation of the site off the northwest side of the East great house (Figure x). To determine their suitability, these sediments were compared with prehistoric mortars at the site and previous stabilization mortars. The Munsell color was determined for the sediments and mortar patties were mixed, dried, and tested for structural strength.



Figure 3. Backdirt piles off the northwest corner of the Haynie East Ruin great house used as a source of mortar sediment during conservation treatments.

Both the previous stabilization mortar and the backdirt sediments generally match the color and texture of the original mortar used in the great house. However, the previous stabilization mortars, which are a mix of screened backdirt material and portland cement are slightly greyer than the original mortar. In addition, the severe freeze thaw related erosion of the previous mortar mixes indicated that it did not hold up to weather related moisture and exposure at the Haynie site. Further testing of the proposed mortar sediments with a bonding adhesive agent created a mortar mix with a level of moisture impermeability and additional hardness.

Based on these findings a mortar recipe was developed for the project. The mortar sediments were sourced from a combination of original mortar and previous stabilization mortars from are light brownish gray (10 YR 6/2) loam (20% sand, 75% silt, 5% clay) with small rock inclusions. The liquid portion of the mortar is a 1 to 4 mix of SikaLatexR and water (i.e., 20% Sika, 80% water). Like Rhoplex, SikaLatexR is a water-based emulsion successfully used in masonry conservation in the Southwest, including at Mesa Verde National Park (Lim 2009). Water for the mortar was obtained from the Cortez City municipal system. No analysis of this water for sodium, calcium, or soluble salts was performed. This mortar mix was used for all wet-laid masonry work at the site.



Figure 4. Photograph of stabilization mortar sediments amended with SikaLatexR. From left to right: original mortar, reconstituted previous stabilization mortar, and backdirt.

Table 1. Comparison of stabilization mortar source materials.

Sediment Source	Texture Dry	Munsell Color without SikaLatexR	Munsell Color with SikaLatexR
Backfill	Firm to Hard	7.5 YR 5/2 brown	10 YR 6/2 light grayish brown
Previous Stabilization Mortar	Firm	7.5 YR 6/3 light brown	10YR 6/3 pale brown
Original Mortar	Hard	7.5 YR 7/2 pinkish gray	10 YR 6/2 light grayish brown

Documentation

Conservation treatments to the East Ruin of the Haynie Site have been documented in several ways. Digital photographs were systematically taken of the masonry before and after stabilization treatments. Any changes to the masonry were annotated on post-treatment photographs. During stabilization, the amount of mortar and new lay stone was tracked by structure.

TREATMENT

Approximately 48 m of wall cap was stabilized in the standing walls of Kivas 200, 201, and 219 and Room 210 in the East Ruin great house at the Haynie site in 2024. Areas capped in each kiva included the interior upper lining wall and standing segments of second story courtyard wall. In addition, a large collapsed section of masonry in the east upper lining wall of Kiva 201 was rebuilt

and large structural cracks in the southern recess of Kiva 219 were sealed. In Room 210, just south of Kiva 219, the west wall was capped.

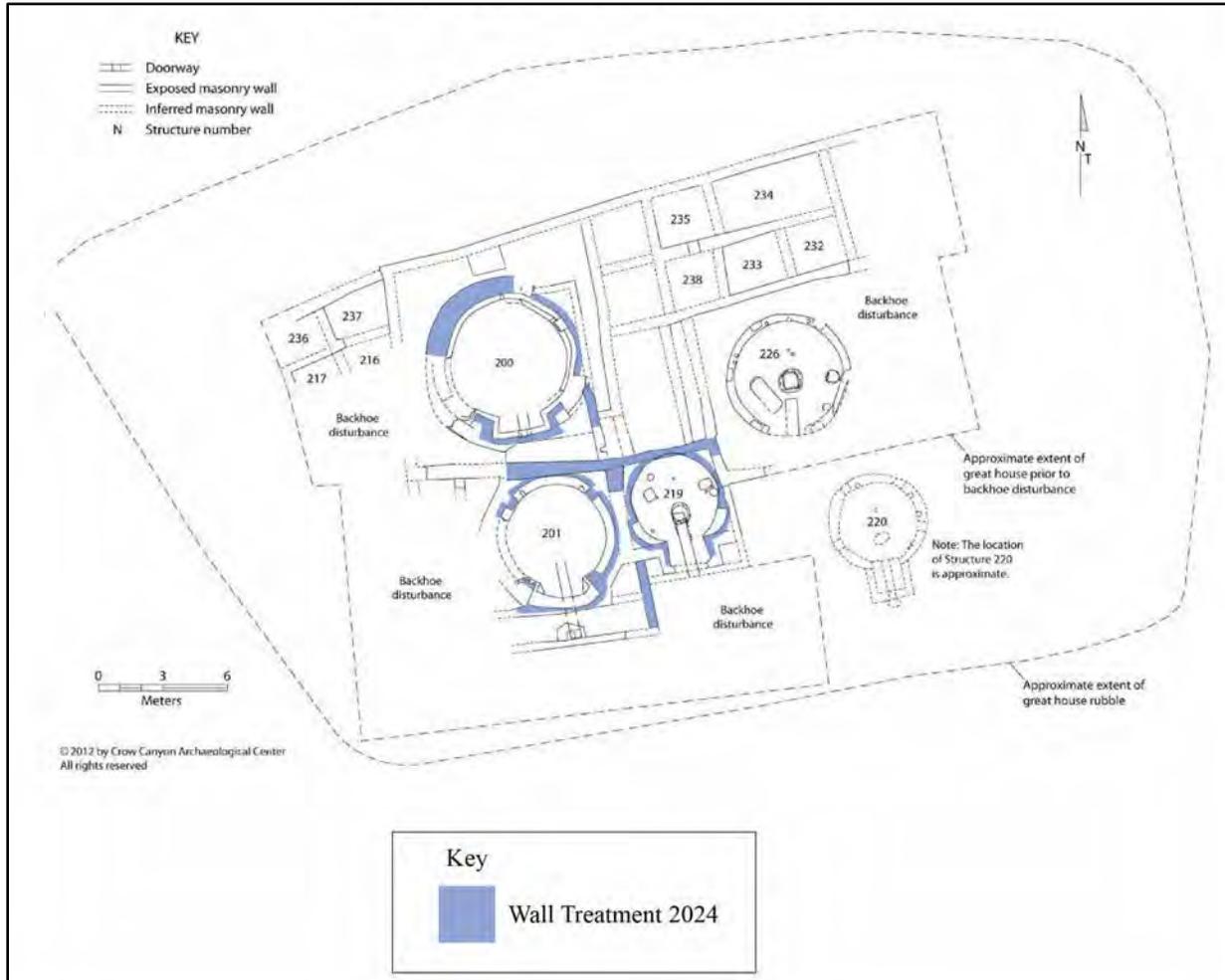


Figure 5. Plan map of the standing architecture at the Haynie Ruin East great house annotated with 2024 wall treatments (based on Ryan 2013:663).

Table 2. List of Stabilized Structures at the East Ruin of Haynie by Wall.

Study Unit	Stabilized Wall Caps
Kiva 200	North
	East
	South
	West
Kiva 200 2 nd Story Courtyard	East
Kiva 201	North
	East
	South
	West
Kiva 201 2 nd Story Courtyard	North
	East

Study Unit	Stabilized Wall Caps
Kiva 219	North
	East
	South
	West
Kiva 219 2 nd Story Courtyard	North
	East
	West
Room 210	West

Kiva 200

Kiva 200 is in the northeast section of the standing portion of East Ruin. It is the largest of the standing blocked-in kivas in the great house. It measures about 7 m in diameter and the original walls stood approximately 3.0 m high. There is evidence that the kiva was remodeled several times with two documented floor surfaces, a switch from sub-floor to above ground vent, and added pilasters and bench veneers. The Haynies destroyed the western quarter, a portion of the floor, and the roof during initial excavation. Portions of the floor were re-exposed by Joel Brisbin and the features mapped and the floor covered with 15 cm of fill. Brisbin then excavated the western third of the room to approximately 1.0 m below the final kiva floor level. He encountered an earlier floor surface in Kiva 200 and exposed an underlying masonry wall arcing to the east which is likely associated with an earlier structure. This trench was not backfilled, leaving the western bench veneer unsupported along the pit edge. Brisbin then stabilized the structure, focusing on major structural issues.

Kiva 200 Condition in 2017

Today approximately 60% of Kiva 200 is standing. Some of the interior walls are original height of 3.0 m tall. Remnants of the second story courtyard wall are standing around the northeast and southeast corners of the kiva, extending the wall heights another .5 to .75 m tall. Sections of the architecture have been heavily impacted by stabilization. The open wall cores on either side of the demolished west wall were rebuilt to halt erosion. Beams were re-socketed across the top of the southeastern banquette bench and a dry-laid retaining wall was built above them to protect a section of intact plaster. Filter fabric was layered in the northeastern cap and all of the wall caps were built up to a leveled height. Portions of the southeast and southwest pilasters and the subfloor vent opening were rebuilt. Approximately 15% of the exposed interior kiva veneer was repointed with cement or soil cement mix. Despite these drastic measures, approximately three quarters of the visible architecture is original materials.

Prior to 2018 stabilization efforts, Kiva 200 was in fair but very unstable condition. The architecture was suffering from moderate to severe deterioration, several sections of masonry were structurally unsound, fragile elements were suffering from erosion, and the kiva interior was unsafe to enter. Kiva 200 was recommended as a high, verging on urgent, priority for treatment in 2017.

The structure suffers from on-going material deterioration. Precipitation is eroding all wall cores. Mortar erosion is moderate to severe in the upper and lower walls. Approximately 20% of the

stone is deteriorating, especially the green tabular stone used in the pilasters, courtyard walls, southern recess, and vent openings. Stabilization concrete used in the wall caps and vent openings has fared poorly and generally shattered due to freeze/thaw activity. The most fragile and actively deteriorating area is the plastered face in the southeast banquette. Both capillary action and runoff are eroding this plaster at a pace that will obliterate it within the next 5-7 years. Six layers of fine plaster are currently visible in cross-section. They vary from white, to reddish-brown, to smoke blackened. A segment of eroding plaster is also visible on the east bench veneer. A few sections of the kiva are structurally unsound. All walls, including the pilasters, had loose upper courses of masonry which were slowly eroding out of the wall. There are low level veneer bulges across the upper lining wall which have led to cracks in the north wall and the east side of the southern recess. The most critically unstable elements in Kiva 200 are the courtyard wall remnants and the added east bench veneer. The courtyard wall sections are undermined, leaning, and actively collapsing. Similarly, the undermined bench veneer is peeling away from the earlier kiva face. The south end of the veneer is severely leaning and the entire veneer is in danger of collapsing to grade.

Kiva 200 was also suffering from fill disturbance. A meter deep floor level hole into the above ground vent and down into sub-floor vent was left open after excavation. This has exposed the masonry and possible intact vent lintels to the elements and rodent activity. This rodent hole and the unfilled excavation pit present unsafe footing in the structure.

Despite excavation damage and prior stabilization, the structure retains a moderately high level of integrity. Several important architectural features were found to be intact but in imminent danger including plaster faces, construction and veneer sequences, wall features, and floor features.

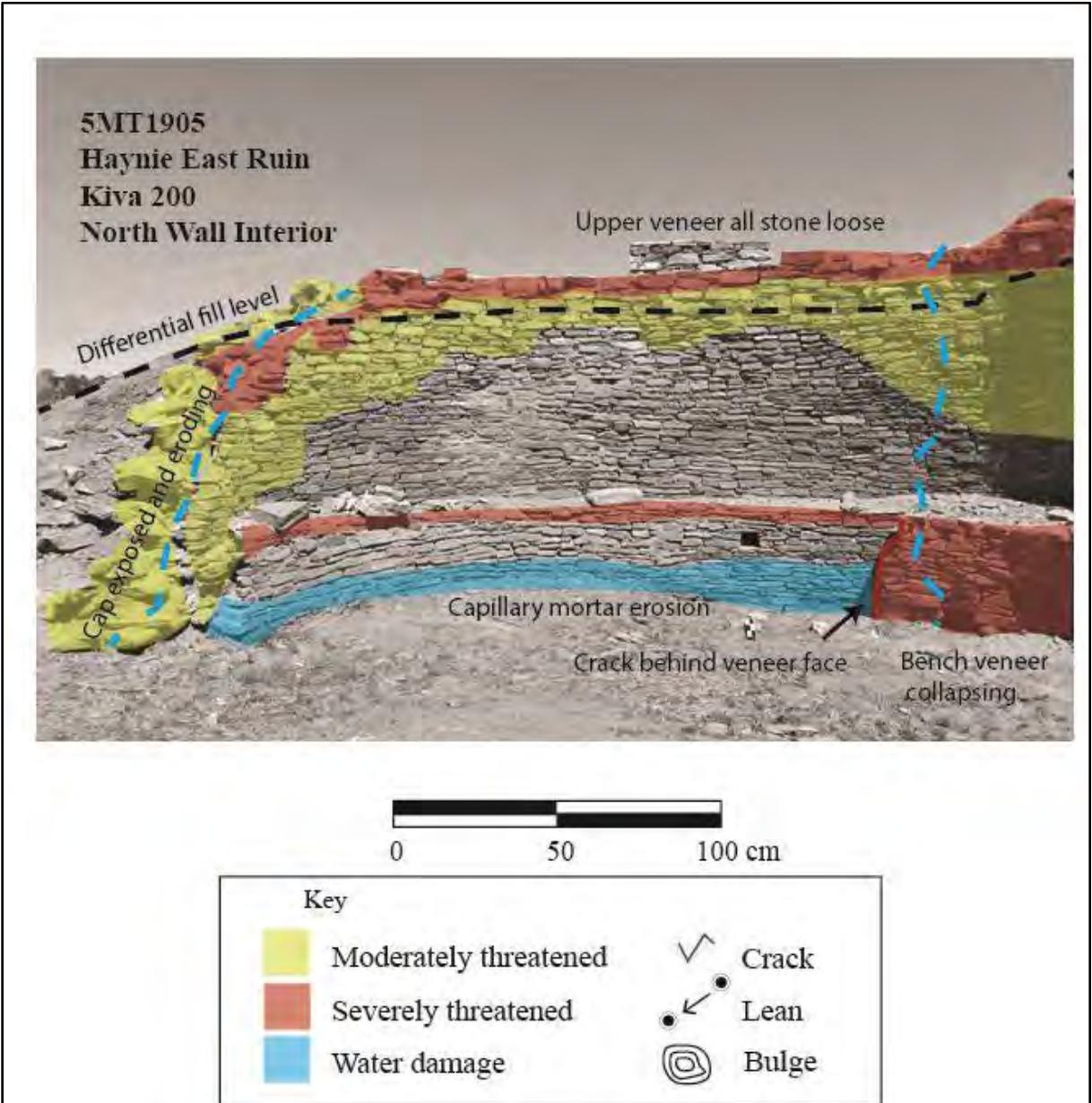


Figure 6. Kiva 200 north interior lining wall condition issues annotated in 2017.

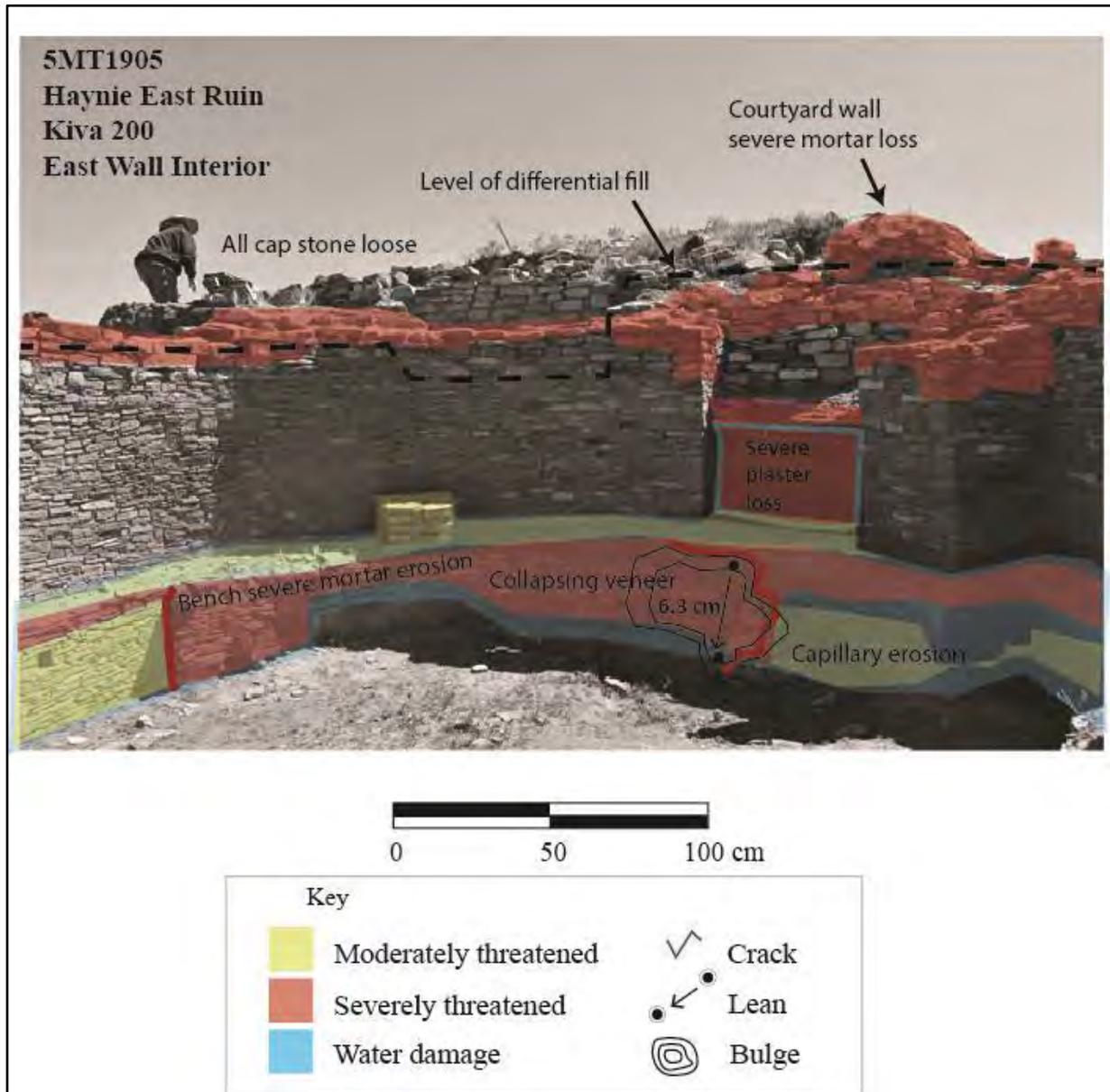


Figure 7. Kiva 200 east interior lining wall condition issues annotated in 2017.

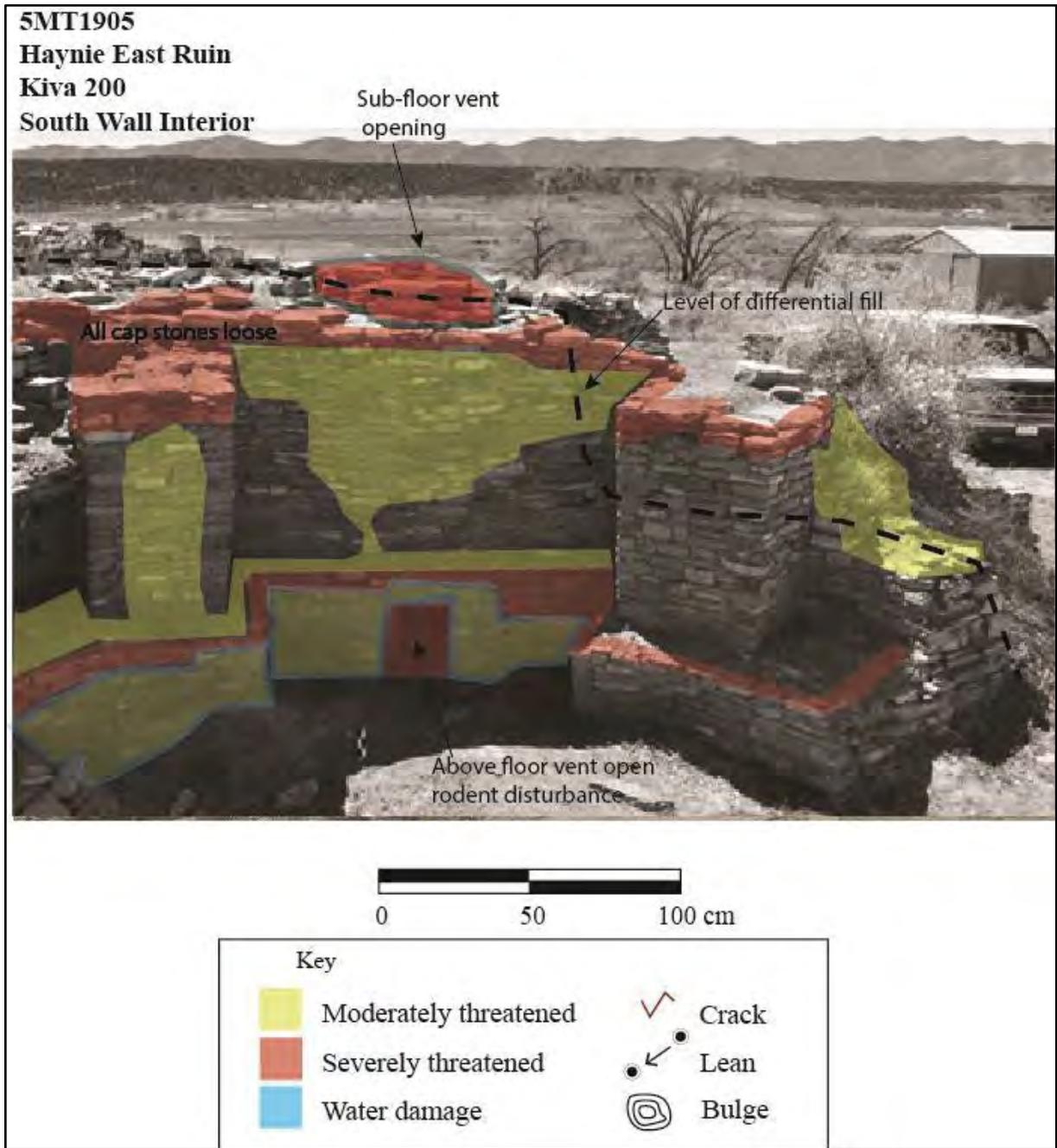


Figure 8. Kiva 200 south interior lining wall condition issues annotated in 2017.

Crow Canyon addressed safety issues in Kiva 200 with stabilization treatments in 2018 and 2020. All loose stone and concrete were removed from the caps and upper veneers of all walls, including the sub-floor vent opening and kiva courtyard walls. The filter fabric layers were removed from the north and east walls and pilaster caps. Upper wall courses were relayed where possible and new lay stones were added to bring the wall caps up to a consistent height. Voids in the courtyard walls, pilaster corners, and upper lining wall were filled with new lay stone. The dry laid wall above the southwest banquette was shored up. Loose stones were piled up in front of the south end of the collapsing bench veneer face and backfill was added to support undercut sections. The large

rodent hole next to the vent was filled with back dirt and loose stone was removed from the kiva to remove tripping hazards.

Kiva 200 Wall Cap Stabilization in 2024

All of the wall caps in Kiva 200 were in a moderate state of deterioration prior to stabilization in 2024. Loose stones in the interior lining wall caps were reset and repointed. The southern recess and the southwest and southeast pilasters were particularly deteriorated and required several courses of stones to be reset and additional cap stones added. The visitor's trail, leading to the unexcavated portion of the great house, runs behind the north wall of Kiva 200. To create stable footing and ensure the safety of people inside the kiva below the trail, the north wall of the kiva was fully capped and the area behind it cleaned of debris.



Figure 9. Overview of Kiva 200 from above after stabilization. View to the northwest.

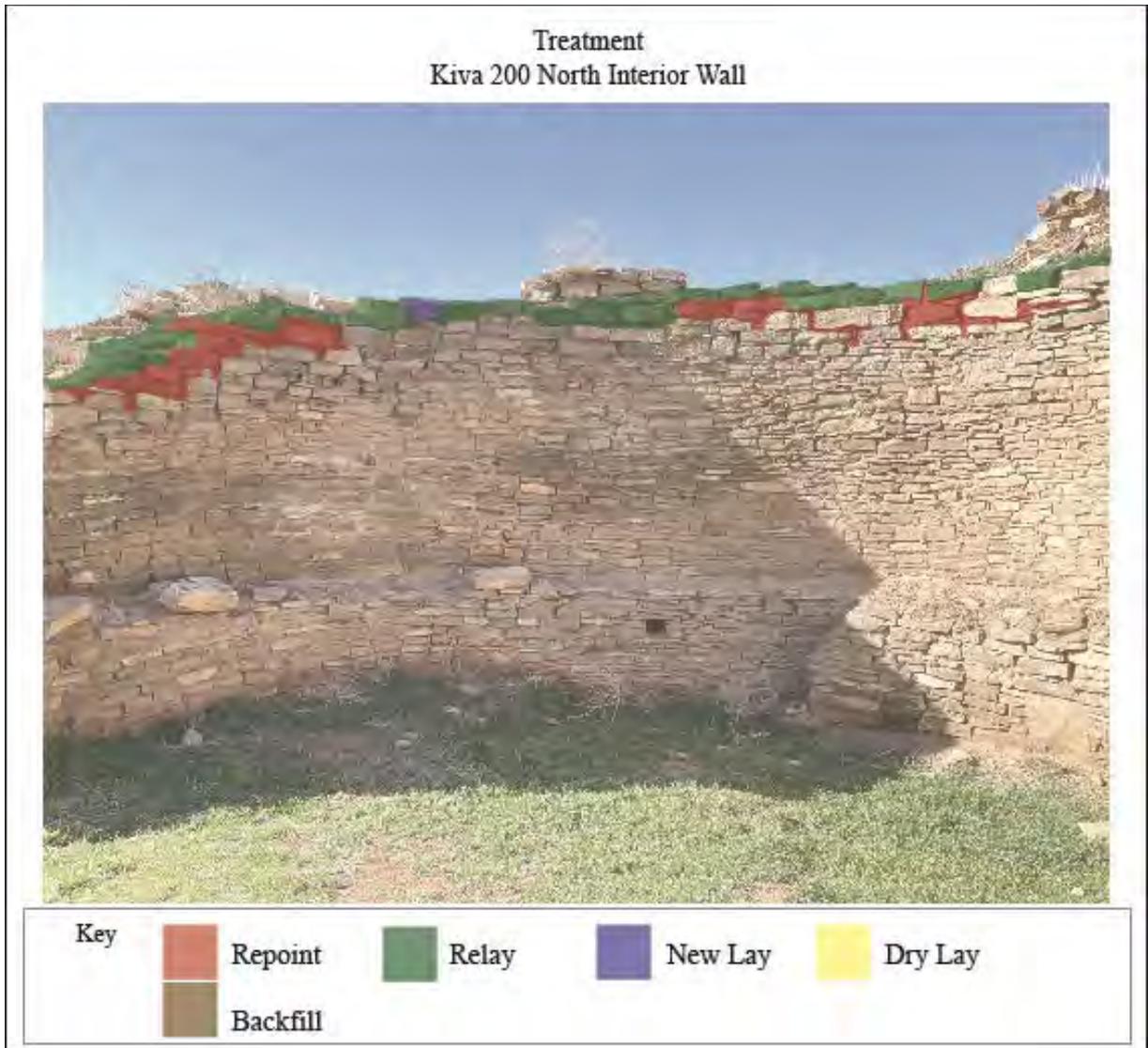


Figure 10. Kiva 200 north interior lining wall after stabilization, annotated with conservation treatments.

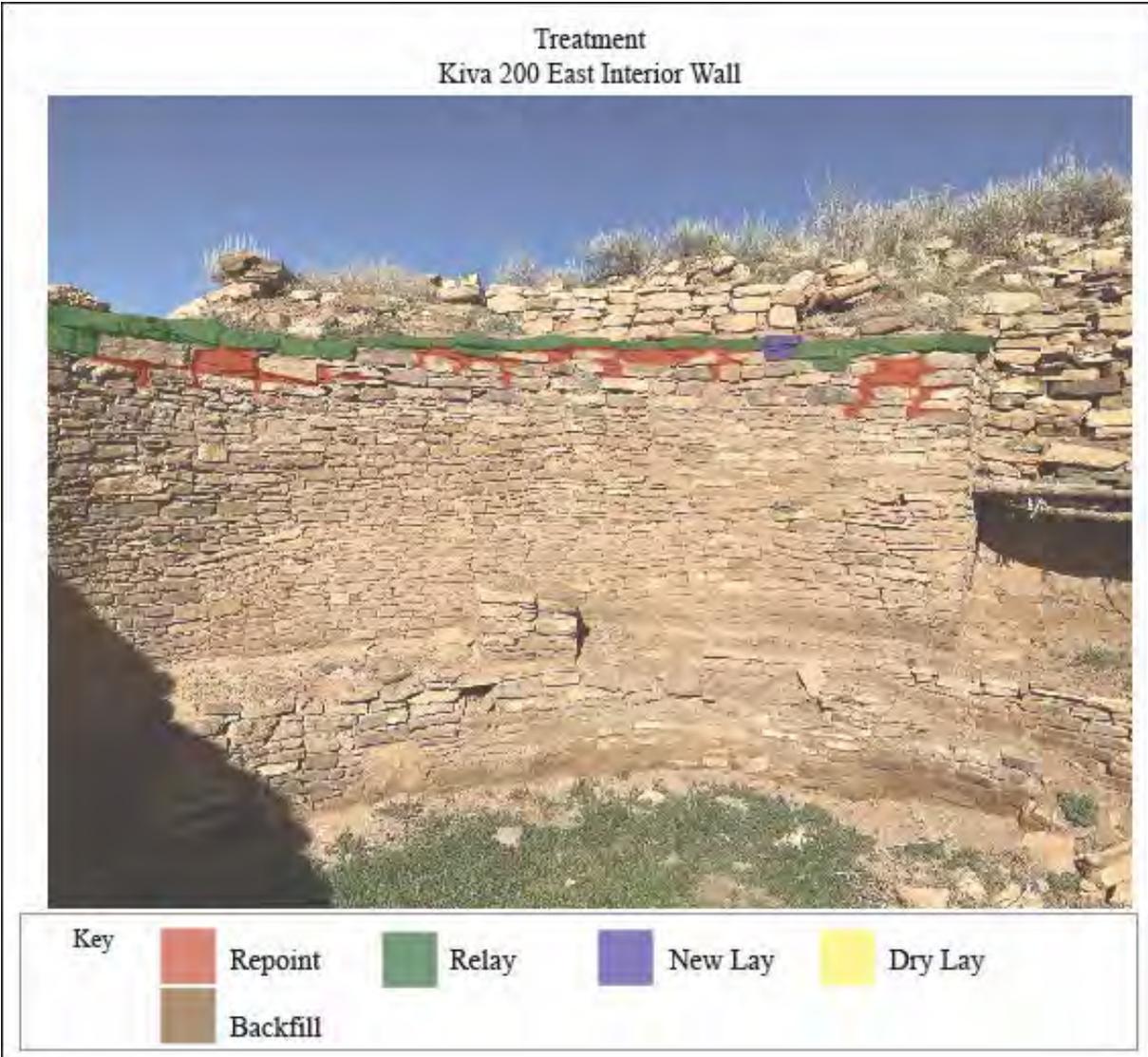


Figure 11. Kiva 200 east interior lining wall after stabilization, annotated with conservation treatments.

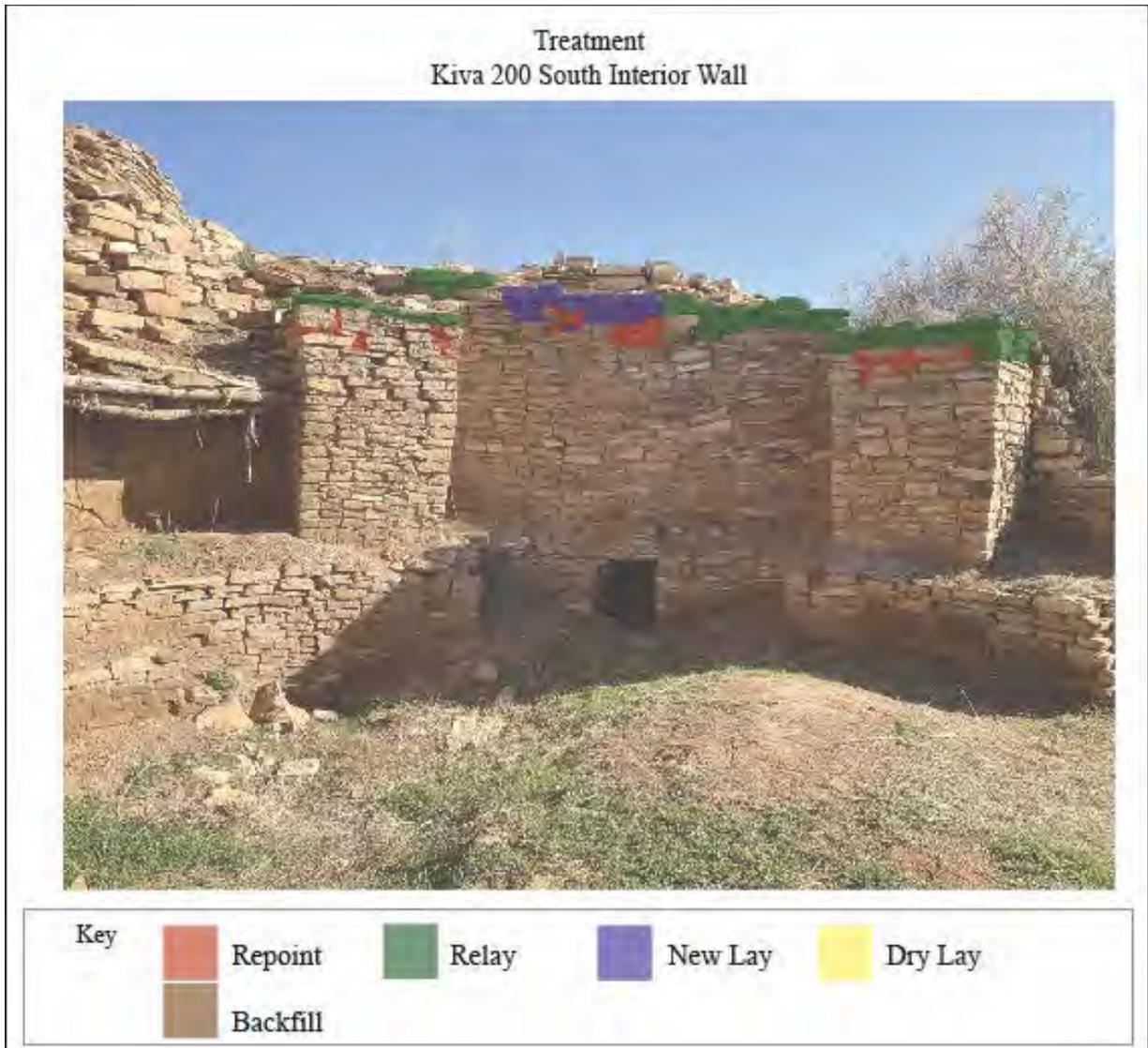


Figure 12. Kiva 200 south interior lining wall after stabilization, annotated with conservation treatments.

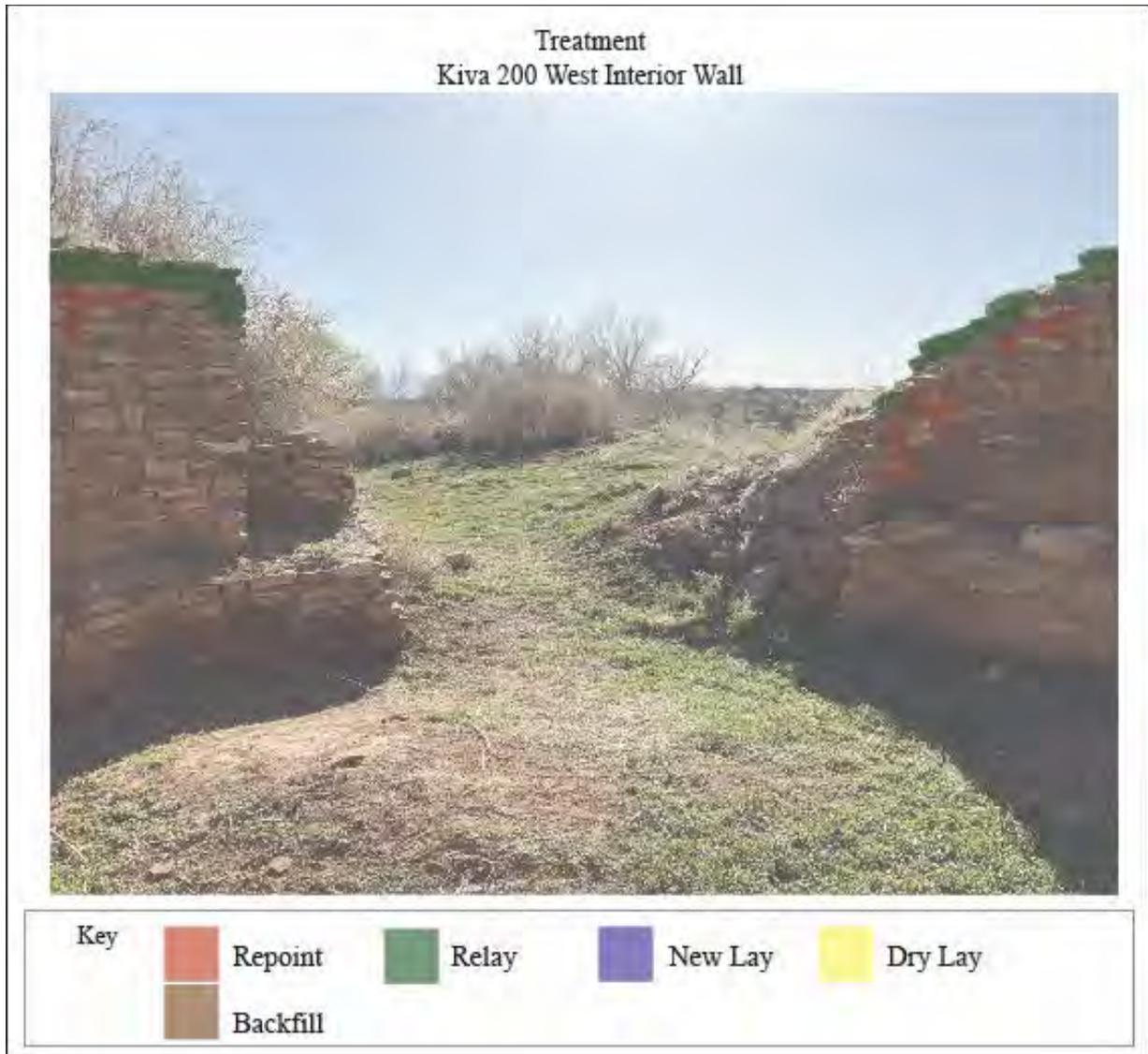


Figure 13. Kiva 200 west interior lining wall after stabilization, annotated with conservation treatments.

The second story northeast and southeast courtyard wall remnants above Kiva 200 were in a state of severe deterioration prior to stabilization. The northeast segment is set back from the edge of the kiva and does not pose a safety threat. The southeast corner fragment of the courtyard, however, runs along the east edge of the kiva and posed a safety threat. The wall suffered severe mortar loss leaving many of the interior face stone loose and in a state of collapse. This face of the courtyard wall sits directly above the drylaid upper lining wall created by Joel Brisbin and posed a severe mortar threat. For this reason, most of the stones on the interior veneer and in the wall cap were reset. The northeast corner wall fragment is set back from the kiva's edge, does not pose a safety risk to people inside the kiva, and was left in place and untreated.

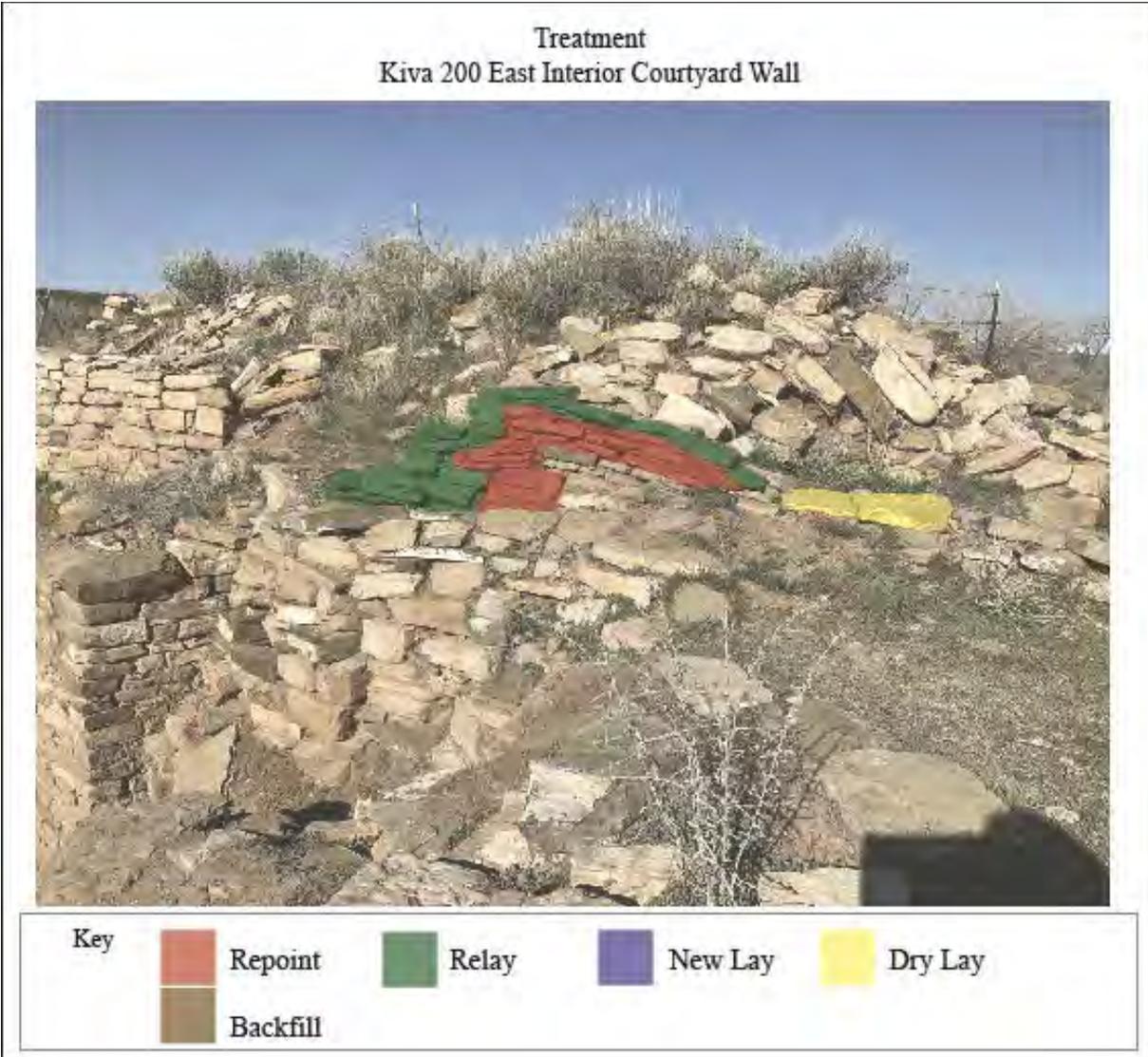


Figure 14. Kiva 200 east wall of second story courtyard after stabilization, annotated with conservation treatments.

Kiva 200 is still considered structurally unstable and a high priority for treatment within the next 2-5 years. In particular, the kiva bench tops have continued to deteriorate, the plaster on the southeast banquet continues to erode, and open sections of the vent are collapsing. High priority treatments include architectural documentation, plaster conservation, and veneer and feature reconstruction and repointing. All of these issues could be mitigated with backfilling.

Kiva 201

Kiva 201 is the southwestern most kiva in the standing portion of East Ruin. It is the most standard of the exposed kivas with four pilasters and evidence of minor remodeling. Kiva 201 measures about 5.47 m in diameter with walls standing up to 2.25 m high. Above the height of the kiva, the entire length of the north and a section of the east second story courtyard wall are still standing several courses high.

When they excavated Kiva 201, the Haynie's broke through the southwest wall during the initial excavation and impacted the adjacent section floor with a backhoe. Any remains of the roof were destroyed at that time. Excavations by the Haynie's south of the kiva also destabilized the structure by exposing the masonry vent opening in the core of the south wall. The kiva floor was re-exposed by Joel Brisbin and the sub-floor vent was mapped at that time. Brisbin removed all of the sub-floor vent lintels leaving a section of open trench in the floor which is now covered with a piece of plywood.

Condition of Kiva 201 in 2017

Around 60% of Kiva 1 is still standing, and most of the masonry is original construction (approximately 72%). Joel Brisbin addressed major structural issues with stabilization interventions in the 2000s but Kiva 201 required less work than the other three kivas in East Ruin. Brisbin finished off the wall faces exposed by the backhoe break in the west wall. He rebuilt the front face of the southwest pilaster and rebuilt a collapsed corner of the southeast pilaster and added filter fabric to the cap. Based on the location of concrete mortar patches, Brisbin repointed patches of loose masonry in the bench face, upper lining wall, and wall caps. He also added 10-20 cm of fill to the plastered floor and benches to protect them from deterioration. Despite these modifications, most of the visible masonry in Kiva 201 is original. A condition assessment of Kiva 201 determined that it was in moderately poor condition with erosional, structural, and safety threat issues that made the kiva interior unsafe to work in.

Water erosion is responsible for most of the deterioration in Kiva 201. Nearly all of the top courses in the upper-lining wall are loose due to severe mortar erosion. The pilasters and bench top masonry was similarly deteriorated. The bench edge was especially fragile and prone to collapse. Along the base of the walls capillary action had caused moderate to severe mortar and stone deterioration. There were two actively deteriorating masonry voids in the bench veneer. Both may be eroding niche features.

Kiva 201 faces a few structural instability threats. The upper lining walls appear to have been built with a 3 to 8 cm lean inward. This has contributed to low level depressions, bulging, and vertical cracking in the veneers. Additionally, the dry-stack support inserted under the exposed end of the north wall core during stabilization has come loose leaving that section hanging. The north kiva courtyard wall was found to be in moderately poor condition with all upper courses loose due to mortar loss.

The fragmentary east second story courtyard wall is in far worse condition due to its location and original construction. The southern two thirds of the east courtyard wall have fallen away because they were undermined at the roof level. Only a few courses, over 1.5 m length, at the north end of the wall are intact. This section is perched on a remnant of first story rubble wall core. The east and west veneers of the second story courtyard wall have peeled away from each other because the wall core was constructed with loose fill. The courtyard wall was determined to be in imminent danger of collapse in the next five years.

The floor and fill in the structure were also in moderately poor condition. The piece of plywood covering sub-floor vent trench was too small. Foot traffic over the feature appears to be causing deterioration of the feature walls and rodents were getting under the plywood. A large rodent hole in the floor fill next to the opening appears to angle into the sub-floor vent suggesting rodents are actively destroying the features wall. A pile of rocks in the center of the kiva along with the plywood and rodent hole created unsafe footing in the kiva.

Condition Assessment identified several safety threats in Kiva 201 including loose and leaning masonry walls and wall tops above head height, scattered rubble underfoot, unfilled excavation and rodent holes. Crow Canyon addressed all safety issues in 2017. The northeast interior wall was additionally capped in 2023. All loose stone and concrete were removed from the caps and upper veneers of all walls. The filter fabric layer in the southeast pilaster was removed. Upper wall courses were relayed where possible and new lay stones were added to bring the wall caps up to a consistent height (Figure 5). The dry laid wall at the west end of the north wall was shored up. The sub-floor vent opening was covered by a larger piece of plywood. The large rodent hole next to the vent was filled with back dirt and loose stone was removed from the kiva to reduce tripping hazards.

The courtyard walls above Kiva 201 were also treated. The loose stones in the upper north courtyard wall were relayed in place. The few intact masonry stones in the east courtyard wall alignment were relayed in place and a few additional stones were added to the south. Rubble was placed across the soil core of the wall to protect it from erosion. All other loose rubble was removed from the wall tops. Though all safety hazards have been addressed in Kiva 201, the structure is still considered a moderately high priority for treatment within the next ten years. We recommend that the structure undergo detailed architectural documentation, that the bench face and eroding voids be stabilized, and the wall veneers repointed. Back filling should be considered as a long-term solution to the material and structural deterioration of Kiva 201.

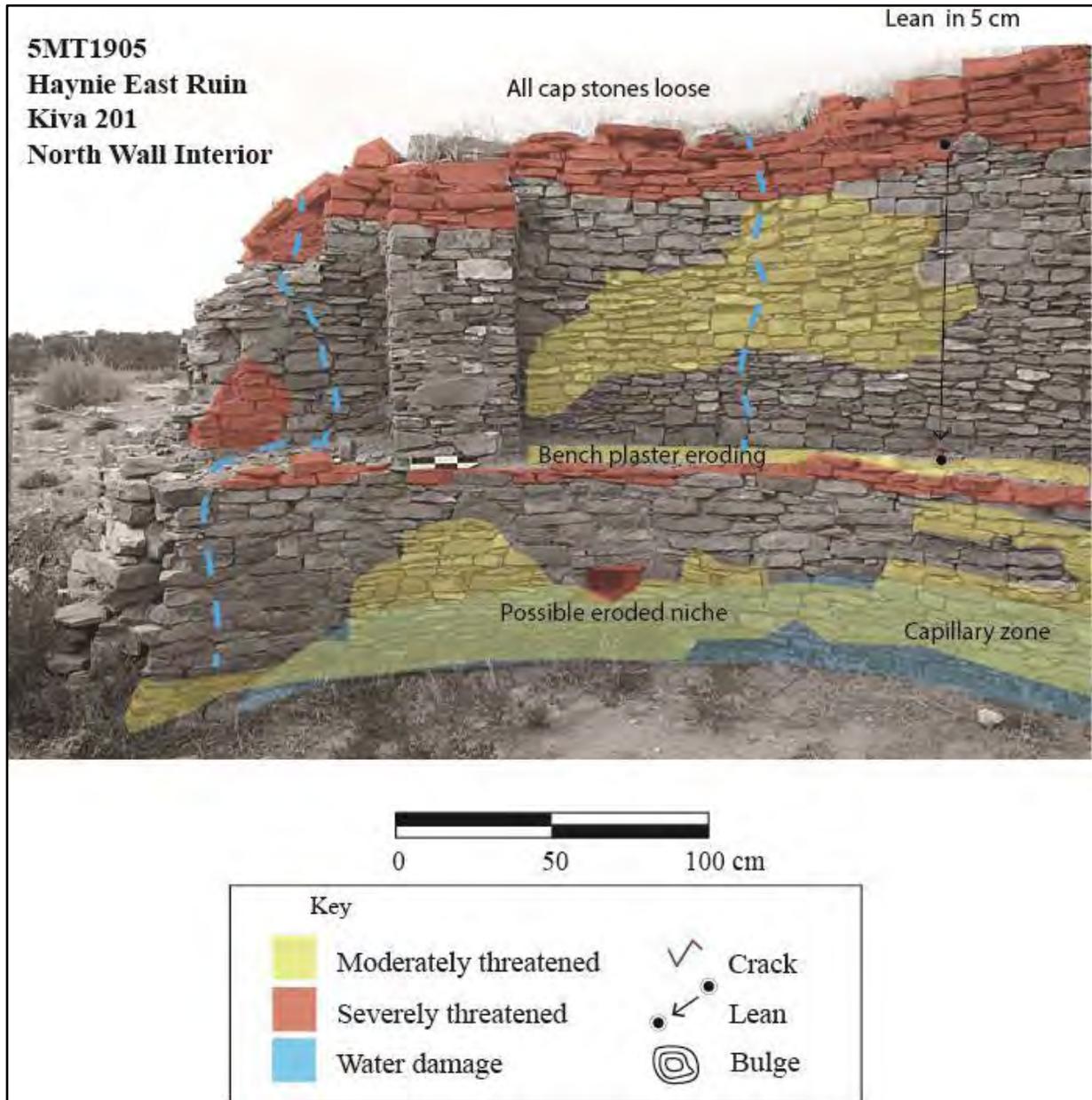


Figure 15. Kiva 201 north interior lining wall condition issues annotated in 2017.

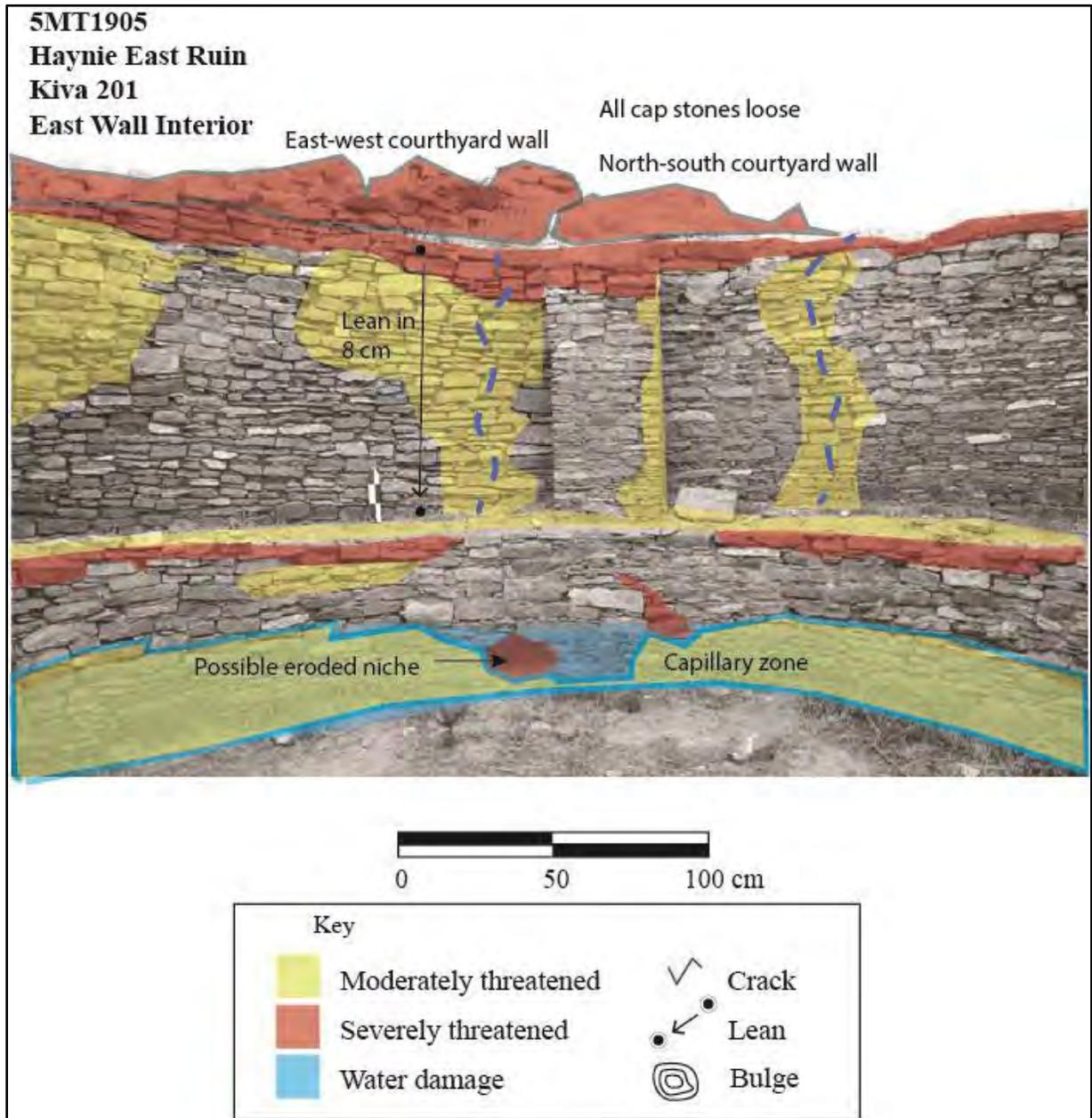


Figure 16. Kiva 201 east interior lining wall condition issues annotated in 2017.

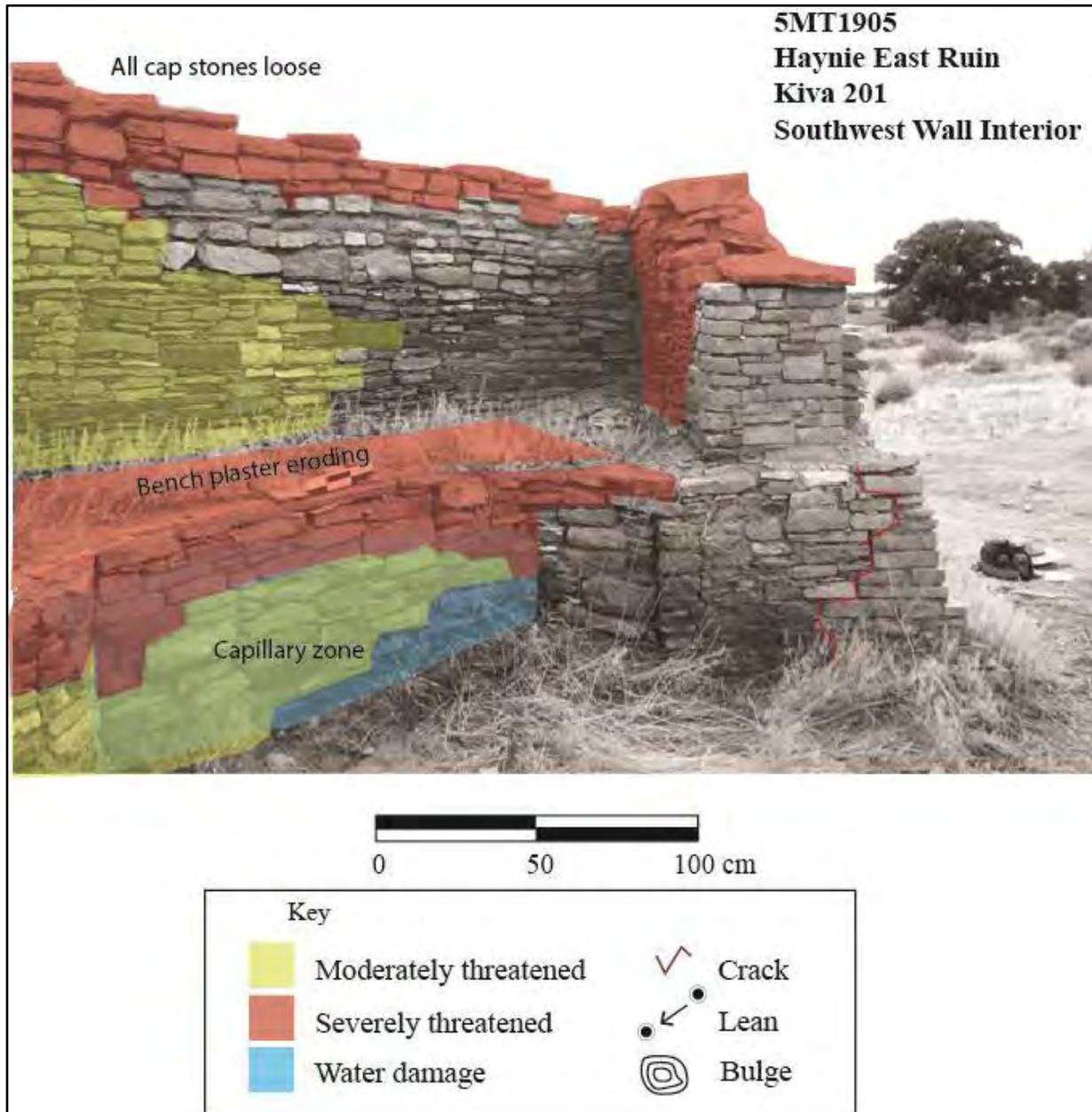


Figure 17. Kiva 201 south interior lining wall condition issues annotated in 2017.

Kiva 201 Stabilization in 2024

Prior to stabilization, all wall caps of Kiva 201 were in a state of deterioration with pockets of imminent veneer collapse. During the winter 2023-2024, a 2 m long and .5 m high portion of the east interior lining wall collapsed leaving a large hole in the upper veneer and several adjacent stones, loose and leaning. Severe mortar loss was noted in the top of the southern recess wall and in the cap of the southeastern pilaster.

Leaning and loose stones around the hole in the east interior lining wall were restacked and reset. The masonry hole was filled with three to four courses of new lay stone. Loose stone in all other wall caps were relaid. This required relaying of up to three courses in the southern recess and southeast pilaster.



Figure 18. Overview of Kiva 201 from above after stabilization. View to the southwest.

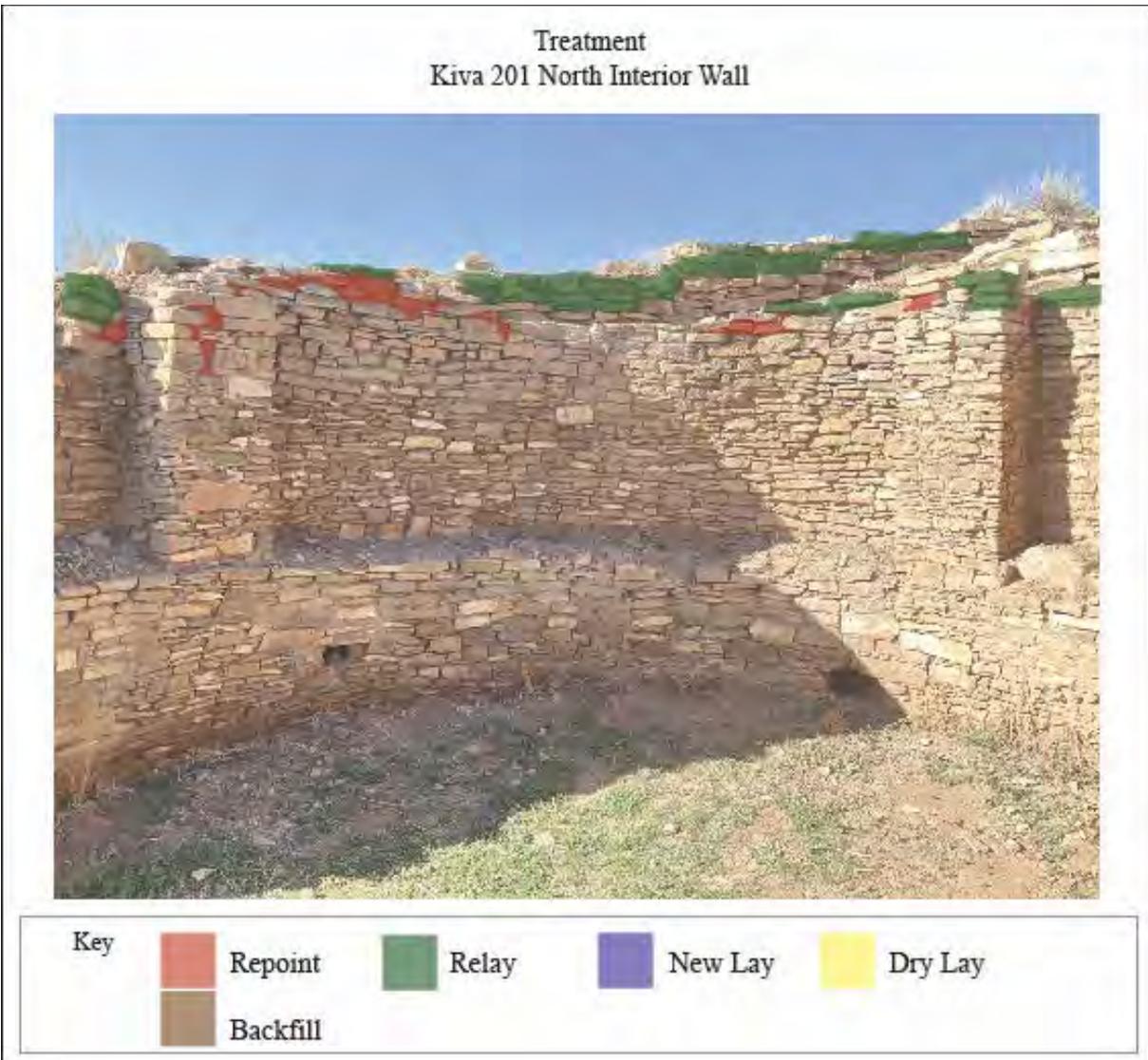


Figure 19. Kiva 201 north interior lining wall after stabilization, annotated with conservation treatments.

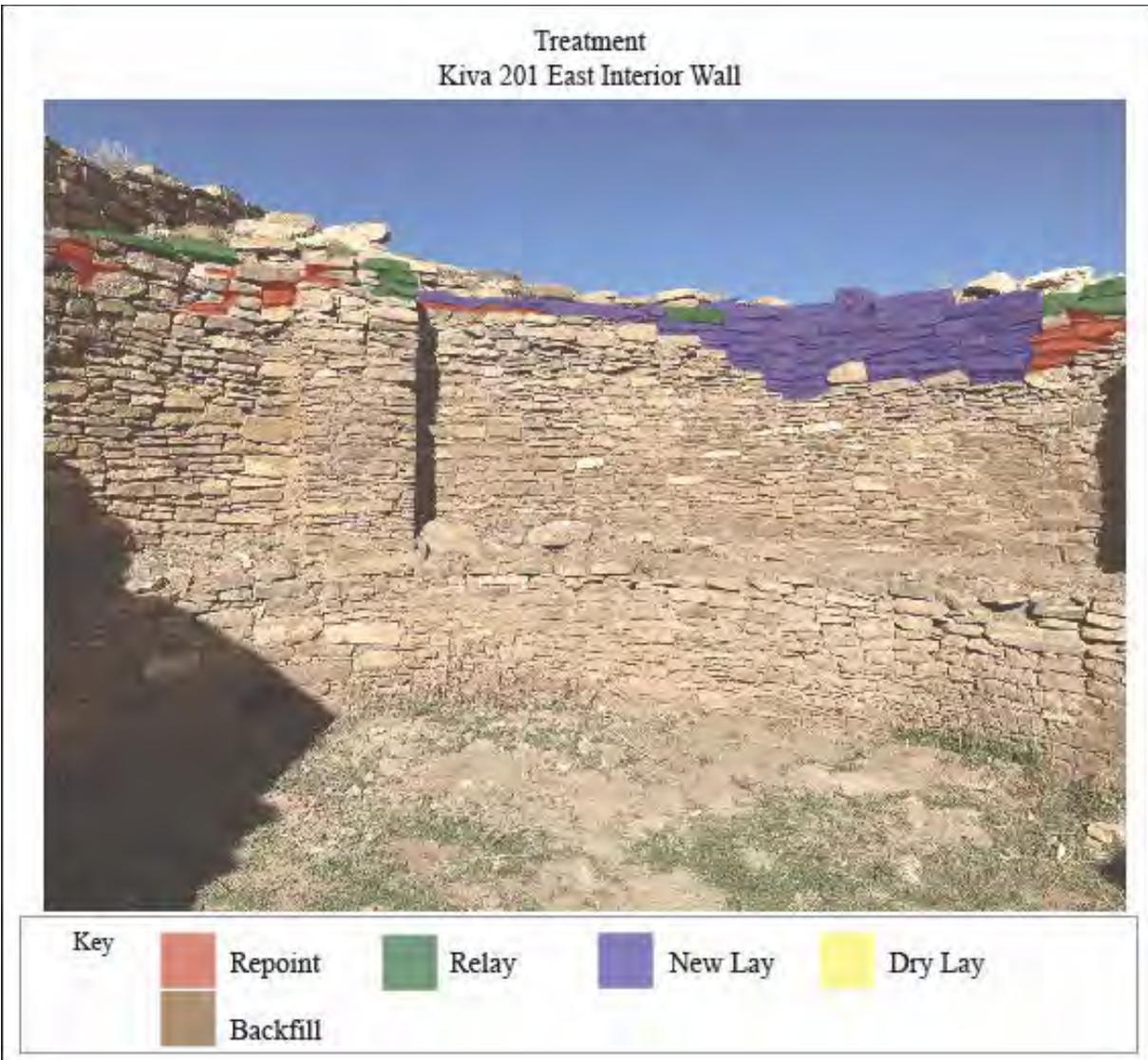


Figure 20. Kiva 201 east interior lining wall after stabilization, annotated with conservation treatments.



Figure 21. Kiva 201 south interior lining wall after stabilization, annotated with conservation treatments.

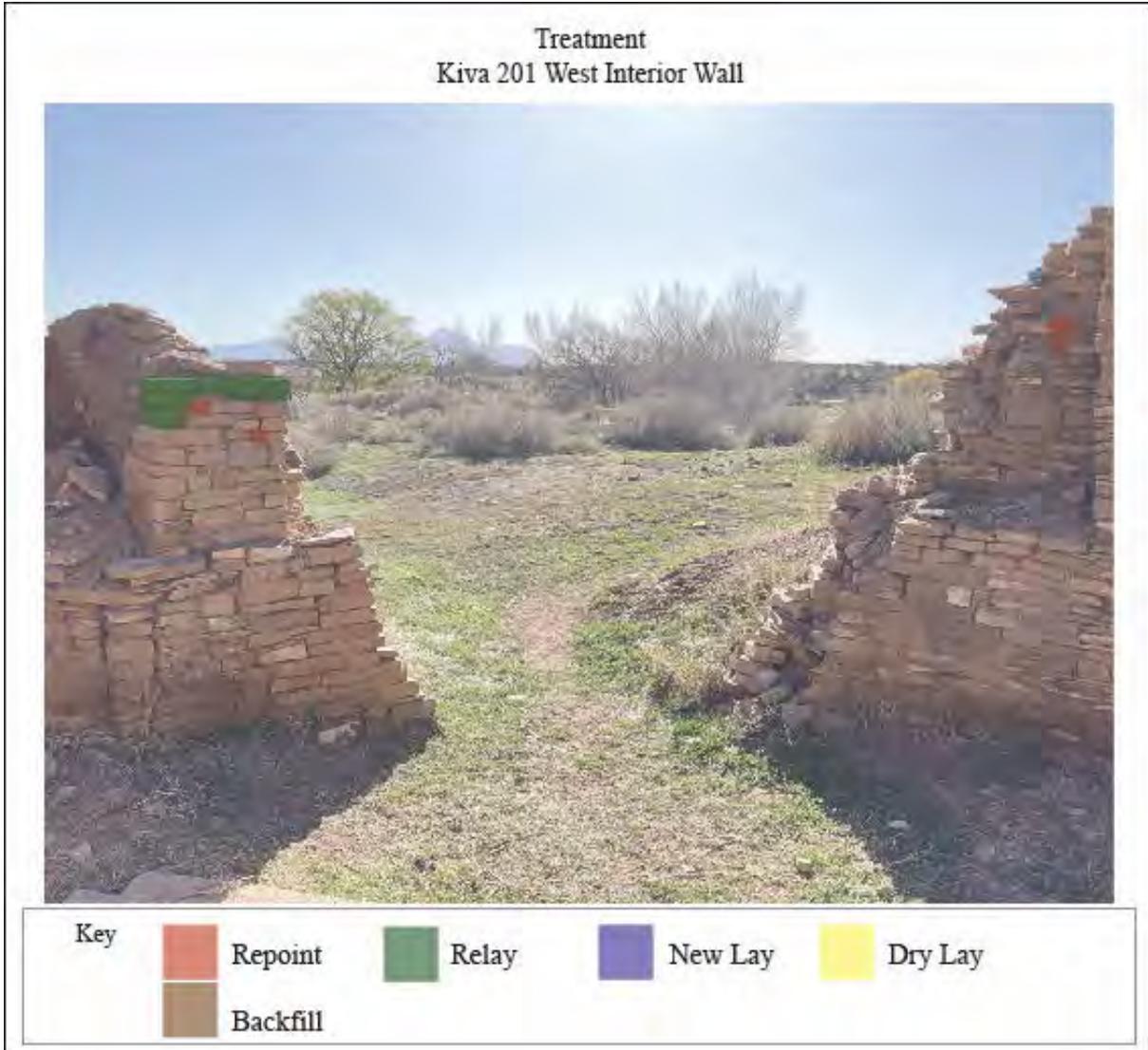


Figure 22. Kiva 201 west interior lining wall after stabilization, annotated with conservation treatments.

Prior to stabilization, the remnants of north and east second story courtyard wall above Kiva 201 were heavily deteriorated. Loose stones in both walls posed safety threats. The .75 m long east wall basal course was completely relaid. Loose stones in the cap of the north courtyard wall were also relaid and most of the wall was repointed.

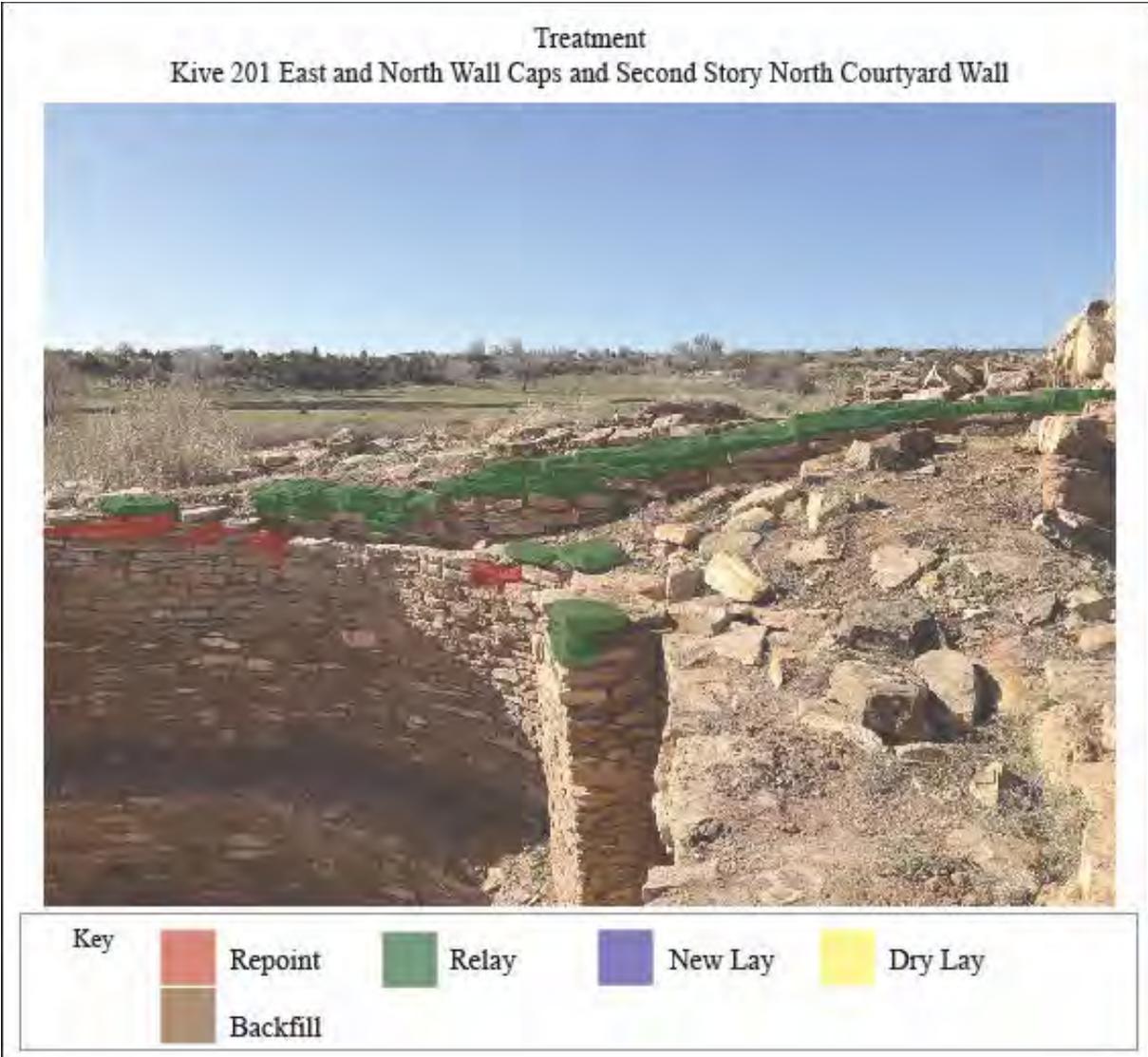


Figure 23. Kiva 201 north interior wall of the second story courtyard after stabilization, annotated with conservation treatments.

Kiva 201 continues to be recommended as a high priority for conservation treatment. The excavated sub-floor vault is open and covered by a piece of plywood. The kiva benchtops are actively eroding and there is mortar loss in all the veneers. Backfilling of the kiva would mitigate most of these architectural threats.

Kiva 219

Kiva 219 is the smallest, and possibly latest, of the four standing kivas in East Ruin. It appears to have been inserted into a 5 m by 5 m square room that was added to the south side of the original great house block. The south wall of the room was partly removed to make room for the kivas southern recess and all four corners of the room were rounded off with added sections of veneer. The original kiva was 4.5 m in diameter with three large pilasters. The near vertical walls stood 2.27 m high. Eventually, the banquette areas on either side of the north pilaster were filled in with

masonry which was blended with the north pilaster veneer. Only a shallow 3 cm deep bench remnant was left protruding from the northern two thirds of the structure walls and the faces of the southern recess. The plaza area above the kiva was enclosed with second story level walls.

The Haynie's broke through the south wall of the southern recess to enter the room. They reportedly disturbed the south half of the floor with a backhoe leaving just a trace of the hearth and ventilator shaft. Joel Brisbin later cleared the floor, mapped the floor features, and covered the floor with a few centimeters of fill. Brisbin stabilized the kiva in the 2000s. Based on the presence of concrete mortar and cut stone in the masonry, Brisbin rebuilt the corners of the southern recess and portions of the east pilaster, repointed an area of water runoff along the southwest wall, added up to three courses to cap the walls, and repointed approximately 4 m² of veneer. He also poured 10 cm of fill on top of the southern banquette surfaces and covered the southwest banquette with filter fabric.

Condition of Kiva 219 in 2017

Today, Kiva 219 is about 65% complete. All evidence of the roof construction is gone and sections of the floor and southern recess are destroyed. Despite a variety of stabilization interventions by Brisbin, the structure retains a high level of integrity. Especially impressive is the intricate veneer face constructed with exceedingly small tabular stone. Condition assessment determined that the structure was in moderately good condition but actively deteriorating.

The 2017 condition assessment found that many of the deterioration issues in Kiva 219 are the result of ongoing water erosion such as direct precipitation, pour off from higher walls, and capillary activity. Approximately 10% of masonry stones are breaking down, especially the green laminated sandstone in the veneer. All wall tops were found to be suffering from severe mortar loss two to four courses deep. The walls caps were found to consist of loose rubble and exposed mortar fill but few wall cap voids were noted. Moderate to severe mortar loss was identified across most wall veneers and the bench face due to capillary deterioration. The southwestern bench face is in fair condition because it was protected by filter fabric. The southeastern bench, however, has deteriorated dramatically over the last decade and is actively eroding with veneer stones loose or fallen five courses deep. Three niches are visible in the north wall. The northeast and northwestern niches are near floor level and seem to be in good condition. The north central niche, which was partly rebuilt by Brisbin, has lost mortar leaving it in moderately good condition.

Though the walls in Kiva 219 tend to lean inward, most of the structure is in sound structural condition. The most extreme lean inward is the north wall which is offset 27 cm from the top to the base of the wall. This wall suffers from 2.75 m of differential fill to the north which is likely exacerbating the lean but have not caused major cracks or bulging. The east and south walls are less stable. The mechanical breach through the southern recess undermined the adjacent 2.2 m compound walls. This has left the wall ends unsupported and the wall to the east leaning outward 18 cm.

The most severe structural issue in Kiva 219 is the eastern pilaster. This 1.35 m high, 2 m long and .36 m deep masonry bulk has detached from the original room veneer and is leaning inward. A large crack has developed up the southeast corner and along the upper back side of the pilaster.

This crack is a maximum of 4.9 cm wide and appears to be active with fill from the cap pouring down behind the pilaster. Concrete added to the front veneer of the pilaster by Brisbin may have weighted the front of the pilaster and exacerbated this lean over the last decade.

The southern recess walls are also unstable. Since 2017, severe cracks have developed at the northern corners of the southern recess where the east and west walls of the recess join the inner lining wall of the kiva. These cracks likely indicate that the southern recess walls are slumping southward and leaning inward. This is likely due to the fact that the Haynie excavations removed the south wall of the recess and undermined the east and west walls.

Remnants of the east, west, and north courtyard walls are perched at second story level above Kiva 219. The north courtyard wall is the exterior of the original great house block and built in a robust core and veneer McElmo style. It stands seven courses (.55 m) above the height of the Kiva 219 north wall and has an intact mortar-lined opening in the middle of the wall. The opening likely served as a beam socket or second story wall vent. This north wall is suffering from severe mortar erosion creating loose capstones along the top but is in otherwise good condition. Short 1 to 1.5 m long north end segments of the east and west courtyard walls are still standing one to three courses tall on either side of the kiva. Both are in poor condition. All remaining stones in the east wall cap were loose but the wall fragment is well supported. The fragmentary west courtyard wall was determined to be in far worse condition due to its location and original construction. The southern two thirds of the wall have fallen away because they were undermined at the roof level. Only a few courses of the north end veneer still stand. This section of wall is perched on a remnant of first story rubble wall core. The east and west veneers have peeled away from each other because the wall core was constructed with loose fill. This courtyard wall was determined to be in imminent danger of collapse within the next five years.

According to Brisbin, the Haynie's removed up to 35% of the floor with a backhoe and the intact portion of floor were left open to the elements for years. Brisbin covered the floor with a small amount of fill but the bottom of the added bench veneer is visible and unsupported in sections along the north and south walls. A large rodent hole developed against and under the north wall and the basal veneer stone in that section are actively collapsing. Brisbin brought in a large amount of stone and piled it .75 m high against the west wall of the kiva. The stone pile, excavation depression, and the large rodent hole created poor footing in the kiva and posed safety threats.

The 2017 Condition Assessment identified several safety threats in Kiva 219 including loose and leaning masonry walls and wall tops above head height, scattered and piled rubble underfoot, and unfilled rodent holes posing tripping hazards. Crow Canyon addressed some safety issues in 2018. All loose stone and concrete were removed from the caps and upper veneers of all walls. The east wall caps were particularly loose requiring cap dismantling three to five courses deep. Wall core clean out revealed the top of the original kiva upper lining wall behind the final veneer in the northeast corner of the room. All upper wall courses of the kiva were relayed where possible and new lay stones were added to bring the wall caps up to a consistent height. The upper three to five courses of wall veneer were repointed to address severe mortar erosion issues and blend the cap into the lower wall face.

The courtyard walls above Kiva 219 were also treated. The loose stones in the upper north courtyard wall were relayed in place but the intact wall feature was avoided to preserve its

integrity. All stones in the east courtyard wall cap were relayed. The few intact masonry stones in the veneer of the courtyard west wall alignment were relayed in place and a few additional stones were added to the south end. Rubble was laid across the soil core of the wall to protect it from erosion. All other loose rubble was removed from the wall tops. To address the unstable footing in Kiva 219, the large pile of stone on the west side of the kiva was removed and piled 5 m south of the structure. The large rodent against the north wall was filled with back dirt to stabilize the wall base.

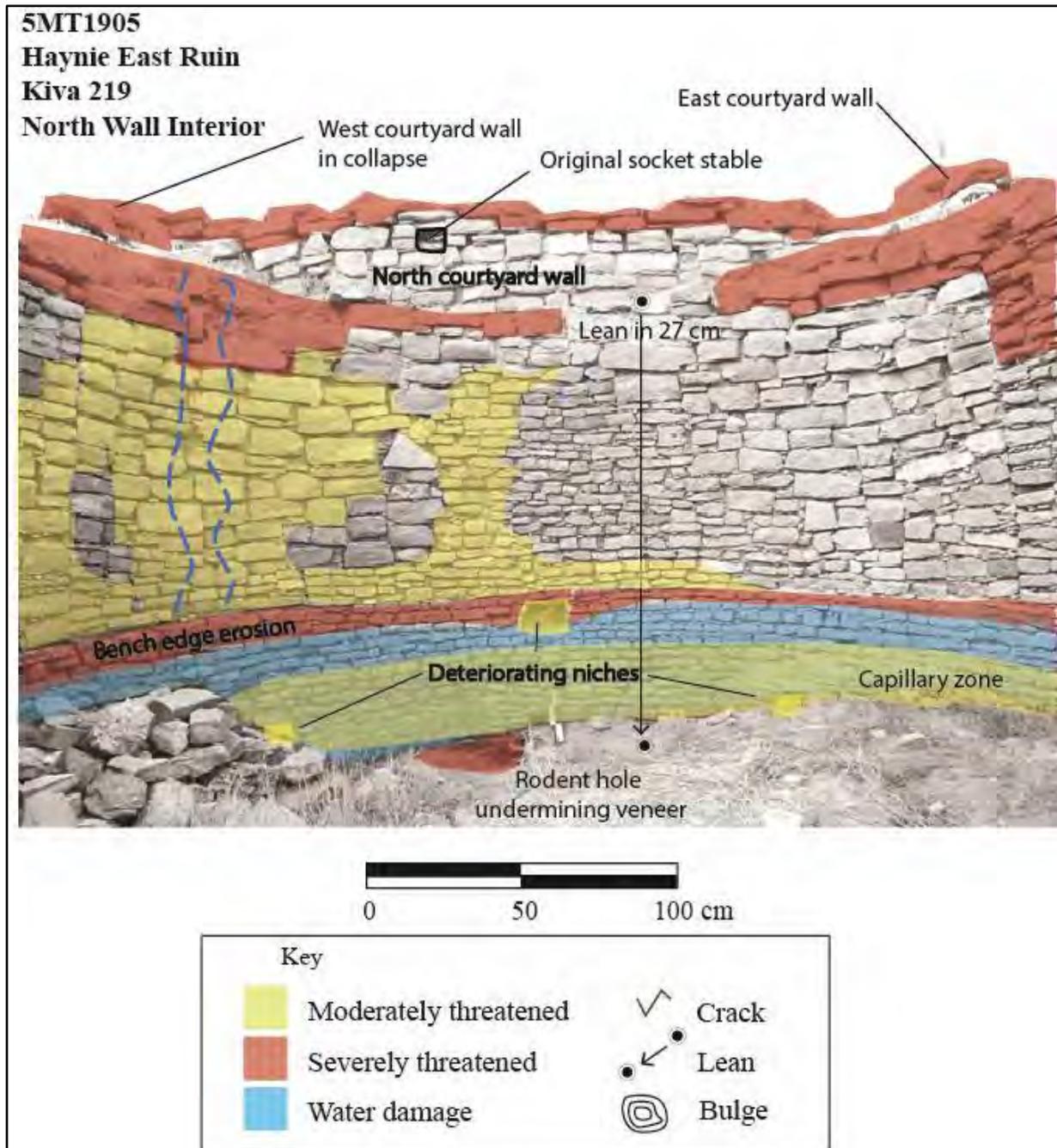


Figure 24. Kiva 219 north interior lining wall condition issues annotated in 2017.

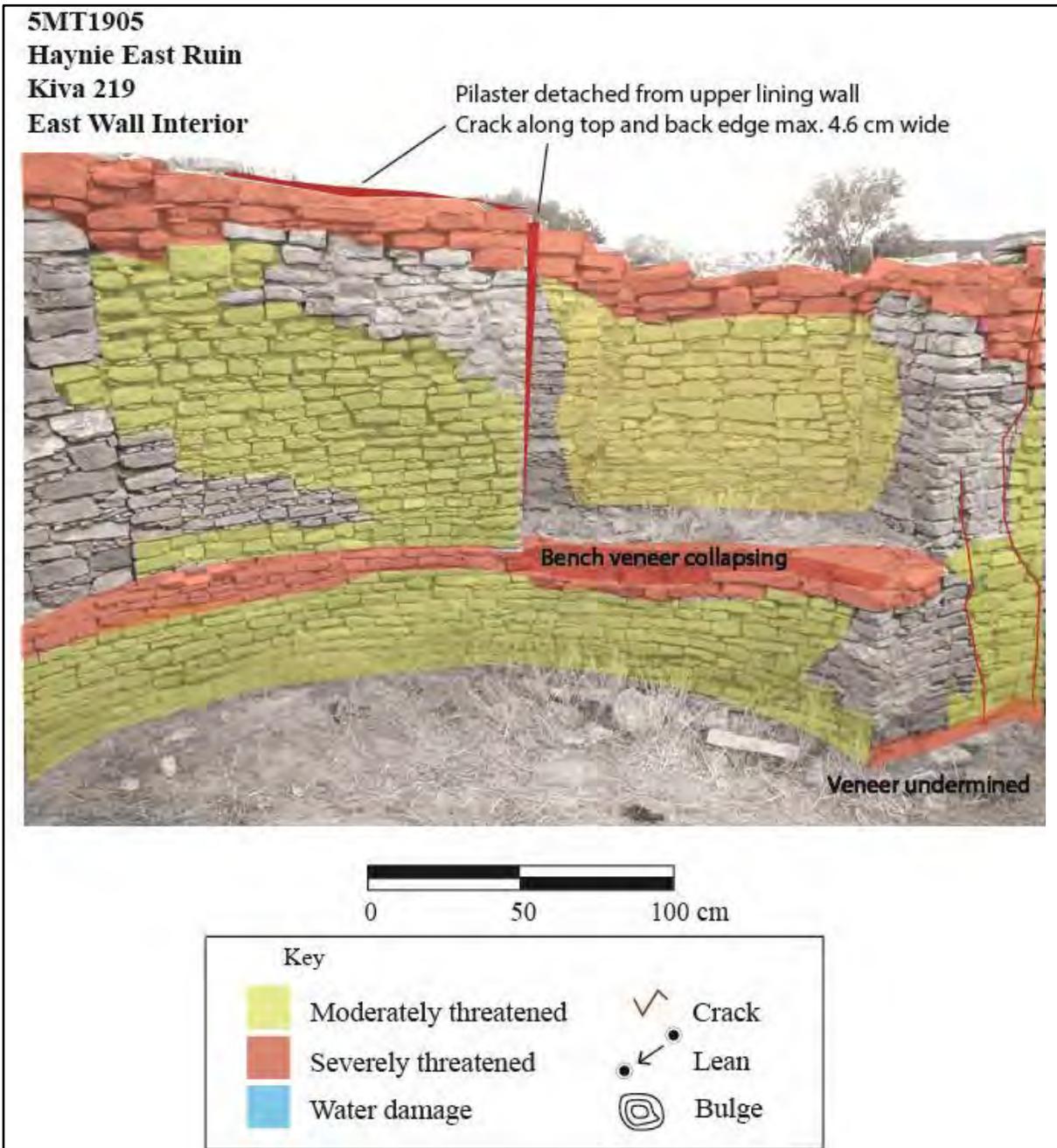


Figure 25. Kiva 219 east interior lining wall condition issues annotated in 2017.

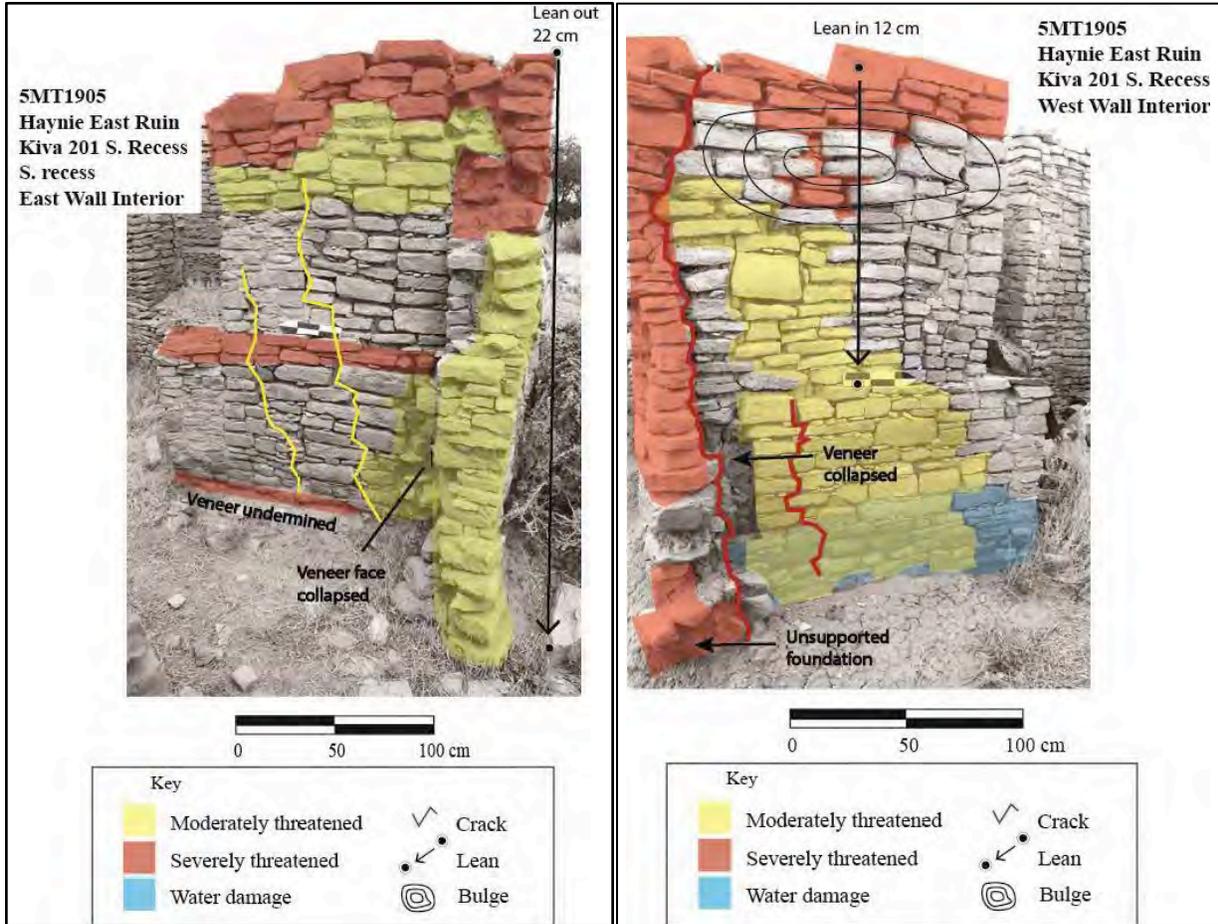


Figure 26. Kiva 219 southern recess east and interior lining walls, condition issues annotated in 2017.

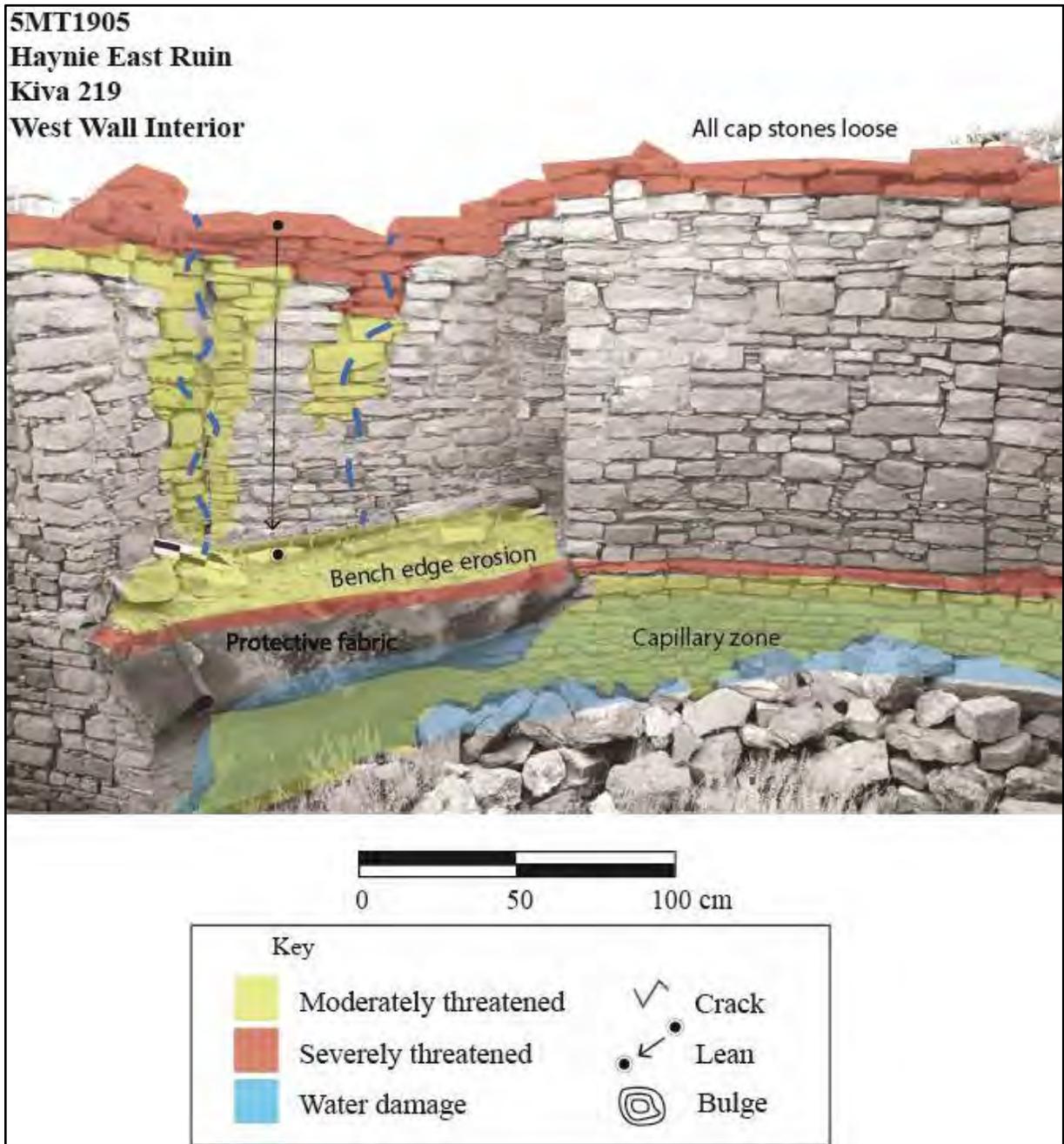


Figure 27. Kiva 219 west interior lining wall condition issues annotated in 2017.

Kiva 219 Stabilization in 2024

No efforts have been made to slow masonry deterioration in Kiva 219 since 2018. Prior to stabilization in 2024, all wall caps were found to be moderately to severely eroded and the cracks in the veneers east and west of the southern recess had grown, posing safety threats to visitors. Though not a safety threat, the tops of both benches were mortarless and deteriorating and a section of the southeast bench veneer face had collapsed to grade.

All of the loose stone in the wall caps were reset and any small holes were filled with new-laid stone. The late addition southwest and southeast inserted veneers required several courses along the top and edges of the wall to be reset and several holes to be filled with new-laid stone.



Figure 28. Overview of Kiva 219 from above after stabilization. View to the southwest.



Figure 29. Kiva 219 north interior lining wall after stabilization, annotated with conservation treatments.

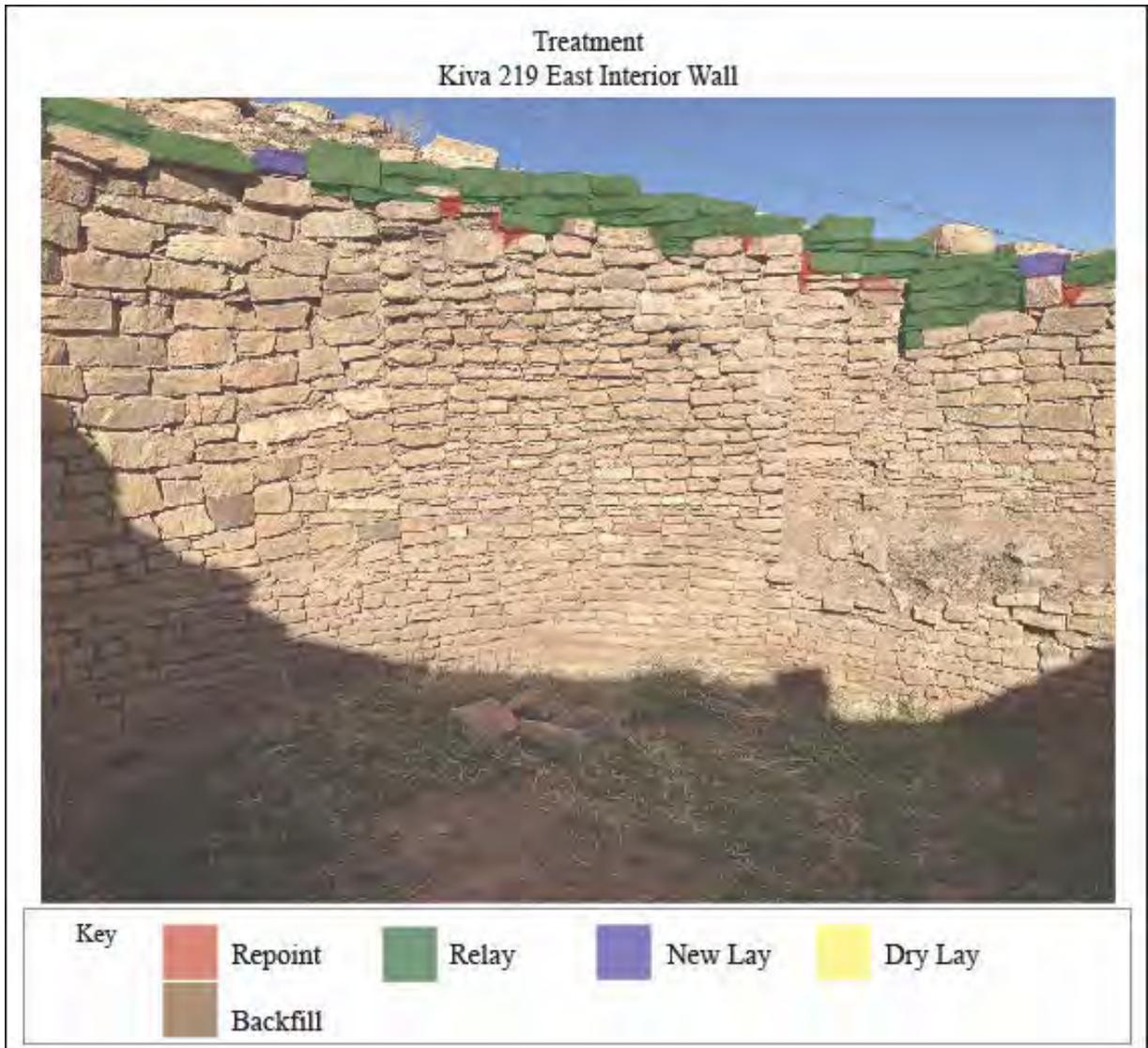


Figure 30. Kiva 219 east interior lining wall after stabilization, annotated with conservation treatments.

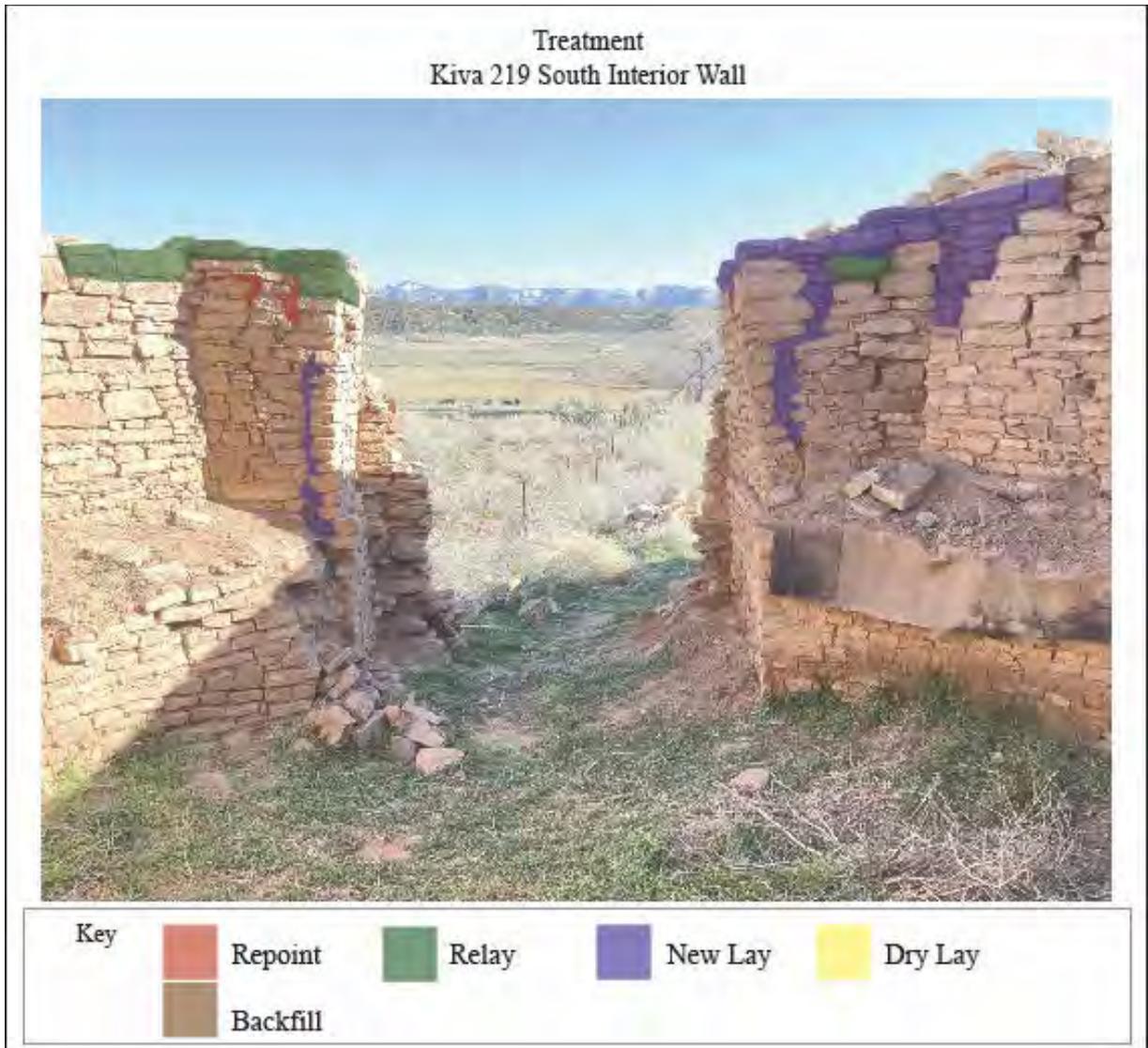


Figure 31. Kiva 219 south interior lining wall after stabilization, annotated with conservation treatments.

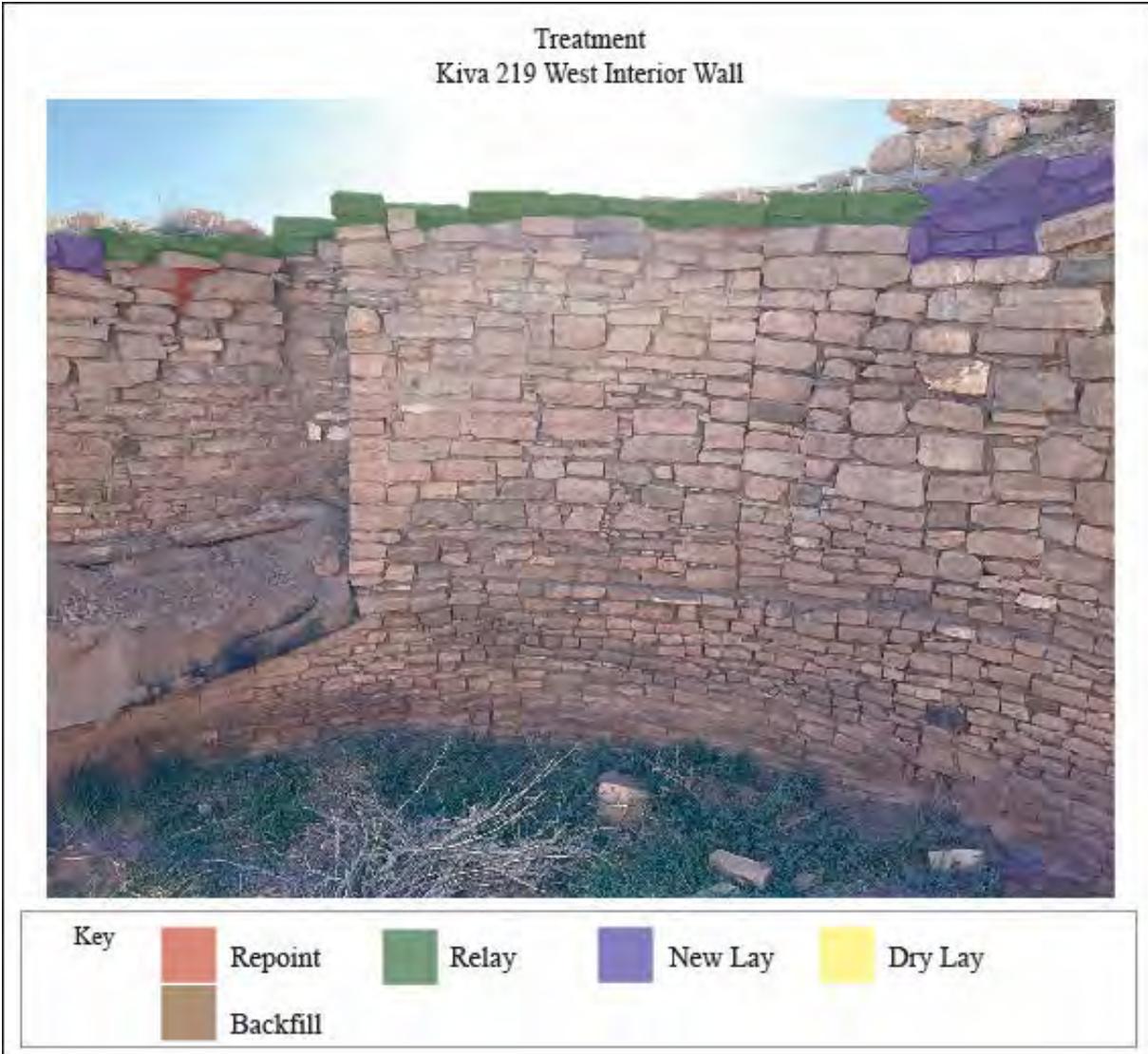


Figure 32. Kiva 219 west interior lining wall after stabilization, annotated with conservation treatments.

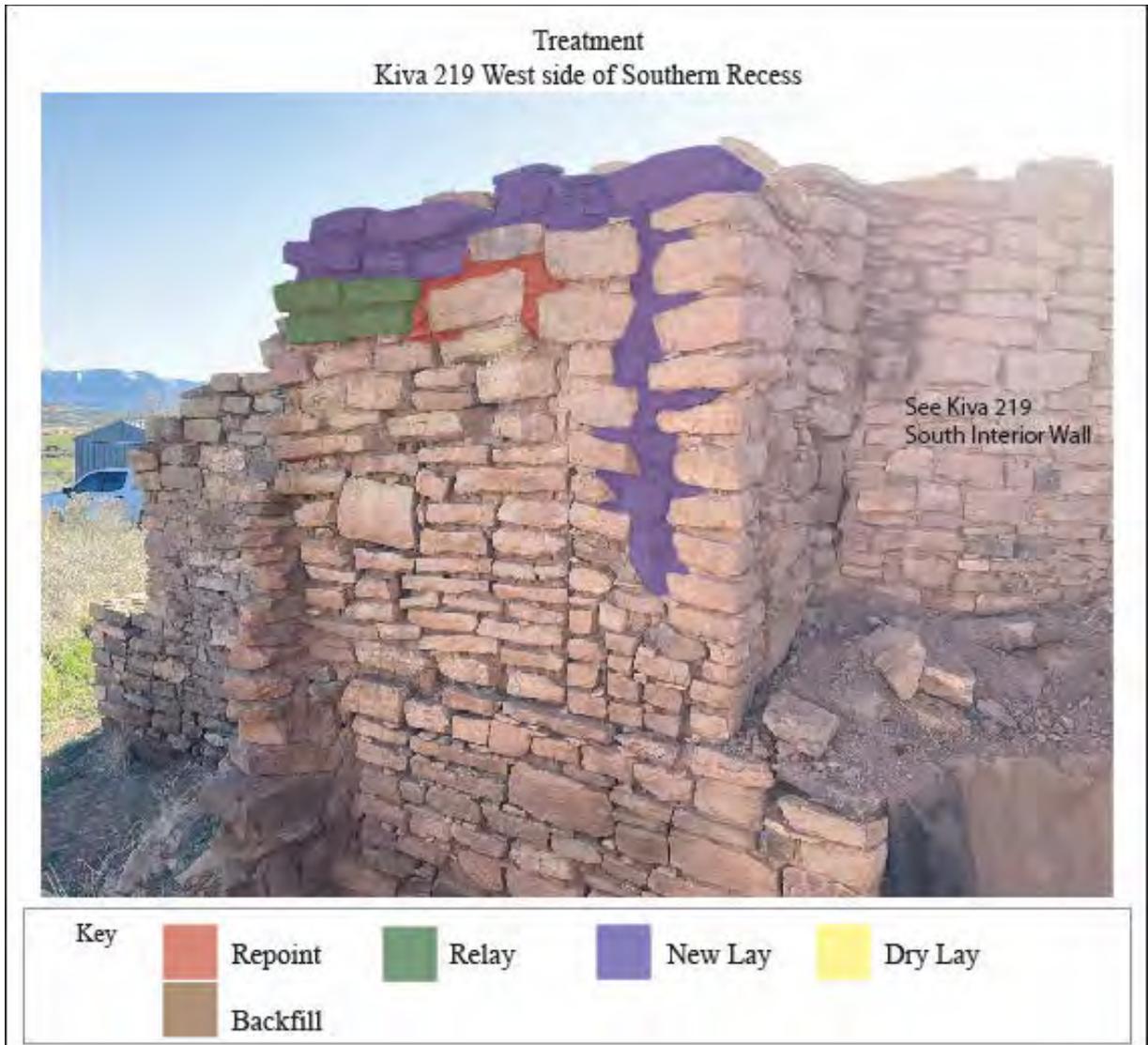


Figure 33. Kiva 219 west side of southern recess after stabilization, annotated with conservation treatments.

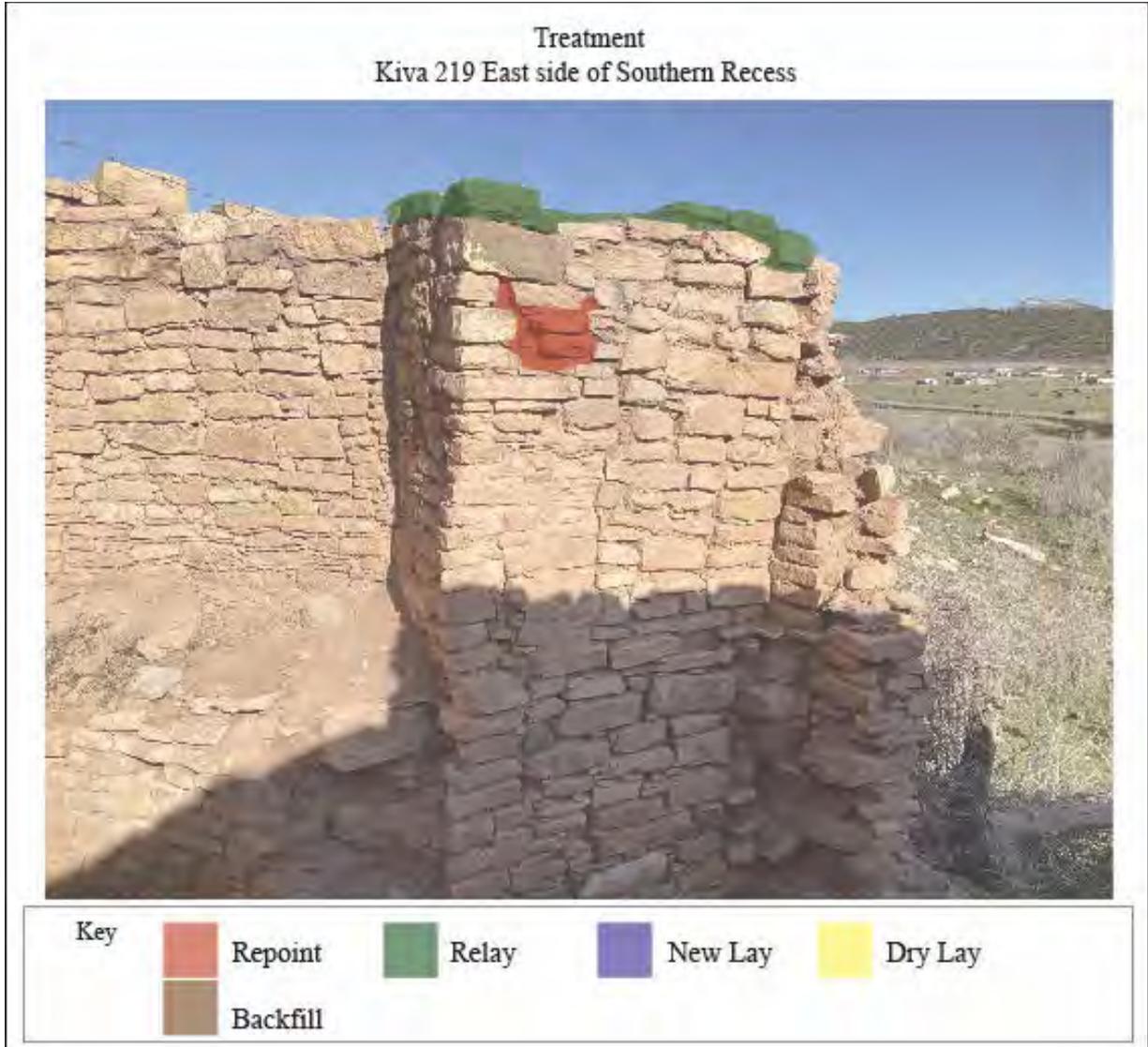


Figure 34. Kiva 219 east side of southern recess after stabilization, annotated with conservation treatments.

The severe cracks east and west of the southern recess were cleaned out. This revealed 2.1 cm of movement in the east crack and up to 4.3 cm of movement in the west side crack. Daylight was visible behind the corner crack on the west side of the southern recess. Tie stones were inserted into the cracks between masonry in the wall core and the masonry in the collapsing corners. Each crack was then packed with mortar and small stones to create contact between the components and increase the tensile strength of the structure.

The upper north and west second story courtyard walls above Kiva 219 were found moderately to severely deteriorated. Loose stone in both walls posed a safety threat. The few basal stones in the west courtyard wall were relaid. A section of collapsed veneer in the north courtyard wall was relaid along with all loose stone in the wall cap. This includes the stones in the west jamb and the

lintel of the small socket feature in the middle of the wall. Additional cap stones were added around the feature to solidify it in place.

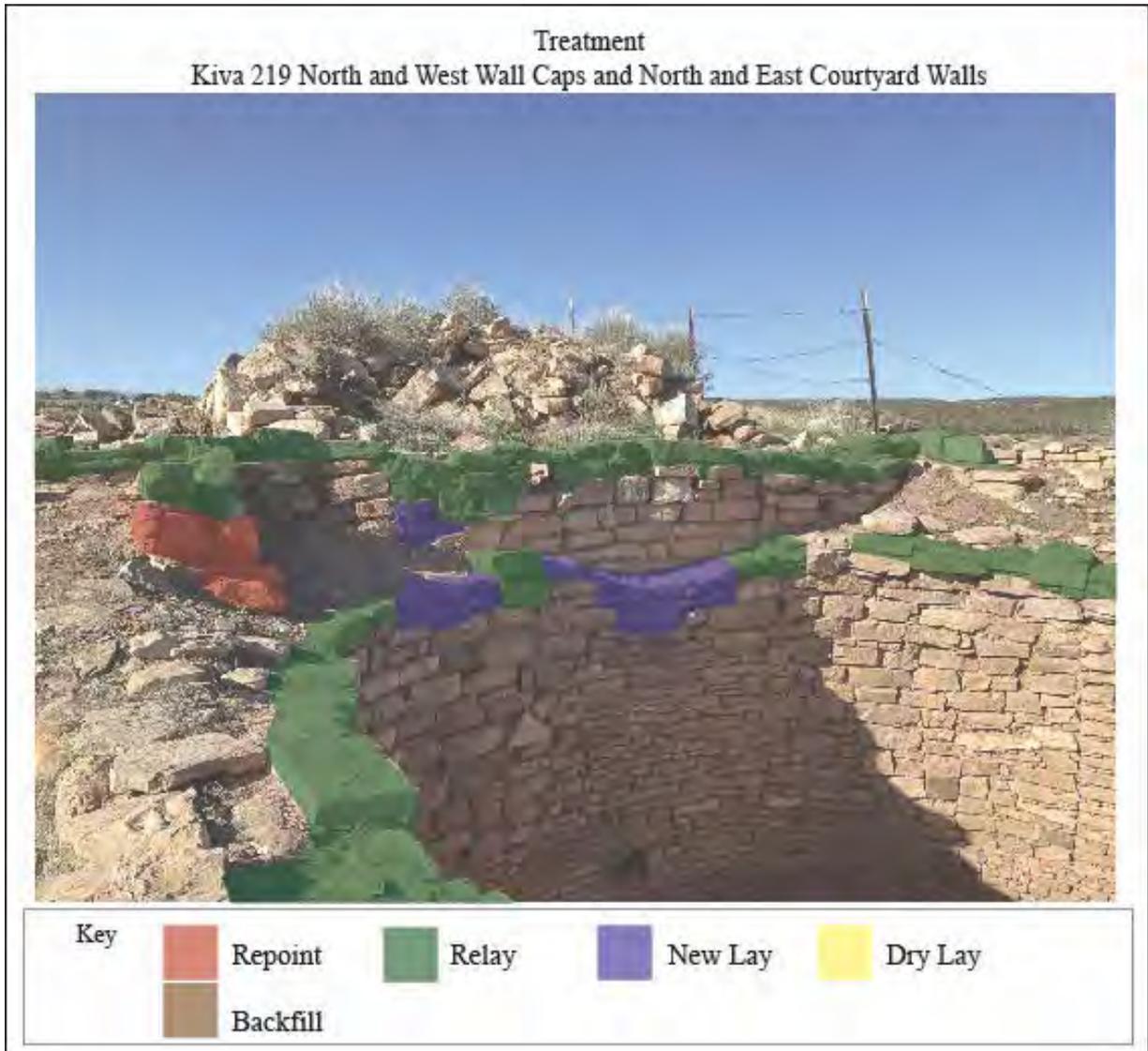


Figure 35. Kiva 219 north and east interior walls of the second story courtyard after stabilization, annotated with conservation treatments.

Though the safety hazards have been addressed in Kiva 219, the structure is still considered a high to urgent priority for treatment within the next five years. We recommend that a crack monitor be installed in several locations. The patched, but likely active, cracks in the veneers east and west of the southern recess should be monitored with crack monitors. The crack along the back side of the east pilaster immediately and be monitored regularly. This unstable masonry bulk will pose a safety threat if the pilaster continues to actively leaning inward. Kiva 219 should also undergo detailed architectural documentation before prior to stabilization. Both banquette bench faces are actively deteriorating and should be stabilized soon. Likewise, repointing of the walls within the next five years will reduce the chance of veneer loss. Back filling should be considered as a long-term solution to the material and structural deterioration of Kiva 219.

Room 210

Room 210 is the nearly obliterated room directly south of Kiva 219. This architectural unit was designated based on a plan map of the East Ruin great house generated by Bruce Bradley, Claudia Haynie, and Ralph Haynie between 1987 and 1989 (Ryan 2013:662).

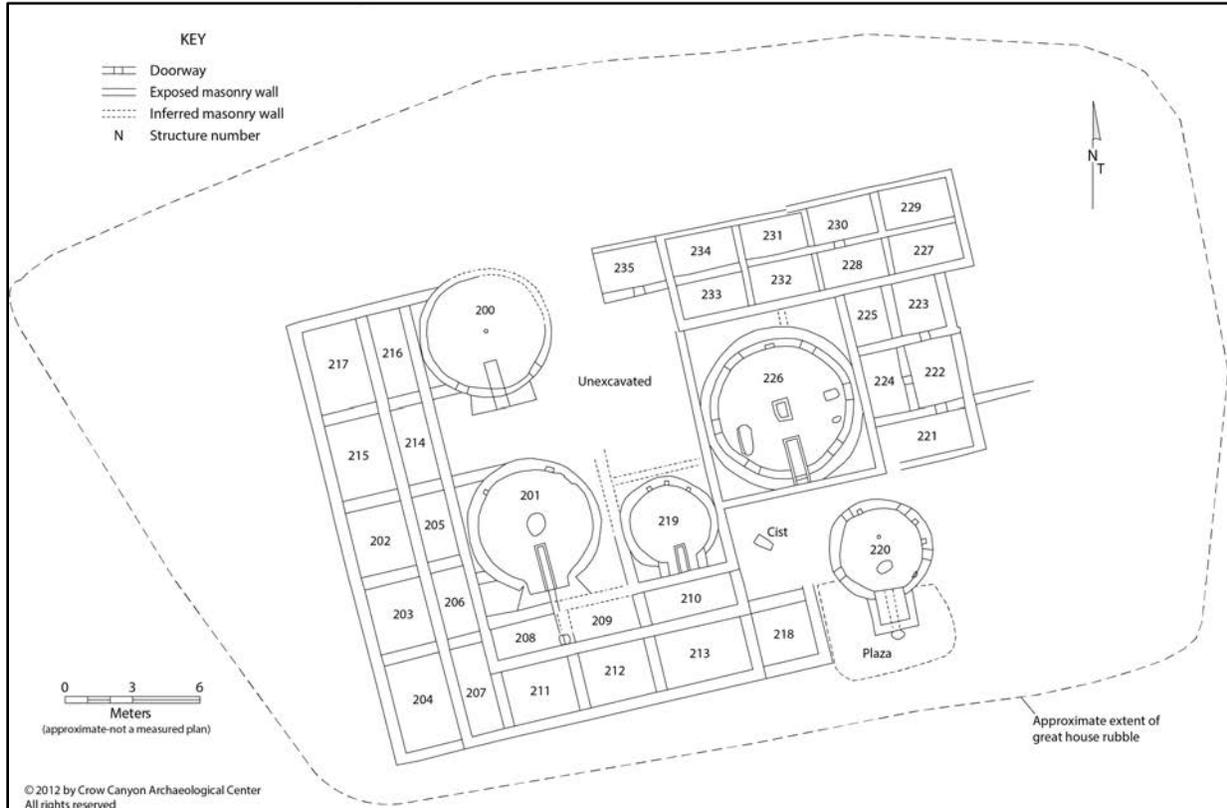


Figure 36. Plan of Haynie Ruin east great house recorded by Bruce Bradley, Claudia Haynie, and Ralph Haynie between 1983 and 1987 (Ryan 2013:662).

Very little of Room 210 still stands today. The middle of the north wall appears to have been dismantled during occupation of the site to make room for the large, open southern recess of Kiva 219. There is no evidence of the east or south walls of the room, which were likely dismantled with heavy equipment during the Haynie excavations to more readily access Kiva 219 through the south wall of the southern recess. The northern half to two thirds of the west wall is still standing and the northern end of the wall is full height. This wall abuts the south wall of the original room into which Kiva 219 was inserted. Room 210 appears to have been backfilled prehistorically to fill the enclosing space around Kiva 219. A bulk of this backfill material remains intact in the northwest corner of the room, between the west wall the room and the west wall of recess of Kiva 219.

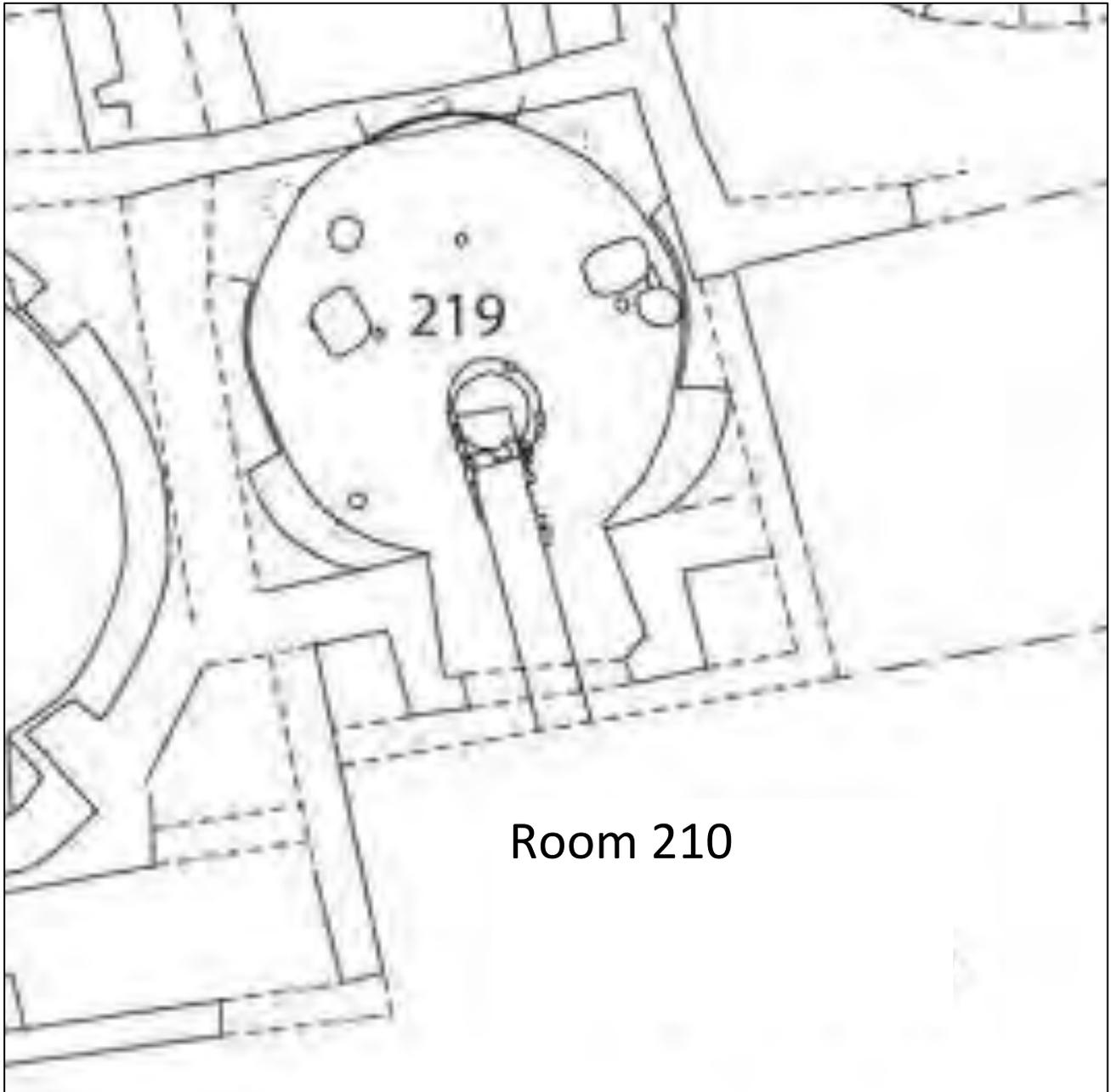


Figure 37. Location of the remnants of Room 210 south of Kiva 219 as mapped in 2012 (Ryan 213:263).

Room 210 was not recorded separately during the 2017 condition assessment of the east ruin. Instead, the standing west wall was considered as part of the west enclosing wall of Kiva 219. A few loose stones were reset in the top of the wall as part of the 2018 treatment of the site.



Figure 38. Meadow Colden resetting a stone in the top of the west interior wall of Room 210 in 2018.

The west wall of Room 210 was treated during the current project because the wall is over 8 feet high and loose stone in the cap of the wall posed a safety threat to people approaching and entering Kiva 219. All loose stones in the cap of the west interior wall of Room 210, above 8 feet in height, were reset in place.



Figure 39. Room 210 west interior wall after stabilization, annotated with conservation treatments.

SUMMARY AND RECOMMENDATIONS

Woods Canyon’s 2024 stabilization of the East Ruin great house at the Haynie site has mitigated the safety threat of overhead rock and unstable architecture in four open architectural units. Kivas 200, 201, and 219 and Room 210 were treated. Areas capped in each kiva included the interior upper lining wall, pilasters, and standing segments of second story courtyard wall. A large collapsed section of masonry in the east upper lining wall of Kiva 201 was also rebuilt and severe structural cracks in the southern recess walls of Kiva 219, were sealed. In Room 210, the west wall was capped. The work performed in 2024 utilized local materials and modern preservation techniques. The materials and stabilization methods applied are compatible and consistent with the goal of preserving the site’s integrity and were achieved by targeting critical safety issues and minimizing physical intervention. These treatments will ensure the safety of Crow Canyon and the

Archeaological Conservancy staff and visitors during excavation and tours of the great house over the course of the 2024 field season.

If left un-backfilled and only partially stabilized, the East Ruin of Haynie will continue to degrade due to mortar erosion. Mortar erosion is caused by capillary moisture movement through walls, direct precipitation runoff, and freeze thaw erosion. Beyond the 2024 field season, the wall caps of open architectural units should be monitored for newly loosened stone. Any loose stone above head height should be reset in place.

Only the safety threat of overhead rock and unstable architecture was mitigated by the 2024 stabilization treatment. As a result, numerous material and structural threats were not addressed. Of the treated structures, Kiva 200 continues to be a high treatment priority because several delicate architectural features (plastered banquet faces, the bench top, wall features, and floor features) are actively deteriorating and collapsing. Kiva 201 is also a high treatment priority as the kiva benchtops are severely deteriorated and collapsing, the veneers are suffering from mortar loss, and the subfloor vault is open and marginally protected by a piece of plywood. Kiva 219 is considered a high to urgent priority for treatment because mortar loss across the structure is severe, the banquette walls and bench tops are eroding and collapsing, and severe structural cracks have developed east and west of the southern recess and along the back side of the east pilaster.

Back filling should be considered as a long-term solution to the material and structural deterioration of the excavated and open architectural units in the East Ruin of the Haynie site. Alternatively, the site could be kept open for visitation with additional conservation and monitoring of the interior walls and features. Detailed architectural documentation of masonry, plaster, and features is recommended before the great house is further conserved or backfilled.

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APPENDIX A: PHOTOGRAPHIC DOCUMENTATION



Site overview of East Ruin facing northeast. Before treatment.

3/28/2024

Muhasd001-1



Overview of Kiva 200 facing east. Before treatment.

3/28/2024

Muhasd001-2



Kiva 200 north interior wall facing north. Before treatment.

3/28/2024

Muhasd001-3



Kiva 200 east interior wall facing east. Before treatment.

3/28/2024

Muhasd001-4



Kiva 200 east interior wall facing south. Before treatment.

3/28/2024

Muhasd001-5



Kiva 200 west interior wall facing west. Before treatment.

3/28/2024

Muhasd001-6



Kiva 201 overview facing east. Before treatment.

3/28/2024

Muhasd001-7



Kiva 201 north interior wall facing north. Before treatment.

3/28/2024

Muhasd001-8



Kiva 201 east interior wall facing east. Before treatment.

3/28/2024

Muhasd001-9



Kiva 201 south interior wall facing south. Before treatment.

3/28/2024

Muhasd001-10



Kiva 201 west interior wall facing west. Before treatment.

3/28/2024

Muhasd001-11



Kiva 219 overview facing north. Before treatment.

3/28/2024

Muhasd001-12



Kiva 219 north interior wall facing north. Before treatment.

3/28/2024

Muhasd001-13



Kiva 219 east interior wall facing east. Before treatment.

3/28/2024

Muhasd001-14



Kiva 219 south interior wall facing south. Before treatment.

3/28/2024

Muhasd001-15



Kiva 219 west interior wall facing west. Before treatment.

3/28/2024

Muhasd001-16



East Ruin overview facing north. Before treatment.

3/28/2024

Muhasd001-17



Kiva 200 east wall cap and second story courtyard wall. Before treatment.

3/28/2024

Muhasd001-18



Muhasd001-19

Kiva 200 northwest wall cap and second story courtyard walls facing northwest. Before treatment.

3/28/2024



Muhasd001-20

Kiva 201 north wall cap and second story courtyard north wall facing northwest. Before treatment.

3/28/2024



Muhasd001-21

Kiva 219 north wall cap and second story courtyard wall remnants facing northeast. Before treatment.

3/28/2024



Muhasd001-22

Second story kiva courtyard wall juncture between Kivas 200, 201, and 219 facing south.

3/28/2024



Muhasd001-23

Kiva 200 second story east courtyard wall remnant facing north. Before treatment.

3/28/2024



Muhasd001-24

Room 235 facing southeast. No safety treatment necessary.

3/28/2024



Haynie East Ruin overview facing northeast. After treatment.

4/11/2024

Muhasd001-25



Kiva 200 overview facing east. After treatment.

4/11/2024

Muhasd001-26



Kiva 200 north interior wall facing north. After treatment.

4/11/2024

Muhasd001-27



Kiva 200 east interior wall facing east. After treatment.

4/11/2024

Muhasd001-28



Kiva 200 south interior wall facing south. After treatment.

4/11/2024

Muhasd001-29



Kiva 200 west interior wall facing west. After treatment.

4/11/2024

Muhasd001-30



Kiva 201 overview facing east. After treatment.

4/11/2024

Muhasd001-31



Kiva 201 north interior wall facing north. After treatment.

4/11/2024

Muhasd001-32



Kiva 201 east interior wall facing east. After treatment.

4/11/2024

Muhasd001-33



Kiva 201 south interior wall facing south. After treatment.

4/11/2024

Muhasd001-34



Kiva 201 west interior wall facing west. After treatment.

4/11/2024

Muhasd001-35



Kiva 219 overview facing north. After treatment.

4/11/2024

Muhasd001-36



Kiva 219 north interior wall facing north. After treatment.

4/11/2024

Muhasd001-37



Kiva 219 east interior wall facing east. After treatment.

4/11/2024

Muhasd001-38



Kiva 219 south interior wall facing south. After treatment.

4/11/2024

Muhasd001-39



Kiva 219 west interior wall facing west. After treatment.

4/11/2024

Muhasd001-40



Kiva 219 east side of southern recess. After treatment.

4/11/2024

Muhasd001-41



Kiva 219 west side of southern recess. After treatment.

4/11/2024

Muhasd001-42



Kiva 219 southwest wall crack. After treatment.

4/11/2024

Muhasd001-43



Room 210 west interior wall facing west. After treatment.

4/11/2024

Muhasd001-44



Rock source pile. After treatment.

4/11/2024

Muhasd001-45



Kiva 200 north and east wall caps and second story courtyard wall facing southeast. After treatment.

4/11/2024

Muhasd001-46



Kiva 200 second story courtyard east wall facing northeast. After treatment. 4/11/2024

Muhasd001-47



Kiva 201 east and north wall caps and second story courtyard north wall facing northwest. After treatment. 4/11/2024

Muhasd001-48



Muhasd001-49

Kiva 219 north and west wall cap and second story courtyard north and west walls facing northeast. After treatment.

4/11/2024



Muhasd001-50

Kiva 219 wall caps and second story courtyard east, north, and west walls overview facing south. After treatment.

4/11/2024



Muhasd001-51 Kiva 201 wall caps and second story courtyard north wall overview facing southwest. After treatment. 4/11/2024



Muhasd001-52 Kiva 200 wall caps overview facing west. After treatment. 4/11/2024



Backfill mortar source area facing northeast. After treatment.

4/11/2024

Muhasd001-53

Appendix E – 2024 Haynie Site Archaeomagnetic Results Report

Please See Next Page

MUSEUM OF NEW MEXICO
OFFICE OF ARCHAEOLOGICAL STUDIES

ARCHAEOMAGNETIC DATING OF TWO HEARTHES
(FEATURES 5 AND 7) FROM THE HAYNIE RUIN
(SITE 5MT1905)

SHELBY JONES, PH.D.

REPORT PREPARED FOR: STEVE COPELAND, FIELD ARCHAEOLOGIST,
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REPORT APPROVED BY JOHN TAYLOR-MONTOYA, PH.D.
AND THATCHER SELTZER-ROGERS, PH.D.

ARCHAEOMAGNETIC LABORATORY REPORT 04
JUNE 2024

ADMINISTRATIVE SUMMARY

The Archaeomagnetic Laboratory (ADL) of the New Mexico Office of Archaeological Studies (OAS) was contracted to date two hearths (Features 5 and 7) from the Haynie Ruin (5MT1905) via archaeomagnetic dating. These studies were undertaken at the request of, and in collaboration with, Steve Copeland, Crow Canyon Archaeological Center (CCAC), as part of a larger archaeological investigation of the Haynie Ruin.

In support of this goal, two sample sets were collected by Kay Barnett on June 4th and October 29th, 2022 (Feature 5 and 7, respectively). These sets were hand delivered by Copeland in 2023 to OAS's Archaeomagnetic Laboratory for measurement and analysis, under the guidance of Dr. Shelby Jones, Laboratory Supervisor and Project Director.

Measurements were collected using a MagInstruments Portable Spinner Magnetometer and analyzed using a combination of Python coding in Jupyter Notebooks and Demag_GUI. Per the original agreement with CCAC, the sample collection notes, specimens, data, and interpretations are stored at the OAS Archaeomagnetic Laboratory.

The archaeomagnetic results demonstrate that the hearths retain a thermal remanent magnetization (TRM) of a high enough quality to be dated archaeomagnetically. Feature 5 (ADLN 1502) dates to large age range of early 1000s to the fourteenth century, due to its increased statistical uncertainty. Feature 7 (ADLN 1503) dates to either the late 1000s or the early thirteenth century. Both these archaeomagnetic dates support the archaeological age estimates provided by CCAC. Twelve specimen cubes from were independently collected, measured and analyzed from each feature to ensure statistical reliability.

SAMPLING SUMMARY

Archaeomagnetic Dating of Two Hearths (Features 5 and 7)
from The Haynie Ruin (Site 5MT1905)

June 2024

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<p><u>Prepared for:</u> Crow Canyon Archaeological Center 23390 Road K Cortez, CO 81321</p>	<p>Steve Copeland: SCopeland@crowcanyon.org</p>
<p><u>Site(s):</u> 5MT1905 (37.37N, -108.511W) Structure 1003, Feature 5 (Hearth) PD 1110, FS 1, PL 87, Vert. SR002 Structure 1003, Feature 7 (Hearth) PD 1268, FS 1, PL 127, Vert. SR003</p>	<p>Archaeomagnetic Dating Lab ID Number(s): ADLN 1502 = Feature 5 ADLN 1503 = Feature 7</p>

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LABORATORY METHODS

Initial measurements were made on every submitted specimen to determine if the magnetic minerals and heating history of the substrates were sufficient for the creation of a TRM (or pTRM) that could be measured reliably. No specimens were eliminated from further measurement at this step due to their magnetic moments being too weak to reliably measure on the laboratory MagInstruments Portable Spinner Magnetometer (PSM). After initial measurement, all specimens were progressively demagnetized, using an alternating field demagnetization protocol to precisely quantify the preserved pTRM or TRM of interest within the heated substrate. Six demagnetization increments (in addition to the NRM) and maximum a step of 300 Oersteds (30 mT) were used on each specimen cube. This demagnetization procedure (NRM, 5 mT, 10 mT, 15 mT, 20 mT, 25 mT, 30 mT) resulted in 80% of the remanence eliminated.

Analysis of the measurement data for each specimen was completed using a combination of Python coding within Jupyter Notebooks and Demag_GUI, an analysis software within the open source PmagPy package (Tauxe et al. 2016). Each specimen was analyzed independently using one of two statistical methods to quantify the preserved magnetic vector of the specimen. If measurement data for the specimen form a linear trend, then principal component analysis (not including the origin) is the preferred method. If progressive demagnetization data form a trend along a longitudinal band, indicative of mixed vector direction between a weak pTRM that is overprinting a stronger pTRM or TRM, then the measurement data are interpreted with great circle plane analysis.

Following specimen interpretation, the specimen results were filtered using a minimal set of criteria to ensure specimen quality. Only specimens that passed minimal quality criteria were included in the mean (i.e. those with an angular deviation (dang) $< 5^\circ$), as is a standard practice in the global paleomagnetic community. The archaeodirectional mean is calculated as a spherical mean and is reported in declination and inclination coordinates, with uncertainty bounds (α_{95} and κ). While incredibly useful, dec-inc coordinates can be difficult to visualize, so the mean and its associated α_{95} uncertainty term are converted to a Virtual Geomagnetic Pole (VGP) position with an associate uncertainty bound, which is displayed as an ellipse. To determine the calendrical date of the sampled substrate, the VGP position is then compared to previously published reference models as a means of relative dating.

The VGP results and uncertainty ellipses are presented superimposed on the DuBois [1989], Wolfman (unpub.), SWCV2000 (Lengyel and Eighmy, 2002) and Hagstrum and Blinman [2010] reference curves. These curves represent four of the available reference curves for the Four Corners region of the United States Southwest, there are others, but these four are the most commonly used for archaeomagnetic dating. The curve from Hagstrum and Blinman (2010) is only used in the rare case that archaeomagnetic dating is needed prior to 585 CE. A recent update to the reference curve was published in Jones et al. (2021) but to the knowledge of the OAS staff in the Archaeomagnetic Laboratory, it has yet to be used for archaeomagnetic dating and as such is not included in report. Each previously published VGP reference curve has its own limitations and benefits, and these authors are not advocating for the use of one reference curve over another during the time range in question.

A further description of the laboratory methods is presented in Appendix B.

ARCHAEOMAGNETIC RESULTS AND DISCUSSION

Both submitted sample sets successfully preserved a remanent magnetization of high enough quality to be analyzed and converted to a Virtual Geomagnetic Pole position (VGP) for visualization and dating. Using the aforementioned criteria threshold of $\alpha_{95} < 5^\circ$, ten of 12 submitted specimens were included in the calculation of the mean for ADLN 1502, while all specimens were included in the calculation of the mean of ADLN 1503 (Table 1).

The interpreted mean VGPs of ADLN 1502 and ADLN 1503 are presented in Figures 1 and 2, respectively. As can be seen in Table 1, the α_{95} of ADLN 1502 (Feature 5) is less precise than that of ADLN 1503 (Feature 7), which affected the precision of the reported date ranges (Tables 2 and 3). The convention in the OAS Archaeomagnetic Laboratory is to only report dates on sample sets with an uncertainty term of $\alpha_{95} < 4.5^\circ$ because often an $\alpha_{95} > 4.5^\circ$ does not produce a meaningful date range. For this project, the decision was made to archaeomagnetically date both burned hearths, despite the large α_{95} of ADLN 1502, because the directions were statistically indistinguishable from each other. The resulting calendrical date interpretations are congruent with the archaeological interpretation (Tables 2 and 3).

Considering all the various models as a whole, the last use of the hearth recorded as Feature 5 (ADLN 1502) has a statistical likelihood of dating to the early 1000s to the fourteenth century. This is congruent with the archaeological interpretation based on architecture and ceramics of the late 900s to the early 1000s. The decreased precision ($\alpha_{95} = 5.0^\circ$) of the sample ADLN 1502 is contributing to the large age range. Conversely, the very precise archaeodirectional mean of Feature 7 (ADLN 1503) results in a much tighter calendrical age range. The calendric age for the last use of ADLN 1503 is either the late 1000s (as is congruent with the archaeological date) or the early thirteenth century; statistically either archaeomagnetic date range has an equal probability of likelihood.

Table 1. Characteristic archaeodirection results.

ADLN	Substrate	Dec	Inc	α_{95}	κ	N/N _m /N _T	Specimens Included in Mean
1052	Feature 5	346.99	61.8	5	96	10/12/12 L=8, P=2	1502_1, 1502_2, 1502_3, 1502_4, 1502_5, 1502_6, 1502_7, 1502_9, 1502_10, 1502_12
1503	Feature 7	348.69	63.4	1.8	615	12/12/12 L=12, P=0	1503_1, 1503_2, 1503_3, 1503_4, 1503_5, 1503_6, 1503_7, 1503_8, 1503_9, 1503_10, 1502_11, 1503_12

*ADLN = Archaeomagnetic Dating Laboratory Identification Number. Collectively the declination (Dec) and inclination (Inc) define the vector direction of the preserved magnetization, corrected for magnetic field azimuth. α_{95} refers to the angular confidence bounds of the mean direction; it is the 3-dimensional angular equivalent to a 2-sigma confidence bound. κ is a statistical measure of the concentration of the distribution about the mean, independent of number (N); a larger number reflects more concentrated data. N refers to the number of specimen directions (L = lines and P = great circle planes) that are included in the mean. N_m denotes number of specimens measured. N_T denotes the total number of specimens collected.

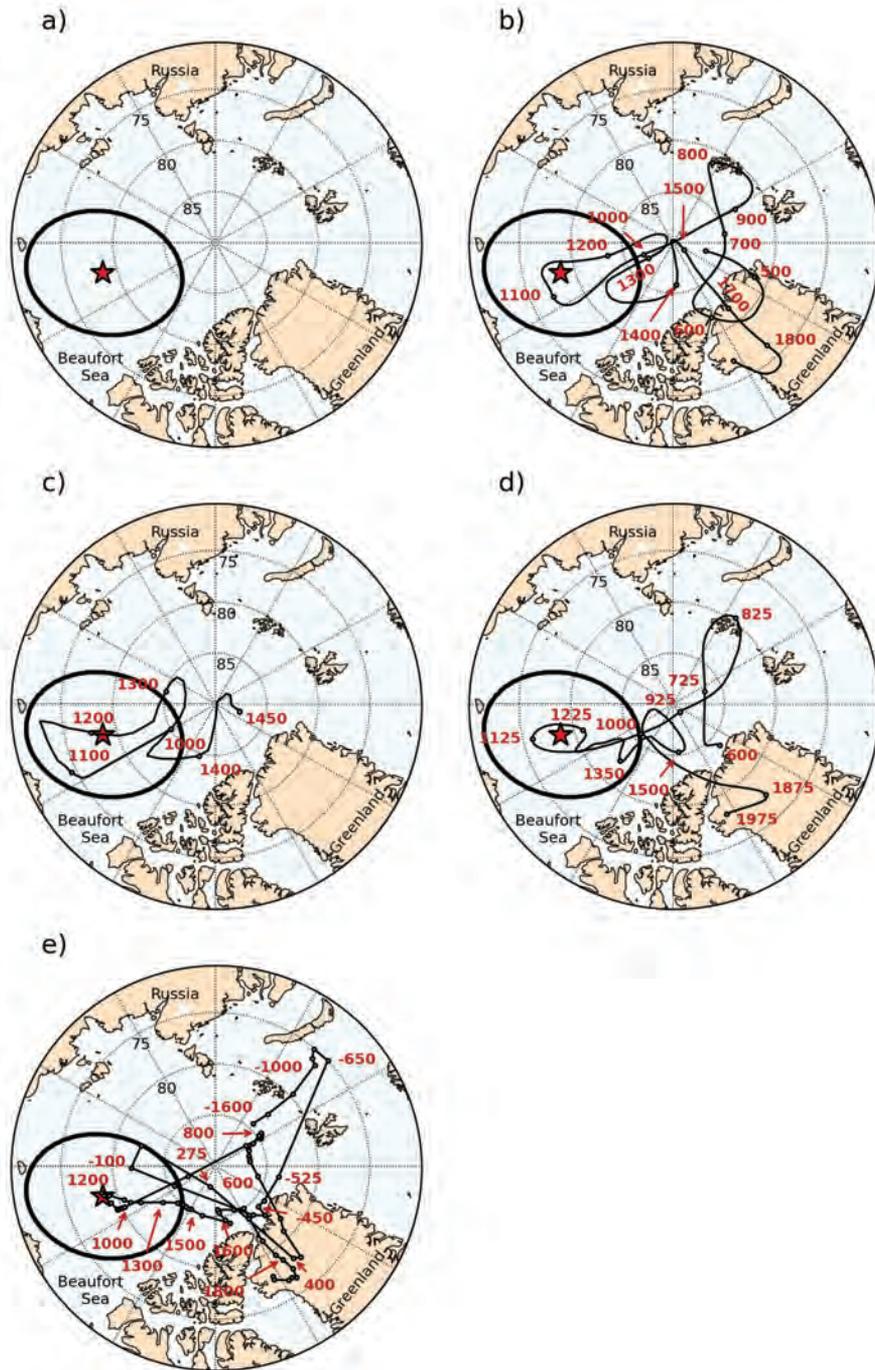


Figure 1. a) The Virtual Geomagnetic Pole position for ADLN 1502, plotted using a North Pole stereographic projection, b) superimposed on the DuBois [1989] reference curve, c) superimposed on the Wolfman (unpub.) reference curve, d) superimposed on the SWCV2000 (Lengyel and Eighmy, 2002) reference curve and e) superimposed on the Hagstrum and Blinman [2010] reference curve.

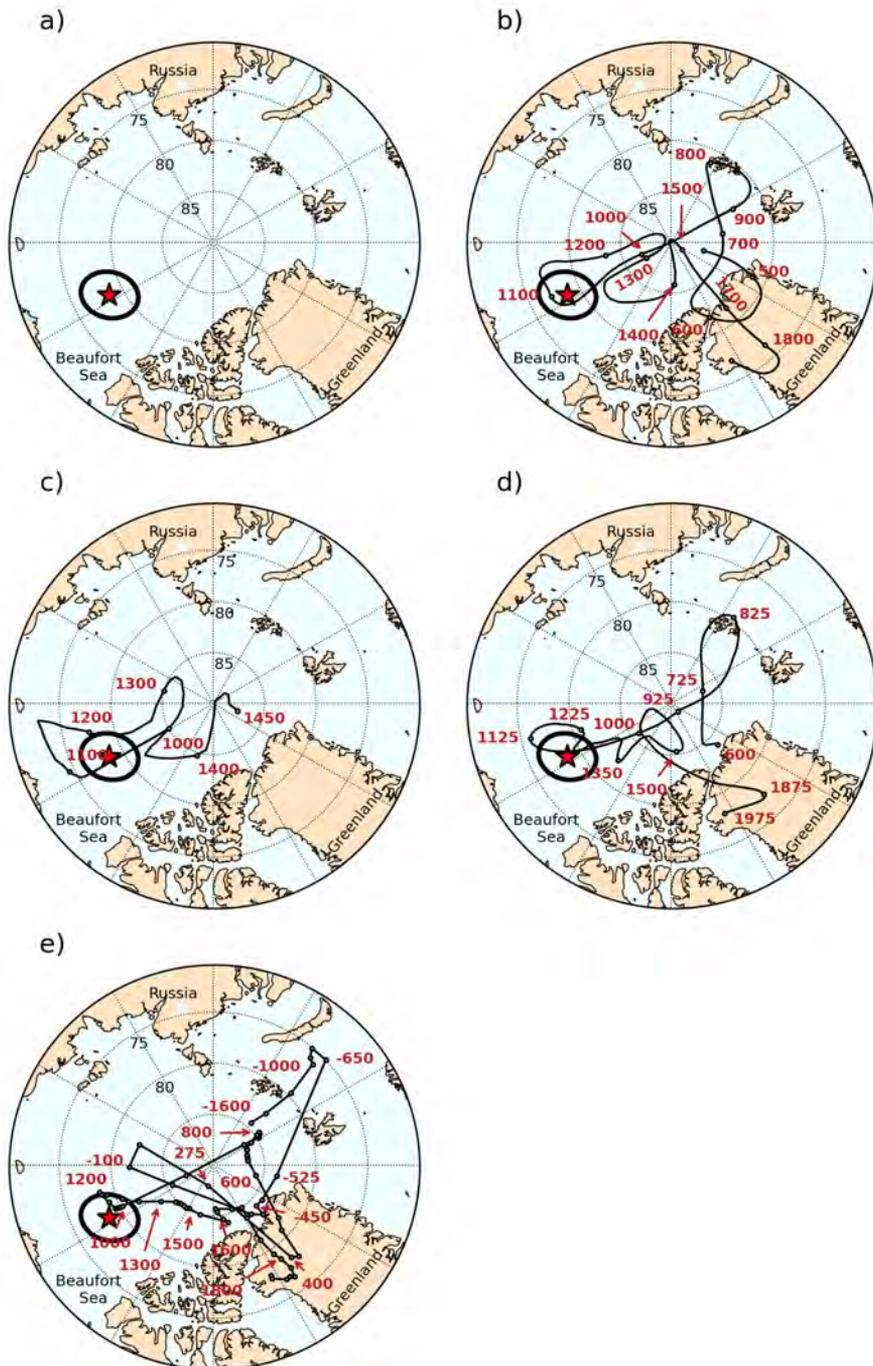


Figure 2. a) The Virtual Geomagnetic Pole position for ADLN 1503, plotted using a North Pole stereographic projection, b) superimposed on the DuBois [1989] reference curve, c) superimposed on the Wolfman (unpub.) reference curve, d) superimposed on the SWCV2000 (Lengyel and Eighmy, 2002) reference curve and e) superimposed on the Hagstrum and Blinman [2010] reference curve.

Table 2. Chronology, by model, for ADLN 1502.

Archaeomagnetic Model	Date ranges within α_{95}
DuBois (1989)	1000 - 1225 CE & 1300 - 1375 CE
Wolfman (unpublished)	1000 - 1300 CE & 1350 - 1375 CE
Lengyel and Eighmy (2002) SWCV2000	1000 - 1400 CE
Hagstrum and Blinman (2010)	975 - 1350 CE
Archaeological Interpretation	
Architecture and Ceramics	Late 900s - Early 1000s CE

Table 3. Chronology, by model, for ADLN 1503.

Archaeomagnetic Model	Date ranges within α_{95}
DuBois (1989)	1050 - 1125 CE
Wolfman (unpublished)	~1050 - 1075 CE & 1200 - 1225 CE
Lengyel and Eighmy (2002) SWCA 2000	~1050 - 1125 CE & 1225 - 1275 CE
Hagstrum and Blinman (2010)	1000 - 1250 C
Archaeological Interpretation	
Architecture and Ceramics	1000 - 1080 CE

CONCLUSIONS

Two sample sets of archaeomagnetic specimen cubes were submitted, measured, and analyzed with the goal of dating the last uses of two hearths (Features 5 and 7) from Structure 1003 at the Haynie Ruin (5MT1905). The specimens collected exhibited a high magnetic fidelity and were both interpretable. The resulting archaeomagnetically derived age ranges were congruent with the expectations of the archaeologists based on architectural and ceramic typology. ADLN 1502 (Feature 5) dates to the large age range of early 1000s to the fourteenth century, due to its increased statistical uncertainty. The calendric age for the last use of ADLN 1503 (Feature 7) is either the late 1000s (as is congruent with the archaeological date) or the early thirteenth century, statistically either date range has an equal probability of likelihood.

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APPENDIX A: MAGNETIC BACKGROUND

Archaeomagnetism, at the confluence of archaeology and geophysics, applies many of the techniques of paleomagnetism to address questions related to the history of archaeological features. The structure of Earth's magnetic field varies with time, and anthropogenic sediments and rocks can acquire magnetic properties (the magnetic vectors and mineralogy) that reflect the prevailing conditions at the time of the magnetic acquisition. The measurement and subsequent interpretation of a material's magnetic characteristics can inform on both the material's chronology and the event(s) of its history.

Traditionally, archaeomagnetic investigations have focused primarily on quantifying a material's preserved magnetic vector (usually direction, but also magnitude) with applications to archaeological chronology (archaeomagnetic dating) and for inclusion in geophysical models. However, there is an increasing interest in using the variation in the magnetic properties across features to support interpretations of feature form, use, history, and taphonomic processes. Of especial consideration is the use of archaeomagnetism to interpret otherwise enigmatic archaeological contexts and functions (e.g. horizontal rock features).

A1. Theoretical Basis

The archaeological materials most often studied are those that are anthropogenically heated (hearths, burned floors, pottery, etc) because the heating and subsequent cooling of the material generally preserves a stable and measurable magnetization. When heated in the presence of a magnetic field, the atomic-scale magnetic moments (vectors) within the magnetic mineral crystals enter a state of instability, with no memory of their former alignment—formally defined as a state of paramagnetic behavior. Upon subsequent cooling, this paramagnetic behavior ceases, and the atomic magnetic moments re-enter a state of stability as close to parallel as possible with the Earth's prevailing magnetic field, effectively documenting the qualities of Earth's magnetic field at the time of cooling. If the temperature reached is sufficiently high, all the material's magnetic moments behave paramagnetically at temperature and all the moments re-align upon cooling, preserving a thermal remanent magnetization (TRM). This temperature is known as the Curie point and occurs at 580° and 675°C for magnetite and hematite, respectively. If the temperature reached does not exceed the Curie temperature of the magnetic mineral crystals in the material, then the subset of magnetic moments that entered into paramagnetic behavior and did re-align upon cooling preserve a partial thermal remanent magnetization (pTRM). Often, this pTRM is still detectable during laboratory measurement and is common in anthropogenically heated materials, since most heating events do not reach as high as the Curie temperatures.

The total net magnetization of the material is formally referred to as the natural remanent magnetization (NRM) and represents the integrated effect of the material's magnetic history. In archaeomagnetism, the NRM is commonly complex because archaeological materials often experience multiple magnetization and heating events. In these cases, the complex history may be detailed through laboratory study, but not always. Since heating can re-initiate paramagnetic behavior, additional heating events effectively erase the vector alignments that were previously acquired at the new temperature and below. In instances where a subsequent heating event of a higher temperature occurs, there will be no preserved magnetic signature of the past heating event. But in cases where subsequent heating event(s) occur at lower temperatures than an earlier heating, there is a potential that measurement and data analysis maybe able to differentiate the magnetic signatures of the original and overprinting vectors. Depending on the research question, these overprinting magnetic signatures may have incredible value or may obscure the higher-temperature magnetic vector of importance. Detailed laboratory measurement procedures and post-measurement statistical analyses are required to understand this type of complex thermal histories, but these complex histories can result in robust perspectives on the anthropogenic feature's history and function.

Overprinting magnetic signatures are not just limited to pTRMs. They can result from a number of different phenomena, each formally defined, and can all partially or completely overprint the primary remanent magnetic vector. Most common in archaeological settings are viscous remanent magnetizations

(VRM) and chemical remanent magnetizations (CRM), but anhysteretic remanence magnetizations (ARM) can occur as well.

VRMs are almost always present and are usually acquired by the least stable or weakest subset of magnetic moments within the material. At ambient temperature and pressures, these weakest magnetic moments can exhibit paramagnetic behavior and have the potential to realign their magnetic moment with Earth's present-day magnetic field on the order of days to centuries. Because VRMs are acquired by the weakest magnetic moments in the material, they will influence the NRM but are easy to remove during laboratory measurement and often do not affect the final interpretation.

CRMs are the by-product of the chemical alteration of the magnetic minerals within the material. They can be the result of mineral weathering converting one magnetic mineralogy into another but can also result from the precipitation of magnetic minerals in or on the material (for example a hematite-based cement within a porous sedimentary rock or a surficial accumulation of magnetite). In archaeological contexts, the anthropogenic use of a material (such as a roasting or boiling stone) may predispose the material to develop a CRM that is different in the nature or pace of weathering than is seen in non-anthropogenically influenced specimens.

ARMs are overprints caused by exposure to strong magnetic or electric fields that are not Earth's field. These often result from lightning strikes within a few meters or from exposures to strong influences after sample collection, such as if the samples are placed too close to magnets, strong electrical currents, or audio speakers. Similar to VRMs, these strong fields can induce a subset of the magnetic moments within the material to realign, partially or nearly completely overprinting the magnetic vector essential to the research question. If the vector of interest was acquired as a high temperature TRM, then the effects of an ARM overprint can usually be identified and accommodated for during laboratory measurement with a well-designed protocol and complex statistical analysis.

Lastly, in addition to magnetic qualities established through thermal means (pTRMs and TRMs), magnetization of sediments can result from grains settling out of suspension. This type of magnetization is known as detrital remanent magnetization (DRM) and is usually orders of magnitude weaker than TRM signatures. The magnitude of a DRM is directly related to the rate grains settled out of suspension, the flow regime and turbulence those grains experienced as they settled, and the shape and size mineralogy of the grains. DRMs can be present in a variety of archaeological contexts, both as *in situ* archaeological formations and as pre-existing geologic moments. Canal or ponded sediments can have a DRM that are relevant to archaeological interpretations. While the DRMs preserved in sedimentary rocks (which have been collected and reorganized into built features) reflect the conditions of the rock's formation and may result in "noise" in archaeomagnetic investigations.

In most cases, the primary DRM is not the vector essential to the archaeomagnetic research question and are weak enough that they do not confound the interpretation of an overprinting pTRM or TRM. But in special cases, a DRM can form in environments that create non-random magnetic alignments (anisotropy). This anisotropy can form naturally, as a result of stream flow and mineralogy, and can result from human actions. Troweling, pottery construction, or polishing of floor or wall plasters can contribute to an anisotropic DRM signature, and that anisotropy can be persistent and influence subsequent overprinting magnetization. In such cases, the precision and accuracy of the interpretation can be influenced.

For a more formal and detailed description of magnetic physics and mineralogy see Butler (1992, Chapter 2). For more detailed descriptions of the types of remanent magnetizations, see Butler (1992, Chapter 3).

A2. Earth's magnetic field

Foundational to archaeomagnetism and paleomagnetism is that the magnetic properties (e.g. the remanent magnetization(s) and mineralogy) of the studied material inform on functional history and the dynamic geometry of Earth's magnetic field. In archaeomagnetism, most research questions focus on the subtle variations of Earth's magnetic field that occur through time and space, known as paleosecular variation

(PSV). Investigating PSV is a two-fold process of archaeomagnetism: 1) Foundational research that uses the abundant magnetic records and independent dating potential of archaeological features to build and test the reliability of regional PSV data. And 2) using the accumulated knowledge of regional PSV as a chronology tool in archaeology to date magnetic records of unknown age archaeological dating.

PSV is the result of the dynamic structure of Earth's magnetic field at both a local and global scale. Through the collection, measurement, and analysis of oriented and well-dated study material, the remanent magnetization vector(s) in the studied material can be used to investigate the field structure at the time of magnetic acquisition, analogous to understanding the dynamic field geometry through discrete "snap shots". With enough discrete data, models of the PSV through time can be developed. In archaeomagnetism, a common way of viewing PSV through time is by tracing the movement of the magnetic north pole through time, referred to as constructing virtual geomagnetic pole (VGP) reference curves.

A VGP location is calculated using a feature's magnetic vector (as recorded by the remanent magnetization vector(s)) and the site's latitude-longitude. The result is a location, usually within the Arctic circle, that estimates the past location of the magnetic north pole. It is an estimate because the calculation assumes that Earth's magnetic field is strictly a dipole field, which while that is an incredibly useful assumption, it is slightly inaccurate. Earth's magnetic field is primarily a dipole structure (accounting for roughly 90-95 percent of the field's power) but the small contribution of non-dipole field geometries (e.g. quadrupole, octupole, etc) contribute significantly to regional field variability and cause VGP reference curves to be regionally specific.

A3. Archaeomagnetism applications in the U.S.

Commonly, regional archaeomagnetic VGP reference curves are constructed for areas of up to a ~750 km radius, as the non-dipole influences cause too much variation in the dataset beyond this radius and the data should be treated independently. Presently in the United States, three regions have proposed VGP calibration curves:

- 1) The Four Corners region of the American Southwest has by far the most data, and multiple generations of reference curves have been proposed (reviewed in Blinman and Cox, in press). The curves proposed for this region have and continue to be used for archaeomagnetic dating.
- 2) A curve encompassing the Lower Mississippi River region of the Southeastern United States (Arkansas focus) was proposed by Dan Wolfman (1982, 1990).
- 3) A mid-continent curve covering the latitudes north of the Lower Mississippi River curve (but also including much of Wolfman's data) was proposed by Stacey Lengyel (Lengyel 2004; Lengyel et al. 1999).

Much of the rest of the U.S. does not yet have a proposed reference curve. This is largely due to a low density of data, including Texas, which lies between the Four Corners region and the Lower Mississippi River region. However, the PSV of the eastern seaboard from 1600 CE to present has been modeled from historical records of magnetic direction in sea captains' log books (Jackson et al. 2000). This model, known as *gufm*, can be utilized in much the same way as a VGP calibration curve for applications of archaeomagnetic dating along the eastern coast of the United States. Further, recent work by Shelby Jones (Jones et al. 2021) has combined results from the three largest sources of archaeomagnetic data for the United States: DuBois, Wolfman, and Eighmy/Lengyel. This large (and growing) data set will provide new opportunities for curve development.

The U.S. tradition of archaeomagnetism began in the 1960s, and the focus has been on the development and use VGP curves for archaeomagnetic dating of the magnetic vectors from thermal features. The VGP position of the preserved TRMs and pTRMs vector(s) can be compared with the appropriate regional reference curve and can be interpreted as a date range.

Whether or not a regional reference curve exists, the contemporaneity of multiple features within a site can be evaluated by comparing the remanent magnetization(s) direction of each. If different features have non-parallel vector directions, this can be interpreted as evidence that the features are not contemporaneous. Conversely, if different features have parallel vector directions, those features have the potential to be contemporaneous; however, there is a chance for an erroneous conclusion. VGP variation is not unidirectional, and at times the reference curves cross over themselves. This overlap can result in a single pole position (parallel vectors) achieved at different times in the past. In these cases, and if a full TRM is present in the material, specialized measurements related to the estimate of the strength of Earth's past magnetic field can be used to distinguish the timing of some points of overlap.

Beyond dating and contemporaneity assessments, archaeomagnetic analyses have the potential to contribute to the understanding of the use and taphonomy of burned rock features. Wulf Gose from the University of Texas at Austin applied paleomagnetic methods usually applied to tectonic questions to archaeological burned rock features (Nickels et al. 1998; Gose 2000). The approach evaluates whether the magnetization vectors of the individual rocks within a thermal feature are coherent or dispersed (non-parallel) in their preserved direction. If the rocks are coherent in their vector directions, it can be inferred that the thermal feature is intact. If the vector directions from the rocks are dispersed, it can be inferred that the rocks moved since their magnetic acquisition. Minor movements in the vector directions of *in situ* rocks are expected as a result of normal post-abandonment taphonomic processes. But radical realignments of the vector directions may support interpretations of human behavior at time of use.

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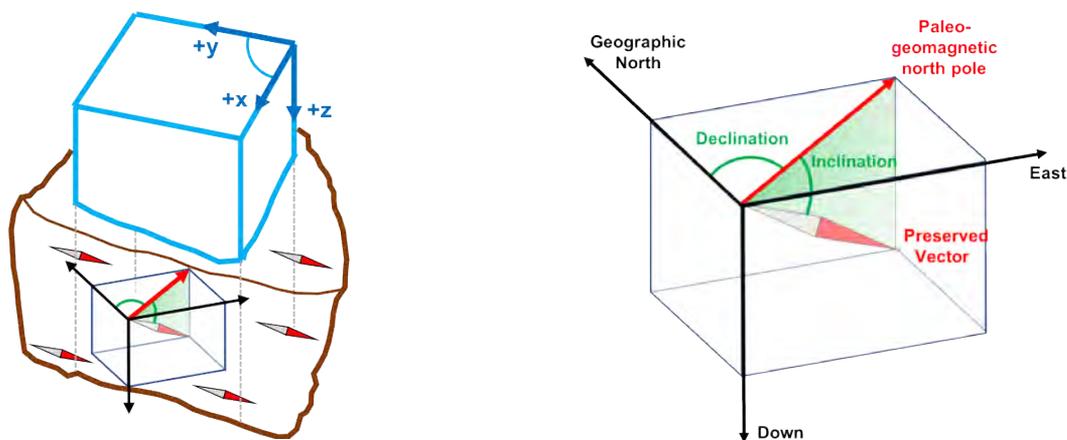
APPENDIX B: TECHNICAL DISCUSSION OF METHODOLOGY

B1. Archaeomagnetic coordinate systems

Sampling design is dependent on the research goals, but in general, most archaeomagnetic studies rely on the preservation of measurable vectors magnetic that inform on feature history. OAS's archaeomagnetic sampling procedure for directional studies is multi-step and utilizes non-magnetic fast curing plaster to fully encase specimens within a 1-inch plaster cube. This method ensures that even slightly cohesive materials remain intact throughout transportation and laboratory measurement, and every measurement made is precisely aligned within the magnetometer.

Successful TRM archaeomagnetic studies require appropriate magnetic mineralogies, anthropogenic heating event(s) sufficiently hot to result in a TRM (or pTRM) magnetic alignment, recovery of a carefully aligned set of 1-inch specimen cubes, and step-wise laboratory measurement of the specimen cubes paired with analysis to determine a direction of the preserved magnetic vector. These magnetic vectors, characterized through laboratory measurement, are measured in a cartesian coordinate system (XYZ) with respect to the carefully aligned reference corner noted as a quarter circle on the plaster support, at time of sampling. During analysis, the measured cartesian vectors of the preserved magnetic vector are mathematically transformed into a polar coordinate system (angular direction and magnitude) using the cube's in-field geometry to determine the relationship between modern geographic north and the ancient geomagnetic north.

In archaeomagnetism and paleomagnetism, the angular direction of the vector is expressed as declination and inclination. Declination is the angle from the geographic north pole to the horizontal projection of the preserved vector, calculated using the X and Y measurement (ranging from 0° to 360° clockwise). Inclination is the angle between the preserved vector and horizontal plane, calculated using the Z measurement (ranging from -90° to +90° and defined as positive when the preserved vector is pointing down).



B2. Laboratory analysis methods

Archaeomagnetic directional determinations are carried out on-site in the OAS's Archaeomagnetic Dating Laboratory (ADL). Classical step-wise alternating field (AF) demagnetization is completed using a single axis 2G Sample Degaussing System (Model 2G600) in a three-step protocol to ensure each axis of the specimen cube is demagnetized prior to measurement on a MagInstruments Portable Spinner Magnetometer (PSM). A six-step measurement protocol is used to ensure measurement reliability, with each specimen axis measured twice in both the positive and negative directions (e.g. +x and -x) for a total of four measurements of each axis. Each composite measurement reported is the arithmetic mean of the four measurements. The six-step protocol is uniquely used by ADL and ensures that +z and -z are both measured

twice, which is a great benefit in archaeomagnetic studies because often archaeomagnetic samples are heterogeneous in nature resulting from a lack of centering of the magnetic specimen within the plaster cube encasement and the heterogeneity of the substrate.

The set of steps used in the AF demagnetization of specimen cubes is project and substrate dependent. Usually five to seven steps are measured between the initial NRM measurement and the last step, typically a peak field of 300 Oersteds (Oe, 30mT). Preliminary analyses are conducted and, if warranted, select specimens can be treated with additional higher-level demagnetization steps. Through AF demagnetization, the goal is to progressively neutralize the specimen's magnetic moments until the net magnitude of the measured vector is less than 20% of the strength of the original NRM. Prior to measurement the specimens "rest" within a zero field for at least two weeks, this allows for the very weakly held VRMs to randomize, so there is not a systemic bias in the NRM measurements due to weak moments that have been acquired during sample, transportation, and preparation.

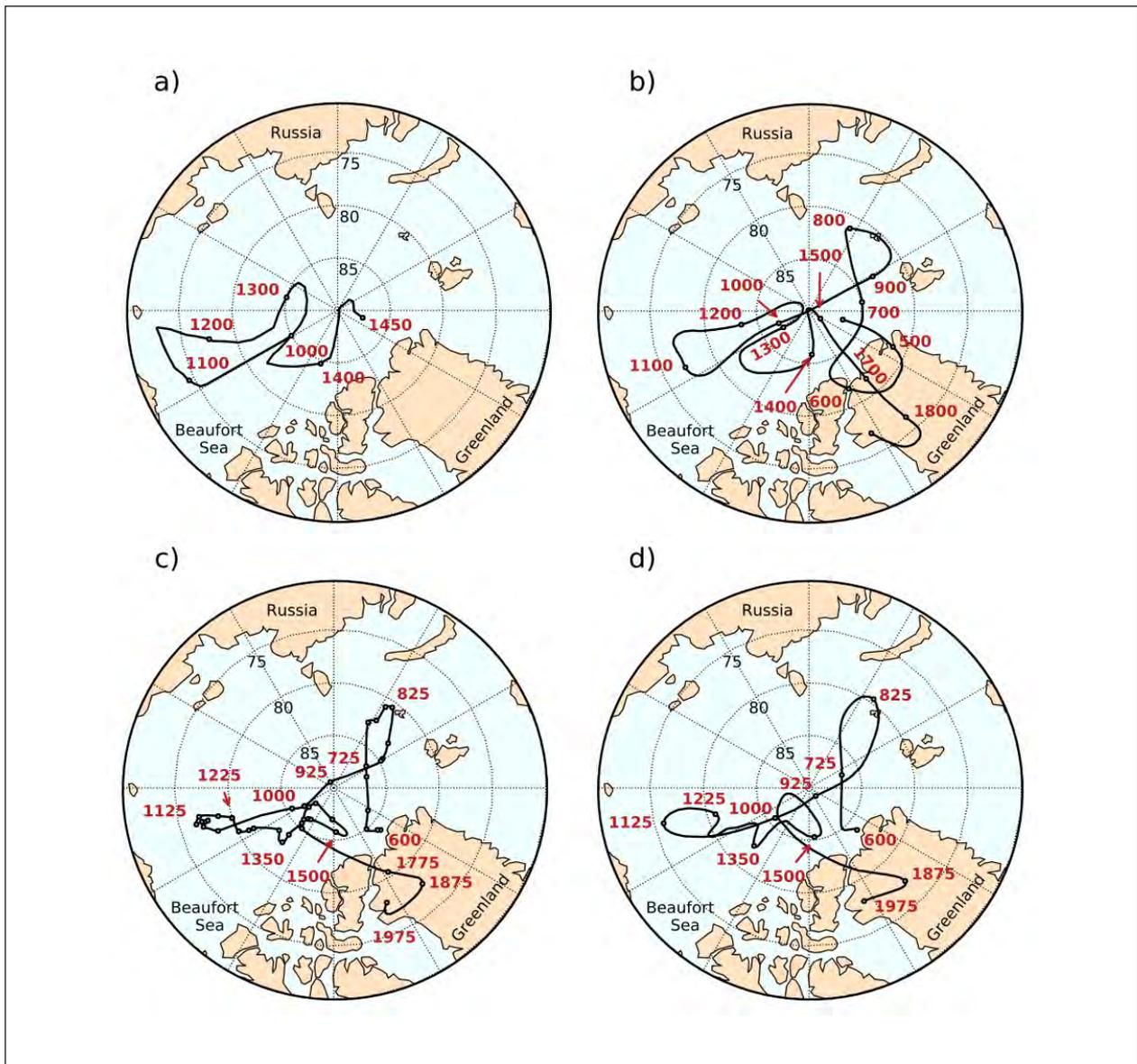
All data are reported in column-delimited file formats compatible with the Magnetics Information Consortium (MagIC - <https://www2.earthref.org/MagIC>), an online NSF compliant and supported data repository that promotes information technology infrastructure for the international paleomagnetic community. This allows for the opportunity for all collected data to be included seamlessly into the global databases. This file format is beneficial because the data are easily be visualized and interpreted as single measurements, by specimen, and averaged by archaeological feature within the MagIC compatible PmagPy software package (Tauxe, 2016). The software package allows for each specimen cube to be interpreted independently, as its data indicates. Commonly employed statistical techniques to determine the preserved vector in a specimen cube from the suite of step-wise AF demagnetization measurement data are principle component analysis (basis in eigenvectors), great-circle plane analysis (beneficial when the preserved vector of interest is a weak pTRM overprinting a strong TRM or pTRM), and an arithmetic mean calculated in spherical coordinates (known as a Fisher mean; Fisher, 1953). The PmagPy software, written in Python, is continually serviced and updated by a consortium of international paleomagnetists to include the newest and traditional statistical techniques.

Once the declination and inclination of each specimen cube is calculated and assessed for quality, a Fisher mean (Fisher, 1953) and statistical uncertainty is calculated from the reliable cubes from a feature. This mean is reported as the feature's declination and inclination, with a statistical uncertainty reported as an α_{95} (meaning there is a 95% probability that the average falls within the bounds of circle with an angular radius equivalent to the α_{95} , in degrees). This mean and α_{95} are transformed to calculate a VGP position and associated uncertainty ellipse, which aids in visualization and VGP-based archaeomagnetic calendric dating.

B3. VGP-based archaeomagnetic dating

Using the graphical depiction of the VGP and uncertainty ellipse, juxtaposed against the pre-defined regional reference curve, an archaeomagnetic-derived age range can be interpreted. As uncertainty terms become larger, the VGP position are less precisely know and the date range interpretations become increasingly large and less useful. Preferred uncertainty terms are less than an α_{95} of 4°. Where possible, calendric archaeomagnetic dates are interpreted based on several of the previously proposed referencecurves available for the Four Corners region of the United States Southwest: a) Wolfman (unpub.); b) DuBois 1989; c) SWCV 595 (LaBelle & Eighmy 1995); and d) SWCV2000 (Lengyel and Eighmy 2002).

To the extent that reference curve paths are accurate and that archaeological feature's VGP position is the expression the targeted preserved vector exclusively, error ellipses should perfectly overlap the curve path. However, neither assumption can be made with absolute confidence. Site taphonomy as well as specimen mineralogy and magnetic anisotropy can slight or significantly affect the preserved vector in question that is central to the research question. A good example is a burned wall that is slightly slumped, the slump may be imperceptible to the eye but the magnetic vector and thus the VGP position of the burned wall could be drastically different. Additionally, depending on VGP position and uncertainty value, an ellipse can intersect the refence curve in multiple locations, each of which could support a valid date in-



terpretation. Since only one date range is actually relevant to the archaeological event that produced the pTRM or TRM, independent information must be used by the archaeologist to determine which archaeomagnetic date range is appropriate. Archaeomagnetic date interpretations are most useful where there are multiple sources of chronology that can help focus attention on a particular date range as relevant.

Data that are independently dated can be added to the database for later inclusion in the development of future regional-reference curves.

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