Geoarchaeological evidence for ritual closure of a kiva at Fourmile Ruin, Arizona

Scott Van Keuren a,*, Christopher I. Roos b

a Department of Anthropology, University of Vermont, Williams Hall 509, 72 University Pl, Burlington, VT 05405, USA
b Department of Anthropology, Southern Methodist University, Dallas, TX 75275, USA

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A B S T R A C T

Geoarchaeological analyses, including soil micromorphology and chemistry, were used to characterize the deposition history of a fourteenth-century Pueblo ceremonial structure (or kiva) at Fourmile Ruin, east-central Arizona. These subterranean structures were often ritually “closed” by Pueblo societies through the burning of roofs and the deposition of special objects. These conspicuous markers are absent in the Fourmile Ruin kiva, but the composition of constituent materials and sedimentation processes nonetheless signal complex, highly-orchestrated closure activities. The study demonstrates the efficacy of geoarchaeological analyses of stratified deposits for modeling the subtle behaviors associated with the ritual closure and abandonment of sacred places.

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1. Introduction

Ancestral Pueblo communities in the US Southwest were fundamentally reorganized during a phase of settlement aggregation in the early Pueblo IV period (ca. A.D. 1275/1300–1400). Archaeologists who work on this time period often focus on the social dimensions of large village establishment and growth. In general, less attention has been paid to the elusive processes by which communities fission and disperse. However, one productive area of scholarship focuses on the formation history of post-occupational deposits in ceremonial structures, or more specifically, evidence for the intentional disassembly and filling of these structures during “closure” events. In the case of structures that are centrally located and shared by multiple households, such activities can potentially reveal village-wide social processes.

Singularized deposits, a phrase we borrow from Walker (1995: 72; see Kopytoff, 1986), are associated with ritualized closures that involve uncommon or specialized sequences of behaviors and objects. In most cases, singularized treatment has been recognized through obtrusive stratigraphic signatures (e.g., roof burning), or on the basis of distinctive associations of artifacts, plants, or animals. Examples of the latter include the interment of articulated animals, collections of unbroken ceramic vessels, or human remains that were placed on the floor at abandonment or in post-abandonment deposits. Outside of these highly visible traces of singularized treatment, the recognition of ritualized closure is difficult. Fortunately, singularized treatment can leave traces in the sediments and stratigraphy of archaeological deposits. Geoarchaeological analyses, including soil micromorphology and chemistry, provide evidence to identify traces of deposit formation history including the composition of constituent materials and sedimentation processes that can identify singularized treatment in the absence of conspicuous markers. Such analyses have been successfully employed, for instance, to study ritual behavior in the symbolically charged construction histories of earthen monuments (Sherwood and Kidder, 2011), but have not yet been routinely employed to study the closure and abandonment of sacred places.

In this paper we report on geoarchaeological analyses of stratified deposits in a subterranean ceremonial room (or kiva) at Fourmile Ruin, Arizona (Fig. 1). The village was the largest Ancestral Pueblo settlement in the Silver Creek drainage, and during its heyday included two to three large plazas surrounded by single- and multi-story masonry and adobe brick rooms. Kivas near the center of each of the two larger plazas were likely locations for non-public ceremonial practices of surrounding households and suprathousehold social units (e.g., lineages, clans). Our excavations exposed intact sediments burying the floor of one of these plaza kivas. Although unusual assemblages of artifacts, faunal, or
2. Research background

The close of the thirteenth century A.D. marked the end of permanent residential occupation in large portions of the Ancestral Pueblo world (Adler, 1996). Broadly speaking, this demographic event reshaped the configuration, cultural composition, and perhaps even religious practices of communities throughout the northern US Southwest (Adams and Duff, 2004; Duff, 2002; Spielmann, 1998; Van Keuren and Glowacki, 2011). By the early 1300s, local populations and migrant groups coalesced into plaza-oriented villages, many of which were organized spatially into loose settlement clusters (Adams and Duff, 2004). Fourmile Ruin was among five villages in the Silver Creek cluster, east-central Arizona (Fig. 1) (Kaldahl et al., 2004; Mills, 1998). This site and others in the cluster are perhaps best known for their production of figurative-style pottery (Fourmile Polychrome) by the 1320s (Carlson, 1970: 71), which may have been associated with new religious beliefs that spread across the Pueblo world (Adams, 1991, 1994; Hays-Gilpin and LeBlanc, 2007).

2.1. Fourmile Ruin in context

Fourmile Ruin was first recorded by archaeologists more than a century ago (Fewkes, 1904; Spier, 1919). Jesse Walter Fewkes excavated portions of the site during a two-week expedition in 1896, but his brief report and unpublished notebook provide scant details on his fieldwork and the site was only recently mapped. Like other early Pueblo IV period villages, the village is composed of long linear room blocks constructed around expansive, partially enclosed plazas (Fig. 2). At least two subterranean ceremonial structures (or kivas) were constructed in the center of two main plazas. During its heyday, the site included 250 to 300 ground floor rooms. Although northern portions of the site have now been destroyed, both Spier (1919) and Fewkes (1904) note the presence of second- and third-storied rooms at the site. We suggest...
a conservative estimate of 350–400 rooms, with one small plaza and two larger plazas. Based on the presence of well-dated ceramic types (Carlson, 1970; Mills and Herr, 1999), the site was first established by the end of the 1200s, and then expanded sometime in the early- to mid-1300s. Permanent residential occupation by Pueblo peoples ended in the area during the final decades of the 1300s (Mills, 1998).

Fourmile Ruin was subject to several episodes of systematic looting prior to its transfer from a private landowner to The Archaeological Conservancy. Although the contents of rooms were cleaned out, the resulting architectural remains provided a wealth of information on wall construction sequences and materials. The earliest occupants of the site built suites of masonry rooms that were built around a small plaza in the northeast area of the village. The village expanded significantly with the arrival of migrants who constructed long, contiguous room blocks that enclosed a much larger plaza (Plaza 2). Wall bonds and abutments reveal that a portion of the late room blocks were “ladder” constructions that involved organized efforts (Cameron, 1999: 208), with rooms delineated by shorter walls placed perpendicular between long parallel walls. The majority of adobe brick walls are located in these areas (Johnson, 1992). During the final phase of aggregation, additional rooms were built around a small plaza (Room 3). The mixed use of multiple architectural traditions indicates that this was a “multi-cultural” community. The best evidence of this was the expansive use of adobe bricks at the site (Johnson, 1992), a construction technology that is not found at other Silver Creek sites, but was used at contemporaneous villages in Middle Little Colorado River drainage sites to the north (Gann, 1996). Despite the paucity of professional excavations at the site, the architectural record of Fourmile Ruin reveals a great deal about the processes of aggregation at the site. In fact, one can infer the basic scenario of population resettlement, the size of arriving migrant groups, and the planning and construction processes involved in the major fourteenth-century expansion of the village. Despite speculation about the role of factionalism (Kaldahl et al., 2004), we know much less about the social processes by which Fourmile Ruin and many other Pueblo IV period villages were vacated in the late 1300s. The stratigraphic deposits of intentionally filled rooms and extramural areas can potentially reveal the social processes of site abandonment.

2.2. The closure of ceremonial rooms in the Pueblo Southwest

The disuse and even closure of individual rooms, along with the processes through which entire Pueblo towns were depopulated, left subtle traces in the archaeological record. In rare cases, catastrophic events are evidenced by the intentional burning of suites of rooms (e.g., Point of Pines Pueblo; Lindsay, 1987). A handful of ethnographic (or ethno-historic) case-studies have documented the ways in which whole Pueblo villages fissured during episodes of social conflict and factionalism during the historic period (Cameron, 1992; Levy, 1992). In most cases, however, the circumstances and rate of depopulation of ancestral villages are exceedingly difficult to detect in the archaeological record of large Pueblo villages. This is not surprising given that the scale of population movement and out-migration in the Pueblo Southwest, normally involved households and other small social groups (Bernardini, 2005; Cameron, 1995; Dean, 1970; Duff, 1998; Ramenofsky et al., 2009). Given the complex nature of the archaeological record of these sites, and the likelihood of extensive future excavations, the scrutiny of stratigraphic deposits becomes critical to modeling village histories. Because plaza kivas are associated with supra-household activities necessary for community religious life, their closure can serve as a proxy of broader room block abandonments within settlements.

We use stratigraphic deposits within the fill of a plaza kiva at Fourmile Ruin to illustrate how ritual closure can be inferred using stratigraphic evidence and geoarchaeological observations of the constituent sediments. Our work builds on recent studies of ritual deposits in the Ancestral Pueblo Southwest, namely work in the Middle Colorado River Valley to the north (Fig. 1). Here, Walker and his colleagues (Adams and LaMotta, 2006; Walker, 1995; Walker et al., 2000) have examined the ritual closure of structures at thirteenth- and fourteenth-century villages in the Homol’ovi region. Adams and LaMotta (2006: 60–62) discuss the nature of “enriched deposits” in religious structures (including kivas) at Homol’ovi I and II as they relate to early forms of Katsina ceremonialism in the area. These deposits were created through the placement of rare objects and other “inalienable possessions” (see Mills, 2004) that effectively sealed off religious spaces to future use. Their research builds on Walker’s earlier work. In an essay that underscores the importance of inferring ritual in the past through “ceremonial trash,” Walker (1995, 1996) documents the ritual deposits and closure of several Homol’ovi kivas. His discussion cannot be fully summarized here, but underscores the complex, and perhaps even temporally discontinuous deposition of objects, trash, and the eventual burning of several Homol’ovi kivas (1995: 72).

The treatment of kivas in our region during the early Pueblo IV period has not been extensively documented, but one example of ritual closure was recorded at Bailey Ruin in the southern edge of the Silver Creek cluster. Here, one small room along the main plaza (Room 2) revealed a complex depositional sequence (Mills et al., 1999: 162–172). This room was possibly once part of a larger kiva before partitioning walls were built. The end of Room 2’s occupation was marked by the placement of two articulated rabbits, a piece of turquoise, and quartz crystals on the floors of these adjacent rooms. Fill was intentionally added to cover the floor in both rooms. Sometime thereafter, but before the upper floor collapsed, a hawk (Buteo sp.) was buried on a bed of decorated sherds in the southeast corner of the room (Room 2). Another closure event possibly occurred at nearby Pinedale Ruin. At this contemporaneous site, Haury and Hargrave (1931: 32) partially excavated a plaza kiva that was intentionally burned, but their report does not make note of any unusual objects or deposits in this structure.

The deposition of religious items or special objects during the closure of southwestern ceremonial rooms stretches deep into the Pueblo past (Wilschusen, 1986). The late pre-Hispanic period examples we cite demonstrate that the closure of kivas involved explicit ritual activities that are reflected both in the objects that are deposited as well as the composition and treatment of the structure fill. These “singularized deposits” were not necessarily created through concurrent events. Rather, they appear to be orchestrated during distinct episodes. The behavioral relationships between multiple stratigraphic layers can thus be complicated (Walker, 2002). Discontinuous closure activities may be difficult to discern on the basis of field observations alone, particularly in the absence of sacred objects, singularized deposits, or other overt markers in the stratigraphic record (e.g., roof burning). Perhaps more important, the ritual treatment of structures may go unnoticed during archaeological excavation when these features are absent.

2.3. Traces of ritual closure in micromorphology

The archaeological analysis of ritual activities emphasizes the presence of, and relationships among, specific artifacts, ecofacts, and features. The sediments and soils in which the objects and features are observed or recovered, often referred to as the
“matrix,” are key dimensions of the context for traditional archaeological subjects but are rarely treated as “artifacts” in their own right (Goldberg and Berna, 2010; Salisbury, 2012). The study of undisturbed soils, sediments, and archaeological materials in thin section (i.e., archaeological soil micromorphology) provides a unique avenue for inferring human behaviors that may be entirely invisible in the macroscopic record of artifacts, features and macrostratigraphy (Courty et al., 1989; Goldberg and Macphail, 2006). Micromorphological analyses (Courty, 2001) of undisturbed soils through petrographic observation, description, and spectroscopic measurements have yielded extremely high-resolution evidence about human behaviors within strata less than 1–2 cm thick (Berna et al., 2007; Goldberg et al., 2009). Micromorphological analyses excel at answering a number of questions that pertain to the singularized life histories of sacred places: What are the sediments and materials that make up the matrix? How are they related? How did they get there? And how were they modified after deposition? Distinguishing the cultural and natural formation processes responsible for the formation and alteration of the deposits (see Schiffer, 1996) is fundamental to parsing the traces of patterned behaviors that characterize ritual (Hollenback, 2010; Walker, 1995, 1996). Although no dendrochronological samples were collected from Stratigraphic Unit IV (see Section 4.4), one across the boundary of Stratigraphic Units III and IV, and two were collected from the top of Unit I to the contact with the paved floor. Additional undisturbed blocks were collected opportunistically from excavation units across the site to characterize architectural material including adobe bricks, construction mortar, and wall plaster.

3. Methods

3.1. Archaeological excavations in Kiva 3

The stratigraphic data we present in this paper were based on samples taken during excavations at Fourmile Ruin in 2008. Kiva 3 was tested in 2008 and 2009 as part of a broader but limited set of excavations at Fourmile Ruin and two other contemporaneous sites in the Silver Creek cluster (Pinedale and Shumway ruins). The research project focused on the recovery of ceramic data, in part to clarify the social context of iconographic-style pottery production in the fourteenth-century. However, limited excavations were also designed to document the settlement history and chronology of these three large aggregated villages, all of which were located on private land and had not been extensively documented. Excavation units were used to investigate room, extramural, and trash deposits throughout the village, including Kiva 3 and rooms in several nearby room blocks.

Kiva 3 is indicated by a shallow depression in the center of the large eastern plaza. The subterranean room was initially tested with a 1 × 1 m excavation unit in 2008 that extended from the modern ground surface to the paved floor of the room. The micromorphology samples reported here were collected from the east and south excavation profiles at the close of the field season. In 2009, this unit was reopened and an excavation trench was extended from the western edge of the 1 × 1 m unit to the structure’s eastern wall. Both test units exposed several characteristic floor features that are found in both Ancestral and historic-period Pueblo kivas (Smith, 1972). Although no dendrochronological samples were recovered, the presence of cross-dated ceramic types in concert with construction sequence data for surrounding roomblocks suggest the structure was built and occupied sometime between the middle- to late-fourteenth century. The paved floor and associated features are similar to a kiva (designated Kiva 1) excavated by Fewkes (1904: 137–139) at the site in 1896. Based on Fewkes’ published diagram, features in Kiva 1 included a slab-paved floor, raised southern bench (paved), slab-lined ash pit and adjacent hearth, and loom holes. A larger plaza kiva (Kiva 2) was also tested in 2008, but a 1 × 2 m test unit revealed approximately 1.8 m of redeposited looter’s spoil atop two displaced paving stones that originally formed the kiva floor.

Five major stratigraphic units above the paved floor in Kiva 3 were described and mapped in the field. These strata included layers of contrasting materials that post-date the original ceremonial use of the kiva. Six undisturbed monoliths (25 cm × 8 cm × 8 cm) were carved into the profiles and removed with the aid of 25–cm long segments of polyvinyl gutter downpiping that had been cut open on one side. Loose “bulk” sediment samples were collected in 5-cm continuous intervals adjacent to the monoliths. Monoliths were impregnated with a polyester resin in the field and cut into 25-cm monoliths and 5.5 cm × 7 cm blocks for preparation of thin sections. Three monoliths and paired sets of bulk samples were collected from Stratigraphic Unit IV (see Section 4.4), one across the boundary of Stratigraphic Units III and IV, and two were collected from the top of Unit I to the contact with the paved floor. Additional undisturbed blocks were collected opportunistically from excavation units across the site to characterize architectural material including adobe bricks, construction mortar, and wall plaster.

3.2. Analytical methods and laboratory work

Loose, bulk samples were dried and ground to pass through a 2-mm sieve before other analyses were conducted. All bulk samples were analyzed using loss-on-ignition to estimate organic carbon and calcium carbonate content using standard methods. Organic carbon was estimated gravimetrically by combusting sediments in a Skuitt programmable electric kiln for 2 h at 360 °C (Storer and Sarquis, 2005). Carbonate content was estimated by re-burning the sediments at 900 °C for 2 h (Machette, 1986). Extractable phosphorus concentrations were estimated using molybdate colorimetry for the fraction of sediment smaller than 125 μm using a modified version of the Mehlich-II extraction originally described by Terry et al. (2000) and described in its modified form by Roos and Nolan (2012).

A total of 21 thin sections were made from sediments collected during the 2008 field season. Ten thin sections from stratigraphic contexts in Kiva 3 were used in this analysis. Thin sections were scanned on a flatbed scanner and observed using plane polarized light (PPL) and crossed polarized light (XPL) at magnifications from 7 × to 400 × using stereozoom and petrographic microscopes. Thin sections were described using standard terminology for constituent materials, porosity, fabric, and post-depositional alterations or “pedofeatures” (Courty et al., 1989; Stoops, 2003).

4. Results

4.1. Stratigraphic Unit I

Stratigraphic Unit I lies conformably on the flagstone floor of the kiva. A few, flat-lying sandstone slabs lay within these sediments less than 2 cm above the floor. In the field, Unit I was identified as a heterogeneous deposit with dark reddish brown (Munsell color designation of 5VR 5/4 dry, 5VR 3/4 moist) silty clays and clays, and pale light greenish gray clay loams (10Y 8/1 dry) with lenses of...
cobbles and dark gray-brown sandy clays (10YR 3/2). This deposit is characterized by very low organic carbon content, relatively high calcium carbonate content, and extremely low phosphorus concentrations (see Table 1). Despite the heterogeneity of constituent sediments, organic carbon and phosphorus concentrations varied little from 130 to 155 cm bd. Phosphorus concentrations were slightly higher in the 15 cm above the floor lying sediments, organic carbon and phosphorus concentrations varied little from 130 to 140 cm (>12%), but otherwise remained consistent with carbonate concentrations in Stratigraphic Unit III and IV (see Fig. 3 and Table 1).

The heterogeneous nature of Unit I sediments are readily apparent in thin section (Fig. 4). Floor contact sediments are heterogeneous mix of gravel sized (>10 mm) aggregates of sandy, calcareous clays. The clays in these aggregates vary in their color in (PPL and XPL) from pale yellow-brown to dusty orange-brown. The sands are quartz dominated multi-lithic sands with feldspars, micas, and micritic carbonate nodules common. Coarse (ca. 1–2 mm) rounded and subangular charcoal is present (but uncommon) within aggregates and between aggregates, where it can be found in association with relatively unweathered bundles of carbonate ashes (see Fig. 4, right-center), from which the slightly elevated phosphorus concentrations at the top (near the contact with Unit II) and bottom (floor contact) of Unit I probably derive. Pebble-sized, rounded aggregates of dark red, iron rich silt and mudstones occur commonly but not abundantly within 5 cm of the slab floor.

Above the floor lying sediments, Unit I materials are a heterogeneous mix of unaccommodated, subrounded clods of contrasting microfabrics. Dark red, iron-stained siltstone and mudstone aggregates are locally the most abundant constituent. These unaccommodated aggregates occur with complex packing voids in association with multi-lithic sands, calcareous clays and rarely with charcoal. Other aggregates include pale green-brown, iron-depleted clays, and red-orange, limpid sandy clays.

Unit I is capped by diffuse bundles of carbonates, sands, and charred plant tissues, including vascular plant stems and fragments of conifer wood charcoal. Bundles of speckled, etching micritic carbonates appear to be weathered ashes in association with the charcoal as well as with microfaunal excrements, suggestive of unburned plant tissues that are no longer preserved.

Unit I is continuous across the entire trench covering both the floor and the bench entirely. It is noteworthy that Unit I accumulated to approximately the height of the bench over the entire exposed floor but also covers the bench more or less evenly. Imbrications of gravel near the east wall of the kiva suggest that the point of origin may have been near the walls.

### 4.2. Stratigraphic Unit II

Stratigraphic Unit II consists primarily of large cobbles and shaped sandstone masonry intercalated with cobble-sized clods dark gray brown sandy clays (10YR 3/2 dry). It lies conformably, although irregularly on Unit I. The contact between the two units is sharp and often demarcated by horizontally oriented dark gray brown sandy clays capping with finely laminated white layers. These laminated white layers appear identical to wall “plaster” that is often found preserved adhering to a base coat of mortar on the facing of masonry or adobe walls. The plaster and clays, in turn, lie atop the calcareous charcoal and sands at the top of Unit I. No bulk chemical data is available for Unit II, but thin-section observations of Sample FMI-001 indicate that the dark gray sandy clays are nearly identical to the material used to make adobe bricks in Room 4 at the site (FMI-004).

There are at least eight layers of sandy, speckled micritic calcite that was identified as wall plaster layers in the field (adhered to fragments of construction adobe). The interior walls of kivas were repeatedly plastered (or “whitewashed”). These were occasionally decorated with painted murals in the Pueblo Southwest (Smith, 1952, 1972), but we encountered no evidence of the latter in this
kiva. Although the plaster is calcareous, it does not appear to have been produced by rehydrating quicklime (CaO). Rather, it appears to have been made by mixing water, wood ash, clay, and sands. The adobe, by contrast, is a well-mixed and well-sorted sandy clay with abundant fine sand-sized charcoal fragments. The clays are brown and speckled in PPL and orange-brown but weakly birefringent in XPL. The plaster adheres to adobe that underlies it, indicating that the wall plaster faces upwards rather than towards the paved floor. As we note later, this juxtaposition between plaster and adobe is the result of human agency rather than post-occupational structural collapse.

4.3. Stratigraphic Unit III

Stratigraphic Unit III is a laterally fining sedimentary unit lying conformably over Unit II, although the lower boundary of Unit III is diffuse. In the field, this was a 10–15 cm thick unit of brown sands (10YR 5/3 dry) with rare 2–5 cm diameter pieces of wood charcoal. The sands are well-sorted and show hints of preserved bedding. The deposits have relatively high organic carbon and carbonate content but are extremely rich in phosphorus (see Table 1). In thin section, Unit III sediments are well-sorted sub-angular to rounded sand grains, sand-sized aggregates of dusty clays or calcareous clays, and subangular to rounded charred plant tissues. Sand grains often have thin, continuous or discontinuous coats of calcareous clays or orange dusty clays. Aggregates and void coats of dusty, microsparitic calcite appear to be etching or dissolving. Fragments of graded beds and crusts are preserved in places. Subrounded, sand-sized bone fragments are present, but uncommon (Fig. 5E and F).

On the west side of the trench, a vertical discontinuity separates Unit III from a redeposited block of slumped material from Stratigraphic Unit IV (see Fig. 3). On the east end of the trench, the well-sorted sands grade to poorly sorted gravels and cobbles toward the kiva wall.
4.4. Stratigraphic Unit IV

Stratigraphic Unit IV overlies Unit III across the trench, except where both Unit IV and Unit III have been cut by a vertical disconformity, indicating that both Unit III and Unit IV were in place before the disconformity was created. Unit III was identified in the field as a moderately consolidated dark grayish brown (10YR 4.5/2 dry, 10YR 2/2 moist) pebbly mud with abundant sherds, very rare small bones and bone fragments, and common chipped stone artifacts. The cultural fill is dominated by ceramic types that date between the early- to late-1300s, and Pueblo IV period diagnostic types that post-date the 1370s were not encountered. Unit IV is thickest towards the center of the kiva depression (>70 cm) and thins towards the margins (ca. 35 cm). The boundary between Unit III and Unit IV is gradual and indistinct and defined primarily on the basis of increasing artifacts, darkening color and loss of bedding structures from the top of Unit III into the lower portion of Unit IV.

Organic carbon content is highest in the upper 10 cm of Unit IV with a gradual decline to 75 cmbd, where values stabilize at about 1.8% or near the mean value for the profile (see Table 1). Carbonate content also declines over this interval from 9% near the top of Unit IV to 7.2% at 75 cmbd (cm below datum), whereas phosphorus concentrations remain stable at approximately 60–65 mg/kg from 35 to 90 cmbd before a slight, stepwise decrease to concentrations approximately 50 mg/kg in the lowest 10 cm of Unit IV.

In thin section Unit IV is characterized by poorly sorted pebbly, sandy clay loams with abundant sherds, very rare small bones and bone fragments, and common chipped stone artifacts. The cultural fill is dominated by ceramic types that date between the early- to late-1300s, and Pueblo IV period diagnostic types that post-date the 1370s were not encountered. Unit IV is thickest towards the center of the kiva depression (>70 cm) and thins towards the margins (ca. 35 cm). The boundary between Unit III and Unit IV is gradual and indistinct and defined primarily on the basis of increasing artifacts, darkening color and loss of bedding structures from the top of Unit III into the lower portion of Unit IV.

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with abundant meso-scale vughs, chambers, and compound packing voids. Lower in Unit IV, porosity is dominated by compound packing voids.

4.5. Stratigraphic Unit Vа/Vb

A sharp vertical discontinuity through Stratigraphic Units III and IV terminates sub-horizontally at the top of Unit II in the western 50–60 cm of the trench. Unit Va is distinctive for its well-bedded, unconsolidated sands interbedded with blocks of material from Unit IV. Unit Va clearly post-dates the formation of Units III and IV but did not yield any modern material culture. Unit Vb lies conformably over a pebble-line at the top of Unit IV through most of the trench but unconformably over Unit Va, wherein it fills a depression identified as a “shovel-pit” in the field. The sediments of Unit Vb are very loose, brown (10YR 5/3 dry) sands with dark green-black plastic fragments. A “Mamba” candy wrapper that dates to the 1980s was encountered in the Unit Vb “shovel-pit” fill above the disconformity between Unit Va and Vb.

5. Discussion

During the initial excavation of the deposits from the Fourmile Ruin kiva, our field observations relied on common sense and long-standing assumptions about the formation of stratigraphic deposits to interpret the structure’s fill (Walker, 2002). Because this was a kiva, both archaeological and ethnographic analogues indicated that it there was a high probability that the lower fill was intentionally deposited as a form of closure behavior. However, our excavations failed to reveal clear evidence of the overt ritualized behaviors that have been noted in other kiva closure events, including roof burning or the deposit of sacred or inalienable objects. Although only a portion of the overall structure was exposed, we did not encounter any unusual objects or other depositional treatments that have been documented in other Pueblo IV period examples in the region (Adams and LaMotta, 2006; Walker, 1995; Walker et al., 2000). Additionally, we assumed that most if not all of the upper fill was post-occupational, naturally reworked material, or perhaps even deposited as a consequence of recent looting activities. In short, our field observations did not indicate that the closure of Kiva 3 was complexly ritualized.

The geoarchaeological evidence from the sediments themselves, however, suggests a much more complicated, prolonged history for the closure of Kiva 3 (Fig. 6). The sediments in Unit I included a variety of contrasting materials, including sandy alluvial soils (see also Roos, 2008 for micromorphological descriptions of young, alluvial soils in the area), ashes, sandstone slabs, and abundant iron-rich (and some iron-depleted) soft sedimentary rocks. These materials are probably local and originated in the Triassic Moenkopi formation that is the underlying bedrock through much of this reach of the Silver Creek drainage. Fourmile Ruin, however, sits atop a mid-Pleistocene gravel terrace, and the Moenkopi siltstones and mudstones must have been acquired off-site, transported to the terrace, and deposited up to 40 cm thick across the floor and covering the bench. The hints of imbrication near the walls of the kiva suggest that the roof had probably been dismantled before burial with Moenkopi mudstones, ashes, slabs, and alluvial soils began (Fig. 6B).

There is evidence of burning associated with the burial of the kiva in the form of the thin (1–2 cm thick), continuous lens of charred plant tissues and weathered ashes capping Unit I. However, the mixed plant assemblage (vascular plants and sand-sized angular wood fragments) do not indicate combustion of the roof, which was probably dismantled at this point. Rather, this burning event appears to have taken place in a thin layer of fuels that covered the initial burial deposits. A ready source for such fine material would have been the reeds or other vegetal materials that made up the fine construction materials of the roof that was removed before burial. Combustion of this layer was probably very low intensity (no in situ thermal alteration of Unit I sediments >500 °C was observed in thin section; F. Berna, personal communication) and some of the plant tissues may have been completely unburned before they were consumed by soil microfauna (Fig. 6C).

The deposits immediately above the charcoal layer are composed entirely of dismantled architectural debris. The nearly continuous lenses of upward facing wall plaster at the base of Unit II indicates that this unit probably formed by purposeful and rapid disassembly of portions of the exposed kiva walls and their deposition in a continuous layer above the burned material (Fig. 6D). The removed and deposited plaster, in turn, was buried by mixed wall construction material. That this purposeful destruction event happened rapidly is supported by the well-preserved, continuous lens of charcoal and ashes at the top of Unit I and the well-preserved nature of the wall plaster sheets in the middle of Unit II. It is unlikely that these fragile layers would have survived undisturbed by wind and water if it they had been left exposed for very long.

Exposure to wind and water action is precisely what appears to follow the destruction of the remaining architecture (Fig. 6E). The well-sorted sands (and sand-sized fine-aggregates and charcoal) probably formed by reworking of plaza surfaces by wind and the infrequently preserved graded beds and crusts indicate periodic reworking of these sediments by water. Sheet middens commonly accumulate in plaza spaces and the enriched organic carbon and phosphorus signals in Unit III probably originate from the parent material (sheet middens) that were reworked by natural processes. Unit III, therefore, represents a hiatus in the cultural activities associated with Kiva 3 and perhaps the surrounding plazas and room blocks. It is worth noting that some rooms surrounding Plaza 3 were dismantled at some time during the occupation of the village.

Cultural activity appears to have resumed with one final burial event. Unit IV is artifact rich but generally lacks the quantity or quality of animal remains characteristic of primary trash deposits at the margins of villages or those that accumulate in abandoned rooms (e.g., Mills, et al., 1999: 154–156). The very high phosphorus and organic carbon concentrations are indicative of midden deposits but the abundance of rounded, sand-sized bone fragments and the lack of internal bedding features are unusual. The former suggests that the refuse in Unit IV was physically weathered on the surface before it was deposited at Kiva 3, whereas the latter suggests that Unit IV probably formed very quickly from dumping homogenous materials. We interpret this as evidence that Kiva 3 was subject to a final episode of purposeful burial, this time with refuse that was redeposited from an extramural trash deposit or midden that had been well-trampled and weathered before deposition in the kiva (possibly a midden located at the northern edge of the village). The use of midden debris for ritual closure and burial is not unprecedented in the Southwest (e.g., Montgomery, 1993: 161), and the last event in the singularized life history of Kiva 3 appears to be one such instance of this type of depositional behavior (Fig. 6F).

The last episode of burial is particularly curious because the closure of the kiva (Unit I and II) appeared to be followed by an interval when the remnants of the kiva and its deposits were exposed to natural elements for some period of time. Without the use of this kiva, the ceremonial activities of the households around Plaza 3 may have moved to a surface room or may have ceased altogether. Another possibility is that the room blocks surrounding
Plaza 3 were no longer permanently occupied after this event. However, the last-phase burial of the kiva indicates that portions of Fourmile Ruin were still occupied. The ultimate burial of the kiva with significant amounts of re-worked midden deposits that probably originated from households living near Plaza 3 may have marked a final closure of this sacred space before the complete depopulation of the village.

After the deposition of Unit IV, a long interval passed wherein these sediments were exposed to pedogenic processes, including the formation of coarse channels, chambers, and vughs through biological activity and organic matter accumulation in the A horizon near the surface, and the dissolution, leaching, translocation, and precipitation of carbonates (probably from ashes within the midden materials). The strong down-profile trend in organic carbon and carbonates is indicative of pedogenic alteration and the microfabric changes support this interpretation as well (Fig. 6G). In more recent decades, or perhaps earlier in the twentieth century, the shallow surface depression attracted a looter who excavated a shovel pit that ended when dense wall debris was encountered (Fig. 6H). Enough time passed after the first episode of vandalism to allow the early shovel pit to fill in completely with naturally-deposited sediments, and the kiva was targeted again by looters during a period of intensive and sometimes mechanized looting of Fourmile Ruin in the late 1980s. Fortunately, this more recent disturbance was limited to the margins of the earlier shovel pit (Fig. 6I). Kiva 2 and several suites of rooms around Plaza 2 were systematically looted during this period.

6. Conclusion

The cessation of ceremonial room use at Ancestral Pueblo villages in the US Southwest often involved ritualized activities and the deposition of sacred objects or “ceremonial trash” (Walker, 1995). At times, however, it is impossible to infer the complexities of these archaeological deposits based on field observations alone. Our analysis of a plaza kiva at Fourmile Ruin demonstrates
the efficacy of geoarchaeological analyses for modeling the social processes that created these complex deposits. This kiva lacks overt features of ritual closure (burned roofing materials or sacred objects on the floor). Nonetheless, pedogenic, sedimentary, and chemical characteristics demonstrate that the structure was closed through a series of orchestrated ritual activities. The deposition of off-site mudstones and the intentional placement and covering of wall fragments (with intact layers of plaster) are particularly intriguing behaviors that to our knowledge have not been documented elsewhere. Perhaps most interesting, the evidence presented here indicates that this treatment likely occurred in numerous episodes that may well have stretched over several years (or decades). Both the deposits in Kiva 3 and evidence for the construction of nearby rooms (around Plaza 3) indicate that this portion of the village was depopulated sometime in mid- to late-fourteenth century. It is worth noting that this kiva, plaza, and surrounding room blocks were built during the last phase of village expansion, but were quite possibly the first to be abandoned. Rather than thinking of ritualized closures as discrete episodes, we echo the statements of Walker and others that such activities are frequently part of drawn-out sequences of ritual behaviors. We also concur with others who point out that abandonment does not mean an end to cultural use or visitation [Nelson and Schachner, 2002: 194; Zedeño, 1997: 94], and some of the depositional activities we detected may well have occurred after residential occupation of the entire village had ended. Although it is impossible to infer the exact reasons why Fourmile Ruin and the Silver Creek area was depopulated by Pueblo groups, modeling the closure of this kiva does provide insight into the ways that these demographic events occurred. Our case-study thus illuminates some of the social processes that encompassed broader depopulation events in the Southwest (see Nelson and Schachner, 2002).

In addition to the obtrusive evidence for burning or the burial of inalienable goods or rare biota, we suggest that understanding the origins of the sediments may play an important role in identifying the ritualized life histories of sacred places in the Ancestral Puebloan world and elsewhere. Our study joins those of other researchers who have renewed attention to the behavioral complexities of cultural beliefs about soils (Salisbury, 2012; Wells, 2006) and the complexity of stratigraphic layers in archaeological contexts (McAnany and Hodder, 2009; Sherwood and Kidder, 2011).

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