

On the Challenges and Benefits of Indoor Archaeology: 15 years at the Archeodome (Mitchell Prehistoric Indian Village, South Dakota)

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Abstract

Field archaeology is normally associated with outdoor excavation and exposure to natural environmental conditions. Archaeological excavations have adapted to a wide spectrum of these conditions, but the recent prominence of archaeological sites as tourist attractions and educational facilities has occasionally led to dramatically different environments for the archaeological excavation, recovery, interpretation, and preservation of evidence, including facilities that permit indoor excavation. This article explores 15 years of experience at the Mitchell Prehistoric Indian Village in South Dakota. An

“Archeodome” covering part of site represents an example of a non-traditional excavation and preservation environment that presents considerable benefits and challenges for archaeologists. This provides the basis for evaluating the nature of indoor excavation within its archaeological and educational context, and provides a cautionary note for archaeologists, heritage groups, tourist boards, and others interested in the preservation of archaeological sites. Though this article focuses on the Mitchell site, the information reported has broad implications for sites where structures cover archaeological deposits.

Keywords: Indoor archaeology, site preservation, conservation risks, modern taphonomic impacts, archaeological conservation, public archaeology.

1. Introduction

Field archaeology is a discipline that, by its very nature, occurs almost exclusively outdoors. The rigors of outdoor archaeological excavation are well-known and endured to varying degrees by all archaeologists who work in the field. At some sites, in attempts to control for the effect of natural processes, archaeology has been brought ‘indoors’ to a ‘controlled environment’ designed to provide for improved excavation methodologies and greater access for public tourism. These indoor environments intended for the excavation and/or preservation of archaeological sites have been scarcely investigated in terms of their effect on archaeological preservation, excavation, and recovery, and the interface between public and scientific interests.

At many archaeological and paleontological sites across the Northern Plains of the United States and around the world, structures have been placed over open excavations.

One of the earliest and most controversial enclosed excavations is the well-known Dickson Mounds site (a Mississippian burial complex in Illinois) (Harn 1980), where the excavation and public display of human burials inspired great public interest, but also considerable backlash in terms of the ethical concerns surrounding the exhumation and display of Native American burials. Among sites on the Plains, Vore (a Late Prehistoric and Early Historic Bison Jump in Wyoming) (Reher and Frison 1980; Walker 1975), Hudson-Meng (a Paleoindian bison kill in Nebraska) (Agenbroad 1978), the Hot Springs Mammoth Site (a paleontological mammoth death site in South Dakota) (Agenbroad and Mead 1994), Gault (an early Paleoindian quarry site in Texas) (Collins 2002), and Ashfall (a paleontological animal death site in Nebraska) (Voorhies 1981) are but a few. Elsewhere around the world, well-known archaeological sites such as Akrotiri (a Minoan settlement in Crete) (Doulas 1983), Çatalhöyük (a Neolithic site in southern Anatolia) (Hodder 2000; Mellaart 1967), Fishbourne Palace (a Roman palace in the United Kingdom) (Cunliffe 1998), the Mausoleum of the First Qin Emperor of China (i.e. the Terracotta Army; Zilin 1985; see Hu *et al.* 2009a, 2009b for treatments of conservation and preservation issues at the site), and many others are enclosed, to varying degrees, by structures intended to preserve the archaeological integrity of sites, and to promote public visitation. While some of these enclosed sites are intended specifically to preserve archaeological evidence, at other sites, excavation proceeds in indoor environments. Among these, Çatalhöyük is perhaps the best known and most thoroughly investigated (Hodder 2000; Mellaart 1967).

Another example of an enclosed, indoor excavation and research facility is found at the Mitchell Prehistoric Indian Village, in Mitchell, South Dakota. This site presents a case study on the nature of indoor excavation and the effect that facilities enclosing

archaeological sites have on the excavation, recovery, and interpretation of the archaeological past. The study of these environments has implications for the manner in which archaeologists understand and assess the nature of archaeological sites not only on the Northern Plains, but also around the world.

The benefits of indoor excavation are many, and are most likely self-apparent to most field archaeologists. The practical difficulties, challenges, risks, and disadvantages, however, are significant and sometimes unexpected, and require serious consideration. This article critically examines indoor excavation experiences at one facility in the interest of elucidating the benefits and challenges that are encountered when open-air environments are converted to indoor environments for the purposes of archaeological excavation, interpretation, preservation, and tourism.

2. The Mitchell Prehistoric Indian Village

The Mitchell Prehistoric Indian Village is an Initial Middle Missouri (IMM) earthen lodge village site located in the James valley of southeastern South Dakota (Figure 1) (Alex 1981; Karr *et al.* 2011; Meleen 1938). It is both on the National Register of Historic Places and a National Landmark that is open to the public. This site and others of its type were largely occupied between 1100 AD and 1200 AD, and represent the village establishments of hunting, gathering, and farming people that ranged from the Missouri River in central South Dakota to the Mill Creek sites of northwest Iowa (Alex 1981; Johnson 2007; Karr and Hannus 2013; Karr *et al.* 2011; Lehmer 1971; Tiffany 1982). Sites pertaining to the IMM tradition often produce evidence of extensive bison hunting, including many bone tools, and evidence of bone fat exploitation (Karr *et al.* 2010). Together with bison hunting, IMM

villagers procured smaller animals, engaged in extensive ceramic and lithic industries, and produced a range of artifacts made from bones, shells, and stones that survive in the archaeological record (Alex 1981; Anderson 1980; Jeffra and Karr 2013; Johnson 2007; Karr *et al.* 2011; Lehmer 1971; Tiffany 1982).

Though dating at the Mitchell site remains problematic, the site was apparently occupied for a period of less than 100 years, between 1050 AD and 1200 AD (Alex 1981; Johnson 2007; Karr and Hannus 2013). A recent radiocarbon date from the middle-to-late occupation of the site produced a date of 870 +/- 20 BP (ISGS-A1869). Using OxCal, this date corresponds to 1052 and 1220 cal AD (two sigma), with 86.3% confidence of dating to between 1152 and 1220 cal AD (Bronk Ramsey 2009). This fits within the generally accepted date range for other IMM sites in the region (Alex 1981; Johnson 2007; Lehmer 1971; Tiffany 2007).

A ditch and palisade system encloses the Mitchell site on its western and southern sides, while the Firesteel Creek valley protected the site on its northern and eastern sides (Karr *et al.* 2011; Meleen 1938; Over 1930). The ditch and palisade may have been expanded near the end of the occupation of the village. Village occupation likely began near the middle of the site, where the deepest deposits are preserved today, and may have been previously enclosed by a smaller ditch and palisade system (Figure 2). The inner ditch may have been filled and abandoned when the outer ditch and palisade were created, allowing for outward village expansion, where preserved cultural deposits are much thinner. Double ditch features at other IMM sites have been recorded (Lehmer 1971), but the Mitchell ditch and palisade features remain poorly understood in spite of repeated investigations (Alex 1981; Meleen 1938; Over 1930).

As successive earthen lodges were built and destroyed at the site, and as waste and fill materials were dispersed across the site area, vertical accumulation resulted in deep deposits in the central portion of the village. An 'Archeodome' has covered one central, deep accumulation of material remains at the Mitchell site since 1999 (see Figure 3). Excavations of columns to support the building revealed deposits reaching depths of slightly more than 3 m in places. The excavations of these columns revealed evidence of superimposed earthen lodges, and dense concentrations of material culture, both of which contribute substantially to the depth of the deposits across the Mitchell site. Basing interpretations of site deposits on two assumptions, the rate of midden deposition across the site must have exceeded 1.7 cm per year. This is predicated first on the assumption that the site was occupied for less than 100 years as has been suggested for all villages in the Middle Missouri region (Lensink 2005; Toom 1992), and second on the assumption that at least some of the earliest features at the site penetrate below the original ground surface by a depth of at least 1.3 m, approximately the depth of some of the deepest cache pits. As such, at least 1.7 m of the Mitchell deposits are likely to have been the result of midden accumulation over time. The location of the Archeodome was selected based on the presence of these densely concentrated and deep artifactual deposits that are suitable for the intensive, long-term excavation of a portion of the village.

The Archeodome was designed to provide a controlled, indoor excavation and laboratory space for the excavation, processing, and storage of archaeological remains, and to allow for year-round visitation by tourists. While occasional excavations since the (re)discovery of the site in 1910 have revealed numerous earthen lodges across the site (Alex 1973, 1981; Meleen 1938; Schell 1942), little effort has been focused on the

excavation of other site areas. Specifically, much of the excavation space within the Archeodome is intended to allow for the investigation of the areas between (rather than within) earthen lodges.

The Archeodome covers only a small portion of the Mitchell site, but provides approximately 268 m² of excavation floor space, sufficient to support occasional excavations decades into the future. With the construction of the Archeodome, and the shift from 'outdoor' to 'indoor' archaeology, a series of benefits and challenges have been realized. These considerations are important for understanding the relationship between the science and practice of archaeology, the integration of public tourism at archaeological sites, and the effect of artificially closed environments at normally open-air sites.

3. Benefits

While indoor archaeology provides considerable benefits and poses significant challenges, the advantages of indoor archaeology are perhaps easier to envision than the challenges. An indoor environment provides for open excavations on a year-round basis, an opportunity that is otherwise impossible given the climatic conditions of the Northern Plains, including cold, snowy, and icy winters, occasional torrential rain, sleet, and hail, strong winds, tornadoes, and blistering sun. Extending the potential field season provides more options in terms of excavation schedules, but perhaps more importantly limits damage to artifacts and features that results from seasonal weather related issues such as flooded excavation units, and the need to backfill excavations for the winter. The process of backfilling and re-excavating in situ artifacts and features inevitably leads to the destruction of some archaeological evidence. The indoor environment theoretically

provides for a more controlled excavation immune from many of the effects of the natural world and from the effects backfilling.

Indoor excavation facilities also provide comfortable environments for both archaeologists and tourists, including amenities like running water, flushing toilets, electricity, air conditioning, and facilities that allow for visitation by the elderly, disabled, and children. On-site and in-facility museum displays allow for the presentation of artifactual and interpretive information within view of the areas from which they were excavated, allowing tourists to better appreciate the nature of archaeological excavation, the context of archaeological materials, the types of evidence preserved in the archaeological record, and laboratory processing of artifacts.

Another benefit afforded by the Archeodome is the ability to maintain long-term open-area excavations that allow for the slow, deliberative excavation of a large area over the course of many years. Early research at IMM sites focused almost solely on house excavations and the definition of a chronological sequence for different phases across the region (Alex 1973, 1981; Anderson 1980; Brown 1974; Lehmer 1954, 1971; Meleen 1938; and others). Continued research in the region has allowed for the more careful investigation of site functionality. The Archeodome has permitted long-term excavations of an area between earthen lodges, and has revealed a structured patterning of archaeological features across the Archeodome excavation area, including a series of intercutting cache pits, clay-lined cooking features, and other activity areas that reveal evidence of recurrent use (Karr *et al.* 2011). This evidence demonstrates the importance of outdoor areas to IMM lifeways, suggests that certain areas were repeatedly reused for similar purposes, and

clearly establishes the value of open-area excavations as a tool for providing detailed information concerning the nature of complex archaeological deposits (Karr *et al.* 2011).

Perhaps even more importantly, given the nature of recent theoretical debates in the broader archaeological community, facilities like the Archeodome provide improved opportunities for “interpretation at the trowel’s edge,” a premise forwarded by some post-processual (or interpretive) archaeologists (Hodder 1985; Shanks and Tilley 1987a, 1987b). Theoretical debates aside, the opportunity to witness the excavation of archaeological remains, process those remains on-site, and interpret them within view of the excavation floor in a controlled environment provides archaeologists with improved opportunities for interpretive success (Figure 4). Artifacts are processed shortly after their recovery from archaeological deposits, allowing for a feedback system between excavation and laboratory staff. Responsibilities for excavation and artifact processing are shared, so that those individuals who excavate archaeological deposits also have the opportunity to process the materials recovered from those deposits and begin to interpret their meaning. This improves both the nature of the interpretation of material remains, as well as the quality of ongoing excavation. Maintaining high quality excavation standards is important at sites like Mitchell as at many archaeological sites, where site deposits represent a deep palimpsest of human activity.

The Mitchell site more closely resembles the deep-midden IMM Mill Creek sites of northwest Iowa (e.g. Orr 1942) than it does the short-term occupations of sites along the Missouri River trench (e.g. Brown 1974; Lehmer 1954, 1971). The lowest levels of the Mitchell site are cut into natural soil deposits (probably the Big Bend paleosol; see Toom 1992:363-364), but continued human activity over the course of decades of human

occupation resulted in complex deposits across the site. The upper levels of the Mitchell site are entirely the result of human activities, and natural, sterile soils are never encountered in the course of routine excavation of those levels. Unlike many other sites where prehistoric activities are manifest in or on natural soil deposits, the matrix of the Mitchell site is represented by frequently intercut events of human activity that have accumulated vertically over time. The ability to interpret complex archaeological contexts, features, and stratigraphic levels as they are excavated allows for higher quality excavation based upon the rapid interpretation of site deposits as they are revealed.

While rapid artifact processing and controlled excavations are basic components of any high-quality archaeological excavation, an enclosed facility provides constant access to laboratory tools and materials, and allows for the integration of excavation and laboratory facilities in a way that is difficult to accomplish at outdoor excavations. The presence of an enclosed laboratory facility improves the quality of on-site analysis by allowing artifacts to be carefully cleaned, sorted, analyzed, and interpreted in high-quality laboratory conditions. As compared with traditional excavation environments, we would argue the Archeodome facilitates more effective efforts at cleaning, artifact sorting, refitting, and analysis that allows for improved interpretation of artifacts, features, and site function.

In many ways, the presence of the Archeodome improves the practice of archaeology at the Mitchell site. Archaeological excavation is always a destructive process, however, the elimination of backfilling preserves more intact features and reduces the risk of re-excavation damage to the site. It provides an improved environment for archaeological tourism, allowing broad access to the public, and facilitating educational opportunities. The open-area excavations that continue within the Archeodome are

atypical of excavations in North America, in part as a product of methodological approach, but also as a result of the difficulties inherent in preserving large, open-area excavations. The Archeodome facilitates long-term, open-area excavations that can remain open from year to year, improving the practice of archaeology at the site. Finally, the ability to process, analyze, and interpret artifacts on-site, in high-quality laboratory facilities allows for an effective feedback system between excavation and laboratory staff, improving the interpretive abilities of archaeologists, and resulting in improved understanding of the nature and function of artifacts, features, and the site as a whole. The Archeodome is a useful tool for understanding the archaeology of the Mitchell site, and allowing for the intensive excavation of one among many sites of its type on the Northern Plains. Notwithstanding, the Archeodome also presents many challenges and risks for the preservation and interpretation of the site.

4. Challenges and Risks

In spite of the many advantages of indoor excavation, the indoor environment also presents some significant and unexpected challenges. Among these, isolation from the natural 'outdoor' environment plays a critical role.

Soil Desiccation

Within the Archeodome, significant desiccation cracking has occurred over the course of the last 15 years, and worsens with the passage of time. Figure 5 depicts an unexcavated portion of the Archeodome floor that exhibits a complex network of desiccation cracks. This desiccation cracking is apparent both at the surface level and

within deep excavation units. Some of these cracks exhibit a measured depth exceeding 1 m, and a width of more than 4 cm. This cracking is the result of extremely dry deposits within the Archeodome, where the climate-controlled indoor environment effectively eliminates the effect of annual rainfall, snowfall, and humidity patterns. The air conditioning system within the Archeodome acts as a further factor that dehumidifies the indoor environment. At other enclosed sites, similar problems have occurred. At the Hot Springs Mammoth Site, desiccation cracking occurred after the building that encloses the site was constructed, but slowed when a humidifying system was installed in the building (Agenbroad pers. comm.). In one extreme case at the Mammoth Site, desiccation cracks in the soils surrounding mammoth remains resulted in the fracture of a mammoth cranium (Agenbroad pers. comm.).

At the Hudson-Meng bison kill site, significant soil desiccation resultant from the indoor environment has also caused problems with the excavation and preservation of the site, including desiccation cracks across the enclosed portion of the site, and extremely dried and hardened soils (Figure 6). Hudson-Meng, however, differs from other sites in the sense that desiccation cracking affects only the fill soils that cover the early Holocene strata at the site. As a result, water that infiltrates from leaks in the roof penetrates desiccation cracks in the fill soils, and the intact Early Holocene soils below serve as an aquaclude, spreading water across the top of the cultural level of the site (Mark Muñoz pers. comm.). This is especially problematic because the extent and degree of water damage is nearly impossible to ascertain because it is hidden beneath recent fill that covers parts of the site. The action of desiccation and water infiltration pose further problems when scientific approaches to understanding the past are employed. At Hudson-Meng, differences in bone

collagen preservation have been noted between indoor and outdoor areas of the site (Mark Muñiz pers. comm.), a phenomenon that may result either from extreme drying, from the action of infiltrating water, or both. Though controlled environments might be expected to slow the degradation of archaeological bones, the compound effects of isolation from natural moisture, the infiltration of unanticipated rainwater, and modern heating and cooling systems appear to be detrimental to the preservation of bone collagen content.

At the Mitchell site, extreme desiccation cracking allows for the vertical displacement of artifacts that have otherwise remained relatively undisturbed for more than 800 years. Desiccation cracks often become filled with loose silt derived from nearby excavations, and are generally easily distinguished from undisturbed deposits, however, the extent of this cracking across the enclosed areas of the site and the presence of artifactual remains within the loosely silted matrix that fills the cracks suggests that at least some vertical displacement of artifacts occurs. Prior to the construction of the Archeodome, desiccation cracking does not appear to have posed a problem at the Mitchell site. Photographs from excavations in the 1930s (Meleen 1938) and 1970s (Alex 1981) reveal clean excavation areas with no indication of desiccation cracks.

Desiccation cracking often follows the edges of features, resulting in difficulties in the excavation and interpretation of those features. Often, soil compaction differences that result from prehistoric activities such as the excavation of cache pits provide a natural course for desiccation cracks to follow. The formation of cracks at the interface between different soil types often removes the visual boundaries that archaeologists utilize when excavating such features. On other occasions, desiccation cracks run parallel to feature boundaries, resulting in confusion over the true boundary of features. Figure 7 provides an

example of one such feature, where a large desiccation crack mimics the edge of a large cache pit.

Further, indoor conditions absent of normal rainfall, snowfall, and humidity cycles have resulted in a dried and severely hardened soil matrix. Outdoor, unenclosed areas of the site exhibit soft loam soils that are easily excavated with a trowel. The dried and hardened soils within the Archeodome frequently require extraordinary strength to excavate, a process that can easily result in damage to artifactual remains. 'New' breaks on bones preserved at the site (that is to say, breaks that result from excavation rather than from the action of natural taphonomic processes) are commonly encountered and are frequently associated with extremely hardened soils. Figure 8 depicts an in situ bison rib that suffered such damage. While these types of damage do little to affect the archaeological interpretation of sites like Mitchell, where preserved bones and bone fragments number in the millions, such damage would certainly be considered problematic at many other sites. Further, the dried and hardened soils within the Archeodome have occasionally required the use of heavier tools, such as a mattock or a pick (Figure 9). While careful excavation with such tools can be conducted with some success, normal excavation with a trowel produces finer-grained results with less likelihood of damaging artifacts and features, and greater promise of successfully interpreting site deposits.

A combination of desiccation and hardened soils also results in occasional damage to walls and features. Dried and hardened soils of excavation unit walls and unexcavated areas around excavated features occasionally crumble, resulting in damage to features. Figure 10 shows the upper rim of a cache pit that is partially collapsed.

As a result of the extremely dry soils within the Archeodome, excavation produces large amounts of dust that result in a variety of problems. First, extremely dusty excavation areas result in difficulty in recognizing and interpreting archaeological features and changes in soil color and texture. Any excavation, whether by trowel, shovel, or mattock, and even activities as mundane as walking across the site, produces large amounts of airborne dust. A very dusty environment makes excavation less pleasant, complicates the excavation and interpretation of features, and as dust settles out of the air, it covers glass display exhibits in thick coatings of fine dust. While regular dusting represents little more than an issue of building and site maintenance, the large quantities of dust produced across the site complicate both efforts at archaeological excavation, preservation, and interpretation, but also affect the experience of visitors to the site. Excavation areas on the site become so dusty at times that a vacuum cleaner must be used in order to reduce the dusty overburden that covers excavated areas, and excavators occasionally use dust masks during activities such as brushing in preparation for site photographs.

Water Infiltration and Mold

Paradoxically, though desiccation poses significant challenges, another series of challenges arises from the occasional infiltration of water to the Archeodome environment. Because indoor excavation facilities necessarily include excavation areas in lieu of a traditional floor, the infiltration of surface water (rainwater runoff, primarily) is a constant threat to the integrity of excavation areas. In some instances, damp patches resultant from rainwater infiltration have resulted in the growth of a variety of molds. Water infiltrates both from leaks in the roof and seepage under the walls of the building, and the potential

exists for groundwater to penetrate some of the deeper excavation units, especially as excavations penetrate deeper into the site. Though excavators occasionally remove these moldy patches, the persistent infiltration of water into excavation areas presents an ongoing problem with no simple solution. Extremely wet soils can result in collapsed walls of excavation units, and often inhibit the further excavation of the site. Damp and moldy soils jeopardize the integrity of artifacts and features preserved within those soils. Figure 11 depicts one episode of mold growth in an area sodden by the infiltration of rainwater. Mold is a recurring problem at many indoor facilities, where enclosed structures allow the penetration of sunlight and effectively act as greenhouses that encourage mold growth.

Further, leaks through the roof of the Archeodome structure and from the pipes supplying the fire control system result in occasional drip points within excavation areas. While these can be easily controlled when they are located and recognized, they are occasionally intermittent and evade detection for periods of time long enough to significantly affect archaeological features. On one occasion, a drip point within a large cache pit soaked the fill of that feature to such a degree that large amount of fractured and fragmented bone material found within the feature was made extremely friable.

Other Challenges and Risks

Though each of these issues may be individually problematic, the combination of these issues is compounded by the nature of the Mitchell site as an archaeological attraction that is open to public visitation. Though care must always be taken to present archaeology as a scientific endeavor worthy of both public interest and serious academic pursuit, one of the challenges of indoor, open-to-the-public archaeological excavation is

achieving a balance between the pursuit of scientific understanding and the provision of experiences of educational value for the general public.

The creation of facilities suitable for tourism—with amenities like air conditioning, running water, and indoor restrooms—requires routes of access for electrical cables, water pipes, and sewage lines. While these systems are routinely installed in most localities, their normal, underground installation at the Mitchell site (and other archaeological sites) is precluded by the presence of unexcavated archaeological deposits. To circumvent this issue, these pipes and cables were installed within an artificially constructed berm, raised above the level of the site by 1-2 m. In Figure 3, this berm as well as some of the surrounding site landscape is visible, and in Figure 2 the berm is clearly visible as a modern landscape feature. Though the berm was constructed on top of a landscape fabric that theoretically allows for the removal of the berm at some point in the future, the critical role that the berm plays in supplying essential services to the Archeodome effectively precludes its removal. The addition of the berm affects the appearance of the site, covering parts that are otherwise relatively undisturbed. Though many IMM village sites are located in cultivated fields, where they are subject to considerable alteration through forces such as plowing and erosion (e.g. the Kimball site, Henning *et al.* 1963; Orr 1942), the Mitchell site has never been plowed, and retains some surface features. The remarkably well-preserved nature of the Mitchell site elevates the importance of preserving the surface landscape at the Mitchell site.

The complex issues presented by the creation and maintenance of the indoor excavation environment described above are largely inevitable issues created by the desire to present an archaeological site as a tourist attraction. Without the Archeodome, visitation

to the Mitchell site would likely be greatly reduced. Without tourist traffic, the Mitchell site would be little different from the scores of Middle Missouri sites found in central and eastern South Dakota, and northwest Iowa. The challenge, then, between maintaining controlled, scientific, archaeological excavation of the site, while provisioning a high quality experience for members of the public interested in better understanding the archaeological past.

Public interest in witnessing ongoing excavation often conflicts with the ability of archaeologists to process, analyze, and interpret the evidence recovered from the site. Enclosed excavation areas create the expectation among the public that the archaeological excavation and recovery of evidence are ongoing, constant processes, while archaeologists realize that the time and effort required to clean, sort, analyze, and interpret archaeological evidence far exceeds that required to excavate it. Unbroken excavation schedules threaten scientific legitimacy if recovered evidence cannot be adequately processed, analyzed, and interpreted.

Establishing footings for a structure of any type further complicates issues of artifact processing, analysis, and interpretation. The Archeodome sits on 18 columns that are 1.37 m in diameter. In order to establish these columns, their locations were excavated to sterile levels below the cultural horizons of the site. In some cases, these excavations exceeded 3 m in depth. The excavation of these columns (before the Archeodome was built) produced many thousands (even millions) of artifacts. While large amounts of archaeological evidence allow for large-scale studies, the degree to which any site can be responsibly excavated and studied must be balanced against the interest of preserving site integrity. At sites with lower artifacts density the establishment of subsurface footings would prove less

problematic, but at any site, such undertakings of excavation, processing, analysis, and interpretation require considerable effort.

A final issue that requires discussion is the cost of maintaining archaeological sites, open excavations, laboratory facilities, and on-site museum displays. Outdoor archaeological sites require relatively low levels of site maintenance, especially once backfilled, but sites like Mitchell require substantial investments in time, effort, and money. Maintenance tasks require ongoing efforts by archaeologists and support staff to preserve archaeological deposits, museum displays, and the site landscape in conditions suitable for public viewing. These include cleaning excavation units, dealing with problems introduced by water infiltration, and others. Further, the excavation of large, open areas produces a large quantity of artifacts that require laboratory processing and interpretation. These activities and others all require large investments of time and effort on the part of archaeologists, but introduce dramatically increased site maintenance costs.

The benefits and challenges presented by indoor excavation environments require complex and multifaceted considerations that incorporate the interests of the scientific community and the public, and take into account the effects of a variety of natural and cultural processes on the preservation of archaeological remains. These complex considerations must be carefully balanced against each other in order to create environments suitable for both the practice of archaeology and public visitation. At other sites, this has proven especially problematic. The most extreme and tragic example of the problems caused by an indoor, open-to-the-public archaeological excavation is the 2005 collapse of a roof structure and the resultant death of a visitor at Akrotiri (Sinha 2012). While this is a particularly extreme example, other issues caused by enclosed environments

threaten the archaeological integrity of sites, and complicate efforts to carefully and accurately excavate, interpret, and preserve sites. At Emperor Qin's Mausoleum in China, airborne particles derived from large-scale tourism settle in excavated areas and cause preservation and maintenance issues, while exposure to atmospheric environments after more than two millennia in a waterlogged environment causes the deterioration of brick and terracotta materials (Hu *et al.* 2009a, 2009b). At other sites across the Northern Plains, similar problems to those detailed in this article have been experienced. A clear understanding of the potential benefits and challenges associated with the construction, maintenance, and operation of indoor archaeological excavation and preservation facilities is critical to those interested in the protection of the archaeological past, as well as to those interested in the public presentation of the past.

5. Recommendations

The critical assessment of indoor excavations environments and the case study presented in this article necessitate the inclusion of some recommendations for others interested in the preservations of archaeological sites through the creation of similar facilities. The case study reported in this article provides one example, among a growing number, of an open-air site that has been enclosed for the purposes of archaeological excavation and preservation, and improved access for tourism. While problems are encountered on archaeological excavations of all types, it is our hope that the experiences and processes observed in this article highlight some of the difficulties encountered when sites are radically altered to allow for 'controlled, indoor' excavations, and that the

recommendations provided here serve in the best interest of both the public and the scientific community:

- 1) Environmental considerations. The construction of other enclosed structures at archaeological (and paleontological) sites—whether those structures are intended to allow for public visitation or not—should be preceded by careful studies that consider the effects of artificial environments on archaeological artifacts, soils, and features, and modifications to site landscape features that are required by the construction of modern facilities.
 - a. Desiccation. At the Mitchell site, desiccation has posed a serious problem since the Archeodome has been built, and worsens with the passage of time. Similar issues have been observed at other sites across the Northern Plains, including the Hot Springs Mammoth Site and the Hudson-Meng Bison Kill. At the mammoth site, Larry Agenbroad (pers. comm.) reports that desiccation cracking slowed when a humidifying system was installed at the site. To prevent desiccation, conditions within enclosed structures may need to be supported by humidifying systems, dependent upon the local climate and soil conditions.
 - b. Water infiltration. Studies of groundwater levels and water infiltration should be undertaken in order to insure the integrity of archaeological sites once they are enclosed. At the Archeodome, these issues preclude the excavation of parts of the Mitchell site, and as excavations continue, issues presented by groundwater and rainwater are likely to worsen.

Architectural solutions to such problems may be possible, at least in cases where surface runoff may penetrate excavation areas.

- c. Dust. Dust that results from the excavation of indoor environments also posed significant problems. High-quality heating, cooling, and humidifying systems play a significant role in the ability to control dust once it is produced, however, specific dust removal systems may provide the only permanent and effective solution to the issue of dust in indoor environments. If humidifying systems are used, it is likely that dust would represent a less problematic issue.
- d. Landscape features. Approaches to construction that minimally affect site landscape features should be employed to allow for the preservation of ancient features preserved across site landscapes.

2) Artifact processing, analysis, interpretation, reporting, and storage. Long-term plans should be in place that allow for recovered artifactual remains to be processed, analyzed, interpreted, reported, and eventually stored. In the absence of a mechanism for insuring that these tasks are consistently undertaken, backlogs of unprocessed materials threaten to jeopardize the scientific legitimacy of archaeological excavation and recovery. Ideally, a college or university could provide the trained archaeologists and students necessary to conduct excavations, process evidence, and produce high-quality academic research, however, none of this is likely possible without substantial economic support. While artifact processing is a basic component of a field excavation, it becomes especially pressing at sites that are open to the public, where pressure

for excavation must be delicately balanced with the capacity of archaeologists to adequately process, analyze, and interpret artifactual evidence.

- 3) Economic considerations. Enclosed structures that allow for indoor excavations entail considerable economic costs. Some of these costs are those associated with normal museum activities and tourist attractions—staff costs, utilities, and basic maintenance, for example. Maintaining indoor excavations and the facilities that surround them, however, introduce many additional costs. Among these are the costs of purchasing and maintaining systems that provide an environment conducive to the preservation of archaeological remains, the costs associated with maintaining an archaeological site as a public display, and the costs associated with processing those archaeological remains once they are uncovered. Ideally, indoor excavations and excavation facilities could be supported through ongoing collaboration with local citizens, a site endowment, or significant grant activity. The costs associated with these types of excavations and facilities are unlikely to be covered by admission fees to sites. Instead, significant outside support is needed in order to allow for both scientific responsibility and public access to educational experiences.

At the Mitchell site, annual month-long excavations continue, and the site remains open to the public during South Dakota's traditional tourist season, typically from April through October. The methods and techniques used to effectively excavate the Mitchell site have been adapted considerably as a result of the changes to the excavation environment brought about by the Archeodome. Certainly, excavations have proceeded at a very slow pace because of the extremely dry and hardened soils; however, this slow pace of

excavation has served as a valuable educational opportunity for students, and has also allowed for the exceptionally detailed and careful recording of a variety of features that may have otherwise been overlooked in the course of faster-paced excavations.

The problems that have been encountered within the Archeodome are considerable, and the purpose of this article is to call attention to some of those issues. These issues, however, are not so severe that undermine the value of the Archeodome as a tool for preserving the Mitchell site. Moldy patches and desiccation cracks, though problematic, do not threaten the general integrity of the site. Instead, they complicate efforts at excavation and interpretation of the site. General maintenance issues at the site require the cooperation of archaeologists with site staff, the local site board, and local donors. While occasionally challenging, these cooperative efforts are critical components at any archaeological site that is open to the public, funded by tourism and donations.

In these ways, and others discussed above, Archeodomes are imperfect solutions to the problems of archaeology. We do not wish to suggest that Archeodomes be constructed at every archaeological site of significance, nor do we wish to suggest that similar structures be eschewed at all archaeological sites. Instead, it is our goal to highlight both some of the benefits as well as the challenges that are presented by the use of facilities that enclose archaeological sites, and to encourage others who are interested in the preservation of archaeological heritage to carefully balance these complex considerations when determining the best methods and techniques for preserving archaeological sites, allowing for continues excavation, and presenting the archaeological past to the public.

In recent years, the analysis and interpretation of the artifacts and features from within the Archeodome has produced fruitful results (Jeffra and Karr 2013; Karr et al. 2008,

2010, 2011; Karr and Hannus 2013), and continued efforts promise to produce further advances. The body of artifactual material being accumulated at the Mitchell site represents a significant opportunity for students and scholars interested in the rich archaeology of the Northern Plains, and holds the potential to reshape previous interpretations of the Middle Missouri period.

6. Conclusions

Indoor excavation environments represent a relatively new phenomenon in the archaeological community, and one that has arisen concurrent with a growth in archaeological tourism. The advantages and challenges presented by such environments merit critical consideration with regard to their effect on the preservation, excavation, and interpretation of archaeological remains. The ways in which indoor excavation environments will aid in the excavation, interpretation, preservation, and public presentation of archaeological (and paleontological) sites should be weighed against the potential challenges.

Indoor excavation environments certainly provide some benefits, both in terms of archaeological excavation and interpretation, and in terms of public education and visitation. The climatic vagaries of the Northern Plains can, to a limited degree, be circumvented through excavation within an enclosed structure, helping to prevent damage to artifacts and features through the process of repeated backfilling and re-excavation. This enclosed, protected environment has also allowed for open-area excavations across an area exceeding 100 m sq., revealing structured deposits in an otherwise rarely investigated area between earthen lodges, a type of excavation that has been scarcely attempted at other

IMM sites. The presence of an open archaeological excavation within view of interpretive displays and exhibits provides a high-quality and memorable experience for visitors to the site, and aids in the explanation of the archaeological evidence recovered from the site. Further, the presence of a laboratory facility adjacent to and within view of the excavation floor provides the opportunity to conduct archaeological interpretation 'at the trowel's edge,' and permits a feedback system between excavation and laboratory staff that improves the quality of excavation and interpretation at the site.

Though it is easy to imagine that indoor archaeology provides both ease and simplicity in high-quality excavation, and a high-quality tourist experience, the challenges that indoor archaeology presents may be surprising to many. While the range of difficulties is vast, some of the most problematic from an archaeological perspective include the desiccation of environments protected from natural climatic moisture, and the infiltration of unanticipated moisture. Further, the constraints of modern construction require accommodations to be made that affect the preservation and appearance of sites. Each of these issues causes myriad problems that influence both the nature of the archaeological record, and the manner in which it must be excavated and interpreted. Even in the face of the significant problems highlighted in this article, successful research continues to be conducted at enclosed sites around the world (Agenbroad and Mead 1994; Jeffra and Karr 2013; Karr *et al.* 2010, 2011; Knappett and Nikolakopoulou 2008; and others). Achieving a balance between maintaining superior scientific excavations and a superior experience for tourists rests on the ability to successfully protect, recover, and interpret archaeological evidence while providing a comfortable, educational environment for tourism.

The difficult, complex, and sometimes unanticipated situations posed by the new environment within the Archeodome at the Mitchell site should serve as a cautionary note for archaeologists and others interested in the preservation of archaeological remains within enclosed structures. While structures like the Archeodome provide considerable pluses for archaeological excavation, interpretation, and tourism, the minuses posed by the altered environment within facilities of this type require careful consideration that weighs the benefits against the challenges when determining if and how such structures might be replicated. While every archaeological site is different, and may experience myriad conditions requiring unique responses, 15 years of experience in the Archeodome at the Mitchell site provides the basis for understanding the effect of indoor excavation areas on archaeological preservation, excavation, and interpretation.

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Figure 1 Map indicating the location of the Mitchell site relative to other similar sites on the Northern Plains.

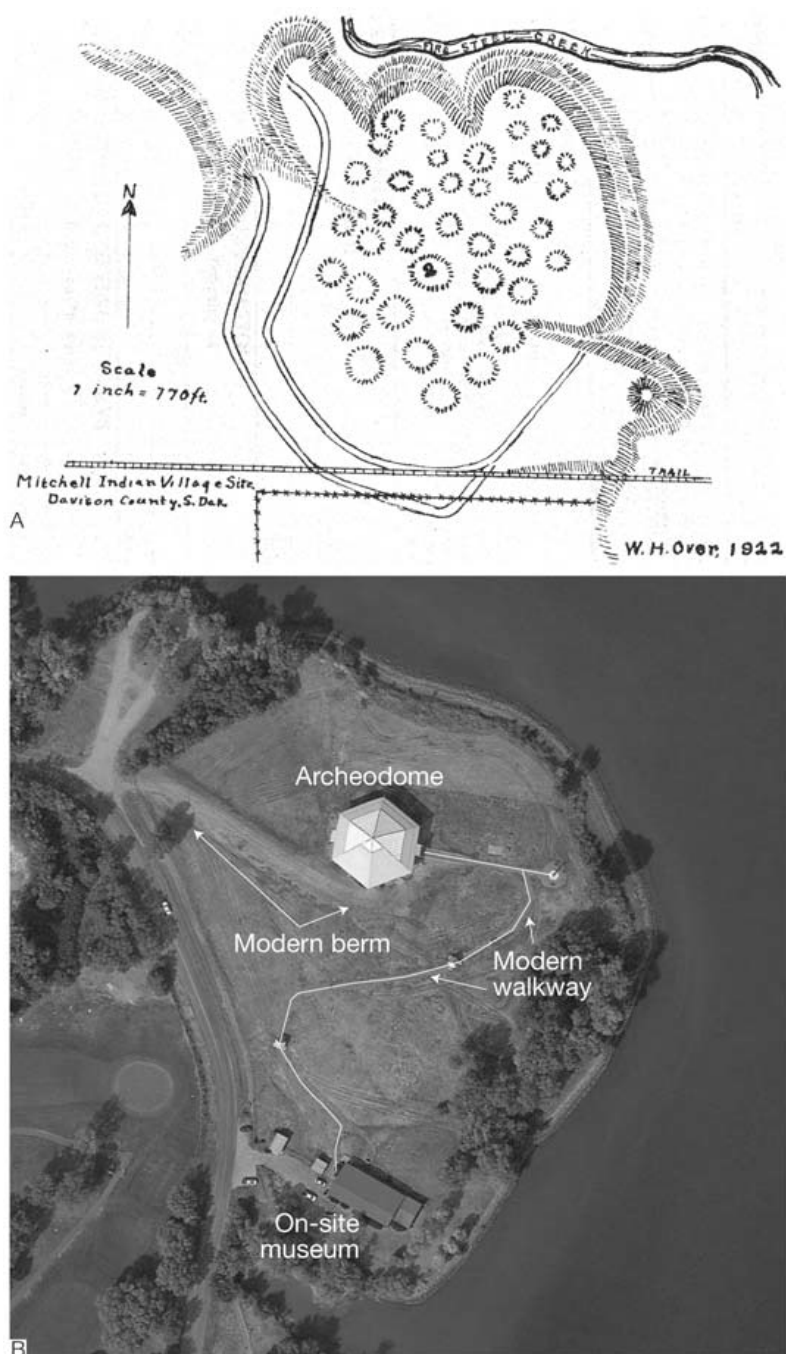


Figure 2 An archive map and a modern photographic overview of the Mitchell site. Over's 1922 map shows the location of two ditch feature at the edge of the site, as well as a variety of visible surface features. The modern photographic overview depicts many modern features that affect the site landscape.



Figure 3 The “Archeodome” at the Mitchell site. The berm in the foreground allows the conveyance of water, sewage, and electrical lines to the Archeodome structure (discussed later in this article). The student in the photo is 1.66 m tall.



Figure 4 Artifact processing laboratory as seen from above the excavation floor. Artifact processing and archaeological interpretation and analysis take place within sight of ongoing excavation.



Figure 5 A complex network of desiccation cracks on an unexcavated portion of the Archeodome floor. The chaining pin is 35 cm long.



Figure 6 Desiccation cracking of fill soils inside the structure at the Hudson Meng bison kill, Sioux County, Nebraska. Note that desiccation cracking affects the recent fill soils that cover early deposits, but do not affect the early Holocene bone-bearing level.



Figure 7 A desiccation crack that follows the edge of a cache pit feature at the Mitchell site.

North arrow scale is in cm.



Figure 8 One example of a bone fragment that exhibits a “new” fracture surface, (or a fracture that has formed as a result of excavation rather than cultural or taphonomic processes). The clean, white fracture surface suggests that the bone was fractured shortly before it was liberated from its depositional environment, in part as a result of the severely dried and hardened soil at the site, or repeated episodes of wetting and drying.



Figure 9 A mattock in use at the Mitchell site. While outdoor soils are relatively soft and easily excavated, some indoor soil matrices are so severely dried and hardened that their effective excavation with a trowel is made nearly impossible.



Figure 10 The upper rim of a cache pit that has partially collapsed. Dried and hardened soils contribute to these events of collapse, and make it difficult to preserve certain features for public viewing over extended periods of time. The chaining pin is 35 cm long.



Figure 11 Mold growth in excavated areas where water has infiltrated beneath the walls of the Archeodome. The chaining pin is 35 cm long.