

Intermountain Region
Resource Stewardship and Science

National Park Service
U.S. Department of the Interior



CROSSROADS IN SCIENCE

Where the Intermountain Region's Resource Stewardship and Science Programs and Centers Meet

Fall 2016

2016
National Park Service
Centennial
Centennial Issue





National Park Service™
C E N T E N N I A L

Editorial Director:

Nida Shaheen, nida_shaheen@nps.gov

Editors:

Robert Parmenter, robert_parmenter@nps.gov

Nida Shaheen, nida_shaheen@nps.gov

Visual Layout:

Damien Joseph, damien_joseph@nps.gov

Front Cover:

Desert View Watchtower at Sunset, Grand Canyon National Park, AZ. (NPS photo).

A. Sayre Hutchison, Photographer.

Contents

Welcome Patrick Walsh - Associate Regional Director for Resource Stewardship & Science	1
The Escalante River Watershed Partnership – Glen Canyon National Recreation Area Teams up with Regional Partners to Restore the Escalante River Watershed—Feature NPS Unit	3
Rangeland Health Assessments Inform Grazing Management in Capitol Reef National Park	9
The Intermountain Region’s CESUs: 17 Years of Accomplishments and Future Directions—Feature Program	17
Green Sunfish Early Detection and Rapid Response	27
Park Places: An Innovative Approach to Visitor Engagement— Centennial Project	35
Sonic Booms and Resource Effects: An Unmanned Measurement System for Shock Waves, Structural Vibration, and Potential Damage	39
Underwater Archeology and Climate Change in the NPS Intermountain Region	49
Water Resource Management in an Overtaxed System: The Colorado River Basin	57
An Interdisciplinary Approach to Architectural Analysis at Montezuma Castle National Monument	63
National Park Service Student Internships – Helping to Bridge Natural Resource Science Needs in the Intermountain Region Parks While Developing the Next Generation of Conservation Stewards—Feature Story .	71
A Fragile Union of Nature and Culture: Aspen Dendroglyphs in the Valles Caldera National Preserve, A Citizen-Science Success Story	77
When Modern becomes Historic: Mission 66 Era and the National Park Service—Cultural Feature	85

— CULTURAL RESOURCES —

An Interdisciplinary Approach to Architectural Analysis at Montezuma Castle National Monument

By Matthew C. Guebard, Archeologist, Southern Arizona Office, matt_guebard@nps.gov; Lucas M. Hoedl, Archeologist, Montezuma Castle National Monument, lucas_hoedl@nps.gov

Contributing Authors: Angelyn Bass, Larry V. Nordby, Douglas Porter, Thomas C. Windes

Introduction

Montezuma Castle, a five story, 20-room cliff dwelling in central Arizona, has captured the imagination of intrepid explorers, passing travelers, and archeologists for decades. Precariously set in a shallow alcove 90 feet above the Verde Valley, the site is protected from wind, rain, and the harsh desert environment. As a result, ancient walls and wooden ceilings that might otherwise deteriorate quickly are preserved in near-perfect condition. The Castle's well-preserved architecture has attracted numerous visitors and beginning as early as the 1870s, antiquarians and curio seekers began publishing accounts of their explorations at the site. The cliff dwelling's growing popularity culminated in its designation as a National Monument in 1906, the first of its kind to protect a prehistoric dwelling.

Today, Montezuma Castle is one of the most well-known cliff dwellings in the American Southwest. Every year over 500,000 visitors travel to the site. Instead of the published journal accounts of the 19th century, the Internet is replete with photographs, videos, and written accounts of recent visitor experiences. Despite its widespread and enduring fame, the iconic structure has received surprisingly little attention from professional archeologists or academic researchers. In fact, until recently, most of what was known about the site was published by archeologists over 25 years ago (e.g., Wells and Anderson 1988).

The cliff dwelling's National Monument status obligates the National Park Service (NPS) to study it using the latest scientific methods. The monument's enabling legislation, published in 1906, highlights the cliff



Figure 1. Montezuma Castle cliff dwelling (Source: Lucas Hoedl, 2016).

dwelling's "ethnological value and scientific interest", a reference to the federal government's duty to study it (National Park Service 1906). Similarly, NPS guidelines for cultural resource management define archeological research as a means to "support management, protection, understanding, and interpretation of archeological resources" (National Park Service 2002). The site's well-preserved architecture contains detailed information about the people that once lived in the cliff dwelling and presents an unparalleled opportunity to learn about the past.

Beginning in 2011, NPS archeologists, university scholars, historic preservation specialists, and tribal representatives from across the American Southwest began a multi-year project to study, record, and interpret the dwelling's prehistoric architecture. The ongoing intent of this project has been to complete

multidisciplinary research as a means of developing a long-term preservation plan for the site and improving public interpretation. Of particular interest are four questions that have puzzled antiquarians and archeologists since the 1870s: When did people build Montezuma Castle? How did they build it? When did they leave? And finally, why did they leave? The study and analysis of architecture at Montezuma Castle has provided insight into each of these questions, as well as helped to develop additional questions for future research.

When Was Montezuma Castle Built?

Visitors to Montezuma Castle have long pondered the age of the ancient dwelling. Beginning in 2011, archeologists from the NPS and the University of New Mexico's Maxwell Museum of Anthropology initiated a study of wooden ceiling elements to understand the site's construction history. The cliff dwelling contains 11 rooms with complete ceilings comprised of over 150 individual wooden roof beams. Unfortunately, dendrochronology, an analytical method where a tree's annual growth rings are used to determine a cutting date, has proven unsuccessful at the site. This problem is caused by local conditions, which result in "complacent" growth rings that cannot be compared to master tree ring chronologies for the region. Conversely, Accelerator Mass Spectrometry (AMS), a form of radiocarbon dating, has been used with far greater success. AMS dating uses a Mass Spectrometer to quantify the amount of isotopic carbon in organic objects like wooden roof beams. The amount of remaining carbon isotopes is then used to determine a

date for when the object was harvested. At Montezuma Castle, AMS dating has therefore defined possible date ranges for when living trees were cut down and presumably used for roof construction.

When statistically evaluated, AMS dates from Montezuma Castle fall within six homogenous chronological groupings (Windes 2015). These groups suggest that ceilings were constructed using trees harvested during several distinct time periods. Based on clusters of radiocarbon dates, it is likely that initial construction and occupation of the Castle began sometime during the 11th century with multiple periods of expansion and repairs until the late 14th century (Windes 2015). The newly defined occupation dates for Montezuma Castle are much longer than the original estimates put forth by archeologists. This makes the site one of the longest continuously occupied cliff dwellings in the American Southwest.

AMS dates also illustrate a complicated history of wood reuse and suggest that architectural wood was often recycled from earlier contexts. For instance, some ceilings contain wooden elements that were cut many decades or even centuries before construction of the Castle. Reuse may indicate that certain elements were intentionally curated and reused because they held ideological meaning, were unavailable in the local environment, or difficult to harvest and process. Future research may provide insight into the prehistoric environmental conditions or social interactions that led to wood curation and reuse.

How Was The Castle Built?

In cooperation with the University of New Mexico, Department of Anthropology, and Archaeology and Architectural Consulting Services (AACS), NPS staff also studied earthen architecture to understand how and in what order rooms at Montezuma Castle were built. Larry Nordby, retired NPS Archeologist and owner of AACS, analyzed details such as construction joints, wall abutments, doorways, hatchways, and other unique architectural features to decode ancient construction methods, as well as to determine the sequence in which rooms were built.

Nordby's assessment of the site illustrates some of the decisions made by builders and how the dwelling changed through time. Based on architectural evidence, Nordby was able to delineate the expansion of the site into five distinct construction episodes. Interestingly, construction of the Castle initially began on the third



Figure 2. Tom Windes collects wood samples in Room 7, Montezuma Castle cliff dwelling (Source: Wendel Navenma, 2011).

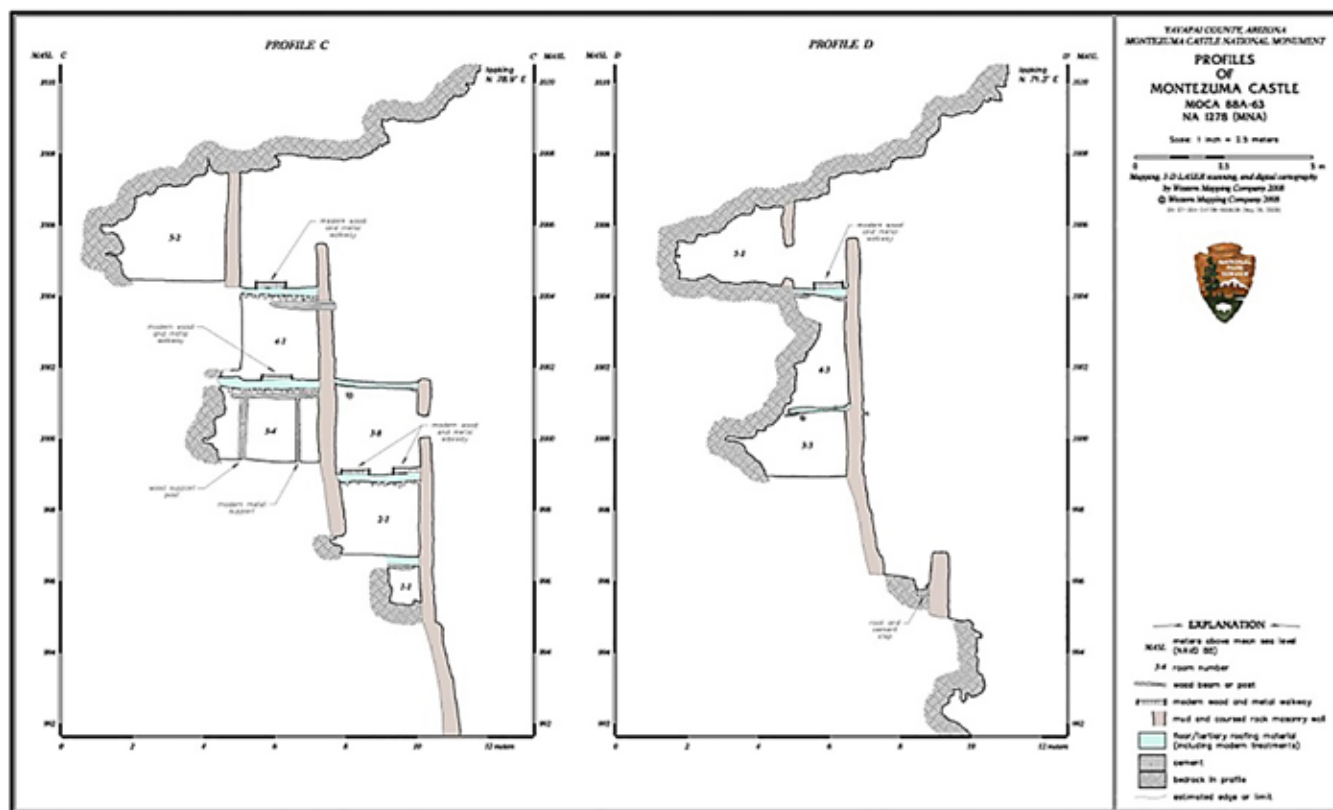


Figure 3. Profile map detailing a cross section of Montezuma Castle (Source: Western Mapping Company, 2008).

level, followed by rooms on level one and then level two. The Castle continued to expand with the construction of level four and five followed by the prominent multi-story tower. Although the construction of the site took less than 100 years, people continually occupied the dwelling for more than two centuries. Nordby's analysis recognizes that each room is a product of decisions made by community members and perhaps an ancient architect, engineer or specialized construction guild, necessitated by the needs of the growing community (Nordby 2015).

Angelyn Bass, an Architectural Conservator from the University of New Mexico, and a team of specialists including Doug Porter from the School of Engineering at the University of Vermont, also assessed earthen mortar and plaster used to build masonry walls and floors. Their study characterized different plaster types using Scanning Electron Microscopy (SEM) and X-ray Diffraction analysis. Technical examination yielded clues about the methods of plaster manufacture, application, and use. Preliminary results suggest that builders selected specific materials for leveling and finishing floors, exterior walls, and interior surfaces. For instance, "base coat" mortars typically incorporate coarse aggregates, possibly to control cracking associated with uneven drying of the thick leveling coats; finish plasters, on the other hand, have finer aggregates with mineral components that contribute colors for fine, polychrome finishes. The fine plaster finishes were installed in uniformly thin layers that vary within and between walls, suggesting, perhaps, that finishing was intended as a way to maintain the appearance and condition of the wall surface. Floor and exterior wall plasters combine well-graded aggregates with binder materials in proportions that yield dense, durable surfaces (Bass et al. 2015).



Figure 4. SEM thin section of plaster from the Room 21 exterior wall. The dark line is soot and dust that accumulated on the wall surface over time. (Source: Bass et al. 2015:8).



Figure 5. Doug Porter records the condition of walls at the Montezuma Castle cliff dwelling (Source: Lucas Hoedl, 2016).



Figure 6. Angelyn Bass identifies plastered surfaces at Montezuma Castle (Source: Lucas Hoedl, 2016).

The project also assessed the condition of each ancient wall surface and wooden ceilings. In total, 233m² (2508 ft²) of original plaster survives on 53 walls at the Castle. This is approximately 77% of all wall faces at the site and proves that the interior of Montezuma Castle contains a remarkable amount of well-preserved architecture.

Additionally, 16 wall segments appear to have some form of embellishment in the form of colored washes, circular depressions, and formalized incising (Bass et al. 2015). Study of the additional wall and floor plasters is currently underway.

The study of architecture at Montezuma Castle indicates that the ancient builders were expert craftsmen, capable of making careful and calculated decisions about the materials and construction techniques employed at the dwelling. The durability of the materials used and the quality of workmanship employed resulted in an incredibly well-preserved structure. Unlike many other similarly aged sites in the area, Montezuma Castle is the best preserved and thus provides a comprehensive example of construction techniques used widely across the Verde Valley. The information gathered from these forms of analysis give interpretative life to the dwelling and offers intriguing insight into regional cultural practices.

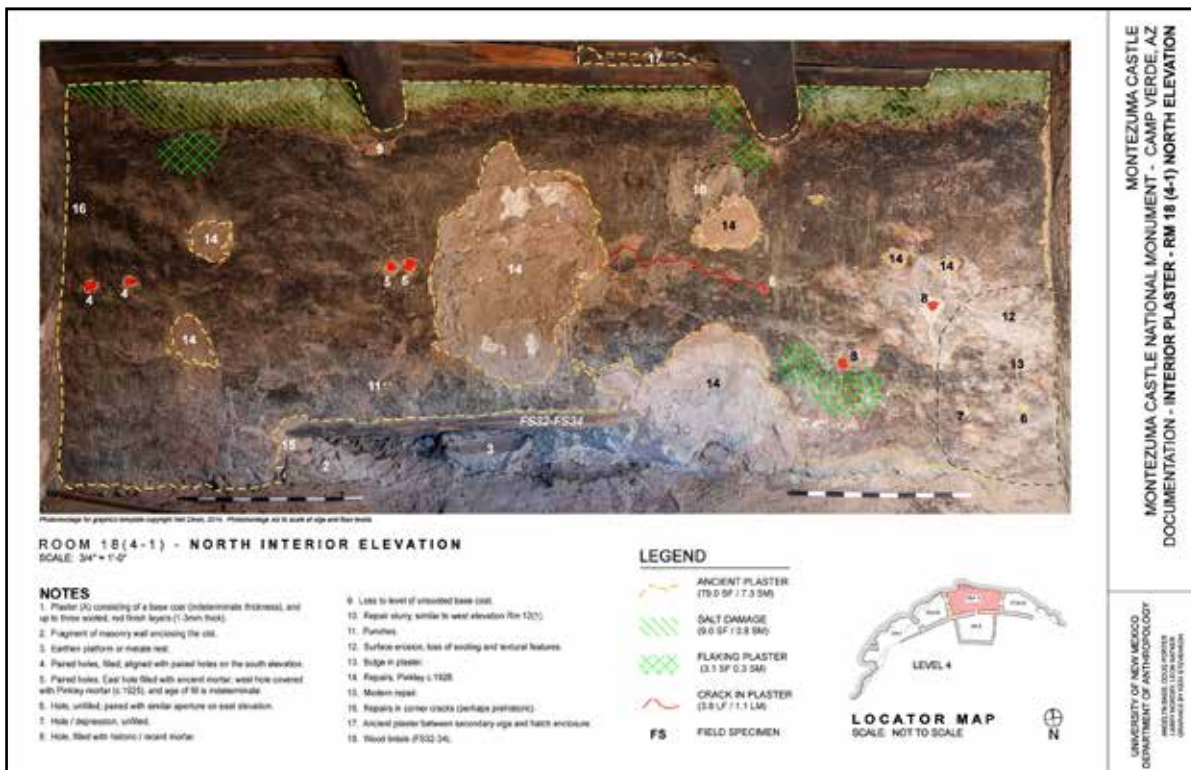


Figure 7. Annotated wall sheet for Room 18, Montezuma Castle cliff dwelling (Source: Bass et al. 2015:135).

When And Why Did They leave?

Using a scientific technique called archaeomagnetic dating as well as traditional knowledge provided by Native American participants, NPS and university scientists can hypothesize when and why the site was abandoned. Archaeomagnetic dating is a form of analysis that uses the earth's magnetic field to determine dates for fire events in the archeological record. In 1933, archeologists working at Castle A, part of the village that includes the Montezuma Castle cliff dwelling, noted evidence for a large and destructive fire (Jackson and Van Valkenburgh 1954). The fire completely destroyed Castle A and produced very hot temperatures, causing iron particles within earthen walls to realign with the direction of magnetic north. In 2011 and 2013, NPS and University of New Mexico scientists collected twenty small samples of burned plaster from one wall at Castle A. These samples were analyzed in the Archaeomagnetic Laboratory at the New Mexico Office of Archaeological Studies. In the laboratory, scientists compared the orientation of iron particles in burned plaster with a known record of changing magnetic orientations through time. Results from archaeomagnetic analysis strongly suggest the fire at Castle A occurred in the interval from A.D. 1375-1395 (Guebard 2015).



Figure 8: NPS Archeologist, Matt Guebard, taking samples for archaeomagnetic dating at Castle A (Source: Melissa Philibeck, 2013).

Additional evidence discovered during the 1933 excavation of Castle A suggests that physical violence accompanied the structural fire. Specifically, human skulls with cranial fracturing and an unburied skeleton found beneath collapsed and burned roofing material suggest that the fire was a product of a violent attack, as opposed to an accidental ignition (Guebard 2015). Interestingly, Native American groups preserve oral histories or stories passed down from generation



Figure 9. Consultation with Apache, Hopi, and Yavapai tribal representatives, Montezuma Castle, 2014 (Source: Melissa Philibeck, 2014).

to generation, describing the fire at Castle A and the abandonment of the Montezuma Castle cliff dwelling. These stories recount a siege-like attack, wherein Castle A was burned and some of the village's inhabitants were trapped inside the Montezuma Castle cliff dwelling. The story concludes with the villager's escape and their eventual resettlement on the Hopi Mesas. The fire at Castle A likely marks the abandonment of both dwellings, although Montezuma Castle was used by subsequent ancestral Native American groups for short-term habitation and storage.

The convergence of archeological data and Native American oral history at Montezuma Castle is an incredible and valuable occurrence. Oral histories and archeological data are two very different forms of information, but when analyzed together provide a more complete narrative of past events. Rooted in oral history and supported by archeological data, events at Castle A provide an explanation for the abandonment of the dwelling at the end of the 14th century.



Figure 10. Research team prepares to depart the Montezuma Castle cliff dwelling (Source: Lucas Hoedl, 2016).

Conclusions

The National Park Service protects the nation's most iconic archeological resources. Among these is the Montezuma Castle cliff dwelling, a site that has inspired curious visitors for centuries. The recent study of architecture using a multidisciplinary team consisting of tribal representatives, archeologists, and historic preservationists has drastically improved our understanding of the iconic cliff dwelling. Many enduring questions about the site, including when and how it was built and when and why it was abandoned have been addressed with data collected using scientific methods and analysis. Future research will continue to provide information about the architecture and the ancestral Native American people that constructed Montezuma Castle over 900 years ago.

References

Bass, Angelyn, Douglas Porter, Larry Nordby, Neil Dixon, Leon Natker, Liisa Reimann, Katherine Shaum, Mike Spilde, and Keri Stevenson. 2015. *Condition Assessment and Treatment Planning for the Earthen Plasters at Montezuma Castle, Montezuma Castle National Monument*. Submitted to National Park Service, Project Number: UNM-92. Copies available from National Park Service

Guebard, Matthew C. 2015. Two to Four Inches of Lime Dirt: Public Archaeology and the Development of Old and New Interpretations at the Castle A site, Montezuma Castle National Monument. *Journal of Arizona Archaeology* 3(1) 161-171.

Jackson, Earl, and Sallie Pierce Van Valkenburgh. 1954. *Montezuma Castle Archaeology, Part 1: Excavations*. Southwestern Monuments Association Technical Series, Vol.3, Part 1. Gila Pueblo, Globe.

National Park Service. 1906. Presidential Proclamation (No.696-December 8, 1906-34 Stat.3265) establishing Montezuma Castle National Monument.

2002 Director's Order #28: Cultural Resource Management Guidelines

Nordby, Larry V. 2015. *Organizing Multi-scalar Architectural Information at Montezuma Castle*. Submitted to National Park Service, Project Number: UNM-92. Copies available from National Park Service.

Wells, Susan J. and Keith M. Anderson. 1988. *Archeological Survey and Architectural Study of Montezuma Castle National Monument*. Publications in Anthropology Number 50. Western Archeological and Conservation Center, Tucson.

Windes, Thomas C. and William H. Doleman. 2015. *Accelerator Mass Spectrometry (AMS) Dating at Montezuma Castle Cliff Dwelling, AZ O:5:14 (ASM)*. Submitted to National Park Service, Project Number: UNM-86. Copies available from National Park Service.



#FindYourPark

About the National Park Service: More than 20,000 National Park Service employees care for America's 413 national parks and work with communities across the nation to help preserve local history and create close-to-home recreational opportunities. Learn more at www.nps.gov.





CROSSROADS_{IN SCIENCE}

National Park Service • Intermountain Regional Office
12795 W. Alameda Parkway
Lakewood, CO 80225