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Managing Change: The Role of Documentation and Condition Survey at Mesa Verde National Park

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Abstract

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A phased conservation program to develop coordinated methods for the survey, analysis, stabilization, and interpretation of the masonry and prehistoric surface finishes in the alcovate (cliff-dwelling) sites of Mesa Verde National Park has been in progress since 1994 by the Architectural Conservation Laboratory of the University of Pennsylvania. The program has included a comprehensive method of study, including archival research, technical analysis, and characterization of the architectural materials; detailed field and digital recording of existing conditions, including environmental monitoring; and the design, testing, and execution of a treatment and protection program specifically focused on the *in situ* stabilization of plain and painted architectural surface finishes. Though case-study oriented, this article addresses in detail the theoretical and technical aspects of condition survey and recording as an important vehicle for material and site diagnostics, which must precede remedial and preventive interventions. Detailed information is provided on the use of current digital technology for condition survey.

Comments

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MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

FRANK G. MATERO

ABSTRACT—The approximately 600 cliff dwellings in Mesa Verde National Park in Colorado represent the apex of architectural sophistication of the Northern San Juan Ancestral Puebloan culture. The cliff dwellings, the final product of 600 years of cultural development on the Mesa Verde, were built between A.D. 1200 and 1300, and were abandoned shortly thereafter. The spectacular setting and the well-preserved state of these masonry structures and their surface finishes resulted in Mesa Verde's being the first nomination by the U.S. government to the World Cultural Heritage Sites List. Moreover, descendants of these ancient peoples, the Pueblo Indians of Arizona and New Mexico, continue to venerate these sites, representing a cultural continuity unique for North America. Excavation and preservation have been continuous since Mesa Verde became one of the first national parks in 1906. The structures interpreted to the public have been preserved over the years with a minimum of repair and replacement, resulting in a cultural resource of great integrity and authenticity.

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TITRE—Gérer le changement: le rôle de la documentation et des constats d'état au Parc national de Mesa Verde. **RÉSUMÉ**—Les quelques 600 habitations troglodytiques du Parc national de Mesa Verde au Colorado, représentent l'apogée de la sophistication architecturale de la culture ancestrale Pueblo du San Juan du Nord. Ces habitations à flanc de falaises, ultime produit de 600 ans de développement culturel sur le Mesa Verde, furent construites entre les années 1200 et 1300 après Jésus-Christ, puis abandonnées peu après. Grâce à un site spectaculaire et au bon état de préservation des structures en maçonnerie et de leurs revêtements, Mesa Verde fut le premier site à être inscrit par le gouvernement américain au patrimoine mondial de l'Unesco. De plus, les descendants de ces peuples anciens, les indiens Pueblo de l'Arizona et du Nouveau Mexique, continuent de vénérer ces sites, ce qui représente une continuité culturelle unique pour l'Amérique du Nord. Depuis que Mesa Verde est devenu l'un des premiers parcs nationaux en 1906, les fouilles et les projets liés à la préservation n'ont pas fait relâche. Ce bien culturel est d'une grande intégrité et d'une grande authenticité car au fil des ans, les structures accessibles au public ont été préservées avec un minimum de réparations et de remplacements.

Dans le but de développer des méthodes intégrées pour le relevé, l'analyse, la stabilisation et l'interprétation de la maçonnerie et des revêtements préhistoriques dans les sites en alcôves (habitations troglodytiques), le Laboratoire de conservation architecturale de l'Université de Pennsylvanie a élaboré un programme par étapes, qui est en cours depuis 1994. Ce programme s'est basé sur une méthode de recherche très détaillée: recherche archivistique; analyse technique et caractérisation des matériaux architecturaux; relevés *in situ* détaillés et numérisés de l'état de conservation actuel, incluant une évaluation de l'environnement; et enfin l'élaboration, les essais et la réalisation d'un programme de traitement et de protection spécifiquement destiné à la stabilisation *in situ* des surfaces architecturales nues ou peintes. À l'aide d'études de cas, cet article aborde en

profondeur les aspects théoriques et techniques relatifs à l'état d'un site et de ses matériaux, qui sont des outils essentiels pour poser un diagnostic préalable à tout projet de préservation ou de restauration. Des renseignements détaillés sont fournis sur l'emploi de technologies numériques contemporaines lors de la réalisation des constats d'état.

TITULO—Manejando el cambio: el rol de la documentación y el estudio de la condición en el parque nacional de Mesa Verde. RESUMEN—Las aproximadamente 600 alcobas edificadas en las quebradas del Parque Nacional de Mesa Verde en Colorado representan la epifanía de la sofisticación arquitectónica de la cultura ancestral llamada San Juan Pueblo Norte. Las alcobas, producto de 600 años de desarrollo cultural en Mesa Verde, fueron edificadas entre el 1200 y 1300 AD y fueron abandonadas casi inmediatamente después de su construcción. La espectacular escenografía y el buen estado de conservación de estas estructuras de mampostería y sus coloridos enlucidos de tierra llevaron a Mesa Verde a ser el primer monumento presentado por el gobierno de los Estados Unidos de Norteamérica para ser considerado Patrimonio Cultural de la Humanidad. Mas aún, los Indios del Pueblo de Arizona y Nuevo México, descendientes de esta cultura ancestral, continúan venerando estos sitios; convirtiendo a Mesa Verde en un extraordinario ejemplo de continuidad cultural para Norteamérica. Desde que Mesa Verde se convirtió en el primer Parque Nacional en 1906, una serie trabajos de excavación y conservación se han venido ejecutando. Las estructuras, expuestas e interpretadas para el público, se han conservado en el tiempo sufriendo mínima intervención; y son consideradas fuente auténtica para el estudio y preservación de esta cultura.

Desde 1994, el Laboratorio de Conservación Arquitectónica de la Universidad de Pennsylvania viene trabajando en un programa de conservación diseñado en etapas para desarrollar metodologías coordinadas de investigación, análisis, estabilización e interpretación de la mampostería y enlucidos prehistóricos de los diferentes grupos de alcobas del Parque Nacional de Mesa Verde. Este programa está basado en una compleja metodología que incluye

investigación de archivos históricos, análisis técnicos y caracterización de materiales arquitectónicos; detallados levantamientos de campo digitales sobre el estado de la condición del monumento, incluyendo monitoreo medioambiental; y el diseño, prueba y ejecución de un programa de tratamientos de intervención y protección especialmente enfocado a la estabilización *in situ* de los enlucidos pictóricos.

Presentado como un estudio de caso, el presente artículo informa al detalle los aspectos teóricos y técnicos involucrados en la investigación de la condición del monumento. Propone el levantamiento como vehículo importante para el diagnóstico del estado del material y del sitio, el cual debe siempre preceder a cualquier intervención preventiva o de conservación. El artículo también presenta detallada información sobre el uso de tecnología digital de avanzada para el estudio, diagnóstico y presentación del estado de la condición del monumento.

1. INTRODUCTION

What is past is prologue.
The Tempest
William Shakespeare

Since its emergence in the early 20th century as a field of intellectual inquiry and applied practice, the conservation of historic and artistic works has matured into a distinct and professionally defined discipline. This development is owing, in part, to the adoption of an etiological approach to the examination and treatment of cultural property—that is, the relational study of the causes of deterioration and interventions based on scientific method. Other disciplines such as medicine and criminology share this methodology, whereby cause and effect (e.g., pathogen and symptom or motive and crime) are explored together in an attempt to offer explanation and thereby direct action accordingly. Establishing such relationships begins with observation and description, which in the case of conservation leads to documentation. Documentation and recording are the cornerstones of conservation practice.¹ Conservators perform documentation based on the belief that by recording the tangible aspects of material

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

culture, one can preserve its inherent informational and aesthetic value or at least its potential value that may be lost through natural degradation and human modification or altered as a result of conservation treatment.

Traditionally, documentation for conservation has long been associated with the physical state or condition of an object or site immediately before and after intervention (AIC 2001). No doubt this connection can be attributed to the physical changes most conservation treatments effect, as well as the contributions that documentation can make toward an increased understanding of the original appearance or technology of the object or site. But it has also been through the study of existing condition as a record of past change that conservators have seen the value of documentation and recording in developing a more accurate knowledge of alteration and deterioration. This relationship is especially the case for understanding long-term trends and patterns of decay, as well as the efficacy of treatment performance and durability predictions. By studying condition as the cumulative result of change over time through scientific observation and description, one can come closer to understanding alteration mechanisms and to identifying and managing deterioration as deleterious change.

The road to accurate and effective diagnosis must therefore begin with a conscious methodology employing descriptive symptomatic recording, preferably executed over time. In this way, the variables of condition type, location, extent, and severity can be observed alone, together, and in combination with other factors such as material design, including construction and composition, environment, use and modification, maintenance, and previous conservation. As Hughlings Jackson cautioned years ago, "The study of the causes of things must be preceded by the study of things caused" (quoted in Beveridge 1957, 15).

In recent years, the technology for producing more accurate and comprehensive documentation has increased dramatically through the development of newer imaging and computer graphic software programs, such as AutoCAD, and Geographic Information Systems (GIS), such as ArcView, and the creation and adaptation of nondestructive investiga-

tion and monitoring apparatus (Palumbo 2000). These tools have promoted the development of condition assessment surveys as critical diagnostic vehicles that go far beyond earlier interests in recording the immediate physical status before and after treatment. As powerful graphic methods, these digital aids allow the manipulation and analysis of large data sets and long-term recording, which ultimately should result in better conservation and management decisions. However the true value of any condition survey program must begin with a clear definition of what information is required and why. All recording is deceptively subjective, always performed with a specific objective or from a particular point of view. Contrary to modern scientific notions, it is the moment at which interpretation begins.

The documentation of structures and sites and associated building arts such as mosaics, sculpture, and wall painting presents enormous difficulties attributed as much to their size and complexity as to the pressures of utility and context. Existing buildings and sites do not come to us unchanged. A great many agents and phenomena, ancient and modern, transform sites over time and in different ways. A variety of natural and cultural processes, including natural decay mechanisms and human actions, continually alter a building's fabric and form. Daily maintenance, intermittent repair, use and reuse (including ritual activity), neglect, decay, abandonment, and recovery are among the diverse yet plausible processes that translate past actions and events into present conditions. As a result, the physical condition of any structure or site is a record of the interaction of many different determinants over the course of its existence (fig. 1). For most archaeological sites these determinants include (in general order of occurrence):

- original design, materials, and construction techniques (0)
- subsequent changes through use, human alteration and natural aging (1–4)
- micro- and macroenvironments and climate (1–4)
- disuse and/or abandonment (4)
- destruction and/or burial (4–8)
- excavation (9–10)
- stabilization, display, and maintenance (11)

These determinants characterize individual

episodes in the formation of all sites and as such shape the “life cycle” for materials, structures, and places. Such models, commonly used by archaeologists to explain multivariate change over time (Harris 1989; Brown and Harris 1993; Schiffer 1996), have been adopted less frequently by conservators to study and explain the condition history of cultural resources (Downman 1970). By considering performance, deterioration, and treatment in a more holistic and integrated manner—linking design, environment, and human agency—conservators can develop and apply documentation and recording methods focused on etiological concerns. Only when one begins to systematically record what one sees, while acknowledging that process as an act of continual interpretation, will conservation realize the potential of the condition survey as an analytical tool for what is and has been and as a method for better controlling unnecessary or unwanted change of that which has yet to occur—i.e., preventive conservation.

Despite the inevitable alteration that entropy effects on all matter, such material transformations are not random but patterned, reflecting the predictable

consequences of natural weathering cycles and decay mechanisms. These processes can be and were altered consciously and unconsciously by human action, thus making the reading of the resultant conditions over time a diagnostic challenge, yet one filled with the potential for understanding the complex and critical relationship between cause and effect, damage and treatment, past and present. In the end, it should be possible to establish a relationship between specific causative variables, specific decay mechanisms, and regular and predictable effects learned through detailed descriptive observation, monitoring, experimentation, and historical research.

Fundamental, then, to the role of condition survey as a diagnostic tool is the concept of a site or building’s life history and the interpretation of condition as “accumulated evidence” of natural and cultural events mapped onto the physical form and fabric. This concept requires a reverse reading of the site or building by first observing and describing—i.e., recording and then interpreting the effects of the alterations leading to an understanding of what, where, when, how, and why such changes occurred.

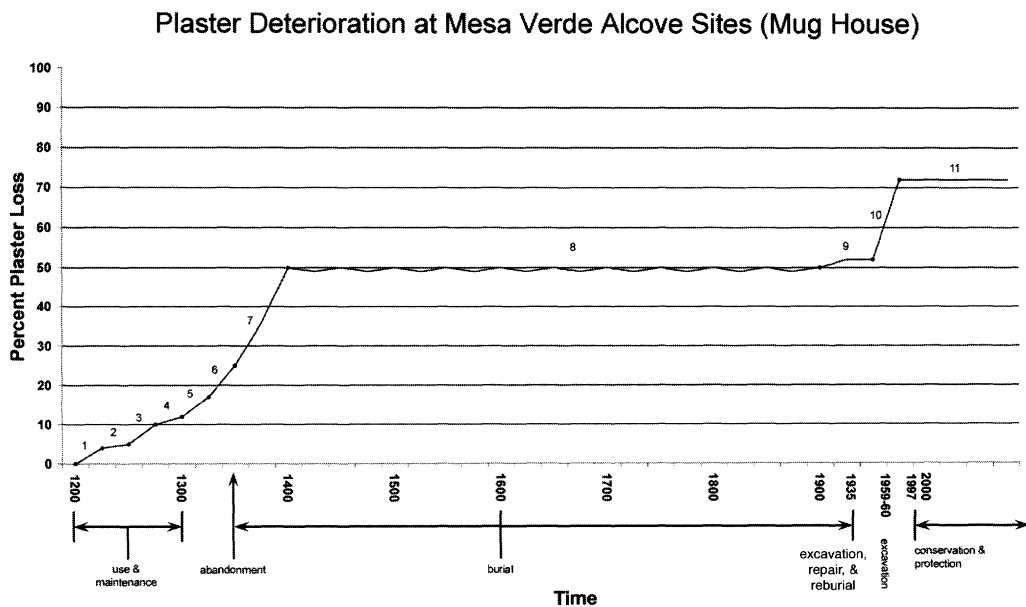


Fig. 1. Proposed life cycle for Kiva C, Mug House, Mesa Verde. Courtesy Architectural Conservation Laboratory, University of Pennsylvania

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

Clearly each site and material has a unique life history, based on a unique combination of factors, yet the mechanisms of such alteration processes can be studied independently and the cumulative and resultant effects explained synchronically and diachronically by an insightful reading of the evidence.

To borrow a much-used linguistic parallel, reading requires an understanding of word definition and grammatical construction, which determine and shape meaning. Meaning is a function of the original text and all the readings and interpretations of that text from the beginning. Similarly, with condition diagnostics, the process of understanding must begin with the construction of an understandable and reproducible language describing the evidence observed. In practice, many conservators underplay the subtle contributions that clear, descriptive conditions recording can bring to the causal interpretation and treatment of works. Once such a system is constructed, tested, and in place, the collection, management, and correlation of the data afforded by recent advances in digital technology can allow for sophisticated readings and flexible interpretations. This correlation can then be applied toward the development of a greater range of conservation treatment options and management strategies, including long-term monitoring and preventive conservation.

All condition assessment surveys depend on qualitative and quantitative recording that describes the type, location (macro or micro), status (active or inactive), extent, and degree of severity for each condition observed. Wherever possible, this recording should be performed over time where photographic or other past descriptive information exists. The medium or format by which this recording is done depends on what is being described, the size and scale of the work, the degree of accuracy required, and the equipment, skill, and time available. The first step in recording any condition involves the use of a structured classification system and precise, exclusive language and graphics.

Because many decay mechanisms can be caused by various and complicated scenarios involving intrinsic and extrinsic factors, and because similar symptoms may result from different causes or different symptoms from the same cause, simple descrip-

tive terminology based on the clearly stated observation of discernible physical characteristics is always preferable during the initial survey process. In this way, observations can be recorded that are free from the causal implications often associated with many commonly used terms (e.g., spalling) and in a more useful manner before a fuller understanding of the problem can be gained through other subsequent or parallel investigative and analytical techniques. This process usually requires the creation of a defined and coherent terminology, often accompanied by photographic and schematic illustrations, and designated colors and graphic symbols for mapping conditions and materials. Classification schemes are usually designed to serve a specific end, be it in preparation for treatment or to monitor deterioration or intervention. They represent an artificial hierarchical typology of the variables observed that, when considered with other information, can be termed "pathography," or the descriptive science of studying and recording physical conditions.

Standardized nomenclature is a fundamental requirement for all scientific inquiry. Early on, Milton Bradley summed up the importance of standardization in his study of color and color systems, warning, "Where there are no standards there can be no measurements, and if . . . we have no measurements of effects, no records can be made, and hence no comparisons of results at various places and times, and consequently no discussion and little progress" (Bradley 1895, 5).

Attempts to develop material conditions standards began with the creation of organizations such as the American Society for Testing and Materials (ASTM) in the early 20th century. However, such standards were developed for specific modern construction materials such as concrete, wood, steel, and paints and relied on simple definitions and photographic or graphic standards for the explication of type and severity of condition. The development of specific condition-recording standards for architectural conservation contexts occurred much later in response to individual need with the creation of institutionally based systems such as the recommendations of the standards committee for stone-based products (NORMAL) in Italy (1990) and the work

of Grimmer (1984), Ashurst and Dimes (1990), and Fitzner et al. (1997). As a result, condition standards for conservation have been slow to be adopted by an international audience due to language restrictions and material specificity.² Quite often and incorrectly, terminology developed for one material has been borrowed and adapted for other materials.

1.1 ARCHAEOLOGICAL SITES AND SURFACE FINISHES

The conservation of architectural remains at archaeological sites presents great difficulties in the development and implementation of resource management programs. Current practice in the conservation and interpretation of such sites attempts to maximize documentation and the retention of original material *in situ* while, at the same time, often requiring interpretation of the remains in a manner that is sensitive to their preservation as well as intelligible to the public. This aim poses a difficult problem for any structure in a fragmented state and especially for fragile elements such as painted plasters, which are best understood in their original context but also highly susceptible to deterioration and loss.

Despite earlier practices of complete or selective removal of architectural plasters and finishes from ruins and archaeological sites, preservation and interpretation *in situ* are now ideologically the preferred solution, even if shelters or reburial are the only option. *In situ* conservation ensures the possibility of future studies of the whole resource and allows the opportunity to view the ruin as a once-complete structure. Surviving plasters with their finishes, in particular, contribute significantly to our understanding and appreciation of these architectural sites by providing additional information on aesthetics and technology, and possibly contributing to a greater understanding of architectural function, status, and meaning (fig. 2, see page 59). In addition, such surface finishes make tangible and human what otherwise might be incomprehensible to the visitor and scholar alike.

1.2 THE MESA VERDE PROJECT

With these issues in mind, the U.S. National Park Service and the Architectural Conservation Laboratory of the University of Pennsylvania began collaborating in 1994 to develop a model program for the study and treatment of the masonry and architectural surface finishes of the cliff dwellings of Mesa Verde National Park, a World Heritage Site in Colorado, in the southwestern region of the United States. The principal goals of the program have been to develop a comprehensive management system for the documentation and recording of these architectural components, to design and implement remedial and preventive conservation methods, and to integrate simple management practices into park maintenance so that further loss and damage of the prehistoric record can be prevented. Dubbed CASPAR—for Conservation of Architectural Surfaces Program for Archaeological Resources—this multiphased program has included a broad range of research and field activities, including architectural and condition documentation and recording, material analysis and characterization, condition survey, environmental monitoring, and treatment development, implementation, and evaluation. These activities have all been accomplished in the context of academic research and training.

Despite the worldwide occurrence of earthen and masonry systems and their susceptibility to decay, no systematic program for their recordation or study as a discrete architectural component had been formalized (Matero 1999). One of the goals of CASPAR was to develop a comprehensive documentation and condition recording program whose objectives included:

- the creation of a systematic (and expandable) manual and lexicon of conditions terminology for architectural finishes and especially for earthen materials, complete with written description, photographic and schematic illustration, and colored graphic symbols for mapping

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

- the development of an efficient, reproducible field-to-laboratory method of recordation using 35 mm rectified photography to create base images for graphic field annotation of detailed conditions in the past and present
- the assembly of existing graphic and database software to digitally manipulate the graphics and textual information in order to record conditions and treatments now and in the future, and to assist in conditions diagnosis and interpretation including the identification of the causes, patterns, and trends of deterioration.

Over the course of seven years, the masonry and plasters within ten rooms and five kivas at Mug House and, later, five rooms and exteriors and five kivas at Cliff Palace were recorded by graduate students using the developed system. Mug House on Wetherill Mesa was selected as the model test site due to its moderate size (90 rooms and 8 kivas), high percentage of original wall fabric, and excellent

documentation both before and after excavation and stabilization in 1959–60 by Arthur Rohn (fig. 3). Kiva C was chosen as the representative unit to be fully documented, with an architectural database and a 53-sector digitized graphic condition survey, due to the significance, extent, and poor condition of its mural paintings (fig. 4, see page 59) and the opportunity to reassess a previous pilot treatment program executed in 1981 by Paul Schwartzbaum and Constance Silver (Silver 1982).

This condition survey, taken together with a compilation of the site's history of archaeological excavation and stabilization, a geological assessment of the alcove, the characterization and analysis of the plasters and surface finishes of Kiva C and Room 28, and the environmental data obtained through a two-year monitoring program (1996–97 and 1998–99), affords a more complete diagnosis of decay mechanisms than has yet been attempted at these alcove sites.



(a)



(b)

Fig. 3. Mug House, before (a) and after (b) excavation and stabilization in 1959–60. Courtesy of NPS-MEVE

2. METHODOLOGY

2.1 FIELD DOCUMENTATION

A sequence of field investigation and recording and off-site data processing was undertaken to document and assess the current conditions of two representative spaces in Mug House. While the details of any methodology are important to report for critical discussion and application, it is important to emphasize that the specific tools of the process—i.e., software and hardware—will change as a function of technological improvements. This development has certainly been the case in this and other projects, with the rapid innovations in applied digital information technology. What remains significant in the reporting of the methodology is the process itself: its goals, objectives, phasing, and ultimate diagnostic value for remedial treatment and preventive conservation for this and similar sites worldwide.

2.1.1 ARCHITECTURAL SURVEY

In preparation for the graphic recording of previous and existing conditions, a sector-by-sector architectural survey of each room or space containing surviving plasters and surface finishes was undertaken for Mug House and Cliff Palace and guided by a manual created for the project. Information recorded included masonry construction materials and techniques, with an emphasis on finishes typology, architectural features, and previous stabilization efforts for each area (see appendix 1, pages 64–67). Architectural terminology was developed in conjunction with park archaeologists to refine existing descriptive terms for Mesa Verdean and Puebloan architecture in general.

A descriptive survey of architectural information was considered a necessary preface to condition recording for several reasons. First, by describing the architectural materials and construction, features, and repair campaigns for each space by architectural segment, surveyors visually educated themselves about the type, variation, and extent of the architectural fabric before recording the range of symptomatic conditions.³ Second, by observing and recording the variables of location, exposure, materi-

als, construction, and previous repair with respect to condition, critical associations could be established early on that would aid in ultimately understanding the complexities of deterioration mechanisms and patterns. These field data were later manipulated using Access database software to test the role of related factors such as construction technique, exposure, and previous repair on existing condition. Detailed documentation of the architectural context of the surface finishes also assisted archaeologists in better understanding the original and subsequent application, use, and meaning of these finish materials in the context of their own work.

2.1.2 PHOTODOCUMENTATION

Two hundred fifty individual photographic images were produced of the 10 rooms and 5 kivas at Mug House for the purpose of recording specific details of the conditions of the architectural surface finishes, including plain and painted plasters. An “ideal” image size, or surface area recorded in each photograph, was first determined to allow sufficiently detailed capture of subtle but significant conditions, such as map cracking, for further graphic annotation. This requirement will vary for each project depending on the specific conditions to be recorded, the degree of detail required, and the architectural configuration. At Mesa Verde, a total distance of 121 cm from the wall was established to ensure adequate overlap from one image to the other, accounting for areas of distortion normally occurring around the edges. Plumbines were hung to indicate in each image the determined 66 cm wide sector, while the top and bottom margins were delineated by the tops of walls and the ground surface accordingly, thereby allowing the architectural form to dictate to some degree the vertical dimension of the recording module.

Equipment employed included a Pentax 28 mm perspective control “shift” lens mounted on a 35 mm single-lens reflex camera. While larger formats were originally considered in order to obtain what is commonly believed to be a finer image quality, they were found to be cost prohibitive both in the field and in postprocessing when utilizing photo-CD

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

technology. Similarly, digital photography was considered; however, at the time of the pilot project, the digital phototechnology available within the budget range of the project was not equal to that of the quality of standard emulsion film technology. With this in mind, the 35 mm film format was selected due to the relative ease in handling and operation as well as the greatly reduced expense of photo-CD production.

Initially several black-and-white films and a number of lighting scenarios were tested to determine the best approach in obtaining image quality and detail of the various plaster conditions. Kodak TMAX 100 black-and-white film was selected for the enhanced contrast required to accentuate certain surface conditions.

One tall and one very small tripod were necessary for all the photodocumentation, not only to stabilize the camera when using the slower film speeds but also to produce consistent results throughout the recording process. Measurements were taken to find the exact center of each sector photographed and to determine the 121 cm distance from the wall. Use of the tripods with bubble levels ensured that the film plane was parallel to the wall each time to eliminate as much distortion as possible. Important to note, however, is that the inherent irregularities of the wall surfaces and curvature of the kiva walls dictated that these photographic images were only marginally rectified or scaleable. This limitation was not disabling, as the primary purpose of the photographs was to provide a background base image for overall dimensions and superimposed graphic annotation of conditions.

Experimentation with supplemental lighting consisted of a small flash unit held away from the camera at an angle to produce a small degree of raking light. The high degree of irregularities in the wall surfaces could be either enhanced to show greater surface detail, or exaggerated so as to appear greater than they actually were. Light from the flash, in other words, can produce at least two conditions: the flattening out of some surfaces, effectively erasing the appearance of cracks and bulges, or an exaggeration of cracks and bulges so that they appear more severe than is actually the case. Each sector of wall was then photographed with natural light only and again with

raking flash to allow selection of the most accurate or best representation of the surface conditions. On the average, however, only the images produced with the natural light were chosen for printing. A flash (or a slave on occasion) was used to fill in the very darkest areas of an image or to even out images with both dark and light occurring simultaneously.

2.1.3 CONDITION RECORDING

All field recording of conditions (and eventual treatments) was executed with waterproof colored pens on Mylar overlays on 8 x 10 in. printed photographs. Direct laptop data entry on-site was not practical due to the harsh environmental conditions, lack of electrical power, and limited budget. Graphic recording systems were developed using color and symbol to define discrete condition types and subtypes within each. Both linear and overall pattern symbols based on standard AutoCAD graphics were employed, depending on the condition category and type (see appendix 1, pages 64–67). For example, subtractive conditions such as loss, detachment, delamination, and cracking were represented with various linear patterns, while additive conditions such as various surface deposits and biogrowth were represented by overall dot patterns.

Within general condition types, color and pattern were further refined, linking subtypes together and/or reflecting the different levels of severity within a type. For example, all subtypes of loss were represented in red, and repair campaigns were represented in blue. In other cases, graphic symbols were further refined so that linked subtypes were expressed as variations on a specific pattern such as diagonal hatching and cross-hatching for detachment and delamination and solid and dashed lines for various modes of cracking. In this way, a graphically compatible and easily legible classification system could be created, allowing a fast visual reading both within condition categories (same type) and across condition categories (different types) while at the same time referencing past conditions and previous treatments through complementary graphic overlays and notes. The result is a graphically meaningful and easily legible system based on color and symbol, and

letter-related text for additional notes that takes advantage of human activity in color and pattern recognition.

2.2 DIGITAL DOCUMENTATION

All field-recorded information was subsequently imported into computer photographic and drawing applications to transfer the field survey into a digital format. The final product is a series of plotted vector drawings within the traditional architectural format of scaled elevations and plans but with complex, discrete overlays of annotated conditions, past treatments, and the ability to quantify each condition. These could be produced with or without the raster photo underlays (figs. 5 and 6, see pages 59 and 60). In addition, all current treatments were recorded on the survey for correlation between condition and treatment method and for future evaluation of treatment efficacy.

Three well-known and available graphic and database software programs were selected based on their compatibility, ability to process and analyze the data, and ease of manipulation and retrieval of the data combining graphic, textual, and numeric data. Adobe Photoshop was used to manipulate the CD-ROM raster image, combining and refining the photo elevations of each space. Selected negatives from the 35 mm black-and-white base images used in the field survey were scanned onto a CD-ROM. This process was performed by a commercial photography laboratory producing high-resolution images. Using Adobe Photoshop, the individual sector photographs were manipulated to correct perspective, crop images, and change contrast and sharpness where necessary to produce a good base image for the conditions graphic overlays. All individually entered sectors were then joined to complete each elevation. Joining and rectifying the photographs as a complete montage elevation should always occur first, before detailed sector recording of conditions is attempted, so that anomalies (e.g., misalignment, perspective distortion, or contrast) can be corrected on the base photographs and allow for accurate conditions overlay on the sector photographs at any scale (i.e., individual sector or entire elevation).

Drawing programs were used to trace the architectural elements and the conditions. Drawing programs read both raster and vector images and therefore translated the information from raster photographs into vectored drawings. To date, two software programs have been used to import the raster photomontages from Adobe Photoshop into AutoCAD: Spittin' Image (in 1995) and, currently, CADOverlay. Compatibility between software is critical from the onset. Through these programs, architectural elements and surface conditions were traced over the photographs, as was done with the Mylar overlays in the field survey. Depending on site conditions and budget, conditions recording can be done directly in the field on laptop computers.

Finally, AutoCAD was used to manipulate the data, assemble all sections, and create architectural drawings to scale. AutoCAD is a graphics software that allows architectural formatting, scaling, and presentation. In this program, the individual sectors were pieced together to form panoramic images or "roll-outs" of the walls of the kivas and individual wall elevations for rooms and open areas. AutoCAD also enabled the display of multiple layers of conditions in any combination simultaneously. The photomontage underneath provided a comprehensive visual representation of the surfaces and spaces, allowing further complex analysis of patterns of deterioration relative to location and orientation within the entire space. Quantification of individual conditions as surface area was performed in AutoCAD and imported into the database program Access. The created database has allowed the quantification of conditions by location and type and will allow future study and tracking of deterioration through time. The field survey data were also transcribed into the database, allowing conservators to test the relationships between condition and deterioration and the variables of original design, materials, construction, exposure, and past interventions.

3. DIAGNOSIS: WHAT THE EVIDENCE SUGGESTS

The breakdown of conditions recording into discrete, symptomatic descriptions allows for the

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

possibility of establishing correlations among conditions and across variables such as environment, composition, construction, and previous modern repairs. This accomplishment has been made all the more possible through the ability to better manipulate digitized data as discrete layered information systems with CAD and GIS software. Short of long-term monitoring, the careful recording and interpretation of existing conditions afford the conservator the opportunity to posit trends and potential cause-and-effect relationships. Instrumental monitoring provides the quantitative data necessary to understand the subtleties of change over time. However, what, where, how, and when monitoring occurs depend first on an understanding of the critical parameters affecting change through an initial reading of the existing physical evidence.

The overall recording of conditions in the context of supporting documentary information such as past uses, treatments, maintenance, etc. allows a working prognosis or prediction of causes, trends, patterns, and significance. These can later be supplemented and confirmed using other methods of investigation and analysis that lead to the point of diagnosis.

The following observations are a summary of the major conditions recorded for Kiva C, Mug House, during the field survey from 1995 to 1998. When considered in conjunction with other factors such as environment and microclimate, wall orientation and exposure, wall composition, construction technology, and previous interventions, these observations suggest a complex etiology for building and material performance and failure through time. The summary observations described below are intended to accompany and supplement the graphic data provided as printout and on screen and are organized by condition type (see fig. 6, page 60). In this way, multiple interpretations of conditions can be explored to reveal patterns and trends as well as anomalies related to time, location, and condition type. With the application of "smart" mapping programs such as ArcView, predictive modeling of conditions as indicators of future damage can offer expanded analysis and opportunities for better risk assessment for cultural resources at any scale.

Although definitive statements confirming the various mechanisms and rates of deterioration observed at Mug House, and specifically for Kiva C, must be deferred, at least until the environmental monitoring data have been finalized, several general correlative observations can be made on the basis of the visual survey and the architectural design and construction, and materials analysis and characterization of the mortars and surface finishes:

- Room/space location and orientation, in terms of exposure and grade, are significant factors in determining the overall condition of the stone, mortar, and architectural finishes of alcove sites, all other factors being equal. This relationship is due predominantly to the deleterious effects of water on the earthen materials either as direct precipitation (melting snow and rain) or as groundwater from percolation and rising damp through the sandstone (fig. 7, see page 60).

- Room construction and use history appear to affect the early condition history of the finishes. Partial vitrification and embrittlement from intense burning both during and after occupancy, instability from the application of numerous plaster layers over time, use-related damage and the presence of carbon soot deposits between layers, as well as the ubiquitous loss of roofs after abandonment, have all affected the durability and hence condition of the finishes both before and after burial and excavation.

- Excavation and subsequent selective exposure to the elements, even in a protected environment such as the cliff alcoves, have caused the most significant damage to the fragile surface finishes. This damage is clearly evident in the increasing loss observed over time since excavation (after 1959 at Mug House).

A more detailed analysis of the observed conditions in Kiva C, discussed below by type (see appendix 1, pages 64–67), suggests various patterns and trends linked to the specifics of the above determinants.

4. SUBTRACTIVE CONDITIONS

4.1 LOSS/PARTIAL LOSS

Total loss is the final and ultimate stage of deterioration for surface finishes. It is the most extreme condition and obviously nonrecoverable; however, the careful recording of total and partial loss is a useful indicator of past and current patterns and trends, especially when datable through earlier photodocumentation. When viewed in conjunction with partial loss, active deterioration characterized by specific conditions such as detachment, delamination, and flaking can be understood as the preface to total loss.

In Kiva C (and most other kivas), nearly all loss has occurred across the upper walls and along the upper quarter of the lower banquette walls (fig. 8, see page 61). This loss pattern is due to the overall vulnerability of these areas to weather exposure during occupation from roof leaks (prehistoric repairs are often found in the upper walls), after abandonment from associated roof collapse, and after excavation and rebuilding during stabilization. Early prestabilization photographs of Kiva C (1935) show masonry and roof collapse, exposed upper walls, and total plaster loss (fig. 9). The lower banquette walls—being concealed and possibly protected by fallen roof and debris—were observed in 1935 to be generally intact, a situation common for many kivas in cliff sites. A comparison of the extent of surviving plaster evident immediately after excavation and stabilization in 1959–60 to today overwhelmingly illustrates the loss of plaster that often results after excavation. At Kiva C more than 25% (surface area) of the existing plaster finishes recorded in 1960 was subsequently lost over the next 40 years of exposure, most of the loss occurring along the upper banquette.

Most partial loss also occurs along this upper banquette wall face, often directly below areas of total loss, as well as along the base of the banquette (fig. 10, see page 61). Conversely the entire middle zone of the banquette walls retains the most complete finishes, especially on the pilasters. This pattern—although dependent on the specifics of room orientation, namely exposure and proximity of the space

to the alcove's rear wall, surrounding wall height and configuration, and the number of superimposed finish layers—generally reveals the critical relationship among design, construction, and weatherability.

The finishes on the walls directly under the flat banquette ledges between the pilasters succumb to the wind-driven rain and melting snow that accumulate on these flat, horizontal upper surfaces along the outer west and northwest sections. This pattern of precipitation has been observed in action and can be deduced from the succession of related conditions along the upper banquette wall, beginning at the top with total loss and detachment and deformation of the remaining plaster edges, to partial loss and delamination lower down the wall. The telltale evidence of new and old soil wash patterns in these locations down the upper and lower walls (monitored over two years) clearly points to active water flow channeling. This activity leads to the probable sequence of plaster decay including saturation, swelling, and shrinking of the clay fraction of the finishes, salt formation, deformation, blistering and detachment of the layers, debris accumulation in the detachment, and eventual mechanical failure and loss. These conditions have been recently induced in sequence through laboratory simulation in preparation for treatment testing and evaluation. Changes in partial loss over time clearly indicate the active nature of this condition in exposed areas (Carr 2002).

Conversely, the lower eastern walls along the rear of the alcove display less differential damage relative to the banquette shelves and no soil wash, presumably due to the protection afforded by the extreme depth of the alcove (fig. 11, see page 62). However, what can be observed along the lower rear walls is severe delamination and flaking, salts, and intralayer root masses, the latter responsible for post-1960 loss of the last dado layer along the upper banquette wall. These conditions suggest typical moisture problems related to cyclical wetting from driving rain and snow and frequent thermal cycling. In fact, Kiva C is uniquely situated in the alcove so that its western half experiences prolonged wetting directly from rain and melting snow captured on the banquette tops, while its eastern half experiences some direct wetting from heavy precipitation events. In addition, sulfate and

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK



Fig. 9. Kiva C. Mug House, 1935, before repair. Courtesy of NPS-MEVE

bicarbonate-rich groundwater periodically saturate the eastern lower walls.

Overall patterns of groundwater emergence for the entire alcove are further complicated by the orientation of the north-south dip of the alcove's shaley layers, which affects the location and quantity of water emerging from the rock. For example, those kivas and rooms located along the rear of the northern half of Mug House, upslope of the shaley seam, exhibit far more salts, presumably due to the initial discharge of water at this end. Conversely, rooms along the rear of the southern half, downslope of the shaley seam, display less efflorescence and water damage where protected from wind-driven rain and snow.

Based on this evidence, room location within the alcove—especially as it relates to rear wall moisture determined by the activity of water percolation and the orientation of the shale seam, subterranean ground elevation, as well as exposure to the weather—is critical in determining plaster conditions. No doubt the immediate physical context of each space, such as the surrounding wall heights,

creates unique climatic environments for each architectural feature and associated surface finishes. Nevertheless, the specific combinations of conditions observed in Kiva C at Mug House reveal the importance of siting within the alcove and the complexity of primary and secondary factors in the explanation of basic decay mechanisms (see fig. 7, page 60).

After environment, composition and layer structure of the finishes, in association with the deposition of carbon soot and embrittlement from intense burning, play an important role in determining condition. All surface finishes examined thus far reveal a well-proportioned ratio of kaolinite-illite clay binders to a fine but well-graded and sorted silt and quartzitic sand fraction, thus ensuring initial good adhesion and low shrinkage of these finishes (Dix 1996, 88–90) (table 1). Cryptocrystalline calcite found in the soil used to prepare the plasters and also possibly deposited subsequently from bicarbonate-rich groundwater helped to give good durability to these finishes. The possible presence of organic plant additives, as recorded in late-19th-century ethnographic accounts, could have also provided short-term dura-

Table 1. Summary of Geo-Technical Analysis of Samples from Kiva C, Room 28, and Adobe Cave, Mug House (Dix 1996)

	KIVA C	ROOM 28	ADOBE CAVE
Number of layers	8-14	2	-
Micromorphology			
Particle size distribution	clay loam/sandy clay loam 30% clay 21% silt 49% fine sand	clay loam 29% clay 31% silt 36% fine sand 4% coarse sand	silty clay 30% clay 65% silt 5% fine sand
Plastic limit	17.1%	17.3%	42.0%
Liquid limit	21%	26%	47%
Plasticity index	4	9	5
Soluble salts	sulfates, carbonates	nitrates	carbonates
pH	6.2	6.6	6.8
Munsell color	7.5 YR 6/6 reddish yellow	7.5 YR 6/6 reddish yellow	7.5 UR 6/4 light brown
Clay minerals	kaolinite with some illite and smectite	kaolinite with some illite and smectite	-
Nonclay minerals	quartz gypsum	quartz	-
Elemental profile	silicon, aluminum, oxygen-primary, iron, carbon, calcium, potassium, magnesium, sulfur	silicon, aluminum, oxygen-primary, iron, carbon, calcium, potassium, magnesium	silicon, aluminum, oxygen-primary, iron, carbon, calcium, potassium, magnesium

bility, initial increased plasticity, water retention and thus shrinkage reduction, and water resistance. No evidence of these additives was found during analysis with Fourier transform infrared reflectometry (FTIR). The general lack of map cracking in protected areas, free from subsequent wetting and drying, confirms the technical skill attained in the original formulation and application of these surface finishes, i.e., free from shrinkage.

Layer structure, and indirectly masonry construc-

tion, is without doubt a significant factor in finish condition. With very few exceptions, each plaster layer applied probably represents a single campaign, evidenced by heavy carbon soot buildup and separation fractures that often occur between layers over time. Of all the building and room types, kivas, without exception, contain the greatest number and most complex application of surface finish layers and intralayer soot deposits (fig. 12, see page 63). This condition may well be due to the largely ceremonial

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

function of these spaces and the direct association of plaster and wash application, plain or painted, with ritual, possibly on an annual cycle such as the historically recorded Hopi Powamu ceremony (Fewkes 1909, 10). Visual interpretation of the finish stratigraphies into architectural campaigns was easily achieved for the studied architecture at Mesa Verde utilizing the existing photomontage as a base for two- and three-dimensional colored reconstructions.

Given the weak and brittle nature of these earthen finishes (when dry), layer stability is generally inversely proportional to the number of layers applied to the surface. As with other plastered masonry, the earthen finishes adhere best to the earthen mortar joints regardless of keying, and less well to the stone. Intralayer delamination often results from poor adhesion caused by carbon soot deposits at these interfaces. Once detached, salts and roots find ideal environments to develop further, thus exacerbating the problem of delamination, salt formation, and moisture retention. At Mug House, most kivas are carefully constructed with regular, well-shaped, and finished stones, especially for the pilasters and lower banquette wall. This construction has the effect of ensuring a smooth, curvilinear surface upon which to apply the numerous thin earthen plasters and washes needed to complete the architecture.⁴ Only Kiva C, whose masonry is roughly shaped, finished, and coursed, has a thick initial leveling plaster of several centimeters applied to the masonry substrate and followed by subsequent thin finish plasters and washes, some of which appear to have been burnished (lower red dado). As a result, this construction technique has caused unique detachment problems in Kiva C, given the vulnerability of the thick base plaster.

4.2 DELAMINATION AND FLAKING

A subset of partial loss characterized as active surface (flaking) and intralayer (delamination) failure has been found extensively along the lower banquette walls, especially in combination with salts and previous root growth.

4.3 DETACHMENT

Loss of bond between the plasters and their masonry substrate occurs as either open or blind separation. This loss is found as a narrow linear zone across much of the upper top edge of the lower banquette wall. It is a discrete condition often occurring in conjunction with total or partial loss since excavation (recorded as "loss since Rohn"; see fig. 6, page 60) due to exposure and failure resulting from wet/dry deformation and stress cracking, debris accumulation pressure, and falling damp.

4.4 BLISTERING

The wetting, swelling, delamination, and subsequent deformation of thin single or multiple layers of plasters and washes result in the formation of blisters of variable sizes and shapes. Often these exist in various stages as blind, cracked, and broken forms, always in locations where water has been or still is present. Although this condition is prevalent in other spaces, its occurrence at Kiva C is very limited.

4.5 CRACKING

No major structural failure exists in Kiva C, although some cracking is related to previous joint and masonry movement that has been translated to the plasters. Map cracking occurs in isolated areas, particularly the lower rear wall in association with root mass-related delamination. There is no evidence to suggest that this map cracking was caused by initial shrinkage of original plasters. However, areas of repeat wetting and drying indicate stress failure in the form of map cracking.

4.6 MECHANICAL DAMAGE

Mechanical damage occurs in isolated areas, especially along the lower walls as random scratches that appear to be due to animal activity and as small divots from the inadvertent strike of the excavators' trowels into the plaster. This damage is not related to any other conditions.

5. ADDITIVE CONDITIONS

5.1 SOIL WASH AND RUNNELS

Soil wash occurs as a thin wash of tan-brown soil or deep runnels extending downward from the upper wall edges and banquette ledges. Soil wash flows down the surface according to divots and jogs in the upper masonry. The recording of variations in the soil wash patterns over two years within the same areas confirms an active condition of water runoff along the western edge of Kiva C, especially in the keyhole and to the north. Active loss and areas of detachment, delamination, and deformation along the upper plaster edge of the banquette walls are all found in association with soil wash and runnels above.

5.2 EFFLORESCENCE

Naturally occurring carbonates, and to a lesser degree sulfates, constitute the major soluble salts present at Mug House. Salts are clearly visible as discrete nodules in the bedding mortar and stone in areas of high moisture saturation both along the front and the rear, depending on the source of moisture. Salt cycling appears to be more severe along the front wall, where summer rains and melting winter snow cause dissolution and recrystallization within these materials. As a result, both stones and mortar in areas along the upper banquette walls to either side of the pilasters display considerable efflorescence and decay due to repetitive, prolonged wetting from melting snow and rain.

5.3 COLOR CHANGE

Color change is most characteristically observed as a localized reddening of the plaster, mortar, and stone, most intense on the surface and gradually diminishing with depth. This color change is caused by the calcination and oxidation of the iron-containing minerals in the clays. Fire reddening occurs exclusively along the upper half of the banquette walls and especially on exposed stones that were covered by plaster visible in the 1960 Rohn photographs and now missing. Burning may have embrit-

tled the plasters (as in Kiva B), resulting in loss through weathering. The location of the fire reddening along the upper half of the banquette wall suggests burning may have occurred after abandonment and roof collapse that might have protected the lower walls.

5.4 CARBON SOOT

The location of carbon soot staining at Kiva C complements the locations of fire reddening. That is to say, carbon soot blackening occurs on the upper walls of *in situ* stone and plaster fragments above the fire-reddened areas and not on the last plaster layer along the lower banquette wall. Continuous thick overall carbon soot application has also been found on elements in some kivas and rooms that appear to have been selectively exposed in combination with the application of colored washes. These situations suggest the conscious application and/or manipulation of carbon-sooted surfaces as a design element.

5.5 VEGETATION AND BIOGROWTH

No active plant growth currently exists in Kiva C; however, ample evidence exists in the form of dead root masses between plaster layers along the rear lower wall. Root growth preference between the plaster surface and the fill is evident from mineral root pseudomorphs on the surface of the plaster. These are calcium deposits leached and redeposited by the plant over time, replicating the form of the original root. Evidence of both forms of growth along the rear wall can be attributed to the moist conditions along the rear alcove and the presence of a favorable growing medium from the deteriorated wet plaster. Biogrowth or microflora of fungi and lichens also occurs in limited and isolated locations in all cases associated with previous or current areas of moisture.

5.6 PREVIOUS REPAIRS

At least six repair campaigns were identified at Mug House, the first beginning in 1935 by Earl Morris and Al Lancaster. With the full excavation of

MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

Mug House by Arthur Rohn from 1960 to 1962, the site was stabilized for projected visitation. At Kiva C, repairs involved reconstructing the upper walls by laying new and recycled stones in Portland cement bedding mortar and pointing with a shallow, tan soil-cement mortar, stabilizing the deflector, and rebuilding and strengthening the ventilator with iron support rods. This pointing is cracked and loose, with areas of loss exposing the hard, gray bedding mortar underneath. No attempts were made to stabilize the painted plasters of Kiva C upon exposure; however, field descriptions of the plasters and hand drawings of the mural paintings were made, indicating areas of mural no longer extant.

6. CONCLUSIONS

Once the Mug House project was established as a model for future conservation at Mesa Verde National Park, the next step was to develop a comprehensive survey program for recording the surface finishes in the more than 600 alcove sites. In 1998 a priority treatment assessment program was initiated by park conservators to establish a prioritized treatment schedule for the remedial care and long-term preventive conservation of these neglected components in select front- and backcountry sites. The program also was designed to provide a management strategy for parkwide planning and budgeting for future conservation work. This survey builds on previous surveys conducted in the 1980s (Silver 1985; Fetterman and Honeycutt 1989; Bohnert 1991) by numerically ranking each room/space and unit for proposed treatment according to detailed physical condition, relative importance or significance, and public accessibility. Data are entered into an Access database where architectural, condition, and treatment information can be queried.

From 1998 to 1999, nine alcove sites with more than 760 walls were assessed and assigned a treatment priority rating based on the criteria above. Ninety-one walls, or nearly 12% of the elevations surveyed, at an approximate total of 375 square meters, have a high priority for treatment. Treatment priority location maps for each site and treatment schedules based on the Mug House pilot program have been made

for each of the high-priority walls. In addition to this parkwide finishes reassessment program, the Mug House pilot program was applied to study and ultimately treat the most-at-risk architectural surface finishes and mortars of Cliff Palace, one of the best known and largest cliff dwellings in the United States. Remedial treatments for detached finishes and temporary site protection methods were developed according to a parallel research program based on the analysis of the condition survey, finishes characterization, and environmental monitoring.

Mesa Verde is public heritage whose care and interpretation are entrusted by law to the National Park Service, and future research and continued public enjoyment of this park must be guaranteed. Given its uniqueness and world-class significance, any conservation measure considered must be evaluated against the physical changes that will result from its implementation now and in the future. To this end, continued site investigation and survey, environmental monitoring, and judicious treatments based on an easy, accurate, and reproducible system of conditions recording can be recommended as the most responsible and appropriate method toward developing, implementing, and modifying, over time, a cultural resource management plan.

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NOTES

1. Documentation is addressed in most international and national conservation charters. See, for example,

Article 16 of *The International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter)* (UNESCO) and Articles 24–28 on Documentation and their Commentaries of the *Code of Ethics and Guidelines for Practice* of the American Institute for Conservation of Historic and Artistic Works. Documentation and recordation can be further defined whereby documentation refers to the compilation of all written, graphic, and photographic information, past and present, and recordation as specifically the processes of describing, through written, graphic, and photographic means, the present configuration and condition of cultural property.

2. By “standard” I mean a reference point. In the case of conditions classification systems, a standard implies developing a consensus among professionals on both the general meaning of specific conditions terminology and an agreed-upon order to that system and its graphic representation. Standard terminology is common in other scientific disciplines, such as geology and cartography, and allows for better communication among professionals. Standards and standardization do not and should not attempt to restrict definitions or fix specific conditions with specific causes.

3. At Mesa Verde, spaces were divided into “segments” to define a practical architectural unit, e.g., banquette, to which quantitative and qualitative descriptions could be assigned. In contrast, conditions were recorded on “sectors” or area units created by the superimposition of an abstract grid over the architectural surface.

4. At Mesa Verde, “plasters” are defined as discrete finish layers greater than 1 mm in thickness; “washes” are discrete colored finish layers less than 1 mm thick. This visual classification according to thickness is reinforced by consistent distinction in granulometry, suggesting an original understanding of the use, if not formulation, of plasters and washes based on observed performance characteristics.

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MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND CONDITION SURVEY AT MESA VERDE NATIONAL PARK

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MANAGING CHANGE: THE ROLE OF DOCUMENTATION AND
CONDITION SURVEY AT MESA VERDE NATIONAL PARK

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(color plates, pp. 59–67; see article pp. 39–58)



Fig. 2. Extant exterior and interior architectural surface finishes at Speaker Chief House, Cliff Palace, Mesa Verde. Courtesy Architectural Conservation Laboratory, University of Pennsylvania

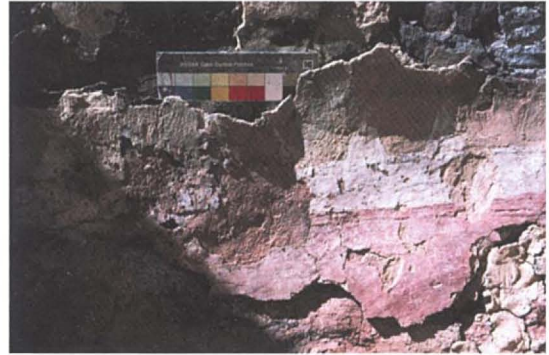


Fig. 4. Mug House, Kiva C, 1995, showing detail of detachment, delamination, and flaking before treatment. Courtesy Architectural Conservation Laboratory, University of Pennsylvania

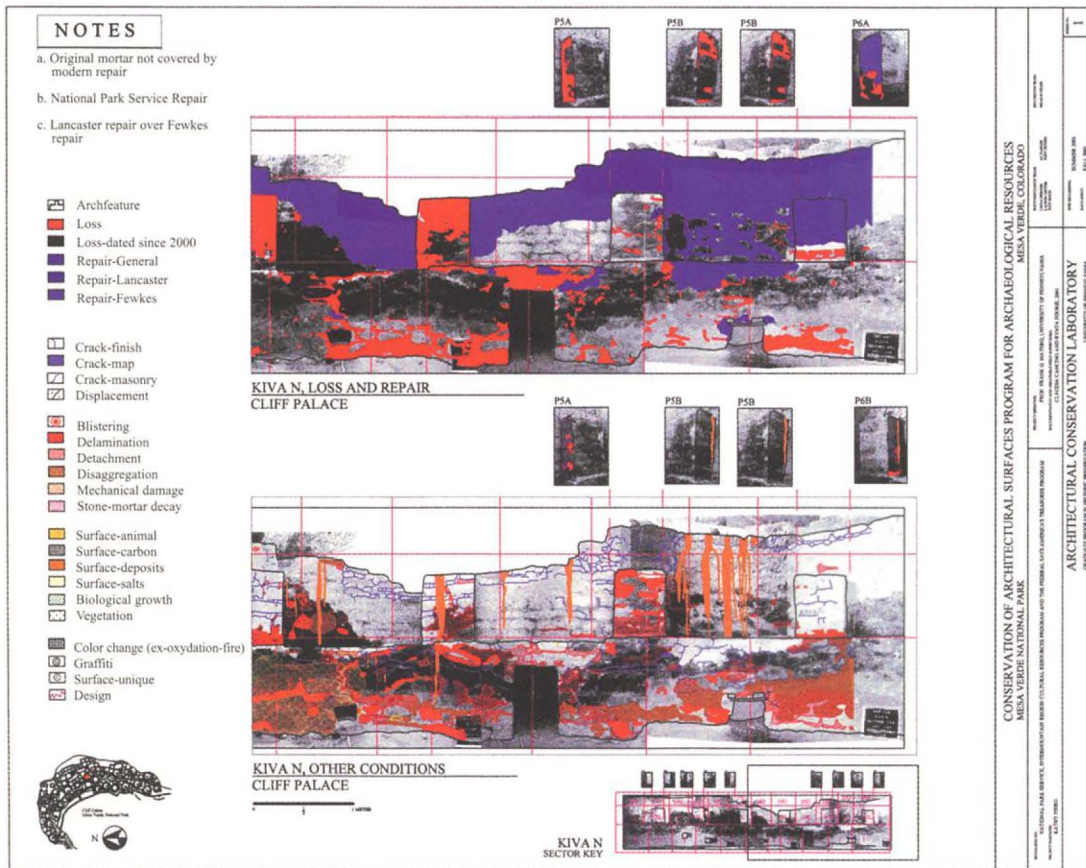


Fig. 5. Elevation montage of Kiva N, Cliff Palace, conditions. Courtesy Architectural Conservation Laboratory, University of Pennsylvania

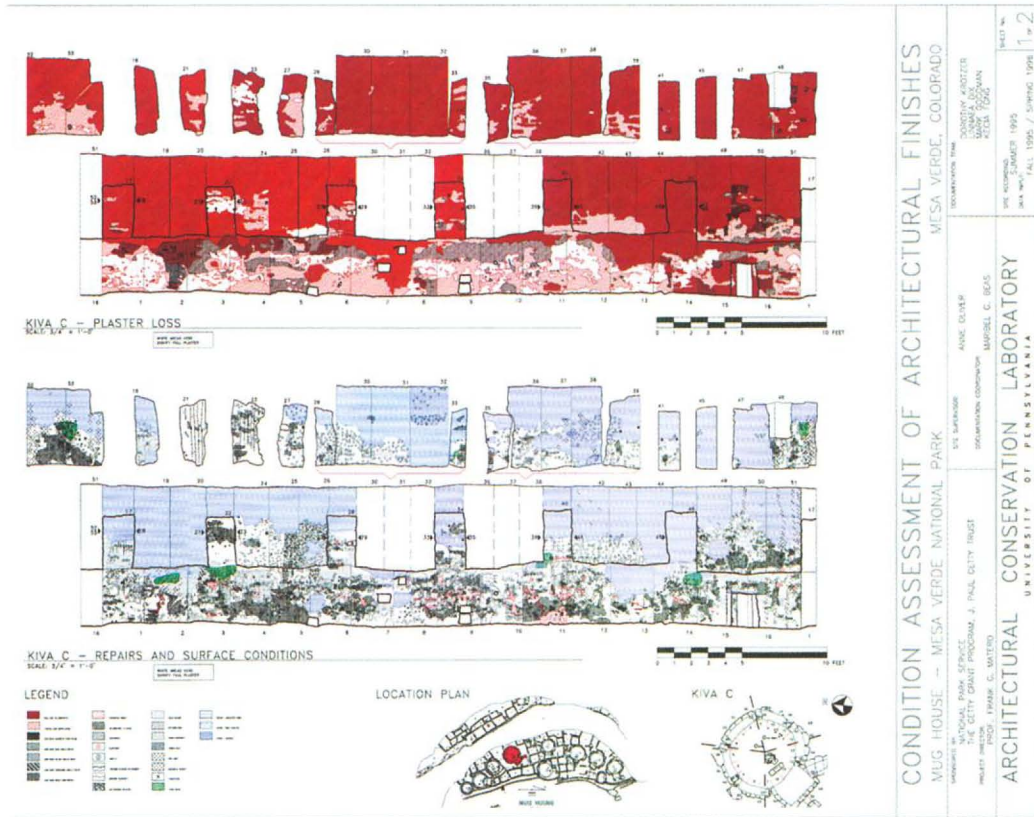


Fig. 6. AutoCAD elevation of Kiva C, Mug House, showing all recorded conditions, past and present. Courtesy Architectural Conservation Laboratory, University of Pennsylvania

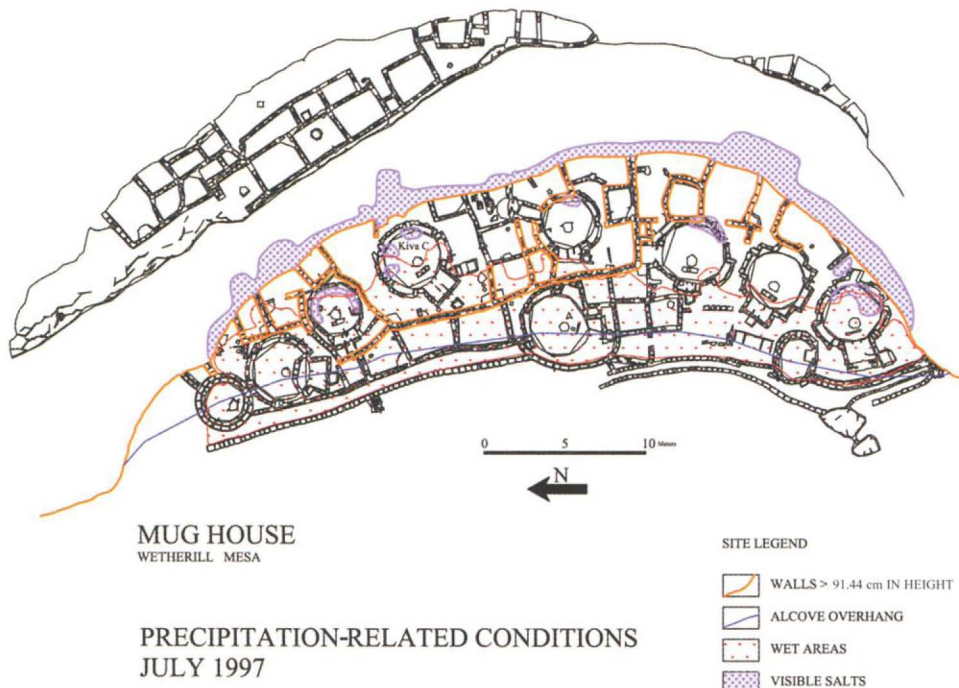
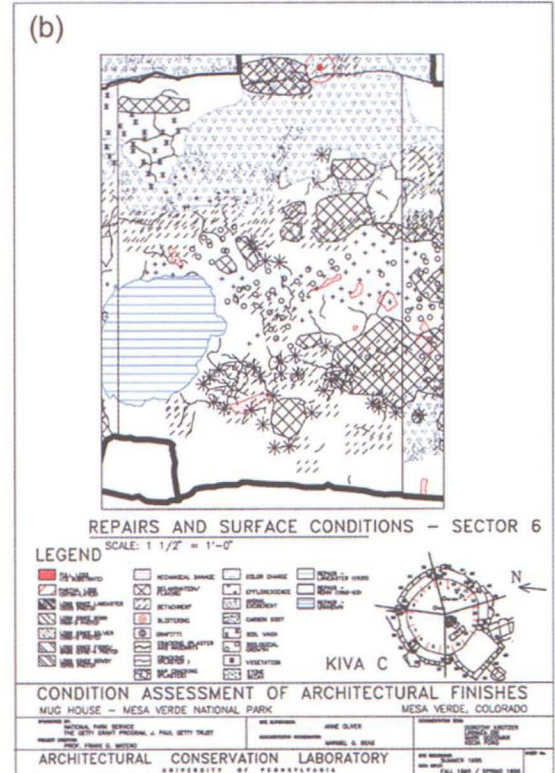
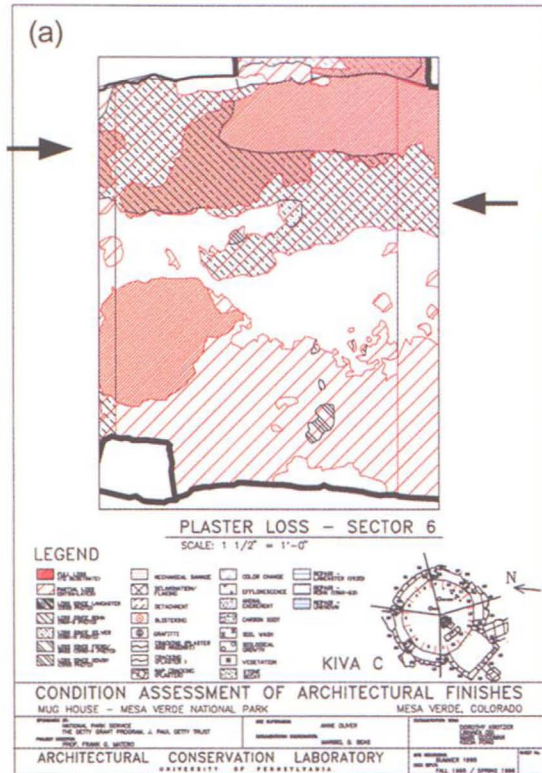


Fig. 7. Plan of Mug House showing field-observed patterns of precipitation and active efflorescence. Courtesy Architectural Conservation Laboratory, University of Pennsylvania



Fig. 8. Kiva C, Mug House, north end, 1994, before treatment. Courtesy Architectural Conservation Laboratory, University of Pennsylvania

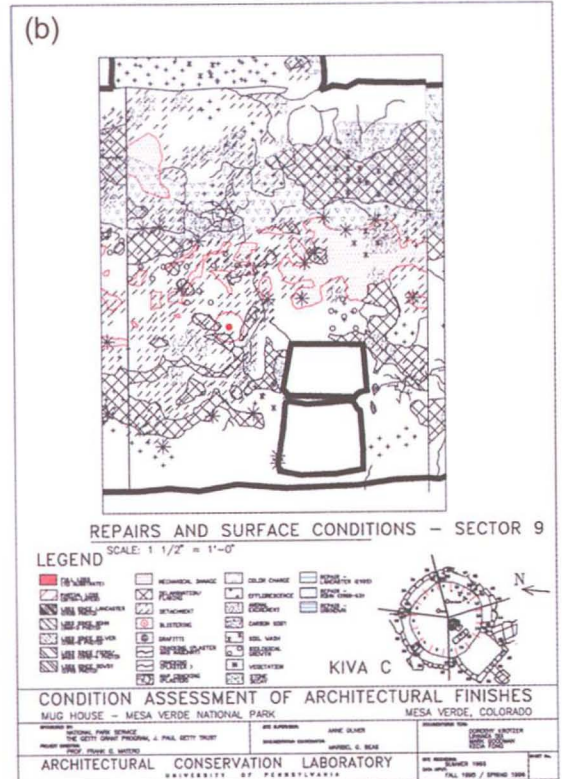
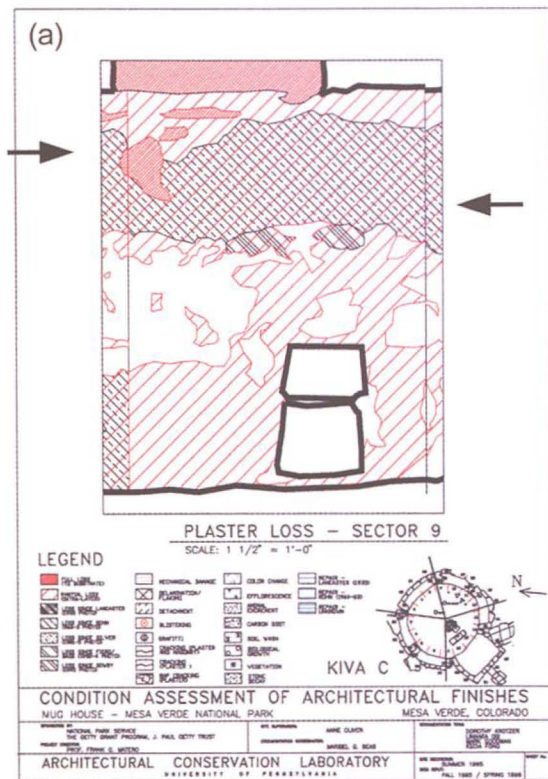


Note areas of loss since excavation (1959–60).

Fig. 10. Kiva C, Mug House, Sector 6-conditions. Arrows indicate areas of loss since excavation (1959–60) in a. Sector 6 photo elevation and condition drawing. Courtesy Architectural Conservation Laboratory, University of Pennsylvania



Fig. 11. Kiva C, Mug House, Sector 9—conditions. Arrows indicate areas of loss since excavation (1959–60) (a) and salts and flaking in lower wall (b). Sector 9 photo elevation and condition drawing. Courtesy Architectural Conservation Laboratory, University of Pennsylvania



Note areas of loss since excavation (1959–60).

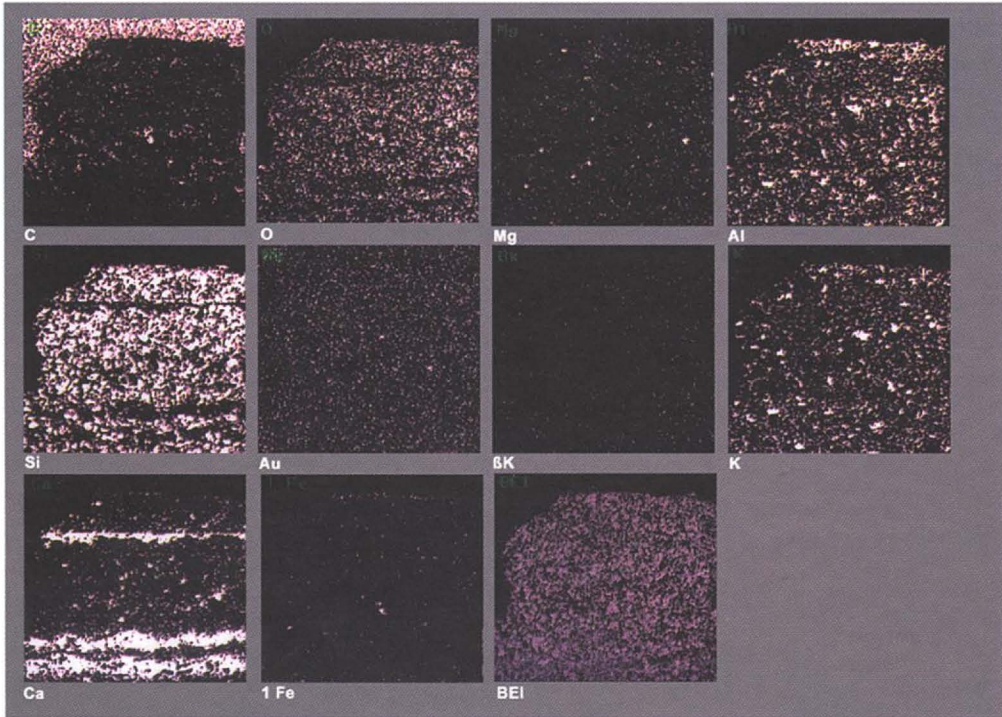
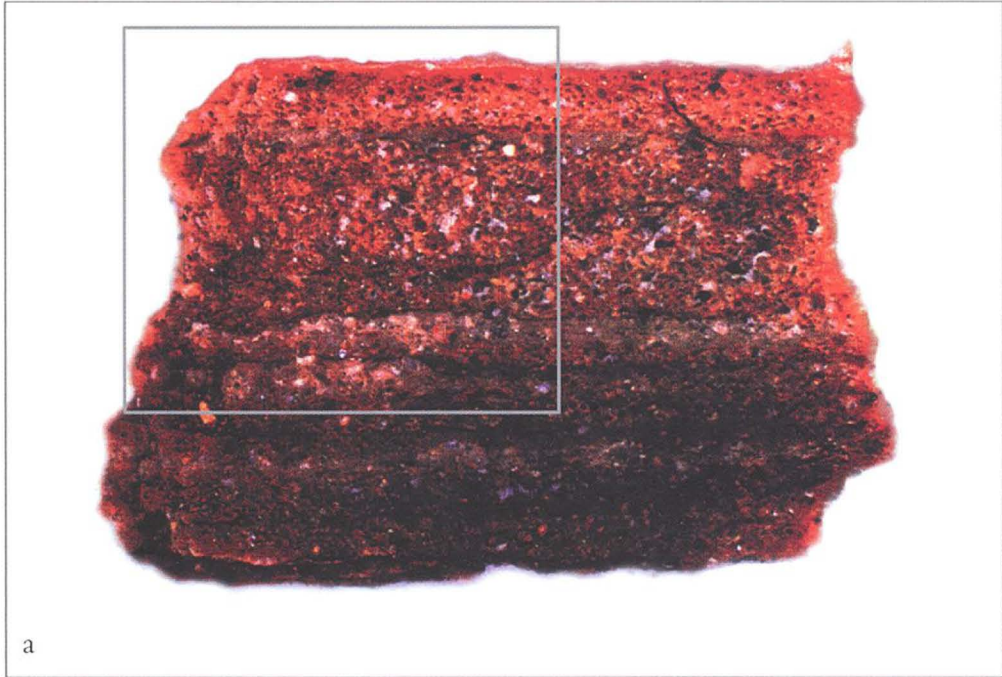
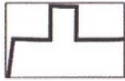




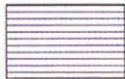







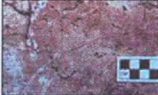

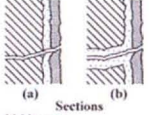




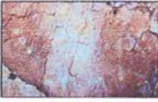
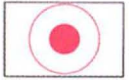
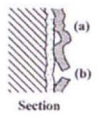
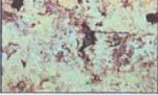


Fig. 12. Kiva C, Mug House, cross section, 25x in reflected light (a) and SEM electron dot map of sample 06 from lower dado wall identifying elemental composition of layers (b) (Dix 1996). Courtesy Architectural Conservation Laboratory, University of Pennsylvania

CONSERVATION OF ARCHITECTURAL SURFACES PROGRAM FOR ARCHAEOLOGICAL RESOURCES MESA VERDE NATIONAL PARK GLOSSARY OF CONDITIONS	
ARCHITECTURAL CONSERVATION LABORATORY AND RESEARCH CENTER UNIVERSITY OF PENNSYLVANIA	
ARCHITECTURAL FEATURE 	<p>Major building features such as wall profiles, openings, beam pockets, hearths, niches, banquettes, etc., outlined to distinguish them from material conditions and repairs.</p>
TOTAL LOSS 	<p>Complete absence of mortar or surface finish layer(s) exposing masonry beneath</p>  
LOSS - DATED 	<p>Total or partial loss since a specific date. Annotation "X" indicates date based on previous documentation.</p>
REPAIR	<p>Subsequent alterations for stabilization made for structural, aesthetic, or functional reasons including rebuilding, mortar infill and pointing, replastering, and conservation treatments.</p>
REPAIR GENERAL 	<p>Undocumented repair, date unknown.</p>
REPAIR FEWKES 	<p>Repairs executed under Jessie Walter Fewkes. Often pinkish yellow (7.5 YR 7/4) in color; friable with organic debris and often smooth finished with trowel application marks evident. Found most often in upper wall sectors of kivas, where it contrasts with the sooted and plastered original wall surface.</p> 

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REPAIR LANCASTER 	<p>Repairs executed under Al Lancaster. Often pinkish yellow (7.5 YR 7/4) in color, and hard. Distinguished primarily by finger impressions and the incorporation of chinking stones.</p> 
REPAIR OTHERS 	<p>Repairs executed by known individuals or date other than Fewkes or Lancaster. Annotation signified by "X" should indicate last name and/or date.</p>
CRACKING	<p>Fractures of variable length and orientation, greater than or equal to 0.40 mm in width, with or without associated planar displacement of the finish, and differentiated by depth and pattern. Three types noted:</p>
CRACKING: FINISH 	<p>Linear cracking through single or multiple finish layers.</p>   <p>Section</p>
CRACKING: MASONRY 	<p>Linear cracking through finishes and masonry (a) or masonry joints (b).</p>   <p>(a) Sections (b)</p>
CRACKING: MAP 	<p>Fine superficial network cracking.</p>    <p>Section Plan</p>
BLISTERING 	<p>Small-scale swelling and/or rupturing of a thin uniform layer(s) of finish either intact (a) or ruptured (b).</p>   <p>Section (a) (b)</p>

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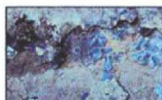
**DELAMINATION/
 FLAKING**



The lifting, separation, and partial loss of one or more finish layers resulting in an uneven, irregular, contoured surface. Flaking is small-scale, thin lamellar loss of the surface finish(es).



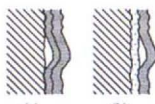
Section



DETACHMENT



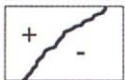
Partial planar discontinuities or voids at the masonry-finish (a) or finish-finish (b) interface detected by a hollow sound produced when tapping on the surface. May be blind or in association with delamination/flaking.



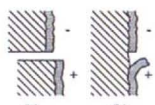
Sections



**DISPLACEMENT/
 DEFORMATION**



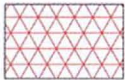
A significant deviation from the plane of the wall resulting after finish application, usually associated with mechanical failure of the masonry (a) or finish (b).



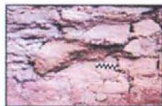
Sections



DISAGGREGATION



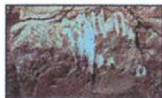
Surfaces that display active friability by grain loss under finger pressure.



**MECHANICAL
 DAMAGE**



Isolated physical damage due to impact or abrasion caused by falling rocks and debris, animal, insect, or human activity, including excavation.



3/7

CONSERVATION OF ARCHITECTURAL SURFACES PROGRAM FOR ARCHAEOLOGICAL RESOURCES
 MESA VERDE NATIONAL PARK
GLOSSARY OF CONDITIONS

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**STONE-MORTAR
 DECAY**

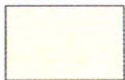


General isolated degradation of the masonry and mortar evidenced by loss, flaking, and disaggregation.



SURFACE DEPOSITS

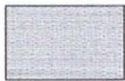
Animal



Animal or bird excrement deposited before or after excavation.



Carbon



Black soot deposited from the burning of organic material.



Soil



Deposits caused by soil runoff from upper surfaces or ground backplash, also isolated remnants of pre-excavation fill.



Salts



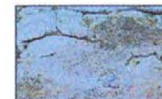
White crystalline deposits composed of water-soluble salts, sometimes visible as biomorphs of root systems of previous pre-excavation plant growth.



**BIOLOGICAL
 GROWTH**



The presence of microflora such as algae (green), fungi (black), or lichens (variable).



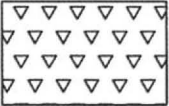




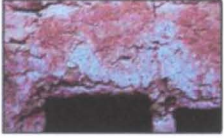
VEGETATION


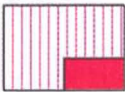

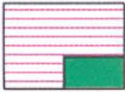
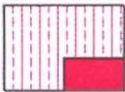


The presence of higher plant forms, including their roots' remnants.





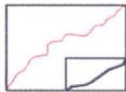


4/7

<p>CONSERVATION OF ARCHITECTURAL SURFACES PROGRAM FOR ARCHAEOLOGICAL RESOURCES MESA VERDE NATIONAL PARK GLOSSARY OF CONDITIONS</p>	
<p>ARCHITECTURAL CONSERVATION LABORATORY AND RESEARCH CENTER UNIVERSITY OF PENNSYLVANIA</p>	
<p>COLOR CHANGE</p> 	<p>Intrinsic chromatic alteration of the stone, mortar, or finishes, usually a localized reddening, caused by high temperatures from fire.</p> 
<p>GRAFFITI</p> 	<p>Incised or painted nonhistoric defacement.</p>
<p>SURFACE-UNIQUE</p> 	<p>A unique condition not described above that requires further explanation. (Include explanation on overlay or on sector description sheet.)</p>
<p>DESIGN</p> 	<p>A discrete image or repetitive embellishment impressed, incised, or applied to the plaster, washes, mortar, or stone.</p> 

CONSERVATION OF ARCHITECTURAL SURFACES PROGRAM FOR ARCHAEOLOGICAL RESOURCES MESA VERDE NATIONAL PARK GLOSSARY OF TREATMENTS		
ARCHITECTURAL CONSERVATION LABORATORY AND RESEARCH CENTER UNIVERSITY OF PENNSYLVANIA		
GELATIN REATTACHMENT TREATMENTS		
TREATMENT	CONDITION	TREATMENT METHOD
WARM 5% GELATIN 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≤ 2 mm in thickness; total area < 5 cm ² .	<ul style="list-style-type: none"> • Dry-clean debris from area. • Inject warm 5% (w/v) gelatin solution in water with 10% glycerine. • Apply pressure for 1 minute with Hollytex and Ethafoam. • Keep moist with 1:1 water/isopropyl alcohol spray.
WARM 10% GELATIN 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≥ 2 mm in thickness; total area < 5 cm ² .	<ul style="list-style-type: none"> • Dry-clean debris from area. • Inject warm 10% (w/v) gelatin solution in water with 10% glycerine. • Apply pressure for 1 minute with Hollytex and Ethafoam. • Keep moist with 1:1 water/isopropyl alcohol spray.
COLD 5% GELATIN 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≤ 2 mm in thickness with soot; total area < 5 cm ² .	<ul style="list-style-type: none"> • Dry-clean debris from area. • Inject cold 5% (w/v) gelatin solution in water with 10% glycerine. • Apply pressure for 15 minutes with Hollytex and Ethafoam.
COLD 10% GELATIN 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≥ 2 mm in thickness with soot; total area < 5 cm ² .	<ul style="list-style-type: none"> • Dry-clean debris from area. • Inject cold 10% (w/v) gelatin solution in water with 10% glycerine. • Apply pressure for 15 minutes with Hollytex and Ethafoam.
WARM 10% GELATIN + CYCLODODECANE 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≤ 2 mm in thickness with soot; total area > 5 cm ² .	<ul style="list-style-type: none"> • Dry-clean debris from area. • Apply melted cyclododecane on surface. • After solidification of cyclododecane, inject warm 10% (w/v) gelatin solution in water with 10% glycerine. • Apply pressure for 15 minutes with Hollytex and Ethafoam.

6/7

CONSERVATION OF ARCHITECTURAL SURFACES PROGRAM FOR ARCHAEOLOGICAL RESOURCES MESA VERDE NATIONAL PARK GLOSSARY OF TREATMENTS		
ARCHITECTURAL CONSERVATION LABORATORY AND RESEARCH CENTER UNIVERSITY OF PENNSYLVANIA		
INJECTION GROUTING TREATMENTS		
TREATMENT	CONDITION	TREATMENT METHOD
ACRYLIC EMULSION GROUT 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≥ 2 mm in thickness with soot; total area < 5 cm ² .	<ul style="list-style-type: none"> • Dry-clean debris from area. • Inject acrylic emulsion grout with microspheres. • Apply pressure for 1 minute with Hollytex and Ethafoam.
HYDRAULIC LIME GROUT 	Delamination and detachment of plaster.	<ul style="list-style-type: none"> • Dry-clean debris from area. • Dam openings with cotton, clay, or mortar. • Inject grout of 1:1:4 (by vol.) hydraulic lime, ceramic microspheres, fine sand, and water. • Fill/edge with soil mortar after set.
MECHANICAL CLEANING TREATMENTS		
DRY BRUSHING - SURFACE DEPOSITS 	Surface deposits: salts, animal, carbon, soil, wash, and soil-cement splash.	<ul style="list-style-type: none"> • Mechanically remove with firm, dry stencil brush in circular movements. • Scalpel if necessary.
DRY BRUSHING - TREATMENT STAIN 	Blistering, delamination, flaking, detachment, displacement, and/or deformation of finish layers ≥ 2 mm in thickness with soot; total area < 5 cm ² .	<ul style="list-style-type: none"> • Mechanically remove with firm, dry stencil brush in circular movements.
FILLING AND ENDING TREATMENTS		
REPOINTING/ EDGING 	Mortar loss, plaster detachment from masonry substrate.	<ul style="list-style-type: none"> • Apply soil mortar of color selected, sieved soil with water or amended with 5% acrylic emulsion.

7/7