# Orphans of the Storm

## The Preservation of Architectural Plasters in Earthen Ruins

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*The pilot plaster conservation project taking place at Fort Union National Monument, Watrous, NM, and Fort Davis National Historic Site, Fort Davis, TX, symbolizes an expanding role for the architectural conservator. The Division of Conservation, Southwest Regional Office of the National Park Service, and the Architectural Conservation Laboratory of The University of Pennsylvania have cooperatively implemented two successful summer field school programs. The following article gives the details of the program. In an earlier issue of* CRM *(Vol. 16, No. 10), Southwest Region Director John Cook gave an overview of the cooperative agreement with The University of Pennsylvania.*

*—Jake Barrow*

The preservation and management of ruins and associated archeological features are complex issues, especially for the diverse number of historic and prehistoric sites in the American southwest, and in particular for those under the care of the National Park Service. Because of the exposed and fragile nature of most ruined structures, contemporary preservation standards demand the best documentation possible and maximum protection of original or historical material. For sites open to the public, this must often be accomplished while interpreting the remains in a manner which is readily comprehensible to the visitor. This is a difficult problem for any structure in a ruined state and in particular for those fragile materials and elements such as adobe and finish plasters which, if present at all, are often fragmentary and subject to rapid deterioration.

**Fig.1. Fort Union National Monument. Watrous , New Mexico, 1992.**

Despite earlier practices of complete or selective removal of surviving plasters and decorative finishes from ruins and archeological sites for protection and display off-site, preservation and interpretation in place is ideologically the preferred solution, even if backfilling is the only option. *In situ* preservation of architectural plasters insures future contextual studies of the intact resource and allows visitors the opportunity to both understand and enjoy the ruin as a once complete structure. Surviving plasters with their finishes often enhance these sites by defining interior and exterior space, related architectural elements, and even room use, clarifying what might otherwise be an incomprehensible jumble of fragmented remains.

As a follow-up to research needs expressed previously in 1990 at the Sixth International Conference on the Conservation of Earthen Architecture in Las Cruces, New Mexico, the Architectural Conservation Laboratory of the University of Pennsylvania with the support of the Gaia Project [CRATerre (Grenoble) and ICCROM (Rome)] has begun a multi-phased research program on the characterization, performance, and conservation of traditional surface finishes (i.e., plain and decorated plaster and stucco) employed on earthen architecture. This research has included a survey of the existing literature on the subject, an assessment of analytical techniques best-suited for the characterization of plasters and stuccoes, the development of standard physical, mechanical, and chemical tests for these materials and systems, and the design and evaluation of conservation treatments. Treatment studies have focused on two major problems associated with these materials: consolidation and reattachment.

Despite the widespread observation and reporting of the detachment and loss of historic plasters on earthen walls, almost no research on reattachment methods has been published. As a consequence, our research in this area has focused on grouting as an appropriate technique for consideration and on the design and performance evaluation of various grout formulations for the reattachment and reintegration of surface finishes on earthen supports. In addition to this program of laboratory testing and evaluation, a field component was designed and implemented in conjunction with the Southwest Regional Office of the National Park Service as part of a three year, four park program directed toward research, design, and implementation of a strategy to preserve and conserve historic and prehistoric plasters in ruined sites.

In response to this initiative and a preliminary condition assessment by the National Park Service in 1990, two of the region's sites, Fort Union National Monument in northeastern New Mexico (figure 1) and Fort Davis National Historic Site in southwestern Texas (figure 2) were identified in 1991 as possible locations for study and treatment testing by the University of Pennsylvania.

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In order to facilitate this endeavor, a five-year cooperative agreement was signed by the University and the National Park Service in early 1992. Project coordinators for the Southwest Regional Office are Jake Barrow, supervisory exhibit specialist, and Barbara Zook, historical architect. Project director for the University of Pennsylvania is Frank G. Matero, Associate Professor of Architecture and Director, Architectural Conservation Laboratory.

**Fig.2. Fort Davis National Historic Site, Texas, 1992. National Park Service photo.**

The following project summaries for the two model sites offer a methodology for the documentation, stabilization and interpretation of architectural plasters at earthen ruins.

### Fort Union National Monument

Fort Union National Monument is located 100 miles northeast of Santa Fe along the historic Santa Fe Trail in Mora County, NM. Three forts have existed on this site: the first built of logs in 1851; the second, an earthen star-shaped field fortification built in 1861; and the third and present adobe and stone ruins dating from 1863. The third installation was the largest military post in the southwest, requiring six years (1863-1869) to complete, and was eventually abandoned in 1891. The ruins of the last or third Fort Union are the most intact and now constitute the largest adobe ruin in North America. The remains of all three forts plus sections of the Santa Fe Trail form the basis of the National Park Service interpretation since the establishment of the park in 1954.

The ruined structures of the third Fort Union are a fitting record of the military's failed attempts to build and maintain serviceable structures in the southwest frontier. This was largely due to a number of factors including the introduction of incompatible building materials used in combination with existing building traditions, poor construction practices such as the making of adobe during freezing weather, reliance on untrained soldier labor, and little understanding or commitment to building maintenance.

Extensive building records and early photographs clearly outline the military's intentions, practices, and justifications in the construction of the third fort and depot. Although none of the third fort's wooden structures survive today, it is clear from the documents and archeological evidence that the majority of the buildings were of masonry construction: adobe walls on sandstone foundations with brick fireboxes and chimney stacks and exterior cornice copings (figure 3). With the exception of a few buildings which possessed steeply pitched wood shingle roofs most adobe structure roofs were nearly flat and of concrete covered with tin-coated iron plates. As a general rule most of the exteriors and interiors of the adobe buildings were originally plastered or stuccoed and often painted (figures 4 & 5).

Despite the widespread use of stucco and plaster at Fort Union, photographs of the 1870s and 80s indicate that much of the exterior stucco had fallen off by that time. This condition was exacerbated by the fact that the repair work was neglected by troops who were not regularly available to execute the work and who lacked the technical expertise, as well as the Army's unwillingness to appropriate sufficient funds for annual maintenance. By February of 1891, 28 years after its erection, the third Fort Union was declared "totally unfit for habitation" and abandoned.

Beginning with the establishment of the park in 1954 and the congressional mandate "…to identify and then stabilize and preserve the outline or form of selected ruins and structures…" experimental testing of new chemical treatments and the eventual use of a wide variety of conservation approaches occurred at Fort Union and other sites in the Southwest Region. These included: unit replacement with soil-cement adobes and structural stabilization with tension wires and steel plates (1956), lime and cement fills and plaster edgings and spraying of aqueous silicone water repellents on the plaster and adobe surfaces (c.1964-mid 1970s), application of epoxy consolidants (1963-64), and resin coatings and polymer-modified mud mortars (1966-67).

Current preservation work at Fort Union has discontinued these practices and instead has addressed the preservation of the adobe ruins through a continuous program of cyclical maintenance involving traditional adobe capping and mudding. The introduction of this more modest preservation program of traditional materials and techniques by the park and regional office in recent years can be attributed to the lack of information and follow-up assessment of many of the past experimental treatments used and, in some cases, their resulting failure and damage to historic materials. Similar observations nationwide of the failure of unproven technologies applied to historic build-

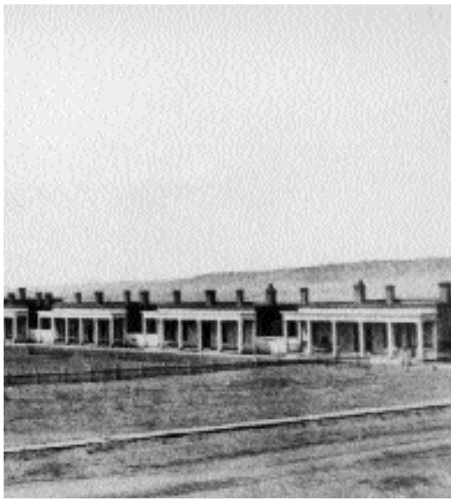

**Fig.3. Officers' Quarters, Fort Union, c. 1875.**

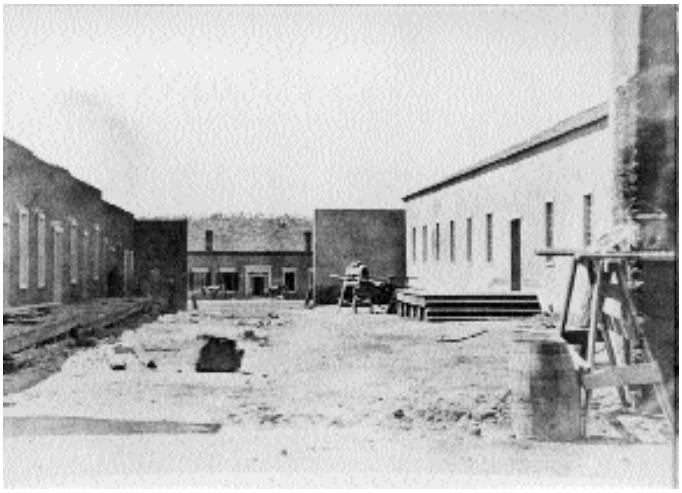

**Fig.4. Quartermaster Storehouse loading yard, c. 1866. Note plastering in progress on the right wall.**

**Fig.5. Mechanics' Corral, interior, 1866. Note fresh exterior plaster up to the brick cornice.**

ings and monuments understandably have resulted in a more cautious approach to the use of new treatments today.

### Fort Davis Historical Site

Fort Davis National Historic Site is situated in the Davis Mountains of southwestern Texas in Jeff Davis County. The site consists of the remains of two separate forts constructed between 1854 and 1891. The ruins of the second fort are the most intact and the focus of the National Park Service interpretation since the establishment of the park in 1961.

A range of building material combinations can be observed at Fort Davis each with their own proclivity to failure. All ruined structures are masonry, the majority being a local red and tan rhyolite quarried 1 1/2 miles from the post. Some adobe brick buildings also exist. These were originally stuccoed, and appear to have been scored and painted to simulate the other stone residences. References were found in the various Annual Inspection Reports of 1886 of painting the exterior of the buildings with a "wash of 12 barrels Paris white and 1/2 barrel dry vermillion." This undoubtedly refers to the pink colored limewash which was applied to the stucco and can still be observed on the fragments of exterior stucco under the front verandas.

Interior wall plasters and their decorative painted finishes survive to a great degree despite their vulnerability to the weather. Interior plasters are of multiple coats, often with thick preparatory base (scratch) and intermediate (brown) coats for surface leveling followed by a thin white finish coat. Large portions of interior woodwork survive in many of the structures. Paints and decorative schemes typical of the late 19th-century are evident in nearly all of the buildings, especially in the officers' houses. The high quality, subtle distinction, and excellent survival of these finishes strongly argue for their conservation. In addition, historic graffiti covers many of the walls.

Since 1962, the National Park Service's preservation approach has been to expose and stabilize the foundations of buildings with no above-grade walls; to stabilize ruins too deteriorated for re-roofing, and to completely and partially restore those buildings with substantial remains, generally defined as structures retaining at least 70% of their original walls. Subsequently, new historically-accurate roofs were constructed over many of the buildings.

### The Plaster Conservation Program

In 1990 a conditions survey of plasters at both sites conducted by the Southwest Regional Office revealed active and widespread deterioration and loss since the stabilization efforts of the early 1960s. This information together with the promising results of a modest pilot treatment program undertaken at Fort Union by the University and regional office in June 1991 led to the development and implementation of a conservation program the following year. It was the intention of this program to provide documentation and emergency conservation treatment for the lime plasters at both sites, as well as to provide field training for National Park Service staff and graduate students.

Treatment areas at each site were designated by the National Park Service and selected according to their inclusion of representative materials and conditions, as well as to their accessibility. At Fort Union, the south end of the Mechanics' Corral (HS-36) was chosen because of the predominance of surviving plaster in that sector and the recognition by the park of the very sensitive and fragile condition present. At Fort Davis, a typical adobe quarters in Officers' Row (HB-12)—protected by the earlier installation of a wood frame and shingle roof—was selected because of the number of similar structures on site and its representative painted plaster and woodwork retaining a high degree of integrity.

The conservation program designed for both sites included the following phases in the designated work areas:

***I. Documentation***

Documentation of the plasters and their previous maintenance and preservation was prepared for each area using archival documents and site reports and photographs. Extant surface materials, i.e., paints and plasters, and verification of their existing conditions were recorded on specially prepared survey forms and graphically documented on photo copies of the 1990 rectified pho-

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tographs. 35 mm and/or 4" x 5" polaroid black and white and/or color photographs were taken before, during, and after treatment.

***II. Emergency stabilization/consolidation***

Emergency stabilization of fragile plasters and paints was conducted to secure all detached plaster and flaking and powdering paint in danger of damage and loss prior to grouting and edging. Where necessary these temporary stabilization measures were left in place until full treatment the following year. All fragments found buried or on the surface of the ground were reburied in clean sand adjacent to the wall nearest their found location. Emergency edging and adobe repairs were coordinated with park personnel in areas requiring plaster stabilization.

***III. Plaster reattachment, cleaning, and replacement of previous repairs***

A complete program of plaster reattachment, compensation and replacement of previous repairs, and cleaning was designed and executed based on materials and techniques tested during the 1991 Pilot Conservation Program and subsequent laboratory testing of various grout mixes from 1992-93. This involved injection grouting for reattachment, mortar fills for cracks, losses and edge detachment, and aqueous cleaning methods.

**Treatment Descriptions**

**Temporary Stabilization:** In cases where plaster or painted finishes were unstable, temporary facings were applied before removal of previous repairs and grouting. Depending on the size and weight of the detached plaster fragment, the facing material selected was either Japanese tissue paper or, for larger heavier pieces, cotton gauze strips tied to wooden stakes inserted into the adobe. The facings were secured by brushing on a 10% solution of polyvinyl alcohol in water. After grouting the facings were removed with water.

**Consolidation:** At Fort Davis, the interior distemper paints proved to be sensitive to water and light abrasion. Since the removal of soiling and the implementation of the plaster stabilization treatments all required some potential wetting of the surface, consolidation of the paint was necessary as a pre-treatment to grouting. As the first step to prevent additional deterioration of the paint, 3 applications of a 3-5% solution of Acryloid B-72 in toluene and xylene (1:1) were brushed onto the surface through a layer of Japanese tissue paper. The solution was brushed on first in the horizontal direction and then in the vertical direction. This treatment consolidated the powdering paint without causing any change in surface texture or sheen and allowed grouting and mechanical cleaning of surface debris to proceed without danger of staining or disrupting the finishes. Field and laboratory assessment of the treatment was conducted using modern standards for evaluation of chalking.

**Glossary of Technical Terminology**

**brown coat:** The second or intermediate coat in three coat plaster work, usually intended to bring out the wall surface to its full ground thickness.

**capping:** Term used in the c. 1960 stabilization work at Fort Union to identify the lime and sand mortar fills placed along the broken edges of the plaster fragments.

compensation General term to denote any conservation treatment designed to improve visual and structural unity, e.g., tinted mortar fills in areas of loss in the plaster.

**consolidation:** A conservation treatment involving the application of a deep-penetrating liquid designed to restore cohesive strength to friable or powdering materials such as plasters, adobe, or paint.

**edging:** Term used in the 1992 conservation work to denote the various mortar fills installed to replace the earlier "capping."

**facing:** The temporary stabilization of fragile or damaged plasters or finishes using Japanese tissue paper, synthetic textiles, or cotton gauze in combination with reversible adhesives such as polyvinyl alcohol (PVOH), methacrylates, or gelatin. Usually applied as a preliminary treatment prior to other conservation work.

**finish coat:** The third or last coat in plaster work, usually very thin (1/16"-1/8") and fine in texture.

**grouting:** A conservation treatment involving the injection of fluid mortars or adhesives into blind or partially concealed voids to readhere and/or fill detached layers and re-establish structural continuity.

**mudding:** The application of a thin slurry coat of clay or mud on adobe as a sacrificial protective layer.

**plaster:** A combination of lime and/or cement binders, aggregates and water that forms a plastic mass which when applied to a surface adheres to it and subsequently sets or hardens to produce a protective and decorative surface. For the purpose of this report, and as sometimes used in the historical documents for Fort Union, the term denotes any interior single or multi-coat render of varying composition and not necessarily containing plaster of Paris (gypsum).

**rendering:** General term for any plaster or stucco as well as the act of laying the material on a surface.

**rough coat, rough casting:** The historical term used to describe the exterior stuccoes at Fort Union. As described in Joseph Gwilt's Encyclopedia of Architecture (1867), it denotes an inexpensive exterior stucco of three layers consisting of washed gravel, lime and water in which the last coat is thrown onto the wall and brushed out with the same to give a uniform texture and color.

**scratch coat:** In three coat plastering, the first or base coat, generally applied as a leveling coat and to prepare the surface for subsequent layers. This coat is often cross-raked lightly to present a roughened surface for a mechanical bond with the second or "brown coat."

**stucco:** According to Gwilt, a term indefinitely applied to any rendered composition employing lime ("calcareous cements") and often reserved for interior molded and cast work, sometimes resembling marble. For the purpose of this report and as used in the historical documents for both sites, the term denotes any exterior rendering used for protection and/or decoration.

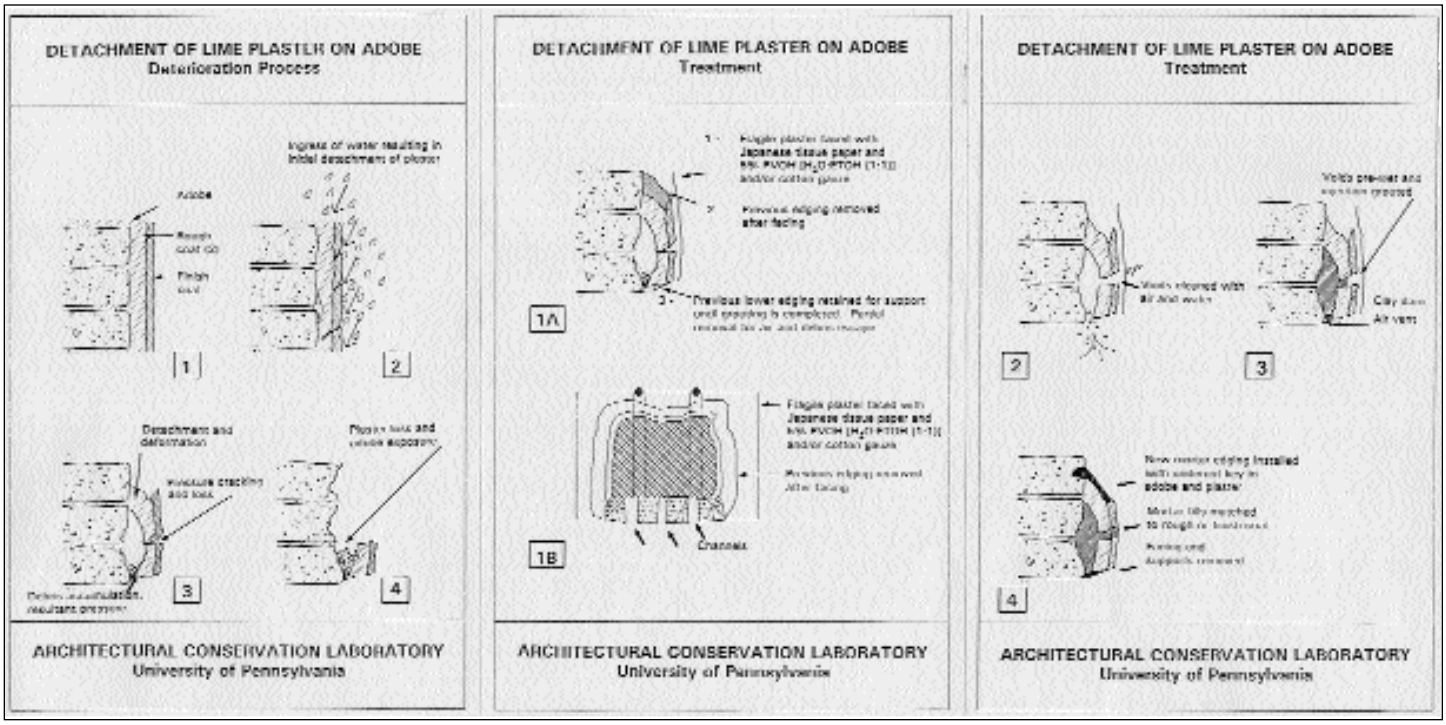


**Fig.6. Detachment of lime plaster on adobe: deterioration process and treatment employed at Fort Union and Fort Davis during NPS study.**

**Grouting:** Grouting is the injection of fluid mortars or adhesives to fill unwanted voids and readhere detached materials. Since grouting methods allow relatively deep penetration of the grout into inaccessible discontinuous areas, grouting is recommended to reestablish structural adhesion between plaster layers and/or their substrate, or to restore exfoliating masonry. Grouting mortars should be mechanically and chemically compatible with the plaster and masonry support material, reestablish structural adhesion between the plaster layers and substrate, and allow the passage of water vapor.

At Fort Union and Fort Davis many of the plasters had been previously edged with a lime-sand or cement mortar, all keyed with iron nails (figure 7). These edgings were cracked and unsightly due to their wide and irregular installation and were removed by hand with small chisels and mallets. This allowed access to the voids between the plaster and the adobe substrate for grouting. Debris, loose adobe and organic matter were removed from the open and blind voids with compressed air, brushes, and small tools.

The location of blind voids was determined by percussive sounding by hand and with small wooden mallets and recorded on the surface with non-staining white chalk. The majority of blind voids were located along existing cracks or holes. These were used as ports where possible. For blind voids with no access, small holes were drilled using a hand drill and 1/8"-1/4" masonry bits.

All voids were flushed and wet with water in order to reduce premature drying of the grout through suction into the adobe and plaster, to clean out the voids, and to rehydrate any remaining loose clay for reattachment. Additionally, the plaster surface was sprayed with water to retard drying. Openings along the edges, areas of surface loss, and cracks were temporarily damned with clay or cotton and sticks were inserted at intervals along the damming for air release holes during grouting. These areas were then prewet with a 5-10% aqueous acrylic emulsion to increase the flow and adhesion of the grout to the existing adobe and plaster and to provide a measure of compatibility between the adobe, grout, and plaster. Based on field and laboratory tests, a light-weight, low shrinkage compatible grout composed of (all parts by volume): 4 parts Riverton hydrated hydraulic lime, 3.8 parts Z-Lite ceramic microspheres (G3500), 1 part fine silica banding sand and 0.4 parts (or 10 % of the lime binder) acrylic emulsion with a defoaming agent was selected (El Rey Superior 200).

Potable water was added to the dry mix and blended for 3 minutes in a high velocity mixer (15,000 RPM) producing a grout with a viscosity of 46.58 sec/500 ml (Marsh Flow Cone) or the consistency of heavy cream (approximately 1 part water to 2 parts solids) . The grout was then injected into the ports through a 12 and 14 gauge steel cannula-tipped syringe always working from the bottom to the top. Excess grout was immediately removed from the surface and the grouted area protected from heavy rains and/or direct sunlight for at least the first 24 hours with polyethylene sheeting.

**Compensation (edging and filling):** (figures 6-4, 7 & 8) Abrupt edges at delamination points, surface holes, and cracks are all invitations for water penetration and its consequential array of conservation problems. While reconstruction of missing plaster was not the primary goal, completing deteriorated, or lost architectural details such as drip edges and contiguous surfaces essential to the proper shedding of water and structural infill in fragile isolated areas was considered necessary for the long-term durability of the plaster fragments.

Edging and fills were formulated to be physically and mechanically compatible and similar in texture and color (using suitable aggregates, lime-proof pigments or earth). They were formulated to be distinguishable from original

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fabric yet provide visual continuity and legibility to the fragment in context. At Fort Union edging and surface fills were formulated to match the underlying rough

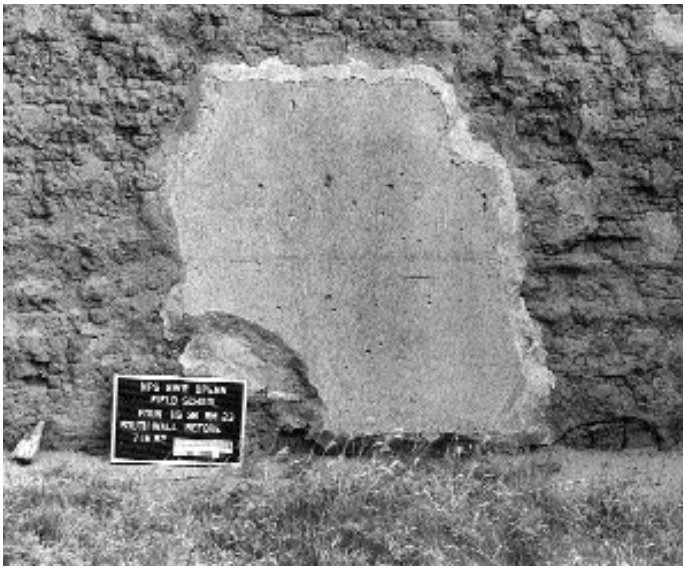

**Fig. 7. Mechanics Corral (HS 36), Room 23, Fort Union. Plaster fragment before recent conservation. Note unsightly and failed previous edging.**

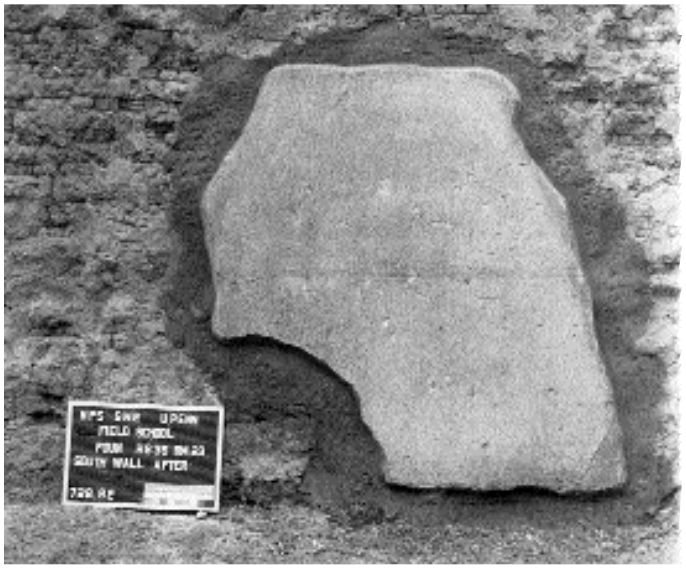

**Fig. 8. Mechanics Corral (HS 36), Room 23, Fort Union. Plaster fragment after recent conservation. Note new edging flashed into adobe wall.**

coats. At Fort Davis both finish and rough coats were matched depending on the level of loss.

At Fort Union and Fort Davis edging of the plasters and filling of the cracks and holes were undertaken after the initial set of the grout, approximately 48 hours. All edgings were composed of lime putty or hydraulic lime and local aggregates selected for color and texture matching. In all cases the dry components were well mixed and the water stirred in until the mix was well blended. After the edging and fills were allowed sufficient time for an initial set, approximately 24 hours, the repairs were shaved down to the desired depth and texture and the surfaces were brush-stippled with 10% acetic acid to dissolve lime laitence and reveal the aggregate. Exterior edgings at Fort Union were partially capped with mud to protect the adobe wall-edging junction.

**Surface Cleaning:** After the grouting and edging and fills had set, facings were removed by wetting the tissue or gauze and carefully peeling them off the surface. Any residue of the 10% polyvinyl alcohol adhesive was also removed by brush with water. The plaster surfaces and adjacent adobe were examined for any grouting, edging/fill or acrylic residue. These were carefully removed with brushes and dental picks. A final cleaning of surface dirt and biological growth was accomplished by brushing the entire surface with 5% acetic acid followed by a thorough water rinse.

## Conclusions

The ability to develop an effective preservation strategy that is conservative yet responsive to the varied contexts of different sites, while acknowledging the fragile nature of earth and plaster in the context of a ruin is no easy task. Past and current preservation practices at such sites include replacement, encapsulation with nonhistoric veneers, protective shelters and backfilling, and remedial conservation treatments including capping, grouting and consolidation. Their selection, however, must be based on careful consideration of the significance of the site, environmental and human factors, maintenance, cost, and treatment predictability. The above conservation program for plasters in earthen ruins offers new possibilities for *in situ* stabilization and interpretation of these important elements for both historic and prehistoric sites. With additional research, similar programs could be established in the hopes of offering practical solutions to the stabilization and re-interpretation of a much neglected component of architectural and archeological sites.

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