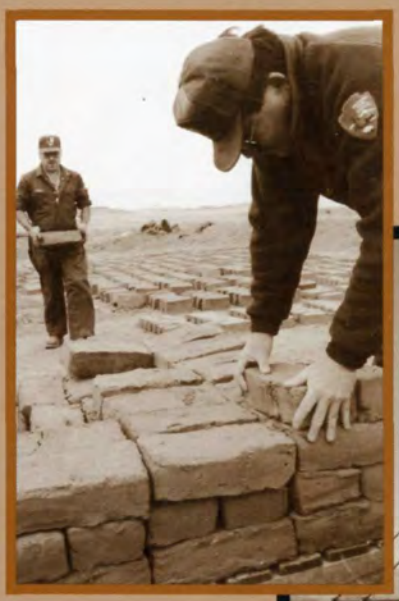
CRM

CULTURAL RESOURCE MANAGEMENT

VOLUME 22 NO. 6 1999

Conserving Earthen Architecture



Conservando la Arquitectura de Tierra

U.S. DEPARTMENT OF THE INTERIOR
National Park Service
Cultural Resources

PUBLISHED BY THE NATIONAL PARK SERVICE
Information for parks, federal agencies, Indian tribes, states, local governments, and the private sector that promotes and maintains high standards for preserving and managing cultural resources

PUBLICADO POR NATIONAL PARK SERVICE
Información para los parques, entidades federales, tribus indígenas, estados, goviernos locales, y el sector privado, buscando promover y mantener los más altos estándares para la preservación y la gestión de los recursos culturales.

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ISSN 1068-4999

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Cover: Top, José Padilla and Teddy Garcia stacking adobes at Ft. Union National Monument, photo courtesy Robert Hartzler; middle, Nuestra Señora del Pilar y Santiago de Cocóspera, photo courtesy Nyle Leatham; bottom, San Elizario Lime Workshop, San Elizario, Texas, photo courtesy Michael Romero Taylor.

Portada: Parte superior, José Padilla y Teddy Garcia poniendo adobes en fila en el Monumento Nacional de Ft. Union, foto cortesía de Robert Hartzler; centro, Nuestra Señora de Pilar y Santiago de Cocóspera, foto cortesía de Nyle Leatham; parte inferior, Taller de Cal en San Elizario, San Elizario, Texas, foto cortesía de Michael Romero Taylor.

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Jake Barrow and Michael Romero Taylor

A Rich Building Tradition
Una Rica Tradicion de Construcción

This issue of *CRM* is dedicated to the conservation and preservation of earthen architecture and its building traditions. It is a bilingual issue, with several entries translated into Spanish. The Southwest of the United States shares a rich traditional commonality with Latin America. International training and meetings in Peru and Mexico occurring in 1999 will offer challenging opportunities for professionals to share and engage on many of the themes set forth.

One of the main objectives of this issue is to make the reader aware of the fact that somewhere between one third and one half of the world's population lives in some type earthen structure. Here in the United States there exists a tremendous inventory of historic earthen buildings—not only in the Southwest, but throughout the country.

The articles reflect a wide spectrum of prehistoric, historic, and contemporary uses of earth as a building material, and address the preservation of these structures. The reader will learn of global initiatives in preserving and perpetuating this venerable building material and how living in earth is the preferred architecture in many parts of the world because it is sustainable and easy to work with, and due to its thermal characterisitcs, comfortable to live in. It may surprise some to know there are many historic actively-used earthen structures in New York State. Also, throughout the

José Padilla and Napoleon Duran repair windows at Ft. Union National Monument.

José Padilla y Napoleon Duran reparan ventanas en el Monumento National de Ft. Union.

Esta publicación de *CRM* está dedicada a la conservación y preservación de la arquitectura de tierra y de sus tradiciones constructivas. Es una publicación bilingüe que contiene diversos artículos traducidos al español. El sudoeste de los Estados Unidos y Latinoamérica comparten una gran riqueza de tradiciones. Durante 1999 se llevarán a cabo en Perú y México encuentros y cursos de capacitación de carácter internacional, los cuales ofrecen grandes oportunidades y desafíos para que los profesionales puedan compartir e involucrase en los temas propuestos.

Esta publicación tiene entre sus principales objetivos demostrar al lector que la mitad de la población mundial vive en algún tipo de estructura de tierra y que aquí, en los Estados Unidos contamos con un enorme legado de edificios históricos construídos en tierra, no solamente en el Sudoeste, sino en todo el país.

Los artículos muestran el amplio espectro de usos prehistóricos, históricos y contemporáneos de la tierra como material de construcción, abordando el tema de la preservación de estas estructuras. Se presentan aquí al lector las iniciativas internacionales destinadas a preservar y perpetuar este venerable material de construcción, para lograr comprender que la tierra es el medio arquitectónico favorito en diversas regiones del mundo, porque es sustentable y fácil de trabajar y por sus características térmicas son construcciones que permiten vivir cómodamente. Se sorprenderán algunos lectores al saber que en Nueva York, un estado reconocido por su duro clima, aún existen estructuras de tierra en uso y que en un período de 7.000 años en toda la región del Medio Oeste y Este de los Estados Unidos los indígenas americanos construían obras monumentales en tierra. A otros lectores les sorprenderá enterarse de las iniciativas de cooperación internacional para preservar la arquitectura de tierra que se están llevando a cabo en la frontera entre

Wilfred Valencia turning adobes at Ft. Union National Monument.

Wilfred Valencia rodando adobes en el Monumento National de Ft. Union.

America's Midwest and East there was a 7,000-year period during which Native Americans were building monumental earthworks and that many of the historic military forts in the West were built out of earth, their fragile remains illuminating the times of 19th-century westward expansion. Currently there are international cooperative initiatives to preserve earthen architecture along the US/Mexico Borderlands. We recognize that these articles reflect only a small part of earthen architectural activity and hope that this issue will stimulate others to consider the topic and continue to enlarge the body of knowledge.

Unlike stone, brick, or timber buildings, earthen structures melt back into the earth when left abandoned. The archeological vestiges of this building medium are subtle and many times have disappeared completely. Where earthen buildings have been protected from moisture and the elements, there exists a tremendous variety of building styles, methods and craftsmanship. We hope that you enjoy these articles and learn about the rich traditions of building with earth in the United States.

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Jake Barrow and Michael Romero Taylor are guest editors of this issue of CRM.

Photos courtesy Robert Hartzler.

Acknowledgments

We want to thank the Getty Conservation Institute who supported this effort through Project Terra, a collaboration of the Getty Conservation Institute, the International Center for the Study of the Preservation and Restoration of Cultural Property (ICCROM), and the International Center for Earth Construction, School of Architecture of Grenoble, France (CRATerre-EAG). We also would like to thank Jenifer Blakemore, Jane Harvey, Anna Zagorski, and Inés Cox for editing and translating assistance.

los Estados Unidos y México, o saber que muchos de los fuertes militares históricos en el Oeste estaban construídos con tierra, con sus frágiles restos iluminando la época de la expansión al Oeste en el siglo XIX. Tenemos claro que el conjunto de artículos reunídos aquí es un modesto reflejo de la actividad de la arquitectura de tierra. Esperamos con esta publicación estimular en otros el estudio de este tema, para así continuar enriqueciendo los conocimientos con que contamos hasta la fecha.

A diferencia de las construcciones de piedra, las estructuras de tierra retornan al suelo cuando se las abandona. Los vestigios arqueológicos de este medio de construcción son sutiles y en muchos casos han desaparecido por completo. Allí donde existen construcciones de tierra protegidas de la humedad y de los elementos, se puede reconocer una enorme variedad de estilos y métodos de construcción y trabajo artesanal. Esperamos que disfruten con estos artículos y aprendan algo de las ricas tradiciones de construcción con tierra en los Estados Unidos.

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Fotos cortesía de Robert Hartzler.

Agradecimientos

Nuestros agradecimientos al Getty Conservation Institute por el apoyo brindado a este esfuerzo a través del Proyecto Terra, un proyecto conjunto del Getty Conservation Institute, el Centro Internacional para el Estudio de la Conservación y Restauración del Patrimonio Cultural (ICCROM), y el Centro Internacional de Construcción de Tierra de la Escuela de Arquitectura de Grenoble, Francia (CRATerre-EAG). Vayan también nuestros agradecimientos a Jennifer Blakemore, Jane Harvey, Anna Zagorski, y Inés Cox por su apoyo editorial y traducción.

Paul G. McHenry

Adobe Today

Las Tampas Church, an example of adobe architecture.

Adobe is the oldest and most widely available building material used by man. A surprising fact about adobe is that nearly half the people of the world today live in adobe or earthwall houses. The second surprise is that adobe is much more durable than one might think. Popular perception is that adobe is used only in a desert or arid lands climate. Nothing could be further from the truth, as it is found in every climate zone, with the exception of the Arctic and Antarctic zones. Even in the Arctic, igloos are built with the same principles as adobe domes, but with snow blocks instead of dried earth bricks.

There are several types of earthwall buildings. The two major ones are adobe (sun-dried mud brick laid up with earth mortar and dried by the sun), and rammed earth, or *pisé*, (earth compacted in forms to make the wall). Both use the same material, but rammed earth is used in humid climate areas where rain and dampness would slow or prevent sun drying of the bricks. Both systems are widely used, with the type of building system chosen dependent on the local climate and the tradition of the builder. There are also two other common types of earthwall buildings. One is called *jacal*, or *Bajareque*, and it uses a wood/thatch armature to support the mud; the other is a "puddled" (wet-placed mud) form.

Worldwide Tradition

The basics of earthwall construction are similar worldwide, but with some notable exceptions. In the Middle East, where trees for structural members are very scarce or nonexistent, a system of arches and domes was developed perhaps as early as 7000 B.C. The ingenuity and masonry skills are truly incredible. Consider the imagination it took to figure out a way to build a roof structure with a span of 50' or more, using only pieces that are less than 10" in length. This was done, and the technology transferred from the Middle East to the shores of the Mediterranean and on to Italy and Europe.

Adobe in the United States

Building with earth was a common occurrence in early America, from the eastern seaboard to the Rocky Mountain west and to the Pacific Ocean. Better building materials were not unknown, but earth often was used when other (better) materials were unavailable or too expensive. Rammed earth buildings are still found in North and South Carolina, Virginia, and Washington, DC. At a recent international conference on adobe preservation, an architect from New York identified more than 25 adobe homes in the State of New York. (See Pieper article, p. 30.)

There are many materials that are stronger, more long lasting, and better than adobe, but the advantages and utility of adobe are repeatedly rediscovered in our history alone. Countless communities, particularly in the western United States, needed buildings for homes, commercial enterprises, and public works, but they were located far from the supplies of more conventional building materials. Furthermore, economics was an additional driving factor. There are in New Mexico countless churches, homes, and commercial buildings. Sometimes the facade of a merchant's store was made of fired brick while the rest of the walls were made of adobe. A Department of Energy study in the State of Colorado uncovered many adobe buildings of great age. They were built in various styles, and often the residents were not aware that these were earth buildings.

In 1941, a large elementary school was needed in the small town of Anthony, New Mexico. The city did not have money to build it, so public-spirited citizens got together, made

Dervish Mosque, Mahan, Iran, covered with tile.

bricks from the local soil, and employed townspeople in need of jobs to build their school. It is in sound shape today. The Works Progress Administration (WPA) made wide use of adobe and rammed earth during the drought and Great Depression of the 1930s. Farmers were relocated to Bosque Farms, New Mexico, where the government provided plats of irrigated land and arranged for the design and construction of more than 40 small homes. The government supervised the construction of the homes, which were leased to displaced persons who were to become future owners. There are 42 of these homes in use today. Many of the designs have been modernized to meet today's standards and expanded to provide the additional space.

Lost Technology

The skills for building with earth are quite simple and were well known to almost everyone until World War II. However, after the war, the new "modern" materials became the first choice because they were, in some ways, better than adobe, and they were affordable. In addition, the building industry was under tremendous pressure to keep up with explosive growth. The industry's rapid growth and the influx of new materials resulted in a whole generation of architects, engineers, and building professionals who in their entire careers never once experienced working with adobe. In this gap of 40 to 50 years, adobe took on an image of poverty, a perception that persists today. The technology was almost lost, except in primitive economies and among a few dedicated builders who used adobe architecture as an artistic medium. At an international conference on housing held in Brussels in the 1980s, a famous Egyptian adobe architect and proponent of low-cost housing was scorned and vilified to where he was accused of trying to return housing to the Middle Ages.

Public Image

Where this material was used only by "poor" people, it is now a premium material. Look at Santa Fe, New Mexico! Poor people, indeed, live here. And, high-end homes made of adobe are very popular in Santa Fe, often favored by people from other areas where high-priced housing is common.

In 1981, the Bureau of Indian Affairs (BIA) wanted to build adobe housing on several Native American reservations, but rejected the idea as "too expensive." Unfortunately, the attitude of the BIA reflects attitudes by the architectural community as well, which values what is new and ignores many benefits from the past.

The Future

Mankind has an extensive history of repeatedly abusing and exhausting natural resources. Energy, natural resources, and ecology will suffer. It cost surprisingly large amounts of energy to manufacture modern building materials. For example, it takes one gallon of gasoline to make eight common bricks. In the past, when the effects of manufacturing building materials reached catastrophic proportions, earth building has come to the rescue.

In most industrial nations the art of building with earth is a lost one. We must create a corps of skilled professionals who are ready to train others and provide answers to questions with regard to earthen construction. The main villain of this situation is ignorance. It starts with the basic tenets of architecture and architectural education, and it ends with the creation of unrealistic buildings and zoning regulations. These regulations are made, of course, with the best intentions, but frequently fall short of meeting practical needs.

In 1997, the Earth Architecture Center International was created to collect and disseminate accurate technical information on earthen building. In 1998, it was transformed into the Earth Building Foundation. For further information on this organization, please visit our web site <www.earthbuilding.com>.

Paul G. McHenry is an architect, author, educator, and adobe builder.

Photos courtesy the author.

Marina Trappeniers

Training in the Conservation of Earthen Architectural Heritage

Formación en el Campo de la Conservación del Patrimonio Arquitectónico de Tierra

The first international expressions regarding the need to preserve the world's earthen architectural heritage were voiced in the early 1970s.

The international recommendations, approved from 1972 to 1987 in different meetings held on this subject and supported by the national International Council of Monuments and Sites (ICOMOS) committees, reflect the thoughts and concerns at various times regarding the need for specific activities in the field. Yazd, Iran, (1972)[1] and Yazd, Iran, (1976)[2] may be seen as the first systematic attempts to characterize earthen architectural heritage and to outline preliminary recommendations for their preservation. The interim meeting in Santa Fe, New Mexico,[3] clearly identified the urgent need to conduct research on specific areas. An attempt to follow up the Santa Fe recommendations was made by researchers of the Institute for Applied Technology and the Center for Building Technology/National Engineering Laboratory (National Bureau of Standards/USA). Although a subsequent meeting in Ankara, Turkey, (1980)[4] did not record further development of the previous recommendations, this forum encouraged a broader view of the field by introducing the expression "earthen architecture" and it fine-tuned all previous recommendations. In Lima, Peru, (1983)[5] specific concerns about the development of a network for this field were expressed and intensive training in established centers was recommended.

It was finally in Rome, Italy, (1987)[6] that commitments were made by the International Center for the Study of the Preservation and Restoration of Cultural Property (ICCROM), CRATerre, and the School of Architecture of

Iniciando la década del 70 se enunciaron las primeras expresiones a nivel internacional relacionadas con la necesidad de conservar el patrimonio arquitectónico de tierra del mundo.

Las recomendaciones internacionales aprobadas entre 1972 y 1987 en distintas conferencias organizadas para tratar el tema, con el apoyo del International Council of Monument and Sites (Comités de ICOMOS) son un reflejo del pensamiento e intereses expresados en distintas ocasiones sobre la necesidad de realizar acciones específicas en este campo. Yazd, Irán, (1972)[1] y Yazd, Irán, (1976)[2] pueden considerarse como los primeros intentos sistemáticos de caracterizar el patrimonio arquitectónico de tierra y esbozar algunas recomendaciones preliminares para su conservación. En la reunión de Santa Fe, Nuevo México,[3] se identificó claramente la necesidad urgente de realizar investigaciones en áreas específicas. Los investigadores del Institute of Applied Technology y del Center for Building Technology/National Engineering Laboratory (National Bureau of Standards) de los Estados intentaron hacer un seguimiento de las recomendaciones de Santa Fe. Si bien en la reunión siguiente realizada en Ankara, Turquía, (1980)[4] no se registraron mayores avances en las recomendaciones anteriores, el foro amplió la perspectiva del campo al introducir la expresión "arquitectura de tierra", ajustando todas las recomendaciones anteriores. En Lima, Perú, (1983)[5] se expresaron intereses más específicos centrados en el desarrollo de una red para esta actividad, recomendando realizar una formación intensiva en centros ya establecidos.

Grenoble to carry out training activities with the formulation of the Gaia Project, a comprehensive plan of action in the field of the preservation of earthen architectural heritage. The Gaia Project was set up within the framework of a formal agreement to ensure continuous activity in training, research, documentation, and technical cooperation. The agreement grew out of the critical evaluation of the implementation of international recommendations, and it is the result of these three signatory institutions' five years of cooperation, which included the gradual exchange of training experience, the common organization of scientific events, the development of publications, and many other activities.

International Activities

The Gaia Project has given a fresh boost to the training of conservation professionals and to the development of their own international network through the four Preservacion Architectura de Tierra (PAT) courses that were organized at the headquarters of CRATerre in the School of Architecture of Grenoble (a pilot course in 1989, followed by three international courses in 1990, 1992, and 1994). In addition to CRATerre-Ecole d'Architecture de Grenoble (EAG) and ICCROM's own contributions, these courses were granted financial support from the Council of Europe, the European Union, the Aga Khan Award for Architecture, and the Rhône-Alpes Region. Twenty instructors, mostly from the Americas and Europe, contributed to the development of the courses' contents, which addressed the general principles of preservation practice; scientific considerations on the earthen material and its relevant construction techniques, documentation, survey, and inspection; the preservation of archeological sites; and the rehabilitation of the earthen architectural heritage.

The courses established a network of some 120 professionals from Europe, the Americas, Africa, and Asia. Two other conferences, Adobe 90 (Las Cruces, New Mexico, 1990)[7] and Terra 93 (Silves, Portugal, 1993),[8] provided this network with a forum for the exchange of ideas, methods, techniques, and research findings.

These events have shown, however, that the demand for training is still growing thus emphasizing the need for additional training programs in the field, both on a regional and a national scale.

Fue finalmente en Roma, Italia, (1987)[6] donde se llegó a un compromiso del Centro Internacional para el Estudio de la Conservación y Restauración del Patrimonio Cultural (ICCROM), de CRATerre y la Escuela de Arquitectura de Grenoble, para realizar actividades de formación a través del Proyecto Gaia, un plan global de acción en el campo de la conservación del patrimonio arquitectónico de tierra. El Proyecto Gaia tomó forma en el marco de un acuerdo formal que garantiza una actividad permanente de formación, investigación, documentación y cooperación técnica. El acuerdo surgió de una evaluación crítica de la puesta en práctica de las recomendaciones internacionales y ha sido posible gracias a los cinco años de cooperación entre las tres instituciones signatarias, que incluyeron el intercambio gradual de experiencias en formación, la organización conjunta de eventos científicos, el desarrollo de publicaciones y muchas actividades más.

Actividades Internacionales

El Proyecto Gaia ha dado un nuevo impulso a la formación de profesionales de la conservación y al desarrollo de su propia red internacional, a través de los cuatro cursos internacionales "Preservación Arquitectura de Tierra" (PAT) organizados en la sede de CRATerre en la Escuela de Arquitectura de Grenoble (un curso piloto en 1989 al que siguieron tres cursos internacionales en 1990, 1992 y 1994). Además de los aportes propios de CRATerre-École d'Architec-ture de Grenoble (EAG) y del ICCROM, estos cursos obtuvieron apoyo financiero del Consejo de Europa, de la Unión Europea, del Premio Aga Khan de Arquitectura y de la región de Rhône-Alpes. Veinte instructores provenientes en gran parte de las Américas y Europa contribuyeron al desarrollo de contenidos de los cursos que abordaron los principios generales de la práctica de conservación; aspectos científicos del material térreo y técnicas de construcción, documentación, estudio e inspección correspondientes; la preservación de sitios arqueológicos; y la rehabilitación del patrimonio arquitectónico de tierra.

Gracias al curso se estableció una red de 120 profesionales de Europa, América, África y Asia. Dos nuevas conferencias, "Adobe 90" (Las Cruces, Nuevo México, 1990)[7] y "Terra 93" (Silves, Portugal, 1993),[8] permitieron disponer de un foro para el intercambio de ideas, metodologías, técnicas y resultados de investigaciones. Sn embargo ha quedado demostrado en

Regional Activities

Since its creation in 1989, the Gaia Project has stressed the importance of organizing regional activities in an institutional framework so as to guarantee the activities' continuation.

In 1996, the Gaia Project and the Instituto Nacional de Cultura de Perú organized, in collaboration with the Getty Conservation Institute (GCI) and with the sponsorship of the European Union and the World Heritage Fund of the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the first Curso Panamericano sobre la Conservacion y el Manejo del Patrimonio Arquitectonico Historico-Arqueologico de Tierra. Classes were held at the museum of the archeological site of Chan Chan, a 14-km^2 earthen city in northern Peru. Twenty-four architects, archeologists, and conservators from 13 countries participated in the intensive five-week course. They were selected from a highly qualified pool of nearly 175 applicants from 20 countries. Twenty instructors from the Americas and Europe combined lectures, demonstrations, and exercises to convey a dense curriculum of theoretical and practical issues. Due to the high seismic risk in many areas of Latin America, seismic mitigation was emphasized throughout the course. Also, because of the wealth of polychrome murals and reliefs in the region, a significant portion of the curriculum focused on decorated surfaces on earthen supports. One of the main concerns was the site's size, a feature that has led to the definition of a particularly complex conservation management plan.

Thus the first regional experience of the Gaia Project—the outcome of a long and complex process—began to set up a pedagogic program with the appropriate didactic and pedagogic materials.

Another regional activity of the Gaia Project concerns the development of a pedagogic program for the Escola Nacional de Artes e Oficios Tradicionais (ENAOTS) in Serpa, Portugal. This school for artisans and entrepreneurs was established by the Director General de Edificios y Monumentos Nacional (DGEMN) of Portugal.

Field Activities

At the same time, a series of short courses and workshops were arranged by some participants of the international PAT courses. These practical training sessions are for the most part organized on a local level. Cornerstones Community Partnerships (Santa Fe, New Mexico)

estos eventos que existe una demanda creciente por formación que enfatiza la necesidad de organizar más programas de formación en este campo, tanto a escala regional como nacional.

Actividades Regionales

Desde su creación en 1989 el Proyecto Gaia ha insistido en la importancia de organizar actividades regionales en un marco institucional que asegure la continuidad de las actividades.

En 1996, el Proyecto Gaia y el Instituto Nacional de Cultura del Perú organizaron en colaboración con el Getty Conservation Institute (GCI) y con el patrocinio de la Unión Europea y el Fondo Mundial del Patrimonio de la UNESCO, el primer Curso Panamericano sobre la Conservación y el Manejo del Patrimonio Arquitectónico Histórico-Arqueológico de Tierra. Las clases se desarrollaron en el Museo del sitio arqueológico de Chan-Chan, zona arqueológica construida de tierra de 14 km2 situada en la costa norte del Perú. Veinticuatro arquitectos, arqueólogos y conservadores de trece países participaron en el curso intensivo de cinco semanas. Fueron elegidos de una selección previa de casi 175 candidatos altamente calificados provenientes de veinte países. Veinte instructores americanos y europeos combinaron charlas, demostraciones y ejercicios centrados en la transmisión de un currículum de aspectos teóricos y prácticos. Debido al alto riesgo sísmico de muchas regiones de América Latina, durante todo el curso se puso énfasis en aspectos de mitigación de terremotos. Asimismo, dada la gran riqueza de murales y relieves polícromos en la región, una parte importante del programa trató aspectos de superficies decoradas sobre soportes de tierra. Una de las principales condicionantes de tal zona es la escala del sitio, lo que llevó a definir un plan de manejo de la conservación sumamente complejo.

De este modo, la primera experiencia regional del Proyecto Gaia, resultado de un proceso largo y complejo, dio inicio a la conformación de un programa pedagógico con los materiales didácticos y pedagógicos correspondientes.

Otra actividad regional del Proyecto Gaia es el desarrollo de un programa pedagógico para la Escola Nacional de Artes e Oficios Tradicionais (ENAOTS) en Serpa, Portugal. Esta escuela para artesanos y empresarios fue creada por la Dirección General de Edificios y Monumentos Nacionales de Portugal.

can be cited as a most successful partnership in which this organization and communities have developed programs that teach young people traditional building skills.

The Gaia Project has also organized various training programs in the field, mainly in Africa (Mali, Benin, Nigeria, Ghana, to name a few countries). Most training programs are organized within the institutional framework of a larger preservation project, and they are often set up by a local individual who has received instruction in one of the PAT courses. As these programs serve specific locales, they do not meet the regional demand for training.

The Current Situation

The dynamic process activated by the PAT courses as well as by other activities of the Gaia Project (research, documentation, technical assistance and dissemination) has had positive effects on different levels:

- Through the support of activities initiated by international and national organizations concentrating on better coordination and a wider dissemination of information resulting from the experience of a network of identified participants, the implementation of the mandates and the role of the Gaia Project have enabled the development of a greater consciousness not only of the value of our earthen architectural heritage but also of the need to define and establish integrated policies and strategies for their conservation, their management, and their *mise en valeur.*
- The integrated approach to the earthen architectural heritage, which takes into account culture and development, has been more precisely articulated. This more definitive approach further integrates the conservation of historical and vernacular heritage and the application of the potential of constructive cultures in the field of housing and public buildings in both industrialized and developing countries.
- The development and expansion of different national and regional networks of those working in the field of the conservation of earthen architecture is remarkable.

Although much has been done in the training arena, we still observe two main problems: The number of specialists trained through the PAT courses and by the different local or regional initiatives is slight given the demand for qualified professionals throughout the world, and the

Actividades in-situ

En paralelo algunos participantes de los cursos internacionales PAT organizaron una serie de cursos cortos y talleres. En su mayoría estas sesiones de formación práctica se han organizado a nivel local. Cornerstones Community Partnerships de Santa Fe, Nuevo México, puede citarse como una asociación muy exitosa en la que esta organización y las comunidades desarrollan programas para enseñar a los jóvenes las técnicas de construcción tradicional.

El Proyecto Gaia ha organizado también varios programas de capacitación a nivel local, principalmente en el África (en Mali, Benin, Nigeria, Ghana, para nombrar sólo algunos países). La mayoría de los programas de capacitación se organizan dentro del marco institucional de un proyecto de conservación mayor y normalmente son montados por una persona del lugar que recibió instrucción en alguno de los cursos PAT. Por tratarse de programas que sirven a necesidades locales específicas, no cubren la demanda regional de formación.

La situación actual

El proceso activado por los cursos PAT, como por otras actividades del Proyecto Gaia (investigación, documentación, asistencia técnica y divulgación) ha tenido efectos positivos en distintos niveles.

- Gracias al apoyo de las actividades iniciadas por las organizaciones internacionales y nacionales, a una mejor coordinación y una divulgación más amplia de la información obtenida de la experiencia de una red de participantes conocidos, más la implementación de mandatos y el papel del Proyecto Gaia, ha sido posible crear mayor conciencia no sólo del valor de nuestro patrimonio arquitectónico de tierra, sino también de la necesidad de definir y establecer políticas y estrategias integradas para su conservación, manejo y valoración.
- Se ha logrado articular con mayor precisión un enfoque integrado del patrimonio arquitectónico de tierra que toma en cuenta la cultura y el desarrollo. Este enfoque más claro permite integrar mejor la conservación del patrimonio histórico y regional con la aplicación del potencial de las culturas constructivas en el área de la vivienda y obras públicas, ya sea en países industrializado como en desarrollo.

knowledge stemming from operational programs and resulting from research programs has been transmitted through intermittent rather than ongoing activities.

The Gaia Project has thus reformulated its mandates with regards to training and is moving into a new phase of dissemination of information and expertise. In 1998, the Getty Conservation Institute (GCI), ICROM, CRATerre, and the School of Architecture of Grenoble agreed to establish within a new framework a collaborative program, Project Terra, for the study and conservation of earthen architecture. Previous institutional activities developed through the Gaia Project, as well as the GCI's past activities in the field, will contribute to Project Terra.

Project Terra

The first regional course, organized in Peru in 1996, can be considered a turning point for the Gaia Project and Project Terra. The course offered specialized training in the conservation and management of earthen heritage in a specific context, and it did this in collaboration with a local institutional partner. In this way, the course is a prototype of the educational activities of Project Terra, whose main objective is to ensure that the conservation of earthen heritage is firmly established in formal education curricula through

- the development of faculty,
- the introduction of the field and its concepts to university programs and other formal education programs that exist or that are under development,
- the preparation of didactic materials for teaching situations, and
- the refinement of curriculum content through methodology development.

The experience of PAT96 will be consolidated through the organization of PAT99, the second regional course that is currently being developed by the initiators of Project Terra in collaboration with the local partners. PAT99 will involve the participation of local and regional universities in the different stages of the development and implementation process of an appropriate curriculum, so as to prepare them to become training centers in the field of the conservation and management of earthen architecture for the Latin American region.

Similar initiatives were set up for the conservation of immovable cultural heritage in Sub-Saharan Africa by the Africa 2009 program, an effort that is based on an agreement between the

- El desarrollo y expansión de las diferentes redes nacionales y regionales de personas que trabajan en el campo de la conservación de la arquitectura de tierra es impresionante.

Aunque se ha avanzado mucho en formación, notamos que persisten dos grandes problemas: el número de especialistas formados a través de los cursos PAT y por las diversas iniciativas locales o regionales es bastante reducido, considerando la demanda por profesionales calificados en todo el mundo; el segundo, que los conocimientos surgidos de programas operativos y de investigación se han transmitido en actividades esporádicas y no permanentes.

Ante esta situación el Proyecto Gaia ha reformulado sus mandatos respecto a la formación y está pasando a una nueva etapa de divulgación de la información y aprendizajes. En 1998, el Getty Conservation Institute (GCI), el ICCROM, CRATerre y la Escuela de Arquitectura de Grenoble acordaron establecer un nuevo marco para inscribir un programa de colaboración, el Proyecto Terra, orientado al estudio y conservación de la arquitectura de tierra. Las actividades previas desarrolladas en el marco del Proyecto Gaia y las actividades anteriores del GCI en este campo se inscribirán dentro del Proyecto Terra.

Proyecto Terra

El primer curso regional organizado en el Perú en 1996 puede considerarse como un momento decisivo para el Proyecto Gaia y el Proyecto Terra. El curso ofreció una formación especializada en la conservación y manejo del patrimonio de tierra dentro de un contexto específico y lo hizo en colaboración con un asociado institucional local. Así, este curso es un prototipo de las actividades educativas del Proyecto Terra, cuyo objetivo principal es asegurar que el tema de la conservación del patrimonio de tierra logre insertarse con fuerza en el curriculum de la educación formal mediante:

- el desarrollo de un cuerpo docente;
- la introducción del campo y sus conceptos dentro de programas universitarios y otros programas de educación formal ya existentes o en desarrollo;
- preparación de materiales didácticos para situaciones de enseñanza, y
- el refinamiento del contenido curricular mediante el desarrollo metodológico

La experiencia de PAT96 se consolidará a través de la organización de PAT 99, el segundo

World Heritage Centre of UNESCO, ICCROM, and CRATerre-EAG. In cooperation with various African institutions, this program is developing a comprehensive method for training a broad spectrum of people involved in the use and upkeep of this heritage in order to improve the conditions for its conservation.

The UNESCO Chair on Earthen Architecture

Given its activities and its goal to incorporate into the university curriculum the conservation of earthen architecture, Project Terra meets the main objective of the UNESCO Chair on Earthen Architecture, Constructive Cultures, and Sustainable Development. This program, conceived as a university consortium, is based on the observation that there is a need for more training. It was initiated by UNESCO in 1996 at the School of Architecture of Grenoble, which has a long-standing record in university and professional training in the concerned field, and was developed in cooperation with national and international partners. The program's main goal is to establish regional and national centers of excellence for specialized studies and advanced research, and to develop with them adapted curricula related to earthen architecture and its conservation.

The experience and information acquired by the Gaia Project/Project Terra partners through the organization of the four international courses (PAT89, PAT90, PAT92, PAT94) and the regional course in Trujillo, Peru, (PAT96) should lead to a reformulation of the objectives and the contents of the post-graduate course on earthen architecture (presented since 1984 at the School of Architecture of Grenoble) and make it an international resource for the participants at other regional centers. The PAT99 course will have a critical and catalytic role in this continuum. It is indeed through its development that the Project Terra partners will synthesize all previous efforts by accumulating and structuring the existing knowledge that resulted from years of training and hands-on experience. Combined with the exploration of innovative approaches to training and education, organizers of PAT99 hope to develop improved pedagogic and didactic materials that will benefit not only the UNESCO Chair partners but also a larger network of universities and training centers.

This new phase will allow those concerned with the conservation and future development of

curso regional que están poniendo en marcha hoy los iniciadores del Proyecto Terra, junto con sus asociados locales. PAT99 implicará la participación de universidades locales y regionales en las distintas etapas del proceso de desarrollo e implementación de un curriculum apropiado que las prepare para transformarse en centros de formación en el campo de la conservación y manejo de la arquitectura de tierra para la región latinoamericana.

Se organizaron iniciativas similares para la conservación del patrimonio cultural inmueble en el África subsahariana, a través del Programa Africa 2009, un esfuerzo basado en un acuerdo entre el Fondo del Patrimonio Mundial de la UNESCO, el ICCROM y CRATerre-EAG. En cooperación con varias instituciones africanas, este programa desarrolla un método integral para la formación de un amplio espectro de personas involucradas en el uso y mantenimiento de este patrimonio, para mejorar las condiciones de su conservación.

La Cátedra de Arquitectura de Tierra de la UNESCO

Considerando sus actividades y su objetivo de incorporar la conservación de la arquitectura de tierra dentro del curriculo universitario, el Proyecto Terra responde al objetivo principal de la Cátedra de Arquitectura de Tierra, Culturas Constructivas y Desarrollo Sustentable de la UNESCO. Este programa, concebido como un consorcio universitario, se basa en la observación de la necesidad de contar con más formación. Fue iniciado en 1996 por la UNESCO en la Escuela de Arquitectura de Grenoble que tiene una larga historia de formación universitaria y profesional en el campo en cuestión, y desarrollado en cooperación con socios nacionales e internacionales. El programa tiene por objetivo principal establecer centros regionales y nacionales de excelencia para estudios especializados e investigación avanzada y desarrollar con ellos un curriculo adaptado a la arquitectura de tierra y su conservación.

La experiencia e información que han adquirido los asociados del Proyecto Gaia/Proyecto Terra gracias a la organización de los cuatro cursos internacionales (PAT89, PAT90, PAT92, PAT94) y el curso regional en Trujillo, Perú, (PAT96) debiera conducirlos a reformular los objetivos y contenidos del curso de post-grado en arquitectura de tierra (ofrecido desde 1984 en la Escuela de Arquitectura de Grenoble), transformándolo en un recurso inter-

earthen architecture to better face the challenges presented by the 21st century.

Notes

1 Premier colloque international sur la conservation des monuments en brique crue, Yazd, Iran, Conseil International des Monuments et des Sites et Icomos-Iran, 25–30 Nov., 1972.

2 2ème colloque international sur la conservation des monuments en brique crue, Yazd, Iran, Conseil International des Monuments et des Sites et Icomos-Iran, 6–9 Mar., 1976.

3 US/ICOMOS-ICCROM Adobe Preservation Working Session, Santa Fe, New Mexico, 3–7 Oct., 1977.

4 Third International Symposium on Mud-brick (Adobe) Preservation, Ankara, Turkey, ICOM-ICOMOS Turkish National Committees, 29 Sept.–4 Oct., 1980.

5 International Symposium and Training Workshop on the Conservation of Adobe, Lima-Cusco, Peru, The Regional Project on Cultural Heritage and Development UNDP/UNESCO and ICCROM, 10–22 Sept., 1983.

6 Fifth International Meeting of Experts on the Conservation of Earthen Architecture, Rome, Italy, ICCROM and CRATerre, 22–23 Oct., 1987.

7 Sixth International Conference on the Conservation of Earthen Architecture, Las Cruces, New Mexico, US, ICOMOS, GCI, NPS-Southwest Region, The Gaia Project, 14–19 Oct., 1990

8 Seventh International Conference on the Study and Conservation of Earthen Architecture, Silves, Portugal, DGEMN, The Gaia Project, and the International ICOMOS Committee for the Study and the Conservation of Earthen Architecture, 24–29 Oct., 1993.

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nacional para los participantes en otros centros regionales. El Curso PAT99 tendrá un papel crítico y catalizador en este continuo. Más aún, gracias a su desarrollo los asociados del Proyecto Terra podrán sintetizar todos los esfuerzos previos, acumulando y estructurando el conocimiento existente que es resultado de años de formación y experiencia práctica. Combinado con la exploración de enfoques innovadores en la formación y educación, los organizadores del curso PAT99 esperan desarrollar materiales pedagógicos y didácticos perfeccionados que serán útiles no sólo para los asociados de la Cátedra UNESCO, sino también para una vasta red de universidades y centros de formación.

Este nueva etapa permitirá que las personas involucradas en la conservación y desarrollo futuro de la arquitectura de tierra puedan enfrentar mejor los desafíos que les presenta el nuevo siglo que ya está llegando.

Notas

1 Primer coloquio internacional sobre conservación de monumentos de ladrillos crudos. Yazd, Irán, Consejo Internacional de Monumentos y Sitios e ICOMOS-Irán, 25–30 Noviembre 1972.

2 Segundo coloquio internacional sobre conservación de monumentos de ladrillos crudos, Yazd, Iran, Consejo Internacional de Monumentos y Sitios et ICOMOS-Irán, 6–9 Marzo 1976.

3 Sesión de Trabajo en Conservación de Adobe US/ICOMOS-ICCROM, Santa Fe, Nuevo México, 3–7 Octubre 1977.

4 Tercer Simposio Internacional de Preservación de Ladrillos de Barro (Adobe), Ankara, Turquía, Comités Nacionales Turcos ICOM-ICOMOS, 29 Sept.–4 Octubre 1980.

5 Simposio Internacional y Taller de Formación en Conservación de Adobe, Lima-Cusco, Perú, Proyecto Regional sobre Patrimonio Cultural y Desarrollo PNUD/UNESCO e ICCROM, 10–22 Septiembre 1983.

6 Quinta Reunión Internacional de Expertos en Conservación de la Arquitectura de Tierra, Rome, Italia, ICCROM y CRATerre, 22–23 Octubre 1987.

7 Sexta Conferencia Internacional sobre Conservación de la Arquitectura de Tierra, Las Cruces, Nuevo México, US, ICOMOS, GCI, NPS-Southwest Region, Proyecto Gaia, 14–19 Octubre, 1990

8 Séptima Conferencia Internacional sobre el Estudio y Conservación de la Arquitectura de Tierra, Silves, Portugal, DGEMN, Proyecto Gaia y Comité Internacional ICOMOS para el Estudio y Conservación de la Arquitectura de Tierra, 24–29 Octubre 1993.

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Erica Avrami

Building Institutional Alliances

Project Terra

Establecimiento de Alianzas Institucionales

Proyecto Terra

Ever since man learnt to build homes and cities around 10,000 years ago, earth has undoubtedly been one of the most widely-used construction materials in the world.

There is hardly an inhabited continent, and perhaps not even a country, which does not have a heritage of buildings in unbaked earth, and even nowadays more than a third of all humanity lives in a home built of earth.

Hugo Houben and Hubert Guillaud*

As the preceding quote indicates, there is a wealth of earthen architectural heritage the world over and thus an enormous challenge to preserve this important legacy. From entire cities to monumental sites to intricate decorated surfaces, the range and complexity of earthen architectural materials and applications makes conserving this heritage a formidable task. Compounding the problem further are the rampant and rapid excavation of earthen sites, unchecked development and encroachment, increasing tourism, and a lack of trained professionals.

Despite the glaring need for a concerted effort on this front, there are relatively few organizations dealing with earthen architecture conservation. This may be due in part to the unfortunate and misguided perception that earthen

* *Earth Construction: A Comprehensive Guide.* (London: Intermediate Technology Publications, 1994).

Desde que el hombre aprendió hace más de 10.000 años a construir casas y ciudades, la tierra ha sido sin duda uno de los materiales de construcción más usados en todo el mundo.

Casi no existe continente ni país habitado que no tenga un patrimonio de edificios construídos con tierra cruda. Más aún, en nuestros días más de un tercio de la humanidad vive en casas construídas con tierra.

Hugo Houben y Hubert Guillaud*

Como señala la cita anterior, en todo el mundo existe una gran riqueza en el patrimonio de la arquitectura de tierra, con el consiguiente enorme desafío que plantea la preservación de este importante legado. Desde ciudades enteras a sitios monumentales y superficies de intrincada decoración, el abanico y complejidad de los materiales y aplicaciones arquitectónicas de tierra hace de la conservación de este patrimonio una tarea de titanes. Agrava este problema la desenfrenada y rápida excavación en sitios arqueológicos de tierra, un desarrollo e intromisión descontrolados, el turismo creciente y la falta de profesionales capacitados.

A pesar de la necesidad de concertar esfuerzos en este frente, existen pocas organizaciones que trabajan en el campo de la conservación de

* *Earth Construction: A Comprehensive Guide.* (London: Intermediate Technology Publications, 1994).

architecture is a "primitive" form of construction. In academia, earthen architecture is largely absent from courses on history, design, and construction technology. With earthen structures constituting only a fraction of new construction in the industrialized world, there is no industry to promote and support continued investigation of earthen materials and their applications. As such, the scientific and technological research base for earthen architecture and its conservation is very limited as compared to that of stone, brick, and timber. Procedures and information are often borrowed from other fields, such as agriculture and road building, but significant differences in application often preclude a direct transfer of technology. The result is a rather fragmented body of knowledge.

Through a series of international conferences, training initiatives, and the formation of national and international committees, there has been in the past two decades considerable advancement of the earthen architecture conservation field. A network of practitioners, scientists, and academics has developed as a consequence of these venues that foster the exchange of information. However, the increase in institutional commitment lags behind, and so too has the support for larger-scale initiatives and policy reform.

Targeting Institutions

It has become increasingly clear that institutional involvement and cooperation are key in developing the type of broad-based support needed for the conservation of earthen architecture. Using the experience of *Preservación de la Architectura de Tierra* (PAT) 96,[1] the International Centre for Earth Construction-School of Architecture of Grenoble (Centre

Chan Chan, Trujillo, Peru. World Heritage Site and venue for the Pan-American Course on the Conservation and Management of Earthen Architectural and Archaeological Heritage (PAT96). Photo courtesy Michael Romero Taylor.

Chan Chan, Trujillo, Perú. Sitio de Patrimonio Mundial y Localidad para el Curso Panamericano en la Conservación y Manejo de Arquitectura Térrea y Patrimonio Arqueológico (PAT 96). Foto cortesía de Michael Romero Taylor.

arquitecturas de tierra. En parte ello puede explicarse por una percepción desafortunada y poco atinada de la arquitectura de tierra como una forma "primitiva" de construcción. En los ambientes académicos no se enseña casi la arquitectura de tierra en los cursos de historia, diseño y tecnología de la construcción. Dado que las estructuras de tierra constituyen solamente una fracción de las construcciones nuevas en el mundo industrializado, no existe una industria que promueva y apoye la investigación permanente en materiales de tierra y sus aplicaciones. En sí, la base de investigaciones científicas y tecnológicas para la arquitectura de tierra y su conservación es muy limitada, si la comparamos con la de la piedra, ladrillo y madera. Los procedimientos e informaciones suelen tomarse de otras disciplinas, como la agricultura y construcción de carreteras. Sin embargo las grandes diferencias en su aplicación constituyen a menudo un impedimento práctico para una transferencia directa de tecnología. El resultado es un cuerpo de conocimientos fragmentario.

Gracias a una serie de conferencias internacionales, iniciativas de formación y la creación de comités nacionales e internacionales, en las dos últimas décadas se ha experimentado un notable avance en el campo de conservación de la arquitectura de tierra. Como un resultado de estas reuniones se ha ido creando una red de expertos, de científicos y académicos que estimula el intercambio de informaciones. Sin embargo, existe un retraso en el compromiso institucional, al igual que el apoyo para iniciativas a mayor escala real y reformas normativas.

Orientación a Instituciones

Se ha hecho cada vez más claro que el compromiso y cooperación institucional resultan claves para desarrollar el tipo de apoyo de amplia sustentación necesario para la conservación de la arquitectura de tierra. Con la experiencia de *Preservación de la Arquitectura de Tierra* (PAT) 96,[1] el Centro Internacional de Construcción de Tierra-Escuela de Arquitectura de Grenoble (CRATerre-EAG), el Getty Conservation Institute (GCI) y el Centro Internacional para el Estudio de la Conservación y Restauración del Patrimonio Cultural (ICCROM) iniciaron conversaciones para establecer un programa conjunto de colaboración entre estas entidades destinado al estu-

International de la Construction Terre-Ecole d'Architecture de Grenoble) (CRATerre-EAG), the Getty Conservation Institute (GCI), and the International Centre for the Study of the Preservation and the Restoration of Cultural Property (ICCROM) initiated discussions to establish a collaborative ICCROM/GCI/CRATerre-EAG program for the study and conservation of earthen architecture. Having a long history of involvement in the field, these institutions are committed to promoting the understanding and appreciation of earthen architecture heritage and have recognized the potential of uniting efforts in one cooperative framework, Project Terra. With this new framework for international collaboration established, previous institutional experiences such as ICCROM/CRATerre- EAG's Gaia Project, as well as the GCI's past activities in the field, are unfolding into Project Terra.

The Project Terra partners recognized—through their independent and collective activities in the field of earthen architecture conservation—that the most successful means of leveraging resources and developing the field was through partnership with other organizations. As such, the project established a framework for ICCROM, CRATerre-EAG, and the GCI[2] to collaborate with each other as well as with other institutions though associate partnerships in four areas of activity.

Project Terra Mission and Activities

The aim of Project Terra is to develop the conservation of earthen architectural heritage—as a science, a field of study, a professional practice, and a social endeavor—through institutional cooperation in the areas of research, education, planning and implementation, and advocacy and outreach.

Research. In the area of research, efforts are focused on establishing the current state of knowledge in the field of earthen architecture conservation and on initiating new research in both the lab and field. As part of the former, a survey has been conducted of individuals and organizations around the world to establish current initiatives and trends in earthen architecture research. The results of the survey will be synthesized in a report on the state of knowledge, which will also incorporate the outcomes of a critical review of recent literature and an analysis of the structure of the discipline and of gaps and trends in the field.

dio y conservación de la arquitectura de tierra. Con una larga historia de intervención en este campo, estas instituciones se han comprometido a promover el conocimiento y apreciación del patrimonio de arquitectura de tierra, reconociendo la fuerza que resulta de la unión de esfuerzos en un marco de cooperación, el Proyecto Terra. Habiendo establecido este nuevo marco de colaboración internacional, las experiencias institucionales previas como el Proyecto Gaia del ICCROM/CRATerre-EAG y las actividades realizadas por el Getty Conservation Institute en el pasado en este terreno se insertan hoy en el Proyecto Terra.

Gracias a sus actividades independientes y colectivas en el campo de la conservación de la arquitectura de tierra, los miembros del Proyecto Terra han visto que la manera más exitosa de valorizar recursos y avanzar en este terreno es asociaciarse con otras organizaciones. Es así como el Proyecto estableció un marco para la colaboración conjunta del ICCROM, CRATerre-EAG y el GCI,[2] como también con otras instituciones a través de asociaciones estratégicas en cuatro áreas de actividad.

El Proyecto Terra: Misión y Actividades

El Proyecto Terra tiene como propósito desarrollar el tema de la conservación del patrimonio arquitectónico de tierra como una ciencia, un campo de estudio, una práctica profesional y un esfuerzo social mediante la cooperación institucional en las áreas de investigación, educación, planificación e implementación, promoción e investigación.

Investigación. En el área de investigación los esfuerzos se han centrado en establecer el estado actual de conocimientos en el campo de la conservación de la arquitectura de tierra e iniciar nuevas investigaciones, tanto en terreno como de laboratorio. Como parte de lo anterior, se aplicó una encuesta a personas y organizaciones en todo el mundo con el objetivo de recopilar iniciativas y tendencias actuales en la investigación en arquitectura de tierra. Los resultados de la encuesta serán resumidos en un informe del estado de conocimientos que también incorporará las conclusiones de una revisión crítica de la literatura más reciente y un análisis de la estructura de la disciplina y de las lagunas y tendencias en este terreno.

Esta nueva investigación que coordina el GCI consiste en el siguiente plan de tres fases:

Huaca de la Luna, Trujillo, Peru. Cleaning and conservation of murals on recently excavated earthen architecture. Photo courtesy Michael Romero Taylor.

Huaca de la Luna, Trujillo, Perú. Limpieza y conservación de murales in una excavación reciente de arquitectura térrea. Foto cortesía de Michael Romero Taylor.

The new research, coordinated by the GCI, consists of a three-phase plan of

- characterizing earthen building materials and their properties
- analyzing and isolating decay factors and mechanisms, and
- developing and testing possible conservation options.

A primary objective of this research is to develop an understanding of the nature of the degradation processes that occur when archeological remains of earthen structures are excavated and exposed to the environment. A secondary objective is to build on this understanding and develop appropriate methods to mitigate the deterioration of these structures. The potential long-term benefits of this research are an understanding of why and how earthen materials degrade, the generation of data on a group of possible intervention methodologies that have been evaluated in the laboratory and in the field, and the development of simplified analytical procedures.

A broad range of analytical procedures are under evaluation to determine which will yield information that can be correlated with the relative resistance to weathering of earthen materials obtained from various historic archeological sites. Through this correlation of data, it may be possible to characterize the critical properties that are responsible for the observed tendency toward degradation, and this in turn will serve to focus research related to conservation techniques.[3]

At present, the GCI is seeking institutional partners to collaborate in the research effort. Collaboration may consist of conducting parallel or complimentary analyses, furnishing material samples and requisite documentation, and/or

- caracterización de los materiales de construcción de tierra y sus propiedades;
- análisis e individulización de los factores y mecanismos de decadencia, y
- desarrollo y pruebas de alternativas de conservación.

Uno de los objetivos básicos de esta investigación es lograr una comprensión cabal de los procesos de degradación generados cuando se excavan los restos arqueológicos de las estructuras de tierra, dejándolos expuestos a la acción ambiental. Un objetivo específico es desarrollar métodos adecuados para mitigar el deterioro de dichas estructuras, a partir de esta comprensión. Las ventajas potenciales en el largo plazo de esta investigación son comprender la causa y manera en que se degradan los materiales, generar datos a partir de un conjunto de metodologías posibles de intervención que han sido evaluadas en el laboratorio y en terreno, y desarrollar procedimientos analíticos simplificados.

Se está evaluando una amplia gama de procedimientos analíticos para elegir luego aquellos que puedan producir información que se correlacione con la resistencia relativa a la meteorización de los materiales de tierra obtenidos de diferentes sitios históricos arqueológicos. Gracias a esta correlación de datos será posible caracterizar las propiedades críticas responsables de la degradación, lo que a su vez servirá para orientar la investigación relativa a técnicas de conservación.[3]

En la actualidad el GCI explora el interés de instituciones asociadas que deseen colaborar en tal esfuerzo de investigación. La colaboración puede consistir en realizar análisis paralelos o complementarios, en la entrega de muestras de materiales y documentación necesaria o en permitir el acceso y apoyo en los sitios, para realizar actividades de pruebas y monitoreo. Las organizaciones que estén interesadas en asociarse a esta actividad pueden contactarse al GCI.

Educación. Uno de los objetivos básicos del Proyecto Terra en el área de la educación es desarrollar la arquitectura de tierra como un campo de estudios universitarios. Esto puede lograrse mediante la elaboración y ensayo de metodologías de formación y materiales didácticos, el desarrollo de un cuerpo docente y el establecimiento de un consorcio universitario.

La década que cubre el legado PAT,[4] el curso de post-grado en CRATerre-EAG y la Cátedra de Arquitectura de Tierra recién inau-

providing access to and support at sites for testing and monitoring. Organizations interested in partnering in this endeavor should contact the GCI.

Education. In the area of education, a primary objective of Project Terra is to develop earthen architecture as a field of study at the university level. This is to be achieved through the elaboration and testing of training methodologies and didactic materials, development of faculty, and building of a university consortium. The ten-year PAT legacy,[4] the post-graduate course at CRATerre-EAG, and the newly inaugurated UNESCO Chair on Earthen Architecture constitute a strong foundation from which this objective is being pursued. (For more information on these training initiatives, see Trappeniers' article, p. 7.)

Additional educational activities include meetings of small groups of specialists to focus on specific issues impacting the field, as well as an initiative aimed at standardizing terminology related to earthen architecture and its conservation. The field has long suffered from the use of inaccurate terms and colloquialisms both in practice and in literature. Through collaboration with organizations dealing with earthen architecture as well as those dealing with vocabularies related to architecture and construction sciences, it is hoped that both momentum and consensus regarding such terminology can be built within the field.

Planning and Implementation. The planning and implementation component of Project Terra involves the development, testing, and application of methodologies specific to the conservation and management of earthen architectural sites. The value-driven planning methodology advanced by the PAT96 course has been applied to the development of a management plan for Chan Chan[5] undertaken by the Instituto Nacional de Cultura—La Libertad (INC-LL), with the support of UNESCO and the Terra Project partners. The same methodology is being adapted for application at Joya de Cerén[6] in El Salvador through a cooperative project of the GCI and Concultura. Through the development of these and other reference projects, Project Terra plans to develop an integrated, interdisciplinary approach to conservation and management that meets the particular needs of earthen architectural heritage.

Advocacy and Outreach. Through the advocacy and outreach component of Project Terra, several cultural institutions are exploring

gurada por la UNESCO son una base sólida que permite ir cumpliendo con este objetivo. (Para mayores informaciones sobre estas iniciativas de formación véase el artículo de Trappenier, p. 7). Entre otras actividades educativas están las reuniones de grupos pequeños de especialistas, centradas en problemas específicos de impacto en el terreno, y también una iniciativa que busca uniformar la terminología relacionada con la arquitectura de tierra y su conservación. Este campo sufre del uso de términos inadecuados y coloquiales, tanto en la práctica como en la literatura. Con la colaboración de las organizaciones que trabajan con arquitectura de tierra y de otras que investigan el vocabulario arquitectónico y de las ciencias de la construcción se espera establecer un consenso en relación con la terminología.

Planificación e Implementación. En el Proyecto Terra, el aspecto de planificación e implementación abarca el desarrollo, pruebas y aplicación de metodologías específicas para la conservación y manejo de sitiosm de arquitectura de tierra. La metodología de planificación basada en valores que presentara el curso PAT96 se ha aplicado a un plan de manejo para el sitio Chan-Chan[5] que asumió el Instituto Nacional de Cultura-La Libertad (INC-LL) con el respaldo de la UNESCO y de los asociados del Proyecto Terra. Se adaptó la misma tecnología para aplicarla en la Joya de Cerén[6] en El Salvador, a través de un proyecto de cooperación del GCI y Concultura. El Proyecto Terra pretende, a través del desarrollo de estos y otros proyectos de referencias, mantener un criterio interdisciplinario integrado para la conservación y manejo que responda a las necesidades específicas del patrimonio arquitectónico de tierra.

Promoción y Extensión. Las actividades de promoción y extensión del Proyecto Terra han permitido que distintas instituciones culturales exploren las posibilidades de organizar una exposición internacional sobre arquitectura de tierra centrada en su historia, su conservación y su continuidad en el futuro. Esta iniciativa es una continuación de la exitosa exposición "Des architectures de terre. Tradition et modernité" inaugurada en 1981 en el Centro Georges Pompidou y que ha sido presentada en 22 ciudades de 14 países. Continúan las solicitudes de préstamo, aunque ya la exposición y su mensaje han sido probablemente superados. La

possibilities for the development of an international exhibition on earthen architecture that concentrates on its history, its conservation, and its continuity in the future. This proposed venture follows the very successful exhibition, "Des Architectures de Terre—Tradition et Modernitè," which opened in 1981 at the Centre Georges Pompidou and has been presented in 22 cities in 14 countries. Loan requests still continue although the exhibition and its message are quite outdated. This new exhibition would build upon the lessons and success of its predecessor, and it would include a strong emphasis on conservation, an issue that was not addressed previously.

In addition, this component of Project Terra may include outreach activities related to specific areas of work or collaboration, such as community outreach efforts in Trujillo, Peru, for the PAT99 course, demonstrations, or project information made available at research sites.

Conclusions

To address the challenges posed by the conservation of the world's earthen architectural heritage, it is necessary to view the field and its needs holistically. There is not—nor will there ever be—a surefire method to preserve earthen materials and structures. The variety of cultural and physical contexts in which this heritage resides, as well as the monumentality, scale, and complexity of its manifestations, preclude a singularly technical approach. By fostering multilateral and multidisciplinary collaboration through several—if limited—areas of activity, it is hoped that Project Terra will develop the field of earthen architecture conservation in an integrated and future-oriented fashion.

Notes

1 Curso Panamericano sobre la Conservacications, 1994). It is hoped that Project Terra will develop the field of ea, a five-week course hosted in Trujillo, Peru, November 10–December 13, 1996, in collaboration with the Instituto Nacional de Cultura.

2 Members of the GCI project team are Giora Solar and Alberto Tagle (Co-Directors), Erica Avrami (Project Manager), Bill Ginell (Senior Scientist), Gaetano Palumbo (Project Specialist), Evin Erder (Fellow), and Anna Zagorski (Project Associate).

3 Bill Ginell and Carlos Navarro-Rodriguez, "Earthen Materials Test Plan," Getty Conservation Institute, Los Angeles, Calif.

4 PAT89, PAT 90, PAT 92, PAT 94 in Grenoble, France (CRATerre-EAG and ICCROM as Gaia); PAT 96 in Trujillo, Peru (CRATerre-EAG and ICCROM as Gaia, GCI, and the Instituto Nacional de Cultura); PAT 99 in Trujillo, Peru (CRATerre-

nueva exposición se fundará en las experiencias y éxito de su antecesora, poniendo un acento fuerte en la conservación, tema que no fue tratado en la primera versión.

Además, este componente del Proyecto Terra incluirá actividades de extensión relacionadas con áreas específicas de trabajo o colaboración, como los esfuerzos de extensión a la comunidad de Trujillo en el curso PAT 96, las demostraciones o informaciones de proyectos que se presentan en los sitios de investigación.

Conclusiones

El sector y sus necesidades deben verse desde una perspectiva global para poder responder a los desafíos planteados por la conservación del patrimonio arquitectónico mundial de tierra. No existe, ni existirá jamás, un método totalmente seguro para preservar los materiales y estructuras de tierra. La variedad de contextos culturales y físicos donde se encuentra el patrimonio, como también la monumentalidad, escala y complejidad de sus manifestaciones impiden abordarlo con un criterio técnico único. Al incentivar la colaboración multilateral y multidisciplinaria en diversas, aunque limitadas, áreas de actividad, se espera que el Proyecto Terra logre desarrollar el campo de la conservación de la arquitectura de tierra de manera integral y abierta al futuro.

Notes

1 Curso Panamericano sobre la Conservación y Manejo del Patrimonio Arquitectónico Histórico-Arqueológico de Tierra, llevado a cabo en Trujillo, Perú entre el 10 de noviembre y el 13 de diciembre de 1996 en conjunto con el Instituto Nacional de Cultura.

2 El equipo del proyecto GCI está integrado por Giora Solar y Alberto Tagle (Codirectores), Erica Avrami (Gerente del Proyecto), Bill Ginell (Científico de Mayor Antigüedad), Gaetano Palumbo (Especialista del Proyecto), Evin Erder (Investigador Becado) y Anna Zagorski (Asociada al Proyecto).

3 Bill Ginell y Carlos Navarro-Rodriguez, "Earthen Materials Test Plan", Getty Conservation Institute, Los Angeles, California.

4 PAT89, PAT90, PAT92, PAT94 en Grenoble, Francia (CRATerre-EAG e ICCROM como GAIA); PAT96 en Trujillo, Perú (CRATerre-EAG e ICCROM como GAIA y el Instituto Nacional de Cultura); PAT99 en Trujillo, Perú (CRATerre-EAG, ICCROM y GCI como Terra y el Instituto Nacional de Cultura La Libertad).

5 Chan Chan es un complejo arqueológico de tierra perteneciente a la cultura Chimu en Trujillo,

EAG, ICCROM, and GCI as Terra and the Instituto Nacional de Cultura—La Libertad).

5 Chan Chan is a 14-km2 earthen archeological complex (ca. 9–14 cent. A.D.) of the Chimu culture in Trujillo, Peru.

6 Joya de Cerén is a Mayan archeological site (ca. 600 A.D.) of non-monumental earthen construction near San Salvador, El Salvador

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Perú, el cual abarca 14 Km2 de superficie (c. entre los siglos 9 y 14 D.C.).

6 Joya de Ceren es un emplazamiento arqueológico Maya (c. año 600 D.C.) de construcción de tierra no monumental, cerca de San Salvador, El Salvador.

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US/ICOMOS
Specialized Committee on Earthen Architecture

The International Council on Monuments and Sites, (ICOMOS), is a nongovernmental organization of professionals and individuals active in preserving the world's cultural heritage. Its principal objectives are to bring together professional specialists from around the world as a forum for professional dialogue and exchange; to collect, evaluate and disseminate information on preservation principles, techniques and policies; to cooperate with international and national authorities on the establishment of documentation centers specializing in preservation; to work for the adoption and implementation of international conventions; and to put the expertise of professionals and specialists at the service of the worldwide community.

US/ICOMOS is the United States committee of ICOMOS. It is one of 95 such national committees that form a worldwide alliance for the study and conservation of historic buildings, districts, and sites. US/ICOMOS has several specialized committees that were organized to offer specific expertise in conservation areas. The US/ICOMOS Specialized Committee on Earthen Architecture is one of these committees. For more information, please access the IS/ICOMOS web page at <www.icomos.org/usicomos>.

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Comité US/ICOMOS
Especializado en Arquitectura de Tierra

El Consejo Internacional de Monumentos y Sitios ICOMOS, (International Council on Monuments and Sites) es una organización no gubernamental de profesionales e individuos involucrados activamente en la preservación del patrimonio cultural del mundo. Sus objetivos principales son reunir a expertos profesionales de todo el mundo en un foro que haga posible el diálogo e intercambio profesional; recopilar, evaluar y divulgar la información sobre principios, técnicas y políticas de preservación; cooperar con las autoridades nacionales e internacionales para establecer centros de documentación especializados en conservación; trabajar por la adopción e implementación de las convenciones internacionales; y poner los conocimientos expertos de profesionales y especialistas al servicio de la comunidad mundial.

US/ICOMOS es el Comité de ICOMOS de los Estados Unidos. Es uno de los 95 comités nacionales del mismo estilo que forman una alianza mundial para el estudio y conservación de edificios, distritos y sitios históricos. US/ICOMOS cuenta con varios comités especializados organizados para ofrecer asesoría experta en áreas de conservación. El Comité US/ICOMOS Especialista en Arquitectura de Tierra es uno de dichos comités. Para más informaciones, consulte la página web de US/ICOMOS en <www.icomos.org/usicomos>.

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Michael Romero Taylor

Earthen Architecture Traditions in New Mexico

Tradiciones de Arquitectura de Tierra en Nuevo México

Jacal construction unearthed during excavations of the Hyde Expedition at the turn of the century at Pueblo Bonito, Chaco Culture National Historical Park. Photo courtesy Department of Library Services, American Museum of Natural History.

Construcción de jacal excavado al principio del siglo durante la expedición Hyde en Pueblo Benito, Chaco Culture National Historical Park. Foto cortesía del American Museum of Natural History.

In the United States, New Mexico can boast of many of earthen architecture's crown jewels, which are scattered throughout its landscape; among the architectural gems are the Palace of the Governors in Santa Fe (the oldest continuously occupied public building dating to 1609), the Old Santa Fe Trail Building (a regional office for the National Park Service built in the 1930s and the largest adobe office complex in the United States), and Taos Pueblo (a multi-storied adobe pueblo occupied for more than 500 years; Taos Pueblo recently was placed on the World Heritage List). These well-known monuments are but a small part of the Southwest's extensive heritage in building with earth that dates back at least 2,000 years.

The styles and methods that have been used in earthen construction in New Mexico are as varied as the people who built the structures. The region has been a settling place for many immigrants, some of whom used the Rio Grande

Dentro de los Estados Unidos, Nuevo México puede enorgullecerse de poseer muchas de las joyas de la corona en arquitectura de tierra repartidas por todo su territorio; entre las gemas arquitectónicas están el Palacio de los Gobernadores en Santa Fe, el edificio público más antiguo ocupado sin interrupciones, que data de 1609; el Old Santa Fe Trail Building, una oficina regional del Servicio Nacional de Parques construída en los años 30, el complejo de oficinas de adobe más grande de los Estados Unidos y el Taos Pueblo, un pueblo de adobe de varios pisos habitado por más de quinientos años que recientemente ha sido incluído en la World Heritage List. Estos famosos monumentos no son sino una pequeña muestra del gran patrimonio de construcción en tierra del Sudoeste que se remonta al menos a 2,000 años atrás.

Los estilos y métodos que se han utilizado en la construcción de tierra en Nuevo México son tan variados como la gente que levantó las estructuras. Son muchos los inmigrantes que se asentaron en esta región, usando el valle del Río Grande como el corredor principal de transporte. Los primeros habitantes del área llegaron aquí aproximadamente en el 10.000 A.C.; los siguieron oleadas sucesivas de indígenas americanos procedentes de las praderas y luego inmigrantes y comerciantes de la región mesoamericana. Los españoles y otros grupos europeos trajeron luego con ellos nuevas ideas de construcción con tierra y asimilaron las tradiciones locales en los estilos prevalecientes en esa época.

En Nuevo México, como en muchas partes del mundo, la tradición de construir con tierra abarca una gran variedad de técnicas a través de los siglos; entre las técnicas y materi-

Valley as the main transportation corridor. The first people to have inhabited the area were here about 10,000 B.C.; they were followed by subsequent waves of other American Indians from the Plains and then by immigrants and tradesmen from Meso-America. Spaniards and other Europeans later brought with them many new ideas for building with earth, and they assimilated local traditions into styles that were prevalent at the time.

In New Mexico, as in many parts of the world, the tradition of building with earth has involved a variety of techniques through the centuries; among the techniques and materials are coursed adobe, *jacal*, and hand-molded and form-molded adobe bricks.

The first structures built in New Mexico were most likely pit houses: semi-subterranean mud-plastered structures, built partially into the ground, with a timber, brush, and dirt roof. Sometimes the subterranean dirt walls were veneered with coursed adobe. Archeological remnants of these types of dwellings can be found in practically all parts of New Mexico and to the rest of the southwestern part of what is now the United States. More and more information on this type of dwelling and its variations through time is becoming available, a consequence of salvage archeological excavations effected by the construction of roads and other publicly funded projects. Examples of such dwellings that are at least 2,000 years old have been found recently through excavations on the outskirts of Santa Fe, a town that is for many of us in this country the epitome of adobe architecture.

Pit house construction was prevalent in New Mexico until about the third century A.D., at which time people began to build surface structures using the available materials at hand; some were made of stone, but many were made of earth. The majority of these surface structures were made using the "coursed adobe" technique, sometimes referred to as "puddled adobe." These coursed adobe structures were made by using semi-stiff mud to create hand-formed courses. Many large earthen towns, which sometimes contain up to 2,000 rooms, were made using this technique.

In addition to the coursed adobe style of building, there are a number of other archeologically documented techniques used to build with earth that predate the European's arrival in the region. Among the techniques was *jacal*, in which

ales están la mampostería de adobes, el jacal, y los ladrillos de adobe moldeados manualmente y encofrados.

Las primeras estructuras construídas en Nuevo México probablemente fueron casas-foso: estructuras semisubterráneas revocadas con barro, construídas en parte dentro de la tierra, con techo de madera, ramas y tierra. En ocasiones los muros subterráneos de tierra tenían un revestimiento de mampostería de adobe. Se puede encontrar restos arqueológicos de este tipo de viviendas en casi todo Nuevo México y en el resto de la parte sudoccidental de lo que hoy son los Estados Unidos.

Paulatinamente se ha ido sumando más y más información sobre este tipo de vivienda y sus variaciones en el tiempo y en distintas regiones, como consecuencia de excavaciones arqueológicas de recuperación previas a la construcción de carreteras y otros proyectos de obras públicas. En excavaciones recientes realizadas en las afueras de Santa Fe, una ciudad que para muchos de nosotros es el epítome de la arquitectura de adobe, se han encontrado ejemplos de este tipo de viviendas que datan al menos de 2,000 años atrás.

La construcción de casas-foso prevaleció en Nuevo México hasta alrededor del siglo III de nuestra era, en que se comenzó a construir estructuras sobre la superficie con los materiales disponibles; algunas se construyeron en piedra, pero hubo muchas de tierra. La mayoría de estas estructuras de superficie se hicieron con la técnica de la "mampostería de adobe" conocida a veces como "adobe amasado" (puddled adobe). Estas estructuras de hiladas de adobe se hicieron con barro semi duro usado para crear hiladas moldeadas manualmente. Muchos pueblos grandes de adobe que tenían hasta 2.000 viviendas se construyeron con esta técnica.

Aparte de la técnica de construcción con hiladas de adobe, existieron varias técnicas documentadas arqueológicamente de construcción con tierra anteriores a la llegada de los grupos europeos a esta región. Entre ellas destaca la técnica del jacal en la que se anclan en el suelo postes rectos, rellenando los espacios con barro. Algunas estructuras de jacal que se han descubierto gracias a las excavaciones arqueológicas aparecen en un entorno de pueblos de casas-foso, mientras que, de acuerdo a la documentación, existen otras que hacen las veces de

upright posts are anchored in the ground and infilled with mud. Some of the *jacal* structures that have been revealed through archeological excavations are associated with pit house villages while others have been documented as interior dividing walls within stone masonry structures such as at Pueblo Bonito in Chaco Culture National Historical Park. The tradition of building *jacales* continued through the European settlement of the area. Some of the early Hispanic dwellings were *jacales*; indeed, many times the first type of dwelling settlers constructed when they arrived at a building site was *jacal* because of its relative ease of construction compared to the more time-intensive adobe brick construction.

Prior to the arrival of the Spanish, form-molded adobe bricks had been for centuries a common type of construction material in many parts of Meso-America and the Pacific Coast Region of South America. This tradition had not spread to the southwestern part of North America.

Hand-molded adobes in the pre-European Southwest did exist, however. Depending on their shape and size, the bricks have been called

muralla divisoria dentro de estructuras de sillería de piedra, como en Pueblo Bonito en el Parque Nacional de la Cultura Chaco. Durante todo el período de asentamiento europeo se continuó la tradición de construir jacales. Muchas viviendas de los inicios de la colonia española eran de jacal; más aún, en muchas ocasiones las primeras viviendas que construían los colonos al llegar a un lugar eran de jacal porque son relativamente fáciles de construir si las comparamos con la construcción de ladrillos de adobe que requiere mucho más tiempo.

Por siglos antes de la llegada de los españoles se usaban bloques de adobe moldeado como material común de construcción en varias regiones mesoamericanas y en la región de la costa Pacífico de América del Sur. Esta tradición no se difundió hacia ni por todo el sudoeste de los Estados Unidos de América.

Sin embargo, en el sudoeste pre-europeo sí existieron construcciones en adobe moldeado manualmente. Según su forma y tamaño los informes arqueológicos le han dado distintos nombres, entre ellos el de "adobe lomo de tortuga" (ladrillos rígidos moldeados a mano cuya

In most regions of the United States where adobe is widely used in construction, locally adopted amendments to the Uniform Building Code establish standard building specifications. In New Mexico, specifications for adobe are covered in Section 2413 of the 1991 New Mexico Building Code. The first version was approved and adopted by the Construction Industries Division in 1977. Prior to this 1977 version, which was developed under the auspices of the adobe industry and written by a team of four New Mexican adobe experts, the section on adobe had been regarded as severely limited and inconsistent in its coverage of the material and its specifications.

Smith, Edward W. and George S. Austin, *Modern Adobe in New Mexico.* Santa Fe, N.Mex.: New Mexico Energy, Minerals, and Natural Resources Department, 1996.

En la mayoría de las regiones de los Estados Unidos en que se usa ampliamente el adobe como material de construcción, se han establecido las especificaciones normales de construcción que son modificaciones locales al Código Uniforme de Construcción. En Nuevo México la Sección 2413 del Código de Construcción de Nuevo México de 1991 incluye las especificaciones para construccioes de adobe. La primera versión fue aprobada y adoptada en 1977 por la División de Industrias de Construcción. Previo a esta versión de 1977 desarrollada con el patrocinio de la industria del adobe y redactada por un equipo de cuatro expertos en adobe de Nuevo México, se estimaba que la sección sobre el adobe era excesivamente limitada y poco coherente en su cobertura del material y especificaciones.

Smith, Edward W. y George S. Austin, *Modern Adobe in New Mexico.* Santa Fe, N.M.: New Mexico Energy, Minerals, and Natural Resources Department, 1996.

Adobe buildings fronting street line on Canyon Road, Santa Fe, New Mexico. Photo courtesy New Mexico Historic Preservation Division.

Edificios de adobe a la largo de Canyon Road, Santa Fe, New Mexico. Foto cortesía New Mexico Preservation Division.

various names, including "turtle back adobes" (stiff, hand-molded bricks with a convex top and concave bottom) and "Vienna-roll shaped," in archeological reports.

By the 17th century, Spaniards in New Mexico had popularized the tradition of building with form-molded adobe bricks. They made the bricks as people do in other parts of the world by placing mixed sand, silt, clay, and water into wooden molds; straw was added to minimize cracking when curing and to add strength. The adobe bricks were then left to sun-dry before being used to build walls laid with earthen mortar. The durability of these adobes depended on the type of soil used. Those with a high amount of caliche (calcium carbonate), for example, have lasted much longer than those without such a natural binder. Those with significant amounts of non-expanding clays have lasted longer than those with more of a sand/silt mix without sufficient clay to serve as a binder.

The majority of structures built in the 17th, 18th, and early part of the 19th centuries were built mostly of *jacal* or adobe brick. The traditions were a blend of Mediterranean and indigenous building traditions. Many of the dwellings consisted of rooms in a single line with multiple doors giving access to individual rooms and the exterior. These often were built fronting the street in a town or along the road in a more linear rural settlement pattern. Many of the larger buildings were made in the shape of a U or a square, with a main door leading to an open patio, and outbuildings in back.

During the mid-19th century, Anglo traders and colonists from the East who had traveled the Santa Fe Trail arrived in the Southwest; with them came new ideas and building materials,

parte superior es convexa y la inferior cóncava) y "de rollo vienés".

En el siglo XVII los españoles difundieron en Nuevo México la tradición de construcción con ladrillos de adobe moldeado.. Hacían los ladrillos tal como lo hace la gente en otras partes del mundo, colocando una mezcla de arena, barro, arcilla y agua dentro de moldes de madera; luego agregaban paja para minimizar el agrietamiento típico del curado y agregarle resistencia. Los ladrillos de adobe se dejaban secar al sol antes de usarlos para levantar muros unidos con mortero de tierra. La durabilidad de estos adobes dependía del tipo de tierra usado: por ejemplo, los que tenían un alto contenido de caliche (carbonato de calcio) han durado mucho más tiempo que los ladrillos que carecen de este aglomerante natural. Los que tienen gran cantidad de arcillas no expansivas han durado más tiempo que los adobes con mayor mezcla de arena y barro, sin la cantidad de arcilla suficiente para servir de aglomerante.

La mayoría de las estructuras construídas en los siglos XVII, XVIII y comienzos del siglo XIX se hicieron con jacal o ladrillos de adobe. Los patrimonios constructivos del Mediterráneo e indígena americano se unieron en una sola práctica para levantar casas de una sola planta con sus habitaciones en línea y varias puertas que permiten acceder a las habitaciones individuales y al exterior. Solían construirse con la fachada continua que da directamente sobre la calle de un pueblo o a lo largo de un camino, siguiendo un trazado rural más lineal en los asentamientos. Los edificios más grandes tenían forma de U o de cuadrado con una puerta principal que conducía a un patio abierto y dependencias.

A mediados del siglo XIX llegaron al sudoeste los comerciantes y colonos de origen anglosajón que venían del Este por el camino de Santa Fe. Traían con ellos nuevas ideas y materiales de construcción que se incorporaron a las tradiciones hispana e indígena. La llegada del ferrocarril a Nuevo México cerca de 1870 puso más a mano elementos como hojalata corrugada, cemento Portland, clavos cuadrados, vidrios para ventanas, tablones de madera y ladrillos cocidos.

Construcción contemporánea de tierra en Nuevo México

En Nuevo México se ha dado una continuidad en la construcción con tierra ya que se

which blended with the existing Hispanic and Native American traditions. The arrival of the railroad to New Mexico in the 1870s made such items as corrugated tin, Portland cement, cut nails, window glass, milled lumber, and burned brick more readily available.

Contemporary Earthen Construction in New Mexico

There has been a continuum in building with earth in New Mexico, although proportionately less so than before especially when one considers the other types of building materials that have been popularized since World War II. New Mexico is currently the largest producer and consumer of adobe bricks in the United States. Each year during the 1980s, three to four million adobe bricks and pressed-earth blocks were produced in New Mexico by commercial manufacturers.

More than 59,000 adobe buildings, representing one-third of the adobe dwellings in the United States, are in New Mexico. Occasionally, backyard adobe producers still build their own homes. Today most builders purchase adobe bricks from commercial yards located throughout the state. The principal standard-size adobe brick produced and used in New Mexico measures 4 x 10 x 14 inches and weighs approximately 30 pounds.

Most adobe buildings in New Mexico are made from traditional adobe brick or from semi-stabilized adobe brick. Other earthen media include stabilized adobe bricks, pressed-earth blocks, and rammed earth (*pisé*). The pressed-earth block is becoming increasingly popular because building with it can be as affordable as building with a wood frame or with cinder blocks. Even though the traditional molded adobe brick is what most earthen builders are used to, the reality of the labor intensiveness of this technique, especially when compared with other building methods, is making builders look at alternative earth building techniques such as pressed block and rammed earth.

Preservation of Earthen Architecture in New Mexico

Buildings of earth can last thousands of years if protected from moisture. The often repeated euphemism "All an adobe building needs is a good hat and good boots" reminds us that adobes only need a good roof and a good foundation to protect them from the weather. Through the years there have been numerous attempts to come up with magic elixirs for pre-

sigue usando hoy, en menor proporción que antes por cierto, especialmente si tomamos en cuenta los demás tipos de materiales de construcción que se han popularizado desde la Segunda Guerra Mundial. Nuevo México es hoy el mayor productor y consumidor de ladrillos de adobe en los Estados Unidos. Cada año de la década de 1980 se fabricaron entre tres y cuatro millones de ladrillos de adobe y bloques de tierra prensada en Nuevo México. En el estado existen más de 59.000 construcciones de adobe que representan un tercio de las viviendas de adobe de los Estados Unidos. Aún existe gente que produce sus propios adobes para construir sus casas. La mayoría de las constructoras compra ladrillos de adobe hechos en fábricas comerciales de adobe repartidas por todo el estado. El principal ladrillo estándar de adobe producido y utilizado en Nuevo México mide 4 x 10 x 14 pulgadas y pesa aproximadamente 30 libras.

En Nuevo México la mayor parte de los edificios de adobe se construyeron con ladrillos de adobe tradicional o semiestabilizadmo. Entre otros materiales de tierra existen los ladrillos de adobe estabilizado, bloques de tierra prensada y tierra apisonada (pisé). El ladrillo de tierra prensada se está usando cada vez más porque resulta tan barato como construir con paredes de madera o con bloques de concreto de cenizas. Aunque la mayoría de los constructores están muy acostumbrados a usar el ladrillo tradicional de adobe moldeado, el uso intensivo de mano de obra requerido para esta técnica, sobre todo en comparación con otros métodos de construcción los ha hecho buscar técnicas alternativas de construcción con tierra, como los bloques prensados o tierra apisonada.

Preservación de la arquitectura de tierra en Nuevo México

Si están bien protegidos de la humedad una construcción de tierra puede durar por miles de años. La cita tantas veces repetida de que "una construcción de tierra solamente necesita tener un buen sombrero y un buen par de botas" nos recuerda que los adobes sólo requieren un buen techo y buenas fundaciones para protegerlos del clima.

Se han hecho numerosos intentos para dar con la fórmula mágica que preserve las construcciones de adobe, sin embargo, las mejores técnicas son mantener seco el adobe, un mantenimiento rutinario y usar materiales compati-

Deteriorating adobe buildings, Taos County, New Mexico. Photo courtesy New Mexico State Monuments, Museum of New Mexico.

Edificios de adobe deteriorando, Taos County, New Mexico. Foto cortesía New Mexico State Monuments, Museum of New Mexico.

serving adobe buildings, but the techniques that work best are keeping the adobe dry, providing routine maintenance, and using compatible materials when replacing deteriorated sections of wall.

In New Mexico, practitioners of adobe preservation are realizing that the cement plasters that were applied almost universally to adobe structures after the Depression and World War II have their drawbacks, one of which is the inhibition of the evaporation of moisture that enters through cracks. Cracking is common, and it is caused by the differential expansion/contraction coefficients inherent in the two dissimilar materials. Practitioners are also realizing that earthen plasters are the best renders as long as they are protected from the elements by a roof overhang, or cyclically maintained every two to three years if left exposed. A renaissance of sorts is taking place in New Mexico with the re-introduction of lime plaster, which was used to protect the surfaces of adobes during the Spanish Colonial and Territorial periods. This traditional technique is being re-introduced from Mexico.

In many parts of the world, earthen architecture is the architecture of choice because of its comfort, ease in construction, and low cost. It is truly a sustainable building material in that its utilization is an environmentally friendly process especially when one considers energy represented in the making and transport of various types of building materials. If the structure is made from the soil on site, the energy involved in adobe transport is negligible. Earthen structures are adaptable to all types of housing, including solar-earthen buildings, yard walls, farm and ranch buildings, and commercial buildings. The structures are fire resistant and well insulated against noise.

Building with earth is the essence of sustainability, and fortunately in New Mexico there

bles al reemplazar las secciones deterioradas de un muro.

En Nuevo México los expertos en preservación de adobe han descubierto que los revoques de cemento que se aplicaron casi universalmente a las estructuras de adobe después de la Depresión y Segunda Guerra Mundial tienen sus desventajas, entre ellas impedir la evaporación de la humedad que penetra a través de las grietas. Es común encontrar grietas causadas por la diferencia de los coeficientes de expansión/contracción inherentes a dos materiales distintos. También han descubierto que los revoques de tierra son los mejores revoques, siempre que estén protegidos de los elementos del clima por una saliente del techo o se le haga una mantención cíclica cada dos o tres años, de estar expuestos. En Nuevo México está ocurriendo un cierto renacimiento, con la reintroducción del yeso de cal que se usaba como protección de las superficies de adobe durante los períodos de la Colonia y Territorial hispánicos. En México enseñan esta técnica los maestros, quienes siguen hoy calcinando y apagando su propia cal.

En muchas regiones del mundo se prefiere la arquitectura de tierra por su comodidad, facilidad para construir y bajo costo. Es un material de construcción realmente sustentable, porque se procesa sin dañar el medio ambiente, especialmente si consideramos la energía utilizada en la fabricación y transporte de diversos tipos de materiales de construcción. Si la estructura se hace con tierra disponible en el lugar de construcción, la energía gastada en transportar el adobe es irrelevante. Las estructuras de tierra se adaptan a todo tipo de vivienda, construyendo con ella casas con calefacción solar, muros de patios, construcciones para haciendas y ranchos y edificios comerciales. Las estructuras actúan como cortafuego y tienen excelente aislación sonora.

La construcción con tierra es la esencia misma de la sustentabilidad y afortunadamente en Nuevo México se conoce cada vez más de su viabilidad para viviendas (véase el artículo de Crocker, p. 27): Nuevo México tiene un código de construcción en adobe (en revisión actualmente) que hace más fácil aún su adopción por la industria respectiva. La futura revisión de los códigos reflejará con mayor propiedad el uso de materiales asociados al adobe (véase cuadro complementario). Se espera que otras regiones

is a growing awareness of its feasibility in housing (see Crocker article, below). New Mexico has an adobe building code (that is currently under revision), which makes it even more practical for the building industry to adopt. The future revision of the codes will more closely reflect the appropriate use of materials in association with adobe (see box, p. 23), and it is hoped that other areas of the country will recognize the practicality and comfort of this building material for housing in the 21st century.

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del país sepan reconocer la practicidad y comodidad de este material de construcción de viviendas para el siglo XXI.

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Ed Crocker

Earthen Architecture and Incentives at Acoma Pueblo

Earthen architectural heritage is more than artifact, and the conservation of that heritage implies far more than the treatment of material culture. On a small planet occupied by more than five billion people, the immense utility and versatility of earthen architecture is underscored by the knowledge that nearly half those people live in or regularly use earthen buildings of one sort or another. Even if poverty is often the driving force behind the use of earth, the choice of material for two and one-half billion people attends the inevitable conclusion that in the use of earth are solutions to issues that even the affluent may find useful. This essay looks at one case, not yet a history, that is seeking in a mult-disciplinary way to answer a modern need through the use of deep tradition. Incorporating and adapting the ways of the past to the imperatives of the present is heritage conservation in its most esteemed form. The past, after all, is prologue.

If we look at heritage preservation as a living, pertinent, and creative pursuit, we need to help forge a mutually beneficial league joining the arts (yes, the liberal ones to be sure, but more explicitly in this case the plastic ones) and the social sciences. When we speak of "traditional technologies," the context is clearly anthropological within a compelling artistic context. Building design, siting, construction techniques, and use are problems solved differently by different groups, always dictated by physical conditions and cultural mandates. The manner in which those problems are addressed comprise part of a

particular culture's local knowledge; the **traditional technologies** offer a solution, with both technical and artistic components, to a physical or social need.

In a world of shrinking space, ubiquitous manufactured goods, and environmental degradation, all of which threaten cultural survival, the social sciences, especially anthropology and its attendant disciplines, are working to redefine and attach day-to-day relevance to their practices. Anthropology, ethnology, and archeology are taught and practiced differently today than they were just a generation ago. Implicit in their evolution is the acknowledgment that it is no longer sufficient to observe and report; objectivity, so long the bastion of anthropology's scientific pedigree, is now being complimented with a subjective aspiration to put the lessons of the past actively to work.

Just as the social sciences are working to recreate themselves, architecture (the most ubiquitous of the plastic arts) is undergoing one of its regular self-examinations. For many of us the very term "architecture" marks a discipline that is anything but disciplined, whose history is punctuated by alternating moods of depressed stagnation and brilliant creative explosion, constantly re-assessing itself and changing to either accommodate or flagrantly ignore the exigencies of the moment. Today, led by theorist-practitioners such as Vittorio Gregotti, cognizant architects are re-examining their roles as both conservationists and innovators. Gregotti suggests that both components of architecture, innovation and conservation, have been in a state of "advanced mediocrity" having intellectually retreated to a safe position characterized by an abhorrence of change. Architects, argues Gregotti, can shake the impasse only if they are as attentive to constituencies as to clients, responding as interestedly to craftsmen and communities as to engineers and planners.

In a wonderful and hopeful nuance, anthropology and architecture are thus learning to understand and to use one another's lessons in an eminently suitable context. This happy circumstance is nowhere more clearly illustrated than in the currently evolving approach to the conservation of earthen vernacular traditions. This includes the use of local knowledge in solving the ever-present quandary (as long as the world's population continues to grow) of providing affordable yet culturally appropriate housing for communities.

Among the indigenous peoples of the southwestern United States are those who have been referred to as the "first penthouse dwellers of America." The Pueblo communities of New Mexico and Arizona have long been renowned for their use of local natural resources in the construction of large, sustainable, and highly efficient communal house blocks.

Early photos capture the beauty of the puebloan forms and hint at the adaptive approach to the environment. Later studies, notably at Acoma in the 1970s, verify that the orientation and massing of the house blocks took maximal advantage of solar exposure, allowed minimal exposure to prevailing westerly winter and spring winds, and took a cognizant approach to the conservation of heat. The precise alignment of the facades a few degrees east of south, and the stepped configuration of up to three stories capping the coolest, northernmost rooms were successful answers to environmental challenges. No modern day engineer could contrive a better solution using the materials of the time.

Cornerstones Community Partnerships, a not-for-profit organization, has for the past 13 years been assisting rural communities restore their crumbling earthen religious structures, including churches, kivas, and clan houses, and revive the traditional technologies that led to their rise in the first place. Among the 150-plus communities to whom Cornerstones has provided technical assistance, training, and long-term support have been the pueblo communities of Hopi and Zuni.

At Zuni, where Cornerstones maintained a youth training program in architectural conservation over a period of six years, concern for finding an alternative to the standard Housing and Urban Development (HUD) plans, characterized by frame-stucco row houses outside the confines of the pueblo itself, became an issue of particular interest. Former governor Robert M. Lewis who, during a nearly 30-year tenure brought running water, electricity, and paved roads to Zuni, acknowledged regret that he had allowed HUD to follow the western pattern of housing in a distinctly non-western setting. The clan system as well as the long-established order in which extended families accreted rooms to their homes as needed, was nearly destroyed by the removal of both from the Middle Village into a setting where both clans and families were arbitrarily mixed.

During the last years of his administration Governor Lewis sought ways to reverse that trend. Among his thoughts was the idea of using local resources, both human and natural, in the building of homes. Although Governor Lewis did not live to see his thoughts materialize, the validity of the concept is about to be realized at neighboring Acoma and more distant Santo Domingo.

In 1997 the tribal governments in both pueblos approached Cornerstones for advice and assistance for the conservation of some of their older homes and for the building of new ones. At Acoma the local housing authority under the directorship of Raymond Concho is planning to build a model earthen HUD-financed home in 1999. If all goes well, this could be the harbinger of massive change in the way Indian housing is approached, and the ramifications for low-income housing generally are immense.

With technical assistance from Cornerstones, and with critical services being provided by the University of Pennsylvania, Graduate School of Fine Arts, Department of Architecture, the Pueblo of Acoma Housing Authority has been provided with designs for a subdivision layout as well as plans for solar-heated earthen dwellings. These designs came about through a graduate studio conducted by Tony Atkin at the University of Pennsylvania in which students worked with tribal officials and potential homeowners to derive plans compatible with the Acoma lifestyle. The plans also reflect the features and forms of the early houseblocks.

Construction of the 2,400-square-foot duplex will be predominantly of pressed earthen block. Following the lead set by Santa Fe Habitat for Humanity architect Alfred von Bachmayr, the design includes double-width cavity-walls effectively eliminating the need for insulation. Earthen plasters on the outside and lime plasters within provide sympathetic finishes easily and inexpensively maintained by the homeowner. Brick and earthen floors, *vigas*, and fireplaces downstairs are among the features, and a well-insulated roof over the second story assures that heat is conserved. Although it would be financially impossible to build homes with such amenities using traditionally cast adobe bricks, the use of pressed blocks makes the project affordable.

A cost analysis of the model home demonstrates that the pressed block is in fact competitive even with frame modular homes. Because a pressed block comes out of the machine and is laid immediately in the wall, transport and handling are eliminated and the cost per unit, laid in the wall comes to roughly 3 cents as opposed to a cast block at about $1.50. In the end, the earthen structure will cost approximately 90 cents per square foot more than a manufactured unit brought in from Albuquerque. And, of immense importance, this house will be built by a local labor force. Art and the social sciences are coming together very nicely in this project.

Those of us who advocate the use of earth as a building material, who see not just utility but beauty in homes constructed thus, are heartened by the visionary approach to their housing issues that the Pueblo of Acoma Housing Authority has taken. A great many communities will be watching closely as this project unfolds. If it works, it will bring jobs to the locally unemployed, reduce the import of high-energy-embodied materials such as Portland cement, and will result in homes that are efficient, beautiful, and sustainable. And in the process of building the houses, local knowledge will be passed along through mentorship programs that are part of the training. Strong incentives, indeed.

Loren Eisley commented that "if there is magic on this planet, it is contained in water.* A paleontologist, he was completely in awe of the diversity of life made possible by the presence of water on Earth. If I may borrow the thought from Professor Eisley, I would turn it to the use of builders, both vernacular and professional, and say that if there is magic in their craft, it is contained in earth.

Note

* Loren Eisley, *The Immense Journey* (New York: Time Inc., 1962), p.10.

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Richard Pieper

Earthen Architecture in the Northern United States

European Traditions in Earthen Construction

In the United States, the use of earth for building is most frequently associated with Hispano-American traditions of adobe construction in the Southwest. There is also, however, in the northern United States a significant tradition of earthen wall construction that is related to techniques of northern European immigrants.

Early construction in the northeast by Dutch settlers exploited the insulative properties of earth used as infill in wood frame structures. "Wattle and daub" typically utilized small riven wood laths secured in stud cavities with wood strips or shallow mortises, and a mud and straw mixture to fill the frame openings of both interior and exterior walls. Exterior wall surfaces were typically boarded or sided with nailed lath and wood shingles, but interior walls were usually plastered and whitewashed directly on the surface of the nogging. Wattle and daub nogging is common in Dutch tradition houses in areas of Dutch settlement (the Hudson Valley and Northern New Jersey) of the 17th and 18th centuries. In the 19th century, traditional Ukranian construction in North Dakota used a similar, if somewhat cruder, system of lath nailed on earthfast poles and filled with mud for dwelling construction.

Greek Revival style mud brick residence in Bath, New York. Nearly all of New York State's mud brick buildings were constructed between 1840 and 1851 and reflect the Greek Revival, Gothic Revival, and Italianate styles popular at that time. Photo by the author.

German-Russian builders in the mid-19th century in settlements as far east as western New York utilized mud brick for nogging within timber frames. In all of these systems earth was a significant component of the wall system, but the structure was basically wood. However, a number of contemporaneous traditions in the Northeast feature buildings constructed with load bearing earthen walls, similar to Southwestern adobes.

Perhaps the earliest method of load bearing earthen wall construction practiced in the northern United States was "cob" walling. Cob walling, a traditional English technique of monolithic earthen wall construction, used a mixture of moistened earth and straw. The mud and straw mixture could be laid as walls with or without the use of wooden form work. In New York State, the earliest documented extant earthen structures are two cob walled residences. The Lawrence Johnston House (1832 or 1833) and the William Gorse House (1836) are located a few miles apart in Penfield, Monroe County, near Rochester. While the Johnston House's wall construction is now obscured by clapboard siding, several exposed areas in the interior show that the mixture of mud and straw was placed within wooden wall forms in layers about six inches deep. An account of the construction of the Gorse House re-published in a Penfield history states:

> A pen was built on the ground and clay drawn from a nearby creek bed spread over the ground to a depth of about a foot. On this, cut straw was spread to a depth of three to four inches. Oxen were driven around and around inside the pen to thoroughly mix the ingredients. Plank forms about a foot high were set up on the wall foundations and filled with the clay mixture. As soon as the clay and straw had dried sufficiently to be self-supporting, the forms were raised and another course poured. Floor joists were laid across the walls and another layer poured on top, thus embedding the joists in the wall. When completed a year later, the house was given a thin

plaster coat of clay and the interior walls were plastered and kept white-washed.*

An account of similar cob walled structures was given by author Stephen W. Johnson, who in 1806 in New Brunswick, New Jersey, published *Rural Economy: Containing a Treatise on Pisé Construction.* Johnson describes several mud walled buildings near Trenton, New Jersey, with "walls ... twenty inches thick, built of mud and straw, as the English ones are done." As its title suggests, Johnson's book was actually primarily a study of *pisé*, or rammed earth construction. Johnson's interest in rammed earth construction was sparked by the the seminal writings of François Cointeraux, French agriculturalist and architect, whose publication of a series of cahiers on rammed earth construction in 1791 started a chain of translations and adaptations that reached the United States in the early-19th century. Cointeraux was not the first Frenchman to write about rammed earth construction, which had been chronicled by others reporting on *pisé* construction then common in the areas around Lyons. Cointeraux' reports were backed by considerable personal experimentation, however, and he pursued the dissemination of his techniques with a proselytic zeal that soon attracted the attention of like-minded architects in Great Britain. By 1797, Cointeraux' first and second cahiers on *pisé* construction were translated into English by noted English architect Henry Holland and published with new illustrative plates in the Communications of the Board of Agriculture of Great Britain. Holland's translation was reworked and plagiarized in America by Stephen Johnson. Johnson's book was illustrated with plates resembling Cointeraux' original engravings, and it included sections on such disparate topics as road building and viticulture. Johnson's book, and Holland's translation, which was republished in the agricultural journal *The American Farmer* in 1821, sparked in the Mid-Atlantic and southeastern United States a series of experiments in *pisé* construction that were chronicled in agricultural journals in the first four decades of the 19th century. Responding to inquiries from the publisher of *The American Farmer,* Virginia planter John Cocke of Bremo Plantation near New Canton wrote of his construction of two small *pisé* buildings during the summer of 1816. Cocke indicated that he had followed the instructions in Johnson's book, and praised the buildings "which have stood perfectly, affording the warmest shelter in winter and the coolest in summer of any buildings of their size I ever knew."

Writing in *The American Farmer* in 1824, a Dr. William W. Anderson of Stateborough, South Carolina, recounted his experimentation with rammed earth construction, which had begun with the construction of a 10' x 14' dairy in April 1821. Pleased with the results, Anderson constructed a rammed earth dwelling for house servants in July 1823. Anderson also appears to have used Johnson's book as his instruction manual, and went on to construct five other structures of rammed earth on his plantation. The plantation's buildings were listed in the National Register of Historic Places in 1972, and along with a local church constructed in the 1850s are believed to be the largest concentration of historic rammed earth structures in the eastern United States.

About the same time that Anderson was completing his complex of rammed earth buildings in South Carolina, and Gorse and Johnston were experimenting with cob wall construction outside of Rochester, English architect and horticulturist John Claudius Loudon was publishing his influential *Encyclopedia of Cottage, Farm, and Villa Architecture* (1833), a compendium of designs and prescriptions for construction that contained no fewer than 29 illustrations for cottages that Loudon proposed were appropriate for earthen construction. Loudon noted Cointeraux' *pisé* experiments but also quoted the report of fellow Englishman John Denson whose *Peasant's Voice* reported on the use of "clay lumps" or unburnt brick, for the construction of cottages in Cambrigeshire. English author John McCann has presented convincing evidence that this technique was developed in East Anglia at the end of the 18th century, and was not, as was earlier thought, an ancient traditional English construction method. Whatever its origins, and whether prompted by Loudon's encyclopedia or simply immigrant English technique, buildings were being constructed of unfired mud brick near Toronto, Canada, as early as 1836. By September 1842, the Canadian publication, *The Church,* was reporting of the new Hurontario Church, "the new church is to be built of mud (or unburnt) brick, which in the opinion of the best informed architects, is the material of all others the fittest for the building with in this province." In February 1843, *The British- American Cultivator,* a Toronto agricultural journal,

This Gothic Revival style residence in Geneva, Ontario County, New York, is typical of earthen buildings constructed in Geneva. Over 20 mud brick buildings had been consructed in Ontario County by 1855. Photo by the author.

reported that "houses, properly constructed (of unburnt brick) are warmer, more durable, and also cheaper than frame, and are destined to take the place of the log shanty, as well as the more expensive wooden walls."

Unburnt brick construction was being championed at the same time in the United States by U.S. Commissioner of Patents Henry Leavitt Ellsworth. Son of U.S. Supreme Court Chief Justice Oliver Ellsworth, and brother of Connecticut Governor William Ellsworth, H. L. Ellsworth chronicled advances in agricultural science in his patent office reports of the 1830s and 1840s. Ellsworth's reports of 1842, 1843, and 1844 reprinted excerpts about unfired brick from Loudon's encyclopedia and *The British-American Cultivator,* and reported on Ellsworth's own successful experiments with mud brick construction in Washington, DC, and Grand Prairie, Indiana, that had begun in 1842. Ellsworth's influential reports were widely excerpted and reprinted in agricultural journals such as *The Cultivator* (Albany, N.Y.), and *The Genesee Farmer* (Rochester, N.Y.). The *New York Tribune,* which published an excerpt about unburnt brick construction soon after the first report's publication in February 1843, separately reprinted a sizable portion of the report in pamphlet form under the title *Useful Works for the People No. II.*

Ellsworth's motivation to experiment with this novel form of construction was apparent. Already a landowner in the Wabash Valley of Indiana, Ellsworth was to become an agent for federal lands in the area following his departure from the Patent Bureau in 1845. An illustration of Ellsworth's proposed "prairie cottage" in the 1844 report leaves no doubt that, in spite of his rather large (18' x 54') experimental brick structure in Washington, DC, Ellsworth was proposing that unburnt brick would well serve those of modest means settling on the untimbered prairies of the then far west.

Ellsworth's intentions notwithstanding, the vogue spread to other areas. By 1855, more than 40 mud brick structures, most not nearly so simple as Ellsworth's prairie cottage, dotted a nine-county area in New York that spanned half the state. While the New York State examples have perhaps been documented best, similar buildings have been identified in Pennsylvania, Michigan, and Nebraska, and no doubt many more are known locally in adjacent states. In his 1967 study of historic construction technology in central Canada, *Building with Wood,* author John Rempel also confirms the popularity of the technique in neighboring York County, Ontario.

In New York State, Ontario County was quite certainly the center of this mud brick vogue; census records indicate that at least 22 mud brick structures had been built in the county by 1855, far more than in any other. At least 14 mud brick buildings were constructed in the village of Geneva alone. One contemporary account reveals that the initial use of unburnt brick in Geneva antedated Ellsworth's first published report, however, and the discrepancy between the brick sizes recommended by Ellsworth (12" x 7" x 5" and 12" x 6" x 6") and that of the majority of mud brick buildings in Geneva (15" x 12" x 6") suggests that immigrant English or Canadian practice may have served as a model for the earliest Geneva construction. It is apparent also that Geneva mud brick construction influenced others wishing to experiment with this construction technique; the 15" x 12" x 6" Geneva brick size can be found in buildings in Bath, Steuben County, and Interlaken, Seneca County.

Although the architectural treatises of the period were not silent on the subject of unburnt brick, few dealt with the mode at length or in adequate detail to assist a would-be builder. One notable exception was The Architect (1849), a journal published by the New York City architect William Ranlett. Ranlett's book may have been the first eastern publication to use the Spanish term "adobe" for the construction technique that previously had been identified as "unburnt brick," "sundried brick," "mud brick," or even "Egyptian brick." While Ranlett devoted only two pages and three designs to adobe construction, he gave detailed prescriptions for construc-

tion and undoubtedly his copiously illustrated pattern book lent a certain cachet to the novel building mode that had prompted so much publicity in the previous five years. It appears that Ranlett's work inspired the construction of what was by far New York's largest documented earthen building, the Judge Samuel Ludlow Residence in Oswego. Under construction in 1851, the Ludlow residence when complete had a major facade 70 feet long, two 2-1/2-story hip-roofed ells 45 feet long, and an adobe tower with a wood frame top that rose 40 feet. Until it was demolished recently, Ludlow's residence served as a convent for a neighboring Catholic high school.

When it was demolished in the 1970s, this board-and-batten sided building in Geneva was found to be load bearing mud brick construction, originally sided with wood. Photo by David Brumberg.

By the early 1850s, the mud brick vogue was slowing considerably, no doubt prompted in part by the difficulty of preventing exterior stucco finishes from failing. The stucco problem had been mentioned frequently in early accounts, and prompted at least two New York State builders to include horizontal wooden members within the walls between alternate layers of brick, so that the completed masonry building could be sided with wood.

Despite the generally glowing tone of the early press, not all later publications treated the topic so favorably. In his 1852 book *Rural Architecture,* Lewis F. Allen indicated "we are aware that unburnt bricks have been strongly recommended for house building in America; but from observation we are fully persuaded that they are worthless for any permanent structure, and if used, will in the end prove a dead loss in their application." *The Cultivator,* which in March 1847 had published an article about mud brick construction entitled "The Cheapest and Best Mode of Building," was by February 1855 stating, "... this mode of building is falling into disuse, doubtless for some substantial reasons, among which is probably the difficulty of having every part done well, and especially the great difficulty of securing good cement, so essential to success." Some innovative builders, inspired by Orson Fowler's *The Octagon House, A Home for All* turned instead to what was to become the next heralded replacement for fired brick masonry—the gravel wall. As early as February 1846 one correspondent to *The Cultivator* offered a comparison of the two technologies: "I read in Ellsworth's report of last winter, the manner of building cheap houses of unburnt brick; but I think they have an improvement in Wisconsin over all others. The material consists of gravel and lime—one-eighth part lime, and the balance of coarse sand and any kind of gravel or small stones, mixed so as to make a mortar that will 'set' so hard as to stand well."

Few stylistic generalizations can be made about northern mud brick buildings. The buidings identified to date reflect then-current Greek Revival, Gothic Revival, and Italianate styles. Similarly, the buildings cannot be said to have been favored by one socioeconomic group; the 1855 census records values for the buildings in New York State ranging from $100 to $15,000. Today most remaining examples are in sound condition and all are occupied. Many retain their original exterior stucco finishes, although some have long been re-sided with wood clapboard, aluminum, or brick, and hide their identity from the casual observer. Quite certainly others remain to be found, unlikely relics of an innovative era in American masonry construction, confirming the claims of adobe's 19th-century proponents about the durability of earthen construction in the harsh climate of the northern United States.

Note

* John McAnn "Is Clay-lump a Traditional Building Material?" *Vernacular Architecture* 19 (Vernacular Architecture Group, 1988): 1-16.

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Edna E. Kimbro

California's Historic Earthen Architecture

Arquitectura Histórica de Tierra en California

California's historic earthern architectural traditions differ in several respects from those in Arizona and New Mexico. In the last quarter of the 18th century, missionaries and military personnel endeavored to imitate the designs of churches with which they were familiar in the drier climates of the Borderlands. However, it soon became apparent that the *azoteas*, or relatively flat-roofed construction with *canales*, or roof drains, were not appropriate along the coast of California where the missions were erected. Around 1780 to 1781 (depending upon the source consulted), barrel roof tiles were first fired at Mission San Antonio de Padua, and low-pitched tile roofs began to replace the leaky masonry *azoteas*.

The fact that most of the missions, if not all, were located in seismic zone four, along the coast where the risk of earthquakes is highest, certainly influenced the design of mission buildings. With experience as their teacher, the designers learned that stout walls with an aspect ratio of five to one or lower could withstand severe ground shaking better than tall, thin walls. Thus, most of the surviving mission churches have walls of five or more feet in thickness.

Rising damp, ever a threat to earthen masonry, was also a problem in California. This was addressed by extending stone foundation stem walls above grade some three to five feet to counteract the propensity of adobe to wick groundwater into the walls. Some of the mission churches were constructed entirely of stone, a material considered more noble and definitely more lasting than earthen materials. Sometimes only the facade of the church was constructed of stone, which had the advantage of greater strength when damp but the disadvantage of

Las tradiciones de la arquitectura histórica de tierra en California se diferencian en varios aspectos de la arquitectura de Arizona y Nuevo México. En el último cuarto del siglo XVIII los misioneros y militares intentaron reproducir los diseños de iglesias que les eran conocidos de los climas más secos de las fronteras. Sin embargo, muy pronto quedó claro que las azoteas o techos relativamente planos con canales de drenaje no eran adecuados para el clima de la costa de California donde se erigían las misiones. Alrededor de 1780 o 1781 (dependiendo de la fuente consultada) en la Misión de San Antonio de Padua se cocieron las primeras tejas cóncavas (tipo árabe) y se comenzó a reemplazar las azoteas de albañilería llenas de goteras por techos de poca pendiente con tejas

Que la mayoría, sino todas las misiones estuvieran ubicadas en la zona sísmica cuatro a lo largo de la costa, donde es mayor el riesgo de terremotos, ciertamente influyó en el diseño de las construcciones de las misiones. Los diseñadores aprendieron por la dura experiencia que los muros gruesos con una proporción dimensional de cinco a uno o inferior soportaban mejor los fuertes movimientos de tierra que los muros altos y delgados. Así, la mayoría de las iglesias de misiones que han sobrevivido tienen muros de 5 o más pies de grosor.

La humedad ascendente que es la amenaza permanente para la albañilería de tierra también era un problema en California. La solución encontrada fue extender los muros de fundación de piedra unos tres o cinco pies sobre el nivel, para contrarrestar la propensión del adobe a desaguar el agua del subsuelo en los muros. Algunas iglesias de misiones se hicieron

Arcaded corridor, Mission Santa Inés, Solvang, California.

Corredor con bóveda continua, Misión Santa Inés, Solvang, California.

being difficult to work. With the importation of skilled master masons from Mexico in the 1790s, stone mission churches were viable for a short time.

In surveying appropriate sites for the establishment of new missions, the founders sought those with good wood and lime sources as well as an abundance of Native American potential converts. Wood was needed for the construction of roofs and scaffolding, while lime was sought to protect walls from surface erosion by water. Because lime was thought to be an effective disinfectant, lime- or whitewashing was encouraged to prevent the spread of infectious diseases such as small pox. Adobe walls were both chinked and scored or incised with lines in a cross hatch manner to provide mechanical keys for the lime rendering. The resultant surface was often decorated with traditional motifs above a three- to five-foot dado at the base of the walls. These motifs were applied using pigments imported from Mexico. Other pigment sources include locally available hematite.

Several of the mission establishments of California featured a long corridor that took the form of an arcade along the *convento*, or associated buildings, adjacent to the church. Typically the masonry arches were constructed of burned *ladrillos*, or thin flat bricks that are similar to quarry tiles but less well fired. *Ladrillos* were also used to fashion architectural details for the facade of the church. The corridors of less elaborate missions were constructed with wooden posts or stone piers supporting the tiled roofs. Comparable to the portales of New Mexican

totalmente de piedra, un material considerado más noble y definitivamente más duradero que los materiales de tierra. En otros casos, solamente se construyó con piedra la fachada de la iglesia, lo que tiene la ventaja de ser más resistente a la humedad pero difícil de trabajar. Los expertos maestros canteros traídos desde México en los años 1790 hicieron posible por breve tiempo construir de iglesias de piedra en las misiones.

Cuando examinaban los lugares más apropiados para establecer nuevas misiones, los fundadores buscaban siempre que existiera una buena provisión de madera y cal y un buen contingente de indígenas como potenciales conversos. La madera era necesaria para la construcción de techumbres y andamios, y la cal interesaba porque protege los muros de la erosión superficial del agua. Como se creía que la cal era un buen desinfectante, se incentivaba el encalado o pintura con cal que evitaba la propagación de enfermedades infecciosas como la viruela. Los muros de adobe se estriaban y calafateaban en líneas, como un achurado cruzado que le daba más adherencia al revoque de cal. La superficie resultante se decoraba con motivos tradicionales sobre un friso de tres a cinco pies que recorría la base de los muros. Estos motivos se aplicaban usando pigmentos importados de México; entre otros orígenes de los pigmentos estaba la hematita local.

Muchos establecimientos misioneros de California presentan un largo corredor abovedado que recorre el convento o edificios anexos adyacentes a la iglesia. Las arcadas de albañilería se construían fundamentalmente con ladrillos cocidos, unos ladrillos planos y delgados similares a las baldosas coloradas, pero menos cocidos. También se usaban ladrillos para dar forma a los detalles arquitectónicos en la fachada de la iglesia. Los corredores de misiones menos sofisticadas se construían con postes de madera o columnas de piedra que sostenían los tejados. Al igual que los portales en la arquitectura de tierra de Nuevo México, los corredores abovedados y los más simples protegían de la lluvia y el sol, ofreciendo también un pavimento seco para transitar.

La arquitectura residencial de los pueblos y presidios (fuertes militares) no se diferenciaba mucho de las áreas residenciales de las misiones, en cuanto a las viviendas para los soldados y neófitos. Normalmente las construcciones de

earthen architecture, both arcaded and simpler corridors provided protection from the rain and sun as well as a dry pavement to walk upon.

The vernacular residential architecture of the pueblos and *presidios* was not unlike that of the residential portions of the missions, the housing provided to the soldiers and the converted neophytes. Typically, the adobe buildings were linear in plan with rooms opening into one another along an axis with corridors along the front and rear. In the *presidios* and around the central plazas of the pueblos, party wall construction was common with continuous corridors similar to the continuous portales of Santa Fe, New Mexico. Portions of the rear corridors were frequently enclosed for use as kitchens or extra rooms. (A little known fact is that during its Hispanic period California had its own version of luminarias/farolitas: According to the reminiscences of Governor Juan Bautista Alvarado, on the evening of special occasions, the roofs of the *presidio* corridors were lined with small pottery oil lamps.)

Starting in the 1830s, around the time of the secularization of the missions, two-story adobe buildings were constructed, again with corridors as a typical feature. Free-standing homes had corridors resembling the verandas of Greek Revival architecture on several elevations while cantilevered balconies were common on urban buildings with party walls. Both features came to characterize Monterey style architecture, named for the Spanish and Mexican capital of California.

Architectural historians have long argued about the origins of the Monterey style, some attributing it to the influence of a single building begun in 1832, the prominent two-story home of U.S. Consul General Thomas O. Larkin. In recent years it has become known that both Governor Alvarado, a Californio, and Consul Larkin, a New England immi-

Castro Adobe, rural rancho adobe in "Monterey style," Watsonville, California.

Adobe Castro, rancho rural en adobe, del estilo Monterrey, en Watsonville, California.

adobe seguían un plan lineal, con habitaciones comunicadas entre sí a lo largo de un eje y corredores por delante y atrás. En los presidios y en torno a las plazas centrales de los pueblos era común encontrar construcciones con paredes medianeras y corredores continuos, similares a los portales continuos de Santa Fe, Nuevo México. Se acostumbraba cerrar parte de los corredores traseros para crear cocinas o más habitaciones.

(Un hecho poco conocido es que durante su período hispánico, California tuvo su propia versión de luminarias o farolitas: En las memorias del Gobernador Juan Bautista Alvarado se relata que en las noches de ocasiones especiales los techos de los corredores de los presidios se cubrían con lamparillas cerámicas de aceite).

En la década de 1830, cuando comenzó la secularización de las misiones, se construyeron edificios de dos pisos en adobe, manteniendo los corredores como rasgo característico. Las casas aisladas tenían corredores parecidos a las galerías de la arquitectura del estilo Greek Revival, en varias elevaciones, en tanto los balcones voladizos eran muy comunes en las construcciones urbanas con muros divisorios. Ambos rasgos son distintivos del estilo arquitectónico Monterrey, llamado así por la capital española y mexicana de California.

Los historiadores de la arquitectura han discutido por años sobre los orígenes del estilo Monterrey. Algunos lo atribuyen a la influencia de un sólo edificio construido en 1832, la notable casa de dos pisos de Thomas O. Larkin, Cónsul General de EE.UU. En estos últimos años se ha sabido que tanto el Gobernador Alvarado, oriundo de California y el Cónsul Larkin, inmigrante de Nueva Inglaterra construyeron casas de dos pisos en 1832; ambas incorporaron elementos de arquitectura Greek Revival, un estilo arquitectónico muy difundido de inspiración clásica. El estilo Monterrey se asemeja al estilo Territorial de Nuevo México pero con tejados de dos aguas de tejuelas finas partidas a mano llamadas tejamaniles en lugar de los techos planos. Las características comunes a las construcciones de estilo Monterrey son las ventanas de guillotina, tablones de techo machihembrados con molduras, vigas y marcos de ventanas, puertas de seis paneles, balaustradas torneadas y pilares de arranque, aleros cerrados, persianas o celosías, tragaluces y vidrios laterales en la

Alvarado Adobe, Monterey, California, with clapboard siding and greek revival corridor.

Adobe Alvarado en Monterrey, California, con entablado exterior y corredor en estilo nuevo greco.

grant, erected two-story residences in 1832, both of which incorporated features of Greek Revival architecture, a widespread and classically derived architectural style. The Monterey style is not unlike the Territorial style of New Mexico, but with gabled, or hipped, roofs of thin hand split shingles, or *tejamaniles*, instead of flat roofs. Features common to buildings constructed in the Monterey style were six-over-six window sash windows, beaded tongue and grooved ceiling boards, joists and window casings, six-panel doors, turned balusters and newel posts, boxed eave returns, shutters or blinds, side lights and transoms at the entry, and verandas with beaded or chamfered posts. Bilateral symmetry and central stair halls were not unusual, but traditional U-shaped homes surrounding courtyards and quadrangular plans (similar to the mission quadrangles, but smaller) were also common.

Generally the southern part of the state was somewhat slower to adopt new architectural features, perhaps reflecting the more conservative rural attitudes of this region. In the south, casement windows similar to those used in the missions were customary rather than the six-over-six sliding sash and two-story adobe homes, which were developed later. Flat-roofed adobe buildings with tar or *brea* (naturally occurring asphalt material) roof covering also continued to be used in the south long after Monterey adopted shingles produced in the nearby Santa Cruz Mountains. The roofs were tarred with *brea* or tiled over a roof system constructed of wooden *vigas*, or round wooden beams, with *latitas*, or thin branches, of willow (lashed with rawhide in the early days), that was chinked and covered with a coating of mud, a method similar to early mission roof construction. In later years, south of Santa Barbara it was possible to find *brea* roofs installed over the Greek Revival styles roof systems characterized by beaded joists and beaded tongue and grooved sheathing. In Santa Barabara, however, shingles replaced roof tiles.

Tile roofs were used in communities where mission and *presidio* buildings robbed of their roof tiles following the decline of the missions and the *presidios* after the end of the Mexican

entrada y una galería con columnas achaflanadas. Era usual encontrar casas de simetría bilateral y recibidores centrales con escaleras, pero también eran comunes las casas tradicionales en forma de U que rodean patios centrales y de plano cuadrangular (semejantes a la cuadrícula de las misiones, pero más pequeñas).

En general, la parte sur del estado demoró en adoptar las nuevas características arquitectónicas, reflejo tal vez de las costumbres rurales más conservadoras de esta región. En el sur, las ventanas con bisagras similares a las usadas en las misiones eran más comunes que las ventanas guillotina deslizantes de seis por seis, y las casas de adobe de dos pisos aparecieron mucho después. Las construcciones de adobe de techo plano recubierto con alquitrán o brea, material asfáltico natural, continuaron usándose en el sur, mucho después que Monterrey adoptara las tejuelas producidas en la vecina cordillera de Santa Cruz. Los techos se recubrían con alquitrán o con tejas sobre una armadura construida con envigado de madera, latitas o ramas finas de sauce (atadas con tiras de cuero sin curtir en las primeras épocas) que se calafateaba y cubría con una capa de barro, método similar al usado en las primitivas construcciones de techos en las misiones. Años más tarde se puede encontrar al sur de Santa Bárbara los techos alquitranados instalados sobre armaduras de estilo Greek Revival, caracterizados por las vigas de techo achaflanadas y entablado machihembrado con molduras. En Santa Bárbara las tejuelas tipo tejamaniles reemplazan a las tejas.

Los techos de teja se usaron después de la decadencia de las misiones y presidios, en comunidades en las cuales las tejas eran robadas

"Larkin House," Monterey, California, Monterey-style icon with broad overhanging corridors.

Casa Larkin en Monterrey, California, símbolo del estilo Monterrey, con amplios corredores colgantes.

War of Independence in 1821. However, the number of tile roofs diminished over time as their production ceased upon the freeing of the mission Indians.

The demise of earthen architecture in California in the later decades of the 19th century is due in part to the influx of Americans (beginning with the gold rush), who brought with them a preference for New England architectural styles and scorned the mud brick buildings of the native Californians, or Californios, they despised. The vulnerability of unreinforced masonry buildings to earthquake damage was a contributing factor to the unpopularity of adobe as a building material, but this did not seem to deter construction in fired brick. In addition, as time went on, the number of former mission Indians skilled in adobe construction methods dwindled, and new generations of Californians were unable to repair damaged adobe buildings.

Today, the scarcity of historic adobe buildings in California (there remain but about 350 such structures, including the missions) can be attributed to rampant development, which generally threatens 19th-century buildings, and to damage by earthquakes. The third historic threat, societal indifference to the cultural manifestations of a vanquished population, is less a factor today than it was in the 19th century. As the state's demographics change, and as the majority of the population becomes Spanish speaking, it is hoped that the remaining historic adobe homes and missions of the state will be better appreciated and conserved. The nascent interest in earthen architecture, specifically rammed earth, in California is encouraging.

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Photos courtesy the author.

de los techos de esas misiones y presidios, al término de la Guerra de Independencia de México en 1821. Sin embargo, el número de techos de tejas había ido disminuyendo paulatinamente con el cese de producción de tejas luego que los indígenas de la misión eran liberados.

La desaparición de la arquitectura de tierra en California en las últimas décadas del siglo XIX se debe en parte a la influencia de los norteamericanos del Este (comenzando con la fiebre del oro), que trajeron consigo el gusto por los estilos arquitectónicos de Nueva Inglaterra y miraban en menos estas edificaciones de ladrillos de barro de los californianos a quienes despreciaban. La vulnerabilidad a los daños causados por terremotos de estas construcciones de albañilería no reforzada fue un factor que contribuyó a la impopularidad del adobe como material de construcción, pero esto no pareció impedir la construcción con ladrillos refractarios. Además, al correr de los años fue menguando el número de indígenas de las antiguas misiones que dominaban los métodos de construcción en adobe y las nuevas generaciones de californianos no eran capaces de reparar los edificios de adobe dañados.

Actualmente, la escasez de construcciones históricas de adobe en California (quedan unas 350 estructuras de este tipo, incluyendo las misiones) puede atribuirse al agresivo desarrollo que amenaza a las construcciones del siglo XIX y los daños por terremotos. La tercera amenaza histórica, la indiferencia social ante las manifestaciones culturales de una población conquistada es menos importante hoy de lo que fuera en el siglo XIX. A medida que vaya cambiando la estructura demográfica del estado y que la mayoría de la población sea de habla española, se puede esperar que las casas y misiones históricas de adobe que aún quedan en el estado serán más queridas y mejor conservadas. El naciente interés por la arquitectura de tierra en California, especialmente de tierra apisonada, es alentador.

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Fotos cortesía del autor.

Anthony Crosby

Earthquakes and Adobes
Effects and Systems for Intervention

Terremotos y Adobes
Efectos y Sistemas de Intervención

In 1811, a series of three major earthquakes, estimated to have registered between 8.4 and 8.7 on the Richter scale, rocked the area of New Madrid, Missouri. Chimneys fell from buildings as far away as Georgia and South Carolina, and the effects were felt 1,100 miles away in Boston. Few deaths resulted because the area was so sparsely populated and because the buildings, most of which were log cabins, were relatively elastic. The 1960 earthquake in Agadir, Morocco, with a magnitude of only 5.8 destroyed the entire city and killed 12,000; in this case the epicenter of the earthquake was within 5 miles of the city center. Armenia's 1988 earthquake, with a magnitude of 6.9 on the Richter scale, resulted in the death of more than 25,000 persons. The magnitude of the Armenian earthquake was approximately 1/30 the magnitude of the New Madrid event, but because of poor building design (noncontiguous reinforced concrete structures with precast floor panels) and the buildings' poor condition, many structures failed traumatically. On the early morning of January 17, 1994, an earthquake that registered 6.8 struck the Los Angeles, California, suburb of Northridge. Eleven thousand residences were damaged and many were destroyed, as were 9 highway overpasses and several larger commercial structures. There was considerable damage to high-rise structures, and 250 gas lines ruptured; it was the costliest natural disaster in U.S. history. The Northridge earthquake resulted in the greatest loss of and most damage to California's historic adobe buildings than that wrought by any previous earthquake. The relative severity of these seismic events was dependent on many factors, the most important of which were the actual characteristics of the event and the design and condition of the buildings affected.

En 1811 una serie de tres grandes terremotos que pudieron haber registrado entre 8,4 y 8,7 en la escala de Richter sacudieron la región de New Madrid, Missouri. Cayeron las chimeneas de viviendas en regiones tan alejadas como Georgia y Carolina del Sur y sus efectos se hicieron sentir a 1.100 millas de distancia, en Boston. No hubo demasiadas muertes porque la región estaba apenas poblada y las construcciones eran más que nada cabañas de troncos relativamente elásticas. El terremoto de Agadir, Marruecos de 1960, con una magnitud de sólo 5,8 destruyó toda la ciudad y mató a 12.000 personas; en este caso el epicentro del terremoto estaba a cinco millas del centro de la ciudad; en el terremoto de Armenia de 1988, de magnitud 6,9 en la escala de Richter murieron más de 25.000 personas. La magnitud del terremoto de Armenia fue aproximadamente 1/3 de la magnitud del terremoto de New Madrid, pero debido al pésimo diseño de las edificaciones (estructuras de hormigón armado no contiguas con paneles de piso vaciados en obra) y el deficiente estado de las construcciones se derrumbaron dramáticamente muchísimas estructuras. Durante la mañana del 17 de Enero de 1994, un terremoto grado 6,8 sacudió el suburbio de Northridge en Los Angeles, California. Destruyó o causó daños en 11.000 viviendas, derrumbó nueve pasos superiores de autopistas y grandes edificios comerciales. Edificios de altura sufrieron graves daños y estallaron 250 cañerías de gas. Fue el desastre natural más costoso en la historia de los Estados Unidos. El terremoto de Northridge generó más daños y grandes pérdidas en las construcciones históricas de adobe de California que cualquier otro terremoto anterior. La gravedad relativa de estos eventos sísmicos depende de varios factores, de

The most commonly referred to characteristic of an earthquake is its magnitude, the quantitative measurement given by the Richter scale, an index of the amount of energy released. The second most familiar measurement of an earthquake is its intensity, indicated by the Modified Mercalli Intensity scale, which is based upon subjective observations of human reaction and structural damage. However, describing the severity of an earthquake is not a simple task. In addition to the magnitude measured by the Richter scale and the intensity measured by the Modified Mercalli scale, other characteristics such as acceleration, the duration of the event, and the location of the epicenter are important in assessing the overall severity. Geologic and soil conditions can exacerbate the severity as well, and aftershocks can destroy buildings that withstood the initial ground motion. All of these factors—the magnitude, the intensity, the acceleration, the duration, and the location—have a huge effect. The ground moves, often quickly and dramatically, and features located on the ground surface must absorb or withstand the motion in some way or they will be affected. A structure on the earth moves or vibrates in response to the seismically induced ground motion, and structures with different properties respond differently. A rigid structure will tend to move with the movement of the ground while a flexible structure will bend. Structures of mud brick, or of other load bearing earth systems, with thick walls in relationship to their height, a characteristic of many archeological monuments, will normally withstand ground motion with little or no damage. An approximate wall height-to-thickness ratio of five to one or less is considered stable. Walls of stronger or more elastic materials can have a much greater height-to-thickness ratio and still be stable. Like the severity of the seismic event itself, predicting the actual performance of a structure with floor and roof systems, combinations of thick and thin walls, intersecting walls, and walls of different heights, is complex.

The primary method used to protect existing earth structures has been to increase the rigidity of the structural system. Often rigidity was achieved with the installation of reinforced concrete bond beams and columns, the installation of which destroyed significant amounts of historic fabric. Not only were these methods destructive to important values of these historic structures but they were often prohibitively

los cuales los más importantes son las características reales del evento y el diseño y condiciones de las edificaciones afectadas.

La característica más conocida de un terremoto es su magnitud o medición cuantitativa arrojada por la escala de Richter, un índice de la cantidad de energía liberada. La segunda medición más conocida de un terremoto es su intensidad medida por la escala de Intensidad Mercalli Modificada que se basa en observaciones subjetivas de la reacción humana y daños estructurales. Sin embargo, no es tarea fácil describir la gravedad de un terremoto. Además de la magnitud medida por la escala de Richter y la intensidad medida por la escala de Mercalli Modificada, existen otras características como la aceleración, la duración del evento y la ubicación del epicentro que son importantes a la hora de evaluar la gravedad total. Las condiciones geológicas y de suelo pueden aumentar la intensidad y las réplicas pueden destruir las edificaciones que habían resistido el primer movimiento telúrico. Todos estos factores, magnitud, intensidad, aceleración, duración y ubicación, producen un efecto terrible. La tierra se mueve con gran rapidez y fuerza y los elementos ubicados en la superficie terrestre deben ser capaces de alguna forma de absorber o soportar el movimiento, o se verán afectados. Una estructura sobre el suelo se mueve o vibra como respuesta al movimiento superficial inducido por el sismo y las estructuras responden de distinta forma según sus propiedades. Una estructura rígida tenderá a moverse con el movimiento del suelo, en tanto una estructura flexible se pandeará. Las estructuras de ladrillos de barro u otros sistemas de construcciones de tierra que soportan cargas, que tienen muros gruesos en proporción a su altura, característica de muchos monumentos arqueológicos, normalmente soportarán el movimiento telúrico prácticamente sin dañarse. Una proporción aproximada de alto por ancho en muros igual o inferior a cinco por uno se considera estable. Los muros de materiales más resistentes o elásticos pueden tener una relación alto/ancho mucho mayor y seguir siendo estables. Como en el caso de la gravedad de un sismo, es complejo predecir el comportamiento real de una estructura que presenta sistemas de piso y techumbre, muros gruesos y delgados, muros intersectados y de distintas alturas.

After being heavily damaged during the Northridge Earthquake, Rancho Camulos was seismically strengthened by less invasive approaches than usual. Photos courtesy the author.

Luego de sufrir graves daños durante el terremoto de Northridge, se le hizo un refuerzo antisísmico con técnicas menos invasivas que las precedentes. Fotos cortesía del autor.

expensive. Given the expense and invasiveness of this method, there was an increasing interest in developing better methods for achieving system rigidity. Significant work had been going on around the world for many years to achieve that goal.

The Northridge earthquake was a tragic event, but it came at a critical time in the recent development of a greater understanding of the performance of mud brick structures and appropriate strengthening technology. The goal of a major study sponsored by the Getty Conservation Institute (GCI) on the protection of California's historic adobe buildings was the development of specific recommendations for strengthening these important structures using less-invasive methods than had often been used in the past. A great deal of investigation and testing of possible strengthening methods utilizing seismic simulation was well underway when the earthquake occurred. Taking place at the same time in other parts of the world was similar test-

El método básico aplicado para la protección de las estructuras de tierra existentes ha sido aumentar la rigidez del sistema estrcutural. En ocasiones la rigidez se lograba instalando vigas y columnas de unión de hormigón armado cuya instalación ha destruído porciones significativas de la trama histórica. Estos métodos no solamente destruyeron partes valiosas e importantes de las estructuras históricas; también eran prohibitivamente caros. Dado la carestía y características invasivas de este método, se ha buscado con gran interés otros y mejores métodos para lograr rigidizar los sistemas. Por muchos años se ha estado trabajando con mucho empeño en todo el mundo con este objetivo.

El terremoto de Northridge fue un hecho trágico pero que ocurrió en un momento crucial en el desarrollo de una comprensión más amplia del comportamiento de las estructuras de ladrillos de barro y de la tecnología de refuerzo correspondiente. Un importante estudio patrocinado por el Getty Conservation Institute (GCI) sobre protección de los edificios históricos de adobe en California tiene por objetivo desarrollar recomendaciones específicas para fortalecer estas estructuras usando métodos menos invasivos que los usados en el pasado. La investigación y pruebas de nuevos métodos de refuerzo aplicando simulaciones sísmicas estaban ya bastante avanzados cuando se produjo el terremoto. Simultáneamente en otras partes del mundo se estaban haciendo las mismas pruebas con los mismos objetvios básicos - proteger las estructuras históricas de tierra con el mínimo de intervención.

A pocos días del sismo de Northridge un equipo de arquitectos, arquitectos conservadores e ingenieros inició una inspección y análisis sistemáticos de los daños. Hubo dos aspectos importantes dentro de esta evaluación y análisis de daños que no habían ocurrido antes. Como el terremoto de Northridge ha sido el sismo más monitoreado de la historia, se pudo estudiar con mayor detalle todas las características reales del sismo y relacionarlas con los daños reales. Otro aspecto importante es que los miembros del equipo de investigación ya conocían las estructuras que en gran parte ya habían sido documentadas y analizadas por el equipo del programa del Getty dos años antes del terremoto. Este conocimiento sirvió muchísimo para que los miembros del equipo

ing with the same basic goals—providing protection to historic earthen structures with the minimal amount of intervention.

Within days of the Northridge event, a team of architects, architectural conservators, and engineers began a systematic inspection and analysis of the damage. There were two important aspects of this damage assessment and analysis that had not occurred before. Because the Northridge earthquake was the most monitored of any earthquake in history, more detail of the actual characteristics of the event could be studied and related to the actual damage. Another important aspect was that members of the survey team were already familiar with the structures, many of which had been previously documented and analyzed by the Getty program team two years prior to the earthquake. This familiarity contributed to the team members' understanding of the effects of pre-existing conditions in relation to the level of earthquake damage. The report of that survey with subsequent development and analysis comparing the actual event to the specific damage to specific structures is the most comprehensive of its type. In addition, the report provides valuable information about failure typology of earthen structures and the effects of pre-existing conditions.

When developing a seismic protection system for a historic building, it is important to understand the values that are to be protected. As an example, building codes for seismic strengthening are directed first to the protection of human life and not to the protection of the structure. Even with our current state of knowledge, it is impossible to strengthen an earth structure so that it will not suffer any damage during an earthquake. The first priority will always be the protection of human life. While all damage can not be eliminated, a system can be designed so that damage is directed to parts of the structure or to its less significant features. Directed failure can take the form of isolating two building components that otherwise might cause damage to one another during ground motion. At California's Mission San Gabriel, the baptistery was structurally separated by cutting through the masonry, allowing the two components to move separately. Because of their specific geometric relationships, if not separated, they could cause severe damage to one another. During the Northridge earthquake, the two structural components did move independently and the only

lograran comprender los efectos de las condiciones pre-existentes, en relación con el nivel de daños causados por el terremoto. El informe del estudio y su desarrollo y análisis posterior que compara el hecho real con el daño específico causado en las estructuras respectivas es el más exhaustivo de su tipo. Además, el informe entrega una información muy valiosa sobre tipología de fallas en estructuras de tierra y los efectos de las condiciones pre-existentes.

Al desarrollar un sistema de protección antisísmica para un edificio histórico es importante comprender cuáles son los valores que deben protegerse. Como ejemplo, los códigos de construcción para refuerzo antisísmico están orientados en primer lugar a proteger la vida humana y no a proteger las estructuras. Incluso en nuestro estado actual de conocimiento es imposible reforzar una estructura de tierra para que no sufra ningún daño en un terremoto. La principal prioridad será siempre la protección de la vida humana. Si bien no puede eliminarse la posibilidad de daños, sí se puede diseñar un sistema que dirija el impacto de falla hacia ciertas partes de la estructura o a sus aspectos menos relevantes. Una falla dirigida podría consistir en aislar los componentes de dos construcciones que en caso contrario podrían impactar uno al otro durante un temblor. En la Misión San Gabriel de California, el baptisterio fue separado estructuralmente cortando a través de la mampostería, con lo cual ambos componentes pueden moverse individualmente. Debido a sus relaciones geométricas específicas, si no se los hubiese separado habrían causado graves daños al elemento vecino. Durante el terremoto de Northridge estos componentes estructurales se movieron independientemente y solamente se dañó la terminación de yeso que unía el corte en la mapostería. Esta es una forma de falla dirigida. Puede haber otra forma de falla dirigida adecuada para el caso de una superficie original de yeso decorada que está intacta, como en la Misión San Miguel de California. En este caso la superficie decorativa no podría sobrevivir si los muros sufrieran grandes agrietamientos sin moverse. Se puede crear aquí un punto de quiebre que permita que los muros oscilen sobre sus fundaciones en lugar de resquebrajarse.

Como material de construcción la tierra no tiene elasticidad o ductilidad real y tiene escasa resistencia a la flexión. Un material dúctil

damage was to the plaster finish that bridged the masonry cut. This is one form of directed failure. Another form of directed failure might be appropriate if an original decorative plaster surface remains intact, such as at California's Mission San Miguel. In this case the decorative surface would not survive if the walls were extensively fractured but remained in place. However, a weak point might be created that would allow the walls to rock on their foundations rather than fracture.

As a building material, earth has no effective elasticity, or ductility, as it has little resistance to bending. A ductile material, such as steel or wood, can deform to a certain degree and then return to its former shape and still perform its structural function. Stone as a material also has little ductility, but it is stronger than compacted earth, and it can resist more loads before failing. In places where earthquakes are an expected part of life, people have learned to build with earth material using a building system that has a greater degree of ductility than does the material itself. In many parts of the world with known seismic acitivity, a traditional building utilizes load bearing mud brick walls on the first floor level and timber frame with non-load bearing mud brick or waddle and daub walls on the upper floors. The system is somewhat ductile and often survives under the stresses of an earthquake.

Another strengthening method is to increase the system's elastic performance. If a structure cannot be made rigid, then it has to be able to perform with a certain level of elasticity to survive seismic ground motion. As building systems, the log cabins of the New Madrid earthquake were somewhat elastic in that they deformed and then returned to their previous form without suffering permanent damage. This elastic quality is referred to as ductility.

The most recent example of strengthening a historic adobe building that incorporates the latest concepts is at Rancho Camulos in Ventura County, California, approximately 30 miles north of Northridge. Rancho Camulos was one of the important adobe structures that suffered severe damage during the Northridge earthquake and was one of the structures included in the post-event survey. Rigidity was achieved by strengthening second story level floors and selected wall systems to perform as semi-rigid structural plates or diaphragms. System ductility was achieved by the installation of a series of cables and straps that, while not designed to pre-

como el acero o la madera se puede deformar hasta cierto punto y luego vuelve a su forma original, conservando siempre su función estructural. La piedra como material también es muy poco dúctil, pero es más fuerte que la tierra compactada y puede resistir más carga antes de romperse. En los lugares en que los terremotos son parte de la vida, la gente ha aprendido a construir con material térreo con un sistema de construcción que tiene un grado mayor de ductilidad que la del propio material. En muchas partes del mundo de conocida actividad sísmica la construcción tradicional utiliza muros de ladrillos de barro que soportan cargas en la planta baja y encofrados de madera con ladrillos de barro no soportantes, o muros de argamasa y fibras en los pisos superiores. Es un sistema bastante dúctil y que ha demostrado su sobrevivencia a las fuerzas de un terremoto.

Otro método de refuerzo consiste en aumentar el comportamiento elástico de un sistema. Si una estructura no puede rigidizarse, debe ser capaz de comportarse con un cierto grado de elasticidad para poder sobrevivir a los movimientos telúricos. Desde el punto de vista de los sistemas constructivos, las cabañas de troncos que soportaron el terremoto de New Madrid actuaron elásticamente, en el sentido que se deformaron y luego recuperaron su forma original sin sufrir daños permanentes. Esta cualidad elástica se conoce como ductilidad.

El ejemplo más reciente de refuerzo de una construcción histórica de adobe que incorpora los conceptos más avanzados es el Rancho Camulos en el condado de Ventura, California, aproximadamente 30 millas al norte de Northridge. Rancho Camulos fue una de las estructuras de adobe importantes que sufriera grandes daños durante el terremoto de Northridge y fue incluida en la revisión posterior al sismo. Se dio rigidez a la estructura al reforzar los pisos del segundo nivel y determinados sistemas de muros, para que se comportaran como placas o diafragamas estructurales semirígidos. Se logró dar más ductilidad al sistema con la instalación de una serie de cables y zunchos que, si bien no fueron diseñados para evitar resquebrajaduras o daños en un nuevo terremoto, podrían evitar la caída de los muros. Este sistema permite que los muros se muevan pero no fallen. El proyecto Camulos fue mucho más barato que otros sistemas de reacondi-

vent cracking or damage during another earthquake, would prevent the collapse of the walls. This system allows the walls to move but not to fail. The Camulos project also was less costly than other more traditional retrofit systems that utilize bond beams at the rooflines.

The current state of knowledge about protecting historic earth buildings and monuments from seismic induced ground motion emphasizes providing an acceptable level of protection with the least impact on historic fabric or historic building systems. The approach takes advantage of the existing building systems and does not try to alter the system as happened in the most severe cases in the past when earthen load bearing systems were changed to reinforced concrete frames with adobe infill. When the original system is inadequate, measures are taken to increase the system's ability to perform.

The work continues. While much has been learned, the ability to predict when an earthquake will occur and to describe its characteristics beforehand is at best an inexact science. What we do know is that the "big one" will occur and that more heritage monuments of earth will suffer damage and be destroyed. What was learned from the Northridge earthquake is important, and our challenge—to improve the strengthening systems that will have even less impact on important heritage values and can be implemented at even lower costs—persists.

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Anthony Crosby recently retired after 25 years with the National Park Service and is currently in private architectural conservation practice.

cionamiento más tradicionales que utilizan vigas de unión en las techumbres.

El estado actual de los conocimientos sobre protección de edificios y monumentos históricos de tierra ante movimientos de tierra inducidos por sismos pone el énfasis en ofrecer un nivel aceptable de protección, produciendo el menor impacto posible en la trama histórica o en los sistemas históricos de construcción. Este enfoque se basa en los sistemas constructivos existentes y no intenta alterar el sistema, como ocurrió en el pasado en los casos más graves, donde se cambiaron sistemas de soporte de carga construídos en tierra por hormigón armado con un relleno de adobes. Cuando el sistema original no es adecuado se deben tomar medidas para fortalecer la capacidad de respuesta del sistema.

El trabajo continúa. Se ha aprendido mucho pero la posibilidad de predecir cuándo se producirá un terremoto y describir sus características por anticipado es una ciencia por decir lo menos inexacta. Lo que sí sabemos es que habrá un "Big One" y que habrá más monumentos de tierra que sufrirán daños y serán destruídos. Las lecciones del terremoto de Northridge son importantes y nuestro desafío sigue en pie: mejorar los sistemas de refuerzo que tengan un impacto aún menor sobre los valores patrimoniales y que se puedan poner en práctica con costos aún menores.

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Anthony Crosby recién jubiló con 25 años de servicio en el National Park Service y ahora trabaja en la conservación de arquitectura.

Ann Rasor

Nuestra Señora del Pilar y Santiago de Cocóspera

...a single human hand with a bit of new soft mud is quicker than time and defies the centuries...

D. H. Lawrence, *Mornings in Mexico*

No one who looks upon Cocóspera can forget her. At first glance you think she is gone, but when you get to know her you realize that even though she is crumbling, her heart and soul still beat within. She wants to tell you her story.

Founded in the late-17th century, Nuestra Señora del Pilar y Santiago de Cocóspera served nobly as one of the Kino mission chain until the mid-19th century; today it still guards its namesake valley about 40 miles west of Imuris, Sonora, Mexico. Just 35 miles (as the crow flies) from the United States-Mexico border, one finds a church whose roof is gone, whose facade is broken and leaning, and whose interior teases us with traces of gilded and painted designs and elaborate plaster work—elements that set her apart from her neighboring missions.

Can something be done to help her? This was the question put forth during an International Earthen Architecture Conference sponsored by the National Park Service and the Institutio Nacional de Antropología e Historia (INAH) in September 1998. Attendees at the conference included preservation experts, restorers, and archeologists from 13 different agencies on both sides of the border. It was agreed then that if a time could be established and some modest support given, many of the attendees would return for a week to help Cocóspera survive. Using contacts established during years of working on preservation projects in Mexico, David Yubeta, exhibit specialist at Tumacacori National Historical Park in Tucson, Arizona, immediately began organizing the project. With INAH's blessing and support from the Southwest Mission Research Center, Tucson, Arizona, and the National Park Service Mexican Affairs Office, Las Cruces, New Mexico, an exceptional group assembled at Cocóspera during the week of March 16, 1998.

...con sólo un poco de suave barro nuevo, una mano humana es más rápida que el tiempo, desafiando los siglos...

D. H. Lawrence, *Mornings in Mexico*

Nadie que haya posado sus ojos en Cocóspera podrá jamás olvidarla. A primera vista, da la impresión que ya no está allí, pero una vez la conozcan se darán cuenta que aunque se esté desmoronando, su corazón y su alma aún laten en su interior. Ella quiere narrarles su historia.

Fundada a finales del siglo 17, Nuestra Señora del Pilar y Santiago de Cocóspera sirvió noblemente como parte de la cadena de misiones Kino hasta mediados del siglo 19. Hoy día aún domina vigilante sobre el valle que lleva su mismo nombre, a unas 40 millas al occidente de Imuris, Sonora, México. A tan sólo 35 millas (lo que vuela el cuervo) de la frontera entre los Estados Unidos y México se encuentra una iglesia que no tiene techo, cuya fachada está rota e inclinada y cuyo interior nos intriga con sus huellas de diseños dorados y pintados y con complejas obras de emplasto, siendo estos elementos los que la distinguen de misiones vecinas.

¿Hay algo que se pueda hacer para ayudarla? Esta fue la pregunta que surgió durante una Conferencia Internacional Sobre Arquitectura de Tierra auspiciada por el National Park Service y el Instituto Nacional de Antropología e Historia (INAH) en septiembre de 1998. Entre los asistentes a la conferencia se encontraban expertos en conservación, restauradores y arqueólogos provenientes de trece (13) entidades diferentes en ambos lados de la frontera. Se acordó que si se lograba establecer un marco temporal y se obtuviera un modesto apoyo financiero, muchos de los asistentes regresarían durante una semana para ayudar a que Cocóspera sobreviviera. A través de contactos hechos durante años de trabajo en proyectos de preservación en México, David Yubeta, un Especialista en Exhibiciones del Parque

The group had three days to work on a site that needs three years! The main objectives were emergency stabilization and the development of a strategic plan for preservation. The multidisciplinary team provided a complete package of research and hands-on preservation specialties. Within 36 hours the group accomplished an archeological survey, tree-ring dating, a construction history, plaster restoration, and emergency stabilization.

Cornerstones Community Partnerships staff from Mesilla, New Mexico joined National Park Service preservationists from all over the southwest to repair severe erosion on the lower areas of the church's massive adobe walls. Fortunately more than 100 pieces of original wood remain in the structure, and a crew carefully obtained over 30 samples for the University of Arizona Tree Ring Laboratory to date and analyze. Archeologists from the United States Forest Service and the Bureau of Land Management with the assistance of the Southwest Archeology Team (SWAT) surveyed and mapped sites on three river terraces. Among their discoveries were the mission's lime and brick kilns. Southwest Mission Research Center members assisted National Park Service historical archeologists in sorting and identifying the thousands of pieces of fallen church plaster. Photographers worked to fully document the project including the mapping of the church walls and keeping a registry of work accomplished. E. Ramón Hinostroza, Director of Centro INAH, Sonora, Mexico, and his staff provided daily project support consulting

INAH and American conservators discuss treatment strategies at Cocóspera. Photo courtesy Nyle Leatham.

INAH y Americano conservadores discuten tratamientos estrategias en Cocóspera. Foto cortesía Nyle Leatham.

Histórico Nacional de Tumacacori en Tucson, Arizona, se dio de inmediato a la tarea de organizar el proyecto. Durante la semana del 16 de marzo de 1998 y con la aquiescencia de INAH y el apoyo del Southwest Mission Research Center de Tucson, Arizona y del National Park Service Mexican Affairs Office de Las Cruces, New Mexico, se logró finalmente reunir un grupo excepcional de personas en Cocóspera.

¡El grupo contaba con tres días para trabajar en un sitio que realmente requería de tres años! Los objetivos principales eran ante todo una estabilización de emergencia y el desarrollo de un plan estratégico de preservación. Este equipo multidisciplinario proporcionó un paquete completo de especialidades prácticas e investigativas de conservación. Luego de 36 horas de trabajo, el grupo completó el levantamiento arqueológico, determinación de fechas por anillos de los árboles, una reseña histórica de la construcción, restauración de emplastos y estabilización de emergencia.

El personal de Cornerstones Community Partnerships de Mesilla, New Mexico, junto con preservadores del National Park Service provenientes de todo el sudoeste unieron sus esfuerzos para reparar la severa erosión en la parte inferior de los enormes muros de adobe de la iglesia. Afortunadamente aún existen más de 100 piezas de madera originales en la estructura y el equipo logró extraer cuidadosamente más de cien muestras para ser fechados y analizados por el Laboratorio de Anillos de Árboles de la Universidad de Arizona. Arqueólogos del U.S. Forest Service y del Bureau of Land Management, con la ayuda del Southwest Archeology Team (SWAT) estudiaron y cartografiaron sitios ubicados en tres diferentes terrazas ribereñas. Entre sus descubrimientos se encuentran los hornos de cocción y secado para cal y ladrillos de la misión. Miembros del Southwest Mission Research Center, ayudaron a los arqueólogos históricos del National Park Service en la clasificación e identificación de los miles de trozos de yeso caído en la iglesia. Un grupo de fotógrafos se dedicó a documentar totalmente el proyecto incluyendo una cartografía de las paredes de la iglesia y además llevar un registro del trabajo logrado. E. Ramón Hinoztrosa, Director del Centro INAH de Sonora, México, junto con su personal, proporcionaron apoyo diario al proyecto, brindando asesoría continua a medida que las actividades

continously as activity progressed and officially recording the project. INAH architects and restorers spent the week perched precariously on scaffolding laboriously re-attaching sections of the remaining church plasters and conserving plaster that had come loose. Their openness to exchanging ideas and their generosity in allowing foreign hands to touch this significant national treasure cannot be over emphasized.

The Cocóspera project paved the way for other cooperative projects. Several months later, colleagues from INAH worked on adobe and lime plaster conservation at Swansea, the Bureau of Land Management site near Lake Havasu, Arizona. In April 1999, they trained Forest Service employees in interior plaster replication techniques at Kentucky Camp on the Coronado National Forest as a part of a Passport in Time project.

What lies in Cocóspera's future? Of great importance is community involvement. Cocóspera cannot survive unless she is cared for by those who share her history.

The team concurred that the most efficient way to halt rapid deterioration is to give Cocóspera a shelter and design is underway. When the design and engineering have been approved, fund-raising efforts to finance its construction will begin.

The Cocóspera project was a first; here professionals from the United States and Mexico worked side by side on the preservation of Nuestra Señora del Pilar y Santiago Cocóspera, an important landmark in Sonoran history. Even though Cocóspera rests in Sonora, Mexico, her story is our story, too—it is only an inconsequential political border that separates us from the Sonoran region, people, and history that we both share.

Ann Rasor is Superintendent of Tumacacori National Historical Park, Tucson, Arizona.

progresaban y llevando un registro oficial del proyecto. Arquitectos y restauradores del INAH estuvieron toda la semana trepados peligrosamente en andamios, cuidadosamente pegando secciones de los restos del emplasto de la iglesia y preservando las partes sueltas. La apertura de estas personas hacia el intercambio de ideas y su generosidad puesta de manifiesto al permitir que manos foráneas tocaran este gran tesoro nacional ha sido inapreciable.

El proyecto Cocóspera preparó el camino para otros proyectos de cooperación. Meses más tarde, colegas del INAH estuvieron trabajando en la conservación de adobe y encalados en Swansea, un emplazamiento del Bureau of Land Management cercano a Lake Havasu, Arizona. Más tarde capacitaron a los empleados del Forest Service en las técnicas de reproducción de emplasto interior como parte del proyecto Pasaporte en el Tiempo.

¿Qué le deparará el futuro a Cocóspera? La participación comunitaria es de gran importancia ya que Cocóspera no podrá subsistir sin los cuidados de aquellos que comparten su historia.

Todo el equipo estuvo de acuerdo en que la forma más eficiente de detener el rápido deterioro es dotar a Cocóspera de un resguardo o refugio, cuyo diseño se encuentra actualmente en progreso. Una vez que el diseño y el proyecto de ingeniería sean aprobados, se iniciarán los esfuerzos para reunir los fondos necesarios para financiar su construcción.

El proyecto Cocóspera fue un pionero en su clase. En él, profesionales provenientes de los Estados Unidos y México trabajaron codo a codo en la preservación de ese importante hito de la historia de Sonora que es Nuestra Señora del Pilar y Santiago de Cocóspera. Aunque Cocóspera yace en Sonora, México, su historia es también la nuestra y solo inconsecuentes límites geopolíticos son los que nos separan de la región Sonorense, de su gente y de nuestra historia común.

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Conservation of Earthen Architecture along the Borderlands

The National Park Service United States-Mexico Affairs Office (MEAF), located at New Mexico State University in Las Cruces, New Mexico, continues to organize and facilitate international cultural conservation initiatives along the United States-Mexico border region. In collaboration with other United States-Mexico organizations, the MEAF staff organizes international forums and educational activities on methods to better preserve both countries' earthen architectural heritage. This heritage includes earthen archeological sites, adobe buildings, and still-inhabited districts along the border states.

Forums have been coordinated in cooperation with the Instituto Nacional de Antropología e Historia (INAH) in Mexico. The collaboration has resulted in a number of symposia and workshops on both sides of the border that are similar to the Cocóspera workshop featured in the accompanying article (see Rasor article, p. 45). The goal of such gatherings is to provide opportunities for the candid and constructive exchange of information regarding adobe preservation techniques. Numerous binational projects that have resulted from these international forums include the publication of the symposia proceedings, the compilation of traditional technical methods of working with adobe materials, the preparation of condition assessments, interventions at adobe sites in need of emergency repairs, instruction in the use of lime plastering techniques, and the preparation of site management plans.

The interaction of practitioners along the border states has enabled a broader understanding of common building practices and traditions and provided opportunities for experts to share information about preservation techniques. This exchange helps to perpetuate the sustainable traditions of building with adobe.

For more information, contact the National Park Service United States-Mexico Affairs Office at 505-646-7880. For more information on our office and upcoming international activities, please access our web page <http://www.nmsu.edu/~nps/>.

Conservación de la Arquitectura de Tierra a lo largo de las Fronteras

La National Park Service United States-Mexico Affairs Office (MEAF), ubicada en la Universidad del Estado de Nuevo México en Las Cruces, Nuevo México, continúa organizando y facilitando iniciativas en pro de la conservación cultural a lo largo de la región limítrofe entre los Estados Unidos y México. MEAF, en conjunto con otras entidades tanto estadounidenses como mexicanas, organiza foros y actividades culturales de carácter internacional sobre métodos que permitan preservar el patrimonio histórico de la arquitectura de tierra en ambos países. Este patrimonio histórico incluye lugares arqueológicos de tierra, construcciones en adobe y distritos aún habitados en los estados limítrofes.

Varios foros se han coordinado en cooperación con el Instituto Nacional de Antropología e Historia (INAH) de México. Este trabajo en conjunto ha producido numerosos simposios y talleres en ambos lados de la frontera, muy similares al taller sobre Cocóspera que aparece en el artículo adjunto (el artículo de Rasor, p. 45). El objetivo de tales encuentros es facilitar un intercambio espontáneo y constructivo de información sobre técnicas para la preservación del adobe. Como resultado de estos foros internacionales, se han llevado a cabo numerosos proyectos binacionales, entre los cuales merecen ser destacados: la publicación de las actas de los simposios, la compilación de métodos técnicos tradicionales para trabajar con materiales de adobe, la elaboración de evaluaciones de condiciones, intervenciones en emplazamientos de adobe que requerían reparaciones de emergencia, instrucciones para el uso de técnicas de encalado y la elaboración de programas de administración de sitios.

La interacción entre profesionales de los estados limítrofes ha permitido un mejor y más amplio entendimiento sobre prácticas comunes de construcción, además de proporcionar a los expertos la oportunidad de compartir información sobre técnicas de preservación. Este intercambio ayuda a perpetuar las tradiciones sostenibles de construcción con adobe.

Si desea mayor información, póngase en contacto con la National Park Service United States-Mexico Affairs Office al teléfono No. 505-646-7880. Para mayor información sobre nuestra oficina y futuros eventos internacionales, por favor conéctese a nuestra página web<http://www.nmsu.edu/~npsl>.

David G. Anderson and Michael Russo

Native Earthen Architecture in Eastern North America

For at least 7,000 years people in eastern North America have made use of earth as a building material. Accumulations of various types of earth, including sand, loam, humus, clay, silt, muck, and loess, often in conjunction with other natural materials such as shell and stone, have been used to bury the dead, raise the living above the floodplain, elevate the social elite above the masses, symbolize political boundaries and mythic beliefs, and demarcate both sacred and secular space, transforming the natural world into a humanly defined landscape. Today, across the great expanse of the eastern United States, thousands of mounds and other mounded earthworks remain as tangible evidence of hundreds of now-vanished societies.

The variety of mounded earth formations included enclosures of public places, burial mounds of single individuals and multiple interments, mounds without burials that served as public monuments, places where communal feasting and ritual occurred, and elevations upon which the temples and residences of hereditary elites were placed. Monks Mound, an edifice near St. Louis, Missouri, was a truncated pyramid measuring 300 meters on each side and nearly 30 meters high. Built between c. A.D. 1000 and 1200, it reflects the intentional activity of thousands of people working together over long periods of time. However, the most prosaic of prehistoric mounds, often called mounded middens, were simple garbage dumps resulting from the disposal of cooking scraps and other debris. When used for short periods of time by few people, they may not have stood more than a few centimeters above the surrounding landscape. When commingled with accumulated soil, however, over time substantial mounding could result. In areas where shellfish were a major source of food, as in coastal and riverine areas of the Southeast, the resultant architectural features stood as high as 15 meters and often were hundreds of meters long. Although often distinguished from mounds composed primarily of excavated soil by being called "incidental" rather than "purposeful" constructions, their sizes and geometrically distinct shapes belie this notion. These shell mounds served the same architectural functions as places of burials, enclosure, habitation, and symbolization as did their strictly earthen counterparts.

The effort required of leaders to gain the cooperation of builders to excavate earth and determine areas to place the building material, combined with the ceremonial and ritual behavior that went along with the construction, served to bring people together and substantiate their culture. Earthworks were viewed as symbols of the groups that made them, and they indicated their tenure in that area.

Historical Trends in Earthen Construction

The earliest known earthen construction in Eastern North America dates to about 7,500 years ago. Located at L'Anse Amour, Labrador, it is a burial mound of a child, and it measures 10 meters in diameter and 1.5 m high. The mound was built by a small group of egalitarian hunter-

Typical Mississippian temple mound complex c. 1200-1450, southeastern United States.

gatherers, typical of the kinds of societies that sparsely populated North America at the time.

By 5,000 years ago egalitarian hunter-gatherers still roamed the East, but populations had grown, and much larger earthworks began to appear. At the Watson Brake site in Louisiana, for example, a complex of 11 mounds was built between c. 5400 and 5000 B.P. The site extends over 300 meters, with seven of the mounds tied together by a circular earthen embankment. It is but the largest and most dramatic of a number of mound complexes built around this time in the Lower Mississippi Valley.

At the same time, large mounded shell and earthen sites were made along many of the rivers in the interior as well as along the Southeastern coasts. The interior riverine "Shell Mound Archaic" cultures of Kentucky and Tennessee participated in long-distance exchanges with societies in other parts of the continent, exchanging valuable raw materials like conch shell from the Atlantic and Gulf coasts and copper from the Great Lakes as well as elaborate finished goods, such as grooved and polished axes and decorated bone pins. Competition between individuals and societies for status increased and evidence of warfare appears in burials with embedded projectile points and other weapons trauma. These mounded middens sometimes contained formal cemeteries demarcating kin groups and territory.

Elsewhere, a notable shell-earthwork dating to 5,000 years ago is found at Horr's Island along the southwest Florida Gulf coast. There, analysis of food remains indicates a permanently settled community, the oldest known from North America. Remains of wooden structures, large sand and shell mounds, and a "ring" midden, which surrounded the site, indicate a relatively complex society compared to those that preceded it. This site combined with the contemporary mound complexes in Louisiana (which were occupied seasonally), were places where large numbers of people came together for at least some extended periods, and is the earliest evidence of the first steps toward the creation of more complex social organizations such as tribes, and eventually chiefdoms, which later built the majority of earthen works in the East.

The "ring" motif in monumental earthen architecture at Watson Brake and Horr's Island reached it apogee 1,000 to 2,000 years later on the coasts of South Carolina, Georgia, and Florida, where scores of circular shell rings up to four meters in height and ranging between 50 and 280 meters in diameter were built from shell and earth between 4,200 and 3,000 years ago. Their function is debated, but it is known that people lived on or adjacent to the rings, and the center "plazas" were kept clean, perhaps for public ceremony.

At about the same time, a most impressive monumental earthen architectural center was built at Poverty Point, Louisiana. The site contains a massive earthen mound, built in the idealized shape of a bird measuring more than 100 meters long and over 20 meters high, with six concentric earthen ridges extending almost one kilometer in diameter. The site is the largest feasting and trading center of a number of mound centers built by this culture, which participated in a vast exchange network spanning much of the lower Southeast.

Pritchard Landing, a Middle woodland mound complex c. A.D. 800, Ouachita Valley, Louisiana.

Beginning about 3,000 years ago, groups throughout the Southeast and Midwest began a tradition of burying their dead in or below earthen mounds. Some of the earliest such mounds were small, and individuals were buried without elaborate burials goods. Collective burials were often placed in larger conical or rounded mounds. In these early mounds, most members of society were allowed burial entry; however, over time

Horr's Island, a Late Archaic earthen and shell mound/ring complex c. 5,000 B.C., southwest Gulf coast Florida.

mound burials were increasingly reserved for higher-status individuals, leaders in ceremony and exchange. As populations increased, certain elites gained more power and prestige. These individuals were the coordinators of the ceremonial and exchange network, directed monumental construction at the centers, and were privileged to receive elaborate burial treatment. High-status individuals have been found in log-lined tombs with rich grave offerings, and others beneath conical mounds massive in extent or intricately constructed of differing textured and colored soils. A ceremonial and exchange network spanned much of the region at this time, and massive mound and earthwork complexes were built in several areas, including the Pinson site in western Tennessee, Marksville in Louisiana, and Kolomoki in Georgia. Numerous other equally large and smaller centers dotted the Eastern Woodlands.

In southern Ohio, the elaborate vast earthen enclosures of the Hopewell culture were built between 2,200 and 1,700 years ago. Some covered tens of acres and were shaped like circles, rectangles, squares, or octagons, often with long causeways leading to them. At this time effigy mounds were also constructed in the shapes of animals such as snakes, birds, panthers, lizards, and humans throughout the Midwest; while in the Everglades, strangely shaped and designed sites such as Fort Center, consisted of linear earthen embankments, mounds, ditches, and circles.

Besides extensive geometric earthworks, flat-topped mounds resembling truncated pyramids also appeared in several areas around the time of Christ, notably in the Southeast. These mounds appear to have been elevated stages where collective ceremony and feasting occurred. Some sites were large, with numerous mounds and extensive earthworks, while other sites were small, little more than single mounds that may have served as simple shrines.

Over time, the nature and function of mound complexes in the eastern North America changed. By A.D. 800, the individualistic geometric mound complexes that characterized earlier constructions had largely disappeared. Large mound and plaza complexes were now functioning as administrative and ceremonial centers of larger, hierarchically organized agricultural societies, or chiefdoms. Flat-topped mounds were now used as platforms upon which temples and elite residences were built, facilities reserved for the highest members of society. Some centers were the largest ever constructed in the East. The largest center, Cahokia in southern Illinois, encompassed hundreds of hectares and well over 100 mounds.

Although the rise of mound-building in the eastern United States has often been linked to influence from complex cultures of South America and Mexico, no direct influence from these distant cultures has ever been found. The unique and ubiquitous traditions of mound building found throughout eastern North America have always been indigenous phenomena.

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All paintings by Martin Pate. Photos courtesy National Park Service Southeastern Archeological Center and (this page) Collier Country Museum, Florida.

Jake Barrow

Against the Odds—Hottai Ki

... only a huge dun colored, almost shapeless mass, looming up strangely from the desolate plain. There is nothing architectural about the structure. It is, at best, but a mud house; though, as he examines it more closely, it seems more and more wonderful, and the mind is filled with conjecture as to the uses to which this great building may have been put, and why it stands so lonely and isolated.

J. Z. Stewart*

In 1879, geologist Professor George Cook participated in the first scientific examination of the earthen materials of the Casa Grande, then over 600 years old. His observations started a preservation process that continues today. In 1892, national interest in this earthen ruin led to the first federally funded stabilization project on an archeological site in America. By 1903, a shelter over the site had been constructed, after due consideration, even though surveys, historical commentary, and professional judgment indicated that some of the parapet top courses and wall surfaces were nearly as they were at construction. These walls built of puddled caliche-rich earth have withstood seasons of weathering, earthquakes, and the destructive forces of man for more than half a millennia. This remarkable history illustrates a perhaps never-ending story of engagement with the material and myth of one of Americas most prominent earthen monuments. To consider its tenure one must approach the place with a measure of reverence and awe.

Jesuit priest Eusebio Kino first popularized Casa Grande when he was led by Native Americans to see the Hottai Ki (Great House, in native tongue) in 1694, and it became an attraction and destination for visitors thereafter. One may assume that natives of the area were well aware of the structure over the centuries since abandonment and had some use for and of it. Sketches, written descriptions, and the first photos taken in 1877 provide a wealth of information from which to discern conditions of the structure since Kino's first observations. The 1877 photographic record is a watershed in the process of documentation, which is essential to establish rate of change. Researchers draw on these documents now, as they did in the past, to discern gross changes.

Constructed of puddled earth in about 1250 by the Hohokam (whose name means "those who have gone") and used through 1400, the site appears to have been abandoned around 1450. The Hohokam, occupiers of the northern Sonoran desert, now south central Arizona, left no written record; they did, however, achieve technical mastery in earthen architecture and left treasures of artifacts and a major regional canal irrigation system. Oral tradition is held by their descendants, American native occupiers of the region today—the Pima Indians.

After abandonment, roof and floor timber were recycled into other uses and the natural processes of decay and the associated deterioration caused by human hand took a toll until the federal government intervened and officially took control of the site in 1892. Preservation started in 1891 when Cosmos Mindeleff, anthropologist for the Bureau of American Ethnology, managed the first stabilization effort. Several 19th-century anthropologists had preceded him to visit the site including Adolf Bandelier in 1883. Commentary, ideas, and proposals were developing and available. Under Mindeleff's general supervision, the site was cleared, braces were installed, and underpinning was added. The idea of a shelter was considered, disputed, and not resolved immediately. Photographic evidence indicates that the earthquake of 1887 (the last major seismic event recorded in the northern Sonoran desert) may have caused several major wall section collapses; and Mindeleff's work was clearly an attempt to re-establish the perceived lost stability. Records

* "Ancient Ruins in Arizona." *Juvenile Instructor* 12 (January 15, 1877): 21-22. Hanks, Henry Garber. "Casa Grande." *Californian* 2 (August 1880): 104. From "A Centennial History of the First Prehistoric Reserve: 1892-1992," A. Berle Clemensen, p. 23, Administrative History, United States Department of the Interior, National Park Service, 1992.

West elevation, The Great House, Casa Grande ruins.

do not indicate that he consulted with an engineer; rather, it appears that the gestation of ideas developed during the previous decade was distilled into a plan of action. Contemporary technical evaluations of this 1891 work aside, the effort reversed the trend of neglect, turning the tide of "grave robbing" destruction that had been increasing on site since the railroad came in 1879 and 1880. The timber shelter with a sheet metal roof was finally built in 1903, also without the benefit of formal architectural or engineering services.

The original shelter was replaced with a designed and engineered steel frame shelter in 1932 (itself placed on the National Register). Current assessments indicate the efficacy and value of sheltering the site.

Current Program

In 1999 the effort is continuing. A review of the 20th-century activity reveals a history rich with proposal and treatment alternatives—cement stabilization, plans to infiltrate the soil with epoxy, geodesic dome covers, modern synthetic elasticized soil amendments, bricks and mortar underpinning, un-engineered stabilizing systems, wall monitors, material studies, documentation programs, test wall programs, surrounding terrain modification, technical scientific excursions, and many anthropologic studies. Each effort was well intentioned and of more or less value depending on viewpoint. After all that has occurred the structure retains a remarkable percentage of integrity. An astonishing recognition is that much of the remaining painted and unpainted interior surface plasters show little to no degradation, appearing as they would have in the 1400s.

East elevation, The Great House, Casa Grande ruins.

As of 1996, the Western Archeological Center (of the National Park Service in Tuscon, Arizona) bibliographic references on this subject exceeded 100 documents, books, and reports, indicating a wealth of studies and information. Little of this material sheds light on an understanding of the physical changes of the structure—the rate of change, the causes for change, and the fundamental structural capability as originally conceived and as it is today. The current program was initiated following the 1995 collapse of a 6-cubic-feet piece. Since the late 1980s, hands-on routine type preservation had been suspended. The routine preservation maintenance actions would probably not have prevented the failure of 1995; and over the years several such sectional collapses are recorded. The current effort seeks to consider all previous work, sift through evaluations, assess treatments, and review as many points of view as possible. Perhaps most important is a re-examination of the structure that takes into account the builders' original intent. What was there, what is there, and why are changes taking place?

In 1996 work began with a partnership planning team made up of the Arizona State Historic Preservation Officer, the Architectural Conservation Laboratory in the Graduate Program of Historic Preservation at the University of Pennsylvania, and National Park Service staff. The University of Pennsylvania has for eight years partnered with parks in the Southwest to answer difficult research questions, develop pilot preservation programs, and assist with training activities through the cooperative

University of Pennsylvania 1998 Field School surveying interior walls.

agreement process. Many of these activities have focused on earthen architectural issues, which for some time now have not had the attention of other more responsive architectural fabrics.

At Casa Grande two concurrent winter field schools documented, surveyed, and assessed conditions evident from surface observations. Students mapped details of conditions across the surfaces, a complete 100%-coverage photo-documentation was accomplished, and an engineering assessment was made. Throughout these campaigns the Arizona State Historic Preservation Officer and staff participated in planning. Analysis sessions were periodically held at the park and at the University; during these forums, participants stood in front of scaled digitized color annotated elevations considering patterns, clues, and other information pertinent to the ruin's condition. Two graduate students undertook thesis topics that involved researching fundamental questions about material, architecture, and deterioration mechanisms. Engineers simultaneously engaged in assessing the structure. In addition, seismic evaluations of the structure in relation to potential earth tremors were made.

Results are coming in. Materials research findings have suggested a theoretical concept that appears astonishingly simple, yet of lasting and profound implication relevant to our considerations. Laboratory testing of samples taken from the 1995 collapsed piece showed a migration of calcium carbonates from the substrates to the surface in the form a kind of case hardening of the surface. One master's thesis defines and characterizes this phenomenon in detail. This factor could explain the resistance of the surface to direct water abrasion and the accompanying phenomenon of detachment of sections resulting from weakening substrates and strengthening surfaces. Most of this action probably occurred before the structure was sheltered.

Photos courtesy the author.

Engineering work clarified the viability of the original architecture. A model of the structure, which included the diaphragm floor and ceiling systems, performed even while any single component could not withstand even dead loads. A rather sophisticated understanding of architectural requirements emerges presumably resulting from empirical knowledge by the builders. Without the original structural fabric in place, the remaining walls are compromised and performance is marginal. The seismic data combined to inform the team of real concerns regarding the viability of Casa Grande in a contemporary earthquake. Continuing engineering work is envisioned and plans for revised monitoring are in the works. Difficult decisions for management lie ahead, and no ready-made methodology is anticipated.

Continued monitoring, stabilization, and preservation programs are taking place at Casa Grande. New findings offer information for interpretive agendas. On the one hand, reassurance of the test of time leads to limited objectives; on the other hand, localized and continuing deterioration begs for attention and action. Regardless of approach, the sustaining preservation principle at this stage should be to maintain a graceful, long, and dignified old age for the deserving Hottai Ki.

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Robert Hartzler

Holding Down the Forts

The Army, Adobe, and Preservation

In August of 1846, U.S. Army General Stephen Watts Kearny climbed atop a low, flat-roofed adobe building overlooking the plaza of Las Vegas, New Mexico. From his earthen podium he proclaimed to the citizens of the village that they no longer owed allegiance to Mexico. It was Kearny's first official stop on his way to Santa Fe with the "Army of the West" to announce that henceforth, the northern territories of Mexico were now under the control of the United States government.

With the signing of the Treaty of Guadalupe-Hidalgo at the conclusion of the Mexican-American War, a vast territory—including most of present-day Texas, New Mexico, Arizona, California, and Utah—suddenly demanded attention, and the U.S. Army found itself obligated to a vast, arid, sparsely populated region, inhabited primarily by immigrants from Spain and Mexico, and by American Indians, who considered the settlers of European heritage to be interlopers.

Sun-dried earthen bricks, adobe, were a Spanish import to the New World. Their use among Native Americans was rare, although other earthen architecture forms were not. The advantages of adobe in the Southwest were obvious. It required only soil with enough clay to act as a binder, water from a creek or river, and labor. Made in wooden molds and dried in the sun, the earthen bricks could be easily formed into houses, stores, government buildings, and—as the army would soon demonstrate—forts.

Each fort was unique in design and construction, depending on its purpose, location, and availability of building materials and craftsmen. Later, each fort was unique in its abandonment, depending on the army's plan of retreat, the fort's isolation, and the climate. And of the forts that survive, each is unique in its preservation.

This article presents four forts in the arid Southwest that are actively interpreted to the public, physical evidence of approximately 40 years of settlement, struggle, and a harsh life on this new American frontier in the last half of the 19th century. The four forts are Fort Bowie, overlooking Apache Pass in the Chiricahua Mountains in southeast Arizona; Fort Davis, at the mouth of a canyon in the Davis Mountains in west Texas; Fort Selden, on the Rio Grande in southern New Mexico on the Camino Real; and Fort Union, on the Santa Fe Trail and the high plains of northeastern New Mexico. All are units of the national park system except Fort Selden, which is a New Mexico State Monument.

What these forts have in common is that they were constructed nearly entirely, or in part, of adobe, and they share the modern problem of preserving such a fugitive material. Adobe construction is a good choice for arid climates because its principal agent of destruction, water, is in short supply. But it does rain and snow and blow in arid climates, and adobe left unsheltered is vulnerable. And while adobe requires little capital, it requires constant maintenance to fix leaky roofs, repair failing plasters, and replace erosion and loss.

Fort Union, New Mexico, post hospital in winter.

Wall fragments at Ft. Selden, New Mexico State Monument.

Military records of the day reveal that preserving the structures during their heyday was no picnic:

> Indeed, from the moment they were completed until their abandonment in 1891, the fort's adobe structures were in an almost constant state of unremitting deterioration. The territorial style of architecture [at Fort Union] proved to be lamentably inadequate on the exposed plains of eastern New Mexico. The flat, tin-covered roofs were unable to provide sufficient protection from the wind-driven rain and hail storms which plagued that level open country. As a result, cracks developed, water seeped through the roofs and walls into the adobe, walls separated from the roofs and threatened to collapse, and floors and foundations rotted. The physical decline of the structures was hastened by two additional factors: the inability of the troops to perform the necessary repairs at a time when strict economy measures prohibited the employment of citizen craftsmen and a pronounced unwillingness on the part of Army officialdom to appropriate sufficient funds for annual maintenance.*

For decades now, the modern caretakers of these sites have sought to "preserve" them, using the best technologies of the day. The sites have been unburied and buried. They have been sprayed with waxes, solvents, epoxies, silanes, silicones, acrylics, and urethanes. They have been capped, uncapped, mudded, plastered, and wrapped. They have been rebuilt, augmented, reinforced, braced, propped, and reroofed. Perhaps the wonder is not how much adobe is gone, but how much remains at these sites.

After the forts were abandoned by the army, they served as hardware and building supply centers for the local populations. Quickly, roofing material, floor and ceiling joists, doors and windows, and hardware— virtually anything useful—dissolved into the surrounding communities. What remained, the adobe and the foundations, was left to the elements. Each fort passed into private ownership, and over the years vandals, picnickers, and ranchers gave nature an assist and inflicted even more damage.

The preservation, or the state of ruination, at each site tells a story. And each has a complex, and continually evolving preservation history.

Fort Bowie National Historic Site

Fort Bowie is located near the summit of Apache Pass, in the Chiricahua Mountains in southeastern Arizona. For centuries Apache Pass was an important crossing point due to the natural springs that occur there. Troops stationed at Fort Bowie were involved in some of the most hard-fought battles between soldiers and Indians in the American Southwest during the last half of the 19th century, including battles with Apache leaders Cochise and Geronimo.

The first Fort Bowie was established in 1862. In 1869 it was replaced by a larger post built nearby. Both were primarily adobe. The post survived until 1894. Now Fort Bowie consists of the stone foundations of both forts, and some adobe wall fragments of the second. In the initial stabilization campaign of 1967 and 1968, the adobe wall fragments were capped with soil-cement adobes (earth amended with Portland cement), and some soil-cement veneer bricks were placed to protect weathered walls. Because of aesthetic considerations and concern that the soil-cement adobes were causing erosion, nearly all the soil-cement adobes were removed in 1978 to 1979, and the adobe was protected with an unamended crest of mud. Some fragments were subsequently treated with chemical consolidants popular at earthen sites administered by the National Park Service (NPS) at the time.

Alarmed by rapid erosion of the adobe at the site following the removal of the soil-cement bricks, the NPS covered the adobe fragments with lime plaster shelter coats in 1988 and 1989. With each change in treatment, more historic adobe was lost. Although the lime plaster will remain and be maintained, the Fort is developing a new preservation guide to shelter the adobe.

Fort Davis National Historic Site

There were two forts known as Fort Davis. Deep in the mountains of west Texas are the remains of the second fort, begun in 1867; these remains have been preserved and in some cases

reconstructed. Of the four forts, Fort Davis retains the most intact original adobe structures, primarily one- and two-story adobe officers' quarters. They are full of original plaster and many original wooden features. Two large adobe barracks buildings were reconstructed and today serve as the administrative offices, visitor facilities, and museum.

Never truly abandoned, Fort Davis had a different fate than the other forts. From the time the army left in 1891 until the site was set aside by the federal government in 1961, the fort saw mixed use by ranchers, local residents, and entrepreneurs. Not all of its buildings stood roofless for 70 years, and several were constructed of stone masonry.

The Park Service made a bold decision to reconstruct missing portions of the adobe buildings that were at least 70% intact and to replace missing roofs. Concrete bond beams were installed around adobe perimeter walls, and the porches were reconstructed. Exterior plasters were renewed on the structures on officers' row.

Sheltering the structures with new roofs has slowed deterioration significantly. Consolidating chemicals also appeared at Fort Davis, but today the unroofed adobe ruins are treated with unamended adobe caps and veneers. Some water repellants are used on modern adobe veneers to lengthen their life.

Fort Selden State Monument

The site chosen for Fort Selden was on the Camino Real de Tierra Adentro, a "royal road" extending from Mexico into its northern colony of New Mexico. Fort Selden was established in 1865 on a bank of the Rio Grande 18 miles north of Las Cruces. There was only one Fort Selden and it was composed almost entirely of adobe.

Fort Selden was abandoned in 1878, but it was reoccupied three years later and reconstruction began, completed in 1885. In 1891, the troops left Fort Selden again, for the last time. The site passed into private ownership in 1892, and remained so until 1963 when it was donated to the State of New Mexico. In 1974, Fort Selden was declared a New Mexico State Monument. Initial stabilization consisted of clearing away the wall falls and fill, and compacting the soil at the wall bases. Most of the walls were initially capped with urethane-modified adobes, but these were removed two years later because of concern about erosion associated with the caps. Some low eroded walls at Fort Selden were covered with geotextile fabric and covered with fill, an effective technique for preserving these ephemeral fragments.

Fort Selden has been the site of an extensive experimentation in adobe preservation. A test wall program—trials of wall coatings, foundations, and capping—was begun in 1985, and the Getty Conservation Institute used the site for consolidation–amended-shelter coat trails beginning in 1993. For awhile, selected wall fragments were wrapped in aerotextiles to protect them from rain and wind.

In 1997, New Mexico State Monuments commissioned a new preservation plan for Fort Selden, and it is investigating the options for constructing free-standing shelters over some of the ruins. Adobe treatments are now limited to unamended shelter coats, and veneer infills and capping with unmodified adobes.

Lime plaster shelter coats over adobe and lime concrete foundation walls of the Cavalry Barracks, Ft. Bowie NHS.

Fort Union National Monument

Fort Union was the first of the four forts to be set aside as a monument in 1956. Constructed in the 1860s on the windswept high plains of northeastern New Mexico, it was the largest fort in the Southwest. Today it is the largest adobe ruin in the United States. The adobe fort preserved today was the third Fort Union, following the first log fort and a Civil War earthworks. The fort housed not only military troops but also served as a depot and arsenal, warehousing freight and munitions hauled down the Santa Fe Trail, and distributing supplies to other Southwest posts.

In the initial stabilization of Fort Union in the late-1950s and early-1960s, soil-cement

Non-commissioned Officers' Quarters, Ft. Davis National Historic Site.

adobe caps were placed on nearly all the walls, and tall unstable walls were braced with internal armatures of iron. Soil-cement adobes were used to rebuild missing corners and fill eroded wall bases. Almost every chemical in the NPS arsenal was at one time or another sprayed on a wall at Fort Union, but preservation today relies primarily on unamended mud shelter coats and adobes.

In 1995 Fort Union commissioned a study of adobe deterioration to determine the patterns and causes of deterioration and suggest treatments. As a result, most of the walls at Fort Union were recently recapped with new soil-cement adobes, and certain deteriorating architectural features, eroded corners and lintels for example, are augmented with unamended adobes immediately.

Conclusion

Following a long flirtation with chemistry (and the romance isn't completely dead) the forts are relying less on chemical solutions and more on compatible materials. Sheltering with mud or lime plaster, or with roofs, and maintaining historic plasters where present are the preferred preservation methods.

Each fort has a documented history of preservation and stabilization. By revisiting these histories, by studying what technologies work and why, and by better understanding the processes of deterioration of adobe architecture the preservation specialists charged with caring for these important sites are becoming more efficient and effective.

For years these cultural properties have had to make do with fewer resources—both financial and human—than required. Nature is an intractable, and unbeatable, foe. Properly and continually cared for, adobe buildings can last for centuries. Indeed, there is evidence that the adobe building General Kearny used to make his pronouncement on the Las Vegas plaza more than 150 years ago is still standing. Today it is a music store. Roofless and exposed to the environment, however, these buidlings are continually at risk.

Note

* Dwight Pitcaithley and Jerome Greene, *Historic Structure Report, Historic Data Section, The Third Fort Union, 1863-1891, Fort Union National Monument* (Denver, Colorado: Denver Service Center, National Park Service, Department of the Interior, 1982), 12.

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Photos courtesy the author.

Frank G. Matero

The Conservation of Plasters in Earthen Archeological Sites

The preservation of architectural ruins and earthen archeological sites presents complex problems of conservation, interpretation, and management. Because of the tremendous difficulties and limitations in stabilizing such fragmented and exposed sites, remaining original fabric must be given maximum protection, and implemented contemporary preservation standards must be thoroughly documented. Sites open to the public must meet these requirements while providing interpretation that is both sensitive to their long-term preservation as well as comprehensible to the visitor. Satisfying these requirements is difficult in any ruin site and in particular those with fragile materials such as earthen walls and plasters, which are best understood in context but are highly susceptible to deterioration from exposure and weathering. The many diverse prehistoric and historic sites in the American Southwest offer a unique opportunity to consider the problem of the preservation of architectural plasters within earthen and masonry ruins.[1]

Plasters as Architectural Materials

Regardless of their appearance, composition, application method, and use, all plasters, stuccos, and renders may be characterized as secondary non- structural components applied to a building's primary structural system for protection, decoration, and meaning. These materials, generally applied as one or more thin and continuous layers, protect a building by concealing its structural core and its vulnerable construction joints. As continuous skins, plasters generally provide protection and a reduced surface area to water intrusion, mechanical abrasion, and biological attack. If damaged or failed, plasters and stuccos are more easily repaired or replaced than is the structural core.

All plasters exhibit certain properties in their wet and cured states, and these properties allow them to perform successfully as protective skins. At the very least, plasters must possess good plasticity and adhesion in the wet state and low shrinkage and a hard durable surface after cure. Specific environmental conditions or use impose other requirements such as resistance to moisture, heat, or abrasion. As an integral component of the entire construction system, a plaster's formulation, application, and use are dependent on its composition and chemical and mechanical compatibility with its structural support. This often produces specific systems of installation, keying, or the addition of various organic additives such as animal hair, plant fiber, gums, oils, and resins. Because plasters require large and exact amounts of water for adequate preparation and because their successful drying or cure is often affected by ambient conditions of temperature and humidity, plastering as an activity is often determined by optimal seasonal or environmental conditions. Other factors affecting plaster's manufacture and use include the availability of raw materials and sources of fuel for calcining.

Plaster occurrence, type, and frequency of application can connote important archeological information about past technical knowledge and attitudes toward space and its differentiation. Moreover, the presence of specific components that determine physical appearance or performance can be useful indicators for identifying cultural values be they aesthetic, utilitarian, or

Cliff Palace, Mesa Verde National Park.

Architectural finishes on the Speaker Chief Tower in Cliff Palace, Mesa Verde National Park.

symbolic. For example, the selection and use of certain binders or aggregates for color, texture, plasticity, low shrinkage, and early or damp set all suggest a level of sophistication in keeping with other technological achievements.

As skins, plaster surfaces are susceptible to the elusive evidences of building use and alteration that might not be readily discernible in a building's structural elements. Such ephemeral information—detected on these fragile surfaces as wear, profile ghosts of architectural details, and other marks—makes them remarkably subtle indicators of past human activity.[2]

Preservation Issues

Whether used externally or internally, plasters generally function as intentional or *de facto* temporary materials that were periodically and sometimes regularly removed or reapplied. Maintenance of this protective skin is tantamount for protection of the entire architectural structure as well as for aesthetic conformity. In a preservation context, these functional requirements and traditional approaches to maintenance are often difficult to satisfy since after years of weathering the plaster surfaces often no longer function effectively as well-integrated and continuous protective coverings. As a result, these materials are generally removed and replaced, often without sufficient documentation or analysis. If replacement materials less compatible with the structural support or existing plasters are used, the result is often unsatisfactory. Unlike inhabited sites, archeological sites whose structures are incomplete and whose materials are exposed in ways never intended (unroofed or fragmented) or in new unstable environments (after excavation) present a particularly difficult problem. In these situations, remaining plasters will almost always deteriorate rapidly or catastrophically.

Despite the earlier practice of complete or selective removal of decorated and painted plasters from ruins and archeological sites for protection and display indoors, preservation and interpretation *in situ* is ideologically the preferred solution, even if reburial or sheltering are the only options. *In situ* conservation of architectural plasters ensures future study of the entire resource and allows visitors an opportunity to understand the ruin as a once-complete structure. Finishes of surviving plasters often assist in site interpretation because they define interior and exterior spaces and make tangible and present on a human scale what otherwise might be incomprehensible.

In situ preservation of extant plasters within ruin sites has received limited attention due to earlier preferences for the removal of choice decorated fragments and the neglect of more common architectural remains. This inattention is probably the result of a bias toward plaster's ephemeral nature, especially as compared with other more durable materials, coupled with a dearth of research on practical site conservation techniques. Published research and field work on *in situ* plaster treatments are limited and have focused largely on lime plasters; little attention has been given to earthen plasters as well as to lime, gypsum, or earthen plasters on earthen supports such as adobe, rammed earth, and *jacal*. Moreover, treatment studies have tended to focus specifically on materials and techniques for consolidation and not on surface finishes. Despite the widespread observation of and many reports on the detachment and loss of historic plasters from earthen and masonry walls, almost no research on reattachment methods has been published. A major research program on this subject was initiated in 1991 by the University of Pennsylvania's Architectural Conservation Laboratory of the Graduate Program in Historic Preservation with the Intermountain Region-Santa Fe Support Office of the National Park Service. This program is directed toward the research, design, and implementation of techniques to record, characterize, test, and treat historic and prehistoric plasters at ruin sites in the American Southwest.

Preservation Strategy

Plasters often represent a large percentage of the architectural finds still *in situ* at archeological sites. Their ephemeral nature (especially when compared with stone or brick) and poor fragmentary condition necessitate the development of a phased preservation strategy that allows for efficient and immediate documentation, stabilization, interpretation, and maintenance of these finds.

Documentation

Documentation of plasters should provide as complete a record as possible of the physical evidence, including fragment location in plan and elevation; support material(s), construction techniques including mechanical keying; number of layers and their thickness, color, texture, and composition (all verified with laboratory examination and analysis); application methods and work sequence; existence of secondary finishes (paints, incisions, relief, etc.); existing conditions (including environmental); and any subsequent alterations or treatments. The specific methods of survey and documentation will depend on available funds, time, and expertise, and the level of recording should be commensurate with the significance of the site and the finds. A standard lexicon of terms, including those describing conditions, should be established and used for long-term assessment and multi-site comparison.[3]

Stabilization

The most important goal of any archeological plaster stabilization effort should be the minimal treatment necessary to insure the preservation of the physical fabric so its informational value remains unimpaired for future study and interpretation. Depending on the conditions of the plasters, their support, or the environment, stabilization may take the form of temporary emergency work (often necessary after excavation) or long-term remedial treatment, such as consolidation and reattachment. Because rates of change (that is, deterioration) are a critical aspect concerning the relevance and efficacy of any intervention, every effort should be made to record and identify the causes and mechanisms of deterioration before treatment. Unlike other integral materials, such as stone or brick, plasters are particularly susceptible to catastrophic failure from subtle conditions such as blind detachment, which leads to collapse and complete loss. As such their present and anticipated conditions must be accurately diagnosed by professional conservators.

Kiva "C" finishes, Mug House, Mesa Verde National Park.

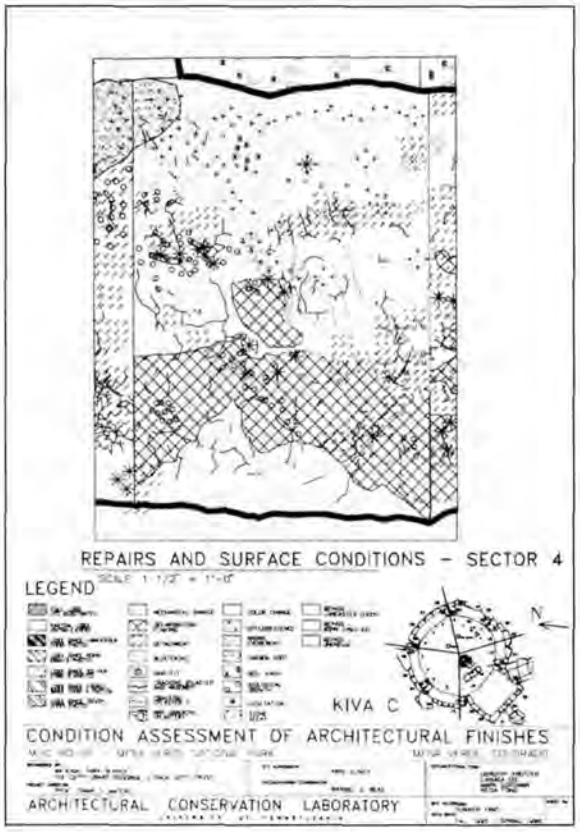
Priority should always be given to intact surfaces and finish layers because features such as tooling, painted decoration, and wear marks often carry much information. In areas where the finish layer is lost and the intermediate or base layers are exposed, preservation is always recommended although it may be discretionary. In areas where a complete loss of plaster has occurred, additional problems may arise due to the instability of isolated non-supported fragments or the deterioration of the structural core resulting from the loss of the protective plaster; such is the case with water-sensitive adobe. Stabilization measures may range from simple protective coverings to complex reburial, or they may involve temporary emergency facing treatments until full-scale conservation can be implemented. Detachment is a common problem affecting many site plasters, especially those of or on earthen materials. During the past eight years, detached plaster has been treated successfully by using moderate strength, low viscosity grouts of moderately hydraulic lime, fine sand, and ceramic microspheres.

Interpretation

The goal of interpretation is to offer a clear explanation of a site and its elements in their fragmented state. While this has sometimes been viewed as an opportunity for reconstruction, or "consolidation" as it is sometimes termed in archeological parlance, the process is most successful when the intervention to the fabric is minimal and supporting materials deciphering the physical remains and enhancing the visitor's understanding of the site are provided. In the case of plasters, effective site solutions that both stabilize and emphasize surviving fragments and their architectural context without requiring the removal or replication of entire finishes can be designed.

Maintenance

Most, if not all, conservation treatments are temporary in that they require monitoring, maintenance, and usually eventual re-application. While modern conservation principles demand treatments to be executed with stable materials and in a manner that allows for re-treatment in the future, it would be incorrect to think that many necessary stabilization techniques, such as consolidation or grouting, regardless of the materials used, are in fact reversible or allow for complete re-treatment. Therefore, every effort should



Condition assessment of architectural finishes, Mug House, Mesa Verde National Park.

be made to employ techniques that best balance preservation needs with the anticipated requirements of future studies and the maintenance of the materials and the site. Although most conservation research has focused on long-term treatment solutions, effective preservation can often be achieved by opting for indirect protection provided by shelters or reburial, or by selecting directly applied prophylactic techniques, such as water repellents, and sacrificial shelter coats, which offer easy renewable protection options but with a higher replacement cycle due to their lower durability. Only through on-site comparative monitoring can such methods be evaluated in contrast to other solutions designed to be long-term.

Conclusions

Developing an effective preservation strategy that is conservative yet responsive to the existing and varied contexts of any ruin site and takes into account the ephemeral nature of surviving building materials (such as adobe and plaster), the vulnerability of the ruin's condition, and the increasing demands for public interpretation is a difficult task. Past and current preservation practices include replacement; encapsulation with nonhistoric veneers; protective shelters and reburial; and remedial conservation treatments including capping, grouting, and consolidation. These practices have been employed at many sites around the world with varying degrees of success.

Their selection, however, must be based on a careful consideration of the site's significance, present materials and building systems, environmental and human factors, maintenance, and treatment predictability. Low pressure injection grouting with a mixture based on a moderately hydraulic lime, ceramic microspheres, and fine silica sand offers an effective method of reattachment and meets the essential performance criteria of injectability with low viscosity, reasonable setting time, minimal shrinkage and weight, maximal stability, adequate adhesive bond strength, and good water vapor transmission. Furthermore, using hydraulic lime as a single component binding material is advantageous because it is cost effective, readily available, chemically compatible, and easy to use. These techniques have been used for plain and decorated mud and lime plasters on a variety of earthen and masonry structures at historic and prehistoric sites in the American Southwest.

Notes

1 The most complete source on the development and standardization of stabilization techniques for ruin sites in the American Southwest is R. V. Richert and R. G. Vivian, *Ruins Stabilization in the Southwestern United States* (Washington, D.C.: National Park Service, 1974). Plaster stabilization, however, is not addressed in this text.

2 Both historical and current terminology is imprecise on the exact meanings of and distinction between these terms. The term plaster is used here to mean any inorganic binder (such as clay, lime, gypsum, natural or artificial cement) used alone or in combination with aggregates that when mixed with a suitable amount of water forms a plastic mass. When this plastic mass is applied to an interior or exterior surface, it adheres to it and subsequently sets or hardens, preserving in a rigid state the form or texture imposed during the period of plasticity.

3 A comprehensive three-part graphic documentation program for the Southwest has been proposed by the Intermountain Region Cultural Resources Management Program (NPS) for historic and prehistoric sites and structures.

Frank G. Matero is Associate Professor of Architecture and Chairman of the Graduate Program in Historic Preservation at the University of Pennsylvania.

Photos courtesy the author.

Todd R. Metzger

Vanishing Treasures
A Legacy in Ruins

Buildings made of the stuff of earth itself . . . as old as time and human labor, the containers of the experience of community, ours in trust. . . . Now there is an undeniable crisis of care. And we need your help.

Roger Kennedy
Former Director, National Park Service

After 20 years of inadequate funding, backlogged treatment needs, and a lack of information on condition, thousands of prehistoric and historic ruins at 38-plus National Park Service (NPS) units in the arid West are threatened with severe deterioration and collapse. These architectural resources—some of them World Heritage sites—are important to our national heritage, and they also hold special and significant meanings for a number of traditional Native American and other communities. In addition, the NPS employs very few highly skilled preservation craftspersons, and many of them are retiring after 30-plus years in the Service. A lack of funding has prevented their specialized knowledge from being passed on to a new generation of craftspersons.

The Program

In 1993, the National Park Service identified and began to correct critical preservation weaknesses through a grassroots program strongly supported by the NPS directorate and managers that has become known as the Vanishing Treasures Initiative.

Currently, more than 40 national parks, monuments, historical parks, historic sites, memorials, and recreation areas in Arizona, New Mexico, Utah, Colorado, Texas, and Wyoming have identifiable Vanishing Treasures resources. Vanishing Treasures resources are structures or groupings of related structures that are in a "ruined" state; have exposed intact fabric (e.g., earthen, stone, wood); are not being used for their original function(s); have experienced occupation(s) and utilization(s) that have been interrupted or discontinued for extended periods of time; are located in the arid West; and are the resources or part of the resources for which the park was created (or, if National Historic Landmarks, are either listed on or are eligible for listing on the National Register of Historic Places). Examples include architectural remains that have intact historic fabric exposed at or above grade (e.g., wall alignments, upright slabs, foundations, bins, cists, constructed hearths); subgrade architecture exposed through excavation or erosion (e.g., pithouses, dugouts, cists); Native American architectural structures (e.g., pueblos, cliff dwellings, hogans, wickiups, ramadas, corrals, earthen architecture); and Euroamerican architectural structures (e.g., churches, convents, forts, ranch/farm structures, homesteads, mine buildings, acequias or related features, kilns). Not included among Vanishing Treasures resources are sites with no exposed architecture or structural remains (e.g., collapsed, buried, mounded, or otherwise not evident); archeological or other sites with no architectural remains (e.g., lithic scatters, dumps, campsites); Civilian Conservation Corps and Civil Works Administration buildings and features; historic structures that are regularly maintained and/or adaptively used and that fit within Historic Structures/List of Classified Structures definitions; structures in use as NPS facilities (e.g., administrative buildings, trails, bridges, ditches, canals); mine shafts and caves without architec-

Antelope House Ruin, Canyon de Chelly National Monument, Arizona. A large multi-story ancestral puebloan village dating from AD 800 to AD 1275 located in Canyon del Muerto. The site exhibits numerous kivas, multi-story structures, intact plasters and decorative paint on walls, stratified archeological remains, and numerous rock art images. Photo by Al Remley.

tural/structural features); pictographs, petroglyphs, and other rock art (except if found in or on architectural structures); and NPS or other reconstructed buildings or ruins (e.g., Aztec Ruins' Great Kiva, Aztec, New Mexico, and Bent's Old Fort, La Junta, Colorado). (Please note that, for purposes of convenience, this article uses the term "ruins" in full recognition of the fact that some Native American and other communities do not use this term because they do not consider the places to be "ruined," out of use, or unoccupied.)

The common thread shared by all Vanishing Treasures units consists of the ongoing degradation of their architectural resources, the continuing and ever-increasing backlog of work required to bring the condition of the resources up to a stable and maintainable level, and the lack of or decline in the availability of qualified expertise to address current and future needs. At present, most parks are doing only emergency work to protect deteriorated infrastructures and stabilize dangerous conditions. Obviously, the longer that vitally needed preservation work is put off, the more expensive the final costs are going to be.

Vanishing Treasures Initiative administrators will create a career development and training program in which skilled craftspersons and other professionals will have career status, benefits, and career development options analogous to other segments of the federal workforce, in order to ensure work continuity. In addition, a computerized data management system as well as clear guidelines for future planning and preservation will be developed. Adequate funding levels to achieve specific goals are estimated to be some $67 million—$59 million for emergency preservation needs and $8 million for the preservation workforce. Parks estimate that approximately 65 to 70 technical craftspersons and 50 to 60 archeologists or other specialists will need to be recruited over the next decade (over time, the boundaries between these two groups will blur, and a new kind of employee—the preservation specialist—will be born). This very rough estimation comes to approximately $1 to $1.5 million. and 3 to 4 new staff for each of the known and potential Vanishing Treasures park units (with actual funding and personnel needs dependent upon the size, number, and complexity of the resources within each unit).

In 1993, a *Vanishing Treasures: A Legacy in Ruins* video was created by concerned NPS managers—and the work began.

Todd R. Metzger is Program Agent of the National Park Service's Vanishing Treasures Program.

For more information on the Vanishing Treasures Initiative, contact Todd R. Metzger, Chief, Division of Resources Management, National Park Service, Flagstaff Area National Monuments, 6400 North Highway 89, Flagstaff, Arizona 86004; telephone 520-526-1157, ext. 222; e-mail <Todd_Metzger@nps.gov>

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VOLUME 22 • NO. 6
Cultural Resources
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