A critical mass of archaeologists gathered for the Tenth Biennial Southwest Symposium in Las Cruces, New Mexico in January 2006. Among the topics discussed was reconstructing the origin and cause of prehistoric structural fires. Archaeologists throughout the Southwest United States and Northwest Mexico frequently encounter ancient burned structures. Based on associated artifacts, these buildings burned between several hundred to over a thousand years ago. Sometime between AD 900 and AD 1450 structural fire was a very common event.

BY JOE LALLY, ALBUQUERQUE, NEW MEXICO—Over the years archaeology has offered many explanations for these fires. Currently most of these explanations are based on either warfare and other forms of social conflict or ritual abandonment of settlements. All of these explanations assume that the fires were intentional incendiary fires. The possibility that these fires were either accidental or the result of natural causes has been either ignored or summarily dismissed.

In the last 2 or 3 years, archaeology has begun to look at the techniques utilized by modern arson investigators. These techniques are beginning to be applied to this prehistoric evidence. Archaeologists from Arizona, New Mexico and Texas have turned to fire protection engineers for help in solving these ancient mysteries. They were introduced to the physics and chemistry of fire behavior, the differences between wildland and structural fires and mathematical computer fire modeling. There have been some modest successes in determining the origin and cause of prehistoric structural fires and more is being learned almost every day.

This is more than interesting trivia or purely academic research. There are some very practical applications for this research. The next time an attorney cross examines an arson investigator and asks how long evidence of fire can remain at the scene, the answer can now be, “Archaeologists have utilized the techniques articulated in NFPA 921 to determine the origin and cause of structural fires over a 1000 years old. They have found that evidence can remain at the scene for hundreds, if not thousands of years.”

The initial stages of this research took years to complete and hundreds of pages to document. Past mistakes have been corrected and future research will correct even more. Some evidence has probably been misinterpreted, but the important fact is that the evidence is still there.

Figure 1 is photographic documentation of the tenacity of fire evidence. This is a photograph of an ancient structure in Sandoval County, New Mexico. This site was excavated by an Eastern New Mexico University (ENMU) field school in 2003. Clear lines of demarcation can be seen approximately 10 cm above the floor. This structure is believed to have been used as a storage room approximately 800 to 1000 years ago. This and other excavations in the state of Chihuahua in northwest Mexico were the basis of a dissertation, Reconstructing the Cause and Origin of Structural Fires in the Archaeological Record of the Greater Southwest at the University of New Mexico (UNM) in 2005. Since that time ongoing research has been conducted at the University of Arizona (UA) and at Southern Methodist University (SMU) in Texas. It was this research that was discussed in Las Cruces, New Mexico in January, 2006.

Three papers on ancient fire investigations were presented during the symposium in Las Cruces, New Mexico. These papers presented the results of archaeological research of fire events in the Southwest. This research would not have been possible without the help of many fire professionals. The long list of fire professionals that provided assistance includes several well respected scholars such as James Quincliffe, David Icove and Timothy Huff. Arson investigators from local fire departments in New Mexico and Arizona provided invaluable assistance. These fire experts had to teach the principles of fire behavior to archaeologists and archaeologists had to explain archaeology to the fire experts. Everyone came away with a better understanding and greater appreciation of the other discipline.

Archaeology can demonstrate that it is possible for the physical evidence created during fire events to survive the ravages of time, perhaps for thousands of years. The excavation and analysis methods utilized by archaeology to recreate distant past fire events can be utilized by arson investigators to recreate more recent past events. This concept is not new; the comparison of arson investigators to archaeologists was made years ago in England. Arson investigation and archaeology do more than merely sift through the ruins of a burned structure in an attempt to determine what happened. Both disciplines bring the technical tools of their trade to determine the nature of the fuel load, the area of ignition and ultimately, the cause of the fire.

These technical tools include expert excavation techniques, determining the point provenience of each item of potential evi-
dence, documentation of observable thermal alterations, chemical and physical examination and analysis of each piece of potential evidence, and the use of mathematical computer fire modeling to test possible explanations of the fire event. It is the painstakingly detailed excavation techniques of archaeology that can form the foundation of an accurate reconstruction of a fire event. A detailed discussion of these excavation techniques can fill volumes and is well beyond the scope and space limitations of this article. There are several excellent introductory texts on the subject and are a worthwhile read.

In order to gain an understanding of ancient structural fires, archaeologists had to take a page out of Francis Brannigan’s book and study ancient structures. Archaeologists knew what fire did to structures, but had to learn how these structures could affect fire. Prehistoric compartments in the ancient Southwest tended to be small, under-ventilated rooms with low ceilings. They were typically built out of adobe or stone masonry with adobe mortar and plaster. The roofs were made of large exposed main beams, known by their Spanish name, vigas. The vigas were covered with thatching material and adobe mud was used to cover the roof. This adobe
mud could be 10 to 20 cm deep over the entire roof. Figure 2 is an artist’s conception of these prehistoric roofs.

The physical configuration of these prehistoric compartments makes a fire behave very differently than it would in a large modern compartment with an 8-foot ceiling. Small compartments with low ceilings are more prone to flashover than larger modern compartments. Flashover would have been a very common event during prehistoric structural fires. There would have been one notable exception. Circular, subterranean or semi-subterranean ceremonial compartments known as kivas are very common. Typically, the only access to these compartments was, and is today, through a large ceiling entrance. These ceiling entrances would have been the functional equivalent of a large ceiling vent and would have inhibited the occurrence of flashover. Figure 3 is a photograph of the interior of a reconstructed kiva.

One of the most difficult tasks facing archaeology was attempting to identify the use and expected fuel load of a compartment at the time of the fire. The excavation and evidence analysis of the compartment displayed in Figure 1 revealed many things. Microscopic and pollen analysis demonstrated that this compartment was used for storage. Complete ears of corn were stored in the western portion of the compartment that is shown in Figure 1. The eastern portion of the room was used to store fuel wood. The pollen evidence also indicated that at the time of the fire, the surrounding environment was the same as it is today, a pignon-juniper woodland with some ponderosa pine. Radio carbon (C14) tests demonstrated that this structure burned between AD 1050 and AD 1270 (95 percent probability level).

X Ray Florence (XRF) tests revealed that the source of the adobe mud used as mortar, plaster and roofing material was a large spring in a nearby canyon. This particular type of mud contains a large percentage of clay that fuses or sinters and even begins to melt at relatively low temperatures. This adobe material contains very little organic matter and will turn into a brick-like material when placed in a smoldering pile of corn. It only begins to melt when placed in a flaming pignon-juniper wood fire that produces a Heat Release Rate (HRR) of slightly less than 200 kW.

Several large pieces of sintered adobe weighing several kilograms and more were recovered from the center of the compartment in Figure 1. These large chunks of adobe displayed unambiguous signs of the initial stages of melting. Figure 4 is a photograph of this thermally altered adobe mud. The results of full-scale compartment experiments as well as mathematical computer models were compared to the thermal alterations observed on the floor and walls of the excavated ruin and the large chunks of fused adobe. The results of these tests and experiments indicated that this fire began in the eastern fuel wood storage area of the compartment and spread to the western corn storage area. The compartment appears to have experienced flashover that eventually resulted in roof collapse. The large chunks of fused, beginning-to-melt adobe were roof fragments that fell into the burning fuel.

This compartment, as well as the rest of the structure, was abandoned after the fire. It was not rebuilt or reused, even though there is substantial evidence that this site was occupied for several hundred years prior to the fire. The compartment did not contain any evidence of a hearth that may have sparked an accidental fire. An internal hearth would have required a large ceiling vent to exhaust the smoke. According to computer models, a ceiling vent large enough to exhaust the smoke from a hearth would have prevented flashover. All indications point to an intentional fire. The motive for setting this fire remains a mystery.

The archaeological record also contains evidence of accidental and naturally caused fires. Figure 5 is a photograph of an 800 year old structure in Rio Arriba County, New Mexico. This photograph displays fused, sintered adobe mud plaster on the exterior of a stone masonry structure in a heavily forested area. No evidence of fire can be seen on the interior of the structure. The source of the heat that caused the adobe mud plaster to sinter was clearly on the exterior of the structure. Experimental tests have demonstrated that a heat flux of 196 kW will rapidly fuse most adobe mud plaster. Assuming a 30 percent radiant fraction, a forest fire with a 7 meter flame length will produce over 245 kW of radiant heat flux on a target 1 meter distant. This is more than enough heat to fuse the adobe plaster displayed in Figure 5. The most logical explanation for this ancient evidence of fire is that a forest fire in close proximity to the structure resulted in the observed exterior fused adobe plaster.

Forest fires in the mountains of northern New Mexico frequently produce flame lengths of 7 to 10 meters.

Research at UA continues to compare the results of full scale compartment models and computer models to the thermal alterations observed during excavations at Chevelon Pueblo, near Winslow, in Navajo County, Arizona. Research at SMU is utilizing computer fire modeling to test possible fire scenarios that may explain large fire events at Pot Creek Pueblo in Taos County, New Mexico. Archaeology still has a lot to learn when applying fire science to ancient evidence, but the evidence is still there.

REFERENCES.

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About the Author

Joe Lally, JD, Ph.D. was a Deputy Sheriff with the Bernalillo County (New Mexico) Sheriff’s Office and worked for the Albuquerque Police Department before attending Law School at the University of New Mexico.

After graduation from Law School, he worked as an Assistant District Attorney in Albuquerque, New Mexico. One of his specialties was the prosecution of arson cases. He completed the Prosecuting Arson for Profit course at the Federal Law Enforcement Training Center in Glencoe, Georgia.

After retiring from the District Attorney’s Office, he returned to the University of New Mexico and received his Ph.D. in anthropology. His dissertation was “Reconstructing the Cause and Origin of Structural Fires in the Archaeological Record of the Greater Southwest.” He is currently employed as an archaeologist with the United States Department of Interior, Bureau of Land Management in Albuquerque.