

Using ground-penetrating radar to analyze interior details of a Hohokam dwelling to test ideas about cultural change and community dynamics in 10th century southern Arizona, USA

Lawrence B. Conyers
Department of Anthropology
University of Denver, Denver, Colorado, USA

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Highlights:

- Integration of two-dimensional and three-dimensional images can define house features in buried dwellings
- Placement and number of interior features allows for determination of duration of occupancy
- Results of many GPR studies of houses of a specific age over a broad landscape can test ideas about community dynamics in the ancient Hohokam world

Introduction

For the last few decades archaeological research in North America has explored ancient households within larger communities to understand individual economic units and broader social interactions in general (Roth, 2000). Here I have used ground-penetrating radar (GPR) to analyze one small house in southern Arizona, which dates to the Rincon Phase of the Pre-Classic Hohokam (AD 950-1150) to identify architectural components, which can be used to assess cultural attributes of these ancient people. Using GPR analysis of reflection profiles integrated with amplitude slice-maps, features within this dwelling were identified that denote human activities, household size and duration of residence. Those attributes of culture can be used to show how the occupants of this small house fit into the larger society, how long they lived at this location, and how that longevity was related to population growth dynamics. This can be accomplished without excavations, and in the future analyses of this type could be used to study several other similar structures nearby, allowing for a more regional understanding of societal changes taking place in the 10th and early 11th centuries along one part of a river system in Arizona.

The house studied here is in the Tucson Basin of Arizona, USA, part of the eastern edge of the Sonoran Desert that continues to the south into Mexico. The Hohokam people were sedentary agricultural people who farmed well-watered river valleys growing maize, beans, squash, cotton and other crops here for more than a millennium. The general location of this site, along the southern bank of the Tanque Verde River, was identified by surface pottery scatters, dated by their painted decorations. It is locally known as the Tanuri Site. This period from about AD 950-1150 was a time of rapid population growth in the Tucson area when large villages along the river became surrounded by smaller hamlets as people splintered away from their home villages and founded smaller settlements near agricultural fields (Roth, 2000).

Houses were constructed in shallow pits with constructed clay or plaster floors and central hearths for cooking and warmth in the winter. Wall foundations were made of sun-dried adobe, with a superstructure of wattle and daub. Many dwellings dating to this time have been excavated nearby (Thiel, 2013; Gregonis, 1997). Some of these show evidence of remodeling over time and multiple interior hearths, which suggests they were occupied for many decades. Others were built in the same way, but not refurbished or remodeled, and quickly abandoned. While this difference in habitation duration can be determined, the cultural aspects of these longevity decisions are still poorly understood.

Hohokam houses from this time usually have just one central hearth that was active at any time and well-constructed plaster floors. Most are sub-rectangular or slightly oval, and have rounded corners, with an average area of about 15-18 m² (Figure 1). Work areas within the dwelling are usually toward the front, near an entrance, which can be identified by a step up to the ground level, or a short ramp. The rear portions of these dwellings are often devoid of artifacts and interior features and were presumably used for sleeping. Sometimes there is evidence of interior barriers between living spaces. There is a general lack of storage facilities for harvested crops within these structures.



Figure 1: Excavated pre-Classic age Hohokam house at the Fort Lowell Park Site, 1.8 km southwest of the Tanuri Site.

GPR analysis

An 8x9 meter grid was set up over the buried house, and 400 MHz reflections profiles were collected with 50 traces per meter and profiles every 20 cm within a grid (both x and y dimensions). The ground surface is gently downward sloping from east to west, and there is no surface expression of the buried house. Slice-maps of relative radar wave reflection amplitudes were constructed in a variety of depth-slices and displayed horizontally (Figure 2). These images show well-developed high amplitude continuous walls on the south and west edges of the dwelling, which are visible in the 10-20 cm depth slice. An entrance is visible on the southern edge of the house, which would have directly led toward what were agricultural fields in or near the floodplain only about 10 meters away. The house is preserved on a raised terrace, which is

about 50-100 cm above what would have been that ancient agricultural field in the 10th and early 11th century.

Toward the front of the house is a well-developed floor, which appears to be plastered and therefore highly reflective (Figure 2). It may have been additionally hardened by foot traffic as people came and went through the nearby entrance (Figure 2). Toward the front is a round hearth, which has raised edges and is placed in the same location as most hearths (Figure 1) from similar age structures nearby (Thiel, 2013). A composite of slices from 20-60 cm depth outlines the house's adobe walls. No wall is visible on the east side of the house, which was built into a gentle slope. On that side the builders likely excavated into that slope, and buttressed the short wall with stones, which are still visible in the amplitude maps (Figure 2: 50-60 cm depth slice).

There is a subtle boundary between the hard-packed plaster floor in the front and a lower-reflective area at the rear. This "vacant" area in the back was likely a sleeping area (Figure 2). While not apparent in the amplitude maps, there are post molds visible in reflection profiles, which supported vertical supports for a roof near the boundary of the sleeping area and the everyday living area to the front.

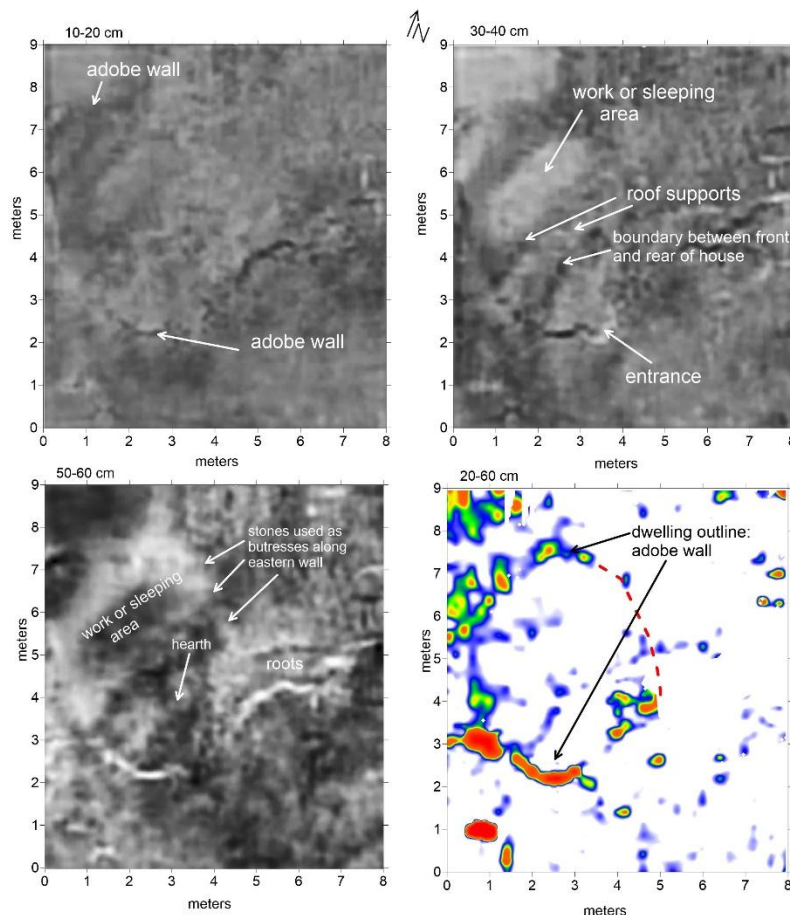


Figure 2: Reflection amplitude maps of various depths in gray-scale, with a composite slice that defines the house walls in color.

Amplitude maps show the larger features of this buried house and can be used generally to define its walls (Figure 2: 20-60 cm slice). When analyzing all the 87 of the two-dimensional reflection profiles, a much more refined look at the house's features is possible (Figure 3). A north-south profile shows the distinct southern adobe wall of the dwelling (Figure 3, profile 7). This wall indicates highly reflective layers of this wall, which are likely two interfaces from when the clay, mixed with binder were placed in a trench and hardened into adobe by the desert sun. The plastered floor inside the house is also highly reflective and a subtle post-hole that held a roof support beam can be seen cutting through this floor.

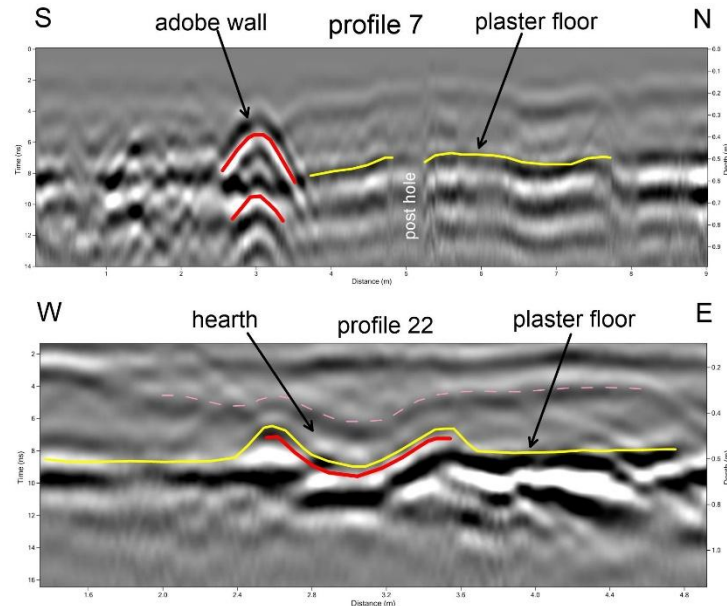


Figure 3: Reflection profiles showing some of the interior house features in two-dimensions.

The hearth located in the front of the house has a highly reflective surface that was constructed in a bowl shape (Figure 3, profile 22), just as the hearth in the nearby excavated house (Figure 1). Many other features that were generally defined in the amplitude maps are defined more specifically in an analysis of the two-dimensional reflection profiles (Conyers 2012; 2013, 2016). With profiles separated only 20 cm across the grid, these interior features are visible and well defined in ways that the standard slice-maps can't readily produce in plan-view.

The interior features are shown in a composite map, irrespective of depth (Figure 4). This house was oval in shape with one central hearth near the entrance. Post holes supporting the roof and a sleeping area toward the back are visible. The stones that supported the eastern edge of the house along the cut-embankment are still present.

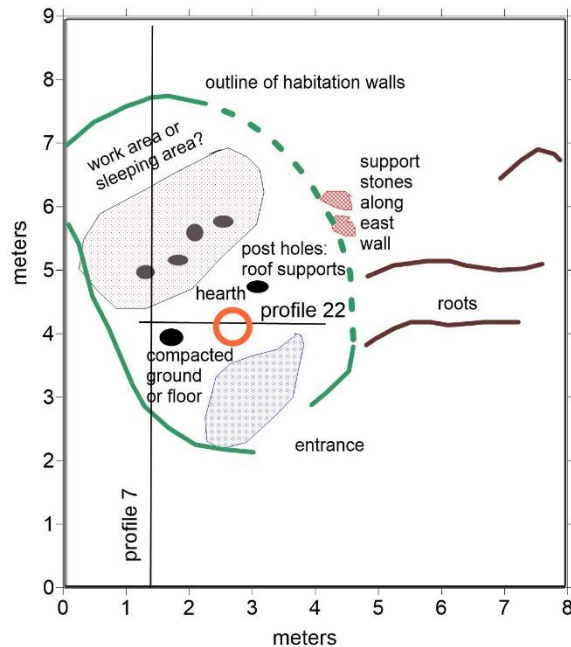


Figure 4: Architectural features of the dwelling with the location of the two-dimensional profiles in Figure 3.

Cultural analysis based on GPR results

Based on what can be seen in the excavated houses 1.8 km to the southwest of the Tanuri Site, the duration of occupancy can be determined by how many hearths were constructed, with long-duration houses having two or more (Thiel, 2013). The Tanuri structure has only one hearth, and no evidence of renovation of it during its life. This suggests that this house was likely occupied for a short period of time.

Elsewhere artifact density within and surrounding Hohokam houses has been used as a proxy measurement for duration of habitation (Roth, 2000). Unfortunately, individual small artifacts are not visible with the resolution of the 400 MHz antennas. This site will be re-surveyed in coming years with the 900 MHz antennas, which might improve resolution and define artifacts or density of artifacts on the floor. Another way to determine length of occupation is the number of floor renovations that occurred. These are visible in excavations where individual floor horizons can be defined and counted. This is also impossible to determine with the 400 MHz images, but might be possible in future surveys.

Within 500 meters east and west of the Tanuri Site, 6 other houses of this age have been identified from surface pottery scatters, and their location in the preserved terrace above the ancient floodplain. These will be surveyed in future years and if the resolution is as good as reported here, then it might be possible to determine how long people lived in these scattered settlements away from the presumed “mother village” on the south bank of the Tanque Verde River. With these geophysical analyses it might be possible to test the idea that during the late pre-Classic Hohokam people had moved here due to population pressure and the necessity to get closer to their productive agricultural fields.

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