

GPR mapping for more than just finding buried materials: A case study in testing ideas about cultural change and community dynamics in 10th century southern Arizona, USA

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Summary

The GPR technique has historically been used by practitioners for finding buried archaeological sites, with little analysis of the discovered remains that can inform historical or anthropological research. Instead the GPR methods can be expanded and integrated with age-dates, cultural affinities and compared to nearby excavations to place GPR results within a regional framework and test hypotheses about anthropological topics such as population dynamics and culture change.

Introduction

For the last few decades archaeological research in southern Arizona has studied ancient households within larger communities to understand individual economic units and broader social interactions (Roth, 2000). Many sites remained to be discovered or are off-limits to excavations, and only geophysical analysis can find and study them. Here I present GPR analyses of one small buried house that dates to the Rincon Phase of the Pre-Classic Hohokam (AD 950-1150) to identify its shape, orientation and architectural components visible with GPR. These attributes can be used to place this house within a larger dataset of other excavated houses in the area and expand our analysis of humans within the environment within this time period along one perennial river in present-day Tucson. Using analyses 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 cultural attributes 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. Most important these analyses can be accomplished without excavations that are both costly but often impossible. This allows for a further understanding of societal changes taking place in the 10th and early 11th centuries along one part of a river system in Arizona.

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 (Figure 1). Wall foundations were made of sun-dried adobe, sometimes anchored with large stones, with a superstructure of wattle and daub. Many dwellings dating to this time have been excavated nearby (Thiel, 2013; Gregonis, 1997). They often show evidence of remodeling over time and contain multiple interior hearths, which suggests they were occupied for many decades. Other houses were built in the same way, but not refurbished or remodeled, and quickly abandoned, which is evidence of short-term occupation. While this difference in habitation duration can be determined, the cultural aspects of these longevity decisions are still poorly understood. The goal for GPR mapping of these structures is to use the features within houses to determine longevity of occupation.



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

Methods and Data Interpretation

An 8x9 meter grid was set up over the buried Hohokam house, and both 400 and 900 MHz reflections profiles were collected with 50 traces per meter and profiles every 20 cm

within a grid (both x and y dimensions). Slice-maps of relative radar wave reflection amplitudes were constructed in a variety of depth-slices (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 river floodplain 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.

The GPR mapping shows the house to contain 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 1). Toward the front is a round hearth, which has raised edges and is placed in the same location as most hearths (Figure 2) 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.

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 2). 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.

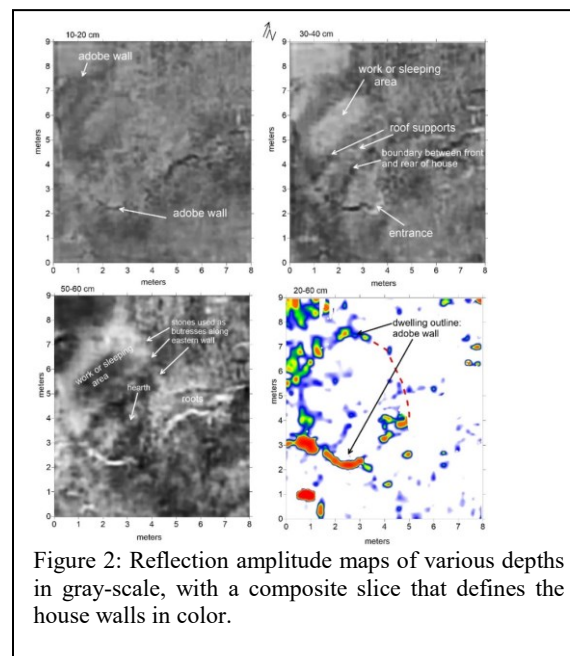


Figure 2: Reflection amplitude maps of various depths in gray-scale, with a composite slice that defines the house walls in color.

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 3). 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.

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.

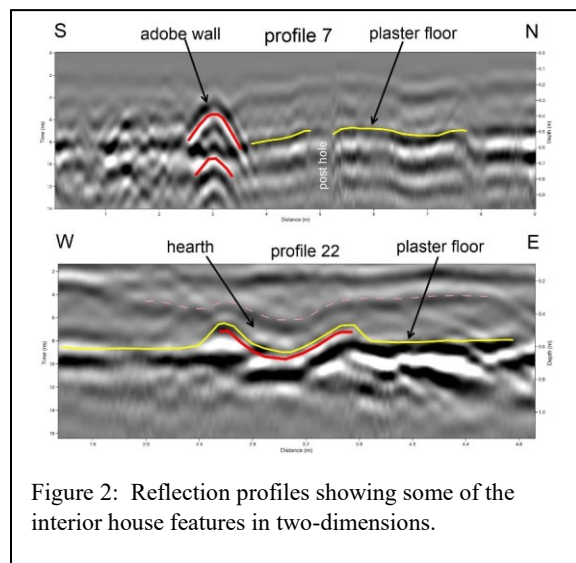


Figure 2: Reflection profiles showing some of the interior house features in two-dimensions.

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 or 900 MHz antennas. 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 these images.

Within 500 meters east and west of the Tanuri Site, 6 other houses of this age have been identified from surface pottery

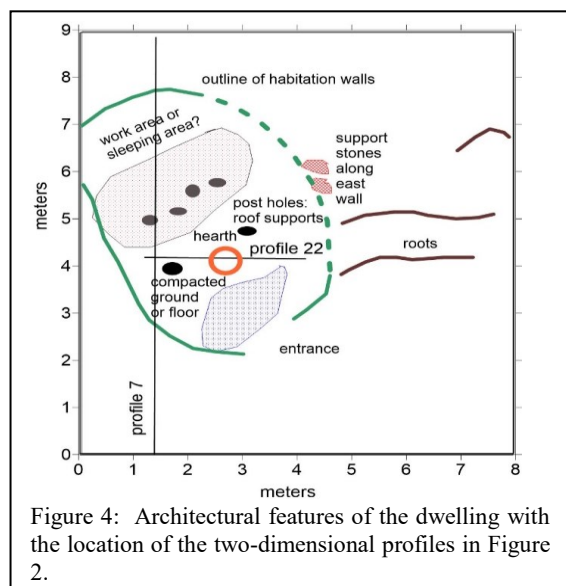


Figure 4: Architectural features of the dwelling with the location of the two-dimensional profiles in Figure 2.

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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