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Assessing the frequency distribution of radiocarbon determinations from the archaeological record of the Late Holocene in western NSW, Australia

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Abstract

When grouped together, radiocarbon determinations from heat-retainer hearths from western New South Wales decrease in frequency with age. One interpretation for this pattern is that it reflects an increase in the frequency of occupation, and perhaps ultimately an increase in Aboriginal populations in this region during the late Holocene. An alternative explanation is that the increase in frequency reflects the differential preservation of the land surfaces on which the hearths are found. According to this explanation, the pre-servation of ancient surfaces itself decreases with time, with the destruction of ancient records of occupation accounting for the relatively recent skew in the age distribution of heat-retainer hearths. We test these hypotheses by comparing the distribution of hearth radiocarbon ages against the distribution of ages obtained from samples associated with buried human remains from western New South Wales. Samples obtained by excavating buried deposits should not be subject to the same range of erosion processes that have affected surface deposits. Therefore the samples from buried deposits are able to act as a control against which the distribution of hearth ages can be evaluated. Results indicate that age estimates obtained from human burials have a distribution different from those obtained from hearths, supporting the conclusion that the decrease in hearth frequency with age is a product of geomorphic preservation rather than cultural change.

Keywords: radiocarbon; hearths; chronology; western New South Wales; human burial

Introduction

The archaeology of the late Holocene in Australia is frequently characterised by, amongst other things, an increase in the number of identified 'sites' (Ross et al. 1992:109), an increase in the number and variety of artefacts found at those sites (Hiscock 1986) and, in western New South Wales (NSW), an increase in the number of heat-retainer hearths (or earth ovens) exposed on the surface (Holdaway et al. 2002). There are two major hypotheses posed to explain these data. On the one hand, the apparent increase in the abundance of artefacts at late Holocene sites may indicate increasing populations (e.g. Beaton 1983), greater occupation spans reflecting in part the existence of more complex social interactions (e.g. Lourandos 1983, 1984, 1985, 1988, 1993), or both — evidence used as part of the argument for a mid to late Holocene intensification in Australia. On the other hand, this pattern may not reflect human behaviour and instead be the result of differential preservation, i.e. more evidence surviving from the recent times compared to the more distant past — the preservation hypothesis (e.g. Bird and Frankel 1993; Fanning et al. 2008; Holdaway et al. 2008)

This issue has proven to be very difficult to resolve, especially in western NSW where the bulk of the archaeological record consists of surface material. Scatters of stone artefacts and associated heat-retainer hearths are visible on the surface because of erosion, the product of overgrazing of domestic stock since the mid to late nineteenth century (Fanning 1994, 1999). It can be very difficult to estimate the age of many of these surface deposits since the same erosion that has exposed them has removed the possibility of determining age through conventional approaches to interpreting archaeological stratigraphy. The challenge for archaeologists is to reliably estimate the age of the surface archaeological record. This will help to determine if the apparent late Holocene increase in the density of the archaeological record results from increases in Aboriginal occupation or whether it is a consequence of the preservation of this record. In this paper, we summarise the results of our investigations of the chronology of a number of locations we have studied in northwestern NSW (Figure 1). We then compare these data with age determinations from burials in southwestern NSW (Figure 2) to help to determine whether intensification or preservation best explains the nature of the late Holocene archaeological record.

Developing a chronology of Aboriginal occupation in western NSW

The two components we have used to develop a chronology for the surface archaeological record in western NSW are radio-carbon determinations from heat-retainer hearths and optically stimulated luminescence (OSL)

Figure 1. Map of western NSW showing locations of the study areas mentioned in the text.

Figure 2. Map of southeastern Australia showing the Lower Darling and Murray Rivers and their major tributaries (from Littleton 2007). Locations where burials forming part of the data illustrated in Figure 4 have been found are indicated.

age estimates from under-lying sediments (Rhodes et al., this volume). The statement that surface deposits lack stratigraphy is correct in an archaeological sense but not true geomorphologically. Over large tracts of western NSW, especially along upland valley floors, erosion has removed much of the surface sediments onto which artefacts were deposited and later buried, leaving the artefacts behind as a lag (Holdaway et al. 2000). The artefacts are today lying unconformably on an older sedimentary unit, the age of which provides the terminus ante quem, or maximum age, for their deposition. Simple application of the laws of superposition says that the artefact deposits cannot be older than the sedimentary unit they are resting on. Individual artefacts in the deposit may be older as they may have been manufactured considerably earlier and used many times prior to discard. Here we are concerned only with the maximum age of the artefact deposit.

In some areas of the world, artefacts themselves provide a method for age estimation since they change their form through time. In Australia, however, attempts at seriation (e.g. Hiscock 1986) have not been successful, and there is currently no means of determining the age of late Holocene assemblages with any precision based on artefact typology alone. In western NSW, the remains of heat-retainer hearths provide a chronology since the hearths frequently contain charcoal that is suitable for radiocarbon determinations. Obtaining age determinations from these hearths does not, however, 'date' the stone artefacts associated with these hearths since there is not necessarily a close relationship between the times at which hearths were constructed and the times when the stone artefacts were deposited. It is not possible to use the age estimates for the hearths to 'bracket' stone artefacts as is sometimes the case with stratified deposits. It is possible, however, to use multiple age estimates from hearths to define patterns in the construction of hearths through time and then to compare the nature of artefact assemblage composition against these patterns (e.g. Holdaway et al. 2005). For example, artefact assemblage composition should be different where occupation was continuous versus situations where the radiocarbon hearth chronology indicates a discontinuous pattern of occupation.

We first applied this strategy for determining the chronology of surface artefact scatters at Stud Creek in Sturt National Park (Figure 1). Here, OSL age estimates on sediments infilling the valley floor suggested that stone artefacts and heat-retainer hearths rested unconformably on a surface with an age no older than about 2000 BP (Fanning and Holdaway 2001). Radiocarbon age determinations on the hearths themselves suggested occupation from 250–1700 cal BP but with a gap of about 300 sidereal years between 910 AD and 1260 AD when no hearths were constructed (Holdaway et al. 2002:357). Significantly, this gap in hearth construction coincides with the Medieval Climatic Anomaly (MCA — Stine 1994), a period of warmer average temperatures and hydroclimatic variability, recognised globally in climate proxy records as extending from as early as 800 AD to as late as 1450 AD (Broeker 2001; De Menocal 2001; Eital et al. 2005; Favier Dubois 2003; Herweijer et al. 2007; Huffman 1996; Jones et al. 2001). This suggested the possibility of an environmental correlate for the period with no hearth construction. However, any cause and effect relationship would need to be based on demonstrating the palaeoenvironmental impact of the MCA in Australia and, as yet, there are no climate proxy records from the Australian mainland that demonstrate an MCA signal.

To test the reliability of the dating strategy established at Stud Creek, we investigated multiple locations on Fowlers Gap Arid Zone Research Station, some 200 km south (Figure 1). Here, we collected samples for OSL dating from exposed sections at each of six sampling locations to provide maximum age estimates for the archaeological surfaces. The results supported those from Stud Creek in one sense, in that radiocarbon determinations from the heat-retainer hearths were all more recent than the OSL age estimates for sediment samples, confirming the applicability of the technique as a means for obtaining the terminus ante quem for surface artefact scatters (Fanning et al. 2008; Rhodes et al. this volume). Additionally, the Fowlers Gap results indicated that surface ages could vary considerably depending on the local geomorphology. For example, at the Fowlers Creek (FC) sampling location, a gravelly terrace surface, OSL age estimates indicated that the sediments within about 32 cm of the surface were deposited at least 4340 years ago and perhaps up to 10,920 years ago. In contrast, OSL determinations from an active proximal floodout environment at the Sandy Creek (SC) sampling location were much younger, ranging from modern at the surface to around 4000 years old at 62 cm depth. At a third location (Nundooka — ND), marginal to a bedrock channel, sediments at 52 cm below the modern surface were deposited around 3730 years ago.

When these age estimates were compared with the results of radiocarbon determinations from the heat-retainer hearths, a similar result to Stud Creek was demonstrated, i.e. there is a close relationship between the age of the landform and the age distribution of the heat-retainer hearths. At Fowlers Gap the oldest hearths (around 6000 cal BP) were found at the FC sampling location that also returned the oldest OSL determination. On surfaces associated with more active geomorphic environments, like the SC and ND sampling locations, hearths were much younger (Holdaway et al. 2005).

These results provide a set of answers to the question posed above. At least in the locations we have studied at Fowlers Gap, there is good evidence that the age of the surface and the age of the record that is visible upon it are correlated, i.e. longer duration archaeological records are found on older landforms. Moreover, relatively ancient records are rare, surviving only where landforms are stable and where the erosion that has exposed the record has not also destroyed it, for example at FC. The geomorphically more active floodplain environments like those at SC and ND are more common at Fowlers Gap than terraces like that at FC, thus, younger archaeological deposits dominate the record. Therefore, at least at Fowlers Gap, the evidence suggests that the prevalence of the archaeological record in contexts dating to the last 2000 years is a function not of people but rather of the geomorphic history of land surfaces that preserve this record ¹.

This inference is reinforced when the heat-retainer hearth age estimates from elsewhere in north western NSW are examined (Holdaway et al. 2005). This record does not illustrate continuous occupation during the last 2000 years, but instead shows episodes of hearth construction and use, interspersed with gaps in the record. Our ninety-six radiocarbon determinations from four widely spaced locations

Figure 3. Calibrated radiocarbon determinations from excavated hearths in western NSW (Holdaway et al. 2005: Figure 9). A gap is indicated in hearth construction coincident with the MCA. Calibrated ages were determined using Datelab 2.0 software (Jones and Nicholls 2002) accessing INTCAL98 calibration curve data (Stuiver et al. 1998).

(Stud Creek, Fowlers Gap, Pine Point/Langwell, and Peery Lake; Figure 3) demonstrate a consistent pattern, with a gap in the record that may be coincident with the MCA (although none of the additional sampling locations provided as clear a pattern as that developed for Stud Creek). As indicated in the discussion of the Stud Creek results above, environmental correlates may help to explain the distribution (Holdaway et al. 2002). However, other causes are possible, not the least of which is variation in the production of ^{14}C in the past, as evidenced by variations in the radiocarbon calibration curve. In the rest of this paper, we consider two sets of evidence that may enable us to better understand the distribution of hearth age estimates from western NSW and also help to resolve the intensification versus preservation debate.

Testing the model using dates from burials

The argument derived from the Fowlers Gap results is that hearth preservation and, by extension, the preservation of other parts of the archaeological record, are a function of the geomorphic environment. Hearths that were once buried structures are visible today because of erosion. However, erosion also occurred in the past, to both a greater and a lesser degree, leading to the differential destruction of hearths in different parts of the landscape (Fanning 2002). If this argument is correct then the patterned distribution of hearth ages through time should reflect the preservation conditions largely controlled by geomorphic processes. Equally, archaeological records where the preservation conditions are different should show a different distribution of ages.

As previously noted the bulk of the archaeological record in western NSW consists of surface artefact scatters and associated heat-retainer hearths. However, other evidence for Aboriginal occupation is preserved in quite different contexts. Human burials have survived from the past because of interment underground, thus reducing the impact of surface erosion. This should, in theory, lead to a different record of preservation, one that paints a picture closer to the true regional chronology of human occupation rather than one more closely related to local geomorphic history.

Littleton (2007) has compiled the results of radiocarbon determinations from human burials from a variety of locations in the lower Darling-Murray region to the south of our study area (Figure 2). With one exception, all the ages are directly from bone and the majority of the determinations come from excavation samples. These are generally locations with multiple burials, although included in the sample are a number of single radiocarbon determinations from burials exposed through erosion.

In Figure 4, we compare the probability distribution of the fifty burial age determinations compiled by Littleton (2007) with that for the ninety-six hearth age determinations (Holdaway et al. 2005). While the distribution of human burial age estimates spans the length of the Holocene, the age distribution for hearths is skewed to younger ages, with a large number of determinations clustering within the last two thousand years. Age estimates older than about 6000 BP form smoother peaks in both graphs, a pattern that reflects the relatively larger error terms associated with older age estimates.

What might be accounting for the differences in the two age distributions? Before discussing the most likely reasons, there are two relatively minor differences in the two data sets that need to be considered. First, the hearth determinations are from charcoal samples while the human burials, in the main, are determined from bone apatite samples. The possible effects of this difference in the composition of the two types of samples on the age distributions are unknown. Second, there are half the number of determinations from burials than from hearths (fifty cf. ninety-six). However, samples of this size are large enough to successfully search for long-term patterns.

Notwithstanding these small differences in the two data sets, the resulting probability plots are fundamentally different in shape. Whereas the plot based on burial data shows a variable, but continuous distribution through time, the plot for the hearths diminishes to zero after 2000 radiocarbon years BP, with only small peaks present at earlier times. As argued above, this most likely is a reflection of the low probability of ancient surface preservation. More recently formed surfaces, and therefore a larger number of younger hearths, are more likely to be preserved. In contrast, the act of burial has preserved human

Figure 4. Probability plot for radiocarbon determinations obtained from human burials (upper) and hearths (lower) from western NSW. Probability is calculated per 50 radiocarbon years.

remains that date from a greater range of past time periods. Thus, there is a more even distribution of the human burial dates throughout the Holocene.

Based on this comparison, we suggest that the accumulative hearth record in northwestern NSW, and, by association, the accumulated record of stone artefacts, increases during the last 2000 years because of geomorphic surface preservation rather than greater numbers of Aboriginal people and/or increases in occupation span.

Gaps in the occupation record

Comparison of the ninety-six hearth age estimates from locations across northwestern NSW (Figure 3) suggests that the times when no hearths were constructed may be regional in extent (Holdaway et al. 2005). It is possible, however, that the gaps we detected in the hearth age distributions illustrated in Figure 3 are in some cases an 'artefact' of plateaus in the calibration curve. The burial data discussed above provide a means to assess this, by providing a comparative data set from which to determine whether a similar gap in the age distribution of human burials exists. Box plots of radiocarbon determinations, generated using the Oxcal software, from hearths and from human burials that span the last 2000 years (Figure 5) allow an assessment of the effect of the radiocarbon calibration curve itself on the distribution of calibrated radiocarbon age estimates.

The influence of plateaus on the distribution of calibrated ages is most apparent for the last 600 years where the calibration curve has steep sections bounded by plateaus. To some degree, the distributions of the hearths and burial age determinations permit a test of whether the plateaus in the calibration curve are responsible for the apparent gaps in the radiocarbon record before 600 BP. For the hearth data, for instance, there is a gap in the distribution of ages beginning around 900 years ago (Figure 5a). Evidence for the existence of such a gap is less apparent, however, in the plot for

human burials (Figure 5b). At face value, this suggests that while construction of heat-retainer hearths appears to have temporarily ceased in northwestern NSW, people continued to bury their dead during this period further to the south along the lower Darling and Murray Rivers.

The overall lack of precision of the radiocarbon determinations together with the spread of ages from burials over a long time period restricts the types of explanations that can account for the difference between the two plots. Nevertheless, the results obtained from both data sets suggest a method for assessing the reality or otherwise of gaps in the record. If the gaps are an artefact of plateaus in the calibration curve they should be present in both data sets. If they are absent, then behavioural and/or environmental explanations may be called for to explain why no age determinations are forthcoming for particular periods.

An important next step would be to conduct a dating program of hearths located close to some of the human burial

sites to see whether there is any difference in the age distributions of hearths and human burials when differences in geography are not a factor. We are also about to date a large number of heat-retainer hearths from the vicinity of Peery Lake, near White Cliffs (Figure 1), where the presence of local floods, overflows from the Paroo River, and artesian mound springs are likely to have guaranteed water supplies in the past. Differences in the distribution of hearth ages through time between environmentally distinct areas may help isolate regional differences in hearth construction and lead to more informed interpretations of the presence of gaps in the distribution of hearth and burial ages.

Conclusions

Based on the comparison of heat-retainer hearths from the locations we have studied in northwestern NSW (Holdaway et al. 2005) and burials from the Lower Murray-Darling region in southwestern NSW (Littleton 2007), buried contexts preserve a more complete record of human occupation than material preserved in surface contexts. Therefore, the apparent relative increase in the frequency of archaeological

Figure 5. Box plot of radiocarbon determinations from hearths (upper) and human burials (lower) from western NSW. The arrow indicates the time period of the Medieval Climatic Anomaly (MCA). (Atmospheric data from Stuiver et al. 1998; OxCal 3.5 [Bronk Ramsey 1995]).

materials during the last two millennia is likely to reflect the preservation of the record rather than an increase in either population size or occupation time. The record that is available for study today reflects the landscape history, particularly the time periods since surfaces were last heavily eroded. Thus, in the majority of surface contexts, there is no correlation between spatial proximity and time: surfaces that differ in age by many thousands of years can exist side by side and accumulate distinct archaeological records.

This has considerable implications for the way archaeologists generate inferences about the past. The results of archaeological survey, for instance, do not translate easily into either settlement patterns or settlement strategies. Although different site types may appear to relate to different environmental or resource zones, our evidence indicates that these differences may simply reflect changes in landscape preservation. In other words, what may appear at first to reflect locations where people undertook different activities related to such things as seasonal variation in resource availability might in fact represent differences in the age of deposits.

The age estimates from hearths (Figure 3) indicate periods when very few hearths were constructed across the northwestern NSW region we have studied. Similar gaps are not apparent in the record of human burials, perhaps reflecting geographical differences in resource availability as well as preservation of the archaeological record. Differences in the radiocarbon ages derived from charcoal from hearths and apatite from burials may be important but are unlikely to be significant. Alternatively, the hearth and burial age estimates may reflect differences in the human reactions to environmental change that affected the creation of one record but not the other. Differentiating among these potential causes will require more research, particularly the investigation of burials and hearths from the same location.

Note

¹ It should also be noted that landscapes at Fowlers Gap, and in much of the Barrier Ranges north of Broken Hill (Figure 1), are dominated by much older surfaces than these (see, for example, Gibson 1997; Hill 2004), but there is little evidence of prolonged Aboriginal occupation of areas that were distant from water sources, save for deposits of flakes and cores at rock outcrops that were utilized as raw material sources (Doelman et al. 2001; Holdaway et al. 2008).

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