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Change or Decay? An interpretation of late Holocene archaeological evidence from the Hamersley Plateau, Western Australia

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Abstract

Data collected from the Hamersley Plateau over the last four decades are examined for patterns in the archaeological record. Data relating to the timing of the archaeological appearance of backed artefacts, seed-grinding technology and rock art are currently too few to indicate major cultural changes with certainty. Increases in numbers of radiocarbon dates from archaeological sites on the Hamersley Plateau are evident in the late Holocene. This can be interpreted as a pattern of cultural change or natural decay in datable material. I conclude that taphonomic bias is the most important variable in the distribution of the radiocarbon date sample from the Hamersley Plateau. That said, further accumulation of dates and data may show archaeological changes in the Hamersley Plateau that represent local expressions of broader trends in the Australian semi-arid and arid zones.

Studies of regional archaeology in Australia often describe a late Holocene (i.e. after 4000 BP) phenomenon of increases in the diversity and quantity of archaeological evidence (e.g. David and Chant 1995, Flood *et al.* 1987, Lourandos 1983, Morwood 1987). Despite the abundance of archaeological resources in the Hamersley Plateau, it is one of the few regions of the Australian continent that has been excluded from discussions of late Holocene change (Figure 1). This is mostly because data from the area are hidden in a grey literature of consultant reports that has accumulated over the last four decades. This aim of this paper is to evaluate the implications of evidence on the dating of backed artefacts, seed grinding technology, rock art and fluctuations in occupation intensity on the Hamersley Plateau.

The dating of backed artefacts and adzes

Backed artefacts and adzes have long been a focus of debates about cultural and technological change in Australian archaeology (Bowdler 1981; Bowdler and O'Connor 1991; Hiscock 2001; 2002; Hiscock and Attenbrow 1998; 2004; Layton 1996). The first evidence of these new types on the Hamersley Plateau is a backed stone artefact with resin on the backed section at Newman Rockshelter. The artefact is associated with a date of 3740±100 BP (Brown 1987:27). Other specimens at this site include five backed artefacts and one adze all deposited after 3700 BP (Brown 1987:29). Backed artefacts first appear at Marillana A at 3000 BP and at 1700–1100 BP at Cleft Rock Shelter (Marwick 2002). A single backed geometric microlith occurs at Site P5313 immediately below a 2400 BP date (Brown 1987:43). At RR3–O there are two adzes representing the new Holocene types in association with a 310±50 BP (Wk 8364) date, suggesting that the new types were continuously present in the Hamersley Plateau until the very late Holocene (Harris 2000:17-25; cf. Hiscock and Veth 1991).

Hiscock (1993, 2001) and James and Davidson (1994) have suggested that a coincidence between the appearance of backed artefacts and increases in artefact discard may represent a sample size effect rather than an important cultural change. This is true here with increases in discard rates of cultural material coinciding with the first appearance of backed artefacts at 3000 BP at Marillana A and 1700–1100 BP at Cleft Rock Shelter (Marwick 2002). Table 1 shows that the strength of correlation between numbers of backed artefacts and excavation unit assemblage size is very low at the five Hamersley Plateau sites with backed artefacts. However, the number of backed artefacts is very small and none of the correlations are significant at the $p(H_0) = 0.05$ level, so sample size effects on the presence of rare items cannot be ruled out.

The dating of rock art

Like backed artefacts, increases rock art production are often considered to represent important cultural changes. At Skew Valley on the Burrup Peninsula five buried engraved panels were recovered by Lorblanchet (1983) from a stratified midden deposit associated with charcoal dated to 3770±80 BP (ANU 1837), 3410±80 BP (ANU 1839) and 2770±70 BP (ANU 1838). Dragovich (2000) attempted direct radiocarbon dating of rock engravings on the Dampier Archipelago using organic components in the varnish overlaying engravings. The five dates obtained were all less than 2800 BP although the varnish that was stratigraphically lowest in the sample was the youngest while the top layers returned older dates (Dragovich 2000). The date of 2800 BP suggests a date after which the engravings were produced,

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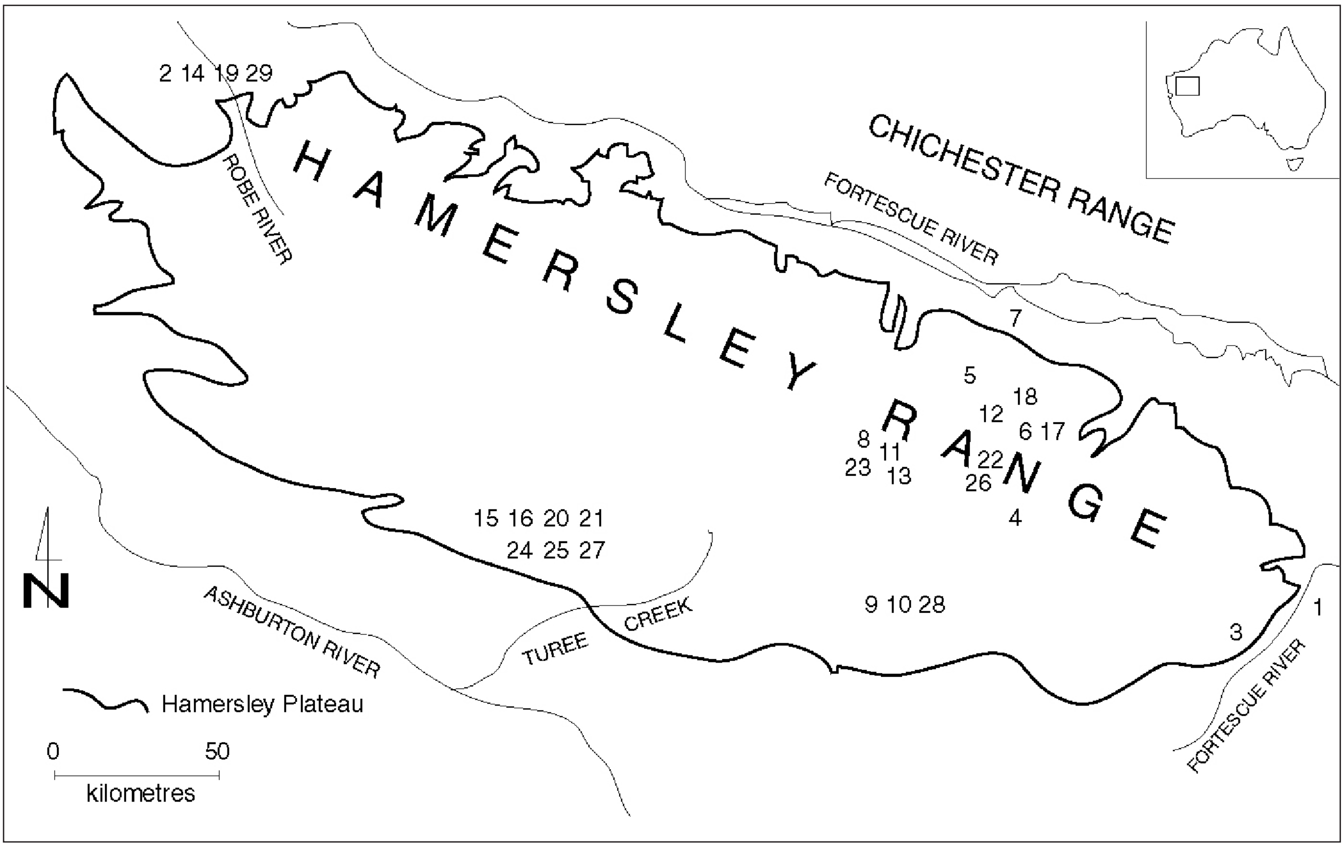

Figure 1. Hamersley Plateau showing sites mentioned in the text.
The numbers indicate the approximate location of sites listed in Table 1.

Site	r	Total number of backed artefacts, etc.	Total number of artefacts	Reference
Marillana A	0.324	2^	1227	Marwick 2002:84-135
Cleft Rock Shelter	0.219	2^	569	Marwick 2002:151-179
Mesa J J23	0.229	1*	293	Hughes and Quartermaine 1992:85
Newman Rockshelter	0.030	2^	266	Brown 1987:27-9
RR3-O	0.061	2*	168	Harris 2000:25
RR3-P	0.392	2^	156	Harris 2000:26
RR8-P	0.004	1*	152	Harris 2000:54
P4627	-0.262	1^	63	Brown 1987:44
P5313	-0.093	1*	30	Brown 1987:43

r = Pearson's product moment correlation coefficient, bold type indicates $p(H_0) < 0.05$
* = adze or geometric microlith
^ = backed artefact

Table 1. Summary of correlations between backed artefacts and stone artefact assemblage size at excavated Hamersley Plateau sites.

although ambiguities in the varnish stratigraphy formation and weathering processes limit the validity of these dates. This small and highly ambiguous sample of dates are currently the only absolute dates for rock art in the Hamersley Plateau. These data simply suggest that rock art was produced in the late Holocene and do not permit any conclusions about the first appearance of rock art or increases in its production.

The dating of seed-grinding technology

Ethnohistoric and ethnographic information from arid and semi-arid Australia suggest that seed-grinding technology may be related to gender-specific subsistence roles, large ritual gatherings and maintenance of social networks (Clarke and Smith 1982:13; Clement 1903:9-11; David 2002:276-8; Withnell 1901: 7-9, 16, 23;). Dates of 1700-1100 BP for mortar fragments from Cleft Rock Shelter and before 1600 BP from P4507 provide the first evidence of dated grinding stones in the Hamersley Plateau, which are more commonly found in undated surface assemblages (Kee and Quatermaine 1986; Marwick 2002; cf. Veth *et al.* 2001). These dates for grinding implements at P4507 may not be representative of the true date because of the strong correlation between grinding material and excavation unit assemblage size (r = 0.971, number of grinding pieces = 92, total number of artefacts in excavated assemblage = 172, Kee and Quatermaine 1986). The correlation at Cleft Rock Shelter is lower with r = 0.229 (n = 4, total number of artefacts in excavated assemblage = 569, Marwick 2002). It is noteworthy that the dates of grinding technology are relatively late on the Hamersley Plateau, compared to central Australia where it appears at around 3500 BP (Smith 1986; 1989:99). However, the very small sample of sites with evidence of grinding technology on the Hamersley Plateau limits the confidence that can be placed in any conclusions about the timing and consequences of region-wide technological changes.

The distribution of radiocarbon dates

Arguments have been made in Australia and internationally for obtaining a general pattern of the timing and intensity of the occupation of sites in a region from analysis of distributions of radiocarbon dates (e.g. Bird and Frankel 1991; David and Lourandos 1999; Gamble *et al.* 2005; Holdaway *et al.* 2002; Shennan and Edinborough 2007; Smith and Sharp 1993; Ulm 2006; Ulm and Hall 1996). These arguments are based on the assumption that, all things being equal, as the amount of human activity increases, so does the volume of datable material in the places they inhabit (Rick 1987). However, large numbers of dates are required to convincingly demonstrate patterns. Shennan and Edinborough's (2007) sample of 2311 dates is a typical example. Australian samples generally have much fewer dates, for example Ulm (2006) uses 96 and Lourandos and David (1999) use 165. The late Holocene components of both of these datasets show dramatic increases in the last 1000 years and are interpreted to indicate major reordering of land-use patterns. These authors argue that that a deliberate search for very old sites has biased their date samples in favour of older deposits, cancelling out or at least diminishing preservation biases that favour the representation of younger dates in the sample (Lourandos and David 1999; Ulm 2006). Archaeologists seeking dates from Hamersley Plateau excavations have little choice in selecting datable material; the small quantities of datable material constrain sampling significantly (Harris 2000:18; Hook *et al.* 2000:94; Hughes and Quartermaine 1992:77; Veitch and Di Lello 2000:40). This suggests that there is no argument for a bias countervailing against preservation.

Following Surovell and Brantingham (2007), a simple model can be employed to investigate the influence of preservation, especially natural decay of organic materials, on the Hamersley Plateau radiocarbon date distributions. If we assume that human behaviours relating to discard of datable remains constant over time, then the change in the amount of the datable materials over time can be described by the equation

$$n = Ke^{-\lambda t} + c$$

where n indicates the amount of datable material, K is the amount at the time the material is first exposed to taphonomic processes, λ is a decay constant, t is the period of time that taphonomic processes have been operating on the material and c represents other functions operating on the amount of datable material (such as demographic changes, changes in site use, etc.). This generic model of exponential decay is chosen because it accurately represents change in quantities over time for many physical phenomena (Leike 2002). By taking logarithms of the exponential decay pattern the behaviour of the data can be easily explored with linear models. The goodness of fit between this equation and the actual distribution of dates will then indicate the importance of preservation bias in shaping the distribution of radiocarbon dates.

In Figure 2 the 65 dates from Table 2 are plotted with arbitrary 500-year sliding intervals measured every 150 years. The 150-year interval approximates the average standard error of 148 years for the sub-sample of oldest or basal dates and 125 years for the total sample (cf. Rick 1987:61). The sliding interval smooths out short-term variations while preserving trends in the raw data but does not account for variations in the standard errors of individual samples. The shape of the distribution of dates resembles the generic model of taphonomic decay in Figure 3. To evaluate the goodness of fit of the model of taphonomic decay, the radiocarbon dates are grouped into 19 bins to remove the rank-order effect. A linear regression is then calculated with the logs of the midpoints of the radiocarbon age intervals of the bins as the dependant variable and the number of dates in each bin as the independent variable. The distribution of the log(midpoint bin interval) data is nearly linear and can be described by the function (Figure 4)

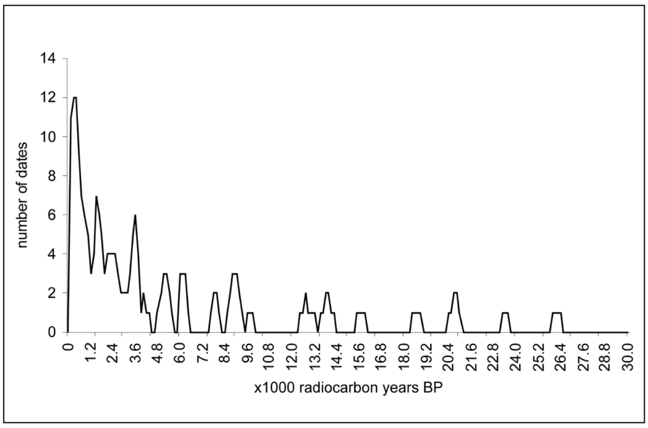

Figure 2. Chronological distribution of all radiocarbon dates (n=65) available from archaeological rockshelter sites in the Hamersley Plateau.

$$\log(\text{midpoint bin interval}) = -0.137\ (\text{number of dates}) + 4.217$$

This function describes 78.5% of the variation in the sample ($F = 62.01$, $p(H_0) < 0.000$). The small sample of dates and the complex nature of radiocarbon age estimation means that it is difficult to be sure that the assumptions of linear regression have not been violated (independence of

Map key	Site	Basal or oldest date			Other dates		Ref.
1	Newman Rockshelter	26,300±500	6,270±210	3,740±100			1
		13,852±72	9,004±51	8,862±51	5,109 ± 43	6,254 ± 43	13
		3,487±40	1,388±37				13
2	Mesa J J24	23,500±350	3,950±110	1,400±60			2
3	Newman Orebody XXIX	20,740±345	9,870±80	5,260±110	3,010±85		1
4	Malea Rockshelter	20,950±330	15,670±240	2,900±90	300±50		3
5	Milly's Cave	18,750±460	14,150±320	719±57			12
6	Marillana A	13,100±89	9,200±200	3,630±70			12
7	Cleft Rock Shelter	12,730±271	7,900±70	3,610±70	1,700±100	1,120±70	12
8	P5315	8,090±80	2,440±60				1
9	RR8	4,290±60	850±50				4
9	P0959	6,311±47	5,425±45				13
10	RR8P	3,520±60					4
11	P4627	2,640±130	260±60				1
12	Whaleback	2,490					5
13	P5316	2,330±50					1
14	Mesa J J23	2,230±160	650±190	240±80			2
15	ERP04	2,000±50					6
16	ERP26	1,840±50					6
17	Marillana B	1,791±80					12
18	Wallaby Rock Shelter	1,730±110					7
19	P4507	1,600±300					8
20	CME-A-18	1,000±60	390±50				9
21	ERP15	950±50					6
22	P07794(1)	810±80					10
23	P4623	770±50	130±50				1
24	ERP22	560±50					6
25	BM99-10	540±50	470±50				11
26	P07794(2))	380±80					10
27	ERP11b	370±50	350±50				6
28	RR3-O	310±50					4
29	P4506	120±150					2

References: 1. Brown 1987; 2. Hughes and Quartermaine 1992; 3. McDonald Hales and Associates 1997, Edwards and Murphy 2003; 4. Harris 2000; 5. Strawbridge pers. comm.; 6. Hook *et al.* 1998; 7. Strawbridge 1992; 8. Kee and Quartermaine 1986; 9. Veitch pers. comm.; 10. Hook *et al.* 2000; 11. Veitch and Di Lello 2000; 12. Marwick 2002; 13. Comtesse 2003.

Table 2. Radiocarbon dates from archaeological sites used for Figure 2. Inversions and dubious archaeological associations excluded. All dates are uncalibrated conventional radiocarbon ages with one standard deviation (except for Whaleback Rock Shelter where the data are not available).

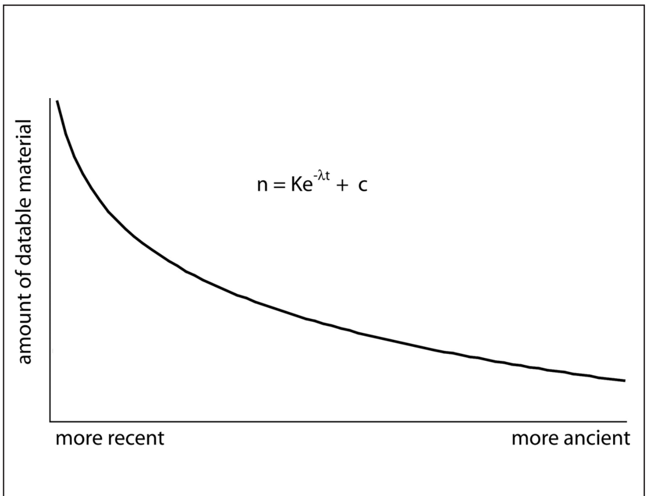

Figure 3. Model of the effect of taphonomic decay on the availability of datable materials in archaeological contexts.

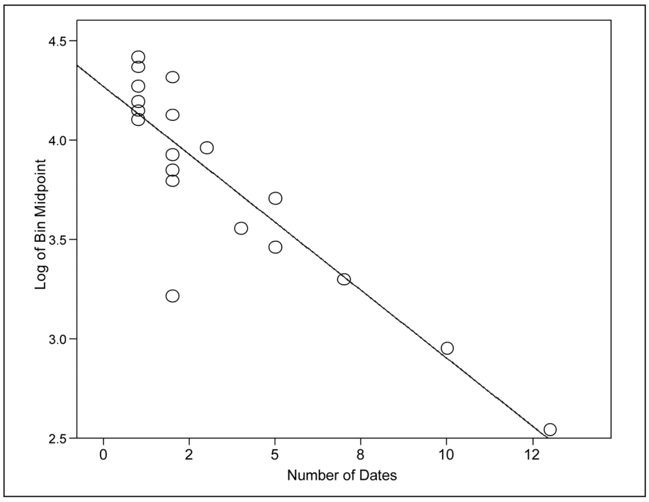

Figure 4. Linear regression fitted to binned radiocarbon dates.

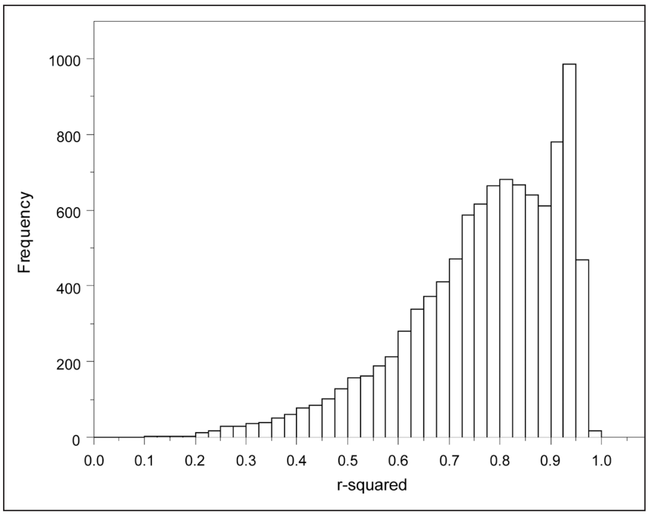

Figure 5. Result of bootstrapping r^2 regression statistic for cross-validation of the strength of the relationship between the log (date) sample and their rank order.

values, independence of errors and homogeneity of variance). In a situation like this, cross-validation of the regression model can be undertaking by bootstrapping the r^2 regression statistic (Chernick 1999; Efron and Tibshirani 1993). Resampling from the original sample of radiocarbon dates 10,000 times gives a 90% bootstrap confidence interval of 0.462 – 0.949 for the r^2 regression statistic and a mean of 0.766, supporting the accuracy of the initial value (Figure 5). These results suggest that a model of taphonomic decay is appropriate and that this model explains more than three-quarters of the variation observed in the distribution of radiocarbon dates from the Hamersley Plateau.

Although relatively little variation in the radiocarbon date distribution remains unexplained by taphonomic bias, a general linear model was employed to further assess the role of factors other than taphonomic decay (i.e. the functions represented by *c* above) operating on the amount of datable material. This model tests the hypothesis that peaks in the distribution of dates reflect culturally significant changes such as demographic expansions or changes in settlement patterns that were related to the first archaeological appearance of backed artefacts, rock art and grinding technology on the Hamersley Plateau. Similar arguments have been made elsewhere in Australia for late Holocene correlations between settlement patterns and social and technological change (e.g. David and Lourandos 1999). For this model, a categorical factor was introduced corresponding to the bin intervals closest to the dates when rock art, backed artefacts and grinding technology first appeared on the Hamersley Plateau. A negative binomial model was found to be the best fit and the model showed no significant effects of the cultural (i.e. non-taphonomic) variable on the distribution of radiocarbon dates ($t = -0.66$, $p(H_0) = 0.508$). The implication here is that the distribution of radiocarbon dates from archaeological sites in the Hamersley Plateau does not reveal culturally significant archaeological changes.

Discussion

The data presented here for the Hamersley Plateau are currently too weak to convincingly engage with relevant themes from neighbouring regions. These themes include the effect of increased climate variability, more open vegetation and decreased rainfall after about 3500 BP (Schulmeister and Lees 1995), links between rock art and the manifestation of group identities (Davidson 1997) and territorial structures similar to ethnographically observed socio-linguistic units (Taçon 1993), the possible adoption of Western Desert section systems, especially after 1600 BP according to linguistic methods (McConvell 1985, 1996, 1997), the westward spread of circumcision rituals (Dench 2001; Gibbs and Veth 2003) and the likelihood that the timing and character of archaeological changes on the Hamersley Plateau cultural are similar to changes throughout the Australian arid zone (Smith 1988; Veth 1993). Only after considerably more data are available can these problems be meaningfully addressed.

The analysis of radiocarbon dates presented here has implications beyond the Hamersley Plateau. Many regions in Australia have similarly shaped distributions of radiocarbon dates from relatively small (n <1000) samples. In the case of the Hamersley Plateau the shape of the distribution is best explained by taphonomic bias that removes datable material from the archaeological record according to a simple exponential function. This taphonomic effect on radiocarbon date distributions has been observed in a wide variety of archaeological and non-archaeological contexts (Surovell and Brantingham 2007). Given this generality of taphonomic bias in radiocarbon date distributions it is likely that it is an important but neglected variable in considerations of distributions of archaeological radiocarbon dates throughout Australia, especially in the late Holocene when the effect is pronounced. The informal and suggestive nature of many interpretations of radiocarbon date distributions in Australian archaeology mean that taphonomic bias cannot be eliminated and demographic conclusions remain unconvincing. It is certainly possible that monotonic increases in radiocarbon dates do correspond with exponential increases in human activity and population rather than taphonomic bias, but this relationship needs to be demonstrated using multiple proxies from many sites; a burden of proof that few regions can satisfy (cf. Dortch and Smith 2001). The need for more rigorous and formal treatment of radiocarbon date distributions echoes Hiscock and Faulkner's (2006) recent concern about uncritical invocations of Aboriginal ethnography to infer mechanisms of archaeological change.

Conclusion

This description of the available data on the dating of new lithic technologies, rock art and possible demographic or settlement system changes has been necessarily limited. The data are few and do not support grand conclusions about regional changes in technology and culture. The timing of the first appearances of backed artefacts, rock art and grinding technology are in general agreement with continental trends, but in this specific case the timing of their appearance is probably most parsimoniously explained by sample size effects. Similarly, the most important factor in the distribution of radiocarbon dates appears to be taphonomic bias. Rather than being indecisive, these conclusions reflect the limits of inference and data. These limitations are also likely to apply to late Holocene archaeological data from other regions of Australia.

Nearly all current work on Hamersley Plateau archaeology is conducted by consultant archaeologists and in recent years, with the increased international demand for iron ore, the intensity of archaeological activity has considerably increased. However, the majority of consultant archaeological projects involve only survey and recording of surface sites that provide little relevant additional information to important questions relating to change over time (Marwick 2004). Although recording surface features might be adequate for the requirements of the relevant legislation, more substantial scientific contributions are likely if the priorities and policies of cultural resource management on the Hamersley Plateau are broadened to include chronological questions. Doing so is likely to result in the increased accumulation of archaeological data and opportunities to robustly test the suitability of regional themes as explanations of archaeological record.

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