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Journal

Australian Archaeology, 53(1)

ISSN

0312-2417 2470-0363

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Publication Date

2016-03-17

DOI

10.1080/03122417.2001.11681724

Peer reviewed

Australian Archaeology

ISSN: 0312-2417 (Print) 2470-0363 (Online) Journal homepage: www.tandfonline.com/journals/raaa20

New Abox Ams-^{14}C Ages Remove Dating Anomalies At Puritjarra Rock Shelter

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To cite this article: M.A. Smith, M.I. Bird, C.S.M. Turney, L.K. Fifield, G.M. Santos, P.A. Hausladen & M. L. di Tada (2001) New Abox Ams-^{14}C Ages Remove Dating Anomalies At Puritjarra Rock Shelter, Australian Archaeology, 53:1, 45-47, DOI: 10.1080/03122417.2001.11681724

To link to this article: https://doi.org/10.1080/03122417.2001.11681724

more generally to gain an appreciation of what information is in existence, its location and how to obtain it.

The creation of the Bowen Basin Collection originated as a response to this. Information within the collection largely (but not solely) derives from material amassed throughout the nearly seven year course of the Bowen Basin Project. As the Collection took shape, major gaps in the information held and the incomplete nature of others were identified. Where possible and practical we have sought to address these gaps. More recently significant portions of the information held have derived from the private collections of individuals and families (Aboriginal and European) from throughout the region. While much of the information within the Collection comes from archives, libraries and the like, it also contains a great array and volume of primary information collected as part of the Bowen Basin Project.

All information that forms the Collection has been systematically organised, in some instances collated/synthesised and turned into relational databases (Table 1) and is held in a single place within the region for access and use by a range of researchers. Protocols and procedures governing access to and use of the collection are in the final stages of development and implementation.

Listings of information and databases held within the collection are available on the web site in four main categories: Archival Information; Cultural Heritage Databases; Oral History Tapes and the Photographic Collection. These listings are primarily provided to alert people to the range of information held within the region that is available for review and research and to provide 'metadata' regarding the creation, structure, contents, and access status of various elements of the collection.

Project Research Areas, Progress Snapshots and Papers and Publications

These areas of the web site provide snapshots of the variety of research areas pursued within Stage 2 of the Bowen Basin Project that have underpinned many of the above specific developments. This includes aspects of the Project's fieldwork program, training and capacity-building aspects of the Project, and student research projects that have been undertaken. Details on a number of specific sub-projects such as community-based land management and GIS workshops, Gangulu traditional associations with the Dawson and Callide valleys and virtual cultural tourism as a cultural heritage management strategy are also provided on these pages.

Also available for review are summaries of the various publications and papers that have derived from the Bowen Basin Project. This includes unpublished conference and workshop papers and in the case of the Project's GIS and movement to web-based mapping applications, project discussion papers as further background to these areas of the web site. Where appropriate, full versions of these have also been provided for further inspection or download.

Where ?

The Bowen Basin web site can be found at www.bowenbasin.com

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NEW ABOX AMS-^{14}C AGES REMOVE DATING ANOMALIES AT PURITJARRA ROCK SHELTER

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A robust site chronology generally requires a large series of age determinations, preferably using a range of dating methods and with sufficient dated samples to allow internal corroboration of the age of individual layers. One of the handful of Australian archaeological sites to meet these criteria is Puritjarra rock shelter in central Australia. The chronology for this site rests on a published series of 31 radiocarbon assays on charcoal and nine luminescence dates on sediments (Smith et al 1997) together with ten radiocarbon dates that have become available subsequently.

The history of research at this site highlights the potential weakness of site chronologies that rely on only a handful of radiocarbon determinations to establish the age of late Pleistocene units. Extensive work on the chronology of Puritjarra since the preliminary reports (Smith 1987, 1989) has shown that levels initially dated to 22,000 BP are in fact much older: ~27,000-32,000 BP (^{14}C) or 35,000 years ago (TL). By the early 1990s the age-depth relationship at this site was better understood and the overall trend of the radiocarbon series was

				Radiocarbon age (yrs BP)	
Sample	Laboratory code	Predicted age BP (from age-depth curve)	Combustion fraction	ABOX-SC method	Conventional ABA-BC method
N11/5-1	ANUA 12304	**1500**	880°C	**715±180**	ANU 6541 **98.6±0.9% modern**
M10/20-4	ANUA 12307	**10,100**	880°C	**10,110±250**	ANU 6538 **9110±120**
N13/20	ANUA 10010	**18,200**	880°C	**20,110±250**	ANU 6918 **17,980±160**
M10/27	ANUA 10009	**30,400**	650°C	**28,540±350**	ANU 6919 **20,360±220**
	ANUA 10013		880°C	**31,140±470**	
	ANUA 11714		340°C	**29,080±460**	
	ANUA 11715		650°C	**29,940±460**	

Table 1 AMS-14C ages on charcoal samples from Puritjarra rock shelter, using acid-base-wet oxidation pre-treatment with stepped combustion (ABOX-SC) to remove contaminants. For M10/27 a second sample was dated using ABOX-SC pretreatment but this produced only 340 oC and 650oC fractions. In general, the 880oC fraction is believed to yield the more reliable age.

clear (Smith 1996). Although this chronology has proved relatively robust when tested against further dating, there remain a number of problems including several age reversals and a poor age-depth trend below 65cm (~20 ka). The most pressing issue however, has been to explain why radiocarbon ages for the basal part of the late Pleistocene cultural horizon vary by as much as 10,000 years. The 1997 study suggested this was due to younger contaminants in the radiocarbon samples rather than vertical displacement of charcoal through the stratigraphic profile, but at that time we were unable to effectively isolate or remove the contaminants. In this paper we report the use of a newly developed pre-treatment method which more effectively removes contamination from charcoal samples than conventional methods. The ages obtained using this method remove several radiocarbon anomalies noted in the 1997 study and show that the age of one previously dated sample (ANU-6919) was under-estimated by ~10 ka (Table 1).

The original radiocarbon chronology relied on liquid scintillation ^{14}C and AMS analysis of charcoal samples prepared using the conventional acid-base-acid pre-treatment followed by bulk combustion of samples (ABA-BC). The new method utilises an acid-base-wet oxidation pre-treatment followed by stepped combustion (ABOX-SC), in conjunction with AMS. The ABOX-SC technique is explicitly designed to strip any residual younger contamination out of ancient charcoal (Bird et al 1999) and has been successfully applied to a number of archaeological sites including Devils Lair (Turney et al 2001). The ABOX-SC dates reported here are duplicate measurements of samples originally assayed in the early 1990s. The ANU Radiocarbon Laboratory had archived part of the original samples from Puritjarra submitted for radiocarbon ten years ago. This material was retrieved and four samples were prepared using the ABOX-SC method. AMS measurements were then made using the 14UD accelerator at the ANU. The technique involves sequential pre-treatment of charcoal samples with HCl, HF and NaOH followed by a $K_2Cr_2O_7/H_2SO_4$ oxidation at 60°C for 14 hours. Pre-treated samples are then progressively combusted at 340°, 650° and 880°C and the CO_2 produced at each stage is used to make graphite targets for AMS dating of which the 880°C combustion stage is assumed to be the most reliable fraction for age control (Bird et al 1999). Typical backgrounds for charcoals using the ABOX-SC technique are of the order of 55 ka BP, well beyond the basal age of the cultural sequence at Puritjarra.

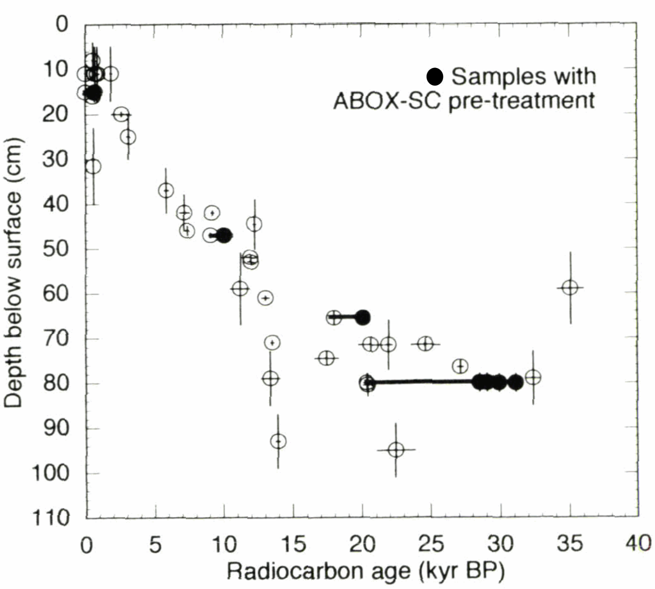

Figure 1 Age-depth curve for radiocarbon determinations from Puritjarra rock shelter showing the impact of ABOX-SC pre-treatment on apparent radiocarbon age for selected charcoal samples.

The resulting ABOX-SC ages (Table 1) agree well with those predicted for these levels using the radiocarbon age-depth curve established by MAS in the 1990s. As Figure 1 shows, these results also reinforce the published chronology for the site (Smith et al 1997). For the three younger samples, the new ages are ~1 ka older than previous determinations. For the remaining sample (M10/27), ABOX-SC gives ages of 28.5 ka (650°C fraction) and 31.1 ka (880°C fraction) for a sample originally dated to 20.4 ka (ANU-6919) using the ABA-BC method. This brings M10/27 into line with the age expected at this level from the overall trend of the radiocarbon series. In the late Holocene part of the sequence the ABOX-SC age (ANUA-12304, 715±180) removes an anomalously modern determination for N11/5-1 (ANU-6541, 98.6% modern). This sample was a single large piece of charcoal explicitly collected from a sealed context where there was no evidence of disturbance from a depth where the expected age was 1-2 ka. Under these circumstances a modern date was inexplicable. Although there was no obvious contamination by humic acids or rootlets the ABOX-SC results indicate that this sample must have been saturated with modern contaminants (possibly fat or blood from animals cooked on nearby hearths, or urine).

The differences in radiocarbon age between samples subjected to ABA pre-treatment and those prepared using the more rigorous ABOX pre-treatment confirms the existence of younger contaminants in the samples analysed. For M10/27 the increase in radiocarbon age with increasing combustion temperature also shows the progressive removal of contaminants during combustion (Table 1). These ABOX-SC results confirm that sample contamination has contributed to the scatter of radiocarbon ages in the late Pleistocene unit.

At Puritjarra there were no field indications to suggest contamination of charcoal samples would be a greater problem here than at any other Australian site. However, it appears that the conventional ABA-BC method used in earlier radiocarbon assays has failed to consistently remove pervasive younger contaminants in these samples. These problems only became apparent with a large series of radiocarbon determinations. If we had limited our chronology to the four radiocarbon dates available in 1987 or the 12 available in 1989 we would have significantly underestimated the age of the basal part of late Pleistocene cultural levels by ~10 ka. We would also have failed to accurately identify the levels that correspond to the last glacial maximum and potential occupation at this time. Archaeologists relying on one or two radiocarbon determinations to provide a chronology for late Pleistocene occupation at a site should therefore retain a healthy measure of scepticism about their dates. At the other end of the time scale, our results also indicate that there are few grounds for complacency about radiocarbon chronologies for recent prehistoric or contact period sites.

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APOLOGY

The following table was omitted from Tessa Corkill's short report, "Rockshelter taphonomy: A monitor program in Darling Mills Creek, Sydney", which appeared in Volume 52. The editors apologise to Tessa for this oversight.

Shelter #	1996	1997	1998	1999	2000
DMC 7	20	12	11	8	1
DMC 8	20	13	11	10	7
PAD 8	20	12	10	5	4

Table 1 Number of glass artefacts found on ground surface in each rockshelter during each recording session.