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New Abox AMS-14C ages remove dating anomalies at Puritjarra Rock Shelter.

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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
I) 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-14C 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 (14C) 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
of charcoal. This was due to younger contaminants in the radiocarbon sample (ANU-6919) was under-estimated by -10 ka (Table 1). The oldest sample (ANU-6541, 98.6% modern) 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 65 cm (~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 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 K2Cr2O7/H2SO4 oxidation at 60°C for 14 hours. Pre-treated samples are then progressively combusted at 340°C, 650°C and 880°C and the CO2 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.

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 (ANU-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

<table>
<thead>
<tr>
<th>Sample</th>
<th>Laboratory code</th>
<th>Predicted age BP (from age-depth curve)</th>
<th>Combustion fraction</th>
<th>ABOX-SC method</th>
<th>Conventional ABA-BC method</th>
</tr>
</thead>
<tbody>
<tr>
<td>N11/5-1</td>
<td>ANU-12304</td>
<td>1500</td>
<td>880°C</td>
<td>715±180</td>
<td>ANU-6541 98.6±0.9% modern</td>
</tr>
<tr>
<td>M10/20-4</td>
<td>ANU-12307</td>
<td>10,100</td>
<td>880°C</td>
<td>10,110±250</td>
<td>ANU-6538 9110±120</td>
</tr>
<tr>
<td>N13/20</td>
<td>ANU-10010</td>
<td>18,200</td>
<td>880°C</td>
<td>20,110±250</td>
<td>ANU-6918 17,980±160</td>
</tr>
<tr>
<td>M10/27</td>
<td>ANU-10009</td>
<td>30,400</td>
<td>650°C</td>
<td>28,540±335</td>
<td>ANU-6919 20,360±220</td>
</tr>
<tr>
<td></td>
<td>ANU-10013</td>
<td></td>
<td>880°C</td>
<td>31,140±470</td>
<td></td>
</tr>
<tr>
<td>ANUA-1714</td>
<td>ANU-6541</td>
<td>340°C</td>
<td>650°C</td>
<td>29,080±460</td>
<td></td>
</tr>
<tr>
<td>ANUA-1715</td>
<td>ANU-6541</td>
<td></td>
<td></td>
<td>29,940±460</td>
<td></td>
</tr>
</tbody>
</table>

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°C and 650°C fractions. In general, the 880°C fraction is believed to yield the more reliable age.
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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