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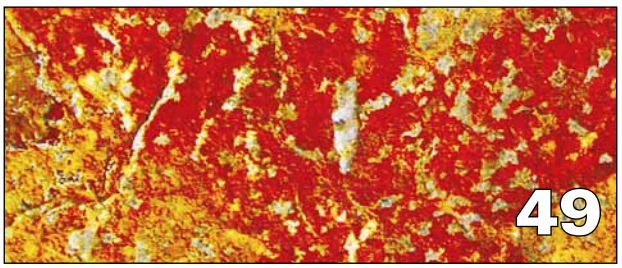

Credits from top: artefacts from the Commonwealth Block, Melbourne (Photograph: Sarah Hayes); the 'Genyornis' image, Arnhem Land (Photograph: R.G. Gunn); excavations at Dunsborough, Western Australia (Photograph: Cat Morgan); 'aligned cupules' at the Blue Tier, Tasmania (Photograph: Silas Piotrowski); Anuru Bay, Arnhem Land (Photograph: Daryl Wesley); bird painting at Wagadagam, Mabuyag, Torres Strait (Photograph: Duncan Wright, enhancement: L. Brady).

Credits: Nawarla Gabarnmang, Arnhem Land (Photograph: Bruno David).

Nawarla Gabarnmang, a 45,180±910 cal BP Site in Jawoyn Country, Southwest Arnhem Land Plateau

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Abstract

Recent excavations at Nawarla Gabarnmang in Jawoyn country, southwest Arnhem Land have produced a long sequence of AMS radiocarbon determinations on individual pieces of charcoal reliably associated with stone artefacts dating back to 45,180±910 cal BP. It represents one of the earliest radiocarbon-dated archaeological sites in Australia. Here we report on initial results.

Introduction

Old archaeological sites at or beyond the limits of reliable radiocarbon dating have typically been the subject of heated debate concerning the actual antiquity of their earliest cultural deposits. Questions have repeatedly been raised around two generic concerns: the reliability of the ages themselves; and/or the integrity of chronostratigraphic associations between archaeological materials, surrounding sediments and dated materials. Cases in point include Nauwalabila (60,300±6700 to 53,400±5400 BP, Roberts *et al.* 1994), Malakunanja II (61,000±8000 to 52,000±8000 BP, Roberts *et al.* 1990), Lake Mungo (50,000 to 46,000 BP, Bowler *et al.* 2003) and Devil's Lair (48,000 BP, Turney *et al.* 2001), although even more controversial claims have also been published (e.g. >116,000±12,000 BP for Jinmium, Fullagar *et al.* 1996). By definition, the less controversial sites tend to have slightly younger ages, and among the earliest include Riwi (41,300±1020 BP, Balme 2000) and Carpenter's Gap (39,700±1000 BP, O'Connor 1995), both dated by radiocarbon. Be that as it may, any site securely radiocarbon-dated to more than 45,000 cal BP will be significant to securing progressively earlier ages for the origins of Aboriginal Australians. Here we report on one such site from Jawoyn country, western Arnhem Land.

Figure 1 Nawarla Gabarnmang from the air (Photograph: Bruno David).

Jawoyn Country

Jawoyn country contains vast numbers of ancestral sites. Many of these sites are located in extremely remote areas and the superb condition of these sites coupled with the presence of exclusively ancient art styles and absence of European contact period artefacts and European scenes in the rock art at many sites suggest that some sites may not have been occupied for many hundreds or even thousands of years. Other sites include known places of ceremony and areas connected to creation and Dreaming stories, as well as rock art sites with more recent depictions.

To date, 117 site complexes, 921 sites and >44,000 individual artworks have been recorded on the Jawoyn Association's GIS database (e.g. Gunn *et al.* 2010; Gunn and Whear 2008). Nawarla Gabarnmang is the first of four sites where excavation has been undertaken at the request of the Jawoyn Association; initial results are presented here.

Nawarla Gabarnmang

In June 2006, RLW and pilot Chris Morgan sighted an unusually large rockshelter during a routine aerial survey on the Arnhem Land plateau (Figure 1). They landed the helicopter and on walking into the open, double-ended shelter, found themselves in a stunning gallery with hundreds of rock paintings (Figure 2). Anthropological work with senior Elders Wamud Namok and Jimmy Kalarriya enabled the Jawoyn to learn the name of the site – Nawarla Gabarnmang (*nawarla*='place of', *gabarnmang*='hole in the rock'). The two men had visited the shelter when they were children, and been told it was an important site where people

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Figure 2 View inside Nawarla Gabarnmang (Photograph: Jean-Jacques Delannoy).

camped en route to ceremonies on Jawoyn country. They also identified the Jawoyn clan Buyhmi as the relevant traditional owners of the site. When Buyhmi traditional owner and Elder Margaret Katherine was taken to the site, she cried out to her ancestors and wept for a place and family she had never known.

BD was emailed photographs of a series of sites which the Association wished to have test-excavated. Nawarla Gabarnmang was the first site selected because of its outstanding artwork and potentially largely undisturbed, stratified sediments. Nawarla Gabarnmang's ceiling consists of interleafed layers of sandstone and hard quartzite, each 10cm to 40cm thick. While poorly soluble, the compact bedrock has witnessed strong chemical alteration along fissure lines and between the individual rock strata, causing dissolution of large parts of the site (Quinif 2010). Over geologically long periods of time, the geochemical hollowing of the site has resulted in a grid-like matrix of ceiling-to-ground level cavities divided by remnant pillars. At floor level the cavities today contain accumulated aeolian sediments, anthopogenically and naturally exfoliated fragments of bedrock, and evidence of past camping activity, while the pillars and flat ceiling surfaces have been extensively painted and quarried for stone artefacts (Figure 2).

Initial archaeological excavations took place at Nawarla Gabarnmang in May 2010. Two 50cm x 50cm squares were excavated, strategically located in an area exhibiting little to no surface disturbance (Square A) and a more open area closer to the centre of the site (Square B). Rock art abounds near both of these squares. Both squares were excavated in arbitrary excavation units (XUs) following the stratigraphy where visible during excavation. Excavated sediments were dry-sieved through 2.1mm mesh, with all materials retained in the sieves bagged and freighted to Monash University where they were wet-sieved, air-dried and sorted. Sediment samples of the <2.1mm fraction were collected from each XU of each square. Cultural items ≥2cm length observed *in situ* and selected charcoal samples were plotted in three dimensions and individually bagged.

Square A was excavated in average 1.8cm-thick XUs and progressed to 66cm depth. Five Stratigraphic Units (SUs) were identified, with good chronostratigraphic integrity. Sediments consist of a matrix of aeolian sands and locally disintegrated sandstone and quartzite rocks incorporating a total 9.4kg of stone artefacts and 2.74kg of charcoal. The vast majority of stone artefacts (98% by weight) were made on quartzite or sandstone available in the cave; the extent of the internal quarrying process is highlighted by the fact that a quarter (25%) of the total 49.7kg of excavated sediment retained in the 2.1mm mesh consist of cultural materials, predominantly stone artefacts. Both the stone artefacts and non-artefactual rocks tended to lie subhorizontally in the ground, sealing underlying deposits and suggesting an absence of significant post-depositional turbation and good chronostratigraphic integrity, as also indicated by the sequence of 25 radiocarbon determinations (Table 1). An 'inversion' of radiocarbon dates occurs at the SU4/SU5 interface, but the two pieces of charcoal representing Wk-28128 (17,722±64 BP) and Wk-28620 (12,746±43 BP) came from 37.8cm and 38.5cm depth respectively (i.e. 7mm apart) and horizontally some 30cm apart, and do not thus constitute a problematic 'inversion'. The radiocarbon determinations from Square A show an absence of occupation dating to the Last Glacial Maximum in this part of the site (but not from other excavated squares).

Bedrock and basal cultural deposits were not reached across the square, as large, sharply slanting rock surfaces hampered excavation beyond XU36, where soft sediments were limited to a <5cm-wide fissure in the rock (Figure 3).

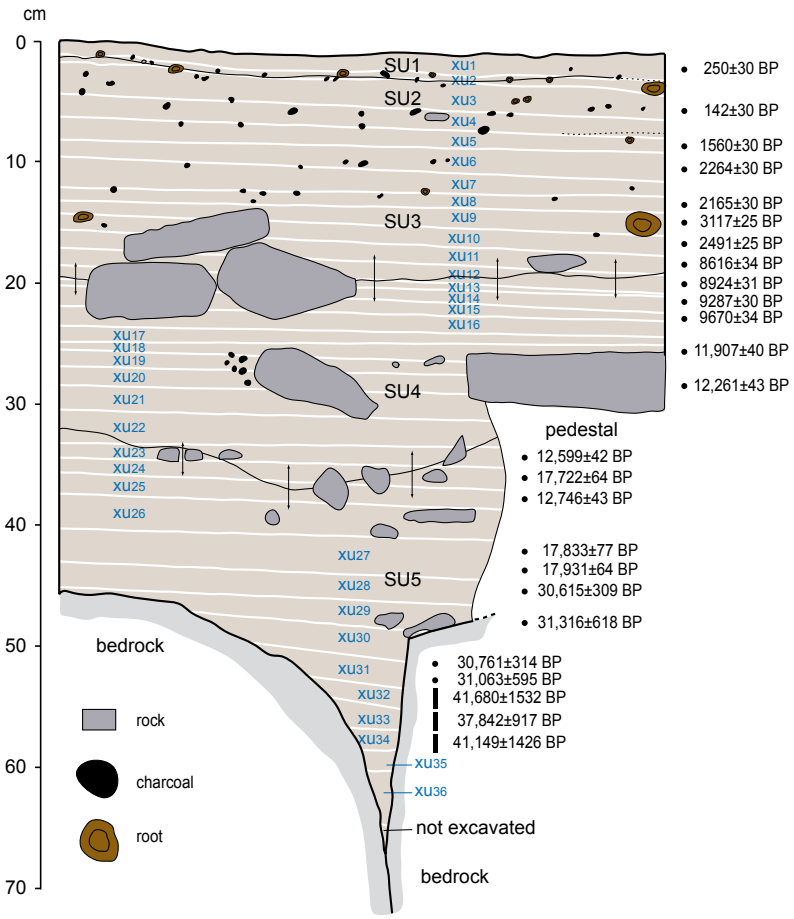

Figure 3 Nawarla Gabarnmang Square A, east section.

Charcoal and flaked stone artefacts were found in every XU (Table S1, supplementary information). Bone was only present in late Holocene contexts, as is typical of Arnhem Land archaeological sites generally (cf. Jones 1985), but preservation of the recovered material is superb and the assemblage will provide important new information on the late pre-European/early contact period vertebrate fauna of this poorly surveyed region. Burnt seeds are present throughout much of the deposit. The pollen sequence extends into Pleistocene levels and will be presented elsewhere. AMS radiocarbon determinations on individual pieces of charcoal have revealed a cultural sequence going back to 45,180±910 cal BP (combining the two statistically similar near-basal dates Wk-29205 and Wk-29207, $\chi^2_{1:0.05}$=0.6<3.84) and include a fragment of ground-edge axe securely dated by association with overlying and underlying charcoal to 35,400±410 cal BP (Geneste *et al.* 2010, in press). Radiocarbon results were calibrated using IntCal09 (Reimer *et al.* 2009) in OxCal v4.1.7 (Bronk Ramsey 2009).

Evidence for the age of the rock art comes from a number of directions. In Square A, a large ochre crayon with facetted surfaces and grinding striations of the same mulberry colour as a painted Dynamic figure located within 100m of the excavation square comes from XU26 at the SU4/SU5 interface (representing the old SU5 surface) and thus dates to sometime between 14,770–21,585 cal BP (covering the XU24–XU27 radiocarbon determinations for the SU4/SU5 interface, at 95% probability). Exfoliated painted rock is also present within excavated squares in other parts of the site. An extensive program of AMS radiocarbon dating wasp nests and other carbon-bearing compounds located beneath and above paintings at Nawarla Gabarnmang and at numerous other sites within Jawoyn country, coupled with detailed geochemical investigations of rock surfaces, paintings and excavated pigments, are under way and promise to reveal significant details on the antiquity of the rock art in this part of Arnhem Land.

Conclusion

Initial results at Nawarla Gabarnmang have revealed secure evidence of people some 45,000 years ago. Ongoing excavations are aimed at tracking the >45,000 year old levels, dating the rock art and further investigating the site's geomorphology (including anthropogenic modifications to the ceiling and pillars). In tandem with the work at Nawarla Gabarnmang, investigations are also progressing at the nearby '*Genyornis* site' complex (Gunn *et al.* 2011); on the geochemistry and radiocarbon dating of decorated rock surfaces; at sites with Dynamic and Yam paintings; on the pollen coring of swamps on the Arnhem Land plateau; and on a systematic recording and dating of the remarkably intact *galngbuy* site ARN58 associated with the major *wubar* totemic cycle. Our major aim is to connect the excavated sequences with the rock art both at Nawarla Gabarnmang and beyond, following high resolution dating of each within individual sites and across the region. Results of individual studies will be presented in more detail as they become available.

Supplementary Information

Supplementary information for this article is available online at www.australianarchaeologicalassociation.com.au.

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Table 1 Radiocarbon determinations on charcoal from Nawarla Gabarnmang, Square A. * $\delta^{13}C$ value measured, but not reported. # sample from interface of stratigraphic units.

XU	SU	Depth (cm)	Lab. No.	$\delta^{13}C‰$ (±0.2)	^{14}C Age (years BP)	Calibrated Age BP
1	1	0.3	Wk-28123	-24.7	250±30	320-280, 170-150 (68%)
						430-360, 330-270, 190-140, 20 to -10 (95%)
3	2	6.1	Wk-28614	-26.0	142±30	280-250, 230-170, 160-130, 120-70, 40-10 (68%)
						290-0 (95%)
5	3	8.3	Wk-28615	-23.0	1560±30	1520-1400 (68%)
						1530-1380 (95%)
6	3	6.7	Wk-28124	-24.6	2264±30	2350-2300, 2240-2180 (68%)
						2350-2290, 2260-2150 (95%)
8	3	13.0	Wk-28612	-26.2	2165±30	2310-2240, 2180-2170, 2160-2120 (68%)
						2310-2060 (95%)
9	3	14.7	Wk-30471	-24.6	3117±25	3380-3330 (68%)
						3395-3315, 3310-3260 (95%)
10	3	14.8	Wk-30470	-24.5	2491±25	2710-2680, 2640-2630, 2620-2610, 2600-2490 (68%)
						2720-2465 (95%)
11	3/4#	17.4	Wk-28611	-25.1	8616±34	9600-9530 (68%)
						9670-9520 (95%)
12	3/4#	19.9	Wk-28125	-26.4	8924±31	10,180-10,130, 10,070-10,010, 10,000-9940 (68%)
						10,200-10,110, 10,090-9910 (95%)
14	3/4#	21.8	Wk-28613	-25.3	9287±30	10,560-10,480, 10,470-10,420 (68%)
						10,580-10,380, 10,320-10,300 (95%)
16	4	23.0	Wk-28126	*	9670±34	11,190-11,090, 10,920-10,900 (68%)
						11,200-11,070, 10,960-10,860, 10,850-10,800 (95%)
18	4	25.2	Wk-28619	-27.1	11,907±40	13,840-13,710 (68%)
						13,910-13,610 (95%)
20	4	28.9	Wk-28622	-25.4	12,261±43	14,220-14,000 (68%)
						14,800-14,760, 14,550-13,920 (95%)
23	4	34.4	Wk-28617	-25.2	12,599±42	15,080-14,790, 14,750-14,660 (68%)
						15,200-14,520, 14,300-14,280 (95%)
24	4/5#	37.8	Wk-28128	-26.1	17,722±64	21,410-21,050 (68%)
						21,480-20,810, 20,700-20,560 (95%)
25	4/5#	38.5	Wk-28620	-25.2	12,746±43	15,240-14,940 (68%)
						15,570-14,870, 14,830-14,770 (95%)
27	4/5#	41.3	Wk-30468	-26.4	17,833±77	21,470-21,215 (68%)
						21,550-20,930 (95%)
27	4/5#	43.5	Wk-30469	-26.6	17,931±64	21,510-21,310 (68%)
						21,585-21,150 (95%)
28	5	46.5	Wk-28616	-23.7	30,615±309	36,120-36,020, 35,340-34,730 (68%)
						36,260-35,820, 35,640-34,620 (95%)
29	5	46.1	Wk-28130	-25.4	31,316±618	36,420-35,200 (68%)
						37,110-34,690 (95%)
31	5	51.2	Wk-28621	-24.2	30,761±314	36,170-35,960, 35,460-34,850 (68%)
						36,290-35,760, 35,710-34,720 (95%)
31	5	52.7	Wk-28131	-24.7	31,063±595	36,280-35,760, 35,740-35,070 (68%)
						36,710-34,650 (95%)
32	5	51.8-55.3	Wk-29205	*	41,680±1532	46,755-44,000 (68%)
						49,075-43,215 (95%)
33	5	55.3-57.4	Wk-29206	*	37,842±917	43,130-41,800 (68%)
						44,090-41,285 (95%)
34	5	57.4-60.4	Wk-29207	*	41,149±1426	46,050-43,665 (68%)
						48,400-42,855 (95%)

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SUPPLEMENTARY INFORMATION

Nawarla Gabarnmang, a 45,180±910 cal BP Site in Jawoyn Country, Southwest Arnhem Land Plateau

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Table S1 Details of excavation, Nawarla Gabarnmang Square A.

XU	SU	Mean Depth Below Surface at Base (cm)	Mean Thickness (cm)	Area (m^2)	Weight (kg)	Volume (litres)	>2.1mm Non-Cultural Sediments (g)	>2.1mm Cultural Sediments (g)	% of Total Sediments >2.1mm (by weight)	pH	Bone	Bivalve Shell		Charcoal	Facetted Red Ochre Crayons with Striations		Flaked Stone Artefacts	
											(g)	(#)	(g)	(g)	(#)	(g)	(#)	(g)
1	1	1.9	1.9	0.28	5.0	4.5	580.7	1022.1	32.1	4.33	24.4			788.78			193	208.96
2	1+2	3.9	2.0	0.28	5.4	5.0	254.4	546.4	14.8	4.31	4.9	3	0.08	418.93			231	122.56
3	2	5.0	1.1	0.29	7.2	6.0	467.5	617.9	15.1	4.14	3.0			368.70			400	243.32
4	2+3	6.7	1.7	0.30	6.6	5.0	562.5	344.0	13.7	3.80	0.4			161.28			454	182.33
5	3	8.7	2.0	0.31	9.0	7.5	1018.2	581.6	17.8	3.78	0.1			217.06			945	364.40
6	3	10.5	1.8	0.31	9.6	7.5	327.7	400.3	7.6	5.57				170.03			372	230.30
7	3	12.0	1.5	0.32	7.6	6.5	276.6	260.9	7.1	3.89				114.41			606	146.50
8	3	14.0	2.0	0.32	9.2	6.5	190.5	256.5	4.9	3.90				97.88			641	158.62
9	3	15.4	1.4	0.35	8.5	8.0	424.6	87.1	6.4	3.90				12.34			519	74.77
10	3+4	16.6	1.2	0.36	8.5	6.5	107.0	64.6	2.0	3.93				6.41			360	58.23
11	3+4	17.8	1.2	0.36	7.4	6.0	172.9	150.4	4.4	3.76	<0.1			41.73			333	108.65
12	3+4	19.2	1.4	0.37	6.4	5.5	239.9	83.6	5.1	3.92				30.25			246	53.36
13	3+4	20.3	1.1	0.37	9.8	8.0	208.9	552.3	7.8	4.20				29.38			263	522.94
14	3+4	20.9	0.6	0.38	6.2	4.0	840.1	84.3	14.9	3.75				22.09			134	62.16
15	3+4	22.5	1.6	0.38	9.6	8.5	299.2	287.1	6.1	3.92				27.95			195	259.12
16	4	24.0	1.5	0.38	7.2	5.0	186.0	363.6	7.6	3.79				16.49			40	347.09
17	4	25.5	1.5	0.40	9.8	7.5	923.2	911.6	18.7	3.98				27.59			123	883.96
18	4	26.9	1.4	0.40	6.0	4.0	877.8	141.0	17.0	3.97				13.50			63	127.53
19	4	27.8	0.9	0.40	7.0	5.0	395.4	287.3	9.8	3.74				13.55			135	273.77
20	4	29.8	2.0	0.40	9.4	7.0	4055.3	206.0	45.3	3.91				21.14			153	184.88
21	4+5	31.3	1.5	0.29	8.2	6.5	2237.0	152.3	29.1	3.81				13.51			140	138.76
22	4+5	33.4	2.1	0.25	6.6	4.5	1093.2	286.4	20.9	3.88				11.07			86	275.37
23	4+5	35.5	2.1	0.25	6.8	5.0	707.1	1139.6	27.2	3.91				11.37			113	1128.20
24	4+5	37.4	1.9	0.25	8.4	6.0	2789.6	78.7	34.1	3.92				4.68			117	74.01
25	4+5	39.0	1.6	0.25	5.2	4.0	935.1	34.5	18.6	3.89				5.77			131	28.75
26	4+5	41.9	2.9	0.24	8.4	6.5	1539.1	217.7	20.9	3.78				8.94	1	6.70	219	202.08
27	4+5	44.5	2.6	0.24	7.0	4.5	2374.7	1039.8	48.8	3.77				7.83			222	1032.00
28	4+5	46.4	1.9	0.18	8.2	5.0	1938.8	728.1	32.5	3.72				15.40			218	712.74
29	5	47.7	1.3	0.17	4.0	4.0	662.7	170.6	20.8	3.80				11.49			153	159.09
30	5	50.4	2.7	0.17	6.2	4.5	1899.6	317.0	35.8	3.74				28.48			165	288.48

XU	SU	Mean Depth Below Surface at Base (cm)	Mean Thickness (cm)	Area (m^2)	Weight (kg)	Volume (litres)	>2.1mm Non-Cultural Sediments (g)	>2.1mm Cultural Sediments (g)	% of Total Sediments >2.1mm (by weight)	pH	Bone	Bivalve Shell		Charcoal	Facetted Red Ochre Crayons with Striations		Flaked Stone Artefacts	
											(g)	(#)	(g)	(g)	(#)	(g)	(#)	(g)
31	5	51.8	1.4	0.15	5.0	4.0	613.7	137.6	15.0	3.71				15.14			173	122.43
32	5	55.3	3.5	0.15	6.0	4.5	1336.9	251.8	26.5	3.79				4.51			137	247.32
33	5	57.4	2.1	0.15	5.6	4.0	1307.8	127.1	25.6	3.77				1.72			104	125.39
34	5	60.4	3.0	0.15	5.6	3.0	2398.2	94.7	44.5	3.91				0.21			33	94.44
35	5	61.4	1.0	0.12	3.0	1.5	1277.3	106.8	46.1	3.96				0.36			16	106.42
36	5	66.2	4.8	0.11	4.0	2.0	1967.6	69.3	50.9	4.03				0.17			43	69.13
Total		66.2	1.8		253.6	193.0	37,486.7	12,200.6	19.6		32.77	3	0.08	2740.14	1	6.70	8476	9418.06