A TERMINAL PLEISTOCENE OPEN SITE ON THE HAWKESBURY RIVER,

Pitt Town, New South Wales

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Abstract

Salvage excavations of 25 m² on a levee adjacent to the Hawkesbury River near Pitt Town, New South Wales, identified a 1.5 m deep sand body containing three discrete artefact assemblages, collectively designated as site PT12. Six optically stimulated luminescence (OSL) ages provide a chronology for the sand body, which began forming >50 ka. Peak artefact numbers for the two lowest assemblages were centred on ca 15 ka and ca 11 ka, and had Capertian (pre-Bondaian) characteristics. These included amorphous pebble tools and manuports of locally-derived river cobbles, which were probably exposed through entrenchment of the river during lower sea-levels. Comparisons with the KII rockshelter, approximately 20 km upstream, show a similar assemblage dated to ca 13 ka. The uppermost assemblage at PT12 was dominated by backed artefacts and composed primarily of silcrete. Reliable OSL ages indicate this assemblage may have been deposited in the early Holocene, with a proliferation of backed blades occurring ca 5 ka, although typological comparisons with other local assemblages suggest an age of <4.5 ka is more likely. Along with other studies, the site indicates the systematic exploitation of resources along the Hawkesbury River from ca 15 ka before an apparent abandonment of the region in the early/mid-Holocene. Late Holocene artefact numbers suggest a subdued reoccupation of the area following this hiatus.

Introduction

The margins of the Hawkesbury River in western Sydney, New South Wales, have been a focus of archaeological research for nearly 70 years (e.g. McCarthy 1948; Stockton and Holland 1974). Initially, these investigations took the form of academic research, but more recently have shifted towards consulting projects associated with development (e.g. White and McDonald 2010).

Such studies have indicated that, despite a wide range of environments and resources surrounding the river, Aboriginal occupation appears to have been relatively sparse until the late Holocene. As yet, only two sites have been published with Pleistocene ages: the KII rockshelter on Shaws Creek and Cranebrook Terrace (Kohen *et al.* 1984; Nanson *et al.* 1987), and the latter remains controversial because of unresolved questions about the stratigraphic association between the artefacts and dated sediments. Notably, the total number of absolutely dated archaeological sites along the river is only five.

Here we present the findings of an archaeological salvage excavation undertaken as part of a series of mitigation measures prior to a proposed development on Bathurst Road, Pitt Town (Figure 1). The excavation identified a 1.5 m deep sand body containing three discrete archaeological assemblages. This site show a focus of occupation/visitation in the terminal Pleistocene, most likely to exploit locally exposed lithic raw materials.

Previous Investigations

One of the first investigations in the region was at Lapstone Creek, southwest of Emu Plains, in the foothills of the Blue Mountains. This site was one of several used by McCarthy (1948) and others to differentiate the Bondaian and Eloueran traditions[1] (e.g. Lampert 1966, 1971; McBryde 1966, 1974; Megaw 1965, 1968; Moore 1970, 1981). Initially undated, radiocarbon ages on archived samples of charcoal suggesting a basal date of ca 4 ka for the site were published in the late 1960s (McCarthy 1978; Polach *et al.* 1967). McCarthy (1978) also identified several 'surface workshops' along the banks of the Hawkesbury River between Castlereagh and Emu Plains. These were large, surface artefact scatters dominated by unifacial pebble blanks, edge-ground implements and percussion stones, with minor quantities of microliths, and were considered to be of late Holocene age.

In the 1970s, Stockton and Holland (1974) undertook excavations at several rockshelters in the Blue Mountains, including Kings Tableland, Walls Cave, Lyrebird Dell and Springwood Creek. Excavations revealed initial occupation of the Blue Mountain/Hawkesbury region by ca 22 ka, with a Capertian assemblage dominating between ca 12 to 6 ka, and a Bondaian assemblage between ca 3 ka and European arrival (and peaking after 600 years). A sterile phase was identified between the two traditions at many of these Blue Mountain sites. As part of this work a disturbed rockshelter – KI – at Shaws Creek, in close proximity to the Hawkesbury River, was excavated, with preliminary findings indicating a potential for deep-time deposits (Stockton 1973). Subsequently, as part of his doctoral research, Kohen (1986; Kohen *et al.* 1984) undertook excavations of KII rockshelter, a less disturbed site immediately east of KI. This excavation identified two main assemblages: a lower assemblage (in Units 1-4/Phases VI-IV) composed of amorphous core/flake tools and thick flakes, and an upper assemblage (in Units 5-6/ Phases I-III) that included backed blades, geometric microliths, edge-ground hatchets and bipolar/scalar pieces (Kohen *et al.* 1984). The lower assemblage was dominated by chert (also referred to as silicified tuff), while the upper assemblage was

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[1] The terms Capertian and Bondaian are explored further in the later sections of this paper. However, in brief these terms were coined in the 1960s to characterise two different types of artefact assemblage, the Capertian being composed of amorphous pebble tools dominated by silicified tuff and constrained to the terminal Pleistocene, and the Bondaian generally composed of microliths, dominated by silcrete and constrained to the late Holocene.

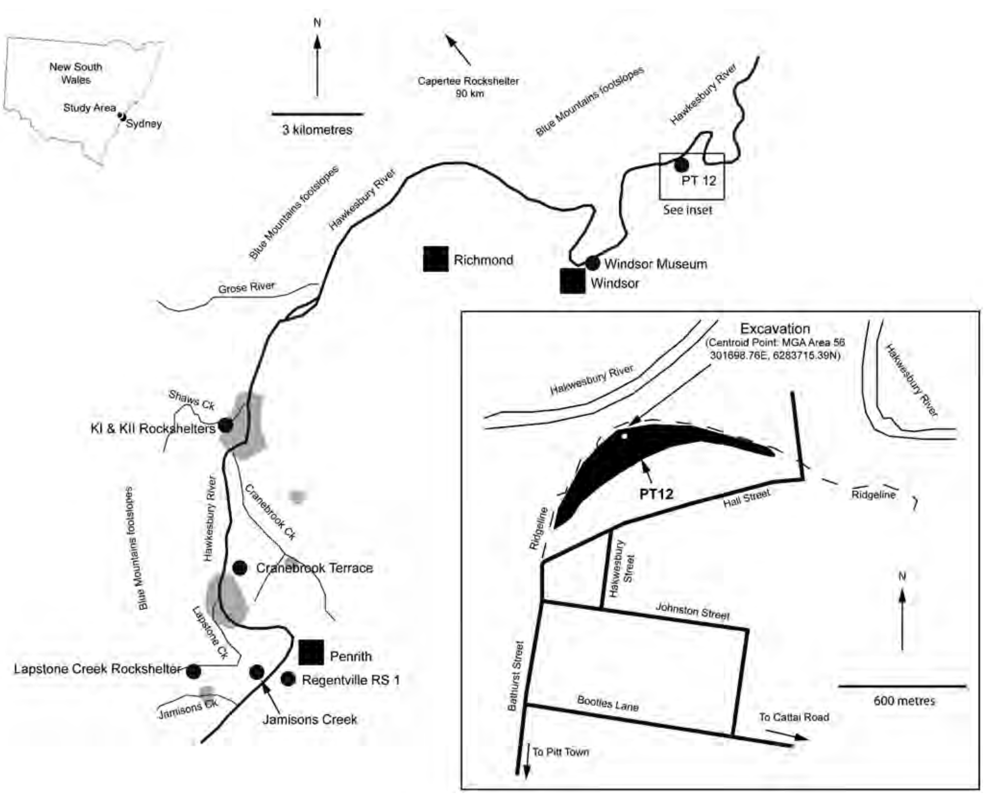

Figure 1 General map of the study area, showing the location of PT12 and other archaeological sites discussed in the text (denoted with dots). 'Surface workshops' as defined by McCarthy (1978) are shown in grey. Co-ordinates shown were recorded using DGPS.

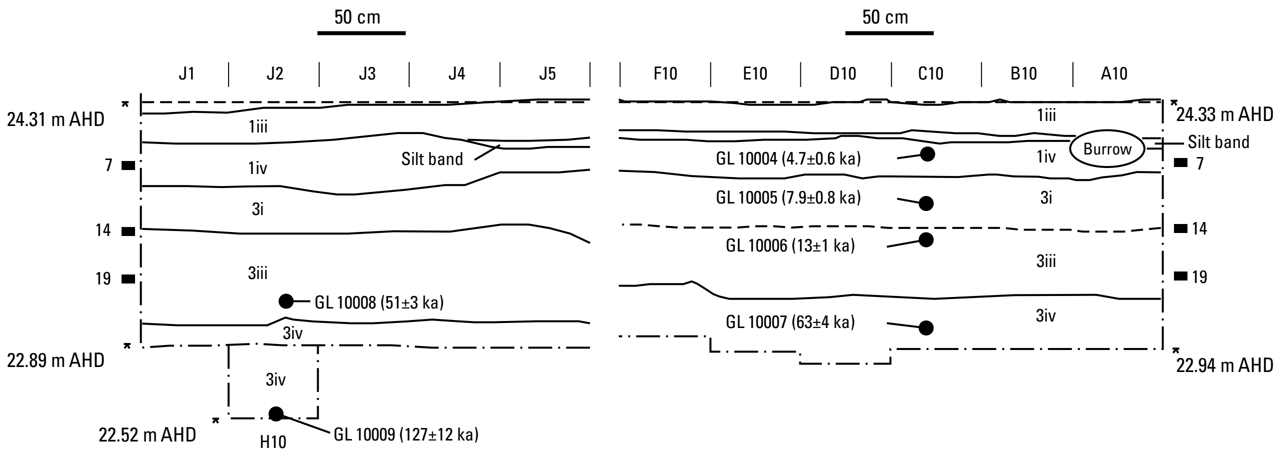

Figure 2 Composite section of the excavations showing Squares J1-J5 (facing west) and A10-F10 (facing north). Square H10 is also included to provide context for OSL age GL10009. Peaks in artefacts at Spits 7, 14 and 19 are indicated by the black squares.

Figure 3 Photograph looking southeast over the final excavations.

dominated by igneous and metamorphic materials, as well as an increasing abundance of silcrete. Radiocarbon ages for the two assemblages indicated that the lower had a minimum age of 13 ka, while the upper was present in various guises from 4-1.2 ka. In contrast to Stockton (1973), Kohen saw no evidence of a hiatus between the two assemblages. With the exception of Cranebrook Terrace, the KII site currently provides the earliest evidence of occupation along the Hawkesbury River.

In the same study, Kohen *et al.* (1984) also referred to an open stratified site at Jamisons Creek, Emu Plains, where two ages suggested initial occupation from ca 7 ka, with a proliferation of backed blades associated with a hearth date of ca 3 ka. More recently, thermoluminescence (TL) dating of an open site at Regentville (RS1), similarly found a focus of occupation between 5.2±0.5 ka (W 1892), with a basal age of 7.6±0.8 ka (W 1893) (McDonald 1995).

The alleged earliest date for Aboriginal occupation in the region comes from the Cranebrook Terrace, where five 'flaked pebbles' identified as stone tools by Stockton were found within a gravel pit (Stockton and Holland 1974). Subsequent work by Nanson *et al.* (1987) demonstrated these gravels to be ca 40 ka. If correct, these finds would represent the oldest site on the Australian eastern coast. However, the artefactual status of the pebbles, their provenance (several were in an eroded context rather than *in situ*) and the association between the dates (which ranged from 10 to 42 ka) and the artefacts have been sources of controversy ever since their announcement. Mulvaney and Kamminga (1999) rejected these findings and, despite extensive monitoring of the Penrith gravel pits over the past 30 years, no comparable artefacts or evidence of human occupation of comparable age have come to light (see Mitchell 2010a for further discussion).

More recently, excavations by Austral Archaeology at the Windsor Museum site recovered an extensive artefact assemblage within a sand dune deposit dated to between 149 ka and 8.5 ka (Peter Mitchell pers. comm.). Correlating these TL ages with the archaeology has proven to be difficult as the sediments are known to be bioturbated, but it is very likely that the oldest artefacts are of late Pleistocene age.

As part of a salvage excavation for the Rouse Hill Infrastructure project, a basal layer of silicified tuff artefacts was recovered at RH/CC2, a stratified open site, was considered to be terminal Pleistocene in age based on artefact typology (JMCHM 2005). Consulting projects undertaken on the western Cumberland Plain by Smith (1986) at Quakers Hill and McDonald *et al.* (1994) at Second Ponds Creek have recovered hearths and other features in association with extensive artefact scatters dated to the late Holocene. Further afield in tributaries of the Hawkesbury River, studies at Upper Mangrove Creek (Attenbrow 2004), Darling Mills SF2 rockshelter (Attenbrow 1993) and MR/1 (Moore 1981) have all demonstrated terminal Pleistocene and early Holocene occupation.

Despite academic and consulting investigation of the Hawkesbury River over the last 70 years, understanding of the occupation and use of the region is still limited. Only two sites (Shaws Creek KII and Windsor Museum) appear to demonstrate terminal Pleistocene occupation, with the majority of sites dating, either through absolute techniques or by virtue of stylistic assessments of assemblage composition, to the late Holocene.

The Pitt Town 12 Site

Pitt Town 12 (#45-5-3198; hereafter PT12) is located across Lots 13 to 18 DP 1021340 on the southern bank of the Hawkesbury River (Figure 1). The site consists of a shallow sand levee, some 700 m long x 100 m wide, located on the river terrace, 23-26 m AHD. The site was identified during a consultancy testing program prior to residential development in the area (see AHMS 2006). Initial testing identified the presence of the levee running along the terrace from Punt Rd in the west, to Hall St in the east. Subsequent investigations suggest the sand body continues east towards Cattai Rd; pockets of a similar sand body have also been observed around Bootles Lane to the south (more than 1 km from the river). Historical activities in this area have been primarily agricultural and pastoral, and therefore, with the exception of the upper 30 to 50 cm, impacts to the site have been minimal.

In 2010 residential development was proposed for the site and, following recommendations from earlier assessments along with advice from the Office of Environment and Heritage (the then NSW Department of Environment, Climate Change and Water), a salvage excavation was undertaken in the deepest, and least disturbed, part of the sand body (this having been identified in a bore-hole program

Table 1 Summary of OSL ages. * K, U and T were measured using Ge gamma spectrometry in the laboratory following collection of the samples. ¤ The ages are presented using present day as their reference point, i.e. GL10004 is 4700 years ago from AD 2010. Ages shown in bold are acceptable; ages shown in italics have analytical caveats; age shown as underlined is the least reliable analytically.

Test-pit	Spit	Depth (cm below surface)	Depth (m AHD)	Lab Code	Equivalent Dose (Gy)	K (%)*	U (ppm)*	Th (ppm)*	Cosmic Dose Rate (Gy/ka)	Water Content (%)	Total Dose Rate (Gy/ka)	Age (ka)¤
C10	6	30	24.025	GL10004	4.7±0.6	0.46±0.03	2.77±0.34	0.88±0.07	0.16±0.02	5±1	1.00±0.05	**4.7±0.6**
C10	12	56	23.740	GL10005	7.7±0.7	0.47±0.03	3.38±0.34	0.72±0.02	0.16±0.02	5±1	0.98±0.04	**7.9±0.8**
C10	15	77	23.535	GL10006	12.4±0.6	0.46±0.03	3.31±0.33	0.75±0.06	0.15±0.02	5±1	0.94±0.04	*13±1*
J10	22	110	23.155	GL10008	47.7±2.4	0.44±0.03	2.88±0.33	0.83±0.06	0.14±0.01	5±1	0.93±0.04	*51±3*
C10	26	130	23.025	GL10007	70.3±3.7	0.54±0.03	3.93±0.37	1.05±0.07	0.14±0.01	6±2	1.12±0.05	*63±4*
H10	36	180	22.520	GL10009	143.3±11.8	0.64±0.04	4.15±0.34	0.79±0.06	0.13±0.01	12±3	1.13±0.05	127±12

across the levee). The salvage work was done in participation with the traditional owners and Deerubbin Local Aboriginal Land Council, and included the excavation of a 25 m^2 open area in the centre of the deposit. All excavation was undertaken by hand using 5 cm arbitrary spits, in contiguous 50 cm squares. Excavation continued until sterile deposits were reached between 128 and 182 cm below the surface (22.52-23.08 m AHD). All excavated sediment was wet sieved through a 3 mm mesh.

Sedimentology

Excavation revealed a Kandosol soil profile (Isbell 2002) across the excavations, overlying Pitt Town Sands. The origins of the sediments could not be definitively determined, but, given the medium- to coarse-grained nature of the sand and absence of primary bedding, it is likely to have been primarily fluvial with some aeolian reworking, an interpretation supported by selective micromorphological analysis. The sequence could be divided into five broad units (Figures 2 and 3):

1. Spits 1 to 3 (0-15 cm bs): Soil Unit 1iii, a brownish grey (5YR5/1) loamy sand with a weak earthy fabric identified as a disturbed topsoil (A-horizon);
2. Spits 3 to 8 (15-40 cm bs): Soil Unit 1iv, a greyish brown (7.5YR4/2) loamy sand with slight clay content, moderately high organic matter, clear evidence of bioturbation by earthworms and cicadas, identified as an undisturbed topsoil (A-horizon). This unit had a mixed boundary grading into;
3. Spits 8 to 13 (40-65 cm bs): Soil Unit 3i, a brown (7.5YR 4/6) to orange (7.5YR6/6) coloured, fine to medium loamy sand with occasional coarse sand grains and very fine (to 4 mm diameter) gravel fragments, interpreted as a weakly differentiated subsoil (B-horizon). The boundary to Soil Unit 3iii was diffuse and consisted of little more than a lightening in colour and a slight increase in clay content. Both Units 3 and 4 were bioturbated but the intensity of soil mixing reduced with depth and bioturbation appeared to stop at about 95 cm bs;
4. Spits 13 to 20 (65-100 cm bs): Soil Unit 3iii, as for 3i but less disturbed; and,
5. Spits 20 to 33 (100-165 cm bs): Soil Unit 3iv, terrace subsoil composed of white to yellowish grey (10YR7/6) clayey sand with abundant ironstone nodules, identified as the Pitt Town Sands.

Table 2 Types of artefacts by spit and depth below surface.

Spit	Depth below surface (cm)	Complete flakes	Broken flakes (proximal end)	Broken flakes (distal end)	Cores/core fragments	Backed blades	Scrapers
1	0 - 5	1	1	3	2	0	0
2	5 - 10	1	0	7	1	1	0
3	10 - 15	4	2	9	1	1	0
4	15 - 20	3	1	4	2	0	0
5	20 - 25	3	3	4	0	0	0
6	25 - 30	4	2	7	0	1	0
7	30 - 35	4	1	12	0	7	0
8	35 - 40	1	0	6	0	2	0
9	40 - 45	5	1	15	0	1	0
10	45 - 50	12	4	13	1	3	0
11	50 - 55	19	2	31	0	3	1
12	55 - 60	10	1	58	0	1	0
13	60 - 65	9	2	168	0	1	0
14	65 - 70	18	2	169	1	0	0
15	70 - 75	5	0	81	0	0	0
16	75 - 80	4	0	33	0	0	0
17	80 - 85	4	1	31	0	0	0
18	85 - 90	3	0	42	1	0	0
19	90 - 95	12	0	21	0	0	0
20	95 -100	6	0	30	0	0	0
21	100 - 105	4	0	7	0	0	1
22	105 - 110	1	0	8	0	0	1
23	110 - 115	1	1	7	0	0	0
24	115 - 120	0	0	3	0	0	0
25	120 - 125	0	0	2	0	0	0
26	125 - 130	0	0	0	0	0	0
27	130 - 135	0	0	2	0	0	0
28	135 - 140	0	0	1	0	0	0
29	140 - 145	0	0	0	0	0	0
30	145 - 150	0	0	0	0	0	0
Total		**134**	**24**	**774**	**9**	**21**	**3**

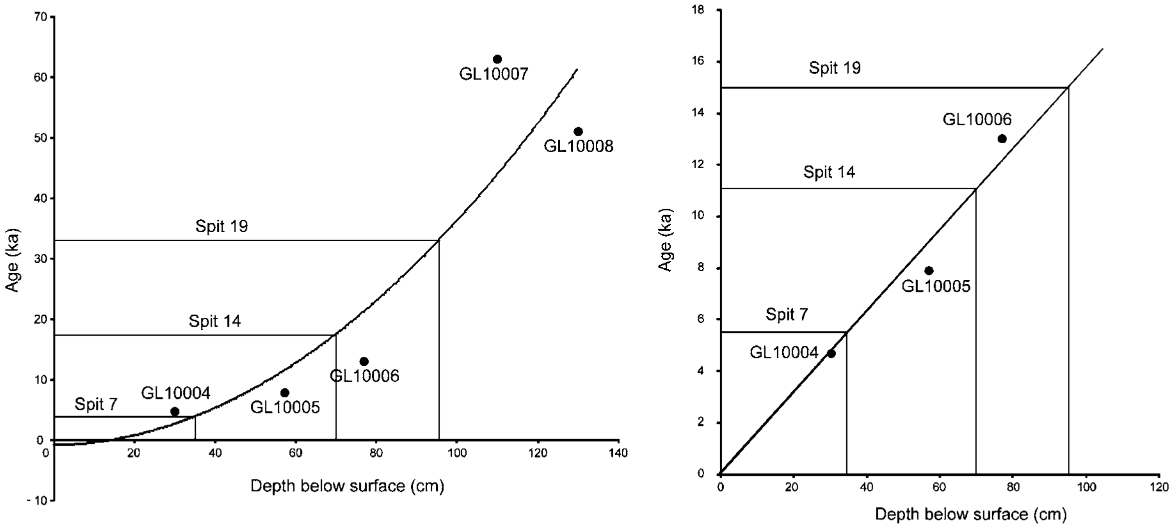

Figure 4 Age-depth models of the six OSL ages (GL10004-GL10009). Spits retaining the main archaeological assemblages are also shown. Left: A two-order polynomial model incorporating all OSL ages ($y = 6800.19629086x^2 + 10999.87907629x + 176.74012324$; $r^2 = 0.99$). This model was considered to indicate the assemblages were considerably older than the surrounding OSL ages. Right: A linear model incorporating only OSL ages surrounding the archaeological assemblages ($y = 15799.76185751x$; $r^2 = 0.98$). This model was considered to more accurately estimate the ages of the assemblages based on a range of factors (see text for discussion).

Table 3 Raw material types by spit.

Spit	Chert	Silcrete	Quartzite	Quartz	Fine Grained Siliceous	Tuff	Volcanic	Total
1	0	4	1	1	3	1	0	10
2	0	7	0	0	2	3	0	12
3	0	9	2	0	3	2	1	17
4	0	6	1	1	2	3	1	14
5	0	8	2	0	0	3	0	13
6	0	6	1	0	1	5	1	14
7	0	18	0	0	3	6	2	29
8	0	8	1	0	0	7	0	16
9	0	13	3	0	2	8	0	26
10	0	31	0	0	2	10	0	43
11	0	35	3	0	4	35	2	79
12	0	19	2	1	2	62	1	87
13	0	18	8	3	0	171	2	202
14	0	10	10	2	0	208	2	232
15	0	7	5	1	3	84	3	103
16	0	7	2	2	0	35	5	51
17	0	6	3	5	0	37	20	71
18	0	3	1	14	1	41	25	85
19	0	1	1	2	0	91	3	98
20	0	0	1	1	0	55	4	61
21	0	2	1	1	1	31	0	36
22	1	0	1	1	1	20	1	25
23	0	1	0	0	0	11	0	12
24	0	0	0	0	1	8	0	9
25	0	0	0	0	0	5	0	5
26	0	0	0	0	0	1	0	1
27	0	0	0	0	0	1	1	2
28	0	1	0	0	0	1	0	2
29	0	0	0	0	0	1	0	1
30	0	0	0	0	0	0	0	0
Total	**1**	**220**	**49**	**35**	**31**	**946**	**74**	**1356**

Table 4 Average and range (standard deviation) measurements for complete flakes between selected spits.

Spits	Length (mm)	Length range (mm)	Width (mm)	Width range (mm)	Thickness (mm)	Thickness range (mm)	Cortex (%)	Cortex range (%)	Platform width (mm)	Platform width range (mm)	Platform thickness (mm)	Platform thickness range (mm)
7-12	16.0	13.1	14.2	8.9	3.1	3.3	5.7	20.5	8.5	7.2	2.3	2.5
13-17	20.1	12.9	21.8	13.6	4.7	4.1	7.6	20.7	14.8	11.6	4.3	4.6
18-21	19.7	9.6	19.7	11.7	5.0	3.4	9.2	28.0	14.1	9.7	4.3	3.5

There was no clear break between the soil profile and the parent sand because bioturbation was evident in all parts of the profile above 95 cm bs. The three archaeological assemblages were situated within Soil Units 1iv, 3i and 3iii (Spits 7 to 20), these being the base of the A-horizon and the disturbed and undisturbed weakly differentiated subsoil (B-horizon).

Chronology

While radiocarbon dating was considered, no charcoal or other suitable material was identified in a secure context. Excavation revealed that extensive burning had occurred in European times and this led to small amounts of recent charcoal moving down through the upper 1 m of deposits, and no charcoal was identified in the lower spits.

Six OSL samples were obtained and processed at the University of Gloucestershire, UK (Table 1 and Figure 2). The samples were prepared using standard procedures. Dose equivalent to the natural luminescence signal was estimated through the Single-Aliquot Regenerative-dose (SAR) protocol (Murray and Wintle 2000, 2003) using 12 multigrain 8 mm aliquots. For each sample, Dose Recovery, Low and High Repeat-Regenerative doses, post-IR OSL (Duller 2003) and partial resetting of OSL prior to burial (Bailey *et al.* 2003) were assessed. The rate of dose exposure was assessed from each sample's radiochemistry (Adamiec and Aitken 1998) using a laboratory-based Ortec GEM-S high purity Ge coaxial detector system, accounting for modulation forced by grain size (Mejdahl 1979) and present moisture content (Zimmerman 1971). Cosmogenic Dr values were calculated on the basis of sample depth, geographical position and matrix density (Prescott and Hutton 1994).

The OSL ages provided a sequential chronology through the soil profile with no reversals apparent. Samples GL10004 and GL10005 revealed no internal inconsistencies; however, other samples were identified as having some complications and the profile was visibly bioturbated:

- All retained an over-dispersion of repeat regenerative-dose data, generally forced in the high-dose region, yet only samples GL10007 and GL10009 were inconsistent with the repeat ratio range of 0.9-1.1 prescribed as reliable by Murray and Wintle (2000);
- GL10006 and GL10009 exhibited some partial bleaching (i.e. where some grains may not have been fully reset prior to burial);
- GL10007 and GL10008 retained feldspar contamination (where inclusion of feldspars within the quartz grains that could not be removed contribute erroneously to the OSL signal, potentially generating an age underestimate); and,
- GL10009 failed dose recovery checks and exhibited partial bleaching, rendering its age estimate the least reliable of the suite.

Whilst these measures of analytical validity do not necessarily imply inaccuracy within the majority of derived age estimates, it is appropriate to report and consider their potential influence on the chronology of the sequence.

The three samples taken from the greatest depth below the surface were recovered from Soil Unit 3iv and the base of 3iii. Analysis of these samples indicates an age of between 51 ka and 127 ka for Soil Unit 3iv. Given the breadth of analytical issues in GL10009 and the presence of feldspar contamination in GL10008, we can conclude that the sand was deposited shortly before >51 ka ago. This provides a first measure of the antiquity of the Pitt Town Sand, which has traditionally been considered to be Pleistocene in age, or even Pliocene, based on limited geological evidence and topographic position (Smith and Clark 1991). The determined ages also broadly relate to the basal age for other fluvial terrace sand bodies at Windsor (149 ka) and Parramatta (50-58 ka) (Mitchell 2010b, 2011).

The archaeological assemblages were recovered from Spits 7-20 (Soil Units 1iv, 3i and 3iii) with a focus on Spits 7, 14 and 19. When applying an age-depth model to the OSL ages, a two-order polynomial proves one of the best fits ($r^2 = 0.99$) (Figure 4). However, by incorporating the lower ages (GL10007 and GL10008), this model suggests the middle part of the soil profile containing the lower artefact assemblages dates between ca 18-32 ka. This is contrary to most of the OSL ages in this part of the soil profile (GL10005 and GL10006, where GL10005 appears analytically faultless) and other typological evidence (see discussion below). By removing GL10007 and GL10008 and using only the upper ages, a linear age-depth model (Figure 4) provides a more satisfactory bracket for the lower assemblages between ca 11-15 ka. In both age-depth models, the upper silcrete-dominated assemblage begins in the early Holocene, with a proliferation of backed artefacts between ca 4 and 5.5 ka.

The authors are currently working on two other sites at Pitt Town, and six further OSL dates have been analysed from the sand body. These dates bracket a similarly deeply-buried tuff assemblage to >9.5 ka and >14 ka in two different areas, providing further confirmation of the general age of the lower artefact assemblage to the terminal Pleistocene. An upper silcrete assemblage was also recovered in association with dates of between 4.5 and 6 ka. Inter-grain analysis of samples GL10007 and GL10008 from PT12 may help to distinguish between the effects of feldspar contamination and possible bioturbation in producing age estimates higher than those of other indicators.

Lithics

The PT12 excavations recovered 1356 stone artefacts at an average of $46/m^2$, with several individual squares having more than 50 artefacts each (Table 2). A total of 134 complete flakes were present. A further 469 non-diagnostic pieces of stone, dominated by tuff (n=268) and silcrete (n=135), and/or unworked pebbles/pebble fragments (n=30) were also documented, but excluded from analysis. The stone artefact assemblage was dominated by tuff (n=946) and silcrete (n=220), with lesser proportions of quartzite (n=49), quartz (n=35), volcanic (n=74), fine-grained siliceous (n=31) and chert (n=1) (Table 3).

The artefacts could be divided into three broad horizons based on composition and spatial location (Table 2 and Figure 5): (1) an upper horizon composed of primarily silcrete artefacts, including backed blades; (2) a middle horizon of amorphous pebble tools and manuports composed of tuff, with lesser occurrences of volcanic and quartzite; and, (3) a lower horizon identical to (2) in composition, and arbitrarily separated based on depth.

The upper artefact horizon commenced simultaneously with the decline of the middle horizon and was primarily recovered from Spits 7-12, with lesser occurrences above and below this level (Figure 5). The horizon was dominated by silcrete flakes and flaked pieces. It included 21 backed blades composed of silcrete (n=18), tuff (n=2) and fine-grained siliceous (n=1), seven of which were recovered from Spit 7. The majority of the cores recovered during the excavation came from the upper horizon (n=7; 78%). Several of the cores were elongated and, along with numerous platform re-directing flakes, indicate that the production of backed blades was occurring at the site. While not recovered as part of this study, an earlier study of PT12 also recovered two silcrete thumbnail scrapers from the upper units (AHMS 2006). No eloueras or bipolar flakes were evident in the assemblage.

The middle and lower artefact horizons both retained similar artefact compositions (Tables 2 to 4). No definitive break between

Table 5 Average weight of individual artefacts by raw material type and spit. The overall assemblage values are also presented.

Spit	Silcrete			Tuff			Volcanics			Quartzite			Total Assemblage	
	Weight (g)	No. of artefacts	Weight/no. of artefacts	Weight (g)	No. of artefacts	Weight/no. of artefacts	Weight (g)	No. of artefacts	Weight/no. of artefacts	Weight (g)	No. of artefacts	Weight/no. of artefacts	Weight/no. of artefacts	Range
1	6.3	4	1.6	8.4	1	8.4	0.0	0	0.0	6.5	1.0	6.5	18.7	3.4
2	3.6	7	0.5	2.0	3	0.7	0.0	0	0.0	0.0	0.0	0.0	1.6	0.3
3	37.0	9	4.1	1.4	2	0.7	5.7	1	5.7	0.2	2.0	0.1	11.1	2.3
4	2.7	6	0.5	4.0	3	1.3	0.5	1	0.5	0.8	1.0	0.8	3.7	0.4
5	9.2	8	1.2	3.1	3	1.0	0.0	0	0.0	0.3	2.0	0.2	2.5	0.5
6	1.3	6	0.2	3.1	5	0.6	0.1	1	0.1	6.8	1.0	6.8	8.1	2.5
7	12.2	18	0.7	2.3	6	0.4	5.7	2	2.9	0.0	0.0	0.0	4.3	1.0
8	7.6	8	1.0	2.6	7	0.4	0.0	0	0.0	11.2	1.0	11.2	12.5	4.2
9	12.5	13	1.0	10.2	8	1.3	0.0	0	0.0	10.3	3.0	3.4	12.7	3.8
10	81.7	31	2.6	4.1	10	0.4	0.0	0	0.0	0.0	0.0	0.0	3.2	1.0
11	34.0	35	1.0	122.9	35	3.5	1.1	2	0.6	3.8	3.0	1.3	15.2	2.5
12	16.2	19	0.9	123.1	62	2.0	1.8	1	1.8	0.5	2.0	0.3	7.3	0.7
13	14.5	18	0.8	301.8	171	1.8	5.5	2	2.8	21.0	8.0	2.6	28.0	7.6
14	65.0	10	6.5	466.7	208	2.2	4.2	2	2.1	3.9	10.0	0.4	18.3	2.3
15	12.7	7	1.8	94.9	84	1.1	12.0	3	4.0	0.3	5.0	0.1	7.4	1.5
16	7.4	7	1.1	69.9	35	2.0	4.6	5	0.9	14.1	2.0	7.1	62.8	16.6
17	10.8	6	1.8	42.8	37	1.2	49.6	20	2.5	1.2	3.0	0.4	12.2	1.9
18	5.2	3	1.7	195.5	41	4.8	92.9	25	3.7	0.9	1.0	0.9	13.6	1.8
19	0.1	1	0.1	208.3	91	2.3	3.9	3	1.3	76.8	1.0	76.8	80.9	28.8
20	0	0	0.0	168.9	55	3.1	15.3	4	3.8	5.4	1.0	5.4	12.4	2.3
21	0.2	2	0.1	34.3	31	1.1	0.0	0	0.0	2.9	1.0	2.9	30.2	9.0
22	0	0	0.0	113.7	20	5.7	20.6	1	20.6	7.0	1.0	7.0	37.2	7.3
23	0	1	0.0	66.3	11	6.0	0.0	0	0.0	0.0	0.0	0.0	6.0	2.3
24	0	0	0.0	1.7	8	0.2	0.0	0	0.0	0.0	0.0	0.0	0.3	0.1
25	0	0	0.0	1.8	5	0.4	0.0	0	0.0	0.0	0.0	0.0	0.4	0.1
26	0	0	0.0	0.1	1	0.1	0.0	0	0.0	0.0	0.0	0.0	0.1	0.0
27	0	0	0.0	0.1	1	0.1	0.7	1	0.7	0.0	0.0	0.0	0.8	0.3
28	0.1	1	0.1	0.1	1	0.1	0.0	0	0.0	0.0	0.0	0.0	0.2	0.0
29	0	0	0.0	0.4	1	0.4	0.0	0	0.0	0.0	0.0	0.0	0.4	0.2
30	0	0	0.0	0	0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.4	0.0
Total	**340.3**	**220**		**2054.5**	**946**		**224.2**	**74**		**173.9**	**49**			

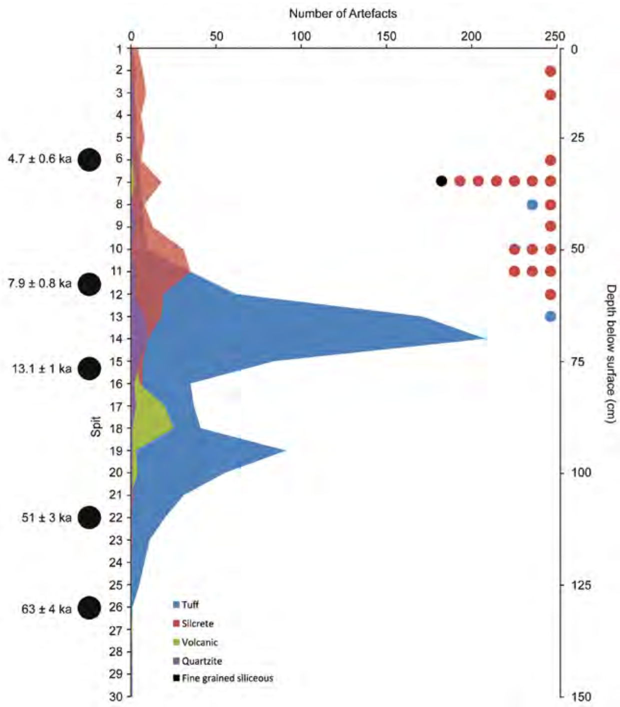

Figure 5 Graph showing number of artefacts by spit, depth and age. Individual backed blades recovered (n=21) are indicated by circles in the top right. Only the five main raw material types are shown.

the two horizons was evident but, broadly speaking, the middle horizon occurred between Spits 7-12, and the lower horizon between Spits 18-21 (Figure 5). Both horizons were dominated by tuff (85% and 78%, respectively) with smaller peaks of volcanic and quartzite materials. The only quartz artefacts recovered from the site were from these lower horizons. Both horizons exhibited amorphous pebble tools and frequent unworked pebbles or manuports. Artefact production was relatively simple, with a succession of flakes being struck from tuff pebbles before one was selected for further reduction. Flakes were typically larger in these horizons (Table 4), though much more variable compared to the silcrete-dominated horizon above. Few tools could be discerned, with only two poorly formed scrapers being recovered from Spits 22 and 23. A grindstone piece was also identified, the examination of which using low magnification (10x) microscopy revealed no evidence of use-wear or other damage.

By weight the raw materials also showed a division between the upper and the two lower horizons (Table 5). The overall tuff (2054.9 g), quartzite (173.9 g) and volcanic (224.2 g) components of the assemblage were mostly constrained to Spits 13-21, while the comparatively minor silcrete component weighed only 340.3 g and largely occurred in Spits 7-12. When considering the average weight of individual artefacts, the majority of heavier artefacts were present in the lower horizons (Spits 13-22) (Table 5). Tuff (1.77 g), quartzite (4.47 g) and volcanic (1.80 g) artefacts proved on average to be individually heavier than those manufactured from silcrete (0.97 g), although due to their amorphous nature variation was higher, with values ranging from 0.1 to 76.8 g/artefact.

Based on the Eastern Regional Sequence (Hiscock and Attenbrow 2005; McDonald 2008), the upper horizon has several characteristics of the early Bondaian period (4-8 ka), including the rapid decline in the use of tuff in preference to silcrete, and an absence of bipolar flaking. However, the appearance and proliferation of backed artefacts in Spits 7-12, as well as small elongated cores, suggests that a middle Bondaian age (i.e. 1-4 ka) is more likely. The occurrence of asymmetric flaking and an absence of eloueras in this horizon also suggest the latter. The lack of bipolar flaking and the absence of a diversification of raw materials (most notably quartz) in the upper horizon suggest that the late Bondaian period is not present at the site. The lower two horizons both have a composition that suggests the pre-Bondaian or Capertian period. Specifically, the assemblage demonstrated a preference for tuff with augmentation from quartz and volcanic materials; the assemblage was amorphous and simple in reduction strategy; and artefacts were variable in both size and weight.

While not a significant part of the overall assemblage, several large river cobbles (n=9) were recovered from the occupation layers (Figure 6). The majority were composed of tuff, volcanics and quartzite, which reflect the use of the river as a raw material source. Of the 134 complete flakes recovered only 16 (12%) retained any cortex, which was in all cases consistent with a river cobble cortex (similar to those recovered intact). This further suggests an exploitation of nearby river gravels. However, most of the complete flakes (n=118) did not retain cortex, indicating that the site was also the focus of later stage reduction in artefact manufacture.

Horizontal spatial analysis of each of the discrete assemblages indicates that each was centred in a different part of the open area excavation (Figure 7). This suggests that they each resulted from a different phase of occupation and lessens the likelihood of bioturbation explaining their vertical distribution. In contrast to the geomorphology, the assemblages revealed little to no evidence of bioturbation, as there was an absence of any form of damage or wear on the artefacts, and the nature and shape of the assemblage by spits was tightly constrained. A lack of bioturbation is also shown by the clear division between the silcrete and tuff assemblages, and the restricted presence of backed blades in the upper deposits. There is little evidence of extensive mixing between these two assemblages or artefact types (a silcrete backed blade within the tuff assemblage, for example) that would suggest extensive bioturbation. Further, conjoin analysis was undertaken on the lower assemblages and four separate conjoins of two or more artefacts were identified in Squares J2/Spit 19, J3/Spit 19, J4/Spit 19, B9/Spit 16 and B10/Spit 17. These findings suggest that the lower assemblage was vertically displaced by <10 cm and horizontally by <100 cm. Ongoing analysis of two other sites within the sand body has shown several further conjoin refits where vertical displacement is <30 cm and more commonly <5 cm, further lending confidence to the *in situ* nature of the assemblage.

Discussion

Site Formation

Interpretation of this site presented a major challenge. The core of the problem was that the determined ages and the age depth curve could be interpreted in two ways, neither of which was unequivocally supported by field evidence. A conventional interpretation of the curve would be that the ages become

Figure 6 Two examples of tuff river cobbles recovered from (left) Square E4, Spit 14 (70 cm bs) and (right) Square C10, Spit 13 (65 cm bs).

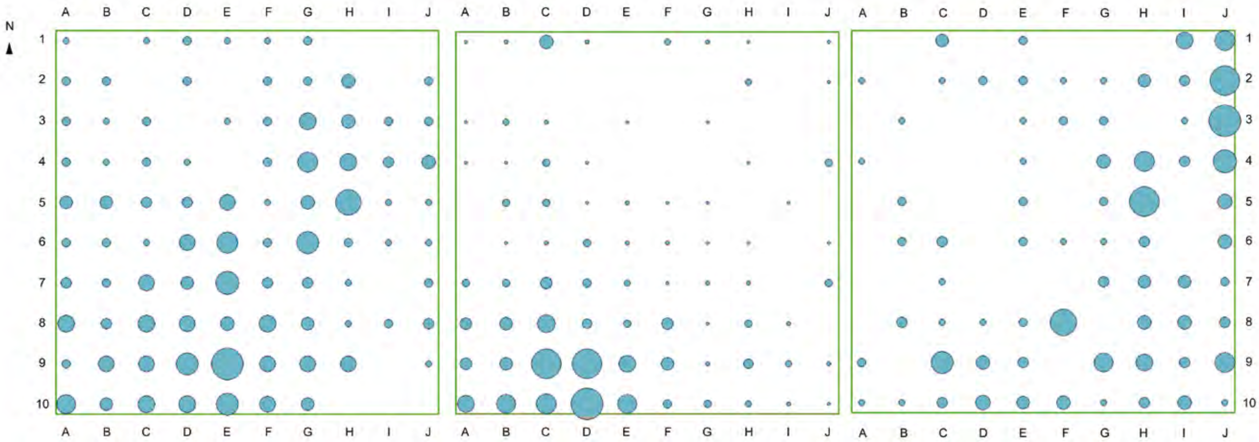

Figure 7 Frequency chart showing horizontal distribution of flaked artefacts. From left to right: the upper silcrete assemblage (Spits 1-12); the upper tuff-dominated assemblage (Spits 12-16); and, the lower tuff-dominated assemblage (Spits 17-25). The variation in spatial distribution between the three assemblages suggests bioturbation is not a major factor in the distribution of artefacts at PT12.

younger toward the surface as new sediment accumulated on the site, with the archaeology approximately dated by the material that encloses it. Using an age-depth model (and assuming no significant disconformities within Soil Units 3i and 3iii), the soil profile from which all of the archaeological material was recovered is less than ca 17 ka (Figure 4). Based on the inferred age-depth model, the lower artefact assemblage appears to date to between ca 15-11 ka, while the upper assemblage dates to between ca 10-5 ka. However, many of the OSL ages have some internal inconsistencies and should be considered tentative.

Alternatively, the curve might also represent a bioturbation decay curve, where the youngest ages are near the surface because of rapid mixing and the oldest ages are near the base of the section because either the rate of mixing is slower, or far fewer quartz grains reach the surface and return in a discharged condition. In this case it is known that artefacts will be lowered through the profile by bioturbation and the age of the artefacts or archaeological events is essentially unrelated to the apparent age of the material in which they are found. Given that neither a bioturbation model nor a sediment accumulation model could be fully supported from the field evidence, the following conclusions are presented as a consensus view.

The upper part of the Pitt Town Sand appears to have been deposited as an aeolian source-bordering dune some time prior to 50 ka. Between the period 50-17 ka, these sands were subject to soil formation and aeolian reworking. Between ca 15-10 ka (Spits 13-23, Soil Unit 3iii), and possibly earlier, people occupied the area sporadically. This occupation was composed of at least two phases centred on ca 15 ka and ca 11 ka (Spits 14 and 19, Soil Unit 3iii). The two artefact assemblages for this period are dominated by amorphous simple flakes struck from river cobbles, sometimes worked into scrapers, and can be characterised as typical of the Capertian (pre-Bondaian) period – a typology frequently found in sites across Australia in levels older than 10 ka. The presence of river pebble cortex and the diverse nature of the raw materials (including quartzite, quartz and a green volcanic stone) all suggest the exploitation of local gravel beds probably exposed with the entrenchment of the Nepean-Hawkesbury River due to lower sea-levels at this time (comparable gravel beds are still evident upstream today toward Penrith). McDonald (2008:349) reached similar conclusions in her study of prehistoric art and information systems in the Sydney Basin:

> During the Pleistocene, groups appear to have been highly mobile, travelling considerable distances between sites. At this time, the focus of stone acquisition was on the Hawkesbury- Nepean River gravels. The cores and tools which people carried were quite large, but they used the stone sparingly, leaving few artefacts behind, and rarely discarding their cores (which acted as portable quarries).

Overlying the Capertian assemblage in Soil Units 1iv and 3i is another assemblage comprised primarily of silcrete and with frequent backed blades. The use of silcrete suggests an increase in foraging range, since no local source is known in Pitt Town. It was most likely obtained from other parts of the west Cumberland Plain, such as Wilberforce, Freemans Reach, Riverstone or Plumpton Ridge, all 5 km or more from the study area (Corkhill 1999). Based on OSL ages, this assemblage appears to have commenced being deposited at ca 10 ka, with a proliferation of backed artefacts occurring ca 5.5 ka. Neither of the OSL ages in this part of the sequence were problematic, and recent work by the authors immediately east of this study show peak silcrete numbers similarly occurring at ca 4.5 ka and 6 ka. It is, therefore, possible that this silcrete assemblage represents an early mid-Holocene use of the region, and reflects a very early appearance of backed blade reduction techniques.

However, many studies across Australia, and more locally, indicate that the appearance of backed blades and associated artefacts generally began in the mid- to late Holocene (<5000 years BP), with a proliferation in the last 2000-3000 years. While some recent studies have shown that backed blades do occur in the early Holocene (AHMS 2011; Hiscock and Attenbrow 1998), and even as individual artefacts into the Pleistocene (Slack *et al.* 2004), even these studies broadly follow the proliferation model outlined above. Therefore, while plausible, we recommend caution in assigning ages of 5-10 ka for the upper assemblage at PT12.

Several sites in the region have identified hiatuses in occupation/use of the area following the Capertian occupation (Stockton and Holland 1974), and this may similarly have occurred at PT12. Such a hiatus could not be determined on geomorphological grounds but, if present, would have occurred around Spit 11 and would be in the order of 4000 years to constrain the upper assemblage to the more commonly quoted last 5000 years. Based on the Eastern Regional Sequence, the lack of eloueras or other bipolar flakes in the upper assemblage suggests that the area was abandoned before the occurrence of the post-Bondaian at ca 1.8 ka.

Acknowledging that the upper assemblage is situated within the top 50-60 cm of the soil profile, which is known to have been heavily disturbed by historical activities, it is possible that chronological inaccuracies and the absence of eloueras and bipolar flakes may reflect biological and taphonomic changes, rather than cultural ones. Further, eloueras and bipolar flakes are relatively sparse in many sites in this area, and the lack of these types may be due to the small size of the excavation rather than a sign of cultural abandonment.

Specific use and activities occurring during the various occupation phases cannot be determined based on the artefact assemblage. However, the lower assemblages reveal elements of early reduction phases, suggesting a dedicated exploitation of the river gravel beds for raw materials. Kohen *et al.* (1984:8) noted similar findings for KII:

> The increasing use of immediately local stone in the upper phases, if not culturally determined ... might be best explained by progressive exposure of the Nepean gravels following Holocene entrenchment of the river through clayey sands which mantle the gravels.

Kohen *et al.* (1981) suggested that such down-cutting and exposure of Nepean gravels occurred in the mid- to late Holocene, although at both KII and PT12 it seems more likely that the exposure of gravels occurred in the terminal Pleistocene, given the abundance of tuff, quartzite and basalt during the earlier time intervals. Any entrenchment of the river in response to lower sea-level must have occurred prior to sea-level reaching or exceeding present day, in other words by ca 7 ka (Lewis *et al.* 2008) and potentially by 9.4 ka (Sloss *et al.* 2007).

The upper assemblage contained several elongated cores, indicating that the production of backed blades was undertaken on site. This may further suggest an extended occupation of the area, given the level of time and effort required to produce these types of tools. As the number of artefacts recovered from the upper deposits was significantly less than the lower assemblage, this suggests a subdued reoccupation of the area in the late Holocene, a pattern also noted in other recent excavations in the area by the authors.

We acknowledge that these conclusions are based on a small salvage area representing <0.05% of the overall levee landform. However, the findings of the salvage are comparable with several earlier and ongoing excavation programs in the region. Currently, three test excavations involving small test-pits across the levee/dune landform in four different areas across a 2 km^2 area of Pitt Town have been undertaken, totalling approximately 200 m^2 (AHMS 2006, in prep.a; Comber 2004). A further 150 m^2 has recently been completed as part of a testing and salvage program adjacent to Bathurst Street (AHMS in prep.b). In all cases, these excavations recovered a deep sand deposit (generally 1-1.5 m) containing a bimodal distribution of tuff overlain by silcrete artefacts. Sterile sand was frequently found between the two assemblages, with the upper assemblage routinely having lower densities than the lower assemblage. Therefore, while the results discussed in this paper explore only a small part of the landform, we argue it is reflective of the wider archaeological picture of the Pitt Town region.

Regional Context

A comparison between the findings of this excavation and other studies along the Nepean River reveal striking similarities.

An excavation of the KI rockshelter identified seven phases of occupation (Stockton 1973). Phase VI, the lowest deposit, contained a 'heavy archaic assemblage, with choppers and serrated flakes' primarily composed of chert (frequently confused with tuff and vice versa) (Stockton 1973:112). Stockton also indicated that quartz, basalt, porphyry and quartzite were evident in both the earliest and uppermost deposits. Overlying this deposit in Phases IV and V were increasing numbers of backed blades and other Bondaian artefacts composed primarily of chert. This site was not dated, though the similarities between Phases VI and IV/V of KI and Spits 11-20 and 7-11 of PT12, respectively, are clear.

When comparing KII with PT12 there are several correlations. Both sites contain a lower Capertian assemblage dominated by chert/tuff overlain by an upper Bondaian assemblage with increasing use of silcrete raw materials. KII's lower assemblage was dated to at least ca 16 ka (Beta-12423: 14,700±250 ^{14}C years BP), which corresponds with the GL10005 and GL10006 dates bracketing the lower assemblage in PT12. Kohen *et al.* (1984)

went on to demonstrate that the KII Capertian assemblage could be correlated with similar assemblages at other sites in NSW, which were frequently dated to >10 ka. The upper KII assemblage was dated to <4 ka years BP, while the age of the PT12 upper assemblage depends on the interpretation of the OSL ages, but was certainly deposited some time during the Holocene. Also of note within the KII sequence was the bimodal nature of the lower assemblage – identical to the situation at PT12. When considering the artefact densities of Phases V and VI in Square A of KII (Kohen *et al.* 1984:Table 7), the deposit retained two peaks of artefacts with a decline (almost a hiatus) in between. The uppermost of the two peaks at KII occurred around 13 ka, which agrees well with the upper peak at PT12 bracketed between 8 and 13 ka (centring on 11 ka). Little interpretation was provided by Kohen on the bimodal nature of the lower assemblage in KII, although, as outlined above, in PT12 it can be clearly shown as two different phases of occupation.

Further afield, rockshelters in the Capertee Valley near Glen Davis (some 70 km northwest of PT12), excavated by McCarthy (1964) and re-investigated by Johnson (1979), also demonstrate several correlations with PT12. At Capertee 3, Johnson (1979:94) identified that there was a,

> … practically sterile level after going through the peak concentration of Bondaian material. Below this sterile zone, artefact concentration rose again and it was apparent that the material was more massive, less well flaked and lacking specialised types of Bondaian.

The lower assemblage was characterised by large pieces of high quality white chert worked to produce large, well-shaped flakes, which appear visually very similar to the artefacts within the PT12 lower assemblages. A date of 7360±125 ^{14}C years BP (V-18) was obtained from a hearth in association with the lower assemblage at Capertee 3 (Bermingham 1966; McCarthy 1964). Further dates from nearby Noola rockshelter suggest ages of >11 ka for a similar artefact assemblage (Bermingham 1966). The upper assemblage and the appearance of backed artefacts was dated to <3 ka (Johnson 1979). As with PT 12, Capertee 3 similarly has an absence of eloueras and bipolar flakes in the upper deposits.

It is important to note that this apparent match between KI, KII, Capertee 3 and PT12 actually strengthens the archaeological case for phased occupation at PT12 and weakens the bioturbation case because KI, KII and Capertee 3 are all stratified rockshelter deposits where the effects of bioturbation might be expected to be minimal.

Conclusion

A salvage excavation of a stratified open site on the banks of the Hawkesbury River has recovered a 15,000 year record of Aboriginal exploitation and occupation. The excavation revealed a complex geomorphological sequence of fluvial and possible aeolian deposits, which has yet to be fully resolved. Site PT12 is situated within the wider cultural landscape of the Nepean/Hawkesbury River. Comparisons with other sites in the region, most notably Shaws Creek KI and KII, show good correlation and indicate a sporadic use of the region since the terminal Pleistocene (ca 15,000 years BP). Early occupation appears to have retained elements of Capertian/Core Tool and Scraper Tradition assemblages and exploited locally available raw materials, most likely exposed due to lowered sea-level and entrenchment of the Hawkesbury River (thereby exposing the underlying gravel beds). Along with that at KII, the lower assemblage from PT12 indicates two periods of increased occupation/visitation at ca 15 and 11 ka. Based on artefact numbers, peak occupation/visitation at PT12 occurred at ca 11 ka, possibly in response to the availability of this raw material resource.

Following the lower occupation of PT12, a more recent occupation dominated by silcrete raw materials occurred. Analytically reliable OSL dates indicate that this occupation, which included backed blade production, occurred in the early Holocene, between ca 5-10 ka. Excavations currently ongoing by the authors in other parts of the levee landform in Pitt Town have also returned dates indicating the appearance and use of silcrete materials (and backed blades) in the early to mid-Holocene. However, more generally, backed blade appearance and proliferation in this region has been constrained to the late Holocene, and hence we suggest these PT12 ages are treated with caution. While a definitive answer is not yet available, it is probable that an occupation gap of as much as 4000 years may have occurred between the PT12 lower and upper assemblages and, based on typological and regional grounds, the upper assemblage more likely dates to ca 4-2 ka. A similar hiatus has been reported at other sites on the Hawkesbury River and Blue Mountains.

The relative absence of tuff in the upper assemblage suggests its loss as a raw material in the mid-Holocene through burial by an aggrading Hawkesbury River. The loss of this resource may also be the reason why artefact numbers (*a priori* occupation/visitation) of the site appears to decline from the terminal Pleistocene into the Holocene. Other cultural processes may also have initiated the change from tuff to silcrete. The presence of backed blades composed of tuff in the upper assemblage suggests that some river cobbles may have still been available on the site, either through natural (e.g. the remains of large islets or deeply-incised channels into the gravel beds) or human processes (e.g. the caching of cobbles, mining the gravel beds or sourcing the stone from up river), and still used as a raw material resource into the Holocene.

PT12 may be one of a series of 'workshops' that have been previously identified along the Nepean River by both McCarthy (1948) and Kohen *et al.* (1984). While initially argued to be of late Holocene age, these sites are in similar environments and locations as PT12, and several open sites in the region have now been shown to date to at least 7 ka, such as Jamisons Creek and Regentville RS1. These workshops may have begun in some form in the terminal Pleistocene and appear to represent a systematic and extensive exploitation of the Nepean River system for both raw materials and probably food resources.

Of increasing importance is that PT12, along with many other sites in the Nepean River system, all show broad chronological correlations. With the exception of the disputed artefacts found in the Cranebrook Terrace dated to ca 40 ka (Nanson *et al.* 1987), the majority of sites indicate that the Nepean River system began to be occupied from ca 15 ka. This early phase of occupation was sporadic and probably only lasted 5000-7000 years. It is unclear why the use of the region, presumably high in resources, was occupied so late in the Pleistocene or so sporadically. Depending on the interpretation of the upper assemblage, either a very early appearance of backed blade production then occurred in the early Holocene, or more regionally, there was a hiatus in many sites. Climatically, this is a period of amelioration (Donders *et al.* 2007), and hence the Nepean River should have been attractive to ongoing use and occupation (further strengthening the argument for an early appearance of the Small Tool Tradition), but in many cases it does not appear to have been. At this time, access to locally derived raw material resources along the Hawkesbury River would have diminished, and this may have been an overriding consideration which led to a reorganisation of settlement patterns to other areas. Following the hiatus, the region was reoccupied and, as with other sites in Australia (e.g. Cosgrove *et al.* 2007; Lourandos and David 1998; Lourandos and Ross 1994; Smith and Ross 2008; cf. Attenbrow 2004; Hiscock 2008; Holdaway *et al.* 2008; Ross 1986; Rowland 1989), this appears to represent a period of increased population and/or exploitation of the Hawkesbury region although artefact numbers indicate the reoccupation of the Pitt Town region was actually subdued compared with other parts of the catchment.

Further research is needed to develop the OSL chronology, to gain a greater understanding of the geomorphological creation of the sand body. Additional phases of work are proposed for other parts of the sand body and these issues will form the focus of future publications. Interim findings of two areas currently being worked on in the region appear to confirm many of the results of this paper, most notably a deeply deposited tuff-dominated assemblage dated to >10 ka that appears to be widespread in the Pitt Town region. In conclusion, regionally speaking, the banks of the Hawkesbury River are being rapidly developed or exploited by industry and sites such as PT12 are becoming rare. A dedicated focus on researching the 'surface workshops' of the Hawkesbury-Nepean River is needed to gain a better understanding of issues, including: the terminal Pleistocene occupation and use of the region; why the region was occupied so late in the Pleistocene; to confirm the possible presence of a hiatus in these sites during the early Holocene; and to further characterise the apparent subdued re-occupation of the region in the late Holocene.

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