A Pleistocene date at Chelsea Heights, Victoria: evidence for Aboriginal occupation beneath the Carrum Swamp

Jim Wheeler, Alan N. Williams, Stacey Kennedy, Phillip S. Toms and Peter Mitchell

Abstract

Compliance-based test excavations at Chelsea Heights recovered a small number of flaked stone artefacts from a sand body located beneath peat deposits that were identified as part of the former Carrum Swamp. The low elevation of the study area (<2 m ASL) suggests that the upper peat deposits formed following inundation of the coastline during the early- to mid-Holocene (~7 ka) (Lewis et al. 2013), and formed a cap over the artefact-bearing sand deposits. Optically Stimulated Luminescence (OSL) age estimates obtained from the sand body indicate that the underlying sands and associated artefacts accumulated between 32 ± 4 ka and 30 ± 3 ka, with burial of the deposit by 10 ± 1 ka. Due to low lithogenic dose rates, additional modelling of the age estimates was undertaken, indicating a more conservative age of artefact deposition at ~25–23 ka, and burial of the sand unit by ~5 ka. Although few artefacts were recovered from the site, and the scope of investigations was limited by the size of the study area, the results suggest that sealed archaeological deposits, which potentially pre-date the Last Glacial Maximum (LGM), exist beneath the Carrum Swamp peats. This highlights the need for future studies in the region to explore deposits that may otherwise be considered to have low archaeological potential.

Introduction

Studies undertaken to the southeast of Melbourne have demonstrated that Aboriginal stone artefact deposits are prevalent within stable sand dune landforms (Smith 1991). For example, investigations undertaken at Bend Road, Keysborough identified three distinct artefact horizons within sediments formed during the Pleistocene through to the mid- to late-Holocene, indicating the potential for archaeological deposits of considerable antiquity within dune landforms (Hewitt and Allen 2010). While the potential of these landforms is now becoming apparent, gaps still exist in our knowledge of where these features occur, and how they were utilised by Aboriginal people in the past.

Chelsea Heights is a small residential suburb situated 30 km southeast of Melbourne (Figure 1). Prior to reclamation works which commenced in the late-nineteenth century, the area formed part of the Carrum Swamp system. Carrum Swamp covered an area of 4,452 ha between Mordialloc and Frankston, extending from the coastal dunes of Port Phillip Bay to ~5 km inland (Whitehead 1988). It formed part of a complex system of barrier dunes and swamps (identified herein as the ‘Sixth Avenue/Wells Road dune’ in this area; Figure 2). These coastal barrier dune systems were constructed by waves and onshore winds at, and just above, sea-level (e.g. Sloss et al. 2007). Given that formation occurred through marine processes, the elevation of the Sixth Ave/ Wells Rd dune is similar to that of the Nepean Highway dune, suggesting two possible ages for its construction: at ~7 ka, when mid-Holocene high-stand sea-levels reached this elevation (Lewis et al. 2013), or; during the penultimate interglacial period (~150–120 ka), when sea-levels were ~3 m higher than at present (Lambeck and Chappell 2001).

The investigations at Chelsea Heights have made an important contribution to understanding the age of the Sixth Ave/Wells Road dune, aspects of its formation history, and its relationship with the Carrum Swamp system. This paper focuses on the results of compliance-based archaeological investigations within Chelsea Heights, where archaeological materials were recovered from beneath the Carrum Swamp. We discuss a number of possible geomorphic explanations for the sedimentary sequence and deposition of Aboriginal cultural material identified at Chelsea Heights. We raise important questions about the conventional view of the geomorphic history of the Carrum Swamp, and current approaches to archaeological investigations and assessments of Aboriginal places within this region.

A Pleistocene date at Chelsea Heights, Victoria: evidence for Aboriginal occupation beneath the Carrum Swamp

Jim Wheeler, Alan N. Williams, Stacey Kennedy, Phillip S. Toms and Peter Mitchell

Abstract

Compliance-based test excavations at Chelsea Heights recovered a small number of flaked stone artefacts from a sand body located beneath peat deposits that were identified as part of the former Carrum Swamp. The low elevation of the study area (<2 m ASL) suggests that the upper peat deposits formed following inundation of the coastline during the early- to mid-Holocene (~7 ka) (Lewis et al. 2013), and formed a cap over the artefact-bearing sand deposits. Optically Stimulated Luminescence (OSL) age estimates obtained from the sand body indicate that the underlying sands and associated artefacts accumulated between 32 ± 4 ka and 30 ± 3 ka, with burial of the deposit by 10 ± 1 ka. Due to low lithogenic dose rates, additional modelling of the age estimates was undertaken, indicating a more conservative age of artefact deposition at ~25–23 ka, and burial of the sand unit by ~5 ka. Although few artefacts were recovered from the site, and the scope of investigations was limited by the size of the study area, the results suggest that sealed archaeological deposits, which potentially pre-date the Last Glacial Maximum (LGM), exist beneath the Carrum Swamp peats. This highlights the need for future studies in the region to explore deposits that may otherwise be considered to have low archaeological potential.

Introduction

Studies undertaken to the southeast of Melbourne have demonstrated that Aboriginal stone artefact deposits are prevalent within stable sand dune landforms (Smith 1991). For example, investigations undertaken at Bend Road, Keysborough identified three distinct artefact horizons within sediments formed during the Pleistocene through to the mid- to late-Holocene, indicating the potential for archaeological deposits of considerable antiquity within dune landforms (Hewitt and Allen 2010). While the potential of these landforms is now becoming apparent, gaps still exist in our knowledge of where these features occur, and how they were utilised by Aboriginal people in the past.

Chelsea Heights is a small residential suburb situated 30 km southeast of Melbourne (Figure 1). Prior to reclamation works which commenced in the late-nineteenth century, the area formed part of the Carrum Swamp system. Carrum Swamp covered an area of 4,452 ha between Mordialloc and Frankston, extending from the coastal dunes of Port Phillip Bay to ~5 km inland (Whitehead 1988). It formed part of a complex system of barrier dunes and swamps (identified herein as the ‘Sixth Avenue/Wells Road dune’ in this area; Figure 2). These coastal barrier dune systems were constructed by waves and onshore winds at, and just above, sea-level (e.g. Sloss et al. 2007). Given that formation occurred through marine processes, the elevation of the Sixth Ave/ Wells Rd dune is similar to that of the Nepean Highway dune, suggesting two possible ages for its construction: at ~7 ka, when mid-Holocene high-stand sea-levels reached this elevation (Lewis et al. 2013), or; during the penultimate interglacial period (~150–120 ka), when sea-levels were ~3 m higher than at present (Lambeck and Chappell 2001).

The investigations at Chelsea Heights have made an important contribution to understanding the age of the Sixth Ave/Wells Road dune, aspects of its formation history, and its relationship with the Carrum Swamp system. This paper focuses on the results of compliance-based archaeological investigations within Chelsea Heights, where archaeological materials were recovered from beneath the Carrum Swamp. We discuss a number of possible geomorphic explanations for the sedimentary sequence and deposition of Aboriginal cultural material identified at Chelsea Heights. We raise important questions about the conventional view of the geomorphic history of the Carrum Swamp, and current approaches to archaeological investigations and assessments of Aboriginal places within this region.
Figure 1. Aerial photograph showing the location of the study area. (Basemap source: Nearmap)

Figure 2. Schematic section from Port Phillip Bay (A) through the site to the Carrum Swamp (B). The sands on the western side of the site (vertical hatching) are younger than those on the eastern side (horizontal hatching).
Study area and methods

Archaeological and Heritage Management Solutions Pty Ltd (AHMS) undertook archaeological test excavations at a proposed development site in Chelsea Heights, as part of a Cultural Heritage Management Plan assessment (Figure 1). The investigations involved the controlled manual excavation of thirteen 1 m² test pits, which were set on a series of transects traversing the site (Figure 3). A further two 3 m² salvage areas were excavated within the southern portion of the study area, to further examine the initial findings. All excavations were done by hand, following 0.1 m spits in contiguous 1 m² squares (where relevant). All excavated material was dry-sieved through a 5 mm screen. Soil and dating samples were recovered from sections of the completed excavations. Excavations continued until sterile deposits or the water table were reached, which varied between 0.8–0.9 m below ground surface. Further information about the excavations can be found in the report by AHMS (2012).

Excavation results

Sedimentology and artefact deposition

Test excavations revealed thick peat deposits, interpreted as a layer formed under swamp conditions, overlying a sand body. The soil units included (Figure 4):

- Upper A1-horizon: brownish-black (10YR 2/2), fine, sandy loam (i.e. fibric peat) with high organic content. Analysis of the sediments indicated some evidence for small and occasional invertebrate burrowing, and sporadic rounded invertebrate faecal pellets of dark organic matter (diameter 0.5 mm). The presence of the pellets was interpreted as reflecting bioturbation, which may have only become significant after drainage of the swamp during the nineteenth century;

- Lower A2-horizon: black (10YR 1.7/1), humic, sandy clay (i.e. hemic to sapric peat) dominated by amorphous, greasy, plastic organic matter. Analysis of the sediments showed that lumps of the material had
almost no voids, but were penetrated by fine plant roots. The clay did not show evidence for invertebrate burrows, but retained clear root-sheaf impressions;

- Upper B1-horizon: greyish-brown (7.5YR 5/2) sands, similar in shape and size characteristics to the lower A-horizon deposits, but stained with organic matter through contact with the upper peat units; and

- Lower B2-horizon: light grey (7.5YR 8/1), pale, bleached sands. The sands comprised clean, single-grained, quartz sands. This deposit was generally the deepest to be sampled, as the water table prevented further excavation without the trench collapsing. Aboriginal stone artefacts were recovered in this layer. According to an unpublished soil and geotechnical consulting report prepared by Coffey Environments which was made available to AHMS during the project, a series of bore holes excavated across the study area showed that this unit extended to depths of at least 1.6 m below the ground surface.

Examination of samples of material recovered from the basal sand body indicated a bimodal grain distribution, with both sub-rounded/rounded (1.0–2.0 mm) and sub-angular/angular grains (0.2–0.3 mm). The larger grains were distinctly different from the smaller grains (Figure 5). All of the grains were of a size that could be moved by wind action, but only the larger grains with their characteristic surface frosting can be said to have had a certain history of aeolian transport at some time. The smaller grains show no sign of this, and, if moved by the wind, they cannot have travelled far.

Trenches T2, 13, 14 and 15, which were excavated in the southern portion of the study area, also contained a lower unit of horizontal interbedding of organic pans and sands above an organic-stained layer of sands (Figure 6). These units were found underneath the Lower B2-

Figure 4. Photograph of Test Trench 12, showing the northern profile

Figure 5. Sand grains from the Chelsea Heights under x20 microscope

horizon sand deposits. The lower units found within the southern trenches comprised:

- an interbedded organic pan/sand horizon: black (2.5Y 2/1 to 10YR1.7/1), loamy sands, with marked plasticity caused by silt and/or clay, and finely divided organic matter. The characteristics of these sand grains were consistent with the above layers, but the sample contained small traces of plant roots preserved as yellow-brown iron oxide moulds. This type of material is often found as the basal sand layer below coastal swamps, as a weak organic pan, and would usually be described as a pedogenic layer (i.e. soil horizon) rather than a stratigraphic unit. However, Trench 14 showed evidence for interbedding of the organic pan materials with the sands immediately above (i.e. Lower B2-horizon). The beds were horizontal, suggesting that the sediments were deposited in water; the clean sands have been interpreted as being deposited quickly as wind-blown sands, or by flood events, and the organic sediments likely represent periods of organic sedimentation from a low-energy water body; and

- organic stained sands: brownish-black (2.5Y 3/1) to yellowish-grey (2.5Y 4/1), loamy sands stained by organic matter. The characteristics of the sand grains were consistent with the above layers, and small amounts of charcoal were present.

The Organosol profile (Upper and Lower A-horizons) found in the trenches is typical of a freshwater-swamp environment, in which organic matter has accumulated on the bed of permanent pools through time. The deeper sand samples (B2-horizon) at, and below, the present water table are the basal sediments upon which the main swamp has formed. Below this, there appears to be a limited sequence of interbedded clean sand layers and layers of organic-stained sands with different amounts of silt and clay.

Figure 6. Photograph of Test Trench 12, showing the northern profile
when these sands were exposed as a land surface prior to the swamp forming.

**Artefact analysis**

A total of 16 stone artefacts were recovered in six trenches (Trenches 3, 7, 10, 13, 14 and 15). The stone artefacts analysed were classified into types based on a series of attributes reflective of the general principles of fracture mechanics (Holdaway and Stern 2004).

The assemblage comprised debitage consistent with general lithic reduction. No retouched tools or cores were identified. The initial stages of stone manufacture were present, and cores were reduced predominantly using hard-hammer percussion. Platform preparation was minimal, indicating that the raw materials used were suitable for obtaining the desired outcome. The analysis did not identify any patterns indicating whether the artefacts were characteristic of a particular stone tool typology, tradition or manufacture process. This was due to the small size of the assemblage recovered. A much larger sample would be required in order to overcome small sample biases that affect the composition of stone artefact assemblages (Hiscock 2001).

The low density of stone artefacts found across the subject site may reflect infrequent or sporadic occupation and use of the landscape at the time the artefacts were deposited. However, the small size of the assemblage and the relatively limited size of the investigation area prevent any definitive conclusions being made about the nature of past occupation and use.

**Optically Stimulated Luminescence dating**

Three samples from the excavation trench that contained the greatest number of artefacts were submitted for OSL dating. These samples were taken from Trench 3, both at the level of artefact concentration (i.e. 0.6–0.7 m below surface), within the B-horizon sand unit deposits, and bracketing the assemblage above and below this depth (Figure 7 and Table 1).

OSL samples were prepared using standard procedures by the University of Gloucestershire. 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).
Table 1. Summary of OSL dating results

<table>
<thead>
<tr>
<th>Field Code</th>
<th>Lab Code</th>
<th>Depth below surface (m)</th>
<th>Age (ka)</th>
<th>Modelled Age (ka)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP 3/1</td>
<td>GL11056</td>
<td>0.50</td>
<td>10 ± 1 (1)</td>
<td>4.5 ± 0.5</td>
</tr>
<tr>
<td>TP 3/2</td>
<td>GL11055</td>
<td>0.65</td>
<td>32 ± 4 (2)</td>
<td>25 ± 3</td>
</tr>
<tr>
<td>TP 3/3</td>
<td>GL11057</td>
<td>0.78</td>
<td>30 ± 3 (2)</td>
<td>23 ± 3</td>
</tr>
</tbody>
</table>

Cosmogenic Dr values were calculated on the basis of sample depth, geographical position and matrix density (Prescott and Hutton 1994).

The age estimates indicate that the sand unit was deposited ~31 ka, with the upper parts exposed until the onset of the Holocene, then buried, perhaps as a result of the formation of the Carrum Swamp. Due to low lithogenic dose rates, and uncertainty regarding sample water content (due to this area being waterlogged at some point following the formation of the Carrum Swamp) additional modelling of the ages was undertaken. The water content of sediment has significant effects on OSL age estimates, since water dissipates and reduces the overall radiation dose to a sample. Here, the flooding of the site by the Carrum Swamp would have resulted in waterlogging of the site and a reduction in radiation dose to the samples from a given point in time. We have attempted to model this change in water content to provide more reliable age estimates. This suggests a more conservative age of artefact deposition ~25–23 ka, and subsequent burial of the sand unit by ~5 ka. For the purposes of this paper, this issue is relatively minor, since the age estimates still place the artefact-bearing deposits within the LGM. However, since sea-levels stabilised by ~7 ka (Lewis et al. 2013), and the swamp formed shortly thereafter, the modelled ages are likely to be an overcorrection, and an age between the two estimates for each sample is probably more realistic.
Discussion and conclusions

Test excavations at Chelsea Heights revealed a complex stratigraphic sequence of sands and swamp deposits. A small number of Aboriginal flaked stone artefacts were found within buried sand deposits below swamp peats. Despite previous investigations in the region, this is one of the first studies to have excavated beneath the former Carrum Swamp, and, in doing so, has demonstrated the potential for deep-time archaeological deposits. Specifically, 16 stone artefacts were recovered from a sand unit that accumulated during the onset of the LGM (~31 ka), before the sequence was buried by the formation of Carrum Swamp.

The use of the region during the LGM has been previously demonstrated, with materials at both Bend Road and Keilor dating to a similar period (Bird and Frankel 1998; Gallus 1976; Hewitt and Allen 2010; Munro 1998; Tunn 2006). Aboriginal places in Tasmania also suggest that Aboriginal populations must have been transiting through the Port Phillip region by at least ~30 ka (e.g. Allen 1996; Cosgrove 1995; Paton 2010; Stern and Allen 1996; Williams 2013; Williams et al. 2013). LGM sea-levels were between -22 and -40m below their current level, and in these conditions Port Phillip Bay would have been dry (Lewis et al. 2013). The climate was also relatively dry, and dune sands were mobile in many parts of southern Australia, probably including those near Cranbourne, to the southeast of the study area (Fitzsimmons et al. 2012). It is tempting to conclude that the very low density of artefacts recovered from Chelsea Heights supports the prevailing view that Aboriginal use of the region during the LGM was ephemeral, and primarily associated with populations moving through the landscape to other parts of southeastern Sahul. However, the small size of the assemblage and the relatively limited size of the investigation area prevent any definitive statements being made about the nature of past occupation and use.

There are also a number of issues that remain unresolved for the site. In particular, the occurrence of bedded deposits beneath the B2-horizon suggests a waterlain mechanism for the lower parts of deposits at the site. The most logical timeframe for such deposition would be during the mid-Holocene sea-level high stand at ~7 ka. However, this is incompatible with the OSL age estimates, which suggest that the overlying sand deposit accumulated ~30 ka. Three plausible scenarios for the formation of the earliest parts of the site can therefore be proposed:

1. Deposition occurred during the early- to mid-Holocene, and the OSL age estimates are incorrect;
2. Deposition occurred through some form of localised flooding, or inundation of the region, during the onset of the LGM. This may have resulted in the formation of the low-energy clays and silts present. Such a water resource may also explain the ephemeral presence of Aboriginal activity; or
3. Deposition occurred during the last interglacial period, during higher sea-levels (~120 ka), and the site contains a disconformity between the B2-horizon and underlying units.

Due to the limited scope of the investigations at Chelsea Heights, none of these scenarios can be completely dismissed. However, we believe that the second scenario provides the most plausible explanation, primarily because there is no evidence indicating that the OSL age estimates are unreliable, and the similarity of the bedded and B2-horizon units reduces the likelihood of a disconformity.

While the sedimentary history has complications, the capping of the sand unit by the swamp layer and the lack of any mixing between the two deposits lend significant support to the stone artefacts being in situ and placed on-site during the onset of the LGM. This removes some of the uncertainty around other open sites, such as nearby Bend Road, since even with bioturbation these artefacts were identified within a deposit that formed relatively quickly at the onset of the LGM, as demonstrated by two statistically identical OSL age estimates encompassing much of the sand unit.

Regardless of the limitations of the investigations at Chelsea Heights, and the unresolved issues cited above, we have demonstrated that archaeological material occurs beneath the former Carrum Swamp, and that the potential exists for archaeological material to be found elsewhere within the Carrum Swamp. This has significant implications for current approaches to cultural heritage assessment work, which typically consider swamps and former swamps to be areas of low archaeological potential. While this is generally the case, the results of our investigations at Chelsea Heights show that a consideration of local geomorphology and swamp formation processes is critical in understanding whether or not there is potential for buried archaeological deposits that lie underneath and pre-date the swamp. The use of augers and examination of geotechnical data would provide an efficient means of assessing whether or not there is potential for buried cultural deposits underneath former swamp soils.

Acknowledgements

We would like to acknowledge the valuable assistance provided by Megan Schutz of Schutz Consulting and the Sponsors. We would also like to acknowledge the assistance and important input provided by the Boon...
Wurung Foundation, the Bunurong Land Council Aboriginal Corporation and the Wurundjeri Tribe Land Compensation and Cultural Heritage Council during the project. We would also like to thank Coffey Environments for providing us with geotechnical data during the investigations.

References

ARCHAEOLOGICAL HERITAGE AND MANAGEMENT SOLUTIONS
Hewitt, G., and J. Allen 2010 Site disturbance and archaeological integrity: the case of Bend Road, an open site in Melbourne spanning pre-LGM Pleistocene to late Holocene periods. Australian Archaeology 70:1–16.

Williams, A.N. 2013. A new population curve for
