13. The Archaeology of the Willandra

Its empirical structure and narrative potential

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Efforts to extend history into deep time have been driven largely (though not exclusively) by historians interested in breaking the apparently artificial barrier that separates historical narratives based on written or oral testimonies from those based on the study of material remains.[1] However, to achieve this goal, historians and archaeologists will have to grapple with the substantive implications of studying the unique material archives that are the particular purview of the historical sciences. This chapter explores some of the issues involved in doing so by investigating the empirical characteristics of an archaeological record that spans the entire known history of human settlement on the Australian continent. As such, it holds out the promise of writing a narrative of the continent's earliest history as well as exploring the dynamics of long-term change that followed the colonisation of a previously unpeopled and unfamiliar country.

Archaeological perspectives on human action

The long time span of the archaeological record is often identified as the critical factor underpinning the potentially unique contribution the discipline can make to an understanding of human actions and their consequences. This is argued in part because material remains are the only record of humanity's first 2.5 million years, and in part because the bracketing age determinations available for most archaeological sites means that they can be assigned only to broad intervals of time.[2] This is viewed by many as an opportunity to investigate the dynamics of changes that take place over long periods of time and which were not necessarily perceptible to the individuals who contributed to or lived through them. By identifying those changes, exploring the dynamics that drove them and understanding how they interact with processes of change that operate over the time span of individual lives, archaeologists believe they have an opportunity to offer unique insights into human action.[3]

1 Shryock and Smail 2011; see also Chapter 1 of this volume.
2 Bailey 1983, 2007; Stern 1993.
3 Murray 1997, 2008; Holdaway and Wandsnider 2008: 2.

However, the idea that archaeology is unique amongst the social sciences derives not only from the long time span of the record and the temporal resolution of its data, but from the fact that material remains represent the consequences of human action, not human action *per se*.[4] The behavioural information embedded in these remains is not intuitively obvious, and neither the naïve ethnographic analogies employed during the late nineteenth and early twentieth centuries or the material-behavioural correlations advocated during the late twentieth century have generated interpretations of the past whose validity can be assessed using archaeological data itself. This results partly from the complex interplay that exists between material objects and a people's world-view, and that material-behavioural relationships are context dependent and not universal. There is also a complex interplay between the loss and discarding of material remains and the depositional processes that cover them with sediment, ensuring their preservation, but also influencing the patterns and associations of surviving material remains.[5] The complexity of these relationships means that there is often a mismatch between the time spans of the observations that underpin the ecological and the social theories used to make sense of these remains, and the time spans involved in the accumulation of the archaeological debris under investigation. As a result, long chains of inference connect material traces to the historical narratives written from them.[6]

Historical narrative versus empirical validation

Since the inception of the discipline, archaeologists have employed historical narratives as a way of summarising what they know and understand about the human past. However, from the outset, scholars were torn between their desire to present intuitively satisfying narratives of the remote human past and their dependence on scientific methods to generate the information from which those accounts were written, and which also provided the basis for assessing their empirical validity.[7]

The tensions between the goals and methods of the fledgling discipline are manifest in its founding text, John Lubbock's *Prehistoric Times*, published in 1865.[8] On the one hand, the long time span of the archaeological record was viewed as an opportunity to document the evolution and differential success of European societies from the durable traces of their technologies. On the

4 Stern 2008a.
5 Stern 2008b.
6 Stern 2008a; Grayson 1986; Schiffer 1982.
7 Stoczkowski 2002.
8 Lubbock 1865.

other hand, life could only be breathed into those material traces by appealing to burgeoning ethnographic information about the habits, customs, tools and weapons of an array of primitive societies employing similar technologies. Explanations for the patterns of increasing technological complexity were derived from recently developed evolutionary theory. As a result, archaeological data in itself was not the primary source of novel insights into the human past.

Similar tensions haunt contemporary archaeological practice. Critical evaluations of the evolutionary scenarios that purport to account for humanity's origins show that they contain some remarkably tenacious cultural constructs whose appropriateness have not been assessed using the discipline's own database. Many of these have deep roots that can be traced back to the discussions of the Enlightenment scholars, and to the philosophical speculations of the Ancient Greeks and Romans, who themselves were undoubtedly drawing on the ideas of the preliterate societies who preceded or lived alongside them.[9]

Anthropologist Wiktor Stoczkowski argues that the persistence of these long-standing cultural constructs reflects the priority that researchers have given to establishing the plausibility of their evolutionary narratives at the expense of developing empirical validation of them. There is tension between the empirical characteristics of archaeological data, the methods available for studying it, and the discipline's goal of making sense of the remote past in the same way as the contemporary world is understood. Stoczkowski's solution to this dilemma is to exhort practitioners to attempt empirical validation of their evolutionary narratives as they are formulated.[10]

In the discussion that follows, some of the issues involved in striving to achieve this balance are illustrated through a discussion of the archaeological traces preserved at Lake Mungo, in south-east Australia. These are being studied with the ultimate goal of writing a dynamic account of Australia's early history, and of exploring long-term patterns of change and their relationship to changes in landscape and climate. Writing a historical narrative whilst subjecting its elements to empirical validation is a multi-stage research endeavour and this project is still in its infancy. This discussion thus focuses on a burgeoning understanding of the empirical characteristics of this record, the categories of information that can be generated from it, and the way in which these can contribute to the writing of a deep time narrative.

9 Stoczkowski 2002: 3–28.
10 Stoczkowski 2002: 191–198.

The study area

Lake Mungo is one of a series of dry lake basins making up a large, relict overflow system on the edge of Australia's arid core.

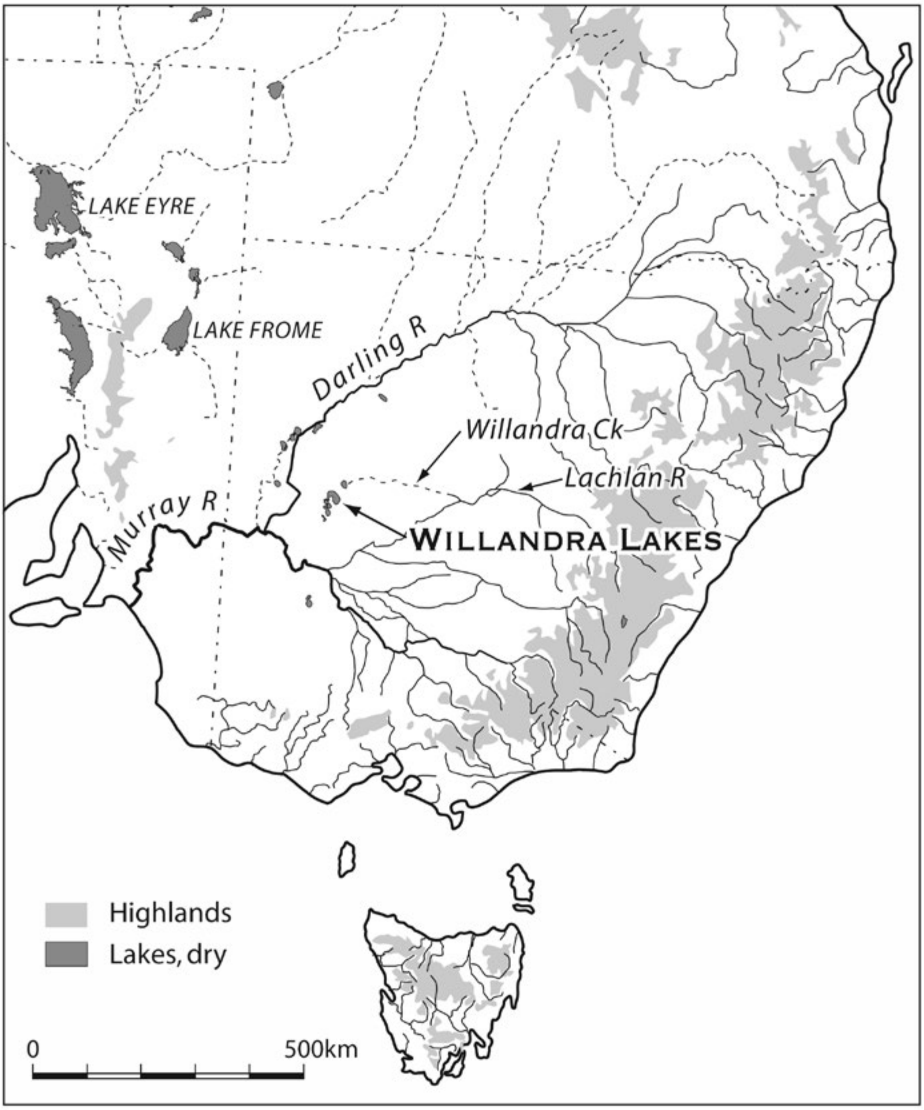

Figure 13.1: Lake Mungo is one of several large and numerous smaller lake basins making up the Willandra Lakes, a relict overflow system in south-eastern Australia.

When active, the overflow system was fed by waters that flowed westward from the south-east Australian highlands towards the continent's arid interior, via the Lachlan River and its former channel, the Willandra Creek.

Source: Base map from Geoscience Australia.

At times in the past when there was more effective precipitation in the Australian Alps, increased discharge in the Lachlan River and its former channel, the Willandra Creek, filled these lakes from north to south. When effective precipitation was reduced, the lakes fluctuated or dried out completely.[11] Each lake in the system has a unique depositional history, recorded in the sediments that built up on its floor; the lunettes bounding its eastern margin and the disrupted linear dunes forming its western margin.

The lunettes have been the main focus of efforts to document the palaeoenvironmental history of the Willandra Lakes region, partly because severe erosion of some lunettes provides a window into their internal structure and partly because their alternating layers of sand and clay reflect conditions that prevailed in the adjacent lakes. Jim Bowler's pioneering geomorphological research in the Willandra provided the key to the relationship between sediment characteristics and hydrological conditions.[12]

Bowler showed that when the lakes in this system were at overflow level, waves driven by the prevailing south-west winds washed sediments to the eastern margin and created high-energy beaches. Sands blown from those beaches contributed to the build up of low, vegetated quartz fore-dunes. When the lakes fell below overflow level, water levels fluctuated, exposing part of the lake floor. Salts precipitated from saline groundwater broke up the lake floor sediments into sand-sized aggregates that were picked up by the prevailing winds and draped across the landscape, forming pelletal clay dunes.[13] When the landscape was stable, soils formed. The sedimentary sequence thus records changes taking place in a distant catchment in the Australian Alps, which were being driven by regional and global shifts in climate.

Traces of human activity were incorporated into the lunette sediments as they accumulated, and recent erosion, which accelerated following the establishment of the pastoral industry in the late nineteenth century, has exposed many of these on the modern land surface. Once exposed, most features disperse and disintegrate within two to three years, unless they lie in micro-topographic and sedimentary settings that provide protection from the impact of water flow during heavy rains. Highly visible clusters of debris lie on the lunette surface towards its lake-ward margin, but these are predominantly accumulations of material whose encasing sediment has blown away (i.e. lags) or that have been reworked and redeposited through erosion of older sediments (i.e. transported).

11 Bowler 1998.

12 Bowler 1971, 1976, 1998; Bowler et al. 2012.

13 Clay particles are so light that they are usually blown hundreds of kilometres from their source before being redeposited. However, in the Willandra, the efflorescence of salts on the partly exposed lake floor caused the clay particles to aggregate around sand grains. The resulting sand-sized particles were picked up by the prevailing winds and deposited on the lunette building up along the lake's eastern margin. Bowler, 1973, describes the mechanism involved in the formation of clay dunes in the Willandra Lakes.

Continuing erosion of the lunette means that *in situ* features weather, disintegrate and disperse whilst new ones are being exposed. As a result, any attempt to document the archaeological traces preserved in the Mungo lunette can only provide a snapshot of what was exposed at the time the survey was undertaken.

These activity traces have long been regarded as a potential treasure trove of information about changing patterns of land use in this swathe of semi-arid savannah on the margins of the continent's arid core. However, a paucity of systematic archaeological research over the past 30 years means that not much is actually known about these activity traces or their context, making it difficult to characterise their empirical characteristics and to assess their potential for contributing to a narrative about the settlement of the Australian continent. To build an understanding of this record, and to assess its information potential, a systematic foot survey of the central Mungo lunette was initiated in 2009.

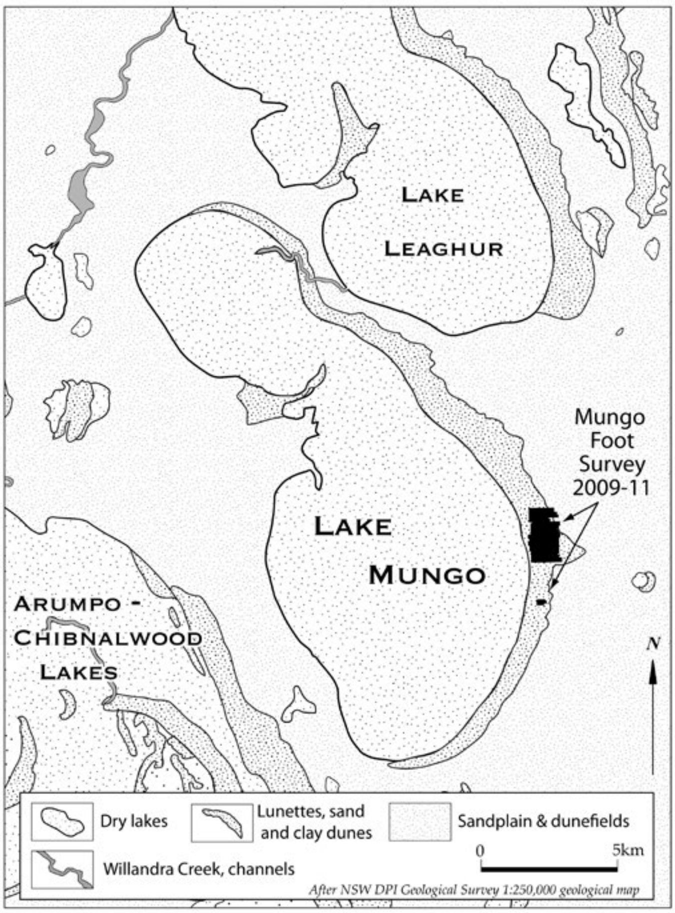

Figure 13.2: The location of the study area in the central Mungo lunette.

Source: After NSW DPI Geological Survey 1:125,000 geological map.

Foot survey of the central Mungo lunette

This systematic foot survey of the central portion of the Mungo lunette was designed to generate information that could be used to assess the empirical structure of this record. To achieve this, three interrelated sets of information are collected: information about the types of activity traces preserved in different depositional settings and stratigraphic units; the time span represented by individual hearths or clusters of stone-working debris; and the time span represented by the stratigraphic units containing large numbers of those activity traces. The latter establishes the time span represented by all the archaeological traces that accumulated on the landscape when the same palaeoenvironmental[14] conditions prevailed.

Together, these data provide a basis for assessing how depositional processes have impacted on the survival of material traces, and on the configuration and associations of those remains. They also lay a foundation for investigating changes in the types of activities in which people engaged during different time spans and corresponding environmental conditions, and thus for exploring changes in the technological, economic and social strategies employed over time.

To collect these data, the foot survey focuses on cultural features whose sedimentary context and stratigraphic provenience can be established without ambiguity. This includes features that remain at least partially embedded in sediments as well as tight clusters of surface debris whose encasing sediment has been removed but which have not yet dispersed, weathered or disintegrated, indicating that they were only recently exposed on the modern surface. Ongoing erosion of the Mungo lunette, together with ongoing aeolian and alluvial deposition of reworked sediments, means that the boundaries between networks of rills and gullies, slope wash surfaces, alluvial fans and deflation surfaces are constantly shifting. Systematic coverage of the lunette is therefore facilitated by the use of a grid system superimposed on digital air photos taken in 2007. The corners of each 50m x 50m grid square are located on the ground using a hand-held GPS.

A great many of the archaeological features exposed on the surface of the lunette are extremely subtle, so to assist their identification, each grid square is walked by a 'police-line', with team members pacing in two directions so that the exposures can be observed in different light conditions. The features being observed include a variety of heat retainer and baked sediment hearths, discrete clusters of burned and unburned animal bone, clusters of chipped stone tools,

14 Past environmental conditions, including temperatures, rainfall, circulation patterns and evaporation, are not the same as those currently experienced; palaeoenvironmental conditions are those that prevailed during some defined time interval in the past.

together with debris from their manufacture and/or repair, and isolated *in situ* finds (mostly animal bones and artefacts). It also includes rare finds, like ochre pellets, grinding stones and shell tools, which lie on the surface, but whose stratigraphic unit of origin can be established. Information about the content and the context of each feature is recorded in the field, using a palm top or tablet computer. This includes information about the type of hearth or stone cluster and the materials of which they are comprised, as well as information about associated material lying within that cluster of debris. Records are also made about the sediment in which the feature is encased, its ancient topographic context (beach, fore dune, dune crest, back dune) and its modern topographic setting (flat erosional bench, low angle slope, high angle slope, rill, gully, etc).

Most of the activity traces recorded so far are small and discrete and contain a limited array of debris. Arguably, each consist of debris generated during a single activity or related set of activities, like the striking of a few stone tools from a nodule of raw material (Figure 13.3), the cooking of an emu egg (Figure 13.4), and the lighting of a fire to cook a bettong, along with the manufacture of a few stone tools (Figure 13.5).

Figure 13.3: A silcrete core and refitting flakes, representing at least part of a single knapping event.

Source: Caroline Spry, Mungo Archaeology Project.

Figure 13.4: A partially burned emu egg in the position in which it was cracked open after cooking.

Source: Rudy Frank, Mungo Archaeology Project.

Figure 13.5: A fireplace comprising ash and lightly baked sediment, with an associated scatter of bettong bones representing a single individual (white flags) and a scatter of stone tools struck from the same nodule of silcrete (black flags). The artefact scatter includes six sets of refits.

Source: Rudy Frank, Mungo Archaeology Project.

Ultimately, the suggestion that these represent single events can be validated through analysis of the debris they contain and/or the materials from which they were made. For example, archaeomagnetic data[15] are being used to establish the number of times a baked sediment hearth was lit as well as the temperature to which it was lit. Refitting chipped stone artefacts or broken up animal bones scattered around a hearth can be used to identify what was brought into that location, in what form, as well as the activities undertaken at that location. The baked sediment hearth in Figure 13.4 has an associated scatter of bettong bones that represent a single individual and a scatter of artefacts struck from the same nodule of silcrete. An initial study of the archaeomagnetic properties of the baked sediments suggest that the hearth may have been heated to high temperature only once.

Each of these features is embedded in sediments (a sand or clay, sandy clay or soil), which record the conditions that prevailed in the lake at the time that debris accumulated. Each is also contained within a stratigraphic unit that records the environmental conditions that prevailed during a specific time interval, for example, between circa 55,000 and 40,000 years BP conditions across the continent resulted in more effective precipitation and in the Willandra, a long phase of sustained lake-full conditions prevailed; between circa 25,000 and 14,000 years BP conditions were cooler and more arid but seasonal snow-melt brought large volumes of water down the Lachlan River, resulting in oscillating lake conditions throughout the Last Glacial Maximum.

The type of sediment in which each feature is encased is documented as part of the site record, while its stratigraphic context is established by mapping the boundaries of the stratigraphic units exposed on the surface of the lunette and through optically stimulated luminescence (OSL) dating of the mapped units.[16] The locations of all dating samples, stratigraphic boundaries and archaeological features and isolated finds are recorded using the GDA (Geocentric Datum Australia – Australian mapping grid) coordinates; these data are then uploaded into GIS software (MAPINFO) to facilitate integration of the archaeological and geological data sets. Both the sediments encasing each archaeological feature and the strata in which those features are preserved can be used as analytical units to generate commensurate behavioural and palaeoenvironmental information. They thus provide the initial framework for writing a narrative account of the history of human settlement in the Willandra.

15 Heating of sediments that contain magnetic minerals can result in the formation of new magnetic minerals, enhancing the magnetic properties of those sediments. Reheating of samples in the laboratory can identify the temperature to which those sediments were heated in the past. See Herries 2009: 245–246.

16 Fitzsimmons et al. 2014.

The history of human settlement

So far, the systematic survey has located and documented 1,442 cultural features over a 2 km^2 area in the central portion of the Mungo lunette. Although Mungo's archaeological record has been characterised as one of middens and stone artefacts,[17] 50 per cent of the features recorded in the study area are hearths, approximately half of which are associated with food remains or tools or both. Isolated finds, clusters of chipped stone artefacts and clusters of burned animal bones make up the remainder of the sample.

Geological mapping of the survey area, combined with OSL dating of mapped units, shows that the stratigraphic sequence in this part of the lunette is similar but not identical to that recorded at the southern end of the lunette during Bowler's earlier work.[18]

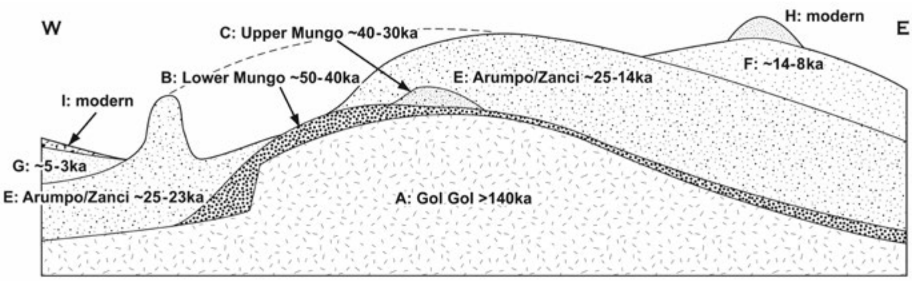

Figure 13.6: A schematic cross-section summarising the stratigraphic sequence in the central Mungo lunette.

Here as elsewhere, the core of the lunette is formed by the Golgol unit, which was deposited during a lake sequence that predates the Last Interglacial (< 130,000 years BP). Units E–B were laid down during a lake sequence that spans the time interval from circa 55,000–14,000 years BP, while Units F and G were deposited after the lake dried out. Units H and I are modern depositional units resulting from ongoing erosion and reworking of the older lunette sediments. Age estimates for each unit are based on those reported in Fitzsimmons et al. 2014, Bowler 1998 and Bowler et al. 2012.

Source: Based on Fitzsimmons et al. 2014, Figure 5 and Mungo Archaeology Project data.

Units B and C, which lie at the base of the present lake sequence, are the lateral equivalents of Bowler's Lower and Upper Mungo units[19] but in the central portion of the lunette they are thin and laterally discontinuous. Unit B represents a long phase of sustained lake-full conditions (from circa 50,000 until circa 40,000 years BP), while Unit C represents the establishment of a fluctuating lake in response to the onset of continental aridity (circa 40,000 until circa 30,000 years BP).[20]

17 Allen et al. 2008; Allen and Holdaway 2009.

18 Bowler 1998.

19 Bowler's description of the stratigraphic units making up the Mungo lunette was based on geological sections recorded in the southern end of the lunette. Although there are similarities between the stratigraphic sequences in the southern and central portions of the lunette, there are also some differences. The units defined by Fitzsimmons et al. in 2014 can be correlated with those described by Bowler in 1998 on the basis of age and sediment characteristics and are thus their lateral equivalents.

20 Bowler 1998; Fitzsimmons et al. 2014.

Unit E, which was deposited between about 25,000 and 14,500 years BP, makes up the greatest volume of sediment in the central Mungo lunette and is the lateral equivalent of what Bowler described as Arumpo and Zanci units.[21] It thus straddles the Last Glacial Maximum, the period toward the end of the last glaciation when sea levels were at their lowest, glaciers and continental ice-sheets were at their maximum extent, and global climates were colder, windier and drier than at any other time during the last 70,000 years. Most of this unit comprises thin beds of alternating sands, clayey sands and clay, indicating that the lake oscillated from being at overflow level to almost drying out. During the height of the Last Glacial Maximum, circa 21,000–17,000 years BP, sediments accumulated so rapidly[22] that in some areas fine laminae[23] of alternating sands and clay, each representing an individual depositional event, are remarkably well preserved.

The final drying of the lake occurred approximately 14,500 years BP and, almost immediately, older lunette sediments were subject to aeolian or wind-driven reworking under the influence of locally more arid conditions, resulting in the build up of unconsolidated sands on the crest and lee of the lunette. The age of these sands is not yet well constrained in age, but numerous weakly developed and laterally discontinuous soil horizons indicate periods of lesser and greater humidity, resulting in episodes of greater and lesser dune stability. During the mid-Holocene, approximately 5,500–3,500 years BP, local conditions were relatively more humid, resulting in gullying of the lunette and the build-up of alluvial fans along its lake-ward margin.[24]

Activity traces are not distributed homogeneously through these strata and this provides a basis for making inferences about the palaeoenvironmental conditions that brought people to the shores of Lake Mungo in greater numbers and/or for longer periods and/or more often.[25] The greatest density of activity traces is found in Unit C, during which the lake alternated from being at overflow level to low and fluctuating. As the overflow system received water from the south-east highlands via the Lachlan River, and as Mungo had no outflow, those fluctuating lake levels reflect the input of successive flood pulses.

21 Bowler 1998.

22 Long et al. 2014: 87–88.

23 Laminae are thin layers of sediment (< 1cm thick) that result from differences in the type of sediment being deposited over short time spans. In this instance, the differences reflect alternating deposition of pelletal clays (lake level low) and quartz sands (lake full). Because laminae are thin they are easily destroyed by the biological activity associated with a stable landscape and soil formation. The preservation of laminae thus suggests that sediment accumulation was rapid and that there was insufficient time for burrowing organisms and root activity to disrupt the laminae.

24 Fitzsimmons et al. 2014.

25 Stern et al. 2013; Fitzsimmons et al. 2014.

The density of activity traces in Unit E is not as high as in Unit C, but its greater volume and the greater area of its exposure means that it actually contains the greatest number and diversity of sites in this part of the lunette. The hearths within Unit E are as abundant in the lenses of quartz sand reflecting high lake levels as they are in the pelletal clays blown up from the lake floor when lake levels were low. This suggests that it was the conditions created by the fluctuating lake levels that attracted people to the margins of Lake Mungo in greater numbers and/or more often and/or for longer, rather than high or low lake levels *per se*.

Traces of people's activities are found in relatively low density in the aeolian and alluvial sediments that accumulated after the lake dried out. There is limited exposure of sites in the alluvial fans but constantly shifting sands overlying Unit F (on the lee and crest of the lunette) repeatedly uncover and cover over heat retainer hearths, discrete sets of refitting artefacts[26] and occasional shell tools and grindstones. The lower density and diversity of these activity traces suggests a significant shift in land-use patterns once the lake dried out, with fewer people coming into this landscape for shorter periods and/or less often.

Systematic data on the distribution of sites through sediments representing different hydrological conditions and strata representing different time intervals and corresponding palaeoenvironmental conditions show the same pattern: most activity traces accumulated when lake levels were oscillating from low to high. This overturns two long-standing perceptions: first, that people were attracted to the overflow system when the lakes were full of freshwater in order to exploit their rich aquatic resources and second, that the area was so inhospitable during the Last Glacial Maximum (LGM) that people abandoned it. There is an obvious ecological explanation for the abundance of activity traces in sediments and strata laid down when the lakes were fluctuating: aquatic resources would have been less abundant and more difficult to locate during periods of sustained lake-full conditions, but when lake levels were low, aquatic resources would have been easier to find and each flood pulse would have recharged the biological productivity of the system. Furthermore, when the lakes were at overflow level, water would have abounded on the adjacent plains, removing a critical constraint on the time people could spend foraging there and the distances they could cover.[27]

26 Chipped stone technology is a reductive technology that creates clusters of artefacts that may contain stone-working debris as well as tool-blanks and tools. If those clusters of debris retain their integrity, despite the impact of depositional and post-exposure processes, some of the artefacts struck from the same nodule of raw material can be refitted back together, like a three-dimensional jigsaw. If sufficient numbers of refitting artefacts are available they can provide insights into the way each block of stone was worked to produce tools. For an example, see Figure 13.3.

27 Bowler 1998: 147.

Individual activity traces and the landscape palimpsest

The survey data establish when people came and went from this landscape and it provides the basic framework from which a narrative of changing patterns of land use will eventually be written. However, to gain insights into the social, economic and technological activities in which people engaged at different times obviously requires more detailed study of the activity traces preserved in specific strata. The central Mungo lunette affords an opportunity to do this for the period straddling the Last Glacial Maximum because of the diverse and well-preserved activity traces it preserves from this time interval.

Detailed investigation of these activity traces, involving studies of surface and excavated archaeological remains, has only recently begun, but it provides a springboard for highlighting some of the issues involved in writing a narrative account of people's lives in the Willandra district during a specific time interval. The most critical of these relate to the empirical structure of the record. Earlier it was argued that the record consists of a myriad of discrete activity traces representing individual events. However, all the activity traces contained within a stratigraphic unit representing a 9,000-year time interval have to be combined in order to investigate the diet and foraging strategies, technologies, or social networks that people employed during the Last Glacial Maximum. This creates what archaeologists and palaeontologists refer to as a time-averaged assemblage: the mixing together of material remains from many different and temporally unrelated events. This is the inevitable outcome of studying archaeological traces that accumulated on a landscape as it built up, because the boundaries between landforms (the lake floor, beach, dune) shift as those sediment accumulate. The resulting three-dimensional bodies of sediment are thus time-transgressive and the contemporaneity (or otherwise) of any two hearths or sets of refitting artefacts can only be established in relation to the upper and lower boundaries of that three-dimensional body of sediment.[28]

It is often assumed that the information generated from time-averaged assemblages of material will be the same as that generated from the study of all the debris from the individual events. This is predicated on the assumption that the debris contained in aggregated assemblages is an average representation of the activities that were undertaken during the time interval under consideration. There are three compelling reasons for scrutinising this assumption. Firstly, some activities generate more debris than others and though they may not take place frequently, they may nevertheless dominate an aggregated assemblage. Secondly, debris from events that take place only rarely

28 Stern 1994, 2008a.

may not be captured by discrete activity traces dispersed through a stratigraphic unit, unless that unit represents a sufficient length of time and unless extensive areas of that unit are exposed for study on the modern land surface. Thirdly, there are some categories of information that can be generated from discrete sets of debris that cannot be generated from aggregated samples and vice versa. In particular, aggregated samples accumulated over long time spans are viewed as a critical source of information about long-term trends and dynamics that may not have been perceived by the individuals who lived through them. The suggestion that explication of these long-term trends and dynamics is archaeology's primary purview[29] has caused a certain amount of consternation, largely because it is seen as a strategy that dehumanises the past. It is, however, a strategy that enables archaeologists to assess the interpretations they make about the past using archaeological data, rather than by reference to theories generated by ancillary disciplines drawing on qualitatively different data.

In the central Mungo lunette, hearths with associated food remains and/or stone tools are a significant feature of the Last Glacial Maximum landscape palimpsest. Some assemblages contain the bones of medium and large-sized macropods, others contain the remains of a single individual, like a bettong, or a single taxon, like a few golden perch, and a few are made up of bones representing fish, and small and medium-sized terrestrial mammals. Although hearths containing some fish remains are found throughout the stratigraphic sequence, hearths that *only* contain fish bones are found at one location in the central Mungo lunette, and they all accumulated during the height of the Last Glacial Maximum. Geochemical analysis of the fish otoliths (ear bones) suggest that the fish recovered from these hearths entered the lake when it was full of fresh water but were captured when lake waters were relatively more saline.[30] The faunal remains associated with each hearth may provide extraordinary insights into individual meals, but ongoing research needs to establish whether the sum of all of those yields the same information as the time-averaged landscape sample.

Attempts to reconstruct the stone technologies employed during the Last Glacial Maximum are confronted by similar interpretive challenges. Analysis of refitting artefacts, together with non-refitting artefacts struck from the same nodule of raw material, provide insights into specific stone-working (i.e. knapping) episodes. Establishing the relationship between those individual knapping events and the technological strategies employed during the Last Glacial Maximum is the focus of ongoing research. However, initial studies point to differences in the categories of information that can be generated from the analysis of individual nodules and refitting artefacts versus the aggregated landscape sample.[31]

29 Murray 1993, 1997.
30 Long et al. 2014: 88–91.
31 Spry 2014.

Towards a deep time narrative

Since the discovery of hearths, tools and burials at the southern end of the Mungo lunette in the late 1960s, Lake Mungo has been given a privileged place in accounts of continental settlement.[32] However, it is salutary to remember that those accounts are based on limited data sets as well as limited appreciation for the research strategies most productively employed to deal with discrete activity traces scattered through a vast eroding landscape made up of successive tiers of three-dimensional sedimentary units. Initial research emphasised the similarity of temporally and geographically scattered artefact and faunal assemblages, in particular the similarity of the species found in the faunal assemblages and the list of species exploited by the Paakantji (Barkindji), who lived along the Darling River during the late nineteenth century. However, at the time, limited assessment was made of how these observations should be applied to the archaeological data they were supposed to explain.[33]

Two decades later, Harry Allen offered a considered evaluation of this initial research strategy, pointing to a mismatch in scale between the archaeological record and the ethnographic and ecological models used to make sense of it. He and his colleagues argued that because study of the landscape sample involves aggregating all the archaeological traces contained in a single stratigraphic unit, the landscape palimpsest is just as readily documented from surface archaeological traces as it is from *in situ* features.[34] However, this is an approach that would fail to realise the extraordinary research potential of Mungo's archaeological record. High rates of sediment accumulation, combined with limited spatial redundancy in the location of activities, has contributed to the preservation of discrete activity traces, and the sediments encasing those also happen to record prevailing lake conditions.

This makes it possible to investigate change over time, to generate behavioural and environmental information at commensurate scales of analysis, and to investigate whether and how behavioural changes are related to environmental shifts. It also affords a rare opportunity to investigate the relationship between individual knapping events and the technological strategies, or the meals and diet and foraging strategies that characterised different time intervals and their corresponding palaeoenvironmental settings.

32 Mulvaney 1975: 147–152; White and O'Connell 1982: 35–39; Flood 1995: 39–55; Hiscock 2008: 5–8.
33 Allen 1972, 1974.
34 Allen 1998; Allen et al. 2008; Allen and Holdaway 2009.

Most archaeological records contain a time-averaged jumble of debris, and the traces of individual activities can rarely be separated out from that jumble.[35] This problem is particularly acute in Australian cave and rock shelter deposits that are often characterised by low rates of sediment accumulation (a few centimetres per thousand years) and sediment accumulation that was not independent of cave occupation.[36] However, it is also a problem that haunts surface archaeological records that are not derived solely from the sedimentary envelopes on which they lie, as is the case at Lake Mungo.[37] For this reason, the research potential of the Willandra will be realised largely through the study of those discrete activity traces and their contexts.

As research in the Willandra progresses, more will be learned about the way the record formed, facilitating ongoing assessment of the information that can be generated from it. However, the very existence of that myriad of discrete activity traces should enable researchers to write a narrative of the continent's early history that retains a plausible human face, even as that narrative is being subjected to rigorous empirical assessment.

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