The lost art of stratigraphy? A consideration of excavation strategies in Australian indigenous archaeology

Ingrid Ward, Sean Winter & Emilie Dotte-Sarout

To cite this article: Ingrid Ward, Sean Winter & Emilie Dotte-Sarout (2016) The lost art of stratigraphy? A consideration of excavation strategies in Australian indigenous archaeology, Australian Archaeology, 82:3, 263-274, DOI: [10.1080/03122417.2016.1251014](https://doi.org/10.1080/03122417.2016.1251014)

To link to this article: <http://dx.doi.org/10.1080/03122417.2016.1251014>

Published online: 06 Dec 2016.

Submit your article to this journal [↗](#)

Article views: 56

View related articles [↗](#)

View Crossmark data [↗](#)

RESEARCH ARTICLE

The lost art of stratigraphy? A consideration of excavation strategies in Australian Indigenous archaeology

Ingrid Ward^a, Sean Winter^a and Emilie Dotte-Sarout^{a,b}

^aSchool of Social Sciences, University of Western Australia, WA, Australia; ^bSchool of Archaeology and Anthropology, The Australian National University, Canberra ACT, Australia

ABSTRACT

Archaeological interpretation is increasingly an interdisciplinary effort between archaeologists and specialists of various archaeological sciences. In such integrated work, excavation data are the primary reference to provide context for the vast range of cultural and biological material that are later investigated. A review of over three decades of published Australian archaeological data shows that there is a widespread practice in the use of arbitrary excavation units, not only as excavation tools but also as analytical units. Building from the lectures of Smith on the Lost Art of Stratigraphy and other published literature, this paper explores some of the issues surrounding different excavation strategies applied today, particularly in Australian prehistoric archaeology, and the implications and impacts on interpretation of archaeological and palaeoenvironmental results. It is argued that, while arbitrary excavation is appropriate in certain circumstances, the best method for excavation, sampling and interpretation of archaeological sites is by stratigraphic context because it provides a more precise understanding of the original depositional context and what that might tell us about past environment and past human behaviour.

ARTICLE HISTORY

Received 28 June 2016
Accepted 17 October 2016
Published online 6 December 2016

Introduction

He knew how to dig a hole and pluck artefacts from the ground like plums from a cake, and that was all that mattered' (Noel Hume 1968:12).

Archaeology began as the scientific study of ancient objects or antiquities to provide information on past cultures and human activities. However, its foundations have evolved from the mere collection of objects ordered by typologies, to the conduct of detailed stratigraphic excavations – a process that can be defined as ‘removing artefacts and sediments from vertically discrete three-dimensional units of deposition and keeping those artefacts in sets based on their distinct vertical recovery proveniences’ (Lyman and O’Brien 1999 – [our emphasis]). In a widely disseminated series of lectures on the *Lost Art of Stratigraphy*, Smith (2012) emphasises that the stratigraphic history of a site is basically its ‘biography’. However, he indicates the art of reading this stratigraphy has become ‘underutilised’ [sic] in the everyday practice of Indigenous archaeology in Australia. Stirred by this observation echoing our own experiences and those of other specialist colleagues on post-excavation material, this paper attempts to examine the current excavation methods in Australian indigenous archaeology.

In this paper, we briefly contextualise this appraisal by summarising the history of excavation

practice internationally and in Australia, then assess papers on Australian excavations published since 1980 in the two main regional journals, *Australian Archaeology* and *Archaeology in Oceania*. Our aim is to understand the way in which excavation methods have evolved and are applied in Australian contexts, and how these methods might affect post-excavation analysis and site interpretation. We compare the two main excavation methods: (i) using natural and cultural strata; also known as Single Context or stratigraphic recording (Carver et al. 2015; Museum of London 1994) (Figure 1(a) and (b)), and (ii) using units of regular interval thickness, also known as Excavation Units (or XUs), Arbitrary Excavation, Unit Level Recording, Planum technique and Metrical Stratigraphy (Lucas 2001; Carver et al. 2015) (Figure 1(c) and (d)). A range of textbooks and articles has been published, which present the fundamental principles of stratigraphy and excavation practice for archaeology (Barker 2003; Connah 1984; Darvill 2008; Harris 1989; Lyman and O’Brien 1999; Roskams 2001; see also Mallol and Mentzer 2015), including Australian contexts (e.g. Balme and Paterson 2014; Burke and Smith 2004; Smith 2012). Rather than repeat this kind of presentation, our emphasis is on the stratigraphic framework as being critical not only for the interpretation of cultural artefacts and features found within the sequence but

Figure 1. Schematic stratigraphic drawings, showing (a) horizontal and (b) non-horizontal (sloped) deposits, with inset graphs showing the difference in relative abundance of artefacts when calculated per stratigraphic unit (SU), (a) and (b), compared to when calculated per arbitrary excavation unit, (c) and (d). The drawings illustrate how arbitrary excavation units (XUs) may cut across stratigraphic boundaries and cultural features, (c) and (d). However, this can be improved by using one or other combined method (e) and (f), which distinguishes arbitrary excavation units within stratigraphic units and removing features separately.

also of associated faunal, floral and other fossil organic remains (Figure 2), sedimentary data and any independently-derived chronology (Barham and Huckleberry 2014). (See exemplary demonstration of this in recent re-dating of Little Foot, Bruxelles et al. 2014, and the Liang Bua site, Indonesia, Gramling 2016).

A brief history of excavation practice

In the early-nineteenth century, the fundamental role of stratigraphy was established to provide context and relative chronology of artefacts and ecofacts found in the ground, as in Lyell's (1830–33) *Principles of Geology*, Boucher de Perthes' (1847) identification of 'couches antediluvienues' and

Worsaae's (1843) Law of Association (see Lyman 2012; Trigger 1989). Despite this, early excavation practice rarely took guidance from stratigraphy. In the late 1800s, Pitt Rivers and Flinders Petrie were the first people to argue for a *scientific* approach to archaeology, but in fact paid little attention to the importance of stratigraphy during excavation itself (Harris 1989:9). Petrie mentioned it only once in what was the first text-book of archaeological excavation in 1904, suggesting that '... the superposition of strata' (Petrie 1904:139) was one of the best forms of evidence for identifying and dating objects and tying them to specific time periods, through the study of excavation profiles. The recognition of the importance of understanding site stratigraphy for archaeological interpretation occurred around 1915,

Figure 2. Illustrative guide of the different types of artefacts and ecofacts that can potentially be found within an archaeological site. Importantly, it is not so much individual finds that are important but rather the *assemblage* of finds that is found within a particular depositional unit.

as evident in Europe with Droop's (1915) book on *Archaeological Excavation* and in the Americas with Wissler's (1917) publication on 'new archaeology' (see also Browman and Givens 1996). At the same time, the use of an arbitrary excavation strategy was championed by Nelson (1916), whose work in New Mexico presented the use of excavation by arbitrary units and 'decisive chronological determinations' as a scientific-looking way of quantifying frequencies of cultural materials in deep sites (see also Praetzelis 1993:81). The perceived advantage of this 'planum' or 'arbitrary excavation unit method' was its comparative economy in both cost and time, compared to stratigraphic methods.

In the 1930s, Wheeler and his student Kenyon developed the method of excavation that involved a systematic recording of numbered layers. By the 1950s, the importance of understanding stratigraphy during excavation was stated in plain terms by Wheeler (1954), who devoted an entire chapter to the subject in his landmark book *Archaeology from the Earth*, in which he likened stratigraphic layers to successive pages of a book and decried what he called the 'mass excavation' tactics of the past as '... archaeological illiteracy' (Wheeler 1954:43). Early in his chapter, he suggested that all sites have stratigraphy, and the denial of such was the result of

the '... observer (who) had simply failed to observe' (Wheeler 1954:44). Instead, he argued for the absolute primacy of following the stratigraphic sequence during excavation in order to understand the origin, dating and provenience of archaeological and ecological material found within it. Even Wheeler's method was found to have limitations, particularly in complex stratigraphic situations (Harris 1975:110).

The introduction of open area excavation (e.g. Barker 1977, 2003; see also Branch et al. 2005 and references therein) allowed the identification of archaeological phenomena not easily recorded in section and for the development of broader questions about the relationship between excavation methodology and interpretation. Harris' seminal 1979 work *Principles of Archaeological Stratigraphy* successfully defined geological and archaeological stratigraphy as different (yet interlinked) concepts and defined a range of non-geological phenomena as stratigraphic evidence of human behaviour. Harris argued that simply defining the stratigraphy of a site by its geology (i.e. sedimentation) ignored the outcomes of human behaviour that impacted upon, or created, that stratigraphy in the first place (Harris 1989:xi–xv). As suggested by Harris (1989:20), the primacy of the stratigraphic method has generally been adopted as a 'best practice' excavation strategy within the discipline. Globally, since the 1950s, most prehistoric archaeology has used stratigraphic excavation (Archer and Bartoy 2007; Barker 2003; Carver et al. 2015; Leroi-Gourhan and Brezillon 1973; Lucas 2001).

Of course, archaeological method must be informed by other considerations, including objectives and theory, and indeed, many see these as indivisible (Shanks and Tilley 1987:25). Methods chosen for a reconnaissance study, for example, may differ from an excavation aimed at resolving a particular research question beyond simply the age and contents. The more recent literature on excavation practice demonstrates that there is a clear nexus between method (as the way we do things) and theory (as the way we interpret and understand the results of the method, and decide upon the method in the first place), and that this is fundamental when deciding on any particular excavation strategy. Hodder (1995) describes this as 'archaeological praxis', suggesting that theory and method cannot exist without each other and that the two are inextricably linked and inform one another. Hodder (1995, 1997) and others (e.g. Chadwick 2003; Cherry 2011; Edgeworth 2011; Lucas 2001; Roskams 2001) argue for a more philosophical approach to excavation practice literally at the trowel's edge (Hodder 1997). A crucial part of this argument is that excavation is an unrepeatable process and hence its recording – and in particular

of stratigraphic relationships and any associated post-depositional features – must be completed in real time, by the excavator, as an ongoing process of interpretation during excavation rather than after it (Chadwick 2003:107).

The development of excavation practice in Australia

In Australia, the earliest systematic excavations of prehistoric sites were conducted in 1929 by Tindale at Devon Downs, South Australia (Hale and Tindale 1930), and in 1948 by McCarthy at Lapstone Creek, New South Wales (Murray and White 1981:256). Whilst these were the first to record and demonstrate the link between stratification and cultural succession via stone tool assemblages (Mulvaney 1980; Smith 2000), following prevailing practice, they excavated by arbitrary excavation units and only afterwards considered the stratigraphy from the section profile. Consequently, later re-analysis of some of Tindale's and especially McCarthy's excavations revealed many issues relating to the lack 'of correspondence between McCarthy's excavated spits and the natural stratigraphy of the sites' (Johnson 1979:43).

Later, after several years in Europe and Africa, Mulvaney considered applying some of the innovative field techniques he had learnt abroad, including 'sample collection according to layer and substance', particularly for samples to be used for radiocarbon dating (Mulvaney 1986:98). However, he argued that 'such important but time-consuming three-dimensional recording' was 'impracticable' in the context of early Australian archaeology fieldwork, instead having to 'temper desirable methodology with realistic goals', which at this time were to 'produce a series of dated stratified deposits on a continental canvas' (Mulvaney 1986:99). Up to the 1970s, before any legal heritage protection, many amateurs continued digging 'holes' to collect artefacts by the hundreds and thousands (see e.g. Walshe 2011). When he edited the first Australian field guide for archaeology, Mulvaney (1968) chose not to detail excavation methods, insisting that these had to be left to the (then dozen or so) other professional archaeologists, partly to discourage amateur readers from excavating sites themselves (Mulvaney 1986). In 1981, Graham Connah repeated this assertion when writing the preface to *Australian Field Archaeology: A Guide to Techniques*, stating:

...in practice excavation is almost too large a topic to include in such a book as this and, in addition, I was not able to find anyone with sufficiently long experience of specifically Australian excavation who was willing to attempt the writing of such a chapter (Connah 1983:vii).

In the 1970s, Ian Johnson (1979:3) attempted to standardise the 'cowboy' phase of Australian prehistory, which 'encouraged the uncritical use of simple 'spit' methodologies'. He argued that 'a common depth below some supposedly isochronic surface is... by no means the best effort we can make at generating diachronic assemblages' even for sites with poor stratigraphic differentiation (Johnson 1979:147). Johnson used newly available computerised recording, together with precise, but flexible excavation strategies, 'to follow minor changes in the deposit and exploit all available data' (Johnson 1979:147). A set of three basic principles were to be employed for all excavations, with records to be kept on standardised forms, including the following.

- i. Horizontal control using a grid (i.e. the quadrat),
- ii. Vertical control using small 'excavation units' (XU) *responsive to stratigraphic changes rather than on precise thickness* [our emphasis], and
- iii. Post-excavation grouping of the excavated units into a final reconstructed three-dimensional stratigraphy (by use of section drawing, forms, etc.) or, in the case of sites without clear stratigraphy, into near-equivalent 'analytical units' (Johnson 1979:153).

This was essentially the beginning of the 'combined approach' in common use today and Johnson is still at the forefront of digital recording methods (Johnson 1995; Johnson and Wilson 2003; see also <<http://sydney.edu.au/arts/timemap/index.shtml>>). Whilst many excavations conducted in Australia today attempt to follow these methods, excavation of prehistoric sites has increasingly followed a more austere use of arbitrary excavation units that is not always so mindful of stratigraphy. Our survey of excavation practice since ~1980, indicates that excavation units have become the *primary* unit for exploring and analysing a site, rather than a tool by which to aid the recognition of stratigraphic units (SUs) and query 'the mode of formation of the excavated assemblages' (Johnson 1979:145).

Excavation trends in the Australian literature

The review

To understand excavation practice in Australian Indigenous archaeology, we conducted a review of every paper published in *Australian Archaeology* (AA) and *Archaeology in Oceania* (AO) between 1980 and 2015, which reported the excavation of primarily Aboriginal sites. We consider this an appropriate way to interrogate Australian methods, as these papers are peer-reviewed and readily

Table 1. variables used in the review of the Australian Literature

Excavation Method	Site Type	Open Site Rockshelter / Cave
	Excavation Strategy	Stratigraphic excavation Arbitrary Excavation Combined (XUs within individual stratigraphic layers)
	Trench Size	1 × 1m 0.5 × 0.5m Other
	Section Drawing	By stratigraphy By excavation unit Stratigraphy and excavation units shown Excavation units cut through stratigraphic horizons
Post excavation analysis/Interpretation	Artefact Analysis (stratigraphic)	By stratigraphy By excavation unit By depth
	Artefact Analysis (by volume)	Weight / volume Normalised
	Chronology	By stratigraphy By excavation unit By depth
	Interpretations	Combination (XU/depth and stratigraphy)
		By stratigraphy By excavation unit By chronology

available. In contrast, excavation reports arising from consulting work largely exist as grey literature, and alongside academic theses, are not always easy to access or be examined representatively.

In total, we reviewed 158 papers published between 1980 and 2015, 79 each in AA and AO. This included full-length papers, short reports and syntheses that described excavation or post-excavation methods in some way. Whilst the main focus was on excavations conducted at sites in Australia and the Torres Strait ($n=109$), we also considered papers published by AO on research conducted in the Pacific (including New Guinea, New Zealand, and numerous Pacific Islands) ($n=49$). Our review outlines the primary excavation methods used in the field, the post-excavation methods used in the analysis of archaeological material, and crucially, the way both of these articulated with the site's stratigraphy. The variables considered are shown in Table 1, and are essentially aimed at determining site type, excavation method, excavation trench size, recording strategy and methods related to artefact analysis. There is no set standard for describing archaeological methods for publication, and many papers only described some of the variables we were examining, and some interpretation was required on our part.

Reporting of excavation methods

It is notable that cave and rockshelter sites constitute most published archaeological sites in Australia (61%), but a minority (29%) in Pacific sites (Table 2). Additionally, most reported Australian excavations are essentially test pits within rock shelters, using either a 1 × 1 m square trench (44%) or smaller 0.5 × 0.5 m (24%) squares (also see Langley

et al. 2011). This may reflect a number of factors including the fact that the majority of test pits are in rockshelters, and legislative arrangements in Western Australia for instance restrict how much floor space (10%) can be disturbed, as well as the reluctance of some Traditional Owners to disturb ground areas, and constraints of time and budget. In contrast, Pacific sites show a higher percentage of larger (e.g. 1 × 2 m, 2 × 2 m) excavations, defined as those for which several cubic meters were excavated *simultaneously* (and not those excavating smaller test pits in sequence) and are thus closer to small open area excavations.

The use of larger (open area) excavations provides a unique way of analysing spatial relationships between strata and also between finds or features, and acknowledges the considerable variation within sites rather than assuming a representative sample of human behavioural patterns from a single 1 × 1 m excavation (Frankel 1989; Langley et al. 2011; Mardaga-Campbell 1986). Open area investigation strategies and stratigraphic recording systems was recently used by Ironbark heritage at *Waturna Jurnti*, a Pleistocene-age rock shelter in the Pilbara. Unpublished reporting suggests that this allowed disturbances to be more effectively identified, isolated and understood compared to previous excavation strategies based solely on arbitrary spits (Ironbark Heritage and Environment 2013).

In terms of excavation practice, the data indicate that in Australia just over half the sites (54%) were excavated using arbitrary excavation units, and just 10% excavated stratigraphically. Over a third (36%) were excavated using a combined method of using arbitrary excavation units but 'following the stratigraphy where visible' (David et al. 2011:74) with several citing Johnson (1979) for this combined

Table 2. Summary statistics of published excavation practices from *Australian Archaeology* (AA) and *Archaeology in Oceania* (AO) from 1980 to 2015.

	Site type		Excavation		Trench size			Section drawing				
	Open	Rockshelter or cave	By stratigraphy	By excavation unit	Combined	1 × 1 m	0.5 × 0.5 m	Other	By stratigraphy	By excavation unit	Includes excavation units	Cuts across stratigraphy
Journal												
AA	28	43	8	36	24	35	20	16	51	3	13	11
	71		68			71			54			
AO	15	23	2	19	12	12	6	19	24	1	8	4
	38		33			37			25			
TOTAL	43	66	10	55	36	47	26	35	75	4	21 of 75	15 of 21
Australian sites (n = 109)	39%	61%	10%	54%	36%	44%	24%	32%	95%	5%	28%	71%
% sites without information			7			1			28			
Non-Australian sites (n = 49)	71%	29%	26%	38%	36%	27%	9%	64%	97%	3%	22%	100%
% sites without information				14			8		24			

approach. Where section drawings were presented for sites that did attempt to follow the stratigraphy whilst using excavation units (i.e. 28%), they indicate only rare success, with excavation units cutting across the stratigraphy in 71% of these sites (Table 2). For most sites, the main objective appeared to relate to changes in the archaeological record over time rather than a more comprehensive understanding of site formation. For Pacific sites, the use of arbitrary excavation and combined excavation were about equal (36–38%), although 14% of authors did not state the method of excavation (Table 2). However, the problem of excavation units cutting across stratigraphy is absolute in Pacific contexts where arbitrary excavation was used (Table 2). For both Australia and the Pacific, the absence of a section drawing or site blueprint in approximately a quarter of sites is problematic, making it difficult to fully appreciate interpretations on any archaeological site.

Reporting of artefact data

In terms of presentation and interpretation of artefact data (Table 3), the results indicate a relatively equal reporting of artefact data by excavation unit (48%) and by stratigraphy (48%) in Pacific contexts, perhaps reflecting that more sites are excavated by stratigraphy to begin with. In contrast, the vast majority of artefact and ecofact data in Australian contexts is presented in relation to excavation units (71%), even where a combined method has been used. Whilst most papers (78%) include a section drawing, few actually refer to it in the text in relation to artefact, dating and other types of analysis. In addition, very few make any distinction on their section drawings whether stratigraphic boundaries are abrupt or gradual, continuous or discontinuous (for a full discussion of section drawing in Australian archaeological practice see Marshall 2008). In other words, in nearly three-quarters of Australian excavations published over the last 35 years, archaeological remains are being treated as separate to their depositional context rather than part of it. This poses serious questions on what the statistics, and other analyses conducted on these assemblages, can inform us beyond a simple depth trend.

Whilst it is assumed that sediment volume (bucket weight) is generally recorded in the field, it is not common to publish it (28–40%) and more rarely are artefact data standardised (per unit volume of sediment) let alone presented in terms of sediment accumulation rate (see Ward and Larcombe 2003). In other words, there are a number of implicit assumptions in the presentation of artefact data by excavation units including: (a) that sedimentation occurs at a constant rate and in accordance with the principle

Table 3. Summary statistics of reporting of excavated artefact data from *Australian Archaeology* (AA) and *Archaeology in Oceania* (AO) from 1980 to 2015.

Journal	Artefact data				Artefact data				Chronology				Interpretations			
	By stratigraphy	By excavation unit	By depth	Weight/vol presented	Standardised	By stratigraphy	By excavation unit	By depth	By excavation unit	By depth	Combination of XU/depth & stratigraphy	By stratigraphy	By excavation unit	By chronology		
AA	12	41	4	9	9	1	17	6			42	4	9	28		
	57					66						41				
AO	6	13		12	1	2	17				7	2	7			
	19					26						9				
TOTAL	18	54	4	21 of 76	10 of 76	3	34	6			49	6	16	28		
Australian sites (n = 109)	24%	71%	5%	28%	13%	3	37%	7%			53%	12%	32%	56%		
% sites without info.	30					16						54				
Non-Australian sites (n = 49)	48%	48%	4%	40%	0%	47%	31%	0%			22%	68%	16%	16%		
% sites without info.	48	49						35					49			

Standardisation is simply the presentation of artefact numbers per unit volume of sediment.

of superposition, (b) sediment volume (including grain size and porosity) does not change, and (c) artefact numbers reflect changes in site use or contemporaneity at a common depth below surface. In reality, site formation processes can be highly complex and sedimentation particularly in arid and semi-arid contexts is often temporally and spatially diachronous, even where there is a constant source (Holdaway and Fanning 2014; Stein 1987; Ward and Larcombe 2003).

Regarding reporting of chronological (absolute age) data, approximately one-third of sites in both Australian and Pacific contexts, present chronology by excavation units (Table 2). Once again a higher percentage of Pacific sites use stratigraphy to define their chronological data (47%), whilst in Australia over half use a combination of excavation units/depth, and stratigraphy to report chronology (53%). Even though age-depth data are a poor guide to grouping excavation units for analysis (Smith 2006:376), the review indicates that greater confidence is given to interpreting data in this arbitrary context and to use chronology to define the stratigraphy. The use of chronostratigraphy (strata defined from absolute ages) rather than lithostratigraphy (strata defined from sedimentological characteristics) might again be a consequence of the high occurrence of undifferentiated sediments in Australian sites. Nevertheless, previous authors have demonstrated that careful excavation methods can be adequately used to detect erosional surfaces and minor changes in the deposit (Johnson 1979; Smith and Sharp 1993).

Generally, our review of published excavation data from the last 35 years indicates a slight increase over that period in excavation by stratigraphy versus arbitrary excavation units. However, there has been no concomitant change in the reporting of artefact data, chronology or interpretation. In addition, although most sites are still excavated and analysed by excavation units, they are being presented visually in terms of stratigraphy and interpreted in terms of a chronology that may only have poor stratigraphic control – a rather incongruous situation.

Discussion

Identifying stratigraphy

Our review clearly indicates the widespread practice in Australian Indigenous archaeology of excavating, sampling and reporting of data by arbitrary units. This contrasts with the ideals that have been developed in international archaeological theory which argue that the default should be a stratigraphic approach to excavation, if for no other reason than 'stratigraphic units, properly interpreted, might divide sites into meaningful behavioural units' (Allen

Figure 3 (upper and lower). Comparison of grain size data (by sieve analysis) from sediments collected from (a) excavation units (XUs) and (b) stratigraphic units (SUs) at near equivalent depths.

pers. comm. 2016). Hughes and Lampert (1977:136) argued that the common use of arbitrary excavation units was due to the absence of any sharp stratigraphic division in many Australian sites. Whilst stratification can be difficult to see in cave and rockshelter sites, which make up most Australian sites (i.e. 61%), the fall-back to arbitrary excavation is flawed. In fact, many of the sites in which an arbitrary method was used were afterwards shown to have some degree of stratigraphic differentiation, and 95% of these sites with an illustrated stratigraphic section show such differentiation. In some cases, especially open sites with sandy sediments, stratigraphic divisions may be more apparent than real, as a result of post-depositional processes such as rubefaction, mottling, salination and changes in groundwater level. Sedimentary texture and fabric are generally more important than colour, which can be misleading (see also Hughes and Lampert 1977; Smith 2012). Overprinting by secondary minerals, such as calcite or gypsum (e.g. Morse et al. 2014;

Figure 5) can also mask the true stratigraphy (see also Richardson 2010).

The presentation of two-dimensional section drawings for sites that were excavated by arbitrary units implies that three-dimensional stratigraphy can be recreated and understood post-excavation. Whilst this may be true, if supplemented by sedimentological data such as composition (including grain size and mineralogy), colour, texture, geochemistry and so on (although such information is rarely provided) and by chronology, it is nevertheless problematic. Consider, for example features that only occur in the middle of the trench (for example a vertical pit or hearth) that will never appear in the two-dimensional profile on the trench walls. At the same time, any single 1 × 1 m excavation may be insufficient to intersect all strata within a single site, again presenting a limited representation of site architecture. Moreover, post-field analyses should ideally supplement and integrate with field interpretations, rather than provide the primary means of

reconstructing stratigraphy and site formation history (Branch et al. 2005; Smith 2012).

Where stratigraphic horizons are the result of human activity, such as vertical cuts caused by the digging of pits or graves, or natural processes such as animal burrows, the use of arbitrary units can include material from vastly different temporal periods, and that are the result of different human activities. Indeed, the wider archaeological definition of stratigraphy acknowledges that human agency impacts on site formation processes, usually in vertical rather than horizontal ways (Harris 1989; Wheeler 1954). To address this, the use of excavation units *within* [our emphasis] stratigraphic units is often advised (Balme and Paterson 2014; Carver et al. 2015). At the same time, the stratigraphy itself has to be both recognised and interpreted, even if it does not have any direct bearing on site use and human behaviour. ‘The art of stratigraphy... just requires you to ask some questions about the nature of your site and how it’s built up’ (Smith 2012) and importantly also how it is subsequently disturbed (Hunt et al. 2015).

Problems associated with use of arbitrary excavation

Without complicating the problem with questions of natural sedimentation versus cultural deposition, it is apparent from our review that preference is given to analysing the data in terms of either equal time periods or equal depth, with the assumption that this equates to equal quantities of deposit. Both stratigraphy and arbitrary units contain the unknown factor, the deposition rate, hence the importance of standardising data to sediment volume or density and more specifically in terms of net sedimentation (Ward and Larcombe 2003).

For the site of Kurturniawak in Torres Strait, David and Weisler (2006) usefully provide tables of archaeological data per XU and SU, and a section drawing which overlays both elements, in addition to data on sediment volume and compaction. However, even with this information, it remains impossible for the reader to reconcile whether particular finds belong to one or another stratigraphic unit. At Puritjarra, Central Australia, where the stratigraphy is poorly resolved, up to 15% of artefacts from excavation units may not be able to isolate to a particular analytical unit (Smith 2006). Careful analysis (by IW) of the Kurturniawak data indicates that this issue does not significantly change the results or interpretations for this study. However, for other sites, particularly slow accumulating sites, exact proveniencing to particular stratigraphic units, may be critical to resolving when and how changes occurred in the past. Where there is no relationship

of artefact assemblages with strata, this may indicate that deposition (environment) isn’t the determining factor on human behavioural patterns – an important assessment in itself.

Figure 3 demonstrates some of the potential issues that can arise from use of arbitrary excavation data, comparing the sediment grain size distribution, as determined by sieve analysis, from (i) representative bulk samples taken from excavation units (3 upper) against, (ii) stratigraphic units in section (3 lower) in the same excavation square of a rockshelter site in the Pilbara. The results show clear mixing in the representative excavation unit samples in contrast to the stratigraphically based samples. The implication is that any shell, charcoal or other samples – including those chosen for dating – that are taken from excavation units (i.e. not in situ) may also be mixed or stratigraphically compromised. Archaeological material ascribed to an arbitrary unit that cuts across a stratigraphic horizon is essentially meaningless in any analytical terms. In some situations, as exemplified at Niah Cave, Sarawak, resolving uncertainties from earlier excavations dug as arbitrary excavation units sometimes cannot even be resolved with subsequent excavation (see < <http://www.abc.net.au/science/slab/niahcave/whyniah.htm> >).

When arbitrary excavation units cut across stratigraphic unit boundaries or interfaces (Figure 1(c) and (d)), this not only means potential information from the nature of the boundaries (Mardaga-Campbell 1986), but leaves any ecofacts and artefact assemblages recovered from that excavation unit without a clear context and instead with uncertain association (Frankel 1988; see also Reynolds 1992). In sites where the rate of sedimentation is not uniform (i.e. the vast majority), the use of arbitrary levels that cut across stratigraphic interfaces mean that archaeological material ascribed to those excavation units actually derive from two (or more) stratigraphic layers that may be temporally or spatially separated (Wheeler 1954:44–45). Numerous Australian sites have been shown to have significant hiatus periods between strata (see O’Connor et al. 1999; Ward and Larcombe 2003; Vannieuwenhuyse 2016; Veth et al. 2016 and references therein) and indeed in most depositional settings there is more gap – or periods of non-deposition – than sequence (Tipper 2015).

Arbitrary versus stratigraphic excavation

A theoretical argument for the arbitrary method is that the excavator cannot know what is just beneath the trowel and even an ideal large open area excavation is essentially done blind, unless there is any vertical control from a previously exposed face, auger

hole or excavation (e.g. Ironbark Heritage and Environment 2013; see also Kintigh 1988; Stein 1986). The use of arbitrary horizontal excavation units is thus often championed on the basis that defining strata during excavation is subject to the variable skills, experience, adequate training and attentiveness of the excavator (Carver et al. 2015) – although a similar claim can be made for the skilled excavation of perfectly flat, thin and regular excavation units. The interpretation of archaeological stratigraphy at the trowel's edge (Hodder 1997) is arguably a fundamental part of training for every archaeologist (for discussions on training see Colley 2004; Hall et al. 2005; Cosgrove et al. 2013).

Arbitrary excavation has also been argued to be more efficient in terms of time, particularly in commercial archaeology, and where there is no test pit to provide a preliminary understanding of the site's stratigraphy (Balme and Paterson 2014; Carver et al. 2015). In other regions, such as in Europe and the Middle-East, a large majority of Palaeolithic sites are themselves located in caves and rockshelters, and commercial or salvage archaeology is conducted under extreme time-pressure; but this has not encouraged a greater use of arbitrary excavation methods (Archer and Bartoy 2007; Carver et al. 2015; Lucas 2001). The experience of the authors, all of whom have participated in commercial (including salvage) excavation in the UK and France, indicates that large area excavation using stratigraphic methods is the norm in these places. Moreover, excavating by context, especially when taking into account post-excavation analysis by archaeologists, earth scientists and other specialist scientists, is no more time consuming than excavating by arbitrary level.

As in any region, Australia presents its own logistical and theoretical challenges, so that no 'universal' method can be prescriptive. Each new site presents its own challenges that even extremely experienced excavators can learn from. As Praetzelis (2003:206) states,

Like a chess game, each site is both unique and repetitive. Unique, because its history, structure, and content aren't duplicated elsewhere; and repetitive in that the structure of every site is an example of the application of principles that don't change regardless of where in the world it is situated.... The field archaeologist's thrill is in teasing out that structure by the careful excavation of layers of soils distinguishable only by subtle differences in colour and texture....

Fundamentally, 'the style and nature of the excavation not only locates artefacts and ecofacts but provides them with a defined context... which determines the possible interpretations placed upon them' (Frankel 1993:876). Whatever method used, enough of a site needs to be excavated to at least monitor

the extent of horizontal as opposed to temporal variability and to begin to understand its biography – and there is no simple formula to say how much is enough. At the same time, while 'one cannot speak of a universal excavation technique, one can conceive of a widely applicable recording system' Johnson (1979:148). Any universal recording system needs to include both stratigraphy and excavation units (e.g. David and Weisler 2006; Flood 1974; Hewitt and Allen 2010). However, even this ideal has yet to be developed.

Conclusion

As Flinders Petrie (1904:169–172) declared over a century ago, archaeological excavation destroys the resource it seeks to understand, so it is the responsibility of archaeologists to record carefully every aspect of that resource during the excavation process. More recently, as Frankel (1993) and many others remind us, the destructive nature of archaeological excavation leads to a responsibility to document the 'record of the ground', including eco/artefacts and their context, in such a way that will not compromise alternative analyses or interpretations of the site. Our paper reinforces the advantages of a precise proveniencing of archaeological and associated assemblage data to its stratigraphic context during excavation in order to provide a more accurate interpretation of behavioural (and environmental) changes through time. In light of this review we recommend that an excavation that follows stratigraphy, and an analysis of finds in terms of stratigraphic units will, in most cases, provide the best opportunity to separate and contextualise cultural features and deposits *in situ*, and from this interpret past human behaviour.

Acknowledgements

The authors wish to thank Dorcas Vannieuwenhuysen, Matt Canti, Alan Watchman, Piers Larcombe, Thomas Whitley, Paul Goldberg and especially Mike Smith for their invaluable comments on the draft manuscript. We also thank Jim Allen, Phil Hughes and one anonymous referee for their useful reviews and comments.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

References

- Archer, S. and K. Bartoy 2007 *Between Dirt and Discussion: Methods, Methodology and Interpretation in Historical Archaeology*. New York: Springer.

- Balme, J. and A. Paterson 2014 Stratigraphy. In J. Balme and A. Paterson (eds), *Archaeology in Practice: A Student Guide to Archaeological Analyses*, pp.26–46. Sussex: Wiley and Sons.
- Barham, A. and G. Huckleberry 2014 Sediments. In J. Balme and A. Paterson (eds), *Archaeology in Practice: A Student Guide to Archaeological Analyses*, pp.47–84. Sussex: Wiley and Sons.
- Barker, P. 1977 *Techniques of Archaeological Excavation*. London: Batsford.
- Barker, P. 2003 *Techniques of Archaeological Excavation* 3rd ed. London: CRC Press.
- Boucher de Perthes, M.J. 1847 *Antiquités celtiques et antédiluviennes. Mémoire sur l'industrie primitive et les arts à leur origine*. Paris: Treuttel et Wurtz.
- Branch, N., M. Canti, P. Clark and C. Turney 2005 *Environmental Archaeology: Theoretical and Practical Approaches*. London: Hodder Arnold.
- Browman, D.L. and D.R. Givens 1996 Stratigraphic excavation: The first “New Archaeology”. *American Anthropologist* 98(1):80–95.
- Bruxelles L., R.J. Clarke, R. Maire, R. Ortega and D. Stradford 2014 Stratigraphic analysis of the Sterkfontein StW 573 Australopithecus skeleton and implications for its age. *Journal of Human Evolution* 70:36–48.
- Burke, H. and C. Smith 2004. *The Archaeologists Field Handbook*. Sydney: Allen and Unwin.
- Carver, M., B. Gaydarska and S. Monton-Subias 2015. *Field Archaeology from Around the World: Ideas and Approaches*. Cham: Springer International Publishing.
- Chadwick, A. 2003 Post-processualism, professionalization and archaeological methodologies. Towards reflective and radical practice. *Archaeological Dialogues* 10(1):97–117.
- Cherry, J.F. 2011 Still not digging, much. *Archaeological Dialogues* 18(1):10–17.
- Colley, S. 2004 University-based archaeology teaching and learning and professionalism in Australia. *World Archaeology* 36(2):189–202.
- Connah, G. 1983 Preface. In Connah, G. (ed), *Australian Field Archaeology: A Guide to Techniques*. pp.vii–viii. Canberra: Australian Institute of Aboriginal Studies.
- Connah, G. 1984 *Australian Field Archaeology: A Guide to Techniques*. Canberra: Aboriginal Studies Press.
- Cosgrove, R., D. Frankel and D. Thomas 2013 From the moat to the Murray: Teaching practical archaeology at La Trobe University, Australia. *Australian Archaeology* 76:44–51.
- Darvill, T. 2008 *The Concise Oxford Dictionary of Archaeology*. Oxford: Oxford University Press.
- David, B. and M.I. Weisler 2006 Kurturnaiwak (Badu) and the archaeology of villages in Torres Strait. *Australian Archaeology* 63:21–34.
- David, B., J-M. Geneste, R.L. Whear, J-J. Delannoy, M. Katherine, R.G. Gunn, Clarkson, C., H. Plisson, P. Lee, F. Petchev, C. Rowe, B. Barker, L. Lamb, W. Miller, S. Hoerlé, D. James, É. Boche, K. Aplin, I.J. McNiven, T. Richards, A. Fairbairn and J. Matthews 2011 Nawarla Gabarnmang, a 45,180 ± 910 cal BP site in Jawoyn Country, Southwest Arnhem Land Plateau. *Australian Archaeology* 73:73–77.
- Droop, J.P. 1915 *Archaeological Excavation*. Cambridge: The University Press.
- Edgeworth, M. 2011. Excavation as a ground of archaeological knowledge. *Archaeological Dialogues* 18(1):44–46.
- Flood, J. 1974 Pleistocene man at Cloggs Cave: His tool kit and environment. *Mankind* 9(3):175–188.
- Frankel, D. 1988 Characterising change in prehistoric sequences: A view from Australia. *Archaeology in Oceania* 23(2):41–48.
- Frankel, D. 1989 Koongine Cave excavations 1986–7: Investigating spatial patterning. *Australian Archaeology* 22:2–13.
- Frankel, D. 1993 The excavator: Creator or destroyer? *Antiquity* 67(257):875–877.
- Gramling, C. 2016 The ‘hobbit’ was a separate species of human, new dating reveals. Retrieved 10 April 2016 from Science Magazine <http://www.sciencemag.org/news/2016/03/hobbit-was-separate-species-human-new-dating-reveals>. doi: 10.1126/science.aaf9853.
- Hale, H. and N.B. Tindale 1930 Notes on some human remains in the Lower Murray Valley, South Australia. *Records of the South Australia Museum* 4(2):145–218.
- Hall, J., S. O'Connor, J. Prangnell and T. Smith 2005 Teaching archaeological excavation at the University of Queensland: Eight years inside TARDIS. *Australian Archaeology* 61:48–55.
- Harris, C. 1975 The stratigraphic sequence: A question of time. *World Archaeology* 7(1):109–121.
- Harris, E. 1989 *Principles of Archaeological Stratigraphy* 2nd ed. London: Academic Press.
- 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.
- Hodder, I. 1995 *Theory and Practice in Archaeology*. New York: Routledge.
- Hodder I. 1997 ‘Always momentary, fluid and flexible’: Towards a reflexive excavation methodology. *Antiquity* 71 (273):691–700.
- Holdaway, S. J. and P.C. Fanning 2014 *Geoarchaeology of Aboriginal Landscapes in Semi-arid Australia*. Melbourne: CSIRO Publishing.
- Hughes, P.J. and R.J. Lampert 1977 Occupational disturbance and types of archaeological deposit. *Journal of Archaeological Science* 4(2):135–140.
- Hume, N.I. 1968 *Historical Archaeology. A comprehensive guide*. New York: Random House.
- Hunt, C., D.D. Gilbertson, E.A. Hill and D. Simpson 2015 Sedimentation, re-sedimentation and chronologies in archaeologically-important caves: problems and prospects. *Journal of Archaeological Science* 56:109–116.
- Ironbark Heritage and Environment 2013 DIA #6287 Shay Gap 4B (PIL_987) Cundaline Ridge – Yarrrie Project Area Pilbara Region–Western Australia. Unpublished report to BHP Billiton Iron Ore.
- Johnson, D. 1979 The getting of data. Unpublished Ph.D thesis, Australian National University.
- Johnson, I. R. 1995 *Mapping Archaeological Data: A Structured Introduction to MapInfo*. Sydney: Archaeological Computing Laboratory, University of Sydney.
- Johnson, I. and A.Wilson 2003 The timemap project: Developing time-based GIS display for cultural data. *Journal of GIS in Archaeology* 1:123–135.
- Kintigh, K.W. 1988 The effectiveness of subsurface testing: A simulation approach. *American Antiquity* 53(4):686–707.
- Langley, M.C., C. Clarkson and S. Ulm 2011 From small holes to grand narratives: The impact of taphonomy and sample size on the modernity debate in Australia

- and New Guinea. *Journal of Human Evolution* 61(2):197–208.
- Leroi-Gourhan A. and M. Brezillon 1973 *Fouilles de Pincevent: essai d'analyse ethnographique d'un habitat magdalénien. La section 36*. Paris: CNRS, 1972, VIIe suppl. à Gallia Préhistoire.
- Lucas, G. 2001 *Critical Approaches to Fieldwork. Contemporary and Historical Archaeological Practice*, pp.246. London: Routledge.
- Lyell, C. 1830–33 *Principles of Geology*. London: John Murray.
- Lyman, R. L. 2012 A historical sketch on the concepts of archaeological association, context, and provenience. *Journal of Archaeological Method and Theory* 19(2):207–240.
- Lyman, R.L. and M.J. O'Brien 1999 Americanist stratigraphic excavation and the measurement of Cultural Change. *Journal of Archaeological Method and Theory* 6(1):55–107.
- Mallol, C. and S.M. Mentzer 2015 Contacts under the lens: Perspectives on the role of microstratigraphy in archaeological research. Retrieved 15 May 2015 from *Archaeological and Anthropological Science*. doi: 10.1007/s12520-015-0288-6.
- Mardaga-Campbell, M. 1986 Prehistoric living-floors and evidence for them in North Queensland rockshelters. *Australian Archaeology* 23:42–61.
- Marshallsay, J. 2008 The Section Drawing and Australian Archaeological Practice. Honours thesis, Flinders University. Retrieved 26 August 2015 from <https://www.flinders.edu.au/ehl/fms/archaeology_files/dig_library/theses/Marshallsay_J_Thesis2008.pdf>.
- Morse, K. Cameron, R. and W. Reynen 2014 A tale of three caves: New dates for Pleistocene occupation in the Inland Pilbara. *Australian Archaeology* 79:167–178.
- Mulvaney, D.J. (ed) 1968 *Australian Archaeology: A Guide to Field and Laboratory Techniques*. Canberra: Australian Institute of Aboriginal Studies.
- Mulvaney, D.J. 1980 Two remarkably parallel careers. *Australian Archaeology* 10:96–101.
- Mulvaney J. 1986 Archaeological retrospect. *Antiquity* 60(229):96–107.
- Murray T. and P. White 1981 Cambridge in the Bush? Archaeology in Australia and New Guinea. *World Archaeology* 13(2):255–263.
- Museum of London 1994 *Archaeological Site Manual*. London: Museum of London.
- Nelson, N.C. 1916 Chronology of the Tano Ruins, New Mexico. *American Anthropologist* 18(2):159–180.
- O'Connor, S., P. Veth and A. Barham 1999 Cultural versus natural explanations for lacunae in Aboriginal occupation deposits in northern Australia. *Quaternary International* 59(1):61–70.
- Petrie, W.M.F. 1904 *Methods and Aims in Archaeology*. London: MacMillan and Co.
- Praetzelis, A. 1993 The limits of arbitrary excavation. In E.C. Harris, M.R. Brown, III., & G.J. Brown (eds) *Practices of Archaeological Stratigraphy*. London & San Diego: Academic Press.
- Praetzelis A. 2003. *Dug to Death: A Tale of Archaeological Method and Mayhem*. Walnut Creek, CA: Altamira Press.
- Reynolds, T.E. 1992 Excavations at Banyan Valley Cave, Northern Thailand: A report on the 1972 season. *Asian Perspectives* 31(1):77–97.
- Richardson, N. 2010 *Conjoin Sets, Stratigraphic Integrity and Chronological Resolution at Kenniff Cave, Queensland*. Unpublished M. Phil thesis, School of Archaeology and Anthropology, The Australian National University.
- Roskams, S. 2001 *Excavation*. Cambridge: Cambridge University Press.
- Shanks, M. and C. Tilley 1987 *Social Theory and Archaeology*. Cambridge: Polity Press.
- Smith, M. 2000 The opening chapter of the romance of excavation in Australia: Reflections on Norman Tindale's archaeology. *Historical Records of Australian Science* 13(2):151–160.
- Smith, M. 2006 Characterizing late pleistocene and holocene stone artefact assemblages from Puritjarra rock shelter: A long sequence from the Australian Desert. *Records of the Australian Museum* 58(3):371–410.
- Smith, M. 2012 The Lost Art of Stratigraphy. Retrieved 1 July 2015 from <http://www.nma.gov.au/history/research/research_centre/our_people/mike_smith/the_lost_art_of_stratigraphy_videos>.
- Smith, M. and Sharp, N.D. 1993 Pleistocene sites in Australia, New Guinea and Island Melanesia: geographic and temporal structure of the archaeological record. In Smith, M.A., M. Spriggs and B. Fankenhauer (eds), *Sahul in Review: The Archaeology of Australia, New Guinea and Island Melanesia*, pp.37–59. Canberra: ANU Press.
- Stein, J. 1986 Coring Archaeological Sites. *American Antiquity* 51(3):505–527
- Stein, J. 1987 Deposits for archaeologists. *Advances in Archaeological Methods and Theory* 11:337–393.
- Tipper, J.C. 2015. The importance of doing nothing: Stasis in sedimentation systems and its stratigraphic effects. In Smith, D.H., R.J. Bailey, P.M. Burgess and Fraser, A.J. (eds), *Strata and Time: Probing the Gaps in Our Understanding*, vol. 404, pp.105–122. London: Geological Society London, Special Publications.
- Trigger, B.G. 1989 *A History of Archaeological Thought*. Cambridge: Cambridge University Press.
- Vannieuwenhuysse, D. 2016. Mind the gap: Geoarchaeology and micromorphology of cave and rockshelter sequences from the Kimberley, North-West Australia. Unpublished PhD thesis, School of Social Science, University of Western Australia, Perth.
- Veth, P.I. Ward and K. Ditchfield 2016 Reconceptualising last glacial maximum discontinuities: A case study from the maritime deserts of north-western Australia. *Anthropological Archaeology*. Retrieved 5 June 2016 from <<http://dx.doi.org/10.1016/j.jaa.2016.07.016>>. doi: 10.1016/j.jaa.2016.07.016.
- Walshe, K. 2011 Past and present status of aboriginal archaeology in South Australia: Collecting, excavating, recording and collections since 1880. *Journal of the Anthropological Society of South Australia* 34:1–20.
- Ward, I. and P. Larcombe 2003 A process-orientated approach to archaeological site formation: Application to semi-arid Northern Australia. *Journal of Archaeological Science* 30:1223–1236.
- Wheeler, M. 1954 *Archaeology from the Earth*. Oxford: Clarendon Press.
- Wissler, C. 1917 The new archaeology. *American Museum Journal* 17(2):100–101.
- Worsaae, J.J.A. 1843 *Danmarks Oldtid oplyst ved Oldsager og Gravhøie (The Primeval Antiquities of Denmark)*. Copenhagen: Trykkefrihedens rette Brug Press.