ARTICLE IN PRESS

Quaternary International xxx (2016) 1–13

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Geoarchaeology in action: A sedimentological analysis of anthropogenic shell mounds from the Cape York region of Australia

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ARTICLE INFO

Article history:
Available online xxx

Keywords:
Shell mounds
Geoarchaeology
Northern Australia
Formation processes

ABSTRACT

Large mounded deposits of shell are prominent archaeological features across much of the north Australian tropical coast. Many of the shell mounds are composed almost entirely of the bivalve *Anadara granosa* (Linnaeus 1758), a food source for Aboriginal people in the past. A relatively long history of inquiry into the nature and significance of the shell mounds has focussed primarily on analysing the shell component as clues to Australian Aboriginal coastal economies in the past. This paper presents results of new analyses on the non-shell sediments, examining the physical and chemical signatures of depositional and post-depositional processes within shell mounds near Weipa in far north Queensland, Australia, with a view to obtaining insights into how they formed and for what purposes, and how their morphology, structure and content may have changed since they ceased accumulating. We also consider how such changes might relate to past and present environmental conditions. Physical and chemical analyses indicate that the primary purpose of mound building was most likely to discard the large volumes of shell resulting from *A. granosa* harvesting and consumption. Post-depositional diagenetic alteration has strongly influenced the present day composition and form of the shell mounds, in particular the accession of carbon and silica to the mounds by environmental burning aided by strong leaching under the seasonal high rainfall conditions. As such the mound chemistry is more likely to reflect modern environmental conditions rather than provide an archive of, or an opening to, the past.

1. Introduction

Large mounded deposits of shell — shell middens largely composed of the sand/mudflat bivalve *Anadara granosa* — are prominent archaeological features across much of the north Australian tropical coast (Faulkner, 2014, p. 57). As a result of their prevalence, there has been a relatively long history of inquiry into their nature and significance, beginning with the observations, in the ethnographic literature, of Roth (1901, in Faulkner, 2014). Initial excavations of north Australian shell mounds were undertaken between the 1920s and 1940s by W. Lloyd Warner, Fred McCarthy and Frank Setzler. In the Weipa region of far north Queensland, the focus of the research reported here, the earliest excavations were carried out in the early 1960s by Richard V.S. Wright, followed closely by the PhD work of his student Geoff Bailey. The continuation of this work through to the present, with a number of detailed research projects in distinct and widely separated geographical regions has, according to Faulkner (2014, p.57), provided us with a relatively broad-scale understanding of the morphology, content, spatial distribution, and temporal patterns of *A. granosa* shell mounds (see, for example, Bailey, 1975, 1977, 1999; Beaton, 1985; Roberts, 1991; Bailey et al., 1994; Cribb, 1996; Veitch, 1999; Bourke, 2004; Faulkner, 2009, 2013; Brockwell et al., 2013).

This work has focussed on the shellfish remains within the mounds and what they can tell archaeologists about what people were gathering and eating, how much, where, and when; i.e., analysing the content of the mounds as clues to Australian Aboriginal coastal food economies. These analyses have, in some places, been linked to more general observations of shellfish harvesting by Indigenous communities today, and the role this

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http://dx.doi.org/10.1016/j.quaint.2016.09.010
1040-6182/

plays in their food economies and cultural practices (see, for example, Meehan, 1982, 1983; Bourke, 2002). In Australia, as well as other parts of the world, the large size of some of these mounds (for example, Bailey (1977, p. 138) recorded one mound that was 13 m high and 9400 m^3 in volume) has led archaeologists to suggest that the mounds represent the remains of intensive food extraction, perhaps supporting large populations of people (for example, Haberle and David, 2004; Jerardino, 2010; Morrison, 2013). Alternatively, they are regarded as specialist processing sites (for example, Parkington, 2012), or simply as highly visible sites that represent only one component of a varied economy that also included other protein sources such as fish and terrestrial mammals (see, for example, Bailey, 1975, p. 55). The large size and the shapes of the mounds have led some to suggest that they represent deliberate constructions – a form of monument (for example, Russo and Quitmyer, 2008; Saunders and Russo, 2011). Some large shell mounds, on the other hand, have been primarily interpreted as occupation locations, with their size and shape seen as attractive for habitation. These various interpretations have, from time to time, resulted in disagreements over site function with, for example, inferences about mounds as "… sites for quotidian subsistence and waste disposal …" and/or the remains of large-scale feasts contrasted with mounds as a form of monument (see Marquardt, 2010, and Thompson and Worth, 2011, pp. 67–71, for detailed reviews of these arguments as they pertain to the North American southeast coast). To try to resolve some of these arguments, recent research on the Crystal River mound complexes in Florida, for example, has used Bayesian analysis of radiocarbon and OSL dates combined with oxygen isotope analysis to pinpoint shell collection seasonality, in order to gauge the temporality of monument construction and the waxing and waning of village life (see Thompson and Andrus, 2011; Pluckhahn et al., 2015; Thompson et al., 2015, 2016). Similar work has been conducted on Saudi Arabian shell mounds by Hausmann and Meredith-Williams (2016). Kim et al. (2016) used high resolution oxygen and carbon isotopic and trace elemental compositions of bivalves from ancient shell mounds, as well as recent bivalves of the same taxon, to delineate palaeoclimatic conditions since the mid-Holocene near Jeju Island, Korea.

Differentiating between alternative behavioural interpretations can become difficult when reliance is placed exclusively on the shell from which the mounds are largely composed. Shellfish have economic value, but this value does not preclude mounds created from discarded shell serving a variety of other functions. For example, Thompson et al. (2016) have been able to demonstrate "mining" of shells from middens for re-use in mound monuments. Shell mounds may, therefore, have complex origins, and it is useful to consider multiple forms of analysis to help understand both how the mounds were formed and, importantly, how they have been affected by post-depositional alterations (Stein, 1992; Marquardt, 2010).

Diagenetic processes have, the world over, been superimposed onto the original stratification of the material comprising shell mounds, and therefore need to be understood as part of the cultural interpretation of the mounds. For example, Correa et al. (2013) identified post-formation pedogenic processes in a Brazilian sambaqui as responsible for an increase in the abundance of phosphatic clay micromass with depth down the profile into archaeologically sterile layers. Phosphate-rich soil layers are usually commonly interpreted as indicating habitation at the time of deposition of the layer (Correa et al., 2013, p. 16).

Having previously reported on the variability in shell mound size and shape near Weipa in far north Queensland, Australia (Fig. 1; Larsen et al., 2015), in this paper we examine the physical and chemical signatures of both depositional and post-depositional processes within one of these shell mounds, with a view to obtaining insights into how the mounds formed, how their morphology, structure and content may have changed since they ceased accumulating, and how such changes might relate to past and present environmental conditions. As observed by Villagran (2014), despite the great potential of a geoarchaeological perspective, including stratigraphic and sedimentological analysis, to understand mound construction and decay, the use of geoarchaeology to study shell mound formation processes is less common than approaches based on, for example, the economics of shellfish exploitation. It is our contention that, at least for the shell mounds we have studied, the non-shell sediment component retains valuable information on shell mound formation processes, in particular the diagenetic processes that take place after site abandonment. In this sense, a geoarchaeological approach can provide important additional lines of evidence to approaches based on the size, shape, and shellfish species composition of the mounds, by standardising stratigraphic and sediment analysis in an overall regional context (Villagran, 2014, p. 212).

2. Methods

A total of 158 shell matrix deposits (SMDs; after Morrison, 2013, pp. 80–81) were located in the Wathayn study area (Larsen et al., 2015) over a geographical range of 4.7 km east to west, or upstream to downstream, along the northern side of the Embley River, and within 1200 m of the present day shoreline (Fig. 2). The SMDs range in character from low density shell "scatters", covering less than 100% of the ground surface, through to mounded shell "middens" up to 2.35 m high (hereafter called shell "mounds"; Larsen et al., 2015, p. 2). They occupy a variety of geomorphic environments, ranging from higher elevation hillslopes and cliff tops (up to 10 m above mean sea level (Australian Height Datum or AHD)) to sand/gravel ridges and muddy estuarine floodplains low down in the landscape. Stringybark (*Eucalyptus tetradonta*) woodland, with an understory of dense shrubs and grasses, forms a continuous vegetation cover across the slopes, with paperbark/saltmarsh and mangrove communities occupying the estuarine floodplain (Shiner et al., 2013, p. 71). For ease of subsequent analysis and discussion, the shell mounds in the Wathayn study area have been grouped into three geographical locations (Wathayn East, Wathayn Central, and Wathayn West), largely separated from each other by tributary drainage depressions (Fig. 2).

Once located, all of the shell mounds chosen for further study were cleared of vegetation and surveyed using a Leica C10 Terrestrial Laser Scanner (TLS), with target locations fixed in 3D space using a Differential Geographic Positioning System (DGPS) (Larsen et al., 2015). To expose the internal stratigraphy and obtain samples, trenches 1 m wide were excavated by hand along the short axis of each shell mound, starting at the outside where the mound intersects the surrounding terrain and working systematically to the centre (Fig. 3). The corners of each trench were permanently marked with stainless steel pins and the perimeter with string lines. Each trench was excavated using mattocks and shovels, with the material removed in buckets and stockpiled nearby. After the descriptions, surveying and sampling were completed, the trenches were all backfilled using the stockpiled material. The express permission of the Wathayn Traditional Owners to use this method was obtained before work commenced. Trench excavation is a method commonly used in geological and geomorphological studies to expose the three-dimensional stratigraphy of a feature and to facilitate sampling. It has also been used as the primary exploration and sampling method in shell mound studies elsewhere (for example, Stein,

Please cite this article in press as: Fanning, P.C., et al., Geoarchaeology in action: A sedimentological analysis of anthropogenic shell mounds from the Cape York region of Australia, Quaternary International (2016), http://dx.doi.org/10.1016/j.quaint.2016.09.010