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Isolating downward displacement: The solutions and challenges of amino acid racemisation in shell midden archaeology

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ABSTRACT

Shell middens are particularly susceptible to post-depositional processes that can rework and redistribute material through a deposit. As archaeological material is moved from its original primary context, the assumption that a temporal connection exists with spatially associated material becomes tenuous. It therefore becomes critical to identify displaced archaeological material within a deposit to ensure correct chronologies are being built. Radiometric dating techniques can identify individual displaced materials, but are sometimes prohibitively costly to utilise on a large scale. This study presents a new application of amino acid racemisation (AAR) dating that identifies stratigraphically displaced midden shell from within a deposit from the northwest Kimberley, Western Australia. Low-cost AAR analysis of 72 samples identified a sample of downwardly-displaced midden shell. Upon close inspection, comparison of AAR and AMS radiocarbon determinations identified fine-grained inconsistencies. Possible processes generating these discrepancies are considered with future avenues for research presented. While an enormous amount of potential is contained within AAR, more work is required to bring the method to the same level of precision as other commonly utilised dating techniques in archaeological research.

1. Introduction

Archaeological deposits are constantly being influenced by environmental and cultural processes that can add, remove or redistribute material (Schiffer, 1996). These processes can result in the distortion or complete disassociation of the original spatio-temporal connections that artefacts and sediments (Bailey, 2007). This is a major complication, especially considering that researchers constantly rely on assumptions of spatial and temporal relationships between materials in archaeological deposits to build interpretations regarding the ancient behaviours and palaeoenvironments represented within the deposit (e.g. Burleigh, 1974: 79, Taylor and Bar-Yosef 2014). Recognising that the potential exists for material within an archaeological deposit to be displaced is therefore critical for any interpretations or subsequent analyses to carry any form of accuracy or relevance. Resolving these ambiguities, however, can present methodological problems.

Radiocarbon dating is by far the most widely used absolute chronological tool in archaeological in archaeological investigation, however issues regarding site integrity and patterns of disturbance still have the potential to greatly skew results and interpretations (Burleigh, 1974). The development of AMS techniques facilitated the direct dating of archaeological material (e.g. Rick et al. 2005; Wild et al. 2005; O'Connor et al. 2010). The key advantage of this practice is that the assumption that spatial association represents temporal association is circumvented by attributing an age to the artefact or ecofact itself rather than relying on the chronology of the surrounding material. Despite its prolific use in archaeological research, the radiocarbon method as we know it today is most effective on a small scale of chronological inquiry; dating one specific event or artefact (see Lucas, 2005: 45, 49; Sullivan, 2008). In answering larger site-scale questions, such as assessing the spatial and temporal relationships between populations of artefacts and material, one single age determination is insufficient. While two radiocarbon ages can at times be enough to identify a disturbed deposit (see O'Connor et al. 2010: 37–38), such minimal data can rarely pinpoint the degree or nature of disturbance. Many individual samples are required to reliably identify disturbed deposits and go beyond the mere label of 'disturbed'. Only then can

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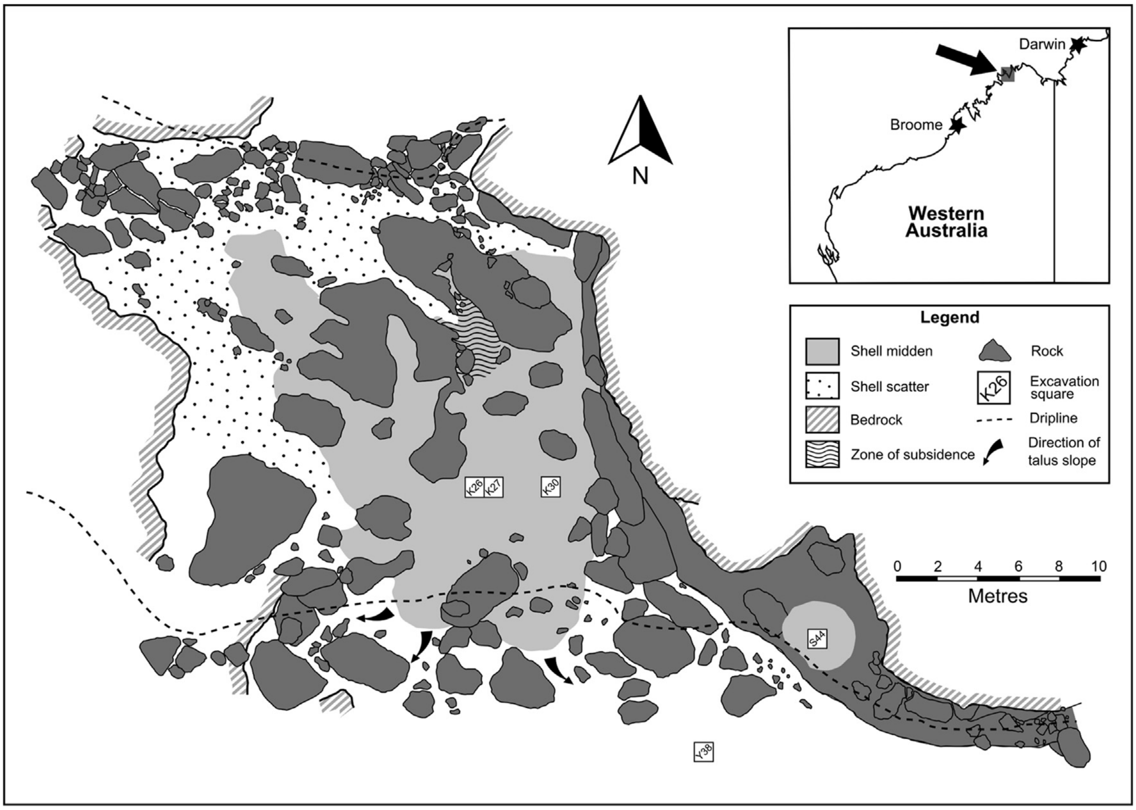

Fig. 1. Site plan and inset map of Admiralty Gulf.

researchers actually assess the relative contributions of units of temporally distinct sediments, ecofacts and artefacts in a time-averaged deposit and build reliable interpretations of site transformation.

Shell middens are ubiquitous archaeological features across the globe, and are particularly susceptible to post-depositional transformation (Stein, 1992). This is largely due to their generally coarse and porous composition that allows material held within to be freely displaced, removed or altered by environmental and cultural processes (e.g. Dwyer et al. 1985; Specht, 1985; Wandsnider, 1988; Rick, 2002; Robins and Robins, 2011; Szabó, 2012). Considering the significant potential that shell middens have in contributing to important issues in archaeological research (e.g. Bailey, 1977; Cannon, 2000; Lombardo et al. 2013), it is critical that the identification of displaced material within a shell midden is identified. Unfortunately, few methodologies are currently utilised that can unambiguously identify and isolate displaced shell in middens, especially on a larger scale (but see Villagran et al. 2009, Villagran et al. 2011a, 2011b for a microscale perspective). While an intensive dating program using the radiocarbon method and multiple samples would identify temporally disconnected, but spatially associated shells, the financial costs associated with so many radiocarbon age determinations generally make this approach unrealistic.

Amino acid racemisation (AAR) is a relative dating method that has had a long history of use in archaeological investigation (e.g. Masters and Bada, 1977; Wehmiller, 1977; Parfitt et al. 2005; Bateman et al. 2008; Ortiz et al. 2009; Demarchi et al. 2011). Rather than providing numerical values, AAR results tell us which samples are more or less racemised and thus, broadly, older or younger. While AAR experienced some negative perception in the discipline of archaeology in the late 20th century as a result of anomalous ages being generated (Bada et al. 1974, see also Johnson and Miller, 1997: 276), refinements in the method have yielded consistently reliable results (e.g. Kaufman and Manley, 1998; Penkman et al. 2008; Demarchi et al. 2013a, 2013b). The technique carries with it major advantages compared with more conventional dating methodologies such as radiocarbon and OSL. Firstly, AAR allows for a substantial number of samples to be analysed for the same cost as a single radiocarbon age determination. This cost effectiveness creates the opportunity for a much more intensive dating program incorporating many more samples than relying on radiocarbon dating alone. A second key advantage is that the archaeological material is being directly targeted and not

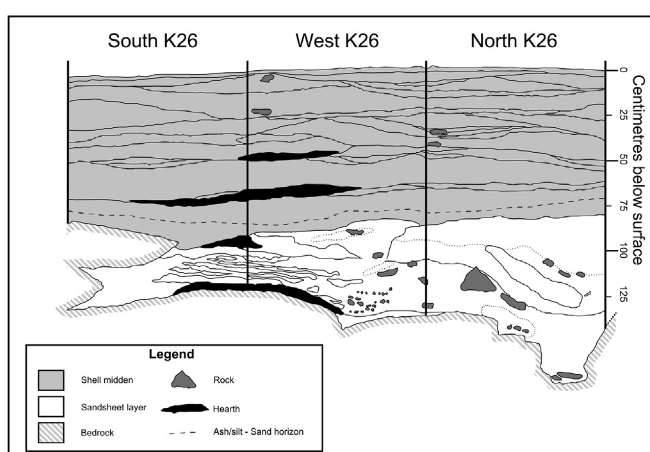

Fig. 2. Stratigraphic section of Brremangurey.

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