4

The Excavated Shell Midden and Mound Sites on the Point Blane Peninsula

The six sites described here were excavated in order to examine previously identified patterns of resource exploitation at a finer level of detail and chronological resolution. These site descriptions provide initial information on the diverse nature of the archaeological record on the Point Blane Peninsula by outlining site location and environmental context, excavation, stratigraphy, chronology and by presenting an overview and comparison of the recovered cultural material. This analysis is also focussed on examining the issue of possible different site functions between shell middens and mounds, ultimately providing the basis for a more detailed economic analysis.

Excavation and laboratory methods

For the purposes of the broader Blue Mud Bay project, 13 excavations were carried out on shell mound and midden sites situated at various points in Myaoola and Grindall Bays. Radiocarbon age estimates obtained from these 13 shell deposits again demonstrate a late Holocene sequence of occupation within the study area, ranging from approximately 3000 years BP to the present, with the majority of the radiocarbon dates clustered between 2500 years BP and the present (Faulkner 2008:84). Of these 13, six sites detailed here were selected for analysis according to differences in location, environmental context, site morphology and, based on the distribution of radiocarbon dates obtained from surface samples, possible variations in site chronology. The aim therefore was to investigate possible changes through time relative to ongoing processes of landscape alteration and associated changes in resource distribution. The midden sites selected on Myaoola Bay were BMB/018, BMB/067b and BMB/084, and the shell mound sites on Grindall Bay were BMB/029, BMB/071 and BMB/045. These sites are highlighted in Figure 4.1, and provide a comparative sample of locations around the present and former coastline throughout the approximate 3000 year period of occupation identified within the study area.

Field methods followed guidelines provided by Johnson (1980). Excavation areas were marked out using string and an arbitrary 5cm depth was excavated for each unit, keeping to any natural strata observed within the site where appropriate. Levels were checked by recording depths with a dumpy level at the corners and centre of each square. Bucket weights from each excavation unit were recorded with a hand-held spring balance and all excavated material was sieved through a nest of 6mm and 3mm mesh sieves and bagged for laboratory analysis. Bulk (un-sieved) sediment samples from the last bucket of each unit were bagged separately. The excavation method employed differed slightly depending on the type of shell deposit being excavated. The shell mounds were

excavated in 1m x 0.5m or $1m^2$ test pits. These excavation squares were further divided into smaller $0.5m^2$ squares or quadrats to enable sampling of the sieve residue following excavation. This level of sampling was required in the examination of the larger mounded deposits due to the time-consuming nature of laboratory sorting and analysis of the large volume of material recovered from each site (Ambrose 1967; Casteel 1970; Barz 1977; Claassen 1991; O'Neil 1993). The lower-lying shell middens were excavated in either $0.5m^2$ or $1m^2$ test-pits. Smaller test pits were used where several areas within the one site or complex were excavated for comparative purposes.

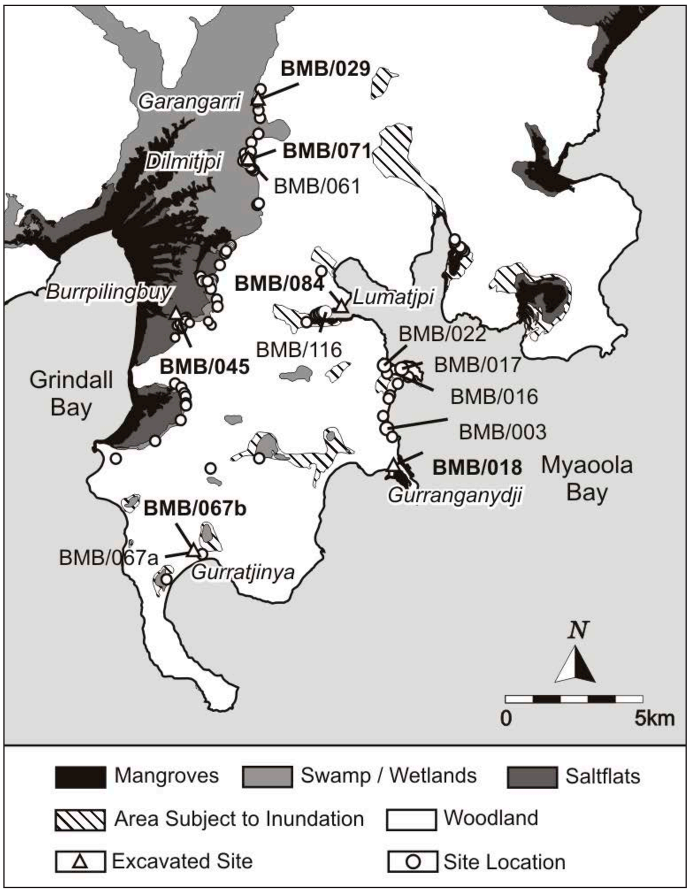


Figure 4.1: Distribution of excavated sites used in this analysis (in bold) and their Yolngu locality name (also indicated are the other excavated sites on the peninsula).

Source: Based on Baniyala 1:50 000 Topographic Map.

In the laboratory all excavated material was weighed and then wet-sieved through a 3mm mesh sieve. The material was then dried, weighed and re-bagged. With the exception of sites BMB/018 and BMB/084, the analysis of the excavated material was limited to the 6mm sieve residue from every second excavation unit due to time constraints and the sheer bulk of material excavated. While not subjected to quantification, visual inspection of selected 3mm samples from the upper, middle and lower portions of the deposits confirmed a lack of any differences in the presence/abundance of the excavated components in comparison with the 6mm residues (e.g. bone). In addition, given the density of material recovered from the midden and mound deposits in combination with the available radiocarbon dates, the analysis of every second excavation unit enables the determination of any trends through time in taxonomic composition, relative abundance and size variability. Components from the 6mm sieve were sorted by hand into major categories of mollusc taxa, bone, crab, fish otoliths, charcoal, ochre, stone artefacts, vegetation

and non-artefactual stone. Shell taxa were identified by Dr Richard Willan, Curator of Molluscs at the Museum and Art Gallery of the Northern Territory (MAGNT), and in comparison with photographs from Blackburn (1980), Hinton (1978, 1979), Lamprell and Healy (1998), Lamprell and Whitehead (1992), Meehan (1982), Short and Potter (1987) and Wells and Bryce (1988). Dr Helen Larson, Curator of Fishes at the Museum and Art Gallery of the Northern Territory, identified the fish bone and otoliths. Dr Sally Brockwell at The Australian National University provided further assistance in the identification of this material. Due to their low occurrence within all deposits, the identifiable non-molluscan elements including charcoal, vegetation, bone, ochre and non-artefactual stone were measured by weight alone. Stone artefacts recovered from the excavations were recorded according to the field survey procedures and cross-referenced to retain consistency and a comparative basis for analysis. Each shell taxon was weighed and minimum number of individuals (MNI) and the number of identifiable specimens (NISP) counted. Although relatively time consuming, this methodology was employed based on faunal studies conducted in Australia and internationally, and the implications for faunal quantification that have arisen as a result. As discussed in the following chapter, the combination of weight, MNI and NISP methods provides a more accurate description of the proportion of mollusc taxa, the degree of fragmentation per taxa through the site, and allows for comparison with the non-shell components (Bowdler 1983:140; Grayson 1984; Marshall and Pilgram 1993; Mowat 1995:81–82; Mason *et al.* 1998; Giovas 2009).

The Gurranganydji area

The area known as Gurranganydji is situated to the east of the Yilpara Community, leading onto a sandy headland jutting into Myaoola Bay. This headland is bordered by large stands of mangroves and extensive tidal mud flats. A series of sand ridges extends into this location, with grasslands interspersed by dense stands of monsoon vine thicket, separating the dune areas from the lower lying *Eucalypt* woodland and mixed grassland. The site located in this area, BMB/18, is situated on the upper western margin of a series of sand ridges, approximately 200m behind the mangroves (Figure 4.2).

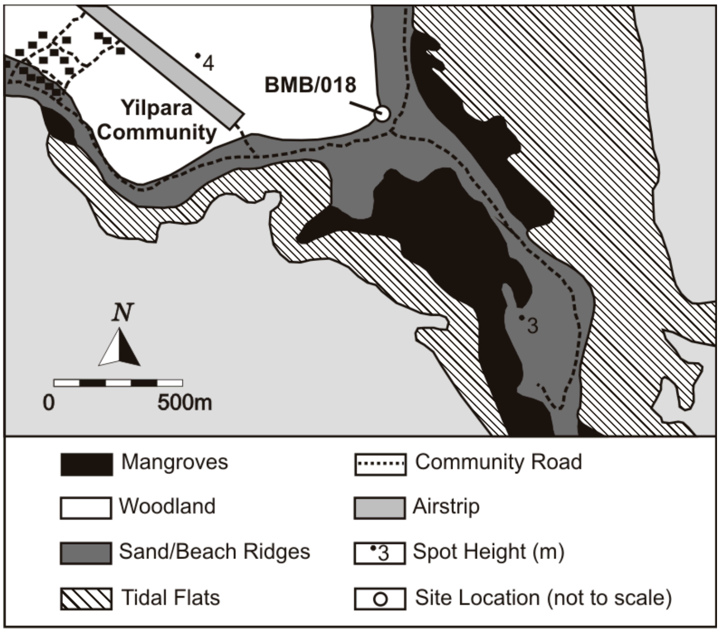


Figure 4.2: Location of the Yilpara community and the site of BMB/018 at Gurranganydji.

Source: Based on Baniyala 1:50 000 Topographic Map.

BMB/018 site description: Stratigraphy, chronology and excavated components

BMB/018 is a highly disturbed site, measuring 10m by 5m. A community vehicle track runs virtually through its centre, and patches of shell are eroding from the centre of the track and along its western edge (Figure 4.3). This track has been formed by vehicle movement, with wheel rutting reaching depths of between 5 and 10cm. The species composition and the condition of the eroding shell were suggestive of a cultural origin for this material, particularly given its environmental context. The dominant species present on the surface was *Septifer bilocularis* and a species of *Pinctada*. This site was excavated as its location suggested that it might have been of greater antiquity than many of the other sites situated within Myaoola Bay. A 1m^2 test-pit was excavated approximately 2m off the side of the vehicle track into the site (a metre beyond the area circled in Figure 4.3), attempting to avoid areas of higher disturbance.

Figure 4.3: Site of BMB/018 at Gurranganydji, location of vehicle track relative to shell deposits, with shell eroding from the edge of the track (arrow) and the density of shell deposited on ground surface (circled).

Source: Photo Annie Clarke.

The midden deposit was exposed below windblown sand and beach debris comprised of small, non-economic bivalve and gastropod species at a depth of approximately 7cm, with the cultural deposit extending for a further 10cm. Roughly 85cm in area, the lens of midden material reached a depth of between 11 and 17cm, phasing out onto the orange beach sand deposit at the base of the site (Figure 4.4). This lower stratigraphic unit was devoid of cultural material, composed largely of sand, coral and small, non-economic bivalve and gastropod species. Based on the stratigraphic profile and the composition of the four excavation units, this site is interpreted as a thin midden layer deposited onto an existing beach ridge. The midden layer was then subsequently covered by naturally deposited shell and sand, possibly via storm surges, wave action and wind-blown material. It was also apparent during the course of excavation that there might have been a degree of reworking within the deposit evidenced by coral, pumice and shell grit. As shown in Table 4.1,

this site returned the oldest date for the study area. An age estimate of 3200±70 obtained from marine shell excavated from the base of the cultural midden layer (excavation unit 3), which calibrates to 2953 cal BP.

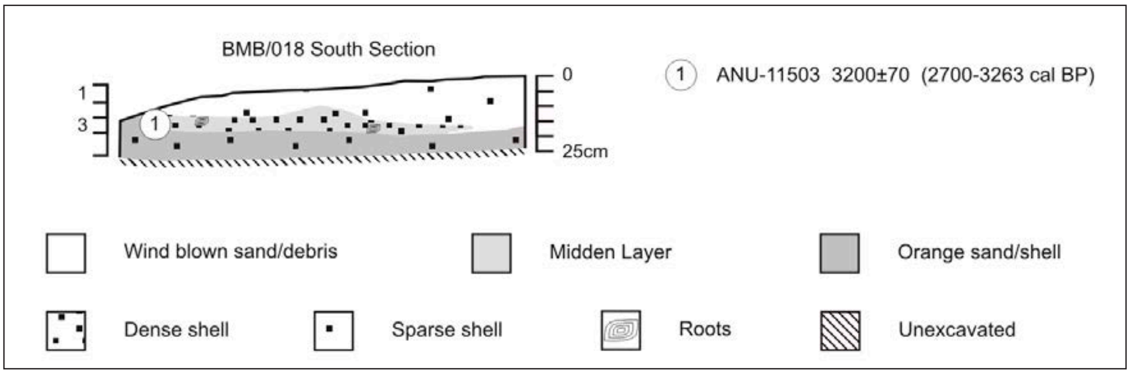


Figure 4.4: BMB/018 stratigraphic diagram, south section, showing conventional radiocarbon age and 2σ calibrated age range.

Table 4.1: Conventional and calibrated radiocarbon age obtained for site BMB/018.

Site Code /XU	Depth (cm)	Lab Code	Sample	$\delta^{13}C$	^{14}C Age	1σ cal Age BP (68.3% probability)	2σ cal Age BP (95.4% probability)	Cal Age BP Median
BMB/018/3	11 -17	ANU-11503	*Septifer bilocularis*	0.0 ± 0.0	3200 ± 70	2779–3080	2700–3263	2953

Source: Calibration data from CALIB 6.1.1, marine04.14c (Hughen *et al.* 2004), ΔR = 55±98 (Ulm 2006b).

Table 4.2 presents the quantitative data by weight in grams for the components recovered from the 6mm sieve during excavation, with density estimates of shell, bone, coral/pumice and laterite/rock by excavation unit graphed in Figure 4.5. The increased density of charcoal in the upper unit of the excavation probably relates to seasonal burning of this area, and has little significance in relation to past economic activity within the site, as the density of charcoal within the deposit is very low. Higher densities of bone occur above the identified cultural midden layer, although this represents a minor change, and the presence of this material may relate to natural deposition of faunal material within the windblown sand and beach debris. The presence of coral and pumice throughout the excavation support to some degree the notion of minor reworking of the deposit, with a similar density pattern to that of laterite/rock. These data demonstrate that molluscan material dominates the assemblage by weight at 71.6%, followed by lateritic/rock deposits at 23.2%. The overwhelming majority of shell was recovered from those units identified as cultural (excavation units two and three). As noted above, the dominant molluscan taxa within the site are *Septifer bilocularis* (48.7%) and *Pinctada* sp. (34.8%), with *Gafrarium* sp. (7.7%) as a minor species. Vegetation remains (1.7%), crab carapace (1.1%), unidentifiable fragments of bone (0.1%) and charcoal (0.03%) form minor components of the assemblage. As there is only one radiocarbon date available for this site accurate determinations of variability in site formation are not possible, such as rates of accumulation or deposition of cultural material. That said, additional radiocarbon dates may not provide further clarification due to the inherent error margins involved, and the thin lens of cultural midden material. In many ways, this suggests molluscan refuse discard and a reflection of short-term occupation.

Table 4.2: Quantitative data for the excavated components from BMB/018, 6mm sieve fraction.

Excavation Unit	Depth (cm)	Volume cm^3	Laterite/ Rock (g)	Vegetation (g)	Coral/Pumice (g)	Charcoal (g)	Shell (g)	Bone (g)	Crustacean (g)
1	0.0 to 7.5	75000	121.0	49.3	4.5	0.9	234.5	1.1	4.2
2	7.5 to 10.7	32000	253.6	14.6	27.2	0.3	1384.4	---	25.4
3	10.7 to 16.9	62000	539.8	9.8	71.6	---	1453.9	0.5	18.0
4	16.9 to 21.5	46000	129.4	4.1	4.9	0.1	154.0	0.7	0.3
Totals			**1043.8**	**77.8**	**108.2**	**1.3**	**3226.8**	**2.3**	**47.9**
% of Total Wt. (4508.1)			**23.15**	**1.73**	**2.40**	**0.03**	**71.58**	**0.05**	**1.06**

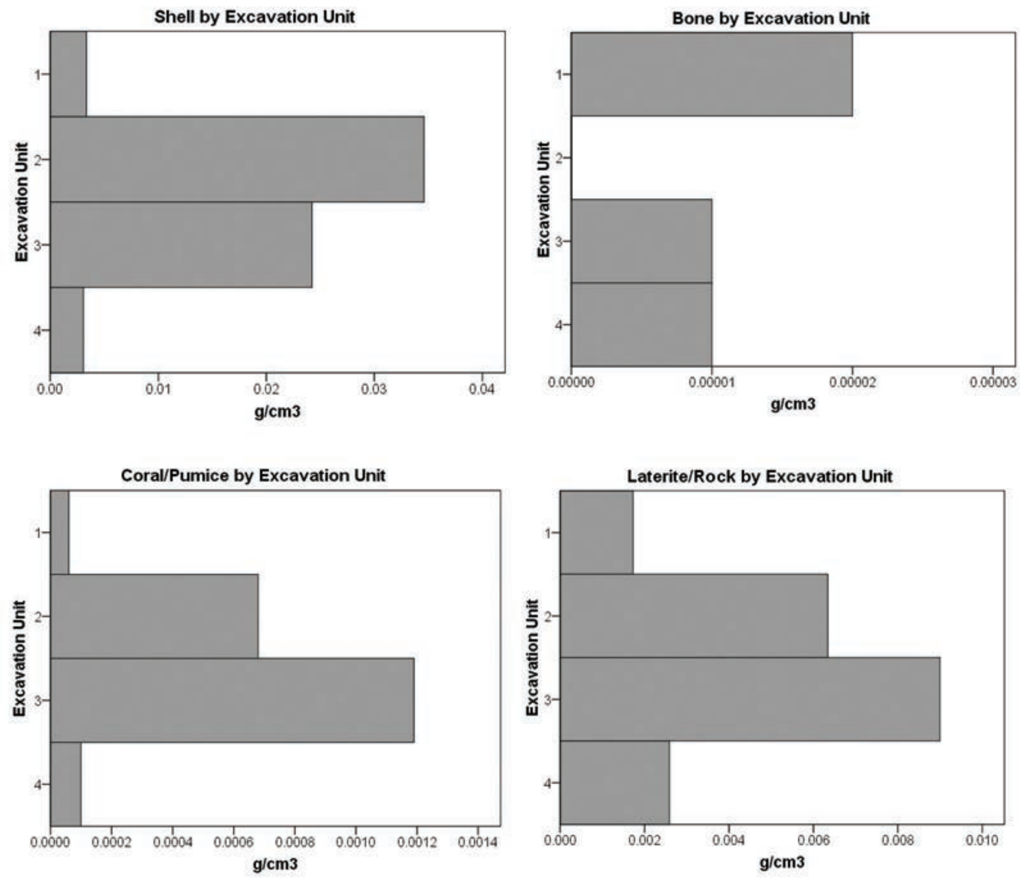


Figure 4.5: Density (g/cm^3) of excavated components (shell, bone, coral/pumice and laterite/rock) by excavation unit, BMB/018, 6mm sieve fraction.

The Gurratjinya area

The Gurratjinya area is located to the south-west of Myaoola Bay, at the end of a track that runs through the centre of the peninsula (Figure 4.6). A high series of sand dunes extend from the beach, covered with extensive patches of monsoon vine thicket vegetation and mixed grasslands. From the high third dune the area plateaus for approximately 100m, and then gradually descends into a large, seasonal paperbark swamp that drains into the small bay to the east. Two sites were located within this area, one amongst the dunes and one bordering the edge of the swamp (BMB/067b).

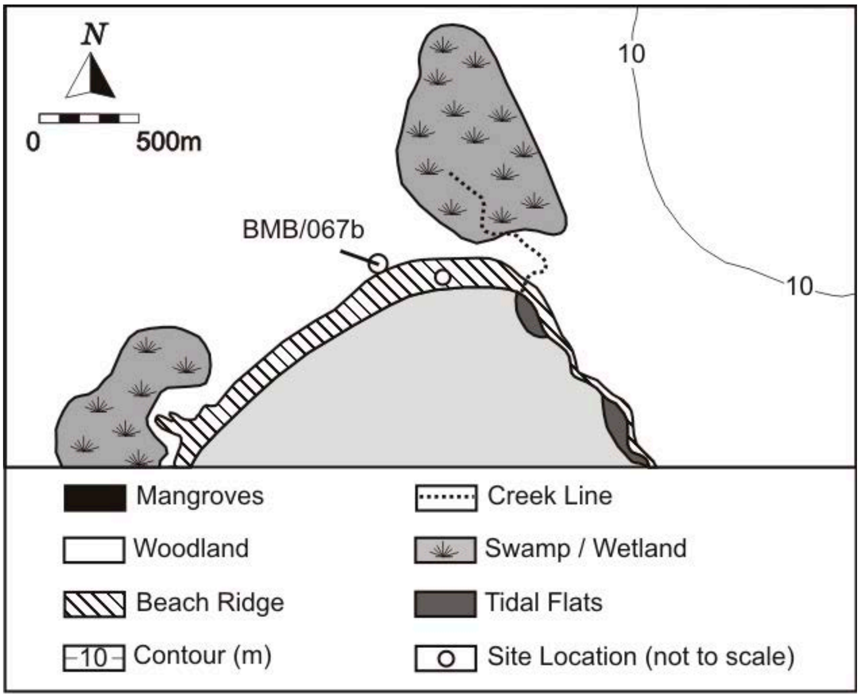


Figure 4.6: Location of site of BMB/067b at Gurratjinya.

Source: Based on Baniyala 1:50 000 Topographic Map.

BMB/067b site description: Stratigraphy, chronology and excavated components

BMB/067b extends down the third beach ridge, which is relatively wide and descends gradually, onto the flatter area bordering the seasonal swamp. It is a dispersed midden, measuring 30 by 400m, with some more concentrated patches across the general low-level surface scatter of shell (Figure 4.7). The surface of the site is dominated by *Anadara granosa*, *Marcia hiantina*, *Gafrarium tumidum*, *Telescopium telescopium*, *Pinctada* sp., *Septifer bilocularis*, *Melo amphora*, *Syrinx aruanus*, *Saccostrea* sp. and *Polymesoda (Geloina) coaxans*. Several stone artefacts were also located on the surface of this site. Two adjacent test pits (designated as test-pits 1 and 2), each $1m^2$, were excavated into one of the more concentrated sections of the site, with the analysis of the material restricted here to test-pit 1. The area chosen for excavation is located approximately 300m off the edge of the lower-lying mixed grassland and swamp, and was covered with a dense stand of vine thicket vegetation and naturally accumulated sand, sediment and decomposing vegetation. As indicated by the stratigraphic profile (Figure 4.8), there was no clear change in stratigraphy throughout the midden deposit other than a slight decrease in shell in the basal layers. This excavation reached a maximum depth of approximately 35cm, with the base of the excavation indicated by stratigraphic change to beach debris and shelly sand. This deposit contained a large amount of shell material, small amounts of fish remains (possibly a species of Wrasse) and several stone artefacts in a dark humic matrix extending throughout the deposit.

Figure 4.7: Location of site of BMB/067b Test-pit 1 at the base of a large beach-ridge, bordering a small seasonal swamp at Gurratjinya (location of excavation indicated by position of ranging pole).

Source: Photo Patrick Faulkner.

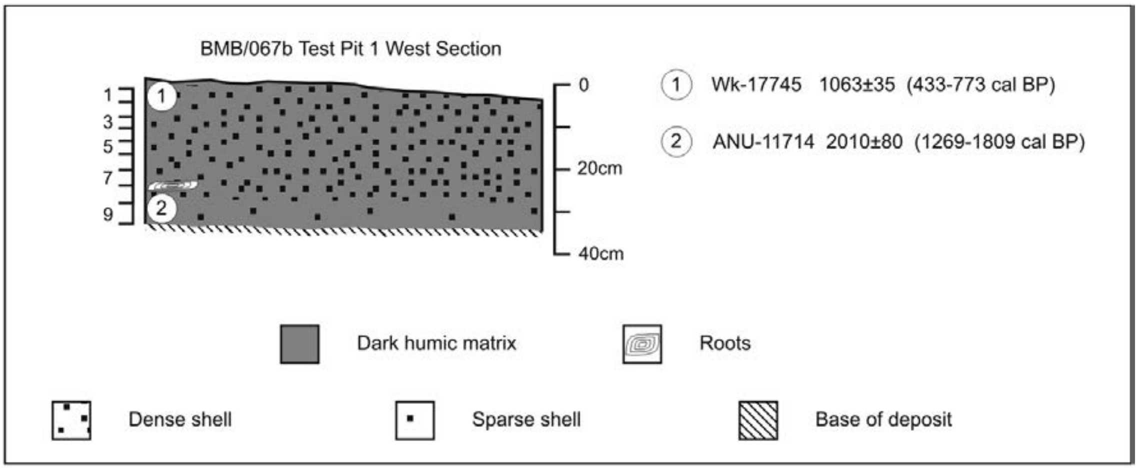


Figure 4.8: BMB/067b Test-pit 1 stratigraphic diagram, west section, showing conventional radiocarbon ages and 2σ calibrated age ranges.

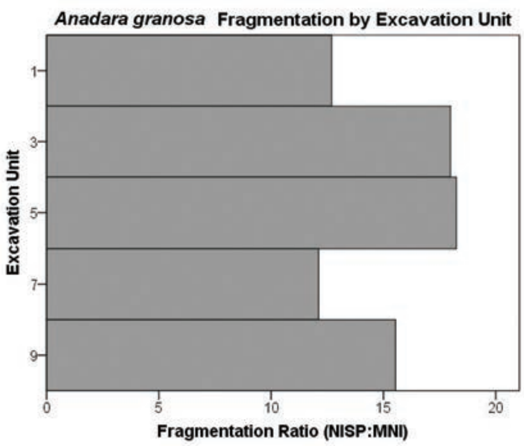
Two radiocarbon age estimates have been obtained from marine shell from the surface and basal excavation units (Table 4.3, and indicated in Figure 4.8). The sample from excavation unit 1 returned a date of 1063±35, calibrating to 592 cal BP, and the sample from excavation unit 9 returned a date of 2010±80, calibrating to 1518 cal BP. These age estimates provide a minimum occupation period of approximately 930 years for this locality, as well as suggesting that this site represents multiple low-level occupation events over a relatively long period.

Table 4.3: Conventional and calibrated radiocarbon ages obtained for site BMB/067b Test-pit 1.

Site Code/XU	Depth (cm)	Lab Code	Sample	δ13C	14C Age	1σ cal Age BP (68.3% probability)	2σ cal Age BP (95.4% probability)	Cal Age BP Median
BMB/067b/1	0 - 2	Wk-17745	*Anadara granosa*	2.2 ± 0.2	1063 ± 35	511–661	433–773	592
/9	27 - 31	ANU-11714	*Anadara granosa*	2.0 ± 0.2	2010 ± 80	1369–1657	1269–1809	1518

Source: Calibration data from CALIB 6.1.1, marine04.14c (Hughen *et al*. 2004), ΔR = 55±98 (Ulm 2006b).

Fragmentation ratios (NISP:MNI) have been calculated for *Anadara granosa* and *Marcia hiantina* by excavation unit (Figure 4.9). The NISP:MNI ratio calculates the approximate number of fragments per individual based on relative abundance counts within individual excavation units. The level of shell fragmentation throughout the site should correspond with phases of increased or decreased occupation. Based on experimental research, it has been suggested that variations in the degree of shell fragmentation may relate more to post-depositional processes rather than those activities occurring at the time of discard, reflecting the intensity of human activity at a site (Muckle 1985:68, 75–78; Claassen 1998:58; Faulkner 2010). For example, when the rate of site deposition is low, cultural material like stone artefacts, shell and bone are exposed on the surface for longer periods, and thus subjected to higher degrees of weathering and fragmentation. Conversely, when deposition is rapid, the length of exposure time and the degree of weathering and fragmentation is lessened (Hiscock 1985:89–90; Bourke 2000:119). Even though the species chosen are representative of robust (*Anadara granosa*) and fragile (*Marcia hiantina*) bivalves, the patterning of fragmentation for both is relatively similar throughout the deposit. These patterns demonstrate that the level of fragmentation increases from a relatively low level at the base of the site and peaks within the central excavation units, then decreases again closer to the surface of the site. The lower levels of fragmentation for both species within the upper layer of the site may be indicative of rapid deposition through natural sedimentation processes occurring after abandonment of the site, therefore protecting the site to a certain degree from weathering and trampling.



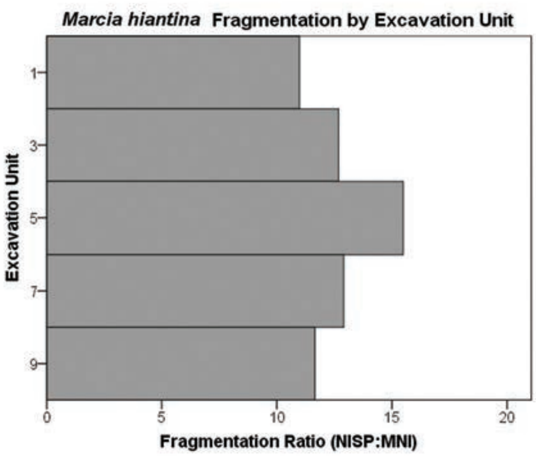


Figure 4.9: BMB/067b Test-pit 1 NISP:MNI fragmentation ratios for *Anadara granosa* and *Marcia hiantina* per excavation unit, 6mm sieve fraction.

Table 4.4 details the quantitative data by weight in grams for the excavated components recovered from the 6mm sieve during excavation, with Figure 4.10 graphing the density estimates of shell, bone and otoliths, charcoal, laterite and rock deposits by excavation unit. Molluscan remains dominate the assemblage by weight at 62.3%, followed by lateritic and rock deposits at 34.4%. Vegetation (0.9%), charcoal (0.01%), bone (0.3%), coral and pumice (1.8%), fragments of crab carapace (0.01%) and stone artefacts (0.4%) form minor components of the excavated assemblage by weight. The significantly increasing density of laterite and rock throughout the deposit (Spearman's $r_s = -0.900$, $p < 0.05$, $n = 5$) relates primarily to processes of site formation. As this material is the dominant ground surface on the inland margin of the series of beach ridges within the area, the higher density of material in the upper excavation unit relates to the post-depositional covering of the site. Due to the possible slow rate of site deposition, some reworking of the deposit combined with surface exposure would account for this pattern.

Table 4.4: Quantitative data for the excavated components from BMB/067b Test-pit 1, 6mm sieve fraction.

Excavation Unit	Depth (cm)	Volume (cm^3)	Laterite/ Rock (g)	Vegetation (g)	Charcoal (g)	Shell (g)	Bone (g)	Coral/ Pumice (g)	Crustacean (g)	Stone Artefacts No./g
1	0.0 to 1.3	13000	700.5	44.6	---	1281.4	1.1	38.2	2.0	4/64.4
3	3.5 to 6.6	31000	1176.0	24.8	---	1941.5	2.1	43.1	---	---
5	10.3 to 13.7	34000	1439.7	46.2	---	2474.0	8.8	48.7	---	---
7	18.9 to 22.0	31000	1154.9	25.3	1.5	2703.5	25.4	60.7	---	---
9	26.7 to 31.3	46000	1388.0	4.5	0.8	2223.6	8.7	118.5	---	---
Totals			**5859.1**	**145.4**	**2.3**	**10624**	**46.1**	**309.2**	**2**	**4/64.4**
% of Total Wt. (17052.5)			**34.36**	**0.85**	**0.01**	**62.30**	**0.27**	**1.81**	**0.01**	**0.38**

Three main species, *Anadara granosa* (31.9%), *Marcia hiantina* (21.1%) and *Septifer bilocularis* (17.0%), dominate the assemblage. While there are peaks in the density of shell in excavation units 1 and 7, there is not a significant relationship between the density of this material and excavation unit (Spearman's $r_s = -0.600$, $p > 0.01$, $n = 5$). By extension, the discard of molluscan remains throughout the history of site deposition or occupation was consistent. Relative to the density of the other components recovered during excavation of this site, the dominance and consistent discard of this material suggests that molluscs were the primary focus of resource exploitation within this area. The condition of bone recovered from the site was poor, even given the better preservational environment compared with other shell deposits in the sample. Due to high levels of fragmentation the identification of the bone was limited, with identifiable elements only recovered from excavation units 1, 7 and 9. All of the identifiable bone elements within the site are a species of Wrasse, which inhabits near-shore coral and rocky reefs. The identifiable elements of the bone sample includes two grinding plate fragments and one vertebrae from excavation unit 1, two grinding plate fragments, three mandible fragments and one vertebrae from excavation unit 7, and three grinding plate fragments and one vertebrae from excavation unit 9. The presence of bone within this site is most likely due to the humic nature of the deposit, combined with the possible rapid burial of the site's surface following abandonment. Although there is a peak in the density of bone within excavation unit 7, it is a minor increase, and there is not a significant relationship between the density of bone and excavation unit (Spearman's $r_s = 0.600$, $p > 0.01$, $n = 5$). This suggests that the use of faunal resources other than molluscs was at a consistently low-level of exploitation, particularly given that the non-molluscan faunal component of the site only comprises 0.3% of the assemblage at an overall weight of 46.1g.

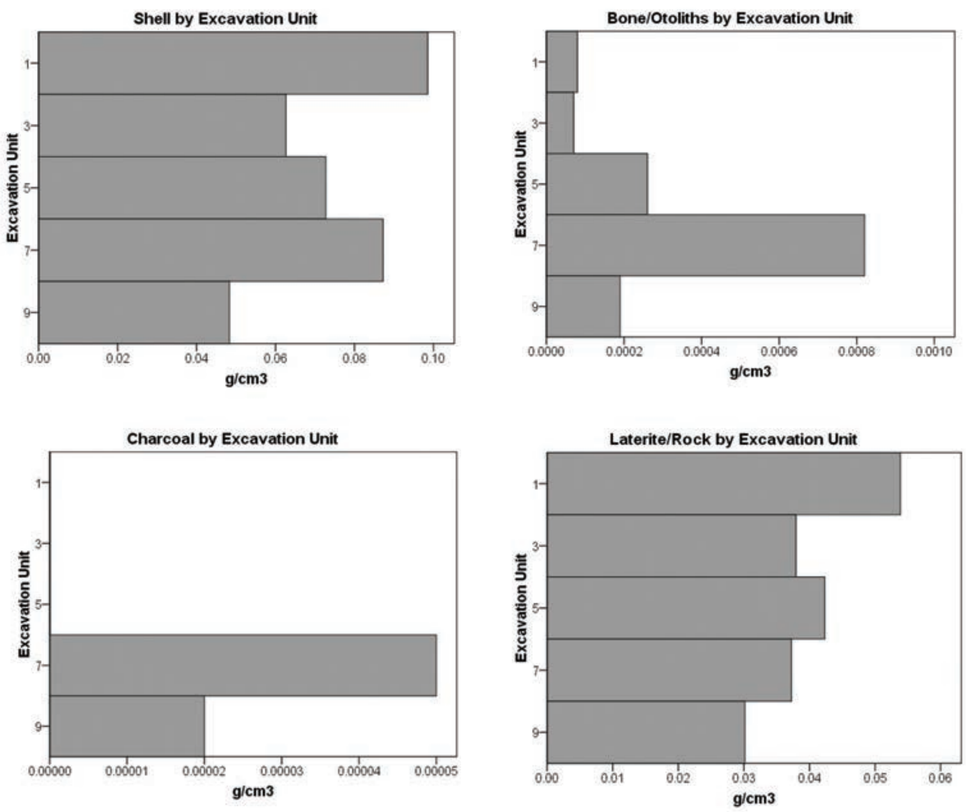


Figure 4.10: Density (g/cm^3) of shell, bone/otoliths, charcoal and laterite/rock by excavation unit, BMB/067b Test-pit 1, 6mm sieve fraction.

Four stone artefacts were recovered from the surface and within excavation unit 1 of this site. It is difficult to ascertain whether these artefacts relate to the period of midden deposition, or whether they were discarded within this area after a phase of natural, rapid sediment deposition occurring following abandonment of the site. The artefacts recovered from the surface of the site prior to excavation consist of one silcrete unretouched flake (weighing 19.4g and measuring 32.57mm by 45.72mm), and one quartzite unretouched flake (weighing 10.9g and measuring 27.79mm by 30.46mm). In terms of raw material and artefact size and shape, the silcrete and quartzite artefacts conform reasonably well to those previously analysed. The other two artefacts recovered from just below the ground surface are of a previously unrecorded volcanic raw material within the area. It is unknown where this stone may have been sourced from, although Aboriginal informants indicated that this material comes from one of the small, offshore islands. It is possible that this material could have been sourced reasonably locally, as based on the geological maps there are undifferentiated volcanics (part of the Arnhem Inlier formation) distributed along the neighbouring peninsulas and small islands. These two artefacts are an unretouched flake (weighing 11.0g and measuring 40.46mm by 22.26mm), and a flaked piece (weighing 23.1g and measuring 49.09mm by 16.50mm). The most notable feature on both volcanic artefacts is the presence of use-wear in the form of marginal smoothing/abrasion.

Interpreting the depositional history of this site is difficult, with only surface and basal radiocarbon dates available. Considering this, the dominance of shell throughout the deposits combined with what appears to be a consistent level of discard in molluscan remains suggests a focus on mollusc exploitation and discard.

The Lumatjpi area

The area known as Lumatjpi is located to the north of the Yilpara community on the Myaoola Bay coastline (Figure 4.11). There are nine sites located in this area, and with two exceptions described below, the majority consist of very small, localised patches of thinly spread surface midden material. Mixed *Eucalypt* woodland covers most of the area leading up to a low, mounded laterite ridge that runs parallel to the coastline. Large swampy areas and paperbark swamps on cracking grey clays are situated in this area, drained by several small, seasonal creeks. Dense mangrove stands occur alongside sandy chenier ridges, dissected by extensive laterite platforms.

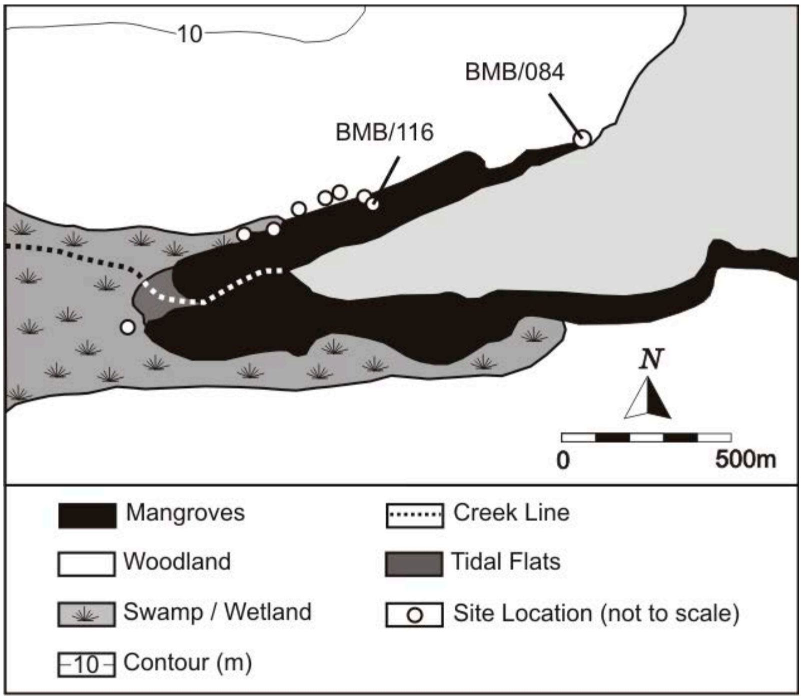


Figure 4.11: Lumatjpi cluster and location of site BMB/084 (excavated and radiocarbon dated site BMB/116 also shown).

Source: Based on Baniyala 1:50 000 Topographic Map.

BMB/084 site description: Stratigraphy, chronology and excavated components

The large midden complex BMB/084 measures approximately 75 by 320m, extending along a low sandy ridge positioned behind mangrove stands. Mangroves and paperbark border the site, except at the eastern end where a laterite gravel ridge forms the boundary. There are variations in the content of midden patches within the site from east to west, with evidence of more recent mollusc exploitation evident along the western edge. One informant (August 2000) stated that her family camped at Lumatjpi to collect freshwater, and to fish and collect shellfish in the 1970s during the early days of the establishment of the Yilpara outstation. This would account for the modern radiocarbon dates obtained from the surface of the site. Four 50cm^2 test pits were located in different midden concentrations across the site as a whole (Figure 4.12). This was due to the high degree of species diversity and abundance occurring across the site, with these different areas possibly reflecting chronological variability in the use of the area. In all test pits the base of the excavation was indicated by clean, orange sand mixed with shell grit, reflecting the natural sand ridge deposit. Test-pit 1 is the focus for this investigation, with this 50cm^2 test-pit excavated into a patch of densely concentrated shell within an area of monsoon vine thicket.

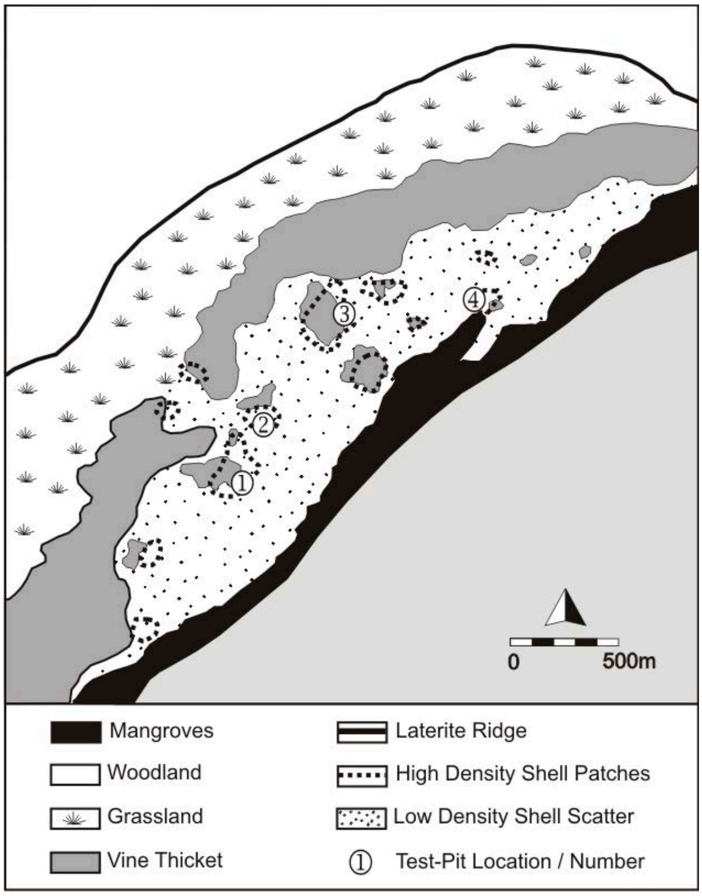


Figure 4.12: BMB/084 site plan at Lumatjpi, showing concentrations of midden material and the location of Test-pits.

The surface of test-pit 1 was covered by loose, whole shell and sand, with two stratigraphic layers recognised in the profile (Figure 4.13). The upper 10cm layer consists of a dark, humic matrix dominated by a species of *Isognomon*. The lower layer, consisting largely of *Marcia hiantina* in a lighter matrix, extends around 20cm down onto the clean, orange sand. Four samples of marine shell were submitted for radiocarbon dating from test-pit 1 to determine if there was a chronological difference between these two stratigraphic units. The approximate locations of these samples, at the surface and base of the site and above and below the stratigraphic break, are shown in the stratigraphic section (Figure 4.13) and detailed in Table 4.5. The surface sample returned a modern conventional radiocarbon age of 122.3%±1.0%, and the sample from the bottom of the initial stratigraphic layer returned a date of 360±60, calibrating to modern. The sample from the top of the lower stratigraphic unit returned an age of 460±70, again calibrating to modern, and a sample from the base of the site returned an age estimate of 860±70, calibrated to 424 cal BP. These age estimates indicate that occupation in this site spans the period from approximately 424 years before present and the present day. This suggests that there may have been at least two phases of occupation within this particular excavated area, one initial phase of intermittent occupation followed by a phase of more rapid deposition in the recent past.

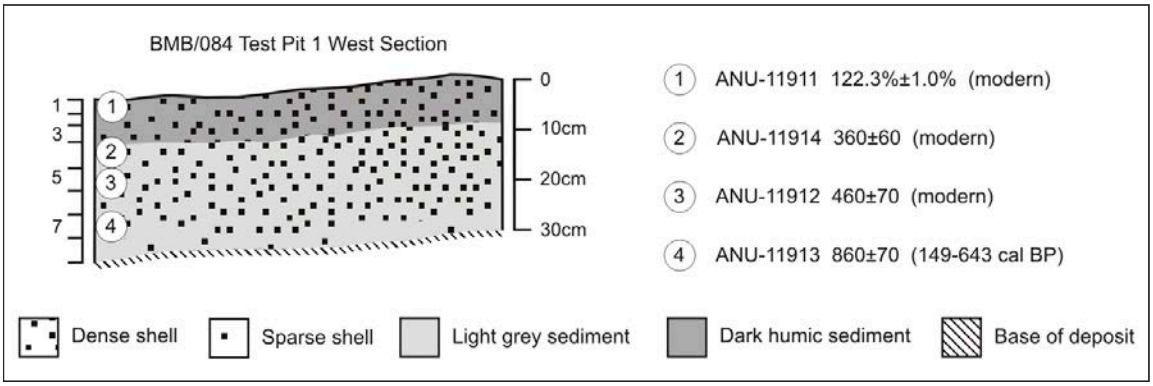


Figure 4.13: BMB/084 Test-pit 1 stratigraphic diagram, west section, showing conventional radiocarbon ages and 2σ calibrated age ranges.

Table 4.5: Conventional and calibrated radiocarbon ages obtained for site BMB/084, Test-pit 1.

Site Code /XU	Depth (cm)	Lab Code	Sample	$\delta^{13}C$ (*estimate)	^{14}C Age	1σ cal Age BP (68.3% probability)	2σ cal Age BP (95.4% probability)	Cal Age BP Median
BMB/084/1	0 - 1	ANU-11911	*Marcia hiantina*	0.0 ± 2.0*	122.3% ± 1.0%	Modern	Modern	--
/4	4 - 7	ANU-11914	*Marcia hiantina*	0.0 ± 2.0*	360 ± 60	Modern	Modern	--
/5	7 - 11	ANU-11912	*Marcia hiantina*	0.0 ± 2.0*	460 ± 70	Modern	Modern	--
/7	14 - 17	ANU-11913	*Marcia hiantina*	0.0 ± 2.0*	860 ± 70	309–516	149–643	424

Source: Calibration data from CALIB 6.1.1, marine04.14c (Hughen *et al.* 2004), ΔR = 55±98 (Ulm 2006b).

Based on assessment of the proportion of juveniles per taxon, the proportion of shell greater than 15mm in size, shell breakage patterns and the presence and quantity of charcoal, Esposito (2005:68–9) interprets the depositional history of test-pit 1 as reflecting a likely cultural midden deposit occurring over the top of an existing beach ridge. While it was also determined that there was a degree of reworking within the deposit by natural processes (e.g. storm surges), this site is more consistent with an anthropogenic origin than a natural shell deposit. Regardless of the level of reworking or mixing of the deposit, it is still possible to extract information on economic activity within this site, especially when tied to patterns of site deposition and the phase of more modern intensive occupation. This is illustrated by investigating fragmentation ratios by excavation unit for *Marcia hiantina*, a relatively fragile and abundant species within this site (Figure 4.14). The level of fragmentation decreases closer to the surface of the site, with higher rates of fragmentation in excavation units 6, 7 and 8 possibly relating to the initial, intermittent phase of occupation for this site indicated by the analysis of the radiocarbon determinations. The lower levels of fragmentation within the upper five layers of the site correspond with the more rapid rate of deposition identified for the relatively recent past.

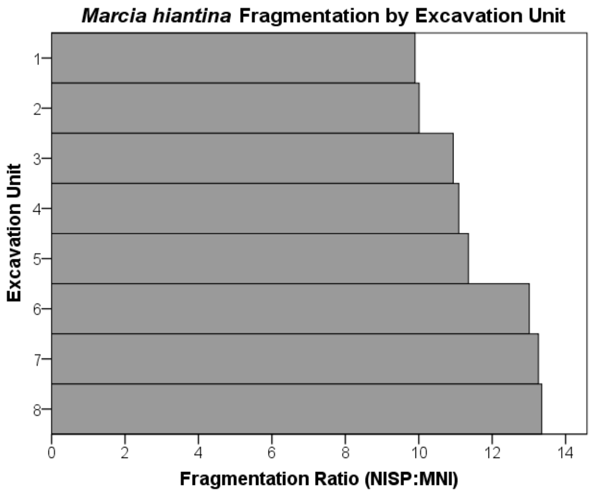


Figure 4.14: BMB/084, Test-pit 1, NISP:MNI fragmentation ratios for *Marcia hiantina* per excavation unit, 6mm sieve fraction.

Table 4.6 details the quantitative data by weight in grams for the excavated components recovered from the 6mm sieve during excavation of test-pit 1, with the density (g/cm^3) of shell, charcoal, calcareous worm shell and laterite/rock by excavation unit graphed in Figure 4.15. These data show that there is considerable variation in the distribution within and between these components by excavation unit. Vegetation remains (0.8%) and charcoal (0.4%) form minor components of the assemblage. Variations in the density of charcoal within the site possibly relates to both processes of vertical decay within the deposit and the depositional history of the site. However, there is not a statistically significant relationship between the density of charcoal and excavation unit (Spearman's $r_s = 0.252$, $p > 0.2$, $n = 8$). The low amounts of calcareous worm shell and coral present in the lower levels of the excavation support to some degree the notion of minor reworking of the deposit, as noted by Esposito (2005:68–9).

Table 4.6: Quantitative data for the excavated components from Test-pit 1, BMB/084, 6mm sieve fraction.

Excavation Unit	Depth (cm)	Volume cm^3	Laterite/Rock (g)	Vegetation (g)	Worm Shell (g)	Coral/Pumice (g)	Charcoal (g)	Shell (g)	Crustacean (g)
1	0.0 to 1.2	3000	348.6	13.7	---	---	0.1	482.1	---
2	1.2 to 1.9	1750	0.9	9.7	---	---	1.9	1026.4	---
3	1.9 to 4.1	5500	138.2	6.3	---	---	0.2	326.3	---
4	4.1 to 7.4	8250	9.1	3.0	1.5	0.1	0.3	527.1	0.5
5	7.4 to 10.8	8500	180.5	8.3	1.1	---	3.1	830.8	---
6	10.8 to 13.7	7250	41.9	1.9	0.2	---	0.1	573.2	---
7	13.7 to 16.9	8000	433.8	4.3	---	---	15.5	660.2	0.2
8	16.9 to 20.2	8250	51.5	1.5	0.1	0.6	0.8	144.9	0.1
Totals			**1204.5**	**48.7**	**2.9**	**0.7**	**22**	**4571**	**0.8**
% of Total Wt. (5850.6)			**20.59**	**0.83**	**0.05**	**0.01**	**0.38**	**78.13**	**0.01**

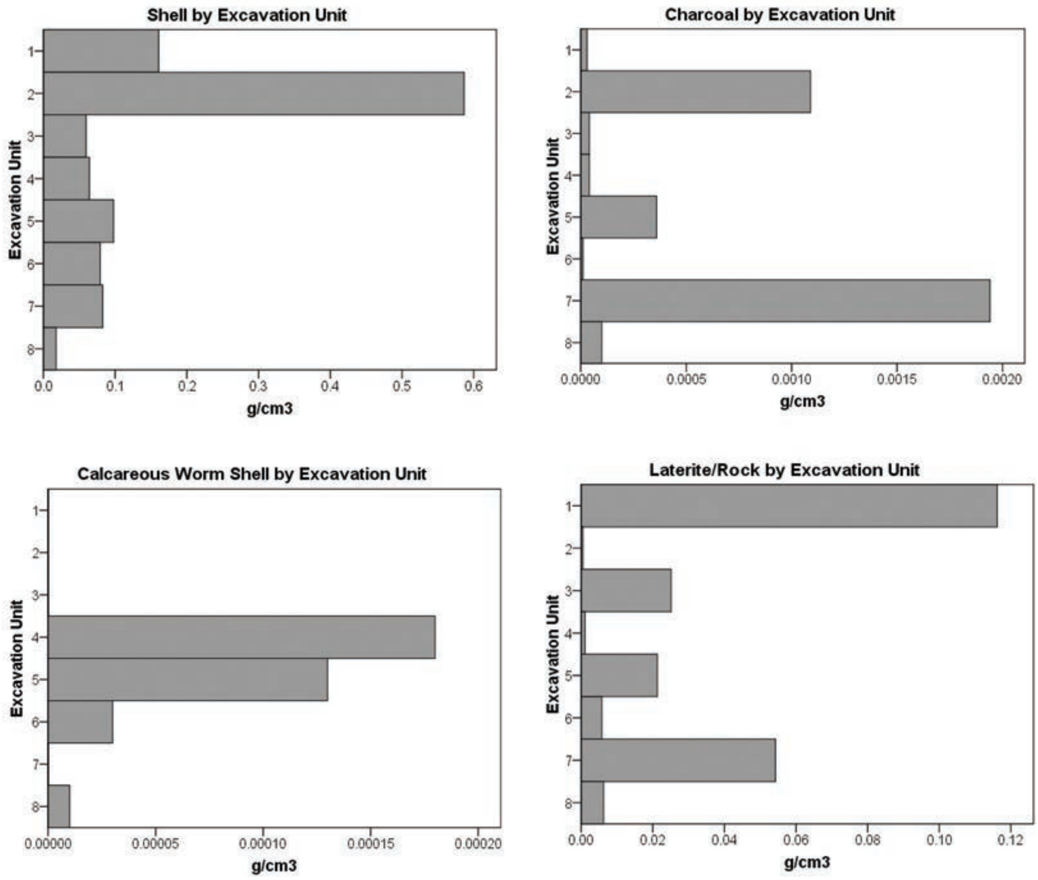


Figure 4.15: Density (g/cm³) of shell, charcoal, calcareous worm shell and laterite/rock by excavation unit, BMB/084 Test-pit 1, 6mm sieve fraction.

The dominant molluscan taxa represented within the site are *Marcia hiantina* (29.0%), *Isognomon isognomon* (27.8%) and a species from the *Mytilidae* family (14.4%). Molluscan material dominates the assemblage by weight at 78.1 %, followed by lateritic and rock deposits at 20.6%. As with charcoal, the relationship between the density of shell and excavation unit is not statistically significant (Spearman's r_s = -0.571, $p > 0.05$, n = 8) or between laterite/rock by excavation unit (Spearman's r_s = -0.048, $p > 0.5$, n = 8). This suggests that the variation noted for these components, particularly relative to the various peaks in the density of material throughout the excavation, is only minor. No artefactual material or bone was recovered from this excavation. Even given the potential for at least two phases with marked differences in the rates of deposition, one that appears quite slow and ephemeral followed by a more rapid and possibly intensive phase, there does not appear to be any differences in the distribution of material between these phases. Therefore, while there is variability in the formation history of the site, given the dominance of shell throughout the deposits, site function appears to have been similar throughout the history of occupation.

The Garangarri cluster

The Garangarri area is located approximately 8km inland from the present coastline near the northern extent of the Dhuruputjpi wetlands system in Grindall Bay. The Durabudboi River feeds into this wetland system approximately 1 to 1.5km north of this locality. Mixed *Eucalypt* woodland forms the dominant vegetation component leading up to the edge of the lateritic ridge,

the lower lying areas at the base of the ridge in this area are dominantly paperbark swamps, mixed grasslands and seasonal wetlands vegetation. The gradient and height of the laterite ridge in this area varies considerably, with height of the ridge ranging between approximately 1 and 3m. The ridgeline is at its highest and most steep in the middle sections of the area, tailing out on either end. This area is dominated by a cluster of 10 shell mounds and midden sites of various sizes. The sites range from low, surface scatters of shell to mounded deposits of approximately 2.6m in height, and in area range from 35m^2 and 1141m^2. The sites are distributed linearly along the edge of the laterite ridge (Figure 4.16); the largest of the 10 sites is located centrally within this cluster, with site size decreasing northwards and southwards from this location. BMB/029, the excavated mound site within the Garangarri cluster, is situated relatively centrally, adjacent to the largest of the mounds in this cluster.

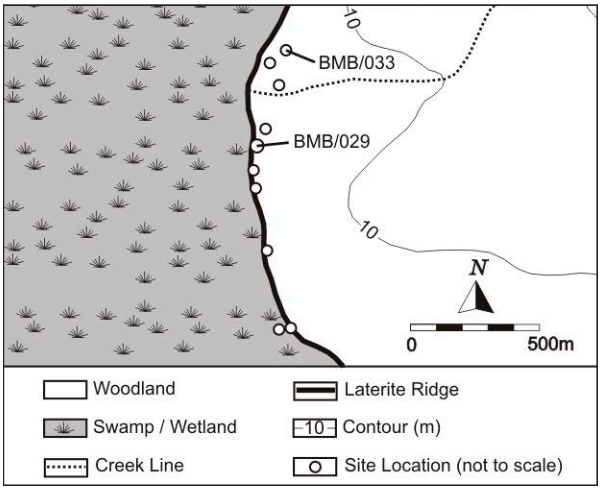


Figure 4.16: Garangarri cluster and location of excavated site BMB/029 (radiocarbon dated site BMB/033 also shown).

Source: Based on Baniyala 1:50 000 Topographic Map.

BMB/029 site description: Stratigraphy, chronology and excavated components

BMB/029 is a low, regularly shaped shell mound, measuring 23.6m by 21m and up to 1m in height, set back approximately 10 to 15m from the edge of the laterite ridge. The site is shown in Figure 4.17, and a contour plan of the site and a cross-section of this mound site are shown in Figure 4.18. This site extends down the ridge slope, and the spilling of the shell deposit down the side of the laterite ridge possibly relates to slumping of the basal laterite surface closer to the edge of the ridgeline. This site was chosen for excavation as it is located centrally within the site cluster and, based on surface inspection, is representative in size and content of sites in this location. Shellfish species dominating the surface of the site include *Anadara granosa*, *Telescopium telescopium*, *Terebralia palustris*, *Marcia hiantina*, *Placuna placenta* and *Polymesoda (Geloina) coaxans*. The shell on the surface of the site exhibits a high degree of weathering and fragmentation, relating to high levels of exposure and trampling.

Figure 4.17: Site BMB/029, view west towards edge of laterite ridge and wetlands.

Source: Photo Patrick Faulkner.

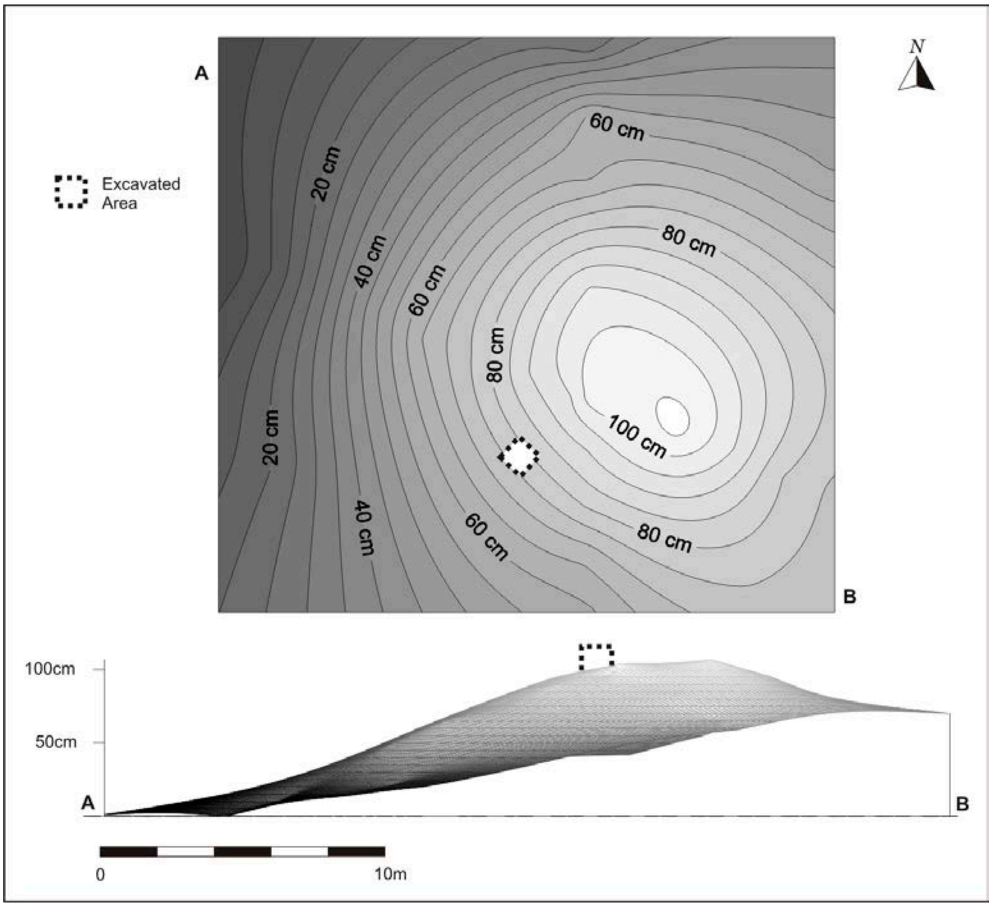


Figure 4.18: Contour plan of site BMB/029 showing location of the excavation square.

A $1m^2$ test-pit was positioned relatively centrally at the higher end of the mound, with the excavation reaching a depth of approximately 90cm. The mound itself is composed of densely-packed shell material, with very little in the way of sedimentary matrix. Several stratigraphic layers were identified (Figure 4.19), although dominantly composed of *Anadara granosa*, mixed with fine grey and white ash material, there are horizontal lenses of *Placuna placenta* occurring throughout the deposit. The surface of the site was heavily fragmented and fine rootlets extended to a depth of approximately 20cm. The lower 20cm to 30cm of deposit consisted of a matrix of yellow brown clay and lateritic pebbles with low numbers of highly fragmented shell material. Excavation ceased on reaching the hard-packed clay and laterite representative of the surrounding ground surface.

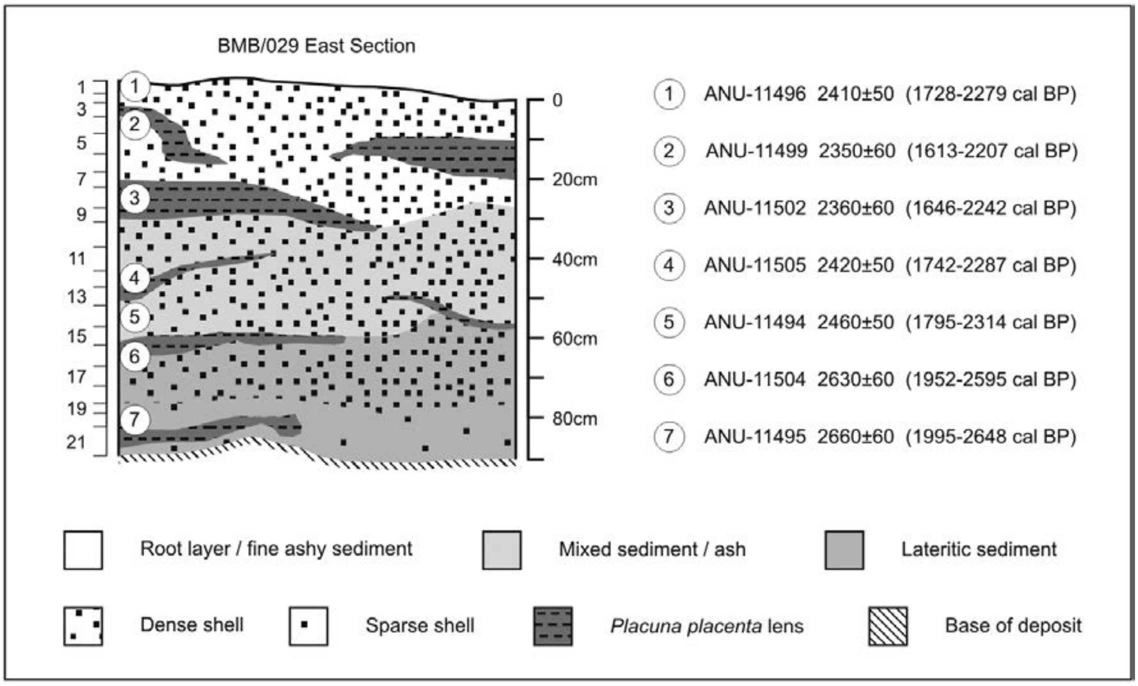


Figure 4.19: BMB/029 stratigraphic diagram, east section, showing conventional radiocarbon ages and 2σ calibrated age ranges.

Seven *Anadara granosa* samples were submitted for radiocarbon dating; the calibrated radiocarbon ages are detailed in Table 4.7 and graphed in Figure 4.20. The surface sample returned a date of 2410±50, which calibrated to 1985 cal BP, and a sample from the base of the site returned a date of 2660±60, which calibrated to 2287 cal BP. The 'test sample significance' function of the CALIB v6.1.1 program indicates that the 2σ calibrated ages for all samples are statistically indistinguishable at the 95% confidence level (t = 7.19, *d.f.* = 6). Two phases of deposition were originally identified for this site based on significant differences in the calibrated radiocarbon ages (e.g. Faulkner 2009, 2011), however calibration of these ages using the revised ΔR correction value of 55±98 recommended for the Gulf of Carpentaria (Ulm 2006b) effectively removes the gaps in the calibrated ages. Therefore, while the data suggests an overall age range for this site of approximately 302 years, formation of this deposit was rapid, and cannot be broken down into further depositional phases based on the radiocarbon determinations.

Table 4.7: Conventional and calibrated radiocarbon ages obtained for site BMB/029.

Site Code /XU	Depth (cm)	Lab Code	Sample	δ13C (*estimate)	14C Age	1σ cal Age BP (68.3% probability)	2σ cal Age BP (95.4% probability)	Cal Age BP Median
BMB/029 / 1	0 - 3	ANU-11496	*Anadara granosa*	-3.4 ± 0.1	2410 ± 50	1850–2120	1728–2279	1985
/ 4	8 - 11	ANU-11499	*Anadara granosa*	-4.0 ± 0.1	2350 ± 60	1771–2058	1613–2207	1912
/ 8	23 - 28	ANU-11502	*Anadara granosa*	0.0 ± 2.0 *	2360 ± 60	1788–2074	1646–2242	1925
/ 12	41 - 45	ANU-11505	*Anadara granosa*	-2.8 ± 0.1	2420 ± 50	1858–2129	1742–2287	1997
/ 14	49 - 53	ANU-11494	*Anadara granosa*	-2.6 ± 0.1	2460 ± 50	1892–2171	1795–2314	2045
/ 16	58 - 62	ANU-11504	*Anadara granosa*	-3.1 ± 0.2	2630 ± 60	2085–2380	1952–2595	2245
/ 20	75 - 81	ANU-11495	*Anadara granosa*	0.0 ± 2.0 *	2660 ± 60	2122–2435	1995–2648	2287

Source: Calibration data from CALIB 6.1.1, marine04.14c (Hughen *et al.* 2004), ΔR = 55±98 (Ulm 2006b).

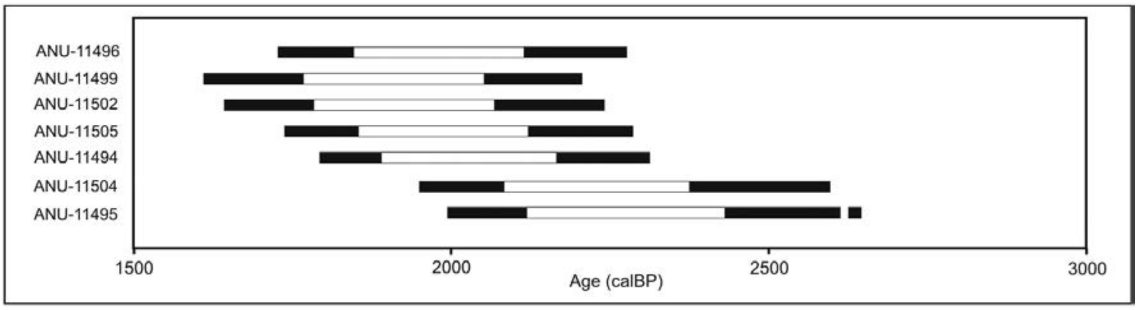


Figure 4.20: Calibrated radiocarbon ages (1 and 2σ) obtained for BMB/029.

To assess variability in the level of fragmentation throughout the deposit, NISP:MNI ratios have been calculated for two different species per excavation unit (Figure 4.21). Levels of fragmentation within the site have again been assessed here using the two dominant molluscan species, the robust *Anadara granosa* and the comparatively thinner-walled *Marcia hiantina*. Using robust and fragile species as a comparison enables a certain level of control with this type of analysis, relating particularly to possible differential patterns of fragmentation related to the structural integrity of individual species. While there are differences in the rate of fragmentation between these two species, there are similarities in the broad patterning of fragmentation relative to depth. The very high rate of fragmentation shown between excavation units 5 and 1 can be related to postdepositional processes of weathering, fragmentation and compaction since abandonment of the site approximately 2140 years ago.

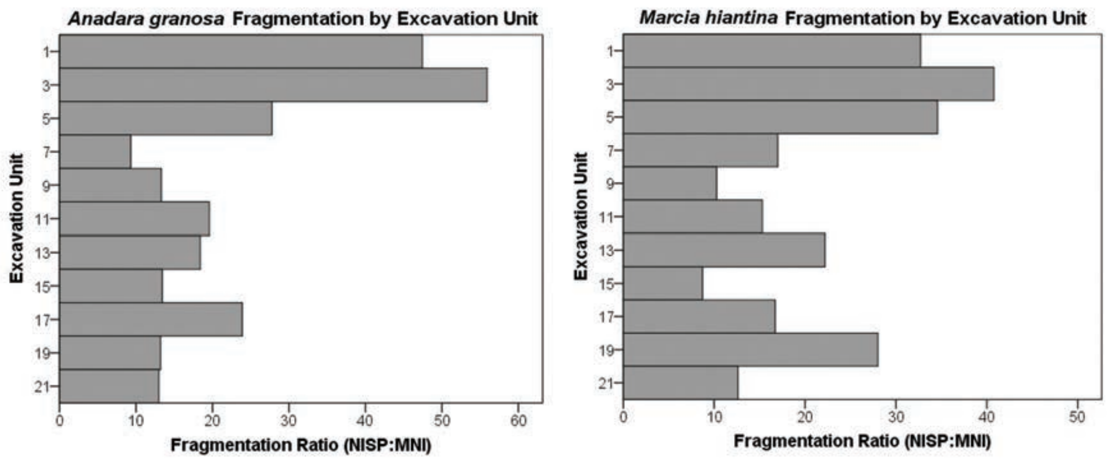


Figure 4.21: BMB/029 NISP:MNI fragmentation ratios for *Anadara granosa* and *Marcia hiantina* per excavation unit, 6mm sieve fraction.

Table 4.8 details the quantitative data by weight in grams for the excavated components recovered from the 6 mm sieve, with Figure 4.22 graphing the density estimates of shell, bone and otoliths, charcoal and laterite and rock by excavation unit. This shows that molluscan remains dominate the assemblage by weight at 75.2%, followed by lateritic and rock deposits at 24.68%. Vegetation (0.1%), charcoal (0.03%), and fragments of crab carapace (0.01%) form minor components of the excavated assemblage by weight. Three species dominate the molluscan remains within this site, these being *Anadara granosa* (68.1%), *Marcia hiantina* (13.5%) and *Placuna placenta* (9.8%). Although molluscan remains dominate this assemblage as a whole, there is a significant relationship between the density of this material and excavation unit (Spearman's r_s = -0.809, $p < 0.005$, n = 11). The significant increase in the density of shell throughout the deposit possibly relate to the timing and nature of environmental change in the area. The initial use of this location at 2465 cal BP would appear to correspond with the initial establishment of suitable habitats for molluscan taxa with progradation. With further habitat development and possible proliferation of mollusc resources in the area there is a subsequent and rapid phase of occupation highlighted by the greater density of molluscan debris.

Table 4.8: Quantitative data for the excavated components from BMB/029, 6mm sieve fraction.

Excavation Unit	Depth (cm)	Volume (cm³)	Laterite (g)	Vegetation (g)	Charcoal (g)	Shell (g)	Otoliths No./ g	Crustacean (g)	Stone Artefacts No./g
1	0 to 3	7000	35.4	16.8	---	2981.8	2/0.4	1.2	---
3	5 to 8	7500	62.0	8.0	---	3772.0	4/1.6	0.2	---
5	12 to 16	11000	37.7	2.9	0.3	3044.7	1/0.3	0.4	---
7	20 to 23	8250	11.4	1.0	1.2	3496.7	1/0.4	---	---
9	28 to 31	7500	60.8	0.2	0.3	2844.8	---	---	---
11	36 to 41	12750	108.3	0.5	1.2	5091.9	---	0.3	---
13	45 to 49	10000	70.3	0.3	2.1	3522.5	1/0.7	---	1/1.5
15	53 to 58	10250	1391.5	0.2	0.8	1777.3	---	---	---
17	62 to 66	10500	1670.3	0.7	3.1	742.6	---	---	---
19	70 to 72	5250	1091.7	---	1.9	530.3	---	0.9	---
21	75 to 82	15750	4762.8	---	0.3	524.5	---	---	1/4.3
Totals			**9302.2**	**30.6**	**11.2**	**28329.1**	**9/3.4**	**3**	**2/5.8**
% of Total Wt. (37685.3)			**24.68**	**0.08**	**0.03**	**75.17**	**0.01**	**0.01**	**0.02**

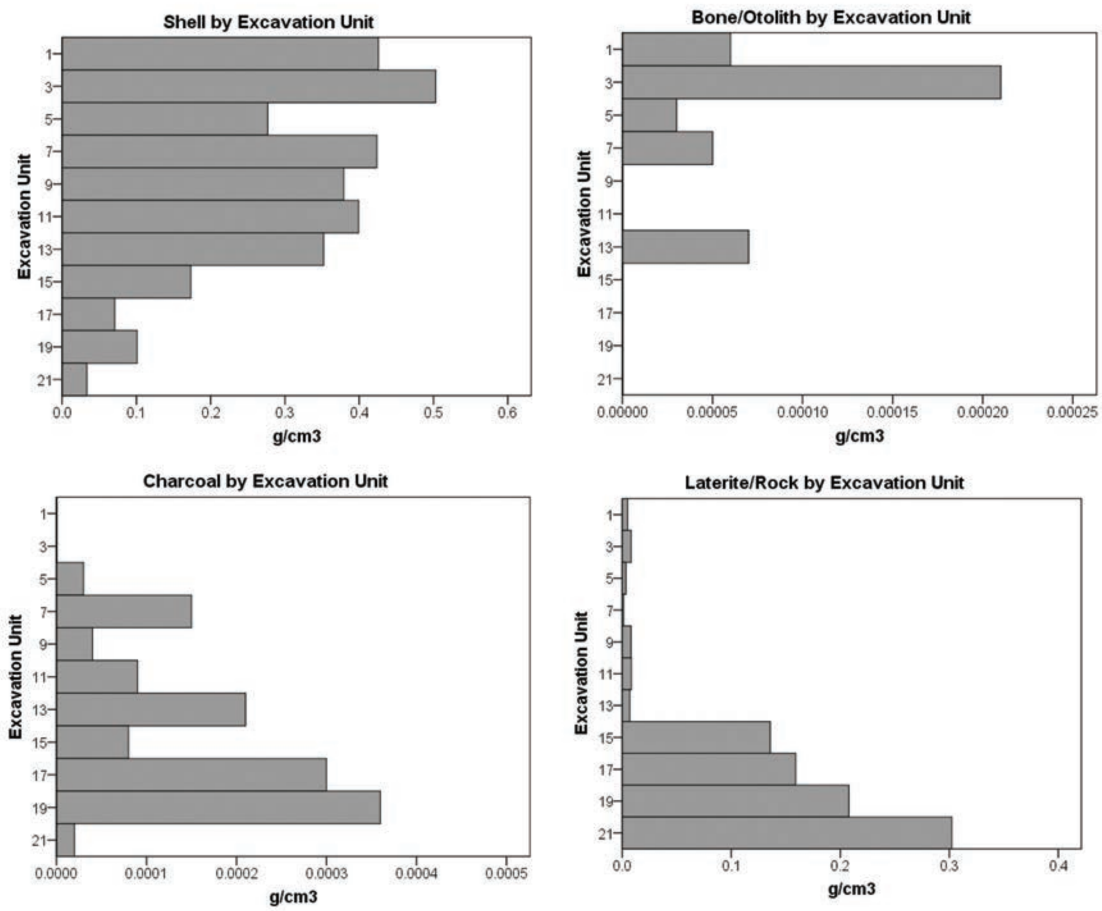


Figure 4.22: Density (g/cm^3) of shell, bone/otolith, charcoal and laterite/rock by excavation unit, BMB/029, 6mm sieve fraction.

Eight otoliths were recovered from the upper four excavation units, with one otolith coming from unit 13. All of the otoliths from this site are Catfish (*Arius* sp.), a species that inhabits estuarine to freshwater habitats. That all of the otoliths recovered from this site are concentrated within the upper portions of the deposit suggests that the use of resources other than molluscs may relate to changes to the local environment and the development of appropriate habitats for *Arius* species with landscape alteration. With regard to dietary contribution, this suggests that resources other than molluscs were possibly of minor importance, as the otoliths representing a minimum number of five individuals and comprising 0.01% of the excavated assemblage by weight.

Turning to the non-faunal components of the assemblage, the distribution of charcoal throughout the deposit could relate to either cultural or natural processes. The combination of a relatively dry climate with natural or anthropogenic burning of this environment may account for the density of charcoal, with mixed lenses of ash and charcoal occurring throughout the deposit and charcoal density increasing towards the base. Regardless of its origin or this distributional pattern, there is not a significant difference in the density of charcoal throughout the deposit (Spearman's $r_s = 0.579$, $p > 0.05$, $n = 11$). In contrast, there is a greater density of laterite within the lower excavation units of the site, with a significant decrease in laterite density throughout the deposit (Spearman's $r_s = 0.818$, $p > 0.002$, $n = 11$). With laterite being the dominant ground surface in the area, the higher density of this material towards the bottom of the site would have enabled the movement of laterite into the deposit through natural processes, combined with the lower height of the mound during this phase. Two stone artefacts were also recovered during the course

of excavation. One flaked piece (a silcrete medial flake fragment) was recovered from unit 13, weighing 1.5g and measuring 18.93mm by 15.05mm. The second, a complete unretouched flake, was recovered from the base of the deposit in excavation unit 21, weighing 4.3g and measuring 42.45mm by 15.28mm. As noted with the silcrete and quartzite artefacts from site BMB/067b, these two artefacts conform reasonably well to those previously discussed.

Overall, it can be seen that in the apparent rapid formation of this site, as evidenced by the radiocarbon determinations and fragmentation data, combined with differences in the density of molluscan material throughout the deposit, provides evidence for the period of initial occupation and subsequent resource exploitation in the Grindall Bay area.

The Dilmitjpi cluster

The Dilmitjpi area, located to the south of Garangarri and separated by a seasonal water channel and floodway, is in many ways similar environmentally to the previous cluster (Figure 4.23). Mixed *Eucalypt* woodland dominates the landscape leading up to the edge of the laterite ridge, which in this area of the wetlands is quite variable in height, ranging between approximately 1 and 5m. The laterite ridge is at its highest and steepest around the small headland area jutting westwards into the wetlands, with the sites clustering around this area. The structure of the cluster is different to that found at Garangarri, with sites located on the edges of the laterite ridge, as well as on the edges of the wetlands at the foot of the ridge, and several hundred metres into the woodlands moving east away from the wetlands. Twenty-three sites are found in this area, ranging in size from small surface scatters of shell with an area of 26.1m^2, to a very large mounded shell deposit extending along the upper edge of the laterite ridge, measuring approximately 354m in length, 1.8m in height and covering an area of 10,620m^2. The sites radiate out from this large composite mound, extending for approximately 300m along the edge of the ridge, with site size decreasing with distance from this point.

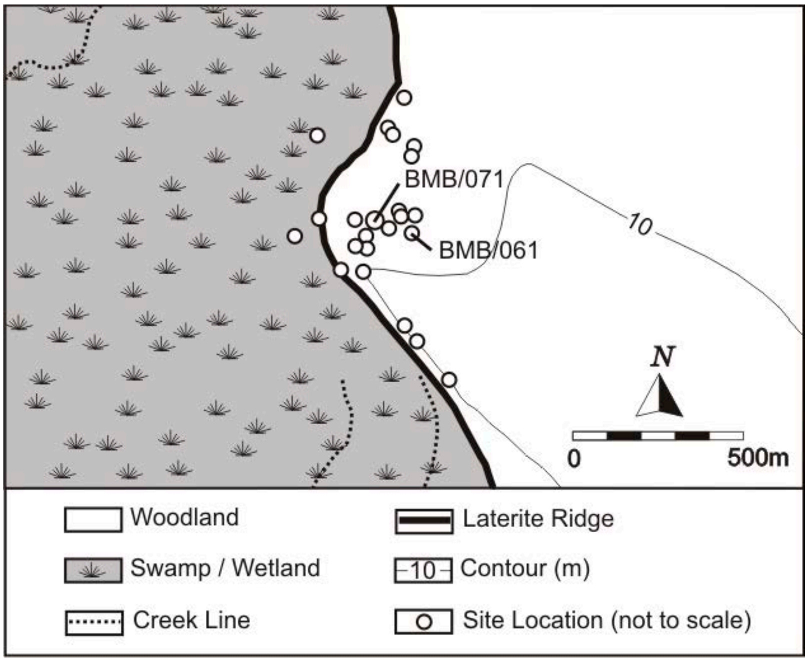


Figure 4.23: Dilmitjpi cluster and location of excavated site BMB/071 (excavated and radiocarbon dated site BMB/061 also shown).

Source: Based on Baniyala 1:50 000 Topographic Map.

BMB/071 site description: Stratigraphy, chronology and excavated components

BMB/071 is a large 1m high shell mound, positioned approximately 100m from the edge of the laterite ridge, measuring 19.8m by 19.4m (Figure 4.24). The mound is surrounded by *Eucalyptus tetrodonta* woodland, with smaller mounds situated between this site and the laterite edge, with much smaller middens leading further into the woodland. This site is situated relatively centrally within this section of the large Dilmitjpi cluster (Figure 4.25). Shellfish species dominating the surface of the site include *Anadara granosa*, *Marcia hiantina*, *Mactra abbreviata*, *Volema* sp. and *Terebralia palustris*. The shell is very heavily weathered and fragmented, with several burnt patches, largely confined to those areas closer to dense vegetation, relating to the annual burning of this area.

A $1m^2$ test-pit was excavated into the side of the site, reaching approximately 50 to 60cm in depth. The mound itself is composed of densely packed *Anadara granosa*, with very little in the way of sedimentary matrix, and fine rootlets extending through the first 30cm of the excavation (Figure 4.26). The base of deposit consisted of a matrix of yellow brown clay and laterite, with highly fragmented shell material. As with BMB/029, excavation ceased on reaching the hard-packed clay and laterite representative of the surrounding ground surface. A small lens of *Placuna placenta* was located at a depth of approximately 40cm, but the quantity of this species is minimal. Rather, it is another bivalve species, *Mactra abbreviata*, which appears to form the sub-dominant component of this site. Three *Anadara granosa* samples were submitted for radiocarbon dating (Table 4.9). The surface sample returned a date of 1700±60 which calibrated to 1192 cal BP, a relatively central sample from excavation unit 6 returned a date of 1810±60 which calibrated to 1310 cal BP, and a sample from the base of the site returned a date of 1980±60 which calibrated to 1483 cal BP. Similar to BMB/029, two phases of deposition were originally identified for this site (Faulkner 2009, 2011), with re-calibration of the radiocarbon dates now suggesting this may not be the case. The age estimates presented here now suggest extremely rapid accumulation of this site, with occupation of approximately 291 years between 1192 and 1483 years BP. As with BMB/029, the 'test sample significance' function of the CALIB v6.1.1 program indicates that the 2σ calibrated ages for all samples are statistically indistinguishable at the 95% confidence level ($t = 3.01$, $d.f. = 2$), indicating rapid formation of this deposit.

Table 4.9: Conventional and calibrated radiocarbon ages obtained for site BMB/071.

Site Code /XU	Depth (cm)	Lab Code	Sample	$\delta^{13}C$	^{14}C Age	1σ cal Age BP (68.3% probability)	2σ cal Age BP (95.4% probability)	Cal Age BP Median
BMB/071 / 1	0 - 3	ANU-11722	*Anadara granosa*	2.9 ± 0.2	1700 ± 60	1067–1299	936–1412	1192
/ 6	19 - 24	ANU-11723	*Anadara granosa*	-2.5 ± 0.2	1810 ± 60	1176–1419	1053–1551	1310
/ 11	42 - 46	ANU-11724	*Anadara granosa*	3.1 ± 0.2	1980 ± 60	1343–1599	1259–1753	1483

Source: Calibration data from CALIB 6.1.1, marine04.14c (Hughen *et al.* 2004), ΔR = 55±98 (Ulm 2006b).

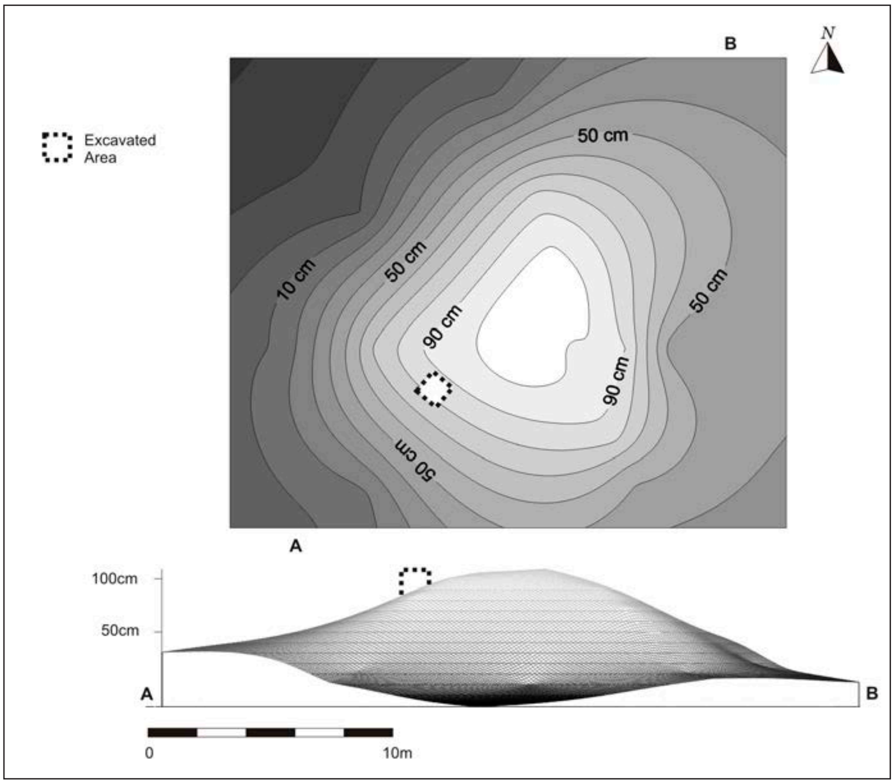


Figure 4.24: Contour plan of site BMB/071 showing location of the excavation square.

Figure 4.25: Site BMB/071, view west towards the edge of the laterite ridge and dense monsoon vine thicket.

Source: Photo Patrick Faulkner.

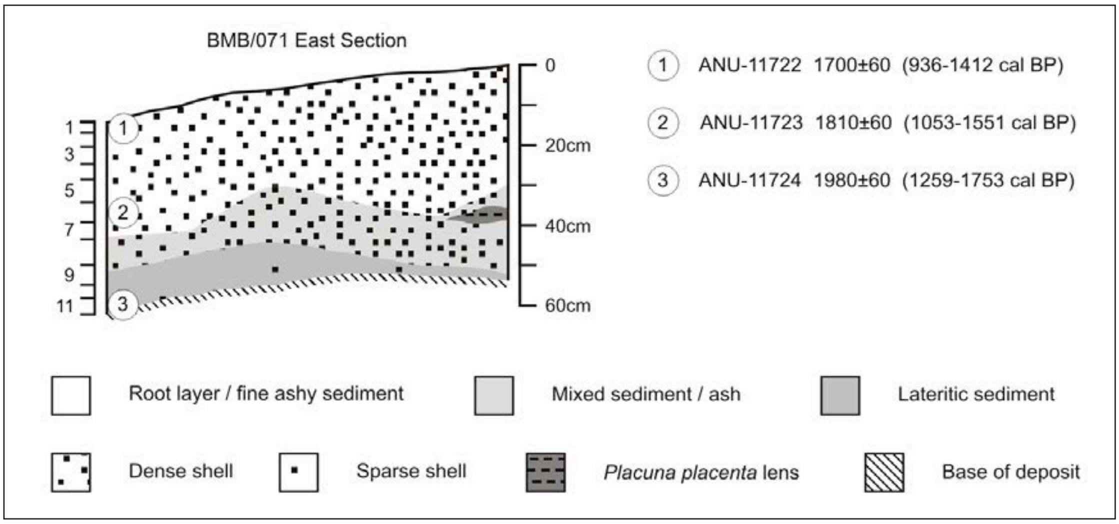


Figure 4.26: BMB/071 stratigraphic diagram, east section, showing conventional radiocarbon ages and 2σ calibrated age ranges.

Levels of fragmentation within the site have been assessed here using the two dominant molluscan species, the robust *Anadara granosa* and the thinner walled and fragile *Mactra abbreviata* (Figure 4.27). While there are differences in the rate of fragmentation between these two species, there are similarities in the broad patterning of fragmentation relative to depth. With the exception of the fragmentation ratio for *Anadara granosa* in excavation unit 11, the rate of fragmentation for both species increases throughout the deposit, possibly relating to post-depositional processes of weathering, fragmentation and compaction since abandonment of the site approximately 1200 years ago. A period of increased exposure may also account for the anomalous pattern in fragmentation in excavation unit 11. The high rate of fragmentation at the base of the site may indicate a hiatus in deposition following the initial period of shell discard in this location.

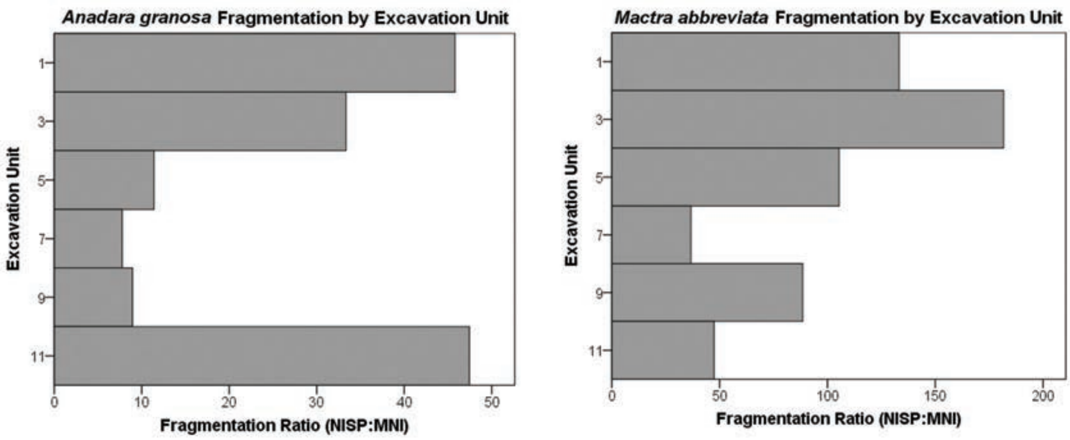


Figure 4.27: BMB/071 NISP:MNI fragmentation ratios for *Anadara granosa* and *Mactra abbreviata* molluscan species per excavation unit, 6mm sieve fraction.

Table 4.10 details the quantitative data by weight in grams for the excavated components recovered from the 6mm, with Figure 4.28 graphing the density estimates of shell, bone and otoliths, charcoal, and laterite and rock by excavation unit. This shows that molluscan remains dominate the assemblage by weight at 99.3%, followed by lateritic and rock deposits at 0.43%. Vegetation

(0.2%), charcoal (0.02%), bone and otoliths (0.01% respectively), fragments of crab carapace (<0.01%) and stone artefacts (<0.01%) form minor components of the excavated assemblage by weight. Molluscan remains, predominantly *Anadara granosa* (87.5%) and *Mactra abbreviata* (7.3%), occur within this site almost to the exclusion of all other excavated components. While the density of shell peaks within the middle excavation units in the site, there is not a significant relationship between the density of shell and excavation unit (Spearman's r_s = 0.257, $p > 0.5$, $n = 6$). This suggests that the discard of molluscan remains was at a relatively consistent and high level throughout the period of occupation. The non-molluscan faunal components of the site also show no significance in terms of the relationship between the density estimates and excavation unit (Spearman's r_s = 0.029, $p > 0.5$, $n = 6$). The identifiable elements of the bone and otoliths within the site are all Catfish (*Arius* sp.). One otolith was recovered from each of excavation units 1 and 3, with five otoliths recovered from excavation unit 5. Highly fragmented pieces of mandible were also recovered from both excavation units 5 and 7. Non-molluscan faunal remains occur within the site at a very low density, and even given issues of bone preservation within the tropics, this low density suggests a predominate focus on molluscan resources in the area.

Table 4.10: Quantitative data for the excavated components from BMB/071, 6mm sieve fraction.

Excavation Unit	Depth (cm)	Volume (cm^3)	Laterite/ Rock (g)	Vegetation (g)	Charcoal (g)	Shell (g)	Bone (g)	Otolith No/ g	Crustacean (g)	Stone Artefacts No./g
1	0 to 3	7500	0.6	11.7	<0.1	1925.7	0.1	1/0.2	---	---
3	6 to 10	10000	14.5	10.9	0.3	3943.2	<0.1	1/0.1	---	---
5	14 to 19	12500	6.2	14.4	0.4	7140.1	0.5	5/0.9	---	---
7	24 to 28	10000	4.1	4.7	0.2	6672.4	0.9	---	---	---
9	34 to 39	12500	64.0	3.4	5.5	5710.0	0.1	---	---	2/0.9
11	42 to 46	10000	34.4	17.8	---	2981.8	0.4	2/0.4	1.2	---
Totals			**123.8**	**62.9**	**6.4**	**28373.2**	**2**	**1.6**	**1.2**	**0.9**
% of Total Wt. (28572)			**0.43**	**0.22**	**0.02**	**99.30**	**0.01**	**0.01**	**<0.01**	**<0.01**

Two stone artefacts were recovered, both from excavation unit 9. Both artefacts are quartzite flaked pieces, one is a medial flake fragment (weighing 0.3g and measuring 7.23mm by 14.10mm), and the second artefact is a proximal flake fragment (weighing 0.6g and measuring 12.20mm by 18.02mm). In terms of raw material, these artefacts conform morphologically to the quartzite noted outcropping on the eastern side of the peninsula. While the distribution of charcoal within this site peaks substantially in excavation unit 9 relative to the density estimates for units 3, 5 and 7, correlation coefficients indicate that there is not a significant relationship between the density of charcoal and excavation unit (Spearman's r_s = -0.058, $p > 0.5$, $n = 6$). This result is mirrored by the distribution of laterite/rock throughout the deposit, where there are peaks in the density of material in excavation units 3 and 9. While the peak in the lower excavation units possibly relates to the relative height of the site as it was being deposited, there is not a significant relationship between the density of laterite/rock and excavation unit (Spearman's r_s = 0.714, $p > 0.1$, $n = 6$). Therefore, while both of these components show a higher density within the lower portions of the deposit, they occur at such a low level that this variation is relatively insignificant.

Overall, there is very little variation in the formation of this site, as evidenced by the lack of significant differences in the density of material throughout the deposit.

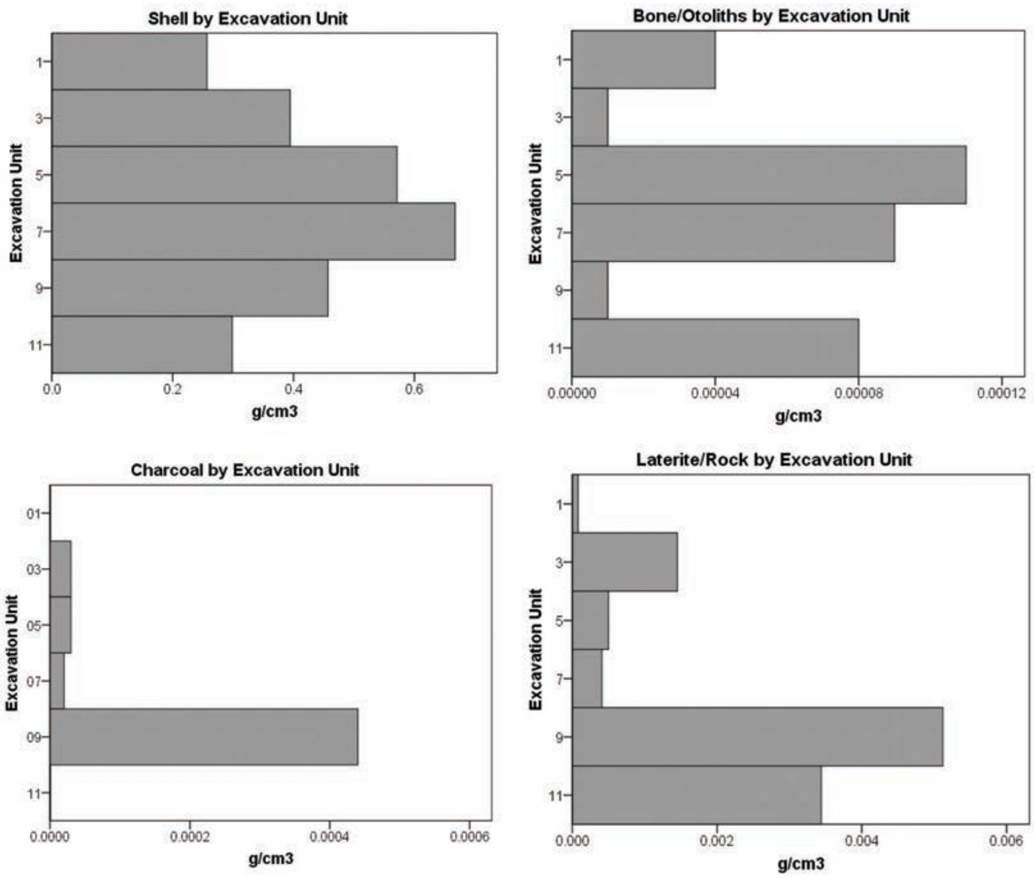


Figure 4.28: Density (g/cm^3) of shell, bone/otolith, charcoal and laterite/rock by excavation unit, BMB/071, 6mm sieve fraction.

The Burrpilingbuy cluster

The site cluster located at Burrpilingbuy (Figure 4.29) is similar to Dilmitjpi, with shell deposits clustered around a large site on the laterite ridge, decreasing in size with distance from this point. This area is at the very southern-most end of the wetlands system, with the saltflats merging into an extensive mangrove system. The sites in this area possibly relate to the final phases of occupation within the Grindall Bay area. Mixed *Eucalypt* woodland dominates the landscape leading up to the edge of the laterite ridge, which is approximately 5 to 8m in height in this area. Twenty sites are found in this area, with sizes ranging from low, surface scatters of shell to mounded deposits approximately 3.3m high, with site area varying from 32.76m^2 to 858.9m^2. The sites generally decrease in size with distance from the very large composite mound on the edge of the laterite ridge, with several small middens into the woodlands, and a series of mounds located on the saltflats. These sites are generally located close to, or at, the base of the laterite ridge, although one site is situated on the saltflats several hundred metres from the ridge.

BMB/045 site description: Stratigraphy, chronology and excavated components

BMB/045 is a low, elongated mound, measuring 22.7m by 11.4m and 33cm in height above the surface of the saltflats (Figures 4.30 and Figure 4.31). This is the nearest site to the mangroves of all mounds recorded on the salt flats, very close to one of the tributary 'fingers' extending out from the mangroves into the saltflats. It appears that high tides create saltwater intrusions onto

the saltflats through these tidal channels. This site becomes covered in sediment when the area floods during the wet season, as indicated by the high cracking clay content on the site surface. The shellfish species dominating the surface of the site include *Anadara granosa*, *Polymesoda (Geloina) coaxans*, *Mactra abbreviata*, *Lucinidae* sp., *Telescopium telescopium*, *Cassidula* sp. and *Cerithidea* sp. The shell exhibits a high degree of weathering and fragmentation on the surface of the site, relating to high levels of exposure and trampling.

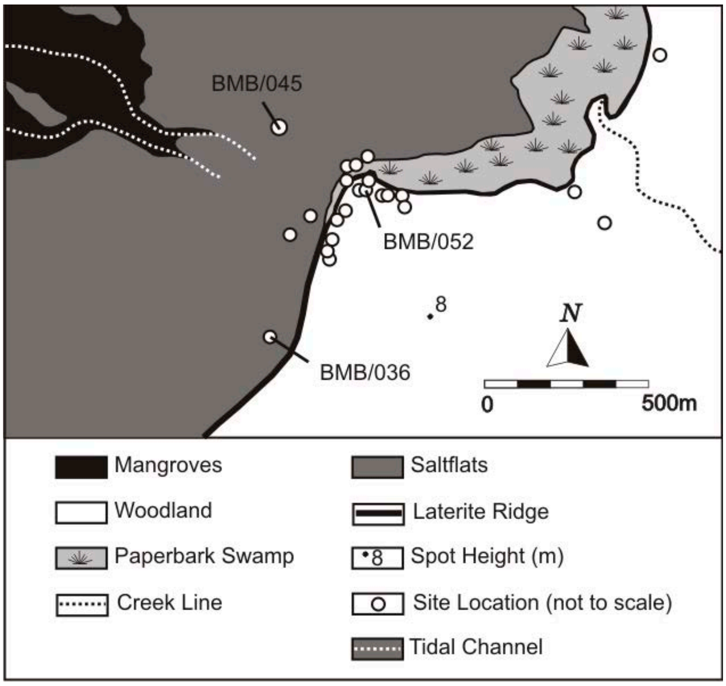


Figure 4.29: Burrpilingbuy cluster and location of excavated site BMB/045 (radiocarbon dated sites BMB/036 and BMB/052 also shown).

Source: Based on Baniyala 1:50 000 Topographic Map.

Figure 4.30: Site BMB/045, view south-west towards the extensive mangrove forest.

Source: Photo Patrick Faulkner.

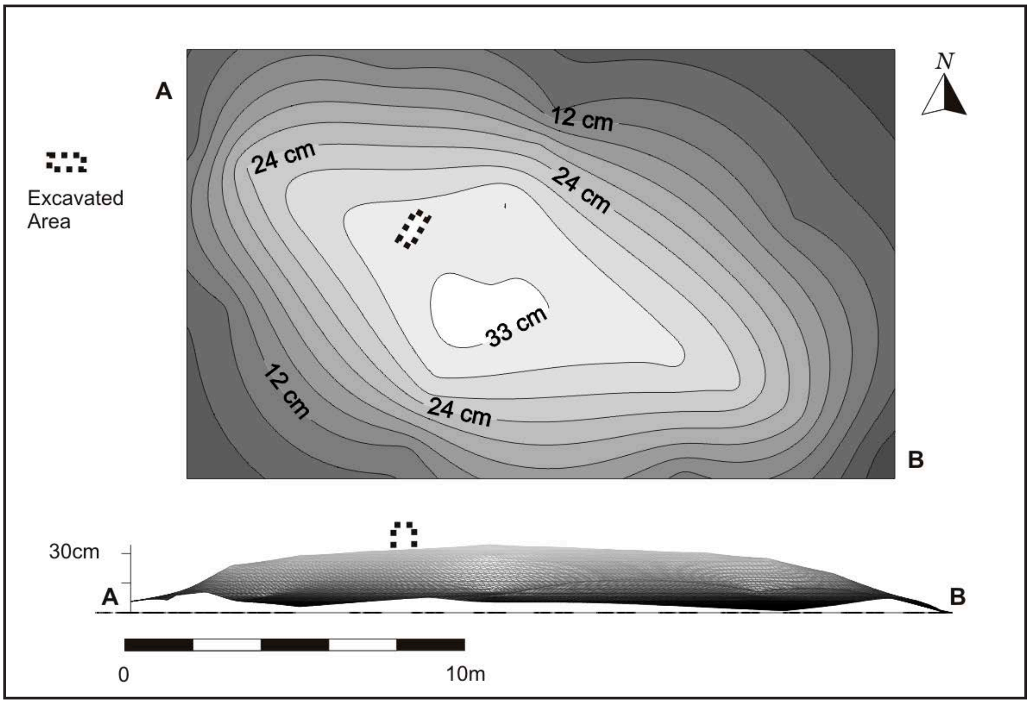


Figure 4.31: Contour plan of site BMB/045 showing location of the excavated area.

A 50cm by one metre square was excavated along the central axis of the site, and although only 33cm above the saltflats, the excavation reached a depth of approximately 1m. Excavation could not continue beyond this depth, having reached waterlogged light grey clay. Only small amounts of shell remained at this point, however, and represents the approximate base of the deposit given the change in the clay and the relative paucity of cultural midden material. The lower half of the deposit appears to have been constantly subjected to these waterlogged conditions due to its close proximity to a tidal channel through the mangroves. This has lead to higher levels of preservation within the deposit, with most of the shells retaining some of their colour and fish bone being noted during excavation. As shown in the stratigraphic profile (Figure 4.32), the surface layers were composed of densely packed *Anadara granosa* cemented in a hard, dried matrix of very fine sediment. The lower half of the deposit was comprised of shell material and charcoal fragments embedded in a matrix of wet clay. Indistinct lenses of more dense charcoal and shell occur throughout the section, as does shell mixed with light grey ash. Three *Anadara granosa* samples were submitted for radiocarbon dating (Table 4.11). The surface sample returned a date of 990±60, which calibrated to 539 cal BP, a central sample from excavation unit 16 returned a date of 1040±60, which calibrated to 577 cal BP, and a sample from the base of the site returned a date of 1050±60, which calibrated to 584 cal BP. The 'test sample significance' function of the CALIB v6.1.1 program indicates that the 2σ calibrated ages for all samples are statistically indistinguishable at the 95% confidence level (t = 0.16, *d.f.* = 2), indicating extremely rapid accumulation of this site, with deposition of a metre of material, potentially within less than approximately 100 years. This suggests a high level of intensity relating to resource use within this locality, with this site the most recent of those dated from the Grindall Bay area.

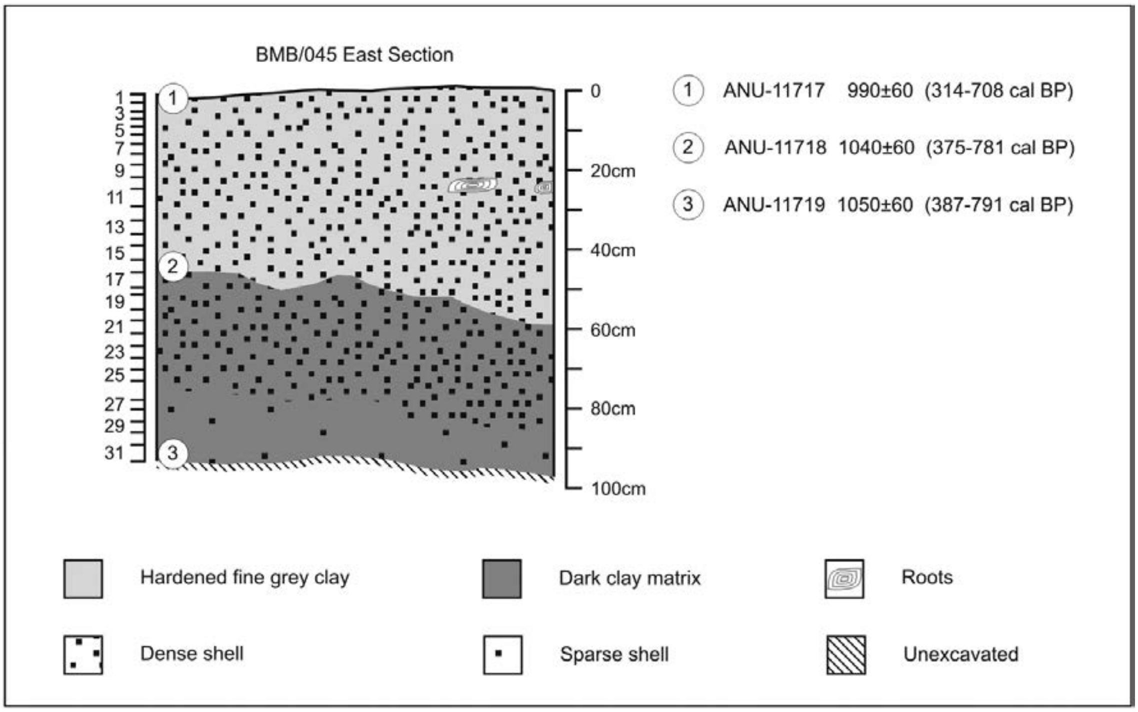


Figure 4.32: BMB/045 stratigraphic diagram, east section, showing conventional radiocarbon ages and 2σ calibrated age ranges.

Table 4.11: Conventional and calibrated radiocarbon ages obtained for site BMB/045.

Site Code /XU	Depth (cm)	Lab Code	Sample	$\delta^{13}C$	^{14}C Age	1σ cal Age BP (68.3% probability)	2σ cal Age BP (95.4% probability)	Cal Age BP Median
BMB/045 / 1	0 - 2	ANU-11717	*Anadara granosa*	3.5 ± 0.2	990 ± 60	461–637	314–708	539
/ 16	43 - 46	ANU-11718	*Anadara granosa*	-3.7 ± 0.2	1040 ± 60	492–659	375–781	577
/ 31	91 - 95	ANU-11719	*Anadara granosa*	3.1 ± 0.2	1050 ± 60	496–664	387–791	584

Source: Calibration data from CALIB 6.1.1, marine04.14c (Hughen *et al.* 2004), ΔR = 55±98 (Ulm 2006b).

Fragmentation levels are again assessed here using *Anadara granosa* and *Mactra abbreviata* (Figure 4.33). The trends in fragmentation presented here can still be described as increasing towards the surface of the site for both species, although the rate of fragmentation varies to a greater degree than that previously seen. Greater depth of deposit combined with a very rapid rate of site deposition may account for this patterning to a certain degree. In addition, the location of this site on the saltflats approximately 250m from the laterite ridge, combined with the high surface clay content caused by seasonal inundation, may have protected this site from the effects of exposure and post-depositional destruction of the shell. Variations in the rate of fragmentation may also relate to phases of more intensive occupation and activity during the formation of the site, as the peaks in fragmentation between the two species roughly correspond. More likely, the patterning in shell fragmentation relates to a combination of these factors.

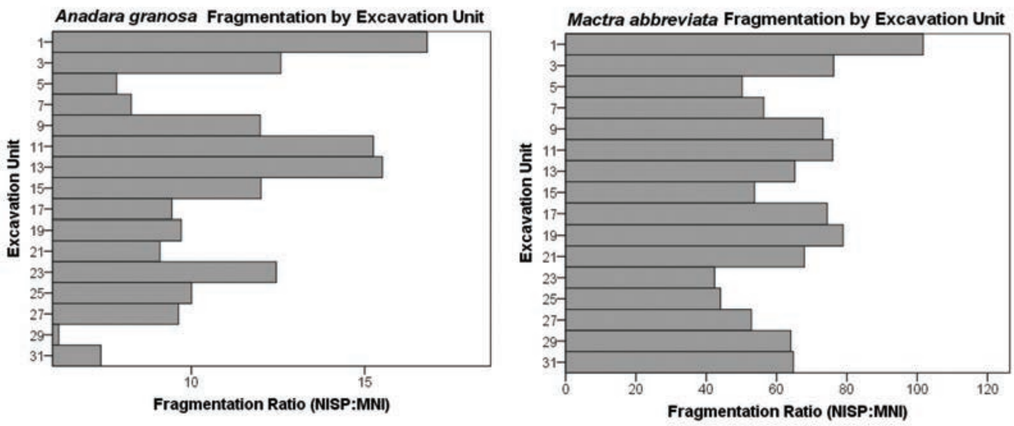


Figure 4.33: BMB/045 NISP:MNI fragmentation ratio for *Anadara granosa* and *Mactra abbreviata* per excavation unit, 6mm sieve fraction.

Table 4.12 details the quantitative data by weight in grams for the excavated components recovered from the 6mm sieve during excavation, with Figure 4.34 graphing the density estimates of shell, bone and otoliths, charcoal and laterite and rock by excavation unit. This data show that molluscan remains dominate the assemblage by weight at 99.8%. This is followed by vegetation at 0.12%, and as the excavation square was positioned close to a relatively dense stand of vegetation, this largely represents present-day root infiltration from the site surface. Laterite and rock (0.1%), charcoal (0.1%), bone and otoliths (0.02% and <0.01% respectively) and fragments of crab carapace (<0.01%) form minor components of the excavated assemblage by weight. *Anadara granosa* (74.2%) and *Mactra abbreviata* (17.2%) dominate the molluscan species recovered from this site. While the density of shell peaks within the middle excavation units in the site, indicating a certain level of variation in molluscan discard, the correlation coefficients indicate that there is not a significant relationship between the density of shell and excavation unit (Spearman's r_s = -0.176, $p > 0.5$, $n = 16$). This suggests that the discard of molluscan remains within this site was not only very rapid, but also at a relatively consistent and high level throughout the period of occupation.

The non-molluscan faunal components of the site also show no significance in terms of the relationship between the density estimates and excavation unit (Spearman's $r_s = 0.144$, $p > 0.5$, $n = 16$). The bone and otoliths are distributed largely between excavation units 9 and 21, with some faunal material recovered from excavation units 1, 25 and 31. Even given better preservation levels within this site, particularly compared with the other two mound sites included in this study, the density of non-molluscan material within the site is very low. This suggests that resources other than molluscs were of a minor importance within this area. In line with the fish bone identification presented for the previous mound sites, the bone and otoliths identified within this site are all of Catfish (*Arius* sp.). These remains came from excavation units 11 to 21 and 25, and were mainly highly fragmented pieces of mandible or cranium. Within this site, there are also several identifiable elements of reptile remains, including freshwater turtle carapace fragments from excavation units 13 and 19, and lizard/snake vertebrae from excavation units 11 and 15. While the distribution of charcoal within this site peaks substantially in excavation unit 13, correlation coefficients indicate that there is not a significant relationship between the density of charcoal and excavation unit (Spearman's $r_s = 0.214$, $p > 0.2$, $n = 16$). The relative densities of charcoal within each of the excavation units are so low, that even given the peak in higher density, there is actually very little variation in the distribution of this material throughout the site. This distribution does not conform to the expected pattern of vertical decay in organic material,

largely due to the previously discussed higher preservation of organic material within the site. As with the faunal material, charcoal is a consistent, low-level component of the assemblage. The distribution of laterite/rock is almost entirely concentrated within excavation units 1, 3, 5 and 7. While there is not a significant relationship between the density of laterite/rock and excavation unit (Spearman's r_s = -0.353, $p > 0.1$, $n = 16$), the relatively low density of this material possibly relates to the position of this site on the saltflats, a location where the ground surface would not have been dominated by lateritic deposits during the formation of the site. The increased density of small lateritic pebbles in the upper excavation is likely due to pre and post-depositional flooding of the site.

Table 4.12: Quantitative data for the excavated components from BMB/045, 6mm sieve fraction.

Excavation Unit	Depth (cm)	Volume (cm^3)	Laterite/Rock (g)	Vegetation (g)	Charcoal (g)	Shell (g)	Bone (g)	Otolith No/g	Crustacean (g)
1	0 to 2	5000	1.4	18.9	---	747.0	---	1/0.2	---
3	4 to 6	5000	0.4	6.0	---	1737.4	---	---	---
5	8 to 10	5000	3.5	2.6	0.5	1951.2	---	---	---
7	13 to 15	5000	2.3	2.5	0.4	1745.0	---	---	---
9	18 to 21	7500	---	1.4	1.1	2730.1	0.2	---	---
11	24 to 29	12500	---	3.2	2.6	2653.0	0.4	1/0.2	0.7
13	33 to 36	7500	---	2.8	5.8	2942.0	1.3	---	---
15	39 to 43	10000	---	0.2	3.8	2887.8	1.0	---	---
17	46 to 50	10000	---	1.1	1.4	2076.0	1.2	---	---
19	52 to 56	10000	1.0	---	1.9	2584.3	1.9	---	---
21	59 to 62	7500	---	---	---	2010.6	0.7	---	---
23	65 to 68	7500	---	1.6	1.1	1801.0	---	---	---
25	71 to 74	7500	---	<0.1	1.1	2162.0	0.5	---	---
27	79 to 82	7500	---	0.4	0.4	2665.8	---	---	---
29	85 to 88	7500	<0.1	0.1	1.1	2164.2	---	---	---
31	91 to 95	10000	2.1	---	1.4	2306.0	0.7	---	---
Totals			**10.7**	**40.8**	**22.6**	**35163.4**	**7.9**	**0.4**	**0.7**
% of Total Wt. (35246.5)			**0.03**	**0.12**	**0.06**	**99.76**	**0.02**	**<0.01**	**<0.01**

As with the previously described mounds, the formation of this site was primarily related to the exploitation and dumping of molluscan debris, albeit at a possibly more intensive level than the other mound sites investigated. The rapid rate of deposition combined with the location of the site relative to the present-day distribution of mangroves may indicate the intensive use of resources within the area relative to the final phase of progradation and the disappearance of suitable molluscan habitats.

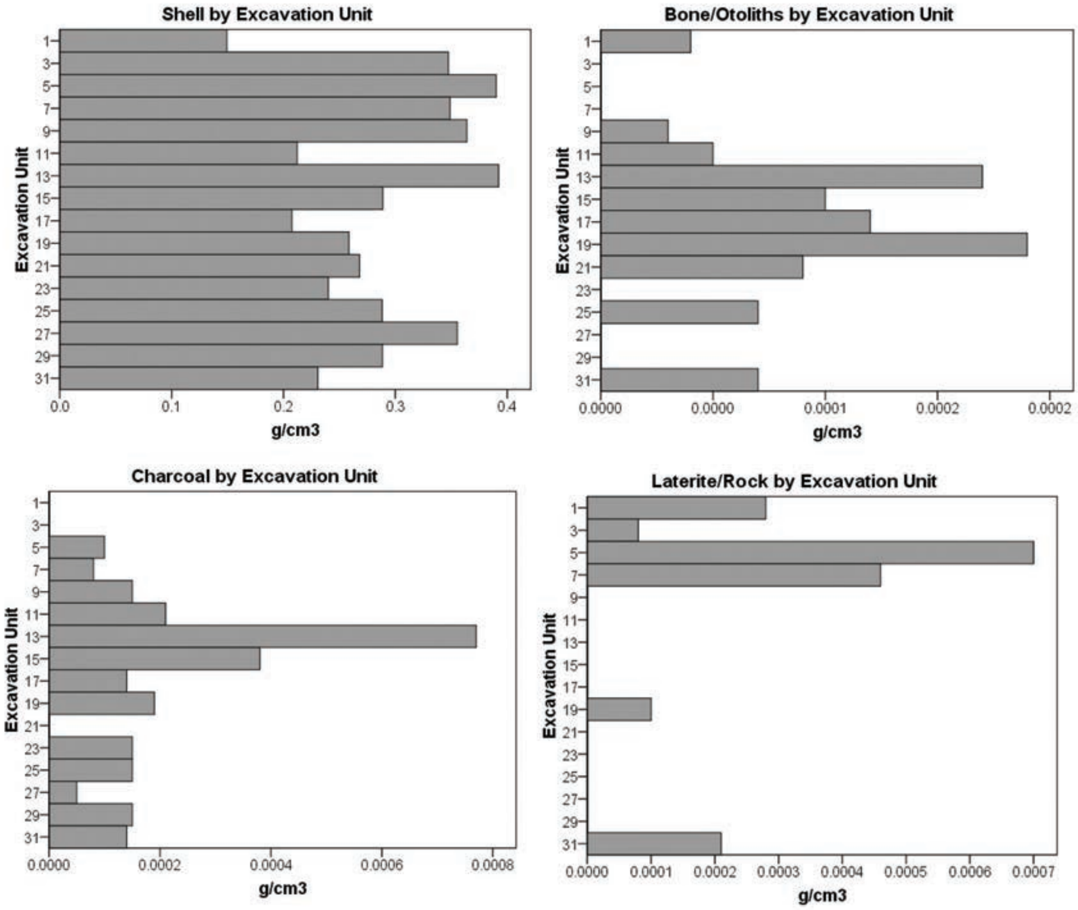


Figure 4.34: Density (g/cm^3) of shell, bone/otoliths, charcoal and laterite/rock by excavation unit, BMB/045, 6mm sieve fraction.

Inter-site comparison and conclusion

There are quite distinct differences in the history of formation within and between each of the six sites described above. A comparison of the excavated components by their percentage of weight (g) for each of the six sites is presented in Table 4.13, with the contrasting patterns of total density (g/cm^3) within each of the sites in Table 4.14. The rank ordering of the excavated components is based on the combined totals for all of the sites in the sample. While this does not take into account the high variability between sites, it shows that while there is some reordering in the rankings of the minor components, the two dominant excavated components (shell and laterite/rock) remain stable in terms of their rank. Other than the dominance of molluscan material, much of the variation in the abundance of the other excavated components between these sites probably relates to differences in the rate of deposition and the type of natural processes acting on the site during and after its occupation and abandonment. This particularly applies to the observable differences in the distribution and density of laterite/rock, the remains of vegetation and coral/worm shell between these deposits. Due to the ambiguous nature of charcoal within these sites, the same may be said for this material as well. An additional factor is the relative stability of the particular environmental location for each site, a point that is important for the distribution and density of laterite within these sites, given that it is the dominant land-surface within the study area.

Table 4.13: Comparison of the excavated components recovered from the six sites by percentage of weight (g), 6mm sieve fraction.

Rank		Myaoola Bay			Grindall Bay		
Order	Component	BMB/018	BMB/067b	BMB/018	BMB/067b	BMB/018	BMB/067b
1	Shell	71.58	62.3	78.13	75.17	99.3	99.76
2	Laterite/Rock	23.15	34.36	20.59	24.68	0.43	0.03
3	Coral/Worm Shell	2.4	1.81	0.06	---	---	---
4	Vegetation	1.73	0.85	0.83	0.08	0.22	0.12
5	Crustacean	1.06	0.01	0.01	0.01	<0.01	<0.01
6	Charcoal	0.03	0.01	0.38	0.03	0.02	0.06
7	Stone Artefacts	---	0.38	---	0.02	<0.01	---
8	Bone/Otolith	0.05	0.27	---	0.01	0.02	0.02

Table 4.14: Comparison of the total density of the excavated components (g/cm^3) recovered from the six sites, 6mm sieve fraction.

Rank		Myaoola Bay			Grindall Bay		
Order	Component	BMB/018	BMB/067b	BMB/084	BMB/029	BMB/071	BMB/045
1	Shell	0.06527	0.36951	1.14732	3.16258	2.64451	4.63053
2	Laterite/Rock	0.01965	0.20159	0.23043	0.81093	0.01100	0.00184
3	Vegetation	0.00131	0.00650	0.01358	0.00392	0.00632	0.00723
4	Coral/Worm Shell	0.00204	0.01030	0.00045	---	---	---
5	Charcoal	0.00002	0.00007	0.00361	0.00131	0.00053	0.00266
6	Stone Artefacts	---	0.00495	---	0.00040	0.00007	---
7	Bone/Otolith	0.00004	0.00142	---	0.00041	0.00035	0.00093
8	Crustacean	0.00100	0.00015	0.00010	0.00043	0.00012	0.00006

By far the most dominant material within all of these sites is shell. The percentage of shell by weight ranges between 62.3 and 99.8%, with variability relating to site location. For example, the average shell percentage by weight for the three sites located in Myaoola Bay is 70.8%, in comparison with an average of 91.4% for the mound sites in Grindall Bay, a pattern reflected in the density estimates for each site. There are several reasons for this apparent difference, for example, the ground surface in Grindall Bay is comparatively stable, and this area is protected to a greater degree from post-depositional disturbance, particularly from additional deposition and reworking via wind, water and storm action. Another possibility is that the rates of deposition and discard of molluscan material are higher in the mounds, resulting in a densely compact matrix of shell with very little sediment or additional material. Differences in the type of vertebrate remains identified within the sites may also relate to variations in the structure of available habitats and resource availability across the peninsula. For example, Wrasse sp. occurs in BMB/067b, a site situated close to this species' preferred habitat of near shore rocky or coral reefs. In contrast, the three mound sites all contain Catfish (*Arius* sp.), a species that inhabits estuarine to freshwater areas. This habitat zone would have been prevalent in this area during the formation of these sites. In a similar situation to the exploitation of molluscan resources within the study area, this suggests that, where available, faunal resources were exploited from within the immediate area of each site. Regardless of these differences, there is a general dearth of non-molluscan fauna within these sites, which may relate to differential preservation of this material, or alternatively, may be a reflection of a focus on molluscan resource exploitation in the area. Recovery techniques might also have a bearing on bone density as well, given that these analyses are based on the

6mm sieve residues. As a broad comparison, however, the relative densities of molluscan remains and non-molluscan faunal material in these assemblages conform to those presented for shell deposits investigated in the Darwin region that incorporated the 3mm material (Bourke 2000; Faulkner 2006). These data (Table 4.15) indicate that shell density (t = -0.281, $d.f.$ = 8, $p > 0.5$) and non-molluscan faunal density (t = 0.315, $d.f.$ = 11, $p > 0.5$) are not significantly different between these two regions. Further to this, Morrison (2010:216–7, 278–9, 297–309) and Veitch (1996) also present strong cases based on comparative data for the 6mm sieve material being representative of the broad range and abundance of archaeological material in mound deposits.

Table 4.15: Comparison of density estimates (g/cm^3) of shell and other faunal material from excavated sites on the Point Blane Peninsula and the Darwin region.

	Site Code	Total Excavation Volume (cm^3)	Total Shell Wt (g)	Density (g/cm^3)	Total Non-Mollusc Fauna Wt (g)	Density (g/cm^3)
Point Blane Peninsula	BMB/084	50500	4571.0	0.09051	0.8	0.00002
	BMB/018	220000	3226.8	0.01467	50.2	0.00023
	BMB/067	155000	10624.0	0.06854	48.1	0.00031
	BMB/029	105750	28329.1	0.26789	6.4	0.00006
	BMB/071	62500	28373.2	0.45397	4.9	0.00008
	BMB/045	125000	35163.4	0.28131	9.0	0.00007
Darwin Region	MA7	120000	26380.9	0.21984	29.9	0.00025
	MA1	110000	29037.3	0.26398	1.7	0.00002
	MA10	57500	6976.5	0.12133	1.5	0.00003
	HI83	980000	253288.9	0.25846	110.7	0.00011
	HI81	1600000	536695.7	0.33543	65.1	0.00004
	HI80	1190000	351541.9	0.29541	331.4	0.00028
	HI66	590000	19947.9	0.03381	18.3	0.00003

Source: Bourke 2000.

Following from this point, several researchers (e.g. Walters *et al.* 1987; McNiven 1989; Morrison 2010) have suggested that a lack of vertebrate remains in shell deposits cannot be explained by taphonomic factors alone, but probably reflects a limited range of subsistence activities at a particular site. While the bone and otolith evidence in these sites probably represents an underestimate of their importance due to poor preservation in tropical environments, the above suggestion may still hold true in this case. This is not to say that faunal resources would not have been exploited in this area, but that they may have been less significant in dietary terms, particularly in those locations of higher mollusc exploitation and discard.

As previously noted, there are a number of possible explanations for the relative paucity of stone artefacts, both in general and within the excavated contexts. Bailey (1993:9) has suggested that the rarity of artefacts in shell deposits could be misleading, possibly reflecting higher rates of accumulation in shell midden and mound sites compared with the often slower rate of sediment accumulation in other site types. While this might be the case, the scarcity of artefacts recovered from the excavations is in line with the relatively low numbers recorded during the course of the surface survey. The general pattern of low stone artefact numbers across the study area suggests that there may be another explanation. The alternative argument is that shell middens and/or mounds were used for a limited range of activities as a special-purpose location, for example as a shell-processing site (Meehan 1982; Bailey 1993:9; Cribb 1996:169), with discard of relatively few or a restricted range of artefacts. In the relative absence of other faunal and artefactual material, the focus on molluscan resources in each of the six sites suggests that, in economic

terms, the function of these sites related almost exclusively to the exploitation and discard of shellfish. Therefore, in spite of the differences in formation and morphology of the shell middens and mounds in the study area, both are a manifestation of the same broad type of behaviour: the exploitation of predominantly intertidal resources and the discard of those remains.

That said, the question of explaining the distinct morphological differences between midden and mound sites remains. Following the interpretation of these sites as being primarily discard locations, one possibility is that differences in the size and shape of these sites is a reflection of the differential availability and level of exploitation of particular species. As each of these sites is dominated almost exclusively by molluscan remains, the first step is therefore to evaluate the level of variability in this resource. A close correspondence tends to exist between the species of shells present in middens and mounds, and the molluscan species that are locally available. In general, a midden or mound is indicative of shellfish gathering within the immediate vicinity. Therefore, differences in the types of species being exploited and/or changes in relative abundances through time and space may indicate an alteration in the structure of the foraging economy, particularly relative to changes in the environment.