

1-1-2009

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Recommended Citation

Slack, Michael; Fillios, Melanie; and Fullagar, Richard L.: Aboriginal settlement during the LGM at Brockman, Pilbara Region, Western Australia 2009, 32-39.
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Keywords

Aboriginal, settlement, during, LGM, Brockman, Pilbara, Region, Western, Australia, CAS

Disciplines

Life Sciences | Physical Sciences and Mathematics | Social and Behavioral Sciences

Publication Details

Slack, M., Fillios, M. & Fullagar, R. (2009). Aboriginal settlement during the LGM at Brockman, Pilbara Region, Western Australia. *Archaeology in Oceania*, 44 (Supplement 1), 32-39.

Aboriginal Settlement during the LGM at Brockman, Pilbara Region, Western Australia

MICHAEL SLACK, MELANIE FILLIOS and RICHARD FULLAGAR

Keywords: excavations, refuge, LGM, Brockman, Pilbara

Abstract

This paper describes the results and implications of recent excavations on the Hamersley Iron Brockman 4 tenement, near Tom Price, Western Australia. Results concentrate on two rock shelters with Aboriginal occupation starting at least 32,000 years ago and extending throughout the Last Glacial period. Preliminary observations are proposed concerning the nature of Aboriginal foraging patterns as displayed in the flaked stone and faunal records for the Brockman region.

There are two enduring research questions that have dominated the archaeology of the Pilbara since research commenced in the region some 30 years ago – antiquity and continuity. The antiquity of the Pilbara continues to be important in our developing understandings of the timing and directionality of continental settlement. At the time Steve Brown provided the first synthesis and review of initial archaeological excavations for the Hamersley Plateau (Brown 1987) the oldest radiocarbon date from an archaeological site was 26,300 ± 500 BP (SUA1510) for Newman Rockshelter (P2055.2) (Brown 1987:22, citing Troilett 1982). Despite 20 years of intensive archaeological work (mostly consulting projects including over 50 excavations with more than 100 radiocarbon dates, see Slack 2008), this antiquity has only recently been surpassed with age estimates for excavations at Djadjiling at Hope Downs in the eastern Hamersley Range, indicating possible occupation of at least 35,159 ± 537 years BP (Morse, this issue, Table 1).

Associated with the issue of the timing of Aboriginal Pleistocene occupation of the Pilbara has been the question of whether such occupation endured into times of markedly increased aridity associated with the last glacial period (i.e. OIS2, between about 29,000–15,000 cal. yr BP, see Burroughs 2005:30, 93), and in particular the peak of aridity associated with the Last Glacial Maximum (LGM) when sea levels off northwestern Australia were at their lowest between 22,000 and 19,000 cal. yr BP (Yokoyama *et al.* 2000). The nature of Aboriginal occupation spanning the LGM has, over the last few decades, become a consistent focus for research in the Pilbara region, with the Hamersley and Chichester Ranges proposed as likely refuges (Hiscock

1988; Smith 1987, 1989; Veth 1989, 1993). It is only over the same few decades that research has shown the impact of the LGM on climate to be more severe and at an earlier time than previously thought (and peaking at 21,200 cal. yr BP in the Greenland ice-core isotope stratigraphy see Turney *et al.* 2006 and Barrows and Juggins 2005).

The nature of regional occupation patterns during the revised and extended LGM has been summarised, based on seven specific rockshelter sites in the Pilbara Uplands argued to exhibit refuge occupation during the LGM (see O'Connor and Veth 2006: 33–39) (Figure 1). Of these sites, only Yirra (Veitch *et al.* 2005) and Milly's Cave (Marwick 2002) were said to feature persuasive evidence of LGM occupation. O'Connor and Veth (2006) concur with Marwick (2002) that the five other sites have no unequivocal evidence of LGM occupation. Marwick's analysis found that of these sites the first two, Newman Rockshelter (Troilett 1982) and Newman Orebody XXIX Rockshelter (Maynard 1980), have stratigraphic records and radiocarbon chronologies that suggest, but do not confirm, evidence of human occupation 13,000 to 17,000 years ago [i.e. 15,000–20,000 cal. yr BP¹] (Marwick 2002:23; see also Comtesse 2003). Similarly, evidence of human occupation in this period is regarded as ambiguous. At Mesa J J24 (Hughes and Quartermaine 1992), Malea Rockshelter (McDonald, Hales and Associate 1997) and Manganese Gorge 8 (Veth 1995:736) uncertainties plague interpretations of artefacts and their relationship to carbon dates.

This leaves Yirra and Milly's Cave as the only sites in the Pilbara interior occupied during the LGM. At Yirra, artefacts said to occur between conventional radiocarbon ages of 19,270 ± 140 BP (Wk-8954) (23,440–22,480 cal. yr BP) and 16,950 ± 90 (Wk-9148) BP (20,300–19,889 cal. yr BP) are considered consistent with LGM refuge occupation (Veitch *et al.* 2005:58). However, despite acknowledged unresolved bioturbation problems, with critical dates at the peak, and with little additional information concerning artefact frequencies, the site and local climatic history, it is uncertain whether Yirra was occupied more intensively at the height of the LGM or immediately afterwards.

Marwick's 2002 paper claimed that the site of Milly's Cave provided the only clear indication of human

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1. Radiocarbon calibrations in this article were completed using OxCal v4.0.5, IntCal04.

occupation during the LGM period. We agree, but the recent re-evaluation of the timing of the LGM (Yokoyama *et al.* 2000; Lambeck and Chappell 2001) suggests that this site may have been occupied only sporadically until after the LGM. The lowest radiocarbon determination and artefact frequencies at Milly's Cave could plausibly indicate more intense occupation immediately after the LGM peak, and discard rates underlying this level (between about 21,000 and 30,000 cal. yr BP) are very low (see Marwick 2002:25). We also note that the lower two radiocarbon dates for the site $14,150 \pm 320$ BP (18,024–16,022 cal. yr BP) and $18,750 \pm 460$ BP (23,686–21,075 cal. yr BP) are separated by possibly only 5 cm of deposit. As such, we suggest that the Milly's Cave data provide more compelling evidence of increased occupation towards the end of the LGM, rather than a persistent occupation throughout.

Accepting for the moment that the Hamersley Plateau constituted a refuge for people during periods of extreme regional aridity, then what was the nature of this occupation? Marwick, in reference to Milly's Cave, suggests that territorial ranges reduced in area. O'Connor and Veth consider more generally that retraction into and within the ranges occurred, but that differences in relation to local catchments would be evident, ranging from complete abandonment through to increased use (O'Connor and Veth 2006:41).

A significant hindrance to understanding the utilization of refuge areas before, during and after the LGM lies in the dearth of evidence for subsistence. Foremost among the evidence needed are systematically analysed organic remains in conjunction with flaked stone. Edwards and O'Connell (1995) discussed the shift toward broad spectrum diets at the terminal Pleistocene, yet true understanding of the phenomenon has yet to be achieved, primarily due to the precious few excavated sites with evidence of occupation that includes not just flaked stone, but faunal (and flora) remains.

There is now solid evidence of Pilbara occupation during and prior to the LGM, but cultural remains are limited to a few excavated, and fewer still, published sites. Sites with evidence of early occupation, such as Newman Rockshelter, Newman Orebody XXIX Shelter, Malea Rockshelter and Milly's Cave offer little in the way of faunal material. Faunal remains were preserved at Malea (Edwards and Murphy 2003), but thus far the published information consists of little more than a species list accompanied by the statement that the assemblage is highly fragmented (Edwards and Murphy 2003:45). At Malea, faunal material was not recovered from every excavation unit, but confined to the upper 16 units. Edwards and Murphy argue that this occurrence is likely due to preservational factors, not true absence. Work at Malea has since been renewed, and we are currently awaiting analyses which we hope will supply much needed data to bolster our understanding of subsistence and settlement in the area. Faunal remains were also preserved at Marillana A, although discussion is limited to a quantitative analysis of density per stratigraphic unit (Marwick 2005:1363-4).

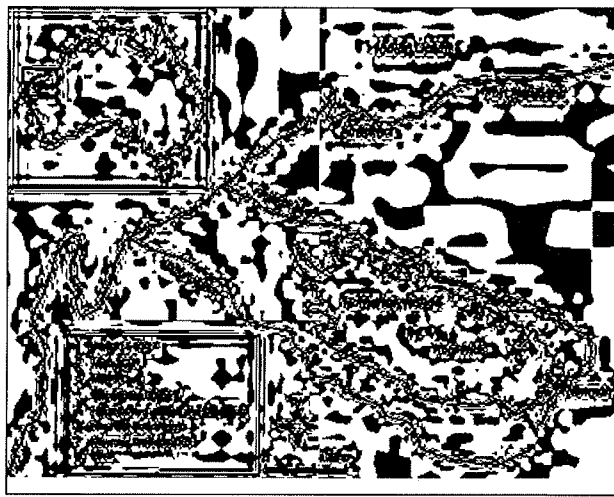


Figure 1. The Hamersley Range area with sites discussed.

Faunal remains at Newman Orebody XXIX are limited to one macropod molar in the top excavation unit (Maynard 1980:5), while data are absent from Newman Rockshelter and Milly's Cave (Marwick 2003). The absence of faunal data in the Pilbara is a significant hindrance to our understanding of refuge areas, as well as early Aboriginal subsistence as a whole.

We report here new sites in the region with the potential to provide important subsistence data and more robust frameworks concerning of Aboriginal settlement in the Hamersley Plateau during the LGM.

Excavations at Brockman 4, Hamersley Plateau

Recently Scarp Archaeology completed a series of excavations within the Rio Tinto Brockman 4 mining tenement, located in the Western Pilbara approximately 60 km west of the town of Tom Price. The results of excavations at two particular sites: Juukan-1 and Juukan-2 provide further substantiation of a regional antiquity of occupation of over 30,000 years, and compelling evidence that occupation persisted even during the height of the LGM (22,000–19,000 cal. yr BP). These results are interesting, and somewhat surprising given the location of Brockman well within the central Hamersley Plateau and over 75 km north of the nearest substantial watercourse (albeit ephemeral), the Ashburton River.

Both Juukan-1 and Juukan-2 are located within a small ironstone gorge, near to a small ephemeral watercourse known as Purlykunti Creek (Figure 2). Three other rockshelter sites occur within this gorge, however all feature very recent occupation sequences. Below the gorge on an extensive floodplain a very large open artefact scatter also occurs. It is thought that the dominant stone raw materials including ironstone, chert, quartz and siltstone are all available from the creek at and near to the open scatter.



Figure 2. Juukan gorge looking towards Purlykunti Creek

Juukan-1

Juukan-1 is a south facing ironstone rockshelter approximately 25 m width, 8 m deep, and has a dripline about 10 m high. The site features a higher collapsing rear chamber and an open entrance area set at a slightly lower level with a lot of roof fall separating the two areas. The floor of the rear chamber consists of soft sediment that slopes down from the rear. Flaked stone material was recorded along the front of the site, particularly in the western end of the shelter.

During August 2008 a single 1x1 m test pit was excavated in the front chamber of the rockshelter. Excavations reached a depth of 75 cm below the surface where a level of solid roof fall or bedrock was encountered. The stratigraphy of the test pit consisted of three main layers: a topsoil of loose material overlying brown/grey compacted sediment with many organic finds, which in turn overlies a horizon of orange/brown. A small pink/white lens of soft chalky material was also noted at a depth of approximately 40 to 50 cm below the surface, as were small lenses of charcoal (Figure 3).

A series of three radiocarbon determinations show that discard of cultural material occurred at Juukan-1 from as early as $32,950 \pm 270$ BP (conventional radiocarbon age) (Beta-249759) at a depth of 60 cm. Until 35 cm below the surface, which is dated to $26,640 \pm 160$ BP (conventional radiocarbon age) (Beta-249758), sediment accumulation and artefact discard were slow. From this point however, a generally more rapid accumulation rate is proposed extending to recent times with a near surface age determination of 760 ± 40 BP (conventional radiocarbon age) (Beta-249757) (740–660 cal. yr BP).

A total of thirty two stone artefacts were recovered from Juukan-1. The majority of these occurred in spits 1 and 2, with only individual artefacts recorded in lower spits. The lowest artefact recovered from the site however was found in spit 14 at a depth of approximately 70 cm, underlying the date of 32,920 years BP. All of the flaked stone was recorded in the far south eastern corner of the test square, and it is likely that further planned extensions to the excavations will provide a greater assemblage size.

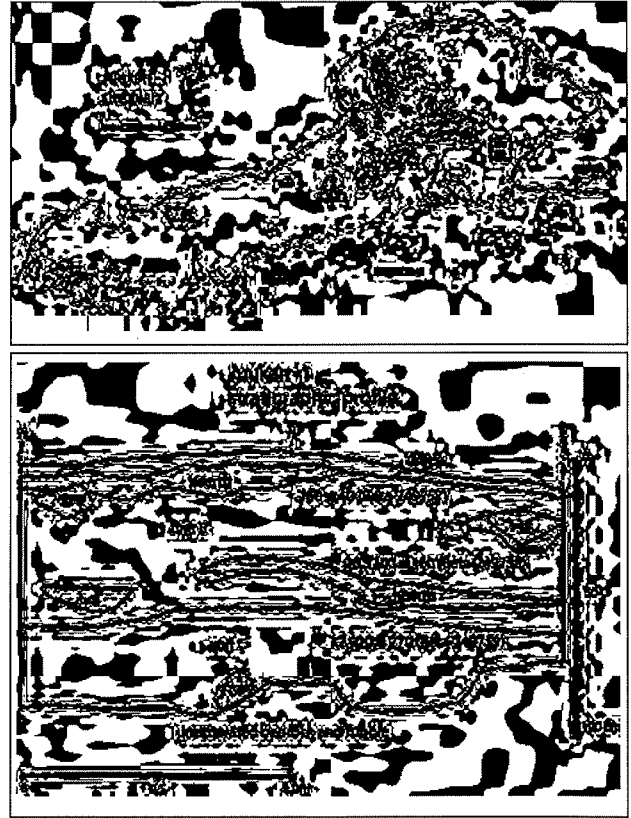


Figure 3. Site plan and stratigraphic profile drawings of Juukan-1.

In addition to flaked stone, a total of 67 fragments of animal bone were recovered, of which 57 were identifiable. Species identified included bandicoot, kangaroo, wallaroo, native mouse, rat and one fish fragment (Table 1). Animal bone from small to large species was recovered from most spits, with the exception of spit 9, with the majority of the bone belonging to medium-large macropods. Overall faunal density is consistently small, with the exception of spit 12, in which nearly 50% of the recovered bone was found (Figure 4). All bone is highly fragmented with long bone shaft fragments accounting for 66% of the bone recovered, followed by teeth (9%) (Figure 5).

Species	Common name	NISP	% Total NISP
<i>Macropus rufus</i>	Red kangaroo	13	23%
<i>Macropus robustus</i>	Common wallaroo	40	70%
<i>Isodoodon</i> sp.	Bandicoot	1	<2%
<i>Pseudomys</i> sp.	Native mouse	1	<2%
<i>Rattus</i> sp.	Native rat	1	<2%
Fish	Fish	1	<2%
Total NISP		57	

Table 1. Juukan-1 Species Frequency

A total of nine fragments of bone are burned, two of which are calcined, suggesting deposition in fire for longer

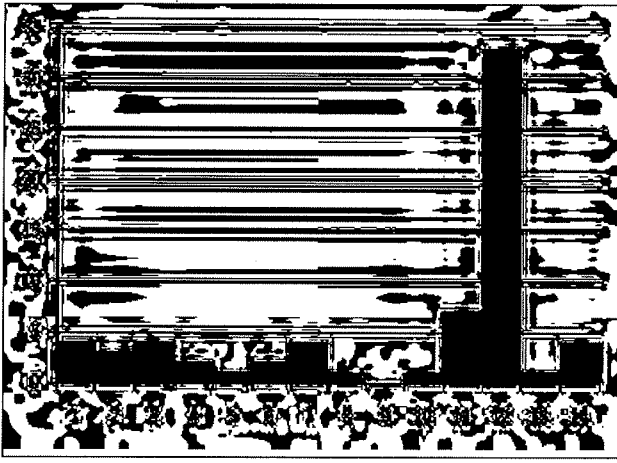


Figure 4. Juukan-1 Faunal density by excavation unit (NISP).

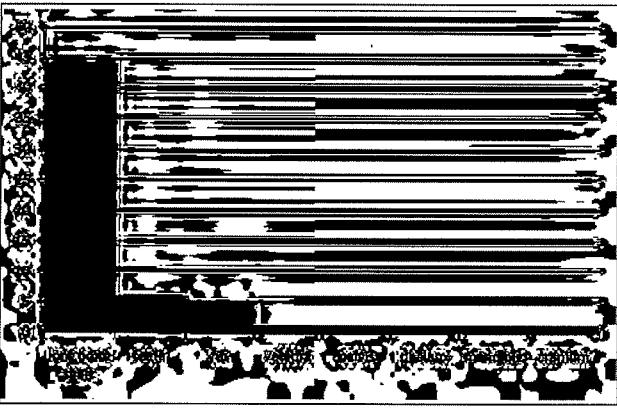


Figure 5. Juukan-1 Skeletal Element Frequency (NISP).

periods of time. In addition to burning, taphonomic analyses reveal several specimens with evidence of heavy mineralization, potentially suggestive of greater time depth. Bone from Juukan-1 is unweathered with no obvious post-depositional surface modifications, suggesting the faunal assemblage is an *in situ* deposit with rapid burial.

The frequency of long bone shaft fragments, coupled with the high degree of fragmentation in the faunal assemblage is suggestive of either human or carnivore activity. However, given the absence of animal gnaw marks on the surviving bone, coupled with evidence of burning from fire, humans are considered the most likely accumulator in this assemblage. Given the small sample size, it is difficult to draw conclusions concerning changes in species utilization and/or frequency diachronically. However, the extant faunal evidence suggests both species and element frequencies remain constant throughout the spits containing bone, showing no obvious signs of diachronic change. Additionally, the highest frequency of bone occurs in spit 12, associated with the oldest date (and possibly) with the oldest artefact, providing even clearer evidence for early occupation.

Juukan-2

Juukan-2 is a large cavernous rockshelter located 50 m to the west of Juukan-1. The site consists of two south-facing chambers; a large western chamber with very deep sediment and cathedral-like roof height, and a lesser eastern chamber which is small and largely unprotected with a bare rock floor. The main chamber is 10 m wide, 10 m deep and has a height at the dripline of about 8 m. There are three general areas to the main chamber; a scoured and rocky area with some plants in the western side where a hole in the roof has allows rainfall to enter, a main central area where large roof fall at the front has aided in trapping extensive sediment, and a raised area at the eastern rear of the site where bedrock is higher than other areas and where sediment deposition is minimal.

Like Juukan-1 a single 1 x 1 m test pit was excavated in 2008. The excavations consisted of 21, 5 cm spits that were concluded at a depth approximately 1.05 m below the surface, where large pieces of roof fall stopped any further excavation. Five stratigraphic units were recorded within the deposit, largely related to the changes in ironstone weathering and minerals (Figure 5). At least five hearths were also noted. A high frequency of flaked stone and animal bones were also recovered.

Three carbon samples from spits 2, 12 and 17 returned dates of 470 ± 40 years BP (Beta-247330) (540–490 cal. yr BP), $16,160 \pm 80$ years BP (Beta-247331) (19,490–19,080 cal. yr BP) and $20,090 \pm 100$ years BP (Beta-247332). The lowest date of 20,090 years BP was obtained using AMS techniques and is derived from a depth of 85 cm below the surface. This date represents neither the level of the lowest artefacts or a basal date for the site. It is likely that the deposit of Juukan-2 might be up to 0.5 m deeper than our excavations.

A total of 272 flaked stone artefacts were recovered from the test pit excavation. Artefacts were noted in all but spit 16 of the excavation, with the lowest recorded in spit 18 (at a depth of 90 cm), below the lowest age determination of 20,090 years BP. The assemblage is dominated by unmodified flakes (95.2%), with few retouched flakes (4.4%) and even fewer cores (0.4%). Retouched artefacts are chiefly comprised of chert ($n = 8$), and ironstone ($n = 4$).

The rates of discard for the flaked stone assemblage are low, but remain steady throughout the period of occupation, until spit 4 at approximately 5000 years BP where discard increases fourfold (Figure 6). Although limited by the sample size, there does not appear to be evidence of a hiatus in occupation or sedimentation at the site before, during and after the LGM peak.

Analysis of raw material richness and diversity of artefacts shows that the assemblage is comprised of five types of stone; ironstone, chert, quartz, chalcedony and siltstone. Chert and quartz dominate the assemblage (55.9% and 29%) with lesser amounts of ironstone (13.6%), chalcedony (1.1%) and siltstone (0.4%). Interestingly ironstone is as dominant a raw material in the lower spits as chert and quartz until the aforementioned massive increase in discard from 5000 years BP onwards. The first retouch in

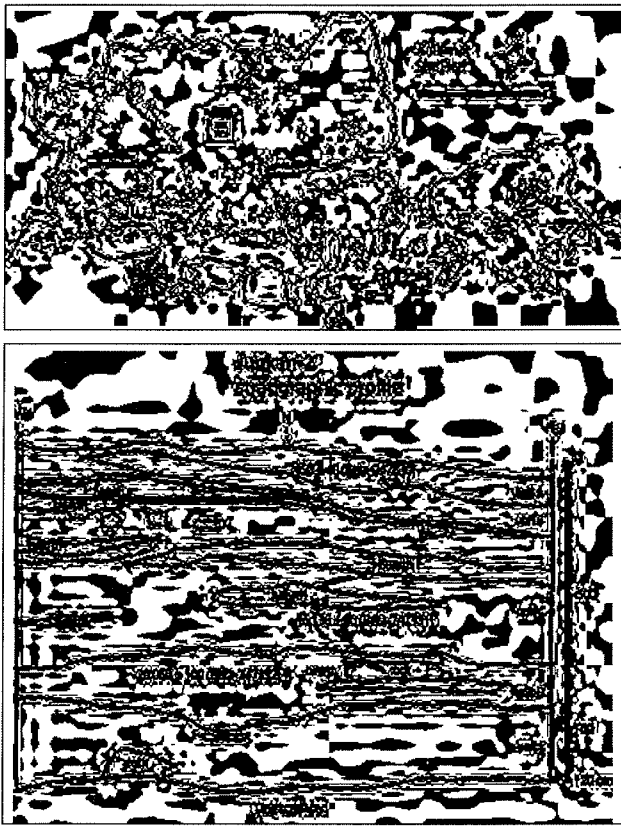


Figure 6. Plan and section drawing of Juukan-2.

the assemblage occurs in spit 14 at about 19,000 years BP, with a sharp peak occurring in spit 5 at about 7000 years BP where the first evidence of backing occurs.

The rate of fragmentation of flakes shows dominance of complete flakes (81.9% $n = 222$), with far lesser quantities of broken flakes – distal account for 7.7% ($n = 21$), proximal for 5.2% ($n = 14$) and medial for 4.1% ($n = 11$). The ratio of broken to complete flakes is very low until spit 3 at about 4000 years BP where complete flakes account for just 65.2% ($n = 43$) and broken flakes total 34.8% ($n = 23$). This is most likely the result of treadage, with more intensive use of the shelter proposed at this time during the Mid-Holocene El Nino arid phase experienced in Northern Australia.

Up until the mid Holocene, the assemblage is dominated by ironstone flakes. These are generally heavier and have a greater size range especially during the periods between about 15,000 and 5000 BP. After 5000 BP, chert is the dominant raw material and the average weight of flakes is much less than 1 g. Retouched flakes are generally heavier than unmodified flakes, and in the case of ironstone, significantly so.

The relationships between the size of complete flakes and the extent of their reduction is further supported by analysis of the amount of cortical surface still present on the dorsal surface of the flake. This analysis shows that ironstone flakes are far more likely than chert to have more cortex, indicating that they have been less reduced. Additionally both chert and quartz flakes are far more likely than

ironstone flakes to have smaller and more reduced platforms, as evidenced by single and multiple flake scar platforms.

In addition to the flaked stone, 857 fragments of animal bone were recovered from Juukan-2. A wide variety of species is present, with small species (native rats/mice, lizard, snake) comprising the majority of the recovered specimens (61%, NISP = 523). Medium-large macropods (kangaroo, wallaby) comprise 30% (NISP = 255), and the assemblage is rounded out by fish and bird fragments. Species identified include: Red kangaroo, common wallaroo, bandicoot, possum, pygmy possum, echidna, bettong, native mouse, rat, gekko, skink, small bird and fish (Table 2), with bone recovered from nearly every spit (Figure 8).

Species	Common name	NISP	% Total NISP
<i>Macropus rufus</i>	Red kangaroo	68	18%
<i>Macropus robustus</i>	Common wallaroo	143	38%
<i>Isoodon</i> sp./ <i>Perameles</i> sp.	Bandicoot	9	2%
<i>Trichosurus vulpeculal.</i> <i>Pseudocheirus</i> sp.	Possum	5	1%
<i>Cercartetus</i> sp.	Pygmy possum	2	<1%
<i>Tachyglossus aculeatus</i>	Echidna	9	2%
<i>Bettongia lesueur</i>	Bettong (boodie)	3	<1%
<i>Antechinus</i> sp./ <i>Pseudomys</i> sp.	Native mouse	37	10%
<i>Hydromys</i> sp./ <i>Rattus</i> sp.	Native rat	89	24%
<i>Gekkonidae</i> sp./ <i>Scincidae</i> sp.	Gekko Skink	8	2%
<i>Aves</i> sp.	Bird	2	<1%
Fish	Fish	1	<1%
Total NISP		376	

Table 2. Juukan-2 species frequency.

All major skeletal elements are represented in the assemblage, with long bone shaft fragments contributing the highest number of fragments (NISP = 120). Differences in element frequency are present, however, between smaller and larger species. Elements belonging to smaller species are dominated by limb bones and are largely unfragmented, with a large proportion of complete skeletal elements. The most frequently occurring elements are teeth and vertebra, respectively. In contrast, bone belonging to medium-large individuals is highly fragmented and heavily weighted toward long bone shaft fragments (Figure 9). There is however, a relative paucity of macropod lower limb elements which can likely be accounted for by the long bone shaft fragments. Teeth from medium-large macropods show a mixture of tooth wear stages ranging from unworn to extremely worn, suggesting a mixture of young and old individuals.

Seven percent (NISP = 61) of the assemblage shows evidence of burning, with a third (NISP = 18) of these being calcined, suggesting deposition in fire for longer periods of time in a defleshed state. Burned bone belongs to a range of



Figure 7. Graph of flaked stone artefact discard at Juukan-2.

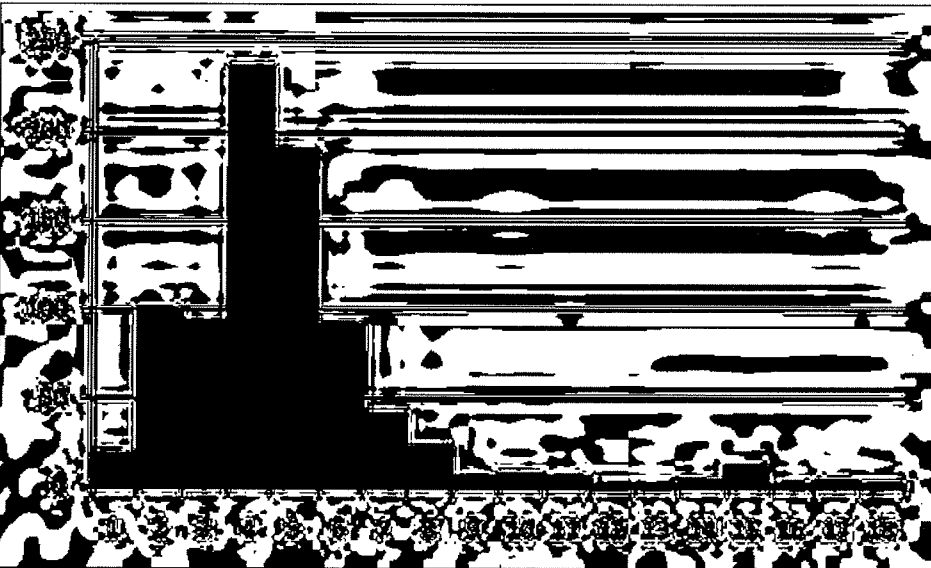


Figure 8. Juukan-2 Faunal density by excavation unit (spit).



Figure 9. Juukan-2 Skeletal Element Representation (NISP).

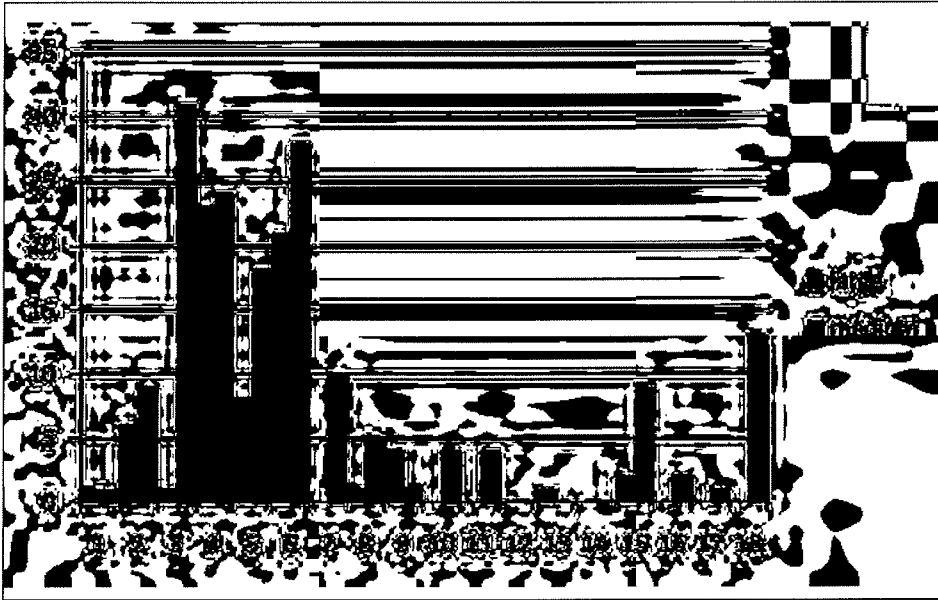


Figure 10, Juukan-2 Frequency of large vs. medium macropods by excavation unit (NISP).

species, and is not confined to any one class of individual. In addition to burning, five specimens show evidence of tooth marks, and five fragments from spit 15 have possible cut marks, including a kangaroo sacrum, pelvis and long bone shaft fragment. Taphonomic analysis suggests the faunal assemblage represents an in situ deposit with rapid burial, as the bone is unweathered and there is no physical evidence on the bone surfaces for either aeolian or fluvial transport.

At Juukan-2 analysis of the fauna may provide important diachronic information on subsistence strategies in the region. While the majority of species and skeletal element distributions appear to remain consistent through time, medium macropods (wallaroos) were more common at the beginning of occupation, while the frequency of large macropods (kangaroos) increases toward the end of the occupation (Figure 10). It is likely that the macropod presence is a cultural rather than natural accumulation, as burned and calcined bone, taken in conjunction with evidence for hearths, suggests people were likely responsible for some of the faunal accumulation. Heavy fragmentation of macropod lower limb bones also supports a primary human role in the accumulation, as do possible cut marks. The presence of bone from less common species such as echidna and fish lends further weight to the notion of people as bone accumulators. Preserved faunal remains are rare in rockshelters, and further faunal analysis at sites in which bone is present has the potential to contribute significant information regarding species exploitation in the Pilbara for which there is a severe dearth of published data.

Discussion

The results of our excavations at Brockman provide important new information concerning the prehistory of the Pilbara. First, our data provide further support for early

occupation of beyond 35,000 BP. Second, the cultural sequence at Juukan-2 indicates a continual, albeit infrequent, occupation of the Brockman region during OIS 2, and even at the height of the LGM.

In terms of hunter gatherer landscape use, our analysis of the data is limited by sample size, however a number of observations and hypotheses are suggested. That these two rockshelters have evidence that people had been in this area of the Hamersley during the LGM indicates that a local population may have actually been more residentially mobile during enhanced aridity than what we might expect, given the dominant refuge models and their previous application to the Pilbara (but see Veth 2005:101). It is clear that people were not just retreating into gorges on the margins of the ranges near to the main river courses, but that a more complex use of the landscape, perhaps following local weather patterns and allowing access to the less drained areas occurred. Further to this we consider that it is likely that with greater rainfall after the LGM residential mobility decreased. This would explain the greater levels of discard at Brockman, the increase in the density of faunal remains at Juukan-2 in the later phases of occupation, and also those trends observed in the flaked stone by Marwick at Milly's Cave (2002:29). However at Brockman, during periods of greater rainfall, we think it possible that while residential mobility decreased, logistical mobility increased (at least on a local level). This is suggested by the greater range of raw materials and larger sizes of flaked stone during the last few thousand years of the Pleistocene and up to the middle of the Holocene. Also apparent is that the intensity of reduction and frequency of artefact discard increased slightly in the mid and late Holocene. Behavioural implications suggested by the faunal remains provide additional support for the increase in occupation during later periods (however, the fauna also show that both Juukan-1 and Juukan-2 were used continually in all periods). Given

the results of other excavations within the region that all date to this period, this trend is likely to be related to increased population levels – as suggested by Marwick (2002).

Conclusion

The results of this ongoing project further emphasise that the archaeology of the Pilbara region will continue to play an important role in developing our understandings of the timing of arid settlement, and the nature of hunter gatherer subsistence during periods of uncertainty like the LGM. Further excavations at Brockman will focus on these issues and with hopefully greater sample sizes obtained, on the nature of technological innovation and its relationship to mobility in such a marginal landscape over such a long period of time.

Acknowledgements

This project would not have been possible without the tireless work of the following people from the Puuntu Kunti Kurruma and Pinnikura and Scarp Archaeology who were involved in the excavation and analysis of the Juukan sites; Harold Ashburton, Corbett Ashburton, Charleston Ashburton, Jimmy Ashburton, John Ashburton, Lenny Ashburton, Kate Connell, Burchell Hayes, Arness James, Robert James McKay, and Sarah Robertson. We would like to thank Rio Tinto Iron Ore, particularly Ed Clarke, Merv Lockyear, Jason Masters and Amy Stevens. We also acknowledge the support of Pilbara Native Title Services.

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