

KABADUL KULA

and the Antiquity of Torres Strait Rock Art

Ian J. McNiven¹, Liam M. Brady² and Anthony J. Barham³

Abstract

Excavations directly below a painted panel at Kabadul Kula rock art site on the island of Dauan, northern Torres Strait, revealed buried fragments of ochre pigment to a depth of 59cm. A series of AMS ¹⁴C dates indicate that most of the ochres and all pieces of faceted ochre were deposited between 1200 and 1400 years ago. Located in a moist tropical environment where the potential for erosion and bioturbation is high, the stratigraphic integrity of the deposit was tested by micromorphological analysis of sediments. Assessment of vertical changes in the size of stone artefacts and sediment particle sizes suggest strongly that this restricted timeframe for ochre use is reliable and not a taphonomic illusion created by post-depositional disturbance. These *in situ* ochres are associated with an early phase of painting at the site and represent the oldest dates currently available for Torres Strait rock art.

Introduction

During the past decade major advances have been made in documenting the form, distribution and meaning of Torres Strait rock art (e.g. Brady 2005, 2006, 2007, 2008; Brady and Kaurareg Aboriginal Community 2007; Brady *et al.* 2003, 2004; David *et al.* 2001, 2003, 2004a; McNiven and David 2004; McNiven *et al.* 2000, 2002, 2004) (Figure 1). While over the same time period understandings of the human history of the archipelago have been pushed back to 9000 years ago (David *et al.* 2004b) and marine specialisation back to 4000 years ago (Crouch *et al.* 2007; McNiven *et al.* 2006), insights into the antiquity of the region's rock art have been less forthcoming. As Brady (2007:112) points out, developing a regional rock art chronology is necessary 'to understand how rock-art from Torres Strait fits into the occupational trends already established' for the region.

Until now, inferences of the antiquity of Torres Strait rock art have been based on two approaches. First, general comments have been made on the likely recent age of much of the region's rock paintings given poor preservation conditions. For example, Brady and Kaurareg Aboriginal Community (2007:21, 24) posit that given the 'harsh coastal climate of the Torres Strait region' it is likely that most of the known rock art sites of southwest Torres Strait date only to the past 'few hundred years'. Second, McNiven and David (2004:221) advocate that a fruitful avenue would be 'indirect dating by excavation of in-situ ochres beneath paintings'. This approach was first applied to Turao Kula site on the island of Mua, where charcoal associated with a small patch of red ochre powder excavated from XU3 at a depth of 1.7–4.6cm below the surface dated to 325±61 BP (Wk-9943) (David *et al.*

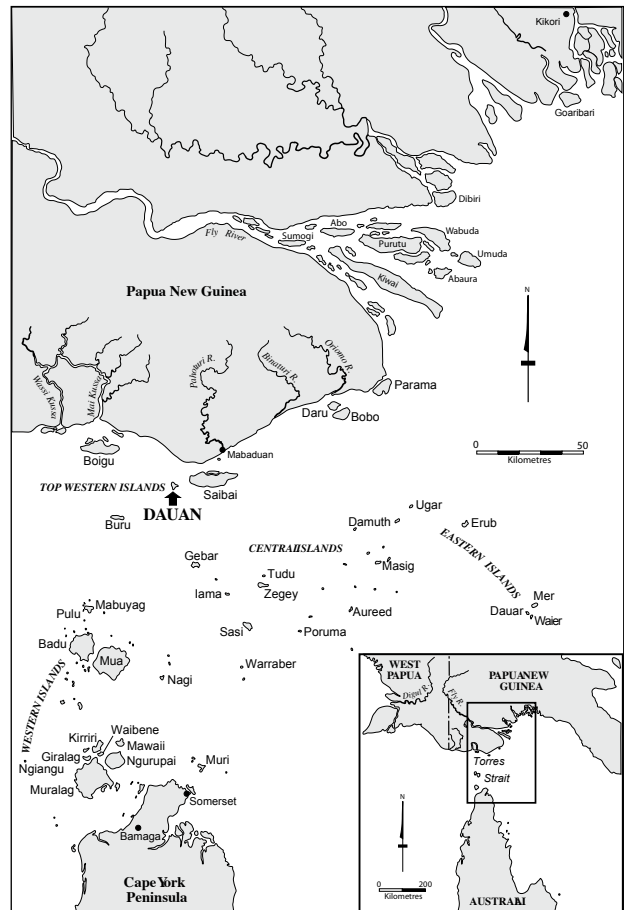


Figure 1 Torres Strait.

2004a). As the powdered ochre was the only ochre excavated from the pit and was 'of the same colour as the paintings' located above, David *et al.* (2004a:168) suggest the buried ochre relates to the paintings and that both date to somewhere between AD 1400 and 1850. The inferred recent antiquity for those paintings is consistent with oral history for the site. Similarly, McNiven *et al.* (2008) suggest that a major peak in *in situ* ochre in the upper levels of Tigershark Rockshelter on Pulu islet dated c.500–700 years ago most likely corresponds to the period of rock art production at the site. Until now, Tigershark Rockshelter was the earliest date available for Torres Strait rock art.

In this paper, we explore further the use of excavated *in situ* ochre to provide insights into the antiquity of Torres Strait rock art. The focus of our research is Kabadul Kula rock art site located on the island of Dauan in northern Torres Strait 10km south of the Papua New Guinea coast (Figure 1). Kabadul Kula is the most comprehensively-recorded rock art site in Torres Strait and the place where the process of computer enhancement of digital photographs of faded rock paintings was first applied and developed for the region (Beckett 1963; David *et al.* 2001, 2003; Laade 1971:xxi; Lawrie 1970:143-147; McNiven *et al.* 2000, 2002, 2004; Vanderwal 1973:182). Our excavations follow

¹ Programme for Australian Indigenous Archaeology, School of Geography and Environmental Science, Monash University, Clayton, VIC 3800, Australia. Ian.McNiven@arts.monash.edu.au

² Archaeology, M405, School of Social and Cultural Studies, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia. lbrady@cyllene.uwa.edu.au

³ School of Archaeology and Anthropology, Australian National University, Canberra, ACT 0200, Australia. anthony.barham@anu.edu.au

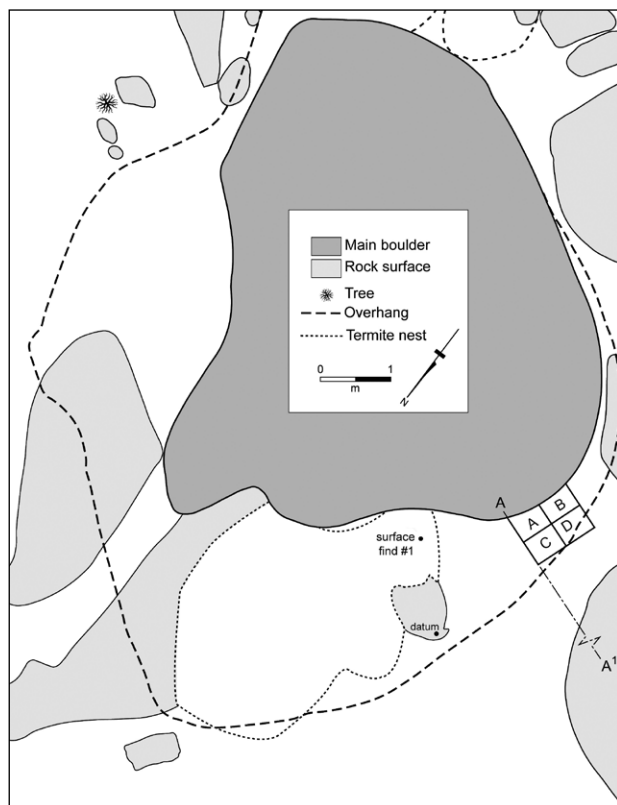


Figure 2 Plan of Kabadul Kula.

a recommendation by McNiven *et al.* (2004:248) that further insights into the antiquity of rock art at the site will require 'highly controlled and fine-grained excavation of archaeological sediments below the paintings and date layers containing spalls with paint and/or lumps of ochre'. However, as a method of dating rock art, the *in situ* ochre technique is premised on a series of assumptions with associated limitations. As the following discussion reveals, recognition and acknowledgement of these limitations allows identification of conditions that need to be met to increase the plausibility and strength of inferences concerning the age of associated rock paintings.

In Situ Ochre and Rock Art Dating

The *in situ* ochre technique is an established method of providing indirect insights into the age of rock paintings (Keyser 2001:118-119; McDonald 2006:77; Morwood 2002:128-130). The technique is based on the plausible assumption that as rock paintings are created, associated ochre pigments will be left behind on the ground surface below and eventually buried and incorporated into stratified archaeological deposits. If these surface ochre fragments are buried with charcoal or other datable materials of similar age, then dating of these materials can provide an estimate of the timing of ochre deposition and hence rock art production. Relatively fast net sediment accumulation will serve to maintain such contextual association. A slowing of net sediment accumulation or stillstands with pedogenesis will serve to progressively complicate the time-discard component associations, especially if sediment upcast or vertical mixing by invertebrates is an important process at the site (Canti 2003, 2006; Morin 2006; Stein 1983). A further complicating factor is that *in situ* ochres may also be associated with painting movable artefacts and even human bodies (Chippindale and Taçon

1998:101; Flood and Horsfall 1986:27; Smith *et al.* 1998:280). As such, the question arises as to whether dated *in situ* ochres are providing insights into a painted rock surface (i.e. rock art) and/or painted objects. Thus, the link between *in situ* ochres and rock art in archaeological contexts is not straightforward.

Despite assumptions and potential limitations of the *in situ* ochre dating technique, it has been used to provide chronological parameters for Australian Aboriginal rock art (e.g. Attenbrow *et al.* 1995:116; Cole *et al.* 1995:154; David 2002:192; David *et al.* 1994; Macintosh 1965:97; McDonald 2008; Rosenfeld and Smith 2002:117-118; Smith and Ross 2008:56-57; Smith *et al.* 1998:280). Recently, McDonald and Veth (2008; see also Veth *et al.* 2001:15) provided case studies from the Western Desert where partial overlaps in chronology for *in situ* ochres and direct AMS dates on rock paintings provided some empirical verification for the reliability of dated *in situ* ochres as an indirect indicator of the antiquity of associated rock art.

The likelihood that *in situ* ochres were associated with the production of rock art can be increased considerably if the following six conditions are met. First, the *in situ* ochres are excavated from sediments located directly beneath panels of rock art (e.g. David and Lourandos 1999:113; Smith *et al.* 1998:280). Second, the *in situ* ochres are the same as ochres used in the rock art (e.g. based on geochemical fingerprinting) (e.g. Clottes and Courtin 1996:165; O'Connor and Fankhauser 2001; cf. Bednarik 2007:120; d'Errico and Vilhena Vialou 2007:188). Third, the *in situ* ochres are associated with fragments of rock art that broke away from adjacent panels (e.g. David *et al.* 1990; O'Connor and Fankhauser 2001). Fourth, the *in situ* ochres are temporally restricted to a narrow timeframe (or a low number of frequency peaks), thus narrowing options for the timing of rock art and decreasing the chances of *in situ* ochres dating other forms of painting activity (e.g. David and Chant 1995:385; Morwood and Dagg 1995). For example, if *in situ* ochres span thousands of years, it is difficult to know whether or not rock art production dates to all or only part of this time span. Fifth, the narrow timeframe and associated ochre concentration/peak is not a sedimentary consequence of selective erosion of sedimentary matrix in the form of a lag deposit of ochre or a remnant ochre deposit created by decay and/or erosion of ochres from surrounding levels (cf. Hiscock 2008:254; McDonald 2008:128). Sixth, any concentration of ochre (or other coarse clastic materials such as lithic artefacts) is not an artefact of post-depositional disturbance or fine sediment upcasting by microfauna (e.g. as coarse clastic 'stone lines' created 10-20cm below surface by bioturbation) (Binet and Le Bayon 1999; Brown *et al.* 2004; Canti 2003, 2006:114-115; Darwin 1881; Madge 1969). These six conditions guide our analysis of *in situ* ochres at Kabadul Kula.

Kabadul Kula

Kabadul Kula is located on the northeast coast of Dauan approximately 30m from the sea (Figures 2-4). It is a large granite boulder with a maximum length of 8m and maximum height of 5.5m. Paintings are located across two panels spanning the lower sections of the northern and northwestern faces of the boulder (see Brady 2005:131-154; McNiven *et al.* 2004 for details). A low density scatter of stone artefacts and marine shells occurs across the ground surface fronting the painted panels. The ground surface at the base of the boulder and painted panels lies within

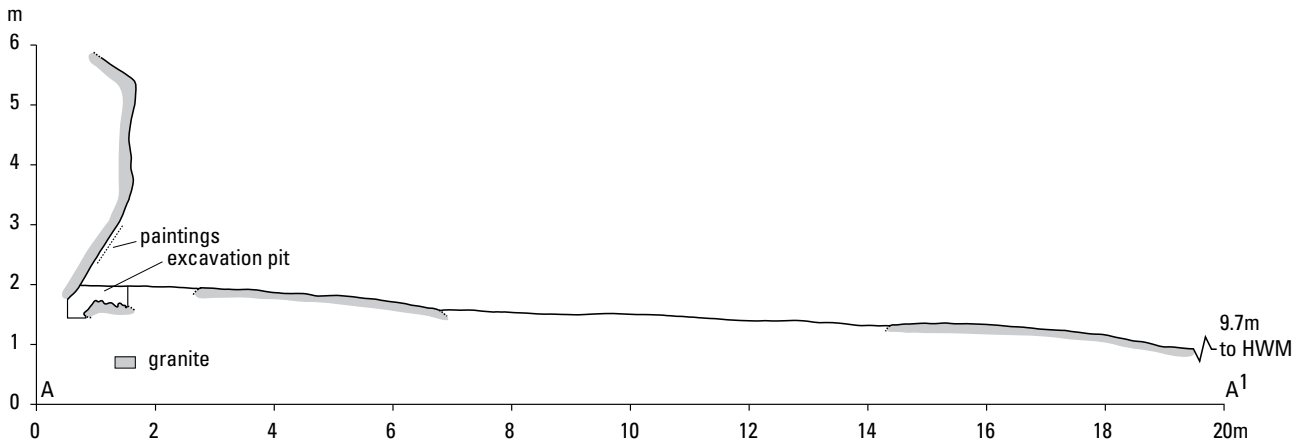


Figure 3 Cross-section of Kabadul Kula.



Figure 4 Kabadul Kula after excavation and before removal of termite nest, looking southeast, 17 November 2007. Scale in 10cm units (Photograph: Ian J. McNiven).

2–3m of Highest Astronomical Tides (HAT). The northern side of the boulder exhibits a large termite nest that is slowly advancing up the boulder wall and in some places is covering paintings. Long grass up to 2m high surrounds the site.

McNiven *et al.* (2004) report 44 paintings at the site, all made using red ochre paint. Key paintings include a *dogai* female spirit being (anthropomorph), an anthropomorph with a turtleshell headdress, a row of dancing anthropomorphs, a crayfish, a fish/dugong, canoes, and various geometrics. Many paintings only became clear after computer enhancement. Subsequent rerecording of the site using a more powerful camera revealed additional heavily deteriorated images, increasing the total number of paintings at the site to 47 (Brady 2005:134).

Local oral history associates Kabadul Kula with a group of Papuan raiders from Kiwai Island to the east who stopped at the site and executed paintings before launching an attack on the nearby village and killing and decapitating many Dauanalg (people of Dauan) (see Lawrie 1970:143–147 for details). The raiders attacked the Dauanalg as punishment for eating a pig loaned to them from villagers on the adjacent mainland of Papua New Guinea. As differences in weathering and superimposition of paintings indicate at least two phases of painting, McNiven *et al.* (2004:248–249) conclude that Kabadul Kula includes more phases of painting than just those created by the Kiwai raiders. Since oral history does not mention subsequent painting events at Kabadul Kula, McNiven *et al.* (2004:248) hypothesise further

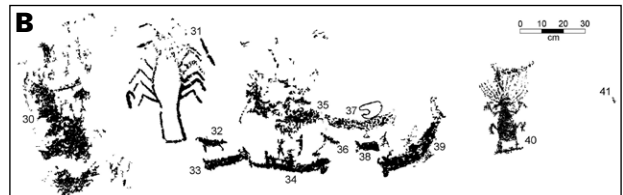
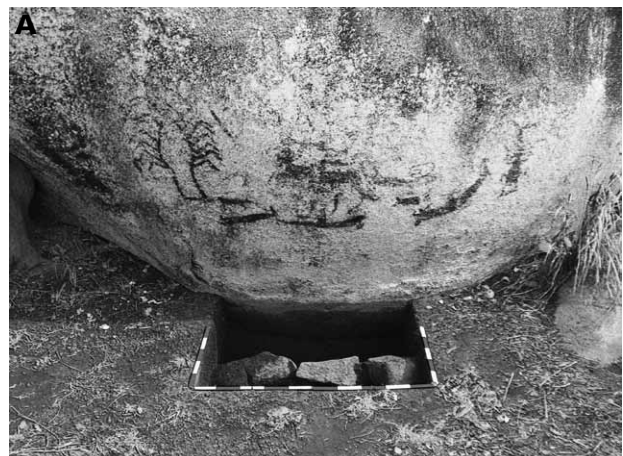


Figure 5 (A) Computer-enhanced photograph of northwest rock art panel at Kabadul Kula showing excavation pit with alignment of three granite boulders (Photograph: Ian J. McNiven). (B) Drawing of paintings based on computer enhancements (from McNiven *et al.* 2004:Figure 6).

that the Kiwai raiders may have been the last painters at the site whereupon they ‘inscribed their own symbols onto an already marked rock in the Dauan landscape’. That is, while the most recent painting phase represents that of the Kiwai raiders, earlier phases of painting also exist at Kabadul Kula.

In November 2007 we carried out excavations at the site in an attempt to obtain buried fragments of ochre associated with datable charcoal that could shed further light on the age of paintings. The excavations were undertaken in conjunction with a project funded by the Department of the Environment and Water Resources through its National Indigenous Heritage Program to remove the large termite nest and help restore sections of the northern painted panel covered by termite nest in recent years. Technical aspects of the conservation work were directed by Andrew Thorn (2008). Our work at Kabadul Kula represents a partnership research project with the people of Dauan.

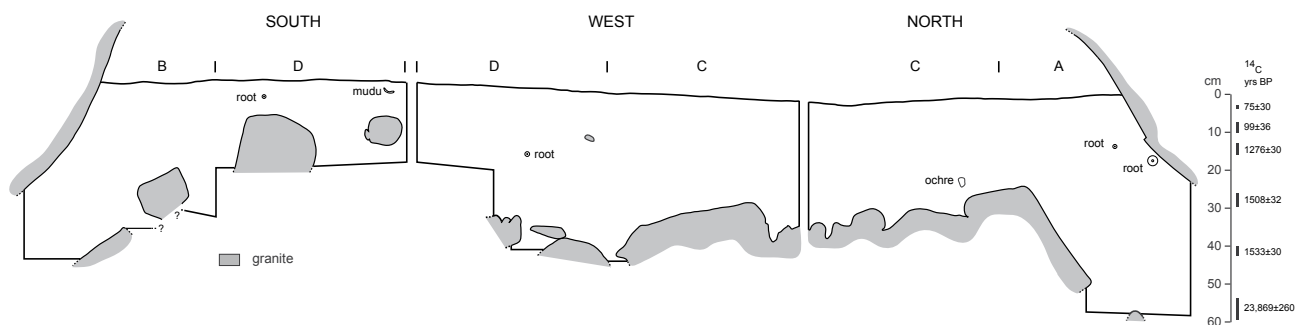


Figure 6 Stratigraphy of Squares A, B, C and D, Kabadul Kula.

Excavation

The excavation pit was positioned against the northwest rock art panel to avoid termite-disturbed deposits fronting the northern rock art panel (Figures 2-5). The 1m x 1m excavation pit was divided into four 50cm x 50cm Squares (A to D) with Squares A and B located against the rock wall of the shelter. Excavation was undertaken using arbitrary spits or Excavation Units (XUs), with all attempts made to avoid mixing different stratigraphic layers within the same XU. The number of XUs and maximum depth of excavation in each square is as follows: Square A (20 XUs, 59.2cm); Square B (18 XUs, 47.7cm); Square C (17 XUs, 44.3cm); and Square D (17 XUs, 43.9cm). Excavation continued to granite bedrock across most of Squares C and D and to the limit of accessibility in Squares A and B (Figure 6). A datum point was established on a localised high point on the western end of a large granite boulder located 1.5m north of the excavation pit. The datum is elevated 23mm above the surface elevation of the northwest corner of Square C.

XUs were thin to increase chronological and stratigraphic control, with a mean thickness of 2.7 ± 0.12 cm (range: 0.5-5.5cm). The weight and volume of each XU was recorded and depth elevations were taken at the corners and centre of each square at the beginning and end of each XU. All excavated deposit was wet sieved through 2.1mm mesh. Samples of <2.1mm dry sieved sediment were taken for each XU. A total of 488.1kg of deposit with a volume of 427 litres was excavated. Squares were backfilled with sediments from the sieve spoil heap located off-site 25m to the west.

Stratigraphy and Stone Structure

Sediments were visually poorly stratified, homogeneous, granitic variably stoney silty loams and stoney sandy loams (Marshall 1947; McDonald *et al.* 1998) ranging in colour from dark grey to black depending on moisture content. The consolidated and hard-setting silty and clay-rich deposit made excavation difficult except when rain moistened and softened sediments. The absence of stratigraphic changes observed while digging and within the pit sections is consistent with textural uniformity throughout the deposit and bioturbation (see below). Pedal development was minimal, with no recognisable Ah horizon, consistent with rapid biodegradation of near-surface organic matter. Evidence of clay illuviation, with incipient Bt formation, was likewise absent. The lack of soil horizon development classifies the sequence as an incipient Entisol (FAO-UNESCO 1988).

The sequence was stratified with respect to some sediment matrix components, particularly cultural materials and coarser clastic stone material. Cultural materials (charcoal, stone

artefacts, bone and ochre) were found throughout the deposit, but marine shells were restricted mostly to the upper four XUs. Land snail shells (3.5g) were found intermittently between XUs 1 and 14 (0-36cm below the surface). Small fragments of pumice (7.3g) were restricted to XUs 4 to 16 (5-46cm below the surface) confirming an absence of mixing or upcast into near-surface layers. Measured pH values (methods following Rayment and Higginson 1992) of sediments from Square A were relatively constant and acidic, ranging from 4.45 to 5.36. Overall, the consolidated nature of sediments coupled with minor evidence for bioturbation disturbance observed during excavation suggests the deposit exhibits reasonable stratigraphic integrity with little post-depositional (vertical) movement of cultural materials. Field observations of soil and sediment sequence properties are broadly supported by particle size analyses and radiocarbon dating; analysis of vertical changes in cultural materials suggests some post-depositional disturbance of sediments (see below).

Coarser pebble gravels (>4mm) and cobbles and rock clasts (>64mm) formed a significant lag to the deposit in XU1 and also proportionally increased towards the base of the sequence (Figure 7). The surface lag is consistent with sediments which form during periodic wet season run-off on coarser-textured regolith on granite slopes on Dauan, especially on slopes subject to dry season burning (Humphreys and Mitchell 1983). XUs 4 to 12 were largely clast-free deposits, but XUs 13 to 20 represent loams which form a trapped infill within a complex nest of unweathered granitic boulders sitting on an underlying (unweathered) bedrock surface. The excavated coarser clastic rocks in XUs 15 to 20 derive from that boulder unit. Higher levels of the natural basal boulder unit have been deliberately repositioned by people. An alignment of three granite boulders was uncovered across the middle of the pit extending horizontally between the north and south sections (Figure 5). The northern and southern stones were partially exposed while the middle stone was fully uncovered. Undercutting of the northern and middle stones indicates that they are resting on granite bedrock. The stones range in depth from 9cm (top) to at least 50cm (bottom) below the surface. While it is unknown at what point in the history of Kabadul Kula the stone alignment was constructed, it is at least as old as the age of sediments burying basal sections of the feature (see below). Why the alignment was built remains a mystery.

Interpretation of the Excavated Stratigraphy

The sequence properties suggest that sediment accumulation has been relatively rapid, onto an underlying clean and unweathered bedrock surface. The basal boulder bed is interpreted as residual,

and acted as a trap for finer sediment accumulation and the cultural sequence. We speculate that the formation of the boulder bed and absence of saprolite/older soils in the basal sequence over clean bedrock reflects marine wave erosion during a higher sea-level stand at the site, possibly in the mid-Holocene. The excavated 50–60cm deep cultural deposit has then accumulated in association with periodic washed inputs of sandier sediments (from upslope), possibly supplemented by seasonal short-distance wind-blown sand inputs from the adjacent shoreline. Discard of ochre, artefacts and charcoal into the accumulating sequence under the rock panel formed the cultural sequence, which has retained some primary stratification. Pedogenesis is minimal because all but the lower boulder bed has accumulated in the last few thousand years (see below).

Sediment Particle Size

Vertical distribution of the frequency of <10cm rocks (mostly in the form of granite gravel) recovered from the 2.1mm mesh sieve reveals few vertical changes (Figure 7), other than the surface lag in XU1. The absence of obvious concentrations of rocks through the main body of the deposit is consistent with an absence of lag deposits associated with old erosional surfaces and stonelines produced at the base of biomantles (zone of bioturbation) (Balek 2002; Brown *et al.* 2004; Johnson 2002).

Laboratory particle size analysis of sediments (<1000µm) produced a more nuanced picture of depositional processes (see Appendix). Non-chemically pre-treated sediment samples from Square A reveal vertical changes in the proportion of sand (Figure 8). Major peaks in sand fraction occur in XUs 2, 8 and 16. The increased sand content in thin beds could reflect either selective removal of finer sediments (silts and clays) (e.g. through weak illuviation) and/or increased addition of sands. Given the proximity of the site to slopes down which episodic wash occurs, and also the proximity to the shoreline, a combination of episodic colluvial and/or local aeolian input is inferred.

A second sediment analysis involved chemically pretreating samples with 30% hydrogen peroxide (H₂O₂) at 80°C to remove organic matter prior to particle size determination. Figure 8 reveals an increase in the proportion of sand up-profile, relative to a decrease in silts. Measured clay content varies little (20±3%). This increase in sand fraction from XU15 to XU1 is again interpreted as reflecting primary deposition, not pedogenesis. Overall, the sedimentary sequence at Kabadul Kula shows no radical changes in deposition or major erosional events creating residual lag deposits.

Cultural Materials

Cultural materials recovered from Squares A to D include: bone (10.0g), marine shell (192.2g), charcoal (26.7g), stone artefacts (296.8g, n=1397) and ochre (205.5g) (Figure 9). Most bone (82%) was recovered from XUs 1 to 4 and nearly all (91%) was identified as large vertebrates with only trace occurrences of fish (0.7g) and small vertebrates (0.2g). Ethnographic and previous archaeological research on Dauan suggest the large vertebrate bone represents turtle and/or dugong (see McNiven 2006). However, some of the bone may also represent pig as a right femur central shaft fragment of an immature pig was recovered from the surface of the site during removal of the termite nest (Surface Find #1 – see Figure 2).

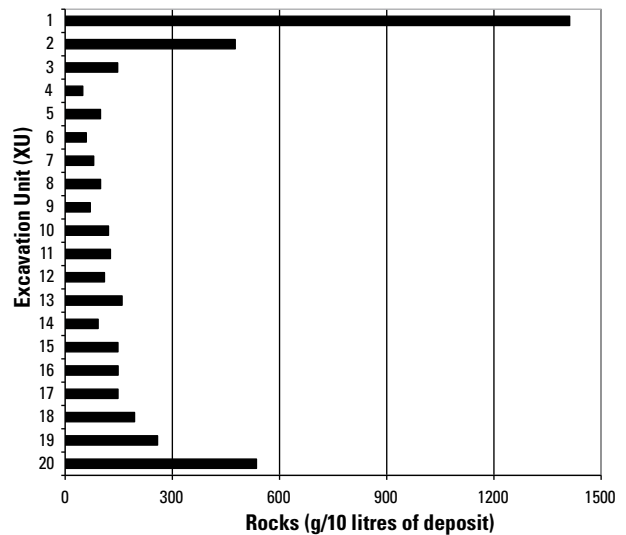


Figure 7 Vertical changes in rocks, Squares A and B combined, Kabadul Kula.

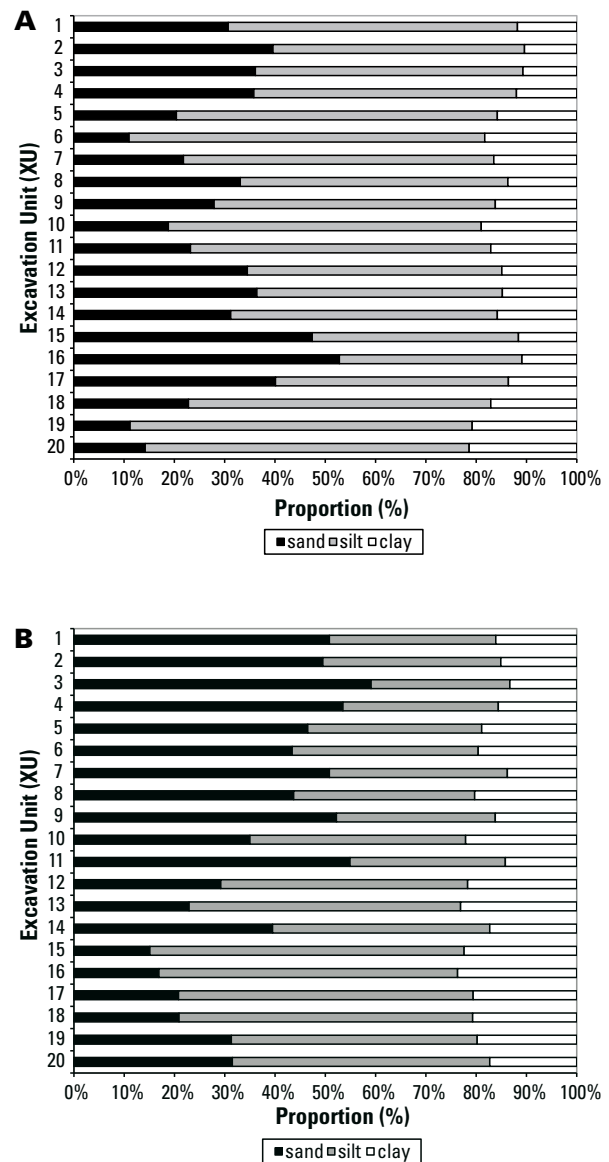


Figure 8 Particle size distribution of untreated (A) and chemically pre-treated (B) sediments, Square A, Kabadul Kula.

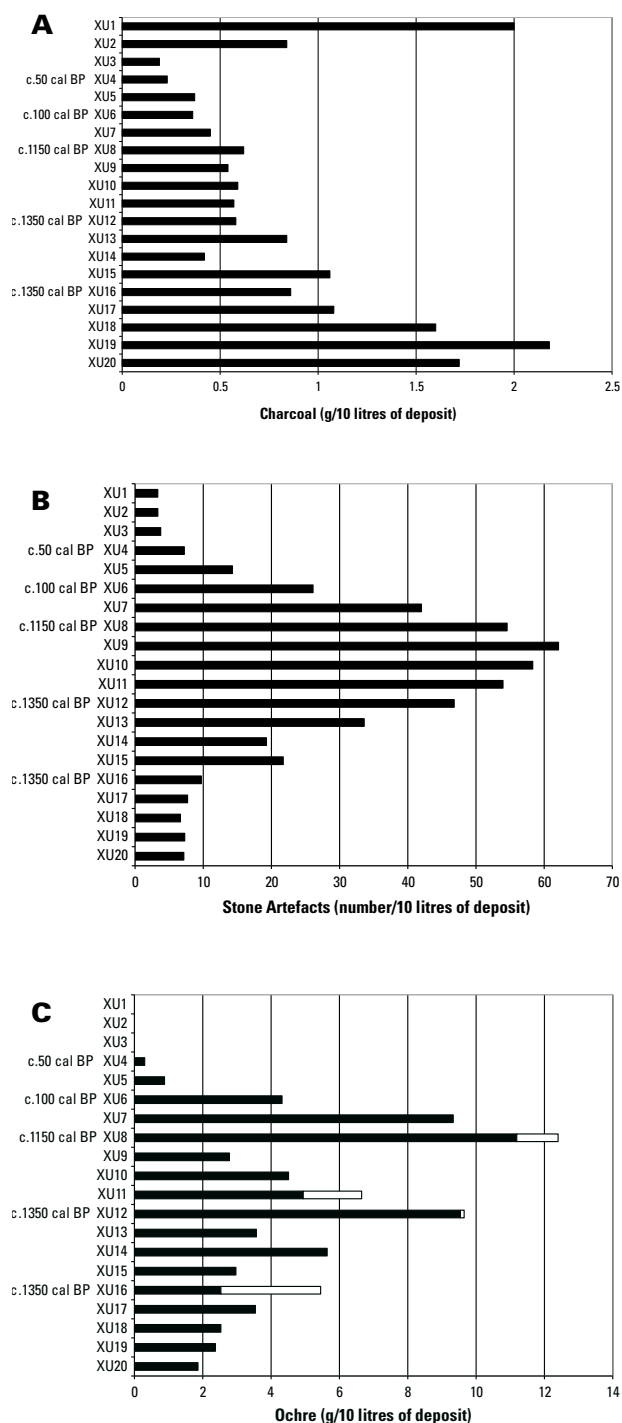


Figure 9 Vertical changes in charcoal (A), stone artefacts (B) and ochre frequency (C) by XU, Squares A to D combined, Kabedul Kula. For C: black=non-faceted, white=faceted.

Almost all marine shell (99.8%) was recovered from XUs 1 to 4. A MNI of only six marine shells was identified: locally available *mudu* (*Anadara antiquita*) (MNI=5) and *akul* (*Polymesoda erosa*) (MNI=1). Charcoal density is relatively high in surface levels (XUs 1 and 2) and basal levels (XUs 18 to 20). The fish bone assemblage was represented by teeth only (NISP=12). Most of the teeth (NISP=8) were identified as Scaridae (wrasse) lower pharyngeals (Square-XU: B-12, C-9, C-11, C-12 and D-9) with one pharyngeal cluster (C-8) and two conical teeth (C-14b) comparing favourably with Labridae (parrotfish).

Flaked stone artefacts peak in density in XU9. Preliminary analysis of flaked stone artefacts reveals an assemblage dominated by small flakes (<1cm long) with most artefacts manufactured from quartz (92.2%, n=1288) followed by minor amounts of volcanics (7.6%, n=106) and chert (0.2%, n=3). Nearly all ochre (98.3%) was recovered from XUs 6 to 20 with peak density in XU8.

In summary, the upper sections of the deposit taking in XUs 1 to 5 down to a depth of 8cm and 20% of the excavated deposit (by volume) contained nearly all bone (82%) and marine shell (99.9%) but only 5.2% of stone artefacts (by number) and 1.7% of ochre. In contrast, XUs 6 to 16 located 8 to 46cm below the surface and representing 72.2% of excavated deposit (by volume) contained most stone artefacts (93.1% by number) and most ochre (93.9%).

Ochres

Ochre is mostly in the form of red (haematite) small fragments – a well-known pigment type for the region (McNiven and David 2004). The six fragments of faceted red ochre were recovered from Square C (Table 1). These faceted ochres are consistent with ochre grinding and the preparation of red pigment at the site. Identification of non-faceted (unmodified) ochre was restricted to fragments soft enough to be fingernail scratched. As such, all fragments of identified ochre are considered pigments suitable for the production of paint and rock art (see Henshilwood *et al.* 2001:431).

That the *in situ* ochres are functionally related to the adjacent paintings is supported further by spatial proximity and similar Munsell colour code determinations. The six faceted pieces of ochre range in colour from dark red (10R 3/6, n=4), dusky red (10R 3/4) to red (10R 4/6) (Table 1). In lieu of Munsell colour determinations taken directly from paintings in the field, five indicative Munsell readings were made for five separate paintings using digital photographs adjusted according to the IFRAO Standard Scale (Bednarik and Seshadri 1995): Crayfish (#31) (weak red, 10R 5/4), Canoe (#34) (pale red, 10R 6/3), Canoe (#37) (pale red, 10R 6/3), Canoe (#39) (weak red, 10R 5/3) and a Fish/Dugong (#38) (weak red, 10R 5/4). The Munsell determinations indicate that the colours of the faceted ochre pieces and rock paintings all have the same Hue: red (10R) (see also Thorn 2008). The lack of any major colour differences (e.g. bright pink, deep mulberry) is consistent with an association between the buried ochre fragments and adjacent paintings.

Differences in Munsell colour Value and Chroma between the *in situ* faceted ochres and wall paintings are consistent with differing weathering contexts. The colours of the wall paintings are lighter (higher Values) and less vivid (lower Chroma) compared to the buried *in situ* ochres. This pattern is consistent with the wall paintings being exposed directly to both anthropogenic and natural factors (especially the elements) for over 1000 years. Such exposure would result in paintings becoming increasingly weathered through time with increasing deterioration of painted surfaces in the form of pigment loss as a result of micro-spalling of granite substrate (Thorn 2008). As Bednarik (2007:12) cogently notes: ‘iron oxides and hydroxides are highly susceptible to chemical alterations that inevitably involve changes in reflective properties (colour), and it is naive even to assume that either the pigment on the wall or the pigment

in the ground would retain the original colour. Both are likely to be modified differently’.

Taphonomic Considerations

Disturbance to sediments observed during excavation was minor and limited to faunal turbation in the form of isolated small termite tunnels and isolated small (0.5cm diameter) burrows, and floral turbation stemming from rootlets (throughout the deposit) and a few scattered larger roots (up to 2cm in diameter). Termite tunnels were observed running horizontally along the granite shelter wall on the east edge of Squares A and/or B in XUs 2, 3, 4, 6, 9, 12, 13 and 14 and Squares C and D in XUs 2, 3, 11 and 12. Most of these tunnels developed overnight during fieldwork. Areas of termite disturbance were discarded. Other insect burrows were restricted to the upper 10cm of deposit in XUs 2, 3, 5 and 6. For example, a live cicada nymph (Cicadidae) was recorded in XU5 (Square D) while live ants were observed in XU6 (Square C).

Restriction of food remains (marine shell and bone) to upper levels of the site (XUs 1 to 4) may be taphonomic (i.e. reflect loss of these materials due to acidic conditions in older deposits). However, there is no pH shift indicating buffering through carbonate dissolution below XU4. Poor preservation is indicated by the reduction of the fish bone assemblage to tooth enamel – a condition consistent with acidic sediments and poor faunal preservation. Bivalve shells in XU4 were in original depositional context as they were lying flat (i.e. horizontal and parallel to the ground surface). This problem requires further investigation, and with hindsight, microscopic examination of resin-impregnated samples of soil fabric might assist in resolving degradation pathways for shell.

Differential preservation is unlikely to be responsible for vertical changes in the density of charcoal, stone artefacts and ochre through the deposit. While rock and sediment data reveal an overall stratigraphic integrity to the deposit (see above), the pattern of vertical changes in stone artefact densities is a normal distribution curve centring on XU9 and slightly skewed to the bottom (Figure 9). This pattern is consistent with gradual post-depositional movement of artefacts both above and below an original artefact concentration centring on XU9 (e.g. Brantingham *et al.* 2007; Hofman 1986; Morin 2006; Rowlett and Robbins 1982). Post-depositional dissipation is most apparent in the lower levels of the deposit (XUs 13-20) which feature only tiny artefacts averaging 0.04g whereas artefacts in the upper levels of the deposit (XUs 1-12) have a higher mean weight of 0.24g (Figure 10). This apparent size-sorting of artefacts is consistent with known selective downward movement of tiny artefacts in archaeological deposits through invertebrate bioturbation, rootlet penetration, rainwater percolation and treadage (e.g. Armour-Chelu and Andrews 1994; Canti and Pearce 2003; McBrearty 1990; Peacock and Fant 2002; Pearce 1984; Stockton 1973; van Nest 2002). As most stone artefacts within lower levels of the deposit (XUs 13-20) probably derive from higher levels of the deposit, they cannot be considered chronologically and behaviourally separate from upper level artefacts.

An implication of hypothesised post-depositional movement of tiny stone artefacts is that other cultural materials such as charcoal and ochre may have experienced similar downward vertical displacement, especially as micro-fabric fragments. As

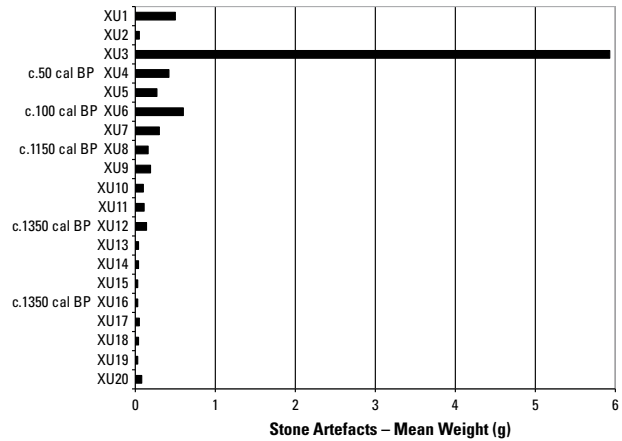


Figure 10 Vertical changes in stone artefact mean weight, Squares A to D combined, Kabadul Kula.

such, some charcoal and ochre fragments in lower sections of the deposit may similarly have an original *in situ* (depositional and discard) context in levels above XU13. However, unlike stone artefacts, density peaks in charcoal and ochre also occur well below XU9 suggesting the presence of original concentrations (i.e. primary stratification) of charcoal and ochre (including large pieces of faceted ochre) in lower levels of the deposit. The overall integrity of lower level ochre and charcoal assemblages is consistent with the rock data which reveals no major post-depositional disturbance within the excavated deposit (see above). Other studies have shown how small particles in sites may move vertically while larger artefacts remain *in situ* (Boulter *et al.* 2006:10). Taking these taphonomic issues into consideration, the following site function and discard events can be inferred: lower levels of the site reveal a focus on ochre and painting activity; upper levels of the site show a broadening of activities that included ochre use and manufacture and use of stone artefacts. Subsistence activities (e.g. consumption of turtle/dugong, fish and shellfish) were a feature of recent occupation of the site and possibly during earlier periods of site use.

Radiocarbon Dating and Chronology

Chronology of the cultural deposit was determined from six AMS radiocarbon dates on charcoal – five from Square C and one from Square A (Table 2). Four of the dates were on fragments of carbonised seed and two dates were on fragments of wood charcoal. Dating was undertaken by the University of Waikato Radiocarbon Dating Laboratory in New Zealand. Radiocarbon dates were calibrated into calendar years using the online calibration programme Calib 5.0.2 (Stuiver and Reimer 1993;

Table 1 Faceted ochre fragments from Kabadul Kula.

Sq-XU	Item #	Weight (g)	Max. Length (mm)	Munsell Colour
C-8	1	2.74	22.5	10R 3/6 (dark red)
C-8	2	0.77	15.2	10R 3/6 (dark red)
C-8	3	0.43	9.9	10R 3/6 (dark red)
C-11	1	4.51	26.9	10R 3/6 (dark red)
C-12	1	0.33	10.8	10R 3/4 (dusky red)
C-16b	1	5.39	39.1	10R 4/6 (red)

Stuiver *et al.* 2005) and the Southern Hemisphere calibration dataset (ShCal04) (McCormac *et al.* 2004). For convenience and heuristic purposes, a single, central best-point estimate was calculated for the probability distribution of each date using the median calibrated age (following Telford *et al.* 2004). These single dates are expressed as 'years ago' (cal BP – i.e. before AD 1950) and have been rounded to the nearest 50 years to emphasise their approximate (*circa*) status. All dates reveal increasing age with depth indicating that the vertical structure of the deposit is largely depositional and consistent with the law of superposition.

XUs 4 and 6 taking in the upper 10cm of deposit and nearly all bone and marine shell produced dates of 75 ± 30 BP (Wk-22804) and 99 ± 36 BP (Wk-22805) respectively and most likely represent the nineteenth century AD. XU8 at a depth of 13–16cm below the surface produced a date of 1276 ± 30 BP (c.1150 years ago) (Wk-22806) indicating that a hiatus of around 1000 years exists in sediments spanning XUs 6 to 8 (i.e. between 8cm and 16cm below the surface). While this hiatus is not represented stratigraphically, the transition from XU8 to XU6 is marked by a decrease in the density of charcoal and a dramatic decrease in the density of stone artefacts and ochre fragments (Figure 9). The absence of a relative concentration peak in cultural (e.g. stone artefacts and ochre fragments) and non-cultural (granitic rock fragments, including roof fall and in-washed gravels) materials in XU7 corresponding to a lag deposit (Figures 7 and 9) suggests strongly that the chronological hiatus represents a disconformity associated with minimal net sediment accumulation and cultural discard at the site and not selective removal of sediments by erosion (see Kelly *et al.* 2006; O'Connor *et al.* 1999).

The remaining two Holocene dates of 1508 ± 32 BP (Wk-22807) and 1533 ± 30 BP (Wk-22808) from XUs 12 and 16b

located 26–29cm and 40–43cm below the surface respectively produced identical calibrated dates of c.1350 years ago, suggesting rapid deposition at this time. Thus, the bulk of the excavated deposit located in XUs 8 to 16b located 13–43cm below the surface date to between 1150 and 1350 years ago (and between 1062 and 1415 cal BP at two sigma). The upper four AMS dates are considered reliable age estimates for associated sediments and cultural materials given that they were based on seeds and thus do not have an inbuilt 'old wood' problem.

A basal age determination of $23,869\pm 260$ BP (Wk-23692) was obtained for XU20 in Square A located 11cm below the age determination of 1533 ± 30 BP (Wk-22808) in XU16b. This Pleistocene determination is beyond calibration using Calib 5.0.2 but probably dates to around 30,000 years ago following Hughen *et al.* (2006). While a jump in age of more than 22,000 radiocarbon years over a vertical distance of 11cm or less has been demonstrated at other archaeological sites in northern Australia (e.g. Balme 2000; David *et al.* 1997), it is unlikely that Wk-23692 reflects the age of surrounding sediments (and associated cultural materials) within XU20. The lack of any obvious visual stratigraphic change between Wk-23692 and Wk-22808, absence of saprolite and broad similarities in the frequency of charcoal, stone artefacts and ochre across the same sediments is inconsistent with a stratigraphic disconformity and major chronological hiatus (see O'Connor *et al.* 1999). While XU20 registers a relative increase in rock (granite gravel) density (Figure 7), it is clear that this concentration relates to the basal bed and not the net result of over 20,000 years of rock accumulation within the site. Parsimony suggests that the single charcoal fragment upon which Wk-23692 is based washed into the site sometime around 1500 years ago, probably derived from eroding

Table 2 Radiocarbon AMS dates for Kabadul Kula (* $\delta^{13}\text{C}\text{‰}$ measured by the accelerator but not reported).

Lab. No.	Square	XU	Depth (cm)	Sample	$\delta^{13}\text{C}\text{‰}$ (± 0.2)	^{14}C Age (years BP)	Calibrated Age BP 1σ (probabilities)	Calibrated Age BP 2σ (probabilities)	Calibrated Age BP Median	Years Ago (cal BP) <i>circa</i>
Wk-22804	C	4	2.8-4.0	1 fragment of seed	-26.2	75 ± 30	0-0 (0.138) 28-59 (0.545) 119-136 (0.288) 233-237 (0.029)	0-0 (0.116) 5-13 (0.015) 17-73 (0.466) 82-106 (0.064) 111-141 (0.257) 227-251 (0.082)	57	50
Wk-22805	C	6	7.6-10.2	2 fragments of seed	-24.5	99 ± 36	0-0 (0.032) 26-71 (0.497) 84-87 (0.019) 94-103 (0.064) 113-140 (0.288) 229-242 (0.101)	0-143 (0.860) 224-254 (0.140)	86	100
Wk-22806	C	8	13.2-16.2	1 fragment of seed	-26.1	1276 ± 30	1078-1178 (0.969) 1214-1219 (0.031)	1062-1188 (0.784) 1200-1260 (0.216)	1146	1150
Wk-22807	C	12	25.9-29.4	2 fragments of seed	-23.5	1508 ± 32	1307-1360 (1.000)	1298-1398 (1.000)	1343	1350
Wk-22808	C	16b	40.0-42.5	3 fragments of wood	–*	1533 ± 30	1330-1392 (1.000)	1300-1415 (1.000)	1362	1350
Wk-23692	A	20	53.7-59.2	1 fragment of wood	-25.2	$23,869\pm 260$	–	–	–	–

Pleistocene soils located upslope and further inland. However, final resolution of the status of this Pleistocene date will require further excavations and geomorphological investigations at the site, and its immediate environs.

Antiquity of Ochre and Paintings

Most ochre (71.8%) and all pieces of faceted ochre were recovered from XUs 8 to 16 dating to within the restricted timeframe of between c.1150 and c.1350 years ago. After a hiatus in occupation between c.1150 and c.100 years ago (XU7), only 8.7% of recovered ochres date to the past 100 years within XUs 1 to 6. Similarly, little ochre (4.4%) was recovered in levels dating to before c.1350 years ago in XUs 17 to 20. These results suggest strongly that not only did the c.200 year period between c.1150 and c.1350 years ago represent the major phase of painting activity at Kabadul Kula, but that such painting activity also involved production of at least some of the extensive rock art at the site. The occupation phase probably increased net sediment accumulation at the site. As XUs 12 to 16 also take in the lower sections of the stone alignment, it is likely that this feature was constructed at or before c.1350 years ago.

Discussion and Conclusion

Excavations at Kabadul Kula reveal that people were using ochre and most likely creating rock art at the site c.1150–1350 years ago. This inference is based on meeting, to various degrees of satisfaction, the six methodological conditions established for associating ochre paintings with *in situ* ochres at the site. Supportive evidence for acceptance of rock art dating at Kabadul Kula include: *in situ* ochres located directly below paintings (Condition 1); *in situ* ochres restricted to a narrow timeframe (Condition 4); *in situ* ochre concentration neither a product of erosion (Condition 5) nor bioturbation (Condition 6). Unfortunately, no fragments of rock art were found associated with *in situ* ochres (Condition 3). While insights into the functional association of painted ochres with *in situ* ochres at the site would be enhanced greatly by geochemical fingerprinting (Condition 2), such an association is consistent with Munsell colour similarities between the two ochre sets. Further research at Kabadul Kula will test this association more directly by geochemically characterising ochres from selected paintings and *in situ* ochres.

That Kabadul Kula was a site of high level ochre use and pigment production on Dauan is indicated by comparisons with Dauan 4, an open midden site located on the west coast of the island. Excavations at Dauan 4 recovered 4.4g of ochre from 773.9 litres of excavated deposit, representing a density of 0.06g/10 litres (McNiven 2006). In marked contrast, the density of ochre at Kabadul Kula is 4.81g/10 litres, which is 80 times that seen at Dauan 4. Clearly, Kabadul Kula rock art site exhibits a much greater quantity of ochre compared to an open settlement site. Such differences indicate the special status of Kabadul Kula as a place of pigment production and use, a finding consistent with extensive rock art at the site.

The Kabadul Kula results represent the earliest available information on the antiquity of rock art in Torres Strait and indicate that in certain contexts exposed rock paintings in this coastal region can survive the harsh tropical climate (heavy rains) for over 1000 years. Along with the recent suggested rock

paintings of c.500–700 years ago at Tigershark Rockshelter on Pulu islet to the south (McNiven *et al.* 2008), the Kabadul Kula findings reveal that the region's rock art can be historicised beyond the last couple of hundred years to investigate long-term changes in artistic traditions, place marking strategies and associated symbolic and socio-religious behaviours.

Despite the identification of c.1150–1350 year old rock art at Kabadul Kula, determining which paintings can be associated with this early phase of artistic activity is fraught with difficulty. While the condition of paintings at the site vary, associating degrees of weathering with age is potentially spurious given weathering at the site is also influenced by wall topography, aspect and relative exposure to the elements, especially rainfall runoff (McNiven *et al.* 2004). However, some degree of weathering control exists for the rock art panel adjacent to the excavation pit given consistency of topography, aspect and exposure to rainfall runoff. As such, it can be expected that some correlation exists between age of paintings and degree of weathering and fading. As three of the most faded paintings on the panel are canoes (Paintings #34, 37 and 39) (McNiven *et al.* 2004:Table 1), canoe paintings may represent the earliest phase of painting on the panel dating to c.1150–1350 years ago (Figure 5). Significantly, one of the canoes appears to have a crab-claw sail, the nearest examples of which are associated with the ethnographically-known *hiri* ceramic traders of the Gulf of Papua (Dutton 1982; McNiven *et al.* 2004:244). While no ethnographic information is available to indicate *hiri* traders ventured westwards into Torres Strait, McNiven (2008) hypothesises that the Papuan Gulf art style once extended into Torres Strait over 1000 years ago (see also Brady 2005 for additional information on artistic links between Torres Strait and Papua New Guinea). Furthermore, David (2008:470) documents a major phase of settlement expansion and 'the establishment of antecedent trade partnerships' in the western Gulf of Papua between c.950 and 1450 years ago.

An inevitable question arising from our research is to what extent oral history of the Kiwai raiders can be associated with suggested >1000 year old paintings at Kabadul Kula. McNiven *et al.* (2004) hypothesised that paintings by the Kiwai raiders represent the most recent of at least two phases of painting at the site. As such, we suggest that >1000 year old rock art at Kabadul Kula pre-dates the Kiwai raiders story. This view is consistent with the generally faded paintings across the northwest panel where the excavation pit was located and the presence of clearer paintings (probably of more recent age and associated with the Kiwai raiders) on the northern panel. Whether or not excavation of sediments beneath the northern panel reveals evidence of a <1000 year old painting phase is a matter for future research. To what extent sediments beneath the northern panel have been compromised stratigraphically by extensive termite nest activity remains to be seen.

Refinements in understanding stratigraphic resolution at the site, and inferred social change through time from the artefact record require new approaches. Excavation techniques and AMS dating no longer constrain interpretive resolution adjacent to rock art panels in tropical Australian sites like Kabadul Kula. Primary knowledge gaps now lie in understanding sedimentation process, the source-pathways of sediments being deposited and the dearth of method and theory regarding the archaeological consequences of the activities of invertebrate

biofauna and their influence on deposits, autecological traces and methods of trace-recognition (e.g. in resin-impregnated thin section). Kabadul Kula demonstrates the need for site-specific microfaunal observational data (see Grave and Kealhofer 1999; Madge 1969) and the application of micromorphological techniques (Davidson and Simpson 2001; Matthews *et al.* 1997) for elucidating formation processes specific to soil fabrics (including micro-artefacts) in Australian tropical archaeological contexts, specifically for archaeological interpretation. This requires a return to 'actuopalaeontology' as advocated by Efemov (1940) and echoes a previous call to the Australian archaeological community (see Hiscock 1990). Recent advances in regolith dating and modelling (see Barrows *et al.* 2004; Chappell 2006; Wilkinson *et al.* 2005) and 're-discovery' of soil production functions (Humphreys and Marshall 2007) provide excellent platforms for retheorising soil-sediment accumulation models over bedrock specific to significant cultural deposit sequences adjacent to rock art panels such as those on Dauan.

Kabadul Kula reveals that people have been living on Dauan for at least c.1350 years. This date doubles the known antiquity of human occupation of the island revealed previously by excavations at Dauan 4, the only other site excavated and radiocarbon dated on Dauan (McNiven 2006). Given that people were living on the nearby island of Saibai 2500–2600 years ago (Barham 1999; Barham *et al.* 2004), it is likely that occupational evidence of similar antiquity awaits discovery on Dauan. Our future excavations on Dauan are aimed at providing an expanded chronological framework from which we can better historicise and model the emergence of local rock art, midden and quarry sites within the broader social context of Torres Strait and neighbouring Papua New Guinea.

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Appendix

Prior to analyses all soil samples were air-dried to constant weight at approximately 30°C. Subsamples, c.5g of air-dry soil, were dispersed in distilled water (hot), and not subjected to any other chemical pre-treatment. The samples were wet sieved at 1000µm. The retained particles were transferred to pre-weighed petri dishes, air-dried to constant weight, and weighted (particles >1000µm). The soil water suspension (particle <1000µm) was analysed using the Backman Culter LS 100 instrument. The particle size distribution was classified using the Standard

Association of Australia scheme (McDonald *et al.* 1998). The size fractions are defined as sand (63–2000µm), silt (2–63µm) and clay (<2µm). The sand size fraction (total sand) is a sum of coarse sand (600–2000µm), medium sand (600–212µm) and fine sand (212–63µm). The coarse, medium and fine sand size fractions are not directly equivalent to phi cut-offs or commonly adopted geoarchaeological standard limits for medium sand and fine sand which are 250–500µm and 125–250µm (see Gale and Hoare 1991; Goldberg and Macphail 2006; Rapp and Hill 2006:29–31). The overall range limits specified for clay, silt and sand size fractions are the same as in other international classification systems based on the Udden-Wentworth system (see Gale and Hoare 1991:58–62). No conversion to phi-scale is therefore undertaken. The fractions of clay, silt and sand (fine, medium and some coarse) size particles were calculated as volume percentage of the size fraction smaller than 1000µm.

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All correspondence and submissions should be addressed to:

Australian Archaeology

PO Box 6088

St Lucia QLD 4067

AUSTRALIA

Email: journal@australianarchaeology.com

URL: <http://www.australianarchaeologicalassociation.com.au>

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