CHAPTER 1

Towards a Regional Synthesis: Rock Art and the Dampier Archipelago

As a matter of fact, the Australian aboriginal employed at least two distinct methods in the production of the strange picture-history of his race. Just as this periodical is illustrated by wood engravings and “processed” drawings, so the weird story of the glimmering life in the primeval bush has been preserved to us by what may conventionally termed the work of the chisel on the one hand and of brush and pigment on the other. (Carroll 1888:187)

Introduction
The genesis for this study came out of the industrial development of the Burrup, once one of the forty-two islands of the Dampier Archipelago, located two-thirds the way up the Western Australian coast in a region known as the Pilbara. One of the major rock art provinces in Australia, the Dampier Archipelago arguably comprises the highest concentration of petroglyphs in the world. It was recording Aboriginal archaeological culture in an area destined for a petrochemical processing plant that brought me in 1980 to the Burrup. It was this same company that established, many years later, the research scholarship that instigated this current rock art study. Ownership of the rock art lies with the local Aboriginal people; its custodianship is held by Yaburara descendants and Ngarluma
people. In the local *Ngarluma* language the Archipelago is known as *Murujuga*, while the word for ‘engraving’ and ‘rock art’ is *Marni* (DAS 1979; Von Brandenstein 1973).

Comprising large and small islands and rocky outcrops surrounded by rock platforms, coral reefs and shoals, the Dampier Archipelago is set in the sub-tropical waters of the Indian Ocean. It is situated on the northwest coast of Western Australia, some 300km north of the Tropic of Capricorn and 1,255km north of Perth. In the sub-tropical, sub-arid Pilbara region, the Archipelago is located one-third of the way along the northeast/southwest trending coastline between Exmouth Gulf and Roebuck Bay (Figure 1.1). The Burrup, formally known as Dampier Island, is the largest (118km²) island of the Archipelago. Covering an area of some 1,750km² (c. 300km² of land), extending from West Intercourse Island in the south to Legendre Island in the north, Eaglehawk Island is the most westerly (Figure 1.2).

Figure 1.1: Section of the northwest of Australia, the Pilbara Region, with towns and major physiographic features displayed (all rivers are seasonal).
This monograph presents a model of the artistic traditions and associated petroglyph production, suggesting that there are five major phases for the Dampier Archipelago. The art is not painted on the rock surfaces but etched into it. Organic pigments or binders are not used, nor are there suitable rock coatings which could provide (at present) a means of dating the rock art. The techniques applied combine use of superimposition, where one motif overlies another, and a five state reference of motif contrast condition (an index of weathering). Defined by the inferred five distinct artistic traditions, the temporal sequence has at its basis the division of the Pleistocene and Holocene, marking the postglacial marine transgression and the effects that this had on the people as reflected in their rock art. The stylistic patterns echo culture change and the associated social conventions which influenced artistic expression.

The Dampier Archipelago is a drowned landmass. What was the
former undulating plain has been converted to sub-tidal reefs, shoals and channels, while the higher hills and ridges form the islands. The coastline of the Archipelago is now characterised by rock platforms and storm boulder beaches, interspersed with localised accumulations of sand and silt in the more protected embayments (WPD 1979). The present approximation of the coastline stabilised about 6,500 years ago (Ward et al. 2013). Sand and silt gradually became deposited around the new seaboard. Initially, sea level was higher with a marginal drop from the maximum at 6,500 BP (Chappell 1982a; Kriewaldt 1966). A higher sea stand of 1.9–2.2m occurred around 6,000 BP, with a second phase at 1,500 BP, 0.5m above current sea level (Baker et al. 2001:266). While based on data from the southern part of the State, these sea-level fluctuations are confirmed by sediment studies from around Broome (Lessa and Masselink 2006). Corroborating data from around the eastern seaboard demonstrates this Holocene higher sea stand was widespread. Certainly the existence of raised cobble beach strands, and the presence of exposed coral beds on the Burrup, may support this evidence of mid- to late Holocene higher sea levels extending throughout the Archipelago.

Petroglyphs occur over the whole of the landscape, and can be found in both general living areas and ceremonial sites. They are fixed in place; whereas other art forms and artefacts are portable. Another feature of these petroglyphs is that once they are produced the images are there for all to see and remain visible for a long but indeterminate period. The hardness of the bedrock and the abundance of rock surfaces on which to execute designs have contributed to the profusion of images.

While the intention of each individual artist is unknown, the accumulated corpus of innumerable images remains visible today.
Their meaning may be obscure, but their challenging display continues. While the Dampier Archipelago is best known for the proliferation of petroglyphs, it is placed on the National Heritage List both for its petroglyphs and the numerous constructed stone features which occur across this landscape. Other cultural heritage sites include very large shell middens, numerous artefact scatters and stone features, such as standing stones, linear heaped stone arrangements, pit-like features and small stone piles. The Archipelago is remarkable for its extensive distribution and exceptional density of petroglyphs, along with their considerable stylistic diversity in subject matter, technique and artistic form. The spatial relationship between the petroglyphs and other archaeological features (e.g. middens, standing stones, quarries) reflects the patterns of past socio-cultural dictates in rock art production.

Until one visits the Archipelago it is difficult to appreciate the immense scale of the rock art production. In a study of the petroglyphs adjacent to the midden at Skew Valley, an area of 20m by 6m was investigated in detail. A total of 47 panels and 153 figures were recorded. Based on this sample, Lorblanchet estimated approximately 5–6,000 figures to be within 100m radius of the midden site. At another site, known as Happy Valley, 6,800 motifs have been recorded in an area of 13ha. Considering the number of petroglyphs recorded in the valleys of the southern Burrup (Lorblanchet 1975; Virili 1974) and in the open areas associated with the North West Shelf Venture Karratha Gas Plant (LNG) development (DAS 1984), coupled with more recent surveys and my own investigations, it is reasonable to estimate there are some 500,000 to one million petroglyphs.

It was a consequence of the Western Australian Museum investigation into the Depuch Island petroglyphs (Ride and
Neumann 1964), coupled with a limited knowledge about the Dampier Archipelago, that influenced later industrial development decisions and the downplay, or at least unrealised potential, of the cultural significance of the area. As the archaeological specialist on the team, Crawford (1964:56) noted:

"The only area in which the art closely resembles that of Depuch is the Dampier Archipelago, and there it seems to be poorer in quality and quantity. As far as we know at the moment, the engravings on Depuch are unique. No doubt, in time we will find more sites with engravings, but we will be fortunate indeed to find a site with such rich variety, excellent quality, and enormous quantity, as represented by the engravings on this Island."

Commenting on the condition of heritage within the States and Territories of Australia, with reference to the Depuch Island petroglyphs, McCarthy (1970:78) stated that ‘this style of art extends into the Dampier Archipelago, although it is not so abundant’. This unfortunately dismissive attitude to the Archipelago petroglyphs was, to some extent, redressed in June 2007 (CoA 2007; JMCHM 2005, 2006) by its listing on the National Heritage Register as well as a recent publication showcasing the rock art and landscape (Donaldson 2009).

It has generally been accepted that rock art within Australia has a Pleistocene antiquity. Most researchers believe that it was only during the Holocene that Australia’s distinct stylistic provinces developed (David 2002; Flood 1997; Layton 1992; Maynard 1979; McDonald and Veth 2008; Morwood 2002; Rosenfeld 2000; Ross 2006; Ross 2013 and Veth 2006, 2008). This is not the case, because recent evidence has established culturally distinct art
provenances, particularly in the north and northwest well before the Holocene (Balme et al. 2009; Chaloupka 1993; Walsh 2000). A date of minimum 28,000 BP obtained for a black pigment fragment of an image from a site in Arnhem Land (David et al. 2013) provides further evidence of the antiquity of Australian rock art. Although there are no archaeological dates which point unambiguously to the Pleistocene rock art production across the Dampier Archipelago, I argue that the rock art sequence here emerges during the Pleistocene and that this rock art corpus is distinguishable from the Kimberley and elsewhere.

Aboriginal people have been established in the Pilbara region for at least 35,000 years (Brown 1987; Law et al. 2010; Marwick 2002; Maynard 1980; Slack et al. 2009; Strawbridge 1993; Veth et al. 2007; see also Morse 2009 and Veth 1995 for lists). Veth (Veth 1993a, Veth et al 2007) has described a sequence of dates ranging from 27,000 BP to 7,000 BP for occupation sites on the Montebello Islands 120km to the west of the Archipelago. This was during a period when the intervening area was an extensive plain with dune fields, as a consequence of lower sea levels associated with the Last Glacial Maximum. Further to the southwest, rockshelters at North West Cape provided basal dates for cultural material between 35,000 and 30,000 BP (Morse 1988, 1993; Przywolnik 2005).

The only date signifying human presence within the Archipelago during the Pleistocene is in the order of 21,000 BP. A portion of a trumpet shell (*Syrinx aruanus*) found among the rocky slopes of the Gum Tree Valley site complex near Dampier provided the datable material (Lorblanchet 1992). Although this shell does not date the rock art, its presence among the rocky slopes is unlikely to be other than anthropogenic. I have observed similar situations of large mollusc shells across the Archipelago. Certainly, the fact
that stone manuports, cores and flakes occur in similar situations is suggestive of human rather than bird transport of the trumpet shell (see Bednarik 2007).

Excavations in the mid-1970s at Skew Valley established a Holocene occupation for the Burrup and indicated a dietary shift from gastropod consumption around 7,000 to 4,500 BP to bivalve consumption from 4,500 to 2,000 BP (Lorblanchet and Jones 1979; see also Bevacqua 1974a). Subsequent work by Bradshaw (1994) and others (DAS 1984) confirm a 7,000 year date for the lowest levels on Burrup middens and a slightly earlier date for gastropod midden material on Rosemary Island, an outer island.

The placement of the Skew Valley excavation was intended to provide some indication as to the age of the associated rock art. Where the excavated midden covered the block slope, four petroglyphs and a fifth rock ‘bearing a groove only’ were exposed. The associated shell layers provide a minimum age of production of the petroglyphs as between 2,700 and 4,000 years ago (Lorblanchet 1992:41). These remain the only confirmed associated dates for the Dampier Archipelago petroglyphs.

Most of the archaeological evidence confirms a Holocene occupation of the Archipelago. This is not surprising as the focus of excavations has been shell middens. The geological structure of the Archipelago does not encourage rockshelter development and opportunities for sediment build-up are minimal.

Aspects of Local History

Europeans named and renamed the islands every time they happened upon this landmass abutting the Indian Ocean. It was not until the 1970s, however, that anyone recorded what the
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indigenous inhabitants called their homeland. The history of European exploration and the nature of settlement and land-use within the Archipelago explains why so little is recorded about the original inhabitants and their culture, and why the rock art has remained so little researched.

The first reference to an Aboriginal name for the area is contained in a Western Australian Museum report which states ‘[t]he Aborigines in Roebourne refer to the Dampier Archipelago as Murujuga (“hip-bone sticking up”). It was also referred to as Kuyuru’ (DAS 1979:np.). This DAS report appears to be the earliest recording of a traditional name for the location which is now widely accepted and generally applied to the Burrup (e.g. Turner 1981, DEC 2007, Bednarik 2007). Bruce Wright (the then Registrar of Aboriginal Sites, Western Australian Museum) is the probable author of this 1979 report. Wright had a longstanding association with the Aboriginal people of the Pilbara and worked closely with them during his own rock art investigations (Wright 1964, 1968, 1970a, 1973, 1977).

When William Dampier, the first documented European in this region, sailed the Roebuck along the coast into this group of islands on 21 August 1699, he (1703:115-7) described them as:

> 3 or 4 Rocky Islands about a league from us between us and the bluff Point; and we saw many other Islands both east and west of it, as far as we could see either way from out Topmast-head: And all within them to the S. there was nothing but Islands … The large Islands were pretty high; but all appeared dry, and mostly rocky and barren. … The stones were all of rusty Colour, and ponderous.
Stepping ashore on 22 August 1699 to dig for water, he observed that ‘[t]here grow here 2 or 3 Sorts of Shrubs, one just like Rosemary; and therefore I called this Rosemary Island.’ (Dampier 1703:117). Subsequent visitors (e.g. King 1827:54–6), suggest that, based on Dampier's written description and the physical character of the islands, Dampier in fact landed and named what has become Malus Island and the bluff, Courtenay Head. Based on bearings given and distance visibility, Tuckfield (1955:15) believes that it was Enderby Island that Dampier named Rosemary, while Macilroy (1979:89–91) reasons the landing place to be Malus.

The name Dampier Archipelago was given by the French expedition led by Nicolas Baudin, who visited the location in July 1801 and at the end of March 1803. They formally named the specific islands Rosemary (Romarin) and Malus, recognising them as the islands that Dampier wrote about (Peron and Freycinet 1824a, 1824b).

Captain Phillip King passed through the area in February 1818 and named Enderby and a number of other islands. He too commented on the rugged nature of the Archipelago. Of Enderby Island he wrote, ‘we crossed several deep ravines which, together with the hills, were thickly covered with wiry grass, (spinifex) growing over and among heaps of rocks that were piled up in all directions as if done purposely; the greater part of the island being covered with these stones’ (King 1827:36). He noted that ‘tracks of natives and their fire-places were everywhere visible, and around the latter the bones of kangaroos and fishes were strewed’ (King 1827:37). King’s party encountered the inhabitants of the Archipelago, both in the water and on land, and in ‘consequence of the communication that we had with these natives, the group between Lewis Island and the main [Burrup Peninsula] was called The Intercourse Islands’ (King 1827:48-9).
Francis Gregory, who sailed round Legendre Island into what is now Nickol Bay in May 1861, made the comment that in ‘passing down the shore we observed that the whole of what is shown on the charts as a promontory, extending to the north of Sloping Head [Point], is an island, with a channel nearly half-a-mile wide, separating it from the main; to the outer portion was given the name of Dolphin Island’ (Gregory 1884:54). The misidentification of the area and its features has an extremely long history. Gregory recognised the Burrup as an island ‘cut off from the main land by an extensive salt-water marsh’, but failed to name this landmass. This was despite naming many of the lesser islands within Nichol Bay, and naming Hearson and Watering Coves on the Burrup, where his party collected freshwater (Gregory 1884).

European settlement came to the region not long after Gregory’s 1861 successful exploration and favourable reports on the pastoral potential. First settlement was established near the mouth of the Harding River. The Tien Tsin settlement (later known as Cossack) provided a port for the fledgling pastoral industry (De La Rue 1979; Withnell-Taylor 1980). One of the sheep runs established was on West Lewis Island where the remains of house structures and stone walled pens are still evident today.

Jefferson Stow (1865:187) entered Nickol Bay on 19 June 1865, sailing the *Forlorn Hope*. Based on Stow’s description, it seems likely that they landed on the midden-laden sand dune in front of the hills where the town of Karratha is today located. Sailing across the bay, Stow’s party skirted the eastern flank of the Burrup without recognising it as an island, pulling into a sandy beach at the northern tip of Dolphin Island. Here they encountered a small group of Aboriginal people. Stow’s party ‘gave them knives and tobacco’ (1865:187) and were offered cooked fish in exchange. The
sailors were shown a place to obtain ‘water in the rocks, nearly at the summit of the hills’ and observed ‘their drawings on the rocks … of fishes, turtles, lizards, and different kinds of birds, including emus’ (Stow 1865:187). This is the earliest account of petroglyphs in the Archipelago. Stow (1865:187) also observed ‘[o]ne aboriginal artist made a sketch of a turtle on the sand’.

The 1900 manuscript of an early pioneer (1876–85) to the area makes mention of rock art ‘amongst the extremely rough, hill ranges surrounding what is known as Dampier Harbour, and the adjoining country extending to the Flying Foam Passage’ (Durlacher 2013:11). John Slade Durlacher spent a period working on the West Lewis Island sheep station and his writing reveals a person sympathetic to Aboriginal culture and social justice. He makes mention that a ‘heavy, sharp pointed flint stone’ is used to produce the images of ‘men, fish and animals’ (Durlacher 2013:11).

A transient European presence in the Archipelago probably predated pastoral development. Graves on Enderby Island, reported in 1851, by their structure probably attest to American whalers operating out of these waters prior to the 1860s (Macilroy 1979:61–5). The whaling vessel *Ann & Hope* was registered as operating from Rosemary Island in 1801 and the *Vesper* in 1856 and 1857 (Langdon 1978). However, it was not until the late 1860s that locally-based whaling commenced, with land-based operations on Gidley and Malus Islands (De La Rue 1979; Macilroy 1979; Withnell-Taylor 1980). Pearlers also worked these waters from the 1860s onwards (De La Rue 1979; Withnell-Taylor 1980). On Dolphin Island there is an engraving of a pearling lugger with the name George Vincent nearby. Both technique and style suggest these were made by a pearler rather than an Aboriginal person (Figure 1.3). The earlier presence of the whalers may account for the local indigenous
people's friendliness and familiarity with European food and words, which was commented upon by King in 1818, Gregory in 1861 and Stow in 1865.

Figure 1.3: Pearling lugger at low tide, Black Hawke Bay, Gidley Island c. 1920 (Battye Library Photograph Collection No. 3488B/12); Line drawing of the scratched and pecked image of a pearling lugger drawn on rocks at a beach on the west side of Dolphin Island, across Flying Foam Passage from Gidley Island.

Local Aboriginal Affiliation

Although Dampier provided the earliest written account of the Archipelago, he made no mention of encountering any inhabitants. King (1827), during his sojourn in the Archipelago, mentions groups of people on several of the inner islands. Importantly, he describes the use of simple log rafts for crossing the seas between islands (Figure 1.4). King (1827:43) made reference to a fishing line attached to such a log raft and reported the presence at Cape Locker of crescent shaped stone tidal fish-traps (King 1827:31). These references indicate that the people occupying the Archipelago in the early nineteenth century were actively exploiting marine resources; a reality demonstrated amply by the archaeological record.
Early records concerning the identity of the people of the coastal area of the Pilbara are contained in the monumental publication on the ‘Natives’ of Australia (Curr 1886; Harper in Curr 1886:287–293; 294–5; Richardson in Curr 1886:296–301). Curr (1886:287) prefaced details of specific tribes by a generalisation that near-coastal groups, from the De Grey to Albany, lacked both circumcision and subincision (‘the terrible rite’) practised by groups further inland. This distribution of initiation practice was confirmed by Gregory (1884), however this is contra to Withnell’s (1901) account.

Whether a consequence of the pearling and whaling activities, and admixture of ‘foreigners’ into the Archipelago, the affiliation of the people occupying the islands is ambiguous. Richardson (in Curr 1886:296) stated ‘[t]he country occupied by the ‘Nickol Bay tribe’ stretches from the mouth of the Markand (Maitland) River to the mouth of the Yule River, and extends inland some twenty or thirty miles’. It is uncertain if Richardson’s reference is inclusive of the mainland and adjacent islands forming the Archipelago. His use of
the term Nickol Bay Tribe could be inclusive of the people residing on the near coastal islands including the Burrup.

Traditional ownership of the islands of the Archipelago is recorded as held by the *Yaburara* people. Norman Tindale (1974:242) records the *Yaburara* as the group that occupied the Burrup and islands to the north, assigning the western islands as part of *Mardudhunera* territory (Figure 1.5a). He records the name *Yaburara* to mean northerners in a language with a dialect similar to *Ngarluma*. Of relevance here is that the *Ngarluma* word for seaward, north and down river is *jaburru* (*yabbaroo*) as identified by H. Aubrey Hall (1971:27,62), the son of an early settler in the Pilbara. *Yaboo-rannee* is recorded as ‘[d]esignating that portion of the *Ngalooma* tribe living about Flying Foam’, the passage along the western side of the Burrup (Hall 1971:28). It is also recorded that Hearson Cove is known by the word *Jurina* [alternative orthography *Yoo-rin-tha* (Hall 1971:73)].

Von Brandenstein (1967:3; 1970) also records the *Yaburara* (*Jaburru* = north; *Jaburrara* = northern *Ngarluma*) as a northern linguistic division of the *Ngarluma* and describes them as the inhabitants of the Archipelago. He includes the mainland section between the Maitland River in the west and the Nickol River in the east. Emile Clement (1903:2), who journeyed through the area from the Fortescue to the Fitzroy Rivers in 1896–98, recorded the *Maratunia* Tribe as being between the Fortescue and Nickol Rivers. His accompanying map (Figure 1.5b) indicates that the western islands of the Archipelago, and what appears to be the Burrup including Dolphin Island, belonged to the *Maratunia*. The northeastern Archipelago islands and mainland including Cape Lambert are recorded as belonging to the *Gnalluma* (Clement 1903:2).
Documenting land affiliations associated with the 1962 investigations of the Depuch Island petroglyphs, an island located 90km to the east of the Archipelago, Berndt (1964:65) noted:

Was told that Depuch, as well as all the coastal area towards Onslow [west], originally belonged to the Madudunara. Around Roebourne and further inland the Ngaluma territory extended, … Tindale (1940) gives a slightly different position for the Madudunara. However, I prefer to rely on my Aboriginal informants’ comments in this respect.

From Ron Berndt’s research it would appear that Mardudhunera and not Ngarluma were the people traditionally associated with the islands along the section of coast between the Fortescue River and Balla Balla Creek. Depuch is regarded today as part of the Ngarluma territory and the islands of the Archipelago as shared country. This shifting land ownership may, in part, be explained by several historical events which had demonstrable effects on the region’s population. In the historic accounts, the devastating effect
of smallpox is recorded. The epidemic reached the De Grey River area 300km to the east of the Archipelago in 1865 and into the Nickol Bay location in 1866. Richardson (in Curr 1886:296) stated that his ‘Nickol Bay Tribe’ ‘numbered from two hundred and fifty to three hundred persons, but a decrease has since taken place as a consequence of small-pox, which committed considerable ravages amongst them in 1866’.

With so little recorded about the *Yaburara* it is now difficult to ascertain whether they were a distinct socio-linguistic group, or a northern or coastal *Ngarluma* sub-group. Whatever the situation, the smallpox epidemic of 1866 (Richardson in Curr 1886) and the consequences of the ‘Flying Foam massacres’ of 1868 (Gara 1983) effectively removed them as an extant group. Certainly by the 1970s it was acknowledged that the *Ngarluma* occupied the adjacent mainland ‘that a different people occupied the Archipelago, and that they are now long gone’ (Dix and Virili 1977:89). This is a fairly standard understanding of the circumstance of deceased estates being subsumed by adjacent groups with affiliate rights. However, as many Land Rights and Native Title Claim investigations show, descendants of supposedly extinct groups do exist. This situation is no different on the Archipelago, where some *Yaburara* matrilineral descendants identify as such.

In the late 1990s the Dampier Archipelago was subject to three Native Title Claims: *Ngarluma/Yindjibarndi* (WC99–014), *Wong-Goo-Ti-Oo* (WC98–040) and *Yaburara/Mardudhunera* (WC96–089). In 2004 the *Ngarluma/Yindjibarndi* Native Title Claim was heard in the Federal Court. One of the findings was that Native Title rights over the Dampier Archipelago had been extinguished. However, *Ngarluma* Native Title rights were still held to exist over much of the mainland extending across the Abydos Plain into the
Chichster Range. The Wong-Goo-Ti-Oo were held to be part of the Ngarluma without Native Title in their own right. However, the Wong-Goo-Ti-Oo group continue to dispute this matter through the courts.

Prior to this Native Title determination, in January 2000, the State of Western Australia notified the Native Title claimant parties of their intention to acquire land for the construction of a heavy industrial estate on the Burrup Peninsula, West Intercourse Island and the adjacent Maitland area. The Native Title parties signed off on the Burrup and Maitland Industrial Estates Agreement Implementation Deed in November 2002. The Wong-Goo-Ti-Oo negotiated a supplementary agreement, the Burrup and Maitland Industrial Estates Agreement Additional Deed, which was signed by all parties. The agreement provided a number of significant concessions on heritage issues. These included the participation of relevant Aboriginals in all heritage surveys, and that ‘site identification’ surveys of the proposed industrial lands be conducted within five years (section 6) of the deed ratification. This final agreement, known as the Burrup and Maitland Industries Estates Agreement (BMIEA), was not executed until 16 January 2003. The three groups party to the agreement are recognised, in accordance with the BMIEA, through the collective name Ngarda-ngarli and are represented through the Murujuga Aboriginal Corporation. This agreement gave a controlling interest by the Aboriginal representative group, through a joint management National Park arrangement, over 49.13km² of the northern Burrup not subject to industrial planning. The Murujuga National Park was proclaimed on 17 January 2013. However, contra to the BMIEA, only a small portion of the identified survey area has been subject to archaeological investigation.
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Murujuga Geology
To understand the topographic and physical patterns within the rock art, it is worthwhile considering the nature of the rocks providing the ‘canvas’ for the petroglyphs. The different rocks with their associated crystal structure, physical properties and weathering patterns determine the character of the surface on which the artists executed their works. Laid down some 2,900–2,700 Ma, the rock mass that is the Archaean sill has domed upwards and cracked along major tension joints, allowing subterranean weathering to occur. This has resulted in deep linear valley formations within an otherwise undulating land surface. During successive climatic fluctuations, which ranged from periods of extreme aridity to high rainfall, the overlying sediments have been eroded to expose the (underlying) closely jointed igneous rocks. Through time, these have fractured and weathered to form a distinctive landscape of angular block massifs (Figure 1.6) which are often, incorrectly, referred to as scree slopes (e.g. Clarke 1978, DAS 1984, Vinnicombe 1987a). The subsurface weathering and subsequent exposure formed disaggregated blocks and angular cobbles, more or less where they now are.

Many of the outer islands of the Archipelago comprise basalt and andesite of the Fortescue Group, which ‘unconformably overlie the Dampier Granitoid Complex and are intruded by the Gidley Granophyre’ (Hickman 2001:26). The Gidley Granophyre is ‘a thick sheet … which has a basal gabbro and is intruded along the basal unconformity of the Fortescue Group’ (Trendall 1990:174). The basalts derive from volcanic eruptions. On Rosemary Island, the volcanoclastic sediments (ash and debris) indicate that these were deposited in a submarine environment (Donaldson 2011).
The northern islands of Legendre, Hauy and Delambre, as well as some of the smaller outer islands, are composed of limestone (calcareous sands and marine shell fragments). These are relatively soft and less suitable for the preservation of rock art. While at Port Hedland petroglyphs are recorded on limestone (McCarthy 1962b), no petroglyphs have been reported on this bedrock in the Dampier Archipelago.

Outcrops of basal granite occur throughout the near coastal islands (Figures 1.7 and 1.8). Unlike other exposures of Pilbara granitoid complexes (see Trendall 1990:142), there have been few petroglyphs noted on the Archipelago granites. Perhaps the inhabitants of the Archipelago did not target this rock type for production of their rock art. Considering that other Pilbara granites form the canvases for numerous petroglyphs, it is more likely that erosion of the friable and granular nature of this local rock, susceptible to greater coastal weathering, have not retained this cultural evidence.
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Figure 1.7: Indicative geological map of the Dampier Archipelago, the granite being the basal rock overlain by the intrusive Gidley Granophyre (2,725 million years), and by extrusive basalts and volcaniclastic sediments; with much more recent Pleistocene limestone and infilling of Holocene age sands, alluvium and mud flats.

Figure 1.8: Example showing the formation, surface texture and structure of the basal granite; location at Watering Cove, east side of Burrup, characterised by exfoliation weathering.
Granophyre dominates the rock types on the Burrup and adjacent islands, with igneous rocks such as gabbro, granite and dolerite (dykes), particularly on the eastern margin (Figure 1.7; see Trendall 1990, Brice and Abeysinghe 1998, Hickman 2001, Donaldson 2009, 2011). Bednarik (2007:216) suggests that the rock selected for production of petroglyphs is ‘fine-grained Mesozoic rock rather than the older (Precambrian) porphyric facies, … they are most likely dolerites, diorites, basalts or gabbros’. However, there are no Mesozoic rocks associated with the Archipelago geology.

Gabbro, directly overlying the granite along the eastern margins of the Burrup and Dolphin Island, appears in two discrete forms. The lowest unit has distinctive branched needle-like crystals tens of centimetres long, and is extremely coarse-grained. These features are indicative of rapid cooling or quenching of the liquid magma (Donaldson 2009, 2011). Outside this quench zone, the gabbros exhibit a variable grain size, but are generally coarse and weather to a rough or very rough surface texture, with a deeper weathering rind (c. 10mm) than is found in the granophyre (Figure 1.9). The weathered profiles of both lithologies are similar and exhibit no visible colour variation through the section. The relatively softer character of this weathered crust, in comparison to the unaltered parent-rock, means that average petroglyph depth on gabbro is greater than on the granophyre, reaching up to 10mm compared with c. 5mm.
Defined by the classic feature of a granophyric texture, granophyre is a structure of simultaneous crystallisation of the quartz and alkali feldspar minerals (Figure 1.10). The granophyre ranges from ‘dark green, dark blue, purple or black, in colour that sometimes gives a false impression of coarse granularity due to a patchy mottling of two contrasting colours; one local variant has red and green mottling’ (Trendall 1990:174). This is due to the presence of the mineral olivine. Granophytic rock is mechanically strong, impermeable to water and highly resistant to chemical weathering (Clarke 1978:1). Due to its extreme hardness and fine-grained nature, this rock produces a smooth flat surface which appears to have attracted ancient artists (Figure 1.10). It was also used in the manufacturing of stone tools (DAS 1984; Veth 1982).
Dolerite is the third lithology relevant to the production of petroglyphs. Later intrusions flowed through the joints and faults formed in the older rocks. These dykes criss-cross the Burrup and adjacent islands: some are tens of metres across, others are less than a metre wide (Figure 1.11). These are medium grained basic rock formed under conditions between plutonic and volcanic. With one exception at the northern end of Watering Cove, these dykes do not show evidence for rock art production. The Watering Cove dolerite dyke is 350m long and up to 15m wide, and has c. 400–500 petroglyphs.

On those islands dominated by basalt, like Enderby and West Lewis, these surfaces were utilised as canvases for the production of rock art (Figure 1.12). Although relatively hard, basalt is more susceptible to weathering than the other lithologies. This may explain why the density of rock art is not as high or extensive as found in the granophyre and gabbro locations.
Figure 1.11: Example showing the formation, surface texture and structure of dolerite dyke; location at Watering Cove, east side of Burrup.

Figure 1.12: Example showing the formation, surface texture and structure of the basalt; location in central Enderby Island.
The granophyre and gabbro are both extremely hard rocks that have been subject to chemical weathering over immense periods. Using cosmogenic nuclide measurements, erosion rates of c. 0.2mm/1,000 years on horizontal rock surfaces and c. 1mm/1,000 years on vertical rock faces are indicated. These are among the lowest erosion rates measured anywhere in the world (Pillans and Fifield 2013). This weathering is expressed as a structurally intact rind or crust formed by the oxidation of minerals, giving a pale brown to dark reddish-brown surface colour. The greater the time exposure of the rock surface, the darker the oxidation colour (see also Bednarik 1979). This is demonstrated where rock slides or fracturing have occurred on individual blocks, exposing fresher (lighter coloured) surfaces. Clarke (1978), in a thin-sectioning study, showed that the weathering front penetrated millimetres into the rock, leaving a rind of iron oxide as well as rock varnish deposition. This pattern is the same for each of the petrologies sampled (granophyre, gabbro and dolerite), although it is thinner in the granophyre compared to the gabbro sampled (see Pillans et al. 2008).

The Dampier Archipelago is effectively a drowned landscape; the islands are partly inundated hills and ridges that rise from what is now a submarine plain. What were the lower hills and rises now form the rocky reefs on which corals are growing. Submerged valleys are the channels and embayments, often following the present terrestrial geomorphology. Above present sea level are the massive, near barren rock piles of gabbro and granophyre, in places interspersed by Pleistocene limestone and fringing beach dunes. On the Burrup and Dolphin Island the gabbro block ranges are best expressed, rising over 100m and in some cases to 125–130m above current sea level (ASL). Most other islands, especially those with an underlying basalt lithology, rise no more that 30–80m ASL and are
dominated by spinifex-covered undulating hills and broad valleys of quaternary sediments.

Heavy precipitation during some stages of the Pleistocene leached calcium carbonate from the igneous rocks and soils, to redeposit as carbonate concretions (Chappell 1982b; Pillans et al. 2008). Bednarik (2007:215) considers that a ‘pre-Quaternary deposit, now depleted, has provided this saprolithic material’, claiming that these formations only formed during the Holocene. Certainly, some marine shell (derived from shell middens) embedded in these carbonate deposits, especially within some of the main valley site complexes, attest to a Holocene age for the upper layers of these formations within the valley floors. Two shell and carbonate deposits in which they were imbedded, obtained from the Happy Valley site, were collected to confirm a Holocene association. Radiocarbon dating provided results of 3,853±59 BP for *Anadara*, the carbonate 2,069±63 BP (S-ANU# 18631, 18603) and for a baler shell fragment 3,552±59 BP the surrounding carbonate 2,355±45 BP (S-ANU# 18638, 18639).

Carbonate concretions are found predominantly in valleys where the deposits may be up to 2m thick (Figure 1.13a) and calcium carbonate is also dispersed as localised lenses and pavements in depressions among the block slopes at all elevations almost up to the summits (Chappell 1982b; Pillans et al. 2008). These redeposited features have an important bearing on localised water storage pockets where plant growth and soil accumulation is promoted (Figure 1.13b). Samples taken from these elevated deposits have provided dates in the range of 33,000 to 18,000 BP (Brad Pillans pers. comm. Jan 2010). This confirms a much wetter (cooler) period in the Pleistocene which appears to have extended into what is regarded as the height of the Last Glacial Maximum (LGM).
Across the Burrup and some other islands, steep-sided valleys contain sporadically flowing watercourses that follow vertical joints in the rock. These intersecting valley systems impose a linear patterning on the rugged terrain. They provided important movement corridors for past populations as well as crucial water resources in the form of rock pools (Figure 1.14). Rainfall drains from elevated areas via ephemeral creeks and streams and through the fractured rock mass to temporary pools formed in rocky depressions along these significant valleys. It has been claimed that surface run-off is relatively efficient (low retention) due to the inability of surface water to infiltrate through the dense ‘volcanic and granitic’ rocks (e.g. DEC 2007). However, having observed water continue to seep out some ten months after a cyclonic rain event, I contend that it is the very nature of the rugged block slopes that, in fact, capture much of the water during rainfall events.
The water penetrates through the capping of disaggregated blocks protected from evaporation. This subsurface water enters the local fractured rock aquifers. As a consequence, this subsurface water, stored in the joint and fault fracture planes and cavities within the rock mass, percolates out, sustaining rock pools and small soaks. This proved a vital factor in animal and human survival.

*Figure 1.14: One of the many rock pools fed by cyclonic rains sustaining life through the drier parts of the year, location north end of Burrup, it is some 14m by 10m in extent and several metres at its deepest.*

**Murujuga Environment**

The Dampier Archipelago lies at the western edge of the semitropical Pilbara region within Australia’s arid zone. The climate is commonly described as having two seasons: fine, warm and dry winters from May to October; and hot, wetter summers from November to March, with high temperatures rising to the mid-40sºC, and episodic cyclonic winds and rain. July is the coolest
month with average minimum temperatures of 13°C and maximum of 26°C (BoM 2013). February and March are the hottest months averaging 26°C minimum and maximum above 36°C. Summer temperatures frequently exceed 40°C with extremes of up to 47°C.

Across the Archipelago, the Pilbara’s high temperatures and low humidity are moderated by the influence of the sea. Generally, Dampier benefits from a degree or two cooler temperatures than are recorded at the nearby mainland town of Karratha. The microclimate of the islands is cooler and more humid than the inland Pilbara. The Burrup (at 118km²) is two-thirds larger again than any of the other islands, yet no point on the landmass is more than two kilometres from the sea.

Erratic rainfall is influenced by both the northern tropical cyclonic systems in summer and the southern winter rainfall systems. The average annual rainfall at Dampier is 261mm (c. 10ins). Although there is great variation between years, the mean number of days of rain is just twenty-three (BoM 2013). Records show that February and March are the wettest months, while October and November are the driest. The annual evaporation rate is 3,500mm (137¾ins); the clear skies and near constant winds provide ideal conditions to draw the moisture from the land. Rainfall events between November and April are associated with tropical cyclones or scattered summer thunderstorms. The Pilbara coast is one of the most cyclone-prone areas in the world, with tropical cyclones and their destructive winds of up to 250km per hour threatening the coastline annually (BoM 2013; Wilson 1980).

The Archipelago falls within the Fortescue Botanical District, dominated by spinifex hummock grasslands, with few shrubs (Beard 1975). Soils are generally shallow and the vegetation sparse, offering little shade. In the valleys where there is greater moisture
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retention and deeper soil, more luxuriant growth is supported, and the ephemeral watercourses are usually marked by a ribbon growth of white-trunked river gums or coolabah trees (*Eucalyptus microtheca*). There is an obvious contrast between the plant communities of the Archipelago and that of the adjacent mainland. The key differences are due to microhabitats created as a result of a combination of topography, geology and soil types of the rugged, block-capped Archipelago, compared to that of the relatively flat sand-sheet structure of the Abydos Plain. A total of 310 plant species have been recorded on the Burrup, which represents a high species-diversity per unit area by comparison with adjacent vegetation patterns (Burbidge and Prince 1972; Trudgen 2002; WPD 1979).

Diversity derives in part from two distinct flora: 1) a tropical plant element associated more with the Kimberley region; and 2) a southern plant element more common to the wider Pilbara region and keyed to the erratic winter rains. The tropical or Kimberley elements flower from March to April (following cyclonic rains) and fruit in May and August, but earlier rains may stimulate advanced growth. The southern flora species usually flower through the months of August to October (Beard 1975; Blackwell *et al.* 1978). Having tropical and southern arid-temperate plant communities extant in the Archipelago enhances the range and seasonal availability of plants potentially useful for exploitation. At least twenty-five species are known to have been used as food by the Aboriginal people, while others were medicinal, or provided material for the manufacture of a range of wood and fibre artefacts (Turner 1981; Wright 1970b).

The fruits of the White Mangrove (*Avicennia marina*), which grows abundantly in the sheltered embayments, also provided seasonal food. The fruits were detoxified through lengthy burial in the mangrove mud, and there are reports of Aboriginal people
in the Nickol Bay area first boiling the fruit in large shells prior to pounding and eating it (Hall 1971:22), which may explain the many fragmented and burnt bailer shell found on middens here. Mangrove poles were also used in the construction of the rafts for travel between the islands (Gregory 1884; King 1827; Turner 1981). Gregory (1884:86), recorded seeing stacked mangrove wood and nets at Hearson Cove. The multi-purpose kurrajong tree (*Brachychiton australis*), that grows in crevices among the rocky slopes, yields seeds that were ground by Aboriginal people for flour (Figure 1.15b). It also provided gum for hafting implements, and fibrous bark for use as string or twine. Kurrajong also has edible tuberous roots which store water, and light-weight boughs which were used for buoyant watercraft (Turner 1981).

Of particular relevance to plant exploitation in the study area is the relatively high number of relict tropical or ‘Kimberley’ species. These include edible figs, nuts and underground tuberous roots. On the Burrup most of these tropical plants are distributed in microhabitats created by pockets in the rock ridges and slopes where soil has accumulated. Such places are associated with the localised platforms of carbonate, which appear to trap rain run-off from the hills, and may be localised springs. These discrete plant communities grow in roughly circular shapes, and are scattered through otherwise bare and rugged rocky terrain (see Figure 1.13b). A dominant tree is the sea almond (*Terminalia supranitifolia*) which bears a tasty and nutritious nut. This is only found on the Burrup and Dolphin Island in the Pilbara (WPD 1979). Other ‘Kimberley’ species that do not grow elsewhere in the Pilbara, but which thrive here, are the fruit-bearing saltbush (*Phagodia sp.*), and a number of edible tubers or yams. These include *Portulaca pilosa, Vigna lanceolata, Ipomoea costata, Operculina brownii*, and five species of *Boerhavia.*
Figure 1.15: Arid and tropical species trees of the Burrup a) White Gum; b) Kurrajong; c) Corkwood; and d) Rock Fig; providing resources throughout the variable seasons.

*Triodia pungens*, spinifex (Beard 1975, see also Burbidge and Prince 1972), or as it is now referred to as *T. epactia* (Burrup form; Woodside 2006), is widely distributed. It provided an important
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resource for Aboriginal people (Figure 1.16). Seasonal harvests of seed were ground into flour, mixed into dough, either eaten raw or baked in hot coals (Angelo 1948; Clement 1903). Seed-grinding patches are a common feature of the archaeology of the Archipelago, especially on the Burrup, and in places utilise the same rock surface on which petroglyphs are situated.

![Figure 1.16: Spinifex grass covers the area between the rock formations, among its many uses the leaf can be used for string, shelter and burning fuel, while the seed is highly nutritious and the resin provides a fixative compound.](image)

Spinifex was also plaited into fibrous twine from which carrying baskets, fishing nets and animal traps were made (Clement 1903:2–3; Curr 1886:299; Gregory 1884:58, 73, 86; Withnell 1901:21–2).

The resin was used for hafting stone artefacts, and clumps of spinifex vegetation were piled together to form windbreaks and temporary shelters (Clement 1903). Clement, who travelled through the Pilbara in the late 1890s, noted that ‘spear-heads are fastened
to wooden shafts with *bulga*, ... a gum obtained by burning green *Spinifex*’ (Clement 1903:5). In fact this gum can readily, and more efficiently, be obtained from the numerous ant nests and trails that occur on the rock surface throughout the Archipelago. The laborious collecting and processing is done by the ants; all that remains is to heat and mould the product. It certainly would have been a highly prized resource.

A wide range of marine biological habitats are present across the seabed of alternating igneous basement rock, limestone capping, sand and mud, each supporting its own characteristic biotic assemblage (WPD 1979). The inter-tidal zone is rich in molluscs and crustaceans, which were an important food source for the Aboriginal people (Harris 1988; Lorblanchet and Jones 1979). The two most abundant molluscs, in terms of archaeological remains, are *Terebralia palustris* and *Anadara granosa* with a number of other species including oyster and chiton (Bradshaw 1994; Harris 1988; Vinnicombe 1987a). There is variation in the dominance of shellfish species through time (Bradshaw 1994; Lorblanchet 1985; Harris 1988), this possibly relating to sea-level fluctuations.

A copious and diverse supply of fish can be found in embayments with stands of mangroves. Abundance and distribution of many fish species change seasonally, dependent upon water temperature and nutrient availability. Many of the embayment fish move in and out of the inter-tidal zone to feed with the rise and fall of tides, and are in turn sought by larger predators. The Aboriginal population exploited marine faunal feeding habits through the use of stone weirs in which they trapped fish on receding tides: several examples still exist on the southern end of Dolphin Island, facing onto Searipple Passage. There are reports of fishing line and also fibre nets, which were in some cases over 8m long (Gregory 1884:58, 73;
King 1827:43; Withnell 1901:21–2). Richardson (in Curr 1886:299) states that ‘fish they take with nets and spears, but have no hooks’: certainly no fish hooks have been reported from sites along the Pilbara coast (Bradshaw 1994; Clune 2002).

Seagrass, which is most prolific in summer, is an important food source for the turtles and dugongs that abound at this time of year. Turtles, of which at least five species breed in the Dampier Archipelago, mate and lay eggs during the warmer weather from September to March (CALM 2005:37). Turtle flesh and turtle eggs would have been an important dietary item at this season (King 1827:46) and remains of these have been recorded in excavations (Vinnicombe 1987a). Stow (1865:187), who mixed with a group of people (probably on the northeastern end of Dolphin Island), made the observation that they ‘had short pointed sticks from one to two feet in length that they informed us were used for stabbing turtles’. Wickham (1843:80) comments that ‘[a]ll the islands are connected to the mainland by extensive flats and ridges of sand, which become quite dry at low water spring-tides, and afford great facility to the natives in reaching them for the purpose of procuring turtle and fish’. A ‘sharp pointed wooden skewer’ is also mentioned as used in conjunction with nets in hunting dugong (Durlacher 2013:61).

The area is also on a migration route of the Humpback whale. These creatures entered the sheltered waters of the Archipelago as a resting area, chiefly for females with calf. They present an important potential food resource, and although not necessarily actively hunted, beached animals were exploited. Extensive dugong feeding grounds occur between the islands and adjacent mainland coast. Finds from excavations and the compositions in the rock art attest to these animals being an important resource (DAS 1984).

A total of 141 species of terrestrial vertebrate fauna have been

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recorded from the study area. The majority of these are birds (95), followed by reptiles (32), native mammals (9), feral mammals (3) and amphibians (2) (WPD 1979). A high proportion of the bird species depend on the rich invertebrate food supply exposed at low tide. The mangroves provide the main nesting habitat for the littoral zone species. King (1824:15) observed that ‘the strait bet.[ween] Legendre and Gidley Is. is full of shoals which at daylight dry, were covered with immense flights of pelicans and water-fowl’. Owen (1933:194) commented that Aboriginal men’s ‘skill in spearing-fish and bringing game to ground is a delight to watch. Birds on the wing are brought down with the kaili’: a hardwood, L-shaped or slightly curved and pointed at both ends; also used for taking fish, or killing boomerang for fish (see Clement 1903:3–4). It is also recorded that people used snake and bird lures for catching hawks, using natural bush or artificially erected screens (Clement 1903:2). One of the many possible uses of the pits found within the rocky formations of the Archipelago were as hunting-hides (DAS 1984). Against this interpretation, some believe these to be natural features, part of the block weathering process, and dismiss them as ever being utilised (ACHM 2003).

Of the terrestrial fauna, by sheer numbers, wallabies and euros (also known as wallaroos) would have provided the greatest quantity of meat, and the larger reptiles are known to have been eaten (Clement 1903; Withnell 1901). Rocky hills, closely followed by coastal dunes, were the habitats that scored the highest ranking for numbers of species collected (WPD 1979). Euros in particular take refuge in lairs and pits among the rocks during the heat of the day, and this habitat is where engravings of large macropods are most commonly found. Euros are highly territorial animals and predictably return to the same spots throughout their lives (Ride 1970). Not all food, however, had to be large and highly visible, as Angelo (1948:18) noted:
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*White ants which in the North grow to a large size and are very plentiful, and destructive, - especially in the hot wet months, were also a considerable item in the blacks larder. A large flat stone would be heated on the coals, handfuls of the termites thrown on to it and then scooped up as they browned and eaten with relish.*

**Aspects of Paleoclimate**

At the time of theorised first human presence in the region, the sea level would have been 60–70m below current stand, and dropping (see Lambert and Chappell 2001). Yokoyama et al. (2001) investigated sea-level history through analysis of sediment cores in the area to the north, in the Bonaparte Gulf (off the Kimberley coast). The LGM sea level was mapped to be 120m below the present. The postglacial marine transgression sea level rose sharply from c. 16,500 BP (Lambeck et al. 2002:358). At c. 12,000 BP the sea level was still approximately 53m lower than that at present, culminating in a c. 2m sea-level high-stand some 6,000 years ago (Baker et al. 2001; Lessa and Masselink 2006, Ward et al. 2013).

This late Pleistocene occupation phase came at the end of a period associated with much wetter conditions, attested by the existence of mega-lakes across Australia (Bowler et al. 2001; Jones and Bowler 1980; Kershaw and Nanson 1993). Dating of the calcium carbonate formations within the block slopes on the Burrup to 27,000–18,000 BP confirm this wetter phase locally (Brad Pillans pers. comm. Jan 2010). Evidence from Lake Gregory, in north Western Australia, indicates paleohydrological conditions spanning the last 300,000 years. This attests that the Quaternary monsoon provided the required conditions (Bowler et al. 2001). The data indicate that there were mega-lake phases at approximately
100,000-year intervals, with dune building phases (more arid) when the monsoons shifted northward. A final lake expansion event occurred in the early/middle Holocene, which is indicative of conditions significantly wetter than those of the late Holocene (Bowler et al. 2001:78). Evidence of human presence in the Lake Gregory area was provided by artefacts recovered from sediments dated to older than 37,000 BP (Veth et al. 2009).

Corroborating this late Quaternary situation is the phytolith evidence from Carpenter’s Gap rockshelter in the southern Kimberley (Wallis 2001). Phytolith species patterns obtained from the excavated sediments indicate a trend from wetter conditions some 40,000 years ago, with gradual drying associated with less rainfall and lower temperatures toward the LGM (Wallis 2001). The pattern suggests a comparatively wetter period from 30,000 to 25,000 BP. This situation is matched by the development of calcium carbonate deposits on the Burrup. Here, however, the evidence is that this wet phase continued well into the LGM (Pillans et al. 2008). Following the dry associated with the LGM (c. 25–17,000 BP), conditions gradually returned to a period of increased water availability by the Holocene.

Conditions associated with the LGM would have seen temperatures drop even further than the preceding cold period, wind speed increase and the sea level retreat to about -120m. During the LGM conditions the Burrup probably would have had less rainfall or surface water availability than was previously encountered by any residential human population. Sea surface temperatures were about 4°C cooler; consequently tropical cyclone formation would have weakened, providing for a generally drier climate than today (Webster and Streten 1978). The LGM conditions resulted in a massive outward expansion of the arid zone,
with dune mobilisation and diminished vegetation cover.

Following the LGM, conditions began to ameliorate, with an associated rise in sea level and increased cyclonic penetration into the Pilbara. There is evidence from the Kimberley to suggest that the Australian summer monsoon was fully active by 14,000 BP (Wyrwoll and Miller 2001). Indications are that the rate of rise associated with the marine transgression was rapid, if erratic, reaching slightly higher than the present level 6,000 years ago (Lambeck and Chappell 2001, Ward et al. 2013). The pause in the progressive flooding of the Sahul Shelf may be linked to the Younger Dryas between 12,500 and 11,500 years ago (Kershaw 1995; Lambeck and Chappell 2001:683; Lambeck et al. 2002:358).

Holocene conditions fluctuated; some changes were associated with general climatic trends, others were tied to localised sedimentary conditions (Semeniuk 1993). Relatively warmer and wetter conditions occurred during the early Holocene, marked by an increase in lake water levels in northern Australia and the southward movement of vegetative communities to their present position (Kershaw 1995). A drop in sea level between 4,500 and 4,000 years ago resulted in a reduction in mangrove communities and the tidal inlets. These changes will have had profound effects on the economic and social aspects of the people living in the Archipelago, attested to in the shellfish sequence in middens across the islands (Bradshaw 1994; DAS 1984; Harris 1988; Lorblanchet and Jones 1979).

The availability and predictability of surface water was an important influencing factor in supporting a human presence in the Archipelago. At different times this availability would have altered, with increased conditions of water in the system prior to the LGM and during the early Holocene. Between 12,500 and
11,500 BP people would have experienced colder, drier conditions than today, with marked fluctuations between cold and dry and tropical conditions after the onset of monsoons c. 14,000 BP. Much of the Holocene would have presented climatic conditions similar to current patterns. The presence of relic tropical vegetation species suggests the Burrup and other larger islands of the Archipelago provided slightly modified climatic conditions. This circumstance allowed for non-arid adapted species to survive through the more adverse climatic regimes.

Based on the general trends in climate and sea-level data it is possible to build up a sequence of conditions likely to be encountered by any local human population:

• 30,000 to 24,000 years ago, conditions were favourable, with a wetter and slightly cooler situation and overall environmental productivity likely to have been higher than today;
• 23,000 to 17,000, cold conditions, high winds and low surface water availability, with the ocean some 100km to the west and at its lowest;
• 17,000 to 14,000, improving conditions with rising temperatures, increased precipitation and encroaching seas;
• 14,000 to 12,000, better conditions with the re-establishment of the monsoon system, providing more reliability for surface water reservoirs, improved and possibly increased range of vegetation species (both tropical and temperate);
• 12,000 to 11,000, return to worsening conditions associated with the Younger Dryas, probably cooler and drier than the preceding period;
• 10,000 to 5,000, conditions were markedly improved, and people would have experienced a wet, relatively stable climate and the establishment of the local marine environment. Sea-level high-stand of c. 2m at end of postglacial marine transgression;
• 5,000 to 3,000, a switch back to fluctuating cold and dry conditions, probably associated with the expansion of arid adapted plant communities through the islands; and
• Post 2,000, improved conditions with seasonal establishment of more predicable monsoonal conditions. Drop in sea level from high-stand c. 1–2m.

The environmental data sets the framework for understanding the archaeology and interpreting the patterns within the rock art. Precisely how this may relate to the subject depiction and provide temporal indices for the Dampier Archipelago petroglyphs will be explored in later chapters.