4 Backed and Forth: An Exploration of Variation in Retouched Implement Production on the South Molle Island Quarry, Central Queensland

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Abstract
The South Molle Island Quarry is unique in Australia because it is situated on a reasonably remote island off the east coast of Australia, and is formed from a rare and distinctive type of extremely high quality stone. The isolation and distinctive nature of the stone provides an opportunity to examine procurement costs and distribution patterns at a regional scale, while also possessing a large number of retouched flakes at various stages of production. The aim of this paper is to describe the origins, properties and form of outcrop of the distinctive stone found at this quarry, and to determine whether retouch on the South Molle Island Quarry is directed exclusively at the production of large backed artifacts (i.e. "Juan Knives"), or whether additional retouch strategies were practiced at the site. This is achieved through the use of metric and non-metric analyses which determine both the extent and degree of variability within the retouched flakes found at the quarry.

Introduction
Descriptions of prehistoric Aboriginal stone quarries are rare in Australian archaeological literature, yet they remain an important source of information. This is because they allow us to understand the variation, range of strategies and frequency of production failures that underlie the procurement and production of stone implements and raw materials that are transported away from quarries, and therefore form a highly informative subset of Australian archaeological sites. The South Molle Island Quarry, located in the Whitsunday Islands, is unique in Australia because it is situated on an island, some 2km from the mainland, and is formed from a rare and distinctive stone raw material type. The quarry thus presents a unique opportunity to examine, not only procurement costs and distribution patterns at a regional scale (the subject of future studies), but it also possesses a large number of retouched artefacts of both informal and formal (backed) design, and therefore lends itself to the description of early stage implement production and the level of variation within techniques in this region. The South Molle Island Quarry is also significant as there is now evidence that it was utilized for at least the last 9,000 years for the production of stone artefacts found throughout the Whitsunday region (Lamb 2005).

Backed artefacts in Australia continue to be defined by a wide range of typological categories, determined by morphological differences, the use of which is often supported by distinct spatial and temporal boundaries between 'types' (McCarthy 1976; Mulvaney and Kamminga 1999; White and O'Connell 1982). In recent years there has been a growing body of evidence that deconstructs these boundaries – temporal, spatial and typological – as being less clearly defined than previously thought (Hiscock 1994; Hiscock and Attenbrow 1998; McNiven 2000). This throws into doubt the validity of such classificatory systems across the spectrum of types, not only, but including backed artefacts. This has led to a range of fresh approaches to the study of stone artefacts in Australia, with an increasing tendency to turn away from typologies and focus instead on technology and processes of artefact reduction and manufacture (Clarkson 2002; Clarkson this volume; Hiscock and Attenbrow 2002; Hiscock and Attenbrow this volume; Hiscock and Clarkson this volume). Exploring variation in artefact morphology in this manner, with the expectation of clinal patterning, and using measurements drawn from an understanding of manufacturing technology, opens the way for inclusion in the analysis of a larger number of artefacts that would not normally meet the requirements of formal typologies, and does so without making arbitrary judgments about prehistoric knappers' intentions.

This type of analysis is meaningful in the South Molle Island context because the quarry contains formal implements (backed artefacts) from initial stages of raw material procurement through to final stages of retouch (Lamb 1996). The identification of these systems requires the separation of distinct technological groupings, which requires measurement of variation and overlap, as well as the identification of strategies involved in their manufacture. Typological systems are not well suited to addressing these issues because they are often constructed without reference to technology or process, and thus suppress variation within the boundaries between types.

In this paper, I examine a sample of 445 retouched artefacts from the South Molle Island Quarry on the central Queensland coast. As backed artefacts were manufactured at this locale, it is expected that a portion of the retouched artefact sample will represent stages in the manufacturing process. The aim of this analysis is to

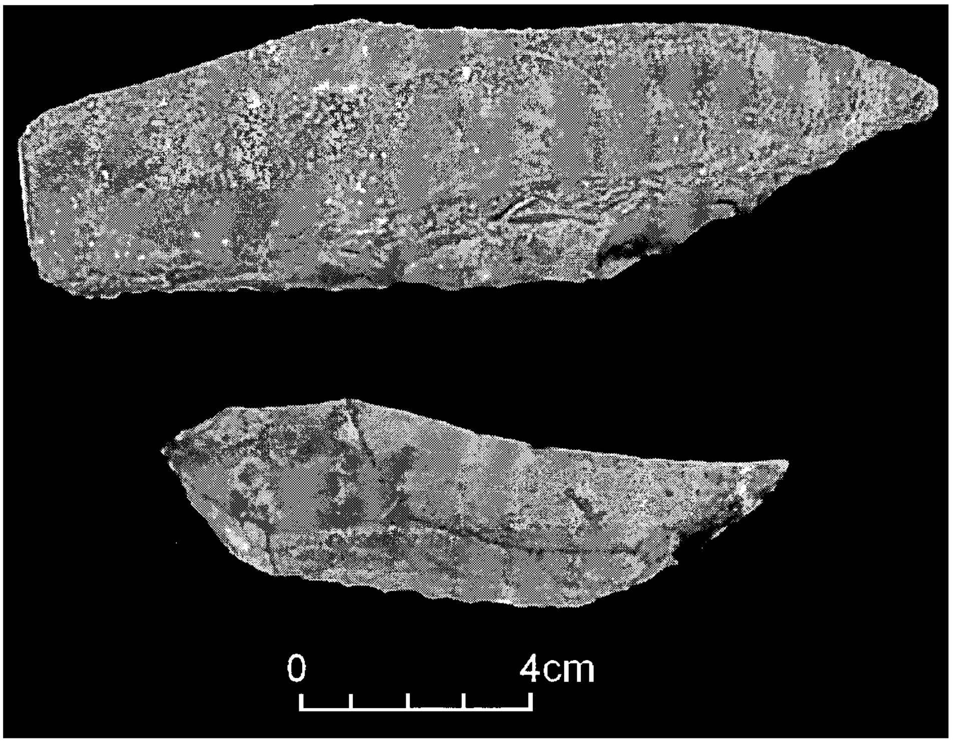

Figure 1: Examples of backed artefacts from the South Molle Island quarry.

determine whether retouch on the South Molle Island Quarry is directed exclusively at the production of backed artefacts, or whether there are other retouch strategies being practiced in addition to backing (see Figure 1 for some examples of backed artefact specimens). This is achieved through the use of metric and non-metric analyses which determine both the extent and degree of variability within the retouch located on the quarry.

South Molle Island Quarry, Whitsundays

South Molle Island is a small offshore island, located on the central Queensland coast, approximately 2km from the mainland. The South Molle Island Quarry (SMIQ) occupies a steep rocky ridge on the north-eastern side of South Molle Island and the site complex as a whole, including quarrying and reduction sites. The quarry and associated artefact scatters cover an area of at least 42,000m^2. Areas of high-density artefact scatter extend along the ridge top for 400m in a north-south orientation, extend down the eastern face of the ridge for 75m, and extend intermittently down the western slope to the beach 300 meters away. Surface artefact densities typically range from between 100-500/m^2 (Figure 2).

The SMIQ source is characterized as a pyroclastic surge deposit and is the only source of this material known to be exploited on the central Queensland coast (Barker and Schon 1994). A complex interaction between basaltic magma and ground water produced a base-surge deposit, which has been classified as a silicious volcanic tuff with a flint-like habit (Brian 1991:56). These deposits typically produce unidirectional bed forms which can include dune forms, low angle cross stratification, pitch and swell structures and wavy lamination. Unweathered, base surges range in colour from gray to black, and demonstrate a 'flint-like' habit which is the result of secondary silicification (Brian 1991:55-56). Grain size, colour, and texture of the SMIQ raw material varies substantially across the site. This is in keeping with the overall characteristics of pyroclastic base surge deposits, which typically become finer grained further away from the source.

The SMIQ source ranges in colour from black, through to dark gray, gray and olive gray. The further from black the colour becomes, the larger the grain size. This pattern extends in a clear north/south orientation in line with the quarry ridge top. The black, fine-grained material occurs at the northern (or beach end) of the quarry, and grades into gray courser grained material, in a southerly direction along the ridge. The material's limited glassy quality combined with the fine-grained matrix gives it remarkably homogenous flaking properties, and thus makes it a versatile raw material for the purposes of stone artefact manufacture.

On the SMIQ, the siliceous volcanic tuff occurs in several different forms and the extraction techniques differ accordingly, as outlined below. The two main distinguishable forms of raw material are the vertically bedded nodules which occur primarily towards the southern end of the quarry, and the much larger horizontally bedded slabs that range in size up to several meters in diameter and are found toward the northern end.

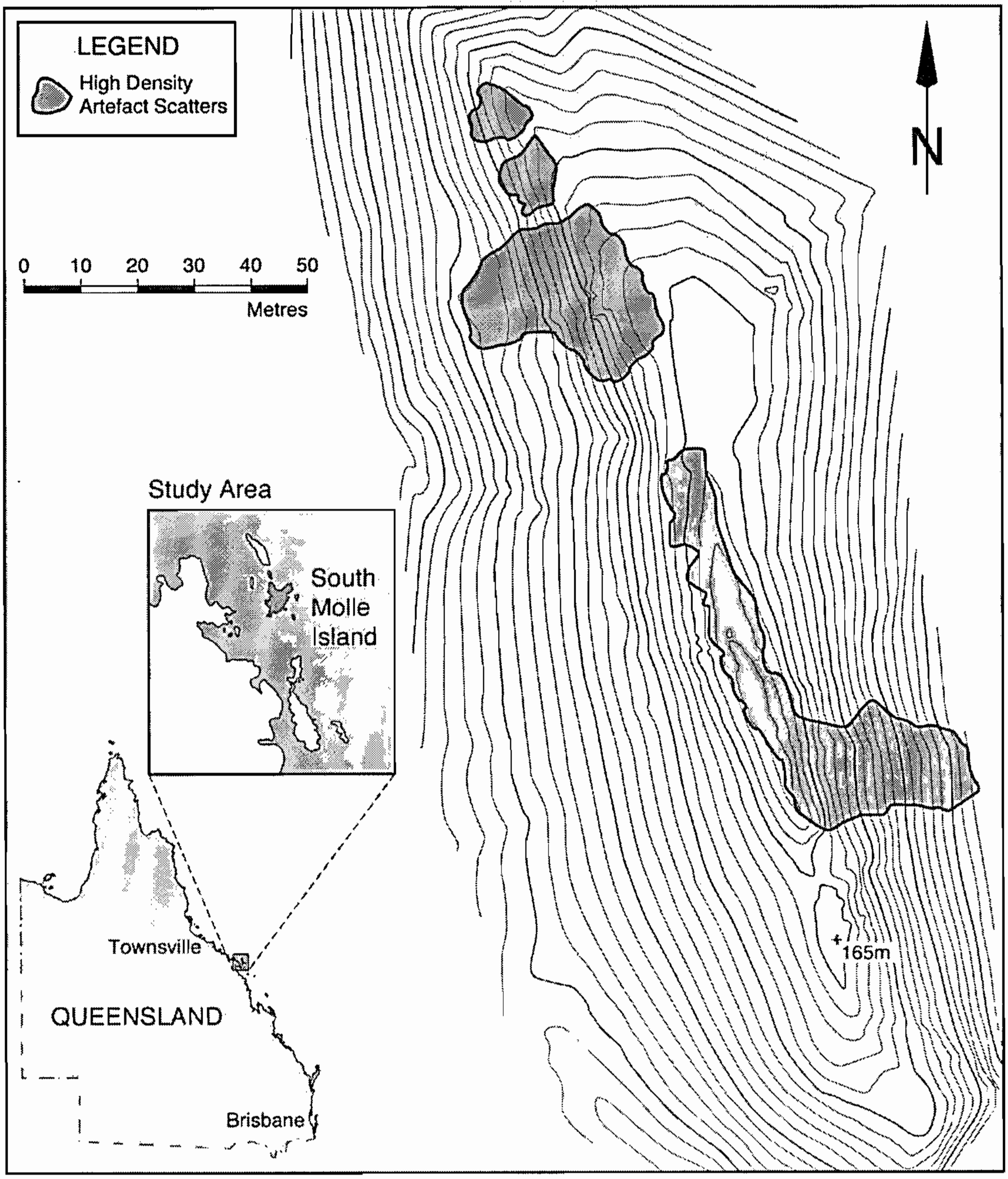

Figure 2. Map of the South Molle Island Quarry, Whitsundays

Base surge deposits result from a ground-level, horizontal surge of pyroclastic materials, mixed with water vapour and ash. These are frequently interspersed or overlain by pyroclastic fall deposits (Brian 1991:55). In these instances, cross-bedding can occur, with one type of material overlaying another. With differing capacity to withstand weathering, one material weathers faster than another, leaving discrete, unidirectional bedded nodules. These vary in size from several centimetres to several metres in diameter, and remain bedded in the soil matrix of the local sedimentary environment. Whether they are exposed or not, depends on local erosional conditions. There is evidence for the extensive procurement of these vertically bedded nodules using several methods, and these are also reflected in various core morphologies found at the SMIQ.

Characterising Variability in Flake Retouch

The SMIQ is both a quarry site and a reduction site (Hiscock and Mitchell 1993). The reduction of the raw material ranges from early stages of core reduction to late-stage retouch of backed artefact forms (Lamb 1996). Fieldwork conducted on the quarry as part of a broader doctoral research project has yielded a sample of 445 retouched artefacts (of which 329 are backed). The following analysis presents a series of tests which together attempt to characterise the nature of retouch in the SMIQ. These tests aim at determining retouch

Table 1. Direction of retouch on all retouched artefacts.

	Bi-directional	Unidirectional	
Backed Artefacts (N=146)	90 (62%)	53 (36%)	
		From dorsal only	From ventral only
		12 (8%)	41 (28%)
Other Retouch (N=63)	17 (27%)	46 (73%)	
		From dorsal only	From ventral only
		22 (35%)	21 (33%)

direction, retouch location, percentage of length retouched, extent of retouching and size of retouched artefacts.

In order to determine the variability of retouch practiced on the SMIQ, a range of variables are examined on two classes of artefacts: backed and non-backed. For the purpose of this study, the term *backed artefact* refers to those artefacts with steep retouch along one margin, at near 90 degree angles to the dorsal and/or ventral plain (Hiscock and Attenbrow 1996; Hiscock 2002a). The pattern of retouch can take bidirectional or unidirectional form, and is not restricted to the lateral margins (Lamb 1996). As the process of backing is already clearly identified and defined in the Australian stone artefact literature (Hiscock 1998, 2002b; Lamb 1996; McNiven 2000), and variation among the backed sample from the SMIQ is the subject of a separate study, I wish to further examine the sample of non-backed artefacts, with a view to characterising the reduction process, and highlighting the nature and variation of retouched artefact manufacture on the SMIQ.

Retouch Direction

During analysis, two directional categories were identified in order to determine retouch direction: bi-directional and unidirectional (with subsets of *unidirectional from dorsal surface only* and *unidirectional from ventral surface only*). Table 1 illustrates a polarity between backed artefacts and non-backed artefacts in terms of retouch direction, with the majority of backed artefacts exhibiting bidirectional retouch, while the opposite is true of non-backed artefacts. The differences in the proportion of bidirectional retouch between categories also proves significant (Chi Square = 100.771; P=<.0005). This result is of particular note and will be discussed in more detail below.

Retouch Location

The location of retouch was recorded as right, left, proximal or distal margins, oriented according to the ventral surface. Adjacent margins are defined as distinct from one another according to the orientation of the retouch to its opposite margin (right being opposite to left, and proximal being opposite to distal). For example, if a line extending out perpendicular to the proximal margin locates retouch on the opposite margin, then that retouch is said to be located on the distal end. If a line extending out perpendicular to the left margin also encounters retouch, then it would be classed as occupying two margins: distal and right.

Generally, the majority of implements were retouched on one margin only (this is in keeping with the generally low curvature index for backed artefacts – see below). However, of note is the fact that non-backed artefacts exhibit significantly higher rates of retouch on *multiple* margins than do backed artefacts (Chi Square = 100.771; P=<.0005), suggestive perhaps of a sub-grouping exhibiting generalised retouch on a range of margins, and not exclusively devoted to early-stage backing of a single margin (Table 2). However, the retouching of multiple margins could instead suggest that this group represents

Table 2. Number of margins retouched.

	1 Retouched Margin	2 Retouched Margins	3 Retouched Margins	4 Retouched Margins	Missing Data
Backed (N=146)	103 (71%)	17 (12%)	2 (1%)	-	24 (16%)
Non-backed (N=63)	35 (56%)	15 (24%)	7 (11%)	1 (1.5%)	5 (8%)

Table 3. Average weight of artefacts, according to number of margins retouched.

	1 Retouched Margin	2 Retouched Margins	3 Retouched Margins	4 Retouched Margins
Backed Mean Weight (N=146)	160g	214g	136g	-
Non-backed Mean Weight (N=63)	724g	1111g	1527g	3259g
t-test	p=.000	p=.004	p=.006	-

Table 4. Mean maximum length of retouched artefacts.

	N	Mean percent of maximum length retouched (mm)	Std. Dev.
Backed	146	89.55	17.7
Non-backed	59	70	25.9

Table 5. Kuhn's reduction index, curvature index and retouched edge angle.

	N	Backed Artefacts	Non-backed Artefacts
Kuhn Reduction Index (mean, std. dev.)	232	0.97 ± 0.07	0.96 ± 0.06
Curvature Index (mean, std. dev.)	233	0.17 ± 0.08	0.2 ± 0.09
Retouched Edge Angle (mean, std. dev.)	372	87.5 ± 11.2	71.7 ± 17.4

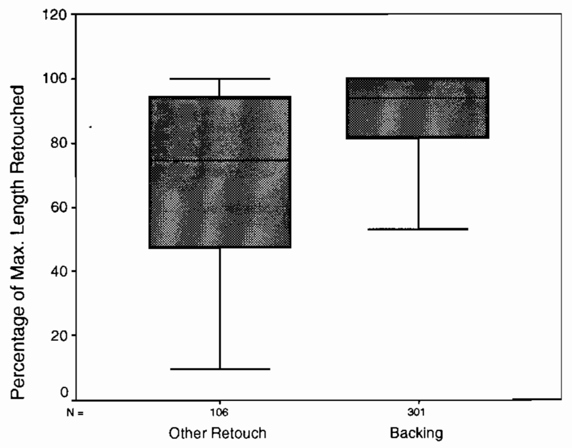

Figure 3. Percentage of maximum length retouched.

the reworking of backed artefacts. If this were the case,we might expect to see similar but not lower mean weights for such a 'reworked' (non-backed) sample. In fact, the opposite is observed (Table 3). A *t*-test indicates that non-backed artefacts are significantly heavier than backed artefacts (Table 3).

Extent of Retouching

In order to determine extent of retouching, three tests were conducted on the South Molle Island Quarry sample: Kuhn's Reduction Index (Kuhn 1992), the Edge Curvature Index (Hiscock and Attenbrow 2002), and the measurement of retouch edge angle as an indicator of retouch intensity (e.g. Clarkson, this volume; Dibble 1995; Hiscock 1982) (Table 5). The use of the Kuhn Index as a tool for measuring reduction intensity has been discussed extensively by Clarkson and Hiscock (this volume). Essentially the test provides a relative measure of reduction by establishing a ratio of retouch height to artefact thickness. This is measured on a scale of 0 (no reduction) to 1 (complete reduction). The edge curvature index is determined by dividing the depth of retouch by the retouch span (Hiscock and Attenbrow this volume). A negative value indicates a concave edge, while a value of >0 indicates a convex edge. A higher positive value represents a greater convex edge. The results are presented in Table 5 for backed and non-backed artefacts.

Two observations can be made from Table 5. Firstly, according to the Kuhn reduction index and the curvature index, the majority of implements in the sample are reduced to a uniform extent and exhibit no significant differences in shape between backed and non-backed categories. Secondly, there is a highly significant difference (*t*-test, p=.000) in retouched edge angle between the two retouch categories, with non-backed artefacts recording lower retouched edges than the remainder of the sample, while maintaining a near-maximum Kuhn reduction index.

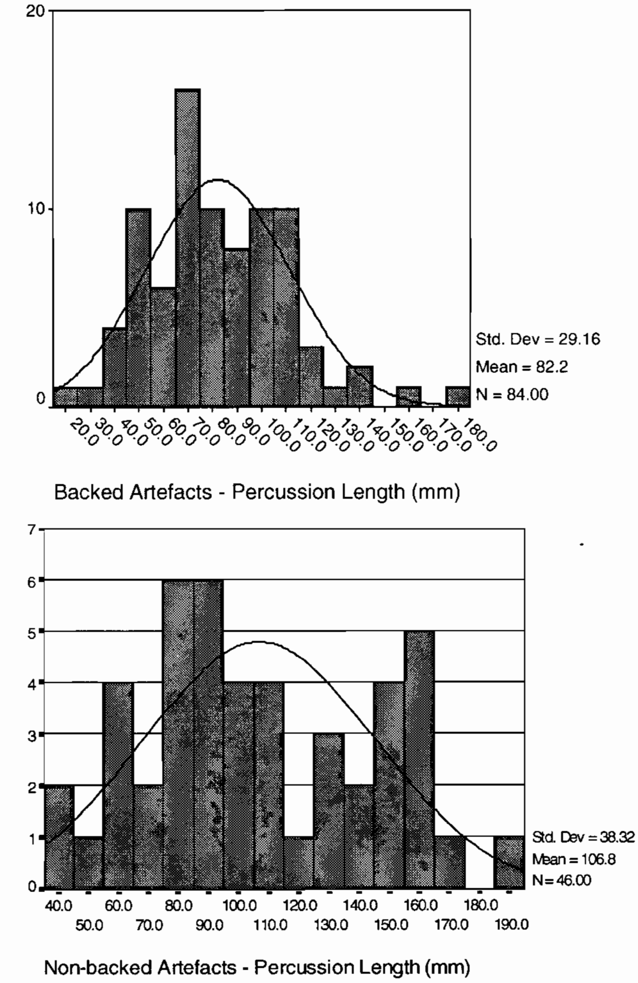

Figure 4. Percussion length of retouched artefacts, illustrating a bimodal pattern within the sample of non-backed artefacts.

Size of Retouched Artefacts
The majority (83.5%) of backed artefacts show a unimodal distribution for percussion length of between 50mm and 105mm, and centred on around 70mm (Figure 4). The non-backed artefacts on the other hand show a bi-modal distribution. The lower mode overlaps almost exactly with that of backed artefacts, but the upper mode (37% of non-backed specimens) indicates the existence of a group of much larger artefacts with a percussion length centred on around 160mm. These larger non-backed artefacts are also more often retouched on multiple margins (59%). Thus, while both backed and non-backed artefacts are common up to around 110mm, only non-backed artefacts retouched on multiple margins are common above this size.

Edge Angle and Scar Size
Both the Kuhn Reduction Index and the Curvature Index results indicate that the sample of retouched artefacts has been reduced to a reasonably uniform extent (Table 5). Yet despite the fact that both groups show extensive retouching, there is a significant difference in the mean retouched edge angle of each group, with non-backed artefacts showing much lower edge angles than backed artefacts.

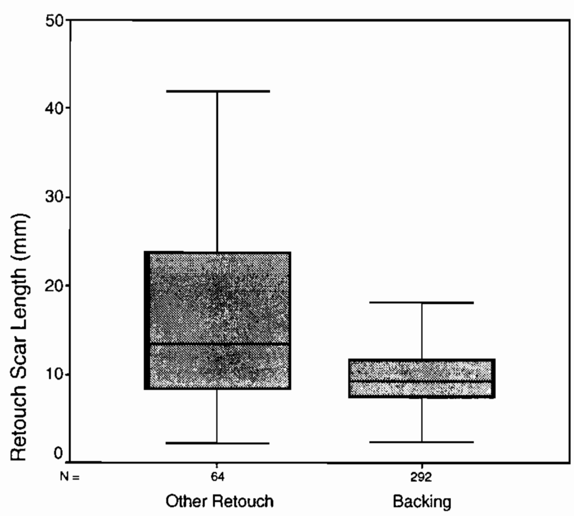

Figure 5. Mean length of retouch scars.

We might typically expect edge angles either to increase as unifacial reduction increases and step terminations build up, as found by Clarkson (this volume), or to increase and then decrease as these areas of steeply retouched edge are removed by deep blows, as found by Hiscock and Attenbrow (this volume). Which of these models best explains the differences in edge angles noted between the backed and non-backed implements found at the SMIQ might be investigated by considering the size of retouch flake scars themselves. Very large and invasive flake scars could conceivably succeed in producing very high Kuhn index values while also maintaining edges at fairly low angles. Figure 5 demonstrates that this in fact seems to be the case, and that a greater range and mean length of retouch scars is found for the non-backed category than for backed artefacts. The conclusion that can be drawn from this test is that some artefacts received relatively short, steep-edged retouch, while others had long flakes removed from their margins that did not overly increase edge angle.

Discussion: The Nature of SMIQ Reduction Strategies
Together, the results of the tests presented above suggest that two quite distinctive reduction processes were in operation at the SMIQ in the past. The first focussed on the production of backed artefacts ranging in size up to around 110mm in length that were steeply and bidirectionally retouched along a single margin. The second strategy was focussed on the production of flakes from numerous margins of other large flakes (i.e. those greater than 110mm in length). While the size distinction seems important in separating these two populations, the overlap between backed artefact and the lower mode in non-backed artefact length is still to be explained. It is suggested here that the smaller mode may represent early-stage backed artefacts that had not yet progressed from single margin unidirectional retouching to the single margin bi-directional flaking that typifies backing.

For example, in backing an edge it is conceivable that the length of the edge might first be unifacially flaked in its entirety before turning the artefact over and working it from the other side, giving it is bidirectional form. Thus, the higher rate of unidirectional retouch on smaller (i.e. <110mm), unimarginal, non-backed artefacts might indicate that many of these specimens belong to an early stage in the backing process. This smaller group is also characterised by a corresponding *percentage of length retouched* which falls within the range for backed artefacts (Figure 3).

In contrast, the differences in retouch location provide an indication that the larger grouping of artefacts within the non-backed category (i.e. >110mm) can be distinguished from both backed artefacts and early-stage backed artefacts. Artefacts within this group have multiple margins retouched - suggestive of a more generalised retouching around the perimeter of the flake. This group also exhibits large flake scars and low edge angles indicative of a very different reduction strategy. I propose that this subgroup of non-backed retouched artefacts was used to produce flakes from their margins of comparable size to those produced from cores. To support this assertion, two further lines of evidence can be presented. Firstly, retouch scars found on the larger non-backed artefact group average 53.5mm in length, compared with an average of 21.4mm for those found on the smaller non-backed artefact group, and for the sample of *backed artefacts* longer than 110mm (*t*-test, p=.000). Secondly, the mean length for flake scars measured on a sample of 424 cores from the SMIQ, is 50.1mm. Thus the length of flake scars on the large non-backed artefact group compares very favourably with that of cores. There is therefore strong evidence to support the existence of two very different strategies of flake retouch having been practised at the SMIQ over the last 9,000 years.

A recent study (Lamb and Barker 2001) has refined the temporal sequence for the stratified rockshelter site Nara Inlet 1, on Hook Island, some 3km from South Molle Island. Among other things, they demonstrate a decline in stone artefact discard from c.7,000BP. In a forthcoming study (Lamb in prep), it is argued that this decline reflected changing patterns of access to the quarry, influenced by rising sea-levels, which saw less stone transported away from the site, and a greater degree of late stage reduction occurring on the site; including the production of backed implements. Thus, while still a topic of future investigation, it seems likely that the backing industry on the South Molle Island Quarry had its origins some 7,000 years ago during a time of changing mobility and provisioning patterns across an altering landscape.

Conclusion

The South Molle Island Quarry was utilised for a period of at least 9,000 years for the production of stone artefacts in the Whitsunday region. A systematic survey of the quarry identified a sample of 443 retouched artefacts, including 329 backed artefacts. The current study has attempted to utilise technological tests to comprehensively characterise the nature of the retouch occurring on the quarry. Analysis of the sample as a whole has identified attributes which suggest that quarry production was aimed at the manufacture of backed artefacts (including early-stage backed artefacts) and larger retouched flakes that appear broadly similar to cores in terms of the size of flakes being removed. Analysis of the variation within the production of the sample of backed artefacts, and the implications for the regional economic tempero-spatial trends is the topic of further study.

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