Abstract

A technological analysis was recently completed on a collection of stone artefacts recovered during bridge construction at Camooweal, northwest Queensland. The results indicate that various bifacial reduction techniques were an integral part of the Aboriginal stone-working repertoire. A sophisticated knowledge of biface flaking and a multi-staged approach to manufacture is suggested by large hand axe-like bifaces and small bifacial points. The reduction techniques used in manufacturing these bifaces were also used on other elements in the stone toolkit.

Introduction

Characterisations of Australian stone technology tend to emphasise an Aboriginal focus on flakes struck from producer cores of various types. As a result, the nature and scope of bifacial reduction technology in Australian assemblages is poorly known and bifaces are rarely described in detail. Nevertheless, bifaces figured prominently in many Aboriginal toolkits. The most ubiquitous examples of Australian bifaces are edge-ground axes made on bifacial blanks, a technology that may date from as early as 32,000 BP in Australia (Morwood and Trezise 1989). Small bifaces in Australia are better described; these range from minimally modified blades (Davidson 1935:166-170; Flood 1970) to percussion- and pressure-flaked points (Elkin 1948; Tindale 1985; Akerman and Bindon 1995; Akerman et al. 2002).

A recent bridge construction project on the upper Georgina River at Camooweal, northwest Queensland (Fig. 1) has resulted in the discovery of a variety of bifacial stone artefacts (Moore 2003a, b, c). This report describes the bifacial manufacturing techniques represented in this assemblage.

Approach to Technological Analysis

This study is part of a research program to reconstruct the technological structure of the Camooweal archaeological assemblage using methods advocated by Hiscock and Mitchell (1993:75-76) for analysis of lithic assemblages in Australia. “Technological structure” refers to the various combinations of flaking techniques chosen by knappers to produce stone tools. A technological structure may encompass a variety of reduction “trajectories” consisting of combinations of knapping techniques leading to a class of end products (e.g. bifaces, blades, adzes, etc.). Variations might occur in the types of techniques and/or their order within a reduction trajectory; these are variations in reduction “method.” The present study applies the analytical procedures described below to explore Aboriginal techniques of bifacial reduction. As will be demonstrated, biface reduction techniques occur in several different trajectories in the Camooweal assemblage.

The analytical procedures involved making systematic observations to identify patterning in the archaeological assemblage and inferring the meaning of these patterns in reference to “middle range” studies (Binford 1983; Tschauner 1996). In lithic studies, inferences are made meaningful through reference to the ethnographic literature and modern experiments. Given the rarity of detailed ethnographic descriptions of stone knapping, meaningful inferences regarding stone technology most often rely on experiments (Amick et al. 1989:9; Yerkes and Kardulias 1993:92). Three procedures are employed to extrapolate technological structure from the “what, when, and why” of stone flaking.

The first procedure involves determining what stone knapping techniques are represented in the artefact assemblage. This is done by identifying “technical stigmata” (after Dobres 2000) through examination of flake scar placement, size, and orientation combined with examination of the debitage assemblages for the flakes that correspond to the scars. These “stigmata”—the material consequences of techniques—are described in the abundant literature generated by middle range experiments and, to a lesser extent, by ethnographic observation.

The second procedure involves identifying the sequence in which these knapping techniques were applied in the reduction trajectory. Flake conjoining is the most powerful analytical method for accomplishing this because conjoin sets reconstruct reduction events blow-by-blow. However, conjoin sets are rarely complete and conjoining may be difficult or unsuitable for sites with a complex taphonomic history and/or projects with a limited research budget. Flake scar analysis, also known as “diacritical analysis” (Sellet 1993:108), is used to fill the breach. This consists of determining the order of technique application by examining the sequence of flake overlap on formed objects and on the dorsal surfaces of flakes. The process

Figure 1  Project location map.

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Figure 2  Late stage large bifaces. (c) biface from Nowranie Creek. The remainder were recovered from the Georgina River project area.
has been characterised as “remontage mentale” or mental refitting (Pelegrin 1985 in Chazan 2001:18). “Minimum nodule analysis” (Larson and Kornfeld 1997) is a complementary approach consisting of mental refitting on artefacts derived from discrete reduction events involving single stone nodules. Artefact conjoining, minimum nodule analysis, and mental refitting were all used during this study.

The third procedure involves synthesising the results of the first and second procedures into a model which interprets why techniques were ordered as they were “in a way that portrays the dynamics of the manufacturing process” (Hiscock 1993:65; see also Seltet 1993:109; Inizan et al. 1999). This “dynamic” character is conveyed by assessing the effects of techniques in the archaeological assemblage and interpreting those effects in light of the technical understanding of the knapping process generated by middle range research. The interpretive model is often broken into reduction steps or stages and may be presented verbally, visually, or both.

Each of these analytical procedures are apparent in Hiscock’s (1993) reconstruction of the “Redbank A Strategy.” Hiscock used the analytical techniques described above to determine what stone knapping techniques were present, when they were applied, and the reasons why they were applied. These analytical techniques included conjoining artefacts, analysis of flake scars, and, indirectly, experimental studies. Hiscock structured his model of the Redbank A Strategy into six reduction “phases,” with one phase—the backing of flakes—broken into two additional reduction “stages.” Hiscock’s model is presented as a narrative of the knapping process supplemented by a figure illustrating three of the reduction phases. Several reduction phases produced distinctive flake types that can be used to distinguish the same knapping phases in other assemblages; these types are described, illustrated, and keyed to the figure and text describing the reduction model.

Hiscock (1993:65) notes that “[d]etailed technological analyses of this kind have not been published before in Australia” although aspects of the method are well-represented in the Australian literature (Hiscock and Mitchell 1993:74-76, e.g. Akerman 1976; Bronstein 1977; Dickson 1973, 1977, 1980, 1981; Dortch and Bordes 1977; Flenniken and White 1983, 1985; Mardaga-Campbell and Campbell 1985; McBryde 1985; McCarthy 1941, 1943:129-130; McNiven 1992; Webb et al. 1994:114-124; Witter 1988; see also Fullagar and Torrence 1991). The method also underpins New Zealand technological analyses (Cleghorn 1984:413-415, e.g. Jones 1984; Leach and Leach 1980; Leach 1984, 1990; Turner and Bonica 1994). Australian ethnographies are rich in middle range observations of knapping, including one of the world’s earliest illustrations of a staged reduction model of stone tool manufacture (Baines 1866). The method has been applied by a number of researchers in the region since Hiscock’s paper (e.g. Akerman et al. 2002; Allen et al. 1997; Araho et al. 2002; Moore 2000a, b; Mulvaney 1998).

Large bifaces

Large chert bifaces are found in the Barkly Tableland region of the Northern Territory and northwest Queensland. Alec Rainey, who discovered large chert bifaces on a cattle station in the Northern Territory, first brought them to the attention of archaeologists in the late 1960s (Rainey 1991). Barkly (1979) collected 16 bifaces from the same region. F. D. McCarthy subsequently published a photograph of the Rainey bifaces, classifying them as “hand axes” (1976:21, Fig. 8; see also Rainey 1991: Figs 1 and 2). They resemble Palaeolithic handaxes, prompting one archaeologist to propose considerable time depth for the Barkly Tableland examples (Rainey 1991:36).

Large chert bifaces are absent from ethnographic descriptions of Aboriginal stone technology at Camooweal. However, Horne and Aiston (1924:101) note “a large chipped hand-axe shaped like a gigantic double mussel-shell was used amongst the Wonkonguru and even now can be found,” perhaps referring to large bifaces. Large, relatively thick bifaces were still manufactured on Bentinck Island (Tindale 1977) and Mornington Island (Tindale 1949) in the 1930s. Rainey’s Barkly Tableland informants in the 1960s were unfamiliar with the tool type (Rainey 1991:33, see also Barkly 1979:85).

Aboriginal groups involved in the Camooweal fieldwork no longer retained a direct knowledge of the manufacture and use of these implements, although an Alywarra man from Lake Nash on the Georgina River in the Northern Territory asked an elder some years ago about this type of tool. The elder described two functions. First, large bifaces were women’s tools used to process yams. The use of stone tools for yam procurement and processing has been reported previously. Tindale (1949:157) notes that bifaces were used by women to dig holes and chop through roots when harvesting yams, and O’Connell (1974) documents the use of stone knives (but not bifaces) as yam spoons among Aboriginal groups southwest of Camooweal. Second, the biface was hafted with a thin wrap-around withy handle about one metre long and used as a weapon in ritual combat. The opponent was hooked behind the neck or knee in the angle formed between the biface and the handle, at which point, it was emphasised, “he can’t get away.”

This method of hafting and use is analogous to the fighting picks made from large blades (Spencer and Gillen 1904:653).

Corroborating evidence for yam processing emerged from a residue and use-wear analysis conducted on four of the large bifaces from Camooweal. The study concludes that three of the tools (Figs 2a, b, d) were used for starchy plant processing, as

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**Figure 3 Early stage large bifaces.**
Figure 4  Biface thinning flakes.
indicated by adhering residues including starch granules and macerated plant tissue. Residues on the fourth tool (Fig. 2e) suggest a butchery function, and include a long hair with a degraded cuticle and root, a bundle of collagen fibrils, and possible red blood cells (Loy and Nugent 2002:22-25).

The Georgina River at Camooweal was a manufacturing area for large bifaces. Some 21 artefacts relating to large biface production were recovered from the project area, including 8 bifaces (Figs 2 and 3) and 13 biface thinning flakes (after Frison 1968:149-150; Whittaker 1994:185-187; Andrefsky 1998:118-119) (Fig. 4a-c). A biface was also collected by an Aboriginal fieldworker on Nowranie Creek, 10 km east of the Georgina River.

The first step in manufacturing a large biface was to procure a suitable chert cobble. A preference for tabular chert is indicated by the presence of cortical surfaces on both faces of most bifaces (see also Barkly 1979:89, 92; Rainey 1991: Figs 1, 2) (e.g. Fig. 2d, e). The lithic terrane of the region is dominated by nodular cobbles, so finding an appropriate large chert tablet without internal flaws may have required considerable effort.

Flake scars on these bifaces tend to be scooped in profile and the biface thinning flakes are marked by prominent bulbs and relatively deep, non-margin platforms. Although soft hammer percussion flaking was sometimes practiced in the local area (Roth 1904:17) and across much of northern and central Australia (Mountford 1941:315; Tindale 1965:135-136; Gould et al. 1971:157; Hayden 1979:27), it is inferred from these features that hard hammer percussion was used throughout the flaking process.

Flakes were sometimes struck from steep cortical cobbles, as indicated by scars emanating from cortical surfaces on bifaces (e.g. Fig. 2d). Also, several biface thinning flakes have cortical platforms (e.g. Fig. 4c). These flakes are often "invasive"—that is, they extend substantially past the biface centreline—as shown by the scar orientations on the dorsal surfaces of biface thinning flakes with cortical platforms (e.g. Fig. 4c), and on biface scars emanating from cortical platforms (e.g. Fig. 2d). Invasive flaking removes cortex and surface irregularities across the face of the stone, creating a relatively smooth, contoured appearance.

Flakes were also struck from previously flaked margins. The first series of flakes on the margin—the platform preparation flakes—tend to be non-invasive (they terminate prior to reaching the biface centreline) and were struck unifacially along part of the perimeter. They also tend to be quite steep in relation to the faces of the biface. To produce these platform preparation scars, the blows were oriented oblique to the stone's mass rather than directly into it (see Whittaker 1994:187-188). A subsequent series of often quite invasive scars is present on the opposite face of the biface emanating from percussion points on the platform preparation scars. The blows that detached these flakes were set in from the biface edge and platform grinding was not conducted. This process creates a platform configuration that is morphologically similar to the cortical platforms described above, except that, rather than occurring naturally, the morphology is created by steep unifacial flaking. It is inferred that this technique, called "unifacial bevelling" (Callahan 1979:34), was conducted when suitable cortical platforms were not available. The short, steep platform preparation scars can be seen on the left-hand view of the biface in Figure 2a, and large flake scars can be seen emanating from these steep scars in the right-hand view of this figure. Similarly, two short, very steep platform preparation scars can be seen on the left-hand view in Figure 3b, and a large flake scar can be seen emanating from these steep scars. The flake travelled across the biface and overstruck the opposite margin.

Biface thinning flakes struck from unifacially bevelled margins have multiple facets on the platforms (e.g. Fig. 4a, b). The ventral surfaces are flat or only minimally curved because, by steeply turning the platform edge and removing the flakes with non-margin blows, the plane of flake propagation into the centre of the biface tended to be relatively flat.

Tindale (1977:Fig. 6) photographed an Aboriginal elder on Bentinck Island making a large biface by striking into the mass of the stone with a hammerstone. It would appear that the biface was held edge-on against the ground and the sole of the right foot was held against the face for support. A very strong platform is required to successfully deliver a hard hammer percussion blow into the mass of a biface. Both the cortical platform configuration and the unifacial bevelling techniques practiced at Camooweal provided such a platform. It is inferred that these techniques were developed by Aboriginal knappers to drive flakes well-past a biface’s centreline using a hard hammer.

A deep undulation is present on some of the large flake scars. Two of the late stage bifaces from the Camooweal project and at least one of the Rainey bifaces from the Northern Territory have this feature (Fig. 2a, e; Rainey 1991: Fig. 1). The undulation consists of a rounded "shelf" between one-half to three-quarters of the distance to the distal end of the scar. The shelf is actually a hinge fracture, and the remainder of the scar is a long inflexion finial (Cotterell and Kamminga 1986).
Dimensions of large bifaces, Camooweal assemblage.

Table 1  Dimensions of large bifaces, Camooweal assemblage.

<table>
<thead>
<tr>
<th>Reference No.</th>
<th>Stage</th>
<th>Maximum Length (mm)</th>
<th>Maximum Width (mm)</th>
<th>Maximum Thickness (mm)</th>
<th>Width/Thickness Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>67900-1</td>
<td>Early</td>
<td>157</td>
<td>142</td>
<td>49</td>
<td>2.90</td>
</tr>
<tr>
<td>72100-4</td>
<td>Early</td>
<td>174</td>
<td>157</td>
<td>78</td>
<td>2.01</td>
</tr>
<tr>
<td>17666-12</td>
<td>Early</td>
<td>(40)*</td>
<td>49</td>
<td>19</td>
<td>2.58</td>
</tr>
<tr>
<td>777-9</td>
<td>Late</td>
<td>118</td>
<td>92</td>
<td>28</td>
<td>3.29</td>
</tr>
<tr>
<td>3666-5</td>
<td>Late</td>
<td>162</td>
<td>100</td>
<td>48</td>
<td>2.08</td>
</tr>
<tr>
<td>40400-2</td>
<td>Late</td>
<td>148</td>
<td>84</td>
<td>27</td>
<td>3.11</td>
</tr>
<tr>
<td>23666-12</td>
<td>Late</td>
<td>155</td>
<td>72</td>
<td>30</td>
<td>2.40</td>
</tr>
<tr>
<td>999-67</td>
<td>Late</td>
<td>160</td>
<td>94</td>
<td>32</td>
<td>2.94</td>
</tr>
<tr>
<td>Nowranie Creek</td>
<td>Late</td>
<td>116</td>
<td>69</td>
<td>30</td>
<td>2.30</td>
</tr>
</tbody>
</table>

* Broken

Replicating this feature requires a steep percussion angle combined with considerable force. Its presence on 50% of the late stage bifaces from the Camooweal project area and on at least one biface from the Northern Territory indicates widespread application of the percussion technique. This may be the consequence of using hard-hammer percussion to achieve a similar end as the soft hammer bifacial percussion techniques practiced elsewhere in the world.

Small bifaces

Although small bifaces proved to be rare in the Camooweal assemblage, examples are known from the nearby region. Two varieties of small bifaces were identified based on the nature of the flake scars.

Variety 1 small bifaces (Fig. 6) display two series of flake removals. The first series of removals created relatively large and invasive flake scars on both faces. These can be flat in cross section and quite broad (e.g. Fig. 6b). The second series of removals intrude into the first series on both faces, and consists of smaller, non-invasive or semi-invasive scars. The first series of scars are inferred to result from thinning and contouring the blank and the smaller second-series scars from final shaping and edge trimming. Three examples of Variety 1 small bifaces have been recognised to date. Two of these, recorded during cultural heritage surveys in the advance of infrastructure development (Moore and Sachs 1999; Brumm 2001), have cortical facets on both faces indicating that they
Australian Aboriginal biface reduction techniques

Figure 6  Small bifaces, Variety 1. (a) after Brumm 2001. (b) biface in the repatriated Camooweal collection. (c) after Moore and Sachs 1999.

Figure 7  Small bifaces, Variety 2. (a) Georgina River project area. (b) after Moore and Sachs 1999.
Figure 8  Bifacial cobble cores.
were manufactured from thin chert tablets (Fig. 6a, c). The proximal end of one biface is the unmodified edge of the tablet (Fig. 6a). Museum workers collected a third Variety 1 biface at Camooweal some years ago and recently repatriated it to the Indjilandji (Fig. 6b).

Variety 2 small bifaces (Fig. 7) display one series of bifacial flake removals. The resulting scars are non-invasive to semi-invasive and are often applied in a discontinuous fashion. These scars are similar to second-series scars on Variety 1 bifaces and are inferred to result from minor blade shaping and edge trimming prior to hafting and/or during use. The need for first-series flaking may have been avoided by producing blanks with the appropriate characteristics directly from the core (e.g. Moore 2003a). Edge-trimming of blades in the region was normally conducted through unifacial percussion (Moore 2003a), and, indeed, blades with minor or discontinuous bifacial retouch have sometimes been classified as unifacial points (Mulvaney 1975:121) or “semi-bifaces” (McCarthy 1976:42). One example of a Variety 2 biface was recovered during the Camooweal project (Figure 7a) although other examples of bifacially retouched blades have been encountered in small numbers during nearby cultural heritage surveys (e.g. Fig. 7b).

Scar sizes indicate that the flakes struck from these variety 1 and 2 bifaces were relatively small. One bifacial thinning flake was recovered at Camooweal that may have been struck from a Variety 1 biface (Fig. 4e).

**Figure 9** Lengths and widths of bifacial cobble cores.

**Figure 10** Lengths and widths of scars on bifacial cobble cores.

**Bifacial cores**

**Bifacial Cobble Cores**

Sixteen bifacially flaked chert cobbles were recovered from the Camooweal project area (Fig. 8). About one-half of the periphery of these artefacts is bifacially flaked with the remaining portion consisting of the cobble’s rounded cortical surface. Flake scars tend to be large and oriented at a steep angle relative to the cobble’s faces. It is inferred from this that flaking was not intended to thin or contour the cobble. As seen in large biface manufacture, flakes were struck using an alternate flaking technique; that is, flake removals switched from one face to the opposite face using the preceding flake scar as the platform for the subsequent flake. The resulting wavy bifacial edge is exaggerated on some cores due to the large size of the flakes removed. No attempt was made by the Aboriginal craftsmen to trim or straighten the alternately-flaked bifacial edges, and hence small flake scars are absent from the edges of these tools. Scar remnants from previous removals are present on several cores. A small discoidal biface of similar morphology is also present in the assemblage; this may be a bifacial cobble core that was flaked completely around the periphery (Fig. 8e).

A scattergram of core lengths and widths is presented in Figure 9, with length defined at the axis between the bifacial edge to the opposite cortical edge, and width defined as the axis perpendicular to length. This shows that most of these cores are wider than long. This may reflect attrition during...
reflaking, a factor which would tend to decrease the core’s length. Core scar sizes are shown in Figure 10. Some 65% of the scars are wider than they are long, complementing the core length/width scattergram in Figure 9. Although the flakes were struck down the short axis of the core (its length) they tended to spread laterally along the core’s long axis (its width). It is unclear whether the cores and/or the flakes struck from them were the target of reduction.

**Tablets**

Two small rectangular bifaces were recovered that appear to have been made on small chert tablets (Fig. 11a, b). Both bifaces have one face marked by short, broad, non-invasive flake scars resulting from percussion blows oriented oblique to the stone’s mass. The remainder of the face is covered by cortex. The opposite face was reduced invasively by blows originating from various points around the perimeter, utilising
the scar surfaces created on the first face as platforms. The percussion angle for these invasive scars was oriented into the mass of the stone, rather than oblique to it. The technique is identical to the unifacial bevelling technique of platform preparation seen in the large biface trajectory but on a much smaller scale. It is unclear whether the cores and/or the flakes struck from them were the target of reduction. Another possibility is that these artefacts are rejected products from the early stage of Variety 1 biface manufacture.

Bifacial hatchets

One metabasalt flake struck from an edge-ground hatchet was recovered from the Canooweal project area (Fig. 4d). Remnants of edge-grinding are present on the platform and along high points on the dorsal surface of the flake. The flake’s platform was the hatchet’s ground edge. Other reworking flakes were struck prior to the removal of this flake. The flake’s platform is relatively shallow, implying a percussion point near the biface margin, and the flake was initiated by a bending fracture, perhaps indicating the use of a relatively soft percussor. The metabasalt appears to derive from the Lake Moondarra axe quarries near Mt Isa, 165 km southeast of the project area, and it is suspected that the axe arrived in Canooweal through the well-documented trade in Lake Moondarra axes (e.g. Roth 1904). The Canooweal flake represents a continuation of bifacial flaking of a hatchet after initial axe blank manufacture and subsequent edge grinding. A complete hammer-dressed dactyl axe was also recovered from the Canooweal project area. Although percussion scars are not apparent on this artefact, the tool may have been initially manufactured by bifacial flaking followed by pecking as described by Spencer and Gillen (1904:656-657).

Conclusion

The results of this study indicate that a variety of bifacial reduction techniques were part of the Aboriginal stoneworking repertoire in parts of northern Australia, a factor not commonly considered in discussions of Aboriginal stone flaking technology. The large bifaces and Variety 1 small bifaces demonstrate a sophisticated knowledge of biface flaking and a multi-staged approach to manufacture. The reduction techniques used in manufacturing these bifaces were also used for other elements in the stone toolkit. For example, blades were bifacially retouched to modify the shape and/or to rejuvenate dull or damaged edges and alternate flaking produced a bifacial edge on cobble cores. Hence it can be seen that techniques used in manufacturing large and small bifaces were carried over into other Aboriginal stone flaking trajectories on the Georgina River at Canooweal.

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