

# Sourcing stone from the Sydney region: A hatchet job

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## Abstract

This paper provides an analysis of 326 edge-ground hatchet heads collected from the region surrounding Sydney, New South Wales. A study of attributes based on raw material and form reveals that the majority of blanks in all areas are likely to have originated in gravels of the present Nepean/Hawkesbury River and abandoned palaeo-channels, which are mainly located about 50 km inland from Port Jackson. This finding supports sparse ethnographic and some archaeological accounts but contradicts a number of reports that have postulated sources for these hatchets considerably further afield. Results of the study also invalidate a commonly held belief about raw material type, which has influenced the identification of sources in the past. The findings have implications for studies of social factors such as trade and exchange, selection criteria, the accessibility of raw materials and time budgeting.

## Introduction

The Australian Museum in Sydney holds hundreds of Aboriginal stone hatchet heads that were obtained in diverse ways from the region surrounding Sydney (Fig. 1) since the nineteenth century. Apart from those found during formal excavations and surface collections, records in the Museum have little locational information for most apart from a general provenance (e.g. “ploughed up at Riverstone” [Museum Registration E77081]). A few are more precisely located (e.g. “Innes Orchard” [Museum Registration E31527]) but practically none has a map reference. And there is rarely any mention, let alone discussion, of what kind of stone they were made from or where the raw material might have originated.

If we knew the source or likely source of the raw material for a particular hatchet, in addition to its collection location, we would have a basis for looking at aspects of social organization such as trade and exchange. For example, how far from sources of the materials were hatchets found? And, does increased distance indicate long distance travel for collection, or trade with people who owned or controlled the sources?

In this paper I present and discuss data derived from The Australian Museum’s collection of Sydney region hatchet heads and from raw material samples I collected during the course of research between 2001 and 2003. The project aimed to identify the rock type and original form<sup>1</sup> of each hatchet and locate a source or potential sources of its raw material (see Corkill 2003 for full data). I also review previous reports that suggested raw material sources, and discuss the veracity of their findings.

Results of the project demonstrate that most Sydney hatchets are almost certainly locally derived and that earlier claims for long distance trade for their raw materials are unsupported.

## Historical background

As soon as members of the Cook expedition set foot on the shores of Botany Bay in 1770, followed later by the First Fleet in 1788, they began to gather information about the Indigenous inhabitants of the Sydney area. In official documents, journals and casual notes they set down details of their appearance, language, rituals and daily life, including what foods they ate and how they obtained them.

Among the items of material culture recorded by these first British explorers and settlers were hafted hatchet heads or *Mogo*. Hatchets were used for various tasks, including bark removal to make “canoes, shelters and shields, and to get wood to make clubs, containers and other implements and weapons” (Attenbrow 2002:89; see also Collins 1798[1975]:487). They were also used to cut toeholds and enlarge holes while climbing trees to collect honey and catch possums (e.g. Attenbrow 2002:89-90; Hunter 1793[1968]: 61).

The hatchet heads were made of stone, with at least one end ground to a sharp edge (see for example Bradley 1792:89, 129, 170; Collins 1798:487, 510; Flannery 1996:52,193; Hunter 1793[1968]:43,61,147, 515,519; Stockdale 1789[1982]:114; White 1790[1962]:136,157, 200-1; Worgan 1788[1978]:51). Very few details about their construction, shape and size are given, but Bradley (1792[1969]:129) calls the implement “a miserable blunt tool”. In a somewhat less disparaging tone, White

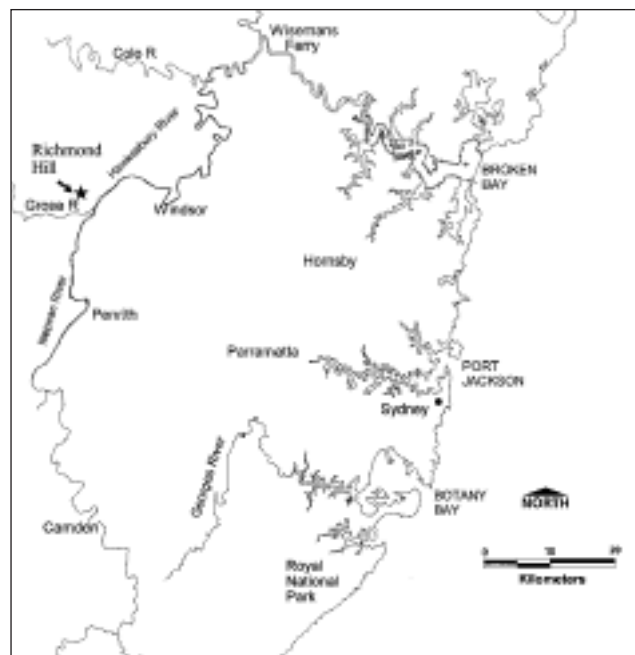
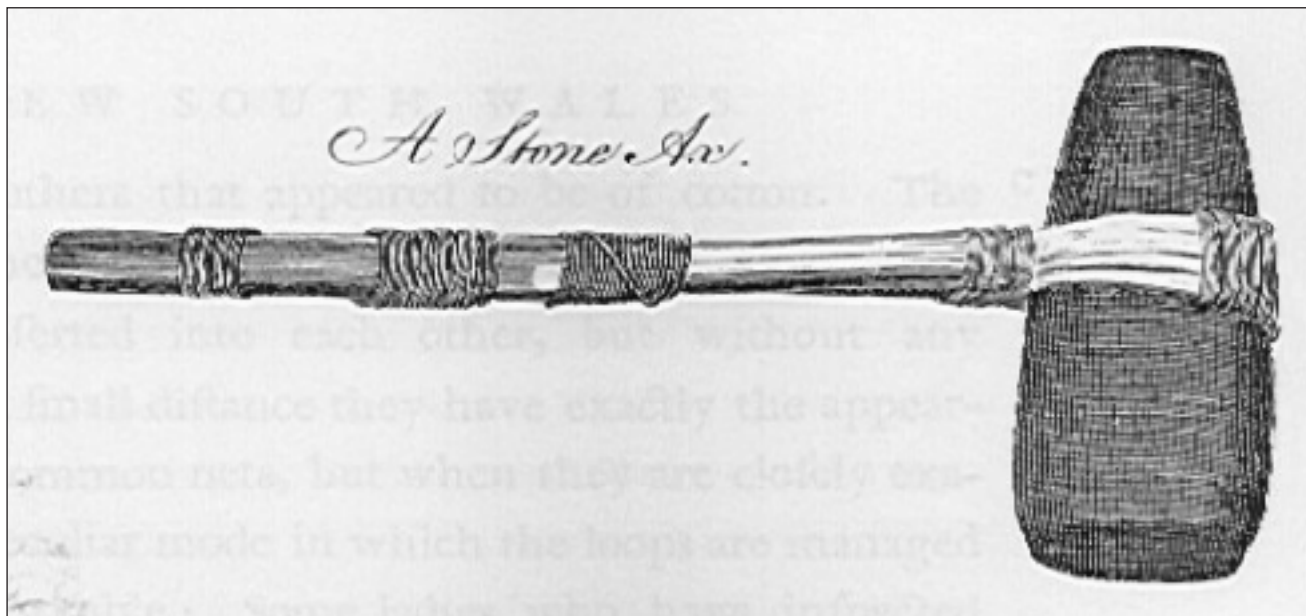


Figure 1 Study area.

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<sup>1</sup> For example a water-rolled cobble or a piece quarried from an in situ lava flow.



**Figure 2** Hafted hatchet (Stockdale 1789[1982]: part Plate 13).

(1790[1962]:157) states that during one of the colonists' first visits to Broken Bay at the mouth of the Hawkesbury (Fig. 1), the stone hatchet he saw in a "native" hut was "of a very superior make to what they usually have".

Stone hatchets also appear in early illustrations (Fig. 2 shows one example, from Stockdale 1789[1982]:Plate 13; see also Beaglehole 1968:397; Collins 1798[1975]:368; White 1790[1962]:Plate 37), but only some of these have scales by which the size of the implement can be estimated. The illustrations are mainly engravings that were produced in England or elsewhere, based on drawings and specimens brought back from the new colony, and were often of dubious accuracy - for example the head of an "ax" (sic) shown in Stockdale appears to be more a stylized than an accurate representation.

Better indicators of size and basic shape are stencils of hafted hatchet heads on rockshelter walls, for example those near Wisemans Ferry, at Maroota (Fig. 1, this paper) and Canoelands (McCarthy 1961:115; Stanbury and Clegg 1990:104), and at Long Island in the Hawkesbury River (Mathews 1896:95, Plate I, Fig. 9a).

There are only two temporally separate early accounts that document where hatchet raw material was obtained. In the first, Bradley (1792[1969]:170) wrote that in July 1789 Governor Phillip's expedition reached "very shoal water with very large hard stones (of which the Natives make their hatchets &c)" near Richmond Hill on the Hawkesbury River (Fig. 1). However, how Bradley obtained this information is unclear (Attenbrow 2002:123).

The second account states that in April 1791 a government party, accompanied by two coastal Aborigines, *Colebe* and *Ballederry*, was exploring land in the same area when they met up with a group of inland *Bu-ru-be-rong-al* people, including *Go-me-bee-re*, *Yal-lah-mun-di* and a child *Jim-bah*. According to Governor Phillip they had apparently "come this journey in order to procure stone hatchets, as the natives get the stones whereof they make their hatchets from that part of the river near Richmond-Hill" (Phillip in Hunter 1793[1968]:513-525). The gist of this report was

repeated in several contemporary accounts, for example Collins (1798[1975]:487). However, it should be noted that no actual observations of Aboriginal people collecting stone from this location or from others in the Sydney region appear to have been recorded.

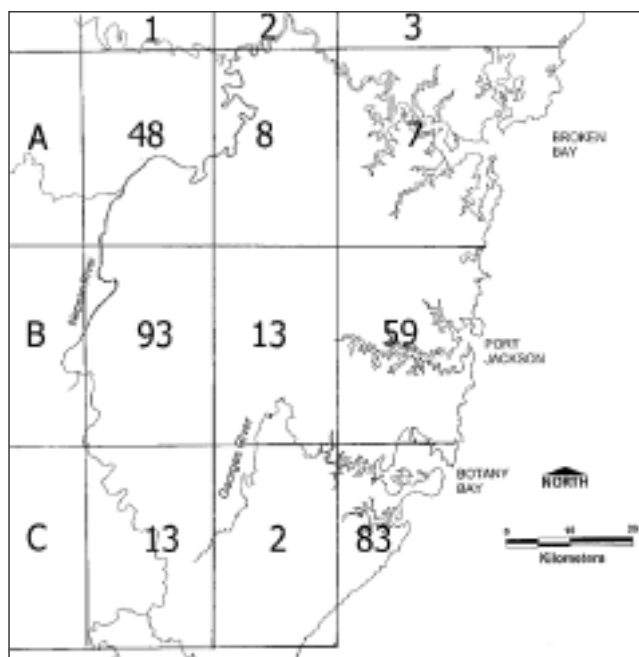
Since the late eighteenth century, many hatchets, usually unhafted, have been collected from various parts of the region. In the early days some were presented by their owners or bartered for, but as the Aboriginal population dwindled, due to disease, conflict and forced removal from their homelands, many hatchets were found abandoned, discarded or cached, either in rockshelters, during ploughing of newly enclosed fields, or during professional and amateur excavations. Some ended up in sheds and private museums but many are now in more formal collections.

### The study area

The Sydney region can be defined in many ways but for the purposes of this research it was taken to extend southwards from Broken Bay and the northern reaches of the Hawkesbury River to the southern parts of the Royal National Park, and eastwards from the lower Blue Mountains to the coast (Fig. 1).

The geology of the area varies from the sandstones of the Hawkesbury and Narrabeen Group rocks (mainly in the north, south, along parts of the coastline and to the west of the Hawkesbury/Nepean River) to the shales of the Wianamatta Group (mainly in the central areas), volcanic diatremes and dykes (widely scattered), gravelly and sandy Tertiary palaeo-channels (mainly in the west) and Quaternary river and beach deposits.

To identify the area in which each hatchet head was found, the study area was divided into nine Project Zones; their code names are based on an alphanumeric grid system (Fig. 3). Although the inland zones appear to be of equal size it should be noted that maps illustrate horizontal area, whereas the presence of hills increases the actual land surface area (Corkill 1992). The three eastern zones also comprise varying amounts of land, due mainly to the



**Figure 3** Hatchet counts in each Project Zone (1-3 = west to east; A-C = north to south).

orientation of the coastline<sup>2</sup>. However, the discrepancies in land area were found to be irrelevant to this project (see below - Spatial distribution - Overall).

### Previous research

Since the late nineteenth century a number of researchers have suggested raw material sources for hatchets found in various parts of the region. Some of these suggestions seem credible but others are improbable. Some of these hatchets (often called axes in the reports) are in the Australian Museum and were included in this research.

In 1880 James C. Cox exhibited eight stone axe heads at a meeting of the Linnean Society of New South Wales (Cox 1880:271-272). They were ploughed up at Castlereagh on the Nepean River and Cox thought (from their position) that they had probably been buried in an Aboriginal grave (though no skeletal material was mentioned as having been found). He also mentioned that 30 similar axe heads had been discovered on the other side of the river “under somewhat the same circumstances”. The raw material was identified as “dioritic”. Although Cox himself did not speculate on the source of the raw material, this is an area where suitable material is abundantly present (see below). Many years later, Australian Museum Anthropology Curator F.D. McCarthy was in no doubt that the hatchets originated from the Nepean River “axe factory” and “quarry” shown to him in the 1930s by G.E. Bunyan, an interested local resident (McCarthy 1978:50).

In 1889 geological surveyor T.W. Edgeworth David and palaeontologist R. Etheridge Junior wrote that the raw material for an edge-ground implement which was found

with human remains at Long Bay, near Botany Bay, and was made of “a dark micaceous flagstone ... may have been obtained from local beds in the Hawkesbury Series” (Edgeworth David and Etheridge 1889b:12 and Plate I). This source seems unlikely as none of the rock in Hawkesbury Sandstone strata conforms with the criteria necessary for the production of serviceable edge-ground artefacts.

Also in 1889, Edgeworth David and Etheridge found two hatchets in a “kitchen midden” at Forty Baskets Beach, Port Jackson. They reported they were made from “travelled pebbles, not representing local rocks” (Edgeworth David and Etheridge 1889a:144 and Plate XX). The description “travelled pebbles” implies that water-rolled, evenly-shaped stones were used. This, plus the suggestion of a non-local source, is significant, as will become clear later in this paper.

In 1894 Chemistry Professor A. Liversidge described 18 hatchet heads from various parts of Sydney, mainly coastal but some from further inland (Liversidge 1894). Fifteen were made from “pebbles of spotted altered claystone” (hornfels) and one each from dolerite, diorite and quartzite. He suggested that the altered (i.e. metamorphosed) claystone pebbles had probably been brought from the old riverbed at Lapstone Hill, Emu Plains (near Penrith) (Liversidge 1894:233). This certainly seems possible, as this material is among those present in the exposed gravels adjacent to the Nepean at Emu Plains.

In a brief paper in 1928 W.W. Thorpe and M.S. Stanley discussed Aboriginal axe manufacture and included a photo of ten “pebble-axes from Emu Plains, Nepean Valley” (Thorpe and Stanley 1928). No raw material source was proposed in the paper but McCarthy (1978:50) referred to this collection when writing of “the great axe factory there on the Nepean”. The axe heads were donated to the Australian Museum by local orchardists and are included in my data. In 1948 McCarthy wrote of the “inexhaustible supply of pebbles” in the Nepean beds for manufacturing edge-ground artefacts. He also stated that “The most favoured material ... is hornfels, although a wide range of other stones is present” (McCarthy 1948:23).

A ground-edge axe, plus a fragment of a second one, were found in the 1960s during excavation of a rockshelter on Gymea Bay (near Botany Bay) by a team led by Vincent Megaw of the University of Sydney’s Archaeology Department. The artefacts were identified as being made of Cordierite Hornfels and the “nearest coastal locality” of this rock was given as the Upper Shoalhaven River (Megaw 1966:33, Fig. 5). This area is over 150 kilometres south west of Gymea Bay and is not what I would call coastal as it is at least 50 kilometres from the sea. Other possibilities were given as Bathurst or Marulan, both of which are also over 150 kilometres away; the latter, in fact, is near the Upper Shoalhaven. The rock type may be present in those areas, but they are certainly not the “closest” known locations - hornfels can be found around 50 kilometres away, coastally at Bellambi Point near Wollongong and inland in the Hawkesbury/Nepean<sup>3</sup> gravels (see below - Potential raw material locations).

David Branagan, a University of Sydney geologist, collaborated with Megaw in a publication on the lithology of artefacts excavated at Curracurrang, in Royal National Park (Branagan and Megaw 1969). Seven axes were said to have been thin-sectioned<sup>4</sup>. Of these, three were identified

<sup>2</sup> In Zone 3A it is also due to the fact that areas north of Broken Bay were not included in the research.

<sup>3</sup> The Nepean and Hawkesbury are different sections of the same river (see Fig. 1).

<sup>4</sup> Although the text says there were seven thin-sections made, the Table stipulates there were only six.

as cordierite hornfels, two of igneous origin and one of tinguaitite, “an unusual [igneous] rock which is known to outcrop only in the Minnamurra region, about 40 miles south”. The other two igneous axes were thought likely to have come from the Wollongong-Kiama region (Kiama is on the coast about 70 km south), although Milton, even further south, was also given as the possible source of one. Again, the nearest source of hornfels is given as the Upper Shoalhaven, but this time “perhaps more likely” sources are even further away (around 250 km), on the south coast near Moruya and Bodalla (Branagan and Megaw 1969:14 and Table 5).

In 1974 Megaw edited a group of Sydney district excavation reports. Again edge-ground hornfels artefacts were potentially sourced to the far south coast. And this time the Blue Mountains, “a dyke on the coast” and the Shoalhaven area were added to the list of possible igneous sources (Megaw 1974:5, 31). It is interesting that the Megaw reports focus on the rock type and tend to ignore the original form of the hatchet blanks when suggesting sources, unlike the next reporter in this list.

Frank Dickson, from the University of New South Wales, is perhaps the best known researcher of Sydney hatchet heads. In 1972 he suggested that the flattish waterworn pebbles of “indurated siltstone”, which were used to make axes found at Kurnell on Botany Bay, might have come from Thelma Head, some 30 km south. Other axes from the same area were reported as having been made of “basaltic” stone, which Dickson says may have been obtained from a formation at the foot of Macquarie Pass “about 100 km by road from Kurnell”. He also notes that there is “a basalt reef below high tide level at Bellambi” (Dickson 1972:206). Unfortunately, as it is unclear which Kurnell hatchets are referred to and whether or not they are in the Museum, it was not possible to verify the raw material of those implements during my research, a necessity before trying to tie them to a source.

In 1984 Jim Kohen and his co-writers felt sure enough of their sourcing of artefactual stone from Shaws Creek II rockshelter, on the western side of the Nepean River, to merely mention in passing that there was a “convenient supply of ...basalt pebbles in the bed of the river and suitable sandstone outcrops for grinding stone hatchet heads” (Kohen et al. 1984:59). Isabel McBryde and Alan Watchman, however, went through a comprehensive process of elimination before concluding that the origin of a spotted hornfels hatchet head, found in material recovered from the 1790 wreck of the “Sirius” off Norfolk Island, was likely to have been the gravels of the Hawkesbury/Nepean (McBryde and Watchman 1993). This artefact is now in the Norfolk Island Museum and was unable to be accessed for this research.

In recent times many archaeologists have found edge-ground hatchets or fragments during field surveys and excavations in the study area. The raw material is usually identified in these reports as igneous, mainly basalt or “fine-grained basic” (e.g. Kohen 1986:81). Similarly, when speculating about hatchet raw materials and their potential

sources, igneous types are often the only ones mentioned (e.g. Attenbrow 1996:36; Smith 1988:16,17,28-29) - in the past I have done it myself (e.g. Corkill 1990, 1995, 1999a). As will become clear below, my current research indicates that many of these identifications are likely to have been incorrect and the speculations inadequate.

As mentioned above, some of the hatchet heads described in reports are present in the Australian Museum and were examined during this project. However, many are in other collections or could not be found or accessed.

### Potential raw material locations

Raw materials for edge-ground stone tools should be “very tough, resistant to fracture and free of cracks and other flaws. Fine to medium-grained rocks with strongly interlocking textures or strong intergranular rocks are preferred” (Domanski and Webb 2000:178-9, citing Fenton 1984:223, 231; see also Dickson 1981:27-33). These are generally metamorphic and igneous rocks such as hornfels, greenstone, basalt and dolerite (Dickson 1981:26; Domanski and Webb 2000; Kamminga 1982:25; McBryde 1978:355-356).

Size and shape also seem likely to have been important when selecting a hatchet “blank”. Preliminary examination of the Museum’s Sydney hatchets indicated that most were made from pebble-shaped<sup>5</sup> cobbles (archaeologists often call them pebble axes, but as the artefacts are usually longer than the accepted pebble length of <64 mm [Whitten and Brooks 1972:88], cobble is the correct term for the item itself, as opposed to its shape). When attempting to source these artefacts it is therefore obvious that one must find locations where such cobbles are present (i.e. in current and ancient river channels, beach gravel deposits and conglomerates).

A minority of Museum hatchets were observed to be more angular (as opposed to pebble-shaped). Although they also might have been selected from gravel deposits and knapped before grinding, their blanks could have been directly quarried from *in situ* igneous or metamorphic strata.

Potential sources were identified from geological maps (but see Corkill 1999b for problems associated with their use), from suggestions made by previous researchers (see above) and during field investigations for this and previous research (e.g. Corkill 1999a; Corkill in prep).

The relevant geological formations within the study area consist of Quaternary and Tertiary channel deposits (which occur most extensively in the western part of the study area) and igneous outcrops such as dykes and diatremes (which are more widely scattered but much less extensive) (refer to Corkill 1999a: Chapter 6; Geological Survey of New South Wales 1983, 1985, 1991; Herbert 1983; Jones and Clark 1991; Sherwin and Holmes 1986 for further information about these formations). At a general level (i.e. identification of a generic rock type such as hornfels, quartzite or igneous, as opposed to a more detailed mineralogical analysis aiming to characterize a particular specimen) it appears that most of the raw materials suitable for edge-ground hatchets (including igneous rocks) are available as loose cobbles in the channel deposits. The igneous outcrops generally contain only volcanic rock<sup>6</sup>, which would usually have to be quarried directly from the *in situ* strata.

In addition to the Sydney region channel deposits,

<sup>5</sup> Pebble-shaped: Somewhat flattened ovoid to semi-rectangular pebbles or cobbles. Their shape indicates water-rolling in river or ocean.

<sup>6</sup> However, some volcanic outcrops contain exotic material picked up during eruption.



ID #	ROCK TYPE	MINERAL % (two highest only)	Chi <sup>2</sup> error
DR 3*	Spotted Hornfels	58% quartz; 29% muscovite	3.02
YC 7	Hornfels	66% quartz; 16% bytownite	1.37
BPt 1*	Sandstone <sup>□</sup>	65% quartz; 35% labradorite	2.12
BPt 10*	Quartzite	83% quartz; 7% labradorite	5.73
GB 6	Sandstone	89% quartz; 4.1% kaolin	1.61
K 1*	Basalt	36% labradorite; 34% augite	1.67
BH 2c	Teschenite	34% labradorite; 27% analcime	2.94

**Table 1** Characterisation of rock types by X-Ray Diffraction. For sample location see Figure 4. (\*= rocks edge-ground by researcher; <sup>□</sup> = slightly metamorphosed?).

Zones	1 (West)	2 (Centre)	3 (East)	Totals
A (North)	48	8	7	63
B (Centre)	93	13	59	165
C (South)	13	2	83	98
Totals	154	23	149	326

**Table 2** Hatchet counts in each Zone.

Raw Materials	Totals	West 1A+1B+1C	Centre 2A+2B+2C	East 3A+3B+3C
Hornfels	52%	64%	61%	38%
Hornfels ?	7%	9%	4%	5%
Igneous	11%	5%	4%	18%
Igneous?	2%	1%	0%	3%
Metamorphic (indeterminate)	4%	1%	9%	5%
Quartzite	8%	6%	0%	11%
Quartzite?	7%	8%	4%	7%
Unknown	9%	6%	17%	11%
Totals	326 100%	154 100%	23 99%	149 98%

**Table 3** Hatchet raw materials from west to east.

unlike most sandstones in the region; however, this results from the separate origin of minerals in the sandstones of the southern coastal areas. BPt 10 was characterized as a quartzite but contains minerals which make it more suitable for grinding than many other quartz-rich quartzites. Teschenite (BH 2c) is a distinctive type of dolerite (a volcanic igneous rock) which could have significance in sourcing, a fact which is discussed below.

**The hatchets**

Three hundred and twenty six edge-ground hatchet heads from the study area were included in analyses. They comprised all those from the Museum’s main collection<sup>7</sup> that were available at the time, plus a few from excavated sites which are stored separately in the Museum.

<sup>7</sup> The “main collection” consists largely of individual hatchet heads stored together in geographically ordered cabinets, regardless of collection date.

**Spatial distribution - Overall**

The hatchets were found within the nine Zones shown in Table 2 and Figure 3. It can be seen that the greatest number of hatchets were found in the west central Zone 1B (93 artefacts) and south east Zone 3C (83 artefacts). As the latter Zone contains much less land than the former, there are actually more hatchets per hectare. At first glance this might appear to have some significance. However, as the Museum collection results from many years of unsystematic accumulation and is in no way likely to represent the number of hatchets that were or are actually present in the region as a whole, or in any of the Zones in particular, there is nothing to be gained from comparing the actual numbers in each Zone. In view of the fact that nearly all hatchet grinding grooves are found in Hawkesbury Sandstone (Attenbrow 2002:121), it is interesting to note that Hawkesbury Sandstone Zones 2A, 3A and 2C have so many fewer hatchets than the Zones with Wianamatta, Tertiary and Quaternary geology. Zone 3C is also mainly Hawkesbury Sandstone, but nearly all the hatchets were found in the Quaternary sands around Botany Bay.

**Spatial distribution - Raw materials**

Tables 3 and 4 show raw material totals and percentages from each Zone (Table 3 from west to east and Table 4 from north to south). Overall it can be seen that hornfels (at 52% of the total, or 59% if hornfels? is included) is the most common material from which hatchet heads were made. Quartzite and quartzite? make up 15% while igneous and igneous? only account for 13%.

From west to east (Table 3) it can be seen that hornfels declines, from 73% in the west to 65% in the central Zone, to 43% in the east. Conversely, igneous increases from 6% in the west and 4% in the centre to 21% in the east. However, it is still only half the percentage of hornfels and only just more than quartzite, which makes up 18% of the total in the east.

From north to south (Table 4) there is also a decline in hornfels percentages (from 78% to 60% to 44%) and an increase in igneous (from 8% in the north and 7% in the centre to 27% in the south). Similarly there is an increase in quartzite (3% to 15% to 24%). Again, hornfels and the other metamorphics are by far the most common in all three areas (86% in the north, 79% in the centre and 68% in the south).

**Spatial distribution - Blank types**

As discussed above, the shape of the hatchet blank is an important indicator of raw material source. The majority of Sydney region hatchets are pebble-shaped (see Footnote 5);

Raw Materials	Totals	North 1A+2A+3A	Centre 1B+2B+3B	South 1C+2C+3C
Hornfels	52%	68%	55%	36%
Hornfels ?	7%	10%	5%	8%
Igneous	11%	6%	6%	22%
Igneous?	2%	2%	1%	5%
Metamorphic (indeterminate)	4%	5%	4%	2%
Quartzite	8%	0%	8%	12%
Quartzite?	7%	3%	7%	10%
Unknown	9%	6%	13%	4%
Totals	326 100%	63 100%	165 99%	98 99%

**Table 4** Hatchet raw materials from north to south.

	P	A
West	95%	5%
Centre	91%	9%
East	84%	16%
Totals	292 90%	34 10%

**Table 5** Hatchet Blanks: West to East. (P = pebble-shaped; A = angular.)

	P	A
North	89%	11%
Centre	92%	8%
South	86%	14%
Totals	292 90%	34 10%

**Table 6** Hatchet Blanks: North to South. (P = pebble-shaped; A = angular.)

they are designated “P” in Tables 5-8. Most are unmodified except for edge-grinding and, in some cases, minimal flaking and/or pitting - the latter perhaps due to use as an anvil. Some of the hatchets are more angular; these are designated “A” in Tables 5-8. It was not possible to ascertain their original (pre-selection) shape but they may have been quarried from *in situ* strata of volcanic outcrops or selected as angular pieces from gravel deposits. They could also have originally been pebble-shaped cobbles that were highly modified during manufacture.

Tables 5 and 6 show that 90% of the hatchet heads in the study were fashioned from pebble-shaped blanks. The other 10% do not have enough diagnostic attributes (e.g. cortex) to tell whether they were originally pebble-shaped cobbles or pieces quarried from an *in situ* primary outcrop. There is some difference from west to east (Table 5) with 95% of those from the west having pebble-shaped blanks, compared with only 84% of those in the east. Nevertheless, the predominant form in the east is still a pebble-shaped blank. The significance of this is discussed below. Table 6 shows that pebble-shaped blanks differ little from north to south, with percentages from 86% to 92%.

	West - P	West - A	East - P	East - A
North	92%	8%	57%	43%
Centre	97%	3%	85%	15%
South	92%	8%	86%	14%

**Table 7** Hatchet Blanks: Western and Eastern pebble-shaped (P) versus angular (A) blanks, from North to South.

Raw Materials	P (pebble-shaped)	A (angular)
metamorphic	234 92%	19 8%
igneous	36 84%	7 16%
unknown	22 73%	8 27%

**Table 8** Blank Shape of Raw Materials.

In Table 7 it can be seen that pebble-shaped blanks comprise between 92% and 97% of the totals from the western zones. In the eastern zones they range from 57% in the north to 86% in the south, but the difference between north and south in the east seems likely to have a statistical rather than a cultural cause (only a small number of hatchets came from the north east zone - See Table 2).

#### **Blank raw materials**

Table 8 demonstrates that more metamorphic than igneous blanks are pebble-shaped (92% versus 84%) but it also shows that only 16% of the igneous hatchets *do not* have a pebble-shaped preform. This is important in terms of sourcing and is discussed below.

#### **Hatchet grinding project**

In order to test the grindability of raw materials five rocks from the field collection were edge-ground (Table 9 gives relevant details). Three were pebble-shaped metamorphic cobbles, similar to many of the hatchets in the Museum collection. Two were irregularly-shaped pieces of igneous material (pebble-shaped pieces of this material were unable to be found).

The grindstone was a rectangular slab of medium-grained Hawkesbury Sandstone placed on a slight slope, with a small sprinkler trickling water over the surface during the grinding process. Each of the three cobbles was ground on both sides of one short end until a reasonably sharp edge was produced. There was no attempt to achieve a specific blade length or angle, which in any case would depend on the size and shape of the original cobble. Detailed descriptions and discussion of hatchet making are to be found in publications by Frank Dickson (e.g. Dickson 1972; 1981).

Apart from some perfunctory wood chopping, no attempt was made to use the finished artefacts as functional hatchets. However it was noticeable that the artefact blade which took the shortest time to grind (BPt 1) chipped almost immediately it was used. This rock is a slightly metamorphosed sandstone with what must obviously be a soft mineral cementing the quartz grains. The other two

ID #	Raw Material	Meta/m or Igneous	% quartz	Blank shape	Length ground (mm)	Grinding time (mins)	Notes
BPt 1	Sandstone	□ meta/m	65	pebble	58	22	chipped easily when used
BPt 10	Quartzite	meta/m	83	pebble	35	120	good edge but hard to grind
DR 3	Hornfels	meta/m	58	pebble	30	45	good edge
K 1	Basalt	ig	0	piece*	30	5	only small area ground
BH 2	Teschenite	ig	4	piece*	49	30	thick piece; not ground to sharp edge

**Table 9** Edge-ground pieces (all were subjected to XRD). (□ = only slightly metamorphosed; \* = irregularly shaped piece)

cobble artefacts took longer to grind - BPt 10, which contained 83% quartz, took 120 minutes to achieve a reasonable edge. When tested these two appeared to be much tougher and less inclined to chip than BPt 1.

The two igneous pieces (K1 - basalt, and BH 2 - teschenite, a variety of dolerite) were not ground to sharp edges as the blank shapes were unsuitable. Each material appeared likely to produce a good edge if an appropriately shaped blank was available or flaked to shape, but, without testing, it is not possible to say how easily damageable they might be.

Variations in the grinding rate and potential for damage of different rock types raise a number of socioeconomic and technological issues (for example those concerning selection criteria, the accessibility of raw materials and availability of time) which await future investigation.

## Conclusions

Data derived from analysis of 326 of the Australian Museum's collection of Aboriginal stone hatchet heads from the Sydney region show that 90% were manufactured from water-rolled cobbles. In the study area these are only available in present day river channels and palaeo-channels at least 20 kilometres, and mainly more than 50 kilometres, from the sea. Along the coastline there are no documented cobble beds or cobble bearing strata until one reaches the Illawarra near Wollongong (around 50 km south of Sydney CBD) or the Munmorah Lake area (around 80 km north). If it is correct that cobbles on north Illawarra beaches result from a tsunami throwing them up from offshore some 500 years ago (Bryant 2001:67-71, 257-259; see also Corkill 2003: Appendix 5), then Sydney manufacturers would probably not have been able to obtain raw material from these sources in earlier times.

Only 10% of the hatchets have blanks which *may* have come from *in situ* strata such as volcanic intrusions. However, even they may have originated in the gravels, as angular cobbles, or larger pebble-shaped blanks of particularly suitable material could have been knapped to size and shape. This 10% includes only seven of the 43 indisputably igneous hatchets. Thus, even if volcanic intrusions (such as those at Barrenjoey, Bondi or further afield) were sometimes exploited for igneous raw materials, it is obvious that material from the gravel beds was usually preferred.

Overall, there is some decrease from west (95%) to east (84%) of hatchets made from gravel-derived blanks, but a large majority were still manufactured from such blanks. Seventy eight percent of the hatchets were made from metamorphic rocks, of which the most popular was hornfels (59% of total). Only 13% were made from

igneous rocks. Even if all those in the "Unknown" category (9%) are igneous they would still only make up 22% of the total. The use of hornfels declined from west to east (from 73%-43%), whereas igneous increased (from 6%-21%). Both metamorphic and igneous rocks are present in Sydney and Illawarra gravel beds. The Munmorah conglomerates to the north also contain metamorphic and probably igneous rocks (Corkill 1999a:53-54). And, of course, there are many gravel and conglomerate outcrops further afield, in areas not investigated for this project.

Perhaps the most significant findings of the research are that the vast majority of Sydney region hatchets were made from waterworn pebble-shaped metamorphic rocks. This is the case in all parts of the region, even those areas where such raw materials are not present, such as along the coastline.

So where did the hatchet makers obtain their raw materials? For the people of the western Sydney region the most parsimonious answer would have to be the nearby Hawkesbury/Nepean River and palaeo-channel gravel beds. That they did so at "contact" is supported by the sparse ethnohistorical reports.

But what about the people further away, particularly those on the coast? Did they travel or trade to the west, north or south, or all three? The fact that the "coastal" Aborigines in Governor Phillip's 1791 exploration party between Rose Hill (Parramatta) and the Hawkesbury area were able to converse with people whose language or dialect differed from theirs (Phillip in Hunter 1793[1968]:513-523), even though they did not know them, indicates that there was considerable social interaction between coastal and inland groups. But whether they traded or collected their own raw material is not recorded. There is also evidence that people travelled up and down the coastline, particularly to and from the north, for various reasons including trade (Attenbrow 2002:122-124; Ross 1976:74-79). But again, collection or trade in hatchets or blanks is not recorded.

This research makes it clear that most raw materials were available within 50 kilometres of any point in the Sydney region. So there was no physical need for the travel or trade over hundreds of kilometres that was suggested by some of the researchers referred to above. Which is not to say it didn't happen from time to time for reasons more complex than pure propinquity.

More detailed research, probably requiring destructive procedures (e.g. thin section or elemental analysis) would be needed to determine a specific source for each of the many hatchet heads in the Museum collection with absolute certainty.



And we are left with a plethora of questions. For example:

- 1) How did the hatchets get to be where they were found? Were they lost, discarded or what? And why?
- 2) Why have so few hatchets been found in Hawkesbury Sandstone country, particularly since nearly all grinding grooves are located in this terrain?
- 3) If people had easy access to inferior material but had difficulty in getting good material, what choices did they make and in what circumstances.

These and many other questions will have to await future research.

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