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– ARTICLE –

Greywacke Gravels and Adze Manufacture in the Inland Taranaki Area, North Island, New Zealand

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ABSTRACT

Stone adzes (toki) made from greywacke are a characteristic feature of late 'Classic Maori' material culture in Aotearoa/New Zealand, particularly in the North Island, but despite the widespread natural distribution of this sedimentary rock type few archaeological source sites have been identified. The pre-European production of adzes from alluvial greywacke-dominated gravels in the inland Taranaki area, south-western North Island, was first reported in 1971. We present new information on the nature, extent, and composition of these gravels, on the geochemistry of the greywacke, and on adzes previously collected from the area. X-ray fluorescence analyses of greywacke cobbles indicates they originated from at least two of New Zealand's Permian to Early Cretaceous tectonostratigraphic 'basement' terranes, which has implications for the future sourcing of greywacke adzes from Taranaki and elsewhere.

Keywords: alluvial gravels, greywacke, XRF analysis, adzes, Taranaki

INTRODUCTION

Within the short 500-year span of New Zealand prehistory (*c.* AD 1250–1770) there was a significant change not only in the styles of adzes (toki) being used but also the kinds of lithic materials from which they were made (Best 1977; Davidson 1987; Duff 1956; Furey 2004; Turner 2000). In the Early (Archaic or 'Moa-hunter') period, most adzes were manufactured from readily flaked, fine-grained rock types such as basalt and metasomatised argillite, obtained primarily from recognizable quarries (Jennings *et al.* 2023; Leach 1990). During the later 'Classic Māori' period, from about AD 1500 onwards, many adzes were produced from coarser-grained, less easily flaked greywacke, particularly in the North Island (*e.g.* Furey 1996). Greywacke is a common sedimentary rock type throughout New Zealand, and good quality stone was widely available from outcrops, alluvial gravels and boulder beaches in both main islands. Yet, with the exception of one early-utilised source on Motutapu Island near Auckland (Davidson & Leach 2017; Turner 2000), there is remarkably little information on the exploitation of this raw material, places of adze manufacture, or the numbers of greywacke adzes produced.

During 1969–70 Raymond Hooker (1971) undertook a detailed field survey of the relatively isolated upper Patea River area in eastern Taranaki, where he recorded over 70 archaeological sites (Figure 1). Many of these sites contained some evidence of adze manufacture in the form of preforms, debitage and hammer stones. The raw material had been procured from alluvial gravels in several of the local streams, which Hooker (ibid, p.146) described as consisting of 'boulders' of grey, well-indurated sandstone and chipwacke, with some greenish mudstone, all of which were represented among the artefacts found. In 1971 he carried out an additional survey around part of the Waitara River to the west, where he recorded further evidence of adze production in similar materials (Hooker n.d.).

In view of the obvious importance of the inland Taranaki gravels as a source of adze material, we considered a more thorough study was warranted. This had two main objectives: (1) to obtain more detailed information on the nature, composition and geographic distribution of the Taranaki gravels, and (2) identify petrographic and geochemical attributes of the main rock types that might assist in distinguishing finished adzes made from local rather than imported stone. There was also a need to properly document Hooker's artefact collection.

GEOLOGICAL CONTEXT AND DISTRIBUTION OF GRAVELS

Northern and eastern parts of the Taranaki region are underlain by a thick sequence of moderately indurated sedimentary rocks, dominated by sandstone and siltstone (often referred to collectively as 'papa') of Miocene-Pliocene age (approx. 7–5 million years old). In the west these rocks are concealed beneath Quaternary lahar deposits originating from Taranaki volcano and, along the coast,

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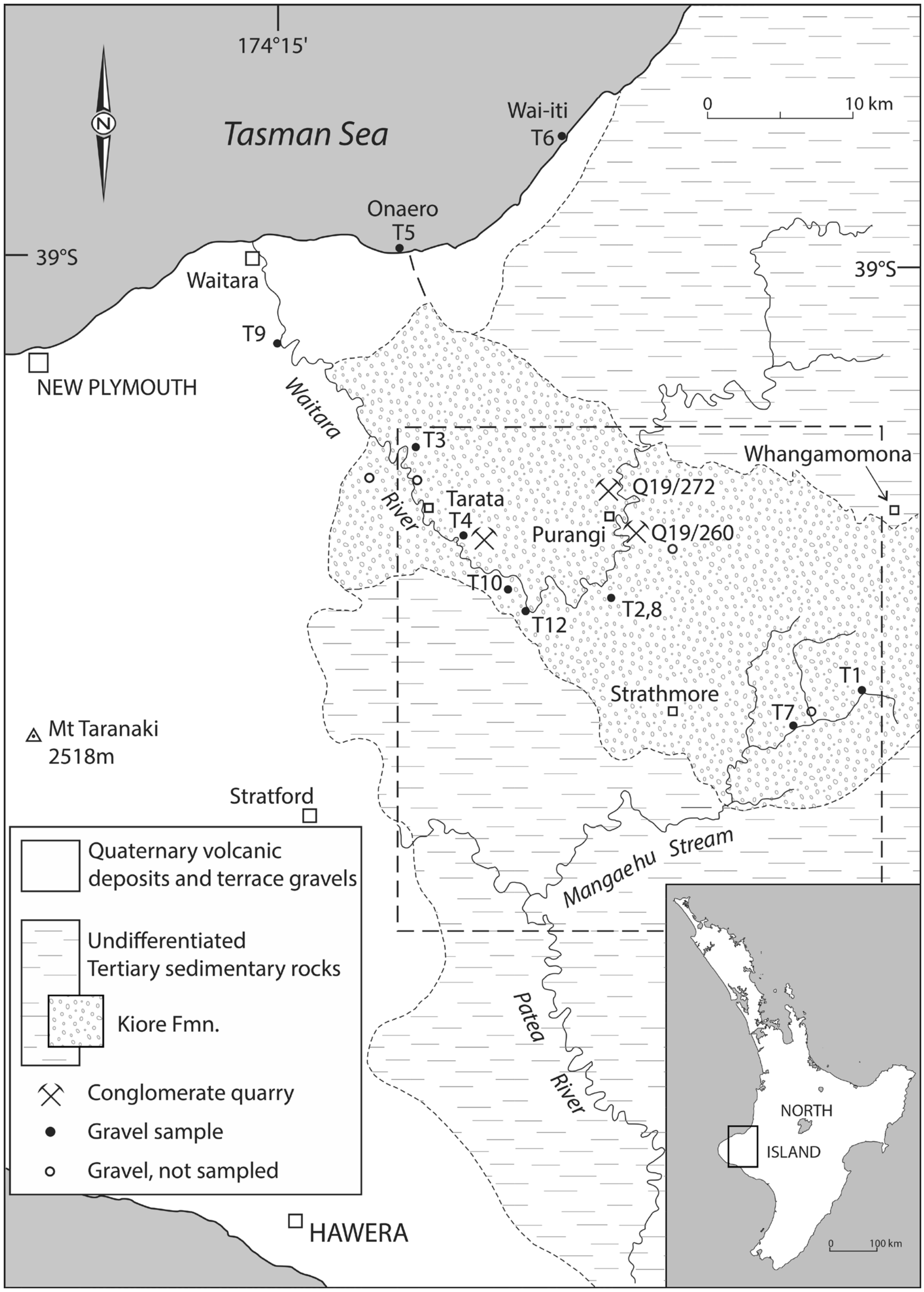

Figure 1. Simplified geological map of the inland Taranaki area (after Townsend *et al.* 2008) showing sample locations. For outlined area see Figure 7.

they are covered by Quaternary marine and alluvial terrace gravels (Figure 1). Greywacke-dominated gravels found in river and stream beds in inland Taranaki are derived primarily from the Late Miocene Kiore Formation, which is composed of up to 500 m of siltstone and sandstone with isolated lenses of pebble-cobble conglomerate (Townsend *et al.* 2008). This unit stratigraphically overlies the Urenui Formation, which contains pebble conglomerates of similar composition. The conglomerates in the Kiore Formation were, and in some places still are, quarried for local roading material. Greywacke bedrock (of Permian to Early Cretaceous age) is not exposed in the inland Taranaki area.

The greywacke gravels are distributed over a relatively wide area (Figure 1). The main occurrences are in the upper Patea River catchment, particularly the Mangarewa and upper and lower parts of the Mangaehu Stream, as previously reported by Hooker (1971), and in various tributaries of the mid Waitara River south of Purangi (Mangaopa and Makino streams) and near Tarata (Mangamoehau Stream). No gravel bars or beaches were observed along the mid Waitara River at the time of our initial survey in May 2014, due to high river levels, but some were exposed in October and may be quite extensive during periods of low flow. Cobbles of greywacke were also found on some ocean beaches on the northern Taranaki coast, at Onaero and Wai-iti. Those at Onaero beach may have come from the nearby Onaero River, which drains the Kiore Formation to the south. At Wai-iti beach the cobbles could be reworked from Quaternary terrace gravels, or from conglomerates within the Urenui Formation.

These greywacke gravels constitute the only suitable source of hard rock for adze manufacture in Taranaki. Andesite from Mt Taranaki and associated volcanoes was apparently too coarse grained for this purpose (Keyes 1971).

COMPOSITION OF GRAVELS

Our observations on the inland alluvial gravels indicate they are largely composed of cobbles and pebbles of greywacke, chipwacke and quartz, with less common green argillite and volcanic rock types. In the lower Waitara River, and some tributaries near Tarata (*e.g.* Taramakou Stream) the gravel beds consist mainly of cobbles and boulders of andesite derived from nearby Mt. Taranaki volcano. Gravels were sampled at a total of 12 locations (Figure 1). Most of these are in the inland area, while two are on the north Taranaki coast (localities T5, T6). Greywacke cobbles were also noted in conglomerate outcrops within the Kiore Formation near Tarata and Purangi.

Greywacke is an indurated sandstone with a muddy matrix (Mortimer *et al.* 2011). Chipwacke is a variety of greywacke containing angular clasts or 'chips' of grey argillite (indurated mudstone), generally >2 mm in size. There is no particular proportion of argillite chips required to distinguish chipwacke from greywacke, but it would typically be >5 per cent. Many of the greywacke cobbles do contain small mm-sized clasts of argillite, and several were simply classed as greywacke/chipwacke. Chipwacke tends to be predominantly of medium to coarse sand size.

In order to obtain some reliable quantitative data on the size and lithology of the cobbles, we recorded a transect across one of the gravel beaches in the upper Mangaehu Stream (locality T7, GPS position NZGD 2000 E1743720 N5650820, Figure 1). This beach, which is relatively close to

Figure 2. Gravel beach in the upper Mangaehu Stream. A transect was recorded along this beach (locality T7, Figure 1).

a stone-working site (R20/33), was about 13 m long by up to 4 m wide, and consisted mainly of small to medium sized cobbles (Figure 2). Two separate profiles were recorded along the beach to adequately cover the size range represented. Profile A was 10 m long and extended across the inner part of the beach, while Profile B was 6 m long and located on the central-outer part, closer to the stream. For Profile A the lithology and size of 60 cobbles was recorded, and for Profile B, 32 cobbles. Pebbles (<64 mm diameter) were excluded. The maximum length of cobbles was measured by metal tape to the nearest 5 mm.

The size of whole cobbles (n = 86) along profiles A and B combined is shown in Figure 3. Broken cobbles, for which only minimum lengths could be recorded, were not included. The chart shows that the majority of cobbles at this location have a maximum diameter of less than 16 cm, and very few are of larger size. The mean length is 12 cm, modal size 9 cm, and the largest cobble was 24 cm in diameter. On the basis of size only, therefore, the proportion of cobbles suitable for the production of adzes >15 cm in length in the upper Mangaehu Stream was probably <20 per cent.

The shape of selected cobbles was also noted in order to obtain some idea of the proportion that were likely to be more suitable for working into adzes, based on the assumption that more elongate and less spherical (flatter) cobbles would be easier to work (Figure 4). Approximately 45 per cent (n = 41) were considered potentially suitable. Of these the majority (60 per cent) were elongate to elongate-oval, while the remainder were of similar shape but flatter; of 11 cobbles >15 cm in length most were elongate-oval. Most of the suitably shaped cobbles were composed of greywacke (68 per cent), and 17 per cent consisted of chipwacke. Volcanic rock types tend to form more spherical cobbles, which are better suited to use as hammer stones than adzes. Such cobbles proved very difficult to break.

In terms of lithology the proportion of greywacke and chipwacke cobbles in the two profiles is almost identical, and the data were therefore combined (Table 1). Overall, greywacke cobbles made up about 63 per cent of the gravel beach while chipwacke formed 15 per cent. Together these two rock types (including intermediate types) account for 85 per cent of the cobbles at this location. Other lithologies represent only a small proportion of the gravel, with green argillite constituting about 2 per cent.

LITHOLOGY OF COBBLES

Sampling of individual cobbles from various locations was aimed at providing both a better indication of the range of lithologies represented in the gravels, and more detailed information on the colour, texture and other characteristics of the greywacke and green argillite. All samples were examined under a binocular microscope, with identification of rock types being based mainly on a combination of texture and mineralogy. Colours were established with reference to the Munsell Soil Color Chart (2000 version), under natural light. The grain size of sedimentary rocks was determined by use of a standard grain size comparator. In total, 88 cobbles were sampled.

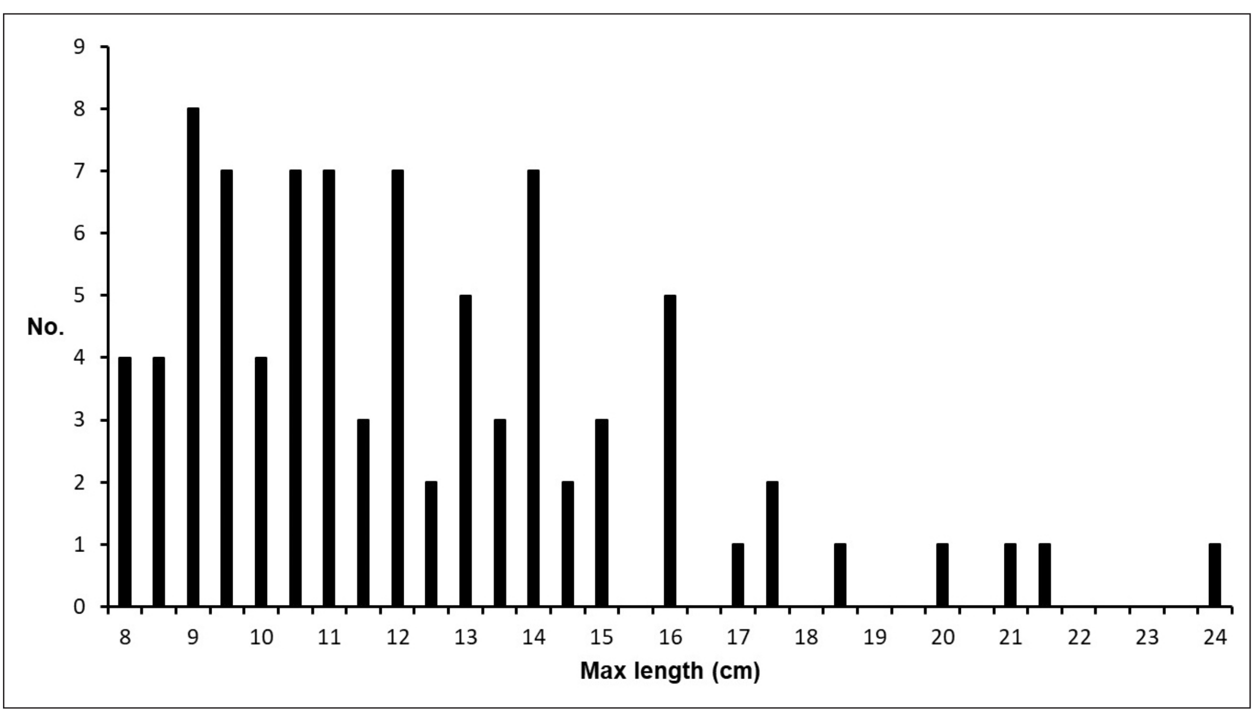

Figure 3. Size range of cobbles along transect at locality T7, Mangaehu Stream.

Figure 4. Examples of cobbles. Left: artificially split cobble of greywacke (note flat surface); Middle: experimental roughout made from other half of same split cobble by flaking; Right: broken cobble of Taranaki argillite.

Table 1. *Lithology of cobbles recorded along transect at Locality T7, upper Mangaehu Stream.*

Lithology	Profile A	Profile B	Total
Greywacke	37 (62%)	21 (66%)	58 (63%)
Chipwacke	9 (15%)	5 (16%)	14 (15%)
Greywacke/chipwacke	5	1	6
Subtotal	**51 (85%)**	**27 (84%)**	**78 (85%)**
Volcanic	3	1	4
Quartz	2	2	4
Green argillite	1	1	2
Conglomerate	1	0	1
Argillite	0	1	1
Unknown	2	2	4
TOTAL	**60**	**32**	**92**

Greywacke and chipwacke

Forty-three greywacke and chipwacke cobbles were sampled from the 12 locations. The freshly broken rock is predominantly bluish grey (5B 5/1) to greenish grey (mainly 5BG, 5G and 10G 5/1), and the cobbles weather to an olive, greenish or light brownish grey colour. In terms of sedimentary grain size about 50 per cent of samples are medium grained, and many others fall into the fine to medium sand class. Very few are coarse grained, and only one consisted of very fine greywacke. Although most greywacke cobbles appear to contain few or no veins, thin veinlets are evident in some samples under the microscope.

To obtain more precise information on the relative proportions of bluish and greenish grey greywacke, pieces were broken off 20 randomly-selected cobbles at locality T8 (Figure 1). Of these, only 2 (10 per cent) consisted of distinctly green material. At locality T7, at least 4 (5 per cent) of the cobbles recorded along the transect were composed of greenish grey greywacke or chipwacke, out of the 78 recorded. This would suggest that green greywacke is a relatively minor component of the gravels.

Green argillite

This is a distinctive, hard, fine-grained rock, for which Turner (2000) introduced the term 'Taranaki argillite'. Keyes (1971: 158) referred to it as a 'greenish impure chert'. The rock generally breaks with a sub-conchoidal to hackly fracture (Figure 4), though some samples do have a good conchoidal fracture, similar to that of chert. It varies in grain size from a true argillite (indurated mudstone) to very fine sandstone, and much of the material would be better classified as a sandy argillite. The fresh rock is predominantly greenish grey (5G, 10GY and 10G 5/1–6/1), but some material is yellowish green, greyish green (5G 4/2, 5/2), pale green (5B 5/1) and light bluish grey. A significant proportion of the argillite has a 'blotchy' appearance due to bioturbation (burrowing) of the original sediment, and some samples are distinctly banded (laminated). Two of the cobbles collected consisted of green argillite layers (up to 5 cm thick) enclosed by greywacke, indicating the argillite originated from a greywacke terrane. Although veining is generally not obvious, many of the samples contain a few very thin linear quartz veinlets. Some also contain small amounts of pyrite and/or marcasite. Detailed petrographic descriptions and a chemical analysis of the argillite are presented below.

Igneous rocks

Thirteen of the sampled cobbles consisted of various types of volcanic rock. Many of these are considerably altered, greenish (5BG 5/1) to dark greenish grey (5G, 10G 4/1) in colour, and may have had a basaltic composition originally. They do not contain obvious veins. Other samples are relatively fresh, dark grey, bluish grey (10B 5/1) or dark bluish grey (5PB 4/1), and moderately magnetic, presumably due to the presence of magnetite. These appear to be basalts or andesites. Two samples consisted of volcanic breccia, one altered and reddish in colour, the other dark bluish grey (10B 4/1) and slightly magnetic.

Two cobbles of fine-grained plutonic rock were also collected. These have a distinctly specked texture and consist of interlocking quartz, feldspar and dark-coloured minerals. Both appear to have a granitic composition.

Other

Quartz is a common component of the gravels, but occurs mainly as small pebbles. Of the two cobbles of 'quartz' sampled, one is a rock of uncertain original composition which is extensively veined by quartz. The other has a distinctly foliated appearance and may be a metamorphosed quartzite. Two definite cobbles of quartzite were also collected, one very pure and fine grained, the other medium grained. Chert appears to be quite rare. Of the three cobbles sampled, the most interesting consists of greenish grey chert (5G 5/1) with grey 'nodules' containing obvious radiolaria. Another, from Onaero beach, is bluish grey (5PB 5/1), has a good conchoidal fracture, and contains common spherical inclusions of unknown composition or origin. The third, which is reddish brown, extensively veined and fractured and of poor flake quality, is typical of cherts derived from the main ranges of the North and South islands.

Two other stones have a very unusual 'spotted' appearance. One consists of grey very fine sandstone, the other of yellowish green/grey siliceous argillite. The spots are not fossil burrows, like those preserved in the green argillite, but were possibly caused by the aggregation of minerals as a result of contact metamorphism. Thus, the two rocks are tentatively classified as hornfels.

In addition to these rock types, Keyes (1971) reported the presence of schist and a 'harzburgite serpentine' (serpentinite) among the samples collected by Hooker from the Mangaehu valley. The latter, if correctly identified, remains the only record of ultramafic rock from the inland Taranaki gravels.

THIN SECTION PETROGRAPHY

Thin sections were made of four samples of the green argillite to more properly characterize this distinctive rock type. These were very well-rounded pebbles or cobbles, 5–10 cm in diameter, with thin (*c.* 1 mm) brownish weathering rinds. All samples have been allocated GNS Petrology Collection numbers, and are lodged in the Petlab database (http://pet.gns.cri.nz).

Sample T1-21 (P83578), texturally, is a sandy mudstone. The thin section (Figure 5) reveals detrital sand-sized grains of altered plagioclase, fresh detrital augite, very rare green-brown pleochroic amphibole, and formerly glassy-textured volcanics, including glass shards, all set in a mudstone matrix. Despite the fine grain size the matrix seemingly lacks any cleavage or a substantial clay mineral content, though the presence of glass shards indicates the rock has a minor tuffaceous component. The sample is cut by quartz veinlets. Metamorphic minerals are all very fine grained, and therefore difficult to identify in thin section, but include albite, sericite, chlorite and prehnite.

Sample T8-23 (P83581) is also a sandy mudstone. The thin section reveals detrital grains of lithic volcanics (probably basaltic-andesitic in composition), altered plagioclase, augite, formerly glassy-textured volcanics, including glass shards, and a single grain of metaquartzite/vein quartz, all set in a mudstone matrix. The metamorphic mineral

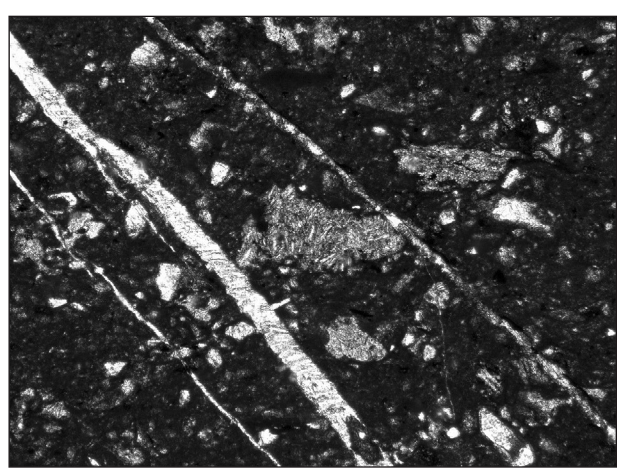

Figure 5. Microscope image of Taranaki argillite (sandy mudstone, P83578) showing lithic volcanic grain (centre) and quartz veinlets. View 2 mm wide, plane polarized light.

prehnite commonly replaces glass shards. Like T1-21 the matrix seemingly lacks any cleavage and does not have a substantial clay mineral content.

The two remaining samples have a very similar composition. One (T2-2, P83579) is a mudstone, and the other (T8-22, P83580) is a sandy mudstone.

GEOCHEMISTRY

Six geological samples – five greywackes and one green argillite – were selected for chemical analysis by wavelength-dispersive X-ray fluorescence (XRF), and the results are presented in Table 2. The greywacke samples were analysed at the University of Waikato in 2023 using a Bruker

Table 2. *Whole rock XRF analyses of selected cobbles. LOI = loss on ignition, na = not analysed, f-m = fine to medium grained, m = medium grained, gwke = greywacke.*

Sample no.	**T1-10**	**T3-1**	**T4-3**	**T7-A1**	**T8-5**	**T8-23**
GNS P no.	93661	93662	93663	93664	93665	83581
Munsell code	10B 5/1	10B 6/1	5B 5/1	10BG 6/1	5G 5/1	5G 5/1
Colour	bluish grey	bluish grey	bluish grey	greenish grey	greenish grey	greenish grey
Rock type	f-m gwke	m gwke	m gwke	f-m gwke	m gwke	argillite
Terrane	Waipapa	Torlesse	Torlesse	Waipapa	Waipapa	Waipapa
Major elements (wt%)						
SiO_2	55.33	71.38	72.61	60.10	58.99	54.23
TiO_2	1.00	0.43	0.37	0.80	0.95	0.93
Al_2O_3	18.46	14.18	13.77	17.10	16.35	15.98
Fe_2O_3T	7.94	3.18	2.20	5.98	7.58	10.02
MnO	0.11	0.05	0.06	0.09	0.12	0.15
MgO	3.47	1.16	0.95	2.36	2.74	4.23
CaO	5.23	1.43	2.36	4.62	4.38	8.32
Na_2O	3.85	4.16	3.60	4.81	3.74	1.89
K_2O	1.39	2.81	2.75	1.29	1.96	0.86
P_2O_5	0.26	0.10	0.09	0.18	0.20	0.15
LOI	3.54	1.56	1.45	2.62	2.95	3.01
Total	**100.60**	**100.44**	**100.21**	**99.94**	**99.96**	**99.96**
Trace elements (ppm)						
Sc	20	7	8	17	18	34
V	190	67	44	156	182	281
Cr	54	34	46	48	42	84
Co	32	44	39	41	36	na
Ni	16	11	8	23	15	18
Cu	55	11	9	26	34	120
Zn	89	45	42	73	84	92
Ga	21	17	16	19	20	16
As	11	7	10	9	9	2
Rb	42	90	94	46	60	16
Sr	650	338	304	583	431	452
Y	18	15	14	21	17	23
Zr	130	156	146	180	151	82
Nb	4	7	7	5	5	3
Ba	316	626	611	369	462	219
La*	4	14	11	17	8	6
Ce*	38	60	40	55	36	12
Nd*	21	22	18	23	22	na
Pb	3	14	14	9	3	4
Th*	6	11	11	9	6	2

*concentration close to detection limit

S8 Tiger 1kW wavelength-dispersive X-ray fluorescence spectrometer, and the argillite by Spectrachem in 2014. All samples have been allocated GNS Petrology Collection numbers, and all sample and analytical data have been lodged in the Petlab database.

Greywackes

The greywacke samples were specifically selected to reflect both the predominant grain size of adzes in the Hooker Collection (*i.e.* fine to medium grained), and differences in colour. Three of these were greenish grey and two were bluish grey.

The whole rock geochemical composition of the samples falls within the known range of compositions of *in situ* Permian to Early Cretaceous New Zealand greywackes, for which there are large published datasets (Table 2; Roser & Korsch 1986, 1999). Two compositional groupings of our samples are evident, based on key element concentrations and ratios (Figure 6): (1) a relatively high-silica group, also with high Na_2O/K_2O, SiO_2/Al_2O_3 and Th/Sc and (2) a low-silica group with low values of the aforementioned ratios and relatively high Fe and Mg. In all respects the two high SiO_2 greywackes are similar to analysed greywackes from the Torlesse Composite Terrane, whose chemistry is controlled by the relatively high content of quartz, feldspar, white mica and granitic and rhyolitic sand grains (Mackinnon 1983; Roser & Korsch 1986). The three low-SiO_2 greywackes match greywacke compositions from the Waipapa, Caples, Murihiku, Dun Mountain-Maitai and Brook Street terranes, although the more restricted outcrop area of the Dun Mountain-Maitai and Brook Street

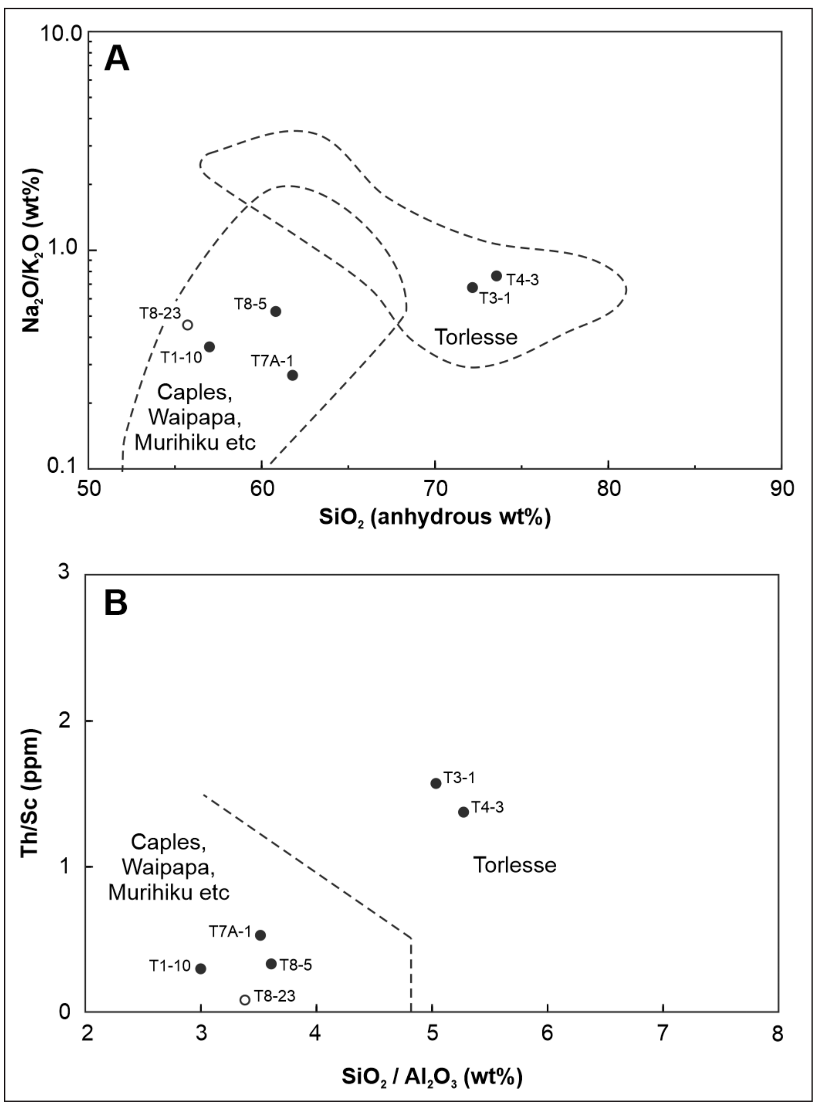

Figure 6. Binary geochemical plots of Taranaki greywacke and argillite samples (see Table 2) compared with datasets for New Zealand greywacke terranes. A. SiO_2 vs K_2O/Na_2O plot (Roser & Korsch 1986). B. SiO_2/Al_2O_3 vs Th/Sc plot of Roser & Korsch (1999). Black symbols = greywacke, white symbol = argillite.

terranes, and lower induration of the Murihiku terrane, makes Waipapa Terrane the most plausible volcaniclastic greywacke source. The chemistry of these volcaniclastic greywackes arises from the relatively low quartz content and the high abundance of sand grains of andesite in the rock.

The common greenish hue of many volcaniclastic greywackes is due to the high Fe and Mg content which is manifested in a higher proportion of green minerals such as chlorite. However, it is evident from Table 2 that colour is not a reliable guide to the source terrane of the greywacke.

Taranaki argillite

The chemical analysis of sample T8-23 (Table 2) indicates it has a composition typical of mudstones and very fine-grained sandstones from the five volcaniclastic terranes mentioned above, an interpretation supported by the petrographic observations, especially the presence of detrital augite and lithic volcanics. However, the prehnite grade of metamorphism provisionally eliminates the Murihiku Terrane as a source, which is typically of zeolite facies (Black *et al.* 1993).

ARCHAEOLOGICAL SITES

The archaeological sites reported here are those originally identified by Hooker (1971, n.d.). These are referred to by the current metric numbers (*e.g.* R20/32), but to facilitate easier comparison with his records we have continued to provide the old imperial site numbers where appropriate (see also Table 3). Site records are available from the NZ Archaeological Association Site Record File, www.archsite.org.nz.

In his survey of the Mangaehu valley in 1969–70 Hooker (1971) recorded a total of 71 archaeological sites, many of which were identified only as a result of ploughing of paddocks and bulldozing of tracks for farming and forestry purposes. This is a remarkable density for an inland area. Of these at least 32 (45 per cent) contained some evidence of adze manufacture in the form of preforms, flakes, cores or hammer stones. Another five consisted of isolated finds of finished adzes. Many of the sites also

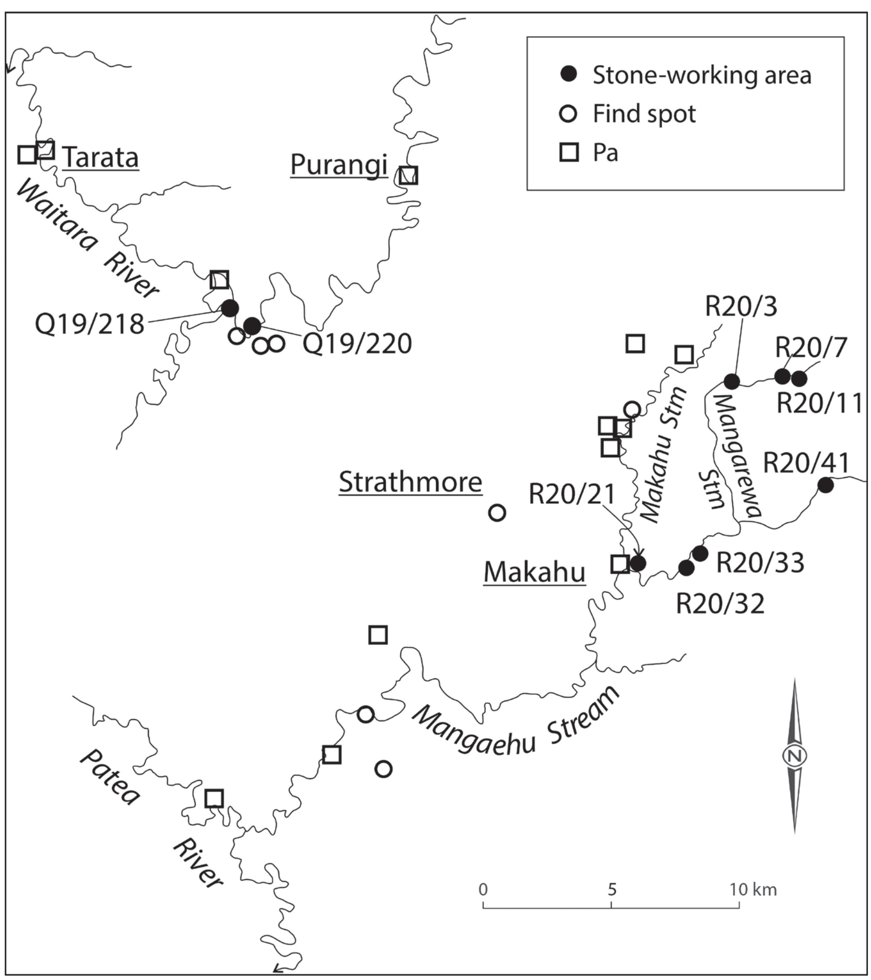

Figure 7. Recorded stone-working and other sites in the inland Taranaki area.

included ovens or oven stones, and 10 were classified as defensive pā. Unfortunately, Hooker (1971) provided very little information on the nature or extent of the stone working sites, though based on his rough sketch plans (Hooker n.d.) two of the sites in the upper Mangaehu valley (R20/32, 33; N120/12, 13; Figure 7) covered about 40 × 10 m and 50 × 20 m respectively. Most sites were situated on flat land or low knolls adjacent to streams.

Although the Makahu Stream, an important tributary of the upper Mangaehu, apparently lacks gravel beaches, the valley contains many oven sites and an extraordinary number of pā. Four of the pā are situated in close proximity to one another (Figure 7). Hooker (1971) implied that adze blanks/preforms found in the Makahu valley (*e.g.* R20/9, N110/17, where a cache of about 12 was discovered) had been carried the short distance over from the nearby Mangarewa Stream to be hammer-dressed, but it is possible that greywacke cobbles were available from the Makahu Stream prior to European settlement. This is supported by Nevin & Nevin's (1979) report of greywacke oven stones at R20/19 (N110/34), and a 'large stone' of the same lithology on the nearby stream flat.

During Hooker's survey of part of the mid Waitara River valley in 1971 a further 12 sites containing preforms, flakes or other indications of stone working were located (Hooker n.d.). One of these (Q19/218, N109/191; Figure 7), sadly destroyed by bulldozing, was a particularly significant site from which >400 flakes were recovered. A number of artefacts were also found on a small pā ('Waihinua', Q19/211) situated at the mouth of the nearby Makino Stream.

None of the sites recorded (or revisited) by Hooker have been properly investigated, although two 2 m squares and a 0.5 m square were excavated at site R20/21 (N120/1) at Makahu in 1969 (Hooker nd, Figure 7). These revealed a layer of disturbed topsoil 5–20 cm thick containing abundant charcoal, stone flakes and some oven stones, but provided no information on the age of the site.

We cannot rule out the possibility that, in pre-European times, some cobbles were obtained from natural outcrops of conglomerate within the Kiore Formation. Indeed, one such outcrop near Purangi, which was quarried for roading material in the 1930s, is also said to have been a prehistoric stone source (Site Record for Q19/260, Figure 1). This, and another abandoned European quarry further north (Q19/272), were formally recorded in 1992, but although both records refer to Keyes (1971) he made no statement on the prehistoric exploitation of either of these quarry sites.

ARTEFACTS

The stone material recovered by Hooker from the various sites in the Mangaehu valley and mid Waitara River area is significant, as it represents all stages of adze manufacture from partially worked cobbles to finished adzes. His collection, now held by Taranaki Museum (Puke Ariki), consists of >600 items and includes adze blanks, preforms, flakes, cores and hammer stones. Our examination of this material (in October 2014), which had not been previously studied in any detail, was mainly concerned with documenting the type of artefacts and their lithology.

Adzes and preforms

There are 32 adzes and preforms in the Hooker Collection, most of which (n = 23) are composed of greywacke, and a smaller number (n = 8) of Taranaki argillite (Table 3). A further 16 finished and unfinished adzes were recorded by Hooker (n.d.), but do not form part of his collection and are of uncertain lithology. The majority of those collected are made from grey to greenish grey, fine to medium grained greywacke (Figure 8). None are composed of very fine or coarse greywacke, and there is only one of chipwacke. Split cobbles, spalls and flakes are similarly composed mainly of fine to medium greywacke, though a number of flakes and fragments are medium to coarse grained. Thus the grain size of the greywacke used for adzes is virtually the same as that seen in the gravels.

Most of the adzes and preforms can be classified as Duff Type 2 forms (Duff 1956), on the basis of a lack of any defined butt. These have cross-sections ranging from subrectangular to elongate-oval to almost square and circular (the latter are generally regarded as being more typical of Type 1 forms). Almost all are hammer-dressed. One of the adzes (N120/27/0/1) has a prominent chin ridge (Figure 8C), a feature which is common among Taranaki Type 2 adzes, and also those in the Nelson area (Challis 1978; Turner 2005). Another two adzes in the collection are tentatively classified as Type 1B forms, due to the presence of a laterally-reduced butt, although Turner (2005) considered this type to be a reworked form. One of these is a large unfinished greywacke adze with a remnant of water-rolled cobble surface, and therefore likely to be of local origin.

The length of the complete greywacke adzes and preforms ranges from 33 mm to 304 mm (Table 3), and averages about 138 mm (n = 18), whereas the Taranaki argillite adzes are generally smaller and average only about 80 mm (range 39 mm to 142 mm). This likely reflects both the smaller size of available argillite cobbles, and perhaps the greater difficulty in making larger adzes from them.

Other artefacts

Nine cores were recorded, all produced from rounded cobbles. They are composed of various rock types, including greywacke, green-grey Taranaki argillite, grey argillite, quartzite and grey chert. The chert core is partially hammer-dressed and may have been used as a hammer stone. There are also at least nine definite hammer stones in the Hooker Collection. They show bruising at one or both ends, or around the sides, and are assumed to have

Table 3. *Details of adzes and preforms in the Hooker Collection. Typology from Duff (1956).*

Site no.	Artefact no.	Form	Made from	Typology	Lithology	Length (mm)
N109/196 (Q20/28)	N109/B/0/1	preform	split cobble	2	med greywacke	274
N109/194 (Q19/220)	N109/C/0/4	adze		2	med greywacke	33
N109/201 (Q20/32)	N109/E/0/1	preform	split cobble	2	Taranaki argillite	142
N109/184 (Q19/211)	N109/G/0/5	preform	cobble	2	fine greywacke	108
N109/184	N109/G/0/9	adze		2	fine-med greywacke	73
N109/184	N109/G/0/10	preform	spall	2	fine-med greywacke	81
N109/191 (Q19/218)	N109/P/0/7	preform		2	fine greywacke	43
N109/191	N109/P/0/9	preform	pebble	2	Taranaki argillite	57
N109/191	N109/P/0/10	preform	cobble	nd	Taranaki argillite	71
N109/191	N109/P/0/11	preform	spall	2	fine greywacke	93
N110/10 (R20/3)	N110/C/0/9	preform	cobble	2	med greywacke	120
N110/21 (R20/11)	N110/N/1/7–8	preform		2	med greywacke	184
N110/21 (R20/11)	N110/N/2/1	preform	spall	nd	Taranaki argillite	117
N110/21 (R20/11)	N110/N/3/5	preform	spall	2	med greywacke	140
N119/4 (Q20/6)	N119/A/0/1	preform		2	fine greywacke	115
N119/12 (Q20/14)	N119/I/0/1	adze (broken)		2	fine-med greywacke	104
N120/-	N120/0/1	adze		1B?	fine-med greywacke	163
N120/-	N120/0/2	adze		2	fine-med greywacke	121
N120/-	N120/0/3	adze	cobble	2	altered volcanic	114
N120/-	N120/0/4	adze		1B?	fine-med greywacke	304
N120/1 (R20/21)	N120/1/0/4	preform/adze		nd	Taranaki argillite	59
N120/1 (R20/21)	N120/1/0/5	adze (broken)		nd	fine-med greywacke	66
N120/1 (R20/21)	N120/1/0/6	chisel	spall	nd	Taranaki argillite	39
N120/1 (R20/21)	N120/1/1/1	adze (broken)		nd	Taranaki argillite	25
N120/1 (R20/21)	N120/1/2/1	adze (broken)		2	fine greywacke	101
N120/1 (R20/21)	N120/1/2/2	preform		nd	Taranaki argillite	75
N120/3 (R20/23)	N120/3/0/1	preform	split cobble	2	fine-med greywacke	194
N120/3	N120/3/0/A1	adze (broken)		2	fine greywacke	122
N120/12 (R20/32)	N120/12/0/A1	adze (broken)		nd	fine greywacke	62
N120/12 (R20/32)	N120/12/0/36	preform (reworked)		nd	med greywacke	113
N120/27 (R20/47)	N120/27/0/1	adze		2	fine-med greywacke	158
N120/28 (R20/48)	N120/28/0/1	preform		2	fine-med greywacke	160

been used mainly for fine flaking and/or hammer-dressing. Greywacke, altered volcanic rock and Taranaki argillite were used for this purpose, and from the presence of some broken cobbles, flakes and pieces it is likely that quartz and quartzite were also being utilized for hammer stones.

Hooker (n.d.) also made a collection of 427 flakes from site Q19/218 (N109/191), and recorded the dimensions of these along with some other features. We have not re-examined this collection in any detail, but did carry out a sorting of the larger flakes (n = 226) into different rock types. Of these about 73 per cent were composed of greywacke, 24 per cent of Taranaki argillite, and 2 per cent of other lithologies, including some volcanic types. This represents a ratio of around 3:1 greywacke to argillite. Another collection of flakes (n = 40) from site R20/11 (N110/21) consisted almost entirely of Taranaki argillite.

ADZE PRODUCTION

While no technological study has been undertaken, the procedure used in the manufacture of Taranaki adzes is evident from the nature of the preforms and waste material, and is basically as described by Furey (1996: 119). The first step in this process involved the selection of suitable sized cobbles, typically elongate-oval in shape, with preference perhaps given to those containing obvious longitudinal lines of weakness (Figure 8). These were probably struck on both ends, presumably with a large hammer-stone, in an effort to split the cobble lengthwise into roughly two equal halves (bipolar technique). Alternatively, hand-held cobbles could have been brought down with considerable force onto a stone anvil, in what Witter (2006) termed the 'mass-impact technique' (an anvil was recorded by Hooker

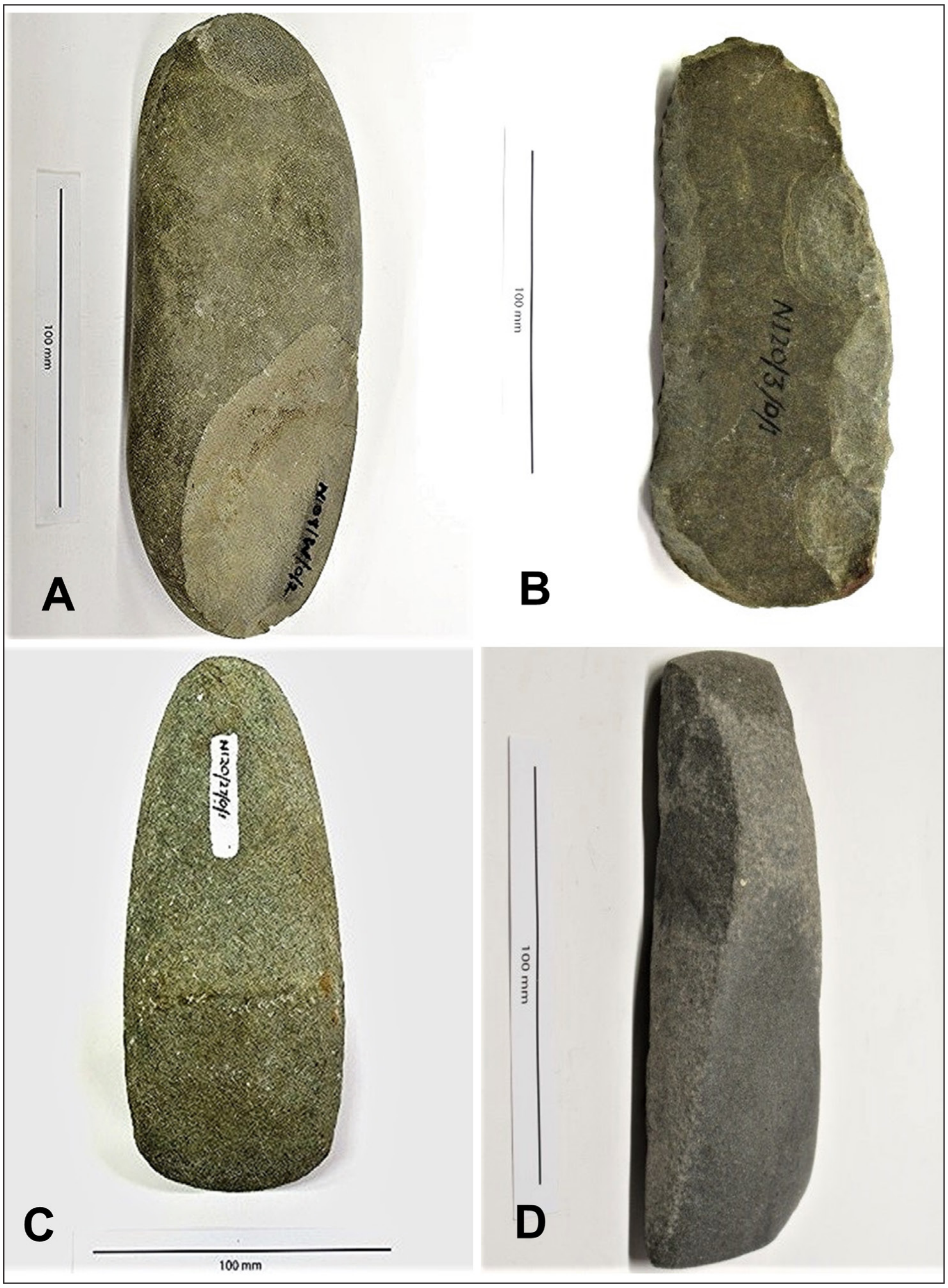

Figure 8. Various stages of adze manufacture. A: Partially worked greywacke cobble with flakes removed from both ends, site N109/W; B: Lateral flaking of split cobble, site R20/23; C: near-complete Type 2 adze with chin ridge, site R20/47; D: Finished Type 2 greywacke adze.

at site Q20/28, N109/196). Some larger spalls produced by this process were also utilized, along with naturally split cobbles. Splitting of the cobbles resulted in a relatively flat striking platform from which flaking of the edges could be easily carried out to form a roughout (as defined by Turner 2000: 233; Figure 8B). From this a preform could be produced by further flaking, where the overall shape, cross-section and final size were more-or-less defined, though part of the original outer surface of the cobble was often left unflaked. Preforms were then subjected to hammer-dressing of the front, back and sides leaving, in some cases, a remnant of the original cobble cortex around the bevel. Finally, the bevel and most other surfaces were ground to produce the finished adze.

The manufacture of greywacke adzes primarily by flaking is unusual, as the prevailing view seems to be that the rock was generally difficult to flake (*e.g.* Furey 2004: 49; Skinner 1943; Turner 2000: 43–44) and therefore late period adzes in this material were produced mainly by hammer-dressing, although the *very fine grained* Motutapu greywacke was obviously an exception (Turner 2000: 47). This could mean that the techniques developed for making early adze types (mainly in basalt and meta-argillite) persisted later in Taranaki. Alternatively, greywacke was actually more amenable to flaking than some archaeologists believe. Although no replication studies in this material have been undertaken, one artificially split cobble was partially worked by us to demonstrate that greywacke could be flaked relatively easily, as illustrated in Figure 4.

Determining the number of finished adzes (and chisels) produced is difficult. There are some data, however, on the number of Taranaki argillite adzes lodged with various museums. Turner (2005, table 7) recorded a total of 48 finished adzes/chisels made of Taranaki argillite from the North Island as a whole, of which eight (cf. Turner 2000 table 5.4, n = 4) were apparently early forms. We have identified only nine definite adzes of this lithology in the Puke Ariki collections (unpublished data). For greywacke, some indication can probably be obtained from the ratio of greywacke to argillite adzes and preforms in the Hooker Collection, which ranges from about 2:1 (adzes) to 4:1 (preforms), and is around 3:1 overall. We can also assume that the recorded sites which were primarily concerned with adze manufacture (n >7) are considerably underestimated, and might only constitute about half the actual number that existed prior to European settlement. As a rough estimate, therefore, we consider that >200 finished greywacke adzes were produced from the Taranaki gravels, perhaps indicating that exploitation of this resource was not simply of local significance.

PERIOD OF EXPLOITATION

No radiocarbon dates have been obtained for the inland Taranaki sites. There is also little indication, from the nature of the sites, of when or for how long the inland Taranaki gravels were exploited as a source of adze material, but it is notable that many of the defensive pā recorded in the Mangaehu valley are located in relatively close proximity to sites containing evidence of stone working (Figure 7). An adze preform was apparently found on one pā (R20/2, N110/9) in the Makahu Stream catchment, and Hooker collected flakes from two others. As mentioned earlier, a considerable number of artefacts (including preforms of greywacke and Taranaki argillite) were also recovered from the small pā Q19/211 at the junction of the Waitara River and Makino Stream. Therefore, exploitation of the gravels was contemporary with the occupation of at least some of the pā in the inland area, in the late prehistoric period (circa AD 1500–1800).

Earlier use of the Taranaki argillite is demonstrated by the existence of a small number of early adze forms made of this material, including Duff Types 1 and 4A (Turner 2005, table 7). More than 700 flakes of the argillite, derived from adze manufacture, have also been identified among the large artefact assemblage from the Kaupokonui site P21/3, on the south Taranaki coast (Turner 2000, appendix A), which is securely dated to the 14th century (Anderson 1991). Although the argillite was not necessarily procured from the inland gravels, Hooker (n.d.) reported being given an early Type 4 adze found at site R20/32 near Makahu, which suggests that the upper Mangaehu valley had at least been explored during the early period.

DISCUSSION

The Taranaki gravels represent a type of stone source that has not been well-documented elsewhere in New Zealand (Jennings *et al.* 2023). One other example of an alluvial greywacke source has been recorded in the Retaruke valley, in the Whanganui River catchment (Butts 1981), and river boulders of metasomatised argillite were utilized in the Nelson area (Challis 1978, 1991), but there are undoubtedly others yet to be identified. The apparent invisibility of greywacke source sites might be attributable, in part, to the fact that manufacture of adzes primarily by hammer-dressing produces very little in the way of debitage (Furey 2004: 50). We can also reasonably assume, as others have done (*e.g.* Furey 1996: 119), that many of the greywacke adzes in the North Island were simply produced by working convenient-sized river, stream or beach cobbles at or close to the source. Use of such cobbles may have been more prevalent in areas where alternative sources of hard rock were scarce or unsuitable, but because of widespread aggradation of rivers and streams, coastal erosion, and human modification of the land in historic times, evidence of this may now be difficult to find. These sources could have provided a range of lithic materials useful not only for adzes but also other stone tools like hammer-stones, stone pounders (patu muka) and kokowai grinders (autoru).

Our discovery that the Taranaki greywacke cobbles originated from at least two different geological terranes has implications for the future sourcing of greywacke adzes in and beyond the region. Although it is highly likely that most of the finished adzes in the Hooker Collection were made from local greywacke cobbles, we have no means of determining, at present, if any of the adzes found elsewhere in Taranaki were manufactured from local stone or imported. Any that were brought in from the east (Manawatu district), for example, would almost certainly consist of Torlesse Terrane greywacke procured from the Ruahine-Tararua ranges (Moore 2021). Similarly, since all five terranes of the Eastern Province are exposed in the Nelson-Marlborough region to the south (Rattenbury *et al.* 1998), any adzes originating from that area will likely have similar compositions to some of those made in Taranaki. Consequently, a reliance solely on geochemical analyses to identify the origin of greywacke adzes may not be an appropriate strategy.

While we do not know if any local greywacke adzes were exported beyond the Taranaki region, it would appear that toki made of Taranaki argillite were quite widely dispersed in the upper North Island. Turner (2000: 360, 435, 448–9) recorded adzes of this material from Raglan on the Waikato coast, 'a few' at Manukau South Head (Matatuahu) near Auckland, one at Bowentown on the Bay of Plenty coast, and another as far north as Mitimiti in Northland. Two of the Type 2B adzes recorded from Oruarangi on the Hauraki Plains may also be made of Taranaki argillite (Furey 1996: 113). Assuming Turner's visual identification of the argillite is correct, it seems likely that some Taranaki greywacke adzes were also transported at least as far north as the Waikato region during the late period. Some probably made it south-eastwards into the Whanganui-Manawatu region as well (Moore 2021). But establishing the distribution of Taranaki adzes in other areas will require more extensive research.

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