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A Norfolk Island basalt adze from coastal New South Wales

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Abstract

Using portable x-ray fluorescence we re-examine a quadrangular basalt adze collected at Dark Point, coastal New South Wales (NSW), in 1928 and described at that time as 'Polynesian-looking'. Comparison with a wide range of Pacific basalts, including from New Zealand, Australia, Bismarck Archipelago, East Polynesia and Norfolk Island demonstrates that it is made from Norfolk Island basalt. We discuss several scenarios as to its possible origin, concluding that a direct derivation from a Polynesian voyage from Norfolk Island is the most likely. We also suggest that the one-piece shell fishhook in NSW may derive from a similar source.

Charlie has always liked a good story and his archaeology with a bit of a mystery, so we hope he will enjoy this one.

Introduction

In 1928 the recently constituted Anthropological Society of New South Wales (NSW) made a field trip to Dark Point, a small peninsula sticking out into the ocean from the Myall Lakes sand dunes, and pointing towards Broughton Island, 170 km northeast of Sydney and adjacent to Port Stephens. The expedition's purpose was to collect Aboriginal artefacts from an extensive midden. Among the artefacts found was a quadrangular-sectioned, asymmetrically bevelled adze, which was eventually presented to the Australian Museum (Catalogue No. E.32114). The adze was described and published by Thorpe (1929), who noted formal similarities to adzes collected on Norfolk Island, and from Polynesia more generally. However, petrological examination of a thin-section removed by the Museum Petrologist, Mr T. Hodge Smith, was inconclusive as to its source (Thorpe 1929:126). Thorpe did not fully describe the adze, so we do so now.

Artefact E.32114 is a fully asymmetrically bevelled adze with a maximum length of 84.3 mm (Figure 1). Maximum thickness is 15.2 mm, and the width at the bit is 39.7 mm and at the butt 27.1 mm. Weight is 95.2 g. The bevel (bit edge) extends 19.3 mm back into the body. At the body end of the bevel the sides are tapered upward from the bit edge side, thinning from 38.5–31.2 mm.

In July 2012 White visited the midden. Its surface remains extend for some 300 m along the first swale behind the fringing dunes, but there is only a vestige of any vertical stratigraphy. The greatest concentration of shell, which is mostly sandy bivalve, is at the northern end where the swale runs into dunes. This is about 50 m from the beach and 100 m north of Dark Point. There are many cobbles scattered over the whole area, possibly hearth stones. The only artefacts

Figure 1 Adze E.32114: (A) Whole tool, viewed from the front side. The cutout is the thin-section removed in the 1920s. Scale in cm; and (B) The bevel, now broken over much of its length (photographs by Peter White).

Figure 2 Silcrete core on Dark Point Midden, July 2012 (photograph by Peter White).

seen were a few fingernail-sized flakes of very fine light grey silcrete, and one flaked core of brown silcrete, origin unknown, but not Norfolk Island (Figure 2).

Much of the main area has been fenced off by the NSW National Parks and Wildlife Service and the Karuah Aboriginal Land Council, but footprints show that it is regularly walked over and there is a scatter of glass and plastic rubbish over the whole area. Thorpe said that the Point itself would have been cut off from the shore at highest tides but there are now dunes high enough to prevent this. After rain, fresh water is available in the swales or in the swamp behind the main dunes, which are some 20 m high and stretch inland for several hundred metres.

Figure 3 Location of Dark Point, Norfolk Island and New Zealand (map by Christian Reepmeyer).

Norfolk Geology and Geochemistry

It is a lucky coincidence for this study that the Norfolk Island geochemistry is unique, with no other basaltic rock in the wider Oceanic region quite like it. The Norfolk Islands are part of the Norfolk Ridge, a submarine feature reaching from New Zealand to New Caledonia. Tectonically, the Norfolk Ridge is part of the Australian Plate; the Ridge developed during widespread Tertiary basaltic volcanism in the area. The Norfolk Islands emerged through three episodes of volcanism in the late Pliocene (3.0–2.3 Mya) and consist of several near horizontal layers of lavas covered, in the central area of the islands, by tens of metres of strongly weathered tuffs (Anderson et al. 1997; Green 1973, 1978).

Geochemically, exposed basaltic outcrops on the shorelines have tholeiitic to alkaline olivine compositions. Green (1973) noted the general petrographic uniformity of Norfolk Island basalts with a nearly constant TiO_2 content of 1.8–2.2 wt%, moderately high Al_2O_3 (15.1–17.4 wt%), high Na_2O (3.3–4.2 wt%) and moderate to low K_2O (0.4–1.2 wt%) content. Trace element geochemistry shows typical basaltic compositions: yttrium (Y, 17–37 ppm), strontium (Sr, up to 750 ppm), moderately low rubidium (Rb, 4–14 ppm) and zirconium (Zr, 140–230 ppm). Green (1978) pointed out that the trace element geochemistry of Norfolk Island basalts doesn't match that of ocean island basalts (OIBs), ocean basin basalts or island arc basalts. He found that they might

correlate with basalts from the Northland region in northern New Zealand and newer basalts from southeast mainland Australia. However, if the Dark Point adze was thought to come from the Northland region, it would have moderately low levels of niobium (Nb, 10–20 ppm). Unfortunately, Green (1978) did not publish Nb levels of the Norfolk Island basalts, which are the most distinctive differences between Norfolk and Northland basalts.

Anderson et al. (1997) carried out further research on Norfolk Island basaltic outcrops, analysing several samples of beach boulders at Ball Bay (Table 1). Their assay results matched Green's (1978) trace element geochemistry of Norfolk basalts, but also showed moderate to high Nb values (~30 ppm). The Nb values supported the uniqueness of the Norfolk basalts as not unambiguously associated with an oceanic provenance, such as OIBs or islands arcs, and most likely deriving from a continental plate tectonic setting (Albarède 2003).

	TiO_2	MnO	FeO	Rb	Sr	Y	Zr	Nb
	wt%	wt%	wt%	ppm	ppm	ppm	ppm	ppm
1	1.92	0.15	8.00	13	742	26	184	35.6
2	1.86	0.32	7.88	13	685	23	182	33.5
3	1.87	0.15	7.90	13	683	23	185	38.2
48	1.87	0.17	8.92	17	783	24	161	31.1
68A	1.81	0.16	8.19	12	750	27	173	33.1
68B	1.93	0.16	8.55	13	963	29	160	33.3
68C	1.86	0.16	8.28	14	800	24	164	38.4
68D	1.72	0.14	7.86	11	850	28	162	27.7
70	1.83	0.15	8.63	16	866	23	171	32.6
69	1.64	0.13	7.34	15	798	25	166	30.3

Table 1 Chemical composition of basalts collected at Ball Bay, Norfolk Island, using SEM-EDXRF (scanning electron microscope energy-dispersive x-ray fluorescence) (data from Anderson et al. 1997). The oxides (TiO_2 , MnO, FeO) are presented in weight percent (wt%), the trace elements (Rb, Sr, Y, Zr, Nb) in parts per million (ppm).

Methods

In this study, Artefact E.32114 from Dark Point was analysed in combination with seven artefacts from Norfolk Island in the Australian Museum collection (Table 2), and basalts from Australia, New Zealand and the Bismarck Archipelago, along with Pacific island arc and East Polynesian islands (Figure 3).

The samples were analysed by portable x-ray fluorescence (pXRF) for silicate (Si), potassium (K), calcium (Ca), titanium (Ti), manganese (Mn), iron (Fe) and selected heavy mid-Z elements (Rb, Sr, Y, Zr and Nb). As macroscopic examination of the samples showed a homogeneous, fine grained volcanic rock without any large crystallisations, it was decided to analyse only three spots randomly distributed on the artefact, with the bias of selecting parts which were sufficiently flat (cf. Grave et al. 2013 for comparable methodology). No soil or dust covering was detected on the samples, no further sample preparation was conducted and pXRF analysis was done in the Australian Museum. For pXRF analyses a Bruker Tracer III-V PXRF was employed, equipped with a rhodium tube, peltier-cooled Si-PIN detector at a resolution of approximately 170eV FWHM at the Mn $K\alpha$ peak (5.9keV at 1000 counts per second) and a 1024 channel

configuration multichannel analyser. Instrument parameters for heavy elements were as the manufacturer recommended: 40 keV, 20 μ A, using a 0.1524 mm Cu, 0.0254 mm Ti and 0.3048 mm Al filter in the x-ray path and a 180 second live-time count at 185 FWHM. Light elements were analysed employing a vacuum and 15 keV and 15 μ A without a filter at 180 seconds live-time count (Clark et al. 2014). Interferences from air were minimised by placing the instrument as close as possible to the sample. Net values of the samples were calculated with the Bruker ARTAX Spectra 7.1 package. Nine correction cycles were run for background stripping and peak deconvolution. Net values were calibrated by linear regression against 15 international standards (BCR-1, BCR-2, BHVO-1, BHVO-2, BIR, CRPG-BR, DNC-1, JB-1, NIST1633a, NIST1646, NIST2704, NIST278, NIST27D, RGM-1, WSE) (Govindaraju 1994) and five ANU in-house standards (GC-006, GC-11, GC-188, Tafahi and Kilauea 93-1489) in Microsoft Excel 2010 (see Clark et al. 2014 for values and calculated calibration algorithms).

Results

Summary results of the analyses of the Norfolk Island artefacts are presented in Table 2, along with the reference international standards BCR-2 and BHVO-1 (for certified values see Govindaraju 1994). Artefact E.32114 shows a geochemical composition with moderate Rb (13 ppm), high

Sr (863 ppm) and moderate to high Nb (30 ppm) values, similar to outcrops at Ball Bay and artefacts determined to be of local origin from the Emily Bay excavation on Norfolk Island (Anderson et al. 1997).

Several of the Australian Museum artefacts from Norfolk Island match the geochemistry of Artefact E.32114. The closest match is E.74865 from Slaughterhouse Beach, i.e. close to the area of the Polynesian settlement. (Specht [1984:18] recorded this particular artefact as being 63 mm long, very heavily rolled and possibly not an adze preform.) Artefacts E.38313, E.74864 (both quadrangular adzes), E.75962_1 and E.75962_2 also show geochemistry similar to the Ball Bay boulders (Anderson et al. 1997), indicative of a local origin.

However, as Green's (1984:54) petrological report noted, Artefacts E32086, E38314 and E70679 appear to be of non-Norfolk origin and Specht (1984:30) suggested that some were brought to Norfolk Island from New Zealand during the European period (we were somewhat surprised at the number of these in his report). Our results show geochemical compositions suggestive of an island arc origin with highly depleted Nb and strongly enriched Rb values.

The pXRF data was additionally compared to 637 samples selected from the GEOROC geochemical database (Sarbas 2008), based on location (Pacific) and rock type (basalt),

		SiO ₂	K ₂ O	CaO	TiO ₂	MnO	Fe _{total}	Rb	Sr	Y	Zr	Nb
		wt%	wt%	wt%	wt%	wt%	wt%	ppm	ppm	ppm	ppm	ppm
E.32114	Mean	49.90	1.40	10.70	2.30	0.20	8.10	13.0	863.0	27.0	175.0	30.0
	SD	1.42	0.20	0.71	0.17	0.02	0.23	1.2	45.9	6.0	4.4	2.0
E.38313	Mean	50.20	1.10	9.50	2.00	0.30	8.20	13.0	722.0	20.0	160.0	25.0
	SD	0.90	0.02	0.47	0.06	0.00	0.89	2.5	88.3	5.3	14.6	5.5
E.74864	Mean	51.70	1.00	9.70	2.20	0.30	8.70	12.0	618.0	20.0	144.0	23.0
	SD	0.14	0.05	0.08	0.05	0.01	0.47	0.9	22.3	1.0	3.4	3.2
E.74865	Mean	51.90	1.00	10.10	2.10	0.30	9.30	13.0	857.0	22.0	162.0	28.0
	SD	1.24	0.05	0.42	0.08	0.00	0.31	2.5	39.8	1.5	3.8	4.2
E.75962_1	Mean	47.00	1.00	12.30	2.00	0.30	8.80	9.0	815.0	19.0	162.0	28.0
	SD	2.37	0.07	0.97	0.13	0.02	0.66	1.3	24.8	1.8	9.0	4.7
E.75962_2	Mean						8.00	12.0	777.0	15.0	145.0	26.0
	SD						1.25	1.4	96.2	3.9	18.8	4.2
E.32086	Mean	48.40	0.50	14.70	0.60	0.40	10.00	7.0	191.0	17.0	49.0	2.0
	SD	0.98	0.01	0.04	0.04	0.01	0.42	1.4	17.0	5.2	5.3	0.5
E.38314	Mean						5.70	50.0	153.0	31.0	210.0	7.0
	SD						0.57	6.9	15.9	4.4	9.6	1.7
E.70679	Mean						7.20	58.0	709.0	20.0	182.0	7.0
	SD						0.35	9.9	70.1	6.1	14.7	1.8
BCR-2	Mean	52.80	1.60	6.40	2.30	0.20	11.40	32.0	315.0	36.0	166.0	12.0
	SD	0.05	0.02	0.00	0.05	0.01	0.04	3.2	3.6	2.7	2.8	0.8
Preferred	GeoReM	54.10	1.80	7.10	2.30	0.20	12.80	47.0	343.0	37.0	186.0	13.0
BHVO-1	Mean	50.30	0.60	11.10	2.70	0.20	10.20	15.0	374.0	26.0	152.0	18.0
	SD	0.25	0.01	0.17	0.01	0.01	0.08	1.0	0.9	5.3	5.2	4.6
Preferred	GeoReM	49.90	0.50	11.40	2.70	0.20	11.60	10.0	396.0	26.0	176.0	19.0

Table 2 Summary statistics for pXRF analyses of the Dark Point adze, seven artefacts from Norfolk Island in the Australian Museum collection and reference values for international basalt standards (BCR-2 and BHVO-1). Locations of Norfolk Island material: E.38313 = Slaughterhouse Bay; E.74864, E.74865_1 and E.74865_2 = Slaughterhouse Beach; E.32086 = Emily Bay; E.38314 = Mission Road; and E.70679 = Anson Bay.

and additional archaeological databases of basalts in the wider region, including samples from Island Arc settings, such as New Hebrides and Tonga-Kermadec Arcs, continental remnants (New Zealand, New Caledonia), back-arc basin basalts (Fiji, Lau region), OIBs (Samoa and eastern Polynesia) and Australia (Anderson et al. 1997; Clark et al. 2014). Multivariate statistical analysis was employed to structure the dataset, groupings of the reference database were established through discriminant function analysis (DFA) (Figure 4) of logarithmic transformed absolute counts (ppm) as published in the reference database. Bias was introduced by the assumption that samples from the same geological formations share the same geochemistry. Centroids of group membership are displayed by a cross, with ellipses representing 95% confidence intervals. The plot shows discrete zoning of different geological settings, with the Norfolk samples forming a separate group, clearly distinctive from the remaining dataset. Artefacts were then added as unknowns. The artefacts unambiguously show

dissimilarities with any groupings of the remaining dataset, but share similarities with the Norfolk group. Artefact E.32114 plots most closely into the Norfolk group. The comparison is limited to mid-Z elements most reliably analysed with pXRF, however, as mentioned before, the selection of elements is sufficient to separate Norfolk basalts unambiguously from any other basalt in the reference dataset.

Discussion

We turn now to the possibilities of how the adze arrived at Dark Point. Thorpe (1929) originally argued that European period deposition, whether by chance or deliberate discard, was unlikely, requiring a string of improbable events in an area he described as wild and not occupied by Europeans. However, if looking for a European period deposition, probably the simplest explanation is that it was picked up and brought back to Dark Point by one of the unknown number of Aboriginal people who visited Norfolk Island after 1788

Figure 4 Discriminant Function Analysis (DFA) of mid-Z elements (in ppm) of the GEOROC basalt reference dataset (Sarbas 2008) with additional samples from Anderson et al. (1997) and Clark et al. (2014); the dataset shows low level of variability with 65.6% of samples correctly classified. Probability prediction for Artefact E.32114 to be associated with the Norfolk group is exceptionally high (99.8%). + represents group centroids of the reference dataset, ellipses 95% confidence intervals of the group centroids. Artefacts, introduced as unknowns into the analysis, are shown as triangles, ▲ = artefacts identified as originating from Norfolk (Anderson et al. 1997), ▲ = E.32114 (Dark Point). Artefacts E.32086, E.38314 and E.70679 are not shown (diagram by Christian Reepmeyer).

(Karskens 2013:110; Specht 1984:29). Pre-European visitation of Aboriginal people to Norfolk Island is unlikely, as there are currently no records of seafaring technology available to travel such a distance (Bowdler 1996; Davidson 1935; cf. recent discussion in Balme 2013:71), but absence of evidence does not mandate absence. More complex and perhaps more improbable scenarios include collection on Norfolk by a European person (cf. Thorpe), perhaps a nineteenth century fisherman from Broughton Island (Clarke 2009) calling in to Norfolk (though we know of no such recorded visit to Norfolk Island), transporting it to NSW, visiting the midden and discarding it; alternatives include giving it to another Aboriginal person who subsequently discarded it or gifting it to a European visiting the area who subsequently dropped or discarded it. Other more elaborate scenarios could be developed, but become increasingly improbable.

The alternative explanation is an original Polynesian deposition. The short-lived Polynesian settlement of Norfolk Island occurred about 1300 CE (800–600 years ago) (Anderson and White 2001), at a time when there was a good deal of Polynesian voyaging in much of the Pacific (Anderson 2003), so it is not inconceivable that a canoe equipped with Polynesian material culture arrived either at Dark Point or Broughton Island. Of its possible cargo, only two kinds of material are likely to survive to the present: basalt and obsidian (Polynesians ceased to use pottery around 1000–1500 years ago [Kirch 2000:220] and it was never used in New Zealand). In the only known Polynesian archaeological site on Norfolk Island, Emily Bay, 3178 basalt flakes were excavated compared with 26 pieces of obsidian (Turner et al. 2001), so the absence of obsidian from any voyage which landed at Dark Point should not surprise us. We can speculate about the several possible fates of the voyagers. A date of around 1300 CE is also about the most recent that can be expected for such an event, since there is reason to believe that long-distance Polynesian voyaging was severely curtailed or ceased about this time (Finney 1997:46–51), although accidental drift voyages could have occurred at any time.

Considering these scenarios, we suggest that a Polynesian deposition is the more likely explanation for the presence of the adze, since it requires no intermediary events, but this is an Occam's Razor solution and history has a way of confounding these.

From the Australian side, in what we can argue is further possible confirmation of direct contact, one-piece shell fishhooks began to be made along the NSW coast some 800–900 years ago (Attenbrow et al. 1998) (or 700–500 years ago; see Walters 1988). The archaeological distribution of this type of hook—northern Queensland, south to Keppel Islands, and along the NSW coast, from Port Stephens south, with a major gap between—has caused considerable discussion. With some northern hooks dating to a little earlier, did they then diffuse to the southern area? Did independent invention occur in the two areas? Or was a different process responsible in each area—perhaps diffusion from New Guinea in the northern case and from southwest Polynesia in the southern? And why were they taken up? Efficiency in a particular environment (White and O'Connell 1982:151)? Changing social relationships within Aboriginal societies (Bowdler 1976; Walters 1988)? As with the occurrence of the Dark Point adze, we argue that the simpler explanation—a Polynesian stimulus for the southern

series at least, whatever the reason for its wider adoption—is the more economical.

As promised at the start, we can solve only part of the Dark Point adze mystery. We can be certain it came from Norfolk Island, but, short of an unexpected historical record or further, less ambiguous archaeological data, its appearance on the midden remains unexplained.

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