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RALe

DEPARTMENT OF ANTHROPOLOGY | THE UNIVERSITY OF AUCKLAND

Archaeology at Opita

Three Hundred Years of Continuity and Change

Part Two: Appendices 1-10

Caroline Phillips
Harry Allen

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makarau

"The boundary of the Opita pa on the ground is a ditch."
Rapata Te Pokiha (Tareranui and Pokiha 1878:328)

It was Rapata Te Pokiha's statement in the Maori Land Court records that prompted the authors, plus students of the 1991 University of Auckland Anthropology Department Archaeological Field School, to investigate the location of Opita pa in a river bend at the junction of the Ohinemuri and Waihou Rivers near Paeroa.

The pa (Maori fortification) proved elusive, but in the search, evidence of a series of nine small kainga (Maori villages) and the pa were uncovered. The main focus of the investigations was on a riverside terrace that contained four overlapping occupations separated by layers of flood silt and sand. Distinctive artefacts and features on this terrace allowed the linking of all the other sites in a chronology spanning 300 years.

These kainga represented intermittent occupation of the Opita area, in which changes and continuities over time were evident. Some of the changes were due to the influence of the new European materials, foods and ideas. Nonetheless, it was clear that Maori often incorporated these new materials into an essentially Maori world. Our understanding of the processes was enriched by information from both Maori accounts and the observations of early European visitors. In the later phases of occupation, this combined information allowed the distinction between foodstuffs cultivated, gathered, hunted, raised and traded; and between goods consumed on the site, prepared and exchanged for external materials; as well as items brought in by outsiders. In other words: the evidence presented a much more complex mix of activities, production and consumption than could have been achieved by archaeological information alone.

CAROLINE PHILLIPS is an Honorary Research Fellow in the Department of Anthropology at The University of Auckland, and an archaeological consultant.

Caroline was a student at the University of Auckland, and her PhD research on Maori settlement along the Waihou River was the reason for the investigation of Opita. Her thesis was later published in 2000 as, *Waihou Journeys: The Archaeology of 400 Years of Maori Settlement*, published by Auckland University Press. She has lectured in archaeology at The University of Auckland and Te Whare Wananga o Awanuiarangi, published academic articles and presented conference papers and seminars, both locally and internationally. Her research questions include how to identify dynamic settlement systems, continuity and change, small-scale cultural changes, and issues of ethnicity and identity using landscape approaches, contextual archaeology and multiple causality.

Recently Caroline Phillips and Harry Allen jointly edited B*ridging the Divide: Indigenous Communities and Archaeology into the 21st Century* (2010) published by Left Coast Press. They are part of a research team studying "The Cultural Significance of Wetlands in Taranaki"; and they previously worked together along the Waihou River on an indigenous training scheme that resulted in the publication *Taskforce Green/University of Auckland Archaeological Project, Waihou River* (1993), published by the Department of Anthropology, University of Auckland.

HARRY ALLEN is an Honorary Research Fellow in the Department of Anthropology at The University of Auckland.

Harry is an Australian trained archaeologist, who has conducted archaeological research in New Zealand, Australia and Southeast Asia. Harry Allen recently retired from the Department of Anthropology at Auckland after forty years of teaching, research and research supervision. He is a past Trustee of the New Zealand Historic Places Trust, a past member of its Maori Heritage Council and an Honorary Life Member of the Trust. He has published numerous articles on New Zealand archaeology and the protection of cultural and archaeological heritage. Harry Allen was awarded an ONZM in the 2008 New Year's Honours for his services to archaeology in New Zealand.

The University of Auckland acknowledges the contributions of all authors. This publication has been peer reviewed, and all reasonable efforts have been made to ensure the accuracy of the materials published herein.

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Cover Photograph: The team excavating Squares F and H, Trench C is out of shot to the left, the line of white spoil behind is Trench B and the stopbank and Coromandel Ranges are in the distance. Photograph taken by Harry Allen around mid-February, 1991.

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Archaeology at Opita

Three Hundred Years of Continuity and Change

Part 2

Appendices 1-10

Caroline Phillips[1]
Harry Allen[2]

1 University of Auckland, Auckland, New Zealand
2 University of Auckland, Auckland, New Zealand

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Appendix 1 List of Features and Detailed Sections

List of Features

Detailed Sections

Note: section C and the plans of excavated squares are shown in detail in the text so are not repeated here.

Plan of Grids

Opita - Squares A, D, J, adjacent Trench T

Feature Number		*Area*		*Horizon*		*Size (cm)*			*Type*	*Comments*
Report	*Field*	*Trench*	*Square*	*Layer*	*Phase*	*Length*	*Width*	*Depth*		
1	1		A			20	16	35	posthole	
2	2		A			50	25	90	posthole	modern posthole, from above rock flour
3	1		J			19	13	19	posthole	depths from point of excavation
4	2		J			13	12	63	posthole	depths from point of excavation
5	3		J			17	12	70	posthole	depths from point of excavation
6	4		J			13	10	42	posthole	depths from point of excavation
7	pit		J			84	76+	14	scoop	
8	23/c		T			19	16	70	posthole	
9	24/d		T			12	12	35	posthole	
10	25		T			8	6	27	posthole	
11	26		T			6	6	35	posthole	
12	27/b		T			14	12	55	posthole	
13	28/a		T			10	8	40	posthole	
14	22		T			9	9	70	posthole	
15	17		T			20	17	24	posthole	
16	18		T			12	11	19	stakehole	
17	19		T			18	9	15	stakehole	
18	20		T			11	10	15	stakehole	depth estimated to base of cultural layer
19	21		T			8	7	9	stakehole	
21	31		T			7	7	33	stakehole	depth estimated to base of cultural layer
22	32		T			11	6	31	posthole	depth estimated to base of cultural layer
23	34		T			12	9	25	stakehole	depth estimated to base of cultural layer
24	35		T			20	14	44	posthole	depth estimated to base of cultural layer
20	pit		D			260	180	44	hollow	
25	36		D			13	10	6	stakehole	
26	33		D			11	10	15	stakehole	
27	37		D			27	22	5	scoop	depth from base of cultural layer
28	39		D			16	13	10	stakehole	
29	38		D			10	9	13	stakehole	depth estimated to base of cultural layer
30	30		D			11	10	51	posthole	depth estimated to base of cultural layer
31	29		D			10	10	54	posthole	depth estimated to base of cultural layer
32	15		D			17	15	43	posthole	

– *continued over page*

33	14	D	10	10	6	stakehole	
34	13	D	14	11	56	posthole	
35	12	D	11	10	10	stakehole	
36	11	D	10	10	12	stakehole	
37	10	D	12	9	7	stakehole	
38	9	D	9	8	8	stakehole	
39	8	D	14	14	43	posthole	
40	2	D	20	10+	20	posthole	
41	1	D	9	8	16	stakehole	
42	7	D	20	16	39	posthole	
43	6	D	17	13	40	posthole	
44	5	D	31	28	18	scoop	
45	4	D	6	5	22	stakehole	depth estimated to base of cultural layer
46	3	D	10	8	9	stakehole	
47	16	D	7	6	12	stakehole	
48	pit	D	84+	70	9	hollow	
49	pit	D	60	50	12	hollow	

Opita - Square E & adjacent Trench T

Feature Number		*Area*		*Horizon*		*Size (cm)*			*Type*	*Comments*
Report	*Field*	*Trench*	*Square*	*Layer*	*Phase*	*Length*	*Width*	*Depth*		
1	1		E			12	10	23	stakehole	depth from base of excavation
2	2		E			13	9	8	stakehole	depth from base of excavation
3	3		E			20	13	20	posthole	depth from base of excavation
4	4		E			20	20	34	posthole	depth from base of excavation
5	5	T				15	5	32	posthole	depth from base of excavation
6	6	T				10	5	33	posthole	depth from base of excavation
7	7	T				9	9	60	stakehole	depth from base of excavation

Opita - Square M

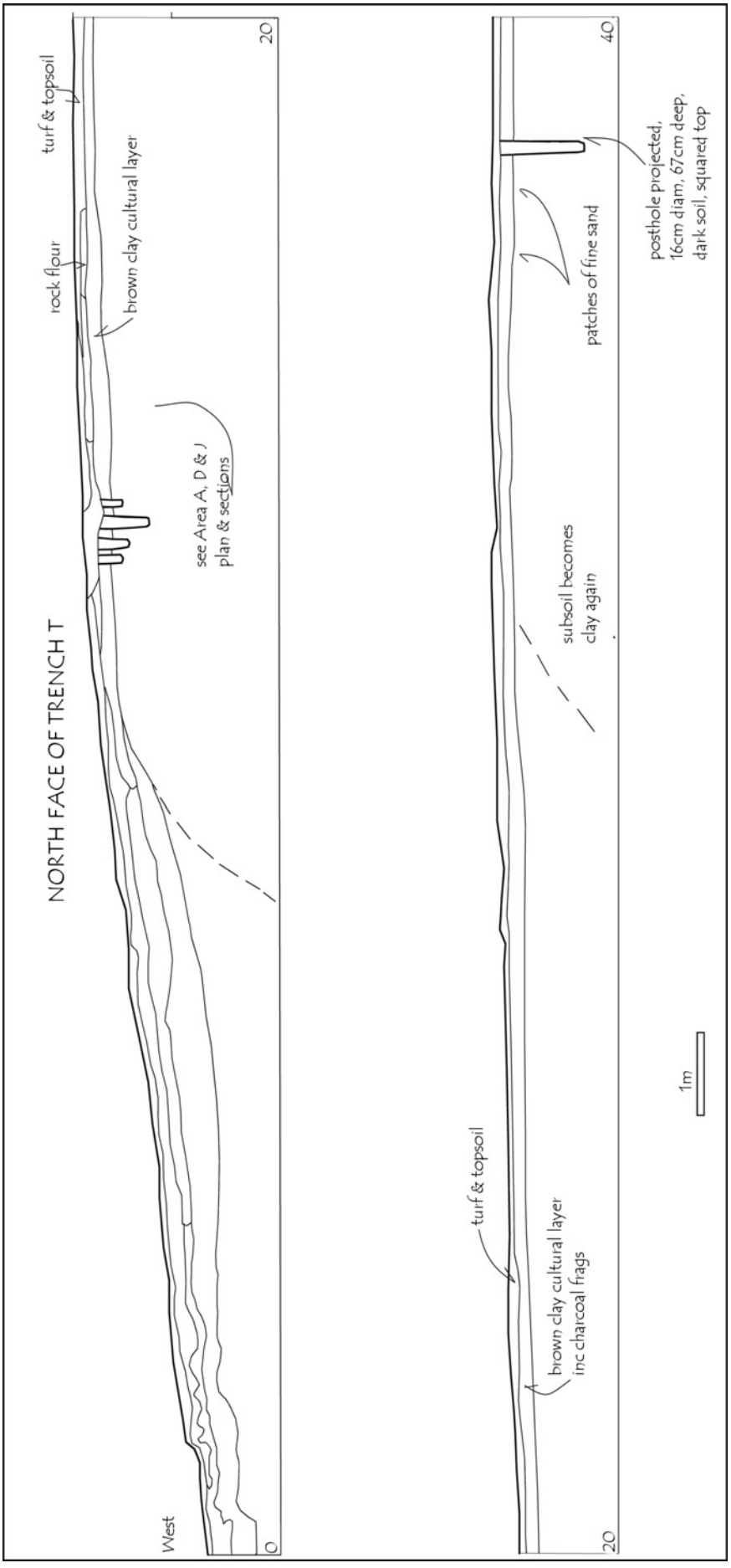
Feature Number		*Area*		*Horizon*		*Size (cm)*			*Type*	*Comments*
Report	*Field*	*Trench*	*Square*	*Layer*	*Phase*	*Length*	*Width*	*Depth*		
1	1		M	4		14	8	10	stakehole	found in midden
2	2		M	4		16+	8	?	stakehole	found in midden
3	3		M	8		6	6	8	stakehole	beneath midden
4	4		M	8		8	6	8	stakehole	beneath midden
5	5		M	8		8	8	10	stakehole	beneath midden
6	6		M	8		18	16	20	posthole	beneath midden
7	7		M	8		6	6	?	stakehole	beneath midden
8	8		M	4		47	20+	7	scoop	on top of midden

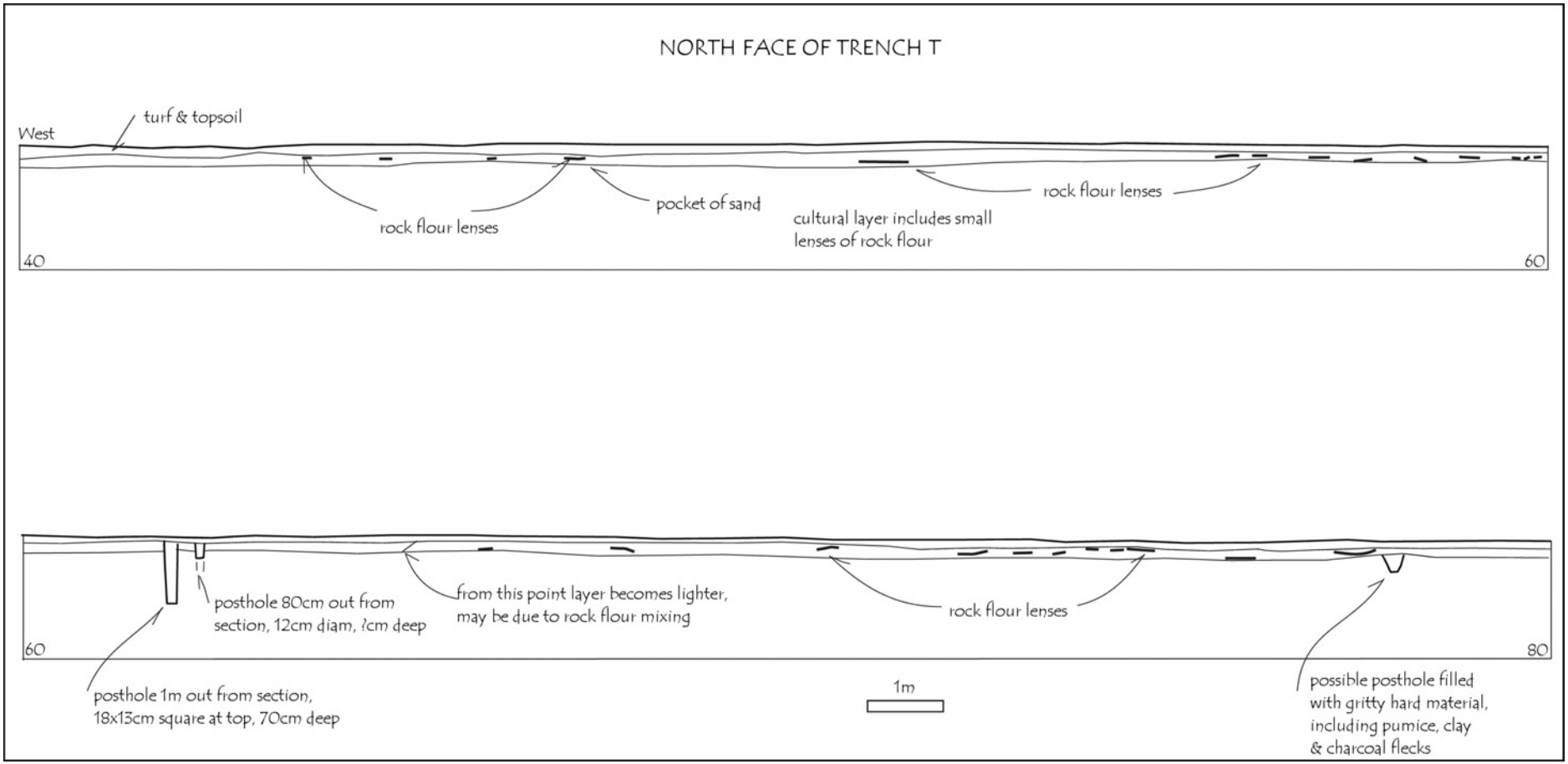
Opita - Squares F, H & Trench C

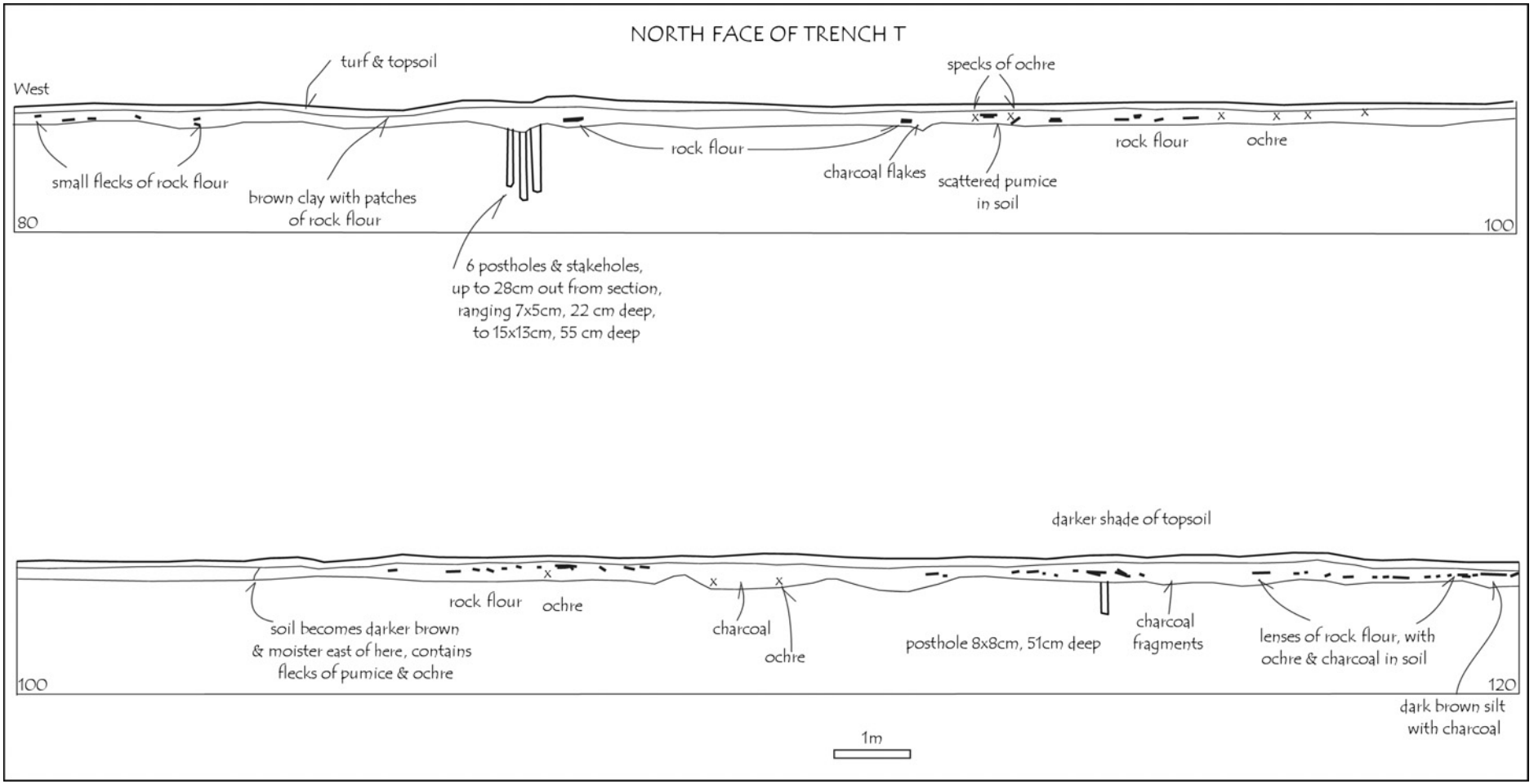
Feature Number		Area		Horizon		Size (cm)			Type	Comments
Report	Field	Trench	Square	Layer	Phase	Length	Width	Depth		
1	5		F	3	IV	32	18+	90	posthole	dark brown soil, frequent charcoal, hangi stone
2	E2		F	3	III	36	26	60	posthole	dark brown soil, occasional shell
3	pit		F	4	III	40	38	10	scoop	charcoal
4	scoop		F	4	III	90	50	10	scoop	
5	pit		F	4	III	135+	90+	25	scoop	hangi stones, charcoal-rich soil
6	burnt patch		F	5	III	64+	18+	?	hearth?	burnt patch
7	D		F	5	III	20	16	40	posthole	dark brown silt, whole shell, hangi stones, occasional charcoal
8	B		F	5	III	24	18	36	posthole	dark brown silt, whole shell, hangi stones, occasional charcoal
9	E1		F	5	III	30	30	45	posthole	shell midden from Layer 4, including dog or pig bone
10	P		F	5	III	35	18	42	posthole	dark brown silt, crushed shell
11	H		F	5	III	30	24	45	posthole	dark brown soil, occasional shell, clay, charcoal
12	J		F	5	III	30	20	39	posthole	dark brown silt, charcoal, occasional shell, hangi stone
13	Q		F	5	III	20	18	54	posthole	dark brown silt, occasional charcoal
14	M		F	5	III	18	6+	35	posthole	shell midden from Layer 4, including dog or pig bone
15	C		F	7	II	6	6	14	stakehole	mostly whole shell, charcoal
16	F		F	7	II	5	5	10	stakehole	dark brown soil, occasional charcoal
17	G		F	7	II	5	5	13	stakehole	dark brown soil
18	I		F	7	II	10	10	28	posthole	dark brown silt, charcoal, ash, occasional shell
19	L		F	7	II	5	5	14	stakehole	dark brown silt
20	K		F	7	II	7	5	5	stakehole	dark brown silt, charcoal, occasional shell
21	N		F	7	II	8	6	7	stakehole	dark brown silt, crushed shell
22	O		F	7	II	6	6	9	stakehole	dark brown silt, crushed shell
23	stake		F	7	II	5	5	11	stakehole	
24	scoop		F	7	II	120	45+	20	scoop	
25	scoop		F	7	II	180	170	18	scoop	
26	scoop		F	7	II	60	42+	5	scoop	charcoal-rich soil? Doesn't show in section
27	A		F	7	II	6	6	14	stakehole	dark brown silt, crushed shell, occasional charcoal
28	3		F	7	II	4	4	21	stakehole	dark brown soil, frequent crushed shell
29	2		F	8	I	14	12	13	posthole	dark brown soil, frequent charcoal with occasional clay lumps
30	4		F	8	I	28	20	7	scoop	dark brown soil, frequent charcoal with occasional clay lumps
31	Scoop		F	8	I	55	36	10	scoop	dark brown soil, with charcoal & pumice
32	1		F	8	I	22	14	10	posthole	dark brown soil, frequent charcoal with occasional clay lumps
33	Drain		F	8	I	340	80	32	drain	dark brown soil
34	2		H	3	IV	52	22+	12	scoop	charcoal, mixed in rock flour
35	3		H	3	IV	50	44	7	scoop	hangi stones, charcoal-rich soil
36	drain		H	3	IV	300+	120	75	drain	rock flour, charcoal lens, bank slump
37	1		H	3	IV	79	76	14	scoop	hangi stones, charcoal-rich soil

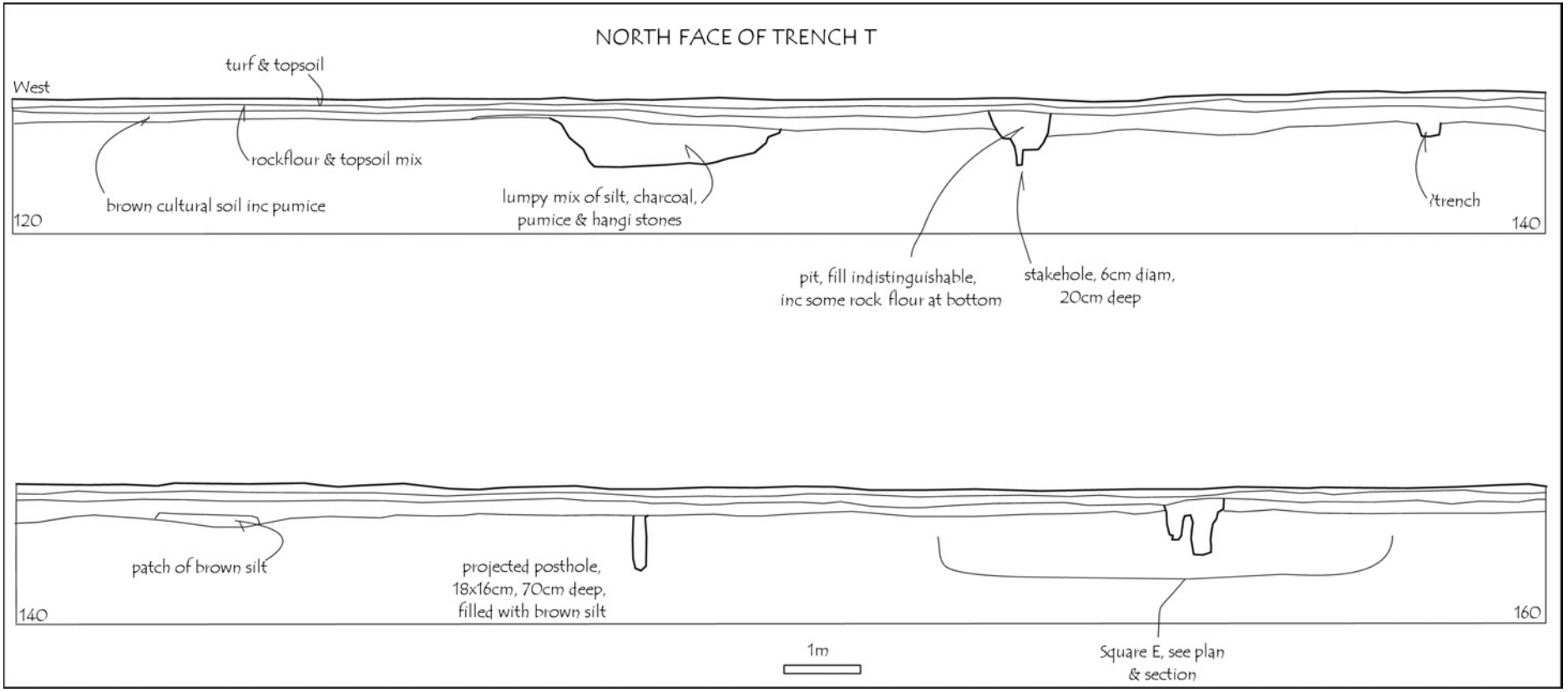
– *continued over page*

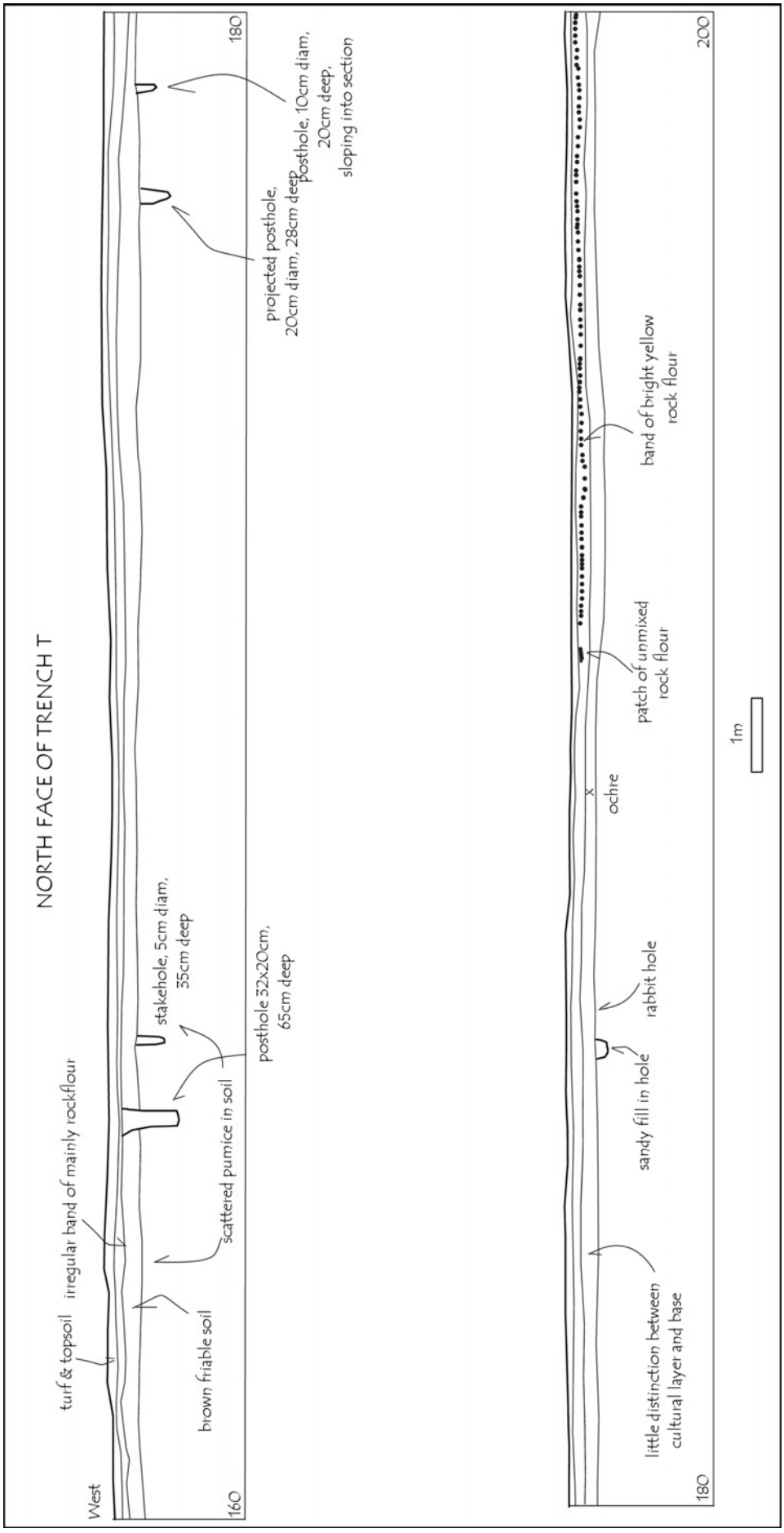
38	5		H	5	III	11	10	20	stakehole	dark brown silt, charcoal
39	10		H	5	III	37	36	5	scoop	dark brown silt, charcoal
40	4		H	5	III	44	42	12	scoop	dark brown silt, charcoal
41	9		H	5	III	58	54	5	scoop	dark brown silt, charcoal
42	3		H	5	III	43	42	12	scoop	dark brown silt, charcoal
43	2		H	5	III	9	9	9	stakehole	dark brown silt, charcoal
44	1		H	5	III	28	27	45	posthole	dark brown silt, charcoal
45	drain		H	5	III	300+	80	85	drain	brown & grey silt layers
46	6		H	5	III	9	9	12	stakehole	dark brown silt, charcoal
47	8		H	7	II	10	9	22	stakehole	dark brown silt, charcoal
48	7		H	7	II	13	10	20	posthole	dark brown silt, charcoal
49	15		H	7	II	17	15	26	posthole	dark brown silt, charcoal
50	16		H	7	II	17	15	18	posthole	dark brown silt, charcoal
51	12		H	7	II	13	6	29	stakehole	dark brown silt, charcoal
52	13		H	7	II	25	22	21	posthole	dark brown silt, charcoal
53	13A		H	7	II	22	19	17	posthole	dark brown silt, charcoal
54	14		H	7	II	22	20	19	posthole	dark brown silt, charcoal
55	11		H	7	II	8	8	4	stakehole	dark brown silt, charcoal
56	scoop		H	8	I	84	54+	30	scoop	dark brown silt, charcoal & lumps clay
57	20		H	8	I	22	12	28	posthole	brown pumiceous silt
58	21		H	8	I	6	6	7	stakehole	brown pumiceous silt
59	17		H	8	I	6	6	8	stakehole	brown pumiceous silt
60	18		H	8	I	6	6	10	stakehole	brown pumiceous silt
61	22		H	8	I	4	4	6	stakehole	brown pumiceous silt
62	19		H	8	I	8	7	11	stakehole	brown pumiceous silt
63	scoop		H	8	I	120+	60	32	drain	dark brown silt, charcoal & lumps clay
64	lens	C		3	IV	?	60	10	scoop	charcoal-rich soil
36	ditch	C		3	IV	?	120	80	drain	rock flour, charcoal lens, bank slump & stream wash
67	Drain	C		3	IV	?	85	45	scoop	rock flour & layer 3
68	scoop	C		3	IV	?	75	25	scoop	rock flour & charcoal
69	scoop	C		3	IV	?	100	30	scoop	rock flour
45	ditch	C		5	III	?	100	100	drain	mixed silts, bank slump
70	posthole	C		5	III	?	25	33	posthole	
71	posthole	C		5	III	?	20	30	posthole	
72	pit	C		5	III	?	22	35	posthole	shell midden, hangi stones & charcaol
66	lens	C		7	I	?	30	7	scoop	charcoal-rich soil
63	ditch	C		8	I	?	120	60	drain	dark brown silt, charcoal, lumps of clay at base
33	scoop	C		8	I	?	130	45	drain	clay & charcoal
65	posthole	C		2	0	?	25	75	posthole	rock flour, remnants of post & wire

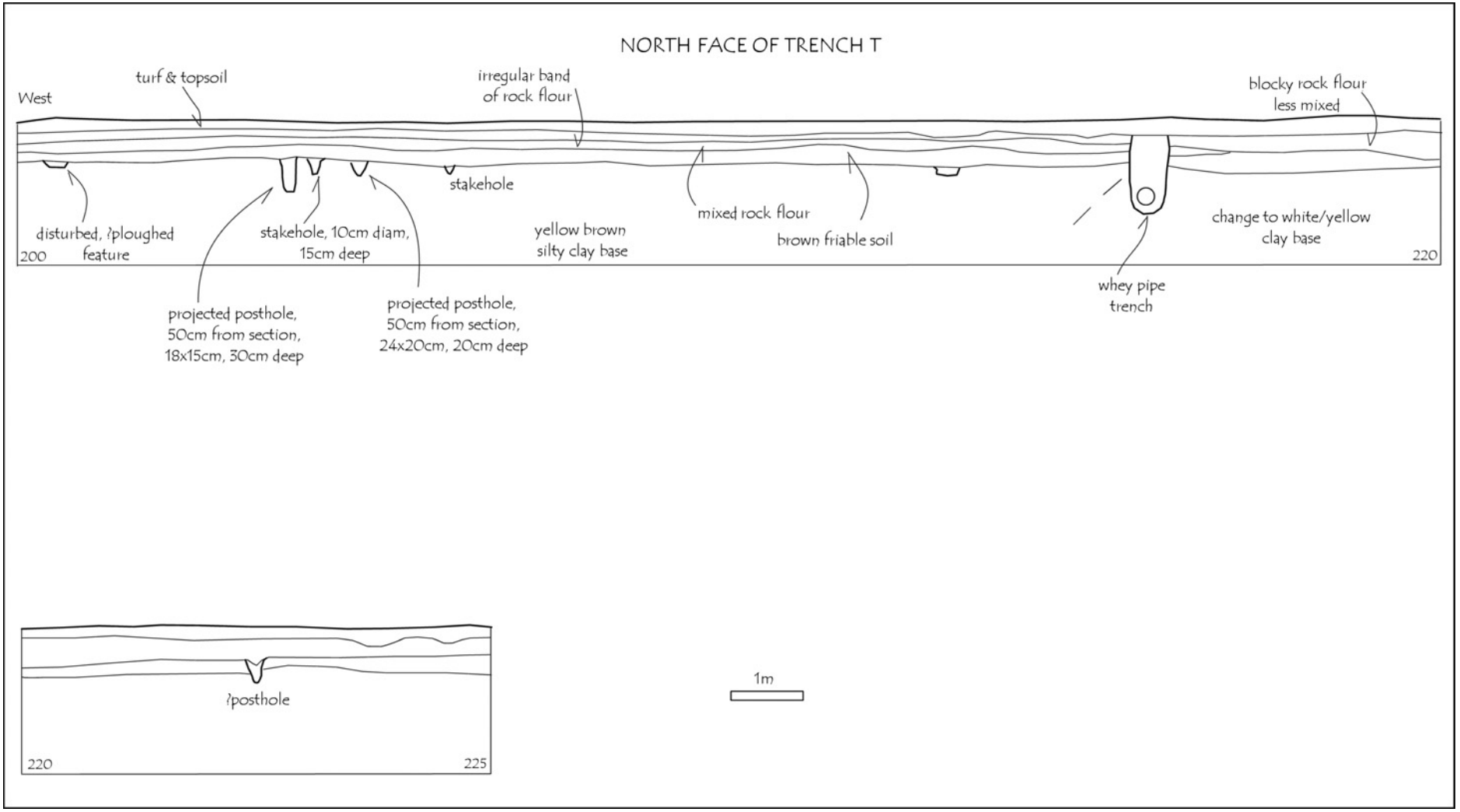

NORTH FACE OF TRENCH T
West
0
20
40
turf & topsoil
rock flour
brown clay cultural layer
see Area A, D & J plan & sections
subsoil becomes clay again
patches of fine sand
posthole projected, 16cm diam, 67cm deep, dark soil, squared top
turf & topsoil
brown clay cultural layer inc charcoal frags
1m

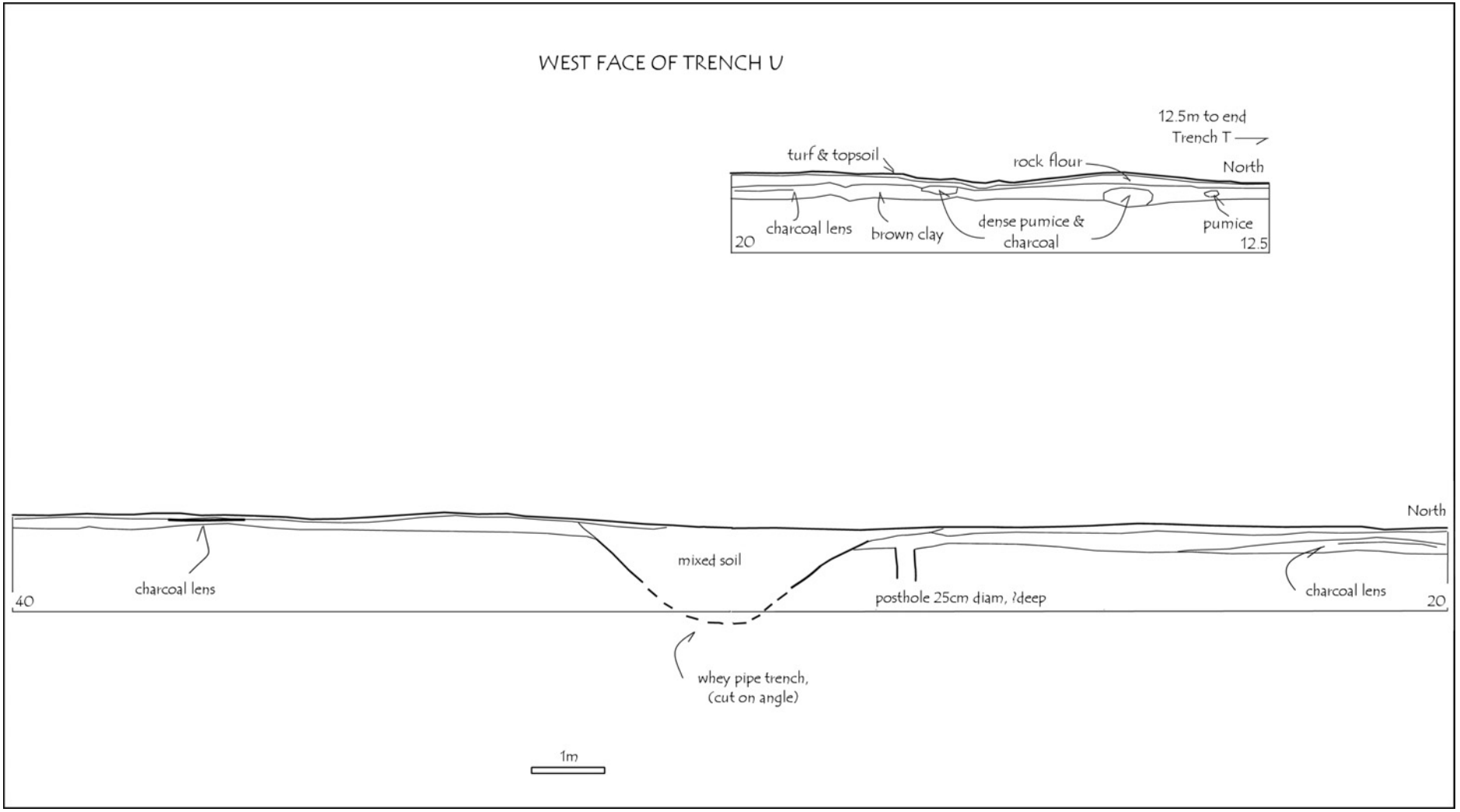

NORTH FACE OF TRENCH T
West
turf & topsoil
rock flour lenses
pocket of sand
cultural layer includes small
lenses of rock flour
rock flour lenses
40
60
posthole 80cm out from
section, 12cm diam, ?cm deep
from this point layer becomes lighter,
may be due to rock flour mixing
rock flour lenses
60
80
posthole 1m out from section,
18x13cm square at top, 70cm deep
1m
possible posthole filled
with gritty hard material,
including pumice, clay
& charcoal flecks

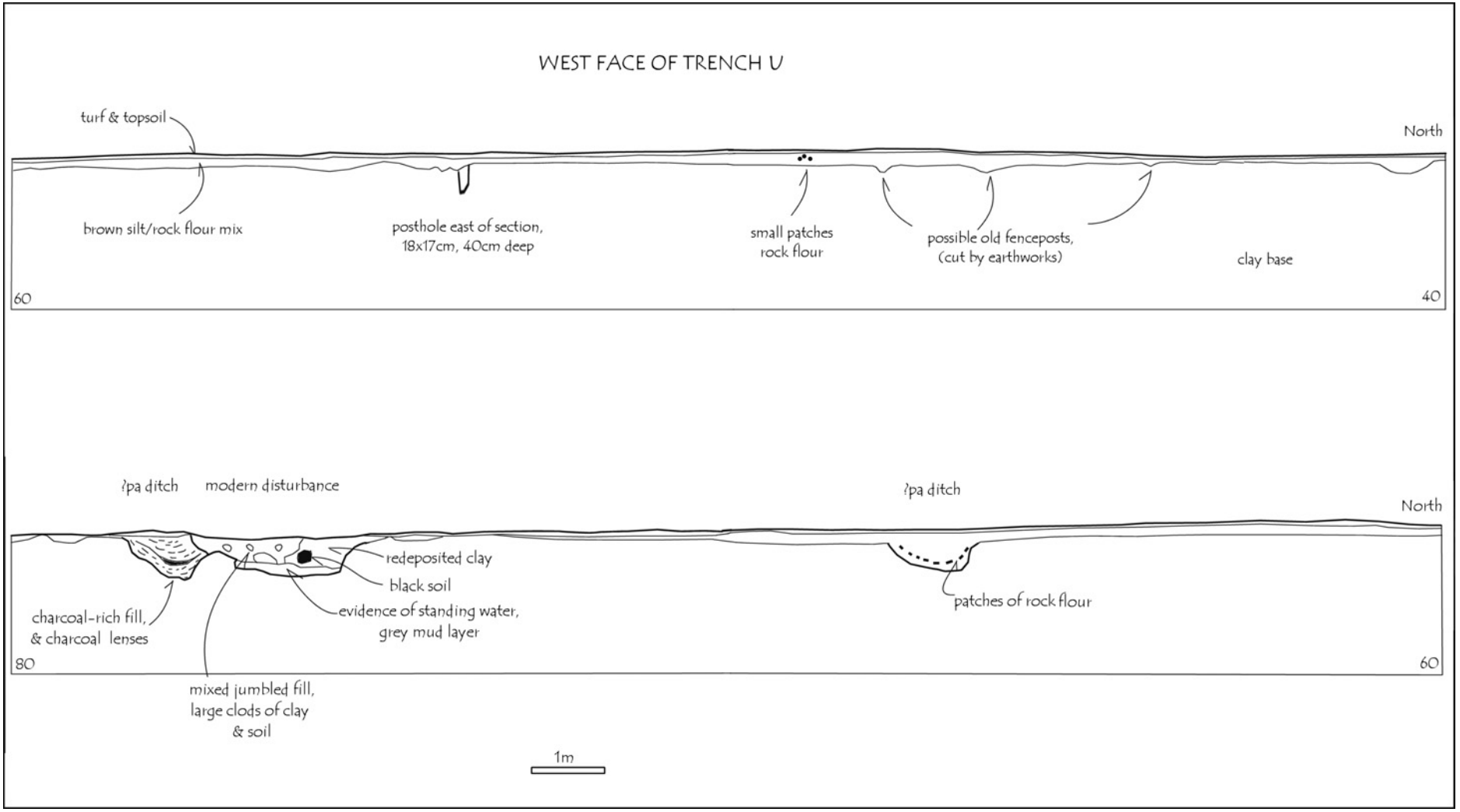

NORTH FACE OF TRENCH T
West
turf & topsoil
specks of ochre
small flecks of rock flour
brown clay with patches of rock flour
rock flour
charcoal flakes
scattered pumice in soil
rock flour
ochre
80
100
6 postholes & stakeholes, up to 28cm out from section, ranging 7x5cm, 22 cm deep, to 15x13cm, 55 cm deep
darker shade of topsoil
rock flour
ochre
soil becomes darker brown & moister east of here, contains flecks of pumice & ochre
charcoal
ochre
posthole 8x8cm, 51cm deep
charcoal fragments
lenses of rock flour, with ochre & charcoal in soil
100
120
dark brown silt with charcoal
1m

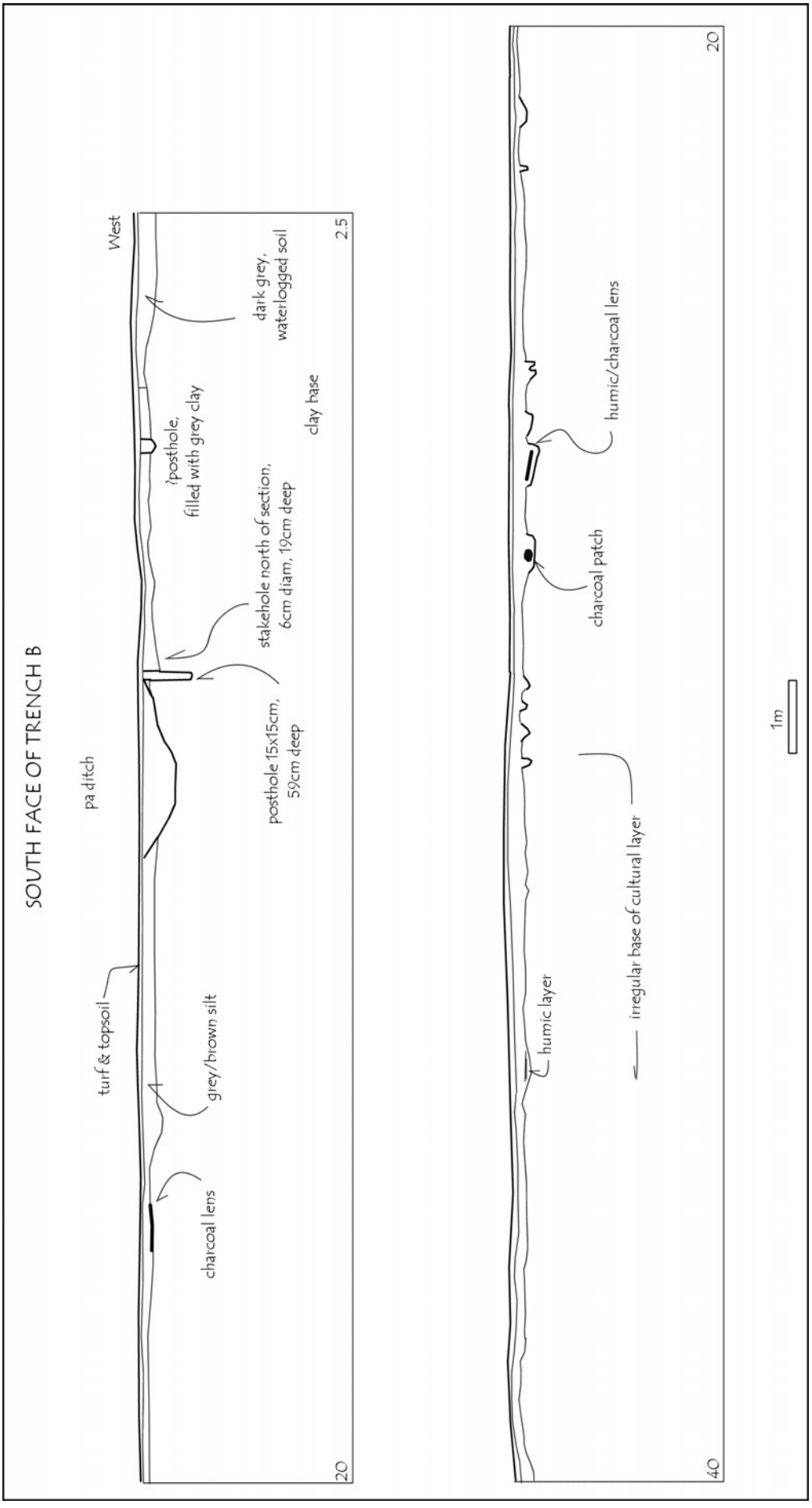

NORTH FACE OF TRENCH T
West
turf & topsoil
rockflour & topsoil mix
brown cultural soil inc pumice
lumpy mix of silt, charcoal, pumice & hangi stones
?trench
120
140
pit, fill indistinguishable, inc some rock flour at bottom
stakehole, 6cm diam, 20cm deep
patch of brown silt
projected posthole, 18x16cm, 70cm deep, filled with brown silt
140
160
1m
Square E, see plan & section

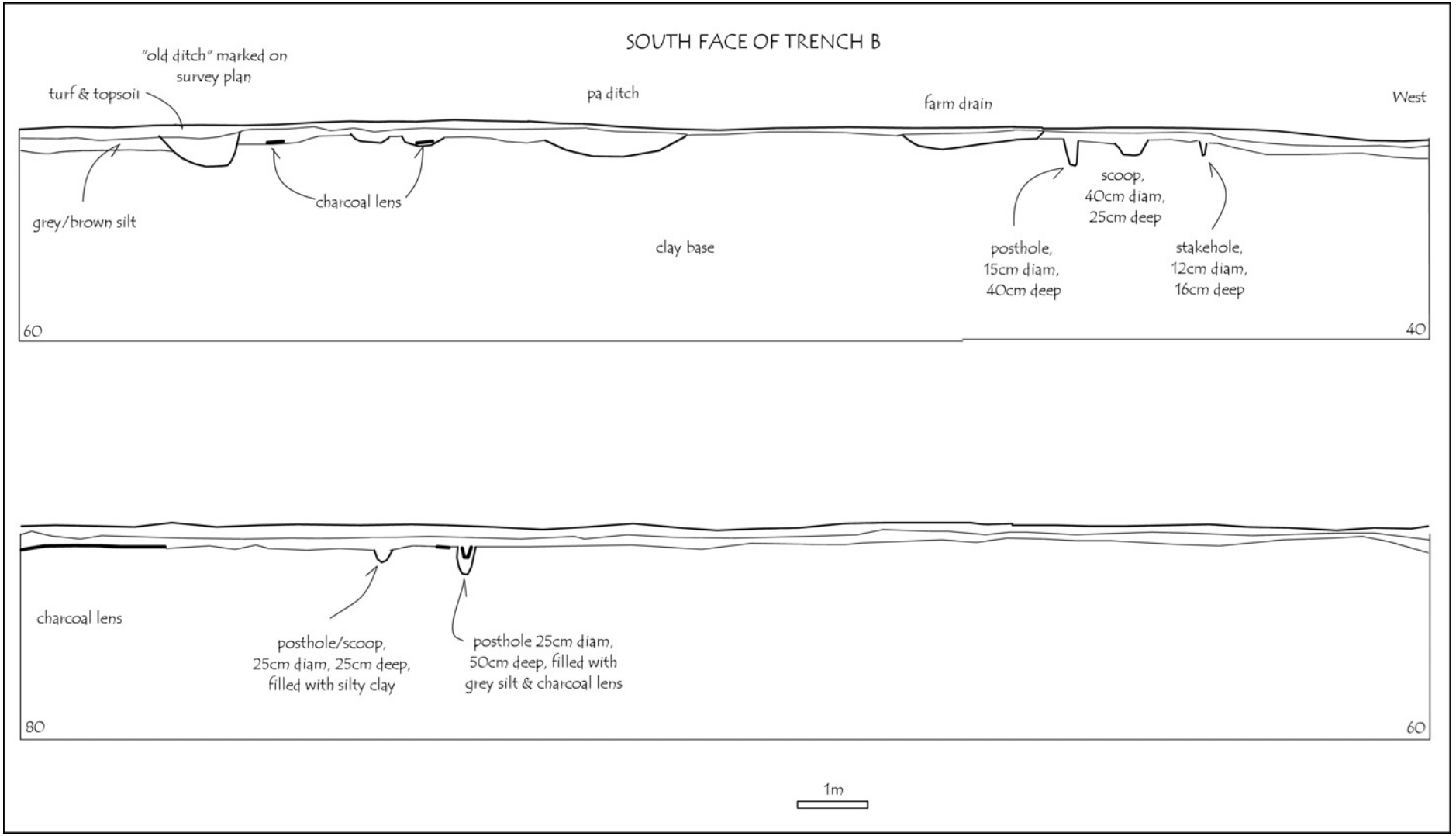

NORTH FACE OF TRENCH T
West
turf & topsoil
irregular band of mainly rockflour
brown friable soil
scattered pumice in soil
stakehole, 5cm diam, 35cm deep
posthole 32x20cm, 65cm deep
projected posthole, 20cm diam, 28cm deep
posthole, 10cm diam, 20cm deep, sloping into section
160
180
band of bright yellow rock flour
patch of unmixed rock flour
ochre
sandy fill in hole
rabbit hole
little distinction between cultural layer and base
1m
180
200

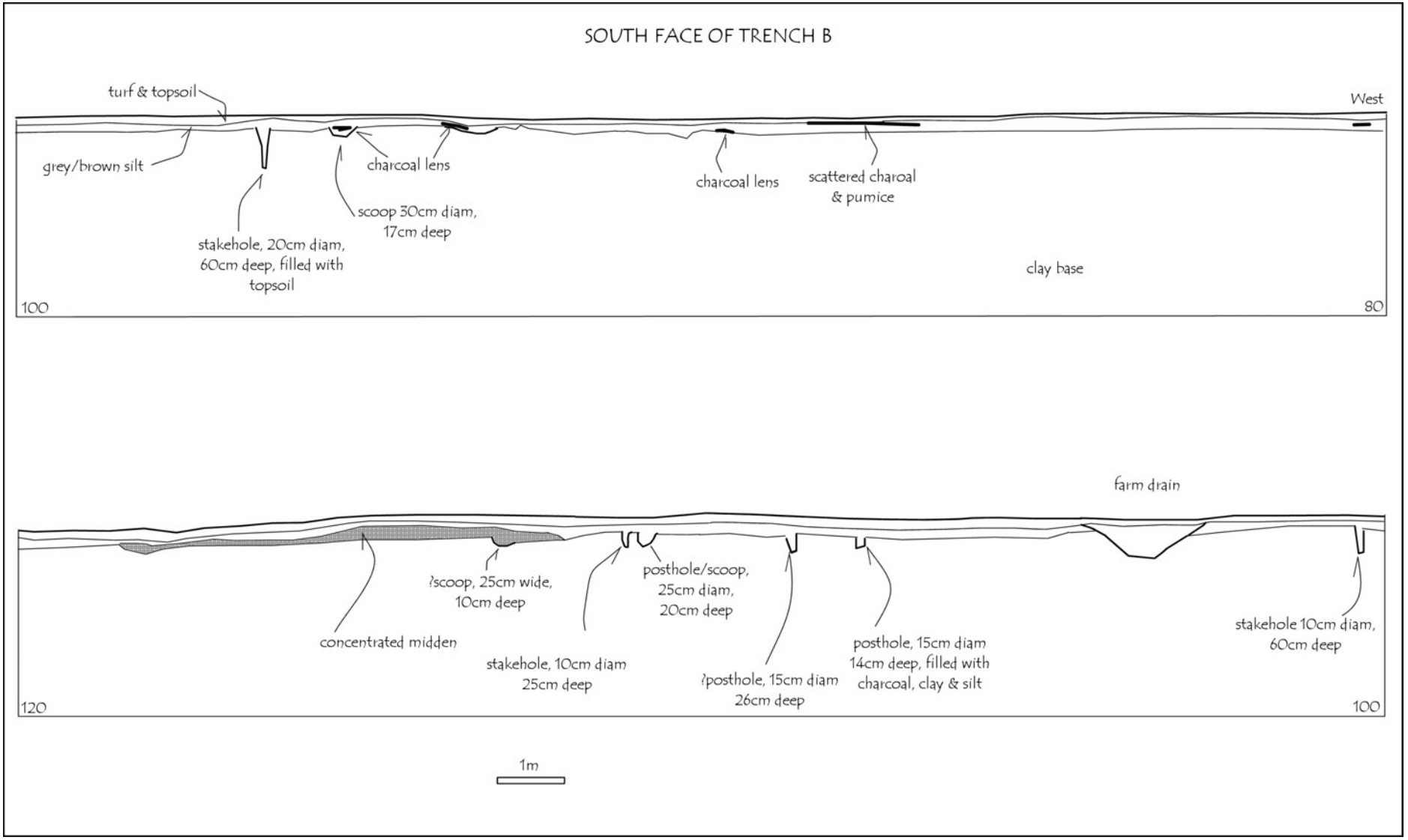

NORTH FACE OF TRENCH T
West
turf & topsoil
irregular band of rock flour
blocky rock flour less mixed
stakehole
disturbed, ?ploughed feature
200
stakehole, 10cm diam, 15cm deep
yellow brown silty clay base
mixed rock flour
brown friable soil
change to white/yellow clay base
220
whey pipe trench
projected posthole, 50cm from section, 18x15cm, 30cm deep
projected posthole, 50cm from section, 24x20cm, 20cm deep
?posthole
220
225
1m


WEST FACE OF TRENCH U
12.5m to end
Trench T
turf & topsoil
rock flour
North
charcoal lens
brown clay
dense pumice &
charcoal
pumice
20
12.5
North
charcoal lens
mixed soil
posthole 25cm diam, ?deep
charcoal lens
40
20
whey pipe trench,
(cut on angle)
1m

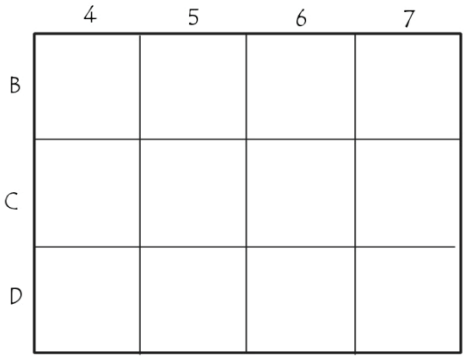

WEST FACE OF TRENCH U
turf & topsoil
North
brown silt/rock flour mix
posthole east of section,
18x17cm, 40cm deep
small patches
rock flour
possible old fenceposts,
(cut by earthworks)
clay base
60
40
?pa ditch
modern disturbance
?pa ditch
North
redeposited clay
black soil
charcoal-rich fill,
& charcoal lenses
evidence of standing water,
grey mud layer
patches of rock flour
80
60
mixed jumbled fill,
large clods of clay
& soil
1m


SOUTH FACE OF TRENCH B
West
pa ditch
turf & topsoil
grey/brown silt
charcoal lens
posthole 15x15cm, 59cm deep
stakehole north of section, 6cm diam, 19cm deep
?posthole, filled with grey clay
dark grey, waterlogged soil
clay base
2.5
20
humic layer
irregular base of cultural layer
charcoal patch
humic/charcoal lens
20
40
1m

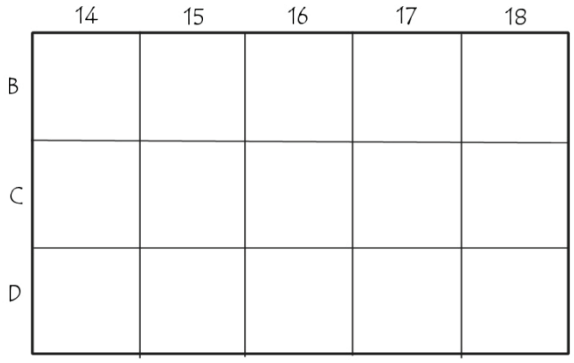

SOUTH FACE OF TRENCH B
"old ditch" marked on survey plan
turf & topsoil
pa ditch
farm drain
West
grey/brown silt
charcoal lens
clay base
scoop, 40cm diam, 25cm deep
posthole, 15cm diam, 40cm deep
stakehole, 12cm diam, 16cm deep
60
40
charcoal lens
posthole/scoop, 25cm diam, 25cm deep, filled with silty clay
posthole 25cm diam, 50cm deep, filled with grey silt & charcoal lens
80
60
1m


SOUTH FACE OF TRENCH B
turf & topsoil
West
grey/brown silt
charcoal lens
charcoal lens
scattered charoal & pumice
scoop 30cm diam, 17cm deep
stakehole, 20cm diam, 60cm deep, filled with topsoil
clay base
100
80
farm drain
?scoop, 25cm wide, 10cm deep
posthole/scoop, 25cm diam, 20cm deep
concentrated midden
stakehole, 10cm diam 25cm deep
?posthole, 15cm diam 26cm deep
posthole, 15cm diam 14cm deep, filled with charcoal, clay & silt
stakehole 10cm diam, 60cm deep
120
100
1m

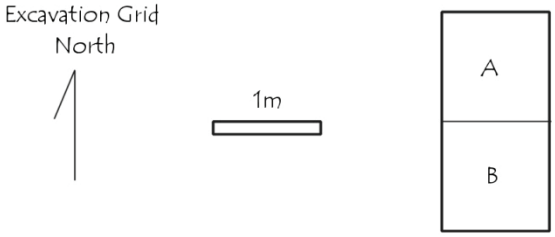
GRID LAYOUTS



SQUARE F



SQUARE H



SQUARE M

Appendix 2 Analysis of Obsidian from the Opita Excavations

Simon Holroyd

[The following is an excerpt from the report by Simon Holroyd, detailing his method, description of finds and analysis of the obsidian found at the Opita sites in 1991 with excerpts from 1994 paper 'Obsidian Sourcing by PIXE Analysis at AURA2' by S.R. Neve, P.H. Barker, S. Holroyd and P.J. Sheppard in Attachment 2, and a table comparing the Holroyd's obsidian sourcing with those of PIXE in Attachment 3]

Method

Sourcing

Using Moore's guide to visual identification of obsidian sources (Moore 1988) it was possible to identify the most likely source for most of the obsidian. Moore points out that although not all potential sources need necessarily have been used (1988:2-3), local use of flake quality material is likely (1988:3), and that discrete deposits within a source region may possess similar physical characteristics. This maxim has been used for the present material unless a particular source was clearly obvious. Mayor Island green obsidian is usually readily identifiable in transmitted light, though Pungaere/Waiare (Northland) or Waihi may also be green in colour. All the green obsidian has been identified as Mayor Island though it is possible that future analysis may find otherwise for a very few of these pieces.

Prickett (1990; 1992) using Coster and Moore (1989) established that some "grey" obsidian from Raupa can probably be sourced at the Waimata Stream, Waihi. Much of the grey obsidian from the present excavation matched this material. Several pieces of dense, opaque obsidian with a brownish tinge matched material from Te Ahumata on Great Barrier Island though this colour is not listed as being from that source in Moore's article. Comparative brown obsidian from the listed likely sources, Waihi and Whangamata, was not located. Some highly translucent grey obsidian also appeared identical to material from Great Barrier though other sources in the Coromandel region are also possible. Moore notes that frequently it is not possible to reliably identify "grey" material beyond the regional stage without density measurement or chemical analysis. This was not possible with the present samples due to their generally very small size, the amount of time needed for the results to be determined and financial constraints. Therefore all the obsidian sourced only as "grey", although likely to originate from sources in the Coromandel Volcanic Zone such as Waihi, Great Barrier, Whangamata, Cooks Beach or any of several others (see Moore 1988), this is not certain.

Use-wear

All the obsidian pieces were examined by eye to determine possible edge damage. Microscopic analysis was not undertaken because it was felt that much of the potential use-wear marks thus revealed could equally be the result of non-use modification. In the following analysis five terms have been used to describe use-wear:

a) Definite - where there is the characteristic chipping found on edges with heavy usage (Morwood 1974).

b) Slight - where there is microflaking on one or more edges which may be marginally attributed to use-wear but could equally have been caused by post-depositional disturbance including excavation.

c) Fragment - where the flake shows signs of possible use-wear but its present size precludes its use as a tool in its own right though it may have accidentally, or even purposefully, been broken from a tool at some stage.

d) Core Remnant - where a large piece of obsidian appears to have had flakes removed from it and the remaining piece does not shows signs of subsequent use.

e) None - where there is no apparent use-wear although usage cannot be entirely ruled out (c.f. Morwood).

Obsidian Finds

In the analysis of finds which follows, each area will be examined in turn from south to north (see Figure 1) concluding with Trench C, Squares F and H which was the most artefactually significant part of the site.

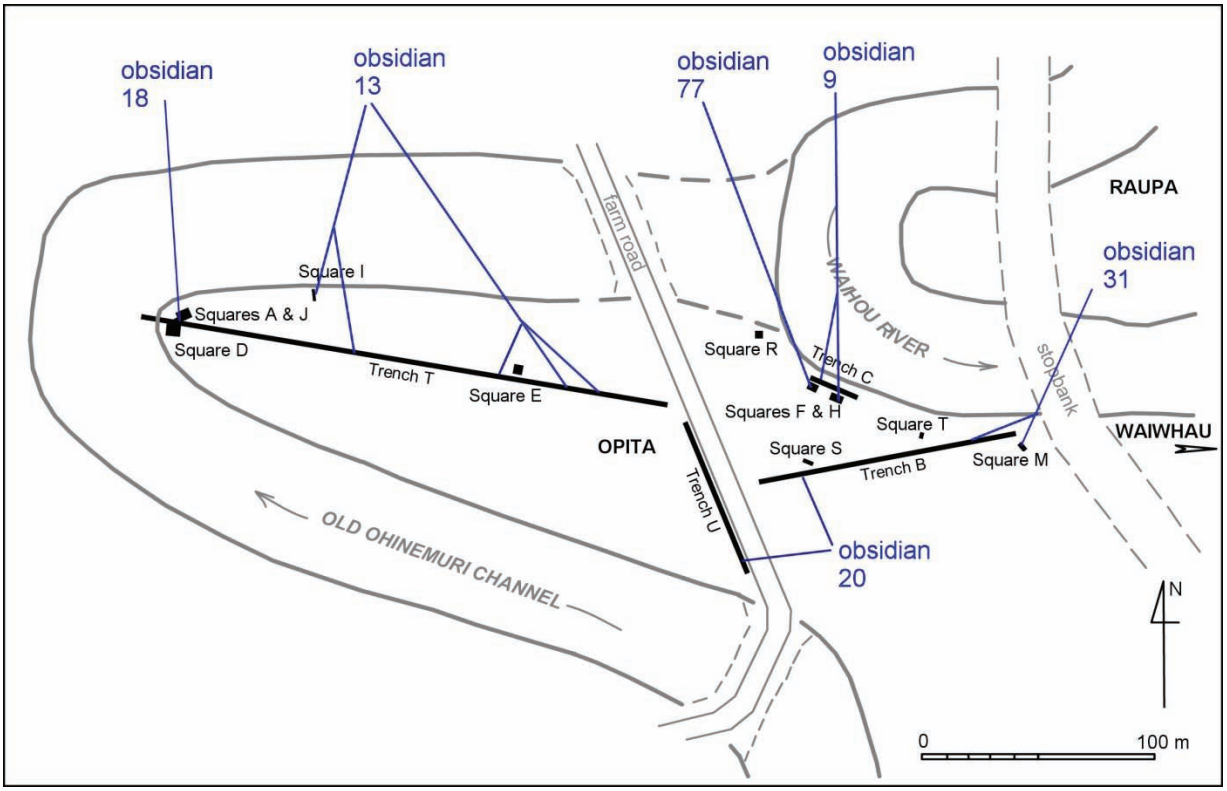


Figure 1. Plan of the excavation areas, showing the locations and numbers of the obsidian finds.

Square A

This area produced only two pieces of obsidian. One piece weighed 6.35 g and was of the usual Mayor Island green variety with no cortex and slight use-wear. It was found in Layer 3 which was the cultural layer. The other was recovered from the topsoil, presumably due to post-depositional disturbance. It weighed 3.00 g and came from Waihi, had cortex and marginal use-wear.

Square J

This extension of Area A produced no obsidian.

Square D

Ten pieces (19.66 g) were recovered from this area which had several postholes and a large hangi-pit filled with charcoal-rich soil. All the obsidian was recovered from within the cultural layer with six

pieces coming from the hangi-pit and one (no. 146) from a large posthole 20 cm from the south edge of the pit. Six pieces (10.99 g, 55.9%) came from the Waihi source one had definite use-wear and two had possible use-wear. Two pieces of Mayor Island obsidian (7.40 g, 37.6%), both had definite use-wear. One piece (0.79 g, 4.0%) of very dense, opaque obsidian had a brownish tinge similar to that found in obsidian from Te Ahumata, Great Barrier. This piece had neither cortex nor any evidence of use-wear. The other piece of obsidian was "grey" and had no use-wear, but was the only piece from this area to have cortex. It weighed 0.48 g (2.4%).

Trench T

This 226.6 m trench was drawn in section for its entire length but not excavated further except to detail a few features, none of which were especially significant. Eighteen pieces weighing 24.22 g were recovered. All were found in the cultural layer or in the spoil. Eleven (61.1 %) of these weighing 18.51 g (76.4%) were from the Waihi source. The two largest of these (7.59 g and 5.22 g) had definite use-wear and one other had slight use-wear; the remainder were unused.

The only five pieces with cortex were all Waihi pieces. Six pieces (33.3%) weighing 5.49 g (22.7%) were from Mayor Island: two had slight evidence of use-wear and none had cortex. The remaining piece (0.22 g, 0.9%) was "grey", had no cortex and was not used. The obsidian in this trench was generally well-scattered but six pieces were sufficiently close to Squares A and D that they might be associated with that area of occupation.

Square E

This square adjacent to Trench T produced no obsidian.

Square I

Only one piece was found in the cultural layer of this square. It weighed 0.39 g and was a fragment of Mayor Island obsidian which had no cortex.

Trench U

This trench was drawn in section from its junction with Trench T for 80 m to the south until the layer of cultural material petered out (where it had been scraped off for the stopbank). Fourteen pieces were recovered weighing 7.25 g, all from between the 66 m and 75 m marks and all in the cultural layer. All were found in association with either one of the two ditch features found in this area. Seven pieces (50.0%) weighing 2.68 g (37.0%) were from Mayor Island: three of which were fragments the rest unused and none of them had cortex. Five pieces (35.7%) weighing 2.83 g (39.0%) came from Waihi; none had cortex, but one showed signs of possible use-wear, another was a fragment and the others were unused. One "grey" piece (0.46 g, 6.3%) was the only one in this trench to have cortex and was unused. The remaining piece (1.28 g, 17.7%) was a translucent grey similar to that found at Great Barrier. It had definitely been used and did not have cortex.

Trench B

This trench was drawn in section for a length of 120 m from the edge of the access road to the fence line by the stopbank. The area had been highly disturbed due to material being taken for the stopbanks (Phillips pers. comm. estimates that at least 50 cm was removed from an original rise in the area), and also due to its use as a cow paddock which had considerably affected the remaining soil layers. Seven pieces weighing 346.29 g were recovered; except for one very small piece (0.38 g) from the vicinity of the 26 m mark, all pieces were from Mayor Island and none had cortex. Three pieces appeared to be core remnants, including by far the largest piece on the whole site (no. 51a) which weighed 247.07 g. This is a very similar size to the largest cores found at Raupa (Prickett 1990). Another large piece (no. 508, 27.16 g) appears to be the perfect shape for cutting or scraping, but did not appear to have been

used. One fragment has some sign of use-wear, but the remaining pieces appear unused. Refitting was tried with all pieces but was unsuccessful. This indicates that, unless there was a single extremely large core, several cores were prepared, though the lack of a large number of small flakes suggests that this may have taken place elsewhere, and the remains dumped, or cached in the recovery area (as in that found in Area IV D2 at Raupa in 1987; see Prickett 1990: 130-3 1, Figure 33).

Square M

This square was laid specifically to investigate the midden found at the eastern end on Trench B. The midden was found in the fourth layer below the surface and was excavated in three arbitrary spits. In total twenty-seven pieces were recovered weighing 32.41 g (Table 1). Eighteen pieces (66.6%) were from Mayor Island, none of which had cortex. One core remnant was found weighing 11.37g and two other pieces (2.15 g and 2.81 g) showed definite signs of use, while the remaining Mayor Island pieces, of which three had only slight signs of use-wear, all weighed less than 1.00 g each. Eight pieces (29.6%) came from Waihi, of which two showed signs of possible use-wear, whereas the others were unused including two (2.98 g and 0.52 g) with cortex. The remaining piece was an unused grey piece from Great Barrier which did not have cortex.

Table 1. Square M Layer 4 spits. An additional three pieces were found in disturbed upper layers and are not included in this table.

Spit	*Total No.*	*Mayor Island*	*weight (g)*	*% Sq M*	*Waihi*	*weight (g)*	*% Sq M*	*Great Barrier*	*weight (g)*	*% Sq M*
1	16	11	14.75	34.2	4	6.61	15.3	1	0.44	1.00
2	6	3	0.93	2.2	3	5.08	11.8			
3	5	4	4.08	9.4	1	0.52	1.2			
Total	**27**	**18**	**19.76**	**45.8**	**8**	**12.21**	**28.3**	**1**	**0.44**	**1.00**

Square S

This square produced some European artefacts and at the base some prehistoric drains, but no obsidian was found.

Square T

This square produced European material near the surface and a thin cultural layer further down, but no obsidian.

Square R

A square which produced no finds and no cultural layer was evident.

Trench C

This trench was dug (by hand) into the bank of the old Waihou River creating a 20 m long vertical face in which numerous features were revealed including two Layers of midden (Layers 4 and 6). Two pieces of Mayor Island obsidian without cortex were recovered; they weighed 2.16 g. Three metres from the western end an unused piece weighing 1.75 g was found in Layer 7. Another flake found 6 m to the east, at the 9 m mark, was a fragment weighing 0.41 g in Layer 5.

Square H

This square was parallel to Trench C and was 5 m long by 3 m wide. It was positioned so as to examine the ditch features at the eastern end of the trench. Seven pieces weighing 10.6 g were recovered, none of which had cortex. One piece weighing 1.86 g (17.4%) recovered from Layer 7 came from Waihi and was unused. The remaining six pieces (85.7%) weighing 8.81 g (82.6%) came from Mayor Island. Three pieces weighing 1.04 g (possibly used), 3.59 g (possibly used) and 1.00 g (no use) were found in Layer 5 (the upper cultural layer) and two pieces (0.15 g, 0.68 g), both unused in Layer 7 (the lower cultural layer). One piece came from Layer 9 which was in the ditch.

Square F

This square was also parallel to Trench C and in line with Square H. Its main purpose was to investigate the midden layers found in the trench. It was the most obsidian-rich square excavated at Opita. The total finds and the areal distribution will be examined first, then according to each source, then each layer. Table 2 presents the total quantity and total weight of obsidian in each quad; Tables 3 and 4 summarise the source and use-wear aspects of the obsidian from Square F and the differences between the layers.

Table 2. Square F, number and weight by quad and layer.

	B4	**B5**	**B6**	**B7**
L4		1 (1.03 g)	3 (1.06 g)	
L5				
L6	11 (4.53 g)		9 (3.65 g)	3 (5.19 g)
L7			13 (22.60 g)	
L8				
	C4	**C5**	**C6**	**C7**
L4	1 (0.60 g)			
L5			1 (3.80 g)	1 (0.27 g)
L6	2 (0.88 g)		5 (5.50 g)	4 (3.48 g)
L7				1 (3.15 g)
L8				13 (23.52 g)
	D4	**D5**	**D6**	**D7**
L4	1 (0.61 g)			
L5				
L6	1 (0.29 g)	1 (1.54 g)		
L7		1 (0.09 g)	1 (7.28 g)	4 (15.85 g)
L8				

Square F by area: The concentrations of material in the north-east quads and in quad B4 are readily explained by two large scoop features in Layer 6 (see Figure 5).

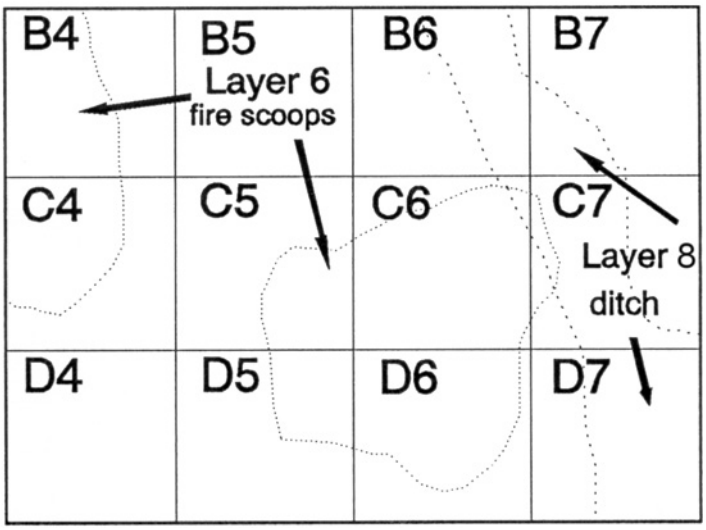


Figure 5. Square F. Major features in which obsidian was found.

Five pieces were found in sieved material from the large fire scoop at C6/D6 and thirteen from a fire scoop the edge of which was found in quads B4/C4. In Layer 8 a drainage ditch was discovered in which 13 pieces were found. The other pieces from Layers 6 and 7 were not associated with any features. The same was true for the obsidian in Layers 4 and 5.

Square F by Source: Seventy-seven pieces were recovered weighing 104.92 g in total.

Forty-six pieces weighing 47.95 g were from Mayor Island (Table 3), of which twenty-six pieces were unused (three of which had cortex), six showed slight evidence of use-wear, seven were used fragments and seven were definitely used.

Twenty-one pieces weighing 47.26 g came from Waihi; eleven of these had cortex including one piece weighing 2.80 g with slight use-wear, there was one fragment (0.19 g), and the rest were unused including the largest piece in this area (14.10 g).

Five pieces weighing 5.19 g came from Great Barrier, of which one unused grey coloured piece (0.17 g) with cortex and the other pieces were brown-tinged. Two of these were unused (0.44 g and 0.62 g), one slightly used (1.36 g) and one definitely used (2.60 g).

Five "grey" pieces (6.5%) weighing 4.52 g (4.3%) were recovered four of which had cortex. One of these had slight use-wear evidence the rest 19 were unused.

Table 3. Square F: Source by layers.

Layer	*Mayor Island*		*Waihi*		*Great Barrier*		*"Grey"*	
	% by no.	*% by wt*	*% by no.*	*% by wt*	*% by no.*	*% by wt*	*% by no.*	*% by wt*
4	2.6	0.9	1.3	0.6			3.9	1.7
5	1.3	0.3	1.3	3.6				
6	28.6	10.0	7.8	5.0	5.2	2.5	1.3	1.5
7 & 8	27.3	34.6	16.9	35.8	1.3	2.5	1.3	1.1
Total	**59.8**	**45.8**	**27.3**	**45.0**	**6.5**	**5.0**	**6.5**	**4.3**

Square F by layer: Layer 4, the upper midden, contained six (7.8%) pieces weighing 3.30 g (3.1%). Two pieces from Mayor Island did not have cortex, one was a fragment the other had slight use-wear. All the other pieces had cortex. One of the three "grey" pieces had slight use-wear the others none, neither did the single piece from Waihi.

Layer 5 was a layer of grey silt and contained two pieces (2.6%) weighing 4.07 g (3.9%). One fragment came from Mayor Island and did not have cortex. The other piece came from Waihi, had cortex and was not used.

Layer 6, the lower midden, contained 33 pieces (42.9% of Square F) weighing 19.87 g (18.9%). Twenty-two pieces (66.7% of Layer 6) weighing 10.50 g (52.8% of Layer 6) were from Mayor Island. One unused piece (1.35 g) had cortex and there were thirteen unused pieces in all. One piece had slight use-wear, four were fragments and two had definite use-wear, these being the only ones so determined in this layer. Six pieces (27.3%) weighing 5.24 g (26.4%) came from Waihi, most of the weight being accounted for by one large piece (4.22 g) which had cortex and was unused. The single fragment also had cortex as did one of the four remaining unused pieces. Four pieces (12.1%) weighing 2.79 g (14.0%) came from Great Barrier. Only the single grey piece had cortex and it was unused, of the three brown pieces one had slight use-wear the others were unused. One piece (3.0%) was "grey" and weighed 1.54 g (7.8%). It was unused and did not have cortex.

Table 4. Square F: Use-wear by layers.

Layer	*None*	*Slight*	*Fragment*	*Definite*
4	3	2	1	
5	1		1	
6	24	2	5	2
7	13	3		7
8	8	4	1	
Total	**49**	**11**	**8**	**9**

Layer 7 contained 23 pieces (29.9%) weighing 54.2 g (51.6%). Fourteen pieces (60.9%) weighing 19.46 g (36.0%) came from Mayor Island, of which two pieces had slight use-wear, five had definite use-wear and 13 were unused. One unused piece had cortex. Seven pieces (30.4%) weighing 30.9 g (57.1%) came from Waihi of which two had light use-wear and the others were unused. One brown piece (2.60 g, 3.3%) came from Great Barrier had definite use-wear and no cortex. The last piece (1.20 g, 1.5%) was "grey" and had cortex, but no use-wear.

Layer 8 was the immediate fill of the drain in which 13 flakes (16.9%), weighing 23.5 g (22.4%) were found. Seven (53.8%) were from Mayor Island and weighed 16.8 g (71.5%), of which four had no use-wear and two had had light use. The remaining six (46.2%) came from Waihi and weighed 6.7 g (28.5%). Of these four had no use-wear and two had slight wear.

Summary and Discussion

The general characteristics of the obsidian recovered from the site as a whole is summarised in Tables 5 and 6. For this analysis some of the pieces from excavation areas and trenches have been grouped, as follows:

1. Squares A and D and the first 30 m of Trench T have been combined as 'Point' because it was felt that these were close enough to be considered as a single occupation.
2. For the same reason, the Trench C and Squares F and H have been combined, as 'Opita', as these areas are the only ones within an undefended settlement adjacent to the pa of the same name.
3. The single piece found at the 98 m mark in Trench B is included with Square M as it is much closer to there than the rest of Trench B obsidian.
4. The single piece from Square I has been included with Trench T as all this obsidian appears to be randomly scattered and not associated with any particular activity/location.

These findings are compared with the Raupa and Waiwhau excavations (see also Table 7). Only eight pieces of Mayor Island obsidian were found at the late pre-contact or early post-contact European site Puriri site of T12/318 (Bedford 1994), so have not been included in the comparisons.

Source

The most obvious aspect of the obsidian from the Opita excavation is the low proportion originating from Mayor Island (57.7% by quantity) (Tables 5 & 6), when compared to 90-95% for the Raupa and Waiwhau excavations (Prickett 1990, 1992; Phillips 1987; Steadman 1988).

Table 5. Quantity from each source by area from Opita.

Location		*Mayor Island*		*Waihi*		*Great Barrier*		*"Grey"*		*Total Area*	
Square	*Trench*	*No.*	*% of Total*	*No.*	*% of Total*	*No.*	*% of Total*	*No.*	*% of Total*	*No.*	*% of Total*
A,D	T	6	3.6	9	5.4	1	0.6	2	1.2	18	10.7
I	T	4	2.4	9	5.4					13	7.7
	U	7	4.2	5	3.0	1	0.6	1	0.6	14	8.3
	B	6	3.6							6	3.6
M		20	11.9	10	6.0	1	3.0			31	18.5
F,H	C	54	32.1	22	13.1	5	3.0	5	3.0	86	51.2
Total		**97**	**57.7**	**55**	**32.9**	**8**	**7.2**	**8**	**4.8**	**168**	**100**

The small proportion of Mayor Island obsidian pieces found in Area 4 at Waiwhau (52.8% by number according to Steadman) compared to the rest of the site (90%, Phillips 1987) may be partially accounted for by the small quantity recovered. This problem might also be applicable to the Opita excavations.

The quantity of Waihi obsidian found at Opita is proportionately much higher than the amount found at Raupa (Prickett 1990, 1992) even though a much greater area was excavated in the latter (213 m^2 in 1987 produced only c.45 pieces and 175 m^2 in 1988 produced c.30 pieces). It is probable that the much of the "grey" obsidian at Waiwhau (Phillips 1987; Steadman 1988) is in fact from Waihi, the identification of the Waimata Stream source being subsequent to the publication of the Waiwhau reports.

Table 6. Weight from each source by area from Opita.

Location		*Mayor Island*		*Waihi*		*Great Barrier*		*"Grey"*		*Total Area*	
Square	*Trench*	*Wt (g)*	*% of Total*	*Wt (g)*	*% of Total*	*Wt (g)*	*% of Total*	*Wt (g)*	*% of Total*	*Weight (g)*	*% of Total*
A,D	T	17.66	3.1	14.57	2.6	0.79	0.1	0.70	0.1	33.7	5.9
I	T	1.99	0.3	17.93	3.2					19.92	3.5
	U	2.68	0.5	2.83	0.5	1.28	0.2	0.46	0.1	7.25	1.3
	B	345.91	60.9							345.91	60.9
M		25.06	4.4	18.06	3.2	0.44	0.1			43.56	7.7
F,H	C	58.92	10.4	49.12	8.6	5.19	0.9	4.52	0.8	117.75	20.7
Total		**452.22**	**79.6**	**102.51**	**18.1**	**7.7**	**1.3**	**5.68**	**1.0**	**568.09**	**100.0**

Size

At Opita the proportion of large flakes is much lower than at Raupa in 1987. Discounting the largest core remnant (247.07 g), the average weight is less than 2 g. Table 7 compares the proportions of sizes from Raupa in 1987 (approximate percentage only) and Opita. Prickett (1990) points out that a lack of small flakes is an indication that there was no obsidian working on the site. The high proportion of small flakes at Opita could thus indicate that some working of obsidian has been carried out on some part(s) of the site. This is discussed further (below). Because areas of midden were specifically targeted for excavation in Trench C/Squares F/H and Square M it is not surprising that large quantities of small (waste?) flakes were recovered. The comparative lack of useable material (c.5-15 g) may be indicative of tool-use, manufacturing, re-touch or storage locations and the differential recovery imposed by selective excavation. All the pieces (four) over 20 g in weight came from the same location in Trench B. Because of the severe disturbance in this area it is not possible to establish the exact context of their deposition and whether or not there was once a much greater quantity of small flakes as might be associated with a working area.

Table 7. Size proportions: Opita vs Raupa.

Weight	*Opita*	*Raupa*
<1 g	60%	42%
1-5 g	33%	34%
5-10 g	4%	10%
10-20 g	1%	8%
>20 g	2%	6%

Use-wear

At Raupa 9-10% of the obsidian showed signs of use-wear though Prickett (1990) suspected that in some areas as much as 20% may have actually been used. This compares with the Opita material in which 10.7% had definite use-wear, this figure increasing to 23.8% if fragments and core remnants are included. Even if the pieces with only slight evidence of use-wear are included the figure of 38.6% is still much less than the 62% recorded for Area 4 at Waiwhau which also included fragments. It has been suggested that this Waiwhau material was probably dumped and the context of much of the Opita material (in the midden in Squares F and M and the pit fill in Square D) suggests that this was also the result of dumping rather than flaking.

Table 8. Use-wear by area.

Location		*None*	*Slight*	*Fragment*	*Definite*	*Core*	*Total*
Square	*Trench*						
A,D	T	9	6		3		**18**
I	T	9	1	1	2		**13**
	U	8	1	4	1		**14**
	B	3		1		3	**7**
M		20	4	3	2	1	**30**
F,H	C	54	13	9	10		**86**
Total		**103**	**25**	**18**	**18**	**4**	**168**

The Opita settlement (Trench C, Squares F and H) is clearly the area where use of obsidian tools was most common (Table 8). It also seems quite obvious that such activity was located in and near Square F as Square H produced far less obsidian. The core remnants in Trench B indicate possible manufacture whose relationship with the historically recorded settlement at Opita cannot be determined due to the severe disturbance in that area.

In Square D there is some indication that obsidian use might be related to whatever structures might have been there but again it cannot be determined if this was contemporary with the defended settlement or not.

Cortex was present on a total of 29 pieces making 17.3% of the total (Table 9). This compares to barely 1% of the Raupa 1987 material. Tables 9 and 10 summarise the source and area for those pieces with cortex. It will be noted that only three pieces of Mayor Island obsidian (31 %) had cortex while 19 of the 55 Waihi pieces (34.5%) and six out of eight "grey" pieces (75%) had cortex. This difference is similar to that found at Raupa (Prickett, 1990) where <1% of Mayor Island obsidian had cortex and approximately 10% of Waihi had cortex, although of course the actual quantity of Waihi obsidian was much smaller at Raupa.

Table 9. Quantity of obsidian pieces with cortex by source and area.

Location		*Mayor*	*Waihi*	*Great*	*"Grey"*	***Total***
Square	*Trench*	*Island*		*Barrier*		
A,D	T		1		1	**2**
I	T		4			**4**
	U				1	**1**
	B					
M			2			**2**
F,H	C	3	12	1	4	**20**
Total		**3**	**19**	**1**	**6**	**29**

Conclusion

The main point to note about the obsidian from the Opita excavation is the comparative decline in the use of the Mayor Island source and the proportional increase in use of the Waihi source. The only area in which a stratigraphic comparison is possible is Trench C, Squares F & H, which shows how the use of obsidian declines over time.

It seems likely that Layers 6, 7 and 8 in Square F are from an early occupation, possibly contemporary with Raupa. This is supported by the difference between the artefacts found in the two midden layers. The upper midden (Layer 4) had very little obsidian but several European items, while the lower midden (Layer 6) had no European items and significantly more obsidian (Holroyd pers. obs.). The layer between the two midden layers is primarily grey silt which suggests that the area was quite severely flooded presumably while the site was unoccupied otherwise the silt would not have been allowed to settle on what would presumably have been living/working areas. Because of its proximity to Raupa, directly across the Waihou River, it is probable that the earlier occupation was related to it in much the same way as the earlier period of the Waiwhau occupation (Phillips and Green 1991). The obsidian from Waiwhau also suggests an increase in exploitation of the Waihi source, compared to Raupa, and a decline in the overall quantity.

Mayor Island is the most common source of obsidian used by Maori, probably due to its higher quality, being more homogenous and with fewer inclusions. As the Waihi source is the most accessible (only 30 km by river, whereas Mayor Island is an additional 30 km by land and sea, and a lot more if taken around the Coromandel Peninsula), it is surprising that more obsidian from Waihi has not been recovered from the Raupa/Waiwhau/Opita area. It is possible that Waihi obsidian was not valued highly, because of its lower quality. Alternatively, this could mean that its presence results from casual/accidental encounters rather than the specific trade, or gift exchange, networks associated with the more established Mayor Island obsidian. This is even more likely for the more distant sources such as Great Barrier which are present only in very small quantities.

The relationships of other areas of the excavation to the occupations in the defended area are difficult to determine on the basis of obsidian alone as the quantity is generally much lower and the context much more disturbed. Square M is very similar to the earlier occupation of Opita, but it is almost as close to Waiwhau and could be related to either, temporally or spatially. The Trench B material is probably as early as anywhere on the site and could possibly even predate the earliest occupation layers in Square F as the nature of the obsidian is most like that at Raupa of anywhere in the excavation. As the identity of the features in Trench U remains unconfirmed, the relationship of the obsidian found there to the other Opita sites is still tenuous. Squares A and D would probably fall into the same category. Trench T and Area I have only scattered pieces of obsidian and therefore their associations with any particular occupation cannot be determined.

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Bibliography

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Best, S., 1980. Oruarangi Pa: Past and present investigations. New Zealand Journal of Archaeology, 2:65-91.

Green, R.C. 1963. *A Review of the Prehistoric Sequence in the Auckland Province*. New Zealand Archaeological Association Monograph 2.

Green, R.C., and K. Green, 1963. Classic and early European Maori sites on the Hauraki Plains. *New Zealand Archaeological Association Newsletter,* 6(1):27-34.

Moore, P.R., 1988. Physical characteristics of New Zealand obsidians and their use in archaeological sourcing studies. Unpublished report.

Moore, P.R., 1999. Whangamata obsidian, Coromandel Peninsula. *Archaeology in New Zealand*, 42:289-294.

Morwood, M.J., 1974. Experiments with obsidian: Functional and typological implications. Unpublished MA Research Essay, University of Auckland.

Neve, S.R., P.H. Barker, S. Holroyd, and P.J. Sheppard, 1994. Obsidian Sourcing by PIXE Analysis at AURA2. *New Zealand Journal of Archaeology*, 16:93-121.

Phillips, C., 1986. Excavations at Raupa Pa (N53/37) and Waiwhau village (N53/198), Paeroa, New Zealand, in 1984. *New Zealand Journal of Archaeology*, 8:89-113.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Phillips, C., and R.C. Green, 1991. Further archaeological investigations at the settlement of Waiwhau, Hauraki Plains. *Records of the Auckland Institute and Museum*, 28:147-183.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Prickett, N., 1992. Archaeological excavations at Raupa: The 1988 season. *Records of the Auckland Institute and Museum*, 29:25-101.

Steadman, L., 1988. Stone artifact analysis of the Waiwhau site, T13/756, Area 4. Unpublished research essay, Department of Anthropology, University of Auckland, Auckland.

Attachment 1: Obsidian Finds from the Opita Excavation

Number	*Area*	*Layer*	*Quad*	*Source*	*Use-wear*	*Cortex*	*Weight*
2	Trench T	S	30	Mayor Island	None	N	1.52
503	Trench T	S	30	Waihi	None	Y	0.42
504	Trench T	S	30	Waihi	None	N	0.16
4	Square A	T	C5	Waihi	Slight	Y	3.00
12	Trench T	S	20	Mayor Island	Slight	N	1.71
13	Trench T	C	95	Waihi	None	N	0.05
507	Trench T	S	109	Mayor Island	None	N	0.12
15	Trench T	C	110	Waihi	None	N	0.02
21	Trench T	C	102	Waihi	Definite	N	7.59
28a	Trench U	C	66	Mayor Island	None	N	0.61
28b	Trench U	C	66	Waihi	None	N	0.95
28c	Trench U	C	66	Waihi	Slight	N	0.82
29a	Trench U	C	68	Mayor Island	None	N	0.25
29b	Trench U	C	68	Mayor Island	None	N	0.25
31a	Trench U	C	77	Mayor Island	None	N	0.44
31b	Trench U	C	77	Mayor Island	Fragment	N	0.80
31c	Trench U	C	77	Waihi	Fragment	N	0.31
38	Trench T	C	116	Waihi	Slight	Y	1.51
44	Trench T	C	164	Waihi	Definite	Y	5.22
46	Square A	3	C6	Mayor Island	Slight	N	6.35
47	Trench B	C	26	Mayor Island	None	N.	2.61
51a	Trench B	C	26	Mayor Island	Core remnant	N	247.07
51b	Trench B	C	26	Mayor Island	Fragment	N	0.70
508	Trench B	C	26	Mayor Island	None	N	27.16
509	Trench B	C	26	Mayor Island	Core remnant	N	47.51
60	Trench C	7	3	Mayor Island	Fragment	N	0.41
66	Trench B	C	26	Mayor Island	Core remnant	N	20.86
70	Trench T	C	200	Waihi	None	Y	2.73
71	Trench T	C	195	Waihi	None	N	0.34
72	Trench T	C	184	Waihi	None	N	0.18
73	Trench T	C	188	Mayor Island	None	N	0.26
75	Trench T	C	200	Waihi	None	Y	0.29
77	Trench C	5	9	Mayor Island	None	N	1.75
87	Square D	C	B3	Gt Barrier	None	N	0.79
98	Square D	C	B5	"Grey"	None	Y	0.48
102a	Trench U	C	67	Mayor Island	Fragment	N	0.18
102b	Trench U	C	67	Waihi	None	N	0.02
102c	Trench U	C	67	Mayor Island	Fragment	N	0.15
102d	Trench U	C	67	Waihi	None	N	0.73
102e	Trench U	C	67	"Grey"	None	Y	0.46
103	Trench U	C	75	Gt Barrier	Definite	N	1.28
106a	Trench T	C	19	Mayor Island	Slight	N	0.66
106b	Trench T	C	19	"Grey"	None	N	0.22
112	Trench B	C	98	Mayor Island	None	N	0.38
116	Square D	C	C4	Waihi	None	N	1.21

Number	*Area*	*Layer*	*Quad*	*Source*	*Use-wear*	*Cortex*	*Weight*
117	Square D	C	C3	Waihi	Definite	N	3.52
119	Square D	C	B3	Mayor Island	Definite	N	6.63
122	Square D	C	A6	Mayor Island	Definite	N	0.77
123	Square D	C	B1	Waihi	None	N	0.58
124	Square D	C	D2	Waihi	Slight	N	1.11
130	Square D	C	B2	Waihi	Slight	N	2.53
146	Square D	C	A4	Waihi	None	N	2.04
231	Square I	C	A2	Mayor Island	Fragment	N	0.39
279	Square F	4	C4	"Grey"	Slight	Y	0.60
287	Square M	1	B1	Waihi	None	N	5.47
288a	Square M	1	B1	Waihi	None	N	0.38
312	Square F	5	C7	Mayor Island	Fragment	N	0.27
322	Square H	9	C14	Mayor Island	Definite	N	2.45
337	Square M	3	B 1	Mayor Island	None	N	4.92
338	Square F	4	B6	"Grey"	None	Y	0.15
339	Square F	4	B5	"Grey"	None	Y	1.03
340	Square F	4	B6	Mayor Island	Fragment	N	0.12
341	Square F	4	D4	Waihi	None	Y	0.61
364	Square M	4	S1	Mayor Island	None	N	0.25
365a	Square M	4	S1	Mayor Island	Core remnant	N	11.37
365b	Square M	4	S1	Mayor Island	Definite	N	2.15
365c	Square M	4	S1	Gt Barrier	None	N	0.44
365d	Square M	4	S1	Mayor Island	None	N	0.32
365e	Square M	4	S1	Waihi	None	N	0.21
365f	Square M	4	S1	Mayor Island	None	N	0.14
365g	Square M	4	S1	Mayor Island	None	N	0.05
365h	Square M	4	S1	Mayor Island	None	N	0.05
3651	Square M	4	S1	Mayor Island	None	N	0.02
365j	Square M	4	S1	Mayor Island	None	N	0.02
366a	Square M	4	S1	Waihi	None	N	5.14
366b	Square M	4	S1	Waihi	Slight	N	1.02
366c	Square M	4	S1	Mayor Island	None	N	0.23
367a	Square M	4	S2	Waihi	None	N	2.01
367b	Square M	4	S2	Mayor Island	Fragment	N	0.07
378	Square F	5	C6	Waihi	None	Y	3.80
393a	Square M	4	S3	Mayor Island	Definite	N	2.81
393b	Square M	4	S3	Mayor Island	Slight	N	0.65
393c	Square M	4	S3	Waihi	None	Y	0.52
394a	Square M	4	S2	Waihi	None	Y	2.98
394b	Square M	4	S2	Mayor Island	Slight	N	0.80
394c	Square M	4	S2	Waihi	Fragment	N	0.09
394d	Square M	4	S2	Mayor Island	Fragment	N	0.06
395	Square F	6	D5	"Grey"	None	N	1.54
396	Square F	6	D4	Mayor Island	Fragment	N	0.29
408a	Square F	6	B6	Mayor Island	None	N	0.13
408b	Square F	6	B6	Mayor Island	Fragment	N	0.44
408c	Square F	6	B6	Gt Barrier	None	Y	0.17

Number	*Area*	*Layer*	*Quad*	*Source*	*Use-wear*	*Cortex*	*Weight*
408d	Square F	6	B6	Mayor Island	None	N	0.10
408e	Square F	6	B6	Waihi	None	N	0.10
408f	Square F	6	B6	Mayor Island	None	N	0.10
408g	Square F	6	B6	Mayor Island	Fragment	N	0.15
411	Square F	6	B6	Mayor Island	Definite	N	1.66
414a	Square F	6	C7	Gt Barrier	Slight	N	1.36
414b	Square F	6	C7	Gt Barrier	None	N	0.44
414c	Square F	6	C7	Mayor Island	None	Y	1.35
414d	Square F	6	C7	Waihi	None	Y	0.33
416	Square H	5	D17	Mayor Island	None	N	1.00
417	Square H	5	C16	Mayor Island	Slight	N	1.04
418	Square H	5	C17	Mayor Island	Slight	N	3.59
427a	Square F	6	C4	Gt Barrier	None	N	0.62
427b	Square F	6	C4	Mayor Island	None	N	0.26
428	Square F	6	B6	Mayor Island	None	N	0.80
439	Square F	7	D7	Mayor Island	Definite	N	0.57
440	Square F	7	D6	Waihi	Definite	N	7.28
441	Square F	7	C7	Mayor Island	Definite	N	3.15
446a	Square F	8	C7	Mayor Island	None	Y	3.60
446b	Square F	8	C7	Mayor Island	Slight	N	5.17
446c	Square F	8	C7	Waihi	Slight	N	1.91
446d	Square F	8	C7	Mayor Island	Slight	N	3.80
446e	Square F	8	C7	Mayor Island	None	N	2.56
446f	Square F	8	C7	Waihi	None	Y	2.59
446g	Square F	8	C7	Mayor Island	None	N	1 .19
446h	Square F	8	C7	Waihi	None	Y	0.89
446i	Square F	8	C7	Waihi	Slight	Y	0.77
446j	Square F	8	C7	Waihi	None	N	0.40
446k	Square F	8	C7	Mayor Island	Fragment	N	0.31
446l	Square F	8	C7	Mayor Island	None	N	0.18
446m	Square F	8	C7	Waihi	None	Y	0.15
450	Square H	7	C17	Mayor Island	None	N	0.15
451	Square H	7	B16	Mayor Island	None	N	0.68
452a	Square F	7	B7	"Grey"	None	Y	1.20
452b	Square F	7	B7	Waihi	None	Y	1.39
470	Square F	7	D7	Waihi	None	Y	14.10
471a	Square F	7	B7	Mayor Island	Slight	N	0.79
471b	Square F	7	B7	Mayor Island	Slight	N	1.00
472a	Square F	7	B6	Mayor Island	Definite	N	5.41
472b	Square F	7	B6	Mayor Island	Definite	N	3.88
472c	Square F	7	B6	Waihi	Slight	N	2.80
472d	Square F	7	B6	Waihi	None	Y	2.22
472e	Square F	7	B6	Waihi	None	N	2.06
472f	Square F	7	B6	Mayor Island	Definite	N	139.00
472g	Square F	7	B6	Waihi	None	N	1.05
472h	Square F	7	B6	Mayor Island	None	N	1.00
472i	Square F	7	B6	Mayor Island	None	N	0.38

Number	*Area*	*Layer*	*Quad*	*Source*	*Use-wear*	*Cortex*	*Weight*
472j	Square F	7	B6	Mayor Island	None	N	0.34
472k	Square F	7	B6	Mayor Island	None	N	0.08
473a	Square F	7	D7	Mayor Island	None	Y	0.33
473b	Square F	7	D7	Mayor Island	None	N	0.85
474	Square F	7	D5	Mayor Island	None	N	0.09
475	Square F	7	B7	Gt Barrier	Definite	N	2.60
477	Square H	7	C16	Waihi	None	N	1.86
502	Trench T	C	138	Mayor Island	None	N	1.22
510	Square F	4	B6	Mayor Island	Slight	N	0.79
511a	Square F	6	B4	Mayor Island	Definite	N	1.60
511b	Square F	6	B4	Mayor Island	Slight	N	1.23
511c	Square F	6	B4	Mayor Island	None	N	0.37
511d	Square F	6	B4	Mayor Island	Fragment	N	0.37
511e	Square F	6	B4	Waihi	None	N	0.18
512a	Square M	4	S 1	Waihi	None	N	0.24
512b	Square M	4	Sl	Mayor Island	None	N	0.15
513a	Square F	6	C6	Waihi	None	Y	4.22
513b	Square F	6	C6	Waihi	None	N	0.22
513c	Square F	6	C6	Mayor Island	None	N	0.21
513d	Square F	6	C6	Mayor Island	None	N	0.33
513e	Square F	6	C6	Mayor Island	None	N	0.52
514a	Square M	4	S3	Mayor Island	Slight	N	0.48
514b	Square M	4	S3	Mayor Island	None	N	0.14
550a	Square F	6	B4	Mayor Island	None	N	0.27
550b	Square F	6	B4	Waihi	Fragment	Y	0.19
550c	Square F	6	B4	Mayor Island	None	N	0.12
550d	Square F	6	B4	Mayor Island	None	N	0.07
550e	Square F	6	B4	Mayor Island	None	N	0.07
550f	Square F	6	B4	Mayor Island	None	N	0.06

Key: 'S' = spoil, 'C' = cultural layer, 'T' = topsoil, Quad = quadrant within the square, or distance along trench

The visual sourcing of obsidian using the physical characteristics (Moore 1988) of colour, lustre, fracture, translucency and flow banding has proved to be very useful for some sources. This technique requires familiarity with the various physical characteristics of obsidian and access to adequate reference materials from known source deposits. It is particularly difficult to identify the source of very small flakes in this way since the procedure relies on the presence of distinguishing characteristics and not on their absence.

The ideal method of elemental analysis would be one that is not destructive or damaging. It would require the minimum of sample preparation, be applicable to samples of a variety of sizes and shapes, capable of determining elemental concentrations for a wide range of elements, sufficiently precise in the results produced, and able to distinguish between different source deposits. It would be reasonable in its cost and availability and, finally, because of the large number of obsidian artefacts available for study, it would also be fast in analysis.

Elemental analysis by proton induced x-ray emission (PIXE) satisfies all these requirements. The technique uses a beam of protons to eject inner-shell electrons from atoms in the target material, and does no damage to the sample. When outer-shell electrons fill these resulting vacancies in the inner-shell, characteristic x-rays are emitted. These x-rays have energies which identify the particular atom in the material, and it is therefore possible to calculate the elemental concentrations in the material by detecting and counting these characteristic x-rays.

This paper presents information on the development of the AURA2 PIXE database of New Zealand obsidian sources, along with results obtained by application of PIXE to samples from an archaeological site in the Hauraki Plains, approximately 70 km south-east of Auckland. Samples weighing from 0.15 g to 247.07 g and of a variety of shapes have been analysed, and a discrimination has been made among samples originating from Mayor Island.

Seventy-six [1] of the artefacts recovered from the Opita site were analysed using PIXE. They ranged in size from one that weighed 0.15 g and had approximate dimensions of 15 mm x 8 mm x 1 mm, to one that weighed 247.07 g with dimensions of 80 mm x 60 mm x 50 mm. The remaining artefacts were beyond the size limits previously stated and were not able to be analysed with any confidence with the beam of 3 mm diameter being used at the time….

The majority of the artefacts were sourced to either Mayor Island or Waihi, with a smaller number to Coromandel sources. None of the artefacts appear to originate from Te Ahumata or Awana on Great Barrier. Of the eight artefacts visually sourced to Great Barrier, six have now been sourced to the Onemana/Whangamata region and two to Waihi….

Of the 27 artefacts originally sourced to Waihi, 26 were confirmed as coming from that source and one was sourced to Onemana/Whangamata. On rechecking, this piece was shown to have been misrecorded in the original analysis as it was clearly of similar apearance to the other material. The seven 'grey' artefacts were all sourced to the Coromandel region: three to Onemana/Whangamata, two to Waihi and two to Cooks Bay/Purangi.[2]

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1 This represents 45% of the total obsidian collection from Opita, of which all but one of the eight originally identified as 'Grey', all of the eight identified as Great Barrier, 27 of the 55 identified as Waihi and 34 of the 97 idenfied as Mayor Island were analysed using PIXE (note from Caroline Phillips).

2 The Purangi source does not exist, but is just part of Cooks Beach; Onemana has been amalgamated with Whangamata (Moore pers. comm., 1999: 289-294).

…of the 34 artefacts originally sourced to Mayor Island, 33 were confirmed as coming from that source….

In conclusion, the Opita obsidian artefacts were shown to be from Cooks Bay/Purangi, Onemana/Whangamata, Waihi and the specified regions on Mayor Island, all of which are in close proximity to Opita. The general characteristics of the obsidian recovered from the site and analysed at the AURA2 PIXE facility are summarised in Tables 6 and 7. In Table 6, the sources of the obsidian from Square F, Square H and Trench C in T13/789 have been differentiated by the phase of occupation previously proposed. Table 7 indicates the distribution and frequency of artefacts from the different obsidian sources throughout all excavation areas of the site. Mayor Island and Waihi were the major sources of the obsidian artefacts found in the site.

Table 6. The sources of the artefactual obsidian recovered from Square F, Square H and Trench C in T13/789 [weight in grams – table redrafted Caroline Phillips].

Phase	*Layer*	*Mayor Island*		*Waihi*		*Cooks Bay/ Purangi*		*Onemana/ Whangamata*		*Total*	
		No.	*Wt.*	*No.*	*Wt.*	*No.*	*Wt.*	*No.*	*Wt.*	*No.*	*Wt.*
I	8	5	16.32	2	4.50					7	20.82
II	7	6	16.03	7	30.54			3	6.02	15	50.73
II	6	4	5.84	3	5.93			3	2.42	10	14.19
III	5	4	7.38	1	3.80					5	7.41
III	4	1	2.35			1	1.03	1	0.15	3	9.16
Total		**20**	**47.92**	**13**	**44.77**	**1**	**1.03**	**7**	**8.59**	**41**	**102.31**

Table 7. The sources of the artefactual obsidian recovered from the site areas [weight in grams – table redrafted Caroline Phillips].

Excavation Areas	*Mayor Island*		*Waihi*		*Cooks Bay/ Purangi*		*Onemana/ Whangamata*		*Total*	
	No.	*Wt.*	*No.*	*Wt.*	*No.*	*Wt.*	*No.*	*Wt.*	*No.*	*Wt.*
T13/788	4	16.21	8	14.68	1	0.22			13	31.11
Trench T	1	1.22	4	17.05					5	18.27
T13/324	5	345.21					2	1.74	7	346.95
T13/789	24	69.17	18	61.39	1	1.03	8	9.03	51	140.62
Total	**34**	**431.81**	**30**	**93.12**	**2**	**1.25**	**10**	**10.77**	**76**	**536.95**

Attachment 3: Comparison between Holroyd 1991 and PIXE Analysis

The attached table shows the changes between the identifications in the original Holroyd paper using Moore's (1988) protocols and the PIXE analysis. In this the names used are Cooks Beach and Whangamata in line with the more recent studies.

Artefact No.	*Location*					*Source*	
	trench	*distance*	*square*	*layer*	*quad*	*Holroyd/Moore*	*PIXE*
2	T	30		S		Mayor Island	Mayor Island
4			A	T	C5	Waihi	Waihi
12	T	20		S		Mayor Island	Mayor Island
21	T	102		C		Waihi	Waihi
38	T	116		C		Waihi	Waihi
44	T	164		C		Waihi	Waihi
46			A	C	C6	Mayor Island	Mayor Island
47	B	26		C		Mayor Island	Mayor Island
51a	B	26		C		Mayor Island	Mayor Island
66	B	26		C		Mayor Island	Mayor Island
70	T	200		C		Waihi	Waihi
77	C	9		5		Mayor Island	Mayor Island
87			D	C	B3	Great Barrier	Waihi
98			D	C	B5	"Grey"	Waihi
102e	U	67		C		"Grey"	Whangamata
103	U	75		C		Great Barrier	Whangamata
106b	T	19		C		"Grey"	Cooks Beach
116			D	C	C4	Waihi	Waihi
117			D	C	C3	Waihi	Waihi
119			D	C	B3	Mayor Island	Mayor Island
124			D	C	D2	Waihi	Waihi
130			D	C	B2	Waihi	Waihi
146			D	C	A4	Waihi	Waihi
287			M	1	B1	Waihi	Waihi
322			H	ditch fill	C14	Mayor Island	Mayor Island
337			M	3	B1	Mayor Island	Mayor Island
338			F	4	B6	"Grey"	Whangamata
339			F	4	B5	"Grey"	Cooks Beach
365a			M	4	S1	Mayor Island	Mayor Island
365b			M	4	S1	Mayor Island	Mayor Island
365c			M	4	S1	Great Barrier	Whangamata
366a			M	4	S1	Waihi	Waihi
366b			M	4	S1	Waihi	Waihi
367a			M	4	S2	Waihi	Waihi
378			F	5	C6	Waihi	Waihi
393a			M	4	S3	Mayor Island	Mayor Island
394a			M	4	S2	Waihi	Waihi
395			F	6	D5	"Grey"	Waihi
408c			F	6	B6	Great Barrier	Waihi
411			F	6	B6	Mayor Island	Mayor Island
414a			F	6	C7	Great Barrier	Whangamata

– *continued over page*

Artefact No.	*Location*					*Source*	
	trench	*distance*	*square*	*layer*	*quad*	*Holroyd/Moore*	*PIXE*
414b			F	6	C7	Great Barrier	Whangamata
414c			F	6	C7	Mayor Island	Mayor Island
416			H	7	D17	Mayor Island	Mayor Island
417			H	7	C16	Mayor Island	Mayor Island
418			H	7	C17	Mayor Island	Mayor Island
427a			F	6	C4	Great Barrier	Whangamata
440			F	7	D6	Waihi	Waihi
441			F	7	C7	Mayor Island	Mayor Island
446a			F	8	C7	Mayor Island	Mayor Island
446b			F	8	C7	Mayor Island	Mayor Island
446c			F	8	C7	Waihi	Waihi
446d			F	8	C7	Mayor Island	Mayor Island
446e			F	8	C7	Mayor Island	Mayor Island
446f			F	8	C7	Waihi	Waihi
446g			F	8	C7	Mayor Island	Mayor Island
452a			F	7	B7	"Grey"	Whangamata
452b			F	7	B7	Waihi	Waihi
470			F	7	D7	Waihi	Waihi
471b			F	7	B6	Mayor Island	Mayor Island
472a			F	7	B6	Mayor Island	Mayor Island
472b			F	7	B6	Mayor Island	Mayor Island
472c			F	7	B6	Waihi	Waihi
472d			F	7	B6	Waihi	Whangamata
472e			F	7	B6	Waihi	Waihi
472f			F	7	B6	Mayor Island	Mayor Island
472g			F	7	B6	Waihi	Waihi
472h			F	7	B6	Mayor Island	Mayor Island
475			F	7	B7	Great Barrier	Whangamata
477			H	7	C16	Waihi	Waihi
502	T	138		C		Mayor Island	Mayor Island
508	B	26		C		Mayor Island	Mayor Island
509	B	26		C		Mayor Island	Mayor Island
511a			F	6	B4	Mayor Island	Mayor Island
511b			F	6	B4	Mayor Island	Mayor Island
513a			F	6	C6	Waihi	Waihi

Appendix 3 Hangi Stones – Analysis

Caroline Phillips, Martin Jones and Jacki MacDonald

Introduction

Stones gathered from the Opita sites that were used, or intended to be used, as hangi stones occurred in the deposits as single stones, in clusters, or within the shell midden layers. There were 48 bags of individual and groups of stones collected from the sites. Another three bags were recovered later from whole midden samples.

The analysis below relates to 39 of the bags collected on site in which there were 220 stones, plus those 472 stones separated out from the three midden samples. Research questions of this material included:

1. Where was the rock sourced from?
2. Were stones selected according to size and stone type?
3. Did the numbers of hangi stones vary over the sites?
4. Did the proportions of different stone types vary?
5. Were there changes over time?
6. How many stones had been previously used?
7. At what size were the stones discarded?

Collection Strategies

Collection from the Sites

The aim was to collect all the stones that were in groups, as they were thought more likely to have been intentionally brought to the site. Single stones were also collected at times. Stones were also recovered from the whole midden samples in the laboratory during the analysis phase (Table 1).

Table 1. Location of collected stones and sample types from the archaeological sites.

Location			*Sample Type*		
Area	*Layer*		*Group*	*Individual*	*Midden*
D	3	west end Trench T	21	2	0
T	3	near Square E	0	4	0
U	various	60-76 m from the south end	7	2	0
TP20	4	60-76 m from the south end	0	1	0
C	5	near Square F	7	1	0
F	3	near Square H & Trench C	0	2	0
F	4	near Square H & Trench C	74	0	132
F	6	near Square H & Trench C	17	0	219
F	7	near Square H & Trench C	17	0	0
F	8	near Square H & Trench C	0	1	0
H	3	near Square F & Trench C	15	0	0
H	5	near Square F & Trench C	13	0	0
S	2	beside Trench B	0	2	0
B	3	near Square M	26	3	0
M	4	east end of Trench B	5	0	121
Total			**202**	**18**	**472**

This strategy was not uniform throughout the sites investigated. Those in Square F were more frequently collected as Jones was excavating in that square, therefore the proportions of stone types and sizes collected from this square are probably a better representation of hangi stones and fragments at the site.

Collection from Local Sources

The Opita location did not naturally contain any rock, the nearest location of suitable stone was the Ohinemuri River, upstream from Paeroa. The first place where stones could have been easily collected by inhabitants of Opita was the lowest of the three sets of rapids; from there canoes could have been loaded and paddled down to the sites, whereas collection from the upper rapids would have involved carrying the stones past the rapids (Figure 1).

As part of this analysis, stones were collected from three different parts of the Ohinemuri. Within each of the three rapids, six random samples were taken from a 25 x 25 cm square. All the stones that projected half way or more into the square were collected. These samples were sub-sampled in the Department of Anthropology laboratory by spreading them out and taking six 5 x 5 cm squares (Table 2).

Table 2. Location of local stones analysed (see map Figure 1).

Location		*Number*
Rapid	*Description*	*individuals*
1	11.2 km along the river from the sites	**26**
2	14.3 km along the river from the sites	**43**
3	16.6 km along the river from the sites	**22**

Analysis

The stones from the sites (groups, individual finds and from midden analysis) as well as those collected from the potential local sources were subjected to a series of analyses including: measuring the weights, visual description, sourcing the rock types, and ascertaining whether the stones had been heated. All details are included in the Attachments.

Measurement

Weight is a measurement that equates to size, and is much easier to calculate. Volume was also calculated by Jones and MacDonald for the stones collected in groups and individually, but not those found within the midden. Here only weights are considered as all the stones were weighed.

The weights were calculated by putting each sample in a beaker of water and measuring their displacement in millilitres and change in weight in grams (see data in Attachments 1, 2 and 3).

Each stone from the sites was labelled, prefixed with the find number and suffixed with its position in the group (i.e. 108.3). The river stones were labelled according to their collection point (rapid 1, 2 or 3) and position within the group (i.e. 1.3).

The weights and standard deviations of river stones are shown in Table 3, while those of the groups and the midden stones are in Table 4. Graphs comparing the weights of both are in Figure 2.

There is no difference between the weights of the stones from rapids 1 and 2, and minimal difference between them and the highest rapid sampled.

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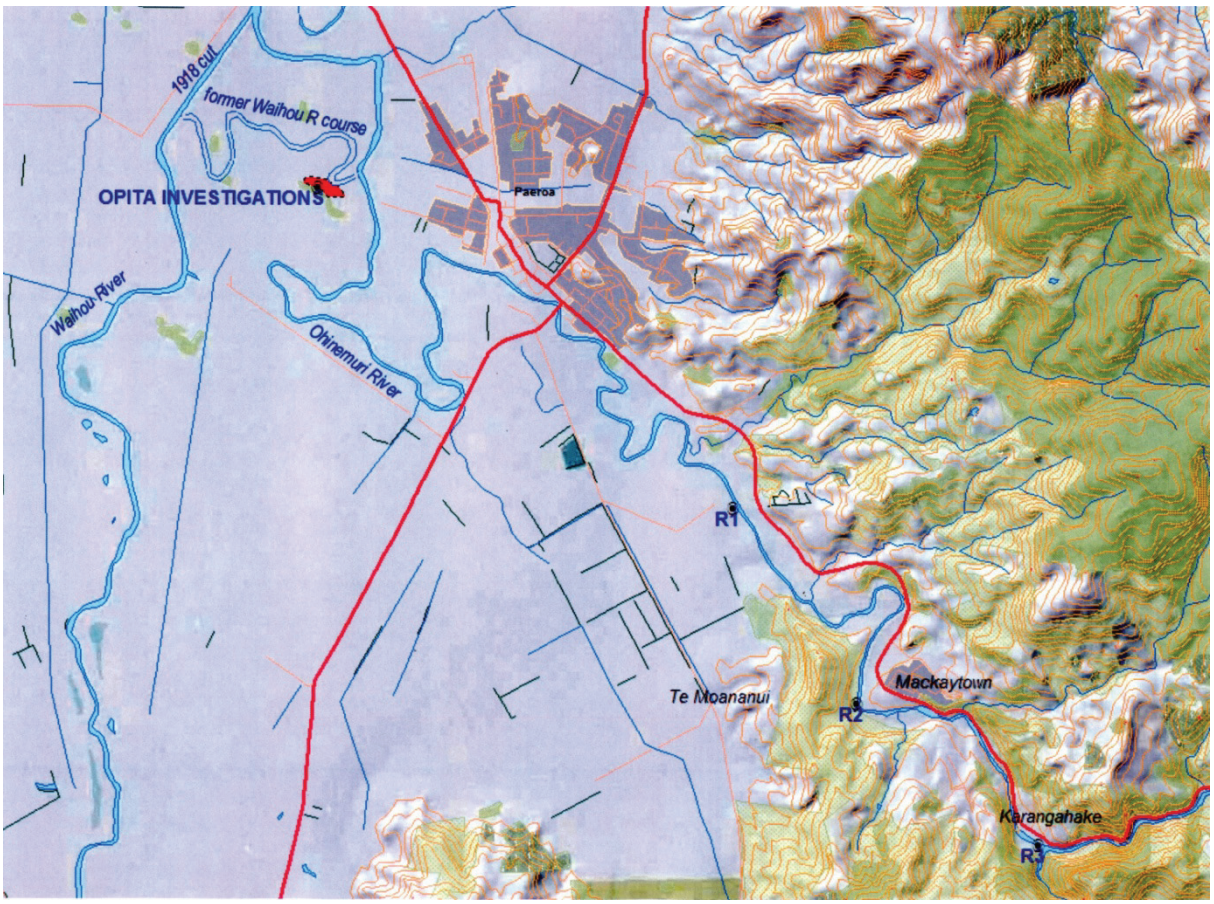


Figure 1. Map showing locations of river stone sources at rapids R1, R2 and R3 in relation to the Opita investigations

Table 3. Weight of stones (in grams) from the river sources.

Rapid	*Number of stones*	*Weight mean*	*s.d.*	*Weight Range*	
1	26	78.38	76.48	10.00	360.00
2	43	78.09	64.36	2.00	290.00
3	22	102.05	86.72	10.00	340.00

Although the standard deviations are high, there is a clear difference between the three sets of stones. The midden samples start much smaller, and have a much smaller mean than the other recovered hangi stones. In turn, the mean weight of the groups and individuals is generally smaller than the river stones, but the range of weights is very similar. These figures are more easily portrayed in graph form (see Figures 2-4).

Table 4. Weight of stones (in grams) from the investigated sites (Trenches C, T and U, Square F layers 3 & 8, Squares M and S, TP20 are not included here due to their small sample sizes).

Location	*Sample*	*Type*	*Number*	*Weight (g)*		*Weight Range*	
Area	*Layer*		*stones*	*mean*	*s.d.*		
B	3	group & individual	29	138.69	112.96	5.00	460.00
M	4	midden	121	9.65	16.05	0.70	117.15
F	4	group	74	45.54	41.07	3.00	270.00
		midden	131	12.05	17.67	1.05	85.08
F	6	group	17	46.76	56.95	6.00	235.00
		midden	219	17.07	48.80	0.54	435.00
F	7	group & individual	17	88.41	77.67	20.00	270.00
D	3	group & individual	23	27.09	24.26	3.00	115.00
H	3	group & individual	15	59.00	29.71	5.00	120.00
H	5	group	13	26.08	22.70	4.00	80.00

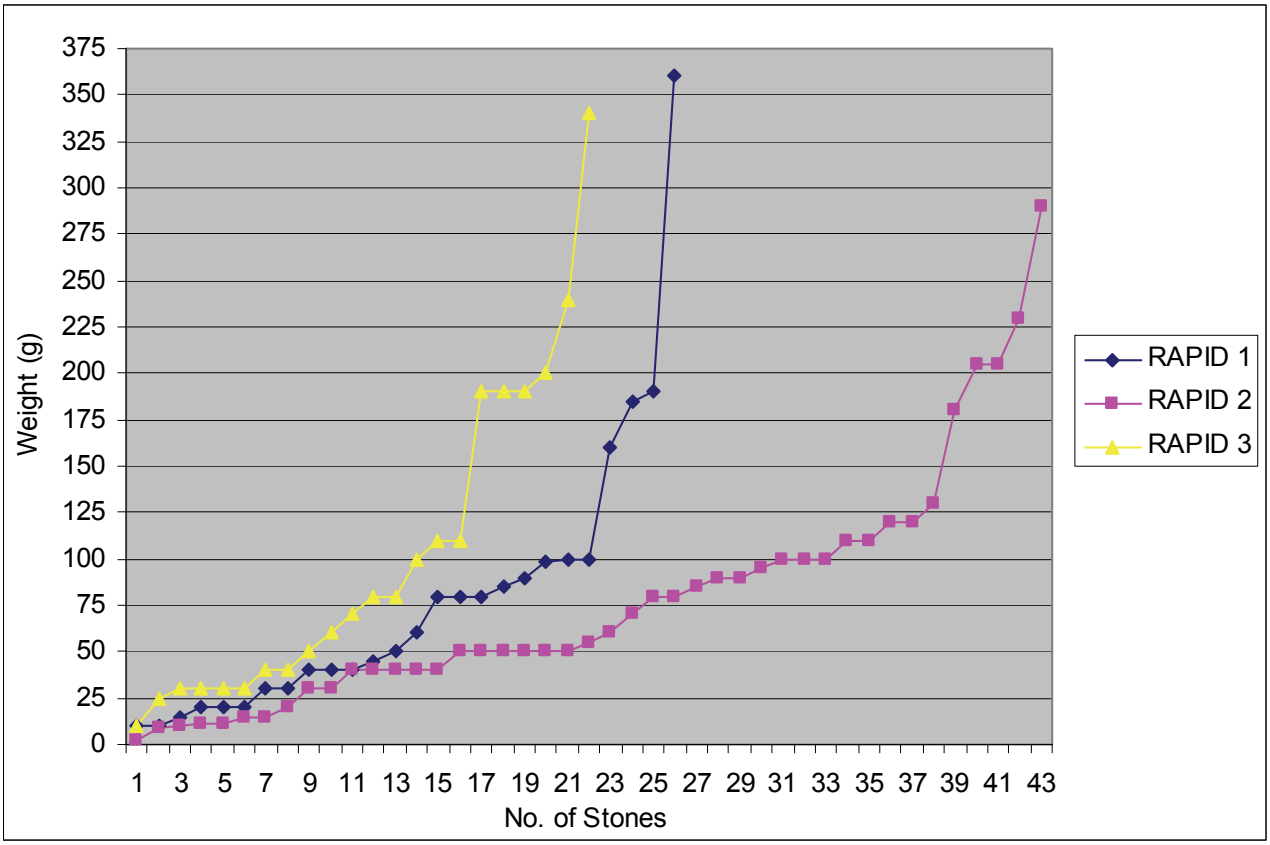


Figure 2. Graph of weights of stones (in grams) found in the river (see Table 3 & Attachment 2).

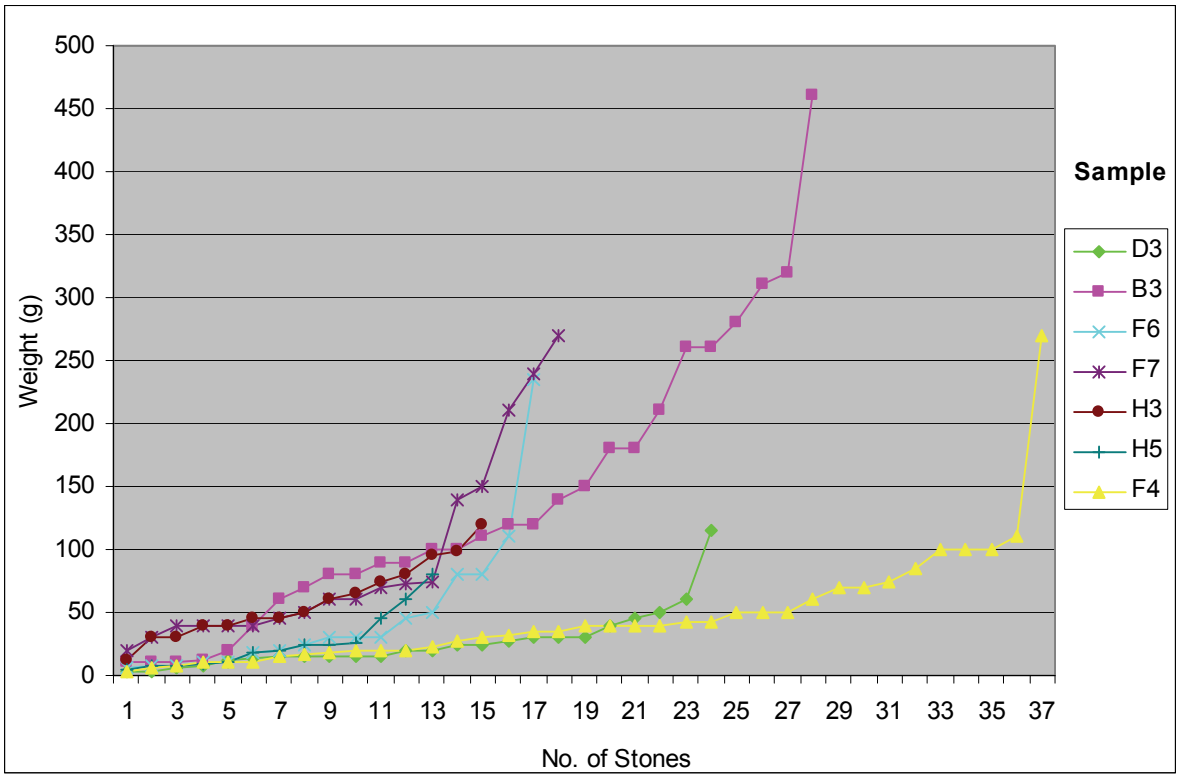


Figure 3. Graph of weights of groups and individual stones (in grams) found in the investigations (Table 4 & Attachment 1).[1]

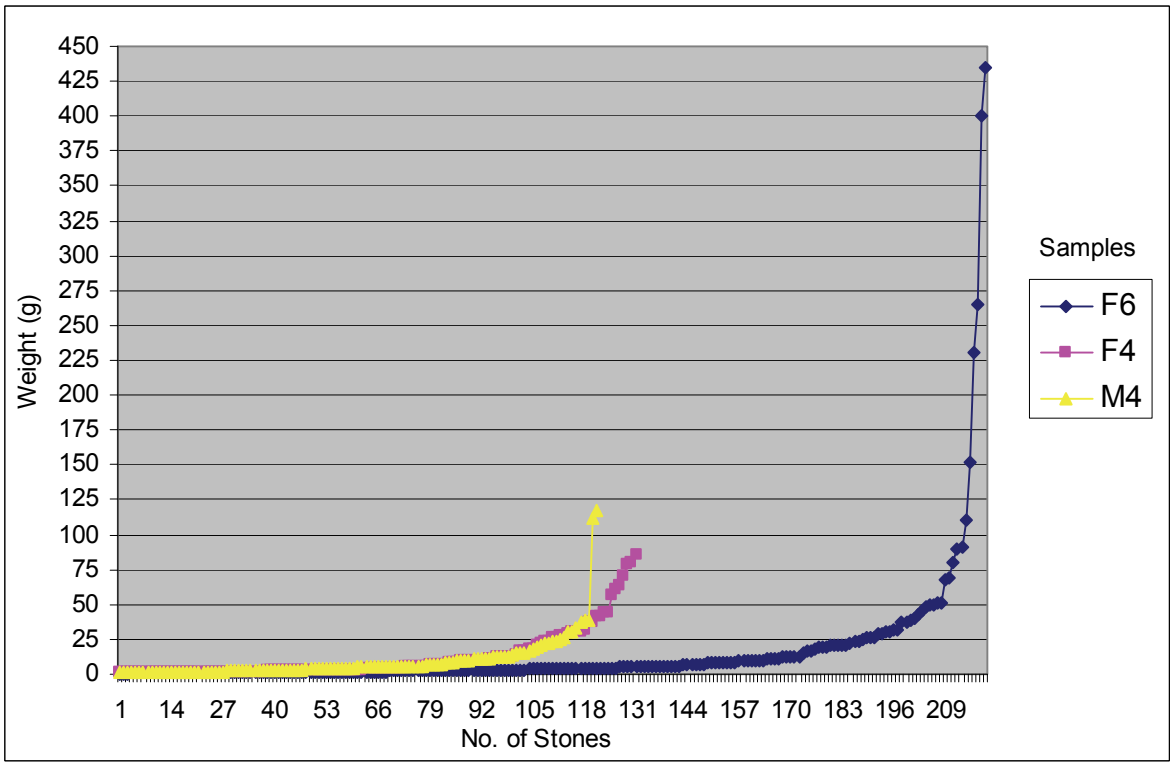


Figure 4. Graph of weights of hangi stones found in the middens (see Table 5 & Attachment 2).

1 Due to the size of the F4 samples in comparison to the others, only every other one by weight is incorporated in Table 3.

Description

Twelve of the 22 groups of stones that were collected from the sites were described according to their visual characteristics (Table 5).

Table 5. Description of 12 of the groups of stones recovered from the investigated sites.

Area	*Layer*	*Find No.*	*No. of stones*	*Description*
C	5	90	3	Medium size, angular. One has river rolled surfaces. All had small amounts of residue charcoal and soil. Fractured river rock.
C	5	91	4	Medium size, show smooth river-rolled surfaced. All have residue carbon. Fractured river rock.
B	2	108	16	Medium to large size, all fractured river rock with residue carbon except one.
B	2	107	4	Medium size. All have river-rolled surfaces as well as angular surfaces. Carbon residue evident.
B	2	109	7	Medium to small size, all extensively covered in charcoal-rich soil and shell fragments. All except one have river-rolled surfaces.
M	4	363	5	Medium-small size. River-rolled stones with smooth fracture faces and rich charcoal and midden residue. Could all be from one stone.
F	4	211	15	Medium to small size. One third appear to have river-rolled surfaces. Angular fracture surfaces. Carbonised remains on majority of stones.
F	4	386	14	Medium to small sized. Half show river-rolled surfaces. All fractured with angular surfaces with carbon deposits.
F	4	384	8	Medium sized, all have river-rolled surfaces, 4 are virtually un-fractured. Carbon deposits evident.
F	4	486	20	Large to small size range. Majority have river-rolled surfaces, all have angular edges too. Rich carbon deposits.
F	6	482	6	Large to very small size. All have river-rolled surfaces. Charcoal deposits on some of the rocks.
D	3	120	17	Medium to small sized. Almost all have weathered river-rolled surfaces. Little carbon deposits on a few stones.

Sourcing

The majority of the stones (73%) that were found in groups and individually were bisected to view the internal structure of the rock. None of the midden rocks were identified. The stones were then split into "look-alikes" and with the help of the Department of Geology, University of Auckland, were identified according to various types.

In total, nine rock types were found in both the river and the sampled collections from the sites[2] (see Table 6). Note that type B was subdivided into B1 and B2 within the site samples, but not in the river stones (see Attachments 1-3).

2 This total does not include adze, chisel, grindstone, flakes and other artefacts as they were not part of this analysis.

Table 6. Identification of stone types.

A	*Basaltic andesite with plagioclase, olivine and two types of pyroxites*
B1	*Pyroxitic andesite with plagioclase*
B2	*Pyroxitic andesite, fresh, quite glassy with plagioclase*
D	*Almost scoria-like andesite*
E	*Highly altered type B1*
F	*Lithified sedimentary tuff*
G	*Highly altered basaltic andesite*
H	*Indurated slicified tuff*
Q	*Quartz*

Five different types of stone were identified from the river (Table 7). The presence of the quartz rocks may be the result of gold mining from the late nineteenth century in several locations along the river, and may not have originally been present as a source of stone. No quartz stones were found in the sites. Consequently these are not included later in this analysis.

Table 7. Stone types from the river samples.

Rapid	*No. of stones*	*Stone Type*				
		A	*B*	*F*	*G*	*Q*
1	26	9	4	8	4	1
2	43	17	5	15	3	3
3	22	20	2	0	0	0
Total	**91**	**46**	**11**	**23**	**7**	**4**

Again the stones from rapids 1 and 2 are very similar, however the third rapid is very different with fewer range of stone types and greater proportion of type A stones. This may be due to the Waitawheta Stream, which enters the Ohinemuri at this point.

The same types of rock were found on the sites with the addition of a few others, such as andesite, sedimentary and indurated tuff (types D, E & H). Pumice and sandstone were originally included in the samples viewed, but these have been removed from the analysis as they are regarded as grinding stones (Table 8).

Type A is by far the most abundant stone type on the site at 56% (89 of the 160 identified stones), and if type B1 and B2 are combined they total 33%. All the stone types, except for the two introductions (type H and I) could have been sourced from the Ohinemuri River. In the river samples 1 and 2, type A is 40%, but type B is only 14%, with types F and G being more common than in the sites.

Pie diagrams showing the proportion of the different rock types in all but the very small site samples and the river sources are shown in Attachment 5.

Table 8. Stone types from groups and individual stones from the investigated sites.

Location		Sample	Number	Stone Type								
Area	Layer	Type	stones	A	B1	B2	D	E	F	G	H	unid
C	5	group	7	5	1	1						0
		random	1									1
B	3	group	27	10	10	5	1					1
		random	2	1						1		0
M	4	group	5			5						0
		random	0									0
F	3	group	0									0
		random	2									2
F	4	group	74	32	15	3	2	1	1	1	9	10
		random	0									0
F	6	group	17	10	2							5
		random	0									0
F	7	group	17	6								11
		random	1									1
D	3	group	21	9	6	1		1		1		3
		random	2	1								1
H	3	group	15		3							12
		random	0									0
H	5	group	13	7								6
		random	0									0
TP20	4	group	0									0
		random	1	1								0
T	3	group	0									0
		random	4	3								1
S	2	group	0									0
		random	2									2
U	1-3	group	7	2	1							4
		random	2	2								0
Total			**220**	**89**	**38**	**15**	**3**	**2**	**1**	**3**	**9**	**60**

Heating

Two methods were used in order to identify whether the stones had been subjected to heating, and therefore been used as hangi stones: colour change and fracturing.

Those stones which had been cut were examined to see if there was a difference between the colour on the outside from the inside. A colour change was assumed to be due to oxidisation and reduction processes caused by heating. Fracturing is another positive sign that the stone has been heated.

A total of 41 stones was examined from the total of 200 collected in groups and found individually. Of these 25 (61%) were found to have signs of heating (Table 9, Attachment 4).

Variations between areas and layers were not significant due to the small sample sizes – none reaching to more than 7 in any sample. What the results do indicate is that at least some of the stones found in groups had been used in a hangi.

Table 9. Evidence of heating in a selection of examined stones.

Location		*Sample*	*Examined*	*Heating*
Area	*Layer*	*Type*		
F	4	group	7	2
		random		
F	6	group	6	3
		random		
F	7	group	6	3
		random		
D	3	group	1	1
		random	1	1
H	3	group	3	3
		random		
H	5	group	8	6
		random		
TP20	4	group		
		random	1	1
T	3	group		
		random	2	1
U	1-3	group	3	2
		random	2	2
Total			**35**	**21**

Discussion

Each of the questions raised at the beginning will be discussed in turn.

Source of hangi stones

All the stones could have come from the first rapid in the Ohinemuri River.

Selection by size and type

The size range in the river is within the range of the stones found in groups on the site (Figure 5). It should be noted that some of those found in the sites had been through a fire and may not have been the original size.

The types do appear to have been selected. A comparison of the pie graphs from the whole of the investigations, without the introduced ballast and slag, compared to that from the first rapid are shown in Figure 6. Types A and B (B1 and B2) seem to have been the most preferred stone, while types F and G that are very common in the river were almost incidental within the samples collected on the site.

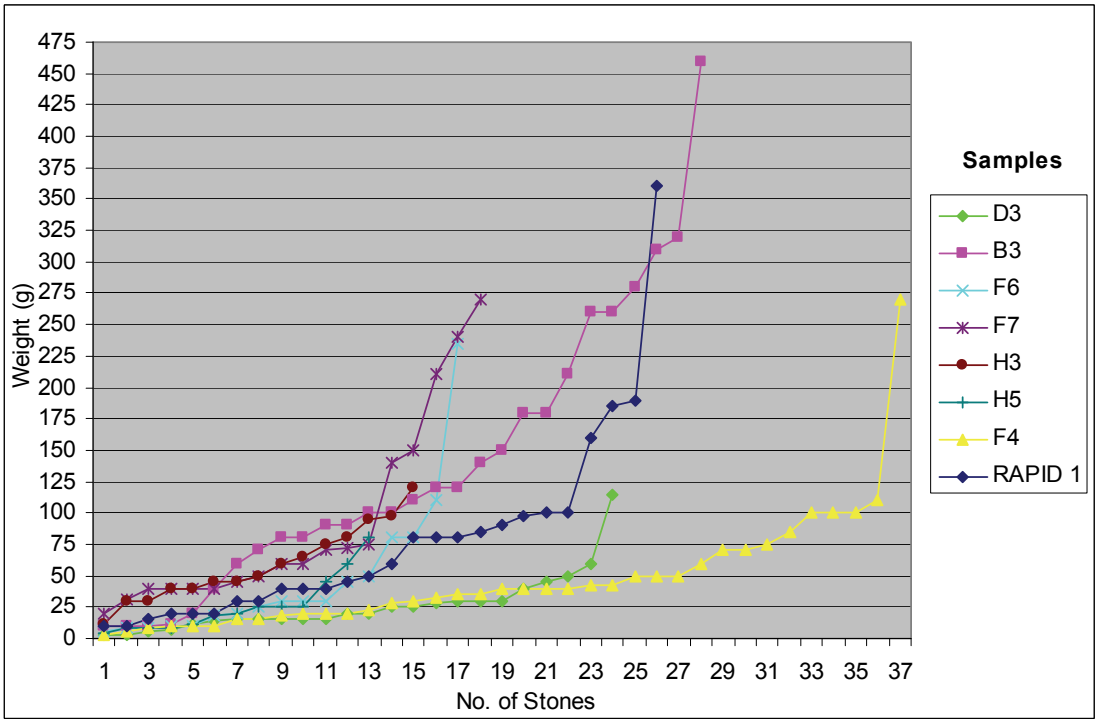


Figure 5. Stone size by weight in grams found in groups in the investigations compared with the size range found at Rapid 1 in the Ohinemuri River.

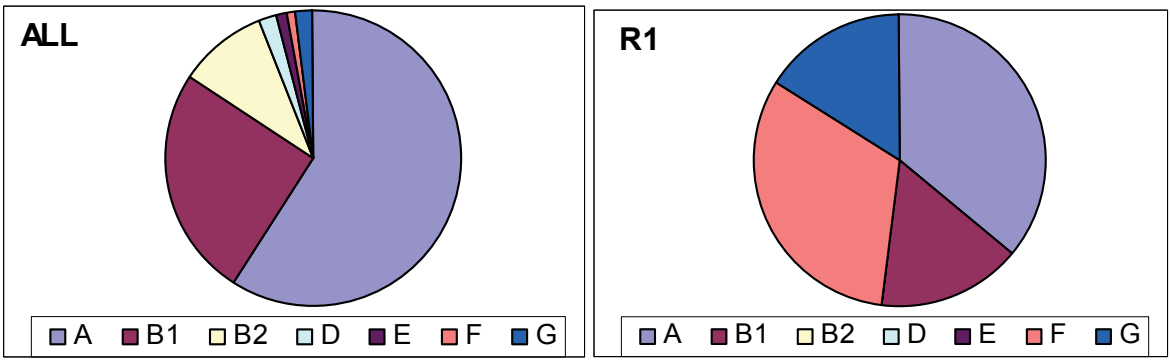


Figure 6. Left: All identified stones collected from local sources, n = 151 (omitting the single cluster of indurated tuff – type H). Right: Rapid 1, n = 25 (the single quartz rock has not been included, as none appeared in the site).

Variation in numbers over the investigations

There were four areas where archaeological evidence was discovered, but comparisons were difficult for various reasons.

In Squares A/D and the west end of Trench T: hangi stones were found in Square D, but no midden was located. It may be that it was outside the area of investigation.

In Square E and the centre of Trench T, again no midden was located but there were hangi stones found nearby in Trench T.

In Square M and the east end of Trench B, midden was located in the excavated square and a few collections of stones in the nearby trench.

However, in Trench C, Square F and H, large numbers were recovered from three different phases, though principally in the two lower layers associated with midden. This was the major focus for the excavation and Martin Jones worked in Square F and ensured that all the stones were collected. All these factors probably affected the differential collections.

Proportions of different stone types in area and through time.

In many areas the numbers of stones found were too small to make any comments regarding the different stone types, however in three of the areas and two of the phases some suggestions can be made (see Figures 6 and 7; Attachment 4).

In Square D, half the stone was type A, more than a quarter was type B1 and the remainder was made up of B2, E and G. In Square M and Trench B nearly a third was made up of types A, B1 and B2 (Figure 6).

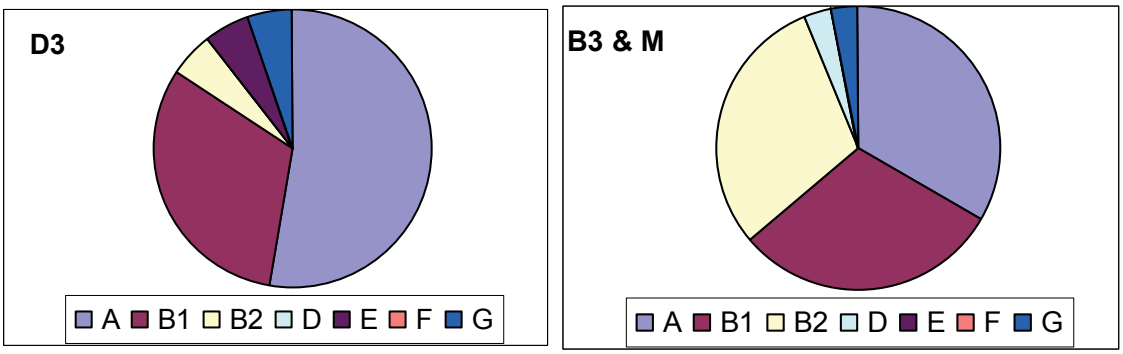


Figure 7 Proportions of stones found in Square D layer 3 (n = 19), and Trench B layer 3 and Square M combined (n = 34).

In Squares F and H, and Trench C in layer 4, almost two thirds are type A, one quarter type B1 with four others types represented by only a few examples. This contrasts to the lower midden where the majority are type A with a quarter being type B1.

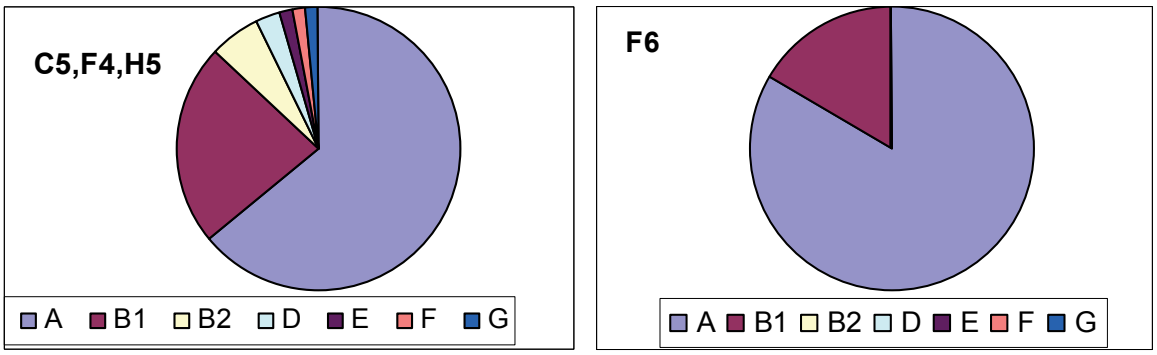


Figure 8. Proportions of stones found in layer 4/5 in Trench C, Squares F and H (n = 69, omitting the single cluster of indurated tuff – type H), and layer 6 in Square F (n = 12).

These variations suggest different selections were made by different people at different times, although they were not identical at any time or place to the stones found in the river (compare Figures 7 and 8 to Figure 6).

Previous use of stones found

The number examined to determine whether or not they had been heated (35 of 220) was not large enough to make any real comments on this question. It is also not clear whether all stones would show signs of heating even if they had been through a hangi once or twice. The visual descriptions (119 of 220) suggested that many had, even though they did not show signs of cracking or colour changes.

At what size were the stones discarded

There is a clear signal that the stones were discarded when they were too small to handle or retain enough heat to be useful as cooking stones.

Although there was a range of sizes within those found in the midden, the majority were less than 25 grams (Figure 3). It may have been that a few larger ones were overlooked, or that the rake-out process had not been very thorough (the F4 midden shows a number of large stones within the much smaller shatter).

This contrasts to the generally larger stones and wider range of stone sizes found in the groups (Figure 2), where at least three-quarters of the stones are more than 25 g in weight. Even in the group found in Square D which had the smallest stones, 50% were over 25 g as opposed to between 8 and 17% of the midden stones.

References

Easy Calculation.com, 2010. Standard Deviation. http://easycalculationcom/statistics/standard.deviation.php

Fraser, C., 1910. The Geology of the Thames Subdivision. *New Zealand Geological Survey*, Bulletin 10, Wellington: Government Printer.

Henderson, J., 1913. The Geology of the Aroha Subdivision. *New Zealand Geological Survey*, Bulletin 16, Wellington: Government Printer.

Thompson, S., 1987. Sample size for estimating multinomial proportions. *The American Statistician*, 41:42-46.

Reference collection – Geology Department, University of Auckland.

Attachment 1: The Non-Midden Site Stones

Missing lab numbers (89, 125 & 137) are not regarded as hangi stones and have been re-assigned as 'odd lithic material'.

LAB No.	Site No.	Area	Layer	Type	X	Y	Z	Weight	Volume	Size	Density
1	486.1	F	4	A	95	80	62	270	615	471.2	2.27178
2	486.2	F	4	A	88	64	53	110	280	298.5	2.54545
3	486.3	F	4	A	57	50	40	50	100	114	2.00000
4	486.4	F	4	A	60	50	37	55	110	111	2.00000
5	486.5	F	4	D	63	55	50	85	185	173.25	2.17647
6	486.6	F	4	B2	78	47	30	40	85	109.98	2.12500
7	486.7	F	4	B1	87	47	28	70	134	114.49	1.41429
8	486.8	F	4	A	60	53	45	70	115	143.1	1.64286
9	486.9	F	4	A	55	53	30	35	85	87.45	2.42857
10	486.10	F	4	A	62	45	29	43	85	80.41	1.97674
11	486.11	F	4	A	65	50	23	40	69	74.75	1.72500
12	486.12	F	4	A	60	47	15	10	35	42.3	3.50000
13	486.13	F	4	A	57	40	33	40	85	75.24	2.12500
14	496.14	F	4	A	50	45	30	30	75	67.5	2.50000

LAB No.	Site No.	Area	Layer	Type	X	Y	Z	Weight	Volume	Size	Density
15	486.15	F	4	A	54	48	35	40	75	90.72	1.87500
16	496.16	F	4	A	43	39	33	25	70	55.34	2.80000
17	486.17	F	4	B1	54	34	20	10	37	36.72	3.70000
18	486.18	F	4	A	40	44	24	11	38	50.69	3.45455
19	486.19	F	4	A	52	39	24	16	45	48.67	2.81250
20	486.20	F	4	A	45	38	32	17	47	54.72	2.76471
21	447.1	F	8		105	94	30	150	335	296.1	2.23333
22	385.1	F	4		83	75	45	100	236	280.12	2.36000
23	385.2	F	4	A	101	52	48	150	359	252.1	2.39333
24	385.3	F	4		64	45	20	15	60	57.6	4.00000
25	385.4	F	4		60	34	31	20	73	63.24	3.65000
26	385.5	F	4	A	51	49	32	22	75	79.91	3.40909
27	385.6	F	4	A	53	47	27	20	65	67.26	3.25000
28	385.7	F	4	A	52	38	23	10	43	45.45	4.30000
29	385.8	F	4		47	36	23	8	35	38.92	4.37500
30	385.9	F	4		46	30	29	5	27	40.02	5.40000
31	384.1	F	4	A	78	64	41	100	253	204.67	2.53000
32	384.2	F	4	B1	72	55	40	100	270	158.4	2.70000
33	384.3	F	4	A	77	55	42	100	270	177.87	2.70000
34	384.4	F	4	B1	87	60	41	108	271	214.02	2.50926
35	384.5	F	4	A	75	52	29	70	154	113.1	2.20000
36	384.6	F	4	A	67	50	42	80	160	140.7	2.00000
37	384.7	F	4	B1	54	54	46	71	150	134.14	2.11268
38	384.8	F	4	B2	50	45	32	32	79	72	2.46815
39	410.1	F	6	A	85	50	28	45	109	119	2.42222
40	410.2	F	6		73	58	46	110	312	194.76	2.83636
41	410.3	F	6	A	61	55	44	80	180	147.62	2.25000
42	410.4	F	6	A	46	40	30	25	65	55.2	2.60000
43	410.5	F	6	A	62	41	10	6	24	25.42	4.00000
44	410.6	F	6	A	43	33	26	10	45	36.89	4.50000
45	410.7	F	6	A	46	37	27	18	50	45.95	2.77778
46	410.8	F	6		48	28	21	8	30	28.22	3.75000
47	386.1	F	4	B1	109	44	32	50	135	153.47	2.70000
48	386.2	F	4	D	69	57	27	39	85	106.19	2.17949
49	386.3	F	4	A	71	57	41	85	175	165.93	2.05882
50	386.4	F	4	B1	77	53	34	45	115	138.75	2.55556
51	386.5	F	4	B1	70	43	21	10	52	63.21	5.20000
52	386.6	F	4	A	64	46	35	40	110	103.04	2.75000
53	386.7	F	4	B1	51	48	36	40	110	88.13	2.75000
54	386.8	F	4	B1	55	51	23	20	67	64.51	3.35000
55	386.9	F	4	A	59	42	12	3	27	29.74	4.00000
56	386.10	F	4	B1	55	30	36	20	77	59.4	3.85000
57	386.11	F	4	E	61	43	31	10	45	58.65	4.50000
58	386.12	F	4	A	52	37	28	10	52	53.87	5.20000
59	386.13	F	4	B1	50	45	28	20	65	63	3.25000
60	386.14	F	4	F	56	43	33	50	96	79.46	1.92000
61	126.1	F	3		37	36	26	10	34	34.63	3.40000
62	125.1	F	3		46	29	28	8	35	37.35	4.37500
63	189.1	F	4	A	43	36	16	8	22	24.77	2.75000
64	189.2	F	4		27	21	20	3	9	11.34	3.00000
65	189.3	F	4		30	30	16	6	19	14.4	3.16667
66	76.1	C	5		96	65	64	206	511	399.36	2.48058

LAB No.	Site No.	Area	Layer	Type	X	Y	Z	Weight	Volume	Size	Density
67	90.1	C	5	B1	61	51	31	30	77	96.44	2.56667
68	90.2	C	5	A	48	43	40	19	30	82.56	1.57845
69	90.3	C	5	A	52	46	17	20	57	40.66	2.85000
70	25.1	U	1	A	102	83	64	280	680	541.82	2.42851
71	64.1	U	2		57	56	17	12	65	54.26	5.41667
72	64.2	U	2		76	50	43	90	215	163.4	2.38889
73	64.3	U	2	A	67	67	22	30	85	98.76	2.83333
74	64.4	U	2		63	56	49	95	210	172.87	2.21053
75	64.5	U	2	B1	63	40	30	20	72	75.6	3.60000
76	64.6	U	2	A	54	51	23	20	70	63.34	3.50000
77	64.7	U	2		60	37	24	15	60	53.28	4.00000
78	145.1	D	3		68	63	54	115	256	231.34	2.22609
79	145.2	D	3		70	51	39	50	110	139.23	2.20000
80	145.3	D	3		47	39	37	15	65	61.82	4.33333
81	145.4	D	3	A	37	27	20	3	21	19.98	7.00000
82	32.1	U	3	A	72	47	40	60	154	135.36	2.56667
83	120.1	D	3	B1	70	60	35	45	120	147	2.66667
84	120.2	D	3	B2	61	49	37	60	147	110.59	2.45000
85	120.3	D	3	BI	79	55	15	30	91	65.17	3.03333
86	120.4	D	3	A	53	48	20	20	80	50.88	4.00000
87	120.5	D	3	A	50	43	40	30	106	86	3.53333
88	120.6	D	3	B1	59	40	29	25	85	68.44	3.40000
90	120.8	D	3	A	65	45	22	20	60	64.35	3.00000
91	120.9	D	3	A	55	55	33	30	105	99.82	3.50000
92	120.10	D	3	B1	61	27	21	6	37	34.59	6.16667
93	120.11	D	3	E	48	41	29	15	65	57.07	4.33333
94	120.12	D	3	B1	65	43	23	15	66	64.28	4.40000
95	120.13	D	3	G	58	47	41	40	90	111.77	2.25000
96	120.14	D	3	A	62	49	35	28	96	106.33	3.42857
97	120.15	D	3	A	55	45	26	12	65	64.35	5.41667
98	120.16	D	3	B1	44	36	27	14	70	42.77	5.00000
99	120.17	D	3	A	50	48	36	25	95	86.4	3.80000
100	120.18	D	3	A	37	33	32	7	45	34.07	6.42857
101	495.1	TP20	4	A	73	64	51	100	262	238.27	2.62000
102	363.1	M	4	B2	66	44	8	8	30	23.23	3.75000
103	363.2	M	4	B2	49	40	31	15	53	60.76	3.53333
104	363.3	M	4	B2	68	44	26	25	65	17.79	2.60000
105	363.4	M	4	B2	70	37	33	35	83	85.47	2.37143
106	363.5	M	4	B2	57	37	42	30	74	88.58	2.46667
107	377.1	F	4		57	47	32	50	90	85.73	1.80000
108	377.2	F	4	A	67	55	37	70	130	136.34	1.85114
109	377.3	F	4		61	58	29	60	115	102.6	1.91667
110	377.4	F	4		48	29	27	15	27	31.58	1.80000
111	377.5	F	4	B1	52	43	24	20	45	53.66	2.25000
112	433.1	F	6		71	42	32	50	100	95.42	2.00000
113	433.2	F	6		54	42	33	30	68	74.84	2.26667
114	433.3	F	6		39	31	21	8	15	25.39	1.87500
115	482.1	F	6	A	113	77	59	235	617	513.36	2.62553
116	482.2	F	6	A	85	57	38	80	215	184.11	2.68750
117	482.3	F	6	A	65	42	19	30	70	51.87	2.33333
118	482.4	F	6	B1	47	33	21	20	55	32.57	2.75000

LAB No.	Site No.	Area	Layer	Type	X	Y	Z	Weight	Volume	Size	Density
119	482.5	F	6	A	53	53	30	30	75	84.27	2.50000
120	482.6	F	6	B1	39	31	23	10	26	27.81	2.60000
121	459.1	F	7		76	35	17	31	62	45.22	2.00000
122	459.2	F	7		44	41	40	40	85	72.16	2.12500
123	459.3	F	7	A	99	47	37	70	180	172.16	2.57143
124	459.4	F	7	A	67	50	33	60	118	110.55	1.96667
126	459.6	F	7	A	75	47	19	20	55	66.97	2.75000
127	459.7	F	7		68	53	28	50	115	100.91	2.30000
128	459.8	F	7	A	61	48	32	60	107	93.7	1.78333
129	459.9	F	7	A	56	49	28	45	77	16.83	1.71111
130	459.10	F	7		55	37	30	40	74	61.05	1.85000
131	459.11	F	7	A	54	42	30	40	70	68.04	1.75000
132	459.12	F	7		115	72	63	240	574	521.64	2.39167
133	459.13	F	7		110	65	48	210	521	343.2	2.48095
134	459.14	F	7		79	62	43	140	80	210.61	0.57143
135	459.15	F	7		94	67	45	270	103	283.41	0.38148
136	459.16	F	7		67	43	34	40	95	97.95	2.37500
138	459.18	F	7		63	52	50	75	140	163.8	1.86667
139	459.19	F	7		61	55	47	72	147	157.68	2.04167
140	211.1	F	4	G	84	60	40	100	265	201.6	2.65000
141	211.2	F	4	B1	70	40	38	38	100	106.4	2.63158
142	211.3	F	4	A	57	52	47	50	135	139.31	2.70000
143	211.4	F	4	A	71	56	45	75	165	178.92	2.20000
144	211.5	F	4	H	67	51	16	18	54	54.67	3.00000
145	211.6	F	4	H	66	38	34	32	136	85.27	4.25000
146	211.7	F	4	H	68	54	28	32	84	102.82	2.62500
147	211.8	F	4	H	53	44	34	35	97	79.29	2.77143
148	211.9	F	4	B1	65	30	26	18	52	50.7	2.88889
149	211.10	F	4	B2	69	49	31	30	85	104.81	2.83333
150	211.11	F	4	H	60	51	32	42	101	97.92	2.40476
151	211.12	F	4	H	58	51	36	42	98	106.49	2.33333
152	211.13	F	4	H	59	45	33	28	71	87.61	2.53571
153	211.14	F	4	H	70	45	33	43	108	103.95	2.51163
154	211.15	F	4	H	50	46	38	35	85	87.4	2.42857
155	91.1	C	5	A	64	49	39	30	100	122.3	3.33333
156	91.2	C	5	A	67	49	28	20	85	91.92	3.03571
157	91.3	C	5	B2	50	43	38	20	71	81.7	3.55000
158	91.4	C	5	A	57	42	27	20	68	64.64	3.40000
159	456c.1	S	2		67	53	34	50	112	120.73	2.24000
160	456c.2	S	2		60	51	40	70	142	122.4	2.02857
161	392.1	H	5	A	68	53	32	45	134	115.33	2.97178
162	392.2	H	5	A	79	48	20	26	80	75.84	3.07692
163	392.3	H	5	A	80	55	32	80	175	140.8	2.18750
164	392.4	H	5		77	51	44	60	140	172.79	2.33333
165	392.5	H	5	A	69	47	27	25	85	87.56	3.40000
166	392.6	H	5	A	62	35	27	20	70	58.59	3.50000
167	392.7	H	5		68	41	29	25	85	80.85	3.40000
168	392.8	H	5		48	34	30	11	57	48.96	5.18182
169	392.9	H	5		47	44	24	9	40	49.63	4.44444
170	392.10	H	5	A	43	34	30	18	70	43.86	3.38889
171	392.11	H	5	A	39	38	29	8	40	42.98	5.00000

LAB No.	Site No.	Area	Layer	Type	X	Y	Z	Weight	Volume	Size	Density
172	392.12	H	5		48	39	25	8	32	46.8	4.00000
173	392.13	H	5		36	31	21	4	27	23.44	6.75000
174	391.1	H	3		95	52	39	95	235	192.66	2.47368
175	391.2	H	3		115	68	25	60	170	195.5	2.83333
176	391.3	H	3		73	64	28	65	167	130.82	2.56923
177	391.4	H	3	B1	71	51	49	80	205	177.43	2.56250
178	391.5	H	3		83	65	52	120	321	280.54	2.67500
179	391.6	H	3		82	64	49	98	254	257.15	2.59184
180	391.7	H	3		75	47	28	30	100	48.7	3.33333
181	391.8	H	3		76	55	37	75	166	154.66	2.21333
182	391.9	H	3		78	58	32	45	120	144.77	2.66667
183	391.10	H	3		61	59	27	40	110	97.17	2.75000
184	391.11	H	3		69	51	26	45	120	91.49	2.66667
185	391.12	H	3		67	49	28	40	112	41.42	2.80000
186	391.13	H	3		67	44	38	50	135	112.02	2.70000
187	391.14	H	3	B1	59	57	30	30	102	100.89	3.40000
188	391.15	H	3	B1	53	43	28	12	56	63.81	4.66667
189	100.1	D	3	A	44	32	14	3	25	19.71	8.33333
190	101.1	D	3		48	48	29	15	60	66.82	4.00000
191	22.1	T	0		77	64	33	80	97	162.62	2.46250
192	41.1	T	3	A	44	26	17	5	28	19.45	5.60000
193	43.1	T	3	A	40	30	15	5	27	18	5.40000
194	40.1	T	3	A	45	35	16	8	35	25.2	4.37500
195	107.1	B	3	B1	77	61	41	80	190	192.58	2.37500
196	107.2	B	3	A	80	94	67	180	415	503.84	2.30556
197	107.3	B	3	B1	70	59	42	60	142	173.46	2.36667
198	107.4	B	3	A	109	90	80	320	750	784.8	2.34375
199	108.1	B	3	B1	150	97	70	460	1175	1018.5	2.55435
200	108.2	B	3	B1	95	88	70	260	635	585.2	2.44231
201	108.3	B	3	A	96	92	77	310	795	680.06	2.56452
202	108.4	B	3	B2	99	84	68	280	700	565.49	2.50000
203	108.5	B	3	B1	105	88	52	210	535	480.48	2.54762
204	108.6	B	3	B1	71	71	41	90	225	206.68	2.50000
205	108.7	B	3	D	75	60	53	120	255	238.5	2.12500
206	108.8	B	3	A	75	55	51	100	245	210.37	2.45000
207	108.9	B	3	A	69	53	50	110	270	182.85	2.45455
208	108.10	B	3	B1	79	60	55	150	330	260.7	2.20000
209	108.11	B	3	B1	90	85	68	260	635	520.2	2.44231
210	108.12	B	3	B2	101	85	36	140	332	309.06	2.37143
211	108.13	B	3	A	65	57	53	70	148	196.37	2.11429
212	108.14	B	3	B1	75	55	47	100	232	193.87	2.32000
213	108.15	B	3	B2	93	77	48	180	407	343.73	2.26111
214	108.16	B	3	A	68	59	54	120	255	216.65	2.12500
215	67.1	B	3		80	55	38	90	180	167.2	2.00000
216	109.1	B	3	A	48	29	25	10	40	34.8	4.00000
217	109.2	B	3	B2	97	55	33	80	185	176.06	2.31250
218	109.3	B	3	A	61	48	34	40	85	99.55	2.12500
219	109.4	B	3	B2	43	42	33	20	65	59.6	3.25000
220	109.5	B	3	B1	45	31	30	12	50	41.85	4.16667
221	109.6	B	3	A	64	29	20	10	42	37.12	4.20000
222	109.7	B	3	A	40	37	25	10	45	37	4.50000
223	110.1	B	3	G	55	26	19	5	20	27.17	4.00000

Attachment 2: *River Stones*

LAB No.	*Site No.*	*Stone Type*	*X*	*Y*	*Z*	*Weight*	*Volume*	*Size*	*Density*
1	3.1	A	93	86	46	190	440	367.908	2.31579
2	3.2	A	116	77	52	240	620	464.464	2.58333
3	3.3	A	113	70	43	190	395	340.130	2.07895
4	3.4	A	107	59	39	110	270	246.207	2.45455
5	3.5	A	118	90	79	340	750	838.980	2.20588
6	3.6	A	87	83	60	200	485	433.260	2. 42500
7	3.7	A	88	77	46	190	315	311.696	1.65789
8	3.8	B1	78	63	42	110	282	206.388	2.56364
9	3.9	A	74	65	43	100	220	206.830	2.20000
10	3.10	A	85	48	37	80	160	150.960	2.00000
11	3.11	A	78	44	27	50	95	92.664	1.90000
12	3.12	A	68	43	36	80	127	105.264	1.58750
13	3.13	A	64	43	37	70	118	101.824	1.68571
14	3.14	A	67	46	30	60	105	92.460	1.75000
15	3.15	A	53	36	30	30	82	57.240	2.73333
16	3.16	A	51	39	26	40	70	51.714	1.75000
17	3.17	A	46	44	24	40	70	48.576	1.75000
18	3.18	A	48	38	20	30	55	36.480	1.83333
19	3.19	A	50	45	27	30	55	60.750	1.83333
20	3.20	A	52	33	33	30	55	56.628	1.83333
21	3.21	B1	40	30	21	25	32	25.200	1.28000
22	3.22	A	35	27	23	10	20	21.735	2.00000
23	1.1	F	87	75	50	185	405	326.250	2.18919
24	1.2	F	119	105	70	360	785	874.650	2.18056
25	1.3	F	60	50	43	80	150	129.000	1.87500
26	1.4	A	61	44	25	40	90	67.100	2.25000
27	1.5	B1	74	41	36	60	145	109.224	2.41667
28	1.6	A	97	85	30	100	222	247.350	2.22000
29	1.7	F	107	59	50	160	352	315.650	2.20000
30	1.8	A	56	32	29	30	77	51.968	2.56667
31	1.9	B1	81	66	25	90	195	133.650	2.16667
32	1.10	A	101	59	53	190	415	310.474	2.18421
33	1.11	B1	80	55	30	80	150	132.000	1.87500
34	1.12	F	58	51	33	40	104	97.614	2.60000
35	1.13	A	94	44	32	80	180	132.352	2. 25000
36	1.14	F	60	39	37	50	95	86.580	1.90000
37	1.15	F	87	67	36	100	230	209.844	2.30000
38	1.16	A	51	40	33	45	100	67.320	2.22222
39	1.17	G	67	55	40	98	175	147.400	1.78571
40	1.18	A	75	44	33	85	170	108.900	2.00000
41	1.19	A	65	42	20	30	77	54.600	2.56667
42	1.20	A	50	22	17	15	25	18.700	1.66667
43	1.21	G	40	28	25	20	30	28.000	1.50000
44	1.22	G	40	27	19	20	27	20.520	1.35000
45	1.23	B1	45	37	23	40	52	38.295	1.30000
46	1.24	G	40	36	17	20	30	24.480	1.50000
47	1.25	F	42	33	5	10	15	6.930	1.50000
48	1.26	Q	30	30	21	10	25	18.900	2.50000
49	2.1	G	78	55	46	110	250	197.34	2.27273
50	2.2	F	99	55	45	120	285	245.03	2.37500

LAB No.	*Site No.*	*Stone Type*	*X*	*Y*	*Z*	*Weight*	*Volume*	*Size*	*Density*
51	2.3	A	60	42	19	40	65	47.88	1.62500
52	2.4	G	65	56	20	50	90	72.80	1.80000
53	2.5	Q	84	46	33	85	145	127.51	1.70588
54	2.6	B1	51	43	15	9	30	32.90	3.33333
55	2.7	F	55	44	30	50	65	72.60	1.30000
56	2.8	F	111	51	40	100	220	226.44	2.20000
57	2.9	B1	84	22	29	11	60	53.59	5.45455
58	2.10	A	64	52	36	30	101	119.81	3.36667
59	2.11	A	60	40	29	11	60	69.60	5.45455
60	2.12	F	38	24	13	10	15	11.86	1.50000
61	2.13	F	95	51	49	120	257	237.41	2.14167
62	2.14	B1	122	103	43	290	730	540.34	2.51724
63	2.15	A	125	70	45	230	615	393.75	2.67391
64	2.16	A	81	64	36	100	232	186.62	2.32000
65	2.17	A	86	76	40	180	385	261.44	2.13889
66	2.18	F	79	63	35	100	215	174.20	2.15000
67	2.19	B1	49	39	23	50	88	43.95	1.76000
68	2.20	B1	57	54	35	80	112	107.73	1.40000
69	2.21	A	81	57	25	55	110	115.43	2.00000
70	2.22	F	59	44	31	50	77	80.48	1.54000
71	2.23	F	70	67	27	90	150	126.63	1.66667
72	2.24	F	47	33	21	40	37	32.57	0.92500
73	2.25	Q	56	48	29	60	122	77.95	2.03333
74	2.26	A	67	65	40	110	240	174.20	2.18182
75	2.27	A	85	55	51	130	325	238.43	2.50000
76	2.28	F	49	49	31	50	75	74.43	1.50000
77	2.29	A	23	23	6	2	4	3.17	2.00000
78	2.30	A	108	35	32	95	197	120.96	2.07368
79	2.31	F	63	27	24	40	55	40.82	1.37500
80	2.32	A	33	23	17	15	20	12.90	1.33333
81	2.33	A	55	36	34	40	67	67.32	1.67500
82	2.34	F	113	68	65	205	465	499.46	2.26829
83	2.35	G	67	52	31	90	162	108.00	1.80000
84	2.36	A	23	21	20	15	15	9.66	1.00000
85	2.37	Q	42	35	21	30	40	30.87	1.33333
86	2.38	F	55	41	27	50	80	60.89	1.60000
87	2.39	F	72	59	29	80	125	123.19	1.56250
88	2.40	F	52	33	30	40	60	51.48	1.50000
89	2.41	A	49	39	32	20	49	61.15	2.45000
90	2.42	A	55	41	38	70	112	85.69	1.60000
91	2.43	A	120	77	42	205	440	388.08	2.14634

Attachment 3: Midden Stones Weight (In Grams)

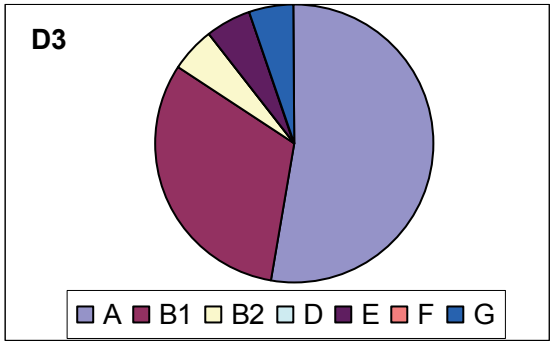
Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight
2	F	6	50.50	2	F	6	3.13	6	M	4	0.70	8	F	4	78.99
2	F	6	90.90	2	F	6	5.98	6	M	4	1.38	8	F	4	26.82
2	F	6	110.03	2	F	6	0.89	6	M	4	4.17	8	F	4	63.86
2	F	6	89.47	2	F	6	1.48	6	M	4	1.63	8	F	4	16.08
2	F	6	48.91	2	F	6	3.38	6	M	4	1.30	8	F	4	27.20
2	F	6	50.08	2	F	6	1.74	6	M	4	1.39	8	F	4	30.38
2	F	6	69.65	2	F	6	2.75	6	M	4	1.54	8	F	4	16.87
2	F	6	67.37	2	F	6	4.27	6	M	4	1.56	8	F	4	17.52
2	F	6	25.49	2	F	6	3.10	6	M	4	1.95	8	F	4	10.00
2	F	6	10.13	2	F	6	2.94	6	M	4	3.28	8	F	4	20.81
2	F	6	4.27	2	F	6	1.86	7	F	6	400.00	8	F	4	22.94
2	F	6	5.24	3	F	4	2.73	7	F	6	435.00	8	F	4	13.23
2	F	6	10.07	3	F	4	2.29	7	F	6	230.00	8	F	4	9.58
2	F	6	3.65	3	F	4	2.20	7	F	6	265.00	8	F	4	17.44
2	F	6	2.26	3	F	4	4.30	7	F	6	152.02	8	F	4	12.73
2	F	6	6.08	3	F	4	2.72	7	F	6	30.70	8	F	4	12.75
2	F	6	3.88	3	F	4	1.44	7	F	6	36.91	8	F	4	7.97
2	F	6	1.86	3	F	4	3.09	7	F	6	28.87	8	F	4	9.48
2	F	6	4.15	3	F	4	1.97	7	F	6	18.72	8	F	4	6.19
2	F	6	2.03	3	F	4	1.05	7	F	6	19.36	8	F	4	12.91
2	F	6	2.76	3	F	4	1.20	7	F	6	21.48	8	F	4	11.70
2	F	6	1.69	3	F	4	1.81	7	F	6	25.71	8	F	4	8.04
2	F	6	1.89	3	F	4	2.62	7	F	6	12.33	8	F	4	6.62
2	F	6	1.44	3	F	4	1.90	7	F	6	7.51	8	F	4	9.50
2	F	6	1.79	3	F	4	2.91	7	F	6	8.32	8	F	4	10.20
2	F	6	2.22	3	F	4	1.18	7	F	6	5.15	8	F	4	9.85
2	F	6	1.16	3	F	4	2.10	7	F	6	17.08	8	F	4	6.17
2	F	6	80.05	3	F	4	1.75	7	F	6	17.44	8	F	4	6.45
2	F	6	45.70	3	F	4	1.83	7	F	6	49.34	8	F	4	7.84
2	F	6	37.27	3	F	4	3.96	7	F	6	10.20	8	F	4	6.23
2	F	6	51.43	3	F	4	2.81	7	F	6	10.20	8	F	4	5.17
2	F	6	43.27	3	F	4	2.33	7	F	6	10.20	8	F	4	3.86
2	F	6	39.08	3	F	4	1.16	7	F	6	16.58	8	F	4	4.37
2	F	6	26.39	3	F	4	1.55	7	F	6	10.63	8	F	4	4.19
2	F	6	28.79	3	F	4	1.24	7	F	6	5.52	8	F	4	3.29
2	F	6	5.38	3	F	4	1.95	7	F	6	4.96	8	F	4	4.32
2	F	6	4.40	3	F	4	1.73	7	F	6	25.55	8	F	4	1.31
2	F	6	4.42	3	F	4	1.45	7	F	6	20.45	8	F	4	1.21
2	F	6	5.09	3	F	4	1.12	7	F	6	11.13	8	F	4	2.38
2	F	6	5.27	3	F	4	2.10	7	F	6	5.75	8	F	4	4.85
2	F	6	2.79	3	F	4	1.37	7	F	6	8.24	8	F	4	3.17
2	F	6	0.70	4	F	4	37.31	7	F	6	7.63	8	F	4	3.54

Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight
2	F	6	2.57	4	F	4	30.05	7	F	6	10.20	8	F	4	2.49
2	F	6	6.51	4	F	4	31.27	7	F	6	8.78	8	F	4	2.20
2	F	6	3.74	4	F	4	11.23	7	F	6	3.49	8	F	4	1.42
2	F	6	3.36	4	F	4	1.67	7	F	6	4.84	8	F	4	1.06
2	F	6	3.95	4	F	4	3.46	7	F	6	2.83	8	F	4	2.24
2	F	6	2.11	4	F	4	4.69	7	F	6	3.98	8	F	4	4.56
2	F	6	1.75	4	F	4	1.58	7	F	6	7.28	8	F	4	3.13
2	F	6	1.79	4	F	4	5.17	7	F	6	3.79	8	F	4	2.31
2	F	6	1.80	4	F	4	23.26	7	F	6	0.54	8	F	4	1.89
2	F	6	1.05	4	F	4	7.48	7	F	6	4.75	8	F	4	2.51
2	F	6	1.78	4	F	4	12.29	7	F	6	2.75	8	F	4	1.28
2	F	6	1.69	4	F	4	4.87	7	F	6	5.47	8	F	4	1.31
2	F	6	1.35	4	F	4	2.13	7	F	6	4.84	8	F	4	2.07
2	F	6	19.83	4	F	4	2.74	7	F	6	0.56	8	F	4	2.63
2	F	6	32.03	4	F	4	11.98	7	F	6	2.39	8	F	4	1.64
2	F	6	1.24	5	M	4	111.99	7	F	6	2.82	8	F	4	2.69
2	F	6	20.12	5	M	4	38.14	7	F	6	1.63	8	F	4	1.96
2	F	6	40.40	5	M	4	117.20	7	F	6	3.48	8	F	4	1.67
2	F	6	20.17	5	M	4	25.63	7	F	6	4.12	8	F	4	1.43
2	F	6	12.38	5	M	4	14.96	7	F	6	4.53	8	F	4	1.57
2	F	6	21.38	5	M	4	20.54	7	F	6	1.94	8	F	4	1.99
2	F	6	4.95	5	M	4	24.46	7	F	6	2.47	8	F	4	1.61
2	F	6	14.88	5	M	4	23.22	7	F	6	3.54	8	F	4	2.33
2	F	6	6.13	5	M	4	5.83	7	F	6	3.45	8	F	4	1.87
2	F	6	9.12	5	M	4	6.02	7	F	6	2.15	8	F	4	1.70
2	F	6	4.58	5	M	4	5.06	7	F	6	3.30	8	F	4	1.19
2	F	6	2.09	5	M	4	5.14	7	F	6	1.06	9	M	4	38.34
2	F	6	6.78	5	M	4	2.15	7	F	6	1.33	9	M	4	29.91
2	F	6	2.49	5	M	4	3.94	7	F	6	3.89	9	M	4	13.52
2	F	6	3.12	5	M	4	1.35	7	F	6	1.40	9	M	4	11.95
2	F	6	3.32	5	M	4	3.34	7	F	6	1.26	9	M	4	22.35
2	F	6	4.57	5	M	4	3.93	7	F	6	1.77	9	M	4	9.11
2	F	6	2.05	5	M	4	3.42	7	F	6	2.98	9	M	4	10.95
2	F	6	1.60	5	M	4	4.07	7	F	6	2.00	9	M	4	4.17
2	F	6	1.10	5	M	4	2.28	7	F	6	2.10	9	M	4	11.16
2	F	6	1.30	5	M	4	1.09	7	F	6	0.69	9	M	4	1.53
2	F	6	1.60	5	M	4	1.16	7	F	6	1.27	9	M	4	5.48
2	F	6	1.15	5	M	4	5.42	7	F	6	1.92	9	M	4	11.17
2	F	6	1.25	5	M	4	12.25	7	F	6	1.57	9	M	4	8.09
2	F	6	0.73	5	M	4	8.6	7	F	6	1.59	9	M	4	11.18
2	F	6	1.14	5	M	4	21.45	7	F	6	1.47	9	M	4	4.69
2	F	6	3.37	5	M	4	12.17	7	F	6	1.28	9	M	4	6.79
2	F	6	6.73	5	M	4	8.12	7	F	6	2.09	9	M	4	5.72

Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight	Lab No.	Area	Layer	Weight
2	F	6	20.74	5	M	4	10.06	7	F	6	1.19	9	M	4	5.81
2	F	6	7.99	5	M	4	12.62	7	F	6	1.35	9	M	4	12.13
2	F	6	6.64	5	M	4	14.62	7	F	6	1.07	9	M	4	1.82
2	F	6	23.33	5	M	4	7.55	7	F	6	1.15	9	M	4	4.43
2	F	6	31.65	5	M	4	4.93	7	F	6	1.89	9	M	4	7.25
2	F	6	12.38	5	M	4	2.46	7	F	6	1.39	9	M	4	5.70
2	F	6	8.73	6	M	4	30.98	7	F	6	1.92	9	M	4	3.25
2	F	6	3.04	6	M	4	22.95	7	F	6	1.08	9	M	4	5.68
2	F	6	8.25	6	M	4	19.15	7	F	6	1.75	9	M	4	2.73
2	F	6	4.13	6	M	4	32.97	7	F	6	1.59	9	M	4	3.54
2	F	6	3.22	6	M	4	16.51	7	F	6	1.13	9	M	4	2.60
2	F	6	1.17	6	M	4	14.58	7	F	6	1.16	9	M	4	2.55
2	F	6	5.08	6	M	4	37.28	7	F	6	2.12	9	M	4	1.85
2	F	6	1.92	6	M	4	10.00	7	F	6	1.18	9	M	4	1.56
2	F	6	2.79	6	M	4	10.29	7	F	6	1.73	9	M	4	1.46
2	F	6	2.46	6	M	4	5.25	8	F	4	22.25	9	M	4	1.95
2	F	6	3.31	6	M	4	4.94	8	F	4	7.09	9	M	4	2.84
2	F	6	1.75	6	M	4	6.05	8	F	4	30.47	9	M	4	4.35
2	F	6	2.04	6	M	4	18.02	8	F	4	26.11	9	M	4	4.29
2	F	6	1.21	6	M	4	7.25	8	F	4	70.26	9	M	4	2.06
2	F	6	1.10	6	M	4	11.35	8	F	4	85.08	9	M	4	1.72
2	F	6	0.99	6	M	4	4.60	8	F	4	57.02	9	M	4	2.51
2	F	6	0.91	6	M	4	4.93	8	F	4	80.16	9	M	4	1.00
2	F	6	30.56	6	M	4	5.57	8	F	4	44.37	9	M	4	2.83
2	F	6	11.18	6	M	4	4.47	8	F	4	37.28	9	M	4	2.45
2	F	6	12.78	6	M	4	4.85	8	F	4	44.77	9	M	4	1.78
2	F	6	12.65	6	M	4	3.06	8	F	4	41.19	9	M	4	2.17
2	F	6	8.24	6	M	4	6.57	8	F	4	60.99	9	M	4	1.46
2	F	6	4.77	6	M	4	3.38	8	F	4	27.72	9	M	4	1.59
2	F	6	23.96	6	M	4	4.46	8	F	4	29.16	9	M	4	1.59
2	F	6	10.45	6	M	4	2.37	8	F	4	22.27	9	M	4	1.38
2	F	6	4.68	6	M	4	2.50	8	F	4	41.28	9	M	4	2.19
2	F	6	2.82	6	M	4	1.29	8	F	4	9.42	9	M	4	1.27

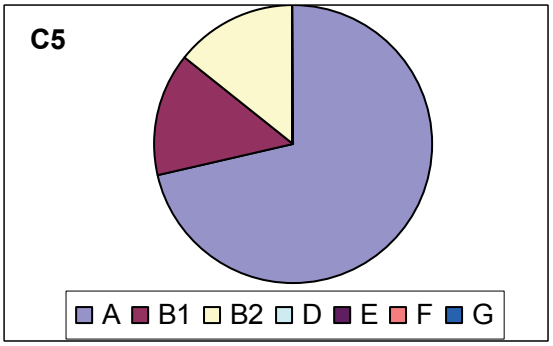
Attachment 4: Pie Diagrams Showing the Proportions of Stone Types in the Sites and River Sample Locations

Site Stone Samples



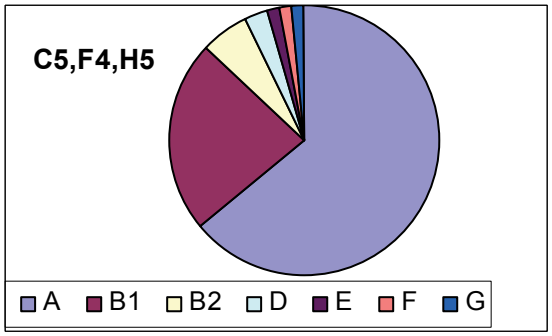
Square D layer 3, n = 19

18 from 2 groups and 2 individual stones



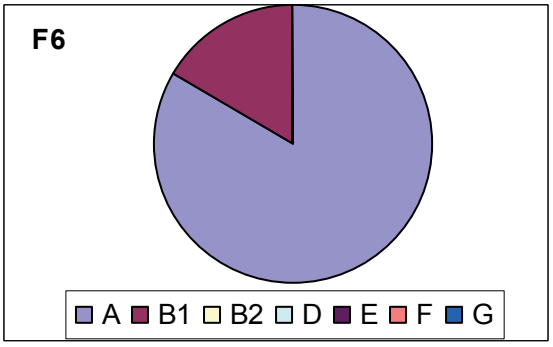
Trench C near Square F, layer 5, n = 7

All from 2 groups



Square F layer 4, n = 55

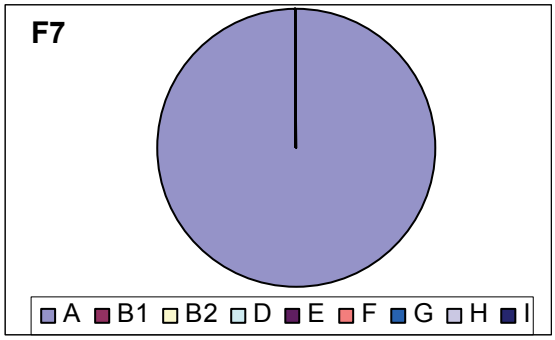
All from 6 groups (omitting the single cluster of indurated tuff – type H)



Square F layer 6, n = 14,

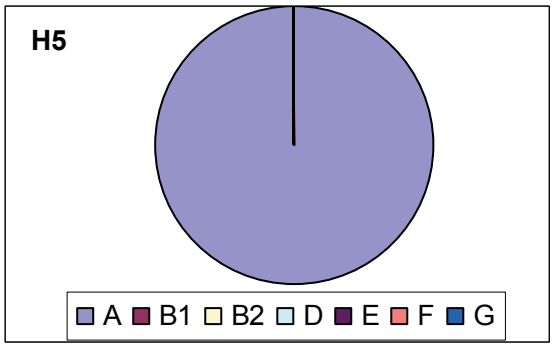
All from 3 groups

Sites Stone Samples



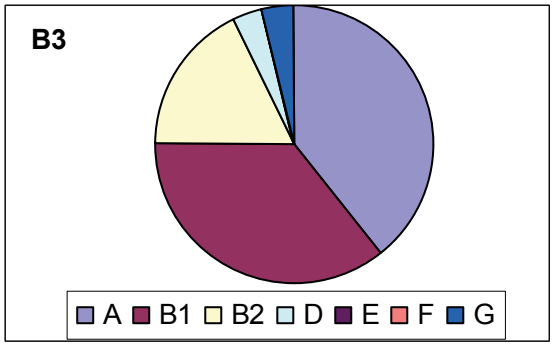
Square F layer 7, n = 6

All from 1 group



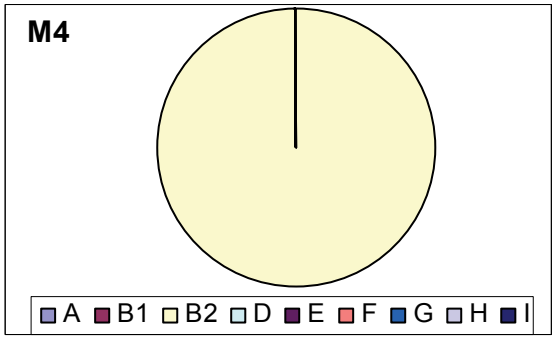
Square H layer 5, n = 7

All from 1 group



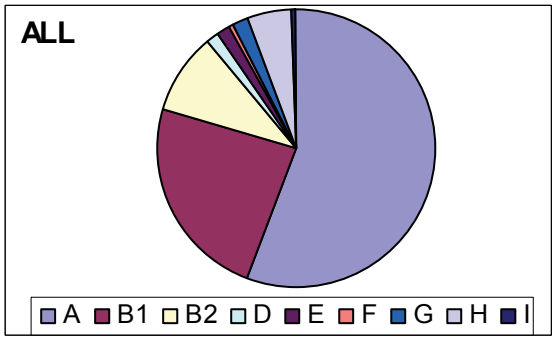
Trench B near Square M, n = 27

26 stones from 3 groups and 1 single stone



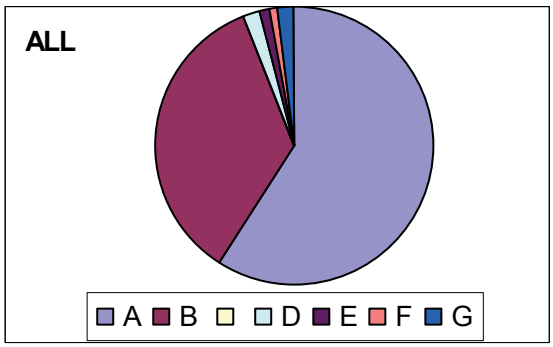
Square M, n = 5

All stones from one group



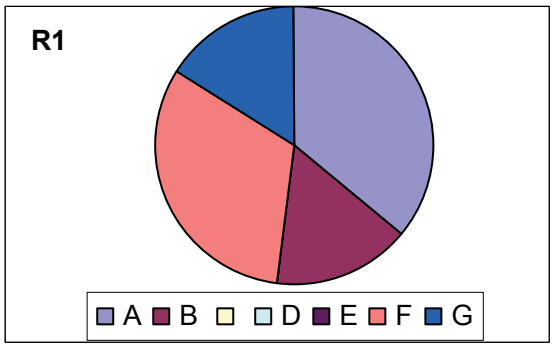
All identified stones from groups and individuals, n = 160

Sites Stone Samples



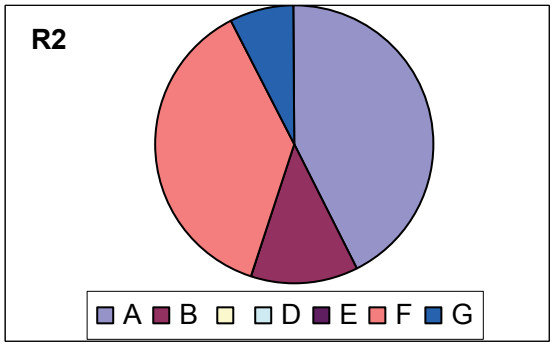
All identified stones collected from local sources, combining B1 & B2, and omitting the ballast and slag brought by other means, to compare with the river stones, n = 151.

River Stones Sampled



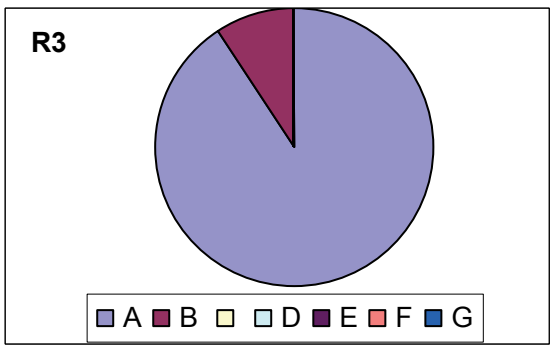
Rapid 1, n = 25

The single quartz rock has not been included, as none appeared in the site



Rapid 2, n = 40

The 3 quartz rocks have not been included



Rapid 3, n = 22

No quartz were sampled

Attachment 5: Evidence of Heating in a Selection of Stones

No:	*Heating*	*Description*
385.2		complete stone, shows signs of heating with fractures, and colour change around outside
385.5		slight colour change, no obvious fracturing, no real evidence of heating
385.6		shows a few small fractures and colour change
385.7		purple grey colouring, fractures apparent
410.1		shows a few small fractures, one fracture shows oxidation on its interior surface
410.3	*	massive fracturing, oxidation in the fractures, colour change apparent
410.4	*	highly fractured internally, very oxidised internally
410.5		no evidence of firing, a very small sliver of rock that appears to be a fire flake
410.6		no colour change or fracturing
410.7	*	few cracks, all show oxidation, slight colour change
189.1	*	few small cracks, no oxidation or colour change
25.1	*	entire large stone, massively fire cracked with oxidisation in the fractures, obvious colour change
64.3		no fractures, but an apparent colour change
64.5		very fractured, no colour change or oxidisation
64.6	*	no fractures, possible colour change
145.4	*	no river rolled edges, small cracks, no colour change
495.1	*	no river-rolled edges, very fractured, distinct colour change, oxidation in fractures
377.2	*	mildly fractured, colour change
377.5		slight colour change
459.3		no real fracturing, slight colour change
459.4	*	fracturing, no colour change
459.5		this is pumice, couldn't tell if it had been heated
459.6		no fracturing or colour change
459.8	*	very large fractures, colour change
459.9	*	large fractures, no colour change
459.11		colour change, no fractures
459.17	*	2 large fractures, definite colour change
392.6	*	fractures, no colour change
392.2		no fractures, slight colour change
392.3	*	large fractures, distinct colour change
392.5	*	large fractures, colour change
392.1	*	fine fractures, colour change
392.11	*	mild fracturing, colour change
392.1		no fracturing or colour change
32.1	*	a lot of fracturing, colour change
392.12	*	fracturing, oxidisation along fractures, distinct colour change
391.4	*	no river rolled edges, mild fracturing, colour change
391.14	*	no river rolled edges, mild fracturing, colour change
391.15	*	fracturing
100.1		no apparent fractures, slight colour change
40.1	*	slight fracturing, distinct colour change
41.1		no fracturing, or colour change
43.1		no real fracturing or colour change

* Evidence of heating present

Appendix 4 Special Objects, Chert and Other Lithics

Caroline Phillips, Peter Sheppard and Kath Prickett

Apart from the obsidian, hangi stones and writing slate (see Appendices 2, 3 & 5) there were a number of other lithic items found in the Opita investigations. The main group comprised chert flakes, numbering 24 pieces, of which one was classed as a special object. A further 20 items included three special objects, tools and waste material from a variety of rock types[1]. These items were scattered throughout the area investigated (see Figure 1, Tables 1).

This analysis looks firstly at the different types of lithics; starting with the special objects, it then describes their locations in the Opita sites. Finally, the special objects, artefacts in the other lithic category and chert material are compared to the assemblages from Raupa, Waiwhau, the Puriri sites and Oruarangi.

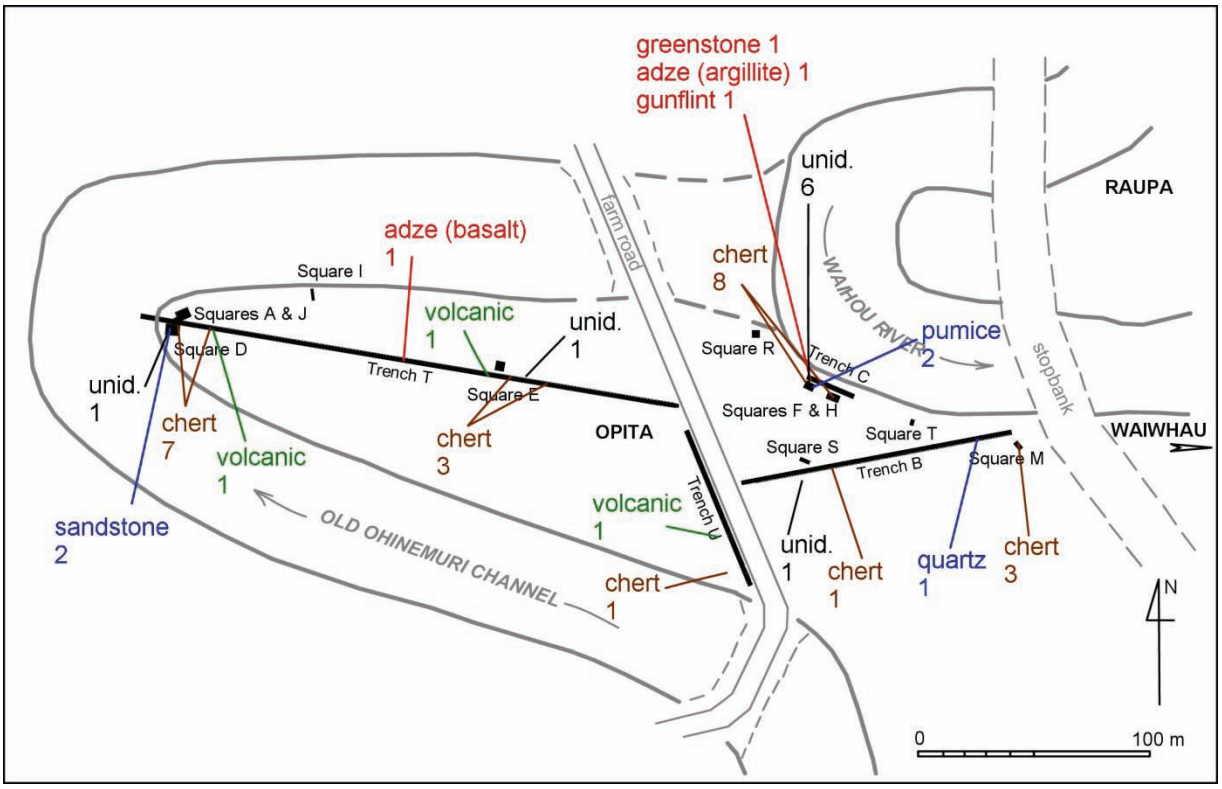


Figure 1. Distribution of special objects (red), chert (brown) and other lithics (blue, green and black).

1 After examination of these items, three stones that were in "other lithics" were re-assigned as hangi stones (these have been added to the hangi stones list in the text, but were not included in the analysis).

Table 1: List of special objects, chert and other lithics found at the Opita.

SPECIAL OBJECTS

Sample	Trench	Distance	Square	Unit	Layer	No.	Type	Details	Analysis	Comments (fieldbook)
371			F	D4	4	1	Lithics	Flint	gunflint	50N,60E
443			F	C4	8	1	Lithics	Nelson argillite	Adze	54E, 114S
445			F	C4	8	1	Lithics	Nephrite		SE,140S
19	T	113.9			3	1	Lithics	Tahanga basalt	Adze flake	in good condition
						4				

CHERT

Sample	Trench	Distance	Square	Unit	Layer	No.	Type	Details	Analysis	Comments (fieldbook)
85			D		3	1	Lithics	Chert	volcanic sediment +1 silicified cherty edge, not used	1 m W - 45cm N
97			D		3	1	Lithics	Chert	quartz with cherty bit, not used	4.4m W -.05m N
101a			D		3	1	Lithics	Chert	brechiated cobble, not used	3.55m W - 1.15m N
250g			F	D4	4	1	Lithics	Chert	small, waste flake	Wet sieved
370			F	D4	4	1	Lithics	Chert	reddish cherty material, not used	75N,84E
409b			F	B6	6	1	Lithics	Chert	small fragment of chert shatter	
452			F	B7	8	1	Lithics	Chert	small pebble, not used	from ditch
444			F	C4	8	1	Lithics	Chert	nice flake	5E, 120S
402			H	B16	5	1	Lithics	Chert	small waste flake of reddish chert	73N,274W
404			H	C15	5	1	Lithics	Chert	(missing)	124W,170S
436			H	C15	5	1	Lithics	Chert	small flake	124W,170S
367c			M		4	2	Lithics	Chert	small broken pieces, waste	
394c			M		4	1	Lithics	Chert	heated fragment, possible a core	
69	B	40			3	1	Lithics	Chert	small cobble, artefact?	
506	T	30			Spoil	1	Lithics	Chert	small waste flake	LAB
2a	T	30				3	Lithics	Chert	(missing)	
39	T	160.45			1	1	Lithics	Chert	small piece of shatter	
42	T	167.11			3	1	Lithics	Chert	small pebble, not used	
53	T	177.4			Post	1	Lithics	Chert	very small fragment, not used	
30	U	75			3	1	Lithics	Chert	burnt cobble, possibly a core	
						23				

OTHER LITHICS

Sample	Trench	Distance	Square	Unit	Layer	No.	Type	Details	Analysis	Comments (fieldbook)
86			D		3	1	Lithics	Unid.	broken pebble	lm W - lm N
121			D		Post fill	1	Lithics	Sandstone?	burnt fragment, not artefact	0.9N - 1.55W
120b			D		Pit fill	1	Lithics	Sandstone	grinding grooves	
250g			F	D4	4	3	Lithics	Unid.	small, not artefacts	Wet sieved
347a			F	B5	4	1	Lithics	Unid.		126E, 50S
431			F	?	7	1	Lithics	Unid.		
459b			F	?	7	2	Lithics	Pumice		
176			H	C16	2	1	Lithics	Unid.	pebble, not artefact	1.28N 1.7W
82b	B	27.05			3	1	Lithics	Unid.		
113	B	65.7			3	1	Lithics	Quartz	small pebble	
505	T	30			Spoil	1	Lithics	Silicified tuff	artefact?	
56	T	152.5			3	1	Lithics	Silicious tuff?	broken pebble, not artefact	
45a	T	165.2			Post fill	1	Lithics	Unid.		in bottom of posthole
26	U	60			1	1	Lithics	Volcanic + silicious tuff?	cortex flake	
						17				

Special Objects

There were four special objects found at Opita: a piece of nephrite (greenstone), an adze, an adze flake and a gunflint. These were examined in June 2011 by Kath Prickett, who provided the following information (see locations Figure 1, and list Table 1).

Nephrite

A piece of nephrite was found in Square F layer 8 in the base of the ditch. Measuring 33.5 mm long, 13 mm wide and 11 mm thick, it has only been ground, but not polished as is generally the case with finished items, including those that are being reworked from some previously finished artefact (see photo below, scale 50 mm long). There are traces of bruising on one end where the stone has been hammered, and signs of burning on the end that is broken: this may have affected the original colour. There are scarfs on both sides, presumably to snap the nephrite into two thinner pieces, each of which would have measured 11 mm wide and 7 mm thick, possibly to make two pendants or chisels. It may have broken due to a fracture while it was being worked, after which it was rejected and then came into contact with a fire.

Originally the stone probably came from Westland (Figure 3).

Figure 2. Nephrite (scale 5cm long).

Argillite Adze

An adze of Duff 2B style, was found in Square F layer 8 in the base of the ditch (Figure 4). Measuring 56 mm long, 35.5 mm wide at the mid-point, 38.5 mm wide at the blade and 16.5 mm thick, it had possibly been reworked from a longer adze (see photo below, scale 50 mm long). It has flake scars on the front, sides and around the poll, hammer-dressing on the sides and poll, and has been finely ground on the front, back and sides. It has a high gloss on the rear due to haft polishing, probably from wear during its former form, plus additional wear in its current form. It has a fresh reground surface on the bevel, which may date from when it was reformed, but it has been used since then, as there are use-wear striations on the front of the blade.

The metasomatised argillite most likely came from the Nelson-Marlborough mineral belt at the top of the South Island, a noted source of early adzes (Figure 3).

Figure 3. Map showing locations of pounamu. The Nelson Mineral Belt extends across a similar area to that of the nephrite in Nelson (Beck & Mason 2002, cited in Te Ara – The Encyclopaedia of New Zealand 2009).

Figure 4. Argillite adze (scale 5cm long).

Basalt Adze Flake

A flake, measuring 36 mm long, 17 mm wide and 8.5 mm thick from the corner of an adze blade, was found in Trench T at the base of the cultural deposit (Figure 5). It is not possible to determine the size and shape of the object it broke off from, but it is likely to have been from a larger adze originally, and appears to have been reworked at the time the large flake broke off, as there is evidence of fresh grinding on the front of the blade.

The stone is a weathered basalt, and originally came from Tahanga, near Opito, on the Coromandel Peninsula, also a noted source of early adzes. Many of the early forms were reworked and found as Duff 2B styles in later sites.

Figure 5. Basalt adze flake (scale 5cm long).

Gunflint

A gunflint, measuring 26 mm long, 23.5 mm wide and 10 mm thick was found in Square F layer 4 (Figure 6). The flint is shaped to fit into the cock of a flintlock musket, so that when the gun was fired the flint would strike the steel frizzen and cause a spark that would light the gunpowder, which in turn ignited the main charge that fired a lead ball (Wikipedia). These weapons were the mainstay of European armies between 1660 and 1840, when they were replaced with percussion lock rifles. Gunflints were made in England from flint, a type of chert, found extensively in southern England.

Figure 6. Gunflint (scale 5cm long).

Chert

There were 23 pieces of chert recorded from the Opita investigations, of which three were flake tools, one was a core with flakes removed and eight were detritus from flaking tools (see locations Figure 1, and list Table 1 and Figure 7). There were also seven small waterworn stones and four items were missing from the assemblage.

The 19 available pieces were examined in May 2011 by Peter Sheppard, who provided the following information.

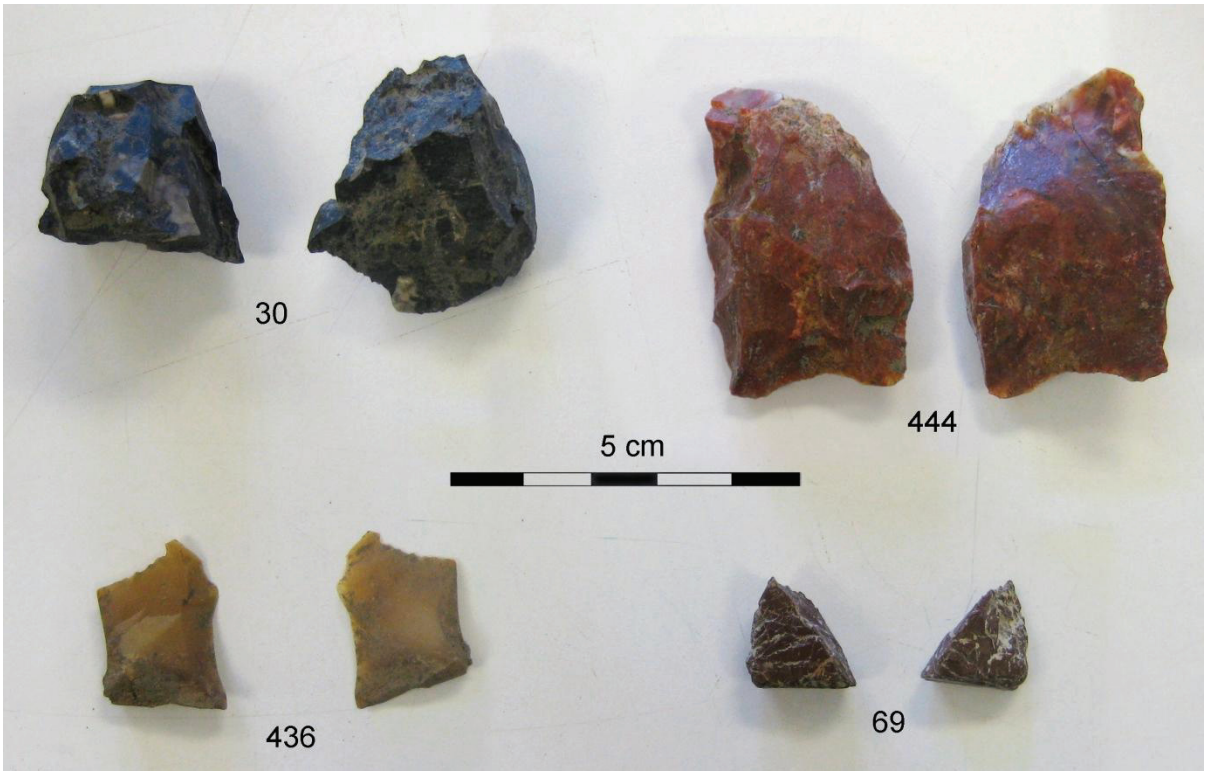


Figure 7. Chert flake tools (444, 436 & 69) and core (30) see Table 1.

The chert was found in association with the main areas excavated. Area D and the adjacent part of Trench T contained seven pieces, Trench T near Area E had three items, eight were found in Squares F and H, while a further three were recovered from Square M. The three flakes came from Trench B, Square F layer 8 and Square H layer 5, the core was found in Trench U, while the detritus was found in Trench T near Square D, Trench T, Square F layers 4 and 6, Square H layer 5, and Square M.

The tools included a red flake 19.7 mm long, 12.1 mm wide and 5.3 mm thick, a yellow flake 9.8 mm long, 6.5 mm wide and 1.8 mm thick, and a small triangular chip which may have been intended as a drill point 7.8 mm long, 5.2 mm wide and 3.8 mm thick. Finally there was a core 10.7 mm long, 10.4 mm wide and 9.8 mm thick, which had been burnt. The small amount of detritus is evidence of some working, although no definite working areas were uncovered.

Chert is found in many areas of the Coromandel Ranges, and there is chert associated with the quartz reefs in Karangahake (pers. comm. Phil Moore 2011), therefore it is likely that there are some outcrops near the Ohinemuri River. These outcrops could have been quarried for the raw material, while eroded material might become incorporated with the river stones. The seven waterworn chert stones may have been gathered along with hangi stones in the river.

Other Lithics

There were 17 other lithic items found in the Opita sites (see locations Figure 1, and list Table 1). These were examined in May 2011 by Peter Sheppard, who provided the following information.

Amongst the other identified lithics are two pieces of sandstone, two pieces of pumice, one small piece of quartz and three small volcanic stones, probably silicified tuff. The nine remaining were small stones that could not be identified.

Most of these lithics came from two locations: Square D and the adjacent Trench T (two sandstone, one siliceous tuff and one unidentified), and Squares F and H (two pumice and six unidentified). The remaining (two unidentified, two silicious tuff and one quartz) were scattered along Trenches T, U and B.

One of the pieces of sandstone had two rubbing grooves on it, and was clearly a tool. The other piece of sandstone may have been a fragment from a tool. The two pieces of pumice may originally have been part of a larger cobble that measured 110 mm long, 65 mm wide and 43 mm thick, but there was no sign of use-wear.

Sandstone and pumice came from outside the immediate area, while the quartz and volcanics could all have come from the adjacent Coromandel Ranges and be present along the Ohinemuri River.

Comparison to other assemblages

Comparison is now made between the assemblages from Opita and the neighbouring sites of Raupa and Waiwhau, sites along the Puriri Stream and Oruarangi nearer the mouth of the Waihou River (Bedford 1994; Furey 1996; Phillips 1986, 1988; Phillips and Green 1991; Prickett 1990, 1992).

Special Objects

The special objects from Opito include adzes made from Nelson argillite and Tahanga basalt, a piece of worked nephrite and a gunflint. No adzes or objects made of these materials were recovered from Waiwhau or Puriri, but were found at both Raupa and Oruarangi.

Raupa excavations uncovered pieces of 14 adzes, one of which was made from Tahanga basalt measuring 130 mm long, 58 mm wide and 25 mm thick, the remainder were made of Waiheke greywacke: none were made from argillite, but there were some argillite flakes that could have been from adze making (Prickett 1990:90, 1992:91).

In the recorded collections from Oruarangi, identified 370 adzes were identified of which 115 were made from Tahanga basalt (Furey 1996). These are mostly small adzes, formed from larger broken adzes, measuring 50-79 mm long. Tahanga as a source of adze stone lost importance towards the end of the pre-European period, but continued to be available within the region. However, the examples from Oruarangi were often irregular, possibly because of inferior material, or because the skills for making flaked adzes had been lost (Furey 1996:119-120). Argillite was also used for 30 adzes and chisels (Furey 1996:104,111-3. These were also small, mostly being between 40-59 mm long. Like Tahanga, Nelson argillite was an important early source of adze material, being a very hard rock that could retain a fine edge, and continued to be used close to its source, but was relatively rare elsewhere in more recent times (Furey 1996:120).

At Raupa nine pieces of nephrite were recovered, which included all or parts of three pendants and five small chisels (Prickett 1990:118, 1992:35,62-3,92). The chisels were 8-10 mm wide and 5-7 mm deep at the mid-section, which is smaller than the Opita nephrite would have been if it had been

successfully separated. The kuru or kapeu form pendant from Raupa was only a fragment of the attachment.

The large Oruarangi assemblage contained 67 items made from nephrite, including 29 pendants of which 19 fell into the kuru style (a straight drop pendant) and measured 37-80 mm long, 6-15 mm wide and 3-9 mm thick (Furey 1996:38-40). There were also four chisel pendants (chisels with a hole drilled at one end) 20-47 mm long, 7-11 mm wide, and 3-8 mm thick. Ten nephrite chisels without attachments measured 4-9 mm long, with a blade width of 6-12 mm wide (Furey 1996:102-105). One wide chisel was in the process of being cut in two lengthwise to form two narrower chisels. The nephrite came originally from at least two sources: central Westland and south Westland. There was also material of bowenite (similar to nephrite and grouped as greenstone or pounamu) from Fiordland (Furey 1996:41).

Although one of the curio-hunters at Oruarangi referred to a jar containing 81 musket balls and flints, the context of these in the site is unknown (Furey 1996:176). No gunflints were found at the other sites, most of which had been abandoned before the musket wars. Raupa was abandoned after the Ngapuhi incursion in 1821, when Ngapuhi had guns, but the defenders did not, and it was not refortified as a musket pa.

Chert

A total of 1258 pieces of chert weighing 16,345 g were found at Raupa, but of these only about 10% had signs of use-wear and the majority was shatter rather than deliberate flaking (Prickett 1992:95-6). Most came from a possible working floor that was estimated to date around 1810 (Phillips 2000a: 137). There was a marked contrast between the high utilisation rate of obsidian compared to the much lower rate seen in the chert (Prickett 1992:38). Although most of the use-wear was on cutting tools, drill points and a hammerstone were also found.

At Waiwhau a few pieces of chert, some of low quality, were found in Areas 1 and 2, with 26 pieces in Area 4. In the latter group some flakes showed signs of use-wear and a few appeared to have been used as drill points (Phillips and Green 1991:169). One chert cobble had been used as a hammerstone (Phillips 1988:62-3).

Among the Puriri sites chert was recovered from T12/882 (8 flakes), T12/883 (2 flakes) and T12/318 (8 flakes) (Bedford 1994:171). Only the latter site contained flake tools.

Only 19 chert flakes are in the Oruarangi assemblage, as well as several unmodified chert cobbles, four chert drill points and five hammerstones, but there is a strong collector bias and it was reported that there was far more present in the site (Furey 1996:151-2).

Other lithics

At Opita sandstone, pumice and quartz were among the other stone materials recovered.

The Raupa assemblage included 13 grindstones of flaggy andesite, sandstone, pumice and possibly quartz (Prickett 1992). Pumice was also used for small pots and possibly a gourd stopper. Other stone found included greywacke, petrified wood and hangi stones of several types.

Other stone material from Waiwhau included sinter and greywacke flakes (possibly some from adze repair), ochre, an andesite sinker, sandstone abraders and a pumice fishing float.

Puriri also contained one or two small flakes of quartzite and chalcedony in T12/882 and 883 (Bedford 1994:171).

At Oruarangi pumice bowls and lids (40) were recovered, as well as sandstone files and grindstones (67) and obsidian flakes (140). Stone flutes known as nguru (31) were recovered, made locally from

sandstone, tuff, ignimbrite, pumice and clay; one was a modified clay pipe. However, apart from these and the other materials mentioned above, the most common lithic material (over 33% of the 1,100 items) was greywacke used for adzes, fishing sinkers, patu muka, patu onewa and other items (Furey 1996).

Summary

The majority of these lithic items were found in four areas at Opita.

Square D and Trench T contained 11 items, including a sandstone abrader and one or more waste chert flakes. This is consistent with a small temporary pre-contact camp.

Square E and Trench T had five items, including one waste chert flake. The other evidence from here suggests that the excavation was close to another small pre-contact camp site.

Square M and Trench B contained four items, including a chert core and two waste flakes. This investigation uncovered midden from what might have been a more extensive kainga. Possible working of chert, rather than just use, indicates a broader range of activities.

Squares F and H and Trench C contained the majority of the lithic material, with four items in layer 8, four in layers 6 and 7, ten in layers 4 and 5, none in layer 3 and one in the disturbed upper deposit.

Artefacts in layer 8 included the argillite adze, a piece of worked nephrite and the larger chert flake. This relative richness in artefacts, especially considering the small area opened up indicates that this was an important kainga, possibly associated with an occupation at Raupa in the late pre-contact phase.

The items in layers 6 and 7 included the smaller chert flake, waste flakes and a piece of pumice. These were associated with the lower midden. Again this suggests a range of activities taking place.

In layers 4 and 5, which related to the period of Opita pa, there was a gunflint, a small waste chert flake, and a number of small unidentified stones that may have been brought to the site with other resources, such as hangi stones or shellfish. The gunflint shows that at least one of the inhabitants had a musket, while the waste chert may indicate they also used chert as tools on occasion.

The assemblages from these sites are consistent with the range of lithic material also brought to Waiwhau and the Puriri sites, but distinctly different to the range and variety of materials and artefacts found at Raupa and, especially, Oruarangi.

References

Bedford, S.H., 1986. *The Excavation of the Halfway House Hotel Site*. Cromwell: New Zealand Historic Places Trust.

Furey, L., 1996. *Oruarangi: The Archaeology and Material Culture of a Hauraki Pa*. Auckland: Bulletin of the Auckland Institute and Museum 17.

Phillips, C., 1986. Excavations at Raupa Pa (N53/37) and Waiwhau village (N53/198), Paeroa, New Zealand, in 1984. *New Zealand Journal of Archaeology*, 8:89-113.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Phillips, C., and R.C. Green, 1991. Further archaeological investigations at the settlement of Waiwhau, Hauraki Plains. *Records of the Auckland Institute and Museum*, 28:147-183.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Prickett, N., 1992. Archaeological excavations at Raupa: The 1988 season. *Records of the Auckland Institute and Museum*, 29:25-101.

Te Ara-The Encyclopedia of New Zealand, 2009. New Zealand's pounamu deposits. www.TeAra.govt.nz/en/pounamu-jade-or-greenstone/1/2

Appendix 5 Slate and Slate Pencils

Gerrard Carter and Caroline Phillips

At Opita 25 fragments of slate were found, along with five fragments of slate pencil. These fragments came from three areas, and possibly amounted to only five items: two writing slates and three slate pencils. The slate fragments and the pencil fragments were divided into groups by area, they were then weighed and the slate pencils were measured. The average (mean) weight was calculated for each area.

Trench B

A total of 15 slate fragments were found near the 26 m mark in Trench B. They were located in the layer underneath the topsoil. The fragments were found in association with two pig teeth, a fragment of clay pipe, and a trace of charcoal. On returning to the lab, it was found that some of the slate pieces could be fitted together.

The fragments range in weight from .01g-21.5 g, the average being 2.82 g. The two largest pieces appear to have both faces of the slate intact. One face of the slate bears parallel lines that are 6 and 12 mm apart, and on the reverse there is a 14 mm wide etched grid. Slates found at Karamuramu were incised with parallel lines 11-14 mm apart (Spring-Rice 1983).

Table 1. Location and number of writing slates and slate pencils.

Sample No	*Location Trench/Square*		*Layer*	*No. pieces*	*MNI*	*Description*
34	B	26m	3	15	1	Writing slate with parallel lines & grid on reverse
187a	F	B5	4	4 1	1 1	Writing slate Slate pencil
346a	F	C5	4	1		Slate pencil
20	T	103.3m	2/3	1	1	Writing slate
405	R		3	3	1	Slate pencil
Total				**25**	**5**	

Square F

Two adjacent metre squares in layer 4 Square F were found to contain slate remnants.

B5: Four pieces of slate and one fragment of slate pencil head were found. The slate fragments had an average weight of 1.9 g, the pencil weighed 0.86 g and measured 2.5 cm. The pencil had apparently been sharpened into a hexagonal head - perhaps whittled. The fragments were found in association with bone, nail pieces, clay pipe and glass.

C5: A fragment of slate pencil head, 2.9 cm long, 0.7 g in weight, was found. The pencil shows signs of wear on two surfaces.

Trench T

A small fragment of writing slate was found at 103 m along the trench, which was near a scatter of other materials, including hangi stones, obsidian and bone.

Square R

Three fragments of slate pencil were found in layer 3. They were found in association with a piece of kauri gum, and two fragments of red underglaze transfer ware ceramic.

Two of the pieces are the heads of slate pencils, these are 4.75 cm and 3.0 cm in length, and weigh 2.47 g and 1.45 g respectively. Both the heads show signs of having been whittled, and one head bears an incised groove 1.2 cm from the tip. The third fragment, 2.5 cm in length, and 1.08g in weight, is either a section of the shaft of a pencil or else is the damaged head of a pencil. It may be the case that the three fragments represent one slate pencil.

Discussion

The writing slate assemblage from Opita is very small: a total of 25 pieces that could be from only five items.

Writing on slates became the "the heart of children's education" from the beginning of the nineteenth century when Joseph Lancaster developed a method of mass education (Hall 2003). Although New Zealand slate was known, writing slate was imported from England and Wales (Clough pers. comm.). As Hall (2003) comments:

> "The slate is a relatively efficient technology. It is hard wearing, portable and as marks made upon it with another softer piece of slate (usually in the form of a slate pencil) are erasable, it is capable of being used over and over again. It is relatively cheap technology, slate being found in many locations and easily split into thin slabs".

The presence of slate in the Opita artefactual assemblage provides a broad time frame, since slate was used in New Zealand as a writing material throughout the nineteenth century and up to 1930 (Spring-Rice 1983).

The presence of writing slate does imply educational activity of some type, presumably initiated by the missionaries, in which case they probably date after 1833 when the CMS established a mission at Puriri.

Slates were also found in two Maori settlements at Puriri. T12/340 was the site of a 1880s household where there were children (Bedford 1994). The assemblage contained a minimum number of 27 pencils and a number of writing slate fragments, two of which had etched lines. T12/883 had three fragments each of pencil and board.

No slate materials have been found at either Raupa (Phillips 1986; Prickett 1990, 1992), or at Waiwhau (Phillips 1988; Phillips & Green 1991).

References

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Hall, N., 2003. The role of the slate in Lancastrian schools as evidenced by their manuals and handbooks. *Paradigm*, 2(7):46-54. Available online at http://faculty.ed.uiuc.edu/westbury/paradigm/Hall.doc

Phillips, C., 1986. Excavations at Raupa Pa (N53/37) and Waiwhau village (N53/198), Paeroa, New Zealand, in 1984. *New Zealand Journal of Archaeology*, 8:89-113.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Phillips, C., and R.C. Green, 1991. Further archaeological investigations at the settlement of Waiwhau, Hauraki Plains. *Records of the Auckland Institute and Museum*, 28:147-183.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Prickett, N., 1992. Archaeological excavations at Raupa: The 1988 season. *Records of the Auckland Institute and Museum*, 29:25-101.

Spring-Rice, W. 1983. The history and archaeology of Fort Galatea, Bay of Plenty, New Zealand, 1869-1969. Unpublished MA thesis, University of Auckland, Auckland.

Appendix 6 Ceramic Analysis

Gerrard Carter and Caroline Phillips, with assistance from Janice Adamson

A range of ceramics, totalling 169 sherds, was found at seven locations in the Opita excavations (Table 1, Attachment).

This report looks at the ceramic assemblage from Opita. The objectives of this study are threefold:

a) To look at the intra-site variation in the ceramic assemblage.

b) To attempt to provide a time frame for events at Opita through the dating of the ceramics

c) To compare this assemblage with the neighbouring Raupa, Waiwhau and the Puriri Stream sites.

Table 1. Location of ceramics found at Opita (note in other tables the sherd found at 20 m in Trench B is included with the rest of Trench).

Location		*Layer*	*No. pieces*	*MNI*	*Description*
Trench/ Square	*Trench Distance*				
B	20 m	2	1	1	earthenware
B	87-93 m	3	93	12	porcelain, stoneware, earthenware
U	21 m	3	1	1	earthenware
F		3	4	3	earthenware
F		4	2	1	earthenware
F		5	4	2	porcelain, earthenware
H		3	59	7	porcelain, earthenware
R		3	2	1	earthenware
S		2	3	1	earthenware
Total			**169**	**29**	

Analysis

Preparation

On returning to the laboratory the sherds were first cleaned by washing in warm water and gentle brushing1. The cleaned and numbered sherds were then divided up by the area in which they had been found, they were further divided up by layer when this was appropriate. Then the sherds were divided by type, into earthenware and porcelain, stoneware.

1 Carter's original analysis notes the following "The sherds were then assigned a number, from 1-167, this was done so that the sherds could be manipulated without confusion. The numbers do not correspond to the finds bag in which they were placed, as in many cases more than one artefact was placed in the bag." Unfortunately he did not record the original field numbers or his laboratory numbers, and rebagged all the samples under one number (which was the site number) – Caroline Phillips.

Refitting

It was found that quite a few of the sherds could be refitted, indeed, on refitting, two of the vessels were found to have provided 27% of the entire assemblage. These were a willow-pattern bowl and Staffordshire jug from layer 3 and the ditch fill in Square H.

The minimum number of vessels was calculated for each area, and vessel form was ascertained (Table 2). However, because many of the sherds were small all identifications are tentative, except in the cases where refitting allowed a large view of a particular vessel.

Table 2. Distribution of vessel forms (including the button) and minimum number by area.

Vessel form / *Location Trench/ Square*	*Button*	*Bowl*	*Cup*	*Toilet Dish*	*Toilet Dish, porcelain*	*Jug*	*Jug/cup, porcelain*	*Necked, porcelain*	*Dinner Plate*	*Tea Plate/ Saucer*	*Unid.*	*Total*
B		1	1	2	1	2		1	1	1	3	**13**
U									1			**1**
F layer 3										1	2	**3**
F layer 4											1	**1**
F layer 5							1		1			**2**
H layer 3	1	1					1		1	1	2	**7**
R										1		**1**
S											1	**1**
Total	**1**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**4**	**4**	**9**	**29**

Condition

Most of the sherds were in good condition, however, those found in Trench B between 87-93 m showed signs of having been in a fire. The majority of the porcelain and the undecorated glazed earthenware sherd came from this area and some of the fragments were particularly small and little idea as to their form could be gained

Dating designs & mark

The decorated sherds were subjected to further analysis (Tables 3 & 4). It was hoped that the designs, or the marks found on two of the sherds, could be positively identified and provide a time frame for the events at Opita.

Because the sherds with the designs on them were fragmentary some in the assemblage could not be identified with certainty. The number of designs appears in the Opita assemblage (Table 3). Blue underglaze transfer-ware was found to comprise 32% of all designs. Willow-pattern vessels made up 50% of the blue underglaze sample.

Table 3. Number of decorated vessels by area.

Decorative finish / *Location Trench/Square*	*Banded ware*	*Black underglaze transfer*	*Blue under glaze transfer*	*Green underglaze transfer*	*Hand painted design*	*Plain white*	*Red underglaze transfer*	*Total*
B	1	2	1	2		7		**13**
U			1					**1**
F layer 3	1		1		1			**3**
F layer 4	1							**1**
F layer 5			1			1		**2**
H layer 3	2		3			2		**7**
R							1	**1**
S			1					**1**
Total	**5**	**2**	**8**	**2**	**1**	**10**	**1**	**29**

Table 4. Datable ceramics at Opita (dates confirmed by Janice Adamson).

Location Trench/Square	*Layer*	*Description*	*Date*
B		Rd No	Post-1884
U	3		
F	3		
F	4		
F	5		
H	3	Doulton Burslem	1891-1902
R	3		Post-1870s
S	2		

The willow-pattern bowl excavated in Square H, was found to have a mark on it bearing the words Doulton and Burslem, inside an irregular mark surmounted by a coronet. Beneath this mark is the word England, and below that in larger print, willow-pattern (Plates 1, 2 and Table 3). This particular mark was used by Doulton and Co. Ltd. of Burslem, Staffordshire, between 1891 and 1902 (Eyles, 1980).

The other mark is fragmentary. It comes from a sherd excavated in Trench B, layer 2. This appears not to be a makers' mark, but a design-registration stamp (Plate 3). Registration numbers were prefixed by 'Rd No'. As this system was introduced in January 1884 the sherd can be no older than that (Godden 1978).

Two sherds proved to be of a design known as Asiatic pheasant. The two sherds are not associated with one another: one came from Trench B, and the other was found in the fill of the ditch in Square H (Plates 3, 4). Asiatic pheasant was the second most popular blue-printed design in the second half of the nineteenth century. The design was used by at least 24 makers right up to the Edwardian period (Coysh and Henrywood 1982).

Stratigraphy & Location

Over half (55%) the ceramic fragments were found in Trench B between 87-93 m and all come from layer 2, the layer directly beneath the topsoil (Plate 6).

The second most prolific area was in layer 3 in Square H (35%), and in the fill of a ditch that extended through to Trench C that had been cut down from layer 3 (the sherds from Trench C were combined with those of Square H in the analyses and tables). Fragments of a single willow-pattern bowl were found in the ditch fill and in layer 3. These scattered sherds were found to fit together (Plates 1, 2). The only button found also came from this area.

Nearby, three layers (3, 4 and 5) in Square F were found to contain ceramics. Layer 3 was the same horizon as the layer 3 of Square H. Layer 4 was a midden which contained charcoal and shell remains as well as cooking hearth features. Four ceramic fragments came from this layer. Layer 5, immediately below, contained two fragments of willow-pattern transfer print and one small fragment of porcelain.

The ceramics from Square R were found in layer 3, a mixture of soil and rock flour. This square was closest to Square F and Trench C.

The ceramics found in Square S, adjacent to Trench B, were also from layer 2, while the sherd found in Trench U was at the bottom of the topsoil layer.

Comparison with Raupa, Waiwhau and Puriri

The Opita ceramic assemblage allows little in the way of comparison with finds from the adjacent sites of Raupa and Waiwhau. No ceramics have been found at Waiwhau (Phillips, 1988, Phillips & Green 1990), and the only ceramic artefact to come Raupa is a fragment of plain white ceramic bowl dating to the late nineteenth or early twentieth centuries from an upper disturbed layer (Prickett 1992).

However, sites along the Puriri Stream do contain substantial amounts of ceramic material, especially T12/340, which was the location of a family home dating to the 1880s, and T12/883, which was probably another household of the same date (Bedford 1994). These contained a minimum number of 77 and 41 ceramic items respectively, which included six ceramic buttons in T12/340.

Not only is the amount of ceramic material greater in the Puriri than at the Opita sites, but the range of objects is also greater. In particular there are a number of toys in T12/340, while none were found at Opita. Interestingly the dates are similar, being around 1880, but the range of transfer print designs are different with willow-pattern being the most common in Square F/H in Opita, an assortment in Trench B, but a preference for Rhine and Rouen in the Puriri site T12/340 and Rhine and Asiatic pheasant in T12/883.

Discussion

Ceramics could have been introduced to Opita by Maori, or it could have come with the Europeans who visited or lived on the site. A European pig trader lived at Opita some time prior to October 1843 (Selwyn 1847), a chapel had been built there by 1846, and Europeans were in the vicinity later in the century while felling kahikatea. Towards the end of the century, the Rasmussen family who farmed the land, brought supplies up the Waihou River by barge; the barges were unloaded near or at Opita.

There may be three or more periods represented by the ceramic assemblages at Opita: the earliest being layer 5 in Square F; the second being layer 4 in Square F; and the latest being layer 3 in Squares F, H, and R. The number of ceramic items at the west end of Trench B, Square S and Trench U are too few to assign to a particular period.

There are several reasons to treat the Trench B ceramics as a discrete assemblage: the designs do not overlap with the collections in other areas (apart from the ubiquitous Asiatic pheasant); the one piece

of undecorated earthenware from an ink or storage vessel came from this area, as did the majority of the porcelain; and some of the vessels appeared to have been part of a toiletry set. This range in ceramic types suggests that a house stood nearby, and the evidence of burning on many of the pieces may indicate the it burnt down with all its contents.

Only one sherd from layer 3 in Square H bore a mark allowing it to be identified with some accuracy to the late n century (1891 at the earliest).

References

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Coysh, A.W., and R.K. Henrywood, 1982. *The Dictionary of Blue and White Printed Pottery 1780-1880*. Woodbridge, Suffolk: Antique Collectors' Club.

England, W., and V. Grouden, 1990. Kawau ceramic analysis. Unpublished student paper; University of Auckland, Auckland.

Eyles, E., 1980. *The Doulton Burslem Wares*. London: Hutchinson.

Godden, G., 1978. *Godden's Guide to English Porcelain*. London: Granada.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Phillips, C., and R.C. Green, 1991. Further archaeological investigations at the settlement of Waiwhau, Hauraki Plains. *Records of the Auckland Institute and Museum*, 28:147-183.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Prickett, N., 1992. Archaeological excavations at Raupa: The 1988 season. *Records of the Auckland Institute and Museum*, 29:25-101.

Selwyn, G. A., 1847. *New Zealand. Part 1, Letters from the Bishop to the Society for the Propagation of the Gospel, together with Extracts from his Visitation Journal, from July 1842 to January 1843*. London: Society for the Propagation of the Gospel. 3rd Edition

List of Plates

Plate 1. Willow-pattern bowl, showing makers' mark: Square H, layer 3.

Plate 2. Willow-pattern bowl, showing design: Square H, layer 3.

Plate 3. (Left to Right): Porcelain dish, Trench B, layer 2; Blue underglaze transfer print, Asiatic pheasant, Square B, layer 2; Registration mark, Square B, layer 2; Banded ware, rim sherd, Square H, layer 3.

Plate 4. (left to Right):

Top row: Red underglaze transfer print, Square R; Green underglaze transfer print, B2; Blue underglaze transfer print, Asiatic pheasant Square H, ditch fill;

Bottom row: Green underglaze transfer print, Square F, layer 3; Blue underglaze transfer print, Square F, layer 3; Banded ware, Square F, layer 4/5; Blue underglaze transfer print, Square H, layer 3.

Plate 5. Staffordshire jug, Square H, layer 3.

Plate 6. Black underglaze transfer print, Trench B, layer 2.

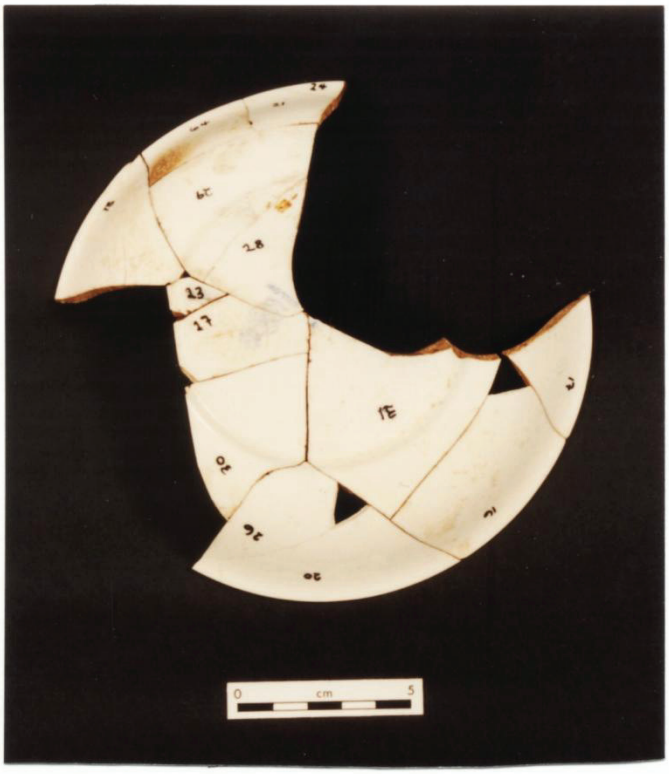


Plate 1

Plate 2

Plate 3

Plate 4

Plate 5

Plate 6

Attachment – Table Of Ceramics

(comments by Janice Adamson indicated by JA)

Area	Layer	No. Items	Type	Details	Design	Form	MNI	Mark	
F	3	1	Ceramic	Earthenware	Blackline edging	unid	1		
F	3	2	Ceramic	Earthenware	Willow pattern	plate/saucer	1		
F	3	1	Ceramic	Earthenware	Green leaf	unid	1		handpainted
F	4	2	Ceramic	Earthenware	Black line edging	unid	1		
F	5	3	Ceramic	Earthenware	Willow pattern	dinner plate	1		non-diagnostic regarding age JA
F	5	1	Ceramic	Porcelain	Plain	?jug	1		
H	3	28	Ceramic	Earthenware	Blue banded ware	bowl	1		unusual upright form JA
H	3	2	Ceramic	Earthenware	Plain	button	1		
H	3	5	Ceramic	Earthenware	Blue transfer	unid	1		
H	3	5	Ceramic	Porcelain	Plain	cup	1		
H	3	1	Ceramic	Porcelain	Pink banded	unid	1		
H	3	16	Ceramic	Earthenware	Willow pattern	saucer	1	Doulton	post 1891 from mark & teaset JA
H	3	1	Ceramic	Earthenware	Asiatic Pheasants	dinner plate	1		
H	3	1	Ceramic	Earthenware	Plain	unid			
B	2	1	Ceramic	Porcelain	Plain	dish	1		?part of toilet set
B	2	1	Ceramic	Porcelain	Plain	necked contaner	1		
B	2	26	Ceramic	Porcelain	Plain	unid			tiny fragments
B	2	2	Ceramic	Earthenware	Blue banded ware	plate/saucer	1		
B	2	2	Ceramic	Earthenware	Green birds transfer	unid	1		
B	2	5	Ceramic	Earthenware	Black transfer	serving dish	1		?soap dish JA
B	2	3	Ceramic	Earthenware	Black transfer	serving dish	1		?toothbrush container JA
B	2	1	Ceramic	Stoneware	Brown	?ink bottle	1		
B	2	1	Ceramic	Earthenware	Plain	jug handle			
B	2	1	Ceramic	Earthenware	Plain	unid		Rd mark	format adopted after 1884 JA
B	2	2	Ceramic	Earthenware	Green transfer	unid	1		
B	2	1	Ceramic	Earthenware	Plain	cup (base)	1		
B	2	1	Ceramic	Earthenware	Asiatic Pheasants	dinner plate	1		
B	2	24	Ceramic	Earthenware	Plain	?jar	1		
B	2	1	Ceramic	Earthenware	Plain	fluted (body sherds)	1		
B	2	16	Ceramic	Earthenware	Plain	unid			burnt fragments
B	2	4	Ceramic	Earthenware	Plain	unid			melted glass onto one fragment
B	2	2	Ceramic	Earthenware	Plain	?bowl	1		
R	3	2	Ceramic	Earthenware	Red transfer	tea plate	1		Japanese design post 1870s JA
S	2	3	Ceramic	Earthenware	Willow pattern	unid	1		
U	2	1	Ceramic	Earthenware	Blue transfer	?dinner plate	1		
		169					**29**		

Appendix 7 Analysis of the Tobacco Pipe Smoking Artefacts

Stuart Bedford and Caroline Phillips

A total of 108 fragments of tobacco pipe material from a minimum of 16 pipes were recovered from the Opita sites (Figure 1). The analysis involved first cleaning the items, then an attempt was made to identify different pipe styles and makers' marks, to date the pipes and comment on their distribution throughout the site. A comparison is then made with other sites along the Waihou River.

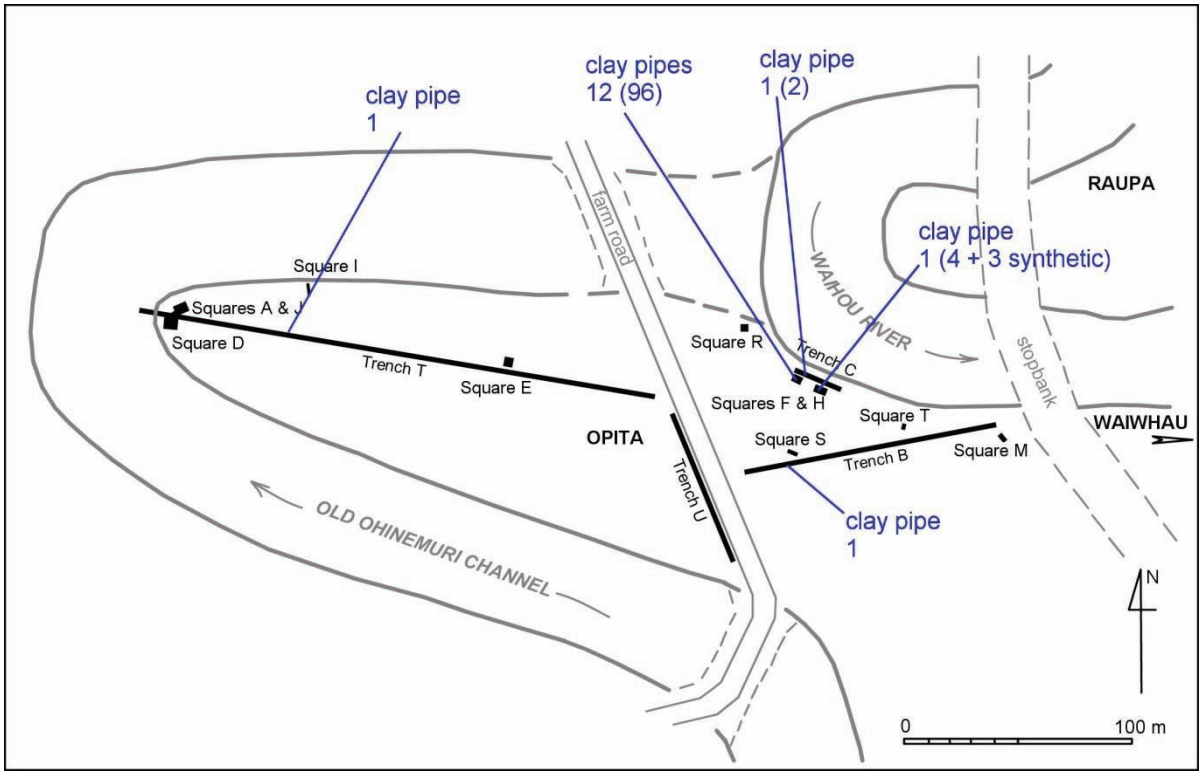


Figure 1. Distribution of clay pipes, with MNI and number of fragments in brackets.

The dating of clay pipes is made possible by their shape and distinctive markings, including makers' names. The usefulness of clay pipes for the dating of sites has a long history overseas, particularly in England and the United States where pipes date from the seventeenth century. The form of the pipes from this period until the nineteenth century changed greatly: and these changes have been extensively researched (see Binford 1962; Davey 1979, 1980, 1983; Oswald 1975).

In New Zealand the pipes are restricted mainly to the nineteenth century, a period when styles did not change radically so there is more concentration on makers' marks when dating pipes. Due to the fact that tobacco smoking was extremely popular in the nineteenth century, that clay pipes were cheap, easily broken and survive in the ground, they are a particularly useful component in archaeological sites. This was highlighted by Gathercole as far back as 1962 when discussing the problems of dating nineteenth century sites in New Zealand (Gathercole 1962:2). A lot of work has been done in New Zealand since then, namely Prickett 1981a, 1981b, Rusden 1982, Spring-Rice 1982, Foster 1983, Ritchie 1986, Goodwyn 1989, and Brassey and Macready 1994.

A minimum number of 16 tobacco smoking pipes recovered from Opita, the number derived from a tally of heels (Figure 2a), or in the case of two pipes, where a heel would have been. The majority of the material was made of white ball clay, with three stems being made of synthetic material. The pipes

are firstly discussed by area and unless otherwise stated, are made of white ball clay (see Attachment 1). Those with distinguishing features are illustrated (Figure 2). Comparison is also made between the neighbouring sites of Raupa and Waiwhau.

Finds by Area

Trench T

The only pipe fragment from this area is an intact bowl (Figure 2 b) from the topsoil layer, decorated with the U.S. flag on one side, a shield on the other and TD stamped on the rear of the bowl. On what remains of the stem a Figure '1' and the last letter of the origin of the pipe, which is a 'w' suggesting Glasgow, can be made out. It. It is thought to post-date the 1860s (Brassey pers. comm. 1991).

Trench B

At the 26 m mark (layer 2), part of a bowl, heel and 60 mm of stem were recovered. There were no distinctive markings.

Trench C

From layer 5, at the 11.7 m mark a part bowl, heel and stem (50 mm) was recovered. There were no distinctive markings. Another stem fragment was found close by.

Square H

From layer 3 of this area two pieces of synthetic amber pipe stem were excavated (Figure 2h). Similar material has been recovered from other sites in New Zealand (Prickett 1981a, Ritchie 1986). These reports suggest that this pipe type post-dates the 1860s. Another synthetic pipe is also from layer 3. It is a black vulcanite stem with the remains of a metal band on one end (Figure 2g). According to Walker these were not invented until 1878 (Walker 1983:39). Ritchie suggests a post-1865 development (Ritchie 1985:490) and illustrates several varieties which are either friction fit (as the excavated example is) or threaded stem types. A fragment of a clay bowl was also found in layer 3.

Clay tobacco pipe remains also appear in layer 5 with three bowl fragments, one with a heel, and part of a stem. No makers' marks or decoration was evident.

Square F

A minimum number of five clay tobacco pipes were recovered from layer 3 of this area (see Appendix 1). Four part bowl, heel and stem fragments were excavated, one part bowl and stem fragment with no heel (Figure 2f) was also recovered. One of the heels was embossed with a '4' (Figure 2c). There were ten bowl fragments, one of which was embossed T D (Figure 2e). Eight pipe stem fragments with no makers' marks were excavated from this area. One stem shows evidence of reuse (wear from teeth).

A minimum number of seven clay tobacco pipes were recovered from layer 4 (see Appendix 1). Four part bowl, heel and stem fragments, a single heel and two part bowl and stem fragments with no heel were excavated (Figure 2f). There were 45 bowl fragments, and two bowl fragments had embossed rouletting around the rim (Figure 2d). Nineteen pipe stem fragments with no makers' marks were excavated from this area. Three of these were brown glazed mouthpieces with end diameters ranging from 5.2 to 5.3 and 5.8 mm. Three stems show evidence of reuse (wear from teeth). The end diameters of these stem fragments range from 6.1 to 7.6 mm.

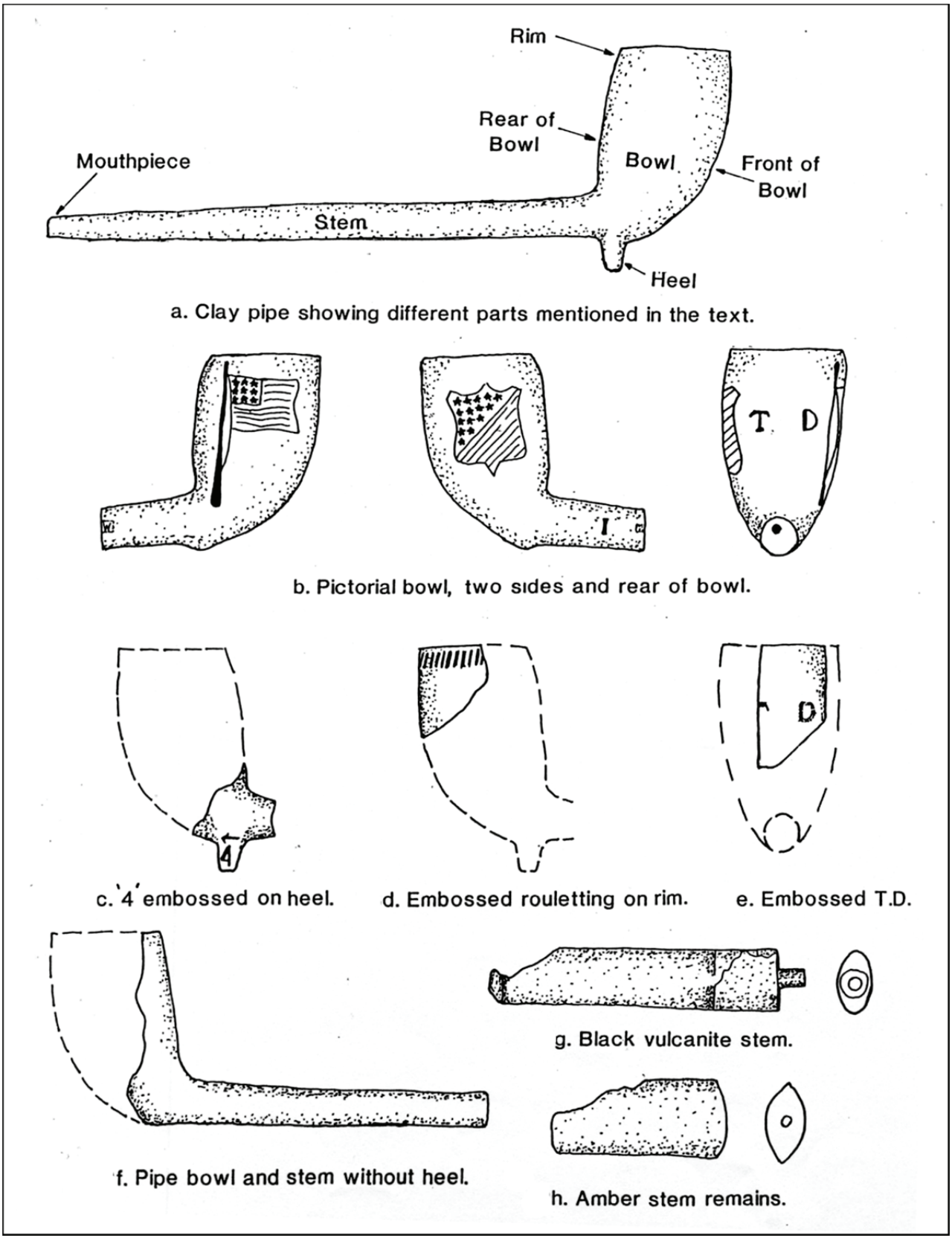


Figure 2. Tobacco smoking pipes from Opita.

Comparison with other sites

No clay pipes were recovered from Waiwhau, however one pipe bowl with no decoration was found in a disturbed upper layer of Raupa (Prickett 1992:75). It was thought to relate to the 1820s Maori occupation of Raupa.

Clay pipe material was found at Oruarangi and Te Kari, which are 18 and 31 km downstream respectively from Opita, however this material was not available for study (Green and Green 1963:33). Oruarangi, like Raupa, was abandoned in the early 1820s, while Te Kari was abandoned sometime in the late eighteenth century and reoccupied for a short time in the 1830s and again in the 1850s-60s (Phillips 2000:116, 125-6).

Clay pipes were more common in the later sites along the Puriri Stream (Bedford 1994:146-9). In T12/340 the upper historic layer, dating around 1880, contained 185 pipe fragments from a minimum of 34 pipes. Unlike those from Opita, 29 had a makers' mark (generally McDougall or Davidson) and the place of manufacture Glasgow impressed onto the stem. Two other sites (T12/318 & 833) each contained three or four fragments of a minimum of one clay pipe.

This evidence would tend to suggest that tobacco pipes began to be introduced into the area during the early 1820s, but increased in popularity later, as is shown by the Opita and especially the Puriri assemblages. It should be noted, however, that the collections from the earlier Oruarangi and Te Kari were not from research excavations and there are biases in the assemblages, so this comment should be read with caution.

Discussion

The only intact bowl from the site was found in the topsoil layer of Trench T, which suggests it either dates from the twentieth century, or more likely, has been disturbed by ploughing. The fragments of clay pipe that were excavated in Trench B were found in association with bottle glass dating to the 1870s.

In Square H, layer 3, three synthetic pipe stems were recovered which are dated after the 1860s.

Almost 90% of the clay pipe material comes from Square F, from layers 3 (21%) and 4 (68%). Two basic styles are represented, one with a heel and one without. There was no evidence of manufacturers' marks, with the exception of one bowl from layer 3 which was embossed TD. The clay pipe remains from layer 5 also had no distinguishing marks.

TD is an original makers' mark from the eighteenth century, a Thomas Dormer who made high quality pipes. Later, the mark was copied and appears on pipes for over 200 years. This mark (both embossed and impressed) has been found on pipes throughout New Zealand in sites dating from the 1840s to 1900 (Prickett 1981a, 1981b, Spring-Rice 1982, Ritchie 1985, Goodwyn 1989; Ian Smith pers. comm. 2011; Janice Adamson pers. comm. 2011).

All the bowl fragments showed signs of use i.e., they were blackened internally. Four of the stem fragments show evidence of reuse, i.e., after original mouthpiece has been broken. Evidence of reuse has also been found at other sites in New Zealand (Prickett 1981b, Spring Rice 1982, Ritchie 1985). Three original mouthpieces were recovered. All were brown glazed (to prevent ones lips sticking to the clay pipe), suggesting a Glasgow origin (Walker 1983:39). Certainly Glasgow was the major centre for exporting pipes in the nineteenth century (Davey 1983:11). The clay pipes are uniformly plain, apart from one embossed with TD and one with rouletting around the rim (Figures. 2d, 2e).

The limited range of decoration may be due to the distance from the source of supply and also that plain pipes were cheaper and more common. According to Rusden decorated pipes did not appear till the middle of the nineteenth century (Rusden 1982:8). However the clay pipe material excavated from Paremata, a site dating from the mid-1840s, has several examples of highly decorated pipes and many

with makers' names (Prickett 1981a). Of the 2003 clay pipe fragments found at the Victoria Hotel in Auckland dating from the 1860s, 214 (11%) have makers' marks and many have decorative features (Brassey and Mcready 1994). Decorated pipes may have become more common during the second half of the nineteenth century. This is certainly suggested by the Puriri material which, dating to 1880, is later than the Layer 4 Opita pipes (which is the level most came from).

Acknowledgements

We would like to thank Janice Adamson, Robert Brassey and Ian Smith for their assistance and comments.

References

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Binford, L., 1962. New method of calculating dates from kaolin pipes stem samples. *Southeastern Archaeological Conference Newsletter* 9(1):19-21. Papers presented at the 1st and 2nd Conferences on Historic Site Archaeology.

Brassey, R., and S. Macready, 1994. The history and archaeology of the Victoria Hotel, Fort Street, Auckland (R11/1530). Unpublished report.

Davey, P., (ed.) 1979. The Archaeology of the Clay Tobacco Pipe, 1. Britain: the Midlands and Eastern England. *British Archaeological Records*, British Series 63.

Davey, P., (ed.) 1980. The Archaeology of the Clay Tobacco Pipe, 3. Britain: the North and the West. *British Archaeological Records*, British Series 78.

Davey, P., (ed.) 1983. The Archaeology of the Clay Tobacco Pipe, 8. America. *British Archaeological Records*, International Series 175.

Foster, D., 1983. Clay pipes from the Cromwell District, Central Otago. *New Zealand Archaeological Association Newsletter*, 26(2):94-102.

Gathercole, P., 1961. Editorial. *New Zealand Archaeological Association Newsletter*, 5(3)2.

Goodwyn, J., 1989. Clay Tobacco Pipes from the Mechanics Institute, Auckland (1843-1879). *Archaeology in New Zealand*, 32(2):70-82.

Green, R.C., and K. Green, 1963. Classic and early European Maori sites on the Hauraki Plains. *New Zealand Archaeological Association Newsletter,* 6(1):27-34.

Oswald, A., 1975. *Clay Pipes for the Archaeologist*. British Archaeological Reports 14.

Prickett, N., 1981a. Clay pipes from Paremata. *New Zealand Archaeological Newsletter*, 24(2):l24-132.

Prickett, N., 1981b. The archaeology of a military frontier, Taranaki, New Zealand 1860-1882. Unpublished Phd thesis, Anthropology Dept., University of Auckland.

Ritchie, N.A., 1986. Archaeology and history of the Chinese in southern New Zealand during the nineteenth century: A study of acculturation, adaptation and change. Unpublished PhD. thesis, Anthropology Dept., University of Otago.

Rusden, K., 1982. *Clay Pipes: Their History and Varieties found in New Zealand*. Auckland: K.G. Rusden.

Spring-Rice, W. 1983. The history and archaeology of Fort Galatea, Bay of Plenty, New Zealand, 1869-1969. Unpublished MA thesis, University of Auckland, Auckland.

Walker, I.L., 1983. Nineteenth Century Clay Tobacco Pipes in Canada. In P. Davey (ed.) 1983. The Archaeology of the Clay Tobacco Pipe, 8. America. *British Archaeological Records*, International Series 175.

No.	Area	Location	Layer	Pieces	Comments	Date
3	T	65-70m	1	1	intact bowl and 20 mm of stem, broken heel, decorated with US flag and shield, impressed TD	1860->
33	B	26m	2	1	part bowl and heel plus 65 mm of stem	
59	C			1	pipe stem frag 32 mm	
79	C	11.7m	5	1	pipe stem 50 mm, plus heel	
311	H	B17	3	1	bowl frag	
321	H	D18	5	1	part bowl and heel plus 27 mm of stem	1830->
388	H	B16	5	2	burnt bowl frag and 31 mm of stem	
390	H	B16	5	1	bowl frag	
132	F	D5	3	1	stem frag 54 mm	
135	F		3	1	stem frag 48 mm	
136	F		3	2	pipe bowl frags	
138	F	C6	3	1	bowl and heel frag '4' embossed on heel	
140a	F		3	2	stem frag 32 mm & 50 mm, longer one with heel	
150	F	C6	3	1	bowl frag with embossed TD lettering 5 mm high	1840-1900
151b	F	C6	3	1	clay pipe	
153	F	D4	3	1	stem frag 40 mm with teethwear	
154	F	D7	3	1	bowl frag with stem and heel	
155	F	C7	3	1	bowl frag	
160	F	B4	3	1	bowl frag	
161	F	B7	3	1	stem frag 38 mm	
162	F	B7	3	1	stem frag with heel	
166	F	D5	3	1	bowl frag	
168a	F	C7	3	1	bowl frag	
171	F	C6	3	1	bowl frag	
172	F	C6	3	1	stem frag 22 mm	
192	F	B5	3	1	stem frag 15 mm	
200	F	B5	3	1	stem frag 42 mm	
203	F	B5	3	1	bowl frag	
204	F	B4	3	1	bowl & stem frag (no heel type)	
284	F	B7	4	4	bowl frags	
144	F	B4	4	1	stem frag	
178a	F	B5	4	1	heel	
180f	F	B5	4	1	bowl frag base (no heel type)	
185b	F	B5	4	3	bowl frags	
186b	F	B5	4	4	bowl frags	
205b	F	B4	4	1	part bowl and 65 mm stem, reuse (teeth wear), diam. at end=7.3 mm (no heel type)	
210a	F	B4	4	1	clay pipe	
237b	F	C4	4	2	stem frags 30 mm, 34 mm, shorter one has teeth wear	
238b	F	D6	4	1	stem frag 38 mm	1830->
247c	F	B5	4	1	bowl frag	
248d	F	B5	4	1	bowl frag	
250h	F	D4	4	1	bowl frag	
251b	F	B5	4	6	5 bowl frags and heel and part stem 20 mm long	
281b	F	D4	4	2	stem frags 18 mm, 42 mm, shorter one with brown glaze	
283b	F	C5	4	1	bowl frag	

286c	F	C4	4	4	4 bowl frags, 2 with embossed rouletting around rim
289b	F	B6	4	7	5 bowl frags, 2 stem frags, one 10 mm long, other 24 mm long with signs of teethwear, diam at end=6.3 mm
290a	F	B4	4	15	10 bowl frags, 1 stem and heel frag, 3 stem frags (20, 35, 40 mm long), + stem 25 mm long has remains of brown glaze
302	F	C5	4	1	stem frag 30 mm with reuse (teeth wear)
332	F	B4	4	1	clay pipe
343a	F	B6	4	1	stem frag 32 mm
344	F	B6	4	1	clay pipe
345	F	B5	4	2	bowl frag & stem frag
359	F	B7	4	1	stem frag 15 mm
361	F	B4	4	1	bowl frag
368	F	D4	4	2	bowl frags
369	F	D4	4	2	bowl frag with heel, stem frag 26 mm
372	F	D4	4	1	bowl frag with heel
400	F	B7	4	2	stem frags 30 mm, 28 mm
429a	F	B5	6	1	bowl frag, in posthole fill probably comes from Layer 4
				105	

Synthetic Pipe Material

No.	*Area*	*Location*	*Layer*	*NISP*	*Description*	*Date*
173	H	D14	3	1	part amber stem, 35 mm long, max width=1.6 mm and max diam=8 mm. Evidence of knife marks	1860->
277	H	B14	3	1	part amber stem, 24 mm long, max wideth=1 0mm, diam=10 mm	1860->
220	H	B14	3	1	bakelite stem with copper band, 65 mm long, max width=13 mm, max diam=9 mm	1880->
Total				3		

Heel or no heel type counted in MNI

Appendix 8 Brick Analysis

Gerrard Carter and Caroline Phillips

The Opita assemblage contains four brick artefacts, from three areas: Trench C, Square H and Trench B. The bricks were washed gently in warm water, so that any marks on the surface of the brick would not be erased, then dried and weighed.

Table 1: Distribution of bricks

Sample No.	*Location Trench/Square*		*Layer*	*No. pieces*	*MNI*	*Description*
49	B	26 m	2	1	1	One piece brick
65	B	26 m	2	1		One piece brick
58a	C	13.5 m	3	2	1	Two fragments of brick
?	H		3	1	1	One piece brick
Total				**5**	**3**	

It was found that relatively little analysis was appropriate for the Opita sample: the bricks did not bear any makers' mark, and sourcing was not considered useful because the production of bricks often involved the mixing of different clays from various sources as well as the introduction of other foreign materials, so chemical analysis of brick can lead to uncertain results (Eaves 1990).

Several typologies have been designed for bricks (Gurcke 1987), but the one deemed appropriate was that developed by Eaves (1990). This typology inclines more to the material attributes of the artefact than many others do. Eaves' typology has the added advantage of having been devised within the New Zealand archaeological context.

Table 2. Trench C, two fragments of brick

Shape		undefinable
Manufacture		wire-cut
Impressions		horizontal wire-cuts
Appearance	size	too fragmentary
	weight	275 g and 74.82 g.
	colour	pale yellow-cream
	glaze	none
	surface	the larger fragment had what appeared to be a band of dark colouring around one end, and suggests the brick may have been burnt after breakage
	condition	both fragments seemed to be quite friable
Matrix		small particle size in both

Table 3. Square H, one fragment of brick

Shape		undefinable
Manufacture		wire-cut
Impressions		horizontal wire-cuts
Appearance	size	too fragmentary
	weight	36.24 g
	colour	red
	glaze	none
	surface	none
	condition	harder than ones in Trench C
Matrix		finer matrix than Trench C

Table 4. Trench B, two fragments of brick

Shape		undefinable
Manufacture		wire-cut
Impressions		horizontal wire-cuts
Appearance	size	too fragmentary
	weight	171.39 and 11 g
	colour	pale yellow-cream
	glaze	none
	surface	none
	condition	friable like those in Trench C
Matrix		small particle size as Trench C

Discussion

The brick assemblage at Opita was comprised of five fragmentary pieces of two different types of wire-cut brick.

The information the bricks provide is minimal. The Opita sample provides no precise information about the date they were made: without makers' marks wire-cut bricks can provide little information on age, since the wire cutting process was utilised in brick production from 1879-1930 (Eaves 1990).

From the stratigraphy it seems apparent that the bricks all come from late in the site's occupation. The bricks from Trench C and Square H itself came from layer 3, the occupational horizon in which late nineteenth century glass and ceramics have been found. The brick fragment from Trench B came from layer 2: the layer directly below the topsoil. It was in this layer that ceramics post-dating 1884 were found and implies that the brick fragments date from the late nineteenth century.

No comparison is available with either Raupa or Waiwhau, as no bricks were recovered from those sites. However, the late nineteenth century Puriri sites did contain bricks (Bedford 1994). Some 134 fragments were recovered from T12/340, with much smaller amounts from two other sites (16 from T12/883 and 3 from T12/318). In T12/340 in particular, broken bricks were used as part of a causeway to gain access to a wharf or loading area from the stream. The causeway bricks were notable from being from a mixture of sources: hand- and machine-mixed, wire-cut and moulded, unglazed and partly glazed, and 11 different colours of clay. It was thought that they were reused at least once, but

none had mortar on any surfaces, so they might have been from ship's ballast. The same may be true of the few brick fragments found at Opita.

References

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Eaves, M., 1990. The heavy clay industry in Auckland, 1830-1930. Unpublished MA thesis, University of Auckland, Auckland.

Gurcke, K., 1987. *Bricks and Brick Making: A Handbook for Historical Archaeology*. Idaho: University of Idaho Press.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Phillips, C., and R.C. Green, 1991. Further archaeological investigations at the settlement of Waiwhau, Hauraki Plains. *Records of the Auckland Institute and Museum*, 28:147-183.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Prickett, N., 1992. Archaeological excavations at Raupa: The 1988 season. *Records of the Auckland Institute and Museum*, 29:25-101.

Appendix 9 Analysis of the Glass Artefacts from Opita

Stuart Bedford

Seventy-four fragments of glass artefacts were recovered from the Opita sites (Figure 1). The glass was first cleaned then separated into two categories, bottle glass and miscellaneous glass. The vast majority of the material was bottle glass. From the fragments, different bottle type/products were identified and then dated where possible. The dating of the bottle glass is done through the recognition of known changes in bottle manufacturing techniques along with changes in shape, glass colour and makers' marks may be embossed with the name and address of the company which produced the contents. Some bottle types have a very limited period of production, some are associated with specific products and others (usually later in the nineteenth century) may be embossed with the company's name and address which produced the contents. It is generally very difficult to date bottles from side fragments unless it is a very distinctive type. The changing technology in bottle manufacture, that can be dated, is most easily recognised from a bottle top or base fragment.

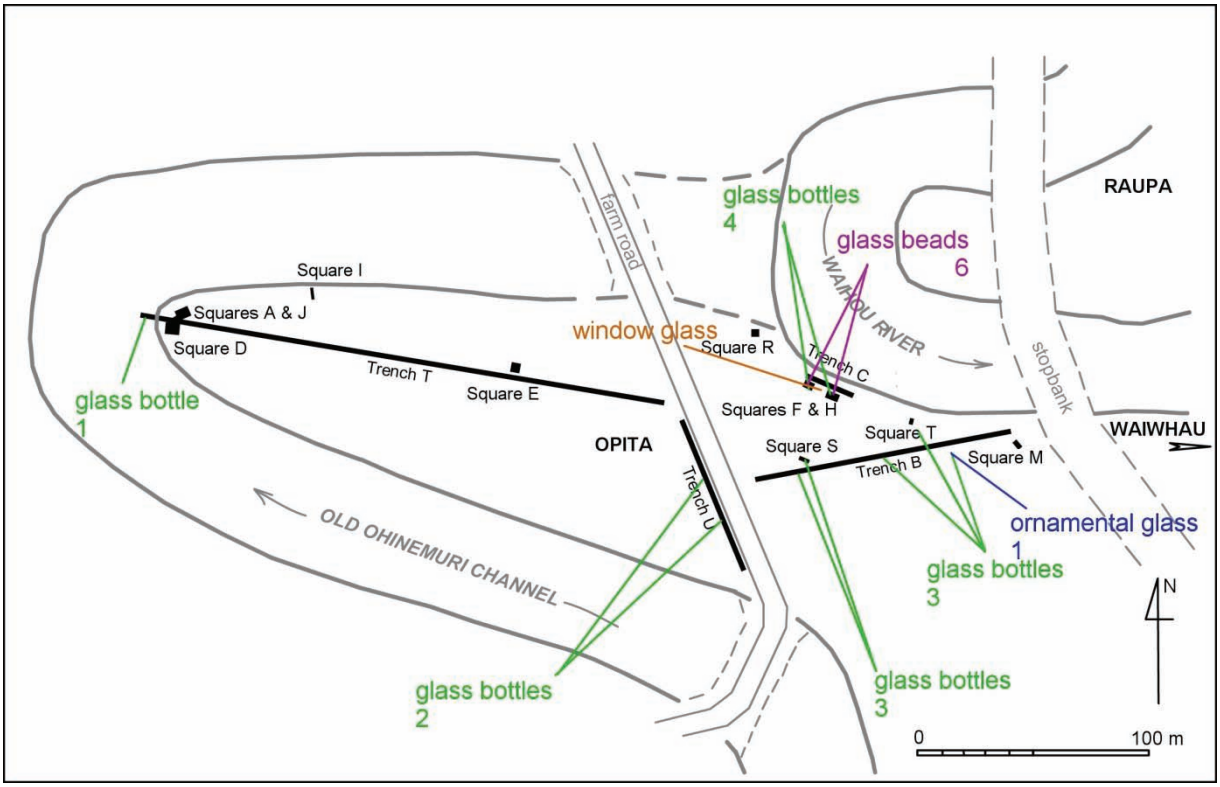


Figure 1. Distribution of the minimum number of glass objects found in the Opita sites.

There is a great amount of technical and historical material pertaining to the recognition and dating of bottles and glass containers, e.g. Fletcher (1972), Vader and Murray (1975), White (1978), Staski (1984), Tasker (1984). New Zealand archaeological reports where a large number of bottles and glass containers were excavated include Prickett (1981), Spring-Rice (1982), Ritchie and Bedford (1983), Bedford (1986), Ritchie (1986) and Brassey (1989).

The glass artefacts from Opita included a minimum number of 13 bottles, six glass trade beads, nine fragments of flat window glass and seven fragments of melted ornamental vessel.

The artefacts will be discussed by area (see tables in Attachments 1 and 2). Bottle types mentioned in the text are illustrated (see Figure 2). Comparison will also be made with the material recovered from the adjacent sites of Waiwhau and Raupa, and the sites on the Puriri Stream 24 km to the north.

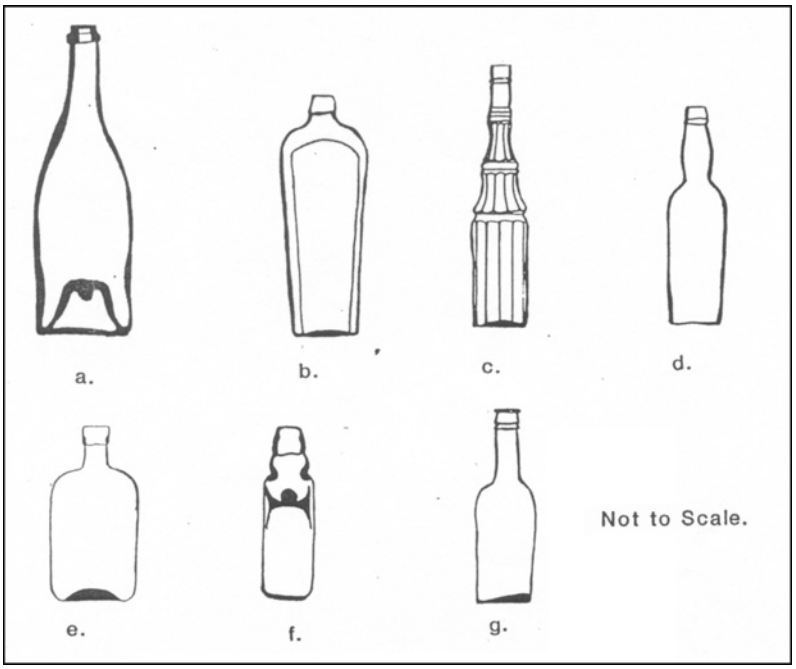


Figure 2. Bottle types and shapes: a = ring seal beer, b = case gin, c = Champions vinegar, d = spirit, e = flask, f = codd, g = condiment.

Finds by Area

Trench T

The glass material from this area consisted of a neck fragment of a codd bottle (Figure 2f) which dates to the c.1880s.

Trench B

All of the glass material from this area was excavated from layer 2, a cultural layer below the topsoil. The base and side fragments of a spirit bottle (Figure 2d) were found at the 26 m mark. The base has a slight kickup which bears the marks of a bare-iron pontil being used at the time of its manufacture (Tasker 1984:2). This dates the bottle from the 1870s to the 1890s. At the 60 m mark the partly-melted side and neck fragments of probably another spirit bottle were recovered. Between 87-93 m, there was evidence of a fire or that material from a fire was dumped here. One fragment of a case gin (Figure 2b) bottle and six fragments of melted and shattered glass were recovered from this mark. The vessel form to which these fragments belonged could not be identified.

Seven fragments of melted ornamental glass, consisting of layered, clear, pink and milk glass were also excavated from the 90 m mark. Vessel form is not known, but they are similar to melted fragments from the adjacent pa site of Waiwhau.

Trench U

Under the top layer of the rock flour at the 24 m mark two side fragments of a spirit bottle were excavated. These fragments could not be dated but as they were found so close to the rock flour layer a

date of 1900 is suggested. At the 45 m mark a clear glass fragment, possibly the shoulder of a flask (Figure 2e), was recovered. This probably post-dates 1900.

Square F

From layer 3 one neck fragment possibly from a vinegar bottle (Figure 2c), dating from 1880-1915, was excavated. Also from layer 3 was a small fragment of window glass. A glass fragment from the adjacent section C was included in this material.

Bottle glass from layer 4 consisted of only four body fragments of a bottle. Other glass material from this layer included 8 fragments of window glass. One piece initially recorded as coming from layer 7 came from the fill of a posthole that was cut from a higher level, i.e. layer 4.

Other miscellaneous glass included an amber coloured multi-faceted bead (Figure 3g, 3h) and a small intact dark blue bead (Figure 3c, 3d). A very similar example of the latter was excavated at Raupa (Figure 3b).

Square H

Fragments of two bottles were excavated from layer 3. One was the base and sides of a ring seal beer (Figure 2a) dating from the 1880s to 1910. The other is two side/corner fragments of a case gin bottle, which post-dates the 1870s as it appears not to be free blown. Also four amber beads came from a firepit in layer 3 (Figure 3e, 3f). These were larger than the beads from Area F.

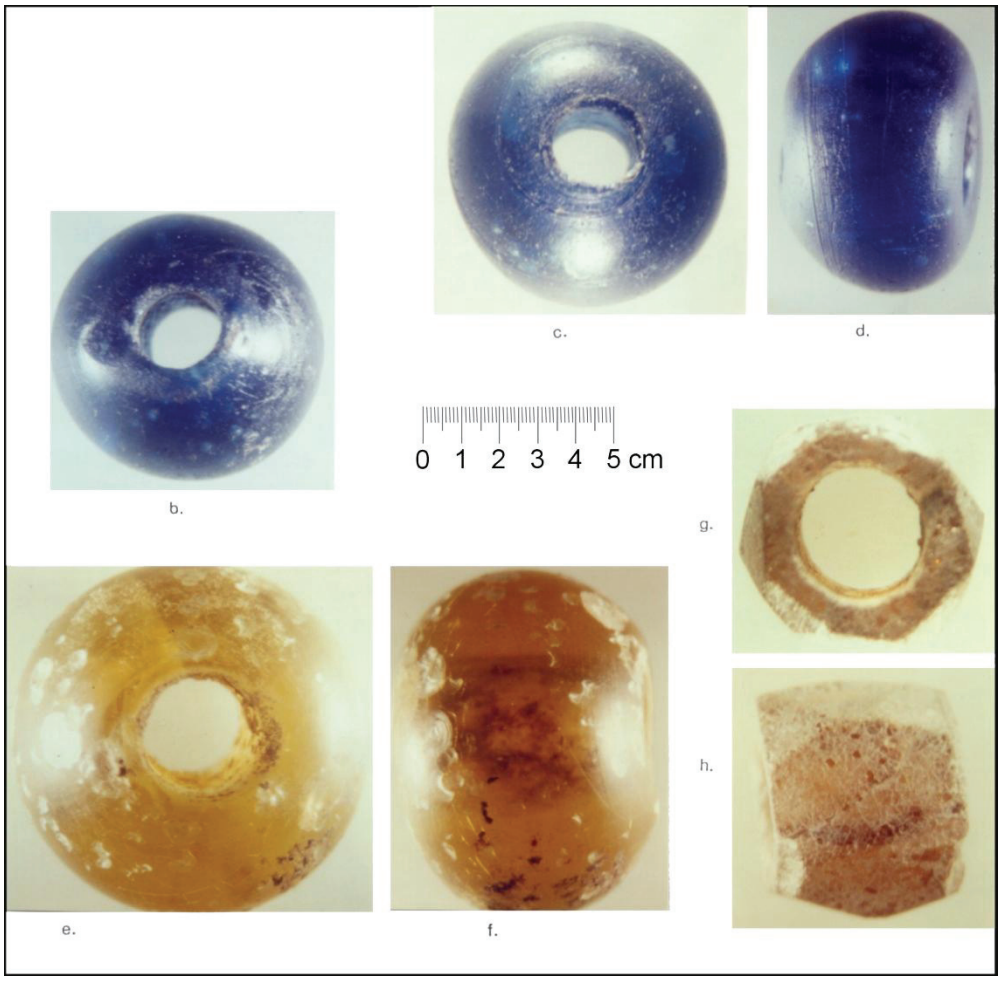


Figure 3. Miscellaneous glass objects: b = bead from Raupa, c & d = dark blue bead, e & f = amber bead, g & h = multi-faceted amber bead.

Square S

Fragments of two bottles were excavated from this area. One was the base and sides fragments of a spirit bottle dating from the 1870s to the 1890s. The other may possibly have been a condiment bottle (Figure 2g), only a side fragment was recovered.

Square T

This small excavation had two amber fragments, probably of a twentieth century beer bottle imbedded in the rock flour.

Comparison with Raupa, Waiwhau and Puriri

The total glass material from Waiwhau consisted of only a small fragment of window glass, a marble and two pieces of melted ornamental glass (mentioned above). All of this material was recovered from a disturbed area (Phillips 1988:69).

The glass material from the 1987 excavations at Raupa is divided into areas. From area 1 fragments of a wine bottle of nineteenth century shape were recovered. According to Prickett this is related to farming activity. The fragment of aqua coloured window glass from Area 2 is also related to European activity. From Area 3 another fragment of window glass (colourless) was recovered. The layer had been disturbed. The only glass bottle remains which were possibly related to the Maori occupation of Raupa were two tiny green glass fragments from a nineteenth century wine type (Prickett l990).

From the 1984 excavations in Area 1 a small blue glass bead (Figure 3b) was found in a disturbed upper layer (Phillips 1986:99).

In contrast, the Puriri sites, in particular T12/340, yielded a large amount of glass material, including 28 alcohol and four aerated water bottles, eight pharmaceutical and 21 condiment vessels, 10 dishes, eight assorted object and 148 fragments of window glass (Bedford 1994). This was interpreted as relating mainly to a 1880s house belonging to a family with children. There were also 85 glass beads and, although some may have related to the earlier mission period (1833-37), most dated to the 1880s.

Discussion

Most of the glass artefacts recovered from Opita are bottle fragments, and those that could be dated appear to post-date the 1870s are similar to those from Puriri. From Trench T one bottle was identified as dating to the 1880s. The fragments of bottles from Trench B post-date the 1870s. From Trench U a minimum number of two bottles were excavated, probably dating after 1900. All the glass material from Areas F and H was recovered from layer 3, and the datable bottle fragments post-date the 1880s. The bottle fragments from Square S date from the 1870s to the 1890s.

The other main glass items were beads and window glass, found in Squares F and H. The beads and window glass in Square F were found in layer 4, and are presumed to date from some time after the mid-1830s when European buildings are known in the area and before the Layer 3 occupation of 1870-1900. In Square H, the amber glass beads were excavated from a circular firepit in layer 3, which is associated with the 1870-1910 bottles.

Glass trade beads have been excavated on sites in New Zealand and the Pacific and are generally thought to have been an early contact trade item (Green pers. comm.). The dark blue beads from Raupa and Opita both showed signs of wear around the hole running through the centre (Figure 3b, 3c), suggesting they were once strung together with other beads. When reporting to the Church Missionary Society on methods of keeping Maori children under control, the missionary Joseph Kendall suggests a system of rewards: “Suitable articles to present as rewards include, fish-hooks,

beads, combs for the hair, scarlet and yellow coloured worsted binding, common ear-rings and rings with and without stones of various colours, clasps, knives, scissors, needles, boy's whistles, birdcalls, or any other toys that will take little room (made of iron)" (Elder 1934:130).

The material which seems most likely to relate to the occupation of the 1830s to 1850s, as with the tobacco pipe material, is that from Area F, layer 4, namely the fragments of a dark green bottle, the window glass and the blue and amber glass beads. None of this material could be definitively dated but in the midden layer below (layer 6) there were no glass artefacts, suggesting a pre-1820s date. In the layer above (layer 3) glass bottle fragments dating to the 1880s were recovered. Also, that only two fragments of bottle glass were recovered along with a much larger collection of clay pipes, points to a period when alcohol was either not so readily available or not sought after. For the Thames-Waikato region this would be the period from the l820s to the 1840s. The window glass may relate to the Maori chapel which is mentioned by the missionary Rev. Charles Dudley in 1849 (see Appendix 17) and post-dates 1833 when the Church Missionary Society arrived in Puriri (Howe 1973:29).

Conclusions

The glass material recovered from the excavation proved to be very useful in interpreting the different areas of the site and layers within those areas.

In 1962 Gathercole stressed the need for increasing the amount of provenanced historical material from nineteenth century sites (Gathercole 1962:2). This has certainly been achieved for the period 1840-1900. With further excavations such as Opita, a greater understanding of the rapid changes occurring during this period may be generated, and along with this a greater interest in the material that is excavated.

Acknowledgements

I would like to thank; Heather Adams, firstly for her recovery of two glass beads while fine sieving the bulk sample material in search of bird and fish bone and secondly for supplying me with a copy of the 1848 sketch of Opita. Also Helen McCracken for directing me to some relevant historic quotes, and Rod Wallace for helping photograph the glass beads. Professor Roger Green, Caroline Phillips and Nigel Prickett assisted with their comments.

References

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Bedford, S.H., 1986. *The Excavation of the Halfway House Hotel Site*. Cromwell: New Zealand Historic Places Trust.

Brassey, R., 1989. Analysis of the artefact assemblages and faunal material. In R. Brassey, *Rediscovering Fort Ligar, Archaeology at R11/1656 Auckland*. Vol.2. Wellington: Science and Research Directorate, Department of Conservation.

Cameron, F.R., 1985. An analysis of buttons, clothing, hardware and textiles of the nineteenth century Chinese goldminers of Central Otago. Unpublished B.A. honours dissertation, Anthropology Dept, University of Otago, Dunedin.

Elder, J.R., 1934. *Marsden's Lieutenants*. Dunedin: A.H. Reed.

Fletcher, E., 1972. *Bottle Collecting*. Dorset: Blandford Press.

Gathercole, P., 1961. Editorial. *New Zealand Archaeological Association Newsletter*, 5(3)2.

Howe, K.R., 1973. The Maori responses to Christianity in the Thames-Waikato region 1833-40. *New Zealand Journal of History*, 7:28-46.

Phillips, C., 1986. Excavations at Raupa Pa (N53/37) and Waiwhau village (N53/198), Paeroa, New Zealand, in 1984. *New Zealand Journal of Archaeology*, 8:89-113.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Prickett, N., 1981b. The archaeology of a military frontier, Taranaki, New Zealand 1860-1882. Unpublished Phd thesis, Anthropology Dept., University of Auckland.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Ritchie, N.A., 1986. Archaeology and history of the Chinese in southern New Zealand during the nineteenth century: A study of acculturation, adaptation and change. Unpublished PhD. thesis, Anthropology Dept., University of Otago.

Ritchie, N., and S. Bedford, 1983. Analysis of the Glass Containers and Bottles from Cromwell's Chinatown. *New Zealand Archaeological Newsletter*, 26(4):235-258.

Spring-Rice, W. 1983. The history and archaeology of Fort Galatea, Bay of Plenty, New Zealand, 1869-1969. Unpublished MA thesis, University of Auckland, Auckland.

Staski, E., 1984. Just what can a 19th century bottle tell us? *Historical Archaeology*, 18(1):38-51.

Tasker, J., 1984. *Collecting Antique Bottles in New Zealand: A Guide for Beginners*. Wellington: Reed.

Vader, J., and B. Murray, 1975. *Antique Bottle Collecting in Australia*. Ure Smith, Sydney.

White, J.R., 1978. Bottle nomenclature: A glossary of landmark terminology for the archaeologist. *Historical Archaeology*, 12:58-67.

BOTTLES

No.	*Area*	*Location*	*Layer*	*#Pcs*	*Type*	*MNI*	*Base (mm)*	*Colour*	*Comments*	*Date*
78	C	7.1 m	4	1	unid			aqua	body frag	
147	T	2.5 m	2	5	codd	1		clear	top & neck frags	1880s
52	B	26 m	2	6	spirit	1	90	dark green	free blown, slight kick up	1870-1890
114	B	62.5 m	2	2	spirit	1		dark green	part melted body frags	
111b	B	9 3m	2	1	unid			clear	melted & shattered frags	
110c	B	93.4 m	2	1	unid			clear	melted & shattered frags	
93a	B	89.9 m	2	2	unid			clear	melted & shattered frags	
62b	B	90 m	2	2	case gin	1		dark green	side & body frags	
94a	B	91 m	2	2	unid			amber & clear	melted & shattered frags	
5	U	24 m	3	1	spirit	1		green	2 side frags	?1900
6	U	24.5 m	3	1	spirit			green	2 side frags	
23	U	45 m	2	1	?flask	1		clear	shoulder	post 1900
140b	Sq F		3	1	?vinegar	1		aqua	body frag	1880-1915
#	Sq F	B4	4	4	unid	1		dark green	side frags	
325	Sq H		3	11	beer	1	90	dark green	part base & sides of ring seal	1880-1910
*	Sq H		3	2	case gin	1		dark green	corner frags	post-1870
454c	Sq S		3	5	spirit	1	90	dark green	base & side	1870-1890
456c	Sq S		2	2	unid	1		dark green	side & body frag	
448	Sq T		1	2	unid	1		amber	body frags	post 1900
				52		**13**				

\# combination of bags 210b & 247b

* combination of bags 308 & 316

MISCELLANEOUS

No.	*Area*	*Location*	*Layer*	*#Pcs*	*Type*	*Height*	*Width (mm)*	*Colour*	*Comments*
63b	B	90 m	2	7	unid			pink/milk & clear	melted & shattered frags
170	F		3	1	window		1.5	clear	
182	F	B5	4	1	window		1.1	clear	
249c	F	B4	4	1	window		1.1	clear	
290e	F	B4	4	2	window		1.0	clear	
248f	F	B5	4	1	window		1.0	clear	
286d	F	C5	4	1	window		1.3	clear	
289c	F	B6	4	1	window		1.0	clear	
469	F	B7	7	1	window		0.9	clear	in fill of Layer 4 posthole
				16					

BEADS

No.	*Area*	*Location*	*Layer*	*#Pcs*	*Type*	*Height (mm)*	*Width (mm)*	*Colour*	*Comments*
233	H	firepit	3	1	bead	6.0	9.3	amber	
239	H	firepit	3	1	bead	6.5	9.3	amber	
240	H	firepit	3	2	bead	7.6	8.6	amber	
279a	F	C4	4	1	bead	4.9	7.2	dark blue	same as Raupa
250e	F	D4	4	1	bead	4.8	6	amber	multi-faceted
				6					

Appendix 10 Metal Analysis

Gerard Carter and Caroline Phillips

In the course of the 1991 University of Auckland Field School conducted at Opita 110 metal fragments of various artefact types were found, in nine of the excavated areas (Table 1).

Table 1. Location and numbers of metal objects found at Opita.

Location Trench/Square		*Layer*	*No. pieces*	*MNI*	*Description*
Tr. B	?90 m	3	1	1	nail
Tr. C	10.2 m	3	2	2	wire & nail
Sq. D		1 2	3 1	3 1	shotgun cartridges nail
Sq. F		3	10	4	nails, key, ring
Sq. F		4	23	8	nails, wire, iron, lead sheeting
Sq. H		3	56	16	file, wall bracket, tins, nails, fork, ring, shotgun cartridges, lead shot, bolts etc
Sq. S		3	7	6	nail, handle, chain, stirrup, hinge
Sq. T		1	4	2	“bed frame”, nail
Tr. T	30 m	1	1	1	horseshoe
Tr. U	19 & 26 m	3	2	2	nails
Total			**110**	**46**	

Analysis

The artefacts underwent several processes in the course of the analysis:

1) The artefacts were divided into groups by the area in which they had been excavated, these groups were further sub-divided by layer where this was appropriate.
2) Once sorted by area the artefacts were divided into functional categories: nails, tools/cutlery, household items, horse equipment, firearm equipment, tins and miscellaneous artefacts.
3) The artefacts were further divided based on their physical composition, into ferrous and cuprous categories.

Attempts were made to remove rust form the ferrous objects with pliers and a dental pick, but some were too rusted to withstand this treatment. Those that were treated were weighed and measured.

Selected artefacts were subject to more sophisticated analyses: three fragments of tin from Square H, layer 3 were found to have some sort of inlay (Plate 1). This inlay was analysed, using an electron microprobe in the Geology department, to determine the metallic composition.

A cuprous artefact identified as a knife handle (Plate 2) was also analysed using the electron microprobe to determine the composition of the metal. A piece was cut out of this handle by Rod Clough using a diamond wafering-blade, and also underwent metallography at the School of Engineering to determine the structure of the metal and thus the method of production of the artefact.

Artefacts by location and stratigraphy

All the artefacts came from a limited stratigraphic range and in only one area (Square F) did more than one layer contain metal artefacts.

Trench B

A nail was found in the cultural layer (Plate 3).

Trench C

A piece of ferrous wire and a nail head was found in layer 3.

Area D

Three shotgun cartridges were found in the topsoil (layer 1), and one ferrous nail was found in the rock flour (layer 2).

Square F

Three layers in Square F were found to contain metallic artefacts: layers 3, 4 and 5/6. In layer 3 seven ferrous nail fragments were found, along with two fragments that seem to have come from an iron key. A cuprous ring was also recovered from this layer.

In layer 4, 16 ferrous nail fragments were recovered, along with a tack, a piece of ferrous wire and two fragments of iron so heavily rusted that it was impossible to tell what they were. At the interface between layers 5 and 6, two ferrous nail fragments were found, along with a piece of thin lead sheeting. These may have penetrated via scoops cut in layer 4, and are included in the following tables with the material from layer 4.

Square H

This square yielded 32% of the entire metallic assemblage from Opita. A greater variety of artefact types was found in this area than in any of the other areas. These included: a 22 cm iron file weighing 102.63 g. with triangular cross-section; an object thought to be a wall bracket (Clough, pers. comm.) weighing 241.17 g; 18 fragments of tins (three with a nonferrous inlay); 15 nail fragments; the remains of an iron table fork with three tines, 16.4 cm in length weighing 77.89 g; a non-ferrous ring; two shot-gun cartridges; one lead shot weighing 14.54 g from a muzzle-loading firearm (Plate 4); three fragments apparently from a bolt or perhaps the remains of metal handles; and 13 unidentifiable amorphous metallic fragments. One piece of metal was found in layer 5, but as with Square F it had probably penetrated via a posthole from layer 3, and is incorporated with the layer 3 material.

Square S

A mixture of artefacts came from this area. All were found in the cultural layer: the layer under the rock flour layer. Fragments of one nail were found; a cuprous handle inlay; a section of chain (Plate 5); a stirrup (Plate 6); the remains of a hinge in two heavily rusted pieces; and one metal fragment. These fragments were found in association with other artefacts: bottle glass, bone and kauri gum.

Square T

The artefacts found in Square T were all found in the topsoil, and comprised three fragments, weighing in total 154.59 g, of what was facetiously described as being a bed frame, but what could indeed be part of farm machinery. A nail head was also found.

Trench T

One horseshoe from a draught horse was found at the 30 m mark, in the topsoil.

Trench U

One bent nail and one nail fragment were found at 26 m and at 19 m respectively, these came from the cultural layer and were associated with a small lens of charcoal.

Functional categories

The artefacts were categorised by function to give an indication of the activities occurring at Opita (see Table 2).

Nails

Nails make up 26.4% of the Opita metal assemblage. The nails were not well-preserved so a minimum number was calculated by counting the number of nail heads, thus, although there are 47 nail fragments a minimum number of 17 nails was derived. It had been hoped to divide the nails into size based categories: the size of a nail implying differing functions, but so many of the nails were so badly preserved that this proved impossible to do, except on the most basic level. The average length for the intact nails was 5.17 cm; only one very small nail, presumably a tack was found in F/4. All the nails were ferrous in composition. Two nails were bent, both of these bent nails were at the large end of the size range for nails, and it was suggested that these had been used in some sort of structure, as nails were sometimes hammered into beams and then bent to strengthen the structure (Clough pers. comm.).

Table 2. Functional categories of metal objects found at Opita.

Location Trench/Square	*Layer*	*Nails*	*Tools & cutlery*	*Household items*	*Horse equipment*	*Firearm equipment*	*Tins*	*Misc.*	*Total*
Tr. B	3	1							**1**
Tr. C	3	1						1	**2**
Sq. D	1 2	 1				3			**3** **1**
Sq. F	3 4	2 5		1				1 3	**4** **8**
Sq. H	3	4	2	1		3	3	3	**16**
Sq. S	3	1	1	1	1			2	**6**
Sq. T	1	1						1	**2**
Tr. T	1				1				**1**
Tr. U	3	2							**2**
Total		**18**	**3**	**3**	**2**	**6**	**3**	**11**	**46**

Tools/cutlery

Three artefacts from the Opita assemblage fall into this category. A file and a table fork was found in Square H, layer 3.

An object of cuprous composition was found in Square S layer 3. This object was thought to be an inlay for a knife handle or some such object, (Clough pers. comm.), it certainly seems to have been designed for attachment to a wooden handle. A sample was extracted and analysed by electron microprobe, which identified the presence of copper and zinc, but due to the corrosion it was not possible to calculate the proportions of these metals. This means that the object is made of some type of brass. The sample was also taken to the Metallurgy Department of the School of Engineering where it was examined microscopically in order to examine the dendritic structures in the metal. Although corroded these seem to indicate that the artefact was manufactured using a casting method (Clough pers. comm.).

Household items

Several items associated with structures were located. Fragments of a possible door key were found in the layer 3, Square F; heavy rust made the identification tentative. A heavy piece of iron from a bracket of some kind was found in layer 3 of Square H. A hinge was found in two pieces in Square S, layer 3.

Horse equipment

Two pieces directly attributable to work with horses were found, a horseshoe in the topsoil of Trench T. The horseshoe, of large size suitable for a draught animal, had a front-clip that suggested it was designed for a forefoot, however its shape indicated it was designed for a rear foot. Its shape also indicated that the shoe had been forged by an amateur farrier (McLachlan pers. comm.). A stirrup was found in Square S layer 3. This stirrup ends in a blunt head and has no rowel, and is of a type common between 1910 and 1940 (McLachlan, pers. comm.), although it could be earlier.

Firearm equipment

Shotgun cartridges and a lead shot indicate that firearms were used at Opita. Three twelve-gauge cartridges were found in the topsoil of Area D, because these were above the rock flour layer they must date from 1920. In Square H two more shotgun cartridges were found: one casing was made of a cuprous metal, presumably brass, the other was presumably made of a ferrous metal. Also found in the third layer of Area H was a lead shot made for a smooth bore muzzle-loading firearm. A gun flint was also found at in Square F, layer 4 (analysed in Appendix 4).

Tins

Eighteen fragments coming from a minimum number of three tins were found in square H, layer 3. The tins were in particularly bad condition, some having the appearance of having been distorted prior to deposition. Three fragments were found to have an inlay. Spot analysis on a sample from this inlay, using the electron microprobe, showed that it was a corroded tin-lead solder (Clough pers. comm.). This solder would have melted had the tin been heated so apparently the tins were not designed to be heated, nor did the solder serve the purpose of joining seams: it appears to be purely a decorative feature. The fragment of lead from Square F layer 5/6 seems to be a strip of solder as well.

Miscellaneous artefacts

Some additional metal artefacts that could not be categorised by function include the possible fragment of a bed frame or farm machinery, the cuprous ring, the small silver-plated ring and the piece of chain.

The cuprous ring is possibly an eyelet for a tarpaulin or other canvas artefact It exactly matches modern eyelets made for tents. The small ring found in Square H layer 3, was found by testing to be cuprous plated with silver. At first thought to have been an earring, it is more likely to have been an inlay on a pen or some other type of object.

A length of chain was found in Square S was comprised of two large rings joined by at least four smaller links. Its association with a stirrup suggests the chain is some type of horse equipment, however it could have come from any type of farming equipment.

Comparison with other sites

A few metal artefacts were found at Raupa and Waiwhau. A piece of barbed wire, rusted iron, nail and shotgun casings were found in the upper ploughed layers at Waiwhau (Phillips 1988; Phillips and Green 1991), while at Raupa a copper nail in the upper layers and two pieces of rusted iron from the Maori occupation layers were found (Prickett 1990; 1992).

In contrast, the Puriri sites of T12/340 and T12/833 dating to the late nineteenth century (c.1870-1890) contained large numbers of metal objects, numbering 1527 and 143 items respectively (Bedford 1994). Using the same categories used above, with the addition of personal items, a comparison can be made between the Opita and Puriri assemblages (Table 3). Due to the small numbers in some categories the differences are not significant. T12/883 at Puriri contains quite a few nails, but otherwise is more similar to layer 3 at the main part of Opita investigated. Nineteen nails were also recovered from T12/318.

However, at T12/340 there were a significant number of nails: many were thought to have been unused, which may mean that there was a shed or store nearby where they were kept. There were also a number of personal items, including buttons of wood, bone, jet, ceramic and metal. The 16 metal buttons were one and two-piece metal types. Possibly there was also some clothing held in the store as well. The other material from T12/340 suggested that there was a house nearby, which is supported by the amounts of household and personal ceramics found there.

Table 3. Functional categories of metal objects found at the main area of Opita (Trench C, Squares F and H, layers 3 and 4) and two sites at Puriri.

Location Trench/Square	*Nails*	*Tools & cutlery*	*Household items*	*Horse equipment*	*Firearm equipment*	*Tins*	*Personal*	*Misc.*	***Total***
T12/340	*1469*	*5*	*8*	*2*	*6*		*36*	*1*	***1527***
T12/883	*128*	*2*	*2*	*4*			*4*	*3*	***143***
Opita C/F/H-3	*7*	*2*	*2*		*3*	*3*		*5*	***22***
Opita C/F/H-4	*5*							*3*	***8***

Discussion

All the metal objects, with the exception of some nails in Square F, come from immediately above or below the rock flour and therefore pre- or post-date the rock flour floods that date to the end of the nineteenth century and the first decades of the twentieth century. Therefore, the assemblage can be divided into three broad groups based on the stratigraphy (Figure 1).

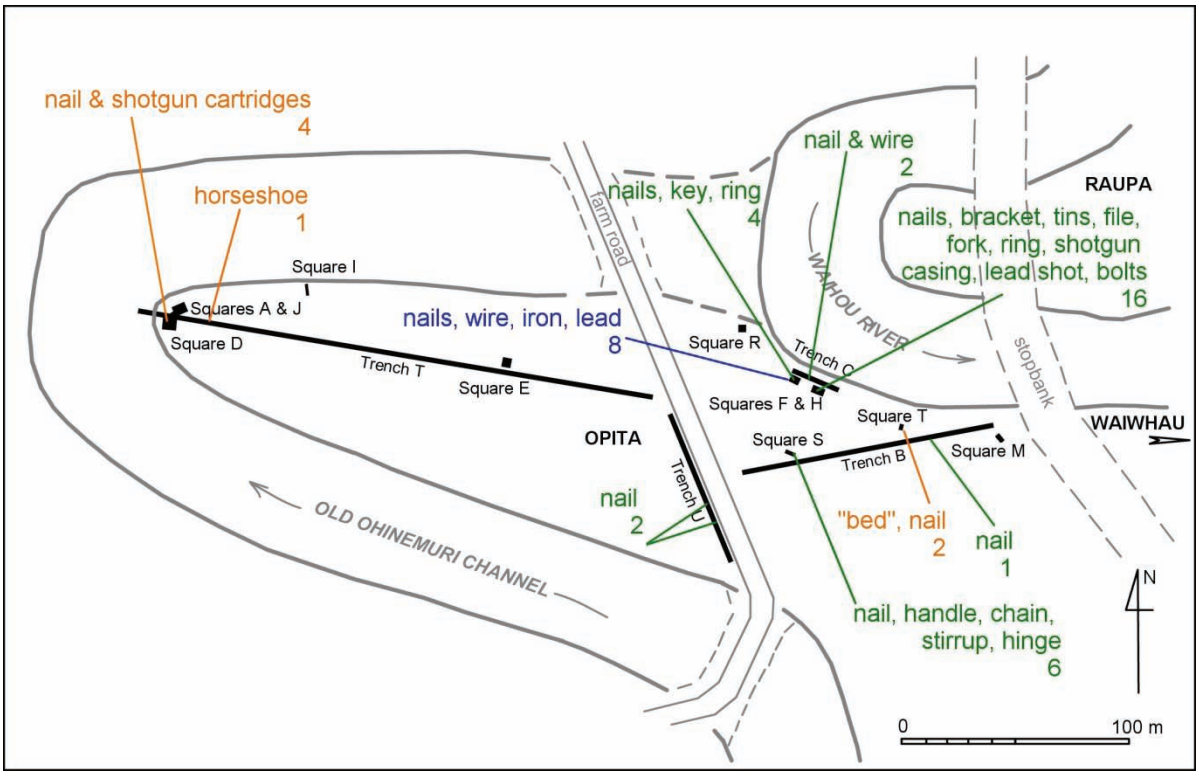


Figure 1. Distribution of metal objects coloured according to stratigraphy: orange items are from layers 1 and 2, green from layer 3 and blue from layer 4.

One group is comprised of the metal objects found after the deposition of the rock flour. These include shotgun cartridges and possible farm and horse equipment, which are all indications of farming activities.

Another group is that comprised of all the artefacts found in the horizon immediately prior to the deposition of the rock flour. The artefacts found in layer 3 all over the site show a range of activities, including all the items defined as belonging to a household, and are centred on Squares H and S.

The third group is made up of those artefacts found in layer 4 in Square F. The artefacts from this layer may form a discrete assemblage: there are 19 artefacts from this layer, 84.21 % of them are identifiably nails or nail fragments, and nearly the whole assemblage could have come from one bag of nails. In fact, all the objects came from four adjacent metre squares (B5, B6, C5 & C6) in the north-west.

The metallic assemblage from Opita contains more than 46 artefacts from several broad categories of usage: horse equipment, nails, firearm equipment, and household artefacts (household items, tools and cutlery, and tins).

The size and content of the Opita assemblage reflects the later period of occupation in contrast to the neighbouring sites of Raupa and Waiwhau: layer 3 at Opita was of similar date to the Puriri sites, layer 4 fell some time in between the occupations at Puriri and Raupa/Waiwhau.

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References

Bedford, S., 1994. Tenacity of the traditional: A history and archaeology of early European Maori contact, Puriri, Hauraki Plains. MA thesis, Department of Anthropology, University of Auckland, Auckland.

Phillips, C., 1988. University of Auckland Field School excavations at Waiwhau, 1987. *New Zealand Journal of Archaeology*, 10:53-72.

Phillips, C., and R.C. Green, 1991. Further archaeological investigations at the settlement of Waiwhau, Hauraki Plains. *Records of the Auckland Institute and Museum*, 28:147-183.

Prickett, N., 1990. Archaeological excavations at Raupa: The 1987 season. *Records of the Auckland Institute and Museum*, 27:73-153.

Prickett, N., 1992. Archaeological excavations at Raupa: The 1988 season. *Records of the Auckland Institute and Museum*, 29:25-101.

List of Plates

Plate 1: Tin from Square H, layer 3 showing inlay.

Plate 2: Brass handle from Square S, layer 3.

Plate 3: Nail from Trench B, layer 3.

Plate 4: Lead shot from Square H, layer 3.

Plate 5: Chain from Square S, layer 3 in unconserved state.

Plate 6: Stirrup from Square S, layer 3.

Plates

Plate 1

Plate 2

Plate 3

Plate 4

Plate 5

Plate 6