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Oven Stones in the Western Bay of Plenty, Northern New Zealand

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ABSTRACT

Analysis of oven stones collected from more than 30 pre-European archaeological sites in the western Bay of Plenty has revealed that volcanic rock types were almost exclusively used for cooking purposes. These were readily available from local rivers, streams and coastal headlands. An overall trend in stone composition is evident from west to east, with andesite and dacite being more widely used in the west and rhyolite and ignimbrite in the east, which closely reflects the geology of the region. Small quantities of greywacke, which almost certainly came from the eastern Bay of Plenty, were also used at some sites in the Tauranga area.

Measurement of 220 oven stones indicates that most are pebble to small cobble sized, although larger stones were used at some sites. There is some evidence for selection of particular sizes and rock types, perhaps in recognition of their better thermal qualities and performance in the ovens.

Keywords: OVEN STONES, WESTERN BAY OF PLENTY, ROCK TYPES, STONE SOURCES.

INTRODUCTION

European observers of Maori life in late eighteenth and early nineteenth century New Zealand witnessed a wide variety of methods being used to cook food. The most favoured was the earth or steam oven, the umu or hāngi, which involved cooking the food on heated stones within a shallow pit (Best 1923: 54, 1952: 102). Stones were also used in several other methods of cooking, notably boiling (Graham 1923) and roasting.

Fire-cracked or heat-altered oven stones[2] often constitute the main lithic material found on archaeological sites in New Zealand, and represent one of the main components of the numerous ovens and fire scoops that have been recorded and described by archaeologists (e.g., Prickett 1992: 75; Allen 2006). But although such stones have the potential to provide useful information on the exploitation of local resources, cooking methods, and connections with people in other areas, they have largely been ignored. Two important studies, however, have been undertaken (Sutton 1971; Gillies 1979, 1983). Sutton's dissertation included a

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[2] Although commonly referred to as 'hāngi stones', and sometimes 'cooking stones', the term 'oven stone' has been used throughout this paper because of the lack of a clear association with hāngi or umu. It is assumed that most were used in earth ovens, but some stones could have been used in other methods of cooking, or in open fires for heating purposes (Leach 1972).

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review of ethnographic accounts of cooking methods, certain archaeological evidence, and initial experimentation on the dynamics of the earth oven. This was later followed up by Gillies (1979, 1983), who carried out more detailed experiments on the thermal qualities and other properties of oven stones.

The western Bay of Plenty forms part of the Coromandel Volcanic Zone (Edbrooke 2001), and contains an abundance of volcanic rocks which would have been suitable for use as oven stones. This paper, which is partly based on a series of unpublished reports prepared by the author since 2001, presents new information on the composition, size, and potential sources of oven stones recovered from various sites in the western Bay of Plenty, and examines some of the factors that may have influenced their exploitation and use.

PREVIOUS OBSERVATIONS

Few of the ethnographic accounts of Maori ovens reviewed by Sutton (1971) make any mention of the nature of the stones that were used. However, one observer noted that they were “about the size of an orange” (i.e., small cobble size), and another recorded that the stones were “the size of potatoes or what you would put on the roads in England” (Sutton 1971). On the other hand, photos of umu or hāngi provided by Best (1923: Fig. 1, 1952: Fig. 26) clearly show that many of the stones being used in those examples were considerably larger, apparently the size of large cobbles or possibly small boulders.[3]

A comprehensive review of the relevant archaeological literature was beyond the scope of this paper, but it is evident from Sutton’s (1971) research and an examination of selected published and unpublished excavation reports that little detailed information on oven stones has been recorded by archaeologists. At most, the composition of the stones has usually received only a brief mention (e.g., Prickett 1992: 75).

WESTERN BAY OF PLENTY

Despite the large number of archaeological sites that have been excavated in the western Bay of Plenty region in the past 40–50 years, there is a scarcity of published information on oven stones. Perhaps the most interesting is that provided by Shawcross (1964, 1966) who, during excavations at Ongare Point pā (U13/8) near Katikati in 1964–65 (Fig. 1), recorded the weight of stones per excavated square in two separate parts of the site. In the central and eastern enclosures of the pā stones averaged about 6 kg/m^2, but reached 30 kg/m^2 in one square. The total area excavated was approximately 400 m^2, or 6% of the pā. Using Shawcross’s figures, and assuming a similar density of stones over at least half of the site, the total amount of oven stone on the pā could have been in the order of 10 tonnes.

Other accounts of excavated sites have provided only limited information. For instance, in their report on the salvage excavation of Ruahihi pā (U14/38) near Tauranga, McFadgen and Sheppard (1984: 23–24) simply record that of the “several hundred” fire-cracked stones, most were composed of rhyolite, some of andesite, and a small proportion were greywacke. More recently, Campbell (2004) described a large oven scoop in the Oropi Valley,

[3] Stone size follows the widely used Wentworth scale (i.e., pebble 2–64 mm, cobble 64–165 mm, boulder >165 mm diameter).

Tauranga, which contained a number of "large" hāngi stones, but made no mention of their composition. The only report that has provided any useful data on the size of oven stones is that by Phillips and Allen (1996), on the excavation of Anatere pā (U13/46) at Athenree (see below).

METHODS OF ANALYSIS

There are several different aspects of oven stones which could be investigated, and various methods that can be applied to their study. Obviously one of the more important aspects is rock type, and in the studies referred to in this paper (Table 1) this has been determined by examination of the stones under a binocular microscope. Although the preparation of thin sections and use of a petrological microscope would be a more reliable means of identifying the rock type, this is much more time consuming and was not considered worthwhile. One problem with employing thin-section petrography is that it would have to be restricted to selected stones, and because many of the geologic formations in the region outcrop over a wide area and/or are compositionally diverse (Houghton and Cuthbertson 1989; Briggs *et al*. 1996), matching a single stone to a particular formation or source may prove very difficult. Despite the limitations of identifying rock types under a binocular microscope, it is relatively quick and has provided sufficiently reliable results.

Identification of volcanic rock types under a binocular microscope relies mainly on the recognition of key minerals, principally quartz, mica (biotite), amphibole (hornblende) and pyroxene, although distinguishing between the last two is difficult and in most cases not practicable. Both hornblende and pyroxene are usually of similar colour (black), and occur in a variety of rock types. Texture is also important, and the spherulitic texture of some rhyolites is a particularly diagnostic feature. In addition, colour and density of the rock are taken into account, but since many oven stones are discoloured by heating, weathering, or partially coated in charcoal or iron oxides, colour is of limited use.

Distinguishing between andesite and dacite, and rhyolite and welded ignimbrite has proved problematic. In general, dacite has been distinguished from andesite on the basis of the presence of quartz phenocrysts, although some andesites also contain quartz. Rhyolite can usually be differentiated from ignimbrite mainly on the basis of texture, particularly flow-banding and the presence of spherulites. Ignimbrites are composed of a mixture of pumice and ash and often contain compressed pumice clasts, but some highly welded varieties closely resemble rhyolites.

Other aspects of oven stones that have been recorded in some studies are shape or roundness, the degree of weathering, and size. The degree of rounding of a stone, which is determined by use of a standard roundness scale (Powers 1953), can provide an indication of the nature of the source. The degree of weathering of the rock may also be useful in identifying sources.

The size of stones is generally established by measurement. Recording the diameter of stones is a problem if they are particularly elongate or flat, and there is a need for consistency in size measurement. In this paper all reported sizes are the maximum diameter. Weighing stones may be a better option in some cases as it overcomes the problem of differences in shape, but does require the stones to be both dry and clean. Weight also depends on density of the rock, which can be affected by the degree of weathering. The relative proportion of different rock types in some collections of oven stones has been achieved by weighing them.

CHARACTERISTICS OF OVEN STONES IN WESTERN BAY OF PLENTY

Since 2001, over 20 separate collections of oven stones have been studied, from more than 30 different archaeological sites in the western Bay of Plenty between Waihi Beach and Maketu (Fig. 1, Table 1). Collectively, these sites span the entire prehistoric period. Most collections were made during salvage excavations or monitoring of earthworks, and include selected stones from various parts of a site, samples from specific features, and some caches. The largest collection consisted of about 350 stones from three adjacent sites at Papamoa, and altogether more than 1100 individual pieces of stone have been examined.

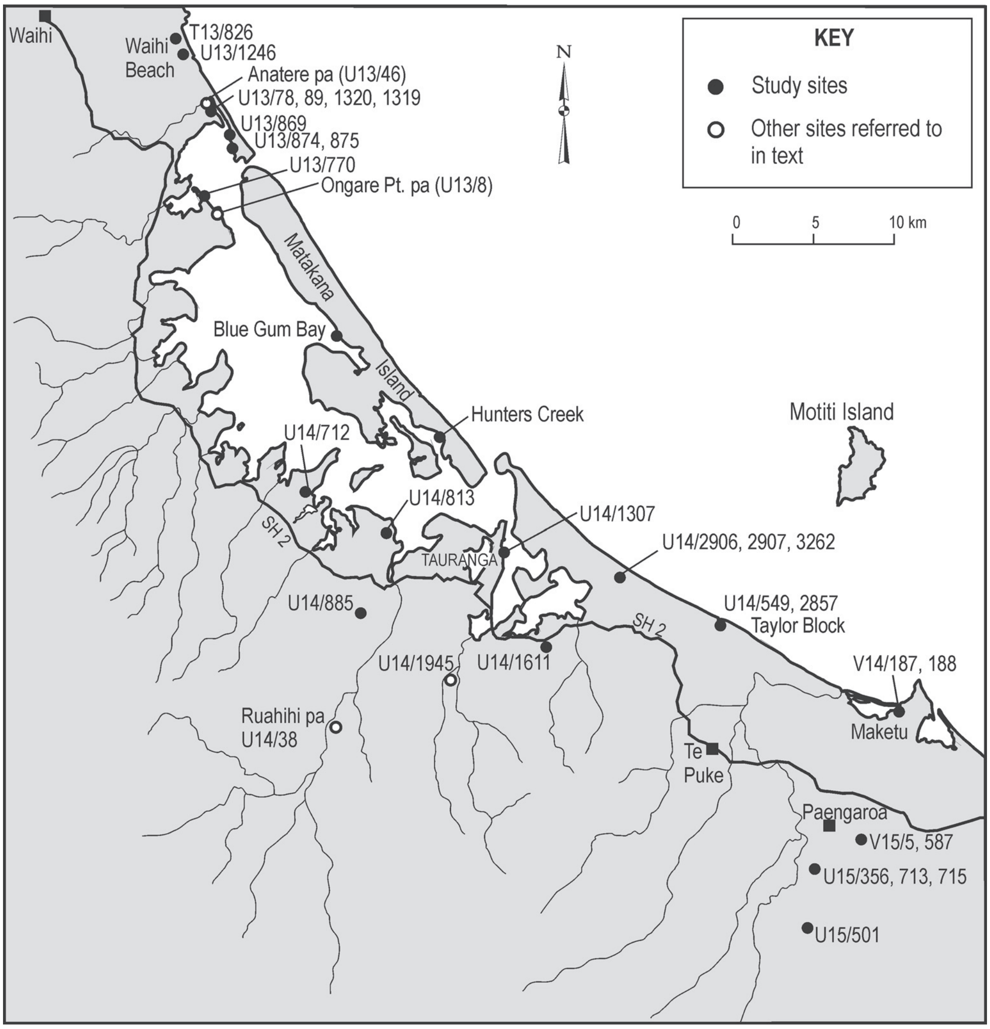

Figure 1: Map of the western Bay of Plenty, showing the location of study sites (black dots) and other sites mentioned in the text (open circles).

Study of these collections involved not only identification of the rock type, but in some cases also measurement of size and observations on the degree of rounding and weathering of the stones. Although this was primarily aimed at trying to establish where the stones originated from it has, in addition, provided some important insights into the pre-European use of oven stones.

TABLE 1
Sources of information (see Figure 1 for locations).

Location	**Site no.**	**No. of stones**	**Total wt. kg**	**Main reference†**
Waihi Beach	T13/826	108	*c.* 10	Moore in prep.
Waihi Beach	U13/1246	10	n/a	Moore 2006a
Athenree	U13/78	6	n/a	Moore 2004a
Athenree	U13/89	69	n/a	Moore & Phillips 2002
Athenree	U13/1320	8	>4.6	Moore & Phillips 2002
Athenree	U13/1319	3	9.4	Moore & Phillips 2002
Bowentown	U13/874, 875	64	n/a	Moore 2004b, pers. obs.
Bowentown	U13/869	>10	n/a	Moore in prep.
Tuapiro	U13/770	>35	*c.* 31	Moore in prep.
Blue Gum Bay¶	no no.	>30	5.6	pers. obs.
Omokoroa	U14/712	30	>14	pers. obs.
Hunters Creek¶	no no.	>45	10.6	pers. obs.
Te Puna	U14/813	*c.* 24	>2.6	Moore 2006
Te Puna	U14/885	9	n/a	Moore 2005
Tauranga	U14/3107	?	n/a	Moore 2003
Welcome Bay	U14/1611	40	8	Moore 2006
Mangatawa	U14/2906,2907,3262	*c.*350	n/a	Moore 2006
Papamoa	U14/549, 2857	31	n/a	Moore 2001
Papamoa	Taylor Block	12	n/a	Moore 2002
Paengaroa	V15/5, 587	44	n/a	Hooker 2006
Paengaroa	U15/501	61	*c.* 3	Moore 2006b
Paengaroa	U15/356,713,715	>130	n/a	Moore 2007
Maketu	V14/187	n/a	>24	Moore in prep.
Maketu	V14/188	>50	18.1	Moore in prep.

† Only available reports are listed in the References
¶ Matakana Island

COMPOSITION

As seen in Table 2, the main rock types used for oven stones in the western Bay of Plenty are andesite, dacite, and rhyolite. Ignimbrite was also used to some extent. Normally ignimbrite would not be regarded as a suitable material for oven stones, but in the cases where it has been used it is generally a hard, dense, highly welded variety which probably behaved much like rhyolite upon heating. The only other rock types identified are greywacke, tuff, perlite (a type of obsidian) and quartz.

TABLE 2
Composition of oven stones.
1 = Andesite. 2 = Andesite/Dacite. 3 = Dacite. 4 = Rhyolite. 5 = Ignimbrite.

Site no.	Location	1	2	3	4	5	Other
T13/826	Waihi Bch	x	x	-	x	-	
U13/1246	Waihi Bch	X	X	-	-	-	
U13/78	Athenree	-	X	-	-	-	
U13/89	Athenree	o	X	o	o	-	
U13/1319	Athenree	-	X	-	-	-	
U13/1320	Athenree	X	-	?	-	-	
U13/874, 875	Bowentown	X	o	o	x	-	
U13/869	Bowentown	-	x	x	x	-	
U13/770	Tuapiro	?	o	X	o	-	
no no.	Blue Gum B.†	o	X	o	o	-	
no no.	Hunters Cr.†	x	X	-	x	o	
U14/712	Omokoroa	X	-	?	o	-	
U14/813	Te Puna	-	X	-	x	-	
U14/885	Te Puna	-	-	?	X	-	
U14/38	Ruahihi pā	x	-	-	X	-	greywacke
U14/3107	Tauranga	o	o	?	X	-	
U14/1611	Welcome B.	?	-	?	X	?	
U14/2906,2907,3262	Mangatawa	X	x	?	X	o	tuff, perlite
U14/549, 2857	Papamoa	x	-	?	x	o	greywacke
Taylor Block	Papamoa	x	-	-	o	-	
V15/5, 587	Paengaroa	-	?	-	X	x	
U15/501	Paengaroa	-	-	-	X	-	
U15/356,713,715	Paengaroa	x	-	-	X	x	quartz
V14/187	Maketu	?	-	-	x	X	greywacke
V14/188	Maketu	-	-	-	x	X	

X = dominant/abundant, x = common, o = present, ? = ID uncertain
† Matakana Island

The relative proportion of different rock types has been determined for only a few collections because of the small size of most samples, and uncertainty over how representative those samples are. At site U13/89 Athenree, for example, rhyolite constituted 12% by weight of the stones recovered from three different features (about 25 kg), and 28% in another collection from this site (total *c*. 20 kg) (Moore and Phillips 2002).

Recent sampling of oven stones eroded out of sites at Hunters Creek and Bluegum Bay on Matakana Island (Fig. 1) has shown that andesite and dacite were the main rock types used at both places. At Hunters Creek the proportion of andesite + dacite combined from the four or five sites concerned ranges from about 65% to 100% by weight, while rhyolite makes up between 0% and 35%. Overall, of the 10.6 kg of stones collected from this area, about 85% are composed of andesite or dacite and 15% of rhyolite. Only one piece of ignimbrite was identified. At Bluegum Bay a total of 5.6 kg of stones was collected from four separate locations along the shoreline, and of these about 90% are composed of andesite or dacite and 10% of rhyolite. Although there does not appear to be any significant difference between the proportions of particular rock types used at Hunters Creek and

Bluegum Bay, biotite-bearing rhyolite seems to be more common at Hunters Creek. At Bluegum Bay, most rhyolite stones contain pyroxene or hornblende only.

SIZE (Table 3)

As demonstrated by Gillies (1983), small stones with an average diameter of 10 cm (i.e., small cobble size) have a greater 'life expectancy' in the ovens and could be re-used about twice as often as larger stones of the same rock type before fracturing. It might be expected, therefore, that the stones found on archaeological sites in the western Bay of Plenty would be predominantly 'small'.

TABLE 3
Sizes of oven stones (see Figure 2).

Location	**Site no.**	**No. Measured†**	**Size range (mm)**
Athenree	U13/78	6	40–65
Athenree	U13/89	27 [27]	50–240
Athenree	U13/1320	8 [8]	50–130
Bowentown	U13/869	2 [2]	n/a
Bowentown	U13/874, 875	6 [6]	40–65
Tuapiro	U13/770	26 [26]	42–190
Blue Gum Bay¶	no no.	11 [10]	33–89
Hunters Creek¶	no no.	11 [11]	54–>125
Omokoroa	U14/712	14 [14]	91–170
Welcome Bay	U14/1611	2 [2]	98–>125
Mangatawa	U14/2906, 2907, 3262	>31 [29]	39–>220
Papamoa	Taylor Block	12	80–170
Paengaroa	U15/501	60§	28–96
Paengaroa	U15/356, 713, 715	34 [33]	40–84
Maketu	V14/187	6 [6]	64–>250
Maketu	V14/188	46 [46]	45–154

† Figures in square brackets = number used in Figure 2
¶ Matakana Island
§ See Figure 3

In order to test this idea the maximum diameters of 220 whole (or nearly whole) oven stones were plotted (Fig. 2). These stones came from more than 15 different sites in the region, including some from Matakana Island. The smallest was 28 mm in diameter and the largest about 240 mm.

From Figure 2 it is evident that the majority of stones are pebble to small cobble sized, with very few >155 mm in diameter. However, it is recognised that this plot is somewhat biased, and that larger sizes are under-represented because of a natural tendency for archaeologists to collect the smaller stones. Also, although large stones have certainly been found at some sites, personal observations suggest that such stones are more likely to have been fractured by heating. More representative collections are required to confirm the dominance of smaller stones.

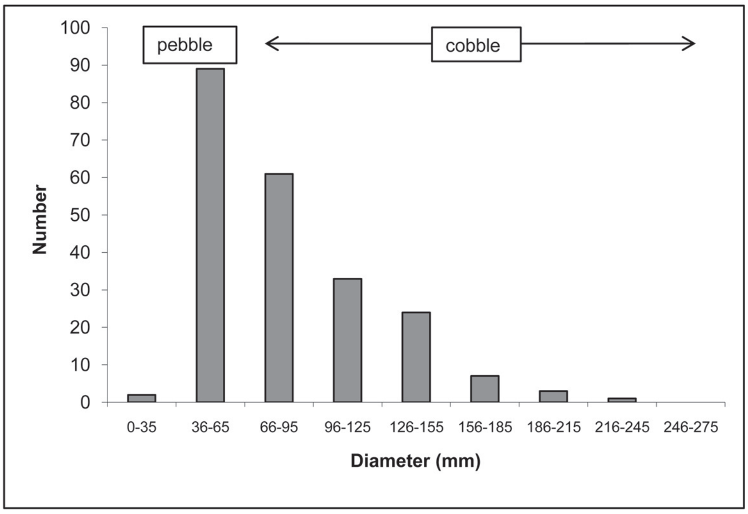

Figure 2: Size distribution of oven stones (N=220) from western Bay of Plenty sites.

The size distribution of a collection of stones (N=53) from a single fire scoop is shown in Figure 3. The majority are between 35 mm and 55 mm in diameter (i.e., pebble sized), with very few of cobble size (>65 mm). Such a size distribution indicates that either (a) the source consisted mainly of pebble-sized stones, or (b) stones of a particular size range were specifically selected. There is no way of knowing which of these options is correct, but the composition of the stones suggests they were probably obtained from the coastline at Maketu (Moore 2006b), in which case they would need to have been carefully chosen. Cobbles are the predominant size along the Maketu shoreline.

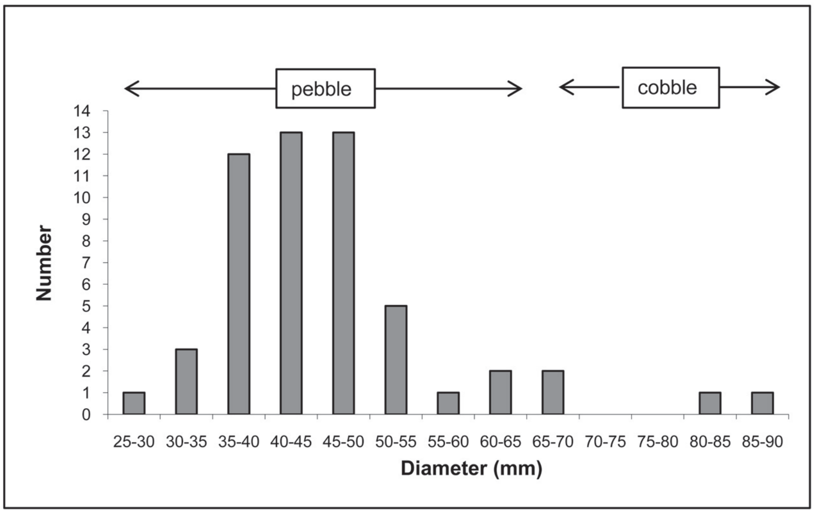

Figure 3: Size distribution of stones from a single fire scoop, site U15/501, Paengaroa (from Moore 2006b).

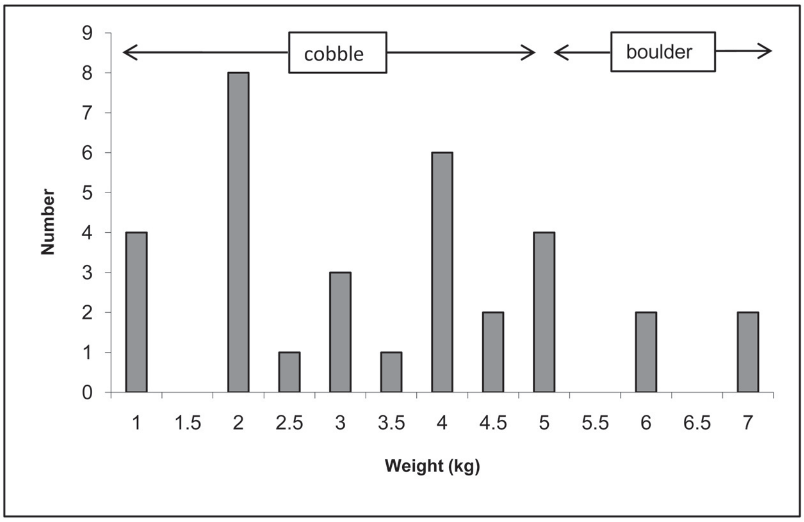

Figure 4: Weight distribution of oven stones from a cache at Anatere pā (U13/46), Athenree (data from Phillips and Allen 1996).

A very different picture is provided by a cache of stones (N=33) from Anatere pā, Athenree, which were all individually weighed on site (Phillips and Allen 1996: 143; Fig. 4). There was considerable variation in the size of stones in this cache, from 1 kg to 7 kg, with the most common weights being 2 kg and 4 kg. Although the diameter of the stones was not recorded, Figure 5 and weight-size data on stones from other sites suggest that most were cobble-sized, and those >5 kg probably boulder-sized (>256 mm in diameter).

There could be several different explanations for the wide range of stone sizes in this cache. For example, it could indicate that size was not considered particularly important or, alternatively, the cache may represent a selection of unbroken stones from different ovens which had simply been gathered together for later re-use. Whatever the reason, there is no doubt that some large stones were being used at Anatere pā.

Only a small number of stones from other sites have been weighed, and these range from <50 g to 4.9 kg. One large cobble recently collected from site U15/356 at Paengaroa weighed just over 6 kg, although it is not certain that it was actually used as an oven stone (Moore 2007).

QUALITY

A specific assessment of quality was not undertaken, but it is evident that hard, dense stones would have had greater heat retention and 'life expectancy' in the ovens than very weathered, highly crystalline, or pumice-rich rocks. In the local context, therefore, andesite and dacite could generally be regarded as 'good quality', and crystalline rhyolite and most ignimbrite would be classed as 'poor quality'. However, what were considered to be 'good' stones in the past may have depended not only on rock type but also other factors such as size and shape.

Figure 5: Oven stones from a cache at Anatere pā, Athenree. Note the variation in size and shape of the stones. Photo: Caroline Phillips.

POTENTIAL SOURCES

In the past 20 years geological maps covering almost the entire western Bay of Plenty region have been published at 1:50,000 scale (Houghton and Cuthbertson 1989; Briggs *et al*. 1996, 2006; Brathwaite and Christie 1996). Although these maps (and accompanying texts) give some indication of the range of rock types likely to be present in river, stream and beach gravels, they do not provide any specific information on the nature and extent of gravel deposits, or the quality of the stones. One other problem is that certain volcanic formations, particularly breccias and ignimbrites, contain clasts of various rock types, some of which may form a disproportionate percentage of river or stream gravels because of their greater hardness than the host rock.

In order to identify potential sources of oven stones, over 16 of the more significant rivers and streams, and three coastal headlands, in the western Bay of Plenty region between Waihi Beach and Maketu, were inspected (Fig. 6). Some streams north of Waihi Beach and southeast of Maketu had been examined previously. This survey, however, was restricted by the limited public access to some streams, and the very entrenched nature of others. It is also likely that there have been significant changes in the nature of many water courses since European settlement, and that some gravel deposits exposed in the lower parts of valleys in pre-European times have since been buried by silt and sand. Another complicating factor is the contamination of streams with road gravel and other foreign stone.

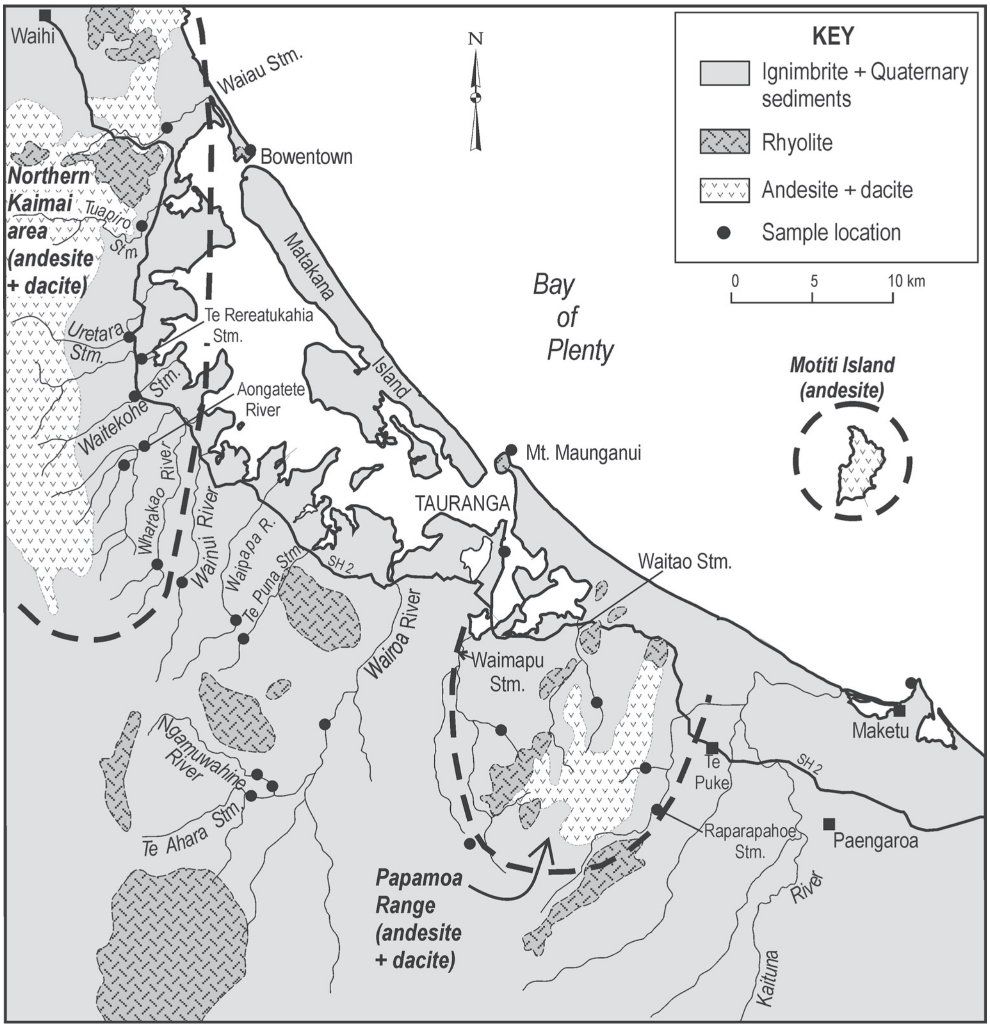

Figure 6: Simplified geological map of the western Bay of Plenty, showing the three main 'source areas' of andesite and dacite, and sample locations. Geology largely from Edbrooke (2001) and Briggs et al. (1996).

Nevertheless, it is evident from the field survey that some rivers and streams have abundant coarse gravel, whereas others contain few suitable stones. This is largely attributable to the nature of the geological formations being eroded. In streams draining areas in which ignimbrite is the dominant or only rock type, hard stones are scarce. This applies to most of the rivers and streams west and southwest of Tauranga as far as the Aongatete River, with the exception of certain tributaries of the upper Wairoa River (Ngamuwahine River and Te Ahara Stream), which contain common pebbles and cobbles of rhyolite. Many of the rivers and streams east of Te Puke, including the Kaituna River, also possess little suitable stone. The main areas with extensive gravel deposits are: (i) between Waihi Beach and Aongatete River, (ii) the Papamoa Range, and (iii) Maketu peninsula. There are more limited sources of suitable stones around the coastal headlands of Bowentown and Mt Maunganui.

On the basis of the published geological maps and recent field survey it is possible to define three main ‘source areas’ for andesite and dacite stones (Fig. 6). These are:

(1) Northern Kaimai area, west of a line between the Whatakao River and Waihi Beach (andesite + dacite).

(2) Papamoa Range, between Waimapu Stream in the west and Raparapahoe Stream in the east (andesite + dacite).

(3) Motiti Island (andesite only).

Rivers, streams and beaches outside these three areas generally contain cobbles and pebbles of rhyolite and ignimbrite only, and andesite is rare or absent. Defining source areas for rhyolites is much more difficult because of the widespread occurrence of this rock type in the western Bay of Plenty, including within the Northern Kaimai and Papamoa andesite/dacite zones. The fact that dacite occurs in the same areas as andesite means that, for the purposes of sourcing oven stones, distinguishing between the two rock types may not be particularly important.

SOURCES OF THE OVEN STONES

A general trend in the composition of stones is evident from Table 2, with andesite and dacite constituting the main rock types in the Waihi Beach-Athenree area and elsewhere west of Tauranga, and rhyolite and ignimbrite becoming increasingly common to the east of Tauranga. In the Tauranga area (including Papamoa), collections of oven stones consist of a mixture of rhyolite and andesite with some dacite. This trend basically reflects differences in the geology of the region, or more specifically differences in the composition of river and stream gravels, as can be seen from a comparison of Tables 2 and 4. There is, however, one notable exception — ignimbrite does not appear to have been used for oven stones west of Tauranga (certainly not very often), even though ignimbrite underlies much of the inland Tauranga area and is a significant component of rivers and streams as far west as the Aongatete River. At present there are insufficient data from the Tauranga area to establish the extent to which ignimbrite was being used at sites there.

For most of the studies undertaken to date it has not been possible to identify specific sources for the majority of stones, primarily because of the widespread distribution of the main rock types (andesite, dacite, rhyolite, ignimbrite). Nevertheless, it has usually been possible to limit the options, and in a few cases to be fairly confident about where some of the stones did or did not come from. At site U13/89, Athenree, there is little doubt that the stones of spherulitic rhyolite were obtained from Bowentown, where there is a limited quantity of cobbles along the harbour shoreline (Moore and Phillips 2002). Most of the stones at site U13/89, however, are composed of andesite or dacite, and these are likely to have come from the Waiau and/or Tuapiro streams.

TABLE 4
Composition of stones from potential sources.
See Figure 6 for locations.
1 = Andesite.2 = Dacite. 3 = Rhyolite. 4 = Ignimbrite

Location	**1**	**2**	**3**	**4**	**Other**	**Quantity†**
Waiau Stream	X	?	o	-	-	abundant
Bowentown	-	-	X	-	-	moderate
Tuapiro Stream	X	x	-	-	-	abundant
Uretara Stream	X	X	-	?	-	abundant
Te Rereatukahia Str.	X	x	-	?	-	abundant
Waitekohe Str.	X	x	-	-	quartz	abundant
Aongatete River	X	x	o	o	-	abundant
Whatakao River	x	?	o	o	-	minor
Wainui River	-	?	X	x	-	minor
Waipapa River	-	-	x	x	-	minor
Te Puna Stream	-	-	o	o	-	minor
Wairoa River	-	?	X	o	-	minor
Ngamuwahine River	-	-	X	-	-	abundant
Te Ahara Stream	-	-	X	-	chert	moderate
Mt Maunganui	-	-	X	-	-	moderate
Waimapu Stream	?	?	X	x	-	moderate
Waitao Stream	x	?	x	o	-	moderate
Raparapahoe Str.	X	?	o	o	quartz	abundant
Maketu	-	-	x	X	basalt	abundant
Motiti Island	X	-	-	-	-	abundant?

X = abundant, x = common, o = present, ? = uncertain
† Estimated quantity of suitable stones

The majority of stones collected from site U14/712 at Omokoroa consist of andesite, and it is evident that these did not come from nearby streams. The nearest sources of andesite cobbles are the Whatakao and Aongatete rivers about 10 km to the west, and the Omokoroa stones were probably obtained from one or both of these sources. At sites in the Paengaroa area almost all of the stones are composed of either rhyolite or welded ignimbrite, and it is highly likely they were procured from Maketu, since there does not appear to be any other suitable source in the vicinity (Moore 2006b, 2007).

The presence of greywacke stones on at least two sites (Ruahihi pā and one at Papamoa) is of particular interest. There are no known outcrops of greywacke in the western Bay of Plenty, and pebbles or cobbles of greywacke have not been found in any rivers or streams in the region. The nearest outcrop of greywacke is at Otamarakau, 15 km southeast of Maketu. Greywacke clasts have been recorded in conglomerate deposits exposed in the cliffs around Maketu peninsula (Briggs *et al*. 2006: 14), but their size and quality is unknown.

SELECTION OF STONES

According to Best (1923: 56) care was taken in the selection of stones because of the potential for particular types to fracture when heated, and good cooking stones were highly prized. However, when suitable stones were unobtainable, indurated clay and pumice were sometimes used instead.

Although there is some evidence that stones of a particular size range were preferred for cooking purposes, as indicated earlier, in view of Gillies' (1983) findings it is also appropriate to examine whether stones of a particular *rock type* were preferentially selected. Was there an awareness of the better heat retention and other qualities of andesite, and if so did this influence the selection of stones?

It certainly appears from the collections made to date from various sites at Athenree and Bowentown that andesite and dacite were preferred over the local Bowentown rhyolite, although the availability of suitable sized stones might have been a more important consideration. At Mangatawa, near Papamoa, one of the main rock types used for oven stones was a coarsely crystalline rhyolite, which is of very poor quality, crumbles readily in the hand, and could not have withstood repeated heating for long. The fact that it was used so extensively suggests that availability was of greater importance than quality.

If most of the stones found at sites in the Paengaroa area were in fact obtained from Maketu then there must have been some selection involved, particularly at site U15/501 (Moore 2006b). There, all of the oven stones consisted of rhyolite, yet the dominant lithology of pebbles and cobbles along the shoreline at Maketu is ignimbrite.

The overall impression is that quality was not of particular concern, and that whatever stones were available within a reasonable distance of the site — say a radius of 5 to 10 km — they were generally utilised. But where there was a choice of rock types within the same area, it seems that harder, denser stone was usually preferred, as at Bowentown. At sites more distant from a suitable source, in some cases it appears there may have been greater selection involved (e.g., Omokoroa, Paengaroa).

DISCUSSION

Although it would appear that andesite and dacite were more widely used for oven stones than rhyolite in the western Bay of Plenty, it is not clear if this was due to a preference for using andesite and dacite because of their superior qualities (hardness and heat retention), or simply a matter of easier access to such rock types. The field survey indicated there is an abundant supply of andesite and dacite stones in the lower reaches of most rivers and streams in the western part of the region, and these would have been readily accessible by canoe. In contrast, the quantity of suitable rhyolite stones in the Tauranga and Te Puke areas appears to be very limited, at least in the lower reaches of some streams.

One factor that obviously needs to be considered is how political boundaries and relationships between tribes may have affected access to suitable sources of oven stones. It is reasonable to assume that particular tribes had some control over certain sources, and at times that might have resulted in stones of lesser quality being used (e.g., Best 1923: 56) rather than good stones from an area where access was restricted. The presence of greywacke stones at Ruahihi pā and at one site at Papamoa certainly raises the issue of wider relationships. The occupants of Ruahihi pā may have had some direct connection with tribes in the Whakatane area, or perhaps the stones were obtained by gift or exchange. Best (1974: 31) notes that Ngāti Awa of the lower Rangitaiki valley possessed the best cooking stones, and on occasions presented collections of such stones to notable chiefs of neighbouring tribes. These stones were most probably composed of greywacke.

This paper has demonstrated that there is some value in the study of oven stones from a number of sites over a wide area. However, future work might more profitably be directed towards other lines of enquiry, such as whether stone size or composition is related to particular types of cooking feature, or types of site. There is some indication that larger stones may be more common on pā sites, perhaps because they were used in larger ovens and expected to last longer, despite the results obtained by Gillies (1979) indicating that smaller stones retain heat better, and are less prone to fracturing in a fire. Alternatively, the use of larger and/or better quality stones may have been a matter of prestige, in which case such stones would be expected to be found on more significant sites. Clearly there is ample scope for further research.

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