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Resource procurement and inter-regional connections in pre-contact Taranaki, New Zealand: New evidence from geochemical analysis of obsidian

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ABSTRACT

Early Polynesian colonists in New Zealand were quick to identify key economic resources. One such resource – obsidian – was transported widely during the early settlement phase of New Zealand. Here, we present the results of portable X-ray fluorescence analysis of obsidian artefacts from five early settlement sites and two later sites in Taranaki on the west coast of New Zealand's North Island. Our research suggests obsidian from six source areas was present in Taranaki sites, with the majority of material coming from Mayor Island and the nearby Coromandel Peninsula. Low rates of cortical material suggest a down-the-line procurement process, although this result is made equivocal by evidence of relatively expedient use of obsidian in the early period. Finally, the marked variation between Taranaki sites and contemporary sites further north appears consistent with the development of regionally specific procurement strategies very early in pre-contact New Zealand.

Keywords: New Zealand, Māori, obsidian, pXRF, exchange networks

RÉSUMÉ

Les premiers colons polynésiens en Nouvelle-Zélande ont rapidement identifié les principales ressources économiques. L'une de ces ressources, l'obsidienne, a été beaucoup transportée au début de la phase de peuplement de la Nouvelle-Zélande. Nous présentons ici les résultats de l'analyse pXRF d'objets en obsidienne provenant de cinq premiers sites de peuplement et de deux sites plus récents à Taranaki, sur la côte ouest de l'île du Nord de la Nouvelle-Zélande. Nos recherches suggèrent que l'obsidienne de six régions sources était présente dans les sites de Taranaki, la majorité du matériel provenant de l'île Mayor et de la péninsule de Coromandel à proximité. Les faibles taux de matériel cortical suggèrent un processus d'approvisionnement en aval, bien que ce résultat soit rendu équivoque par la preuve d'une utilisation relativement rapide de l'obsidienne au début de la période. Enfin, les différences marquées entre les sites de Taranaki et les sites contemporains plus au nord semblent concorder avec le développement de stratégies d'approvisionnement spécifiques à une région très tôt dans la période de contact avec la Nouvelle-Zélande.

Mots-clés: Nouvelle-Zélande, Maori, Obsidienne, pXRF, Réseaux d'échange

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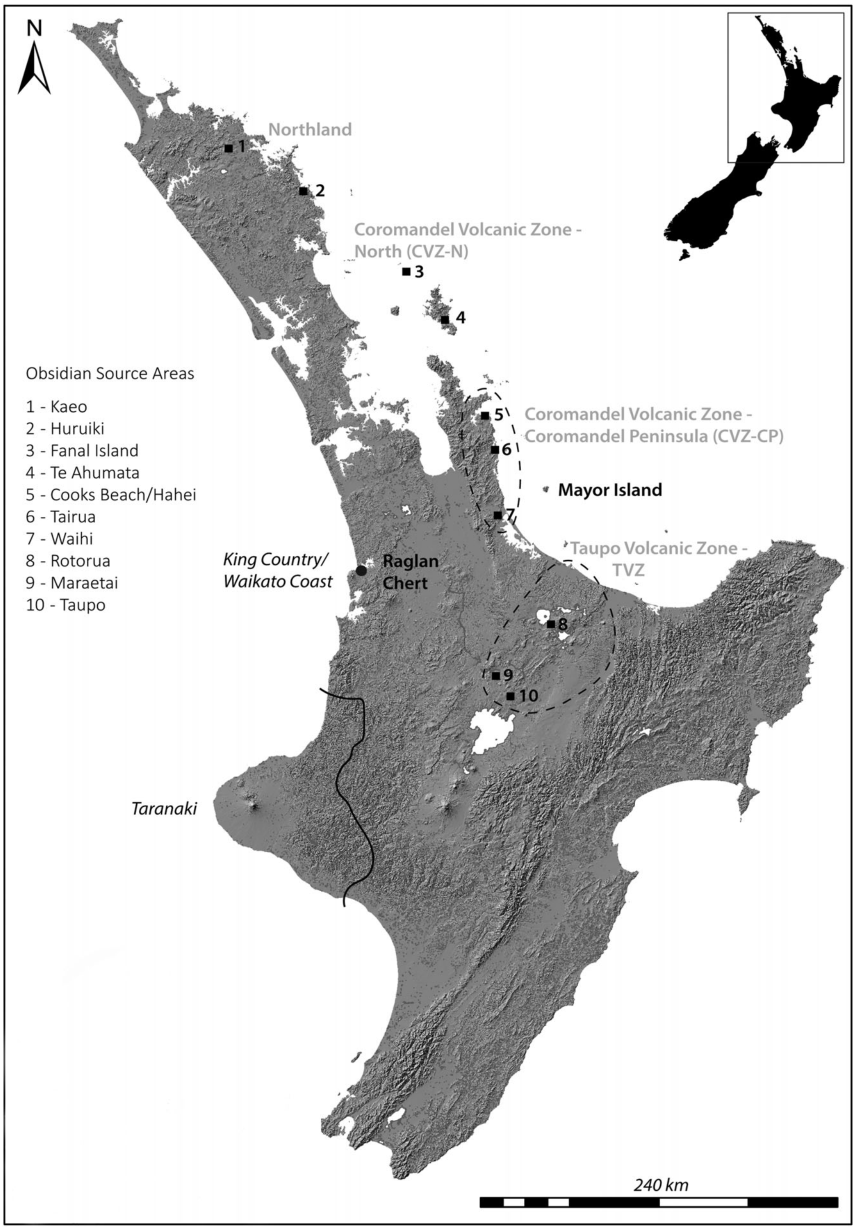
INTRODUCTION

New Zealand was settled from tropical East Polynesia around AD 1300 (Walter *et al.* 2006). Upon arrival, the colonists were confronted with the challenge of establishing themselves in the new land. Immediate concerns, such as the need for food and water, could be overcome by the exploitation of local resources; indeed, proximity to clusters of basic economic resources appears to have been a major driver of settlement and mobility in the early period (*c.* AD 1300–1500; Anderson & Smith 1996). However, the archaeological record of this period makes it clear that engagement with resources beyond individual site catchments was also a key component of early Māori settlement strategy (Walter *et al.* 2006). This wider scale of colonising behaviour is most often investigated through the study of lithic movement (e.g. Jennings *et al.* 2018; Walter *et al.* 2010). Among the most common materials studied for this purpose is obsidian (Sheppard 2004). New Zealand contains over 20 distinct source areas of obsidian, which are frequently grouped into four zones: Northland, the Taupō volcanic zone (TVZ), the Coromandel volcanic zone (CVZ – often sub-grouped into northern sources and those on the Coromandel Peninsula) and Mayor Island

Figure 1. Map of the North Island of New Zealand, showing the Taranaki region, obsidian source regions, selected obsidian source areas and the location of the Raglan chert source.



(McCoy *et al.* 2010; Sheppard 2004; Figure 1). The last of these groups, Mayor Island obsidian (MIO), is consistently present in early sites across New Zealand and elsewhere in southern Polynesia (Anderson 2018; Seelenfreund & Bollong 1989; Sheppard *et al.* 2011). Utilitarian aspects of MIO, such as its high-quality conchoidal fracture, are discussed in the literature (e.g. Sheppard *et al.* 2011; Walter *et al.* 2010); however, it is the social aspects of MIO exchange that has seen the greatest focus. In particular, the trade of MIO is seen as a conduit for social (and biological) relationships between scattered colonising groups, which strengthened overall survivability in the new land (Walter *et al.* 2010; Weisler & Walter 2017). The ubiquity of MIO in early New Zealand sites has also become a component of models of colonisation, which emphasise the large-scale and coordinated nature of colonising groups in New Zealand (e.g. Walter *et al.* 2017).

However, based on increasing evidence from geochemical sourcing, McCoy and Robles (2016) suggest colonising communities may have had more restricted and less integrated zones of interaction than is assumed by models built upon analysis of MIO alone. Analysis of both primary (i.e. the source representing the majority of an assemblage) and secondary obsidian sources from sites on the east coast of the South Island shows clear variation in obsidian assemblage composition (Lawrence *et al.* 2014; McCoy & Robles 2016; Mosley & McCoy 2010). Most notably, sites nearer Otago Harbour had higher frequencies of Taupō obsidian compared with neighbouring sites, such as those along the North Otago coast (*c.* 100 km to the north) where MIO was the primary source (McCoy & Robles 2016). Similar variation has also been observed along the King Country coast (Moore 2011a), albeit based on limited chemical analysis. Here, the northernmost assemblage (Maioro) is dominated by obsidian from Great Barrier Island, whereas those farther south contain predominantly MIO with a secondary mixture of Taupō and Coromandel material. While contributing a finer-grained understanding of obsidian movement in early New Zealand, these studies also provide an impetus for further analysis and testing of existing models.

Taranaki, on the west coast of New Zealand's North Island (Figure 1) occupies an interesting cultural and geographic space in early New Zealand. The region is away from the major concentration of early period sites in the eastern South Island and all major lithic quarries, but is one the richest enclaves of early occupation in the North Island (Anderson 1989; Walton 2000). In this paper, we analyse obsidian artefacts from a collection of sites in Taranaki in order to contribute to the broadening picture of resource exploitation in the region and to test models of inter-regional connections in the colonisation phase of New Zealand.

BACKGROUND: EARLY NEW ZEALAND, EARLY TARANAKI

The early phase of pre-European New Zealand is generally defined as the approximately two-hundred year period following first settlement (*c*. AD 1300–1500; Walter *et al.* 2006). This period is characterised by a suite of material culture, including large polished adzes, bone and ivory ornaments and one-piece fish hooks that closely resemble types found in East Polynesia and are distinct from later forms (Davidson 1984; Furey 2004). In this period, larger permanent settlements were located in close proximity to resource clusters with smaller camps positioned to exploit a more restricted range of resources (e.g. lithic sources; Smith 1999). The early economy was built upon hunting and foraging, although horticulture, a core component of the later period economy, was almost certainly a factor, particularly in warmer northern areas of the country (Walter *et al.* 2006). The transition between early and late (*c*. AD 1500) is materialised by the emergence of fortified sites (pā), which hint at increased territoriality and social stratification in the later period (Davidson 1984).

Taranaki lies on the central west coast of New Zealand's North Island (Figure 2). The region is dominated by a large, central volcanic cone (Mt. Taranaki) surrounded by flat to rolling country, which gives way to steep cliffs at the coast. Streams radiate from the mountain and at their mouths cut the cliffs, providing access to the land above. The majority of early sites are located adjacent to the stream mouths and background scatters of early artefacts also tend to concentrate at these localities (Buist 1961, 1962; Walton 2000). Despite the rich concentration of early archaeological sites along the Taranaki coast, large-scale erosion has had a serious impact upon known sites (e.g. Kāūpokonui) and has likely erased evidence of many others.

Archaeological investigation of early sites in the region has been variable. Excavation has been carried out at larger sites such as Kāūpokonui and Ōhawe. Here, internal spatial organisation and evidence of intensive exploitation of local marine and terrestrial resources, including marine mammals and a large array of avifauna (Anderson 1989), were observed. This same faunal profile is also found at smaller sites along the coast, although evidence for prolonged occupation or multiple activity zones is not. Formal artefacts are rare, but include objects such as reel ornaments and one-piece fishhooks, which are typical of the early period (Buist 1961; Furey 2004). Finally, flakes of Raglan chert (Figure 1) and obsidian are common across most sites, with evidence of adze reworking present only in larger sites. Details of the sites analysed in this research are provided below.

MATERIALS

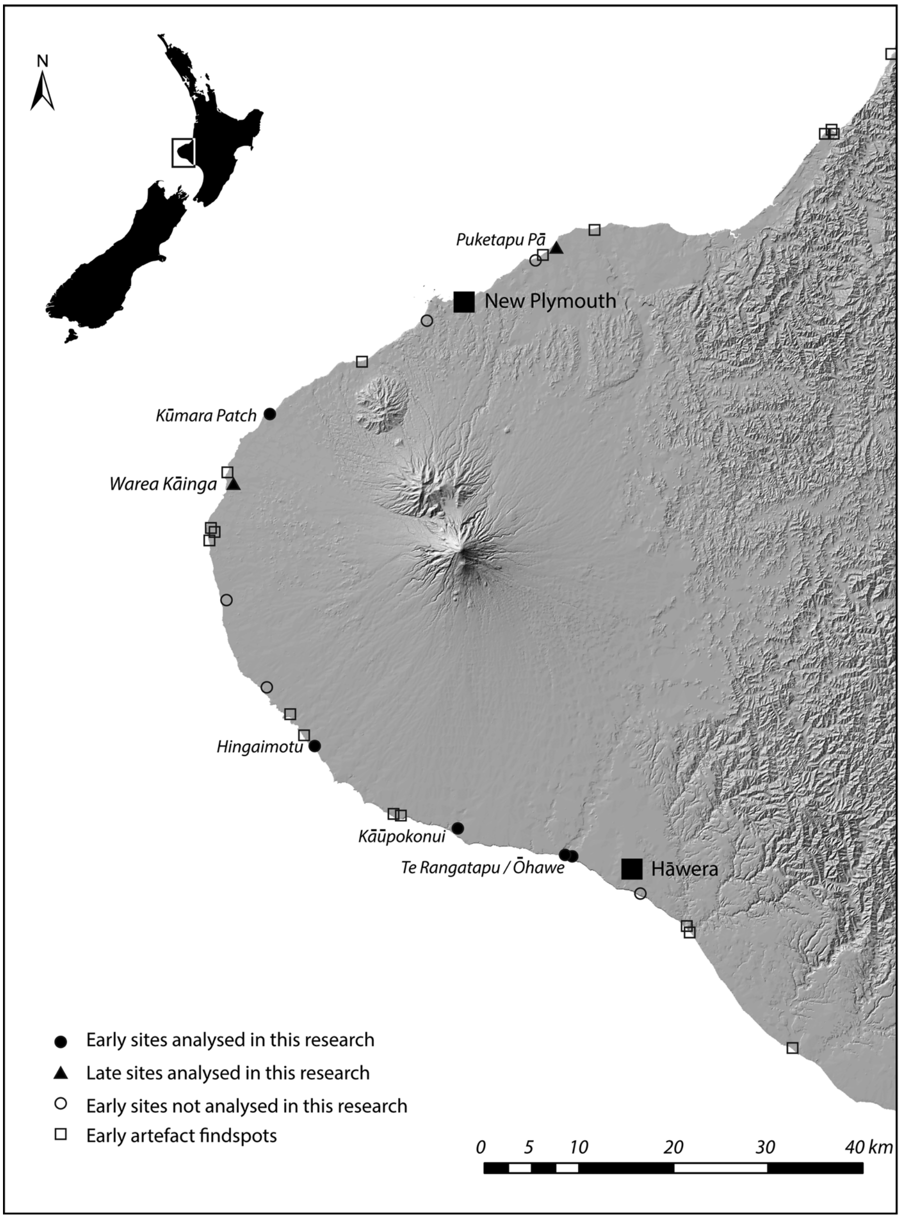
We examined 270 obsidian artefacts held at Puke Ariki Museum, New Plymouth, New Zealand. The majority of artefacts come from five early period coastal settlements (details below). Few reliable radiocarbon dates exist for these sites, but several characteristics such as site location, midden composition – particularly the presence of avifauna species like moa (Aves: Dinornithiformes) that went extinct during the early period – and material culture, allow these sites to be placed at the earlier end of the New Zealand sequence. For comparative purposes, we also analysed a smaller number of artefacts from two late sites (e.g. post-AD 1500), Puketapu pā and Warea kāinga. Where possible all excavated obsidian from these sites was included in analysis with the exception of Kāūpokonui, which was sampled due to its large assemblage size. To do this we followed Moore's (2011a) methodology of macroscopically assigning material into "grey" or "green" categories and sampling each equally. Further analysis was carried out on three pieces of red/brown obsidian.

Sites analysed

Kūmara patch (P19/122): This site is located on eroding dunes near the mouth of the Stony River. The site consists of a series of deflated ovens with associated scatters of obsidian and chert artefacts, which were surface collected and deposited in Puke Ariki (K. Day, pers. comm., 2019). While not definitive, the location and nature of the site is consistent with smaller-scale early occupation.

Hingaimotu (P20/120): This site is located in eroding dunes to the north of the Taungatara Stream mouth. The site contains moa, seal and sea lion bone (Smith 1985; Walton 2000) as well as other scattered midden. Two early style adzes were found at the site, and a small rescue excavation produced a bird spear, a stone-lined hearth into which two whale teeth had been placed and the flake assemblage (Fyfe

Figure 2. Taranaki sites analysed in this research and other areas where early material has been recovered.



n.d.). While not dated, this evidence is consistent with smaller-scale early period occupation at the site.

Kāūpokonui (P21/3): Kāūpokonui is the best known and largest of the early Taranaki sites. The site is located on actively eroding dunes adjacent to the Kāūpokonui Stream mouth and was excavated in the 1960s and 1970s. These excavations revealed a large range of extinct or extirpated bird species, together with a number of dogs and sea mammals (Anderson 1989). The site also contained an array of material culture including a small number of adzes, bone tools, a large number of flakes and flake tools and a "reel" ornament, all of which are typical of the early period and support the early radiocarbon date for the site (Anderson 1989; Robinson 1963; Buist 1963). Evidence of spatial organisation and a range of activities, such as hunting, processing, fish hook production and burials, is consistent with village-scale occupation.

Ōhawe (Q21/75): The Ōhawe site is located on a low dune approximately 200 m east of the mouth of the Waingongoro stream and the Te Rangatapu site (discussed below). Early reports of the site suggest the presence of a double row of ovens, which may indicate internal spatial organisation, although these were not relocated during excavation in the 1960s. However, two other ovens were located, which contained evidence of extinct species and were in association with a dark, charcoal-rich occupation layer. The site contains a similar array of bird species to Kāūpokonui, including both moa bone and eggshell. The material culture from the site was limited to one moa bone needle and the obsidian and chert stone tool assemblage

(Buist 1960, 7). Including lost evidence leads to the conclusion that Ōhawe may have been an early village site, although available evidence suggests the range of activities undertaken were not at the same level as nearby Kāūpokonui.

Te rangatapu (Q21/344): This site is located in a bend near the mouth of the Waingongoro Stream. The site consists of a small number of stone-lined ovens in association with a black occupation layer. Like Kāūpokonui, the site contains a number of bird species, including moa together with fur seal, dog, fish bone and shell (Canavan 1960, 1962; Smith 1985). A single one-piece shank was recovered from the site alongside the obsidian and chert assemblage (Canavan 1960). The Ōhawe and Te Rangatapu sites combined imply extensive occupation at the mouth of the Waingongoro stream (Anderson 1989). However, individually, the available evidence suggests a limited range of activities more consistent with restricted-function camps.

Puketapu pā (Q19/157): This site is a defended site dating from the late period in pre-European New Zealand. The site is located on a low dune hill northeast of the Waitaha stream, by modern day Bell Block. A small part of the site was excavated by Richard Cassels as part of the 1970 University of Auckland field school; however, the obsidian material in the Puke Ariki collections appears to have come from surface collections of eroding sections of the pā.

Warea kāinga (P20/92): This site is a late period site located near the mouth of the Teikaparua stream. The site was occupied from the late pre-contact period until the mid-nineteenth century, at which time it was famously shelled by the HMSS *Niger*. The obsidian from this site was surface collected by Kelvin Day from a section of site eroding into the true left bank of the Teikaparua Stream (K. Day, pers. comm., 2019).

METHODS

Chemical characterisation

This research used a Niton XL3t Gold+ portable X-ray fluorescence analyser (pXRF). Analyses were recorded for a total of 180 seconds using the instrument's in-built Fundamental Parameters calibration, in this case mining mode. Four filters were selected to optimise the detection of a range of elements, this included "Main" (60 seconds), "Light" (60 seconds), "Low" (30 seconds) and "High" (30 seconds). While shorter than other protocols (e.g. McCoy & Carpenter 2014), we note that a comparison with longer run times did not yield any significantly more accurate results (see Supporting Information). A geological standard (BHVO-2; Table 1) was run periodically during analysis to ensure consistent results. The data were then empirically calibrated using linear regressions of five mounted geological standards (AGV-2, BCR-2, BHVO-2, QLO-1a & SRM-278).

To source artefacts, we followed the method outlined in McCoy and Carpenter (2014), which systematically compares elemental values of artefacts with those of known geological provenance. The major consideration when selecting this method was the clear explanation of certified standards used in previous studies and availability of data. In the first instance, this allowed us to follow best practice for inter-study comparisons and select equivalent standards (Shackley 2005) and in the second the availability of data allowed the assignment artefacts to source in the absence of our own geological data.

McCoy and Carpenter's (2014) assignment method involves the step-wise comparison of biplots displaying zirconium (Zr) and rubidium (Rb) ratioed to strontium (Sr). In the first step, artefacts are compared with values from all four source regions. In the second, the geological and archaeological samples from sources with the larger rationed values (Northland and Mayor Island) are removed to allow finer-grained comparison between samples in the TVZ, those from the Coromandel Peninsula sub-region of the Coromandel volcanic zone (CVZ-CP) and those from the northern islands in the Coromandel volcanic zone (CVZ-N). In the final step, the geological and archaeological samples from CVZ-N are removed to allow comparison between the TVZ and CVZ-CP source areas. This final level analysis is repeated using the iron (Fe) and calcium (Ca) values.

Lithic technology

Basic technological measurements and observations of artefacts have provided important evidence to allow inferences about the procurement and exchange of obsidian in New Zealand (e.g. McCoy & Carpenter 2014; Walter *et al.* 2010). In order to address similar issues, we recorded basic quantitative measures of artefacts (Andrefsky 2005), including length (mm), width (mm), thickness (mm) and weight (g). We also recorded artefact type and occurrence of edgewear and cortical material. This information is provided in the Supporting Information.

RESULTS

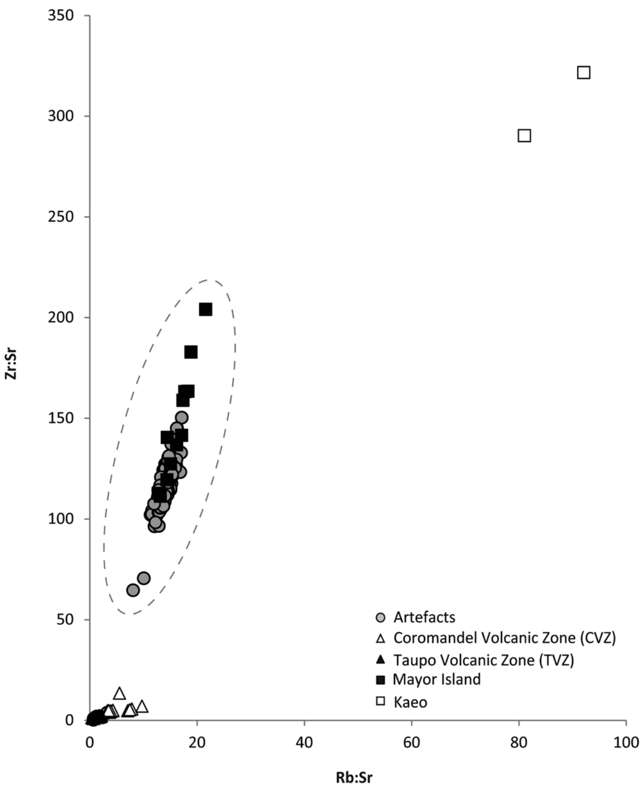
Source assignment

Following the step-wise process outlined above, we first compared Rb:Sr and Zr:Sr values of artefacts with geologically provenanced specimens (Figure 3). This showed none of our artefacts could be assigned to the Kaeo source in Northland, and a significant number of artefacts ($n = 171$, 63%) appeared consistent with Mayor Island. In the second step, the Mayor Island artefacts were removed with the remaining samples compared to the Rb:Sr/Zr:Sr values of CVZ-CP, TVZ and CVZ-N (Figure 4). A majority of artefacts fell within the expected range for CVZ-CP and TVZ obsidian, with a single artefact showing a signature closest to the Huruiki source. The assignment of a single artefact to this source may seem erroneous. However, it is interesting to note that, in this case, the artefact was one of

Table 1. PXRF analysis of two standards used in this research with comparison to recommended values.

BHVO-2						**SRM-278**				
	Rb	**Sr**	**Zr**	**Fe**	**Ca**	**Rb**	**Sr**	**Zr**	**Fe**	**Ca**
Recommended (ppm)	9.8	389	172	86030	82191	127.5	63.5	N/A	14268.7277	7025.4431
Observed (ppm)	4.05	270.93	148.5233	79625.97	65375.9	56.96	43.99	263.92	13213.72	2501.89
SD	0.54	2.74	0.59	263.34	1074.70	0.55	0.61	N/A	63.45	53.96
RSD	13.4%	1.0%	0.4%	0.3%	1.6%	1.0%	1.4%	N/A	0.5%	2.2%

Figure 3. Step one of the assignment of artefacts to source involving the comparison with geological samples from all four source regions (Northland [Kaeo], CVZ, TVZ and Mayor Island).



four large, retouched flake tools recorded at Kāūpokonui, which may suggest that obsidian was also transported in this form as well as cores.

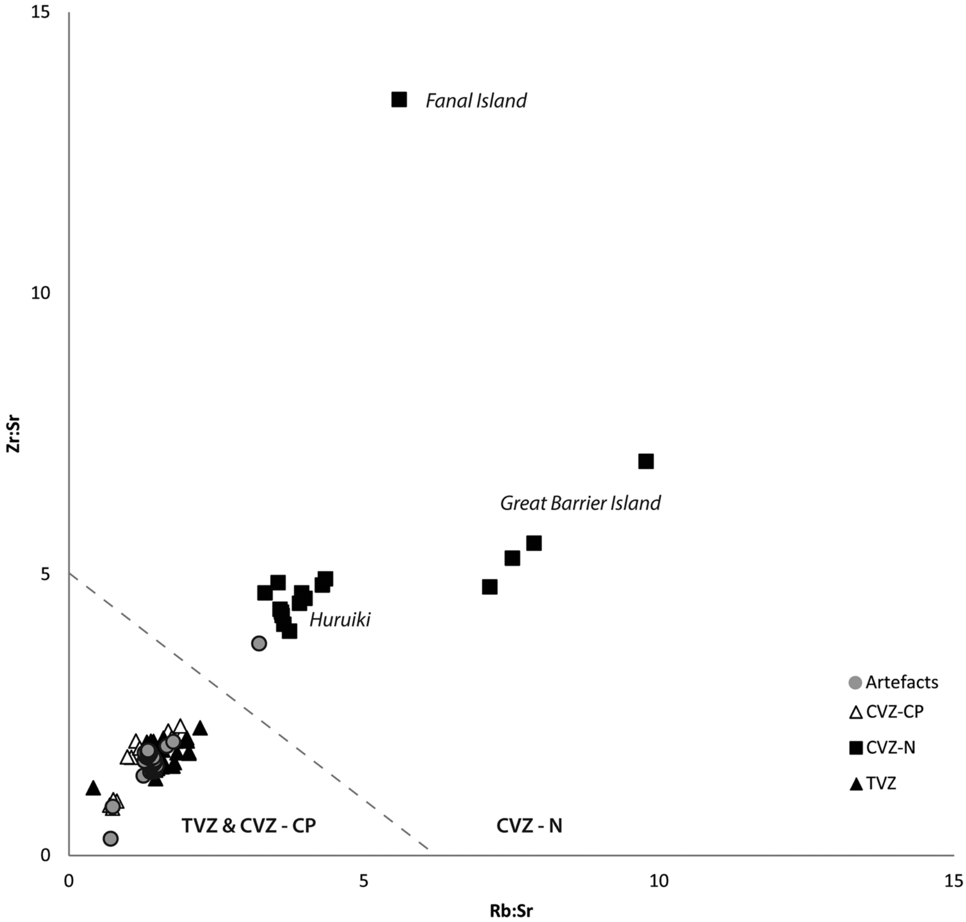
To differentiate sources within the CVZ-CP and TVZ source regions, we assessed the Fe and Ca values of our artefacts (Figure 5). This biplot suggested that the artefacts were not sourced from the TVZ, with the majority forming two clusters on either side of the Hahei geological samples, two artefacts aligning with the Waihi source and two outlier artefacts of unknown source. One potential caveat to these source assignments is the evidence of higher Fe values among TVZ obsidians than the McCoy and Carpenter (2014) method allows (e.g. Leach 1996; Moore 2011b). These data are largely produced using different geochemical analyses and therefore cannot be directly compared with our own with high confidence. However, while recognising these difficulties, comparison with pXRF analysis reported by Sheppard *et al.* (2011) shows overlap between the Fe values of the artefacts assigned to Hahei/Tairua (see below) and the upper half of the 1σ range of geological samples from Maketu ($n = 8$) and central North Island ($n = 59$) sources within the TVZ. Thus, while we believe our original source assignment to CVZ is correct, we cannot rule out the presence of TVZ obsidian.

To further investigate the sources determined to be CVZ-CP in the previous step of analysis, we returned to the Zr:Sr/Rb:Sr comparison (Figure 6). Two distinct clusters were again noted near the Hahei geological samples. The first overlays the Hahei geological samples and is consistent with material identified as Hahei in a previous analysis of material from this source (Maxwell *et al.* 2018). The second has a slightly higher Zr:Sr ratio and is equidistant, or slightly closer to the Tairua geological samples. We believe this material is distinct from the other Hahei material, but cannot confidently ascribe it to one source above the other; therefore, it is conservatively labelled Hahei/Tairua (but see above). With respect to the other possible sources, the two suspected Waihi artefacts again fell within the geological sample range and two artefacts previously grouped with Hahei in Figure 5 appear more closely aligned to Cooks Beach in Figure 6. Finally, one outlier from the Fe/Ca biplot falls within the Hahei group in Figure 6, the other artefact remains classified as unknown.

Table 2 presents a breakdown of the artefact count, frequency by count and frequency by weight of each source within sites and across all assemblages. Measuring the quantity of sources based on weight substantially increases MIO dominance from 63 to 80%. The weight measure may be biased by the limited sampling of Kāūpokonui; to address this, we separated the non-pXRF material into "green" and "grey" obsidian, which provides a coarse approximation of MIO versus non-MIO. Combining the weights of these groups with the pXRF material resulted in MIO representing 76% of the overall assemblage. Overall, it appears the early inhabitants of Taranaki obtained their obsidian from Mayor Island, with the Coromandel Peninsula the major secondary source zone.

Collapsing our data into broad categories – early/ late and MIO/non-MIO – allows a coarse assessment of change over time. The picture that emerges is one of stability; early assemblages contain 62% MIO to 38% non-MIO, whereas the later period contains 71% MIO to 29% non-MIO. The

Figure 4. Step two of the assignment of artefacts to source involving comparison of non-MIO artefacts with geological samples from TVZ, CVZ-N and CVZ-CP.



limited number of late assemblages and low overall count of late artefacts together with targeted sampling based on colour (see above) at the Kāūpokonui site means this result must be regarded with caution.

Assemblage-level analysis

Table 2 shows the breakdown of obsidian sources within each assemblage. Artefacts from Mayor Island are the majority material in six of the seven assemblages analysed. The exception is the late period site of Warea kāinga, which has a very low artefact count ($n = 6$) and therefore has low explanatory power in terms of understanding source composition. Among sites with larger sample sizes, Mayor Island accounts for between 50 and 91% based on artefact count (Table 2). Among the secondary sources, material from the ambiguous Hahei/Tairua source is most frequent in all sites with the exception of Hingaimotu where the material more securely assigned to Hahei is more common. This site also contains the bulk of artefacts assigned to this source (18/23 or 78%), perhaps suggesting a single core of this material was transported to Taranaki and reduced in large part in one location.

The larger sites, Kāūpokonui and Ōhawe, have a correspondingly large range of obsidian sources with six and three sources, respectively. Between them, these sites contain 90% of the cores analysed in this research, they also have the largest rates of retouch (Kāūpokonui = 14%, Ōhawe = 12%) and, along with Hingaimotu, the greatest amount of cortex (Kāūpokonui = 1.8%, Ōhawe = 4.1%, Hingaimotu = 10%). The latter figures are agglomerated across all materials; however, analysing rates of cortical material from individual sources does little to inflate these low numbers. Hahei obsidian from the Hingaimotu site has the greatest frequency of cortex at 22%, with Hahei/Tairua material from Ōhawe having the second most at 11%. All other assemblages fall well below 5% (see the Supporting Information).

Assessment of the average length of flakes suggests the early Taranaki sites sit within the range found in contemporaneous sites from the South Island (Figure 7), where expedient material use is inferred (e.g. Walter *et al.* 2010). Increased economisation through time can be assessed by comparing the size (length and weight) of early and late period Taranaki sites. In each case Mann–Whitney U-tests revealed statistically significant differences in the means of early and late sites (length, $p = 0.000$; weight, $p = 0.000$), with later sites having a lower average size consistent with the idea of greater economisation over time. We note the small sample size of the late period reduces the power of this result.

Figure 5. Step three of the assignment of artefacts to source involving comparison of Ca and Fe elemental values to split TVZ and CVZ-CP artefacts and assign source areas within CVZ-CP.

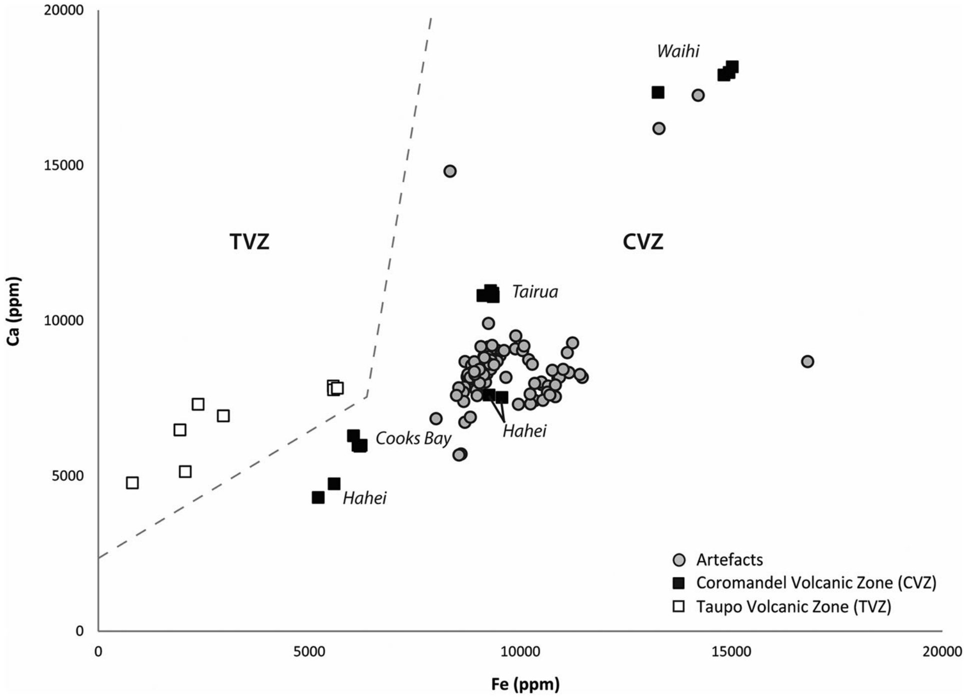


Figure 6. Step four of the assignment of artefacts to source involving comparison of the Rb:Sr and Zr:Sr values from artefacts assigned in step three to the CVZ-CP source area.

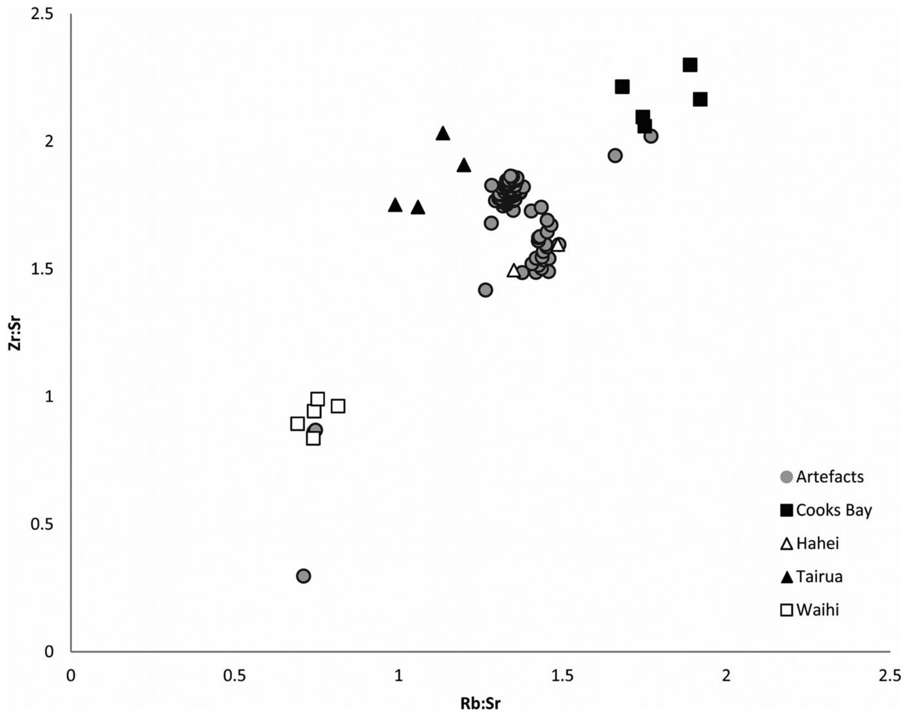


Figure 7 shows the average flake length at Kāūpokonui and Hingaimotu is near the top of the values from all early period sites. Further investigation of this pattern (Figure 8) shows this may be influenced by a group of large flakes from the Kāūpokonui and Hingaimotu sites, one of which is the single artefact from the Huruiki source. On the basis that these flakes may be functionally distinct (see below) from smaller flakes, we carried out a second set of size analyses, which excluded artefacts beyond 1σ from the mean of each measure. While this excluded the large flakes

Table 2. Breakdown of the number (*n*), frequency by count (%) and frequency by weight (% - g) of obsidian sources in each site (the flake of unknown source is excluded from the table).

	Cooks Bay			**Hahei**			**Hahei/Tairua**			**Huruiki**			**Mayor Island**			**Waihi**			
	n	**%**	**% - g**	***n***	**%**	**% - g**	***n***	**%**	**% - g**	***n***	**%**	**% - g**	***n***	**%**	**% - g**	***n***	**%**	**% - g**	**Total *n***
Hingaimotu				18	42	8	2	5	1.3				23	53	90.5				43
Kāūpokonui	2	1.9	0.5	1	0.9	0.42	38	35.8	13.4	1	0.9	3.9	64	60.4	81.3				106
Kūmara Patch				2	6.7	10.1	6	20	22.8				22	73.3	67.1				30
Ōhawe							17	35.4	41.4				29	60.4	55.4	2	4.2	3.3	48
Puketapu Pā				1	4	3.4	4	16	27.6				20	80	69.0				25
Te Rangatapu							1	8.3	3.4				11	91.7	96.6				12
Warea kāinga				1	16.7	5.3	3	50	63.2				2	33.3	31.6				6
Total (all assemblages)	**2**	**0.7**	**0.2**	**23**	**8.5**	**3.5**	**71**	**26.2**	**13.7**	**1**	**0.4**	**1.7**	**171**	**63.1**	**80.2**	**2**	**0.4**	**0.5**	

a Mann–Whitney U-test (weight) and *t*-test (length) showed a significant difference between the means of early and late period artefacts was retained (weight, $p = 0.000$; length, $p = 0.000$).

DISCUSSION

This research has focussed on developing a greater understanding of early Taranaki sites and, in so doing, contributing to the broader understanding of the colonising landscape in New Zealand. Below, we discuss aspects of the Taranaki obsidian assemblage and compare these to the patterns expected based on existing ideas about obsidian procurement and exchange in early New Zealand.

The first step in this process is to establish what patterns we might expect of the Taranaki data should the existing ideas apply in the region. The "coloniser mode" model of Walter *et al.* (2010) suggests the exchange of MIO obsidian represents a materialisation of prosocial long-distance connections between spatially dispersed early communities. For the Taranaki data to conform to this model, three key patterns should be observed. First, due to its preferential selection by early colonists, MIO should make up the major portion of early obsidian assemblages (Walter *et al.* 2010). Second, we should expect evidence of direct access to sources since the social benefit of undertaking long-distance procurement reduces the net cost and requirement for economisation behaviour; this is evident in high cortex ratios or signs of expedient use. Third, based on the presumption that the coloniser network was reasonably dynamic and the estimated multi-decadal occupation length of early sites, a reasonably large amount of obsidian should be found at each site or at least within the region as a whole. Alternatively, while McCoy and Robles (2016) do not attempt to develop a model per se, they do offer a view about the extent of interaction spheres, favouring a much more limited scale than is proposed by the coloniser mode model. For McCoy and Robles' (2016) ideas to apply, we would expect some degree of discrete spatial variation in terms of assemblage composition, either within the Taranaki region or compared with sites on nearby coastlines.

Obsidian sources

Our geochemical analysis of obsidian shows the earliest Taranaki communities gained much of their material from the major early source area on Mayor Island. The apparent preference for MIO, which represents 80% of the assemblage by weight, is broadly in keeping with the coloniser mode model. However, the presence and diversity of secondary sources also offers insight into behaviours of the colonising group, including: the rapid exploration of New Zealand (Davidson 1984) and a degree of experimentation with sources, links between Taranaki sites and the development of exchange networks.

The Taranaki sites reinforce that, despite having an awareness of and access to the high-quality material on Mayor Island, colonists also sought, transported and used other materials. Serendipity may have played a part in this, as some obsidian sources on the Coromandel Peninsula are very close to areas known to have been settled by early communities (Moore 2013; Maxwell *et al.* 2018). However other sources, such as Waihi, are located inland (Moore & Coster 1989) and could only have been found by deliberate exploration away from the coast. The Taranaki data therefore demonstrates both the importance of MIO and a greater complexity of behaviour than could be assessed by focussing on MIO alone (McCoy & Robles 2016).

Comparing the frequency of both primary and secondary sources at sites provides evidence of close connection between the early Taranaki sites. While we see a greater range of materials at the larger Kāūpokonui site, the major source areas represented at Kāūpokonui are the same across all of our sites that have a reasonable sample size. This pattern may arise either through separate groups accessing the same obsidian sources or some degree of connection between early Taranaki sites through either trade or occupation of the sites by the same community or group. The first suggestion is the least parsimonious, requiring different groups to engage with the exact same obsidian (and other lithic) sources. Thus, we favour the idea that early sites within Taranaki were occupied by the same community or group.

Our data provide no evidence of different small-scale networks emerging along what is now the Taranaki coast as

Figure 7. Mean flake lengths (mm) from early Taranaki sites (grey), South Island early sites (dark grey) and a late period site from Taranaki.

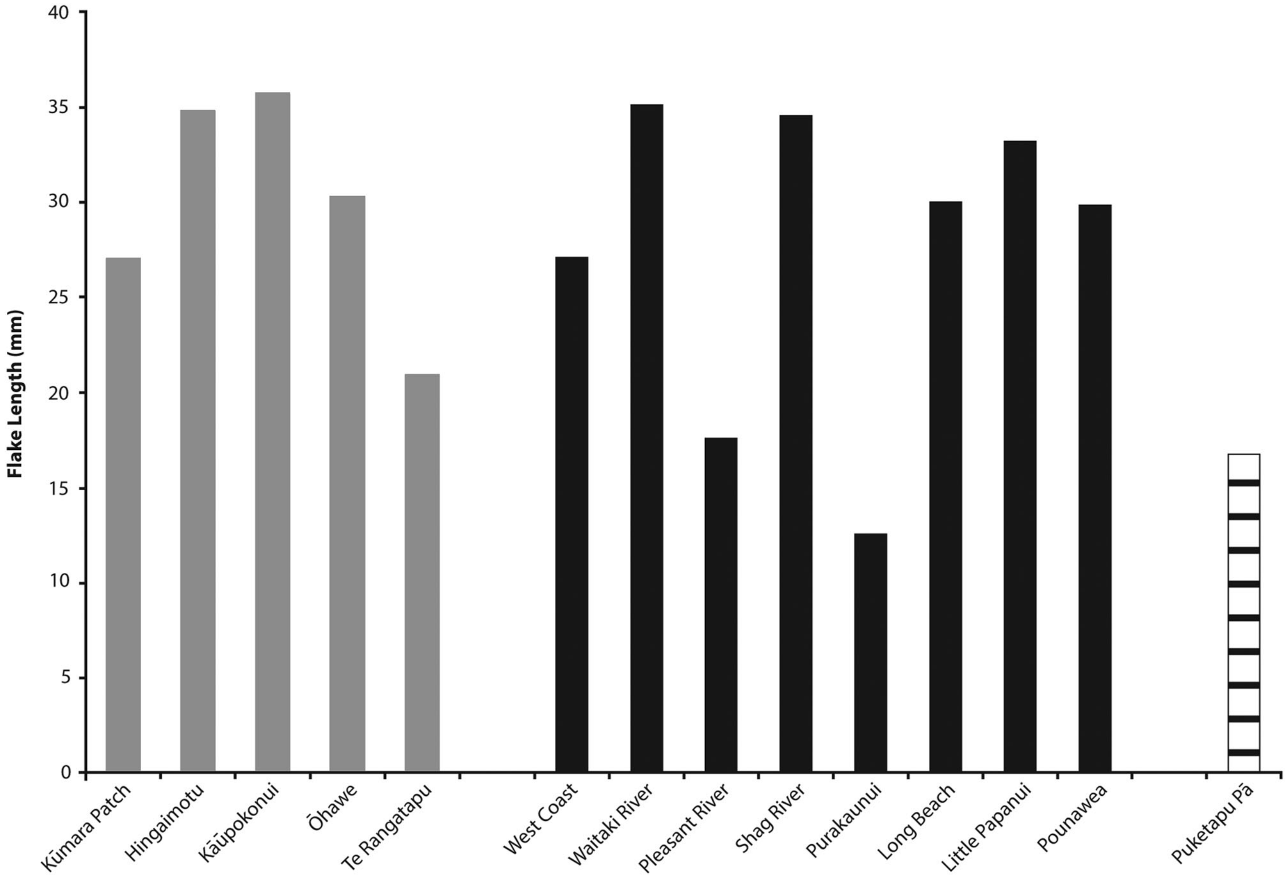


Figure 8. Box and whisker plots of the length of flakes (mm), showing a collection of outliers representing very large flakes within the Kāūpokonui and Hingaimotu sites.

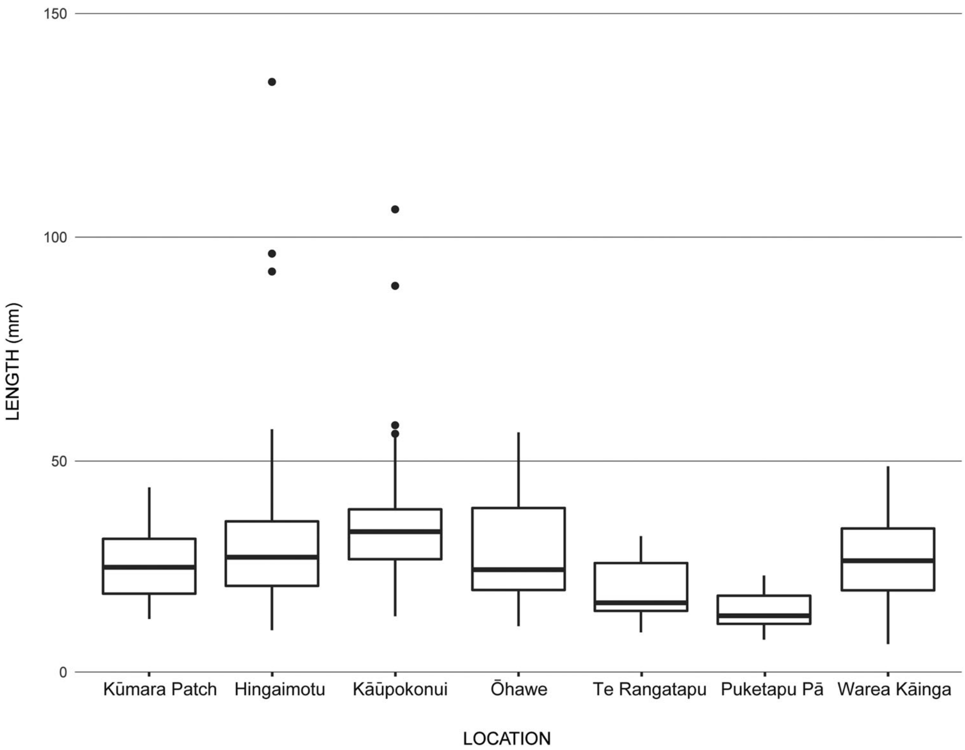
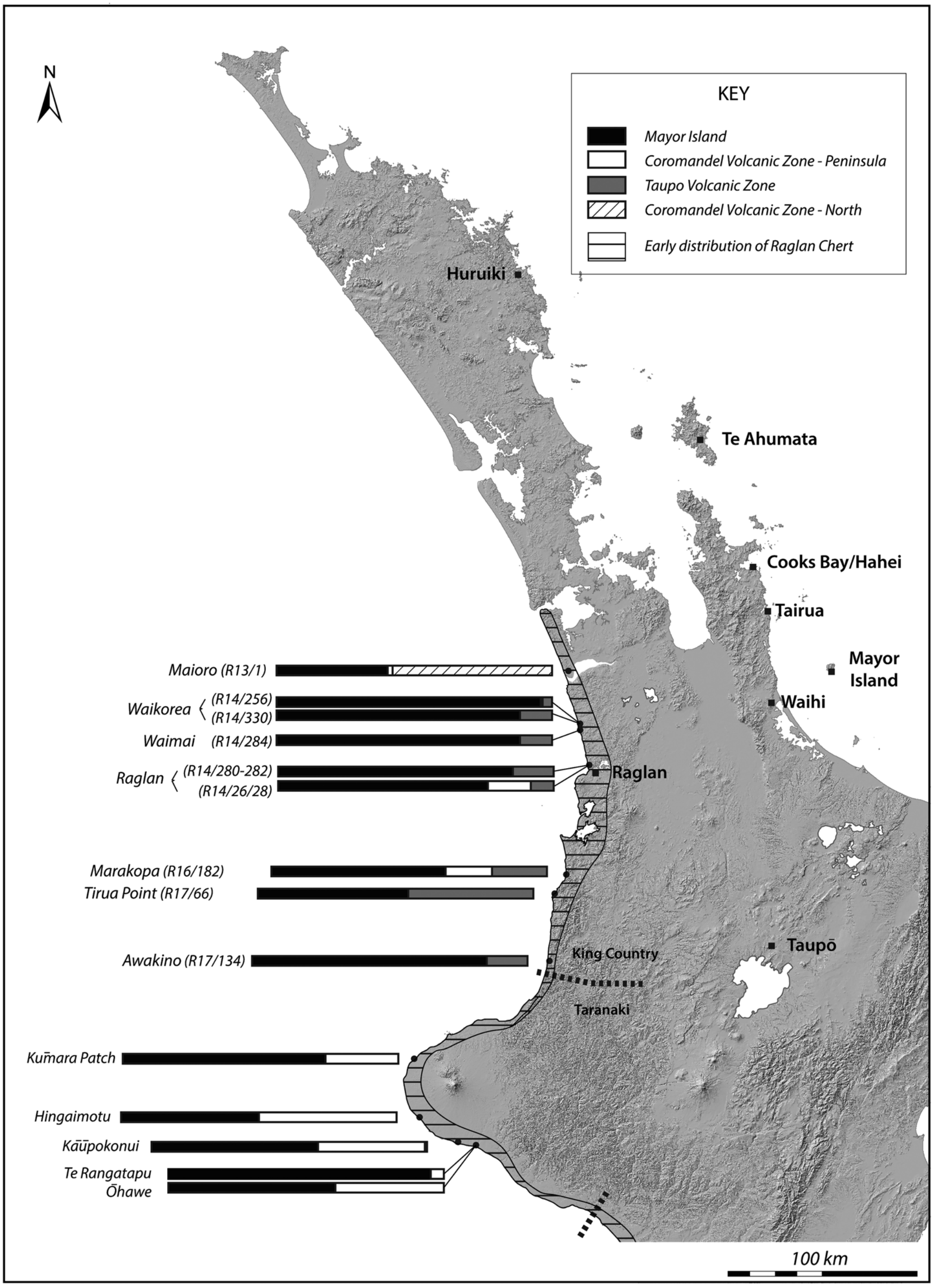


Figure 9. The west coast of the North Island with King Country in the north and Taranaki in the south. Early sites and the source composition of their obsidian assemblages are shown to the left.



per McCoy and Robles (2016). However, broader-scale comparison of obsidian sources and other forms of lithics from the Taranaki sites with those from sites on the King Country coastline to the north, suggests a connection between early communities on the west coast of the North Island, and potentially the presence of unique obsidian procurement spheres at this scale. Connectivity between sites along the west coast of the North Island can be inferred by the presence of a yellow/brown chert from the Raglan area in sites from South Manukau Head into Taranaki and potentially beyond to the Wellington coast (Moore & Wilkes 2005; Turner 2000; Figure 9). This distribution suggests that the interaction sphere of early Taranaki community extended north to Raglan, thus overlapping with some early sites on the King Country coast. Despite the connections inferred from Raglan chert, our results suggest discontinuity in terms of obsidian procurement across these areas of the west coast. The key potential difference is the source of major secondary material. In the King Country sites, the largest and often only source of secondary material is believed to be the TVZ (Moore 2011a). Moore (2011a) argues this material was transported out to the coast along river systems where it was then traded south to north away from Taranaki. Our application of the McCoy and Carpenter (2014) method supports this view as we did not find TVZ obsidian within the Taranaki assemblage. Such a pattern suggests a spatial discontinuity in the obsidian procurement spheres along the west coast, consistent with McCoy and Robles' (2016) observations from the Otago.

Alternatively, if we accept that artefacts assigned to the Hahei/Tairua group may be from the TVZ, the obsidian profiles from Taranaki and King Country sites become more aligned, but retain differences from other regions where geochemical analysis has been carried out (e.g. McCoy & Robles 2016). This result increases the operational scale of the obsidian network in which Taranaki sites fit, but still support the notion that regional social networks formed relatively early in New Zealand.

Ultimately, the evidence presented above for the diversity and frequency of secondary source material in Taranaki sites suggests an altogether more complex picture than a simple focus on MIO allows. A final noteworthy aspect of the data is the consistency of MIO to non-MIO over time, with a small increase in the frequency of MIO in later sites. This stability is counter to evidence from northern regions of New Zealand where Moore (2012) argues that MIO declines in frequency over time, but appears consistent with Taranaki being in a "local supply zone" extending approximately 500 km away from Mayor Island (Walter *et al.* 2010: 504). Although, we note the low sample size of the later period means less certainty can be placed on this result.

Procurement

Direct access has been suggested as the major means of obsidian procurement in both the early North Island (Seelenfreund 1985) and later sites in northern New Zealand (McCoy & Carpenter 2014). However, in the Taranaki data, only Hahei obsidian from Hingaimotu approaches the c.25–50% rate of cortex used as an indicator of direct procurement in Hawaii and later period New Zealand (McCoy *et al.* 2011; McCoy & Carpenter 2014). To some extent, the relatively small amount of cortical material in Taranaki sites may be due to the manner of extraction. For example, the Hingaimotu assemblage consists of three very large MIO flakes, which we suspect may have been removed as primary flakes from flows and weathered blocks in a similar manner to practices observed in adze quarries (Jennings *et al.* 2018; Jones 1984; Leach & Witter 1987), before being transported for use as either tools or cores. This method would create a ventral facet without cortex and reduce cortical material in assemblages compared with procurement of cobbles. Nevertheless, based on established measures of exchange using cortex we can only conclude that the Taranaki data are not consistent with direct access to sources. This assertion is made equivocal by other evidence of the changing size of artefacts through time. In particular, we see a statistically significant reduction in flake size (length and weight) over time, indicative a pattern of expedient to more economic use of obsidian. This may suggest material was more easily accessed, perhaps via direct procurement, in the early period (Walter *et al.* 2010). However, the low sample size from the late period somewhat reduces the reliability of this result leaving us, on balance, to suggest the direct procurement cannot be strongly supported in the Taranaki data.

Obsidian weights

Finally, as we suggested earlier, we believe the coloniser mode of exchange presented by Walter *et al.* (2010) implies a high-traffic network with multiple re-supply events, which, over the supposed multi-decadal occupation length of larger early sites (Walter *et al.* 2006) should have led to a large accumulation of obsidian. In practice, the weight of obsidian within many early sites, including Kāūpokonui, is much lower than we might expect. However, while we believe the consideration of the amount of material being transported can provide important information about the nature of early networks, we acknowledge that the systematic assessment of obsidian weights in early New Zealand is complicated by the obvious recovery biases, the nature of obsidian collection (i.e. often involving surface collection) and differential levels of reporting. This makes assessment of this part of the model using Taranaki data difficult.

CONCLUSION

This research contributes to a new picture of activity in Taranaki, an important centre of early North Island settlement. It also provides a regional test of existing models of obsidian procurement and exchange in early New Zealand. Our results suggest that MIO was the most frequent obsidian material in early Taranaki sites, entirely consistent with patterns observed elsewhere in New Zealand. However, while lower frequency, secondary sources still contribute a significant amount of material to the Taranaki assemblage (20%). In the case of Taranaki, the major secondary source zone is the Coromandel Peninsula, although we cannot completely discount that possible importance of material from the TVZ. The lack of strong support for direct procurement in Taranaki may suggest some sort of down the line exchange. We argue the operational scale of this exchange may have been much smaller than is the nation-scale models often presented (e.g. Walter *et al.* 2010). Alternatively, the amount of material present in the Taranaki region could be the result of a single or limited number of journeys made as part of the initial colonising pulse in the region (Irwin 1991). In this model, obsidian may have been collected and transported by colonists as a failsafe measure against encountering lithically barren areas with cortex reduced elsewhere on route to the Taranaki region. Overall, these results suggest much more complex picture of early resource procurement and exchange than is offered by the study of MIO alone.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Geochemical and Archaeological Data from Taranaki Sites