The pre-European Use of Lithic Materials in the Canterbury Region, New Zealand

Phillip R Moore

Canterbury Museum, 11 Rolleston Avenue, Christchurch 8013, New Zealand

Email: peninres@xtra.co.nz

Former Māori inhabitants of the Canterbury region, in the South Island of New Zealand, had access to a variety of stone (lithic) materials for utilitarian tools such as adzes, chisels, drill points and cutting implements, as well as for ornaments and items employed in fishing. More than 20 different rock types have been identified among artefact collections from the region, though only about half of these were widely utilised. Some were imported, either as finished artefacts or raw materials, from the north (Nelson-Marlborough and North Island), south (Otago-Southland) and west (West Coast/Westland), but others were obtained within Canterbury. These include greywacke, basalt, silcrete, chert, chalcedony, silicified tuff, sandstone and red argillite.

This study involved the examination of more than 6,700 Māori artefacts from 11 key archaeological sites in Canterbury. New information was obtained on the composition, distribution and sources of some of the lithic materials utilised at both Early (fourteenth to sixteenth century) and Late (sixteenth to eighteenth century) period sites in the region. The data also reveals some important intra-regional variations and temporal changes in the use of certain materials, including a significant decline in silcrete during the Late period (post-sixteenth century) and a corresponding increase in the use of chert and chalcedony. The presence of a few distinctive minor lithologies at multiple sites indicates there was probably a considerable degree of interaction between many of the early communities situated along the Canterbury coast.

Keywords: archaeological sites, Canterbury, lithic materials, Māori artefacts, stone sources, taonga

Introduction

The Canterbury Lithics Project was initiated in 2017 in order to provide an overview of the pre-European utilisation of kōhatu (stone materials) in the Canterbury region. Although a useful review of existing information had already been published (Challis 1995), it was considered important to obtain some new data on the various lithic materials previously used by Māori, with an emphasis on those found within Canterbury. There were two specific objectives: (1) to better document known or suspected pre-European stone sources and obtain new information on the attributes of the rock; and (2) re-examine existing artefact collections at Canterbury Museum (and other museums where appropriate) to provide more reliable identifications of rock types, establish their provenance, and determine any regional variations in the use of particular materials. The first objective has been largely met through the publication of separate papers (Moore and Trotter 2017; Moore 2019; Moore and Davis 2020; Moore et al. 2020). The second is the main focus of this paper.

The study involved the examination of more than 6,700 Māori artefacts (taonga) from 11 key archaeological sites, most of which are located along the coast. The majority of these sites date to the Early or Moa-hunter period (fourteenth to sixteenth century) of New Zealand prehistory, but a few were occupied during the Late or Classic Māori period from the sixteenth to eighteenth century (Davidson 1984; Challis 1995). Most of the artefact collections from these sites are held by Canterbury Museum. Some were also examined at South Canterbury Museum (Timaru) and Otago Museum (Dunedin).

Study Area and Archaeological Sites

For the purposes of this study the Canterbury region is taken as that area between Claverley in the north and the Waitaki River in the south (Fig. 1). In contrast to Environment Canterbury boundaries this excludes the entire Kaikōura District and most of the Waitaki District but is similar in extent to the Department of Conservation's Canterbury Conservancy region (Challis 1995). Mid Canterbury is regarded here as the area between the Waimakariri River and Rangitata River, including Banks Peninsula.

The locations of archaeological sites from which artefact assemblages were examined are shown on Figure 1. In general, only those sites containing significant numbers of artefacts were considered in this study. Site numbers (e.g. M36/24) are those of the New Zealand Archaeological Association Site Recording Scheme, ArchSite (www.archsite.org.nz).

Previous Work

There has been a long-standing interest in Māori stone artefacts in Canterbury which began, formally, with Julius von Haast (1871). As Provincial Geologist, he made a particular note of some of the rock types used at the expansive Rakaia River mouth site, including silcrete, palla (silicified tuff) and flint. Later, he also recorded the range of stone items recovered during excavations at Moa-bone Point Cave and the adjacent dunes at Redcliffs (Haast 1874).

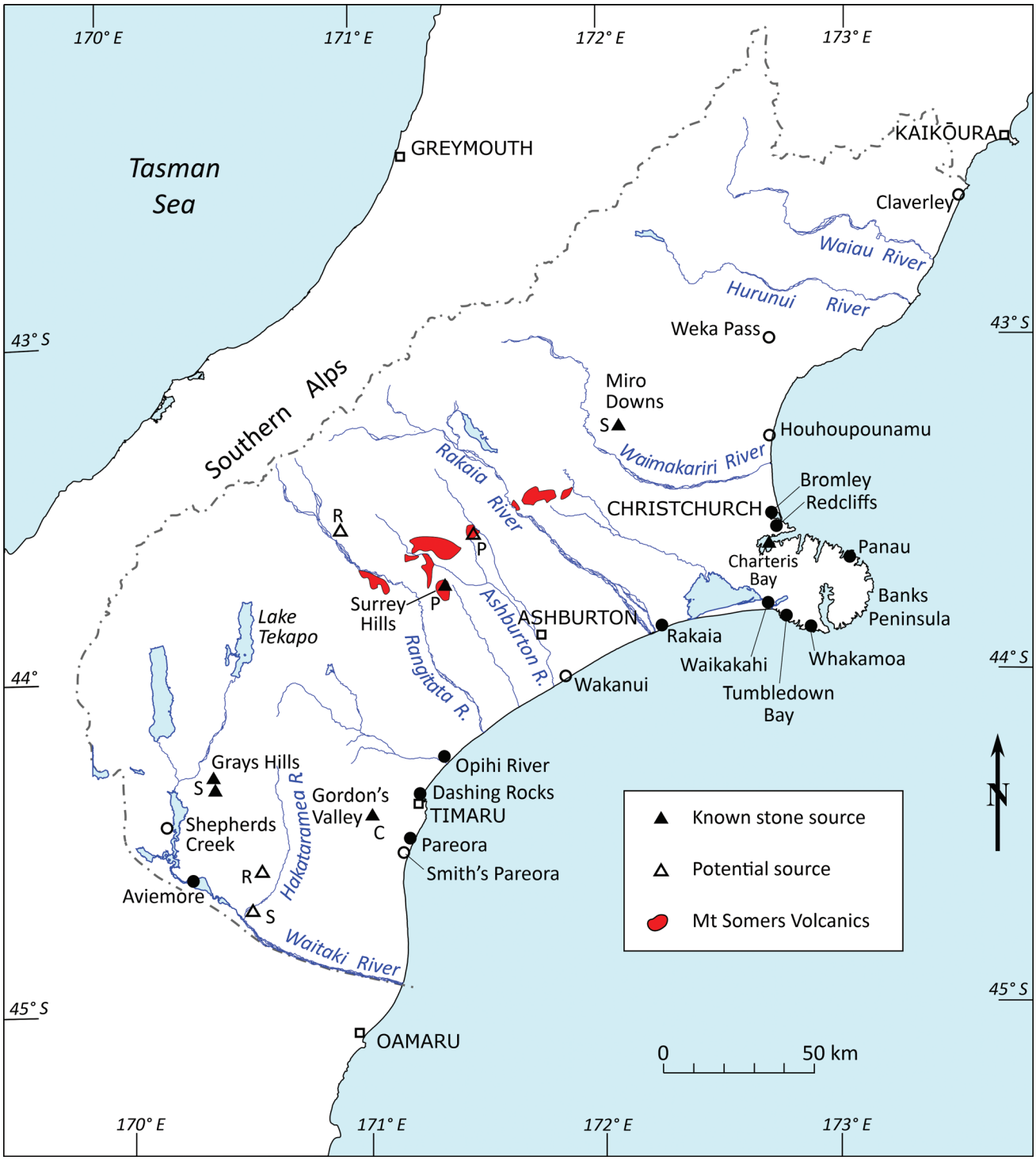

Figure 1. Map of the Canterbury region, showing the location of archaeological sites (black dots = main sites, open circles = other sites) and known and potential stone sources. Letter codes associated with stone sources are: C = chert, P = porcellanite/palla, R = red argillite, S = silcrete

No comprehensive lithologic study of artefacts from the Canterbury region has been previously carried out, but an important petrological paper on pounamu (nephrite and bowenite) artefacts from Otago and South Canterbury was published by Turner (1935). Further petrographic work was undertaken by Simmons and Wright (1967) on silcretes from various South Island sites, including the Grays Hills quarry in the Mackenzie Basin. Some brief notes were also provided by Dawson and Yaldwyn (1975) in an account of their small-scale excavations at Redcliffs in the 1940s (see Trotter 1975).

As part of his monumental PhD thesis, Orchiston (1974) documented the occurrence of a range of artefacts made from such materials as palla, porcellanite, red argillite and greywacke, though he did not undertake any petrographic study of these rock types. Only one paper – on palla – was published (Orchiston 1976). In a later study, Jacomb (1995) carried out an analysis of artefact assemblages from 15 sites between Wairau Bar in Marlborough and the Rakaia River in mid Canterbury. Adzes were classified according to Duff's (1956) typology, but simply divided into greenstone (nephrite) and non-greenstone. Some additional information was provided by Jacomb (2000, table 1).

Chemical analysis has been previously restricted to small numbers of obsidian flakes from selected Canterbury sites (Seelenfreund and Bollong 1989), including an assemblage of obsidian and what was thought to be pitchstone from the Wakanui site (K38/3) near Ashburton (Mosley and McCoy 2010). Both studies employed non-destructive X-ray fluorescence (XRF) spectroscopy.

Methods

In the present study many artefacts were examined under a binocular microscope in order to establish the grain size of sedimentary rocks (using a standard grain size comparator), composition, texture and, in a few cases, fossil content. Colours were based on the internationally recognised Munsell Soil Color Chart (2000 version). A small magnet also proved useful, particularly in distinguishing basalt from some similar-looking non-magnetic rock types such as black metasomatised argillite and fine-grained greywacke. Additionally, some materials were subjected to non-destructive geochemical analysis using portable XRF (pXRF).

While an effort was made to examine complete collections from a range of archaeological sites (both geographically and in terms of their age), in many cases only artefacts of certain lithology or type were closely studied. For example, finished adzes were generally excluded, and items made of pounamu (nephrite), meta-argillite and greywacke were not always recorded. Greater emphasis was also placed on the analysis of flake material, particularly of rock types which had received little attention in the past (e.g. chert). Collections from some areally extensive sites, like Redcliffs and Rakaia, were only partially examined. That from the Late period site of Houhoupounamu was not included because of the very large size of the assemblage (>4800 items, Challis 1995: 38) and the need for more detailed analysis of the artefact material. Small collections were examined from a few other sites such as Claverley, Weka Pass (Moore in prep a), Connolly's Seadown (near Temuka) and Shepherds Creek (Moore in prep b; Fig. 1).

Catalogue numbers (e.g. E154, 2008.1005.1) referred to here are those of the Canterbury Museum, unless otherwise stated. Artefacts held by South Canterbury Museum and Otago Museum are prefixed SCM and OM respectively.

Lithic Materials

The more significant lithic materials recorded from Canterbury sites are listed in Table 1. They are divided into those that were definitely imported, and those that are considered to be at least partly of local (Canterbury) origin, like chert and silcrete, based on existing geological and archaeological knowledge. Of the local materials, new information was obtained on the visual attributes, sources or archaeological distribution of basalt, silcrete, sandstone, chert, chalcedony, red argillite, palla, Panau flint, and pitchstone. In total, more than 23 different rock types have been identified. Māori names for some of these are recorded where known.

Table 1. More significant lithic materials utilised at Canterbury sites.

Local rock types	**Imported** (source)
Basalt	Meta-argillite (pakohe)* Nelson-Marlborough
Silcrete	Pounamu# (nephrite and bowenite) Westland, Otago
Chert	Obsidian (mataa) – North Island
Chalcedony	Porcellanite – Otago-Southland
Pitchstone	Silcrete – Otago
Panau flint	Chert – Kaikōura area
Palla (silicified tuff)	
Red argillite	
Sandstone	
Greywacke	

* An abbreviation of metasomatised argillite

Pounamu is the Māori name for both nephrite and bowenite (Beck 1984). Some was apparently procured from the Wakatipu area (western Otago), and possibly Fiordland.

Meta-argillite (Pakohe)

This is a particularly hard and tough, but readily flaked, fine-grained metamorphic (metasomatised) rock, well suited to the manufacture of adzes and chisels (Johnston 2011). It is referred to simply as argillite or indurated mudstone in earlier reports. The bulk of the meta-argillite used at Canterbury sites undoubtedly originated from quarries in the Nelson-Marlborough region. It is mostly grey, dark grey or black, but some is light grey with black veins, typical of material from the Ohana quarry on D'Urville Island (Keyes 1979). A few flakes and other items of greenish grey argillite were also recorded at some sites (e.g. Rakaia, Dashing Rocks), which may originate from Southland (Jennings 2009).

Basalt

The question of where the basalt used to manufacture local adzes came from, such as those found at Redcliffs, has been a long-standing problem in Canterbury archaeology. Although the prevailing opinion is that the basalt was procured from Banks Peninsula (e.g. Trotter 1975; Challis 1995), in the absence of any recorded Māori quarries or dedicated stone-working areas this has remained unproven. Doubts were also raised by the petrological study of a single basalt flake from Redcliffs, which suggested the most likely source was somewhere in East Otago, possibly Dunedin (Dawson and Yaldwyn 1975).

In 1990, however, apparent evidence of stone-working was recorded at nine sites along the eastern side of Lake Forsyth (Challis 1995). Given the importance of this discovery the area was re-visited in 2017, but it was evident that what was thought to be flaking visible on scattered basalt boulders in this area had been caused by natural impacts as a result of rolling down the steep hillside, or being hit by other falling rocks, not by pre-European Māori. No adze preforms, concentrations of stone flakes or hammer-stones were found in the vicinity.

In March 2018 a project was initiated to try and establish the source(s) of basalt used in the manufacture of adzes found on Banks Peninsula and surrounding area by employing non-destructive pXRF analysis. Unfortunately, no definite source was able to be identified.

Figure 2. Silcrete blades from Rakaia (top, E70.57) and Bromley (bottom, E155.81). Canterbury Museum collection

Silcrete

Also referred to as quartzite or orthoquartzite, silcrete is a hard, silica-cemented sandstone. Much of it was probably imported from Otago, where there are a number of significant quarries (Hamel 2001; Anderson 2003), but two primary sources are also known in Canterbury: Grays Hills in the Mackenzie Basin, and Miro Downs near Oxford (Fig. 1). More detailed accounts of these sources are provided by Moore and Davis (2020) and Moore et al. (2020).

An occurrence of detrital (alluvial) silcrete has also recently been recorded by the author in the lower Hakataramea Valley, South Canterbury, consisting of sparse cobbles and rare boulders in the Hakataramea River and some tributaries (Fig. 1). The silcrete is of moderate to poor quality, varies from white to grey, is fine to medium grained and moderately sorted. Many samples also include patches, layers or clasts of white clayey material. Harder pieces have a sub-conchoidal fracture.

Artefacts of silcrete are common at many early sites along the Canterbury coast, such as Bromley, Redcliffs, Rakaia, Dashing Rocks and Pareora, where it seems to have been used mainly as a cutting implement (Fig. 2). It was also used for drill points. The stone varies in colour from white to grey to yellowish brown, and generally has a similar grain size, though some material from the Pareora site J39/29 is unusually coarse grained (e.g. OM D67.4063). A few artefacts from some sites (e.g. Opihi River) have remnants of smooth, water-worn cortex, indicating they were derived from river or beach cobbles. However, without detailed petrographic study and/or geochemical analysis it would be very difficult to establish exactly where the silcrete originated from.

Porcellanite

Porcellanite (also spelled porcelanite) is defined as a dense siliceous rock with a texture, hardness and dull lustre similar to that of unglazed porcelain (www.mindat.org), and can be of sedimentary, volcanic or metamorphic origin. It generally refers to a siliceous shale or impure chert, but the term is also applied to fine-grained tuff cemented by silica (e.g. palla), hard baked clay or shale associated with burned-out coal seams and sedimentary rocks melted by volcanic eruptions. In Canterbury, some porcellanite artefacts appear to have been previously classified as jasper or jasperoid (e.g. Mason and Wilkes 1963a; Trotter 1972). The latter is a cherty rock formed by the replacement of calcite or dolomite by silica (i.e. silicified limestone), and not an appropriate term.

An unstated number of porcellanite artefacts, of variable colour, were recorded by Orchiston (1974) from eight sites along the Canterbury coast between Banks Peninsula and the Waitaki River. He considered all of the porcellanite had come from known sources in Otago and Southland (e.g. Anderson 2003; Gillespie 2020), where it was formed by the baking of clay or shale by natural burning of coal seams. Artefacts of this material are relatively common at Rakaia, and also occur at Pareora, Lake Aviemore and in the Mackenzie Basin (Moore in prep b). Colours recorded from these sites include grey, bluish grey, reddish grey (2.5YR 7/1, 10R 6/1), reddish brown (5YR 3/2), brown and yellow-brown. Some of the yellowish material looks remarkably similar to chert (jasper).

At least one geological occurrence of porcellanite is known in Canterbury. This is an isolated deposit of what appears to be baked siliceous tuff at Mt Alford, which has been formally recorded as a pre-European quarry (site K36/2). However, the extent of flake quality material is small (pers. obs.), and it is doubtful that many artefacts could have been produced. A chemical analysis of the rock is presented in Moore and Trotter (2017). Another occurrence was reported by Speight (1928) at Burnt Hill near Oxford. This locality was re-visited in 2018 to see whether the porcellanite was of sufficient quality to have been utilised by early Māori, but none could be found. Both of these occurrences, therefore, can probably be ruled out as a source of the porcellanite artefacts found in Canterbury sites, particularly those in South Canterbury.

Two flakes of white porcellanite (2008.1009.2503) were recorded from Tumbledown Bay, site N37/12 (see also Mason and Wilkes 1963a: 99). These do not fall within the colour range of Otago-Southland porcellanites reported by Orchiston (1974) and may originate from one of the silcrete sources in Canterbury, possibly Grays Hills. Three other flakes from Tumbledown Bay that had been previously labelled "?porcellanite" (E163.228D, 234H, I) were identified as yellowish brown chert. These may be the items recorded by Orchiston (1974).

Palla

One of the more colourful rock types found in Canterbury is a distinctive green silicified tuff termed palla, which can be regarded as a variety of porcellanite. Its use for adzes by early Māori was initially recognised by Haast (1871) and later documented by Orchiston (1974, 1976). A more complete account of the occurrence, composition and utilisation of this material has recently been published (Moore and Trotter 2017). The only known source of palla is at Surrey Hills (Gawler Downs), west of Mt Somers (Fig. 1).

Since 2017 some additional artefacts of palla have been recorded, from Bromley (43 flakes and pieces), Redcliffs (2 flakes, part of preform adze, drill point), Tumbledown Bay (5 flakes) and Rakaia (10 flakes and pieces). These new records do not extend the known archaeological

limits of this rock type (Moore and Trotter 2017, fig. 4), but do indicate greater use of palla at Bromley, and establish its use at Tumbledown Bay. One flake possibly of palla (SCM, E444) has also been recorded from Milford in South Canterbury, a locality previously noted by Orchiston (1974).

Chert

Artefacts of chert (or flint) have been recorded at many Canterbury sites, but the lack of any consistency in terminology or description of the material in previous reports has made it difficult to establish, with any certainty, where it originated from or how many sources may be represented. The terms chert, flint and jasper have all been used at various times.

It has been previously recommended that a broad definition of chert be adopted to include highly siliceous rocks of different origins (i.e. sedimentary and volcanic) and modes of occurrence, and that use of the term flint be abandoned (Moore 1977). However, it is probably reasonable to assume that in most cases the flint recorded in reports on Canterbury sites (e.g. Jacomb 2000) generally refers to chert derived from the Mead Hill Formation and/or Amuri Limestone in the Kaikōura area, and therefore constitutes an imported lithic material. It is referred to here as Kaikōura chert (Moore 2021a). Other forms of chert, variously described as jasper or jasperoid rock (e.g. Parry 1960; Mason and Wilkes 1963a; Trotter 1972) are likely to be of local origin.

Most of what was considered in this study to be Kaikōura chert is grey, though some is white, pale brown or black. It is also characterised by the presence of tiny microfossils (primarily radiolaria and foraminifera), as well as bioturbation (fossil burrows, Fig. 3). In contrast, local chert (or jasper) is typically red-brown to yellow-brown, and in some cases brown or green. In addition, it has a distinctive moss-like texture and often contains veins of chalcedony (Fig. 4). Some difficulty was experienced in deciding upon the likely source of white chert, and it seems that such material may have come from both Kaikōura and local sources. At least two flakes of white chert from Redcliffs contained microfossils, indicative of a sedimentary (marine) origin.

The probable source for much of the local chert is the Mt Somers Volcanics, which outcrop discontinuously along the Canterbury foothills between the Malvern Hills and Rangitata Gorge (Cox and Barrell 2007; Fig. 1). Most archaeological material could have been obtained from rivers draining the various areas of these volcanics, particularly the Hororata, Ashburton, Hinds and Rangitata, or from gravel beaches along the

Figure 3. Core of Kaikōura chert, with well-preserved bioturbation (compressed burrows), Rakaia. Canterbury Museum 19xx.1.2470 Photo by author.

coast. Some of the cores and flakes of local chert from the Opihi River site K38/11 contain remnants of water-worn cortex.

Gordons Valley Chert

A different, rather distinctive type of chert has been identified in the Pareora area (Moore 2019). It occurs in situ in the form of nodules and irregular masses within limestone at several localities around Gordons Valley, including some rock shelters (Fig. 1). Use of this material, which is only of moderate quality, seems to have been mainly restricted to the Gordons Valley-Pareora area. It is relatively common at the Pareora site J39/29.

Pahautane Chert (Heaphyite)

This chert, which has also been referred to as heaphyite (Wilkes and Scarlett 1967), occurs on the West Coast near Punakaiki, and also at Karamea (pers. obs.). It is very similar in appearance to Gordon's Valley material. Four flakes of what are considered to be Pahautane chert were identified from Redcliffs (2008.1108.8, 78), along with a core from Sumner (E167.545) and another from Weka Pass (Moore in prep a). The cores and at least two of the flakes contain common sponge spicules, a feature of both the Pahautane and Gordon's Valley chert.

Black Speckled Chert

A total of 15 flakes and pieces and three cores of this previously unrecognised rock type were recorded, from four different sites (Rakaia, Dashing Rocks, Pareora and Aviemore). It is most common at Rakaia (Fig. 5). The rock is typically dark to very dark grey, has an unusual speckled texture, and contains abundant white platy crystals (up to 0.5 mm across), sand-sized quartz grains and rare mica. The white crystals, which may be feldspar, are randomly oriented. Some artefacts also include white blotches (in two cases with small quartz crystals) and veins of chalcedony. Although the rock does not contain any obvious organic material, a few pieces show what appear to be bioturbation and thus it may have a sedimentary origin. It could be a silicified tuff and, if so, possibly came from the Mt Somers Volcanics.

Chalcedony

This cryptocrystalline variety of quartz (which includes agate and carnelian) was utilised at many sites along the Canterbury coast, and is assumed to be of local origin. It appears to have been used, like chert, mainly for cutting and scraping purposes, although one possible drill point was recorded from Tumbledown Bay, and several others from Connolly's Seadown (site K38/13) north of Timaru. There is also a round cobble, used as a hammer-stone, from Redcliffs (E142.277). Some small cores and flakes

Figure 4. Core of local chert, Temuka. South Canterbury Museum no. 433. Photo by author

Figure 5. Flake of black speckled chert, Rakaia. Photo by author. Canterbury Museum E167.95

from the Opihi River site have remnants of water-worn cortex, indicating the chalcedony was obtained from a river or beach environment. One core of carnelian from Whakamoa (site N37/14) has a rough cortex suggesting procurement from close to the primary source.

Most chalcedony probably originated from the Mt Somers Volcanics, where it occurs mainly in the form of nodules or veins (as agate) within the Barossa Andesite and Hinds River Dacite (Oliver and Keene 1989). Significant quantities of agate have been collected for lapidary purposes from the Malvern Hills, Mt Somers, Clent Hills, Upper Hinds River and near the Rangitata Gorge, as well as from other rivers and parts of the coast (Luxton 2015). A minor occurrence of agate has also been recorded at McQueens Valley on Banks Peninsula in an old andesite quarry (Speight 1935; Luxton 2015) but this may not have been exposed in pre-European times.

Other Silica Varieties

Other silica minerals or varieties recorded in some artefact assemblages include common opal (sometimes referred to as opalite), petrified wood and quartz. A few flakes and pieces of common opal (or opaline chert) were recorded at Rakaia, the Opihi River and Dashing Rocks. Most of it is white, but two pieces of bright green material were identified from Rakaia. The opal is brittle and generally very fractured, and unlikely to have been easily worked. It probably originated from the Mt Somers Volcanics.

Only a few flakes of petrified (silicified) wood were recorded, from Rakaia (n=1), Dashing Rocks (n=2?) and Pareora (n=2). Potential sources of this material include the Waitaki River and various rivers draining the Mt Somers Volcanics, notably the Hororata, Ashburton and Rangitata. It is also found along the coast, particularly at Birdlings Flat.

Quartz veins have been recorded from the Gebbies Pass area (Speight 1935) and quartz (including amethyst) is

also found in the inland Mt Somers Volcanics. It rarely occurs in archaeological sites.

Pitchstone

This is defined as a dense, generally black, glassy material with a dull, resinous lustre and irregular to conchoidal fracture, similar to obsidian but with a higher water content of around 3–10%. While pitchstones are usually rhyolitic in composition, some are dacitic or andesitic (Preston et al.1988).

In 2010 a small number of flakes (n=12) of what was thought to be pitchstone from the Wakanui site (S103/1, now K38/3) near Ashburton, were analysed by Mosley and McCoy (2010) using a portable XRF at the University of Otago. Although no specific source could be identified they ruled out the possibility of it being from Otago Peninsula or the known occurrence of rhyolite at Gebbies Pass on Banks Peninsula (Sewell et al. 1993) and considered it probably originated from the inland Mt Somers Volcanics. Re-examination of the same 12 flakes in 2019 showed that they do not consist of pitchstone but vesicular obsidian. This is brown in transmitted light and contains vesicles up to 5 mm in diameter, as well as common to abundant white sugary inclusions of variable shape. None of the flakes have any cortex. Pitchstone previously recorded at Tumbledown Bay by Mason and Wilkes (1963a) is of the same material. Ten flakes and pieces (2008.1192.8) have also been identified from the Dashing Rocks site (K39/1) at Timaru.

To establish where the Wakanui pitchstone may have originated from, three of the flakes (2008.1005.605, 618, 655) previously analysed by Mosley and McCoy (2010), along with the single flake from Tumbledown Bay (E150.1093), were re-analysed using a pXRF instrument from the University of Canterbury. This produced very similar results to those obtained by Mosley and McCoy (2010). However, comparison with available wavelength-dispersive XRF analyses of geological samples of pitchstones from the Mt Somers Volcanics (from the Mt Somers area, Malvern Hills and Gebbies Pass) indicated that the Wakanui pitchstone did not originate from any of these areas. Further, there was no match with any of the known obsidian sources in the North Island. Thus, at present, the source of this material remains unknown.

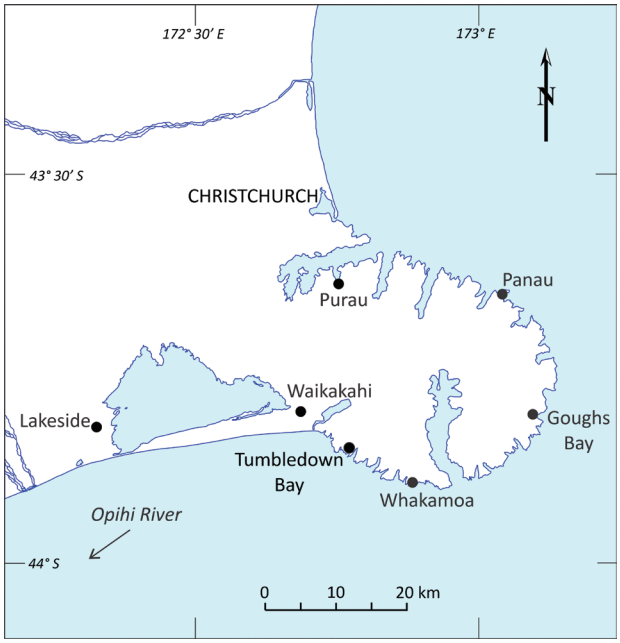

Figure 6. Distribution of Panau flint (informal name, see text)

Panau Flint

This term was coined by amateur archaeologists who excavated almost the entire site of Panau, a former Māori village on the northern side of Banks Peninsula (Fig. 1) between 1967 and 1975 (Jacomb 2000). It is not actually flint but a black, vitreous volcanic stone and is used here as an informal name.

Panau flint has now been identified from six different sites on Banks Peninsula – Panau, Purau, Goughs Bay, Whakamoa, Tumbledown Bay and Waikakahi (Table 2, Fig. 6). It is particularly common at Panau and Whakamoa. There is also one flake from an unknown location on Banks Peninsula, a core from Lakeside at the western end of Lake Ellesmere (Fig. 7), and one small piece from the Opihi River mouth in South Canterbury.

Table 2. Recorded artefacts of Panau flint.

Location	Number	Catalogue number	Artefact type
Panau	45	2008.1109.22, 53	flakes, cores
Purau	10	19XX.1, E159.271.2, 6	flakes, 1 core
Goughs Bay	3	E192.100-102	flakes
Whakamoa	c.60	2008.1014.1, 2	flakes
Tumbledown Bay	1	2008.1009.2339	flake
Waikakahi	5	E166.648-650	flakes, core
Banks Peninsula	1	E181.453	flake
Lakeside	1	E178.811	core
Opihi River	1	E163.167C	piece
TOTAL	**127**		

In hand specimen the Panau flint is black (N2) to very dark grey (N3), with a dull waxy lustre similar to that of pitchstone. Although it superficially appears relatively homogeneous, under a microscope it is seen to have a variably mottled, streaky or blotchy texture resulting from complex intermixing of black and light to medium grey, or less commonly pale to chocolate brown, glass. Many pieces also contain sparse to abundant tiny vesicles, but phenocrysts are rare. The cortex is generally rough and pitted, though four of the flakes from Panau have a definite water-worn outer surface. The rock is quite strongly magnetic, which clearly distinguishes it from obsidian, Wakanui pitchstone, and the black speckled chert. Previous thin-section petrography classified the rock as a "welded spatter", consisting of granules of volcanic ash and basaltic spatter (Jacomb 2000: 94).

Red Argillite

A small number of artefacts made from red-brown argillite (hard mudstone) were documented by Orchiston (1974, table 2.26). Most of these had been found at early coastal sites between Banks Peninsula and Otago Peninsula and included small adzes or chisels, 'slate' knives, minnow shanks and some unusual carved objects. Altogether 20 items were recorded from Canterbury.

No detailed study of the artefacts made from this material has been undertaken, but those items listed by Orchiston (1974) that could be located in the Canterbury, South Canterbury and Otago Museum collections were re-examined and better documented, and several other examples added to his list (Moore 2021b). Two potential primary sources of red argillite have also been identified, at Mt Potts in the Rangitata River valley and the Hakataramea valley in South Canterbury (Fig. 1).

Sandstone

Sandstone was widely utilised for grinding and sharpening adzes, polishing ornaments, smoothing of wood and bone (e.g. fishhooks), and in some cases as a cutting implement (Best 1974), although its use has often been overlooked. The main artefact types are classified as hōanga (grinding stones), abraders and files.

Most of the abraders etc. found at archaeological sites on Banks Peninsula were thought to be composed of Charteris Bay sandstone (e.g. Allingham 1988), but this was not backed up by any description or analysis of the rock. Outcrops of Charteris Bay sandstone on Banks Peninsula are restricted to a small area around the upper part of Lyttleton Harbour, notably on King Billy Island (Aua or Little Quail), at Charteris Bay and between Head of the Bay and Governors Bay (Sewell

Figure 7. Core of Panau flint (black volcanic glass), Lakeside. Canterbury Museum E178.811

et al. 1993; Fig. 8). Māori are known to have obtained sandstone from Aua (Jackson 2006) and are also likely to have procured some material from Charteris Bay (Fig. 9).

The Charteris Bay sandstone is a white, but commonly iron-stained, moderately indurated, well sorted, quartzose fine to medium grained sandstone (grain size 0.15–0.4 mm diameter). It consists predominantly of angular to sub-rounded quartz grains in what appears to be a white clay matrix. A few quartz grains are up to 1 mm across. It also includes rare dark mineral grains, but generally no mica. None of the geological reference samples examined from King Billy Island, Charteris Bay and Orton Bradley Park contain any glauconite, though in North Canterbury the formation is glauconitic (Browne and Field 1985). Glauconite is a green silicate mineral which occurs in the form of sand-sized pellets and is generally considered to be a good indicator of marine deposition (Mortimer et al. 2011).

According to Jackson (2006: 13-14) there were two types of sandstone on Aua: coarse-grained matanui and fine-grained matarehu, with the former being considered ideal for grinding stone implements. Use of both types, though, is not supported by examination of artefact collections from Banks Peninsula, where grinding tools are composed almost exclusively of fine to medium grained sandstone. There are only a few items of fine to very fine sandstone.

Identification of the Charteris Bay sandstone in artefact assemblages was based mainly on the highly quartzose composition, good sorting, general absence of glauconite and mica, and consistent fine to medium grain size. Some items, however, do contain sparse to common glauconite grains, particularly from Redcliffs and Paua Bay, which suggests they are either from a different geological formation or a different occurrence of the Charteris Bay sandstone. A few also contain abundant mica (e.g. 2008.1108.246, Redcliffs; E177.32 Moa-bone Point Cave) and this sandstone may well be from elsewhere.

Some of the artefacts were classified as hōanga (grinding stones). According to Best (1974) hōanga were stationary slabs of sandstone that were used primarily for grinding and sharpening adzes on. These were of various shape, with some being almost circular, and ranged upwards in size from about 25 cm across. Smaller stones may have been used to grind small implements and ornaments on, and were probably hand held. Best (1974) makes it clear, however, that such items were always rubbed on the grinding stone, not the other way around. Jacomb (2000: 81) used the term hōanga/abrader for a "piece of sandstone with at least one flat to concave worked surface, indicative of use as a grindstone or abrader". Many pieces were considered likely to represent fragments of larger hōanga. He recorded 154 objects from Panau.

In the present study, only a few items were identified as hōanga (Table 3). One of these, from Sumner (E173.209), is deeply grooved on both sides. Another from 'Moa Sandhills', Redcliffs (E72.29) consists of a large slab of very fine sandstone. Many other pieces, with one

Table 3. Artefacts of Charteris Bay sandstone from the Banks Peninsula area. The number classed as abraders may be considerably underestimated. X = present.

Site	No.	Hōanga	Abraders	Files	Pieces[#]	Other[^]
Bromley	>75		>6	3	>66	
Redcliffs	235		X	>23	X	4
Moa Sandhills (Redcliffs)	3	1			1	1
Moa-bone Point Cave	2	1				1
Sumner	2	1			1	
Purau	22		1	1		
Port Levy	4		2		X	
Panau	4*		2		X	
Goughs Bay	3	1	1	1		
Paua Bay	8		7			
Sleepy Bay	1				1	
Whakamoa	13		4		8	1
Tumbledown Bay	37	1	X	1	X	
Birdlings Flat	1	1				
Kaituna	1		1			
Waikakahi	2		1		1	

*Jacomb (2000) recorded 154 items from Panau

[#] Many pieces had at least one smoothed side. They may represent broken hōanga or individual abraders

[^] Other includes possible reamers

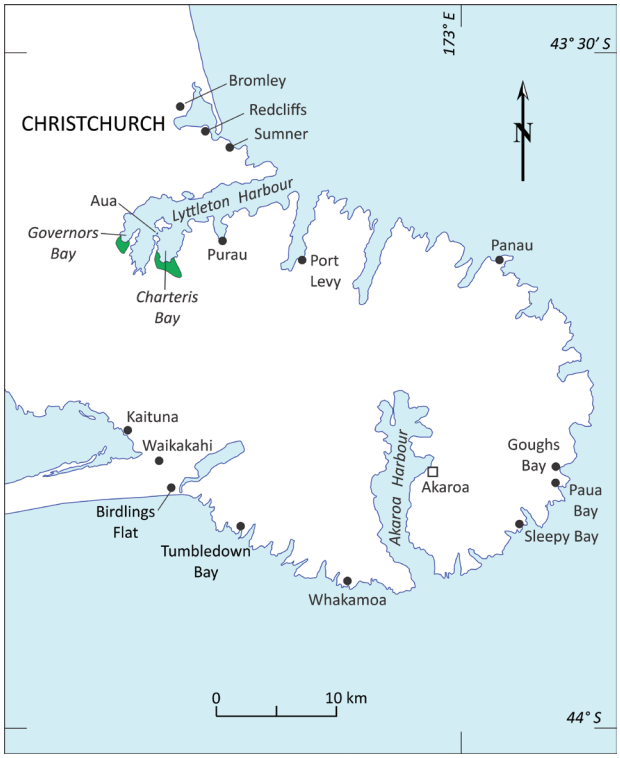

Figure 8. Distribution of Charteris Bay sandstone. Geological occurrences shown in green

Figure 10. Unusual grooved sandstone hōanga, Redcliffs. Canterbury Museum E72.98

Figure 9. Charteris Bay sandstone, Charteris Bay, 2017. Photo by author

or more smoothed surfaces, may represent fragments of larger hōanga. Those with flat surfaces might also have been used as hand-held abraders, for smoothing wood or bone. None of them showed any evidence of use to grind kokowai (red ochre). Other short pieces with a semi-cylindrical cross-section and smoothed or flattened sides were recorded as files. Some unusual items have a conical shape (e.g. Redcliffs E158.520) and may have been used as reamers to grind the interior of roughly drilled holes. Jacomb (2000, fig. 925) illustrated one such item from Panau. A high proportion of the pieces recorded from some sites appear to have been unused: of 32 pieces from Redcliffs (2008.1108.80), for example, only 3 or 4 (10%) had smoothed sides.

There is one particularly unusual hōanga from Redcliffs (E72.98), distinguished by a series of narrow, sub-parallel grooves on two sides (Fig. 10). The grooves range from 2-8.5 mm wide and are up to 5 mm deep. Some are also gently curved. This item must have been utilised for a specific purpose.

Hōanga, abraders, files and unworked pieces made of what are considered to be Charteris Bay sandstone have now been identified from at least 14 sites on and around Banks Peninsula (Table 3, Fig. 8). In total >400 pieces of this sandstone were recorded, many of which were examined under a microscope. It is particularly common at Bromley, Redcliffs and Tumbledown Bay, as well as Panau (Jacomb 2000).

Greywacke

This hard grey sandstone is the most widespread rock type found in the Canterbury region and, together with interbedded mudstone or argillite, forms much of the Southern Alps. It is the dominant material in all the major river beds and on beaches along the coast south of Banks Peninsula. However, there is little possibility of identifying a specific source for greywacke artefacts as the rock has a similar composition throughout the region (Roser and Korsch 1999).

Greywacke cobbles obtained from the rivers and beaches were an important resource for Māori, who used them to produce sharp-edged cutting and scraping tools known as teshoa (a term borrowed from North America). These were made by striking spalls or flakes off rounded cobbles (Witter 2006) and are believed to have been used mainly in cutting meat, wood and bone (Fig. 11). In later times they were also used in sawing pounamu. Mason and Wilkes (1963b) collected more than 200 spalls from an excavated area of about 38 m^2 at Dashing Rocks and at Normanby (site K39/3) Griffiths (1941) recorded at least 220 of them.

Small numbers of adzes were also made from greywacke, particularly during the Mid to Late period, from both grey and green greywacke (Orchiston 1974; Challis 1985), though some early adze types (e.g. Duff Type 1A from Dashing Rocks) are also known. A few other artefact types have been recorded as well, including a

Figure 11. Greywacke teshoa, Waikakahi. Canterbury Museum E159.761, 2008.1032.13 (BAF.67 & BAF.61)

hōanga (2008.1192.25) and sinker (2008.1192.27) from Dashing Rocks.

Other

A few other rock types were recorded at some sites, including serpentine (Dashing Rocks, 1 piece) and quartzite (Waikakahi, 5 pieces). Rodingite, which is largely composed of pale green hydrogrossular garnet and pyroxene (Mortimer et al. 2011), was imported in small quantities from the Nelson area and used for hammer-stones. Granite had previously been reported from Panau (Jacomb 2000) and Tumbledown Bay (Mason and Wilkes 1963a), but none was identified in the present study and its occurrence at these sites cannot be confirmed. Schist, which was recorded from both Early (e.g. Bromley) and Late period sites (e.g. Panau), could have been obtained from larger rivers draining the Southern Alps, such as the Rangitata and Waitaki. It was presumably chosen for its abrasive qualities, for example in polishing pounamu and the manufacture of fish hooks.

Intra-regional and Temporal Variations

As well as providing information on the types of lithic materials exploited by pre-European Māori, analyses of artefact assemblages are important for making comparisons between sites and determining any spatial variations and temporal changes or trends in the use of those materials. The reliability of such analyses is very dependent, however, on how and by whom artefacts were collected, for example whether small flakes (debitage) were retained or discarded by the excavators, or there was preferential on-site selection of particular objects, like those made from nephrite. Additionally, at very large sites like Redcliffs and Rakaia, where there was greater likelihood of spatial (and temporal) variation in activities, differences in the type and abundance of stone materials could be expected across the site. Consequently, there may be a significant bias in some artefact collections.

Quantitative data on the various lithic materials identified from 11 key sites are provided in Table 4. It is important to note, however, as mentioned under Methods, that not all artefacts of some rock types were examined; this is particularly the case for greywacke, pounamu and meta-argillite. Some artefacts were also excluded because of their very small size or condition. Nevertheless, it is evident that not only was a wide range of lithologies used at most Canterbury sites, but that the variety of imported and local rock types utilised was quite similar throughout the region. Of the imported types, pounamu was recorded at every site, and is particularly abundant at Panau (Jacomb 2000). Meta-argillite is also relatively common, particularly at larger sites. Obsidian is well-represented at some sites, notably at Bromley, but apparently rare or absent at others (e.g. Waikakahi). Although porcellanite was widely utilised in Otago (Hamel 2001), this was not the case in Canterbury and at most sites it is rare or absent.

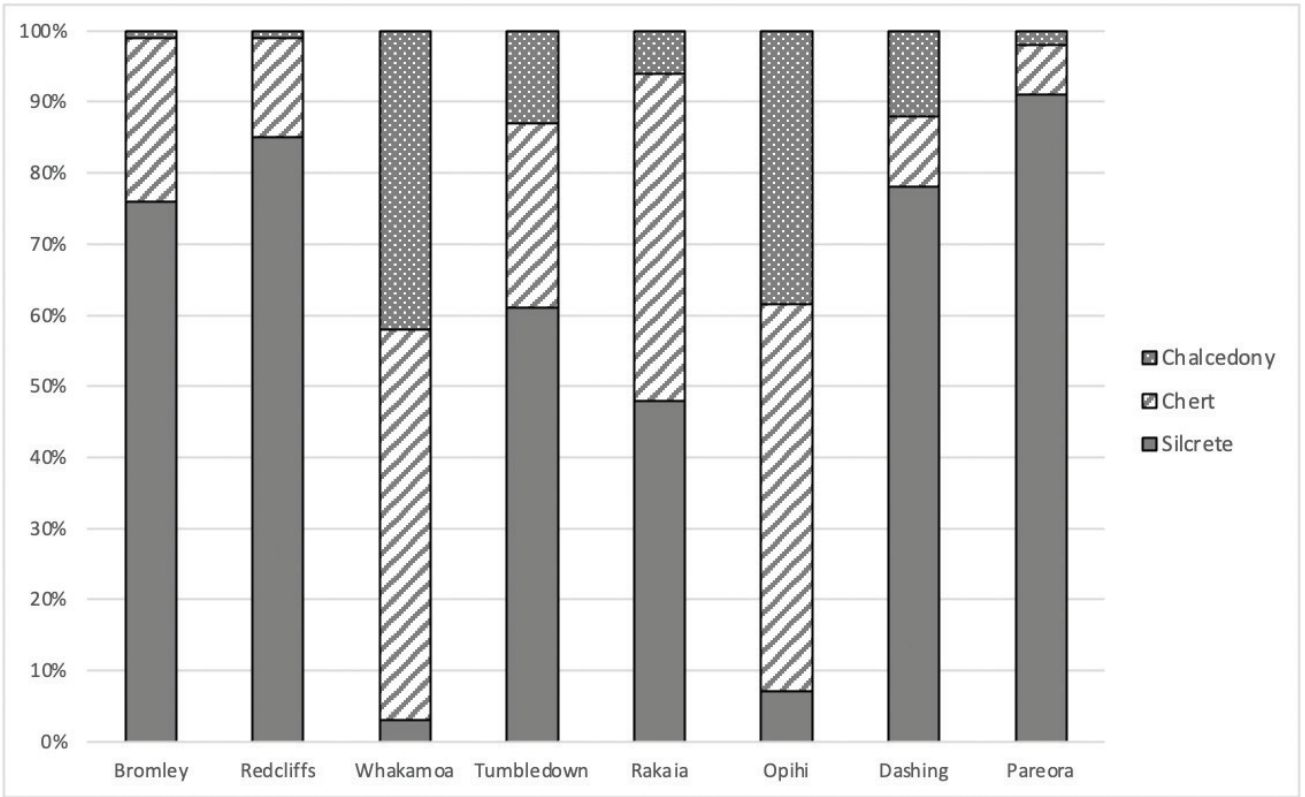

Figure 12. Geographic variation in the use of silcrete, chert and chalcedony at sites along the Canterbury coast, from north to south. See Fig. 1 for location of sites

Table 4. Numbers of artefacts of specific rock types from key archaeological sites in Canterbury. See Figure 1 for locations of sites. X = present. [1]Collection from School Section only (see also Trotter 1975). [2]Data mainly from Jacomb (2000). [3]Collection from various sites in the Lake Aviemore area, including Woolshed Flat (site I40/27). [4]Repositories: CM – Canterbury Museum, SCM – South Canterbury Museum, OM – Otago Museum. [5]Jacomb (2000) recorded 19 meta-argillite and 364 pounamu adzes from Panau.

SITES	**Bromley**	**Redcliffs[1]**	**Panau[2]**	**Whakamoa**	**Tumbledown**	**Waikakahi**	**Rakaia**	**Opihi River**	**Dashing Rocks**	**Pareora**	**Aviemore[3]**
Site no.	**M35/323**	**M36/24**	**N36/72**	**N37/14**	**N37/12**	**M36/78**	**L37/4**	**K38/11**	**K39/1**	**J39/29**	**I40/27+**
Repository[4]	CM	CM	CM	CM	CM	CM	CM	CM	CM, SCM	OM	CM
IMPORTED											
Meta-argillite	>84	330	X[5]	3	58	1	128	8	12	3	1
Pounamu (nephrite)	>21	28	X[5]	>12	12	3	28	8	13	6	
Obsidian	222	135	6	5	108		102	4	62	3	
Porcellanite					2		30			12	30
Rodingite	2	3	1?								
LOCAL											
Greywacke	4	1	36	14	50	80	17	1	30	23	26
Basalt	9	178	13	12	127	5	9		3		
Silcrete	215	1100	9	1?	112	4	485	18	157	590	183
Sandstone	75	124	192	14	41	21	2	3	9	8	1
Chert	66	186	5	18	48	9	461	133	19	45	
Chalcedony	3	4		14	23	6	62	93	24	12	
Opal				2			8		3		
Quartz		1		1	4			1			
Palla	43	2			9		13				
Red argillite	1	6					2			1	
Argillite/slate	6		X						1	6	9
Wakanui pitchstone					1		1?		10		
Panau flint (informal name)			45	c.60	1	5		1			
Ochre/kokowai			X	>3	1		1				
Schist	13	2	5?		3	1		1	1	3	11
Quartzite		1?			1	5		2			
Black speckled chert							13		1	2	2
Other						1	2		1	3	
TOTAL	**764**	**2101**	**>312**	**159**	**601**	**141**	**1364**	**273**	**346**	**717**	**263**

Table 5. Approximate numbers of artefacts of imported (Kaikōura) and local chert

Site	Total	Kaikōura chert	Local chert	Uncertain
Bromley	66	58 (88%)	1	7
Redcliffs (School)	180	178 (99%)	2	-
Tumbledown Bay	48	14 (29%)	26 (54%)	8
Rakaia*	456	245 (54%)	211 (46%)	10
Opihi River	133	19 (14%)	113 (85%)	1
Dashing Rocks	19	5 (26%)	10 (53%)	4
Pareora	45	26 (58%)	18 (40%)	1

* Of one collection of 238 flakes, cores and pieces of chert examined from the Rakaia site (2008.1105.22, 34) at least 63% (65% by weight) were confidently attributed to Kaikōura

Geographic Variations

In Canterbury, the main lithic materials employed for flake tools (apart from obsidian and greywacke) were highly siliceous silcrete, chert and chalcedony, and these are practically the only ones for which there are sufficient quantitative data to permit an examination of intra-regional variations in use. Figure 12 shows the approximate proportions of these rock types in both Early and Late period sites along the Canterbury coast, as well as at Tumbledown Bay which is regarded as a Mid to Late period site. Clearly, silcrete was the dominant material used at Early period sites in the north and south (Bromley, Redcliffs, Dashing Rocks, Pareora), but at Rakaia chert was almost as common. Chert and chalcedony were used more extensively at the Late period sites of Whakamoa and Opihi River.

As outlined earlier, the bulk of the chert came from two main sources, the Kaikōura area (Kaikōura chert), and mid Canterbury area (from the Mt Somers Volcanics), though some of the so-called local chert found at sites in South Canterbury could be from undocumented sources in North Otago. A very small quantity was obtained from near Pareora (Gordons Valley chert, Moore 2019) and apparently also the West Coast (Pahautane chert).

The approximate proportions of the two main types of chert are given in Table 5, and illustrated in Figure 13. It is evident from the collections that have been examined that there was, as we might expect, an overall decline in the use of Kaikōura chert southwards. Notably, this was the case regardless of the age of the sites. At Bromley and Redcliffs its use was very high, but at Opihi River it constituted only about 14%. Local chert was more widely utilised south of Banks Peninsula.

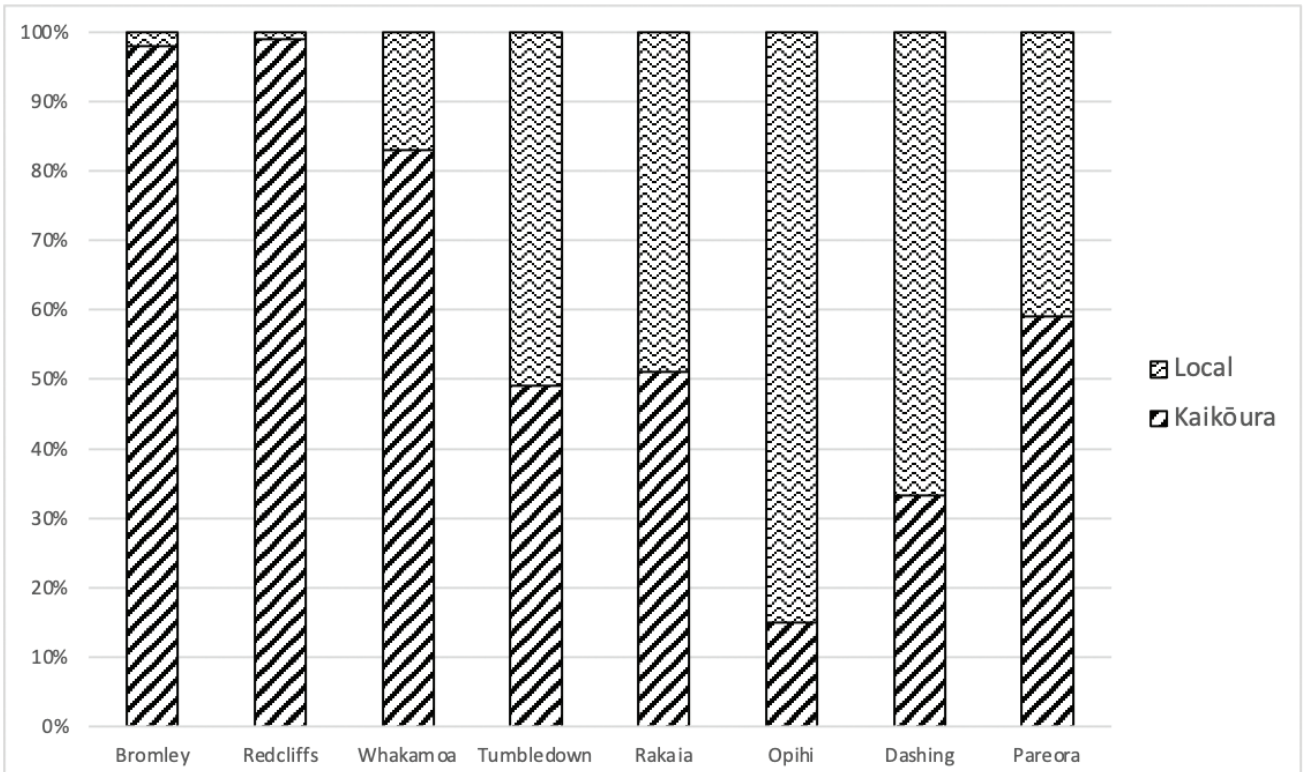

Figure 13. Proportions of Kaikōura and local chert at sites along the Canterbury coast, from north (left) to south (right).

Table 6. Chronology of Canterbury sites (* = radiocarbon dated). Ages mainly from Anderson (1991), Challis (1995) and Jacomb (2000, 2005, 2009)

EARLY (c.1300–1500 AD)	**MID** (c.1500 –1600 AD)	**LATE** (c.1600 –1850 AD)
Bromley	Tumbledown Bay* (16th–17th Century)	Panau* (16th–19th Century)
Redcliffs*(14th–early 15th Century)		Whakamoa
Rakaia* (14th Century)		Opihi River
Dashing Rocks		
Pareora		
Aviemore* (13th–15th Century)		

Temporal Changes

Many of the differences in lithic assemblages appear to be more closely related to the age of the sites. Unfortunately, few sites have been reliably dated, so for others it is necessary to make an assumption about a site's antiquity based upon the general nature of the artefact assemblage and presence/absence of moa bone. For the purposes of this study, sites have been classified as Early, Mid and Late (Table 6), although the existence of a Mid or transitional period between Early and Late is a matter of debate (Davidson 1984; Challis 1995; Anderson 2016).

Some sites are difficult to place within a single age bracket. At Panau, for example, there is dating evidence of initial Early occupation, though the bulk of the site is considered to be Late (Jacomb 2000). The undated Opihi River (Greenstone Island) site also appears to be relatively late, based on the presence of nephrite artefacts and the fact it was seen to be palisaded (site record form for K38/11), but certain artefacts (e.g. Duff Type 4A adze) from there are distinctly early.

The relative proportions of silcrete, chert and chalcedony at Early to Late period sites are shown in Figure 14. This more clearly illustrates the dominant use of silcrete during the Early period (except at Rakaia) and its significant decline in the Late period (at Whakamoa and Opihi) when it was largely superseded by chert and chalcedony. Its high use at Tumbledown Bay indicates that silcrete continued to be used in significant amounts, at least locally, into the sixteenth century.

Temporal variations in the use of imported and local chert are less marked (Fig. 15). Although there tended

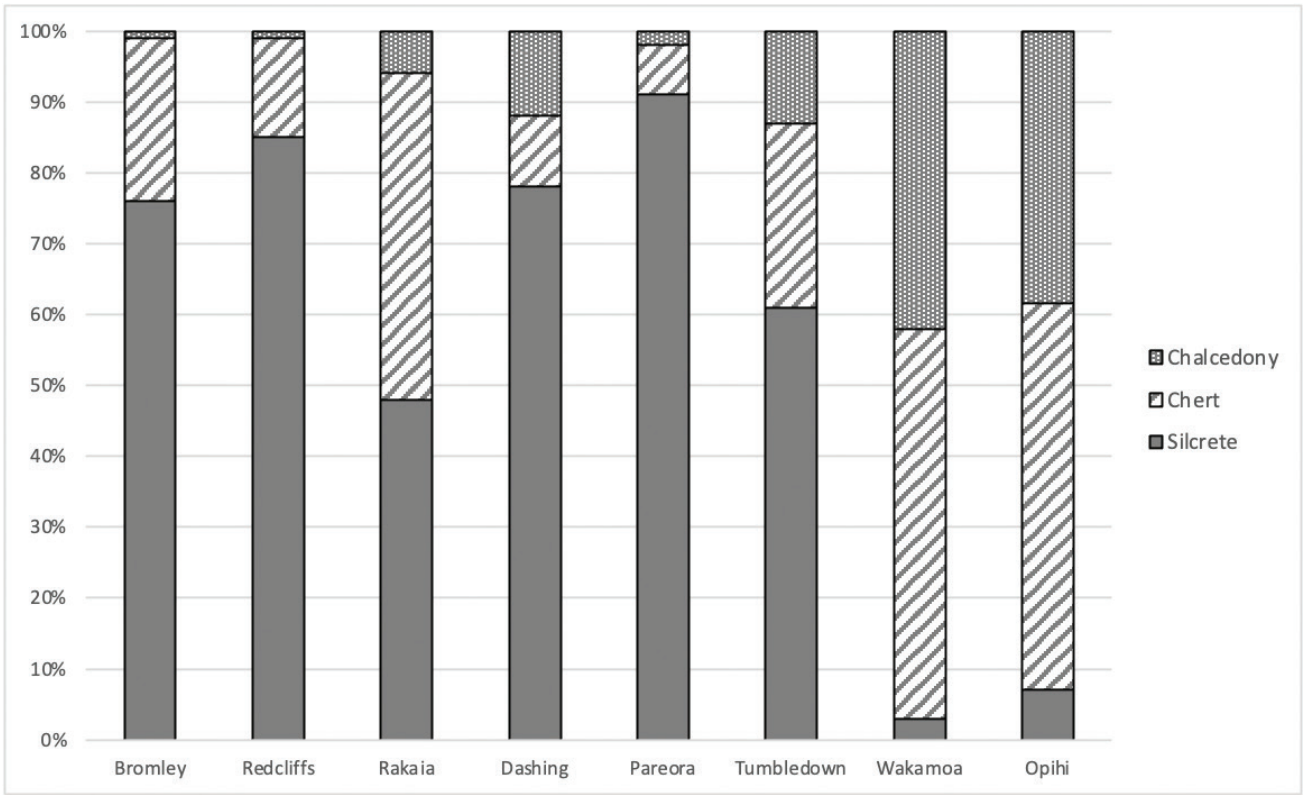

Figure 14. Use of silcrete, chert and chalcedony at Canterbury sites, according to age (older to younger from left to right). The order among Early period sites is not necessarily correct. See also Table 6

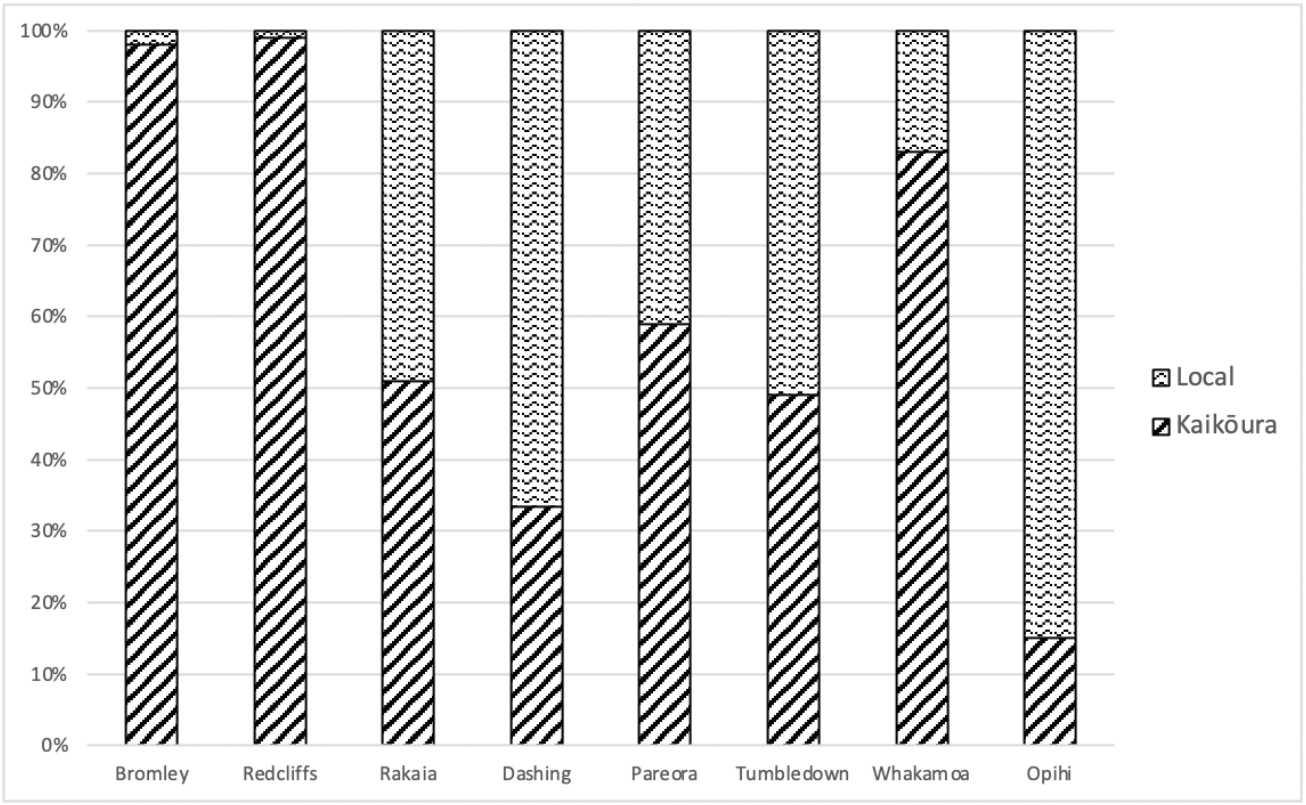

Figure 15. Temporal variations in the use of chert at coastal sites, from early (Bromley to Pareora) to late (Whakamoa, Opihi). The order of Early period sites is not necessarily correct.

to be an overall decline in the use of imported Kaikōura chert in the Early to Mid period, its use at the Late period site of Whakamoa for example was unusually high.

Temporal Markers

The potential for using certain rock types as temporal or chronological markers, at least on a regional scale, has been largely overlooked in the past, except for a few broad changes such as the dramatic increase in use of

Table 7. Chronological distribution of selected rock types.

Site/period	Silcrete	Porcellanite	Palla	Red argillite	Pitchstone	Black chert	Panau flint
LATE							
Panau	9						45
Whakamoa	1?						60
Waikakahi	4						5
Opihi River	18						1
MID–LATE							
Tumbledown	112	2	9		1		1
EARLY							
Bromley	215		43	1			
Redcliffs	1100		3*	6			
Rakaia	594	20	73	2	1?	13	
Wakanui #	X	X	10		>12		
Dashing Rocks	157				10	1	
Pareora	590	12		1		2	
Aviemore	183	30				2	

Data from Mosley and McCoy (2010), Moore and Trotter (2017), and personal observation

*This is the number recorded from the School Section only. A further 17 were reported by Moore and Trotter (2017)

pounamu, which is well documented (Walter et al. 2010). Minor rock types, however, are probably more likely to have been exploited over a relatively short time span (a few decades?) and, where found at multiple sites, not only imply some interaction between communities but that the occupation of those sites was, in part, contemporaneous. The spatial and chronological distribution of silcrete and some of the less common rock types is shown in Table 7. As illustrated above, silcrete is relatively abundant at Early period sites but was still being used in small quantities at later sites, consistent with the situation in Otago (Hamel 2001). The occurrence of porcellanite, however, is patchy during the Early period and non-existent at all Late period sites.

Of the minor rock types, palla has been recorded only from Early period sites in Mid Canterbury (Moore and Trotter 2017) and Tumbledown Bay, although there is also one possible flake from Milford in South Canterbury. Artefacts of red argillite are also known only from Early period sites, including some in the Mackenzie Basin (Moore in prep b) and Otago (Orchiston 1974; Moore 2021b). The so-called Wakanui pitchstone has a very restricted spatial distribution and appears to be mainly associated with Early period sites. Black speckled chert has only been identified from Early period sites from Rakaia southwards. So far, Panau flint seems to be the sole minor lithology confined to Late period sites (and Tumbledown Bay), most of which are located on or near Banks Peninsula, apart from Opihi River (Fig. 6).

Clearly, Tumbledown Bay is an unusual site in containing abundant silcrete and other lithologies (porcellanite, palla, pitchstone) that appear to be mainly restricted to Early period sites, but also a single flake of Panau flint. This site, however, consisted of three cultural layers (Allingham 1988) and it is possible that both the palla and Wakanui pitchstone came from the lowest level (Layer 3) while the flake of Panau flint was found in the upper Layers 1 and 2. The earliest radiocarbon date for Layer 3 is AD 1447–1635 (NZ7656, charcoal; Challis 1995) at 95% confidence, which is backed up by a second date (NZ7654, shell) of AD 1490–1670. This could indicate, potentially, that both palla and Wakanui pitchstone were still being exploited in the late fifteenth or sixteenth century. Alternatively, a few artefacts of these lithologies might have been scavenged from an older abandoned site.

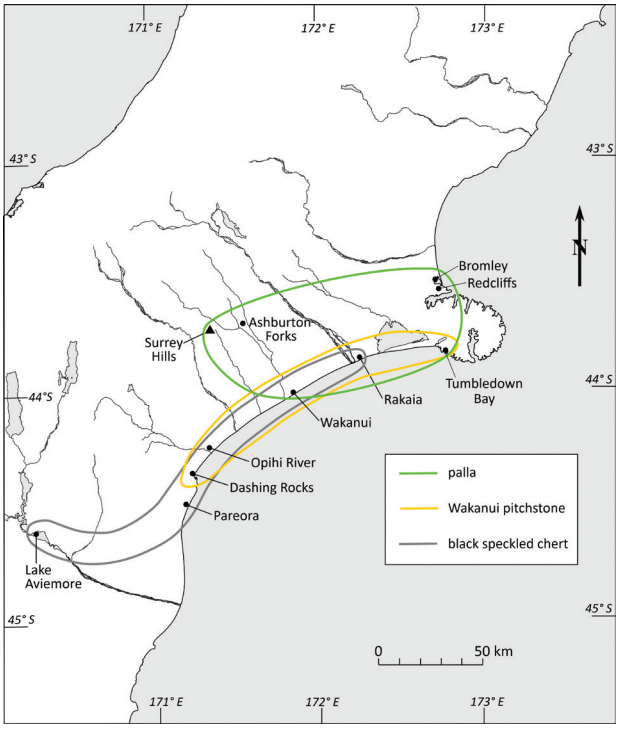

Figure 16. Spatial distribution of some minor rock types

The known archaeological distribution of three of the Early lithic markers is shown in Figure 16. This reveals a somewhat different distribution pattern for palla than for Wakanui pitchstone and black chert. It may reflect the use of these materials for different purposes (i.e. palla primarily for adzes, the others for flake tools), but the presence of all three rock types at Rakaia and occurrence only of palla at Redcliffs and Bromley would seem to suggest some differences in how or when materials were being procured. It is likely there were only single sources for these rock types, as appears to be the case for palla (Moore and Trotter 2017).

The distribution of black speckled chert could indicate a direct connection between the settlements at Rakaia, Dashing Rocks, Pareora and Lake Aviemore. If so, there is a case for arguing that all of these sites were more-or-less contemporary, although radiocarbon dating of the Dashing Rocks and Pareora sites would be required to substantiate that.

Discussion and Conclusions

The widespread occurrence of similar rock types at early Moa-hunter sites in Canterbury demonstrates that distribution or exchange networks were already well established with the Nelson-Marlborough region, Otago-Southland and West Coast/Westland, as well as the North Island, by the fourteenth century. It is also evident that there was considerable exploration of the Canterbury region at this time, resulting in the utilisation of a range of local rock types including basalt, silcrete, chert, chalcedony, palla and red argillite. The presence of some distinctive minor lithologies at multiple sites is probably indicative of a direct connection between early communities occupying the Canterbury coast.

By the sixteenth century, however, there is evidence of a significant decline in the use of silcrete, obsidian and porcellanite, as well as the abandonment of some local materials such as palla and red argillite. Instead, there was greater emphasis on the use of chert and chalcedony, and of imported pounamu. The utilisation of Panau flint at Late period sites on Banks Peninsula could be a

response to the difficulty in obtaining obsidian from the North Island. These changes likely reflect a breakdown of the early long-distance exchange networks and decreasing access to certain lithic resources, with the exception of pounamu.

There is still inadequate information on how long some of the local stone sources were utilised for. In the case of silcrete there are indications that quarrying at Grays Hills began quite early, probably in the late thirteenth or fourteenth century (Moore et al. 2020), but for Miro Downs this is much less certain. However, the relative abundance of silcrete artefacts at both Tumbledown Bay and Houhoupounamu (Challis 1995) suggests that Miro Downs in particular could have been exploited well into the sixteenth century. As for palla, there is good evidence the Surrey Hills source was first utilised in the fourteenth century (Moore and Trotter 2017), although the discovery of a few flakes at Tumbledown Bay raises the question of whether raw material was still being procured from this source in the sixteenth century, or old artefacts were being recycled.

In the case of Wakanui pitchstone and black speckled chert, it seems unlikely they were utilised for more than a decade or so given that the sources of these materials, wherever they are located, were probably small and the pitchstone is of poor quality. Both were being used in the fourteenth century, but again the presence of one flake of pitchstone at Tumbledown Bay does raise the issue of recycling. The use of Panau flint only at Late period sites on Banks Peninsula and at Opihi River suggests this material may not have been discovered by Māori until the sixteenth century. It is highly unlikely that the source was located in the fourteenth century and not exploited, so its discovery may be related to the increased clearance of forest on the peninsula; assuming, of course, the source was on Banks Peninsula.

Acknowledgements

This study arose from a suggestion by Roger Fyfe Canterbury Museum and I am grateful to him for his foresight. I also wish to thank the Director of Canterbury Museum Anthony Wright for his support of this project and Museum staff for their considerable assistance, particularly Emma Brooks, Hatesa Seumanutafa, Lisa McDonald, Julia Bradshaw and Nic Boigelot. Access to collections at South Canterbury Museum was kindly facilitated by Philip Howe and at Otago Museum by Anne Harlow. My appreciation also to Michael Trotter for information and useful discussions, Sam Hampton University of Canterbury for pXRF analyses, Malcolm Luxton and Vince Burke for willingly sharing their knowledge of local siliceous rocks, Louise Cotterall for drafting the maps, and Chris Jennings and Michael Trotter for their helpful comments on the paper. A special thanks to Chris and Adrienne for their exceptional hospitality during my visits to Christchurch.

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