JOURNAL OF
Pacific
Archaeology

– ARTICLE –

"The material for boring the greenstone": characterization and archaeological distribution of the Pahautane chert, West Coast, South Island, New Zealand

Phillip R. Moore[1,2*] and Andrew La Croix[3]

[1]Peninsula Research, Bay of Plenty, New Zealand; ORCID: 0009-0001-2782-091X
[2]Canterbury Museum, Christchurch, New Zealand
[3]Sedimentary Environments and Analogues Research Group, Earth and Environmental Sciences, School of Science, University of Waikato, Hamilton 3240, New Zealand; ORCID: 0000-0002-9716-9501
*Corresponding author: peninres@xtra.co.nz

Abstract

The Pahautane chert, which occurs as isolated pockets within Oligocene bioclastic limestone on the West Coast of the South Island, New Zealand, was exploited by indigenous Māori communities over a period of at least 500 years. Thin-section petrography of samples from two localities reveals that the chert is composed predominantly of quartz (85-90% SiO_2) and calcite (10-15% $CaCO_3$) with common silicified fossil remains, mainly of benthic foraminifera and sponge spicules, but including a variety of other fauna. Wavelength-dispersive XRF analyses indicate a slightly higher silica content (91-95 weight % SiO_2), and very low concentrations of all other elements except calcium. The visually similar Gordon's Valley chert in South Canterbury, some 260 km to the south, has an almost identical composition.

Examination of artefact collections at Canterbury Museum, and other records, shows the Pahautane chert was more widely dispersed than previously thought, and distributed along the western coast of the South Island over a total distance of at least 300 km. This distribution pattern reflects the use of well-established communication routes for the export of nephrite (pounamu) from the West Coast, probably beginning in the late 13th or early 14th century. On the West Coast, Pahautane chert was being used for drilling holes in nephrite up until the middle 1840s.

Keywords: chert, Pahautane; petrography; artefacts; South Island

To cite this article:
Moore, P.R. & La Croix, A. 2025. "The material for boring the greenstone": characterization and archaeological distribution of the Pahautane chert, West Coast, South Island, New Zealand. Journal of Pacific Archaeology, 15(1): Article 12:1-20. DOI: https://doi.org/10.70460/jpa.v15i1.383

Submitted: 04/08/2025, Accepted 12/11/2025, First online 25/11/2025

Copyright
©2025 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See http://creativecommons.org/licenses/by/4.0/

1. Introduction

Chert was one of the more common lithic materials used by early Māori settlers of Aotearoa New Zealand, particularly in regions where there are significant natural deposits such as Northland, eastern North Island and the Kaikoura area in the north-eastern South Island (Moore 2021, 2025; Figure 1). The chert was utilised mainly for cutting and scraping purposes, but also drilling holes, and in some cases for adzes and chisels. There has, however, been very limited research into the sources and composition of cherts in New Zealand. Although the broader geological distribution is reasonably well known (e.g. Moore 1977, 1983), only a few specific studies have been carried out from an archaeological perspective, mainly in the North Island (Fredericksen 1990; Keyes 1970; Moore 2019, 2021; Moore and Wilkes 2005).

In this paper we present new information on the geological occurrence, composition and archaeological distribution of a distinctive sedimentary chert (here referred to as Pahautane chert) found on the West Coast of the South Island (Figure 1), a region best known for its nephrite ('greenstone' or pounamu) resources (Beck 1984). Two significant archaeological investigations of early Māori occupation sites have been undertaken in this region, at the Heaphy River mouth (Wilkes and Scarlett 1967) and the Buller (Kawatiri) River mouth at Westport (Jacomb *et al.* 2004; Walter *et al.* 2011), both of which yielded considerable numbers of stone artefacts, including many composed of Pahautane chert. These investigations, along with historical records and the examination of artefact collections at Canterbury Museum (Moore 2022, 2023), demonstrate that this chert was utilised during both the early period of settlement (circa AD 1300-1500), and in historic times up until the mid-19th century, and was more widely distributed than previously thought.

2. Historical background and name

The earliest known European reference to chert ('flint') on the West Coast is by the explorer, soldier and artist Charles Heaphy in his account of an epic five-month journey, accompanied by Thomas Brunner, around the coast from Nelson to the Arahura River in 1846 (Heaphy 1862). While staying at a remote Māori village (or pā) at Taramakau, south of present-day Greymouth (Figure 2), Heaphy observed men drilling holes in greenstone mere (a short flat-sided weapon) and recorded: "for this pieces of sharp flint are obtained from the Pahautani (sic) cliff, forty miles (60 km) to the north and are set in the end of a split stick, being lashed in very neatly" (Heaphy 1862: 169). On 18 May he also noted that "at Pahautani there is a stratum, in the secondary limestone rock, containing pure flints, which I believe are not to be found in any other part of New Zealand, presents of this stone being carried by the natives to all parts of the islands, as *the material for boring the greenstone*" (Taylor 1959: 233; our emphasis).

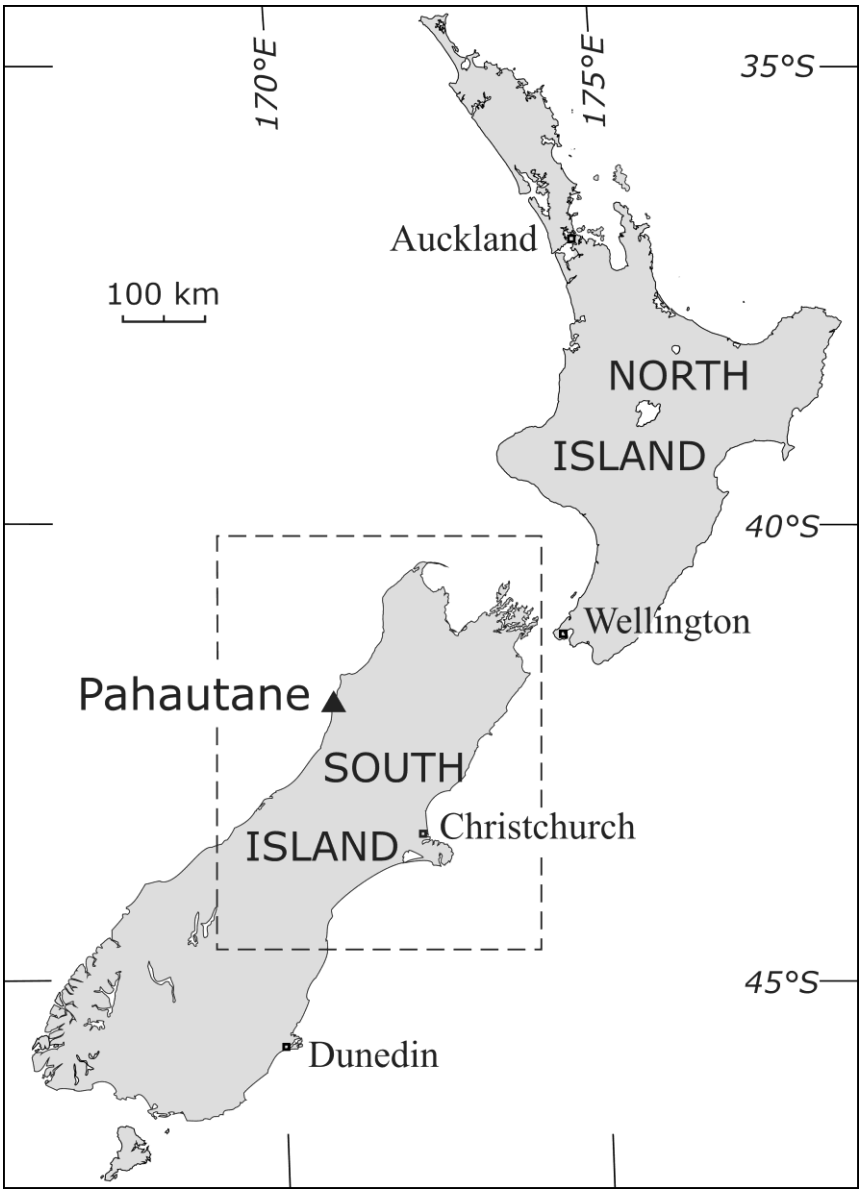

Figure 1: Map of New Zealand showing location of the study area. For outlined area see Figure 2.

More recently, the chert has been referred to as 'heaphyite', an informal name introduced by Wilkes and Scarlett (1967), on the suggestion of geologist H.W. Wellman, for an unusual siliceous rock used at the early Māori occupation site of Heaphy River for cutting and scraping purposes. They believed it to be a silicified quartzose sandstone, but did not provide any detailed description of it, and no petrographic study was undertaken. Although this term has been used by other archaeologists working on the West Coast (e.g. Jacomb *et al.* 2004), we consider that since 'heaphyite' has never been formally defined and has no designated reference locality it is not an appropriate name. Therefore, we prefer to use the name 'Pahautane chert', particularly since Pāhau (an abbreviation of Pahautaniwha) is recorded in Māori legend to have been a source of flint (Te Taiao Māori 2010: 66).

Figure 2: Map of the northern South Island, showing the location of chert sources and sites containing artefacts of Pahautane chert. Sites in Canterbury marked with 'x' include possible Pahautane chert artefacts.

The Pahautane chert source was officially recorded as an archaeological site (S37/7, now K30/25) in 1982 (site numbers are those of the N.Z. Archaeological Association Site Recording Scheme, https://nzaa-archsite.hub.arcgis.com). The source area also includes a possible 'cave' shelter (K30/4) at the rear of the beach, formed by large fallen blocks of limestone.

3. Geological context

The Pahautane chert is found within, and appears to be restricted to, limestone of the laterally extensive Nile Group, of Oligocene age, which forms prominent bluffs and escarpments along the western coast of the South Island between Greymouth and Cape Farewell (Figure 2). Surprisingly, though, none of the published geological maps and reports on this area make any mention of chert in the Nile Group (Nathan *et al.* 2002; Neef 1981; Rattenbury *et al.* 1998). This chert has now been recorded at two (Pahautane and Little Wanganui Head), and probably as many as four, locations. It is the only known type of chert on the West Coast.

3.1. Pahautane

The chert at Pahautane (or Pahautaniwha) occurs within the Oligocene Tiropahi Limestone (Laird 1988, Nathan *et al.* 2002). This limestone does not continue south of Pahautane, and wedges out north of Charleston (Nathan 1975). It is overlain by the more extensive Potikohua Limestone. Laird (1988) and Nathan (1975) described the Tiropahi Limestone as a muddy to sandy foraminiferal biomicrite, although Anderson (1984) noted that the faunal content was quite variable and included bryozoa, echinoderms, foraminifera and algae. Neither Nathan (1975) or Laird (1988) refer to chert nodules in the limestone.

At Pahautane, sparse, irregular-shaped masses and rounded nodules of chert are found within outcrops and fallen blocks of the Tiropahi Limestone along the rear of the ocean beach up to 150 m north and 50 m south of Limestone Creek (Figure 3A). They are also exposed in the nearby road cutting (Figure 3B). The nodules consist of slightly brownish dark grey chert up to 25 cm across, though Brailsford (1996, figure 33) illustrates one elongate lens at least 50 cm in length. Detrital cobbles of chert are also found around the mouth of Limestone Creek.

The full extent of the source is unknown. Chert nodules have not been seen at Kaipakati Point, about 2 kilometres further north, but they may be present in the limestone bluffs inland, and Anderson (1984: 151) observed there were rare "silica concretions" in the Tiropahi Limestone near the Nile River, about 14 kilometres north of Pahautane.

3.2. Little Wanganui

The occurrence of chert at Little Wanganui Head, near Karamea (Figure 2), was originally recorded by German (1976). He described it (p. 182) as consisting of light brown translucent chalcedony forming irregular-shaped nodules up to 30 cm long, within limestone beds. The limestone apparently consists mainly of foraminifera and bryozoa. Local silicification of calcareous mudstone and muddy sandstone was also

noted. A few cobbles of brownish chert, up to 23 cm across, have been found on the boulder beach at this location (Figure 3 C, D), and it also occurs in situ at the Little Wanganui River mouth. No mention of this was made by Neef (1981) or Riordan (2016).

German (1976, log 4) also recorded the presence of "scattered chert nodules" in the uppermost limestone unit (his Oparara Member) at 'Limestone Creek', a tributary of the Little Wanganui River. No other information was provided, and the location has not been visited by us.

3.3. Other occurrences

According to Wilkes and Scarlett (1967: 205) H.W. Wellman considered that 'heaphyite' probably occurred, in addition to the Fox River area, along the coast somewhere north of the Heaphy River, although this does not appear to have been confirmed. Wellman's unpublished geological map and stratigraphic columns for this area do not depict any occurrences of chert, but his accompanying manuscript does refer to a 10 foot (3 m) thick interval of hard limestone with nodules in the upper part of the limestone sequence (S. Nathan pers comm. Jan 2018). Unfortunately, there is no information on the location. Notably, Scarlett (1982) also mentions the presence of 'heaphyite' at Frenchman's Gully, apparently a reference to the Gordon's Valley chert in South Canterbury (Moore 2019).

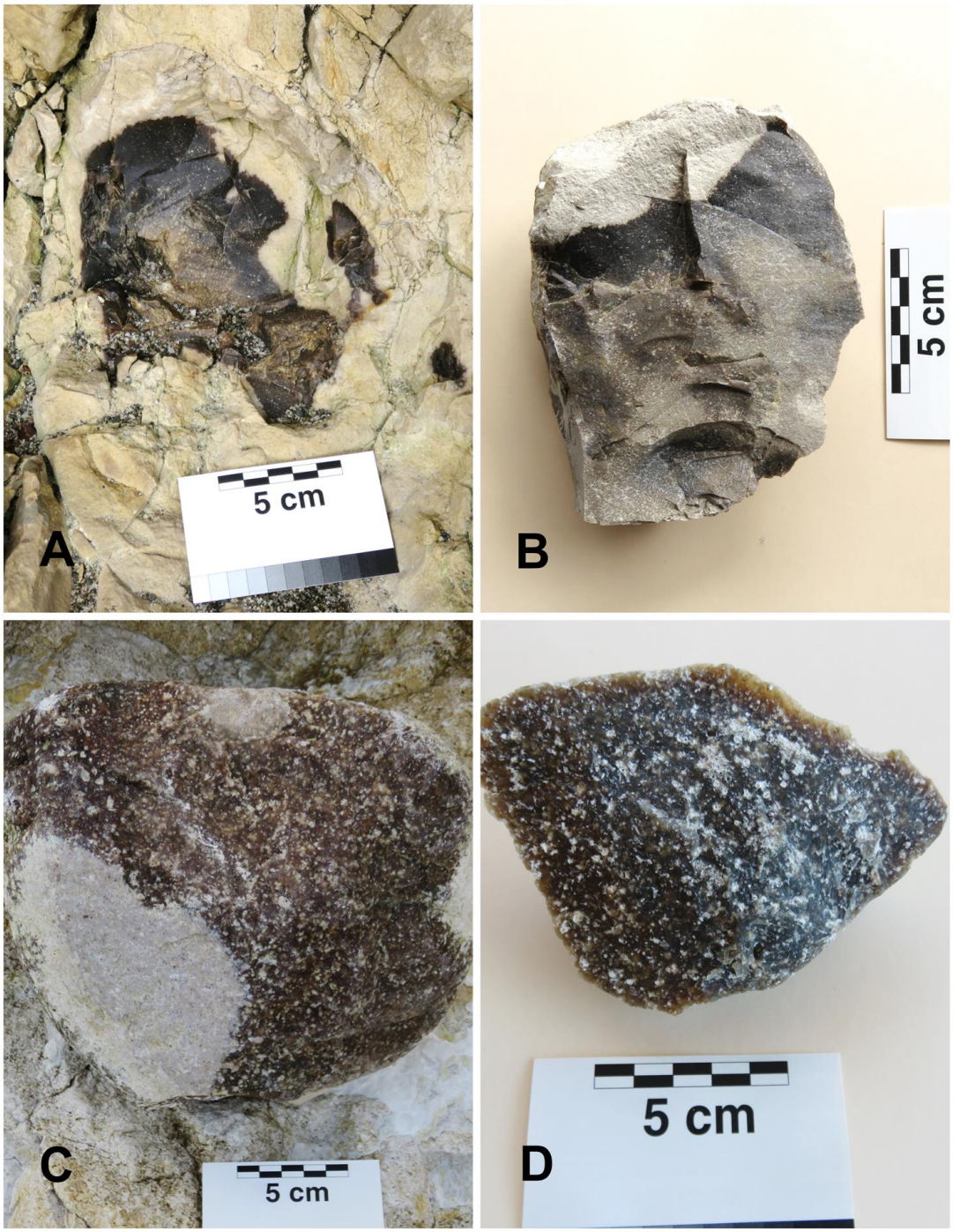

Figure 3: Photos of Pahautane chert. A: Irregular nodule of chert in limestone, Pahautane beach; B: Chert sample from road cutting, Pahautane; C: Cobble of chert at Little Wanganui Head; D: Freshly broken spall, Little Wanganui Head.

4. Petrography and geochemistry

Representative samples of chert from Pahautane and Little Wanganui were examined in hand specimen, under a binocular microscope, and in thin section (Figure 4). Of the samples thin-sectioned, one (PT-1) was from Pahautane beach, and another (PT-2) from a nearby road-cutting. Both were collected in situ. The sample from Little Wanganui (LW-1) came from a beach cobble. A piece of the visually similar Gordon's Valley chert (GV-1) from near Pareora in South Canterbury (Moore 2019) was also thin-sectioned for comparative purposes. Additionally, all four samples were analysed by X-ray fluorescence (XRF), and one by X-ray diffraction (XRD).

Fresh samples of the Pahautane chert range in colour from light to very dark grey (2.5Y 7/1 to N3; Munsell Soil Color Chart, 2000 version), and have a blotchy appearance due to varying degrees of silicification of the parent limestone. Lighter patches are calcareous. The chert has a speckled texture, a dull waxy lustre and is semi-translucent. It breaks with a conchoidal to irregular fracture, and is capable of yielding flakes with a moderately sharp edge.

Examination under a binocular microscope (10-20 X magnification) shows the chert contains some sand-sized grains of detrital quartz, rare mica (biotite and/or muscovite), green glauconite, and well-preserved foraminifera. Moderately silicified material also includes sparse to abundant sponge spicules up to 1 mm in length but generally about 0.2 mm. They are present but less obvious in patches of more siliceous darker grey chert.

The chert from Little Wanganui Head (sample LW-1) is distinctly coarser grained and of poorer quality. It is brownish (7.5YR 5/2), semi-translucent, and has a speckled texture (Figure 3C, D). It breaks with a sub-conchoidal fracture, and large flakes with a sharp but brittle edge can be produced from it. It contains detrital quartz grains, some mica, abundant well-preserved foraminifera (up to about 1 mm diameter), bryozoa, and rare sponge spicules.

Gordon's Valley chert has a very similar appearance, and varies from light to dark grey (7.5YR 6/1 to 4/1). It contains rare to sparse spicules, some mica, and tiny grains of green glauconite ranging from about 60μ to 120μ (0.06-0.1 mm) in size. The density of these grains varies from about 2-10/cm^2, but by volume they constitute <1% of the rock.

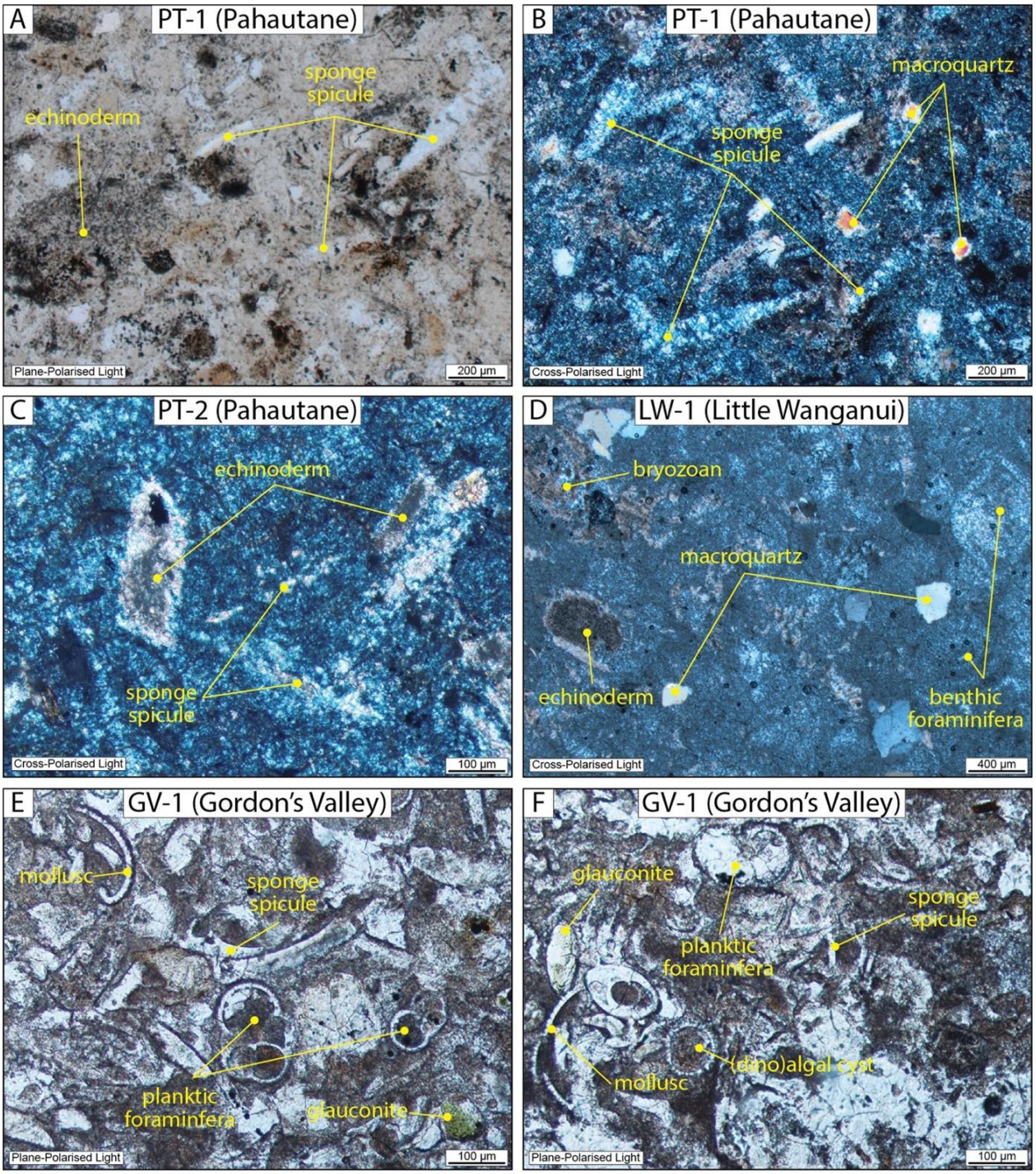

Figure 4: Major petrographic features of thin sections. (A) Plane-polarised light photo of sample PT-1 (Pahautane chert) showing sponge spicules and an echinoderm plate. (B) Cross-polarised light photo of sample PT-1 displaying characteristic microquartz sponge spicules, along with some well-developed macroquartz (detrital quartz). (C) Cross-polarised light photo of sample PT-2 (Pahautane chert) showing echinoderm plates composed of calcite, and microquartz sponge spicules. (D) Cross-polarised light photo of sample LW-1 (Little Wanganui) with microquartz benthic foraminifera, echinoderm

plates, as well as calcite-microquartz bryozoan fragments. (E) Plane-polarised light photo of sample GV-1 (Gordon's Valley chert) with microquartz bivalve shell fragments, sponge spicules, planktic foraminifera, and glauconite grains. (F) Plane-polarised light photo of sample GV-1 displaying microquartz bivalve shell fragments, sponge spicules, planktic foraminifera, (dino)algal cysts, and glauconite grains.

4.1. Thin-section petrography

In thin section, the chert samples from Pahautane (PT-1 and PT-2) show a relatively high degree of variability in their textural characteristics and bioclastic composition, though are quite similar in their mineralogical traits (Table 1). They consist approximately of 85-90% silica (quartz) and 10-15% calcite. Grains of biotite and opaque minerals are rare, with the latter comprising predominantly framboidal pyrite. Herein the silica component is subdivided into microcrystalline quartz ('microquartz'; roughly equidimensional grains smaller than 20 μm) and macrocrystalline quartz ('macroquartz'; equant or elongate grains larger than 20 μm), following Folk (1980). Chalcedony (cryptocrystalline and optically fibrous grains around 100 μm in length) is rare to absent in both samples.

In plane polarised light (Figure 4A), the PT-1 thin section has a 'dirty' light reddish brown (7.5YR6/4) appearance (predominantly microquartz), with darker brown (7.5YR3/4) to black patches up to 300 μm (opaque minerals), and transparent areas taking the form of calcite shell fragments, silica-replaced shell fragments (macroquartz or relict calcite), or equant grains of macrocrystalline detrital quartz. Views in cross polarised light reveal that the sample predominantly comprises shell fragments floating in a matrix, suggesting that the parent rock was a sparse biomicrite (c.f. Folk 1959). The major fossil fragments in descending order of abundance are sponge spicules, benthic foraminifera, bryozoans, echinoderms, and (dino)algal cysts (i.e. 'calcispheres'; Figures 4A and B).

Sample PT-2 has a 'dirty' light reddish brown (7.5YR6/3) appearance in plane polarised light. The sample also shows microfractures dispersed throughout. There are noticeably fewer transparent shell fragments, including silica-replaced or relict calcite type, as well as fewer well-developed macroquartz grains (detrital quartz). Views in cross polarised light (Figure 4C) confirm this observation. It is not possible to give an accurate assessment of the parent-rock type from the thin section. The major faunal components include benthic foraminifera, sponge spicules, bryozoans, echinoderms, and red algae (Figure 4C).

The Little Wanganui Head sample (LW-1) has a similar mineralogy to the Pahautane chert, consisting of c. 90% silica and 10% calcite. It also contains rare biotite and opaque mineral grains (Table 1). In plane polarised light LW-1 is predominantly light grey (2.5Y8/1; microquartz), with minor transparent macroquartz (detrital quartz), dull yellowish brown (10YR5/4) shell fragments/grains (calcite) up to 400 μm, and black opaque minerals ranging from 5 to 75 μm scattered throughout. Cross polarised light suggests that although replaced by silica, the parent rock would have had a greater proportion of shell fragments to matrix material such that it would have been a packed biomicrite to poorly washed biosparite (Folk 1959).

In decreasing order of abundance, the major fossil fragments are benthic foraminifera, echinoderms, bryozoans, (dino)algal cysts, planktic foraminifera, and sponge spicules (Figure 4D).

The Gordon's Valley chert (GV-1) is slightly more siliceous than the Pahautane or Little Wanganui samples, comprising 90-95% quartz, 5-10% calcite, with rare biotite, opaques, and glauconite (Table 1). In plane polarised light GV-1 shows a patchy mixture of colourless to light grey (10YR8/1; microquartz and minor macrocrystalline (detrital) quartz) and dark greyish brown areas (10YR3/2; microquartz with some calcite). Green (1-GY4/6) glauconite grains are scattered throughout, possibly representing replaced pellets. Colourless to light grey (7.5Y8/1) portions of the thin section clearly show the form of shell fragments, whereas in dark brown (10YR3/3) areas they are generally more diffuse. In cross polarized light, however, these same areas clearly demonstrate the form of shell fragments. The parent rock likely ranged from a packed biomicrite to a poorly sorted biosparite (Folk, 1959). In order of abundance, faunal remains consist of planktic foraminifera, benthic foraminifera, molluscs, sponge spicules, (dyno)algal cysts, bryozoans, and echinoderms (Figures 4E and 4F).

Overall, thin-section petrography shows there is limited variation within the Pahautane chert, in terms of its mineral and faunal content (Table 1). It also confirms the close similarity of the Pahautane and Gordon's Valley cherts, with the only significant differences being the more common planktic foraminifera and glauconite in the latter.

4.2. X-ray Diffraction

XRD analysis of the Pahautane chert (PT-1) confirms that it primarily comprises quartz (87%) with lesser calcite (13%), based on the d-spacing of the two largest peaks on the XRD spectrum at 3.35 Å (quartz) and 3.04 Å (calcite). No clay minerals were identified.

4.3. X-ray Fluorescence

Four samples, from Pahuatane (PT-1, PT-2), Little Wanganui (LW-1), and Gordon's Valley (GV-1), were analysed using a Bruker S8 Tiger 1kW wavelength-dispersive X-ray fluorescence spectrometer at the University of Waikato, Hamilton (Table 2). Major elements were analysed from fusion beads with 12:22 flux, and trace elements were measured using the pressed pellet method. USGS standard SCo-2 was run with each analysis. Although 29 trace elements were measured, concentrations of many of those were at or below the Limit of Determination (LOD) and are not included in Table 2.

XRF analysis of the samples supports the observations from thin sections and the XRD analysis in regard to their composition. All samples have a high SiO_2 content, ranging from 91-95%, with CaO varying between 1-3% (equivalent to 2-6% $CaCO_3$). All other major oxides are below 1%. Trace element concentrations are also very similar between the four samples.

Table 1. Summary of mineral and fossil constituents of chert samples

Locality	**Pahautane**		**Little Wanganui**	**Gordon's Valley**
Sample no.	**PT-1**	**PT-2**	**LW-1**	**GV-1**
Mineral *				
Quartz	85-90%	85-90%	c.90%	90-95%
Calcite	10-15%	10-15%	c.10%	5-10%
Biotite	Rare	Rare	Rare	Rare
Glauconite	Absent	Absent	Absent	Rare
Opaques (mostly pyrite?)	Rare	Rare	Rare	Rare
Fossil #				
Foraminifera (planktic)	Absent	Absent	Absent-very rare?	Common
Foraminifera (benthic)	Rare	Rare	Common	Rare
Sponge spicule	Common	Rare	Absent-very rare?	Rare
Bryozoan	Rare	Rare	Rare	Very Rare
Echinoid	Rare	Rare	Common	Very Rare
Bivalve	Absent	Absent	Absent	Rare
(Dino)algal cyst	Rare	Absent	Rare	Rare
Red Algae	Absent	Rare	Absent	Absent

* Minerals: rare = less than 5% (usually 1-3%); # Fossils: common = several visible in thin-section; rare = some to few visible in thin section, very rare = maybe 1-3 possible; absent = none visible in thin section

Table 2. XRF analyses. LOD = Limit of Determination.

Sample	PT-1	PT-2	LW-1	GV-1	LOD (ppm)
Major elements (wt%)					
SiO_2	91.09	95.16	93.66	93.63	730
Al_2O_3	0.71	0.65	0.34	0.31	200
TiO_2	0.045	0.04	0.013	0.022	2.7
MnO	0.006	0.006	0.005	0.005	4
Fe_2O_3	0.175	0.163	0.059	0.109	57
Na_2O	0.135	0.144	0.049	0.154	38
MgO	0.048	0.039	0	0.013	24
K_2O	0.211	0.184	0.155	0.214	17
CaO	3.21	1.11	2.405	1.717	36
P_2O_5	0.078	0.073	0.025	0.174	6
LOI	4.34	2.48	3.3	3.67	-
TOTAL	100.16	100.23	100.13	100.3	-
Trace elements (ppm)					
S	538	945	543	475	3
F	92	140	0	185	11
Sc	5	3	4	4	1.5
V	8	5	2	5	3
Cr	26	26	6	12	7
Co	90	103	118	141	4
Ni	8	10	8	9	3.5
Cu	5	6	5	5	4.5
Zn	10	9	7	9	3.5
As	4	5	3	4	4
Rb	11	10	10	7	3
Sr	50	28	55	51	3
Zr	47	29	8	11	0.5
Ba	12	5	15	5	11
Ce	23	21	19	22	22
Sr/Rb	4.5	2.8	5.5	7.3	-

5. Sites, artefacts and archaeological distribution

Artefacts of Pahautane chert have now been identified from four archaeological sites or localities – three on the West Coast (plus two unconfirmed) and one in northwest Nelson (Figure 2). Details of these occurrences are provided in Table 3. So far, the chert has not been identified in any museum collections from sites in the Nelson-Tasman Bay area (Anapai, The Glen, Rotokura, Tahunanui). However, a few artefacts of very similar chert have been recorded from Mid and North Canterbury (Moore 2022, 2023).

5.1. Heaphy River

The Heaphy River site (L26/1) was excavated between 1961 and 1963 (Wilkes and Scarlett 1967) revealing a single occupation layer 10-24 inches (25-60 cm) thick, composed of charcoal-blackened sand with lenses of crushed mussel shell, stone and a considerable range of early style artefacts, now held by Canterbury Museum (catalogue number 2008.1006). The collections include about 5000 stone flakes, of which 1052 consist of 'heaphyite' (Figure 5). No cores of this material were recorded by Wilkes and Scarlett (1967), but there are at least seven in the museum's collections, along with two possible roughout chisels. Two drillpoints were also recorded by Wilkes and Scarlett (1967: 203).

Cortex preserved on some of the cores and other artefacts provides an indication of the nature of the chert source that was exploited. Of the flakes and cores recovered from the Heaphy River site, many have remnants of rough, weathered cortex, while only a few possess obvious water-worn surfaces (Figure 6). This would suggest the chert was obtained primarily from a colluvial deposit close to source, rather than a high-energy stream or boulder beach environment, though we cannot exclude the possibility it came from more than one location. It also demonstrates that some of the chert was transported to the site in the form of complete or only partially worked nodules.

Table 3. Localities with artefacts of Pahautane chert. CM = Canterbury Museum collections.

Locality/site	Description
Puponga, Golden Bay	Single flake 44 mm long from mouth of Taupata Stream near Puponga Lagoon. Contains common spicules. Collected by W. Orchiston c. 1970. (CM 2008.1097.5)
Heaphy River mouth, L26/1	See Wilkes & Scarlett (1967), and below
Kawatiri, Westport, K29/8	See Jacomb *et al.* (2004), Walter *et al.* (2011), and below
Fox River (Te Ana-o-Matuku cave), K30/2	Part of a water-worn cobble, 69 mm across. (CM E163.913)
Twelve Mile Beach, north of Greymouth	In cave deposit (Wilkes & Scarlett 1976: 205). Not confirmed.
Taramakau pā, J32/2	Pahautane chert was recorded by Heaphy in 1846 being used at this village for drilling holes in nephrite (Heaphy 1862). There are no known artefacts of the chert from this site, which was apparently destroyed by river erosion (Site Record form).

Figure 5. Flake with secondary retouch, Heaphy River site. Canterbury Museum E163.927.

Figure 6. Core with water-worn cortex, Heaphy River site. Canterbury Museum E163.1248.

5.2. Kawatiri

This site (K29/8) is situated close to the mouth of the Buller (Kawatiri) River, near Westport (Figure 2). A limited investigation was carried out in 1969 (Orchiston 1974), and more extensive excavations were subsequently undertaken by Otago University between 2004 and 2008 (Jacomb *et al.* 2004, Walter *et al.* 2011). A significant number of artefacts were recovered during the later excavations, including finished adzes and preforms, abrasive tools and >7000 flakes, of which over 500 consisted of 'Pahautane flint'. A few drillpoints and cores of the 'flint' were also recorded.

5.3. Distribution

Prior to the present study, available evidence suggested that the archaeological distribution of Pahautane chert was restricted to the West Coast. But identification of the single flake from Puponga in Northwest Nelson, demonstrates that this chert was transported more widely, over a direct distance from source of up to 200 km (Figure 2). To some extent this supports Heaphy's rather exaggerated claim that it was "carried to all parts of the islands" (Taylor 1959: 233).

Although the few artefacts previously recorded from Canterbury (from Redcliffs, Sumner and Weka Pass, Moore 2022, 2023) have a very similar appearance to the Pahautane chert, and all or most contain sponge spicules, their identification as Pahautane chert is not absolutely certain. This is because of the similarity of the Gordon's Valley chert in South Canterbury (Moore 2019). However, this type of chert has not been recorded from any early or late period sites along the Canterbury coast between Pareora and Christchurch (e.g. Dashing Rocks, Wakanui, Rakaia, Tumbledown Bay; Moore 2022), and therefore the Gordon's Valley material is presumed to have a very localised distribution. It is possible that the artefacts recorded from Christchurch and Weka Pass could have originated from the West Coast.

6. Period of Exploitation

Radiocarbon dates have been previously obtained for the Heaphy River and Kawatiri sites. One of the original dates from the Kawatiri site, on charcoal (NZ1285), yielded a calibrated age of AD 1287-1410 at 95% confidence level (Anderson 1991), suggestive of a 14th century occupation. An additional date of 1105 ± 30 BP on cockle shell (Wk14505) was also obtained by Otago University from their excavations (Walter *et al.* 2011). This has been recalibrated using Calib v.8.2 (Stuiver and Reimer 1993; calib.org/calib) and the Marine20 calibration curve (Heaton *et al.* 2020) with a regional Delta R offset of -154 ± 38 years BP (Anderson and Petchey 2020), giving an age of AD 1158-1434 at 95% confidence and a median of AD 1295, which suggests the site could be slightly older, possibly late 13th century. The single date (NZ0509) from Heaphy River of 965 ± 68 BP on unspecified shell (Aotearoa NZ Radiocarbon Database), calibrated as above, provides an age of AD 1320-1475 at 68% confidence (or AD 1240-1585 at 95% confidence) and a median age of AD 1405, and thus the site could conceivably have been occupied up to a century later than Kawatiri.

In summary, these dates suggest the Pahautane chert was being utilised on the West Coast from as early as the late 13th or early 14th century, and probably at least until about AD 1400 (at Heaphy River). Heaphy's

(1862) observations at Taramakau in 1846 demonstrate the chert was still in use on the West Coast as late as the middle 19th century. Thus, potentially, the chert was exploited over a period up to 550 years.

7. Discussion

The distinctive visual, textural and compositional attributes of the Pahautane chert enable it to be distinguished from other known chert types in the South Island. It is certainly very different from the more widely dispersed and higher quality Kaikoura chert in texture and faunal content (Moore 2021), though geochemically it may only be distinguished by its significantly lower Ba concentration (<15 ppm). It also differs from the volcanic chert identified at various sites in Canterbury, which is far more variable in colour, contains quartz veins, and lacks remains of marine fossils (Moore 2022). But its remarkable similarity to the Gordon's Valley chert in South Canterbury remains a problem, at least in determining the origin of artefacts found in Canterbury, and for now there seems to be little option other than to rely upon the greater abundance of planktic foraminifera and more common glauconite in the Gordon's Valley chert to distinguish between them.

The archaeological distribution of the Pahautane chert provides further evidence for the use of important communication routes between the West Coast and Nelson area. Although the existence of such routes has previously been identified from historical accounts (Brailsford 1996), and from the discovery, on the West Coast, of early style adzes made of argillite from the Nelson Mineral Belt (Scarlett 1967, Walter *et al.* 2011) and presence of pounamu at many sites in Nelson, Marlborough and Canterbury (Challis 1991, Moore 2022), the isolated artefact of Pahautane chert from Puponga could also indicate a specific connection with particular communities or tribal areas (rohe) in Northwest Nelson that is not evident from more widely distributed lithic materials.

At this stage it is not possible to establish if the chert was utilised throughout the entire prehistoric period. Its early use is confirmed by its presence, in considerable quantity, at both the Kawatiri and Heaphy River sites, and Heaphy's (1862) observations illustrate that it was still being used on the West Coast in the 1840s. However, the apparent temporal 'gap', spanning the mid to late prehistoric period (15th to 19th century), can probably be largely attributed to the very limited archaeological investigation of late period sites on the West Coast (Anderson 1982). Whether there was also a change in the primary use of the chert during this interval, from initially as a cutting/scraping tool to the drilling of pounamu in later times, is a subject for future investigation.

Funding

This research received no external funding.

Data Availability Statement

Data is available within the article.

Partnerships

This research did not use any primary data from Indigenous contexts.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Conceptualization, P.M.; methodology, P.M. and A.L.C..; formal analysis, A.L.C.; investigation, P.M.; resources, A.L.C.; writing—original draft preparation, P.M. and A.L.C.; writing—review and editing, P.M. and A.L.C; visualization, P.M. and A.L.C. All authors have read and agreed to the published version of the manuscript.

Acknowledgements

Our sincere thanks to: Simon Nathan and Kathy Prickett for information; Kirsty Vincent for preparing thin sections and undertaking the XRD analysis; Annette Rogers for the XRF analyses; Canterbury Museum staff for their assistance; Louise Cotterall for drafting the maps; and two unknown reviewers for their helpful comments.

References

Anderson, A. 1982. West Coast, South Island. In *The First Thousand Years. Regional Perspectives in New Zealand Archaeology*, N. Prickett (Ed); New Zealand Archaeological Association monograph 13. The Dunmore Press, Palmerston North, pp. 103-111.

Anderson, A. 1991. The chronology of colonization in New Zealand. *Antiquity* 65: 767-795.DOI: https://doi.org/10.1017/S0003598X00080510

Anderson, A., Petchey, F. 2020. The transfer of kūmara (*Ipomoea batatas*) from East to South Polynesia and its dispersal in New Zealand. *Journal of the Polynesian Society* 129 (4): 351–382.

Anderson, J.M. 1984. The sedimentology and diagenesis of an Oligocene carbonate sequence (Nile Group), Westport to Punakaiki. M.Sc thesis, Victoria University of Wellington.

Beck, R.J. 1984. *New Zealand Jade.* A.H. & A.W. Reed Ltd., Wellington.

Brailsford, B. 1996. *Greenstone Trails. The Maori and Pounamu.* Stoneprint Press, Hamilton.

Challis, A.J. 1991. The Nelson-Marlborough region: an archaeological synthesis. *New Zealand Journal of Archaeology* 13: 101-142.

Folk, R.L. 1959. Practical petrographic classification of limestones. *American Association of Petroleum Geologists Bulletin* 43: 1-38.

Folk, R.L. 1980. *Petrology of Sedimentary Rocks.* Hemphill Publishing Company, Austin, Texas, 182 pp.

Fredericksen, C. 1990. A chert quarry workshop (07/346} at Onerahi, Whangarei. *Archaeology in New Zealand* 33: 152-163.

German, R.C. 1976. Stratigraphy and sedimentology of the Nile Group (Oligocene), southwest Nelson. M.Sc thesis, University of Canterbury, Christchurch.

Heaphy C. 1862. A visit to the greenstone country. *The New Zealand Magazine* vol.1 no.4: 166-171.

Heaton, T.J., Köhler, P., Butzin, M., Bard, E., Reimer, R.W., Austin, W.E.N., Bronk Ramsey, C. *et al.* 2020. Marine20–The marine radiocarbon age calibration curve (0–55,000 cal BP). *Radiocarbon* 62: 779–820.

Hogg, A.G., Heaton, T.J., Hua, Q., Palmer, G.J., Turney, C.S., Southon, J., Bayliss, A., Blackwell, P.G., Boswijk, G., Ramsey, C.B. 2020. SHCal20 Southern Hemisphere calibration, 0–55,000 years cal BP. *Radiocarbon* 62 (4): 759–778.

Jacomb, C., Tucker, B., Walter, R. 2004. Excavations at the Buller River site (K29/8), January 2004. *Archaeology in New Zealand* 47 (2): 118-135.

Keyes, I.W. 1970. Wairarapa chert sources in New Zealand prehistory. *New Zealand Archaeological Association Newsletter* 13 (3): 128-134.

Laird, M.G. 1988. Sheet S37 Punakaiki. Geological map of New Zealand 1:63,360. DSIR, Wellington.

Moore, P. 1977. The definition, distribution and sourcing of chert in New Zealand. *New Zealand Archaeological Association Newsletter* 20 (2): 51-85.

Moore, P.R. 1983. Chert-bearing formations of New Zealand. In *Siliceous Deposits in the Pacific Region*, Iijima, A., Hein, J.R., Siever, R. (Eds). Elsevier Scientific Publishing Company, pp.93-103.

Moore, P. 2019. Gordons Valley chert, South Canterbury. *Archaeology in New Zealand* 62 (4): 11-16.

Moore, P.R. 2021. Visual and geochemical characterisation of Late Cretaceous – Paleocene cherts in eastern New Zealand: a preliminary study. *Journal of Pacific Archaeology* 12 (2): 68-78. DOI: https://doi.org/10.70460/jpa.v12i1.327

Moore, P.R. 2022. The pre-European use of lithic materials in the Canterbury region, New Zealand. *Records of the Canterbury Museum* 36: 55-75.

Moore, P.R. 2023. A re-examination of stone artefacts from the Weka Pass rock shelter. *Records of the Canterbury Museum* 37: 25-31.

Moore, P.R. 2025. The geological occurrence and visual attributes of sedimentary and 'volcanic' cherts in northern New Zealand. *Journal of Pacific Archaeology* 15 (1): Article 8. DOI: https://doi.org/10.70460/jpa.v15i1.382

Moore, P., Wilkes, O. 2005. A significant chert source at Raglan, Waikato coast. *Archaeology in New Zealand* 48 (4): 342-350.

Nathan, S. 1975. Sheets S23 & S30 Foulwind and Charleston (1st ed.). Geological map of New Zealand 1:63360. DSIR, Wellington.

Nathan, S., Rattenbury, M.S., Suggate, P. (compilers) 2002. Geology of the Greymouth area. Institute of Geological & Nuclear Sciences 1:250,000 geological map 12.

Neef, G. 1981. Cenozoic stratigraphy and structure of Karamea-Little Wanganui district, Buller, South Island, New Zealand. *New Zealand Journal of Geology and Geophysics* 24: 177-208.

Orchiston, D.W. 1974. Studies in South Island New Zealand prehistory and protohistory. PhD thesis, University of Sydney, Sydney.

Rattenbury, M.S., Cooper, R.A., Johnston, M.R. (compilers) 1998. Geology of the Nelson area. Institute of Geological & Nuclear Sciences 1:250,000 geological map 9.

Riordan, N.K. 2016. A cool-water carbonate seaway in an extensional setting: Oligo-Miocene sedimentology of the Nile Group and Paparoa Trough, western South Island, New Zealand. PhD thesis, University of Canterbury, Christchurch.

Scarlett, R.J. 1967. Adzes and chisels from the Heaphy River. *Records of the Canterbury Museum* 8 (3): 219-230.

Scarlett, R. 1982. Archaeology on a shoe-string: excavations at Heaphy River mouth 1961-1963. *New Zealand Archaeological Association Newsletter* 25 (3): 180-182.

Stuiver M., Reimer, P.J. 1993. Calib ver. 8. *Radiocarbon* 35: 215-230.

Taylor, N.M. (Ed) 1959. *Early Travellers in New Zealand.* The Clarendon Press, Oxford, U.K.

Te Taiao Māori and the Natural World. 2010. David Bateman Ltd., Auckland.

Wilkes, O.R., Scarlett, R.J. 1976. Excavation of a Moa-hunter site at the mouth of the Heaphy River. *Records of the Canterbury Museum* 8 (3): 177-208.