Hostile Shores

Catastrophic Events in Prehistoric New Zealand and their Impact on Maori Coastal Communities

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[Extracts re West Coast]

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earthquake (M7.2), the load carried over several years can increase almost fourfold; and the increase is likely to be much higher shortly after an earthquake, because floods transport most of the sand and silt within months. The eroded rock moves downstream as gravel, sand, and silt. Abrasion reduces the size of the particles carried, so that by the time a load of eroded rock reaches the coast, the gravel may be entirely reduced to sand and silt. Rock abrasion ensures an ongoing supply of sand to the coast during normal storms and floods. Currents carry some of the sand offshore, and long-shore drift carries some along the shore where it accumulates as part of beach and fore-dune systems.

The increase in sand following an earthquake can trigger a rapid response at the coastal end of the supply line. Landslips contribute mostly sand and finer particle sizes (Adams 1980). Sand travels downstream faster than gravel, and floods carry almost all of the sand and gravel as suspended load during rainstorms. Following a large earthquake, a new sand dune or shoreline ridge can form within a few years, as happened in Peru in the 1970s (Moseley et al. 1992), and thereby initiate the rapid progradation of a shoreline, or an advance of sand inland from the coast (Goff & McFadgen 2002). The Peruvian earthquake, which was in the north of the country, registered M7.9 and caused thousands of landslides, including one that killed 18,000 people. The area has a very low annual rainfall, and for two years millions of cubic metres of debris were poised in the mountains, waiting until heavy rains brought by the 1972–73 El Niño washed the debris down to the sea. Within two years of the El Niño, wave action had begun to form new dunes along the seashore (Couper-Johnston 2000).

In southern Westland, on the west coast of the South Island, the measurement of annual rainfall is in metres, and sediment transport begins almost immediately. A series of sand dune ridges just north of the Haast River indicates just how immediate. The dune ridges are discrete landscape features that separate low-lying wetlands. The four newest dune ridges formed following the four most recent ruptures of the Alpine Fault. Trees that colonise the ridges date the entire formation of each ridge, including initial colonisation, to within a few decades of each earthquake (Wells & Goff 2006).

The currents that carry sand and silt offshore deposit some on the near-shore seabed, and some on the sides of the submarine trenches along the plate boundary. Sediment transport by rivers in New Zealand is high by world standards (Hilton & Nichol 2003) – a result of high erosion rates, high rainfall, and tectonic processes. The Hikurangi Trough is at no point very far from the coast, and in the eastern Cook Strait between the North and South Islands it is a steep-sided submarine canyon. Eventually, sediment deposited on the sides of such trenches becomes unstable and moves as an underwater landslide displacing sea water, which may cause a tsunami (Bryant 2001).

Tsunamis

Tsunamis are long, deep, fast-travelling ocean waves (Dudley & Lee 1998: 90). Most earthquake-generated tsunamis begin at a plate boundary, where movement of the seabed upwards or downwards during an underwater fault rupture can displace a huge mass of water. The Pacific Ocean is most susceptible because there are deep ocean subduction trenches, explosive volcanoes, and actively building mountain ranges surrounding the Pacific Rim. Earthquakes, especially ones occurring at trenches, produce most tsunamis, and nearly all of those that travel long distances across the Pacific Ocean. New Zealand is both part of the Pacific Ring of Fire and surrounded by water. Thus, the New Zealand coast is exposed not only to locally generated tsunamis, but also to tsunamis that have originated elsewhere.

Where tsunamis are concerned, the type of fault rupture which occurs is significant. To propagate a tsunami there needs to be a displacement of water, and how the seabed moves determines whether a tsunami first strikes a coast as a *wave* (movement upwards), or as a *trough* (movement downwards). Strike-slip faults will not necessarily trigger a tsunami, because there is no vertical movement. There are, however, special situations where, even without vertical movement, sea water is displaced by a strike-slip rupture. For instance, a strike-slip fault down the slope of an inclined sea floor, or across a coastline, can propagate a tsunami when the horizontal movement displaces water by bumping it sideways. It is for these reasons that the Alpine Fault or the Wellington Fault, for example, are unlikely to produce tsunamis when they rupture – both are strike-slip faults – except possibly where the fault rupture crosses the coastline and enters the sea. For the Alpine Fault, this might only happen if the southern segment of the fault moves, otherwise a tsunami is unlikely.

A variety of other violent seabed movements triggered by geological activity can generate tsunamis (Dudley & Lee 1998: 79), but earthquakes are the most common cause. The earthquake need not even be large – indeed, people onshore may barely feel it. Two such earthquakes are thought to have triggered the two tsunamis that struck the East Coast in March and May 1947 (Eiby 1982). The tsunamis came ashore as waves up to 10 metres and 6 metres high, along 120- and 50-kilometre stretches of coast respectively, the March tsunami causing damage to buildings and bridges.

Other events that can displace water and generate a tsunami include terrestrial and submarine landslides, terrestrial and underwater volcanic eruptions, including the formation of an underwater caldera (collapsed volcanic crater), and meteorite impacts (Dudley & Lee 1998, de Lange 1998, Bryant 2001, Downes 2002). Clathrates – large bodies of frozen methane and water under the seabed (Kennett et al. 2003) – can melt if the temperature rises or the pressure falls, releasing gas and triggering underwater landslides or mud explosions, which can also cause tsunamis (de Lange 1998). There are clathrates off the New Zealand coast (Pecher et al. 2004), although they may not be common causes of tsunamis around its shores. Mass movement of material – such as landslides, lahars (volcanic mudflows caused by melting of snow and ice), and pyroclastic flows (masses of hot, dry volcanic rock fragments charged with hot gases) – which enters the sea from the land, can likewise cause tsunamis, but less often than earthquakes do, and the tsunamis to which they give rise are usually localised.

In the deep ocean, tsunami waves can travel up to 700 kilometres per hour, with a wave height of about 0.5 metres, and a wave length greater than 150 kilometres. As the waves get closer to the coast, the sea becomes shallower, reducing their speed and wave length, and increasing their height. A wave height of half a metre in the deep ocean can reach up to 35 metres near the shore (de Lange 1998). When a wave strikes the shore, the water may run up higher than the wave height, and, depending on the local topography, flood for several kilometres inland. If the water carries a load of sediment – sand or gravel – the sediment drops out when the water slows down and becomes less turbulent, and is left behind when it recedes. Not all waves are necessarily turbulent, depending on the length of the wave and the slope of the offshore seabed. If a wave comes ashore without breaking, the sediment signature will be less evident and the impact less damaging.

How high and far the water penetrates inland depends on the tsunami height, the direction it is travelling, and the coastal configuration. Some parts of the coast enhance whilst other parts reduce the impact of tsunamis. Funnel-shaped bays, such as Mercury Bay on the east coast of the Coromandel Peninsula, can concentrate wave energy. Tsunamis that form bores in estuaries, rivers, and streams are the most common and destructive sort in New Zealand, and a cause of severe erosion. Seiching – sloshing of water back and forth induced by tsunami waves in basins such as harbours, estuaries, and the lower reaches of rivers – can increase the height and destructive power of the waves (de Lange 1998). On the other hand, a tsunami can be remarkably gentle. In 1960, at Okains Bay on Banks Peninsula, the Chilean tsunami came ashore like an ever-rising tide until it was more than 1 kilometre inland, while a boy on horseback rode to safety through the water, which lapped his saddlebags. There was little damage as the water receded, other than the temporary loss of a small boat that was washed out into the bay and later recovered (Murray Thacker pers. comm.).

Their apparent gentleness at times notwithstanding, tsunamis are tremendously powerful. The sheer force of the moving water, turbulence, and the sediments and debris picked up by the waves from the seabed and onshore, can cause considerable devastation. Further destruction may be caused by the withdrawal of water, that can move at more than 70 kilometres per hour, scouring and sweeping out to sea sediments and debris that may be picked up and taken ashore again by the next wave (de Lange 1998, Dudley & Lee 1998). Damage does not stop with the final withdrawal of water – saltwater inundation can kill forest trees, and its effects on soils and vegetation can last for months, or even years, depending on the types of soils inundated (Young 2005).

Signatures of catastrophic events

Catastrophic events leave their signature in the sedimentary record: the layers of deposits that accumulate in the landscape due to normal geological and weathering processes. Such signatures range from distinctive, visible layers of tephra, to subtle changes in the chemistry or micro-faunal content of a tsunami deposit, detectable only by careful analysis. In the case of tsunamis, the signature might be little more than an eroded contact in the sediment record of a wetland, or it might be a wedge of sand more than 1 metre thick containing stones and gravel.

The terms *clay*, *silt*, *sand*, *gravel*, *stones*, and *boulders* are used throughout this book to indicate particle size. Precise size ranges for the diameters of particles are set according to the International Scale. As a rule of thumb, however, clays are the finest particles and give a plastic and sticky character to sediment. Silts are a little coarser and impart a smooth feel, while sands are gritty. Above 2 millimetres in size are gravel, stones, and boulders. Based on common English usage, one throws a 'handful of gravel', or a single stone, but a boulder is too large to throw. *Pebble* is used informally for rounded gravel and small to medium, smooth rounded stones.

Because of the stratigraphic nature of signatures, sections are the best means to observe them. In their simplest form, sections are near-vertical exposures a few metres high cut by marine or river erosion, along a coastline or riverbank (see Figure 2.7). Continuous exposure is not necessary, and a section can be generalised from several exposures, including dug holes and drilled cores. The most useful sections are those formed through coastal deposits younger than about 6000 years (i.e. deposited since the end of the post-glacial sea-level rise), especially where the record for the last 2000 years is between 2 metres and 5 metres thick. The main exceptions to this dictum are sections dug mechanically across earthquake faults to study and date earthquakes; these sections are rarely at the coast. Ideal sections (see Figure 2.8) contain alternating

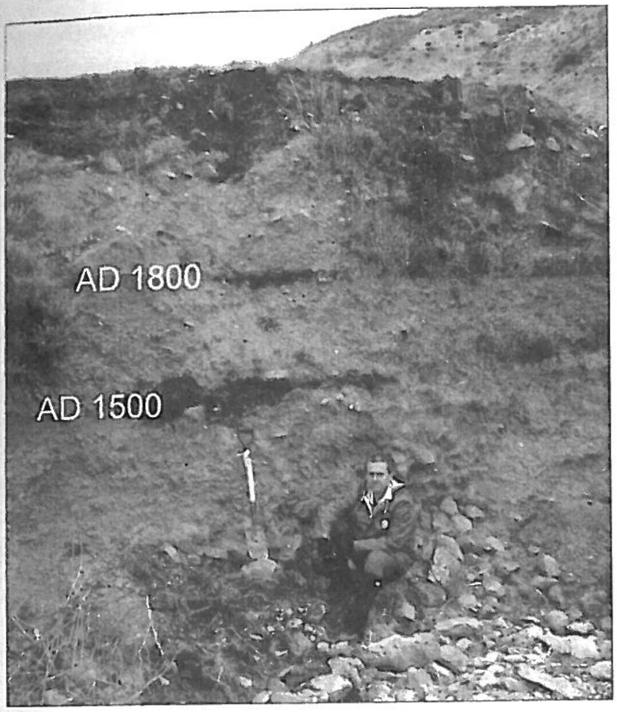

Figure 2.7 A section through a stream fan at Te Awaiti on the southeast Wairarapa coast, showing two buried soils (with dates). Each soil has on it the remains of Maori occupation that renewed sedimentation subsequently buried at approximately the dates shown.

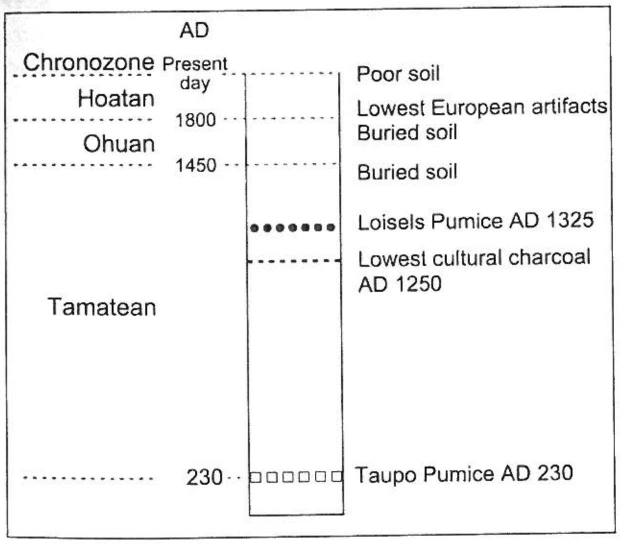

Figure 2.8 Idealised section showing late Holocene chronozones, soils, Loisels Pumice, and Taupo Pumice. Inferred ages in calendar years AD (adapted from McFadgen 2003b).

fluvial (river), aeolian (wind), and marine deposits, volcanic deposits including sea-rafted pumice of known age, buried soils, and remains of human occupation.

The remainder of this chapter describes the more common signatures according to the type of catastrophic event that produced them.

Volcanic eruptions

Tephra is unconsolidated material erupted from a volcano (Froggatt & Lowe 1990). It includes volcanic ash (ejected material less than 4 mm in diameter), air-fall lapilli

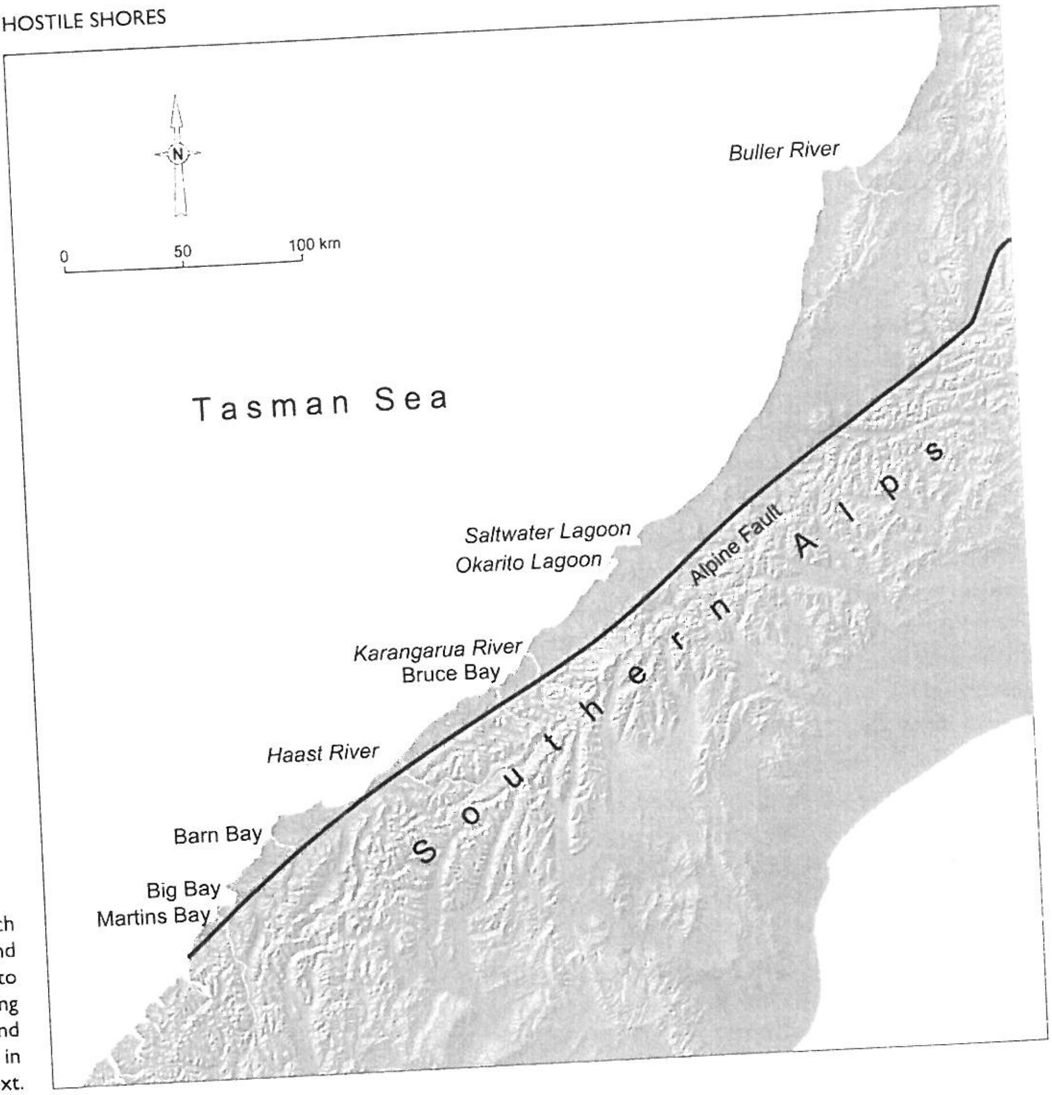

Figure 9.16 Sketch map of Westland and part of the coast to the north showing the Alpine Fault and places mentioned in the text.

Westland

With few exceptions, the recorded archaeological sites in Westland are seaward of the Alpine Fault (see Figure 9.16), which generally marks the boundary between the steep mountains of the Southern Alps to the east and the low hill country and glacial outwash terraces to the west. McCaskill (1954) characterises Westland – 500 kilometres of harbourless coast, with alternating bold cliffs and sandy beaches – as 'one of the least promising environments for stone-age man in New Zealand'. Nevertheless, people occupied the coast relatively early in prehistory – there are fourteenth- or early fifteenth-century sites from the Buller River in the north to Martins Bay in the south – possibly attracted by moas, and by stone resources, which included greenstone (Anderson 1982). At Buller River mouth (Orchiston 1974) (see Figure 9.16), people in Archaic times left the remains of their occupation distributed over an estimated two hectares or more (Anderson 1982). Records of Archaic artefact finds cover almost the full length of the coast from Buller River to Barn Bay (Hooker 1986), showing that, in the early part of the prehistoric period, people were visiting, or living along, a substantial portion of the coast. Apart from these finds, very little else is known about the archaeology of the coast. What evidence there is provides a picture of coastal instability that is hardly surprising given the proximity of the coast to New Zealand's biggest active fault, as well as several smaller but also active faults in Fiordland and northern Westland. Earthquakes, uplift, floods, river aggradation, and sand deposition all helped to alter the coastal ecology by providing relatively fresh, new ground for people to settle without the need to first clear heavy forest, and by changing the river and foreshore habitats in ways that affected prehistoric food collection.

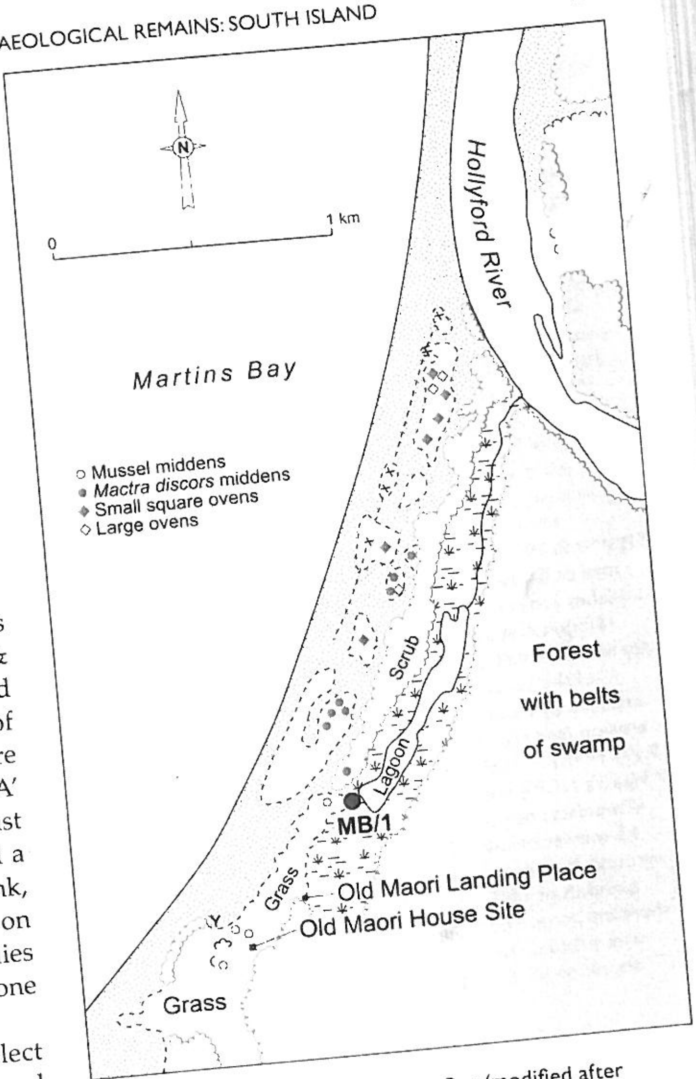

Figure 9.17 Sketch map of Martins Bay (modified after Wellman & Wilson 1964). Y, point where dune sand with moderately well-developed soil overlies mussel midden. Relict beach ridge with many *Mactra discors* shown by crosses. Beach and bare dune sand shown dotted. MB/1 = site excavated by Coutts (1971).

Martins Bay

A sand dune advance at Martins Bay separates two periods of Maori occupation (Wellman & Wilson 1964). People first occupied a gravel and sand bank that once separated an old course of the Hollyford River from the sea (see Figure 9.17). Well-developed soil called 'Surface A' covers the bank. Fresh sand arriving at the coast precipitated the dune advance, which formed a dune ridge seaward of the gravel and sand bank, and a soil – called 'Surface B' – then formed on the dune ridge. The dune advance partly overlies the gravel and sand bank, and buries at least one site from the first occupation.

Shellfish species in the middens reflect changes to the foreshore following the sand advance, and indicate that an increased sandy environment developed between the first and second occupations. Middens deposited by people during the earlier occupation, which are composed almost entirely of rocky shore mussels (*Mytilus edulis*), lie within the soil of Surface A. Middens deposited by people on Surface B comprise almost entirely the sandy shore bivalve *Mactra discors* (Wellman & Wilson 1964). An archaeological excavation on the sand and gravel bank shows a similar change in species through time (Coutts 1971), which probably spans the period when the sand accumulated. The site (MB/1) shows a lower and an upper series of occupation layers separated by a very sandy layer. Rocky shore mussels were prominent in the lower occupation layers, whilst *Mactra discors* was prominent in the upper layers. Neither mussels nor *Mactra discors* are common in Martins Bay today (Wellman & Wilson 1964, Coutts 1971). There are, however, large numbers of *Mactra discors* shells on a relict beach ridge seaward of the dune ridge, and the shellfish would appear to have been much more common in the past.

Based on the profile development of the soil on the dune ridge, Wellman and Wilson

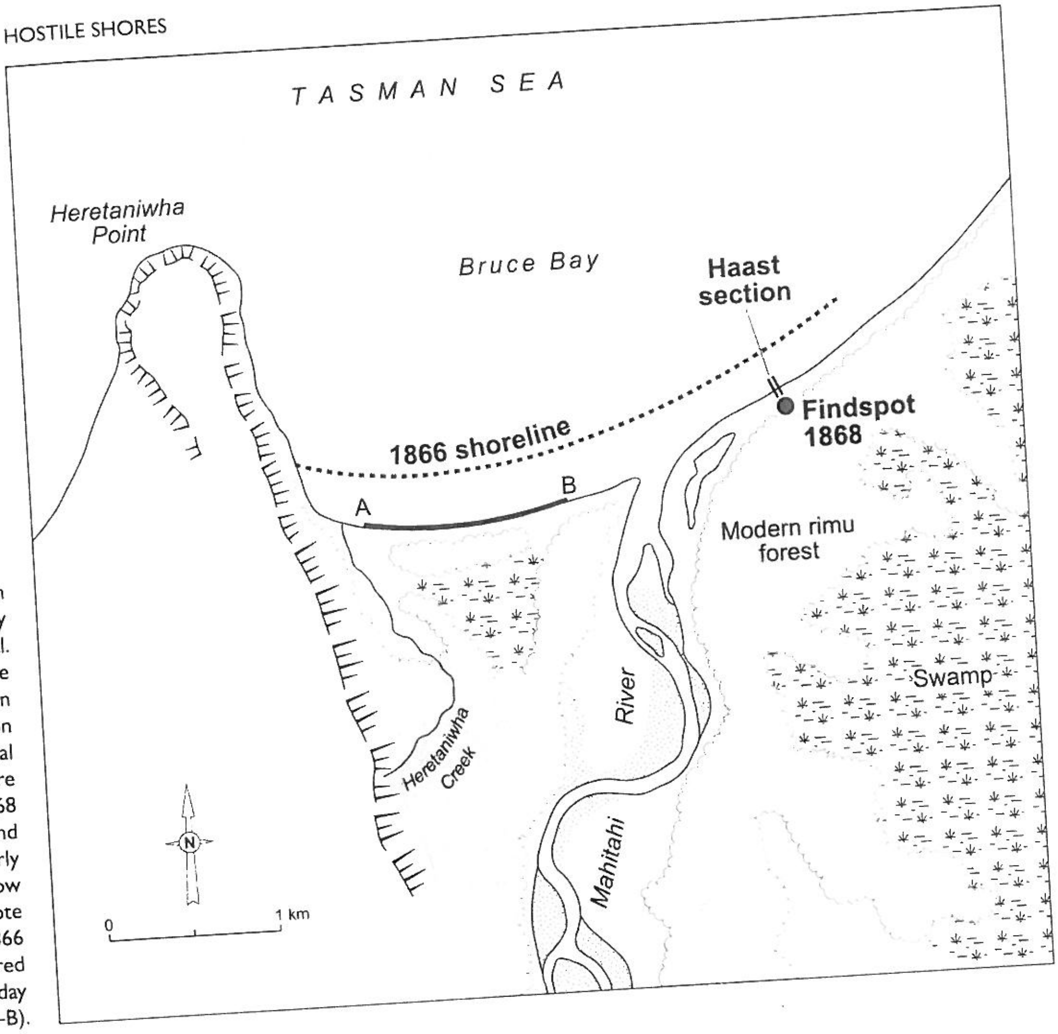

Figure 9.18 Sketch map of Bruce Bay (after Jones et al. 1995). A–B = the approximate location of the section exposed by coastal erosion (see Figure 9.19). Findspot 1868 = Haast's (1870) find of artefacts nearly 4.5 metres below ground level. Note position of 1866 shoreline compared with present-day shoreline (A–B).

(1964) estimate the dune advance to be earlier than AD 1450. Because the advance was after human settlement, it is later than about AD 1250.

Bruce Bay

Bruce Bay (see Figure 9.18) is about 150 kilometres northeast of Martins Bay. In 1870, Haast reported a find made by gold miners of stone tools – a chisel and sharpening stone – in black gold-bearing beach sand, nearly 4.5 metres below the ground surface, and 160 metres inland of high-water mark (Haast 1870). The find, on the east side of the Mahitahi River (Jones et al. 1995), was in undisturbed ground, indicating that there had been considerable changes to the coast in the time since the deposition of the tools. Bruce Bay is eroding, and today's shoreline is now close to where the miners discovered the tools (see Figure 9.18). Many middens that were visible in the 1930s are now destroyed (Hooker 1986).

Erosion to the west of the Mahitahi River has exposed a section around the back of the beach, which cuts across four old shoreline ridges. The ridges, from oldest to youngest, are numbered 1 to 4 (see Figure 9.19). The earliest occupation remains, undated charcoal and fragmented shells, are on the oldest ridge, and there are two

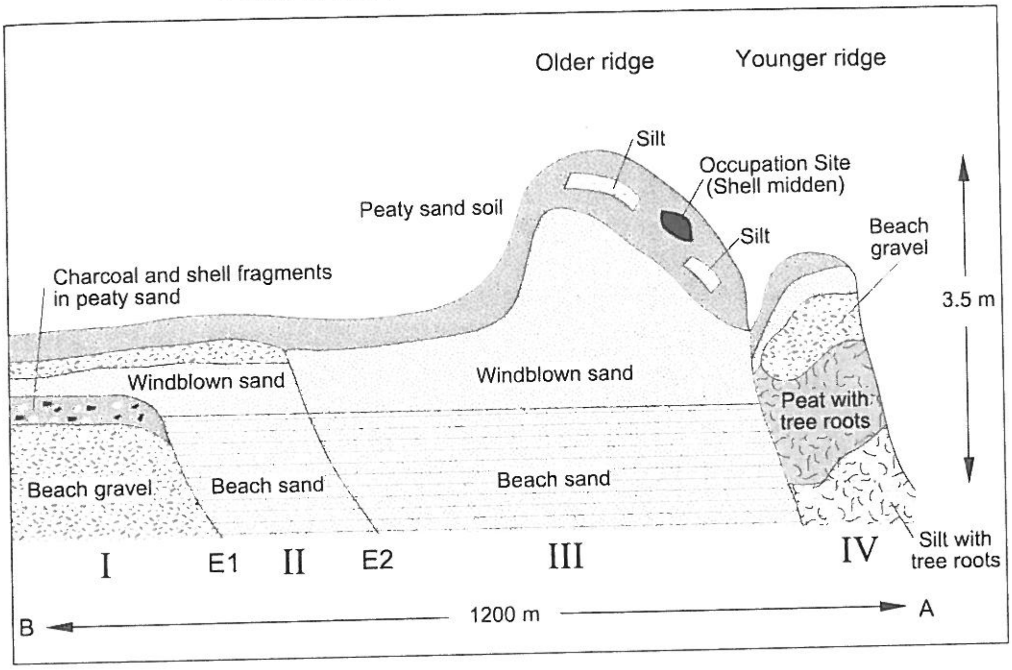

Figure 9.19 Generalised section of Bruce Bay foreshore showing four inferred phases of shoreline accretion (I to IV) and two inferred erosion intervals (E1 and E2) (after McFadgen 2002: Fig. 3). A European-age gravel deposit on the top of the section is not shown. Note tree stumps in the peat and silt underlying the younger ridge. (Vertical exaggeration is x200). A to the right-hand end of the section, B to the left.

radiocarbon-dated shell middens on ridge 3 (Jones et al. 1995, Allingham & Symon 1999), one with Archaic-style fishhooks (Allingham & Symon 1999).

The ridges reflect a foreshore that, following the arrival of people, changed from beach gravel to sand, and later back to beach gravel. The earliest occupation remains are charcoal, and fragmented shells that were too small to identify. The occupation remains on ridge 3, however, are two shell middens dominated by sandy shore species (mainly tuatua (*Paphies subtriangulata*)) (Jones et al. 1995, Allingham & Symon 1999), reflecting the sandy shoreline that then existed. What is remarkable is that there are no tuatua on the beach today, and according to Jones et al. (1995), sandy shore species do not appear to have been available in south Westland during the historic period. The time span of the sandy period, bracketed by the occupation of ridges 1 and 3, is thus between about AD 1250 (first human settlement of New Zealand) and AD 1425 (see Table A9.6) – comparable with the estimate date of the sand dune advance at Martins Bay.

Wells et al. (1999, 2001), using tree cohort ages, show that the formation of the four youngest aggradation terraces along the Karangarua River, 18 kilometres northeast of Bruce Bay, closely followed large earthquakes thought to have been along the Alpine Fault. At the coast, the ages of the three youngest dune ridges north of the Haast River, estimated from the ages of trees growing on their surfaces, are also in good agreement with estimated ages of the presumed Alpine Fault ruptures (Wells & Goff 2006). However, the inferred dates for the river terraces and dune ridges (AD 1450 or younger) are more recent than the sand influx at Martins Bay and Bruce Bay. There are older river terraces and dune ridges, but these are undated. Tree dates for the next oldest terrace in the Karangarua Valley (K5), although few in number, suggest an aggradation event at around AD 1350 (Wells et al. 1999, 2001) – about the same date as a fault rupture inferred from proxy data (see Figure 4.14) (Bull 1996). An event around AD 1350, not necessarily a rupture of the Alpine Fault, but possibly of another fault, sits well with the estimated date for the sand influx at Martins Bay and Bruce Bay.

Saltwater Lagoon

At Saltwater Lagoon (Poherua Lagoon[*]), 85 kilometres northeast of Bruce Bay (see Figure 9.16), the surveyor Arthur Dobson records seeing a drowned Maori village in January 1864, with stumps of posts and fireplaces exposed at dead low-water spring tides (Dobson 1930). Dobson's opinion was that the land had subsided not long before, because the remains were still extant. His Maori companions had no recollection of the place, which suggests that it is unlikely to be the former 'summer residence of the natives [*sic*]' that Brunner noted in 1847 (Brunner 1952). Today, the only recorded archaeological remains on the spit that are possibly from the village is an archaeological site (I34/22). The site comprises fire-burnt stones, charcoal, and midden that high tides wash when not covered with sand. Two other archaeological sites of possible Maori origin are both deposits of oven stones on the inland shore (I34/39 & 40), and both are occasionally flooded by the lagoon.

A record of environmental changes in the Okarito Lagoon, 15 kilometres southwest of Saltwater Lagoon, show at least two down-drop events during the last 6500 years (Goff et al. 2001). The Alpine Fault passes about 10 kilometres east of the lagoon, and Goff et al. (2001) explain the down-drop events by compaction, liquefaction, and local tectonic subsidence caused by Alpine Fault ruptures. It is assumed that an event large enough to cause the bed of the Okarito Lagoon to drop would also affect Saltwater Lagoon, and may also produce a tsunami.

Buried soils in the Okarito sediments mark the down-drop events, and Goff et al. (2001) correlate both with inferred tsunami deposits. Such deposits are marked by a suite of attributes that includes upward-fining beds, of which the sediments record possibly as many as ten. Goff et al. (2001), however, make it clear that such signatures need not represent tsunamis, especially where there is no contemporary record of a down-drop event. They point out the possibility of other kinds of catastrophic salt water inundations such as storm surges.

There are two upward-fining beds interpreted as tsunami deposits above the younger buried soil. Radiocarbon dates for shells in the older of the two beds show that both are since AD 1320 (Goff et al. 2001), but only the older correlates with a down-drop event.[†] Large South Island earthquakes younger than AD 1320 dated by proxy methods are in the fifteenth, seventeenth, and eighteenth centuries AD (see Figure 4.15). (For reasons given in Chapter 2, the strike-slip character of the Alpjne Fault makes it unlikely that earthquakes on this fault are the cause of the tsunamis unless the earthquakes triggered underwater slumps.)

Goff et al. (2004b) correlate the younger signature with an event shortly before 1837, possibly an earthquake reported from Fiordland in the 1820s (Downes et al. 2005). Wherever the earthquake originated, however, it was not big enough to have caused a down-drop of the Okarito Lagoon bed. If Dobson (1930) is correct that the remains of the village were not very old when he saw them, then the village may have sunk as late as the 1700s (Goff et al. 2001). Alternatively, the remains of the village could be older, with wave action uncovering them only a short time before Dobson saw them. However, without further dating evidence of the archaeological remains,

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[*] This is the name used by Dobson and Brunner.

[†] The first reported position of the shells, which was not very clear, appeared to be in the top of the younger buried soil beneath the lower upward-fining bed (Goff et al. 2001) – their position was, in fact, at the base of the bed (James Goff pers. comm. 11 November 2004).

entirely forest-covered in prehistoric times. Most of the lowland is at the coast, with sites nearly all located to the north around Golden Bay, Tasman Bay, and D'Urville Island (Wellman 1962a, Challis 1991). A prehistoric earthquake appears to have uplifted the west coast, at the same time causing the sinking of the coast of Golden Bay and Tasman Bay.

Heaphy River

The Heaphy River, on the west Nelson coast (see Figure 9.20), is about 360 kilometres northeast of Bruce Bay. There is a moa-hunting site on the south bank of the river, sitting on interfingering fan deposits and estuarine/marine sand, gravel, and cobbles. There is charcoal in the sand beneath the site. Natural fires are rare in the rainforest environment of north Westland, and the charcoal is probably from old cooking fires. When people first visited the estuary, the land was lower than when the site was occupied. A wave-cut notch on the north bank of the river, an old lake bench on the south bank, and the height of the marine gravels beneath the site indicate tectonic uplift of about 3 metres (McFadgen & Goff 2003).

The uplift exposed estuarine/marine gravels that would have provided a comparatively well-drained soil, and probably explains why the site is in its present position. Rainfall at the Heaphy mouth is between 3.2 and 6.4 metres per year (Tomlinson 1976), and the silt soils in the area tend to pug and inhibit drainage (Wilkes & Scarlett 1967) – a condition that the better-drained estuarine/marine gravels would help to ameliorate. Uplift of the site shortly before occupation would have been a further advantage to its inhabitants, because the young vegetation growing on it would be easier to clear than the more mature forests of older surfaces. If the charcoal under the site is cultural, the uplift was after about AD 1250, which is the currently accepted date for the Maori settlement of New Zealand, and before AD 1465 (see Table A9.7).

Golden Bay, Tasman Bay, and D'Urville Island

In eastern Tasman Bay, early Archaic sites are rich in animal remains, including moa and seals, and in artefacts. D'Urville Island Archaic sites, found in Wellman's (1962a) lower occupation layer, contain moa bones. In western Tasman Bay and Golden Bay, sites with rich faunal remains are uncommon, early Archaic sites are rare, and the earliest sites fall into what Dr Ian Barber (1994) calls the northern South Island middle period – a period of transition between the Archaic and Classic.

Marine erosion in western Tasman Bay and Golden Bay is a major cause of site loss and damage. At the outer end of Farewell Spit, and at places between Farewell Spit and Jacketts Island, there are burnt, fractured stones in the tidal zone. The stones, originally in sand above high-water mark, are the remains of ovens that wave action has undermined. Because the wave energy is low and the sand easily moved, many of the stones have fallen vertically from their original position and are still close by (Challis 1978).

A late Archaic adze was found alongside the stones at the outer end of Farewell Spit (N24/9) (McFadgen 2001b). There were two groups of stones, one possibly an oven still in its original position (see Figure 9.21). Nearby were two circular basins about a metre in diameter and more than 5 centimetres deep, filled with shells, charcoal, and burnt, fractured stones. The stones and basins were more than 40 metres from the shore and about 0.5 metres below high-water mark, indicating an apparent drop in the height of the land since late Archaic times. At Fenwick Road (see Figure 9.20),

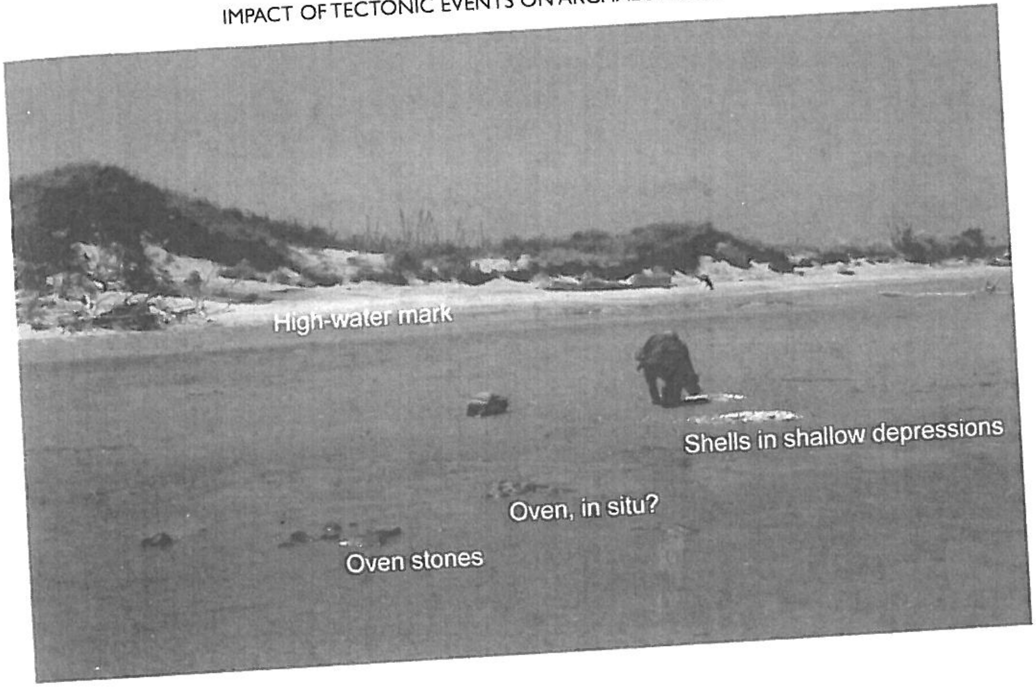

Figure 9.21 Photograph showing the base of archaeological pits and ovens in situ, more than 40 metres from high-water mark and 0.5 metres below high-water mark inside the outer end of Farewell Spit (photograph courtesy of Steve Bagley, Department of Conservation, Nelson).

33 kilometres southwest of the Farewell Spit fireplace, no intact ovens were seen, and the oven stones were near tree stumps, in growth position, in peat in the intertidal zone. The tree stumps are emerging from beneath well-weathered sand behind the beach, and although they are probably several thousand years old, their depth below high-water mark is similar to the oven and basins at Farewell Spit. At Awaroa Inlet (see Figure 9.20), 34 kilometres south of the Farewell Spit fireplace, midden shells and burnt, fractured stones litter the intertidal zone next to Sawpit Point. Here, overlying an Archaic occupation layer slightly above high-water mark (Taylor 2004) is a sand dune soil with an eroded surface. I equate the soil with one that extends out into the tidal zone to more than 0.50 metres below high-water mark (McFadgen 2001b). The soil indicates that, since Archaic times, there has been an apparent drop in the height of the inlet of at least 0.50 metres. On the seaward side of Jackett Island, near the southeast end, oven stones in the tidal zone are in scattered groups. Two of the groups, just below high-water mark, are the remains of intact ovens still emplaced in black greasy sand (Challis 1978).

The fireplace, tree stumps, dune soil, and ovens are too far below high-water mark to have been submerged by the 15-centimetre global sea level rise last century alone. The apparent drop in height requires the involvement of some other process. If the whole of the coastline, and adjacent land and seabed, between the four sites has changed level, then regional tectonic subsidence is a possibility, but there is not enough information to be sure. Awaroa is an estuary, Jackett Island is near the mouth of the Moutere River, and the two other sites are in a large bay bounded by Farewell Spit where silt and mud from streams and small rivers flowing into the bay forms part of the substrate. The simpler explanation is that the fall in land level is the result of local compaction and liquefaction of sediments following a very large earthquake, similar to that already described for eastern Murihiku following the rupture of the Akatore Fault.

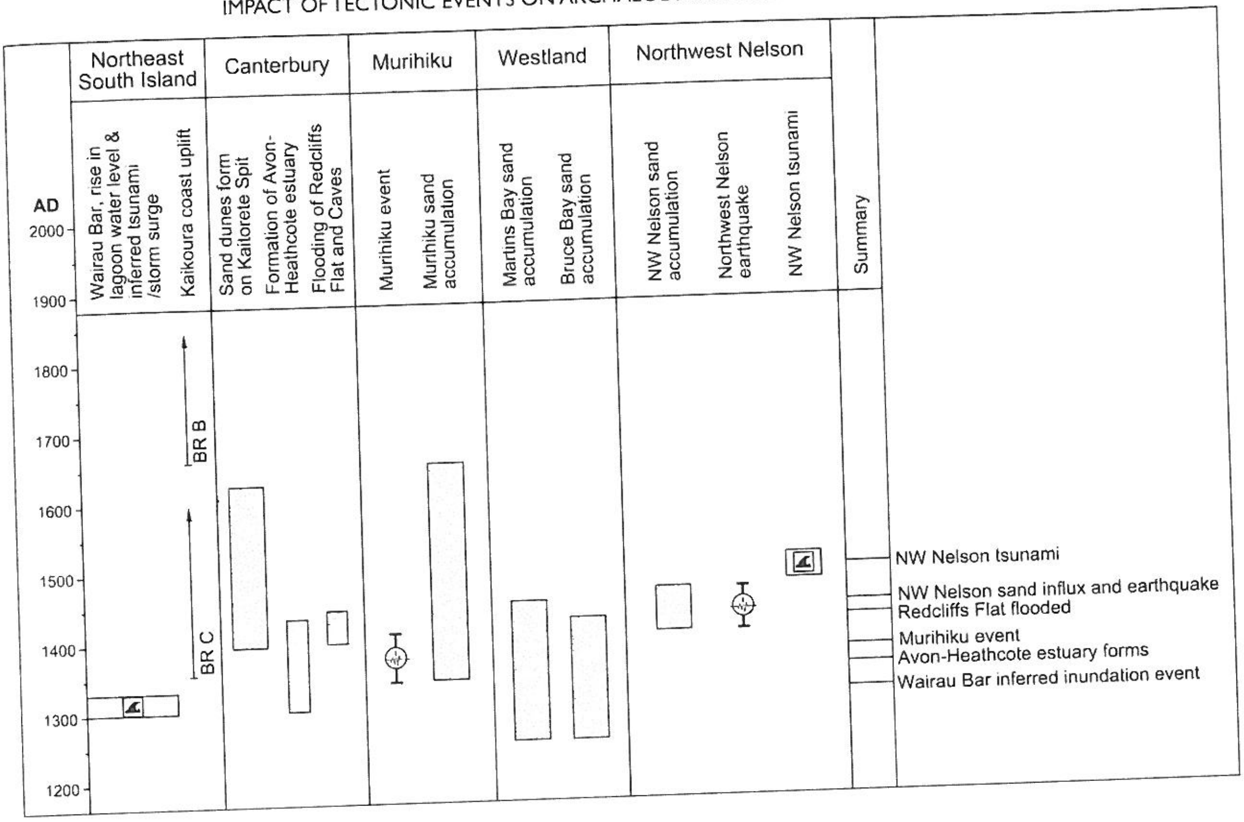

Figure 9.25 A summary of tectonic events recorded in the archaeological record around the South Island coast. Upward-pointing arrows for the Kaikoura uplifts indicate maximum ages for the events. Bracket ranges for other earthquakes – the Murihiku event and northwest Nelson earthquake – are shown as bars. Age ranges for sand accumulation are boxes with stippled fill. Bracket ranges for tsunamis/storm surges are boxes with stylised waves.

the suggested tsunami is not. The tsunami is slightly younger than the earthquake (see Figure 9.23) and appears to have been a separate, unrelated event that just happened to occur close to the time of the earthquake.

Tectonic events on the South Island coast

Figure 9.25 shows the tectonic events recorded by archaeology in four of the coastal sectors of the South Island. There are two types of event: short-lived and effectively instantaneous (earthquakes and tsunamis); and long term, that would have persisted for several years or decades (periods of sand accumulation and the rise of water level in the Avon-Heathcote estuary). The figure labels each event, and shows the full range of possible ages that the dating errors indicate. For all events, the bracket range indicates generally the period within which the event took place. The bracket ranges are variable – some are small and give a reasonably precise estimate of age, whilst others are large. The figure shows adopted dates only for short-lived events where the bracket range is less than about 75 years, and the adopted dates are the centres of the bracket ranges.

Based on their adopted dates, there are three events – an earthquake in Murihiku, a possible tsunami in the northeast South Island, and the forming of the Avon-Heathcote estuary in Canterbury – that occurred in the fourteenth century AD. These events were followed in the fifteenth century by the flooding of Redcliffs Flat alongside the Avon-Heathcote estuary and, in northwest Nelson, by an earthquake, sand accumulation, and a probable tsunami. Sometime between the late thirteenth and early fifteenth centuries AD, there was sand accumulation in south Westland at Bruce Bay an Martins Bay. Sand accumulation followed the Murihiku event, but whilst its brack range spans nearly 300 years, its duration was probably somewhat less. These even influenced human settlement by altering the availability of food species that peop collected and by making the places where they lived uninhabitable.