Geoscience Society of New Zealand 2011 Conference

FIELD TRIP GUIDE


St Arnaud, Lake Rotoiti, Alpine Fault


Mt Owen marble massif


Marlborough Sounds


Awaroa Bay, Abel Tasman National Park

NELSON 27 November - 1 December 2011

Geoscience Society of New Zealand


Abel Tasman National Park

Geosciences 2011

Annual Conference of the Geoscience Society of New Zealand
Nelson, New Zealand

Field Trip Guide

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Geosciences 2011

Annual Conference of the Geoscience Society of New Zealand,
Nelson, New Zealand

Field Trip 5
Tuesday 29 November 2011

Geology and History of the Nelson Boulder Bank

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Bibliographic reference:
Dickinson, W., Hartstein, N., Warren, K. 2011. Geology and History of the Nelson Boulder Bank.
In: Lee, J.M. (ed). Field Trip Guides, Geosciences 2011 Conference, Nelson, New Zealand.
Geoscience Society of New Zealand Miscellaneous Publication 130B. 18 p.

ISBN 978-1-877480-14-0
ISSN (print) 2230-4487
ISSN (online) 2230-4495

HEALTH AND SAFETY ISSUES

PLEASE READ!

There are certain inherent hazards in working along the coastline and adjacent areas. The cliffs can be unstable and portions may collapse or shed debris without prior warning. Caution should therefore be exercised when examining rocks at the base of natural or man-made cliffs. In addition, wave, river, and tidal conditions can be potentially dangerous. Participants must heed and observe the warnings and time limitations imposed at certain stops by the trip leaders. Caution must also be exercised when crossing public roads, standing on the road reserve, or farm track locations where vehicles or machinery may be in use.

Participants should carry any personal medications, including those for allergic reactions (e.g. insect stings, pollen, food allergies).

Participants need to be prepared for cold, warm, wet, and/or dry conditions. The expectation is that temperatures would be in the range 15–25°C. A sunhat, sun cream, sunglasses, waterproof and windproof raincoat, and warm clothing (layers) are essential. If the weather is warm, drink plenty of water to combat dehydration. Please don't underestimate the climatic variations that are possible or the potential to get sunburnt. A change of clothing may be useful to bring and to leave in the vehicles, as would a small hand towel.

An average level of fitness and mobility is required for this trip; there will be some clambering over rocks and some moderate beach walks (up to 3 km at any given stop). Be aware that visits to the coastal and stream sections may involve getting wet feet, walking/wading through knee-deep surf (unlikely), or walking through and adjacent to streams and rivers. Coastal access is controlled by the tide. There are a number of natural coastal cliffs, and these may be unstable. The party is requested therefore to stay clear of such areas that are vertical or capped by young sediments, and to not linger at cliff exposures at all. Lightweight boots are recommended footwear.

Tasman Bay beaches are often subject to strong undertows and unpredictable currents. There is to be no swimming at fieldtrip stops. In addition, due to the changing nature of the coastal sections, we cannot guarantee that conditions will be exactly as we expect them. Conditions change frequently sometimes on a daily if not hourly basis. Circumstances on the day may dictate what is appropriate in terms of access and HS & E considerations.

There is a real but very low frequency risk of tsunami. These might be generated from around the Pacific Ocean (in which case we should get forewarning) or locally, in which case we might get no warning except a rapid fall in sea level. A tsunami generated by submarine slope failure need not be associated with a felt earthquake.

There will be one stop on the left side of a busy road. This will exit onto a viewing platform. Please exit on the verge/left side of your vehicle. If you need to go onto the road surface itself ("live lane"), for example to take photos, you must ensure you have a traffic spotter whose full attention is solely to alert you to approaching traffic.

Introduction

The Nelson Boulder Bank is a well known geomorphic feature of Tasman Bay, and perhaps one of the most unique gravel beaches in the world. It is also an icon of Nelson and has played a significant role in the physical, economic and social development of the city. However, the Boulder Bank is only one of a number of similar, but smaller gravel beaches and barriers which may be found in eastern Tasman Bay at Greville Harbour, Croisilles Harbour, and Cable Bay (Fig. 1). The main aim of this trip is to look at the general features that define the gravel beaches at Cable Bay and the Boulder Bank. From these observations, we will discuss the processes, which have produced them and the origin of their unique geomorphic features. Unfortunately by their nature, the boulder platforms are visible only at low tide, and for part of the trip, you will need to have faith in pictures and diagrams that show they genuinely exist below the waves.

Nelson tides & heights (m): 29 Nov 2011; High 13:20 (4.2) Low 19:20 (0.7)

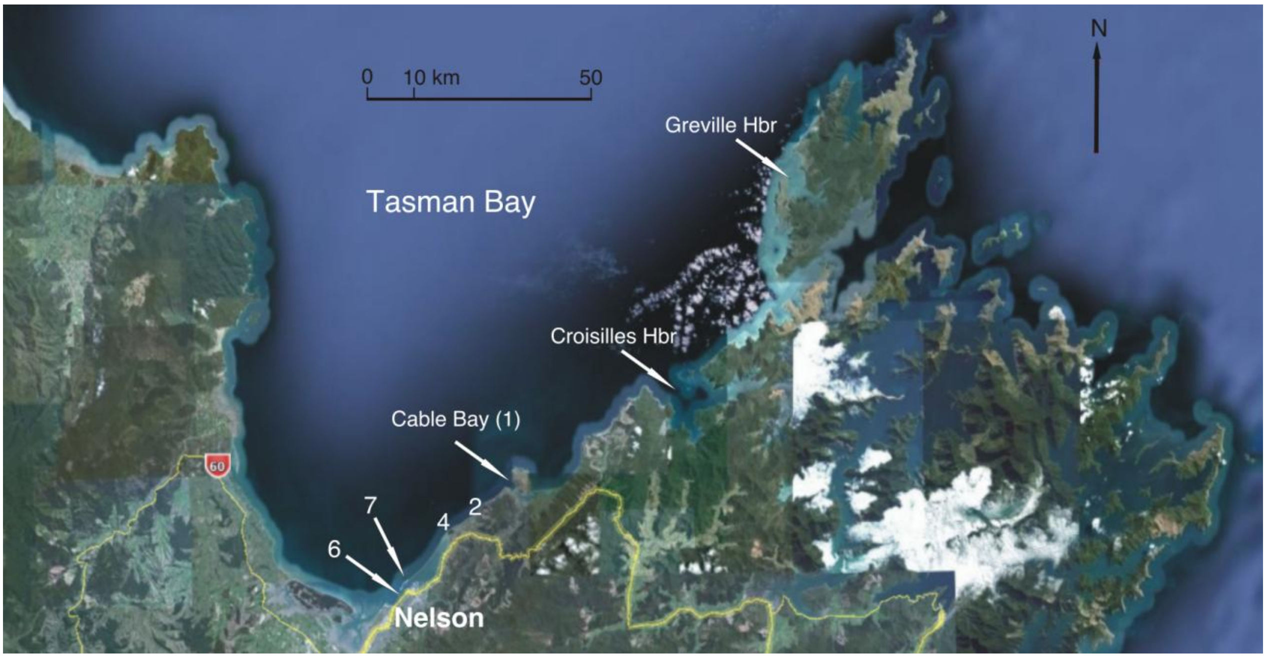


Figure 1 Tasman Bay showing location of Boulder Banks and numbered stops on field trip.

Background

The Boulder Bank is composed of boulders (>265 mm), cobbles (256-64 mm), and pebbles (64-4 mm), which consist only of Cable Granodiorite. This formation crops out only at Cable Bay and Mackay Bluff just north of the barrier (Fig. 2). The point source of Cable Bay Granodiorite, angle of incident waves together with the decrease in size and increase in roundness of clasts have made longshore drift the Occam's razor explanation for origin of the Boulder Bank. This mechanism has been supported by numerous workers from Hochstetter (1864) to Johnston (2001). However, under the past and present, low-energy wave environment in Tasman Bay, it is not clear how large boulders from Mackay Bluff could be transported 13 km to the southwest end of the barrier (Dickinson and Woolfe 1997). This field trip will attempt to show that although the Nelson Boulder Bank has been modified by the present wave environment, it owes its origin to the deposition of underlying gravels.

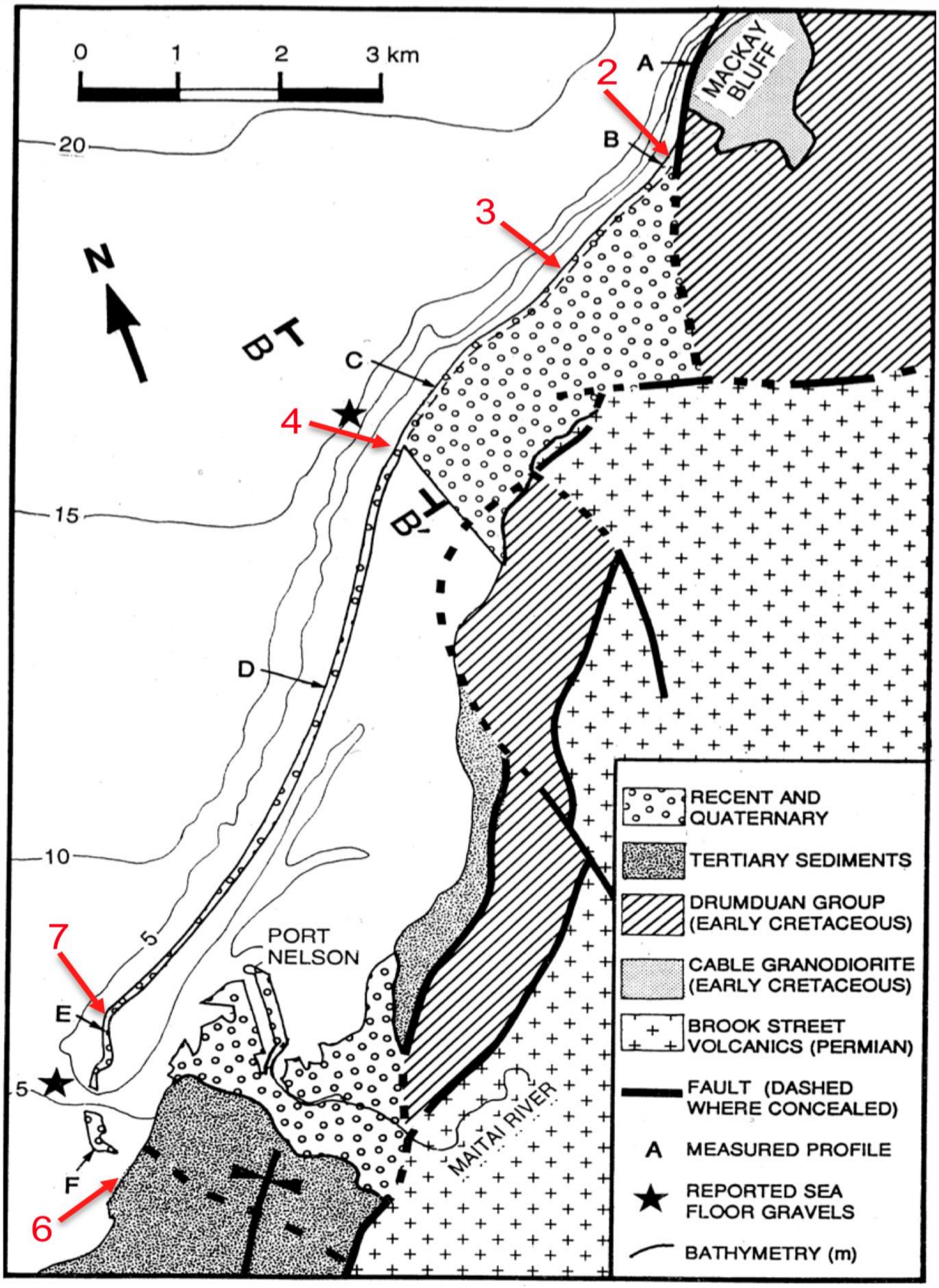


Figure 2 Map of Boulder Bank area shows the geology from Johnston (1979, 1981), and location of measured profiles A-F. Field trip stops in red numbers. Bathymetry is from Royal New Zealand Navy (1988).

Beach profile and particle size data show that the Boulder Bank as well as the other gravel (refers to all particle sizes between 4 and 250 mm) beaches in eastern Tasman Bay have three distinct units: 1) a gravel ridge (‘top course’ in Johnston 2001), 2) a boulder platform (‘base course’ in Johnston 2001), and 3) sub-platform gravels. Gravels on the ridge are actively transported in the present wave environment and consist of well-sorted pebbles (4-64 mm) and cobbles (64-256 mm). The boulder platform is exposed only at low tide and its surface is covered by poorly-sorted pebbles, cobbles and boulders (Fig. 3). These gravels are immobile (Dickinson and Woolfe, 1997; Johnston 2001) and occur as an armoured layer, which in most places is a single clast thick on the platform surface (Fig. 3). The sub-platform gravels lie below this armoured surface and are unconsolidated, poorly sorted, and massive with no apparent sedimentary structure.

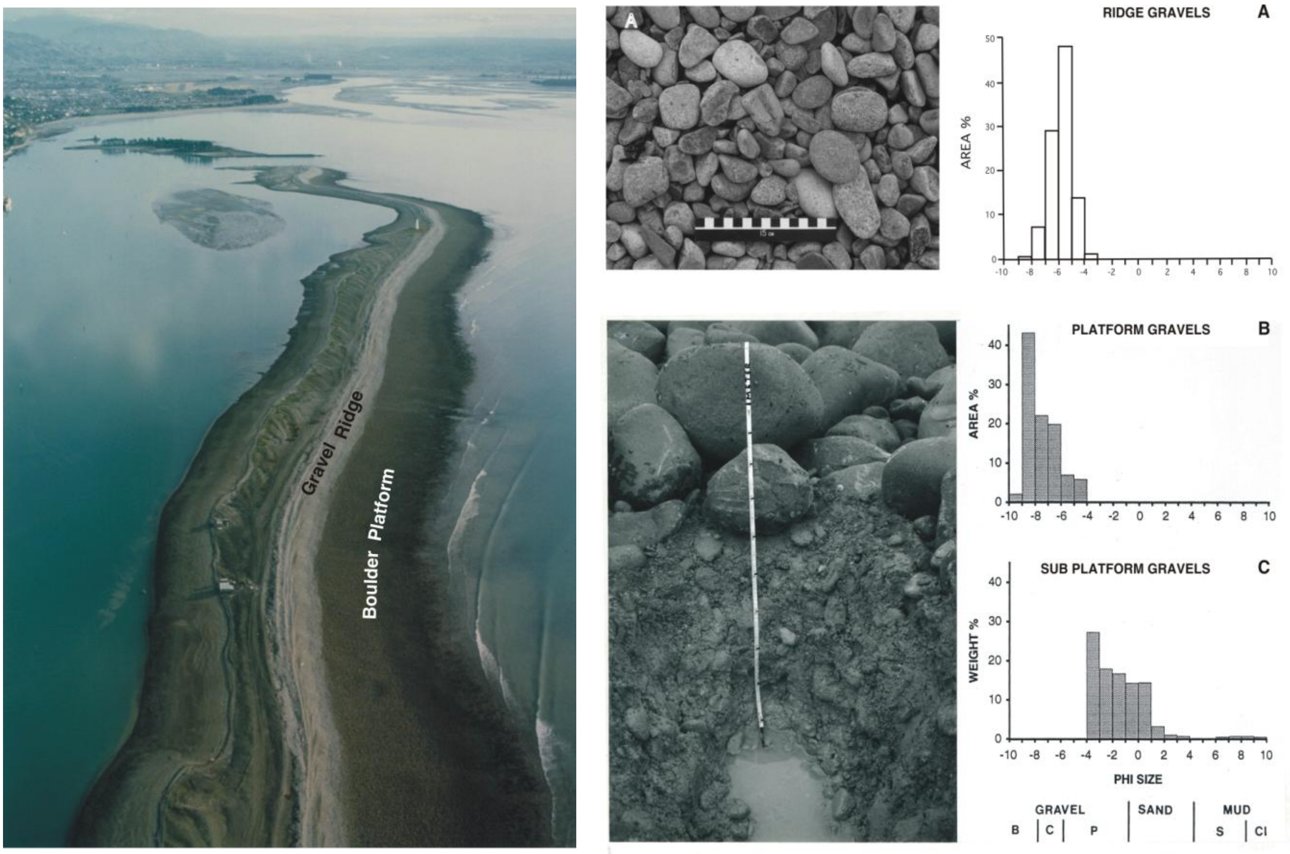


Figure 3 Boulder Bank at low tide. Shallow 1 m deep pit on the boulder platform shows a boulder lag over poorly sorted and unconsolidated gravels. Mean phi size distribution of surface clasts determined by area percent at four locations (45 m at profiles C, D, E, and F, Fig 2). Mean size distribution of subsurface clasts (1 m deep) determined by weight percent for >-4 phi fraction at same four locations. Shown are phi divisions for the various size classes:

gravel (B = boulder; C = cobble; P = pebble), sand, and mud (S = silt; Cl = clay).

Fundamental to understanding the origin of the Boulder Bank is recognizing that these three gravel units have evolved by different physical processes. These different processes can be seen by comparing gravel characteristics in both the shore-perpendicular and shore-parallel directions. Ridge gravels are smaller, better sorted, and less round when compared to their platform counterparts. With distance from Mackay Bluff, rounding improves for both units, but platform gravels become smaller whereas ridge gravels remain the same size (Fig. 4). Geomorphologically, the boulder platform is a wave cut platform which has an erosional-lag surface. The sub-platform gravels are poorly sorted, yet the clasts are generally sub-rounded.

All of the gravels in the beaches of eastern Tasman Bay are generally composed of one rock type, which crops out locally to the beach. The gravels also have a high degree of roundness, and show no directional trends with either roundness or size. However, the Boulder Bank is an exception to these generalities in that the apparent source rock is over 13 km distant and the gravels become slightly rounder and smaller with increasing distance from their apparent source.

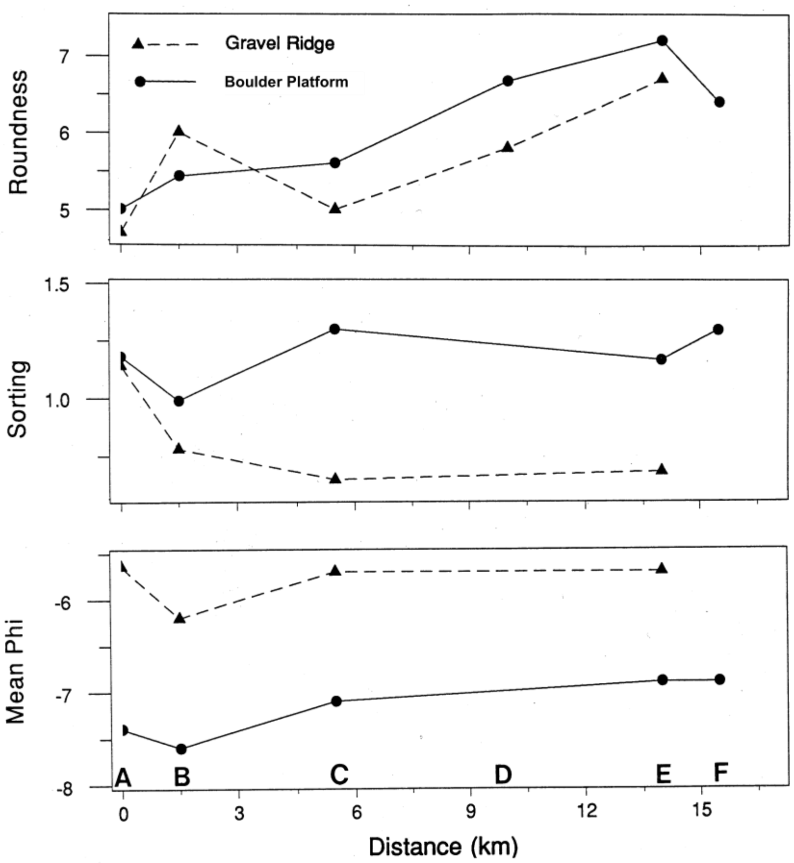


Figure 4 Mean phi size, sorting, and roundness of clasts on the gravel ridge and boulder platform plotted as distance from Mackay Bluff (A). Ridge gravels at profile F are artificial and not shown. See Fig. 2 for location of profiles A-F. Data are from Dickinson & Woolfe, 1997).

Stop 1 Cable Bay

Points to discuss and observe

1) Local geology and geomorphology
2) Rock types and clast roundness
3) Evolution of the bay
4) Terminology: boulder platform, gravel bar, gravel ridge, gravel barrier
5) What would a Tsunami deposit look like in the estuarine muds?

Cable Bay lies just to the northeast of Mackay Bluff and about 5 km from the head of the Boulder Bank (Fig. 1). Its name derives as the site where the first undersea cable (pictured in Fig. 4) from Sydney came ashore in February 1876, making possible direct communication with Australia, Asia and Europe. Geomorphic features of Cable Bay are important because they provide a model to better understand the Boulder Bank.

Unlike the Boulder Bank, the origin of Cable Bay is constrained by local geology and topography. The mouth of the bay is about 700 m wide (Fig. 5). About 1000 m landward from the mouth is a gravel barrier at the head of the bay. This barrier, which has the geomorphological form of a tombolo, separates Cable Bay from Delaware Estuary and connects Pepin Island to the mainland.

The gravel beaches on the northeast and southwest sides of Cable Bay have platforms and ridges, but they are not as distinct as those on the Boulder Bank and Mackay Bluff. All of the clasts on the southwest side of the bay consist of Cable Granodiorite, but those on the northeast consist of both Cable Granodiorite and Pepin Group lithologies. Discontinuous gravel bars, mapped from aerial photographs, extend part way across Cable Bay and can be accessed at low tide (Fig. 5). Shallow pits dug into these bars, show that poorly sorted gravels lie below a thin lag of large cobbles. This erosional lag or armouring is similar to that found on the platform of the Boulder Bank. On the central bar, light grey muds, similar to those found in Delaware Estuary behind the barrier, were cored under this gravel (Fig. 6).

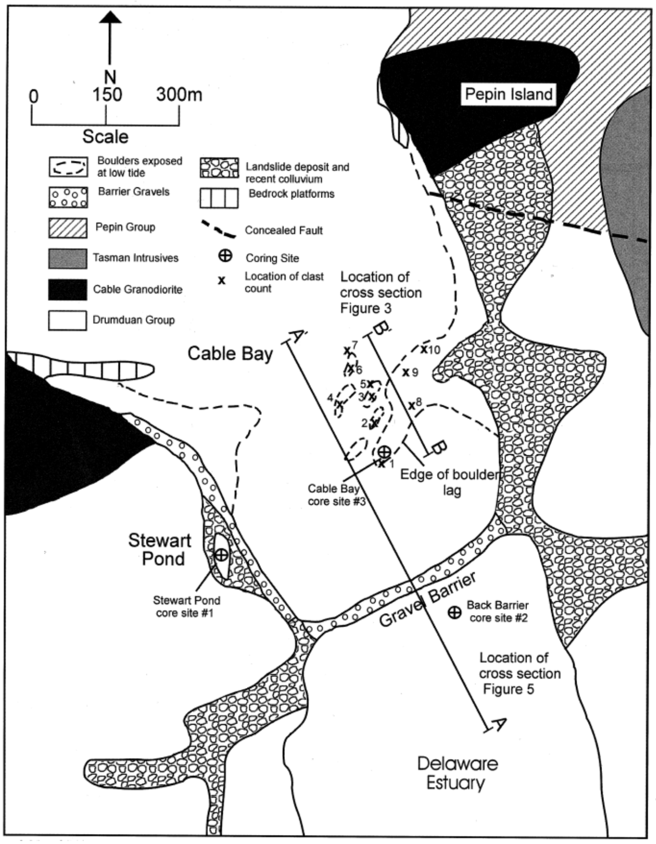


Figure 5 Map of Cable Bay showing the geology (after Johnston 1981; Hartstein 1999) and gravel bars exposed at low tide as visible from a low altitude 1943 aerial photograph.

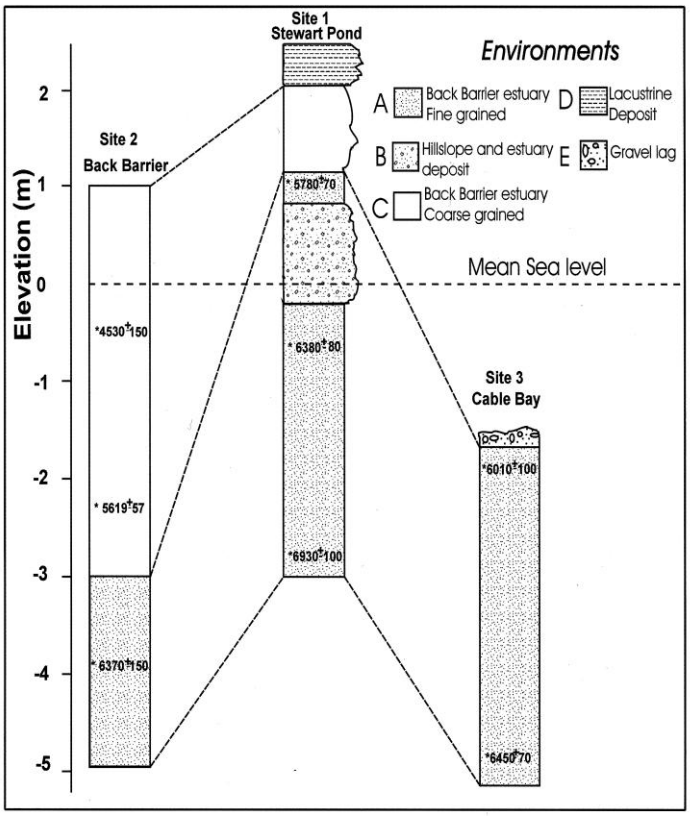


Figure 6 Estuarine mud stratigraphy from 3 cores in Cable Bay. See Fig. 5 for core locations. Calibrated radiocarbon ages from (Hartstein and Dickinson 2000).

The present geomorphology suggests that Cable Bay formed when the Cable Granodiorite, which extends across its mouth, was eroded below sea level (Fig. 7). Prior to this erosion, Mackay Bluff and its gravel beach must have extended across the mouth of Cable Bay to Pepin Island. C-14 dates of shells found in the cores suggest the final breach of the sea from Tasman Bay must have occurred during sea level rise about 8 Ka. Once the Cable Granodiorite was gone from the centre of the bay, the coast transgressed rapidly through the softer Drumduan Group rocks as sea level rose. Large clasts on the former beach were left behind as gravel bars, extending across the bay (Fig. 5). Small cobbles and pebbles from these gravel bars as well as those from the sides of the bay transgressed over estuarine muds to form the present gravel barrier. The estuarine muds were protected by the gravel armour as the sea transgressed.

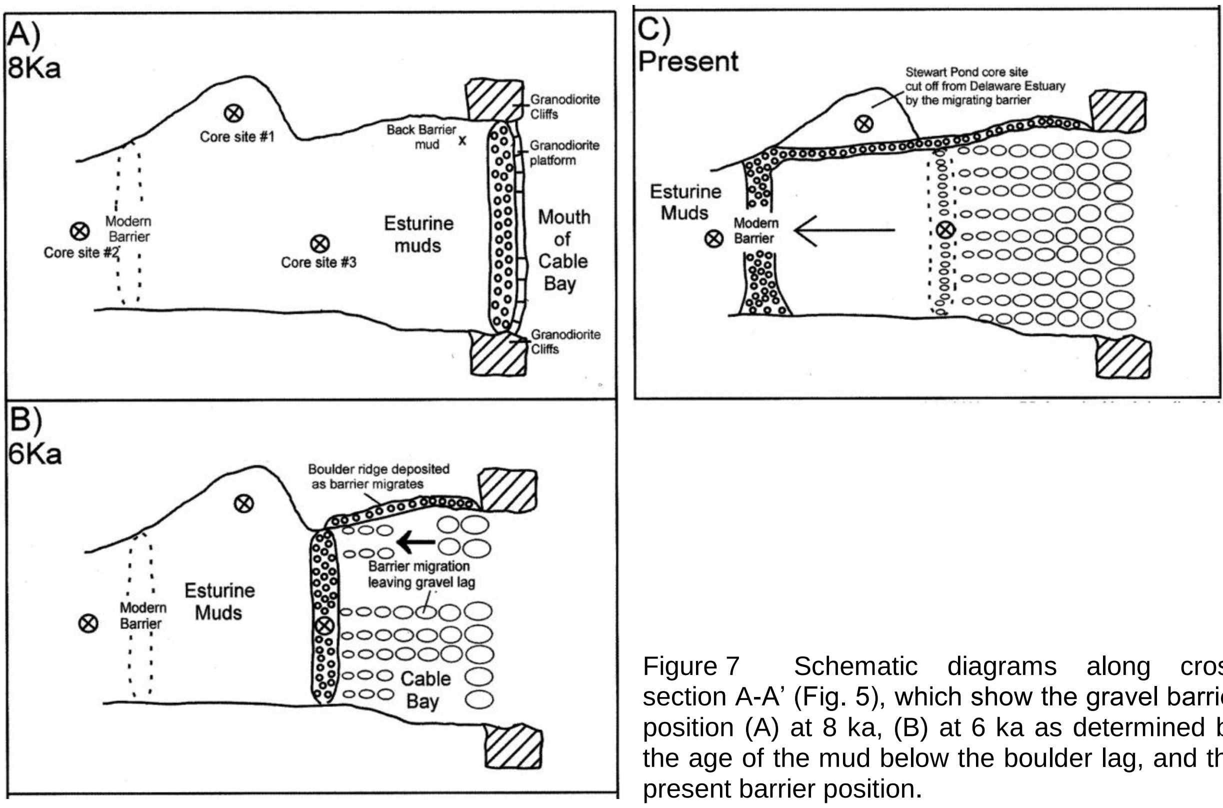


Figure 7 Schematic diagrams along cross section A-A' (Fig. 5), which show the gravel barrier position (A) at 8 ka, (B) at 6 ka as determined by the age of the mud below the boulder lag, and the present barrier position.

Stop 2 Mackay Bluff

Points to discuss and observe

1) Gravel ridge and boulder platform
2) Debris flows and cliff retreat
3) Rock type, clast movement and rounding

Mackay Bluff rises 300 to 400 m at the northeast end of the Boulder Bank. Cable Granodiorite crops out for most of the length along the bluff, but small outcrops of the Drumduan Group and Port Hills Gravel occur near the Boulder Bank (Fig. 2). The Flaxmore Fault runs along the base and just off shore of Mackay Bluff and separates it from the Boulder Bank (Fig. 2). Johnston (1981) rates this fault as Class III, or one that has had little movement in the past 500,000 years and no movement in the past 50,000 years.

Although it has a steeper boulder platform and narrower gravel ridge, the seaward profile (profile A, Fig. 8) along Mackay Bluff is similar to that along the Boulder Bank. The boulder platform and gravel ridge form a continuous beach at the base of Mackay Bluff from the Boulder Bank to the southwest corner of Cable Bay where they pinch out against steep cliffs. Small outcrops of Cable Granodiorite are common on the gravel platform which is littered with large boulders, 1 to 5 m in diameter. The crest of the gravel ridge is generally 5 to 10 m seaward of the cliffs, but in a few places active scree slopes, 10-20 m wide, truncate the ridge. Particles in the scree range from clay to boulders, and many of the large angular blocks have rounded edges and show signs of moderate weathering.

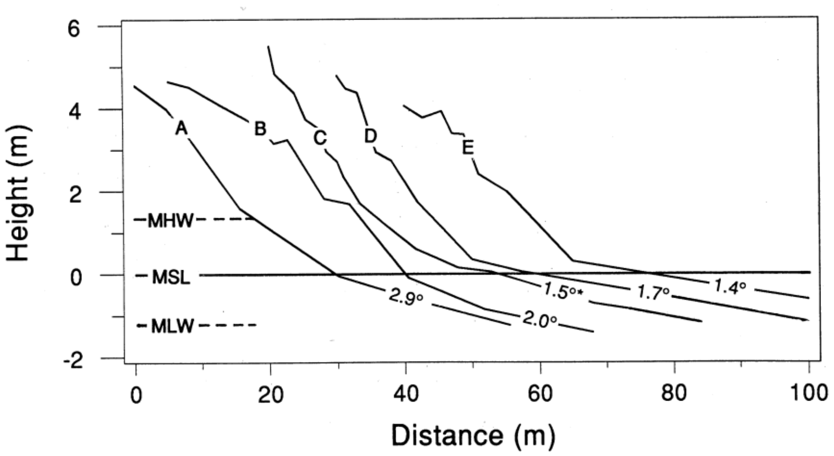


Figure 8 Five seaward profiles along the Boulder Bank measured from the crest of the gravel ridge to low tide in August 1991. Average slopes for the gravel platform are shown and "*" indicates it has probably been modified by mining. Profiles D and E are truncated at their seaward end. See Fig. 2 for profile locations.

Stop 3 Glenhaven Aquaculture Centre

An excellent site for aquaculture lies behind the Boulder Bank. Here the land elevation is below spring high tide, and culture ponds can be filled with fresh seawater at no cost. In addition, seawater quality is excellent because there is no major freshwater inflow nearby and there is little suspended matter in the water during the rare Northerly storms.

Research and development at the centre specializes in the hatching and nursing of mussels, oysters, and paua. This also includes seed production systems, which accommodate the biological needs of the animals. Phytoplankton is used to grow shellfish spat and to condition broodstock.

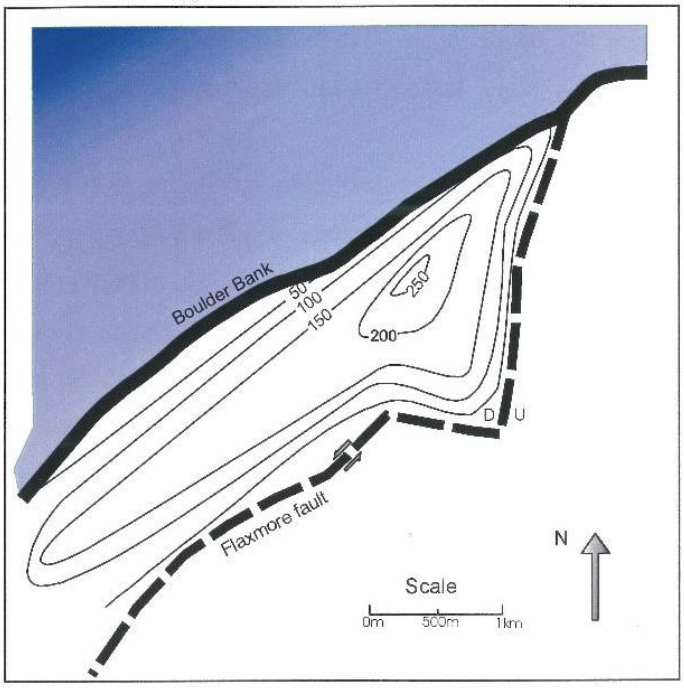
In Feb 2011, the facility was expanded to include an additional 1200 square metres of wet and dry laboratories, offices, educational spaces and workshops to support aquaculture research and commercialisation activities. The Glenhaven Aquaculture Centre provides a shared facility used by Cawthron Institute researchers, industry, and the Nelson Marlborough Institute of Technology for its aquaculture diploma programme.

Stop 4 Schnapper Point at Sewerside Drive

Points to discuss and observe

1) Outfall channel and profile
2) Major bend in direction of Boulder Bank
3) Thickness and age of Nelson Haven muds.

Access to this part of the Boulder Bank was greatly enhanced with the construction of the sewage settling ponds in 1969. At that time an approximate 400 m outfall pipe was laid in a 2-3 m deep trench extending off shore. The design and digging of this trench provided a detailed look at the sub-platform gravels, which extend offshore at this point for at least 400 m. Below mean sea level (MSL), the trench remains open and unfilled with boulders. Near the radio mast at Schnapper Pt. estuarine muds can be found below the boulder platform.



The Nelson Haven estuary is landward of the Boulder Bank. It drains to the southwest, and at low tide, about 60% of it is subaerially exposed. Seismic and gravity data (Richardson 2002) indicate that estuarine muds may be around 250 m thick along Sewerside Drive (Fig.9). Cores to 4 m deep show that the muds are light to dark grey and contain numerous shelly horizons, however, tsunami deposits with clasts and debris were not apparent. Johnson (1981) reports an age of about 7800 years BP (NZA4357) for estuarine fauna lying on top of terrestrial gravels 4.5 m below MSL on the south side of Nelson Haven.

Figure 9 Map shows thickness of estuarine sediments as depth to basement (m) in Nelson Haven. Interpreted (Richardson 2002) from gravity and seismic data.

## Stop 5	Pick up half-day participants at convention centre

## Stop 6	Rocks Rd (State Hwy 6) opposite Arrow (Fifeshire) Rock

Points to discuss and observe

1) Arrow Rx, Magazine Pt. Fm., and Port Hills Gravels
2) Haulashore Isl and end of Boulder Bank gravels

At this stop we will have an excellent view of Arrow Rock and Haulashore Isl, which forms the end of the Boulder Bank and gravels of Cable Bay granodiorite (Fig. 10). Here, we are about 13 km from Mackay bluff! A 300 m sequence of southeast-dipping, graded beds of the Magazine Pt formation is exposed from Arrow Rock to the cliff face on the other side of the highway (Johnston 1979). Macrofossils suggest the formation is Oligocene to Miocene in age (Bruce 1962). Arrow Rock, at the lowest part of the Magazine Pt formation, is a 20 m thick lens of coarse igneous breccia consisting of tonalite, syenite, and fine-grained volcanic clasts. Arrow Rock is thought to represent a channel of coarse debris flow deposits in the turbidity sequence of the Magazine Pt formation (Bruce 1962).

The Port Hills Gravel lies unconformably on the Magazine Pt formation. These gravels are 0.1 – 0.8 m in diameter and consist of granites, granodiorites, tonalites and fine-grained volcanics (Johnston 1979). The variety and size of these gravels excludes them as a source for the Boulder Bank.

Most of the ridge gravels on Haulashore Isl were deposited ca. 1905 as spoil from the initial dredging of the Cut, which is the man-made entrance to Port Nelson. Prior to this entrance, ships had to navigate the ‘narrows’ passage at high tide between Arrow Rock and Haulashore Island to reach the Port. Of particular interest at this stop is to note the abrupt terminations of the Magazine Pt formation and Haulashore Island clasts on each side of this passage. No clasts of Cable Bay Granodiorite have been found southeast of Haulashore Island. If boulders from Haulashore Island were deposited by longshore drift, it is not clear why they were not also deposited along the shore at Magazine Pt.

Figure 10	View of the ‘Narrows’ between Arrow Rock and Haulashore Island from above Stop 6.

Stop 7 Lighthouse

Points to discuss and observe

1) Progradation and source of ridge gravels
2) Change in clast parameters along the Boulder Bank
3) Boulder platform and sub-platform gravels (exposed in shallow pit)
4) Extensive area and depth of the sub-platform gravels

After a short ferry ride from Wakefield Quay, we arrive at the Lighthouse, which was commissioned in 1862. At that time, it was built on the southwestern tip of the gravel ridge, which progrades over the boulder platform (Fig.11). Especially prominent on the ridge gravels near the lighthouse are the recurved ridges and swales. These are remnants of successive storm events as the gravel ridge elongated, and represent the best evidence for longshore transport of these gravels. Southwestward along the Boulder Bank, the ridge gravels show little change in size but increase in roundness (Fig. 4). Between 1850 and 1943 the gravel ridge extended south westward at 7 m /yr and from 1950 to 1965 at a rate of 30 m/yr. Ridge gravels near The Cut were deposited mostly as spoil from deepening and widening of the shipping lane since 1905 (Fig. 11).

Southwestward along the Boulder Bank, clasts on the boulder platform show little change in sorting and a small decrease in size, however, like the ridge gravels, they increase in roundness (Fig. 4). Seaward slopes for the boulder platform decrease from about 3° at Mackay Bluff to 1.5° at Haulashore Island (Fig. 8). The bathymetric map suggests the boulder platform extends seaward (1000m to 300 m) to a break in slope. Observations from diving confirms this break is where Tasman Bay muds cover the platform gravels.

Recent dredging of The Cut (Johnston, 2001) have found that the sub-platform gravels extend at lease 10m deep and 1000 m seaward of the gravel ridge. Extremely large boulders have been recovered from previous dredgings (pictured above) of the sub-platform gravels. Two shells in the sub-platform gravels dredged at c. 10 m below MSL in The Cut gave calibrated ages of 7461 and 7255 years BP (NZA11596 & 11597; Johnston, 2001), while a worm tube on a clast from a 1 m deep pit gave 5165 years BP (NZA3217; Dickinson & Woolfe, 1997). These ages suggest that some of the platform gravels transgressed during Holocene sea level rise.

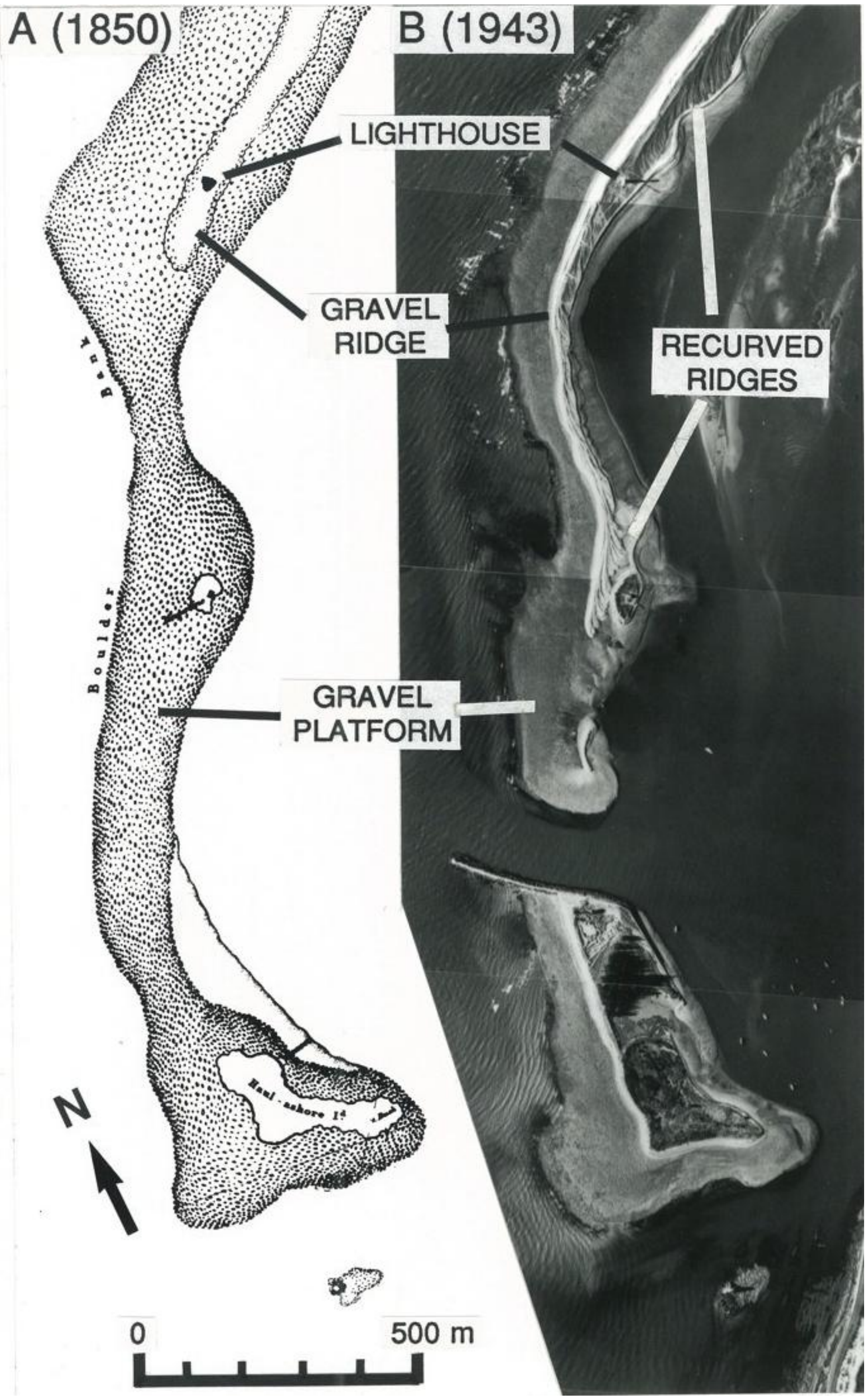


Figure 11 Nelson Harbour map at mean low water of Stokes (1850) shows the gravel platform supporting a gravel ridge which ends about 160 m southwest of the light-house built in 1862. Photograph (1943) at low tide shows the gravel ridge extended 650 m farther along the gravel platform since 1850. Dredged gravels from the harbor entrance were dumped on Haulashore Island from 1903-1906. The 1850 map courtesy Turnbull Library, NZ; the 1943 photo courtesy RNZAF.

Summary and Synthesis of Observations

Longshore drift as a mechanism for the origin of the Boulder Bank may be summarized into pros and cons below:

Pro:
1) Point source of material and no outcrop of Cable Bay granodiorite elsewhere.
2) Wave transport of gravels on the ridge.
3) Particle rounding and decrease in size of platform gravels (note that both of these observations do not necessarily result from longshore drift. Also, accurate particle size analysis of the sub-platform gravels is not possible without using tonnes of material).

Con:
1) Sub-platform gravels: extensive deposit of poorly sorted material.
2) Low slope of the boulder platform which is an erosional surface (non mobile).
3) Low energy environment of Tasman Bay and extreme size of some boulders.
4) Abrupt termination of particles at Haulashore Island.

Dickinson and Woolfe (1997) argue that the origin of the Boulder Bank is tied to the origin of the sub-platform gravels. These gravels are thick (> 10m) and extensive (1 x 13 km). The surface of these gravels is a wave-cut erosional lag of boulders, which we call the boulder platform. Clearly, this wave-cut surface is the substrate for the mobile gravel ridge (Fig. 11). Thus, the sub-platform gravels had to exist before the gravel ridge. If one accepts this reasoning then the mobile gravels of the ridge derive from the sub-platform gravels. Either storm erosion or mining of the boulder platform could remove its protective armour of boulders and release the smaller material of the sub-platform gravels for deposition on the gravel ridge.

Johnston (2001) argues that the 'base course' (boulder platform and sub-platform gravels) is a product of storm and tsunami deposition during the last interglacial stand of high sea level. This view maintains that both the base course and 'top course' derive from Mackay bluff by longshore drift. Large boulders are 'rafted' on the smaller clasts along the top course by waves. The base course represents a remnant of an older boulder bank whereas the top course is mostly a product of Holocene stationary sea level.

The origin of the poorly sorted sub-platform gravels remains unresolved. Deposition by longshore drift should produce well sorted deposits, but the poor sorting of these gravels suggests debris flow deposition similar to that at the base of Mackay Bluff. Although other boulder platforms in eastern Tasman Bay are associated with bedrock outcrops, remnants of resistant Cable Bay granodiorite are not apparent along the length of the Nelson Boulder Bank. However, an important feature in Cable Bay (Fig. 5) is that the gravel bars in the middle of the bay lie 300 to 400 m landward from the granodiorite. Seismic imaging of the sub-platform gravels has not been successful, and proof of a granodiorite bedrock 500 to 1000 m seaward of the Boulder Bank must wait for shallow offshore drilling.

Unresolved problems of the Nelson Boulder Bank

1) Origin of the sub-platform gravels: modified longshore drift or in situ erosion
2) Controls on the slope of the wave cut boulder platform
3) Cause of kinks in the boulder platform: topography, outcrop, wave currents

Human History of the Nelson Boulder Bank

Maori

Maori tradition and legends provide some colourful accounts about how the Boulder Bank was created. Early Maori used the Boulder Bank as a seasonal base for the gathering of kai. This included birds and birds' eggs from the Bank itself, and also seafood from Nelson Haven and Tasman Bay. It also provided a base for harvesting resources from the wetland and lowland coastal forest which used to lie at the head of the Haven. Waihi Creek at the Glen provided fresh water and land was utilised close by which could be cultivated and planted on one visit and harvested the next. Maori from the Nelson region used the Boulder Bank in this way, but it is also suggested they came from much further afield.

Maori also carried boulders from the Boulder Bank up to the argillite quarries along the Whangamoa mineral belt, and used them as hammerstones to break off chunks of argillite and roughly shape these into tools and other implements. The finishing off work was typically done back at camp, before these goods were traded around New Zealand.

European Discovery

Karen Warren (Warren 2009) reveals the events that led up to the "discovery" of the Boulder Bank by Europeans and the subsequent decision by Captain Wakefield to establish the new colony of Nelson on the shores of Nelson Haven. Prior to this, it was highly likely that Nelson would have put down its roots in a different location altogether – one for which a tentative subdivision plan had already been drawn up – but the sheltered harbour provided by the Boulder Bank made the difference.

Old Harbour Entrance

The entrance to Nelson Haven at the time of discovery by Europeans was between the two coastal features now known as Haulashore Island and Fifeshire Rock. This was called "the Narrows" on account of the narrow and tortuous stretch of water that vessels were forced to navigate. Safe passage was absolutely dependent on tide, swell and weather conditions. Having a pilot on board was very strongly recommended but records show that that a large number of vessels still got into difficulties.
Towards the end of the 19th century, a significant change in the course of eastern outlet of the Waimea River at Tahunanui, compounded by shifting sandbanks, led to the Narrows becoming less and less accessible to shipping. Debate raged over how to overcome the problem and finally led to a new passage being dredged through the entire width of the Boulder Bank, commencing in 1903. This was to the north of Haulashore Island and was, and still is, known as the "Cut".

The Cut

The Cut proved a very difficult passage to dredge but it was officially opened in 1906. It was much narrower and shallower than originally envisaged in the plans at the turn of the 19th century but pressure for a better harbour entrance to be operational was fierce. It required many more years of dredging to become fully accessible to all kinds of vessels.

Haulashore Island

This island got its name from the early days of Nelson's settlement by Europeans. The Maori name for the island is Manuka. The early settlers used the island for hauling vessels up for repair and maintenance. The first time it was used in this way was for the Whitby, one of Captain Wakefield's ships, which grounded in its first attempt to enter Nelson Haven in November 1841.

There were a number of schemes to develop a fully fledged slipway on Haulashore Island, but none got off the ground. Cannons were installed on the island as part of Nelson's early defence system. The entire island is now a council-owned reserve.

Powder Magazines

A powder magazine was erected by the early colonists near the southern end of the Boulder Bank in 1843. This was soon removed but another erected in 1873. A third and private magazine was also installed a little further north. Only the remains of the 1873 magazine are now visible. The area where the first magazine was built was known as "Magazine Island" as at high tides this part of the Bank was an island. This is no longer the case.

Lighthouse

The Boulder Bank lighthouse was commissioned in Aug 1862 and became the second permanent lighthouse in New Zealand. At its decommissioning in 1982, it was the longest operating lighthouse in New Zealand and remains a reminder of the importance of marine transport to the early colonial settlement of Nelson. There are many interesting stories told of the lives of the lighthouse keepers who lived there until 1916, many from the family of John Kidson, who served as keeper for an extraordinary 27 years.

Baches

There are currently six baches on the Boulder Bank but there were more than this at one time, certainly eight and possibly nine. Some of the existing baches are very old, and were likely started by fishermen who used to tar their nets on the boulders, and needed somewhere to stay overnight while their nets were drying. There is evidence of the haphazard construction of these structures, for example four-gallon kerosene tins filled with boulders stacked one on top of the other to make the walls. There is on-going debate with the Department of Conservation over the long-term tenancy of these baches on the Bank.

Uses

The Boulder Bank has been put to a wide range of uses over the years. The historical extraction of boulders is the most well-known. The boulders were crushed and used as the basecourse for many of Nelson's early roads. However, the Bank was also used for other purposes, e.g. as a site for shooting practice by the early "City Rifles". Ambitious proposals were also advanced from time to time, e.g. a proposal in 1899 to construct a fully formed coastal promenade along its length.

Future Management

Although the Bank appears a robust structure, it is still vulnerable to damage. Vandalism, by the illegal taking of boulders (possibly raising the potential for a breach), 4-wheel drive vehicles driving over and around vehicle barriers (destroying the profile of the Bank, crushing birds' nests etc.) and the dumping of rubbish, all have an adverse impact. The Bank is a landform significant on a global scale, provides a habitat for nationally threatened birds and continues to play an integral role in the city of Nelson.

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