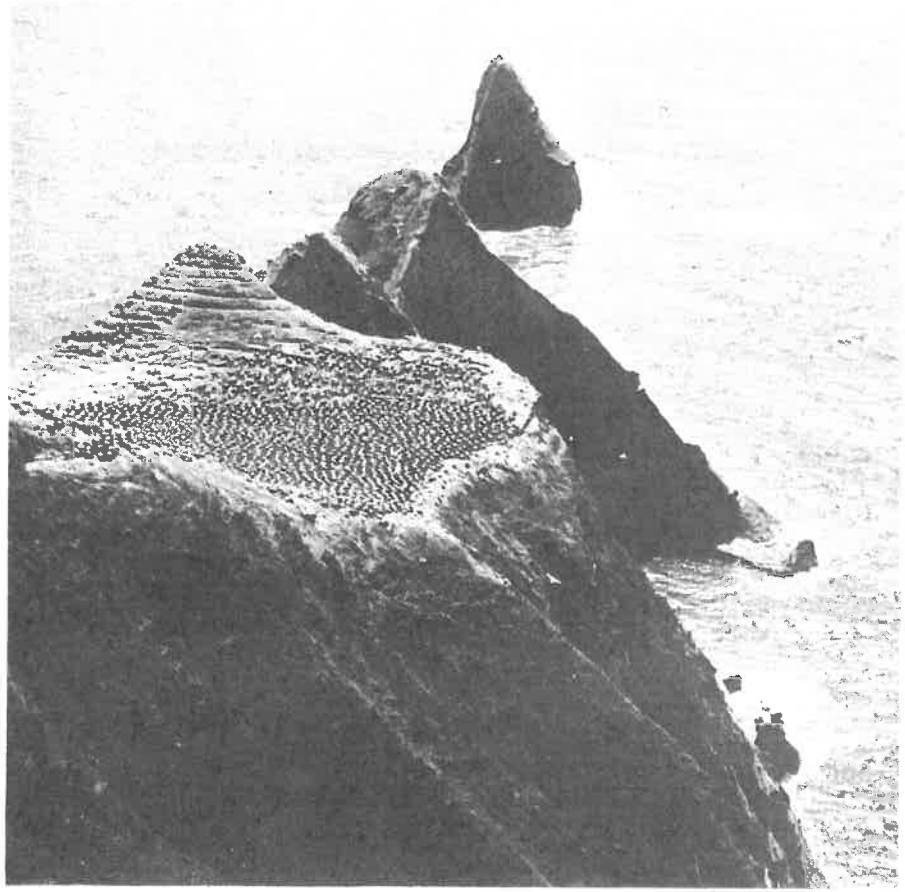
GEOLOGY AND FOSSILS

OF THE

CAPE KIDNAPPERS

AREA



GEOLOGY AND FOSSILS OF THE CAPE KIDNAPPERS AREA

by

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INTRODUCTION

During a walk along the beach from Clifton to Cape Kidnappers you have an excellent opportunity to see exposed in the cliffs the sorts of rocks that underlie coastal Hawkes Bay, some of the fossil shells that can be found in them, and evidence of some of the geological events that formed the present land around the bay. This booklet sets out to explain the general geology of the cliff section from Clifton to the Cape and its relationship to the geology of the nearby countryside, so that you can understand some of the geological features during your walk.

GENERAL GEOLOGY OF NEARBY SOUTHERN HAWKES BAY

Apart from young river gravels, all the rocks forming the coastal area of Hawkes Bay were deposited under the sea during the last five million years, so that in geological terms they are very young indeed. The rocks record the latest details of the long history of formation and gradual raising of New Zealand, a small oceanic landmass which lies along the actively moving junction of two major sections of the earth's crust.

If you study the sequence of rocks underlying the countryside from, say, Waimarama Beach through Te Mata Peak and the Te Aute hills (Raukawa Range) to Maraekakaho (see Figure 1), you find from the ages indicated by the fossils in them that there were no long interruptions in the deposition of sediments in the area, and almost all of the last 4 or 5 million years are represented by rocks containing fossils. In the entire area on the eastern edge of the Hawkes Bay plains from Napier south-west to at least Takapau, the rocks are tilted gently down to the north-west, so that they get progressively younger from east to west (see Figure 2). In the east of the section, near Waimarama Beach, the oldest rock is a fine-grained, firm, pale bluish-grey siltstone with rather sparse fossils, laid down 4 to 5 million years ago in water 100 to 200 m deep. Within the siltstone are bands of calcareous concretions formed by deposition of lime from solution. The siltstone is overlain by a thick succession of limestone beds which were deposited in shallow water. In the east near Waimarama the limestone is pale grey and very hard, and as you move west the limestone gradually becomes softer and more yellow. The limestone is made of broken shells, mainly barnacles, and a few whole shells of large fan shells and oysters. These fossil fan shells show that the limestone is about 3 - 4 million years old near Waimarama, about 1.8 to 3 million years old from about the Maraetotara Road, through Te Mata Peak, to the Te Aute hills, and about 1.8 - 1.0 million years old in the hills between the Raukawa Range and Maraekakaho. In the Maraekakaho area a thick succession of limestone and siltstone beds 1.0 - 1.8 million years old is overlain by shallow-water gravel, silt and pumice beds and some beds of fresh

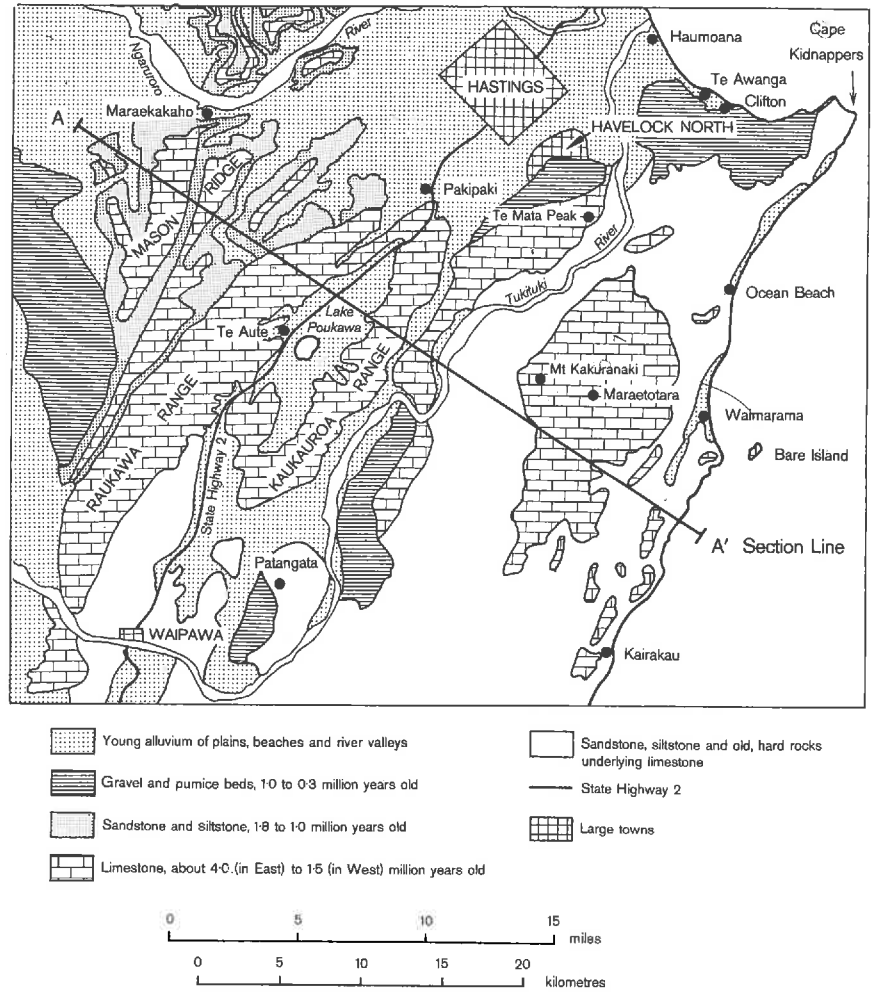

Figure 1 - Geological map of part of central Hawkes Bay, to show the generalised geology of the area near Cape Kidnappers.

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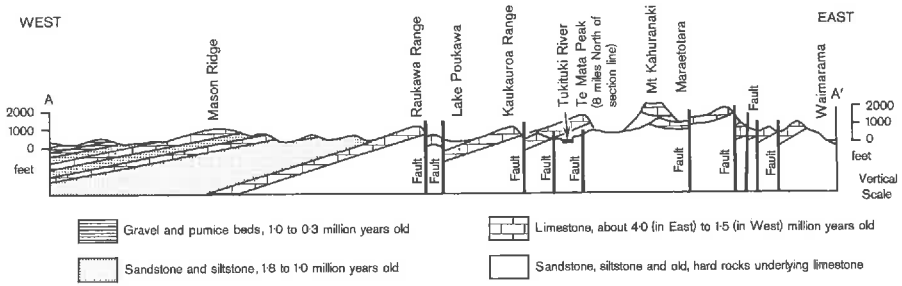


SKETCH OF SECTION A–A', TO SAME SCALE AS MAP (young alluvium ignored)

Figure 2 - Cross section through the geological map shown in Figure 1. Rocks have the same symbols in Figure 2 as in Figure 1. Vertical scale is four times the horizontal scale.

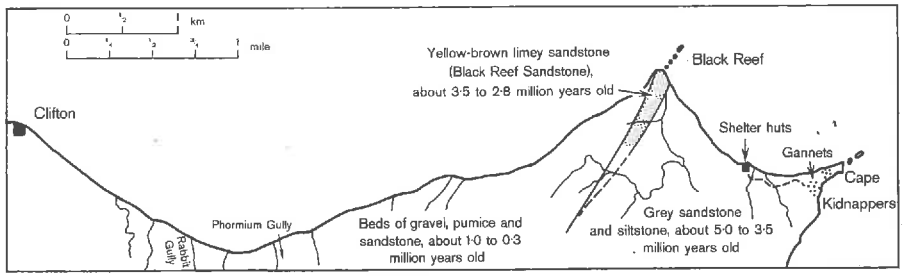


Figure 3 - Map of Clifton - Cape Kidnappers coastline, showing localities and main rock types.

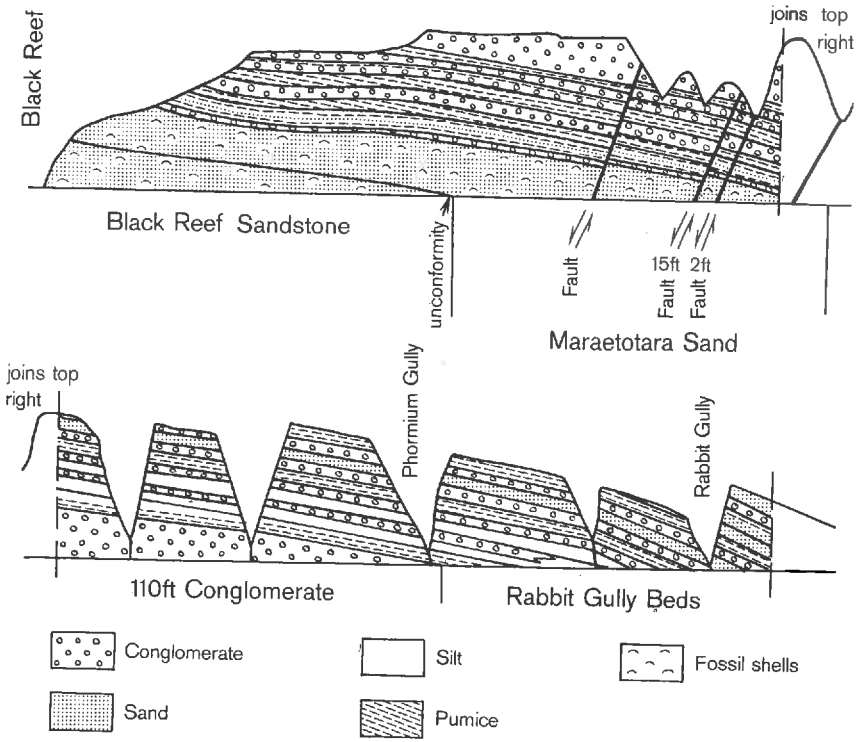
water gravel about 1 million to 400,000 years old. Throughout the whole district, river valleys and hill tops are capped by very young river gravels which were laid down as the major rivers built up gravel fans and plains from debris supplied by erosion of the gradually rising land, and especially the RuahineRange.

GEOLOGY OF KIDNAPPERS AREA

The cliff section between Clifton and Cape Kidnappers is similar to the one described for the area between Waimarama and Maraekakaho, except that the middle part of the inland section is missing on the coast. A map (Figure 3) shows where the main types of rock occur in the cliffs between Clifton and Cape Kidnappers.

From Clifton almost to Black Reef the cliffs are composed of sandstone, gravel, pumice and silt beds, about 300,000 years old in the west near Clifton and about 1 million years old in the east near Black Reef. A sketch of the cliffs between Clifton and Black Reef (Figure 5) shows the types of rocks which occur in the cliffs, the names given to the groups of beds, and the positions of small breaks in the rock, known as faults, where the beds are offset by a few feet, probably because of compaction and settling of the rock. The beds were deposited in very shallow water and consist of gravel deposited in river beds and estuaries, thin peat beds with fossil leaves and even tree trunks, thick beds of white pumice, and a few beds of very shallow marine bluish-grey sand and silt containing sparse fossil shells. Figure 4 is a photo of the dark gravel and white pumice beds in the cliff near Black Reef. Hard gravel beds, or other rocks made up largely of pebbles, are known to geologists as "conglomerate", and a rock made up of fine-grained pumice is called a "tuff". The lowest bed in this sequence of young

Figure 4 - Pumice (light) and gravel (dark) about 800,000 years old, looking towards Clifton from Black Reef.



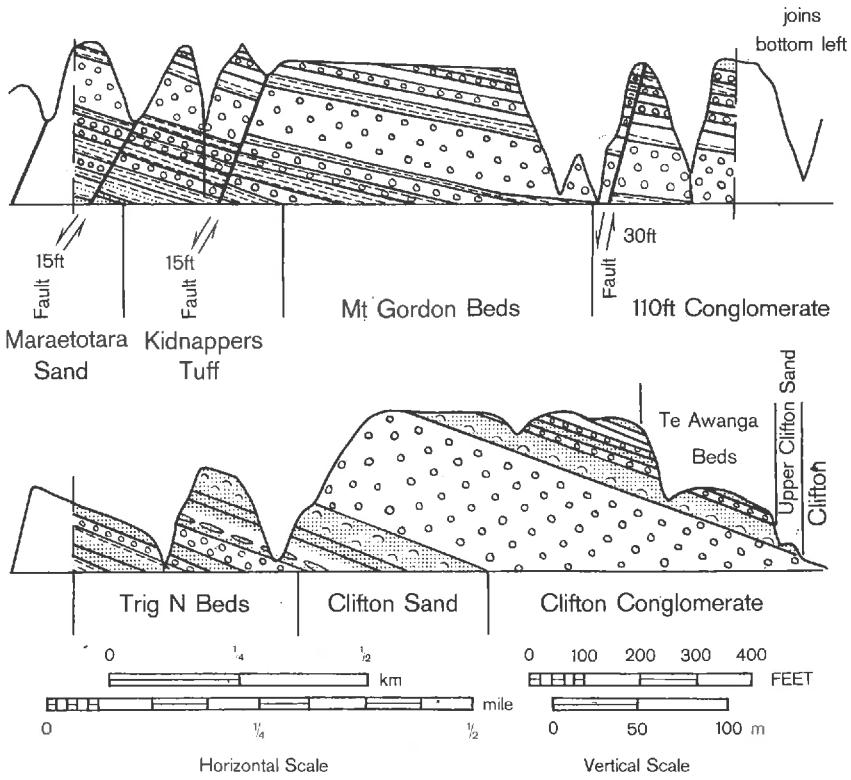


Figure 5 - (two facing pages) - Sketch of cliff section between Clifton and Black Reef, showing the main rock types which can be seen, the names of the groups of beds, and the positions of faults, in rocks about 300,000 to 1 million years old.

rocks, immediately above the hard sandstone forming Black Reef, is a fossiliferous sandstone bed called the Maraetotara Sand, containing more numerous fossil shells than are in the higher beds in the section. The numerous shells show that the Maraetotara Sand was deposited in slightly deeper water than the younger beds further towards Clifton, probably in water 10 to 20 m deep off a gently shelving sandy beach. The base of the Maraetotara Sand is marked by an especially rich, thin bed of shells.

Below the Maraetotara Sand a clear line in the cliffs marks a sharp

break in deposition, and the rest of the rocks forming the base of the cliffs from Black Reef to Cape Kidnappers are about 2.5 million years old and older, becoming progressively older towards the Cape. The Maraetotara Sand rests on a hard, pale yellowish brown, limey sandstone with common large fossil fan, or scallop shells, about 2.5 to 3.0 million years old, called the Black Reef Sandstone. The sandstone resists erosion and so extends out to sea as Black Reef, and also forms the base of the cliff towards Clifton, descending to beach level for about a kilometre before reaching Black Reef itself.

On the southeast side of Black Reef you can see the Black Reef Sandstone merging gradually down into a thick bed of soft, grey, richly fossiliferous sandstone which extends almost to the shelter huts, and forms low outcrops on the beach southeast of Black Reef when the tide is well out. The sandstone is about 3 to 4 million years old, and contains many more fossil shells than any of the other beds in the district. The shells show that the sandstone was deposited on the inner part of the continental shelf, in about 20 to 50 m deep. To judge from its age, the grey sandstone was deposited out to sea at the same time as the earliest bed of limestone in the sequence near Waimarama, was being deposited in shallower water nearby.

Figure 6 - View from the air inland from Black Reef, showing blocks of Black Reef Sandstone with gannets nesting on them in the foreground, old raised marine benches in the middle distance, and young terraces in the centre which were cut by the stream flowing out of the cliffs to the east of Black Reef.

Figure 7 - View from Black Reef to Cape Kidnappers, showing cliffs and islets of siltstone about 4 million years old in the background and blocks of Black Reef Sandstone in the foreground. The shelter huts are in the trees at the right, and the track to the main gannet colony can be seen rising behind the trees. The flat surface on the sky line is an old marine bench.

From just northwest of the shelter huts to Cape Kidnappers (see Figure 3) and for some distance south, the cliffs consist of fine-grained, firm pale bluish grey siltstone ("papa") with scattered fossils and bands of concretions (Figure 9), about 4 to 5 million years old, the same as the oldest rocks in the section from Waimarama to Maraekakaho. The scattered shells lived in deeper water than those in any other rocks in the district, and show that the siltstone was deposited well off shore on the continental shelf.

Figure 8 - Cliff section about 200 metres east of Black Reef, showing (1) charcoal-rich soil with midden shells, (2) screeslope debris from the cliff behind, (3) young raised beach deposits with shells, lying on (4) fossiliferous sandstone about 3.5 million years old.

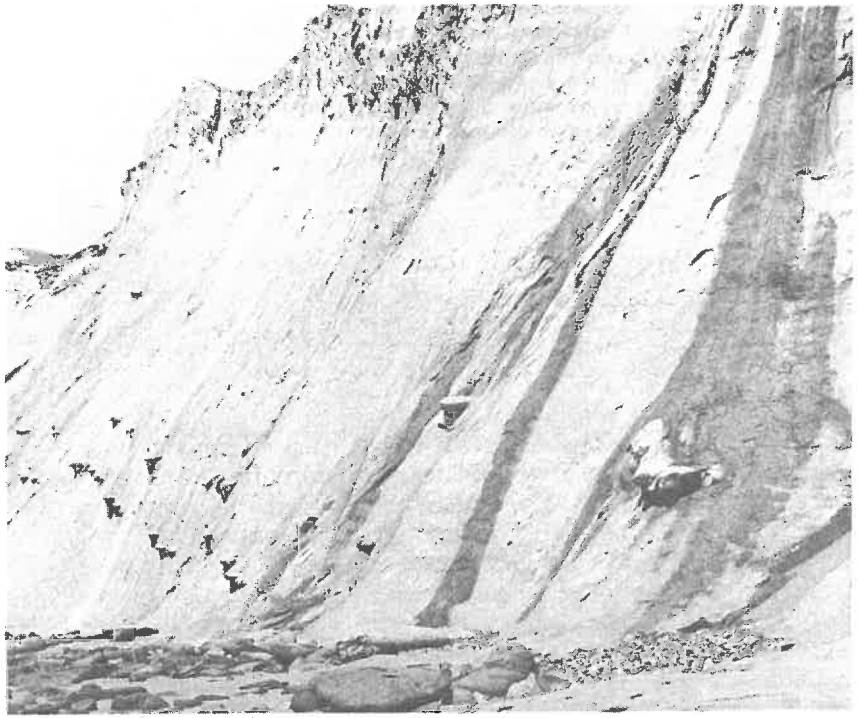


Figure 9 - Cliffs of siltstone about 4 million years old, between the shelter huts and Cape Kidnappers, showing bands of concretions sloping down towards the foreground.

The flat surfaces at the tops of hills and cliffs in the area between Clifton and Cape Kidnappers were carved by the sea to form a series of benches while the area was being uplifted, and young thin gravel deposits cover most of them. The high benches show up well in oblique air photos (Figure 6). The shelter huts are built on a small remnant of a low, very young, raised marine bench, also visible in the cliff face at Black Reef, and estimated to be a few thousand years old. On the beach in front of the shelter huts, shells can be collected from raised beach deposits covering this youngest bench. Large, hard pumiceous boulders weathering out of the raised beach deposits have been bored shortly after deposition by a piddock, or rock-boring bivalve, belonging to a species with finer sculpture than the similar living borer *Pholadidea suteri*. The rock-borers are the youngest true fossils that can be collected in the area.

SIGNIFICANCE OF THE BREAK IN DEPOSITION ABOVE THE BLACK REEF SANDSTONE

Compared with the complete geological section seen between Waimarama and Maraekakaho, the section between Cape Kidnappers and Clifton is very incomplete. The sharp line in the cliffs where fossiliferous

rock about 1 million years old and younger rests on the 2.5 to 3 million year old Black Reef Sandstone represents a long break in deposition. The rocks about 1 to 2.5 million years old seen in complete sections nearby in Hawkes Bay have been eroded away by the sea after they were deposited. The plane in the rocks where this break occurs is called an unconformity. The unconformity vanishes south-westwards towards Te Mata Peak and Pakipaki, and this shows that the Cape Kidnappers area has probably been at about the site of the southern headland of Hawke Bay for something like the last million years. The whole sequence of marine limestone, sandstone and siltstone about 1 to 4 million years old on both sides of the Hawkes Bay plains, was deposited on the edges of a seaway. This originally ran across the present site of the Ruahine Range from the Manawatu Gorge to the Napier - Taihape Road, and out to deeper water in Hawke Bay, and from about 1.0 to 1.8 million years ago, it ran from the Manawatu Gorge to Hawke Bay. Approximate positions of land and sea at this time are shown in Figure 10. Probably the currents running through this gradually narrowing seaway eroded away the soft young rocks but were unable to erode away the hard thick Waitotaran limestone mass of the Waimarama - Te Mata Peak area after it was elevated, and thereafter the seaway was forced to pass around the end of the limestone mass.

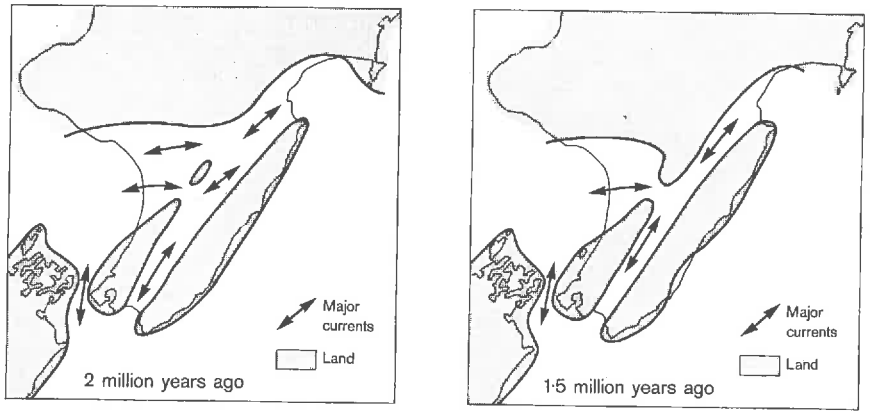


Figure 10 - Approximate positions of land and sea 1.5 and 2.0 million years ago, superimposed on outlines of present land. Major current directions shown in seaways where rocks were deposited which presently underlie parts of Hawkes Bay, Wanganui and Wairarapa.

ORIGIN OF THE PEBBLES IN THE GRAVELS

Very obvious in the cliffs between Black Reef and Clifton are the thick, white beds of pumice that are interbedded with the darker gravel, and these can be seen clearly from a great distance. (See Figure 4) The gravel consists mainly of river pebbles of old, very hard, dark grey sandstone carried down from the axial ranges such as the Ruahine and Kaweka ranges. However, there are a few pebbles in some beds which

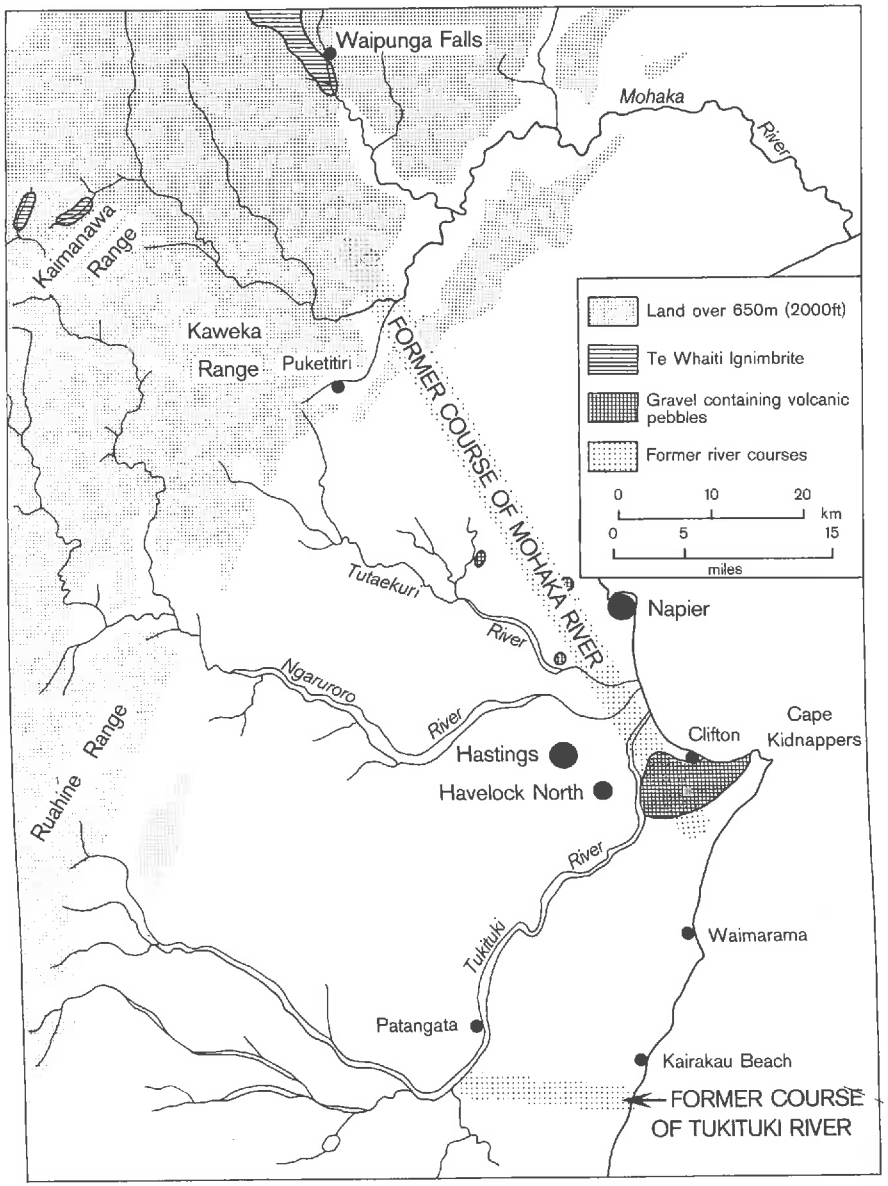


Figure 11 - Map of part of central and northern Hawkes Bay, showing the inland ranges, the distribution of volcanic rocks in the ranges and of gravels on the plains that bear pebbles of volcanic rock, the present courses of major rivers, and the approximate former courses of the Mohaka and Tukituki Rivers.

are from nearer sources and therefore show the directions in which the rivers must have been flowing to carry the pebbles.

All the gravel beds overlying the Maraetotara Sand and underlying the Rabbit Gully beds to the east contain pebbles of a volcanic rock, ignimbrite, similar in composition to the Te Whaiti Ignimbrite found at Waipunga Falls in the headwaters of the Mohaka River. Distribution of Te Whaiti Ignimbrite and positions of old river courses are shown in Figure 11. West of Rabbit Gully a thick sequence of estuarine silt and sand beds with the cockle *Chione* underlies gravel beds which contain no volcanic rock, but have pebbles of a hard, white, siliceous rock about 70 million years old (Whangai Argillite) which, in this area, is presently carried only by the Tukituki River.

The thick white beds consist largely of pumice, but include a few pebbles of hard volcanic rocks from the central volcanic plateau, in the Rotorua - Taupo area. These must have been carried down by a large river as floods of pumice, immediately after major eruptions in the volcanic region. The oldest pumice bed, near Black Reef, is 920,000 years old, and the youngest bed of pure pumice at Rabbit Gully is 300,000 years old. The hard volcanic rock found in these beds is very like the Te Whaiti Ignimbrite, which was formed by a "glowing cloud" eruption of pumice-like rock which was still hot enough to weld together when it stopped flowing.

Although there are small quantities of this ignimbrite in a few valley bottoms in the Kaimanawa Range in the headwaters of the Ngaruroro River, the amount of ignimbrite found in the Kidnappers section is so great that it must have come down a river draining from the main area of ignimbrite, in the headwaters of the Mohaka River, rather than down the Ngaruroro River. Isolated remnants of river gravel containing ignimbrite have been found at several places between the Kidnappers area and the main northward bend of the Mohaka River near Puketitiri, so that the Mohaka River probably carried most of the volcanic pebbles into the Kidnappers area which are found below the Rabbit Gully beds. Below the Rabbit Gully beds there are no pebbles of the hard, white Whangai Argillite, and apparently the Tukituki River did not flow into the Kidnappers area at that time, but flowed eastwards from Patangata to the coast south of Kairakau through a broadly open valley presently occupied by small streams and oxbow lakes (see Figure 11).

The fine-grained Rabbit Gully beds seem to have been laid down about a quarter of a million years ago during a period of major reorganisation of drainage, when both the Tukituki and Mohaka rivers abandoned their old courses to flow out to sea further north.

FOSSILS OF THE KIDNAPPERS AREA

The main fossils you can collect from the Cape Kidnappers area are illustrated in Figure 12, and are from oldest to youngest:

1. Scattered univalve shells about 4 to 5 million years old in the

siltstone cliffs between the shelter huts and the Cape. The most common species is *Hartungia postulata*, a member of a surface-floating family of "violet snails". All specimens have been slightly crushed during compaction of the siltstone.

2. Common univalves and sparse bivalves about 3 to 4 million years old in the grey sandstone east of Black Reef and west of the shelter huts. These comprise one of the most varied and interesting shell faunas of this age known in New Zealand, but the shells are extremely soft and fragile and must be collected with great care.

3. Common large fan shells, some still unnamed, in the Black Reef Sandstone to the south-west of Black Reef. The most common is *Phialopecten marwicki*, which can be easily collected if you have a geologist's hammer, or a hammer and a screwdriver or cold chisel.

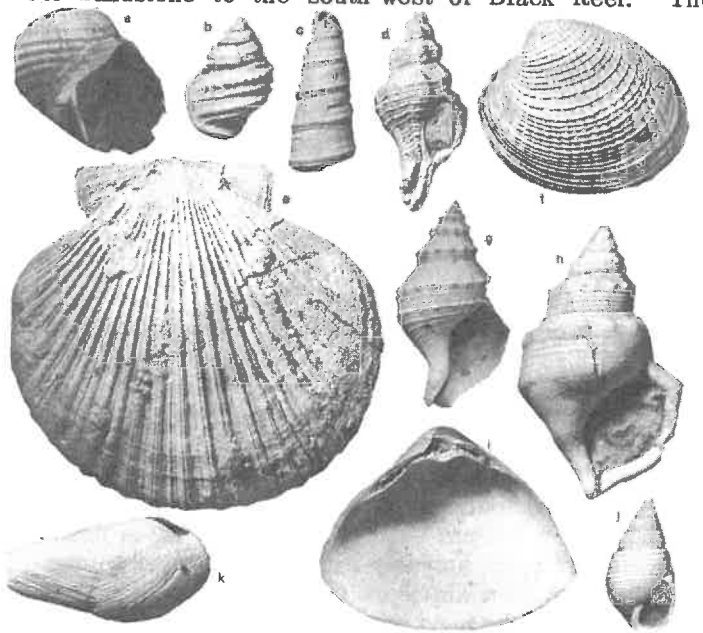


Figure 12 - Fossil shells from the Kidnappers area.

a. Hartungia postulata, a univalve from siltstone about 4 million years old near the Cape; b. Struthiolaria parva, c. Zeacolpus Opoitius, and d. Murexsul espinosus, univalves from sandstones about 3.5 million years old between the shelter huts and Black Reef; e. Phialopecten marwicki, a large fan or scallop shell from the Black Reef Sandstone, about 3 million years old; f. Chione stutchburyi, g. Austrofusus glans, h. Struthiolaria papulosa, i. Spisula aequilateralis, and j. Leucotina ambigua, bivalves and univalves from the Maraetotara Sand, about 1 million years old (Chione occurs also in silt beds higher in the section, near Clifton); k. Pholadidea suteri, a rock-boring bivalve from very young raised beach deposits at the shelter huts. (All pictures are about natural size except e, g and h, which are reduced to about two-thirds of their natural size).

4. Shells about 300,000 to 1 million years old from the sands and silts between Black Reef and Clifton. The Maraetotara Sand, overlying the Black Reef Sandstone, has a long list of over 100 species of shells (recorded in Dr J.T. Kingma's bulletin on the geology of this part of Hawkes Bay; see reading list at end of this booklet) that are nearly all very similar to shells living around New Zealand at present. Most common are: *Perna canaliculus* (green mussel), *Ostrea lutaria* (oyster), *Mesodesma subtriangulatum* (tuatua), the common surf trough shells *Mactra discors*, *Maorimactra acuminella*, *Spisula aequilateralis* and *Zenatia acinaces*, the common cockles *Bassina yatei* and *Chione stutchburyi*, *Zethalia zelandica* (wheel shell), *Struthiolaria papulosa* (ostrich foot), *Austrofusus glans* (southern whelk), the olive shells *Baryspira mucronata* and B. *australis*, and the extinct bubble shell *Leucotina ambigua*.

   Higher in the section towards Clifton, the presently abundant cockle *Chione stutchburyi* is the only common shell, although many plant fossils can be collected from the peat beds.

5. Shallow-water bivalves and univalves from the raised beach deposit, a few thousand years old, weathering out in front of the shelter huts, and described above. A total of 12 species are recorded, and common ones are *Zelithophaga truncata* boring date mussel, *Protothaca crassicosta* (tuangi), the rock borers *Anchomasa similis* and a species of *Pholadidea* close to *suteri*, *Haliotis iris* (paua), and *Cookia sulcata* (Cook's turban shell).

THE KIDNAPPERS SEAL JAW:

A fairly complete fossil lower jaw bone of a seal was collected from the cliff just east of Black Reef many years ago, and was assumed to be from the grey sandstone underlying the Black Reef Sandstone, and therefore about 3 to 4 million years old. However, recent studies have shown that the bone is from the modern New Zealand sea lion *Phocarctos hookeri*, and is less than 1000 years old. Therefore it must have come from a midden or young terrace cover deposit rather than from the much older sandstone. The Geological Survey would be most interested to examine any further seal bones collected from the area.

GEOLOGICAL HISTORY

The geological story of the Kidnappers area began with quiet deposition of fine silt on the seabed of the outer continental shelf. Shells (and presumably a wide variety of other animals, not represented by fossils)

burrowed around in the silt, or crawled on its surface. Between three and four million years ago the sea bed began to rise slowly, as part of a general rising of the land mass and particularly of the major mountain ranges. This caused new land to be created, the water to shoal, the incoming sediments to coarsen (as the coast was nearer), and shells to be correspondingly more common and of the sorts found in shallower water and nearer shore than those in the siltstone.

The rather sudden change to the deposition of the coarse, limey sand of the Black Reef Sandstone indicates that the sea shallowed again more quickly, causing limestone deposition in the area south-westwards from Havelock North because strong currents in the narrowed inland seaway carried all fine sediment out into deeper water. Large fan shells were common lying on the shallow sandy seabed.

Deposition probably continued for the next two million years, but under what conditions is unknown because the sea suddenly shallowed again slightly about a million years ago, and strong currents in the shallow water at the mouth of the seaway eroded away all the sediments down to the hard Black Reef Sandstone. Rapid current action continued for some hundreds of years, winnowing the sediment from the shells lying on the seabed, so that the shells were concentrated into a thin shellbed. Later quiet sand deposition in shallow water near land formed the Maraetotara Sand, and was followed by very rapid deposition of a wide variety of rocks including gravel, pumice, peat and silt. The presence of few fossils other than *Chione* (common purple cockle) in the silt shows that it was laid down in extremely shallow water, probably in small enclosed embayments or small river estuaries. During this time the main Hawkes Bay rivers changed their courses markedly, bringing in varied boulders to the gravel and pumice beds, and many major eruptions of pumice and ignimbrite occurred in the Rotorua-Taupo volcanic zone.

During the relatively rapid rises and falls of sea level during the ice ages, over about the last 100,000 years, the periods of steady sea level were long enough for the sea to cut several wide, flat benches across the Cape Kidnappers area (Figure 6). As the land was slowly rising throughout this time, the oldest benches are the highest and most eroded ones, younger and younger benches are progressively closer to present sea level. Later, small rivers such as the one flowing out of the cliffs just east of Black Reef cut terraces in the older marine benches, deposited thin veneers of gravel, and then cut deep trenches as the area gradually rose to almost its present height above sea level. A final brief pause in the elevation of the land within the last few thousand years allowed the sea to cut a narrow bench between Black Reef and the Cape and the land has risen only a few metres since then.

FURTHER READING

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NOTES

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