Holocene of the North Island of New Zealand: a Coastal Reconnaissance

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Abstract

FIFTY Holocene stratigraphic sections, well distributed around the coast of the North Island, are described. Layers of volcanic ash or water-borne pumice make close correlation possible. Several previously undescribed ash showers and pumice layers are named. Leigh (*c.* A.D. 1), Taupo (A.D. 150), and Loisels (*c.* A.D. 700) pumices, and the Kaharoa Ash (A.D. 1300) are the most widely distributed. Provisional dates given above are based on stratigraphic interpolation from the radio-carbon-dated Taupo Pumice and will be more closely defined when critical radio-carbon samples have been processed. Petrology of the pumices and ash showers, described in an appendix by Miss G A. Challis, proved essential for accurate correlation.

Sea-level changes are inferred from a comparison of the Holocene deposits with those now accumulating. Drowned forests at the base of many sections indicate the lower sea level at the end of the Pleistocene. Sea level was higher than at present at about 2000 B.C., and very slightly lower at A.D. 150. Since A.D. 700 it has differed little from that of the present day.

Maori occupation soils, an important part of the top of most sections north of New Plymouth and Napier, are used to infer Maori population and distribution in the past. A rapid and simultaneous population increase from a value too small to be recorded to about 150,000 at A.D. 700 is the most conclusive result of the study. Eastland population probably decreased to a minimum at about A.D. 1300 and then increased again. Coromandel and Northland populations reached their maximum after A.D. 1300. The large pre-A.D. 1300 population makes it likely that present day Maoris are the descendants of the earliest inhabitants, and it is suggested that the traditional "Fleet" canoes, supposedly of A.D. 1350, may have been those of the first people to arrive here.

Charcoal is the most critical indicator of Maori occupation. Charcoal-darkened soils extend inland at those places that were scrub-covered in 1780 and probably represent forests that were burnt by the Maori.

INTRODUCTION

THE Holocene Period extends back for seven thousand or so years from the present day and largely corresponds to the historical period of ancient civilizations. It followed the last glacial epoch of the Pleistocene, climate (Brooks, 1950) and geography of the late Holocene being not very different from that of the present day.

New Zealand has a written history that extends back for a mere two hundred years and for its earlier history is dependent on Maori tradition and on the record of the stratified rocks. The significant Maori traditions are those that were held on the arrival of the Pakeha (Sharp, 1957). They have been rationalized according to nineteenth century Pakeha opinion and are now taught as our earliest history (Sinclair, 1959).

Like the early tradition of all races, Maori traditions are partly historical and partly mythical; and served to explain the past as well as to record it. Stratigraphy may help to separate the historical from the mythical part of the tradition.

The events of the Holocene as recorded by stratigraphy are thus of considerable importance as pre-history. They are also a guide to the geological events that are likely to take place in the immediate future. In this last respect the study of the Holocene is of greater importance than the study of any other equal interval of time in the past.

Only at particularly favourable localities have sediments accumulated sufficiently rapidly and uniformly to provide a clear record of Holocene events. Coastal deposits are the most easily correlated because they record the events of the sea as well as those of the land, besides being well exposed by marine erosion at many places. Favourable accumulations consist of interbedded layers of blown sand, beach deposits, ash, water-borne pumice, soil-wash, and midden material, the optimum thickness being from four to ten feet. Thicker deposits are usually irregular, and thinner ones are difficult to interpret.

The following factors have controlled the nature of the sediments and the rate at which they have accumulated at particular sites: (1) Local climate, as reflected by storms and wind direction and intensity; (2) tsunamis (tidal waves); (3) human population; (4) volcanic eruptions; (5) vegetation; (6) eustatic changes in sea-level (controlled by world climate); (7) tectonic elevation or depression of the land. The stratigraphic record is confused and not easy to interpret. In particular, tectonic elevation and depression cannot be distinguished from eustatic sea-level changes in individual sections. In the following account sea-level changes are expressed throughout as though entirely eustatic, the land being considered stationary.

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The sections described are those that contain the most complete geological record of the Holocene, but they are not average sections. In a sense they are geological curiosities, for they are restricted to a few places where rapid and uniform accumulation has been followed by equally rapid erosion. Unless erosion is checked many of these deposits will be destroyed in a relatively short time. Where land values are high because of settlement erosion is causing economic loss, and sea walls are being built to prevent it. Present-day settlement favours the same sheltered localities as those favoured by the earliest settlers, and many sections of archaeological interest are likely to be hidden by sea walls in the near future. After sea-walls are built coastal deposits are protected and can be examined at leisure if excavated. But excavations have to be unusually extensive to rival natural coastal sections, and the time and cost is prohibitive for all except the most important localities. It is thus important that those sections now exposed be described in detail as soon as possible.

To contain a worth-while record most Holocene sections have to be several hundred feet long and at least four feet high. They are consequently quickly found, the major problem in a reconnaissance being transport. Most of the North Island beaches are only a short distance from roads and can be reached without much difficulty. Those most difficult of access are on the eastern side of Northland near the Bay of Islands, where many possibly important sections have not been examined.

The North Island coastal sections were examined at various times during the last four years. The east coast from Mahia to Reporoa was studied in the greatest detail, about a month being spent in the field, several of the more important sections being examined several times. About two weeks were spent examining the sections in the Bay of Plenty. Eight weeks were spent in a systematic examination of the beaches in Coromandel, Northland, and the west coast. The parts of the North Island coast examined are shown by heavy lines in Fig. 1.

About fifty useful sections were measured and about a hundred examined, but not measured. The measured sections are well distributed over the North Island coast and give a fair idea of the regional stratigraphy. Because Holocene deposits are mostly built from locally derived material lithologic correlation of the kind used in older sediments is impossible. The common molluscan fossils are also useless for correlation, because the time is far too short for significant evolution to have taken place and the differences caused by climate changes have been negligible. Correlation has to be based on short and dramatic events, and in this respect we are fortunate that several large volcanic eruptions took place in New Zealand during the Holocene. The products of the eruptions were rapidly distributed by wind as ash showers, and even more widely as water-borne pumice by rivers and by the sea (cf. Richards, 1957, for rate of oceanic pumice transport). Where ash showers or water-borne pumice are present, correlation is possible, provided that the products of individual eruptions can be recognized.

In the following account the term "ash" is used for air-transported volcanic deposits that have not been significantly reworked, and "pumice" for material sufficiently buoyant to float in rivers or the sea, and "tuffaceous" for fine-grained volcanic material that has been reworked and mixed with sediments. Most tuffaceous sediments are not sufficiently distinctive to be correlated directly with particular eruptions, and they may be considerably younger than the volcanic material they contain.

The earliest eruption at present known to be useful for North Island correlation is that from near Lake Taupo and dated at about A.D. 150 by many C^{14} samples. It covered 5,000 square miles with over a foot of ash, and at least twice that area with over an inch. It is the youngest of several showers that occurred during a short interval of time and was described by Baumgart (1954) as the Taupo Lapilli shower. It is distinguished from other showers by a large proportion of pumice lumps, which are particularly conspicuous at its margin. At most places the pumice, referred to here as Taupo Pumice, can be distinguished from other pumices without much difficulty. Enormous quantities were washed into the rivers, carried out to sea, widely distributed by wind and currents, and finally thrown up on the beaches, to be covered by sand and soil. Seaborne Taupo Pumice directly overlies Taupo ash at several sections, and the first pumice probably reached the beaches shortly after the eruption. Rounded lumps of charcoal from forests destroyed by the eruption were washed up with the Taupo Pumice at a few beaches. Taupo Pumice is still being thrown up on many beaches, as it was frequently in the past, but the "primary" deposits that immediately followed the eruption are generally much thicker and coarser than the younger "secondary" deposits. The area covered by the Taupo Lapilli and the position of primary deposits at present known on the coast are shown by Fig. 2. Pumice about the same age as Taupo Pumice, occurs on several beaches in eastern Northland; it is named Leigh Pumice.

The other important pumice is darker, more basic in composition, and stronger than the Taupo Pumice. It came from a volcano in the Bay of Plenty, most probably from near Mayor Island, and is referred to as Loisels Pumice (Wellman, 1960). The pumice has not yet been dated by C^{14}, but from its average stratigraphic position relative to the Taupo Pumice it is thought to have been erupted about A.D. 700. Loisels Pumice is widely distributed on the beaches on the east side of the North Island, but is absent from most of the beaches on the west side. Its distribution is shown by Fig. 3.

The Kahoroa Eruption from Mt Tarawera, near Rotorua, may be important for dating. No pumice was erupted, but its ash is probably present in a few coastal sections near Gisborne and in the Bay of Plenty. A single C^{14} sample gives a date of about A.D. 1050 (Golson, 1957). Other Holocene eruptions are known from Mt Egmont and Mt Rangitoto, but the ash and pumice from these were not widely distributed.

Human occupation is recorded by shells of edible molluscs, by burnt stones, by bones of fish, birds, and seals, by flakes of obsidian and chert, and exceptionally by other more finished artifacts. Charcoal, either as small scattered fragments or as a darkening of the soil, has proved to be the most sensitive indicator of human occupation. Stratigraphic levels that carried a relatively dense population are dark, seemingly greasy, and distinctive (Taylor, 1958). Where the population was less dense they are somewhat lighter in colour but darker than most soils or sediments. Rare angular fragments of charcoal a few inches below the other definite signs are considered as being the earliest evidence of human occupation. The fragments of occupation charcoal are easily distinguished by their angular shape and higher stratigraphic position from the water-borne, rounded charcoal lumps of the Taupo Eruption.

There are no traces of human occupation below or immediately above the Taupo Pumice in any section. Rare fragments of charcoal first appear a few inches below the Loisels Pumice and become more abundant at the base of the pumice layer. The "lower occupation layer", with abundant charcoal and other signs of human occupation, lies just above the Loisels Pumice, and is well defined in Eastland; and uniformly present as a weak occupation layer in Coromandel and Northland. An overlying layer with few traces of occupation contains the ash that is tentatively correlated with the Kaharoa Ash of A.D. 1300. An "upper occupation layer", somewhat less well defined than the lower in Eastland but well defined in Coromandel and Northland, is overlain in many sections by blown sand or soil-wash that is still accumulating.

Estuarine clay and soil with standing stumps occur in several sections a few feet or more below the Taupo Pumice. The beds indicate a sea level at least ten feet lower than that of the present day and are thought to have been deposited at the close of the Pleistocene, when the sea is known to have been lower than at present (Godwin *et al.*, 1958). Because of tectonic movements the upper part of these deposits is likely to be of different ages at different places.

It has recently become possible to date sediments that contain carbon (as charcoal, as wood, as carbonate in shells, or as charcoal from bones) by the percentage of the radio-active isotope C^{14} they contain, provided the carbon was formed from carbon dioxide at the time the sediments accumulated. Two C^{14} dates have already been given, but only a few Holocene (as distinct from Pleistocene) datings are made in New Zealand each year, and if full advantage is to be made of the method it has to be restricted to the dating of samples that mark events and not merely used for dating objects that are of no importance for correlation (Fleming, 1953: 122). Consequently correlation should precede and not follow C^{14} dating. When sufficient useful C^{14} determinations have been made, Holocene deposits will be dated in terms of the conventional B.C. and A.D. dates, but until this has been done the purely sequential terminology of the stratigrapher is needed.

Divisions of the Holocene

Six stratigraphic divisions are defined on the basis of the ash showers and occupation layers mentioned above. A seventh and lowest division is used for beds that indicate a significantly lower sea level and are considered to be Pleistocene in age. The divisions, their approximate age-ranges in years, and the information used in defining them are outlined in Fig. 4. They are described in greater detail below. Ages in years are given mainly for their archaeological interest; they are certain to be modified in the future when further C^{14} datings become available. It should also be noted that the C^{14} dates themselves are subject to modification because of the variations in the percentage of C^{14} in the atmosphere and ocean at different times in the past, but the corrections are probably less than 200 years for most of the Holocene.

The Holocene divisions are not cultural but stratigraphic, and except that they are much shorter in duration, are similar in nature to the stages of the New Zealand Mesozoic, Tertiary and Pleistocene. Because it is likely that C^{14} determinations will make it possible to date the divisions with reasonable certainty in the near future, formal names are hardly required and the divisions are therefore numbered, but type localities are desirable. The section on the south side of Cooks Cove (No. 15) is an admirable type locality for all six of the Holocene divisions.

Division (1) ? A.D. 1800 to present day. Deposits above the upper occupation layer. Generally either wind-blown sand or soil and mud flows, but absent from most localities where sediments are not now accumulating. Age of base of layer is estimated and is doubtless somewhat different at different places.

Division(2) *c.* A.D. 1300 to ? A.D. 1800. Upper occupation layer and, on east coast, upper part of relatively barren layer below. Base taken at base of thin subaerial ash present at several east-coast localities, which is tentatively correlated with the Kaharoa Ash of *c.* A.D. 1300.

Division (3) ? A.D. 700 to *c.* A.D. 1300. On east coast, lower occupation layer and lower part of overlying relatively barren layer. At Coromandel and Northland deposits with moderately abundant charcoal. Base clearly defined in most sections by lower limit of Loisels Pumice.

Division (4) ? A.D. 550 to ? A.D. 700. Oldest layer with evidence of human occupation. Base defined by lower limit of charcoal fragments. Within most of the area studied the base of this layer is only a few inches below the base of the Loisels Pumice and the interval of time represented by the division is small.

Division (5) A.D. 200 to ? A.D. 550. Deposits between the lowest charcoal fragments and the lowest Taupo (or Leigh) Pumice. It includes one or more thin subaerial ash showers.

Division (6). Several thousand years B.C. to A.D. 200. Deposits between the base of the Taupo (or Leigh) Pumice and the highest horizon that formed when sea level was significantly lower. At North Taranaki and elsewhere this layer includes several ash showers. It represents a relatively long time interval, including a short interval when sea level was probably a few feet higher than now, and will doubtless be subdivided in the future.

Division (7). Deposits formed during the last cool period, when sea level was significantly lower than at present. Marked by drowned forests, and peat below present mean high-water mark. Base not well defined. It represents a long interval of time and because of sediment compaction and tectonic movements its end may not be accurately dated solely from the rise in sea-level.

The sections on which these divisions have been based are described below. The most reliable are those that extend for several hundred feet and are well exposed throughout. The main advantage of an extensive section is that any particular bed can usually be examined at different heights above present sea level, allowing deposits that accumulated simultaneously but in different environments to be related. For instance, if possible Holocene sea-level changes are neglected, a particular bed is most likely to contain sea-borne pumice near the upper limit of waves, and subaerial ash and evidence of human occupation a few feet higher. From mean high-water mark to a level five or so feet higher is the most important vertical height range, and the longer the section the greater is the opportunity of finding any particular bed extending through this range. A few extensive sections (Figs. 5, 7, 9, 12, and 13) illustrated by longitudinal sections drawn with a highly exaggerated vertical scale, show the considerable height range of individual beds. These sections, and several that are not figured, are based on a series of closely spaced vertical measurements.

Most measured sections are recorded as "text sections" that generalize the stratigraphy from several points along a beach and express it in terms of the average or the best exposed vertical section. This method is essential in order to save space, but gives a wrong impression of the height of some of the deposits relative to sea level. Loisels Pumice is younger than Taupo Pumice and is shown at a higher stratigraphic position in all text sections in which both occur. From the text sections alone it would be reasonable to infer a rise of a few feet in sea level during the interval between the eruption of the two pumices, but at most places the two pumices are actually most abundant at almost the same height above sea level. The height difference is merely apparent and is the result of the method of representation adopted.

East Coast Sections

Sections are described in a counter-clockwise direction around the North Island coast (Fig. 1). Approximate positions are defined by sheet district and grid reference.

Section 1 is exposed two miles west of Cape Palliser lighthouse at the point where the Tertiary sediments of Kupe's Sail reach the coast. It shows on both sides of a small bay but is well exposed for about twenty feet only.

Section 1.—*Kupe's Sail, near Cape Palliser (N168, 798827).*

Soil of blown sand, oven stones at base	1.0ft
Sandy soil, moa bone at top	1.0ft
Sand and beach boulders, boulders die out inland	2.0ft
Beach sand, with scattered Taupo Pumice	2.0ft
Beach sand with Taupo Pumice lumps up to 2ft	2.0ft
Grey beach sand	2.0ft
Tertiary sandstone, top about 10ft above M.H.W.M. at least	20.0ft

Taupo Pumice is abundant and was seen in similar sand 500ft north-west between Kupe Stream and the west side of the Tertiary sediments. It lies at the same height above sea level as present-day drift wood and drift pumice, and the difference between sea level during the Taupo Eruption and that at the present day is unlikely to be more than 2ft or 3ft. This is rather surprising because the coast is fringed by a series of beach ridges that appear to be Holocene or late Pleistocene in age, and indicates a relatively rapid lowering of sea level relative to the land during some part of the Holocene. The moa bone near the top of the section was identified as *Euryapteryx geranoides* (Owen, 1848) by Dr J. C. Yaldwyn,

of the Dominion Museum (pers. comm. 23/9/1959). The Holocene sediments probably accumulated gradually, and the bone from its stratigraphic position would appear to be no more than a few hundred years old. The oven (*umu*) stones are the only evidence for human occupation and are scattered through the base of the layer immediately above the bone. The coast is extremely windswept and so inhospitable that the small population it would have supported are unlikely to have left a continuous record of their presence, and the moa bone is probably younger than the first period of human occupation recorded from the more favourable localities to the north.

The coast was examined near Flat Point, from Castle Point to Owahanga River, and to the north at Porangahau and Blackhead Beach, but no satisfactory sections were seen south of Waimarama Beach. Shell middens are not uncommon in the more sheltered parts of the coast, but they are small and patchy compared with those farther north, and indicate that on this cold and windswept part of the North Island coast the total population was small.

At several places, particularly at Blackhead Beach, north of Porangahau, the middens are in heaps, not evenly spread as is usual to the north. The difference is attributed to a difference in living habits caused by the colder climate. Shelters would be important and the middens were probably heaped up near them.

Thick charcoal layers composed of the stems and leaves of bracken-fern lie near the base of several of the Blackhead Beach middens. Bracken is no longer abundant at this place, but was probably the dominant plant after the original scrub and forest had been destroyed.

SECTION 2.—*Waimarama Beach* (*N142, 442985*)

Blown sand and beach boulders	2.0ft
Occupation layer with shells and charcoal	1.0ft
Blown sand	0.2ft
Dark clay, charcoal, and moderately abundant Loisels Pumice (H6)	0.3ft
Tuffaceous sand	2.0ft
Estuarine mud with wood and stumps	*c.* 5.0ft

The section at Waimarama Beach (Section 2) extends for about 300ft from the cliffs at the south end of the beach. It is fairly well exposed and uniform for most of its length. The two layers with charcoal are correlated with the two occupation layers to the north. Loisels Pumice is moderately abundant, but was not seen on beaches to the south except as small fragments of drift pumice. No Taupo Pumice was seen, but the tuffaceous sand below the Loisels pumice probably contains Taupo Pumice sand. The estuarine mud crops out only at the north end of the section, and its relation to the overlying beds is not clear. It probably represents a lower sea level, but no stumps that are certainly in place were seen. This is probably the layer from which Hamilton (1888: 313) reported moa bones.

Most of the beaches between Waimarama and Cape Kidnappers were examined, but no clear sections were seen.

CAPE KIDNAPPERS TO MAHIA PENINSULA

From Cape Kidnappers around the coast of Hawke's Bay to the Wairoa River the outer coast is not favourable for occupation sites, being either rapidly eroding cliffs or exposed gravel beaches. The more favourable localities around the inner harbour at Napier were not examined. At the coast on the north side of Wairoa River a thin section shows about a foot of occupation soil, underlain by Taupo Pumice that rests on a dark clay that appears to have formed when sea level was lower than now.

Thicker sections were found at the mouth of Tahaenui Stream, 12 miles east of Wairoa, and in gravel pits near Nuhaka. The Tahaenui Stream section

(Section 3) is exposed on the right bank of the stream about 300ft from the coast and extends for 50ft. Two ash bands can be identified with reasonable certainty, the Taupo Ash because of the large size of the fragments and the Waimihia Ash by the central dark band (Baumgart, 1954: 465). The load casts at the base of the clay between the two ashes and the evenness of the Waimihia Ash indicate that the lower part of the clay and the Waimihia Ash were deposited in water. The Taupo Ash was deposited on a soil and shower bedding is less well preserved than in the Waimihia Ash.

SECTION 3.—*Mouth of Tahaenui Stream* (*N116, 055915*)

Non-pumiceous blown sand	1.5ft
Pumiceous blown sand	2.0ft
Ash with ¼-inch pumice lumps (Taupo)	0.1ft
Sandy pumiceous clay with load casts at base	1.0ft
Granule-grade ash with light top and dark base (Waimihia)	0.3ft
Light granule-grade ash (Waimihia)	0.2ft
Dense clay silt, no remains of vegetation	2.5ft
Greywacke gravels, top about 5ft above M.H.W.M.	3.0ft

SECTION 4.—*Nuhaka Gravel Pit, south of road entrance* (*N116, c. 085912*)

Dark grey blown sand with ovens and shells near top. Up to	6.0ft
Pumiceous blown sand	1.0ft
Pumiceous earthy silt with soil at top	1.0ft
Granule-grade light ash (? Waimihia Ash)	0.7ft
Blue Lake silts	1.0ft
Old beach gravels, seaward dip of 3°, primary	5.0ft

The Nuhaka gravel-pit, Section 4, is clearly exposed down to the permanent water table which is probably not far above M.H.W.M. The gravels at the base of the section are similar to those on the present-day beach, but slightly lower. The beach has prograded, and sea level has probably risen a few feet since the gravels formed. The section and similar ones at Tahaenui Stream and near Gisborne are discussed later in the description of sea-level changes.

Dunes composed of pumiceous sand similar to that in the upper part of the last two sections are best developed on the isthmus that connects Mahia Peninsula with the mainland, and are overlain and underlain by non-pumiceous sand. The pumiceous sand can be traced north along the east coast for many miles and represents an enormous volume of pumiceous ash. At the isthmus the pumice part of the sand is being winnowed by the wind to accumulate in pure layers that are easily confused with directly deposited ash. Farther north the pumice sand is finer, has fewer air cavities, and does not concentrate as readily. A similar dune-sand sequence is present on the western side of the North Island at Wanganui, Taupo Pumice sand being present in the younger dunes and absent from the older ones (Fleming, 1953: 117).

Most of the likely bays between Nuhaka and Waikokupu and those to the south-east on the western side of Mahia Peninsula were examined, but no clear sections were seen. The southern point of Mahia Peninsula was not examined.

The only good section on the western side of the peninsula (Section 5) is about a mile south of the Post Office and store. It forms the upper part of a low cliff and extends for over a thousand feet, the lower 4ft of the cliff being composed of Tertiary rock. The terrace at the top of the section is about 9ft above M.H.W.M. and extends inland for about a hundred feet. It would be considered pre-Holocene and possibly interglacial if the sediments were not clearly dated as Holocene by water-borne Taupo and Loisels pumice. The full section, well exposed for its whole length, is illustrated in a longitudinal section by Fig. 5. The column (Section 5) generalizes the main features. Except at the west end, the base of the section is now 5ft above M.H.W.S.T. and the two pumice layers are

considerably higher. It seems unlikely that they could have been deposited with sea level at its present position, and recent tectonic uplift is the most probable explanation for their anomalous height.

SECTION 5.—*Mahia Peninsula, Generalized Section (N117, 290869)*

Moderately developed soil with grass	0.2ft
Shelly sand	0.5ft
Sandy soil with scattered charcoal	1.5ft
Local occupation layer	0.4ft
Sandy soil with charcoal	0.5ft
Continuous occupation layer, Loisels Pumice in layer and at base	0.3ft
Wind blown sand, *Cookia sulcata* common	2.0ft
As above with Taupo Pumice as scattered lumps	0.5ft
Black sand and angular fragments Tertiary sandstone	0.5ft
Shell sand and gravel of Tertiary mudstone resting on top of Tertiary mudstone. *c.* M.H.W.S.T. + 5ft	0.6ft

Two miles to the west and opposite the entrance to the lagoon that lies on the north side of Mahia Isthmus, there is a thick Holocene section at the base of a steep slope that rises to hills of Tertiary rock. The sea has repeatedly advanced by eroding the mudflows from the cliff and has repeatedly been driven back by further mudflows. Because of the rapidity of accumulation the stratigraphic record is unusually complete, but large thickness variations and poor exposures make the section difficult to interpret. More detailed examination supplemented by some excavation is required. Because of the variation in the thickness of individual layers the position of M.H.W.M. shown on the accompanying column (Section 6) applies to the lower part of the section only.

SECTION 6.—*Mahia Lagoon Section (Oraka Beach) West End. Generalised. (N117, 275882)*

Soil mudflow with scrub on poorly developed soil	2.0ft
Occupation layer (local only)	0.5ft
Soil mudflow	2.5ft
Tuffaceous sand (? Kaharoa)	0.1ft
Soil with scattered charcoal grading down into	1.0ft
Fine conglomerate of mudstone with abundant *charcoal*	1.0ft
Dark sand and *Loisels Pumice*	0.1ft
White pumiceous sand, possible ash shower	0.1ft
Tertiary mudstone conglomerate	2.0ft
Very white silty *ash* overlying charred leaves (? Ohui Ash)	0.02ft
Tuffaceous soil	0.2ft
Very white *silty ash* (? Ohui Ash)	0.05ft
Tuffaceous swamp soil with wood fragments	0.8ft
Water-borne *Taupo Pumice*, 1ft lumps, carbonized wood	0.8ft
Scree of Tertiary mudstone	0.2ft
Conglomerate of Tertiary sandstone, shells	2.0ft
Estimated position of M.H.W.S.T.	

The thin, very white, silty ash layers immediately above the water-borne Taupo Pumice have not been appreciably disturbed since they were deposited and are clearly subaerial ash. The layer two feet above and that immediately below the Loisels Pumice are less clearly defined, but are probably ash showers. The two occupation layers are distinct, but not very dark in colour. probably because the site was too steep for continuous occupation.

From Mahia Peninsula northwards the coast is steeply cliffed in Tertiary rocks until just south of Young Nick's Head, where two good coastal sections are exposed. The southern section at Maraetaha River is two miles south of the headland and ten miles south-west of Gisborne Town (Section 7). The section is exposed for 70ft on the north-east (left) bank of Maraetaha River and is 600ft from the coast. Inland the ground surface rises gently for about 200ft to the base of Tertiary mudstone hills. Except that the occupation layers die out upstream the section is remarkably uniform and complete for its whole length.

SECTION 7.—*Maraetaha River Section* (*N107, 309232*)

Immature soil with grass	0.5ft
Occupation layer, *umu* (oven) at east end of section	0.5ft
Mudflow of soil and Tertiary mudstone	2.0ft
Soil layer	0.2ft
Continuous layer of fine ash (shower or rewash) (M 4)	0.02ft
Soil grades laterally into occupation layer, charcoal at top	0.1ft
Shelly sand, ? blown	0.3ft
Rain-wash clay, soil at top	1.0ft
Conglomerate of Tertiary mudstone, mudflow	1.0ft
Occupation layer, *umu* (oven) at base, grades down into	0.8ft
Loisels Pumice, well defined layer. Fragments up to 1in	0.2ft
Tuffaceous soil, rare charcoal	0.5ft
As above, no charcoal	0.5ft
Taupo Lapilli, coarse-sand-grade brown pumice. ½in lumps at top	0.2ft
Rain-wash clay with mud-flow conglomerate lenses	3.0ft
Fine-sand-grade *tuff* (Waimihia Ash)	0.5ft
Coarse-sand-grade even white *tuff* (Waimihia Ash)	0.3ft
Base about 2ft above M.H.W.S.T.	

Although the central dark band was not seen, the identification of the basal ash as Waimihia is reasonably certain. The Taupo Ash contains the usual large lumps of pumice. The absence of water-borne Taupo Pumice and the presence of water-borne Loisels Pumice a foot higher in the section suggests that sea level rose in the interval between the two eruptions. Loisels Pumice is restricted to a thin layer and is not abundant. The upper ash has been partly reworked and is mixed with soil, but is so continuous as to be probably a subaerial ash deposit; it is tentatively correlated with the Kaharoa Eruption.

Conspicuous Maori fortification embankments that have not been appreciably eroded and cannot be more than a few hundred years old are built on both banks of Maraetaha River about 600ft inland. Section 8 is well exposed on the left bank of the river at the centre of the fortifications, and extends for 50ft. Although the river is tidal, the section is too far inland to be reached by sea-borne pumice, and so the Loisels Pumice is absent. Deposition has been slow but, judging from the position of the Taupo Ash, probably fairly uniform, and it is reasonably certain that the ill-defined dark band and the underlying silt with very rare charcoal and a few burnt stones represent the lower occupation layer on the coast. Most sites of archaeological interest are too far inland to receive water-borne pumice, and this section is given as an example of how correlation may be effected at a favourable locality.

SECTION 8.—*Maraetaha River, "Diggings" at Maori Earthworks* (*N107, 300230*)

River silt deposited in *c.* 1930	0.5ft
Occupation layer, at places 3ft thick, average	1.0ft
River silt	0.5ft
Ill-defined dark band, probably lower occupation layer	1.0ft
Silt with very rare *charcoal* and a few burnt stones	2.0ft
Silt, no evidence for human occupation	1.0ft
Taupo Ash, coarse-sand-grade brown pumice (M 17)	0.2ft
Silt, no evidence of human occupation	1.0ft
Ash, medium-sand-grade, lenses only (? Waimihia)	0.2ft
Silt exposed down to M.H.W.S.T.	9.0ft

The northern coastal section (9) is at Orongo Beach, a mile south of Young Nick's Head, and extends from the rock cliffs at the south end of the beach, where it is thin, for 300ft north to disappear under the modern beach gravels. The identity of the two lowest ash showers—the Waimihia and Taupo—is reasonably certain. Loisels Pumice is rare. Its presence above the subaerial Taupo Ash and the absence of water-borne Taupo Pumice suggests a rise in sea level in the interval between the two eruptions. That the Taupo Ash is now being eroded by waves is a further indication of a post-Taupo sea-level rise. The origin and

identity of the two tuffaceous layers in the upper part of the section are uncertain. Mr Leo Fowler, of Gisborne, found glass and pig bones at the base of the upper occupation layer. The upper tuffaceous layer is thus less than 200 years old and, if actually a subaerial ash, must be correlated with the Tarawera Eruption of 1888.

SECTION 9.—*Orongo Beach Section* (*N107, 329254*)

Soil from drain, variable up to	2.0ft
Continuous light-grey tuffaceous layer	0.02ft
Sandy soil	0.5ft
Occupation layer with glass and pig bones at base	1.0ft
Tuffaceous layer, ? Kaharoa (M 3)	0.1ft
Occupation layer with many shells	1.0ft
Tuffaceous soil	0.5ft
Tuffaceous soil with scattered charcoal	1.0ft
As above with rare *Loisels Pumice*	0.1ft
As above with no charcoal	1.0ft
Ash with 1in *pumice fragments* at top (Taupo Lapilli)	0.5ft
Soil, tuffaceous	3.6ft
Ash, fine white above, coarser below (Waimihia)	0.5ft
Sequence uncertain	?10.0ft
Old soil with tree stumps	3.0ft

The wide alluvial flats of the Waipaoa Valley lie to the north of Young Nick's Head and meet the sea at Poverty Bay. The bay is fringed by very recent sand-hills that are building seaward. Mr W. A. Pullar, of the Soil Bureau at Gisborne, has made a detailed study of the valley soils and kindly supplied the following information on the distribution of the Taupo Ash and sea-borne Taupo Pumice. The ash covers the higher part of the plain inland but is covered by the Waipaoa River alluvium in the lower part of the valley near the river. The sea-borne pumice forms a well-defined bank that lies about half a mile inland and decreases in height from 10ft above sea level at the north side of the valley to a few feet above sea level at the south side, where it is overlain by river silt. Loisels Pumice was found only near the junction of the old railway line to Motuhora with the main line from Gisborne to Napier. It directly overlies the toe of the Taupo Pumice bank at about 5ft above sea level.

Sections 10, 11 and 12, which are important for indicating a Holocene high sea-level, are exposed on Tuaheni Point on the east side of Poverty Bay.

SECTION 10.—*Tuamotu Island, south end* (*N98, 320425*)

Light coloured sand	0.5ft
Occupation layer, gradational contact at base	1.0ft
Shelly pumiceous sand with water borne Taupo Pumice (M 18)	1.0ft
As above, but without pumice	1.0ft
Ash, silt grade (Waimihia) (M 23)	0.5ft
Ash, coarse sand grade (Waimihia) (M 24)	0.1ft
Clay with brackish-water mollusca	0.5ft
Tertiary rock	

The section extends for about 300ft and is well exposed. The base is 15ft above sea level.

SECTION 11.—*Coast opposite Tuamotu Island* (*N98, 426327*)

Dark soil	0.5ft
Pumiceous soil	1.0ft
Ash, fragments up to 1 inch (Taupo)	0.2ft
Tuffaceous soil	1.5ft
Laminated fine tuffaceous silt	0.5ft
Ash, fine lapilli (? Waimihia)	0.1ft
Laminated green silt	0.3ft
Clay, gravel and mudflows, base at M.H.W.M.	6.0ft

The section matches that at Tuamotu Island, except that the Waimihia Ash is less certainly identifiable. It extends for 200ft but has been disturbed by mud-flows.

About a mile east of Section 11, Section 12 is exposed at the low cliff at the end of the Sponge Bay Road from Gisborne. The section lies between headlands of Tertiary rock and extends for about 50ft. It is fairly well exposed. This section, the two just described, and the Nuhaka Gravel Pit and Tahaenui Stream sections are compared and discussed later in the description of sea level changes (Fig. 18).

SECTION 12.—*Sponge Bay Road Section* (*N98, 433329*)

Gravelly soil, glass fragments	0.3ft
Ash, lapilli grade (Taupo)	0.2ft
Greenish-white clay, gradational contact at base	1.0ft
Ash, medium sand grade, partly reworked (Waimihia)	1.0ft
Greenish-grey swamp clay	6.0ft
Estuarine clay with woody layers and estuarine shells	c. 2.0ft
Dark carbonaceous siltstone with 3ft logs. Old soil	3.0ft
M.H.W.M.	

The estuarine beds with brackish water mollusca (Section 12) extend beneath alluvial flats to crop out north of Gisborne at the south end of Wainui Beach, where they are less well exposed than to the south.

Section 13 is exposed at the south end of Tatapouri Beach, six miles north-east of Gisborne, not far from the East Coast Road. The section extends for 500ft and lies to the east of the hotel on the coast road north-east of Gisborne. It is being gradually eroded back but is mostly hidden by loose sand during the summer. Taupo Pumice is absent, probably because the base of the section is younger than the eruption, but the band of Loisels Pumice is well defined, with some charcoal and burnt stones below. The occupation layers are not well defined, possibly because the site is inhospitable.

SECTION 13.—*Tatapouri Beach Section* (*N98, 519389*)

Light blown sand with grass on immature soil	1.0ft
Soil layer, poorly defined	0.3ft
Sand, probably blown, grades laterally into occupation layer	1.5ft
Soil layer, poorly defined	0.2ft
Sand, probably blown, *umu* 150ft east near base	2.5ft
Soil layer, discontinuous	0.3ft
Sand with flat cobbles of Tertiary sandstone at base	0.5ft
Sand with 1in lumps of Loisels Pumice concentrated at base	0.5ft
Sand with charcoal and burnt stones	0.5ft
Sand with pebbles of Tertiary sandstone and shells	0.5ft
Base of exposed section at M.H.W.S.T.	

Loisels Beach (Section 14), the type locality for Loisels Pumice, is 20 miles north of Gisborne, and can be reached by a branch road that leaves the East Coast road 18 miles from Gisborne. The beach is about a mile long and for most of its length is backed by dunes that are being rapidly eroded and now form cliffs up to 12ft high. Loisels Pumice is abundant, the largest lumps being up to 6in across. It was first recognized by Mr W. Waye, of Gisborne, who noticed that it is darker and more dense than Taupo Pumice. The name "Loisels" is chosen for the pumice because of its abundance and first recognition on this beach. For most of the length of the beach it is abundant as a band at the base of the lower occupation layer. The clearest section, described in the text column (Section 14), is at a small stream 1,000ft south of the point where the road reaches the beach. The change in the thickness of the layers when traced inland is represented by Fig. 6.

SECTION 14.—*Loisels Beach, 1,000ft South of road entrance.*

Blown sand with immature soil and grass	0.5ft
Occupation layer, obsidian common, grading down into	1.0ft
Blown sand, light coloured	1.0ft
Occupation layer, shells, charcoal, fish bones, dog dung, large bone fragments, and abundant obsidian	1.0ft
Sand, blown or beach, worm borings at top	0.7ft
Loisels Pumice lumps up to 6in. Scattered lumps above	0.3ft
Light coloured sand, rat bones	0.5ft
Sand as above, no evidence of human occupation	3.0ft
Cemented shelly sand on Tertiary sandstone at about M.H.W.S.T.	0.5ft

Loisels Pumice forms a well defined band six inches below the base of the lower occupation layer. Rat bones immediately below the Loisels Pumice are of interest in view of the suggestion by Sharp (1956) that rats may have arrived earlier than man in some islands, but the bones are not low enough stratigraphically to verify this interesting possibility. Taupo Pumice was seen as a primary water-borne deposit at the north side of the second stream north of the road entrance, where it is separated from a well-defined band of Loisels Pumice by 6in of dark sand. The two occupation layers are distinct for almost the whole length of the beach.

Cooks Cove is a small sheltered inlet on the south side of Tolaga Bay, 25 miles north-east of Gisborne. It is separated from Tolaga Bay by a narrow ridge of Tertiary sandstone that has been cut through by the lateral erosion of a small stream which now flows directly into the Bay through a natural tunnel, and has abandoned its former outlet at Cooks Cove. The cove itself was sketched by Cook (Beaglehole, 1956), the amount of vegetation then being similar to that at the present day. Although no permanent habitations were shown, the area seems to have been cultivated. A photograph taken in about 1900 (Duncan, 1903: pl. 7) shows that a thick cover of tall scrub had grown up after Cook's visit. This advance of scrub is probably related to the decline in Maori population, which reached its lowest level at about 1900. Section 15, based on continuous exposures on the south side of the cove (Fig. 7), is one of the best in the North Island, and is made the type locality for the Holocene divisions.

SECTION 15.—*Cooks Cove, South Side (N90).*

Occupation layer, many *Haliotis iris*	0.5ft
Shelly loam with charcoal fragments	0.9ft
Tuffaceous horizon, probably Kaharoa Ash shower, extends for 50ft (M5)	0.1ft
Shelly sand with many whole shells, not midden material	0.9ft
Occupation layer, charcoal, burnt stones, shells, fish bones, rare obsidian and flint	0.9ft
Loisels Pumice, lumps up to 2in, base well defined	0.2ft
Shelly beach-sand with rare bones and charcoal at top	1.0ft
Tuffaceous silty sand	1.0ft
Taupo Ash: yellow, medium sand grade tuff, coarse top	0.5ft
Sandy silt with trees up to 2ft, no standing trunks	3.0ft

Base 2ft below M.H.W.S.T.

Two distinct occupation layers that are correlated with those to the south are separated by shelly sand with a discontinuous light-brown tuffaceous layer, probably subaerial ash, in the centre. A well developed soil at the top of the section makes it probable that the ash is more than 200 years old, and the layer is tentatively correlated with the Kaharoa Ash. The shelly sand is not wind-blown, but appears to be wave-deposited; it is well above present-day average storm waves and suggests either a higher sea level or, more probably, a tsunami or a period of extremely severe storms.

Loisels Pumice is abundant and lies in its normal position—at the base of the lower occupation layer and a few inches above the lowest charcoal. The Taupo Eruption is represented by an ash band six inches thick at the head of the inlet but thinner and less distinct seaward, where wave action was stronger, and by sea-borne lumps of white pumice up to 3in across at the top of the ash. Estuarine sand with 3ft totara logs, but with no stumps in position of growth, underlies the Taupo Ash at the head of the inlet, the lowest logs being several feet lower than timber would accumulate at the present day.

Five samples taken from three horizons have been forwarded for C^{14} dating: (1) wood from below the Taupo Pumice; (2) charcoal; and (3) shells from immediately above the Loisels Pumice; (4) charcoal; and (5) shells from the upper occupation layer.

No worthwhile sections were seen within the cove on the north side, but the thick section described below (Section 16) has accumulated at the foot of sandstone cliffs 200ft north of the entrance. The section extends for 300ft, but is irregular and not fully exposed for its whole length. The two well defined occupation layers are correlated with those on the south side of the cove, but the base of the lower layer is four feet above the reach of present waves and no Loisels Pumice was seen. The ornament found near the base of the lower occupation layer is composed of coarsely crystallized calcite probably from one of the veins that cut Tertiary sandstone near the cove. The underlying fish-scale layer represents a single catch of several hundred fish and, judging from the size and uniformity of the scales, all snapper. Cooks Cove is a suitable locality for detailed archaeological exploration, particularly of the lower occupation layer. Fig. 8, a sketch from air photographs, shows the position of the two sections 15 and 16.

SECTION 16.—*North side of entrance to Cooks Cove (N90)*

Scree of Tertiary rocks, immature soil above	2.0ft.
Occupation layer, charcoal, and many shells	1.0ft
Soil and scree, few shells or charcoal	3.0ft
Occupation layer, calcite ornament	2.0ft
Layer of fish scales up to ½in thick, extends for 6ft	0.03ft
Soil and scree with rare shells and charcoal	1.00ft
Soil with no charcoal or shells. M.H.W.S.T. at base	3.0ft

Tolaga Bay is not being eroded and no Holocene sections are exposed. Kaiaua Bay, the next large bay, five miles north of Tolaga Bay, is about two miles long and is backed by sandhills for most of its length. The two occupation layers and the band of Loisels Pumice show at several places, Section 17 being exposed on the north side of the first stream north of the road from the beach. The blown sand with layers of pumice sand at the base of the section is thought to represent the Taupo Eruption. The lens of tuffaceous sand a foot higher in the section is in the same stratigraphic position as the better-defined band at Anaura Bay, six miles north, and is correlated with it. The ash band is tentatively correlated with the Ohui Ash of Coromandel.

SECTION 17.—*Kaiaua Bay, north side first stream north road entrance.*

Blown sand, variable up to	3.0ft
Occupation layer with abundant charcoal	2.0ft
Blown sand	0.5ft
Occupation layer: charcoal, obsidian, flint, shells, rat bones, large bones of (? seal) at base	1.0ft
Loisels Pumice, scattered layer	0.2ft
Sand, medium brown	1.0ft
Tuffaceous lens in sand, not well defined (? Ohui Ash)	0.1ft
Sand, medium brown	1.0ft
Blown sand with layers of pumice-sand (? Taupo Ash)	3.0ft

Anaura Bay, reached by a branch road from the main East Coast Road, is about a mile long. Except at the south end where thickened by soil and mudflows from the hills of Tertiary rock, Holocene sediments are only a few feet thick. A longitudinal section along the south end of the beach is shown by Fig. 9. A representative section showing the lithology in greater detail is given by Section 18. The two occupation layers are well defined. The Loisels Pumice at the base of the lower layer is rare and the fragments smaller than to the south. A thin, inconspicuous tuffaceous band below the Loicels Pumice extends for 400ft and is so continuous and uniform in thickness that it can hardly be explained other than as an ash shower. Taupo Pumice was not seen, but the Taupo Ash is probably represented by the white pumiceous sand exposed near the base of the section at the north end.

SECTION 18.—*Anaura Bay, south end.*

Mud flow, south end of section only	0.5ft
Occupation layer, continuous and well defined	0.5ft
Clay, mud flow or soil creep	0.8ft
Lens of shelly sand grading north to occupation layer	0.3ft
Clay, as above	1.4ft
Lens of shelly sand, at south end only	0.2ft
Occupation layer, well defined and continuous, rare Loisels Pumice at base	0.5ft
Clay, as above	0.5ft
Light-grey very fine ash (? Ohui Ash) extends for 400ft	0.1ft
Clay as above	3.0ft
Sand, white and tuffaceous (? Taupo Ash)	1.0ft
Beach sand with shells on Tertiary sandstone at about M.H.W.S.T.	1.0ft

At Tokomaru Bay, nine miles north of Anaura Bay, a thick Holocene section at the north end of the bay is mostly hidden by a retaining wall built to protect the road from marine erosion. No worth-while sections were seen to the north at Waipiro Bay or at Teporoa Bay. The section at Reporua (19) is the most northern seen on the East Coast and is 60 miles north-east of Gisborne. The section is well exposed but, although it contains two occupation layers that appear to correspond with those at the beaches to the south, it is not extensive enough to be satisfactory. The sediments were mostly deposited by the stream that flows along the foot of the section.

SECTION 19.—*Reporua, south side stream near road.*

Soil with iron and glass	1.0ft
Sandy occupation soil	0.5ft
Soil of clay and fine gravel	2.0ft
Occupation layer with abundant shells and charcoal	0.5ft
Loisels Pumice, 2in lumps	0.1ft
Sandy soil with scattered charcoal	0.7ft
As above, no charcoal	0.7ft
Blown sand, no charcoal	1.0ft
Clay and fine gravel, stream deposit	2.0ft

From Reporua north to Waiapu River the coast consists of either steep, rapidly eroding coast, from which any sections that existed have been eroded, or of sand dunes that are building seaward and appears to be devoid of worthwhile sections. The six miles of coast between the mouth of Waiapu River and East Cape was not examined.

The five Eastland sections that record the lower part of the Holocene are shown together in Fig. 18 and are discussed later under sea-level changes. The remaining eleven are shown, together with the Coromandel and Northland sections, in Fig. 14, the lowest Loisels Pumice being used as the datum horizon. The columns are on the same scale and are arranged from south to north.

The lowest Division, 7, is either not exposed or absent because of unconformity in most of the sections, but is probably represented in the Waimarama, Orongo, and Cooks Cove sections. The horizon of the Taupo Eruption, the base of Division 5, is defined by ash or by water-borne pumice in five sections and is considered to be represented by tuffaceous sand in two. Ash that is younger than the Taupo Eruption and slightly older than the oldest charcoal occurs at Mahia Lagoon, Kaiaua Bay, and Anaura Bay. It is thought to represent a short-lived but violent eruption, and is correlated with the Ohui Ash of Coromandel. Division 4, beds with charcoal or other evidence of human occupation below the Loisels Pumice, is thin and remarkably uniform in thickness in all sections except the two at Mahia, where it is absent. The Loisels Pumice is present in all sections and defines the boundary between Divisions 3 and 4. The two occupation layers are reasonably well defined in all the localities that were suitable for human occupation. The boundary between Divisions 2 and 3 lies between the occupation layers and in the Mahia Lagoon, Maraetaha, and Cooks Cove sections is defined by the ash band tentatively correlated with the Kaharoa Eruption. Division 1, the relatively barren layer above the upper occupation layer is present in all sections but varies considerably in thickness and composition.

BAY OF PLENTY SECTIONS

The eastern shore of the Bay of Plenty was examined at many places between East Cape and Te Araroa, but although occupation layers are well developed, the coast is not being eroded, and no good Holocene sections were seen. About a mile west of East Cape a marine bench cut in Tertiary mudstone with large boring molluscs still in place, extends for about a hundred feet at 6ft above M.H.W.M. and is directly overlain by 4ft of sandy soil with evidence of human occupation in a conglomerate at the base. The marine bench is probably Holocene in age but cannot be closely dated. A thicker but equally unsatisfactory section is exposed in dunes a mile east of Te Araroa. Below a growing pohutukawa tree with a 2ft trunk ten feet of blown sand contains three distinct occupation layers. At the base, gravel with charcoal and Loisels Pumice rests directly on Tertiary mudstone.

Most of the rocky coast from Matakaoa Point to Cape Runaway, and all the accessible bays between Cape Runaway and Opotiki were examined, but the only diagnostic section seen is at Opape (Section 20). Opape is at the last greywacke headland before the sandy beach that extends west for ten miles to Opotiki. The pohutukawa tree is at least a hundred years old, and the ash below the upper layer of scree is tentatively correlated with the Kaharoa Ash. The upper occupation layer is not represented, probably because the site became less favourable as the scree advanced and buried the narrow strip of flat ground that had been occupied earlier. Loisels Pumice is abundant but no Taupo Pumice was seen.

SECTION 20.—*Opape, west side of Headland.*

Scree of greywacke, with 3ft-diameter pohutukawa tree at top	4.0ft
Dark grey fine volcanic ash, extends for at least 200ft	0.2ft
Scree of greywacke, as above	2.0ft

Beach sand with scattered charcoal and Loisels Pumice, grades into occupation layer to north	0.2ft
Beach sand with 1ft log and *umu* stones	1.0ft
Beach sand, no charcoal. M.H.W.S.T.	1.0ft

From Opotiki west to Waihopai River the main road follows the coast. No Holocene sections were seen. Section 21, exposed at the west end of Waiotahi Estuary, is reached by a branch road that leaves the main road on the west side of Waiotahi River, crosses the hills to the east side of Ohiwa Estuary, and then strikes east at the foot of coastal cliffs to the headland at the west end of Waiotahi Estuary. The section is about 600ft west of the end of the road, and extends for 200ft.

SECTION 21.—*Waiotahi Estuary, east end headland.*

Mudflow and gravel, 6ft pohutukawa growing above	1.5ft
Soil	0.5ft
Peat	0.1ft
Mudflow, obsidian flake	0.7ft
Light grey fine ash (? Kaharoa)	0.2ft
Soil with blown sand at base	0.5ft
Mudflow with 3in laminated silt at base	1.0ft
Occupation layer, rare Loisels Pumice	0.5ft
Beach sand, with thin occupation layer at base	1.0ft
Beach sand with rare Loisels Pumice	1.0ft
Loisels Pumice band, 2in lumps, some light-coloured pumice (M21)	0.3ft
Sand, with large *umu* stones	0.4ft
Beach sand, medium grade. No Loisels Pumice or charcoal	3.0ft
Greywacke gravels, top at about M.H.W.S.T.	

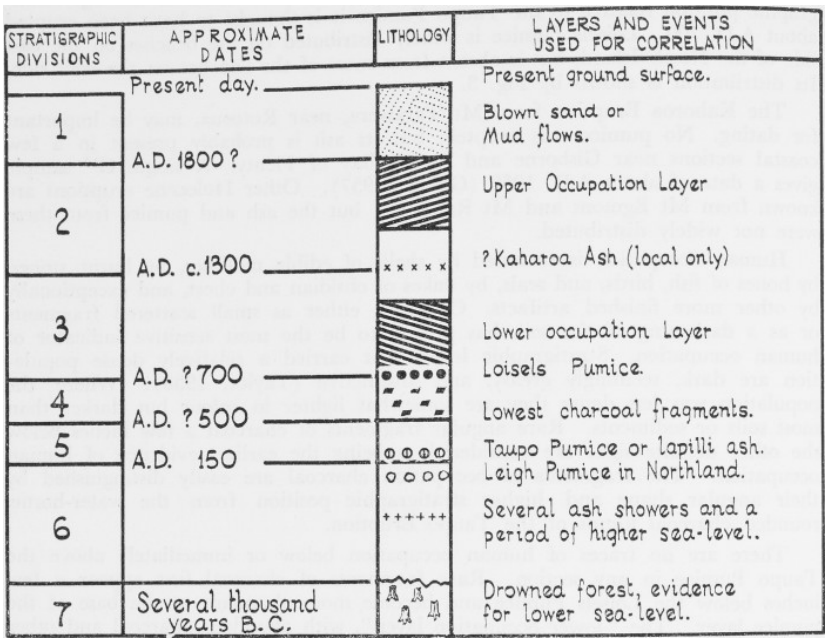

FIG. 4.—Chart showing criteria for defining proposed Holocene Divisions and their tentative age ranges in years.

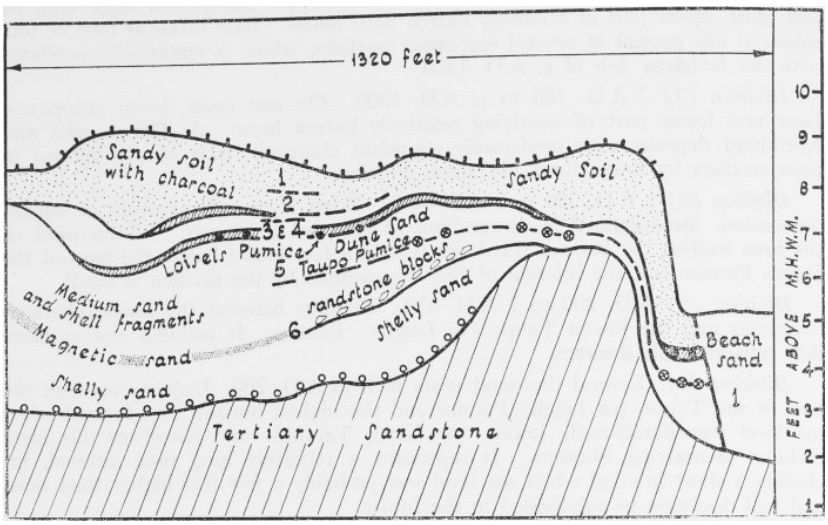

FIG. 5.—Longitudinal section with a hundred-fold vertical exaggeration along beach at Mahia Peninsula showing persistence of Holocene Divisions. Occupation layers in heavy shading.

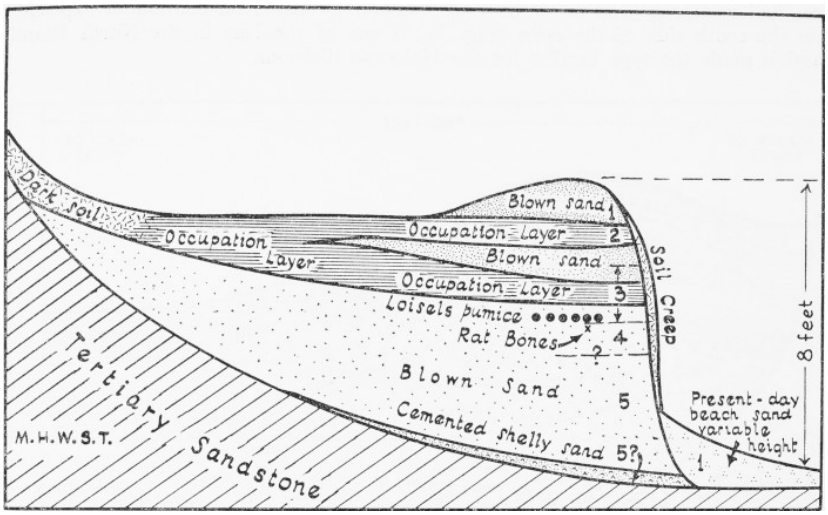

FIG. 6.—Diagrammatic section transverse to Loisels Beach showing Holocene deposits thinning and passing inland into a few inches of dark soil. Vertical exaggeration about ten-fold. Similar inland thinning is typical of almost all Holocene coastal sections.

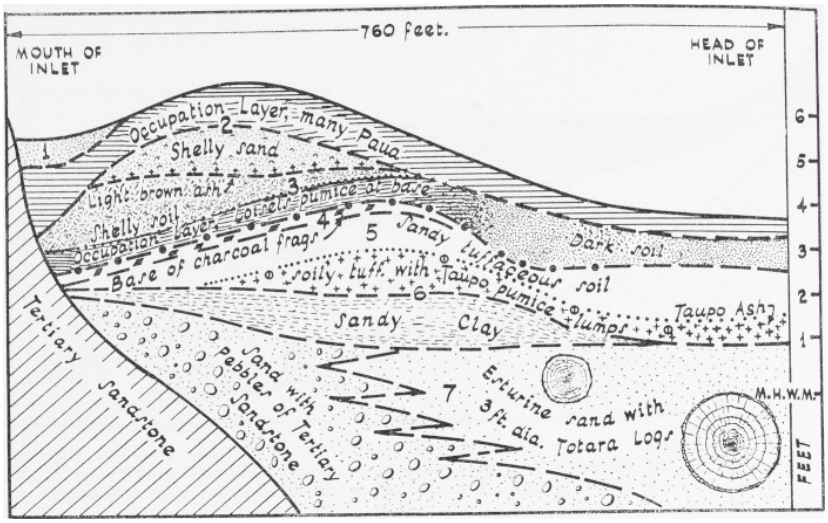

FIG. 7.—Longitudinal section with an eighty-fold vertical exaggeration showing Holocene Divisions along south side of Cooks Cove.

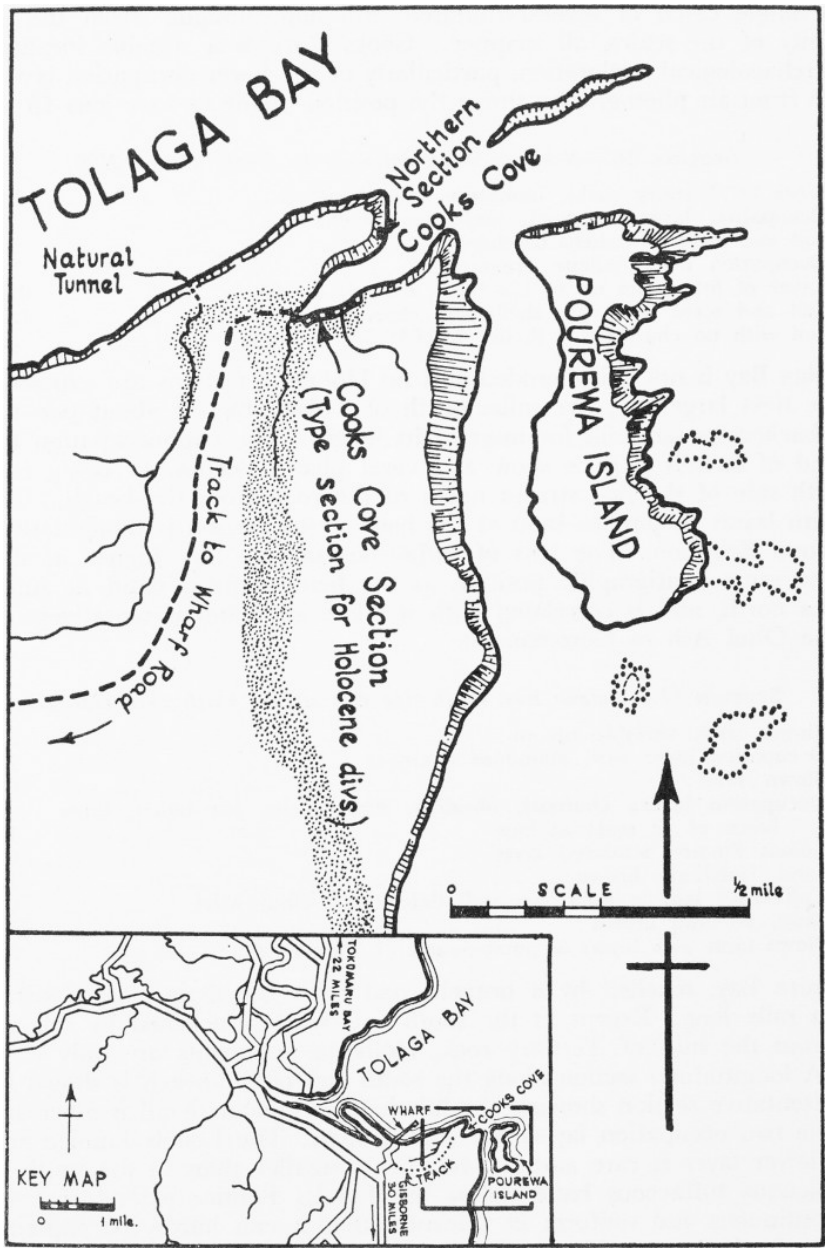

FIG. 8.—Sketch map from air photographs showing position of type Holocene section on south side of Cooks Cove and position of northern section. Inset: Locality map.

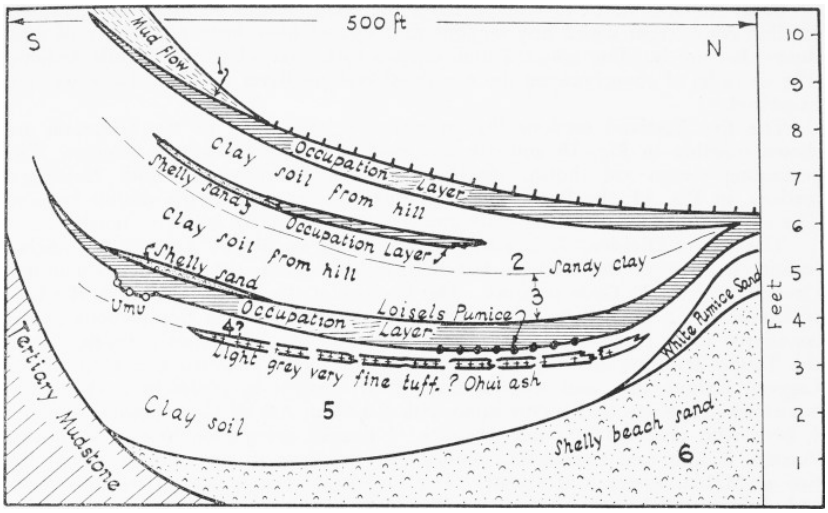

FIG. 9.—Longitudinal section with a forty-fold vertical exaggeration showing Holocene Divisions along southern part of Anaura Bay.

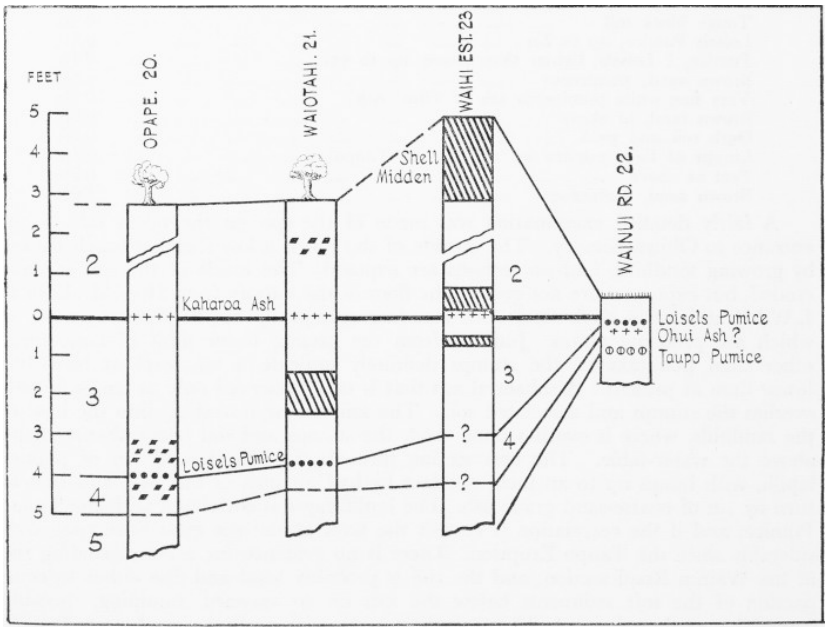

FIG. 10.—Correlation chart showing Holocene sections at Bay of Plenty. Ash layer that is tentatively correlated with that at Kaharoa is made datum horizon. Numbers at top of columns are those of text sections. Occupation layers are indicated by heavy shading.