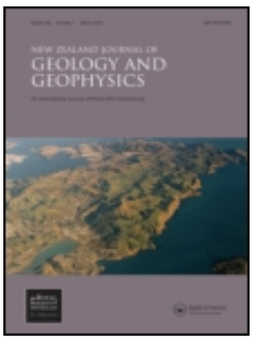

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# Zoological report on beach samples, Mangatawhiri Spit, June 1963

P. E. Hyde

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APPENDIX 1

# ZOOLOGICAL REPORT ON BEACH SAMPLES, MANGATAWHIRI SPIT, JUNE 1963

P. E. HYDE

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## *Procedure*

Fifteen beach samples were collected along Mangatawhiri Spit at the following intervals: Stations 1–11 at 400 yd; 11–12 at 300 yd; 12–15 at 200 yd (Fig. 5).

At each station, a representative sample of all specimens along the high-tide level was collected, and divided into four categories depending on the type of locality in which the forms were originally living. These were rocky-shore forms, harbour forms, ocean-sand forms, and off-shore channel forms. The species of each of these groups are listed in Table 1.

The relative numbers of each of these four types were calculated as percentages of the whole sample for each station, and these results are depicted in Graphs 1–4 (Fig. 14) with distinction between worn and fresh specimens.

## *Observations*

### *Graph 1—Specimens from Littoral Rocky Areas*

These could have come from the rocks at either end of Little Omaha Bay, as there were no rock outcrops along the beach, and, as far as is known, no outcrops off shore in the bay. The distribution shows a general along-shore drift, as specimens are scattered all along the Bay, decreasing slightly at the southern end.

### *Graph 2—Specimens from Harbour Localities*

There is a fairly constant, though low, level of harbour specimens along the whole beach, showing a definite along-shore drift from north to south, as the only available locality in which they could occur is the Whangateau Harbour. There are larger numbers of live, fresh, and worn specimens within the Whangateau Harbour mouth.

### *Graph 3—Ocean-sand Forms (Low Tide to Depths of 10 Fathoms)*

Apart from a decrease within the harbour, the percentages of worn shells show no definite pattern. There is a slight tendency for a decrease northwards in the number of fresh specimens. This is probably due to a greater number living away from the harbour mouth, and need not provide evidence for littoral drift.

### *Graph 4—Channel (Off-shore) Species (From Depths of 2 to 20 Fathoms, but Most Likely from 5 to 10 Fathoms)*

The probable origin of these forms, as also suggested by Mr W. F.

TABLE 1—List of Species Found Along Beach and at Off-shore Positions

ROCKY-SHORE SPECIES

MOLLUSCA

Polyplacophora
*Amaurochiton glaucus*
**Sypharochiton pelliserpentis*

Gastropoda
**Tugali sp.*
**Notoacmaea parviconoidea*
*Patelloidea corticata*
**Atalacmea fragilis*
*Cellana ornata*
*C. radians*
**Trochus viridis*
**Melagraphia aethiops*
**Anisodiloma lugubris*
**Micrelenchus sanguineus*
**Maurea punctulata*
*Cookia sulcata*
*Lunella smaragda*
*Nerita melanotragus*
**Zeacumantus subcarinatus*
**Maoricrypta costata*
**Lepsiella scobina*
**Maustrum haustorium*
*Neothais scalaris*
**Buccinulum heteromorphum*
**Cominella maculosa*
***Siphonaria zelandica*

Bivalvia
***Crassostrea glomerata*
***Anomia walteri*

BRACHIOPODA
***Waltonia walteri*

ECHINODERMATA
***Evechinus chloriticus*

OFF-SHORE CHANNEL SPECIES

MOLLUSCA

Polyplacophora
**Anthochiton canaliculatus*

Gastropoda
**Cominella quoyana*
**Xymenella pusilla*

Bivalvia
*Glycymeris laticostata*
*G. modesta*
**Venericardia purpurata*
*Tawera spissa*
***Longimactra elongata*
*Gari strangei*
**Notocorbula zelandica*

HARBOUR SPECIES

MOLLUSCA
Gastropoda
*Zediloma subrostrata*
*Zeacumantus lutulentus*
***Cominella glandiformis*
***Amphibola crenata*

Bivalvia
*Amphidesma australis*
*Chione stutchburyi*

OCEAN-SAND SPECIES

SANDY-SHORE SPECIES

MOLLUSCA

Bivalvia
*Amphidesma subtriangulatum*
*Dosinia anus*
***Spisula equilateralis*

SANDY OFF-SHORE SPECIES (not in Appendix 2)

MOLLUSCA

Gastropoda
*Zethalia zelandica*
*Struthiolaria papulosa*
*Cominella adspersa*

Bivalvia
*Panopea zelandica*

*Noted on beach only by P. E. Hyde (Appendix I).
**Noted only from marine floor by W. F. Ponder (Appendix 2).
Species without * or ** were noted both on beach and in off-shore positions.

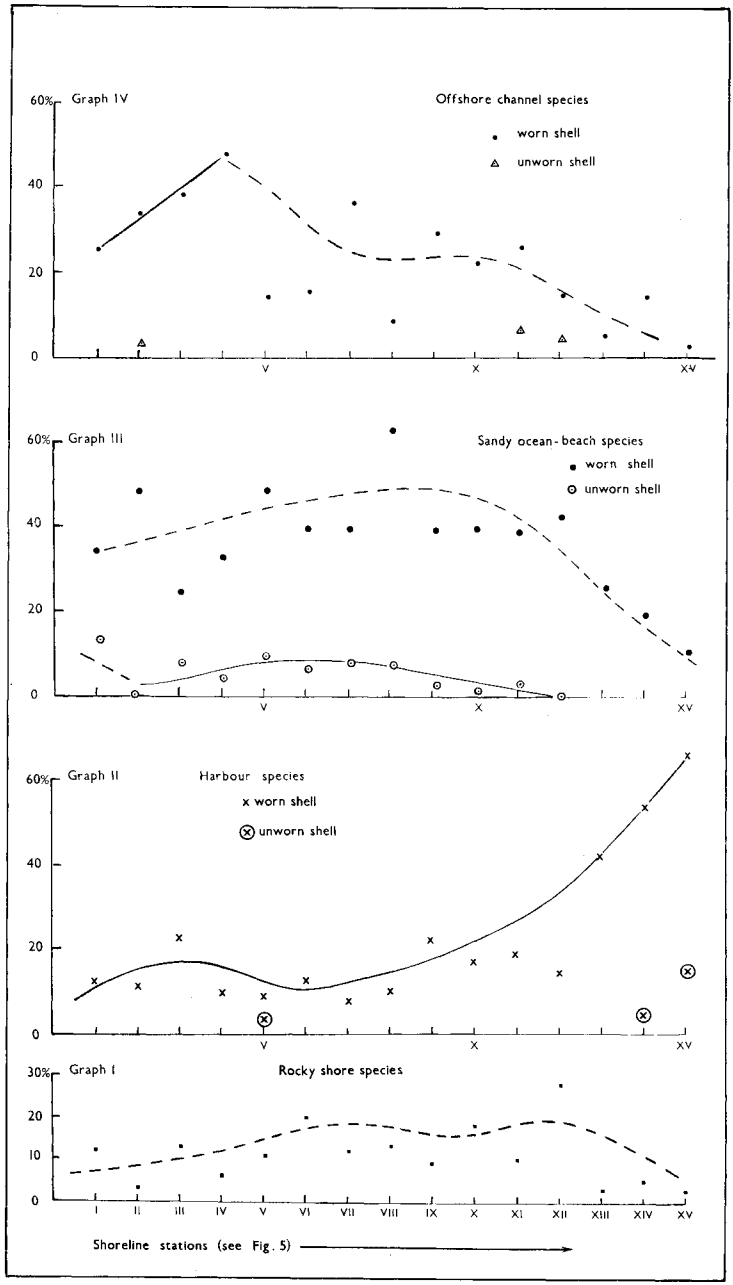


FIG. 14—Occurrence of molluscs along Mangatawhiri Spit—"rocky-shore" (graph 1), "harbour" (graph 2), "ocean-beach sand" (graph 3), and "off-shore channel" (graph 4) species, by P. E. Hyde.

Ponder (Appendix 2), is at the northern and southern extremities of Little Omaha Bay, and this is borne out by the occurrence of fresh specimens at stations 2, 11, and 12. The marked scatter in the results could be due to interaction of past periods of deposition (*see* footnote p. 707), with a dominant trend of new specimens brought to the coast at station IV (*see* Fig. 5).

### *Discussion*

The evidence from graphs 1 and 2 suggests that the present position of the bulk of the shells is due to many past events, littoral drift having been sometimes northwards and at other times southwards. Graph 4 suggests that littoral drift may have been, at the time of collection, southwards and northwards from station 4, which is slightly south of the mid-point along the ocean coast of Mangatawhiri Spit.

APPENDIX 2

## MALACOLOGICAL EVIDENCE, LITTLE OMAHA BAY, DECEMBER 1963

W. F. PONDER

Zoology Department, University of Auckland

### *Procedure*

Each sample filled a half-gallon tin and was dried and sieved with $\frac{1}{10}$ and $\frac{1}{4}$ in. sieves. The fraction between $\frac{1}{10}$ and $\frac{1}{4}$ in. was called the "fine fraction" and that larger than $\frac{1}{4}$ in. the "coarse fraction". Each fraction was weighed and total weight calculated (Table 2). The *Tawera spissa* valves, including all recognisable fragments, were sorted from the "coarse fraction" and weighed (Table 2). Harbour, sandy-shore, channel, and rocky-shore species (Table 1) (including fragments) were counted from both the fine and coarse fractions (Table 2).

### *Observations*

(1) Within Little Omaha Bay the greatest number of harbour species is close to the entrance of Whangateau Harbour. From here the greatest concentrations spread southwards near the shore of Mangatawhiri Spit, and also across the northern parts of the Bay (Fig. 9).

(2) In-shore sandy-beach species which live at, or just below, low-tide springs occur in only a few stations close to the shore, and provide no evidence for drift, except eastwards towards N34/158 (Fig. 9).

(3) Distribution of the rocky-shore species suggests considerable movement from the northern end, where suitable rocky outcrops occur towards

the centre of the Bay. Although rocky-shore species exist at the southern end of the Bay, there is little evidence for movement northwards (*see* Table 2). There is also no evidence for transportation of these species into deep water.

(4) *Tawera* was selected to demonstrate transportation of "off-shore channel" species. Living specimens have been found in the vicinity of sample stations N34/149 and N34/162, and it is from these regions that *Tawera* concentrations decrease, suggesting transportation southwards near the shore of Mangatawhiri Spit and in several directions away from Karamuroa Point (*see* Fig. 10).

TABLE 2—Shell Fractions within a Half-Gallon Sample

| Sample No. | Weight in Grammes of Shell | | | | Number of Fragments of: | | | |
|---|---|---|---|---|---|---|---|---|
| | Coarse Fraction | Fine Fraction | Total | Tawera (Coarse Fraction) | Harbour Species | In-shore Sandy Species | Channel Species | Rocky |
| N34/145 | 42·2 | 13·3 | 55·5 | 38·2 | 10 | 14 | ... | 2 |
| /146 | 57·3 | 11·8 | 69·1 | 52·0 | 9 | 5 | ... | 1 |
| /147 | 92·9 | 71·4 | 164·3 | 53·4 | 89 | 7 | 3 | 9 |
| /148 | 396·8 | 58·3 | 455·1 | 73·8 | 108 | 7 | 3 | 12 |
| /149 | 68·5 | 55·9 | 124·4 | 36·0 | 50 | ... | ... | 7 |
| /150 | 106·7 | 76·4 | 183·1 | 95·1 | 3 | 1 | 1 | 20 |
| /151 | 28·3 | 28·8 | 57·1 | 12·8 | ... | ... | 8 | 8 |
| /152 | 56·6 | 6·0 | 72·6 | 4·7 | 2 | ... | ... | 7 |
| /153 | 26·7 | 22·5 | 49·2 | 23·6 | 1 | ... | 1 | 13 |
| /154 | 37·4 | 35·4 | 72·8 | 32·4 | 8 | ... | ... | 2 |
| /155 | 76·0 | 54·5 | 130·5 | 63·7 | 2 | ... | 5 | ... |
| /156 | 12·8 | 14·1 | 26·9 | 7·6 | ... | ... | ... | ... |
| /157 | 211·3 | 72·5 | 283·8 | 201·8 | 2 | ... | 4 | 3 |
| /158 | 228·9 | 120·4 | 349·3 | 183·5 | 3 | 1 | 5 | 1 |
| /159 | 34·4 | 5·8 | 40·2 | 25·4 | 5 | 3 | ... | 4 |
| /160 | 42·2 | 17·3 | 59·5 | 29·6 | 3 | ... | 1 | 3 |
| /161 | 21·6 | 14·4 | 36·0 | 19·9 | ... | ... | 2 | 1 |
| /162 | 342·6 | 858·4 | 1200·8 | 260·7 | 4 | ... | 60 | 128 |
| /163 | 270·8 | 87·3 | 358·1 | 254·3 | ... | ... | 2 | ... |
| /164 | 80·8 | 46·4 | 127·2 | 54·1 | ... | ... | 9 | ... |
| /165 | 10·4 | 39·3 | 49·7 | 1·6 | 3 | ... | 5 | ... |
| /166 | 57·9 | 60·5 | 118·4 | 32·4 | ... | ... | 27 | 2 |
| /167 | 26·1 | 20·4 | 46·5 | 20·5 | ... | ... | 10 | ... |
| /168 | 16·4 | 17·4 | 33·8 | 13·5 | ... | ... | ... | ... |
| /169 | 7·4 | 19·1 | 26·5 | 5·3 | ... | ... | 1 | 1 |
| /170 | 13·7 | 19·6 | 33·3 | 9·2 | ... | ... | 1 | 27 |
| /184 | 5·6 | 7·1 | 12·7 | 0·8 | 6 | ... | ... | 8 |

## *Conclusion*

During December 1963 there appeared to be a shallow-water southerly drift and a deeper-water northerly current that, at about the region of N34/158, also moved in towards Mangatawhiri Spit (Fig. 10).

APPENDIX 3

# STATISTICS

## INTRODUCTION

J. C. SCHOFIELD

Over 100,000 grains of sand were mounted on microscope slides, chemically treated, and counted to produce the mineralogical evidence for the above report, and over half of these were counted for a statistical appraisal of the results. Although deductions from the feldspar/quartz ratios were in keeping with deductions from other evidence, they were also the best evidence for major off-shore changes between June and December 1963. To be certain of the reality of these changes there were three aspects that required statistical investigation: Firstly, how much variation could there be of feldspar/quartz ratios within one sample of sand; secondly, how much variation could there be of feldspar/quartz ratios within the sand close to any particular sampling point; and thirdly, what effect had grain size on feldspar/quartz ratios?

TABLE 3—Feldspar/quartz Ratios for Median Grain Sizes, Mangatawhiri Spit

| Locality | Sample | Median in mm | F/Q Ratios | |
|---|---|---|---|---|
| | | | 1st | 2nd |
| (1) | | | | |
| Approx. mid beach | (a) | 0·15 | 2·48 | 2·30 |
| | (b) | 0·16 | 2·6 | 2·64 |
| | (c) | 0·17 | 2·44 | 1·97 |
| | (d) | 0·185 | 2·36 | 2·68 |
| (2) | | | | |
| Twenty chains north of (1) | (a) | 0·195 | 2·63 | 2·66 |
| | (b) | 0·20 | 2·32 | 2·50 |
| | (c) | 0·21 | 2·93 | 2·44 |
| | (d) | 0·20 | 2·10 | 2·48 |
| (3) | | | | |
| Twenty chains north of (2) | (a) | 0·195 | 3·21 | 2·66 |
| | (b) | 0·17 | 2·59 | 2·62 |
| | (c) | 0·195 | 2·66 | 2·35 |
| | (d) | 0·185 | 2·26 | 2·90 |
| (4) | | | | |
| Twenty chains north of (3) | (a) | 0·19 | 2·54 | 2·39 |
| | (b) | 0·20 | 2·05 | 2·20 |
| | (c) | 0·19 | 2·64 | 2·21 |
| | (d) | 0·185 | 2·67 | 2·23 |
| (5) | | | | |
| Twenty chains north of (4) | (a) | 0·24 | 2·21 | 1·96 |
| | (b) | 0·23 | 2·1 | 2·0 |
| | (c) | 0·21 | 2·23 | 2·44 |
| | (b) | 0·24 | 2·24 | 2·24 |

Figures for the first two investigations are given in Table 3 and for the third in Table 4. The statistical results are summarised as follows by Dr H. R. Thompson, Director, Applied Mathematics Laboratory, D.S.I.R.

TABLE 4—Feldspar/quartz Ratios for Different Size Fractions

| Sample | Grid Ref. in N. 34 | Size Limits in Millimetres | | | |
|---|---|---|---|---|---|
| | | 0·25–0·35 | 0·178–0·25 | 0·152–0·178 | 0·104–0·152 |
| N34/138 | 293256 | 1·7 | 1·7 | 1·95 | 2·15 |
| /139 | 277252 | 1·45 | 1·45 | 1·4 | 1·0 |
| /140 | 280248 | 1·40 | 1·65 | 1·90 | 1·3 |
| /148 | 295244 | 1·80 | 2·60 | 2·50 | 2·20 |
| /152 | 299236 | 2·00 | 1·90 | 2·10 | 1·70 |
| /156 | 328234 | 3·00 | 3·80 | 3·20 | 2·75 |
| /157 | 318229 | 1·90 | 2·35 | 1·90 | 2·05 |
| /159 | 298226 | 1·75 | 2·20 | 1·85 | 1·20 |
| /161 | 311220 | 2·20 | 2·40 | 2·60 | 1·75 |
| /163 | 322222 | 2·65 | 2·70 | 2·80 | 2·60 |
| /164 | 330223 | 2·80 | 2·90 | 2·75 | 2·95 |
| /186 | 299214 | 3·25 | 3·40 | 3·35 | 2·15 |
| /188 | 294225 | 2·75 | 2·70 | 2·90 | 2·35 |
| /192 | 293278 | 2·60 | 2·50 | 2·60 | 2·80 |

## RESULTS

H. R. THOMPSON

Applied Mathematics Laboratory, Department of Scientific and Industrial Research

To determine the degree of accuracy with which estimated contours of feldspar/quartz ratio could be drawn, a sample investigation was planned, in which four samples approximately 5 yd apart were taken from five places along the beach at 20 ch. intervals. On each of the 20 samples two separate repeat estimations of the feldspar/quartz ratio *at the median grain size* were made (Table 3). *Analysis* of the results showed that the largest component of variation was that due to repeat estimates, and that the component due to different samples at the same place was negligible in comparison. This indicates that one point is reasonably representative of its immediate vicinity, and that greater accuracy can be obtained by making more determinations in the same samples.

The standard error of the average of two repeat estimations from a single sample was found to be 0·17; by this is meant, for example, that there is a better than 90% chance that the true value is within $\pm 0{\cdot}3$ of the estimated value. Corresponding chances for within $\pm 0{\cdot}25$ and $\pm 0{\cdot}2$ are 85% and 75% respectively. The standard error of 0·15, found for the *mean*

of the four different grain-size fractions in 14 samples (Table 4), is within the limits of error found in repeat estimations and will have no significant additional effect. On this basis it is very unlikely that enough observed feldspar/quartz ratios would be so far out as to make any appreciable difference to estimated contours with an interval of 0·5, such as on Fig. 5 or Fig. 7.

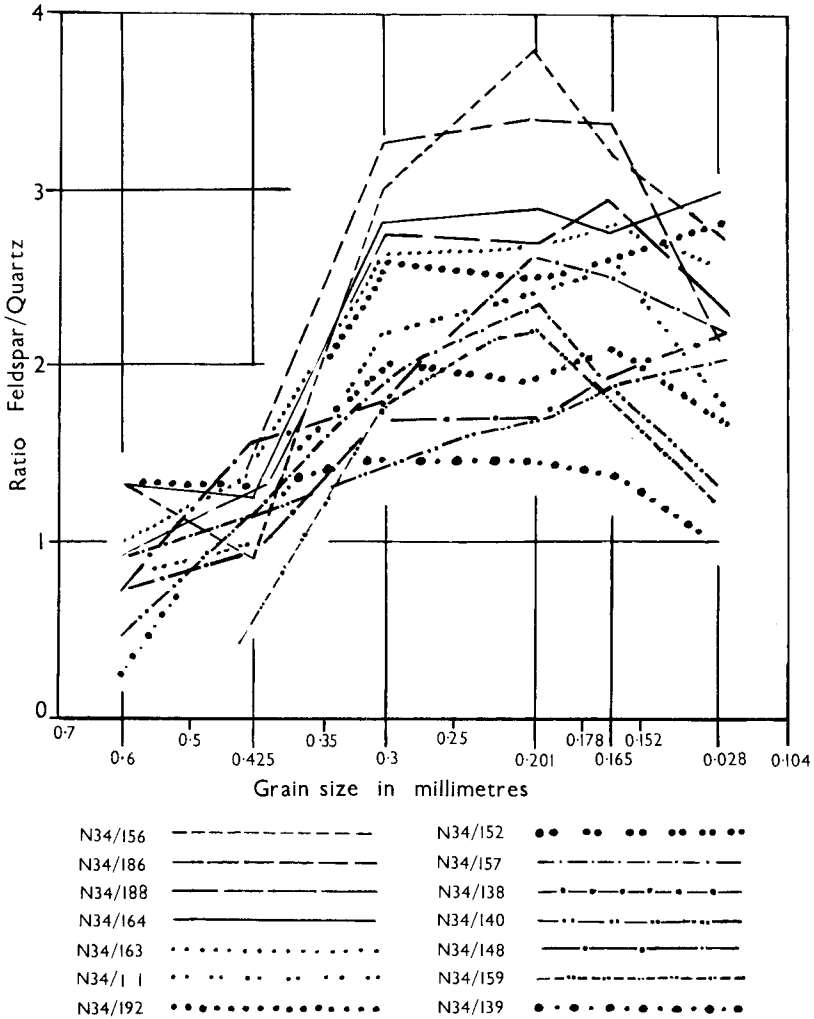


FIG. 15—Feldspar content related to grain size. Grain size is plotted on a log scale. Each plot is the mean of the range for each fraction, the fractions being 0·104–0·152, 0·152–0·178, 0·178–0·25, 0·25–0·35, 0·35–0·5, and 0·5–0·699 mm.

## TABLE 5—Mineralogical and Grain-size Analyses

| Sample in N34/ | Percentage* (shell free) Q | Na | K | Fe | R** | F/Q*** | Median (mm) | Depth B.L.T. (ft) | Grid Ref. N34/ | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 35 | 59 | 0.9 | 5.2 | - | 1.71 | 0.225 | - | 294244 | H.S.T.B. |
| 101 | 30 | 62 | 0.8 | 7.2 | - | 2.05 | 0.22 | - | 294245 | H.S.T.B. |
| 102 | 38 | 60 | 1.8 | 0.8 | - | 1.64 | 0.25 | - | 295248 | H.S.T.B. |
| 103 | 27 | 71 | 1.4 | 1.4 | - | 2.66 | 0.22 | - | 295252 | H.S.T.B. |
| 104 | 31 | 66 | 3.6 | 0.4 | - | 2.27 | 0.155 | - | 294243 | H.T.L. |
| 105 | 33 | 64 | 2.3 | 0.4 | - | 1.97 | 0.135 | - | 294235 | H.T.L. |
| 106 | 21 | 74 | 3.3 | 1.0 | - | 3.37 | 0.140 | - | 295228 | H.T.L. |
| 107 | 28 | 66 | 3.7 | 1.7 | - | 2.50 | 0.145 | - | 303215 | H.S.T.B. |
| 108 | 30 | 58 | 3.1 | 8.7 | - | 2.01 | 0.115 | 34 | 306242 | - |
| 109 | 22 | 60 | 3.6 | 12.0 | - | 2.91 | 0.15 | 45 | 311237 | - |
| 110 | - | - | - | - | - | - | - | 52 | 324218 | Coarse shell with live Tawera spissa and Notocorbula zealandica |
| 111 | 26 | 71 | 1.4 | 1.2 | - | 2.75 | 0.14 | 22 | 327212 | - |
| 112 | 19 | 73 | 1.9 | 6.0 | - | 3.93 | 0.26 | 60 | 324220 | - |
| 113 | 25 | 63 | 0.6 | 12.0 | - | 2.59 | 0.24 | 68 | 328224 | - |
| 114 | 36 | 61 | 0.6 | 2.3 | - | 1.71 | 0.31 | 87 | 326245 | - |
| 115 | 36 | 49 | 4.0 | 11.0 | - | 1.45 | 0.125 | 87 | 316252 | - |
| 116 | 27 | 69 | 2.4 | 1.5 | - | 2.58 | 0.135 | 2 | 302219 | - |
| 117 | 30 | 66 | 3.3 | 0.8 | - | 2.33 | 0.14 | 13 | 306220 | - |
| 118 | 27 | 66 | 6.6 | 1.1 | - | 2.8 | 0.114 | 22 | 309221 | - |
| 119 | 30 | 59 | 7.8 | 3.1 | - | 2.24 | 0.107 | 35 | 311223 | - |
| 120 | 21 | 71 | 4.9 | 2.6 | - | 3.56 | 0.145 | 48 | 319226 | - |
| 121 | 29 | 62 | 2.3 | 6.8 | - | 2.25 | 0.26 | 65 | 325226 | - |
| 122 | 22 | 71 | 3.5 | 3.7 | - | 3.32 | 0.166 | 73+ | 333230 | - |
| 123 | 30 | 57 | 1.7 | 11.0 | - | 1.95 | 0.19 | 50 | 318236 | - |
| 124 | 37 | 48 | 2.6 | 14.0 | - | 1.42 | 0.15 | 57 | 318243 | - |
| 125 | 33 | 58 | 5.0 | 4.2 | - | 1.9 | 0.127 | 24 | 303242 | - |
| 126 | 30 | 66 | 1.7 | 2.1 | - | 2.21 | 0.34 | 1 | 297251 | - |
| 127 | 34 | 63 | 2.1 | 0.5 | - | 1.94 | 0.29 | 1 | 296251 | - |
| 130 | 46 | 47 | 0.8 | 6.5 | - | 1.03 | 0.59 | 10 | 300248 | - |
| 131 | 29 | 66 | 2.1 | 1.7 | - | 2.42 | 0.26 | 6 | 297245 | - |
| 132 | 40 | 58 | 0.97 | 0.97 | - | 1.49 | 0.41 | 11 | 299245 | - |
| 133 | 27 | 55 | 3.7 | 15.0 | - | 2.14 | 0.185 | 16 | 301245 | - |
| 134 | - | - | - | - | - | - | 0.17 | - | 302245 | - |
| 135 | 26 | 69 | 3.3 | 1.7 | - | 2.78 | 0.17 | 8 | 298237 | - |
| 136 | 24 | 69 | 4.9 | 2.4 | - | 3.05 | 0.18 | 14 | 299237 | - |
| 137 | 25 | 69 | 5.1 | 1.3 | - | 3.02 | 0.19 | 15 | 301237 | Samples 138-140 see Table 4 |
| 141 | 34 | 53 | 5.5 | 7.5 | - | 1.7 | 0.17 | - | 283247 | Harbour channel |
| 142 | 30 | 67 | 2.1 | 1.0 | - | 2.3 | 0.16 | - | 303214 | Dune |
| 145 | 37 | 57 | 4.2 | 1.4 | - | 1.64 | 0.155 | 6 | 299217 | - |
| 146 | 25 | 70 | 2.7 | 1.1 | 1.4 | 2.95 | 0.17 | 6 | 299225 | - |
| 147 | 27 | 63 | 1.5 | 2.7 | 5.0 | 2.39 | 0.27 | 7 | 294238 | Sample 148 see Table 4 |
| 149 | 41 | 52 | 1.9 | 2.7 | 2.5 | 1.32 | 0.24 | 18 | 298242 | - |
| 150 | 28 | 48 | 1.8 | 22.0 | - | 1.75 | 0.175 | 26 | 306242 | - |
| 151 | 36 | 50 | 1.5 | 6.6 | 6.7 | 1.41 | 0.135 | 43 | 313243 | Sample 152 see Table 4 |
| 153 | 35 | 50 | 4.2 | 6.0 | 4.6 | 1.56 | 0.132 | 36 | 307238 | - |
| 154 | 29 | 62 | 1.3 | 5.7 | 2.2 | 2.19 | 0.182 | 56 | 317237 | - |
| 155 | 25 | 52 | 0.6 | 18.0 | 4.3 | 2.08 | 0.27 | 76 | 322239 | - |
| 158 | 26 | 59 | 1.8 | 12.0 | 1.1 | 2.31 | 0.15 | 45 | 311226 | Samples 156, 157, and 159 see Table 4 |
| 160 | 37 | 58 | 2.4 | 2.6 | - | 1.66 | 0.14 | 18 | 302218 | Sample 161 see Table 4 |
| 162 | 24 | 70 | 2.3 | 2.6 | 0.7 | 3.03 | 2.4 | 38 | 316216 | Mainly Shell Results for 0.104-0.25 mm |
| 165 | 24 | 66 | 1.8 | 4.2 | 3.5 | 2.8 | 0.175 | 95 | 340228 | Samples 163, 164 see Table 4 |
| 166 | 28 | 53 | 0.3 | 11.0 | 7.5 | 3.05 | 0.39 | 90 | 335221 | - |
| 167 | 23 | 71 | 0.9 | 4.9 | 0.7 | 3.2 | 0.24 | 75 | 334215 | - |
| 168 | 25 | 66 | 1.9 | 7.3 | - | 2.78 | 0.155 | 60 | 327214 | - |
| 169 | 24 | 68 | 1.8 | 3.0 | 2.4 | 2.87 | 0.145 | 45 | 325213 | - |
| 170 | 28 | 65 | 2.3 | 4.5 | - | 2.32 | 0.13 | 42 | 322213 | - |
| 171 | 17 | 14 | 1.6 | 3.3 | 64.0 | 0.93 | 0.44 | 56 | 371163 | F/Q for 0.178-0.25 mm = 1.0 |
| 172 | 12 | 14 | 0.6 | 0.6 | 72.0 | 1.15 | 1.25 | 56 | 371174 | Analyses are for grain sizes 0.25-0.5 mm. F/Q for 0.178-0.25 = 1.68 |
| 173 | - | - | - | - | - | 2.61 | 1.35 | 67 | 381203 | F/Q given is for 0.178-0.25 mm |
| 174 | 23 | 51 | 0.7 | 1.2 | 23.0 | 2.23 | 0.85 | 109 | 380210 | Results are for 0.25-0.5 mm |
| 175 | 27 | 53 | 1.0 | 5.9 | 13.0 | 2.06 | 0.21 | 145 | 397215 | - |
| 176 | - | - | - | - | - | 3.0 | 0.85 | 103 | 378213 | F/Q is for 0.178-0.25 mm |
| 177 | 24 | 62 | 1.2 | 10.0 | 3.0 | 2.57 | 0.52 | 79 | 364205 | Results are for 0.104-0.25 mm |
| 178 | 23 | 64 | 1.8 | 10.0 | 0.9 | 2.8 | 0.21 | 57 | 357202 | - |
| 179 | 25 | 57 | 4.0 | 14.0 | 0.4 | 2.43 | 0.16 | 35 | 353198 | - |
| 180 | 27 | 63 | 1.8 | 5.4 | 2.7 | 2.4 | 0.145 | 19 | 334207 | - |
| 181 | 26 | 67 | 1.6 | 5.2 | - | 2.65 | 0.14 | 36 | 338210 | - |
| 182 | 23 | 66 | 2.9 | 4.1 | 3.9 | 2.97 | 0.155 | 62 | 342213 | - |
| 183 | 24 | 66 | 4.5 | 6.3 | - | 2.95 | 0.132 | 81 | 344219 | - |
| 184 | 29 | 60 | 5.2 | 6.0 | - | 2.23 | 0.12 | 24 | 310215 | - |
| 185 | 33 | 59 | 3.7 | 2.6 | 1.7 | 1.9 | 0.137 | - | 302211 | H.S.T.B. |
| 187 | 25 | 72 | 3.0 | 1.0 | 1.5 | 3.01 | 0.17 | - | 296220 | H.S.T.B. For samples 186 and 188 see Table 4 |
| 189 | 25 | 68 | 2.9 | 1.4 | 2.4 | 2.8 | 0.165 | - | 293231 | H.S.T.B. |
| 190 | 30 | 65 | 0.9 | 4.3 | - | 2.21 | 0.17 | - | 297237 | H.S.T.B. |
| 191 | 31 | 64 | 1.4 | 3.2 | - | 2.11 | 0.195 | - | 293242 | H.S.T.B. For 192 see Table 4 |
| 193 | 43 | 42 | 1.0 | 3.8 | 10.0 | 1.0 | 0.37 | - | 295250 | Matrix of shelly sand bar in Whangateau Harbour |
| 194 | 37 | 42 | 1.3 | 3.1 | 17.0 | 1.17 | 3.0 | 82 | 352173 | Result for 0.25-0.5 mm F/Q for 0.178-0.25 = 1.73 |
| 195 | 37 | 41 | 1.0 | 1.3 | 20.0 | 1.13 | 1.5 | 58 | 320160 | Results for 0.25-0.5 mm F/Q for 0.152-0.178 = 1.17 |

Abbreviations

Q, quartz; Na, soda-calc feldspars; K, potassium feldspar; Fe, ferromagnesian minerals; R, unidentified but mainly rock fragments; F/Q, feldspars (Na plus K)/Q; depth B.L.T., depth below low tide; H.S.T.B., high spring-tide berm; H.T.L., high-tide level.

* All percentages are calculated to the nearest two significant figures.

** Where "R" (unidentified minerals) has not been observed, the percentages for Q, Na, K, and Fe are on an "unidentified mineral-free" as well as a shell-free basis. As "R" is generally low, and as "R" for the rest of the samples in this table means samples re-collected over the whole area in December 1963, it was considered unnecessary to recount those samples in which "R" was not counted.

*** F/Q results in both this table and on figures accompanying this paper are based on ratio of the actual counts and hence may be slightly different from those calculated from the percentages given in this table.

### FELDSPAR CONTENT RELATED TO GRAIN SIZE

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As feldspar breaks up more easily than quartz, it was thought that there may be an inverse relationship of feldspar/quartz ratios and decrease in grain size. Six size fractions—0·5 mm plus, 0·35 to 0·5 mm, 0·25 to 0·35 mm, 0·178 to 0·25 mm, 0·152 to 0·178, and 0·104 to 0·152 mm—for 14 samples were accordingly analysed with the results plotted in Fig. 15. As only three of the 80 samples collected north-west of Tawharanui Peninsula (i.e., in Whangateau Harbour, shores of Mangatawhiri Spit, and Omaha Bay) had medians greater than 0·35 mm, only the results for the fractions less than 0·35 mm (Table 4) were used in statistical analyses (*see above*). Fig. 15 confirms the lack of any definite trend of feldspar content in grain sizes ranging from 0·104 to 0·35 mm, but it shows a marked decrease of feldspar in grain sizes greater than these.

The sudden change in feldspar content between 0·5 and 0·35 mm suggests that most of the original feldspar grains were below 0·5 mm, and that there has been little transport to produce a more gradual change. That there has been little transport is suggested also by the high angularity of the sand grains and the exceptionally high feldspar content, which ranges between 50% and 75% (Table 5).

## APPENDIX 4

## MINERALOGICAL AND GRAIN-SIZE ANALYSES (Table 5)

J. C. SCHOFIELD

Most of the grain-size analyses were determined by the settling-tube method (Emery, 1938). The "tails" are not accurately determined by this method, but the greater part of the sample (and thus its median) is as accurately determined as when sieves are used.

Feldspars were determined by use of hydrofluoric acid and sodium cobaltinitrite (Hayes and Klugman, 1959). Microscopic slides were coated with a solution of Canada balsam or a moderately viscous solution of D.P.X. or Depex, and then dried. In mounting a sand sample the surface of the mountant was reactivated by smearing a little xylol on it, which allowed the grains to stick to the outside but not be buried. The mountant must not be too thin on the slide or the hydrofluoric acid penetrates and weakens the adhesion of the mountant to the slide, and also of the grains to the mountant. This is particularly true of the feldspar grains, for adhesion is also weakened by their reaction with the hydrofluoric acid.

### REFERENCES

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