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DISTRIBUTION OF SURFACE SEDIMENTS OF PAUATAHANUI INLET

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INTRODUCTION

Surface sediment samples collected from Pauatahanui Inlet during January, February, November and December 1975 and March 1976, biological samples collected by I.N. Estcourt and intertidal sediment samples collected by Ministry of Works and Development have been examined in a study initiated to assist the Pauatahanui Environmental Programme. It is also intended to produce a sediment chart on a scale of 1:5,000 in the N.Z. Oceanographic Institute Miscellaneous Chart Series.

EQUIPMENT AND COLLECTION OF SAMPLES

An 18 ft aluminium boat was used for sampling, with the first series of station positions taken from a pre-determined grid covering the inlet. As analysis of these samples progressed, further station positions (Fig. 1)* were selected to give better definition to the sedimentary boundaries. Station positions have been expressed with reference to N.Z.M.S.1 Sheet 160 (N.Z. Department of Lands and Survey 1965) (Table 1). Positions from the boat were obtained from visual cross bearings using natural features and prominent landmarks.

Scuba divers obtained the samples using a modified corer for 24 stations (19 cores) and a hand shovel for the remaining 92 stations. The results of sediment analysis from nine intertidal samples have been made available by the Ministry of Works and Development. A visual survey of the total intertidal area has also been made.

The corer consists of a section of galvanised-iron pipe, 1 metre long and 7.6 cms diameter with a steel cutter fitted on the bottom end to facilitate penetration. A heavy mallet is used to drive the corer into the sediment. No catcher was required to prevent loss of the core on removal as in a standard gravity corer, owing to the extremely dense nature of the sediment found at the majority of stations. At five positions sediment density made it impossible for the corer to penetrate further than 10 cm.

Surface samples were obtained by the diver scooping the upper 5-10 cm of sediment into a jar with the small shovel. It was unnecessary to anchor the boat during this procedure as the maximum time involved was only 2 minutes. However when coring, with a possible time of 5 minutes, movement of the boat by tide and wind made anchoring essential. Water depths were obtained from the diver's gauge with an accuracy of 1 metre.

Bathymetry of Inlet

From a sounding survey of the inlet carried out by Truebridge, Callendar, Beach and Co. in 1974†, together with additional soundings at the eastern side by N.Z.O.I., a bathymetric chart on a scale of 1:5,000 has been produced (Irwin, in press).

There is a significant relationship between the bathymetry and the sediment pattern of the inlet which is shown specifically in the main channel with depths to 9 metres (*see* below). At the deltas of the inflowing streams, shoals of silt and sand are exposed at low tide. The 1855 earthquake which raised Pauatahanui Inlet slightly more than 1 metre (Adkin 1921; Stevens 1974 : 186, 239) has caused a large area to become dry or marshy and, by decreasing the volume of water coming in on each tide, has allowed sediment to settle and accumulate, leading to the build-up of shoals. These shoals and surrounding areas are exposed at low tide (Fig. 2).

SEDIMENT DISTRIBUTION

Surface

The surface sediments of the inlet consist of areas dominated respectively by sand, silt or shell (gravel grade) with intermediate zones of sandy silt, silty sand or shelly sand in varying proportions. The percentages of surface sediment grade sizes (gravel > 2 mm; sand 0.06-2 mm; silt 0.006-0.06 mm) at the station positions where sampling was undertaken are shown in Table 1.

The most noticeable sedimentary features are the shoals east of Mana (Fig. 2) which are exposed at low tide. The dominant grade size is sand ranging from 87% (M82) to 95% (M83) of the total sediment.

Similar shoals are found on the southern side of the main channel from Shearers Point to Moorhouse Point (*see* Fig. 1 for localities) and east of this point. An abundant growth of eel grass (*Zostera* sp.) is found

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* M 1-120 : NZOI stations
MW 1-7, 9, 10 : MOWD samples

† Unpublished collector commissioned by Porirua City Council. Truebridge, Callendar, Beach and Co., Hunter St, Wellington.

TABLE 1. Station positions and grain-size distribution in the surface sediments of Pauatahanui Inlet.

NZOI Stn No.	NZMS 1 N160 Grid Ref.	Depth (m)	Percentage in Total Sediment Gravel	Sand	Silt	Clay
M 1	674103	4.0	visual analysis			
M 2	673106	2.0	"		"	
M 3	683099	1.7	"		"	
M 4	680109	1.1	2.0	91.1	3.2	3.7
M 5	684106	1.8	-	90.0	4.0	6.0
M 6	696097	2.0	1.0	11.9	61.0	26.1
M 7	697103	1.8	-	74.0	14.0	12.0
M 8	697099	2.2	-	6.0	65.8	28.2
M 9	697101	2.1	-	4.0	67.2	28.8
M10	693106	1.7	5.0	13.3	58.0	23.0
M11	693103	2.3	-	5.0	69.4	25.6
M12	692100	2.4	-	3.0	67.9	29.1
M13	692098	2.3	-	3.0	66.9	30.1
M14	687099	2.3	-	18.0	54.9	27.1
M15	686102	1.1	-	91.0	3.3	5.7
M16	703101	0.9	-	93.0	4.1	2.9
M17	698104	1.5	5.0	71.0	18.7	5.3
M18	698102	1.8	-	84.0	8.9	7.1
M19	698099	2.1	-	13.0	60.9	26.1
M20	697097	1.8	-	23.0	52.4	24.6
M21	694103	2.2	-	4.0	70.1	25.9
M22	693101	2.4	-	2.0	69.6	28.4
M23	693099	2.3	-	2.0	72.5	25.5
M24	692098	2.2	-	3.0	70.8	26.2
M25	686098	2.6	-	12.0	57.2	30.8
M26	686099	2.4	-	40.0	43.2	16.8
M27	688102	1.8	-	90.0	7.0	3.0
M28	689108	1.9	-	6.0	72.4	21.6
M29	690111	1.4	-	21.0	66.0	13.0
M30	677106	0.8	-	92.0	2.2	5.8
M31	679109	0.9	-	74.0	23.1	2.9
M32	680104	0.9	5.0	73.2	13.9	7.9
M33	683107	1.4	-	85.0	12.0	3.0
M34	686109	2.0	-	23.0	59.3	17.7
M35	685111	1.8	-	6.0	80.0	14.0
M36	688113	0.8	-	88.0	10.0	2.0
M37	682112	1.1	-	89.0	7.4	3.6
M38	681097	2.3	-	5.0	52.0	43.0
M39	682100	2.6	-	11.0	56.0	33.0
M40	685100	1.8	-	89.0	7.0	4.0
M41	678103	5.0	visual analysis			
M42	687107	2.3	"		"	
M43	685111	1.8	"		"	
M44	683111	1.8	"		"	
M45	683107	2.0	"		"	
M46	672098	4.6	14.0	82.6	2.6	10.8
M47	677102	3.6	37.0	55.4	4.0	3.6
M48	680104	2.4	17.0	73.0	3.7	6.3
M49	683104	2.4	-	88.0	4.9	7.1
M50	683102	2.4	-	93.0	5.0	2.0
M51	683102	2.4	13.0	56.5	19.5	11.0
M52	683100	1.2	2.0	81.3	7.3	9.4
M53	680099	1.2	-	57.0	27.9	15.1
M54	684097	2.4	9.0	66.4	17.0	7.6
M55	683098	1.8	-	52.0	34.6	13.4
M56	689097	2.4	-	91.0	4.0	5.0
M57	689099	2.4	-	5.0	85.5	9.5
M58	690102	2.3	-	8.0	84.6	7.4
M59	691104	2.1	-	7.0	71.6	21.4
M60	691107	1.7	-	8.0	75.4	16.6
M61	693109	0.8	-	16.0	66.4	17.6
M62	693111	0.8	-	13.0	65.3	21.7
M63	695103	1.8	-	7.0	67.0	26.0
M64	695102	2.1	-	5.0	69.4	25.6
M65	695100	2.1	-	2.0	73.5	24.5
M66	695097	2.1	-	4.0	70.1	25.9
M67	700097	0.6	-	94.0	4.5	1.5
M68	701099	0.6	5.0	83.6	7.2	4.2
M69	698100	2.1	-	82.0	14.0	4.0
M70	697102	2.0	10.0	71.1	13.0	5.9
M71	689104	1.8	-	4.0	72.0	24.0
M72	687106	2.1	-	4.0	73.9	22.1
M73	688111	1.8	-	5.0	72.2	22.8
M74	686116	0.6	-	92.0	5.9	2.1
M75	683112	1.3	-	94.0	4.0	2.0
M76	684109	2.1	-	11.0	68.5	20.5
M77	685107	2.0	-	14.0	70.5	15.5
M78	681108	2.1	-	73.0	16.7	10.3
M79	679107	0.9	-	46.0	40.0	14.0
M80	675109	1.0	14.0	74.8	6.4	4.8
M81	676107	0.6	-	88.0	6.0	6.0
M82	678105	0.6	-	87.0	6.2	6.8
M83	676103	0.6	-	95.0	3.8	1.2
M84	674098	6.0	-	68.0	22.7	9.3
M85	675100	3.1	34.0	61.4	1.6	3.0
M86	672100	0.6	2.0	96.0	2.0	-
M87	673101	<0.6	-	93.0	4.0	3.0
M88	672105	1.5	-	42.0	41.8	16.2
M89	674106	1.5	-	54.0	31.7	14.3
M90	675105	0.6	1.0	93.1	3.0	2.9
M91	675103	0.6	3.0	75.6	11.3	10.1
M92	685103	0.6	-	95.0	3.0	2.0
M93	686101	1.1	1.0	89.1	4.4	5.4
M94	685105	0.5	-	96.0	2.5	1.5
M95	670098	10.0	11.0	73.9	6.6	8.5
M96	675099	3.0	7.0	83.7	3.8	5.5
M97	676101	7.0	52.0	40.8	2.9	4.3
M98	682105	4.0	-	43.0	27.4	29.6
M99	683105	1.0	1.0	91.1	4.2	3.7
M100	689101	3.0	-	6.0	66.7	27.3
M101	687096	2.0	1.0	93.1	3.9	2.0
M102	689098	3.0	-	5.0	65.5	29.5
M103	691098	2.5	-	4.0	62.4	33.6
M104	691102	2.5	-	4.0	69.1	26.9
M105	695106	1.5	2.0	68.6	20.3	9.1
M106	690107	2.0	1.0	10.9	64.3	23.8
M107	689112	1.0	1.0	85.1	8.3	5.6
M108	685113	1.0	12.0	79.2	6.7	2.1
M109	681112	1.0	2.0	37.2	41.9	18.9
M110	679111	1.0	15.0	61.2	17.4	6.4
M111	678109	3.0	15.0	70.5	7.5	7.0
M112	679109	1.0	3.0	80.5	8.9	7.6
M113	677108	0.5	3.0	75.6	11.8	9.6
M114	675108	1.5	1.0	79.2	10.3	9.5
M115	668097	0.5	-	98.0	2.0	-
M116	668098	6.0	11.0	86.3	0.9	1.8
M117	669099	1.0	-	95.0	2.9	2.1
M118	668100	3.0	17.0	80.5	1.3	1.2
M119	669101	1.0	3.0	92.1	2.4	2.5
M120	670098	6.0	57.7	39.3	3.0	(mud)

over large areas of these shoals as well as on the deltas of the Horokiwi and Pauatahanui Streams at the eastern end of the inlet.

Gravel-grade sediment is found principally in the main channel from the entrance of the inlet to the vicinity of Moorhouse Point. Scouring caused by the intense tidal flow has removed the bulk of fine sediment from the channel leaving high percentages of coarse sand, gravel and shell, and shell fragments.

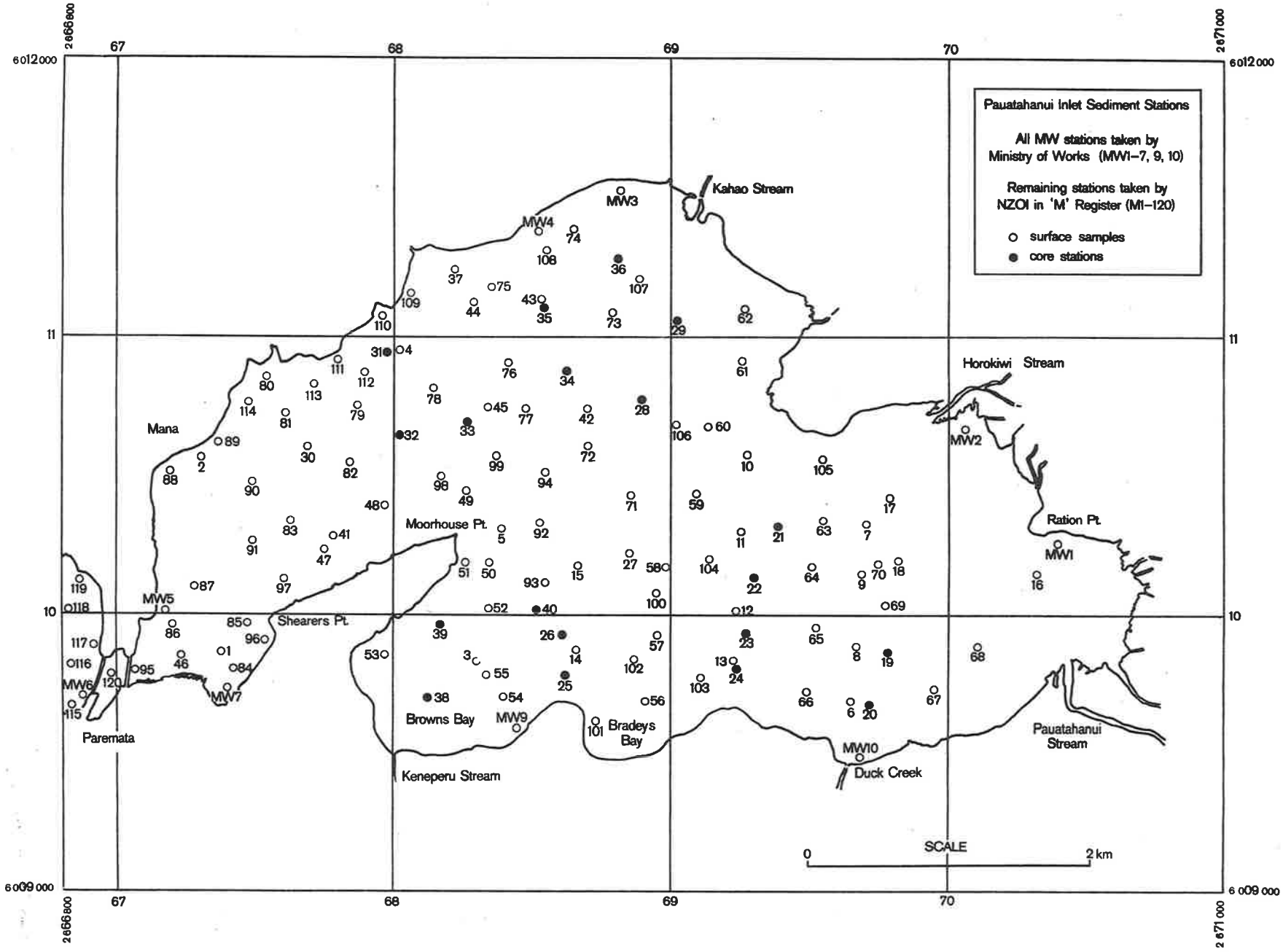

Fig. 1. Pauatahanui Inlet showing station positions. The prefix M denotes samples taken by N.Z.O.I. The prefix MW denotes samples taken by Ministry of Works and Development. Hollow circles represent surface samples; solid circles represent core stations.

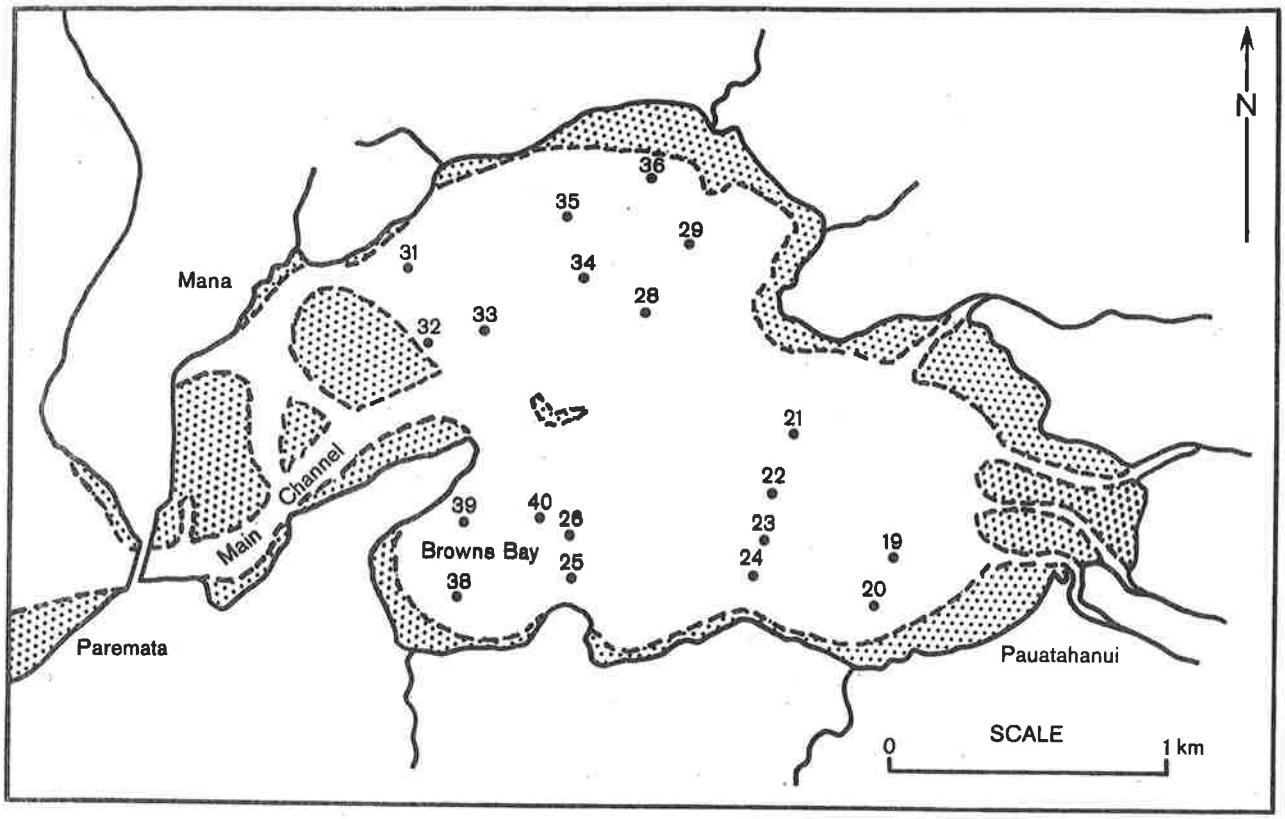

Fig. 2. Areas exposed at low tide in Pauatahanui Inlet. Figures show positions of cores entered in N.Z.O.I. Station Register M.

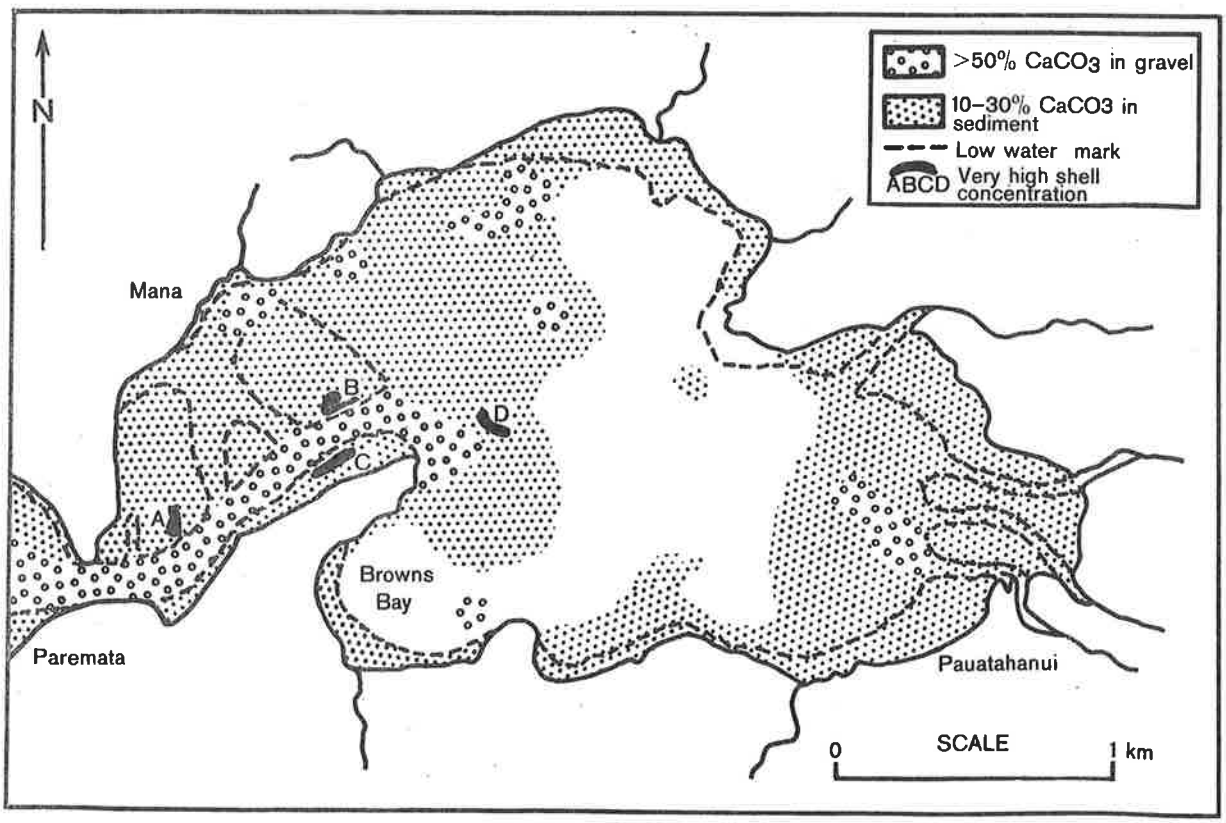

Fig. 3. Shell and shell fragment distribution on Pauatahanui Inlet. Central unstippled area has high silt concentration.

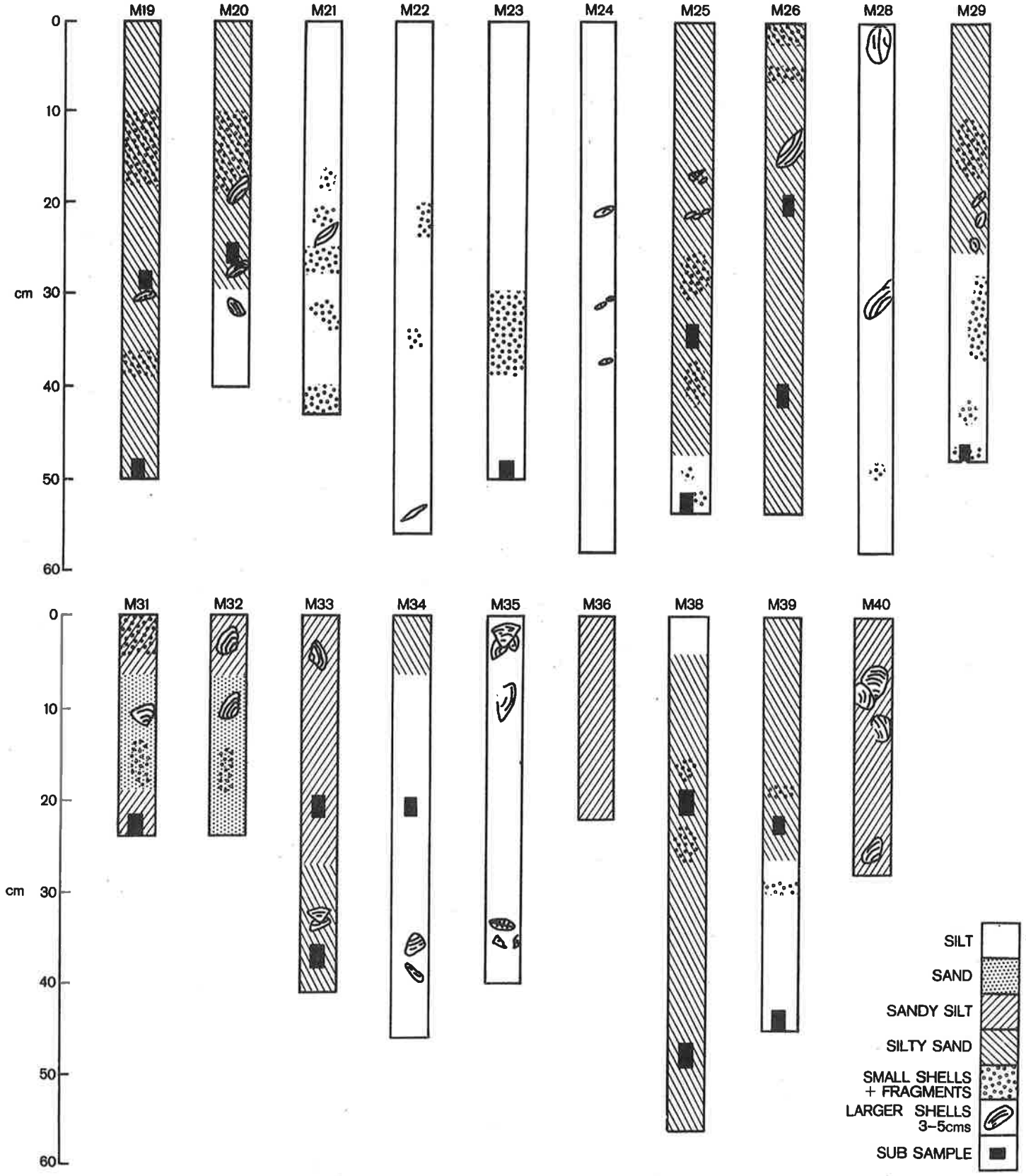

Fig. 4. Stratigraphy of cores shown in diagrammatic form. In addition to subsamples shown (solid black rectangles), samples for analysis were taken from the top 2 cm of each core.

TABLE 2. Grain-size analyses from selected levels in six cores from Pauatahanui Inlet.

NZOI Stn No.	Depth of sub-sample from surface	Percentage in Total Sediment Gravel	Sand	Silt	Clay
M19	0 - 2 cms	-	13.0	60.9	26.1
	28 - 30	-	13.0	67.0	20.0
	48 - 50	1.4	27.8	61.0	9.8
M20	0 - 2 cms	-	23.0	52.4	24.6
	25 - 27	-	11.4	72.6	15.9
M23	0 - 2 cms	-	2.0	72.5	25.5
	48 - 50	-	3.0	80.0	17.0
M25	0 - 2 cms	-	12.0	57.2	30.8
	34 - 36	0.1	22.2	61.6	16.1
	52 - 54	-	7.1	92.9	(mud)
M26	0 - 2 cms	-	40.0	43.2	16.8
	19 - 21	-	23.0	55.0	22.0
	40 - 42	0.1	43.0	45.2	11.7
M29	0 - 2 cms	-	21.0	66.0	13.0
	46 - 48	2.2	4.8	93.0	(mud)
M31	0 - 2 cms	-	74.0	23.1	2.9
	22 - 24	-	87.0	10.9	2.1
M33	0 - 2 cms	-	85.0	12.0	3.0
	20 - 22	-	78.8	14.1	7.1
	36 - 38	-	28.0	51.0	21.0
M34	0 - 2 cms	-	23.0	59.3	17.7
	20 - 22	-	1.5	89.7	8.8
M38	0 - 2 cms	-	5.0	52.0	43.0
	19 - 21	-	11.0	61.0	28.0
	46 - 49	-	12.0	68.0	20.0
M39	0 - 2 cms	-	11.0	56.0	33.0
	22 - 24	-	13.6	67.4	19.0
	43 - 45	-	5.0	78.0	17.0

Off Shearers Point at a depth of 3.1 metres, sample M85 contains 34% gravel (diameter > 2 mm) of which over half is pebbles and rock fragments. The diver reported an outcrop of bedrock and large pieces of rock on the bottom in this area. In the northern channel, M111 (3 metres) has 15% gravel of which over half is rock fragments up to 2.5 cm long.

The distribution of shells and shell fragments is shown in Fig. 3. At Stns M47 and M97 in the channel, 37% and 52% respectively of the total sediment is shell with the percentage ranging from 7% to 17% shell at other stations in the channel.

On either side of the channel, extremely large concentrations of shell (Fig. 3; A, B, C, D) are found at the low tide boundaries of the adjacent shoals.

Apart from a central area of the inlet where very few shells were reported (Fig. 3), the remainder of the inlet has a liberal cover of shells, both live and dead, in the upper layers of sediment.

The central area (Fig. 3) is also characterised by sediments with a high silt content and less than 10% sand. The silt extends into Browns Bay with three of the stations (M38, M39 and M53) showing a slight increase in the clay content. The general tendency is for the central silt area to become coarser in grain size towards the surrounding shoreline. This becomes apparent at the tidal reaches exposed at low tide where the dominant sediments are sand and gravel with the gravel-grade (> 2 mm) composed of pebbles and shell.

On the northern side of the inlet there is a predominance of pebbles and gravel on the beaches whereas on the southern side, sand, pebbles and shell are in varying proportions.

Cores

A series of 19 cores (Fig. 2) ranging in length from 22 cms to 58 cms has been obtained and sediment analyses have been carried out on surface layers of all cores and on sub-samples from selected positions in 11 cores (Table 2). No stratified layering is noticed although variations in grade size follow the pattern of the surface sediments. There is no obvious bioturbation in any of the cores.

When the cores are displayed in diagrammatic form (Fig. 4) it is seen that there is uniformity of sediment in the central silty area of the inlet (Fig. 3) down to 58 cm (M21, 22, 23, 24, 28 and 35). Apart from a surface layer of sandy silt this also applies to M34.

In other areas of the inlet there is a variation of grain size (Table 2) within the cores as in Browns Bay where three cores were obtained (M25, 38, 39). Core M38 near the outlet of the Kenepuru Stream, shows finer sediment at the surface with the clay content being 43% of the total sediment and sand 5% decreasing to clay - 20% with sand 12% at the bottom of the core. Cores M25 and 39 taken in the channel which is subjected more to tidal currents, show coarser sediment at the surface, 11% and 12% sand, decreasing to 7% and 5% at the bottom.

The distribution of shells and shell fragments occurs in a random manner in all cores except M19 and M20 where there is a layer of shell fragments 10 cms to 20 cms from the top of each core.

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REFERENCES

ADKIN, G.L. 1921: Porirua Harbour : A study of its shoreline and other physiographic features. *Trans. Proc. N.Z. Inst. 53* : 144-56.

IRWIN, J. (in press): Pauatahanui Inlet Bathymetry 1:5,000. *N.Z. oceanogr. Inst. Chart, Misc. Ser. 47.*

N.Z. DEPARTMENT OF LANDS AND SURVEY, 1965: Topographical Series. NZMS 1. 1:63,360. Sheet 160 Hutt. 3rd ed.

STEVENS, G.R. 1974: "Rugged Landscape. The Geology of Central New Zealand". Reed, Wellington. 286 pp.