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Recent Marine Sedimentation on the Continental Shelf South of Lae, New Guinea

by

F. Walraven

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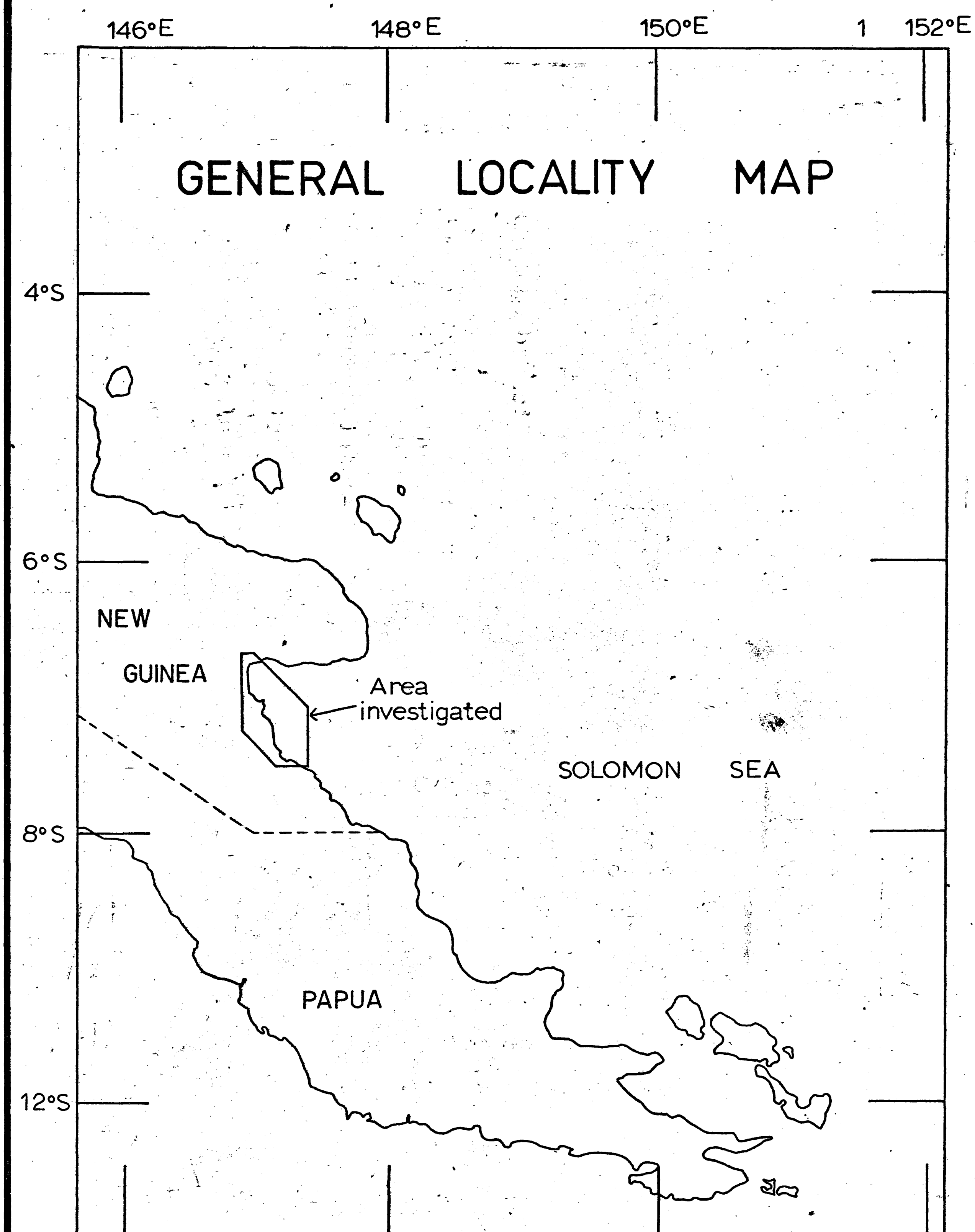
SUMMARY

Forty-nine bottom samples were collected along 50 miles of the coastline of New Guinea south of Lae. Except for six samples from near the mouth of the Markham River, all were collected from the continental shelf and upper slope in water depths of 15 to 293 metres. The continental shelf is everywhere narrow, ranging in width from almost nothing on the southern flank of the Huon Peninsula to about 5 miles near Lasanga Island.

Despite the few samples available, their somewhat irregular distribution, and the rapid variation in depositional environment over small areas, statistical interpretation of mechanical analysis data can be related to shelf morphology and sediment distribution patterns.

The shelf can be broadly divided into two areas, that to the north of Salamaua where there are no shelf-edge reefs, and that to the south where these reefs occur. In the northern area there is a relatively consistent decrease in grainsize and increase in carbonate content seawards. Sorting of the sediments also becomes progressively poorer away from the shore. To the south the influence of the offshore reefs is reflected in the local disruption of this ~~bottom~~ pattern, with rapid variations in grainsize and sorting which can be related to shelf morphology.

Sorting of the sediments is everywhere poor, the mean inclusive graphic standard deviation value (Folk) for all samples being 2.0 phi. Poorer sorting than average in the area to the south of the mouth of the Markham River is attributed to the admixture of fine material from the river's suspended load.



To accompany Record 1968/95 P/A199

Figure 1

INTRODUCTION

During the period from September 1967 to March 1968, the Bureau of Mineral Resources undertook a marine geological survey off the northwest coast of Australia and in waters off the coast of New Guinea and New Britain. The survey was conducted from the ship "KOS II", a 230-ton, 125 feeet length, converted whalechaser which was chartered by the Bureau from a Brisbane firm. Most of the equipment for the survey was provided by the Bureau and included a portable laboratory and a small winch. A larger winch was supplied by the ship's contractors.

Samples were taken by means of dredges, both large and small corers, Shipek sediment sampler, and van Veen type grab samplers. Bottom profiles were obtained down to 260 fathoms with the ship's 'Furuno' echo-sounder and acoustic reflection profiles were run with sparker equipment supplied by the Bureau.

The survey off New Guinea and New Britain was supervised by Dr C.C. von der Borch of Flinders University and Dr Tj. H. van Andel of Scripps Institute of Oceanography.

This report deals with the sediment samples collected off the coast of New Guinea between Lae and Lasanga Island in January to March 1968 (Fig.1). A study of the morphology and structure of the shelf in this area has been made by Dr von der Borch and will appear in a later BMR publication.

FIELD AND LABORATORY PROCEDURES

Between Lae and Lasanga Island the majority of the sediment samples were obtained by means of a van Veen type grab sampler and a 2-foot gravity corer. Maximum depth of sampling with the grab sampler is about 6 inches. With the corer depths of one to one-and-a-half feet were reached. When collected the samples were thoroughly mixed to ensure homogeneity and approximately 1 Kg of the samples was stored in water-tight sample jars. Smaller amounts of sample were collected in phials, one to be preserved as a reference sample and another to be used for studies of foraminifera and other organisms. The latter were treated with a solution of Rose of Bengal (potassium 4', 5', di-iodo 1, 3, 7, 9, tetrabromofluorescene) in alcohol in order to stain and preserve the living tissue.

Upon arrival at the Bureau of Mineral Resources the samples were first given a rough description including the average grainsize and the carbonate content. The colour of the samples when wet was recorded using the colour charts published by the Munsell Color Company. Subsequently the samples were washed by decantation with water to remove the salt and oven-dried at 110°C. When dry more accurate grainsize analyses were made of the samples and total carbonate content of the samples was also determined.

TABLE I.

Bureau of Mineral Resources, Geology and Geophysics

Phosphate Group

GRAIN SIZE ANALYSIS

Sample Number: ....   Date: ....

Mass Sample		A		
Wet sieve onto 75 mu*				
+ 75 mu		B		
Dry sieve			x 100/A	
+ 2000 mu				%
2000 - 1000 mu				%
1000 - 500 mu				%
500 - 250 mu				%
250 - 125 mu				%
125 - 63 mu				%
- 63 mu		C		
- 75 mu		D		
C + D		E		

Split sample to 5 - 10 grammes

Mass Subsample		F			
Pipette analysis			x E/F or C/F	x 100/A	
+ 63 mu					%
63 - 31 mu					%
31 - 16 mu					%
16 - 8 mu					%
8 - 4 mu					%
4 - 2 mu					%
- 2 mu					%

* See text

GRAINSIZE ANALYSIS

Two slightly different approaches were used in treating the sediment samples for grainsize analysis. Those samples which, when dry, could be easily disaggregated by hand were quartered down to a 50g subsample and sieved using a set of sieves having one phi size intervals. The sieve mesh sizes range from 2000 microns to 63 microns. The results of the sieving have been recorded on a specially prepared data sheet (Table 1). The -63 micron fractions were then quartered, if necessary, down tp 5 to 10g. for pipette analysis.

Standard pipette techniques were used, as described by Krumbein and Pettijohn (1938) and Folk (1965). Demineralized water was used throughout as the dispersing medium and fluid medium. Soaking for 24 hours and stirring with a mechamical stirrer was found to disaggregate the clays size particles adequately.

In order to make the data obtained from the pipette analyses comparable with the results of the sieve analyses 1 phi intervals were used to arrive at the required depth-time intervals for taking the aliquots. The smallest grains determined were 9 phi (2 microns).

The formula used to derive the depth-time intervals for the various particle sizes is given below:

$$t\ (\text{sec}) = 18\, h\eta / (\sigma - \rho)\, d^2\, g$$

where
- h = fluid height in centimeters
- η = viscosity in poises
- σ = density sediment
- ρ = density fluid
- d = particle diameter in centimeters
- g = acceleration due to gravity

The results of the pipette analyses were then recorded on the data sheet mentioned above and, together with the sieve results, the fraction weights were recalculated to percentages of the weight of the original subsample (about 50g).

The second approach was used on those samples which were not easily disaggregated by hand. These were mainly samples with little or no coarse fraction (over 63 microns). These samples were soaked in demineralized water, stirred mechanically, and wet-sieved on a 75 micron mesh sieve. The + 75 micron and -75 micron fractions were then dried at 110°C and the + 75 micron fraction was sieved as above.

NOMOGRAPH FOR THE CALCULATION OF PERCENTAGE $CaCO_3$ IN SEDIMENTS

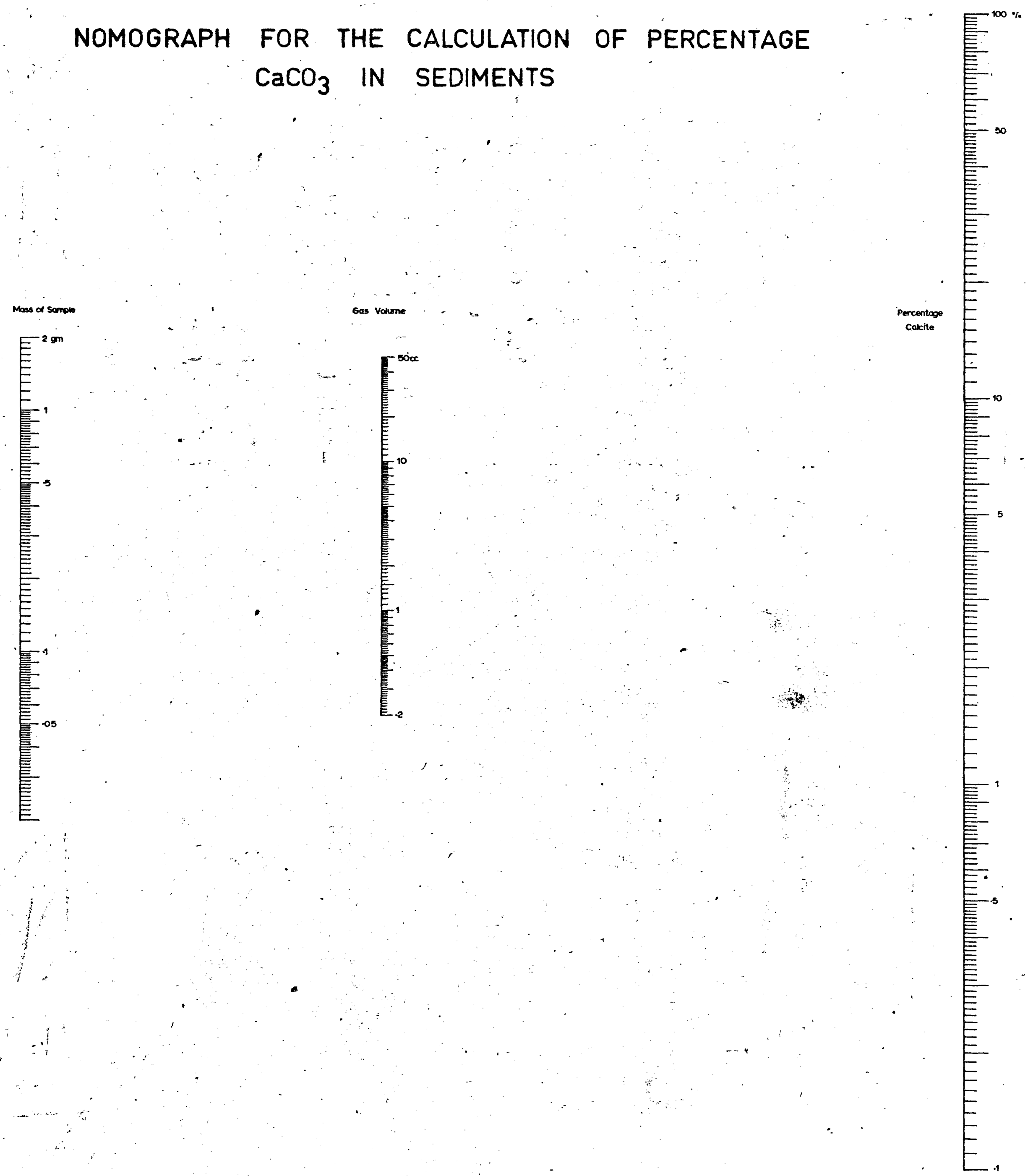


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Figure 2

The fraction passing through the 63 micron sieve was then added to the -75 micron fraction obtained by wet-sieving and this subsample quartered down to 5 to 10g. for pipette analysis as above. In theory there should be no -63 micron fraction after sieving, but due to adherence of small particles to larger ones there is usually a small amount passing through the 63 micron mesh sieve.

The data were again recorded on the prepared data sheet and the results recalculated to percentages of the total weight. In both cases the percentage weight of material 125 to 63 microns in size obtained by sieving was added to the percentage weight of material -63 microns in size obtained by pipette analysis. In one or two samples this may have produced an anomalous bulge in the 4 phi region of the cumulative frequency curve, but in the majority of samples such an effect cannot be noticed.

CALCIMETRY

Determination of the total amount of calcium carbonate was carried out using apparatus similar to that described by Hülseman (1967) which measures the volume of CO_2 gas evolved from a known quantity of samples. The percentage calcium carbonate in the sample was calculated using the following formula:

$$\% \text{ (at } T^{o}C) = (A / B)\, f(T^{o}C)\ 100.091/22414$$

where A = volume of CO_2 gas (ml)

B = mass of sample (g)

$f(T^{o}C)$ = function dependent on temperature and being equal to 1.0 at 25°C

In order to facilitate the calculation of results a nomograph was devised from which the percentage of calcium carbonate in the sample may be read off directly when the gas volume and the sample mass are entered. Figure 2 is a reproduction of this nomograph which is based on a temperature of 25°C. It was normally found that the temperature deviations in the laboratory were small enough to disregard and the nomograph was used throughout.

Earlier methods of calcimetry (Martin & Reeve, 1953) make use of the displacement of the fluid against atmospheric pressure. This was considered unsatisfactory from two points of view:

1. The air-tightness of the system is put to greater tests than with the equal pressure method.
2. Calculation of the percentage carbonate becomes much more complicated due to the inclusion of factors for pressure and compression of the gases in the system.

Hülseman (1967) uses mercury as the fluid in the burette. This was also considered unsuitable owing to its high specific gravity, which increases the difficulty in equalizing the pressures in the burette and the reservoir. After some experimentation, kerosene was used and it was found that results could be reproduced to within 3 percent. As a check on operational errors, one in each batch of ten samples was duplicated. Appendix IV shows the results of the calcimetry analyses.

GEOMORPHOLOGY AND HISTORY OF THE AREA

New Guinea is a country of large relief and high rainfall. The average rainfall of the area covered by this report is about 120 inches per year, with the heaviest falls during the months of April, May, June, November and December. These periods correspond to the time during which the southeast monsoon blows. Usually rainfall starts in the late afternoon and continues for part of the evening. Low hanging clouds usually fill the mountain valleys during the early morning and in the evening.

Langbein and Schumm (1958) have published a diagram relating effective precipitation to annual sediment yield.

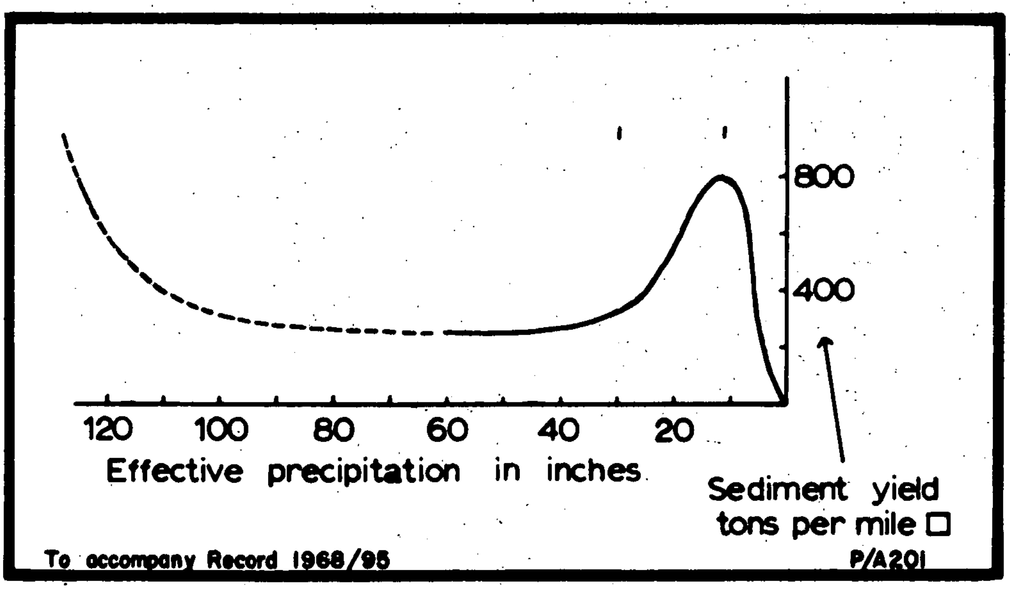

Figure 3

The source of their data is mainly the United States, but the results have proved to be generally applicable all over the world. Initially the sediment-yield increases from zero to a maximum at about 15 inches annual effective precipitation. As

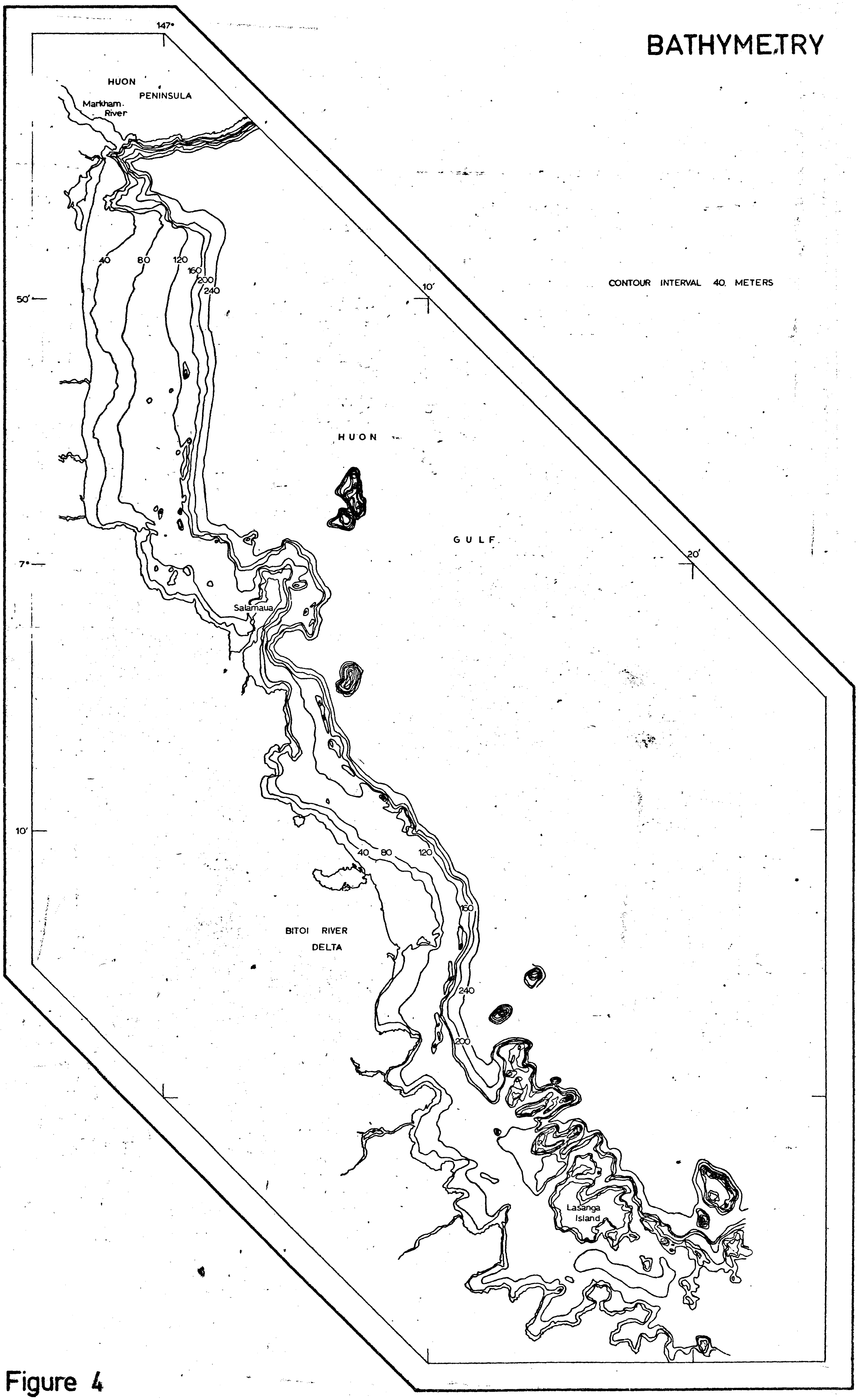

Figure 4

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the effective precipitation increases the effects of soil binding and stabilization by vegetation increases and sediment yield consequently decreases (Fig.3).

Subsequent investigations in areas of extremely high rainfall such as Hawaii and New Guinea have shown that the diagram may be extended. This is shown by the dotted line in Figure 3. With still increasing effective precipitation the sediment yield starts to increase around 90 to 100 inches effective precipitation. At this stage the processes involved in sediment movement are different from those encountered at lower precipitations. Soil creep, slumping, slides, and mudflows play a large part.

This then would seem to be the case in the area investigated. Extremely high rainfall causes numerous landslides and mudflows, evidence of which may be seen in the form of large scars of brown soil in the otherwise continuous mantle of vegetation. It may be safely concluded that the supply of terrigenous sediment from the land is quite large, although recent lowering of the land surface, well displayed in the lowlands flanking the high ranges of the Boqutu Mountains, the Kuper Range, and Shungol, has resulted in a drowned topography and the trapping of the greater part of the sediment carried by the rivers.

The Markham River is an exception to the above. It has a very large drainage basin compared to most of the other rivers in this area and consequently a high capacity. The flow velocity at the river mouth amounts to 4 or 5 knots. Samples collected from the river mouth include coarse-grained sands and pebble conglomerates. However, the Markham River does not contribute this material to the sediments on the continental shelf. The head of the Markham River submarine canyon (von der Borch, manuscript) comes right up to the mouth of the Markham River and all of the bedload moves straight down into this canyon. As a result the only sediment which reaches the adjacent continental shelf is the fine material which stays in suspension for a long enough period.

The geological history of eastern New Guinea (Thompson, 1967) has been one of repeated submergence and emergence of the land as evidenced by the alternating transgressive and regressive sequences in the stratigraphic records. During late Pliocene and Pleistocene times sediments of the northern New Guinea Basin were folded, faulted, and uplifted. In the Owen Stanley Ranges continued uplifting occurred and numerous abandoned strandlines along the south Papuan coastline testify to this very recent emergence. Deeply incised valleys and sharp-crested ridges along the east coast of New Guinea contribute supporting evidence.

As a result of the active geological history of New Guinea there is only a narrow continental shelf. The bathymetry of the area investigated is shown in Figure 4 and from it can be seen that while the continental shelf is virtually absent along the southern coast of the Huon Peninsula, it ranges from as little as three quarters of a mile to 5 miles between Lae and Lasanga Island. This

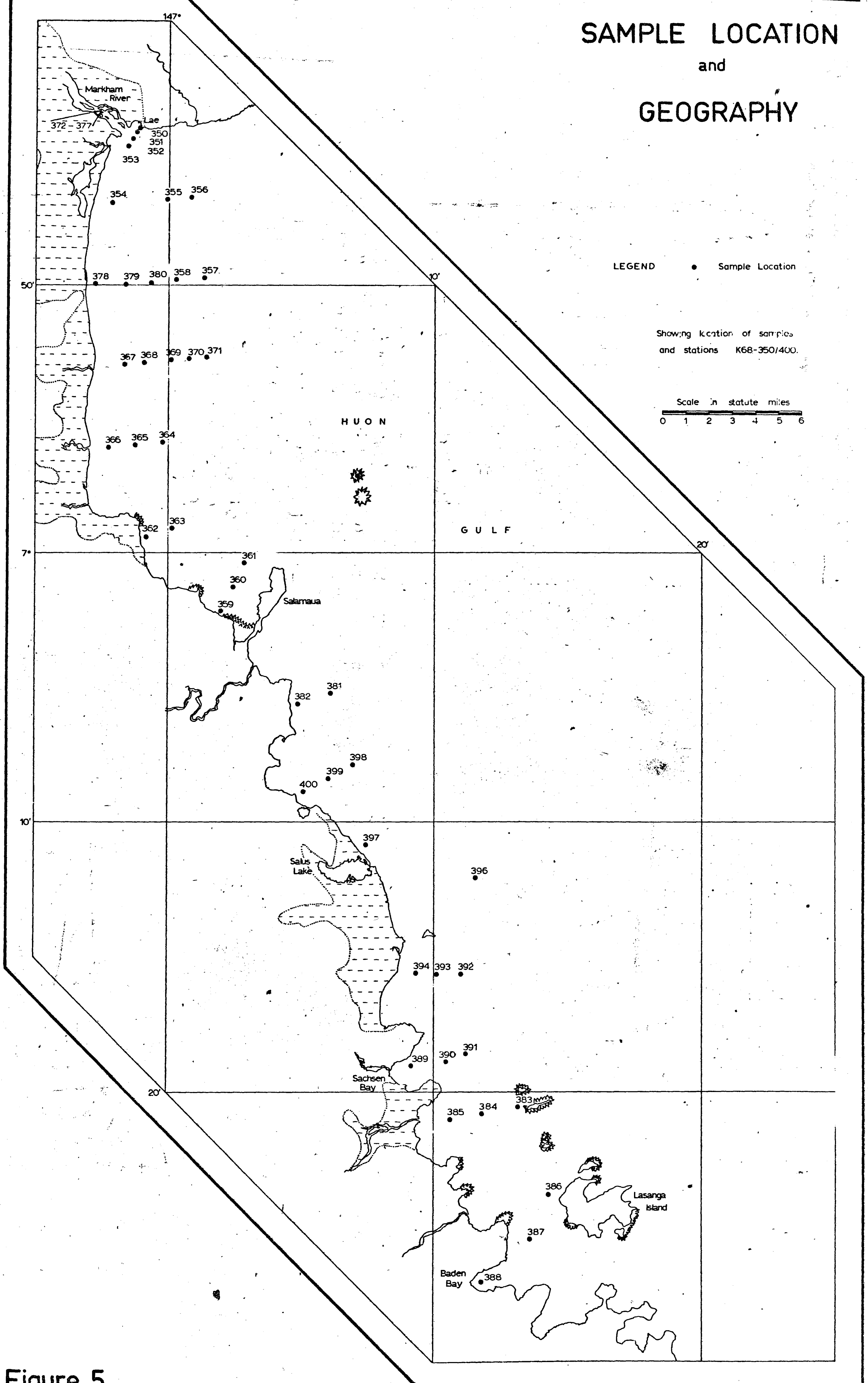

Figure 5

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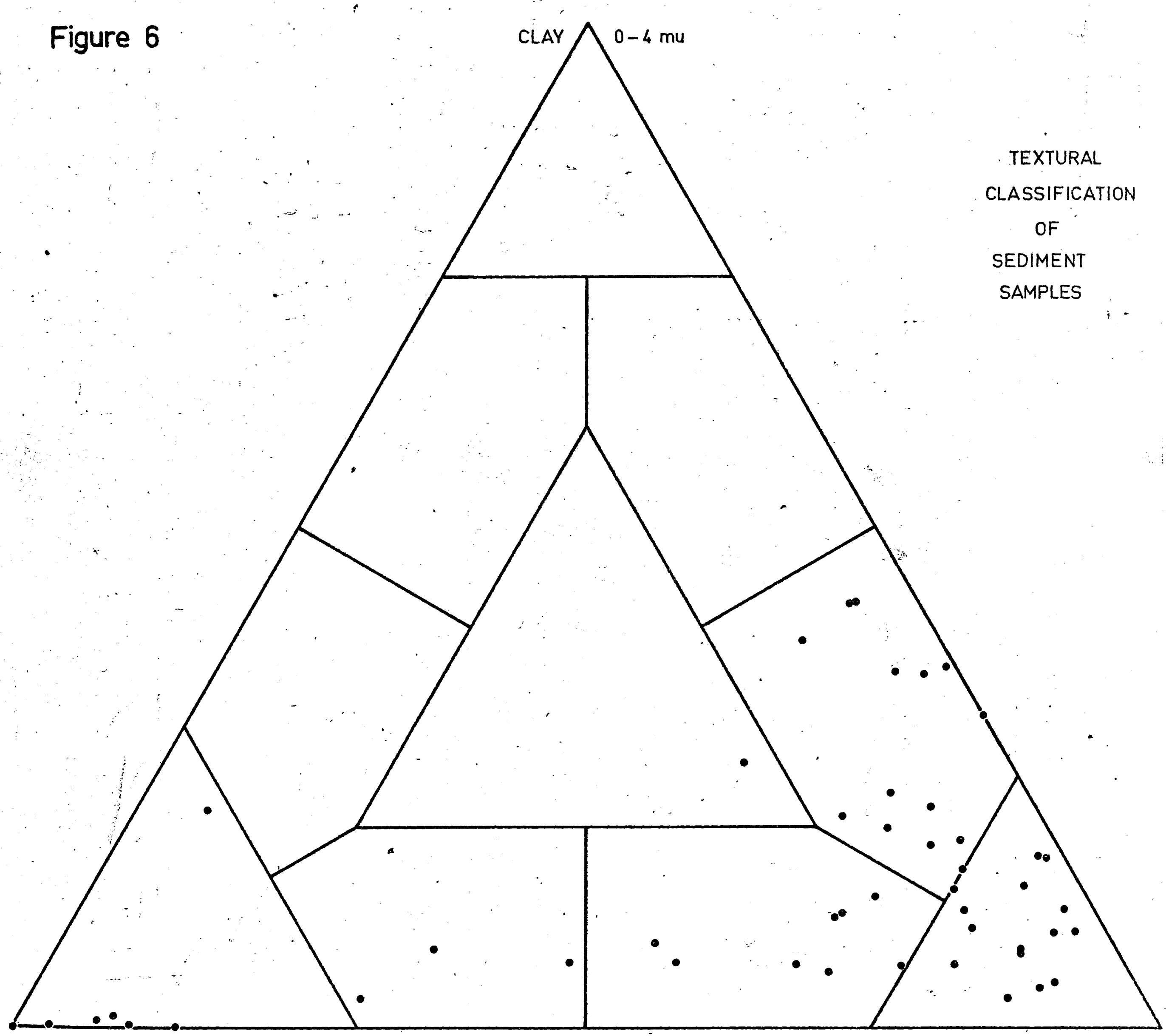
Figure 6



TEXTURAL CLASSIFICATION OF SEDIMENT SAMPLES

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TEXTURAL DISTRIBUTION OF SEDIMENTS

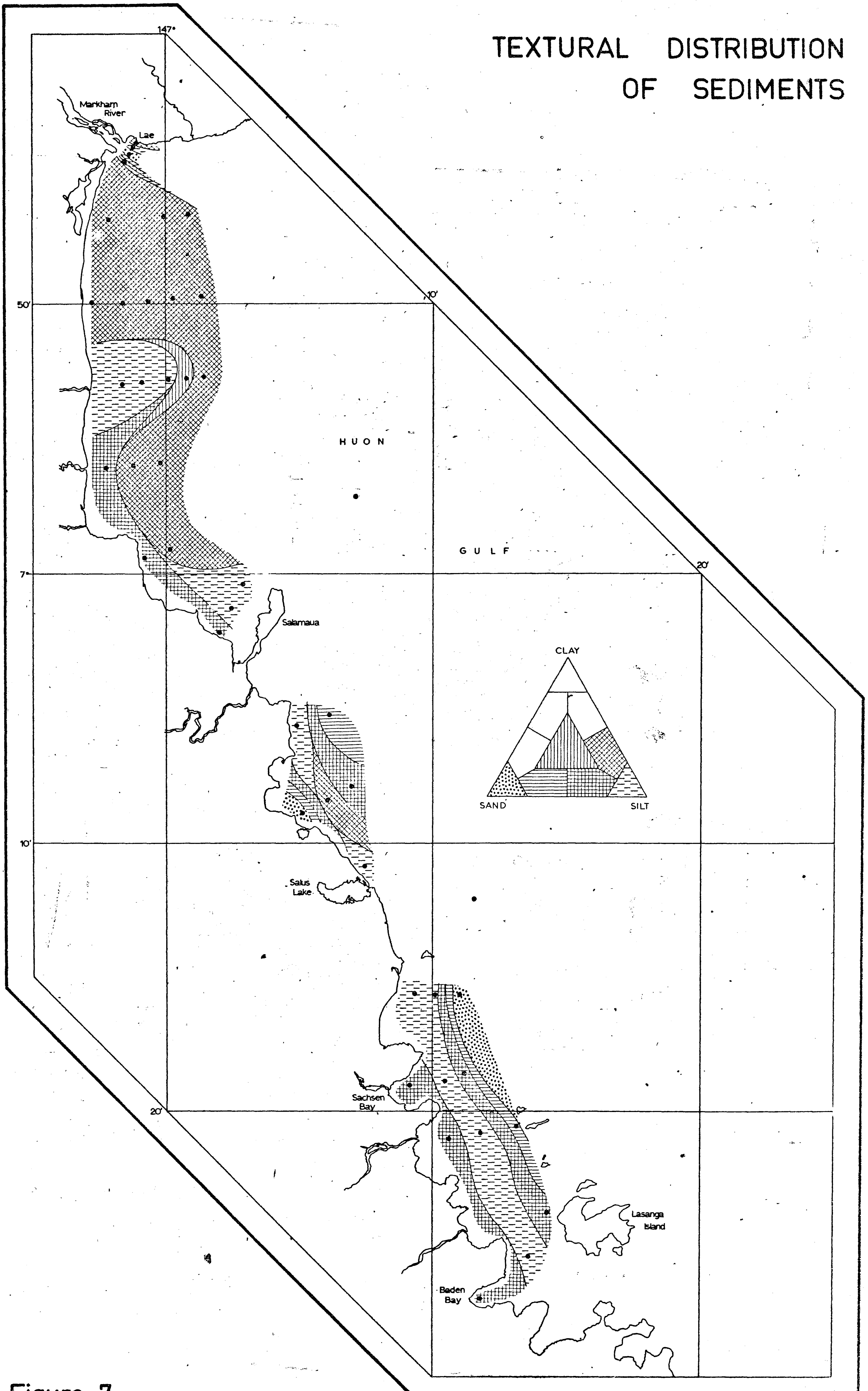

Figure 7

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PHI ARITHMETIC MEAN

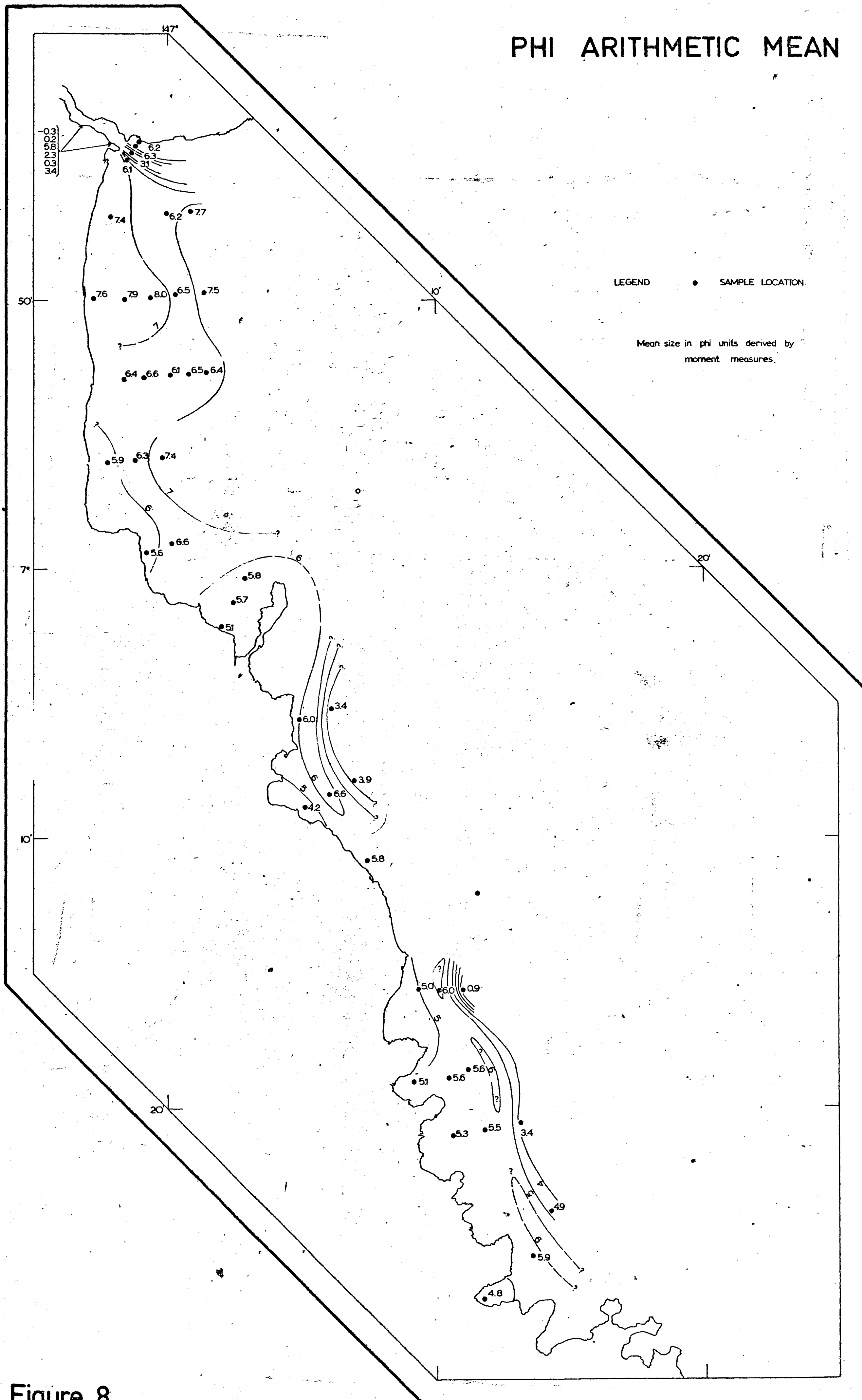

Figure 8

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is indeed very narrow when compared to continental shelves off stable areas such as the northwest coast of Australia and the Great Barrier Reef, where widths of over 100 miles are not uncommon. The lack of any continental shelf bordering the Huon Peninsula may be attributed to faulting along the continental margin which, together with its extension, is held responsible for the existence of the Solomon Trench. Any sediment shed from the Huon Peninsula is dumped straight into the trench.

Owing to the narrowness of the continental shelf one may expect the sedimentation to be dominated by the terrigenous influences. This effect can be seen plainly at the mouth of the Bitoi River where a well defined deltaic fan displaces the bathymetric contours seawards; foreset beds of this structure can be recognized in the sparker records obtained in this region.

DISCUSSION OF RESULTS

Forty-nine samples were collected from the continental shelf between Lae and Lasanga Island. The locations of these samples are shown on Figure 5, and in Appendix I a complete list of samples including latitude and longitude and other particulars of the samples is given. The results of the grainsize are given in Appendix II and the moment measure panameters calculated therefrom are shown in Appendix III.

Plotting the samples on a triangular diagram according to their contents of sand (> 63 microns), silt (63-4 microns), and clay (< 4 microns), and using Shepard's (1954) textural classification, it can be seen that 30 percent of the samples are silt, 28 percent clayey silt, 18 percent sand, 16 percent sandy silt, 6 percent silty sand, and 2 percent sandy silty clay.

Comparing this distribution with those from other areas such as the Timor Sea (van Andel & Veevers, 1967), Gulf of Mexico (van Andel, 1960), Mississippi Delta (van Andel, 1960), and Gulf of Paria (van Andel & Postma, 1954), it may be noted that the content of fine material in the samples under discussion is considerably less. In fact no samples occur in the silty clay or clay range. This, no doubt, is attributable to the proximity of land to all the samples and to the large amount of sediment being supplied to the shelf.

Figure 7 shows the distribution of the textural types on the shelf. Generally the textures of the sediments follow the expected pattern of decreasing grainsize away from the shore. This pattern may also be distinguished on Figure 8, which shows the distribution of mean size (phi arithmetic mean, computed from moment measures).

However, in both cases there is a large amount of confusing deviations from this trend. These deviations can be attributed to the presence of coral reefs on the outer edge of the shelf and in bays and around islands. In the vicinity of reefs there is a general increase in the grainsize of the sediments.

One anomaly in the trend occurs just south of the Markham River mouth. Here there is an area of fine sediments close inshore. The sorting of these sediments is poorer than average. Figure 9 shows the frequency distribution of the inclusive graphic standard deviation (σ_I) values which average 2.0 phi over the whole area. South of the mouth of the Markham River these values increase from 1.81 phi (K68-354) to 2.32 phi (378), 2.63 phi (379), and 2.55 phi (380).

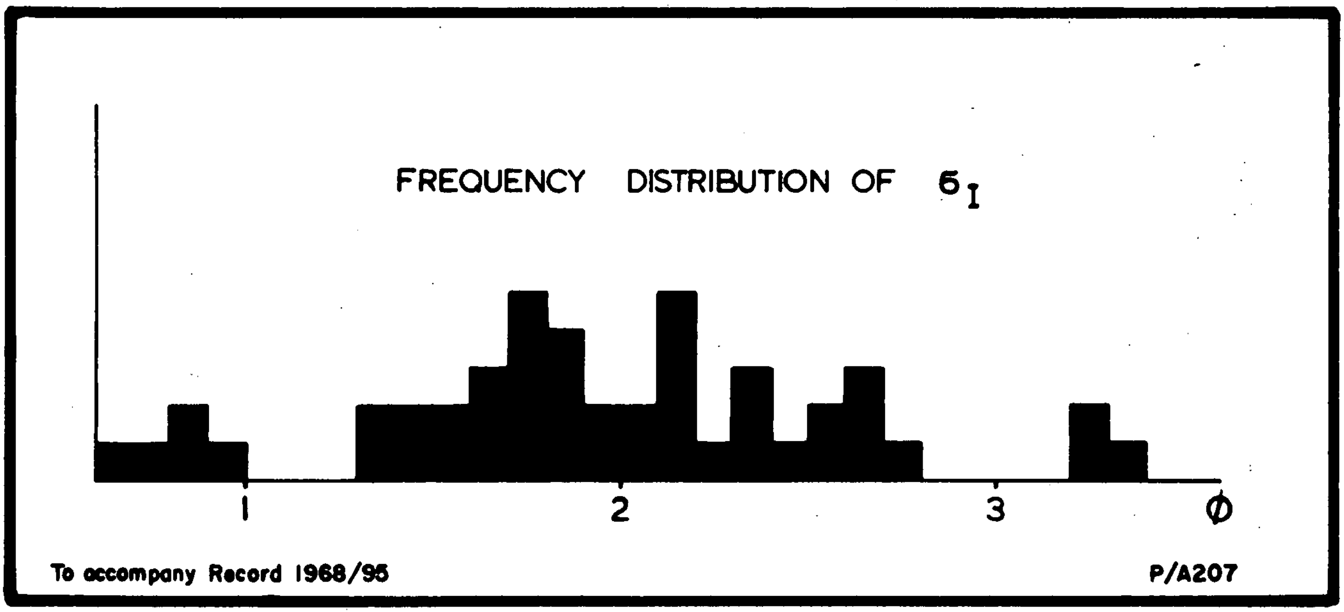

Figure 9

It is considered that these sediments come from two sources. One is the normal supply from the coast, the other is a supply of fine material from the suspended load of the Markham River which is transported southward by longshore currents. The three samples noted above are markedly polymodal. South of latitude 7°51'S this effect is no longer important and the samples become somewhat coarser and better sorted.

In general the sediments of the Lae shelf are poorly sorted. There are only five samples which fall in Folk's category of moderately sorted. Twenty samples are poorly sorted and the remaining samples are very poorly sorted. The average

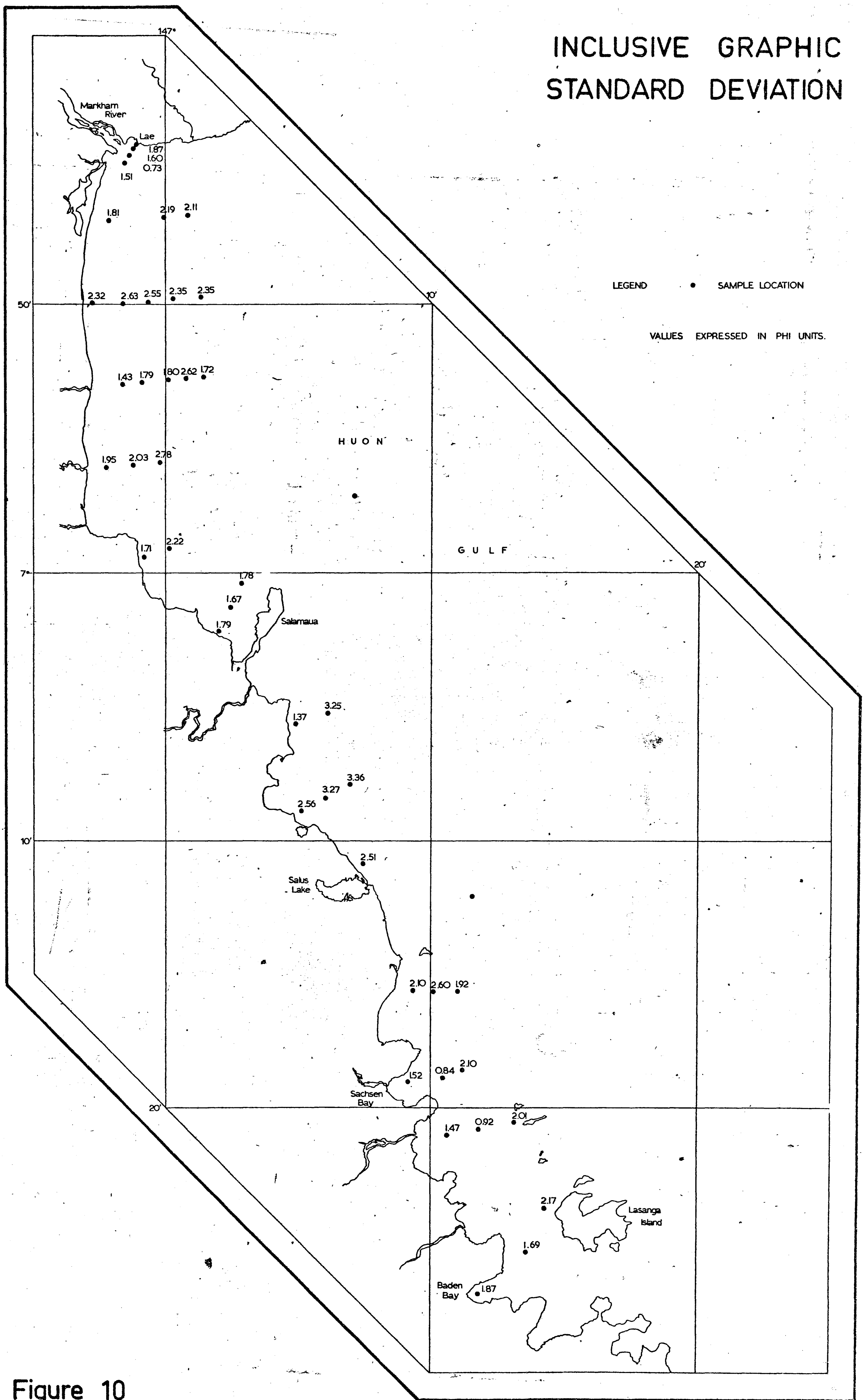

Figure 10

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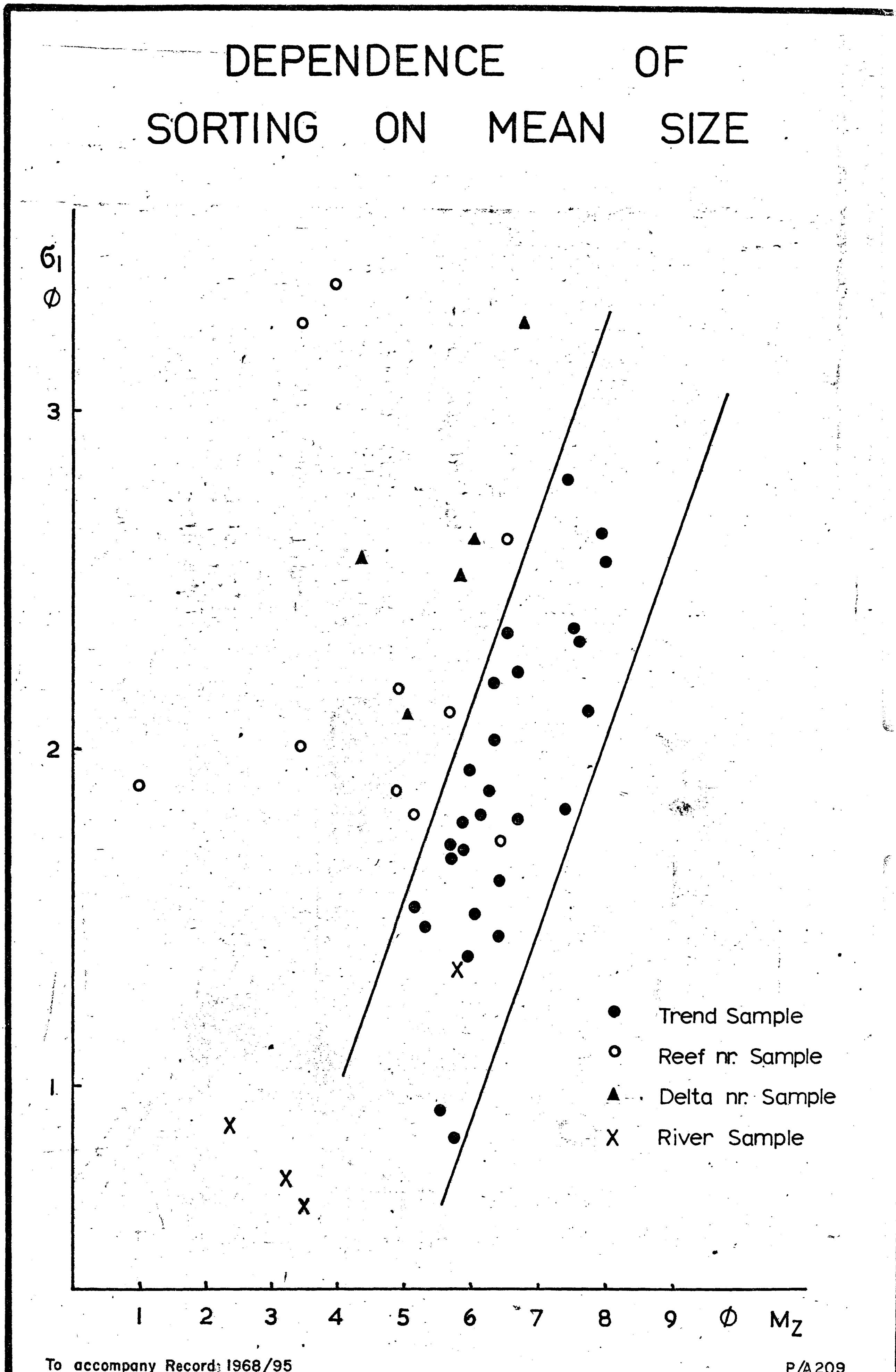
DEPENDENCE OF SORTING ON MEAN SIZE
σ1 Φ
3
2
1
1 2 3 4 5 6 7 8 9 Φ Mz
Trend Sample
Reef nr. Sample
Delta nr. Sample
River Sample
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Figure 11

TOTAL CARBONATE CONTENT OF SEDIMENTS

Values express total content in percentage weight

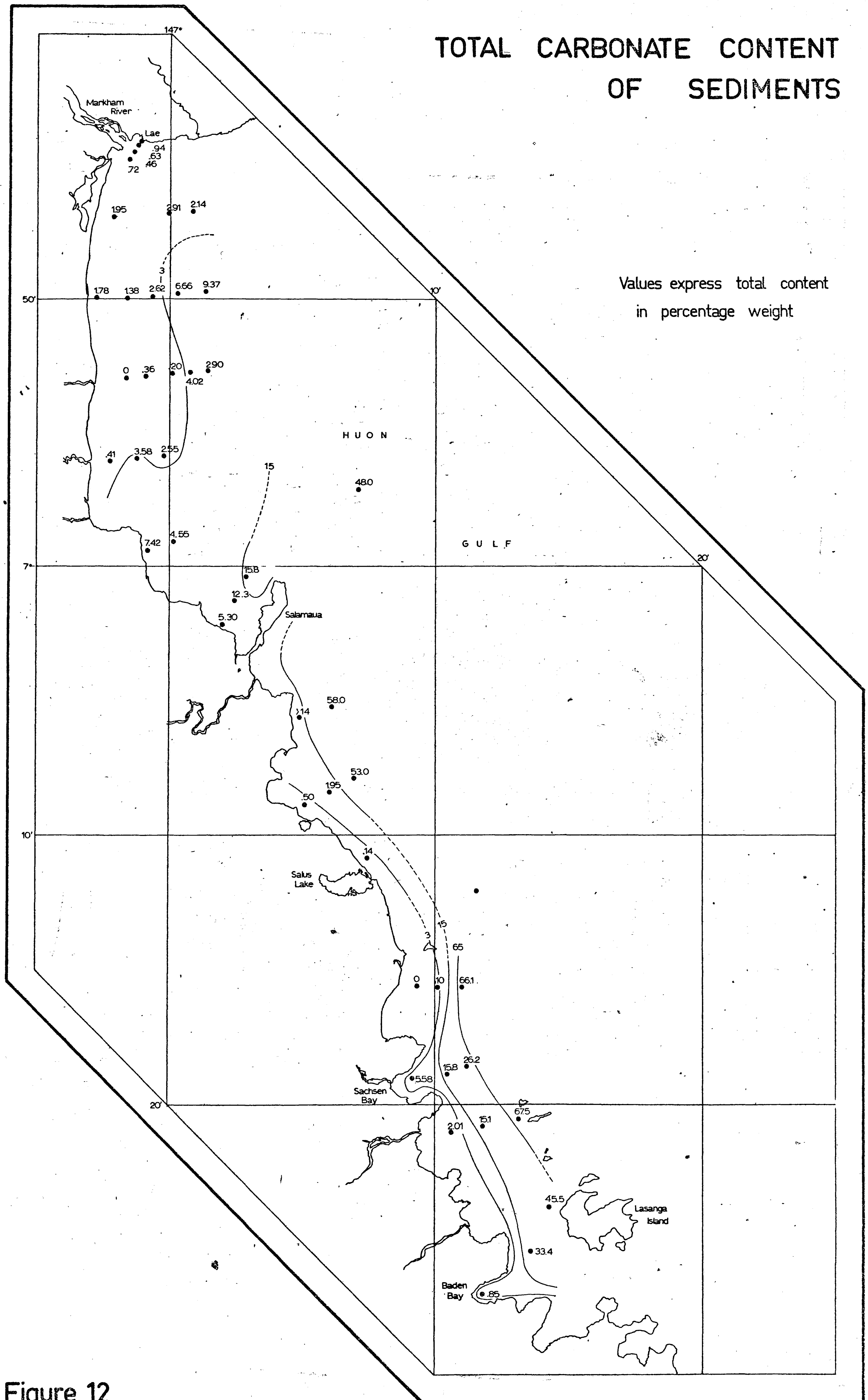

Figure 12

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sorting noted above coincides with Folk's boundary between the poorly sorted and the very poorly sorted sediments.

Very poorly sorted sediments are commonly associated with rapidly deposited material which has had little or no reworking by marine agencies in the area of deposition. Another method for obtaining poorly sorted sediments is by having a multisource origin. Figure 10, which is a plot of the inclusive graphic standard deviation, shows the trend of the sorting values. Apart from the anomalous area described above there is a marked trend of the sediments becoming more poorly sorted seaward. Since the samples close to the shore vary only by small amounts laterally in sorting and mean size, it seems unlikely that the poorer sorting of the more seaward sediments can be derived from the mixing of these sediments only. It seems more probable in this case that the deterioration of the sorting seaward is due to the material supplied by the coral reefs (both growing and dead) which are found on the edge of the shelf. This can be noted especially in the region to the south of Salamaua and around Lasanga Island, where very large decreases in the sorting are seen in the sediments closest to the coral reefs (Fig.5).

Figure 11 is a plot of mean size of the sediments against their sorting. The unmodified points present no meaningful pattern. However, if certain points are qualified a meaningful trend relating mean size to sorting becomes apparent. The bases on which points may be disregarded are:

a. Those samples taken from the Markham River may be excluded as being irrelevant.

b. The samples in close proximity to coral reefs may be excluded since they will have a large admixture of coarse reef debris which gives anomalously poor sorting.

c. The samples in the vicinity of the delta of the Bitoi River may be excluded owing to the admixture of finer material to the sediments again resulting in poorer sorting than normal.

The remaining points then present a distinct trend of decreasing sorting towards the finer samples.

A plot of the results of the carbonate analyses, Figure 12, presents no clear relationship between carbonate content and depth. As might be expected, the carbonate content increases sharply in sediment samples taken close to reefs and also tends to increase with increasing distance from shore.

In the area of finer sediments south of the Markham River mouth mentioned above, a tongue of low carbonate content (less than 3 percent) may be noted. This possibly also reflects the control of water turbidity on carbonate content, since this area was postulated to have a relatively high content of suspended material brought in by the Markham River.

The coarse fractions of the sediment samples (see Appendix V) generally make up only a small amount of the sediments. Coarse fraction analyses show that over 50 percent of the samples have more than 55 percent terrigenous material and that 20 percent contain more than 90 percent terrigenous material in their coarse fraction. The remainder of the coarse fractions is commonly made up of molluscans of one type or another. Benthonic and planktonic foraminifera play a large part in some of the samples.

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APPENDIX I.

STATION DATA

Sample Number	Latitude Degrees	Latitude Minutes X 10	Longitude Degrees	Longitude Minutes X 10	Date Mth/Day/Yr			Time Greenwich	Depth Metres
K 68350	06	439	146	589	FE	01	68	2215	18
K 68351	06	442	146	588	FE	01	68	2338	121
K 68352	06	445	146	587	FE	01	68	2358	190
K 68353	06	448	146	585	FE	02	68	0008	110
K 68354	06	470	146	578	FE	02	68	0245	18
K 68355	06	468	146	599	FE	02	68	0405	124
K 68356	06	468	147	009	FE	02	68	0445	238
K 68357	06	497	147	013	FE	02	68	0520	194
K 68358	06	498	147	003	FE	02	68	0535	146
K 68359	07	021	147	020	FE	02	68	2200	64
K 68360	07	012	147	024	FE	02	68	2215	102
K 68361	07	003	147	029	FE	02	68	2302	113
K 68362	06	594	146	595	FE	02	68	2335	91
K 68363	06	591	147	003	FE	02	68	2355	101
K 68364	06	560	146	598	FE	03	68	0300	108
K 68365	06	560	146	588	FE	03	68	0328	95
K 68366	06	561	146	578	FE	03	68	0400	73
K 68367	06	529	146	584	FE	03	68	0438	49
K 68368	06	529	146	591	FE	03	68	0505	77
K 68369	06	528	147	001	FE	03	68	0525	101
K 68370	06	527	147	008	FE	03	68	0540	102
K 68371	06	527	147	014	FE	03	68	0610	112
K 68372	06	436	146	580	FE	05	68	0000	4
K 68373	06	436	146	580	FE	05	68	0012	4
K 68374	06	436	146	580	FE	05	68	0024	4
K 68375	06	436	146	580	FE	05	68	0036	4
K 68376	06	436	146	580	FE	05	68	0048	4
K 68377	06	436	146	580	FE	05	68	0100	4
K 68378	06	499	146	573	FE	05	68	0400	40
K 68379	06	499	146	584	FE	05	68	0420	64
K 68380	06	499	146	593	FE	05	68	0440	91
K 68381	07	052	147	061	FE	08	68	2215	174
K 68382	07	056	147	048	FE	08	68	2230	110
K 68383	07	205	147	132	FE	09	68	2100	24
K 68384	07	209	147	118	FE	11	68	0221	102
K 68385	07	210	147	106	FE	11	68	0310	77
K 68386	07	238	147	143	FE	11	68	0340	168
K 68387	07	254	147	135	FE	11	68	0450	88
K 68388	07	271	147	114	FE	11	68	0530	29
K 68389	07	191	147	092	FE	12	68	0135	81
K 68390	07	188	147	102	FE	12	68	0205	91
K 68391	07	184	147	115	FE	12	68	0225	152
K 68392	07	158	147	112	FE	12	68	0310	93
K 68393	07	157	147	101	FE	12	68	0340	82
K 68394	07	157	147	091	FE	12	68	0410	15
K 68395	07	124	147	107	FE	12	68	0450	293
K 68396	07	122	147	113	FE	12	68	0525	293
K 68397	07	108	147	074	FE	13	68	0020	101
K 68398	07	078	147	069	FE	13	68	0110	161
K 68399	07	083	147	060	FE	13	68	0150	117
K 68400	07	088	147	051	FE	13	68	0220	110

APPENDIX II

RESULTS OF GRAIN SIZE ANALYSES.

Serial Number	Weight percentages (% x 10)											
	<-1ø	1-10ø	0-1ø	1-2ø	2-3ø	3-4ø	4-5ø	5-6ø	6-7ø	7-8ø	8-9ø	9ø
K 68350	000	001	002	005	008	078	180	241	206	122	080	076
K 68351	000	000	000	000	000	017	113	256	287	159	077	092
K 68352	002	004	009	073	353	464	060	012	005	004	000	012
K 68353	000	000	000	000	000	026	302	289	146	110	063	063
K 68354	000	000	000	000	000	000	047	276	216	150	157	154
K 68355	000	000	000	004	011	075	262	240	139	048	112	107
K 68356	000	000	000	000	000	008	051	182	207	192	156	203
K 68357	000	000	000	001	004	025	126	180	145	163	137	217
K 68358	000	003	005	008	019	083	217	196	124	111	087	146
K 68359	001	004	007	024	077	173	222	229	141	060	024	038
K 68360	001	003	005	012	026	090	241	283	153	074	060	051
K 68361	001	003	008	010	016	079	209	334	117	111	048	063
K 68362	000	001	002	005	007	206	224	214	143	086	054	057
K 68363	000	001	004	013	021	099	124	067	307	165	086	112
K 68364	000	000	004	012	017	087	121	105	121	148	140	245
K 68365	000	001	004	008	011	058	227	258	156	090	075	112
K 68366	001	002	004	007	012	157	186	197	189	114	058	072
K 68367	000	000	000	000	001	025	135	297	281	164	030	066
K 68368	000	001	001	001	001	020	161	270	225	151	061	109
K 68369	000	000	001	001	002	046	305	254	152	098	051	090
K 68370	000	000	002	008	024	196	170	128	092	115	087	176
K 68371	000	002	003	002	011	092	099	334	144	131	077	104
K 68372	425	236	173	098	062	006	000	000	000	000	000	000
K 68373	200	288	272	159	061	019	000	000	000	000	000	000
K 68374	000	000	001	006	011	067	195	376	209	061	042	033
K 68375	012	017	054	235	468	213	000	000	000	000	000	000
K 68376	544	055	056	084	058	100	060	032	007	001	003	000
K 68377	000	000	000	003	270	584	099	031	008	002	002	001
K 68378	000	000	001	004	006	047	042	155	200	192	136	217
K 68379	000	000	000	004	012	041	040	172	119	186	146	278
K 68380	000	000	001	003	009	040	044	160	149	167	138	288
K 68381	096	084	072	104	105	131	087	110	078	053	036	042
K 68382	000	001	001	004	013	063	129	424	211	075	030	048
K 68383	014	035	059	131	195	247	137	090	035	027	015	015
K 68384	000	001	002	014	016	052	123	663	066	023	010	030
K 68385	000	000	002	005	020	167	275	318	100	051	022	038
K 68386	000	011	019	052	106	210	169	179	098	072	034	050
K 68387	000	003	004	017	030	060	165	299	199	122	046	054
K 68388	000	000	005	053	160	170	160	222	110	056	027	038
K 68389	000	000	001	023	059	178	223	298	120	044	022	033
K 68390	000	001	004	009	017	040	072	698	079	036	023	020
K 68391	000	006	013	024	050	136	152	248	160	103	036	071
K 68392	172	194	213	203	115	023	013	024	017	016	004	006
K 68393	000	000	000	001	003	041	214	346	193	106	051	044
K 68394	000	001	000	001	003	114	526	223	080	023	011	018
K 68397	000	000	001	003	008	136	143	321	194	133	022	038
K 68398	109	016	054	071	079	107	067	182	120	086	017	048
K 68399	000	000	002	005	015	149	105	013	355	145	092	118
K 68400	000	000	001	006	270	443	022	062	075	058	022	040

APPENDIX III

Moment Measure Parameters of Sediments at Lae Shelf

		Mean	Standard Deviation	Skewness	Kurtosis	3rd Moment	4th Moment
K68	350	6.01	1.71	0.13	-0.18	0.64	24.06
	351	6.56	1.44	0.42	-0.45	1.26	10.90
	352	3.13	1.13	2.14	12.03	3.09	24.42
	353	5.95	1.51	0.82	-0.23	2.83	14.42
	354	7.06	1.50	0.22	-1.26	0.73	8.70
	355	6.04	1.85	0.48	-0.76	3.06	26.05
	356	7.31	1.54	-0.08	-1.10	-0.29	10.70
	357	7.06	1.81	-0.14	-1.14	-0.83	19.88
	358	6.18	2.06	0.03	-0.59	0.30	43.07
	359	5.02	1.80	0.19	0.43	1.14	36.30
	360	5.59	1.74	0.14	0.67	0.74	33.62
	361	5.72	1.75	0.06	0.82	0.34	35.81
	362	5.51	1.76	0.55	-0.18	2.98	26.73
	363	6.38	1.93	-0.37	-0.25	-2.64	38.34
	364	6.90	2.18	-0.46	-0.83	-4.76	49.13
	365	6.08	1.84	0.24	-0.24	1.53	31.68
	366	5.78	1.85	0.13	-0.10	0.80	33.85
	367	6.28	1.35	0.58	0.14	1.42	10.46
	368	6.43	1.58	0.34	-0.13	1.33	18.02
	369	5.95	1.64	0.72	-0.23	3.20	20.25
	370	6.11	2.25	0.15	-1.28	1.69	43.98
	371	6.20	1.79	0.08	-0.13	0.43	29.31
	372	-0.35	1.24	0.94	-0.21	1.80	6.58
	373	0.15	1.21	0.58	-0.37	1.02	5.59
	374	5.70	1.38	0.44	1.06	1.16	14.94
	375	2.27	0.93	-1.17	2.34	-0.95	4.08
	376	0.33	2.36	0.97	-0.37	12.76	82.02
	377	3.43	0.78	2.15	9.35	1.02	4.55
	378	7.18	1.76	-0.46	-0.29	-2.54	26.28
	379	7.37	1.85	-0.60	-0.46	-3.81	29.89
	380	7.38	1.84	-0.57	-0.45	-3.60	29.50
	381	3.34	3.05	0.15	-0.87	4.34	184.80
	382	5.82	1.41	0.36	1.45	1.00	17.59
	383	3.35	2.05	0.44	0.63	3.78	64.46
	384	5.42	1.19	0.30	5.24	0.51	16.68
	385	5.22	1.48	0.86	1.20	2.83	20.45
	386	4.77	2.13	0.26	-0.17	2.48	58.38
	387	5.82	1.72	-0.16	0.66	-0.79	31.63
	388	4.74	1.94	0.42	-0.24	3.05	39.25
	389	5.05	1.61	0.51	0.63	2.13	24.45
	390	5.54	1.15	-0.02	5.54	-0.03	15.16
	391	5.49	2.01	-0.05	0.05	-0.38	49.33
	392	0.94	2.10	1.45	2.63	1.35	110.20
	393	5.92	1.39	0.66	0.26	1.79	12.24
	394	4.96	1.12	1.53	4.68	2.12	11.87
	397	5.72	1.50	0.27	0.11	0.91	15.53
	398	4.04	3.05	-0.32	-0.77	-8.93	192.30
	399	6.42	1.92	-0.26	-0.67	-1.85	31.88
	400	4.17	1.91	1.35	0.81	9.38	50.50

APPENDIX IV

Calcimetry Results

Sample Number	Percent $CaCO_3$	Sample Number	Percent $CaCO_3$
K68-350	0.94	K68-377	0.63
351	0.63	378	1.78
352	0.46	379	1.38
353	0.72	380	2.62
354	1.95	381	58.0
355	2.91	382	14+
356	2.14	383	67.5
357	9.37	384	15.1
358	6.66	385	2.01
359	5.30	386	45.5
360	12.3	387	33.4
361	15.8	388	0.85
362	7.42	389	5.54
363	4.55	390	15.8
364	2.58	391	26.2
365	3.58	392	66.1
366	0.41	393	0.10
367	0.00	394	0.00
368	0.36		
369	0.20		
370	4.02	397	0.13
371	2.90	398	53.0
372	1.11	399	1.95
373	1.48	400	0.50
374	1.30		
375	0.64		
376	0.30		

APPENDIX V

Analyses of coarse fractions

	% Coarse fraction	% Terrigenous non-micaceous	% Mica	% Glauconite	% Pyrite	% Faecal pellets	% Plant fibres	% Echinoids	% Forams benthonic	% Forams planktonic	% Molluscs	% Ostracods	% Polyzoans	% Sponge spicules	% Fish remains	% Volcanic glass	% Coral
K68-350	9.38	44	.	.	.	.	40	.	01	01	14	.	.	.	.	.	.
351	1.66	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
352	90.53	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
353	2.64	90	01	.	.	.	.	.	02	05	01	01	.	.	.	.	.
355	9.10	90	.	.	01	.	.	.	.	02	07	.	.	.	.	.	.
356	0.82	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
357	3.05	32	20	.	.	.	03	.	08	17	14	06	.	.	.	.	.
358	11.88	11	01	.	01	.	.	.	12	31	41	03	.	.	.	.	.
359	28.59	68	05	.	01	.	.	.	04	02	15	05	.	.	.	.	.
360	13.70	02	.	.	.	.	.	02	12	29	54	01	.	.	.	.	.
361	11.77	02	04	.	.	.	04	10	12	34	34	.	.	.	.	.	.
362	22.08	03	80	.	.	.	.	.	03	12	02	.	.	.	.	.	.
363	11.78	02	55	.	.	.	.	.	25	.	18	.	.	.	.	.	.
364	11.95	28	55	.	.	.	.	01	01	03	12	.	.	.	.	.	.
365	8.21	01	25	01	.	01	04	01	10	15	40	02	01	.	.	.	.
366	18.27	25	61	.	.	.	.	.	03	01	09	01	.	.	.	.	.
367	2.70	37	07	01	03	.	05	01	06	27	14	.	.	.	.	01	.
368	2.28	36	11	01	01	.	02	.	10	16	21	03	.	.	.	.	.
369	4.99	24	60	.	.	.	11	.	03	01	01	.	.	.	.	.	.
370	23.08	22	17	.	.	.	04	01	05	09	35	06	01	.	.	.	.
371	11.01	76	09	.	.	.	.	.	05	02	05	.	02	.	01	.	.
372	100.00	98	02	.	.	.	.	.	.	.	.	.	.	.	.	.	.
373	100.00	99	01	.	.	.	.	.	.	.	.	.	.	.	.	.	.
374	8.46	99	.	.	.	.	01	.	.	.	.	.	.	.	.	.	.
375	100.00	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

<u>APPENDIX V (contd)</u>

Analyses of coarse fractions

	% Coarse fraction	% Terrigenous non-micaceous	% Mica	% Glauconite	% Pyrite	% Faecal pellets	% Plant fibres	% Echinoids	% Forams benthonic	% Forams planktonic	% Molluscs	% Ostracods	% Polyzoans	% Sponge spicules	% Fish remains	% Volcanic glass	% Coral
K68-376	89.63	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
377	85.66	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
378	5.67	38	.	.	03	.	.	.	03	22	23	05	06	.	.	.	.
379	5.69	58	.	.	01	.	.	09	07	16	06	.	03	.	.	.	.
380	5.36	61	01	.	.	.	01	.	04	09	19	04	01	.	.	.	.
381	59.28	56	.	.	.	.	03	02	07	05	19	03	03	02	.	.	.
382	8.26	57	.	.	.	.	.	.	13	09	11	06	01	03	.	.	.
383	68.09	60	.	.	.	.	.	04	07	08	14	01	05	01	.	.	.
384	8.48	33	.	.	.	.	.	.	09	11	36	07	04	.	.	.	.
385	19.48	70	.	.	.	.	03	.	08	.	17	01	01	.	.	.	.
386	39.79	40	.	.	.	.	.	.	11	09	35	05	.	.	.	.	.
387	11.34	45	.	.	.	.	.	.	07	06	35	04	03	.	.	.	.
388	38.80	92	.	.	.	.	03	.	01	.	03	01	.	.	.	.	.
389	26.14	83	01	.	.	.	05	.	04	.	06	.	.	01	.	.	.
390	7.09	20	.	.	.	01	.	.	06	13	55	04	.	01	.	.	.
391	22.90	25	.	.	.	.	.	.	08	23	38	06	.	.	.	.	.
392	92.11	30	.	.	.	.	07	.	13	08	22	01	04	.	.	.	15
393	4.60	04	10	.	.	.	.	.	20	10	48	02	04	.	.	.	02
394	11.89	12	35	.	.	17	01	.	04	03	19	03	05	.	.	.	.
395	.	32	07	.	.	01	.	.	09	09	30	08	.	01	01	.	01
397	14.82	27	03	.	.	01	.	.	14	17	52	06	.	.	.	.	.
398	48.05	35	.	.	.	.	.	.	08	07	41	06	01	.	.	.	02
399	17.17	56	02	.	.	.	.	.	03	10	27	01	01	.	.	.	.
400	72.03	88	03	01	.	01	.	.	.	.	05	02	.	.	.	.	.