THE RECENT SEDIMENTOLOGY OF THE TOWY ESTUARY, DYFED, S.W. WALES

BY

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VOLUME 2

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ENCLOSURE FIGURES

(in pocket at back)

ENCLOSURE FIGURE 1 - General location map of the Towy estuary.

ENCLOSURE FIGURE 2 - Sediments and tidal streams of Carmarthen Bay

ENCLOSURE FIGURE 3 - Map of the Towy estuary showing the distribution of the sub-environments.

ENCLOSURE FIGURE 4 - Surveyed cross-sections of the Towy estuary and the Towy river.

ENCLOSURE FIGURE 5 (AND 8) - Estuarine and fluvial sediment and coarse fraction sample sites.

ENCLOSURE FIGURE 6 - Nomenclature of gravel-sand-mud mixtures (2 sheets).

ENCLOSURE FIGURE 7 - Nomenclature of sand-silt-clay mixtures.

ENCLOSURE FIGURE 8 - See Enclosure Figure 5.

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ENCLOSURE FIGURE 10 - Longitudinal variation in composition of very coarse to medium sand fraction of the sediments of the estuarine and fluvial channel zone and offshore sediments.

ENCLOSURE FIGURE 11 - Results of the coarse fraction analysis of the graded sediment samples together with the distributions of the sand grades within the samples.

ENCLOSURE FIGURE 12 - Longitudinal variation in composition of the fine and very fine sand fraction of the sediments of the mudflats and fluvial mud banks and some offshore sediments.

ENCLOSURE FIGURES (cont.)

ENCLOSURE FIGURE 13 - Longitudinal variation in composition of the sand fraction of the sediments of the salt marshes and flood plain and of some offshore sediments.

ENCLOSURE FIGURE 14 - Averages of the fine-very fine sand fraction compositions of the offshore, estuarine channel zone, fluvial channel zone and boulder clay sediments.

ENCLOSURE FIGURE 15 - Stratification of the channel zone sediments (5 sheets).

ENCLOSURE FIGURE 16 - Stratification of the upper sandflats (5 sheets).

ENCLOSURE FIGURE 17 - Stratification of the mudflats (11 sheets).

ENCLOSURE FIGURE 18 - Stratification of the salt marshes (4 sheets).

ENCLOSURE FIGURE 19 - Stratification of the creeks (2 sheets).

C H A P T E R 1

FIGURES AND TABLES

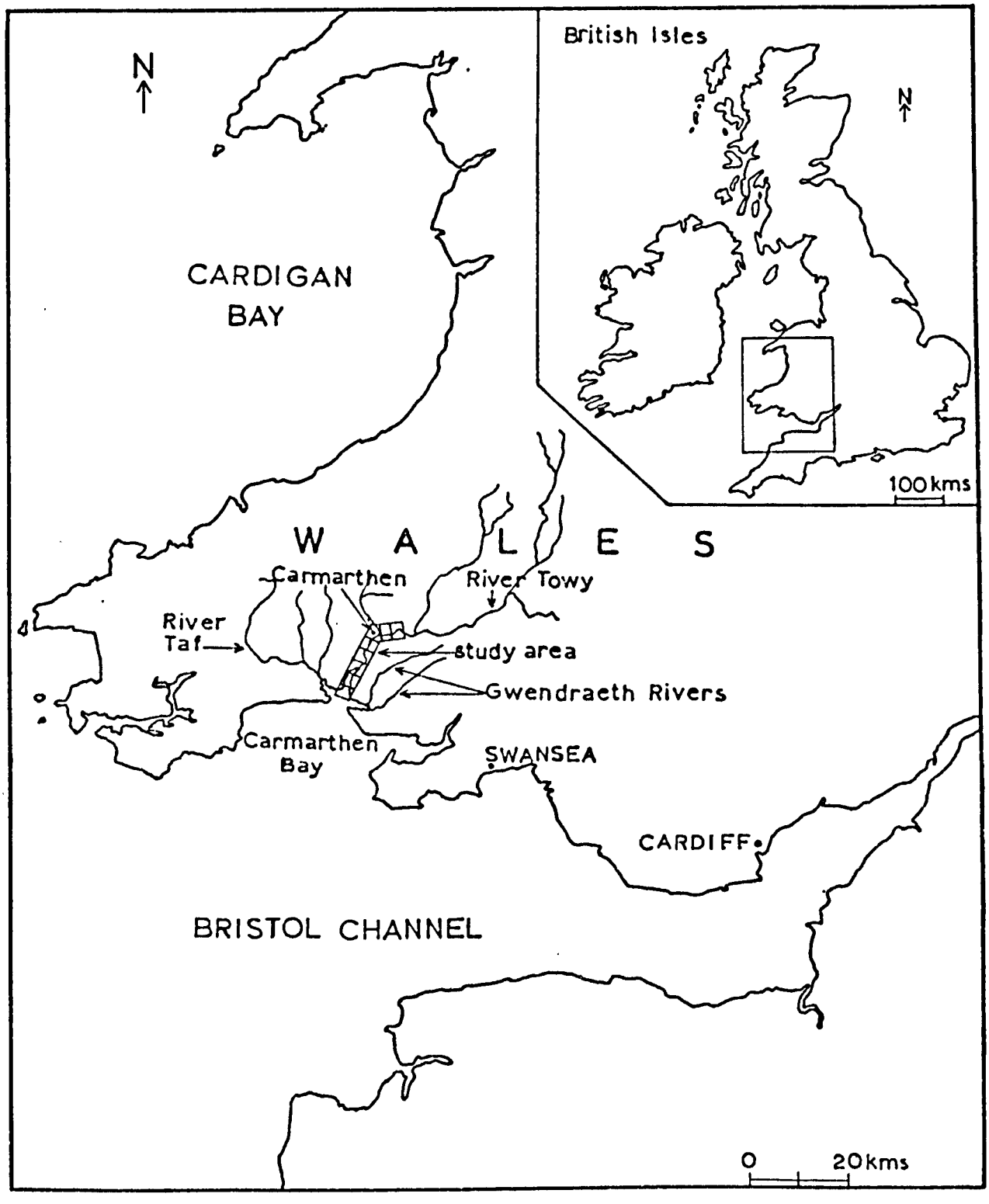


FIGURE 1.1 LOCATION OF THE STUDY AREA

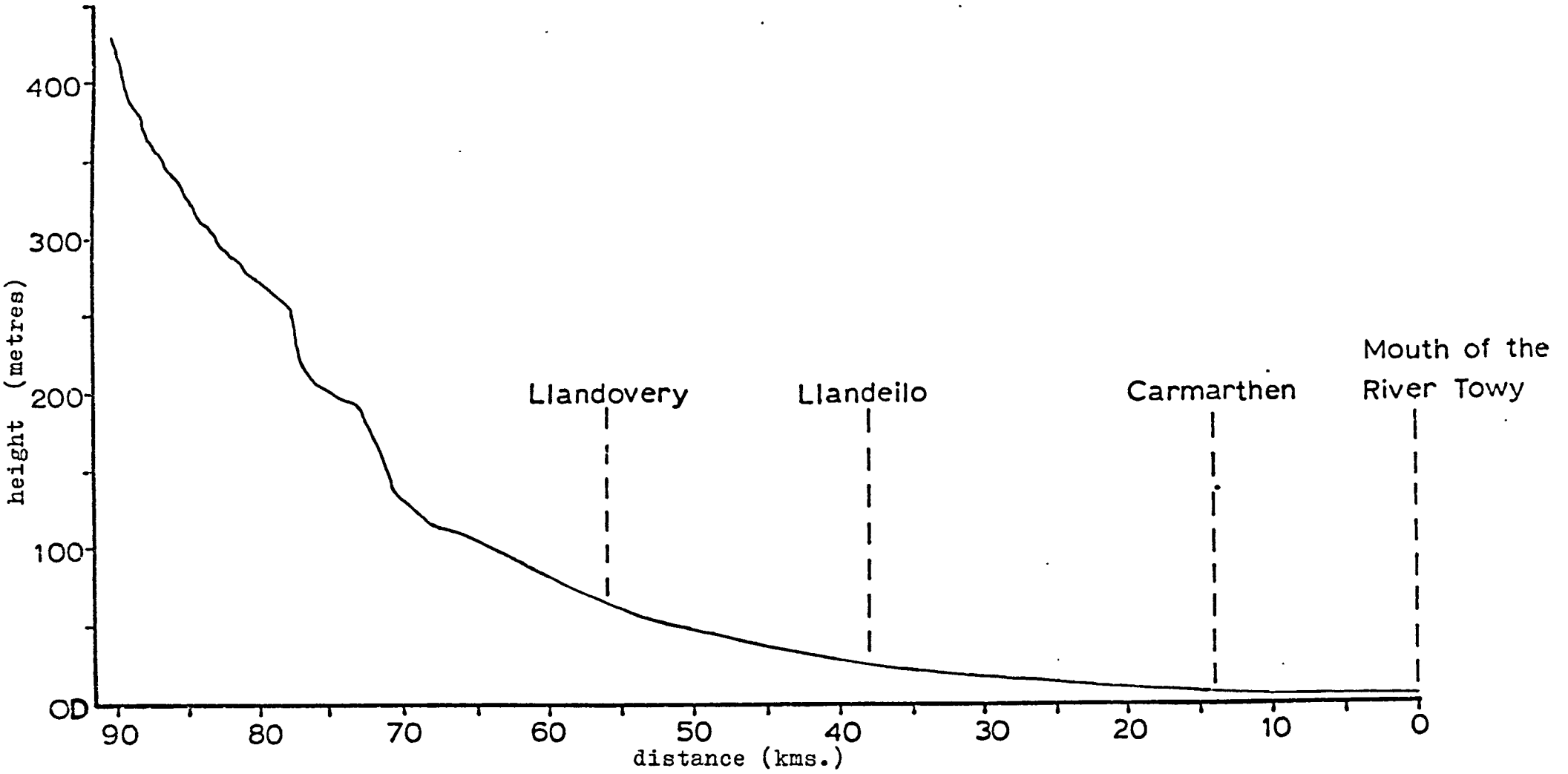


FIGURE 1.2 LONGITUDINAL PROFILE OF THE TOWY RIVER (based on Jones 1924)

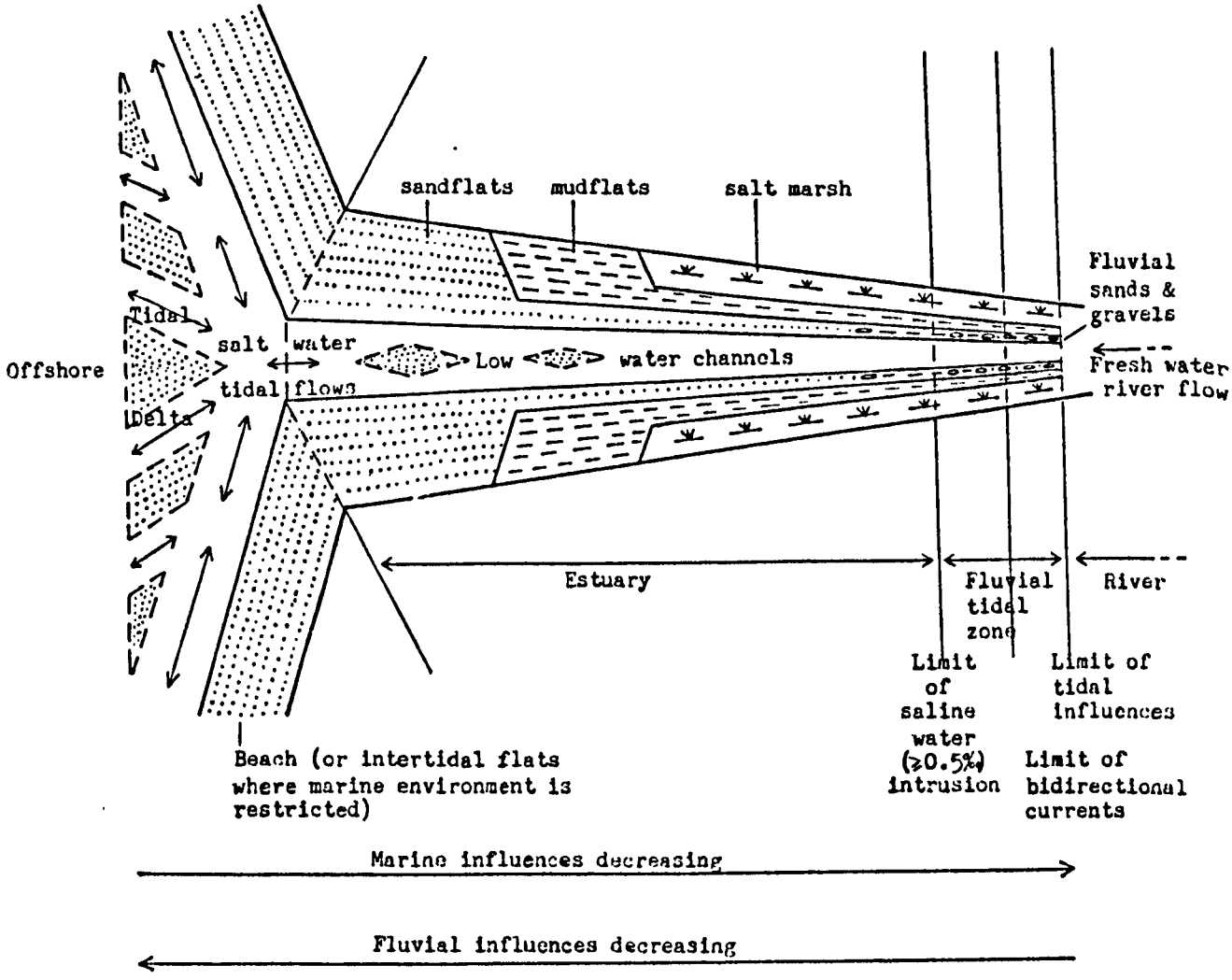


FIGURE 1.3 SCHEMATIC VIEW OF A TEMPERATE CLASTIC ESTUARY



FIGURE 1.4 THE TOWY RIVER IN ITS MIDDLE REACHES NEAR LLANGADOCK



FIGURE 1.5 THE TOWY VALLEY NEAR WHITE MILL

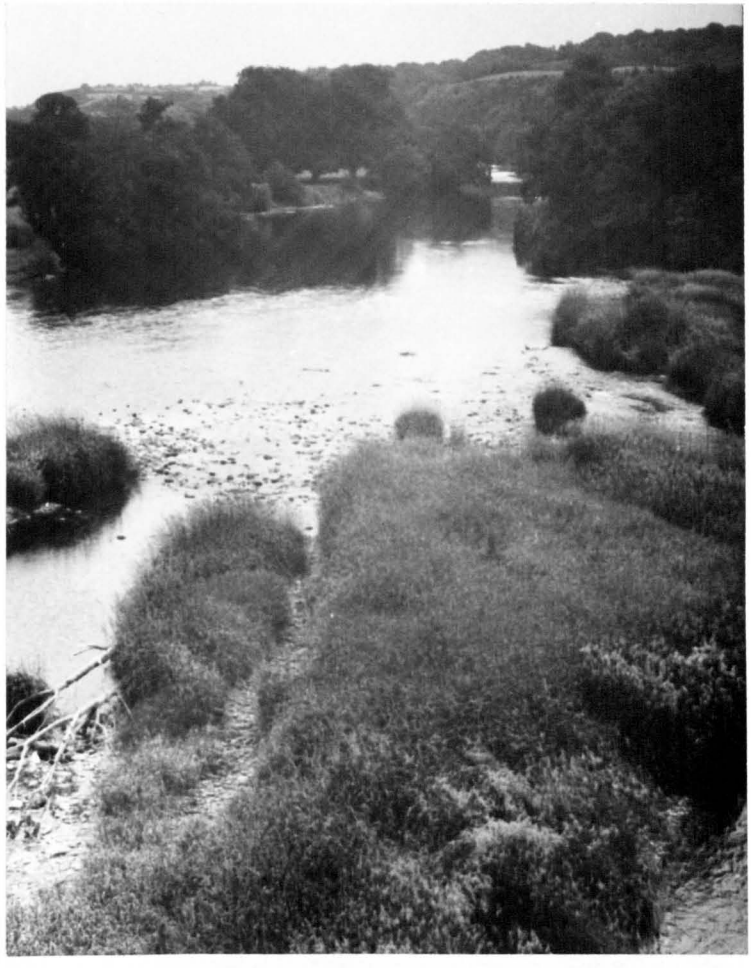


FIGURE 1.6 THE TOWY RIVER IN ITS LOWER REACHES NEAR NANTGAREDIG



FIGURE 1.7 THE TIDAL DELTA AND THE MOUTH OF THE TOWY ESTUARY



FIGURE 1.7 THE TIDAL DELTA AND THE MOUTH OF THE TOWY ESTUARY

TABLE 1.1. MONTHLY FLOWS OF TOWY RIVER (AT TY-CASTELL)

	Measured Flows 1974	Measured Flows 1975	Long Average Natural Flow *
January	3738.9	3137.5	2116.0
February	2690.5	1092.7	1377.1
March	808.8	739.7	1065.7
April	241.4	1072.7	1064.5
May	270.0	329.5	810.7
June	223.3	150.4	499.2
July	533.3	251.5	459.1
August	754.9	166.3	665.6
September	2224.1	479.8	867.2
October	1651.8	674.0	1360.7
November	2220.5	1289.3	1741.5
December	2500.5	1134.0	2031.4
ANNUAL TOTAL	17858.0	10517.4	14042.5

All flow figures in 'cumec-days'

'Long Average Natural Flow' is the average of natural flows in the River Towy at Ty-Castell over the 17 years October 1958 - September 1975. Natural flows have been calculated by taking into account change in storage in Llyn-y-fan Fach and Llyn Brianne Reservoirs and abstraction from the river above Ty-Castell.

(Data from W.N.W.D.A.)

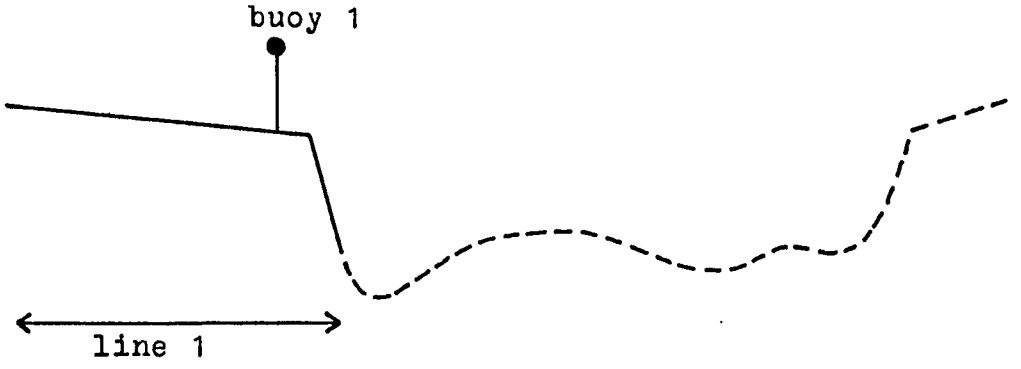
	Height ft.	Jan. in.	Feb. in.	Mar. in.	Apr. in.	May in.	June in.	July in.	Aug. in.	Sept. in.	Oct. in.	Nov. in.	Dec. in.	Year in.
Carmarthen	62	5.78	3.76	3.28	2.96	3.16	2.87	4.13	4.55	4.22	5.78	6.02	5.84	52.35
Llandilo	202	5.92	3.92	3.39	3.05	3.36	2.91	4.08	4.50	4.23	6.11	5.96	5.94	53.37
Llandovery	249	5.85	4.17	3.25	3.17	3.29	3.20	4.08	4.57	4.29	5.85	5.98	5.63	53.33
Llyn-y-fan Fach	1,172	10.20	6.48	5.61	4.91	5.04	4.43	6.04	6.54	6.26	8.73	8.88	9.55	82.67

TABLE 1.2. MONTHLY AND ANNUAL AVERAGES OF RAINFALL 1916 - 1950 FOR THE AREA OF THE TOWY VALLEY

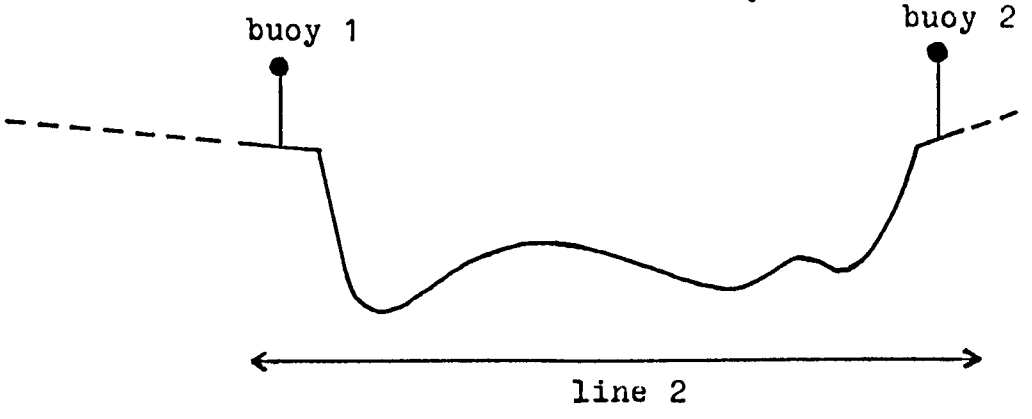
C H A P T E R 2

FIGURES AND TABLES

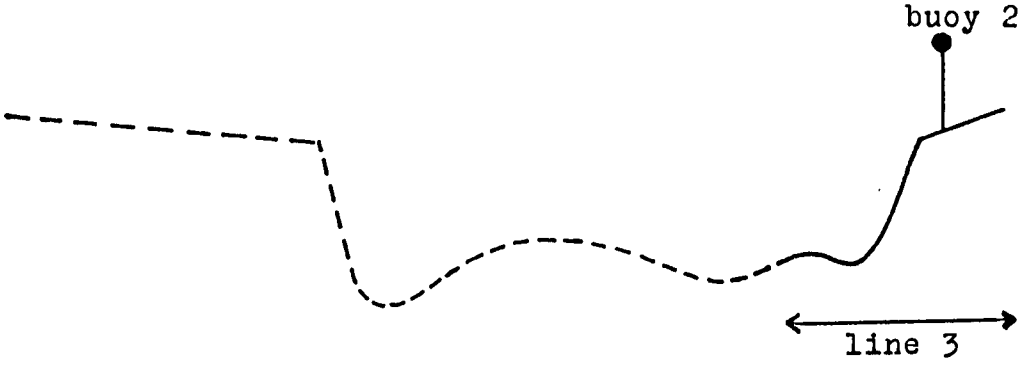
a. Level traverse made on one side of the estuary.



b. Echo traverse made across the estuary.



c. Level traverse made on the other side of the estuary.



Lines 1+2+3 = Cross-section profile

FIG. 2.1 SKETCH ILLUSTRATING THE METHOD OF PROFILING THE CROSS-SECTIONS OF THE ESTUARY.



FIGURE 2.2 THE INCLINE BETWEEN THE CHANNEL ZONE AND THE 'UPPER' INTERTIDAL FLATS IN THE LOWER REACHES OF THE ESTUARY



FIGURE 2.3 THE ESTUARINE CHANNEL AND VALLEY IN THE UPPER REACHES OF THE TOWY ESTUARY NEAR GREEN CASTLE



FIGURE 2.4 LOW WATER CHANNELS AND SANDBANKS WITH A POINT BAR IN THE LOWER REACHES OF THE TOWY ESTUARY OFF FERRYSIDE

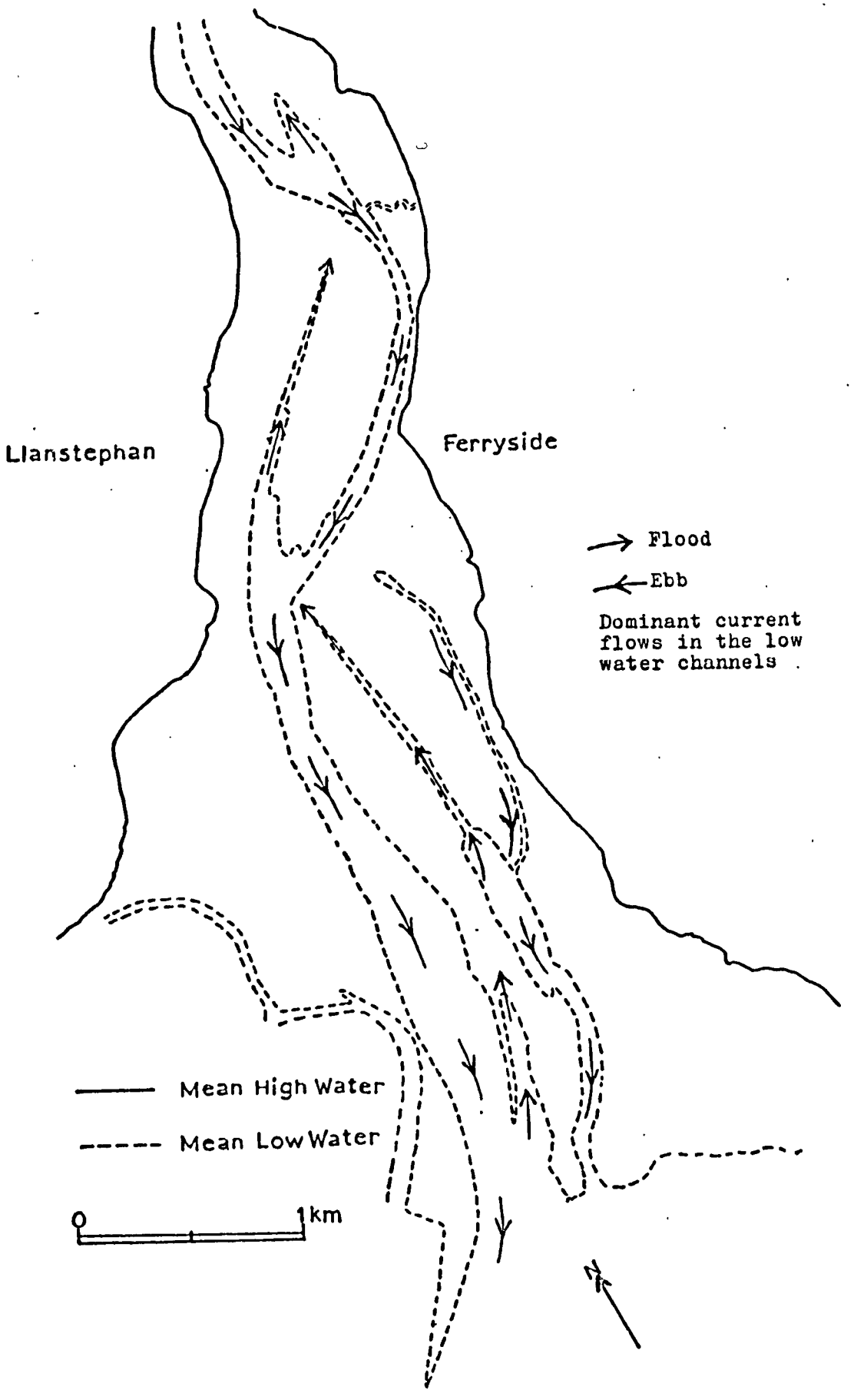


FIGURE 2.5 SUGGESTED TIDAL CURRENT DOMINANCE IN THE LOW WATER CHANNELS OF THE LOWER ESTUARY



FIGURE 2.6 THE ESTUARINE CHANNEL AND STREAM GRAVEL OUTWASH FAN IN THE MIDDLE REACHES OF THE TOWY ESTUARY

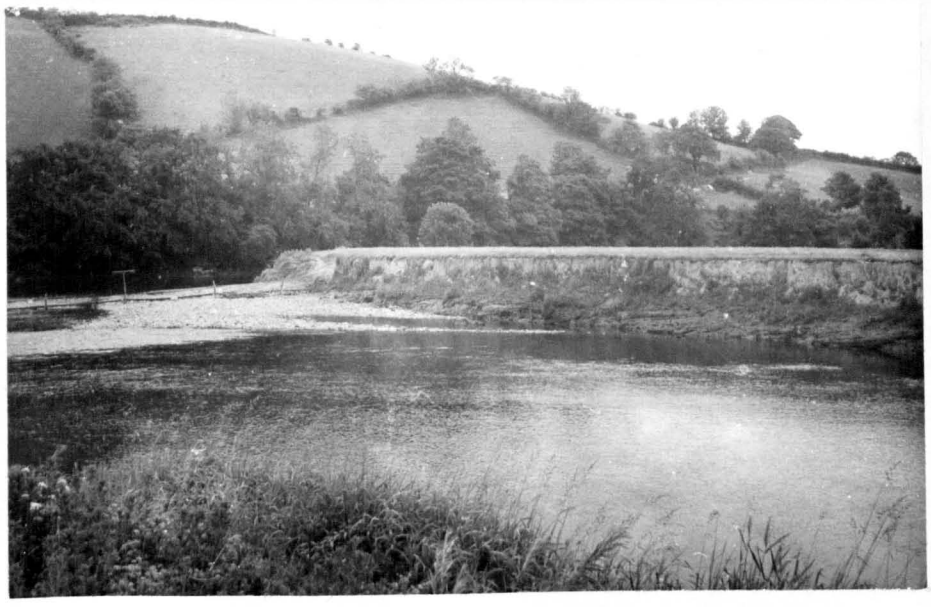


FIGURE 2.7 THE ESTUARINE CHANNEL IN THE UPPERMOST REACHES OF THE TOWY ESTUARY (Note the dark inclined mudbank deposits discordantly overlying the gravel point bar)



FIGURE 2.8 ASYMMETRICAL TIDAL CURRENT RIPPLES WITH MUD FILLS TO THE RIPPLE TROUGHS (Note the small tracks on the sediment surface) - Scale 19 cms



FIGURE 2.9 ASYMMETRICAL TIDAL CURRENT RIPPLES ON THE CHANNEL SANDFLATS (Note terracing on the stoss limbs) - Scale 30 cms

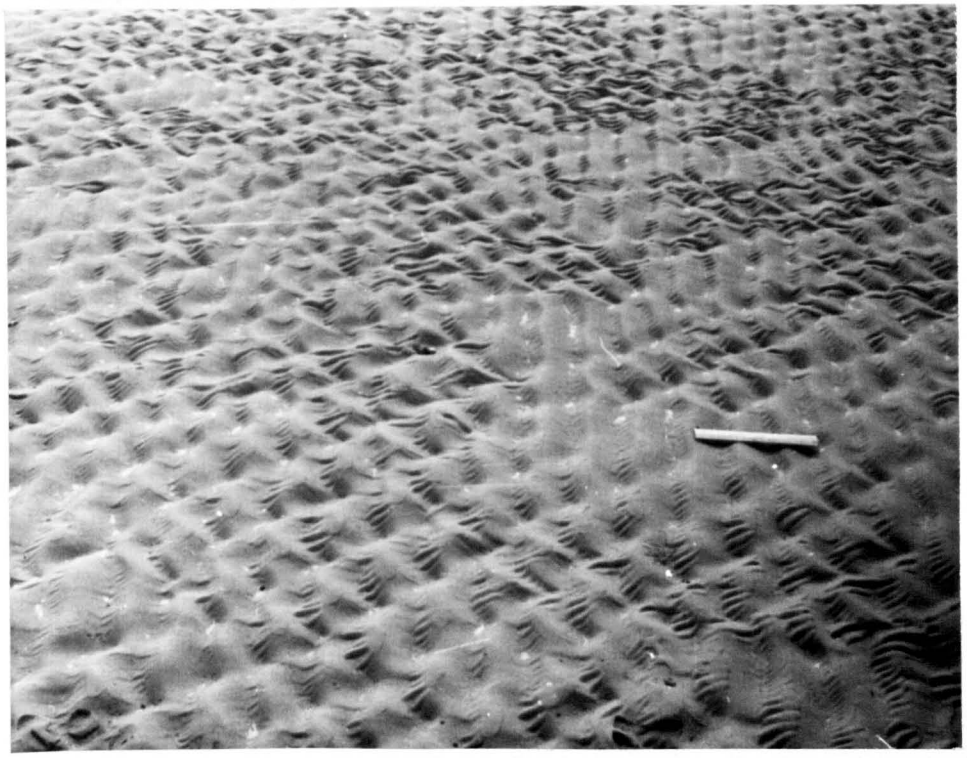


FIGURE 2.10 INTERFERENCE PATTERN OF TIDAL CURRENT AND WAVE CURRENT RIPPLES ON THE CHANNEL SANDFLATS - Scale 19 cms



FIGURE 2.11 FLOW SEPARATION RIDGE ON THE CHANNEL SANDFLATS - Scale 19 cms



FIGURE 2.12 ASYMMETRICAL TIDAL CURRENT RIPPLES WITH SUPERIMPOSED WAVE CURRENT RIPPLES ON THE CHANNEL SANDFLATS - Scale 19 cms

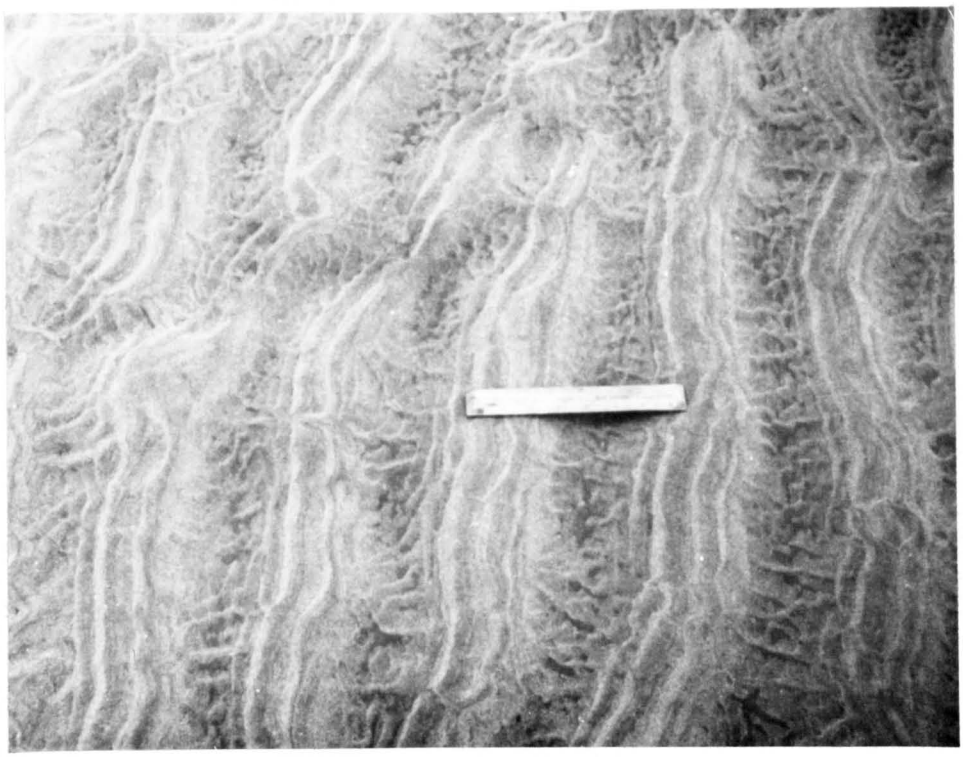


FIGURE 2.13 DOUBLE-CRESTED RIPPLES ON THE CHANNEL SANDFLATS - Scale 19 cms



FIGURE 2.14 DOUBLE-CRESTED RIPPLES ON THE CHANNEL SANDFLATS - Scale 19 cms



FIGURE 2.15 MEGA-RIPPLES IN A FLOOD BARB IN THE CHANNEL ZONE



FIGURE 2.16 FLUTED SCOUR MARKS ON THE LOWER MUDFLATS OF THE CHANNEL ZONE - Scale ca.15 cms

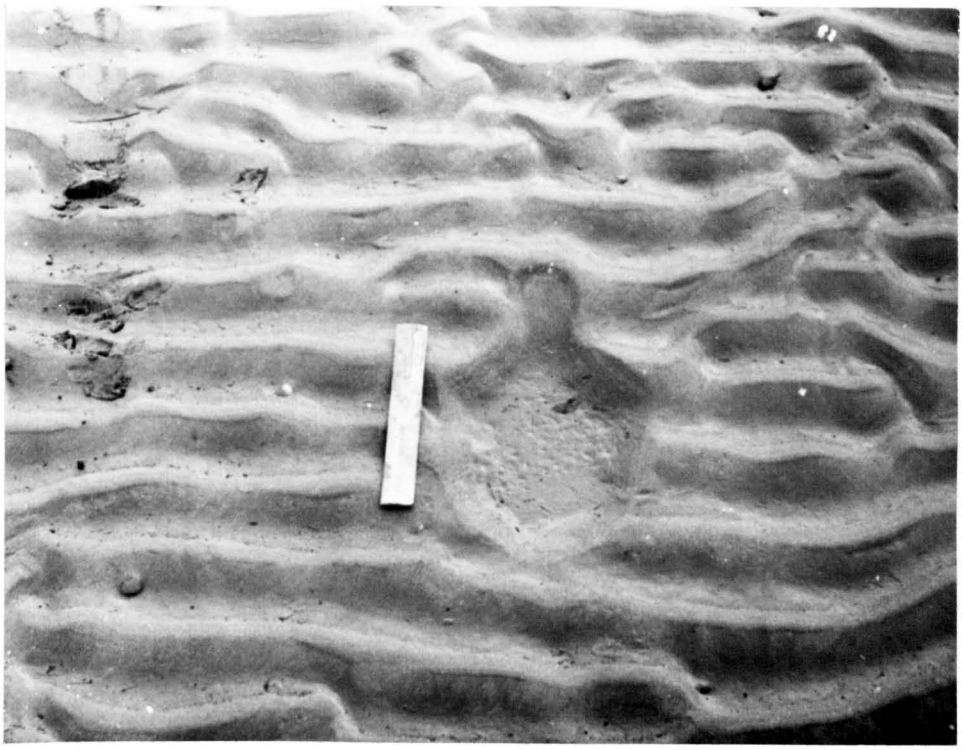


FIGURE 2.17 A DAB PRINT (Note the flattened ripple crests) - Scale 19 cms

FIG. 2.18 BURROWS AND SURFACE MARKINGS OF VARIOUS ESTUARINE ORGANISMS.

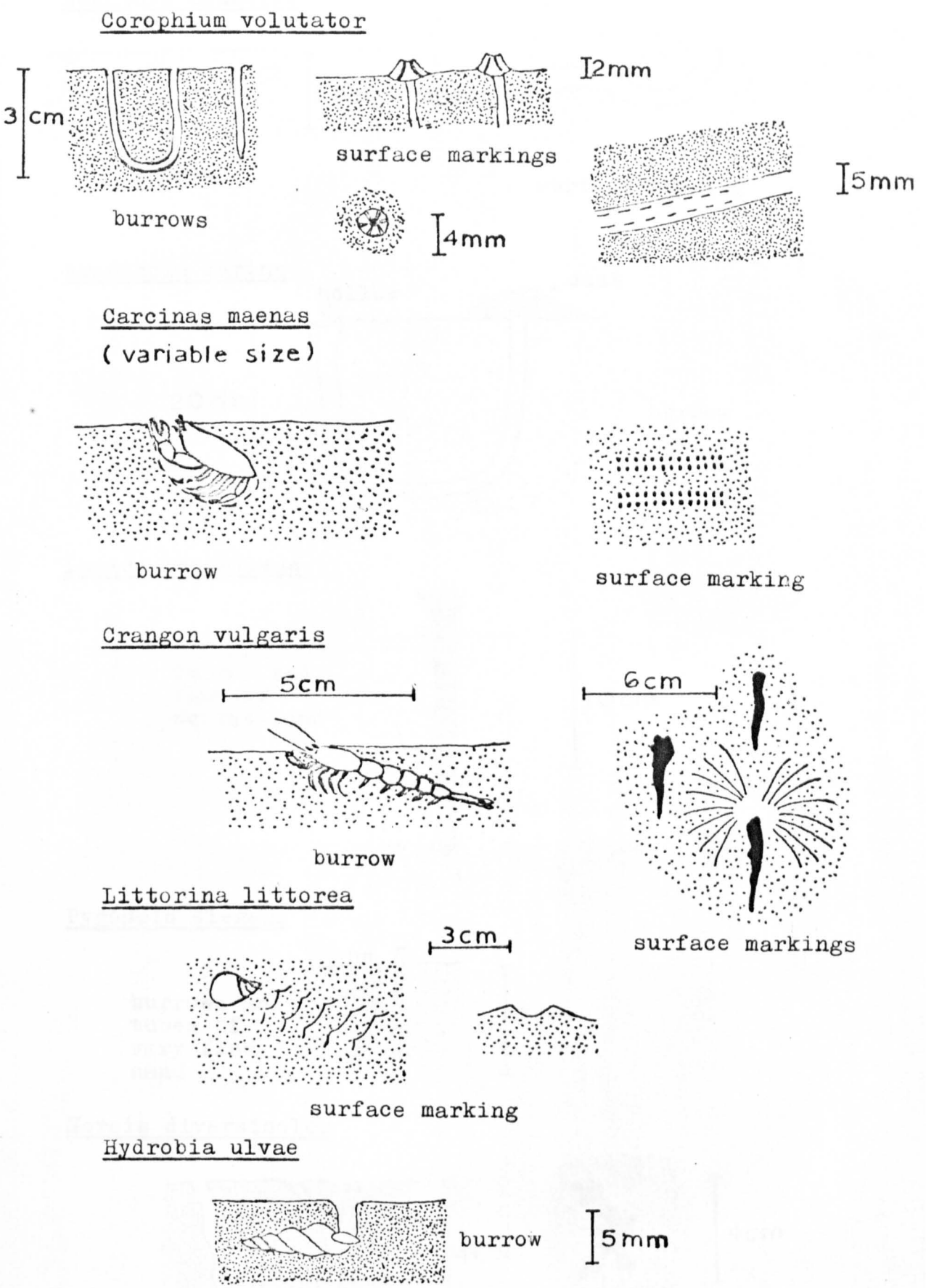
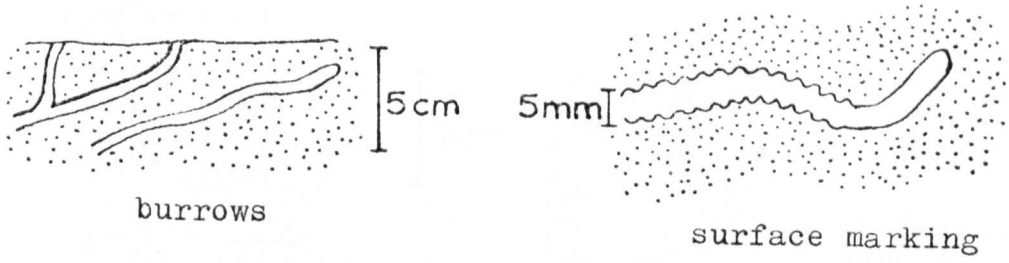


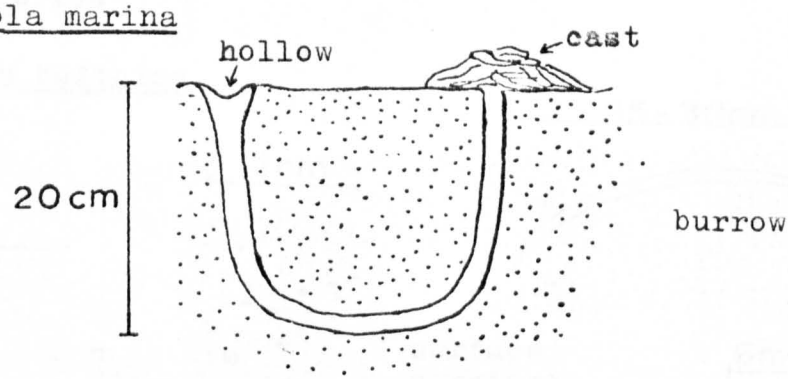
FIG. 2.18.i

FIG. 2.18.ii

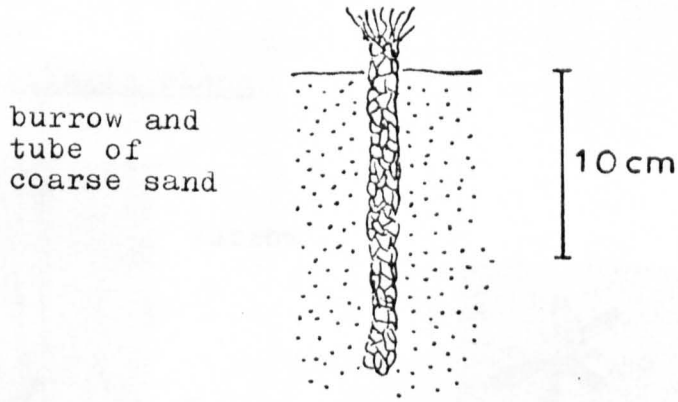
Nephthys hombergi



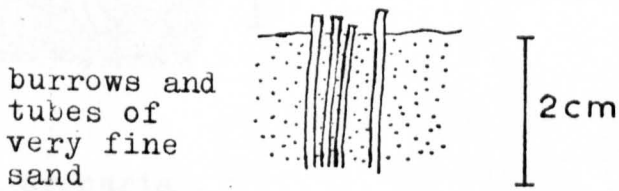
Arenicola marina



Lanice conchilega



Pygospio elegans



Nereis diversicolor

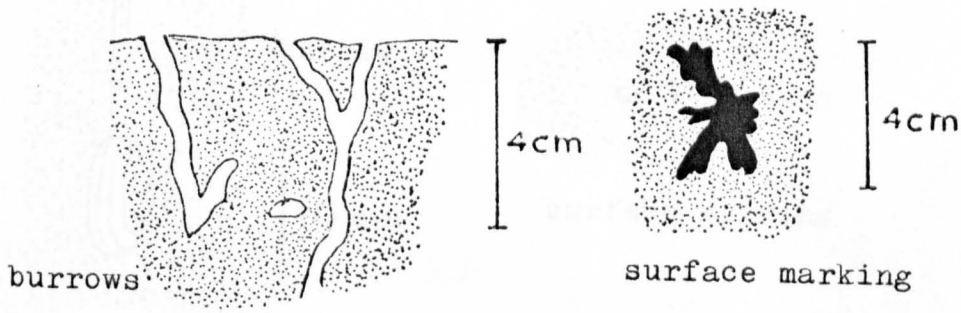
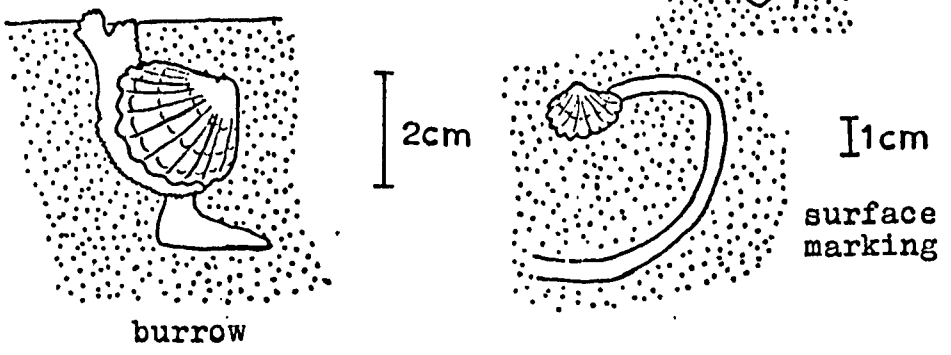
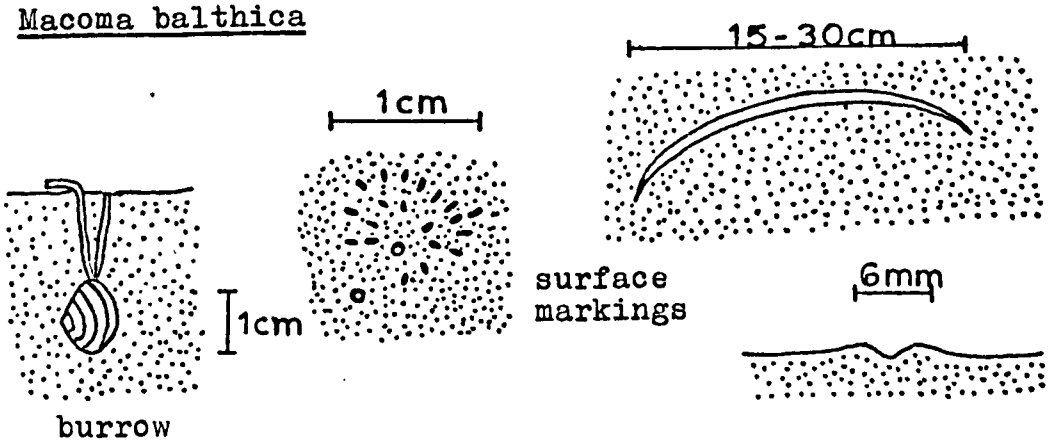


FIG. 2.18.iii

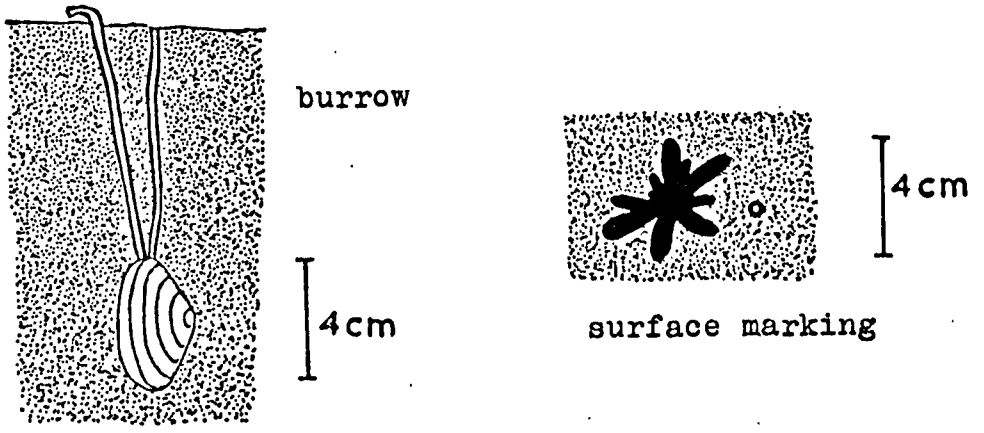
Cerastoderma edule



Macoma balthica



Scrobicularia plana



Mya arenaria

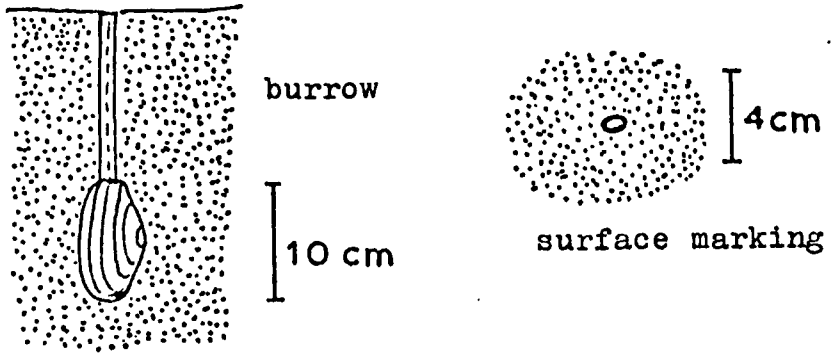




FIGURE 2.19 LLANSTEPHAN BEACH AND THE LOWER REACHES OF THE TOWY ESTUARY



FIGURE 2.20 GRAVEL BERM WITH HIGH WATER MARK LITTER LINES ON FERRYSIDE BEACH



FIGURE 2.21 RIPPLE MARKS ON LLANSTEPHAN BEACH



FIGURE 2.22 RIPPLE MARKS AND SURFACE MARKINGS OF ARENICOLA MARINA AND TUBES OF LANICE CONCHILEGA ON THE UPPER SANDFLATS



FIGURE 2.23 ACCUMULATION OF IMBRICATED SCROBICULARIA PLANA TESTS ROUND THE BASE OF A CLUMP OF SPARTINA SP. ON THE UPPER SANDFLATS



FIGURE 2.24 ANTIDUNES ON LLANSTEPHAN BEACH



FIGURE 2.25 ADHESION OF DRY SAND TO THE RIPPLED WET SURFACE OF THE UPPER SANDFLATS -Scale 19 cms

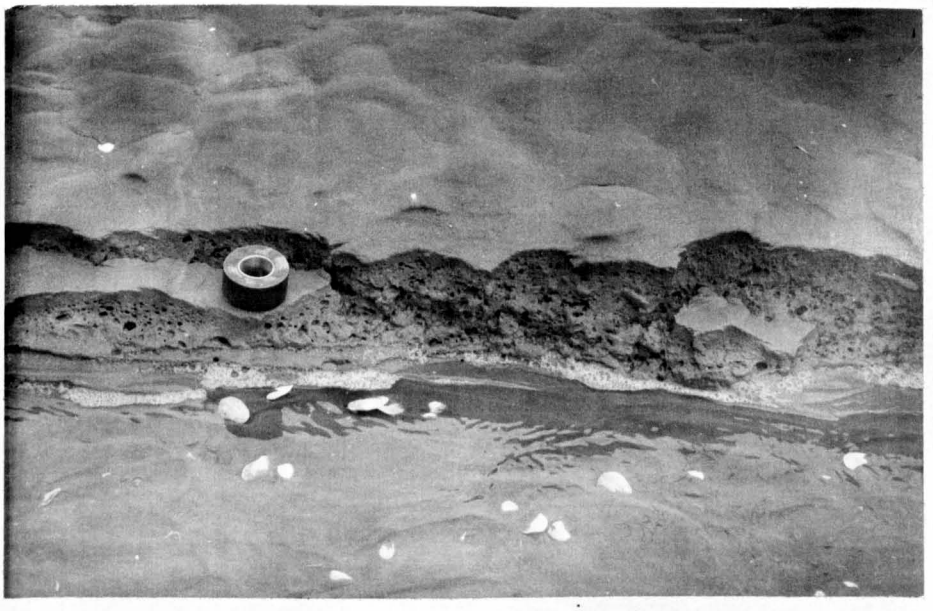


FIGURE 2.26 AIR CAVITIES IN SANDS OF THE UPPER SANDFLATS EXPOSED IN THE SIDE OF A RILL (Note the shells on the bed of the rill) - Scale ca.6 cms



FIGURE 2.27 MUDFLATS BACKED BY SALT MARSH CLIFF OFF MORFA UCHAF

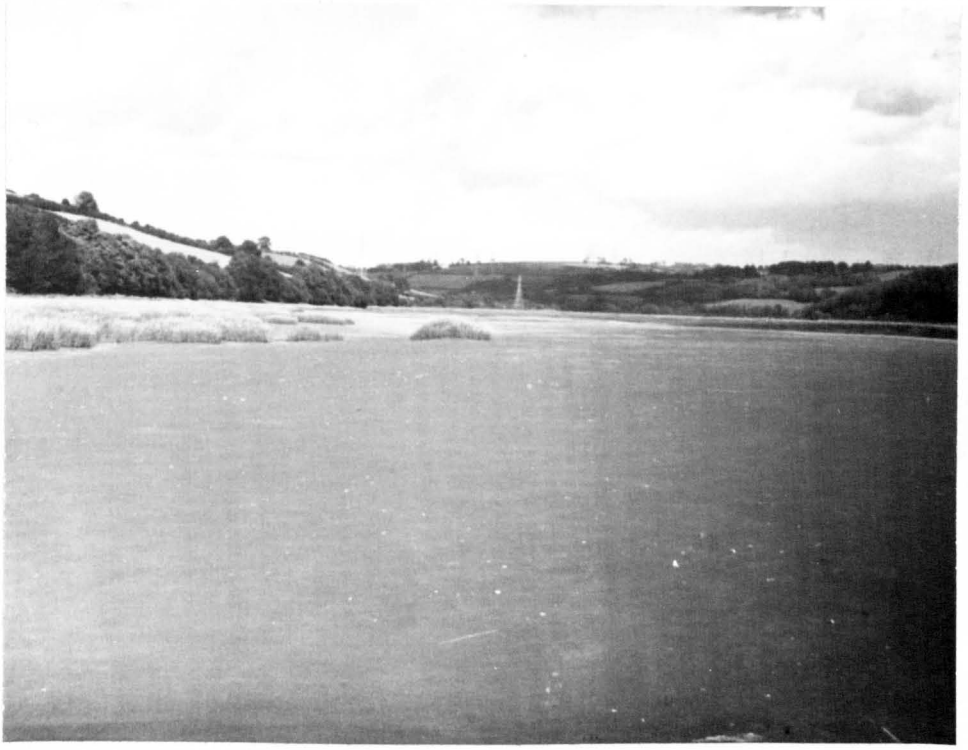


FIGURE 2.28 MUDFLATS AND SPARTINETUM SALT MARSH IN THE MIDDLE REACHES OF THE TOWY ESTUARY

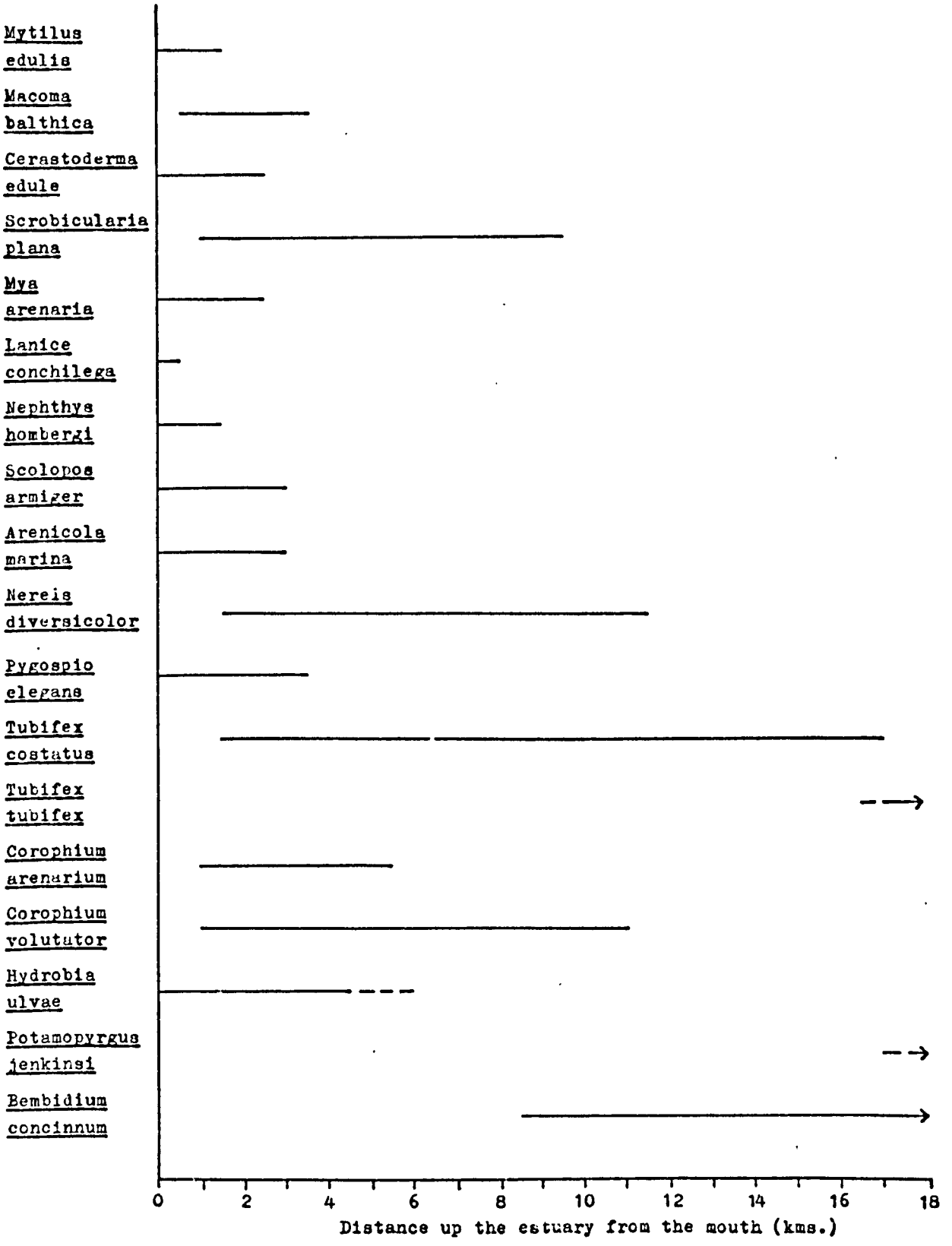


FIGURE 2.29 LONGITUDINAL DISTRIBUTION OF SOME OF THE MACROFAUNA OF THE TOWY ESTUARY (in part after Howells 1964)



FIGURE 2.30 IMBRICATED SCROBICULARIA PLANA TESTS ACCUMULATING IN A SMALL SCOUR ON THE MUDFLATS



FIGURE 2.31 MUDCRACKS - Scale ca.6 cms



FIGURE 2.32 SURFACE MARKINGS OF COROPHIUM VOLUTATOR BURROWS, A FEW SCROBICULARIA PLANA AND NEREIS DIVERSICOLOR BURROWS AND AVIAN FOOTPRINTS Scale ca.6 cms

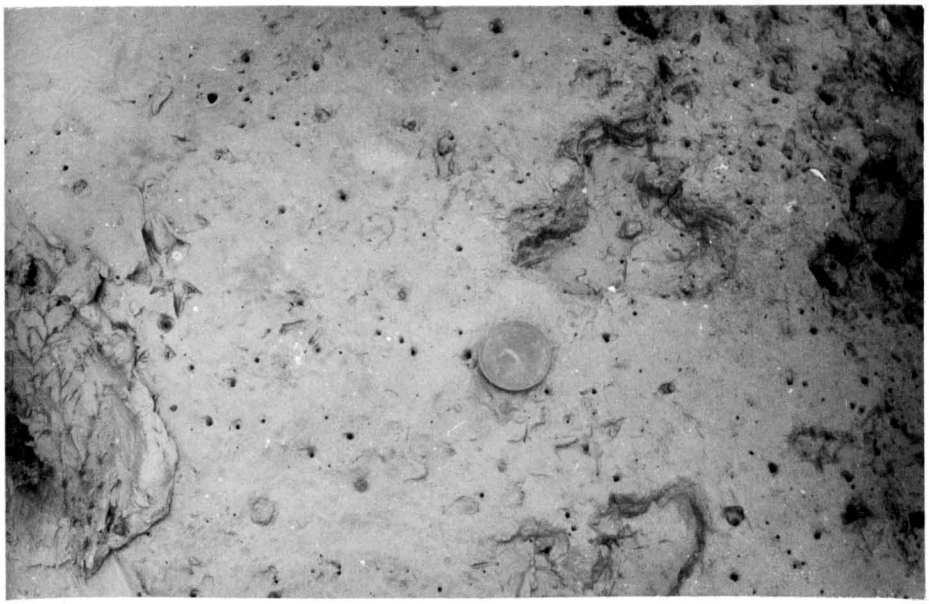


FIGURE 2.33 SURFACE MARKINGS OF NEREIS DIVERSICOLOR BURROWS, CRAB BURROWS AND AVIAN FOOTPRINTS AND BEAK MARKS - Scale ca.6 cms



FIGURE 2.34 SURFACE MARKINGS OF SCROBICULARIA PLANA, COROPHIUM VOLUTATOR, NEREIS DIVERSICOLOR AND HYDROBIA ULVAE ON THE MUDFLATS. (Note the thin algal film on the surface of the mudflats and the occasional strands of green algae). Scale - ca. 10 cms.



FIGURE 2.35 THE SURFACE MARKINGS OF THE FEEDING ACTIVITIES OF WADERS AND POORLY FORMED RIPPLES ON THE MUDFLATS

FIGURE 2.36 LONGITUDINAL AND VERTICAL DISTRIBUTION OF THE SALT MARSH COMMUNITIES AND THE LONGITUDINAL PROFILE OF THE BED OF THE TOWY ESTUARY

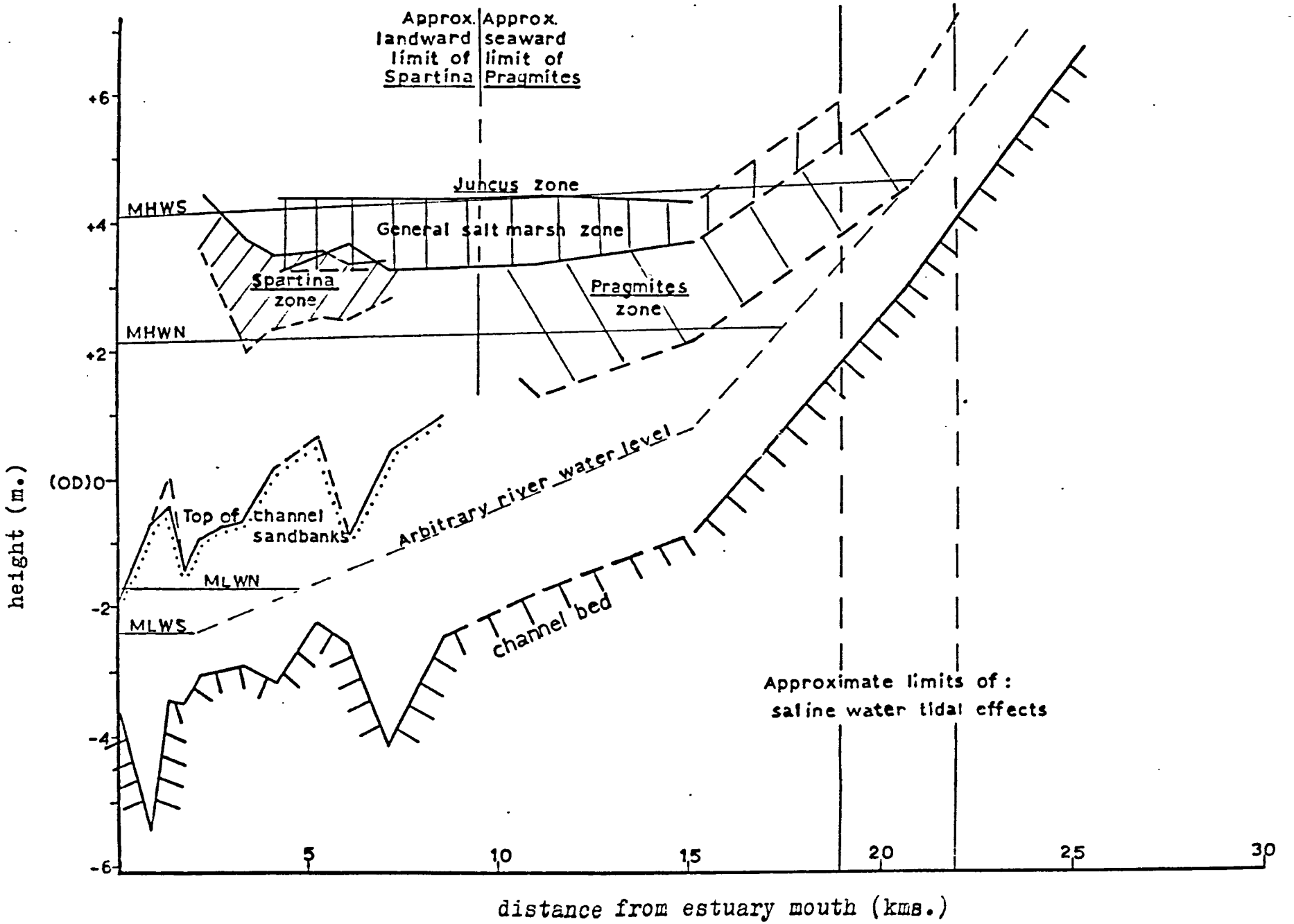

Approx. landward limit of Spartina
Approx. seaward limit of Pragmites
+6
+4
+2
(OD)0
-2
-4
-6
MHWS
MHWN
MLWN
MLWS
Juncus zone
General salt marsh zone
Spartina zone
Pragmites zone
Top of channel sandbanks
Arbitrary river water level
channel bed
Approximate limits of : saline water tidal effects
height (m.)
5
10
15
20
25
30
distance from estuary mouth (kms.)



FIGURE 2.37 GENERAL SALT MARSH AND JUNCETUM AND SALT PANS ON MORFA UCHAF



FIGURE 2.38 GENERAL SALT MARSH AND HIGH WATER MARK LITTER LINE



FIGURE 2.39 A STORM SAND SHEET ON THE GENERAL SALT MARSH OF MORFA UCHAF. (Note the small cliff in the surface of the general salt marsh)

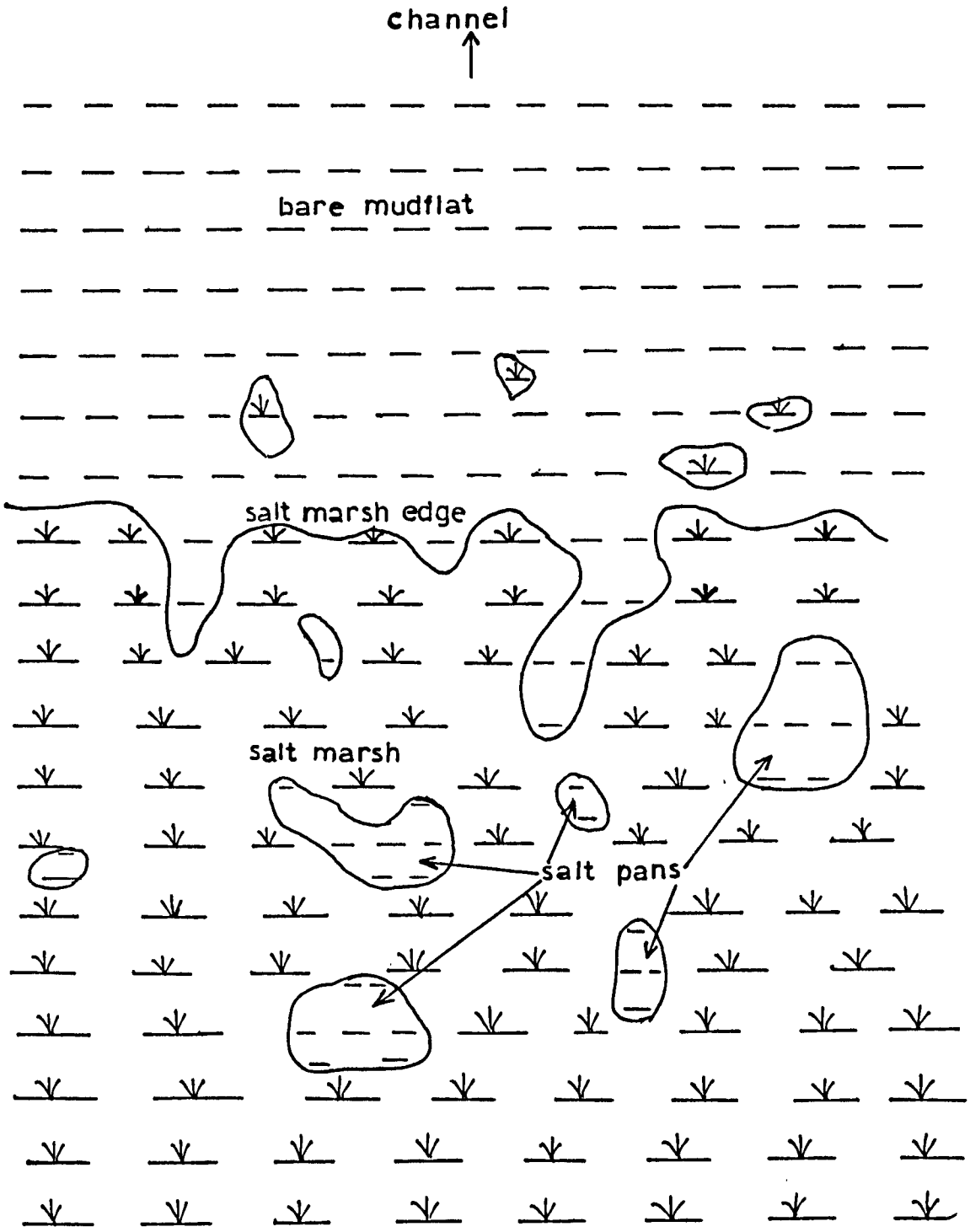


FIG. 2.40 SKETCH ILLUSTRATING THE ORIGIN OF CIRCULAR SALT PANS BY UNEVEN COLONISATION OF THE MUDFLATS BY THE SALT MARSH PLANTS.



FIGURE 2.41 CREEK IN GENERAL SALT MARSH ON MORFA UCHAF



FIGURE 2.42 SMALL CREEK IN SPARTINETUM



FIGURE 2.43 CRAB BURROWS IN THE BANK OF A CREEK
Scale ca.6 cms



FIGURE 2.44 ST. ISHMAELS SCAR, AND SALMON POINT SCAR IN THE MIDDLE DISTANCE (LEFT)



FIGURE 2.45 SALMON POINT SCAR AND DUNES UNDERLAIN BY A RIDGE OF BOULDER CLAY



FIGURE 2.46 LOW CLIFF CUT IN BOULDER CLAY AT HIGH WATER MARK (Note gravel talus lag and the imbrication of the gravel in the boulder clay)

	CZ	US			MF	SM	C
		CSF	HWZ	MSF			
Cerastoderma edule		P		P			
Macoma balthica	P	P		P			
Mya arenaria		P		P			
Mytilus edulis	P	P					
Scrobicularia plana				P	P	P	P
Hydrobids			P	P	P	P	P
Littorina littorea	P	P					
Arenicola marina	P	P		P			
Lanice conchilega		P					
Nephthys hombergi	P	P					
Nereis diversicolor				P	P	P	P
Pygospio elegans	P	P		P			
Scolopos armiger		P					
Tubifids	P			P?	P	P	P
Carcinas maenas	P	P	P	P	P	P	P
Corophium spp.	P	P		P	P	P	P
Crangon vulgaris	P	P		P	P?		
Talitritids			P				
Birds	P	P	P	P	P	P	P

TABLE 2.1 THE DISTRIBUTION OF SOME OF THE ESTUARINE FAUNA WITHIN THE SUB-ENVIRONMENTS (CZ-channel zone, US-upper sandflats, CSF-'clean' rippled sandflats, HWZ-high water zone, MSF-muddy sandflats, MF-mudflats, SM-salt marshes, C-creeks. P-present.)

TABLE 2.2 FAUNA OF SALT PANS ON MORFA UCHAF

(After Howells 1952)

MARINE SPECIES	BRACKISH SPECIES	FRESHWATER SPECIES
Eurydice pulchara	Tubifex costatus	Eucyprus virens
Crangon vulgaris	Nereis diversicolor	Agabus bipustulatus
Carcinas maenas	Cyclops bicuspidatus	Notonecta glauca
Aphya pellucida	Eurytoma velox	Sigara striata
	Eurytoma affinis	Agabus negulosus
	Cyprideis littoralis	Hydroporus planus
	Mesochra lilljeberqi	Ochthebius viridis
	Sphaeroma rugicauda	Ochthebius dilatatus
	Gammarus duebeni	Ochthebius punctatus
	Palaemonetes varians	Helophorus mulsanti
	Corophium volutator	Helophorus brevipalpis
	Aedes detritus	Helophorus aquaticus
	Hydrobia ulvae	
	Gobius minutus	
	Gasterosteus aculeatus	

TABLE 2.3

CHANGES IN THE FAUNA OF THE SALT PANS ON MORFA UCHAF DURING DESSICATION

1. Bottom soil very moist
   - *Nereis diversicolor*
   - *Tubifex costatus*
   - Chironomid larvae
   - *Gammarus duebeni*
   - *Sphaeroma rugicauda*
   - *Corophium volutator*

2. Bottom soil drier
   - Chironomid larvae
   - *Gammarus duebeni*
   - *Sphaeroma rugicauda*
   - *Corophium volutator*
   - *Orchestia gammarella*
   - *Helophorus mulsanti*

3. Mud cracks forming
   - Various beetles
   - Various species of spiders
   - *Orchestia gammarella*
   - *Sphaeroma rugicauda*

(TABLE AFTER HOWELLS 1952)

C H A P T E R 3

FIGURES AND TABLES

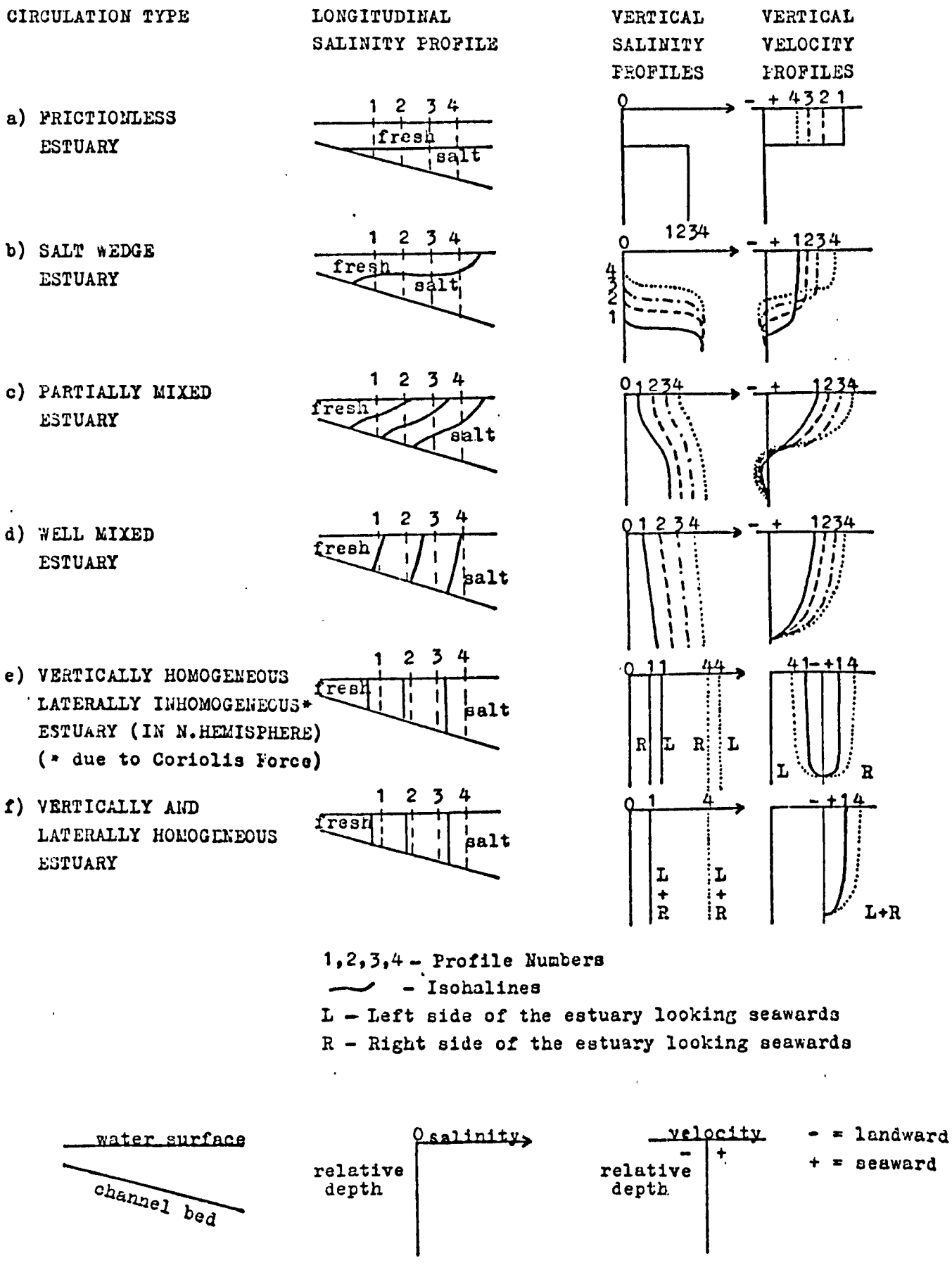


FIG. 3.1.1 MEAN SALINITY AND VELOCITY PROFILES FOR VARIOUS TYPES OF ESTUARINE CIRCULATION (Based on Dyer 1973).

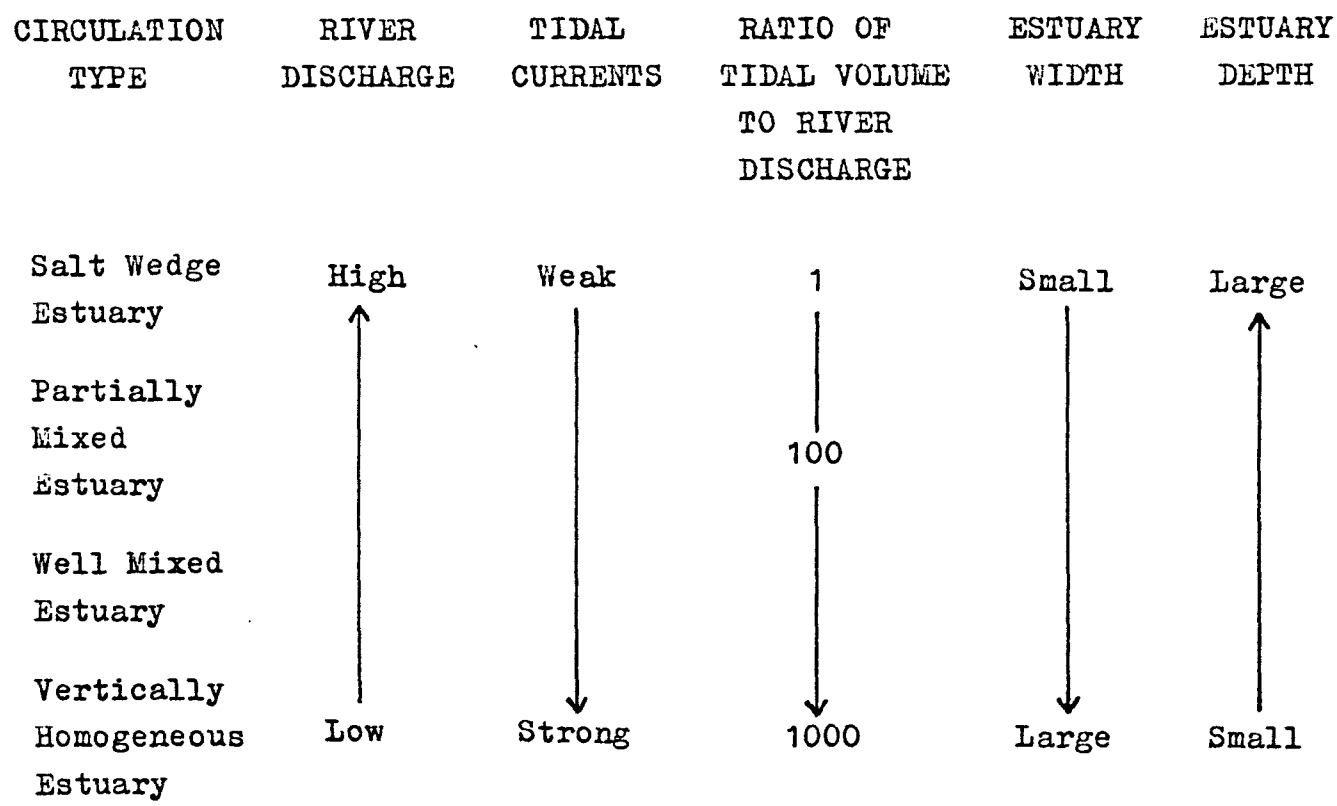
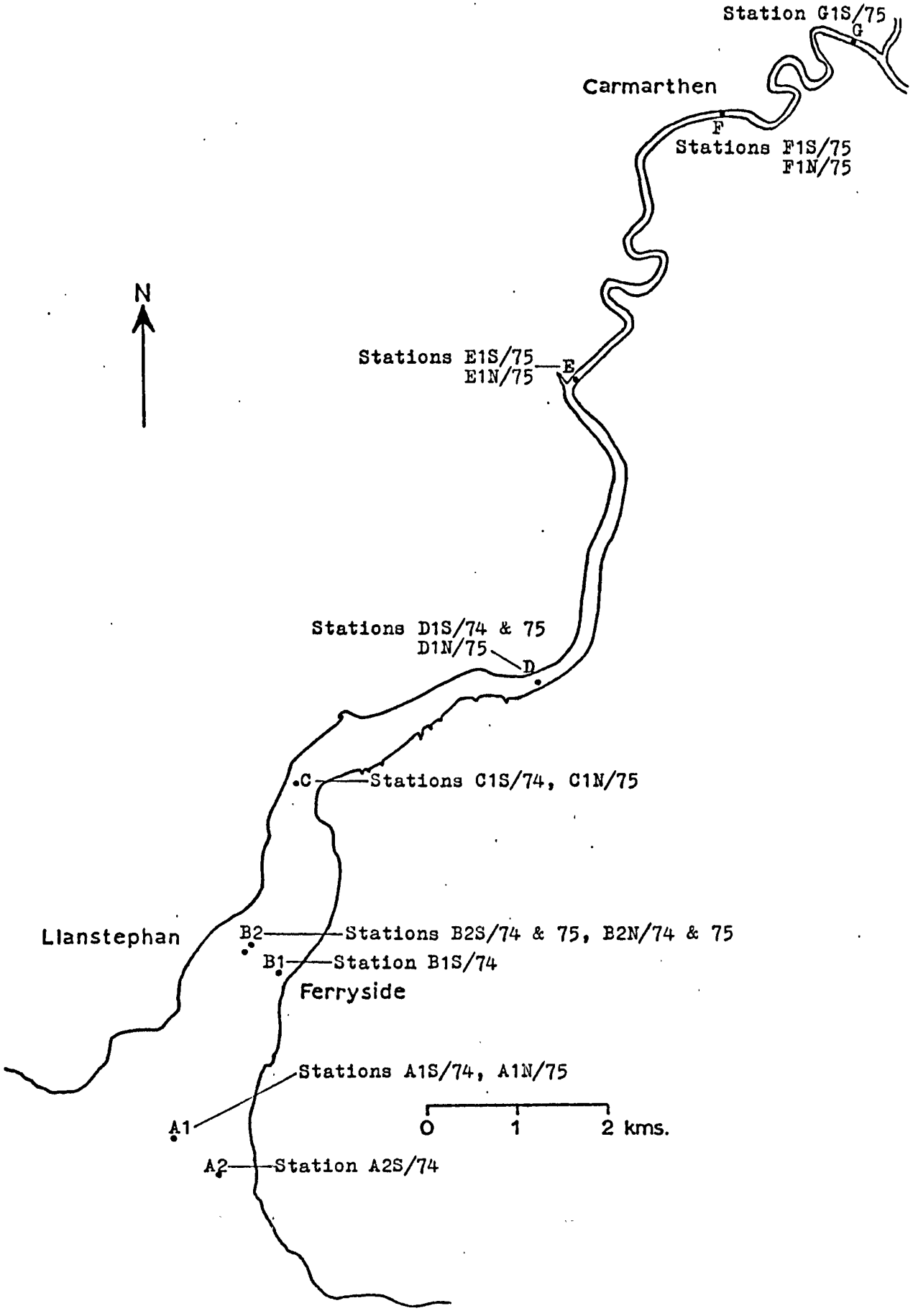


FIG. 3.1.ii CONTROLLING FACTORS OF THE TYPES OF ESTUARINE CIRCULATION

(BASED ON GIBBS 1970)


Station G1S/75
G
Carmarthen
F
Stations F1S/75
F1N/75
N
Stations E1S/75
E1N/75
E
Stations D1S/74 & 75
D1N/75
D
C
Stations C1S/74, C1N/75
Llanstephan
B2
Stations B2S/74 & 75, B2N/74 & 75
B1
Station B1S/74
Ferryside
Stations A1S/74, A1N/75
A1
0
1
2 kms.
A2
Station A2S/74

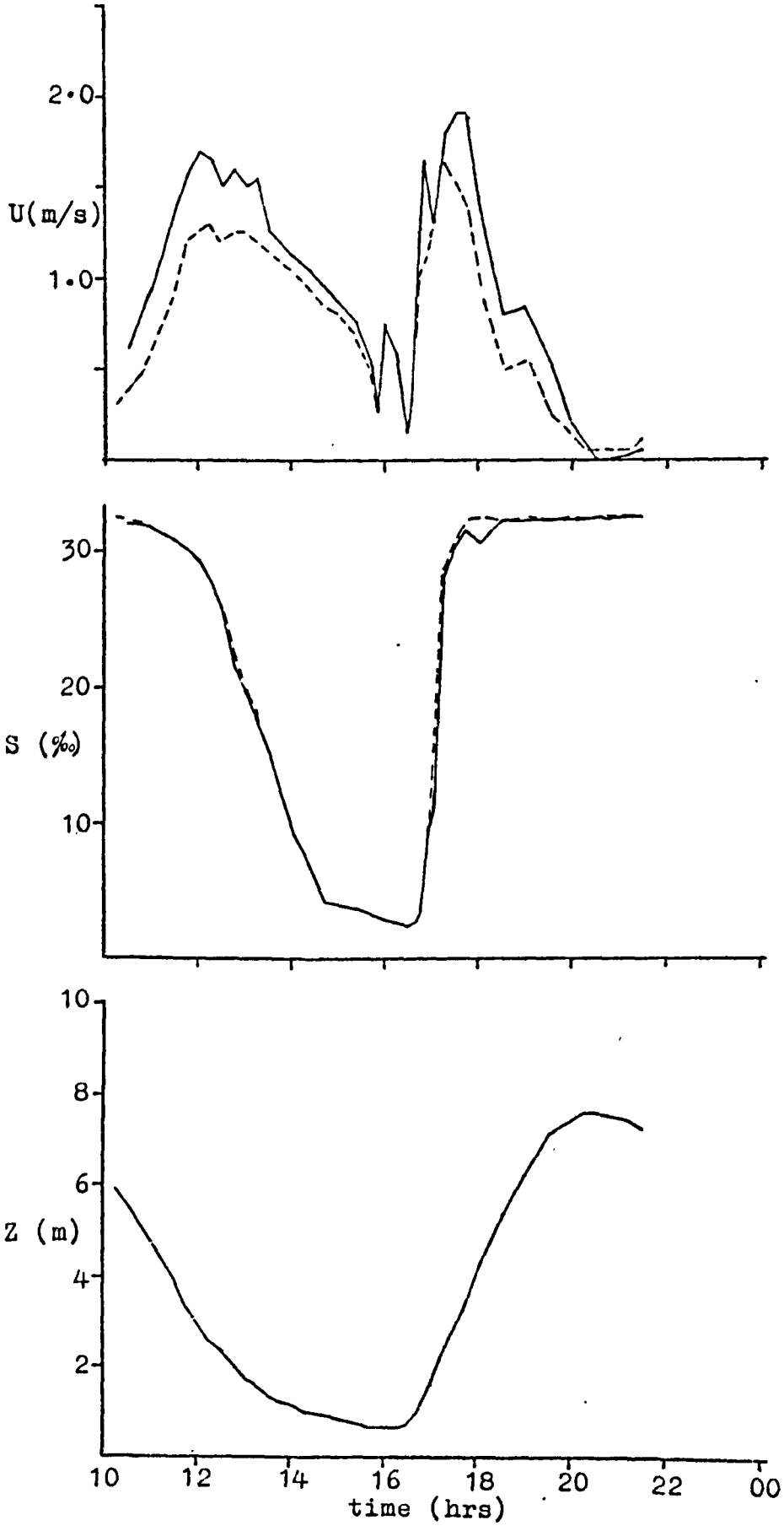


FIG.3.3 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION A1S/74

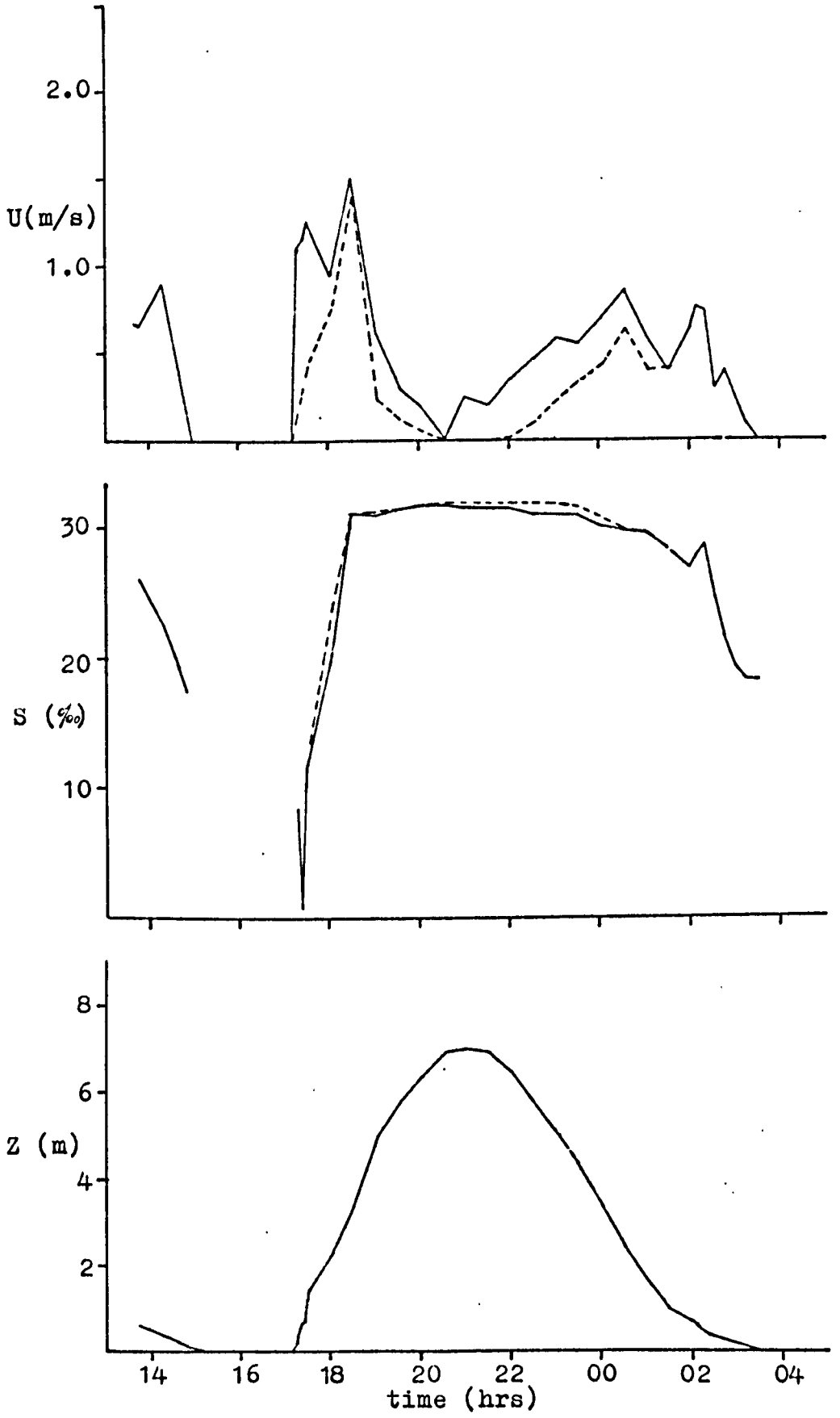


FIG.3.4 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION A2S/74

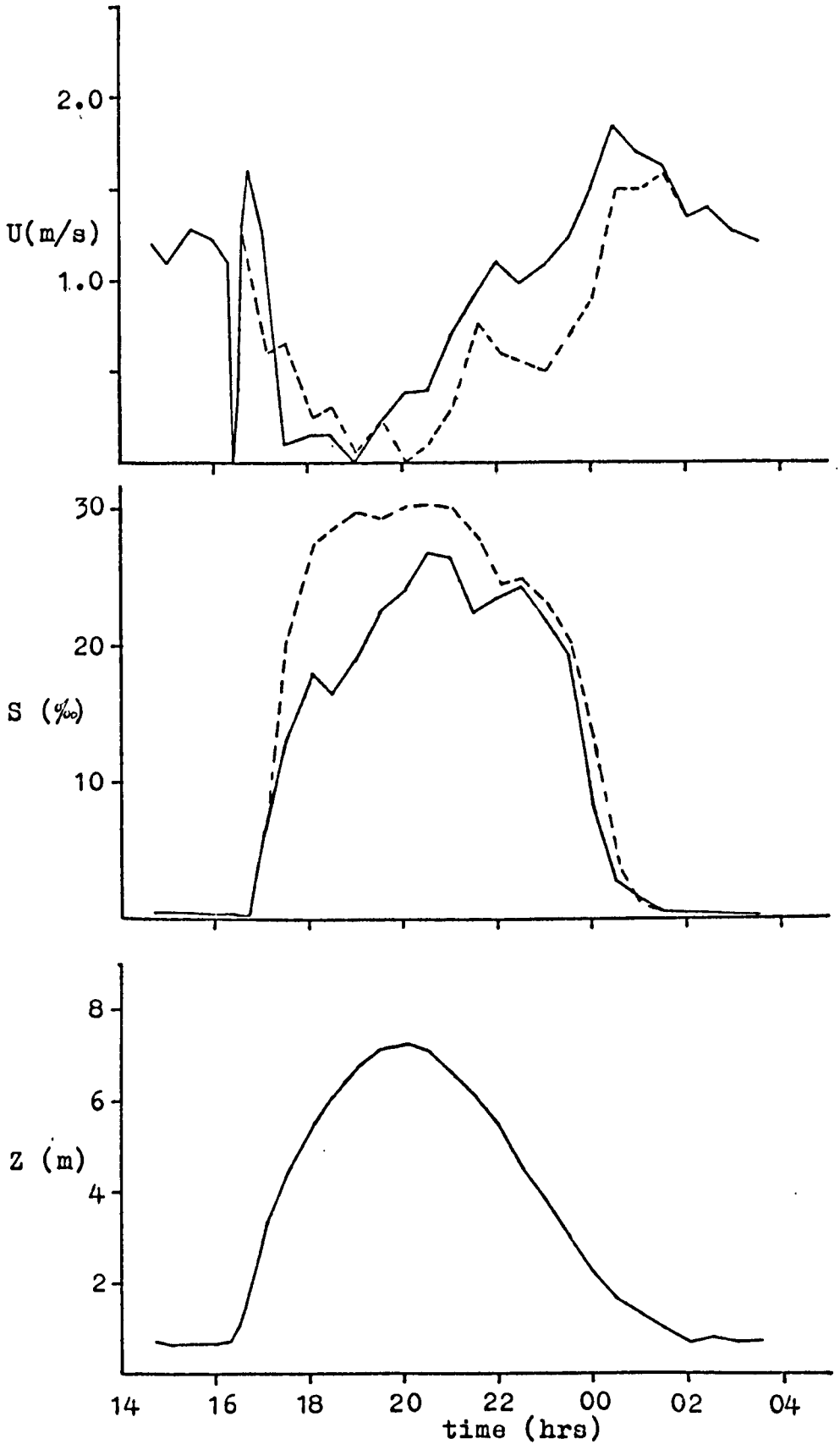


FIG.3.5 TEMPORAL VARIATION IN CURRENT SPEED(U), SALINITY(S) AND WATER DEPTH(Z) FOR STATION B1S/74

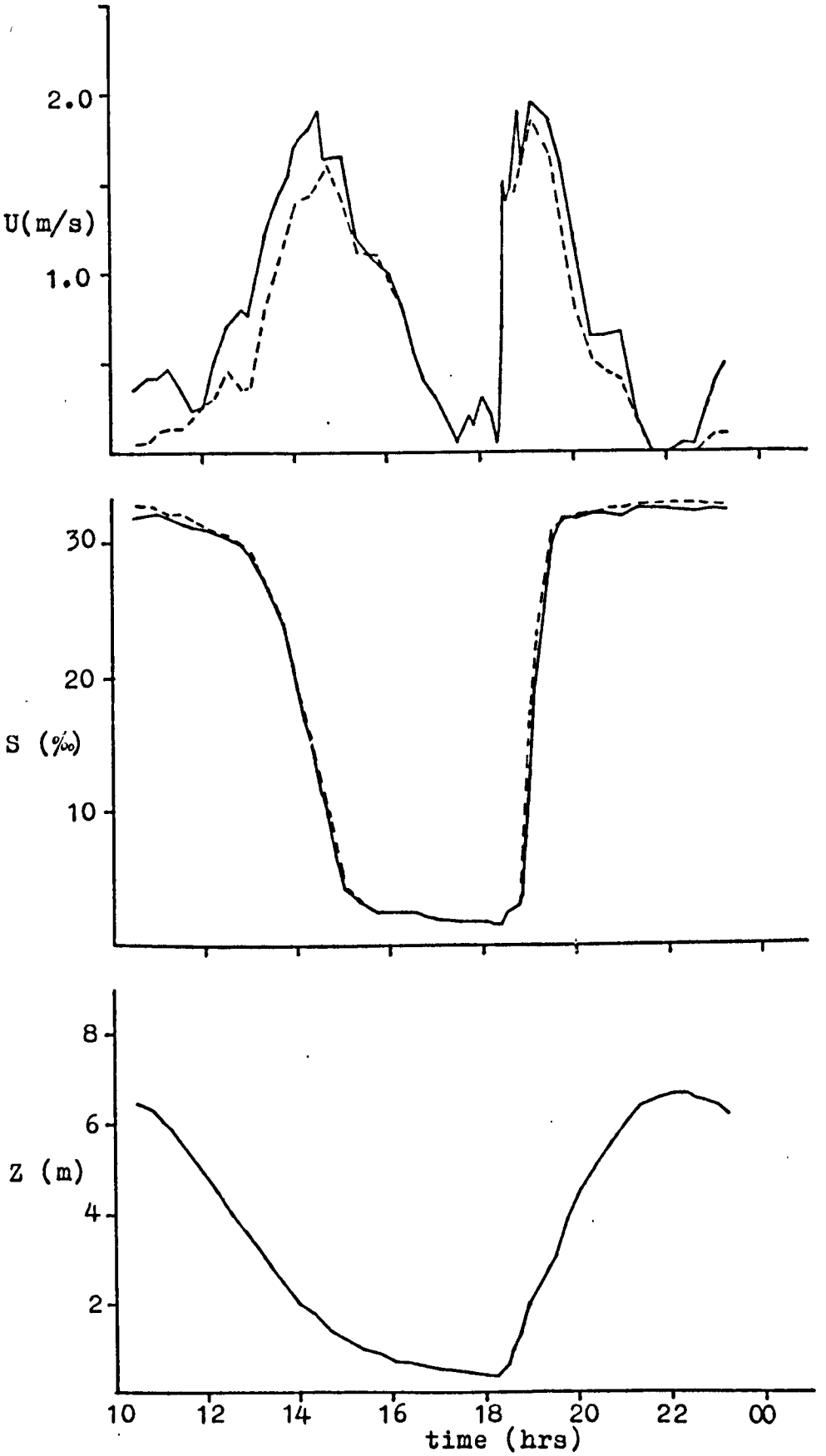


FIG.3.6 TEMPORAL VARIATION IN CURRENT SPEED(U), SALINITY(S) AND WATER DEPTH(Z) FOR STATION B2S/74

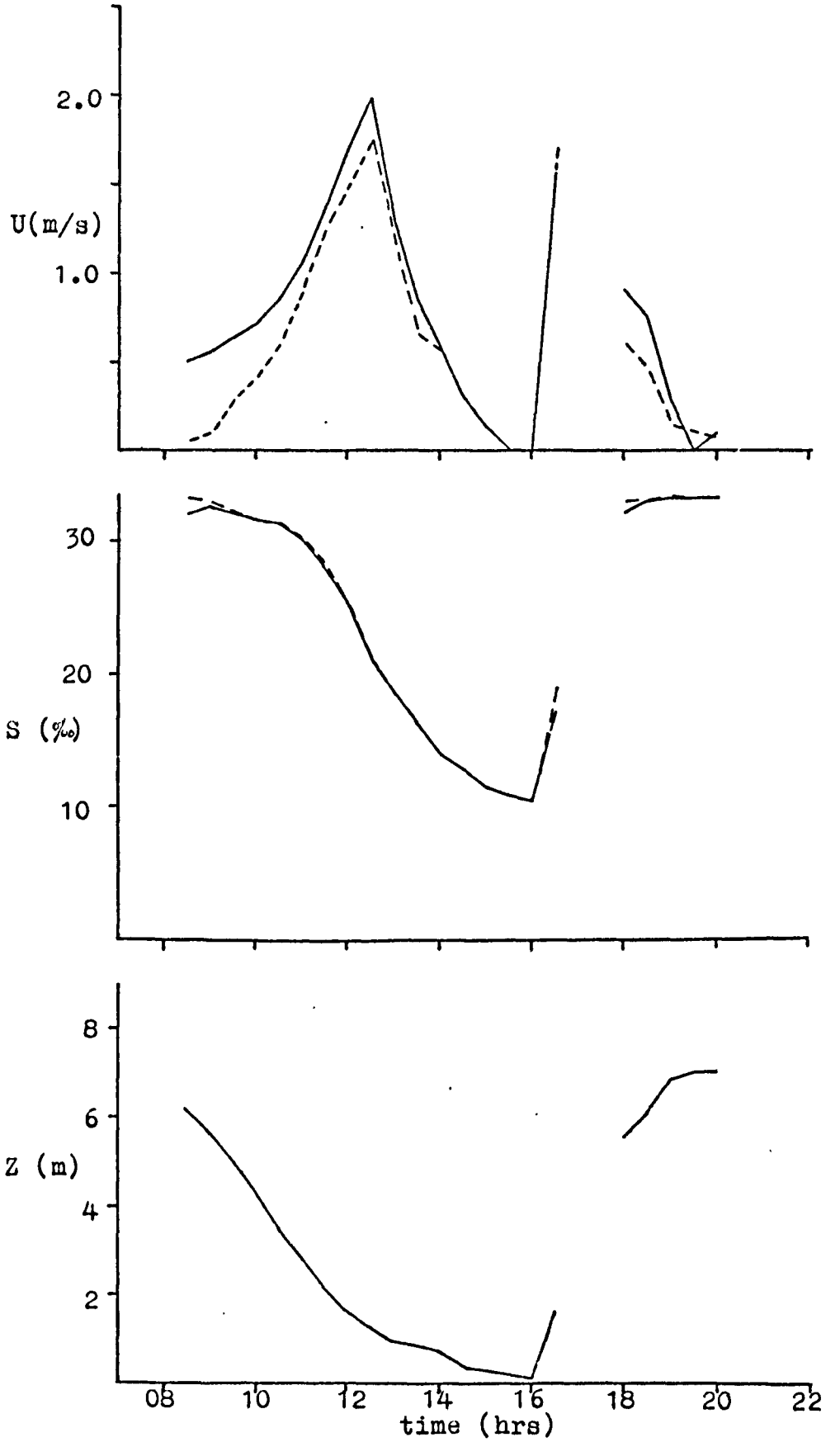


FIG.3.7 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION B2S/75

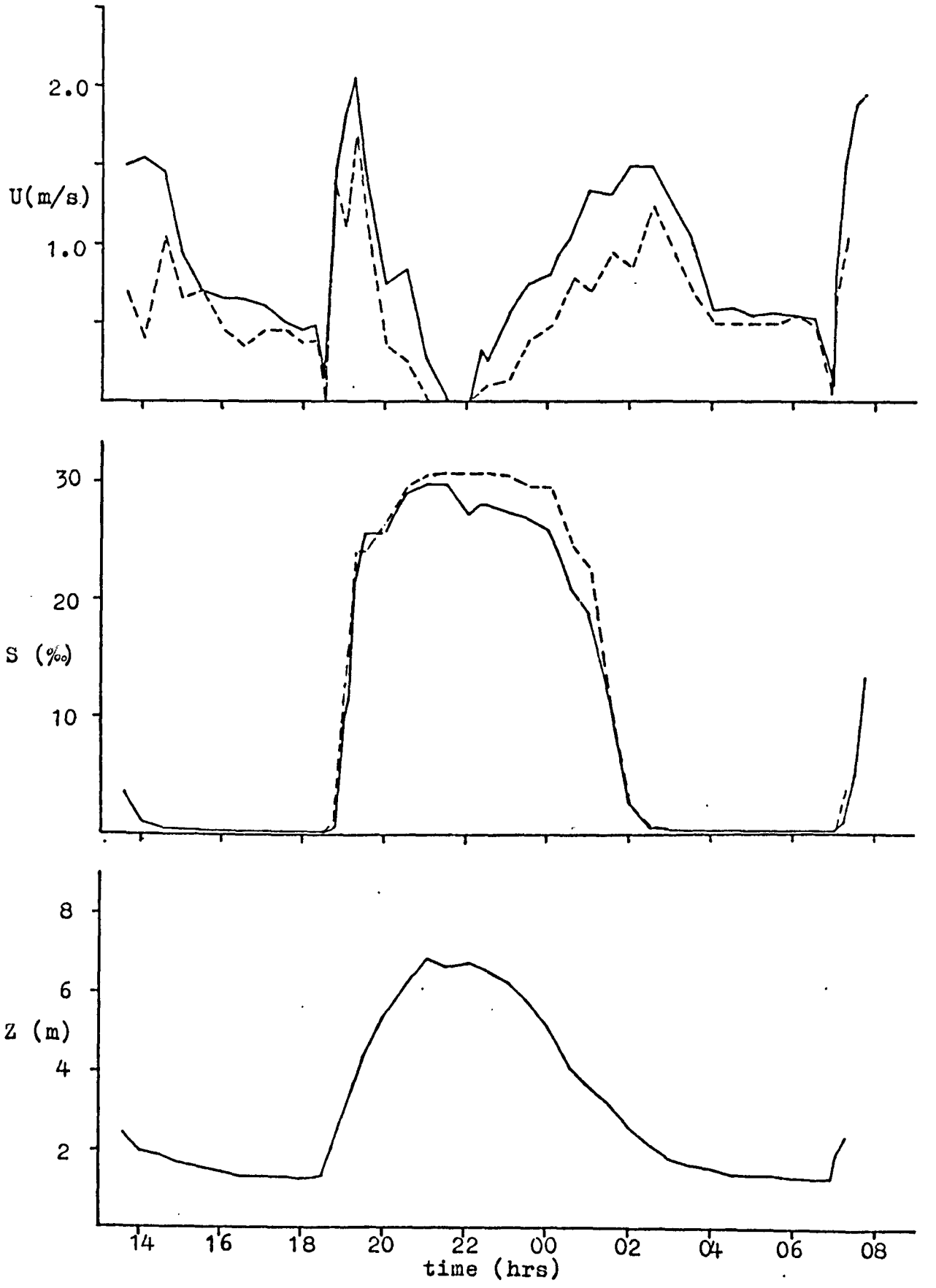


FIG.3.8 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION C1S/74

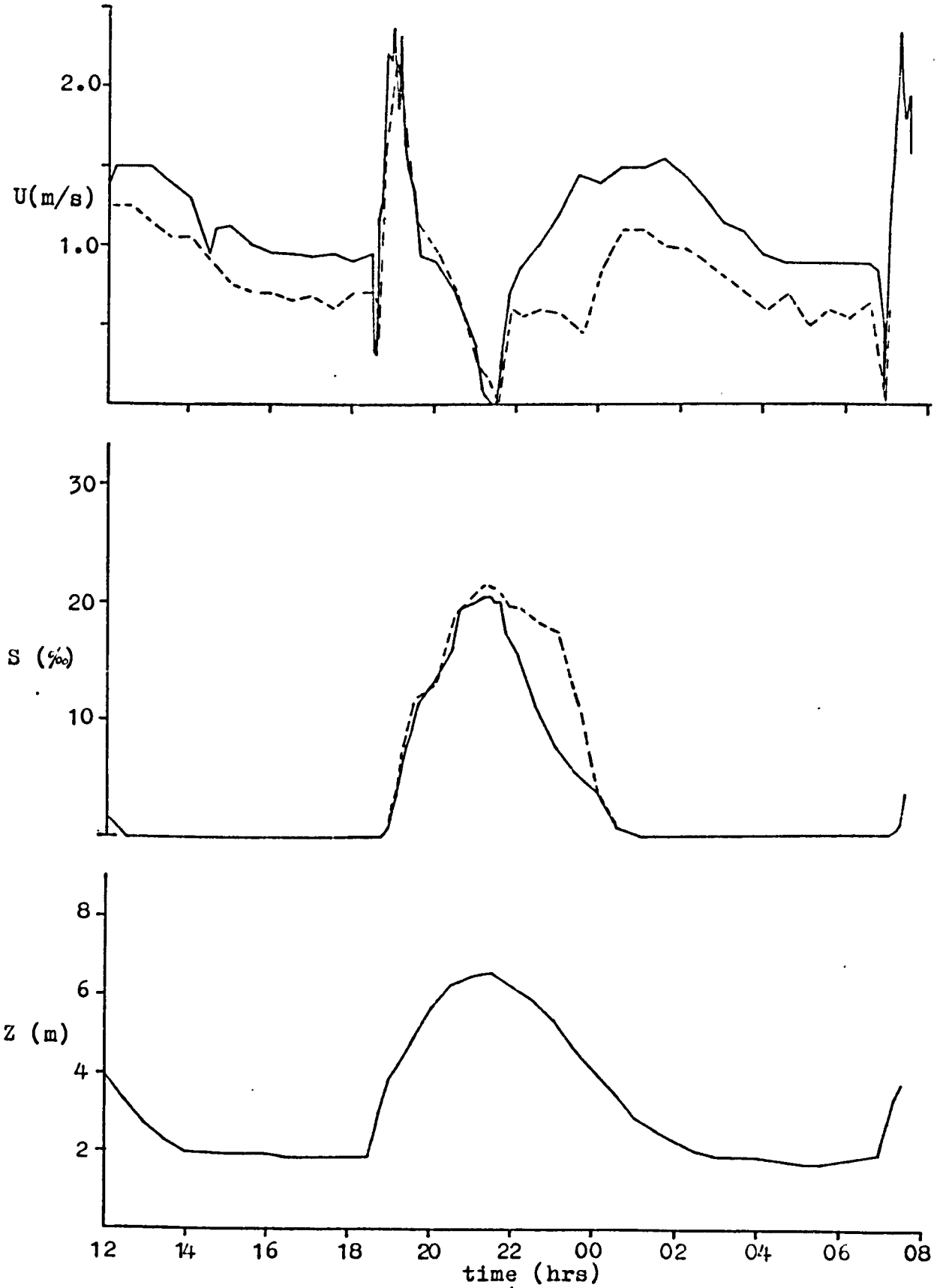


FIG.3.9 TEMPORAL VARIATION IN CURRENT SPEED(U), SALINITY(S) AND WATER DEPTH(Z) FOR STATION D1S/74

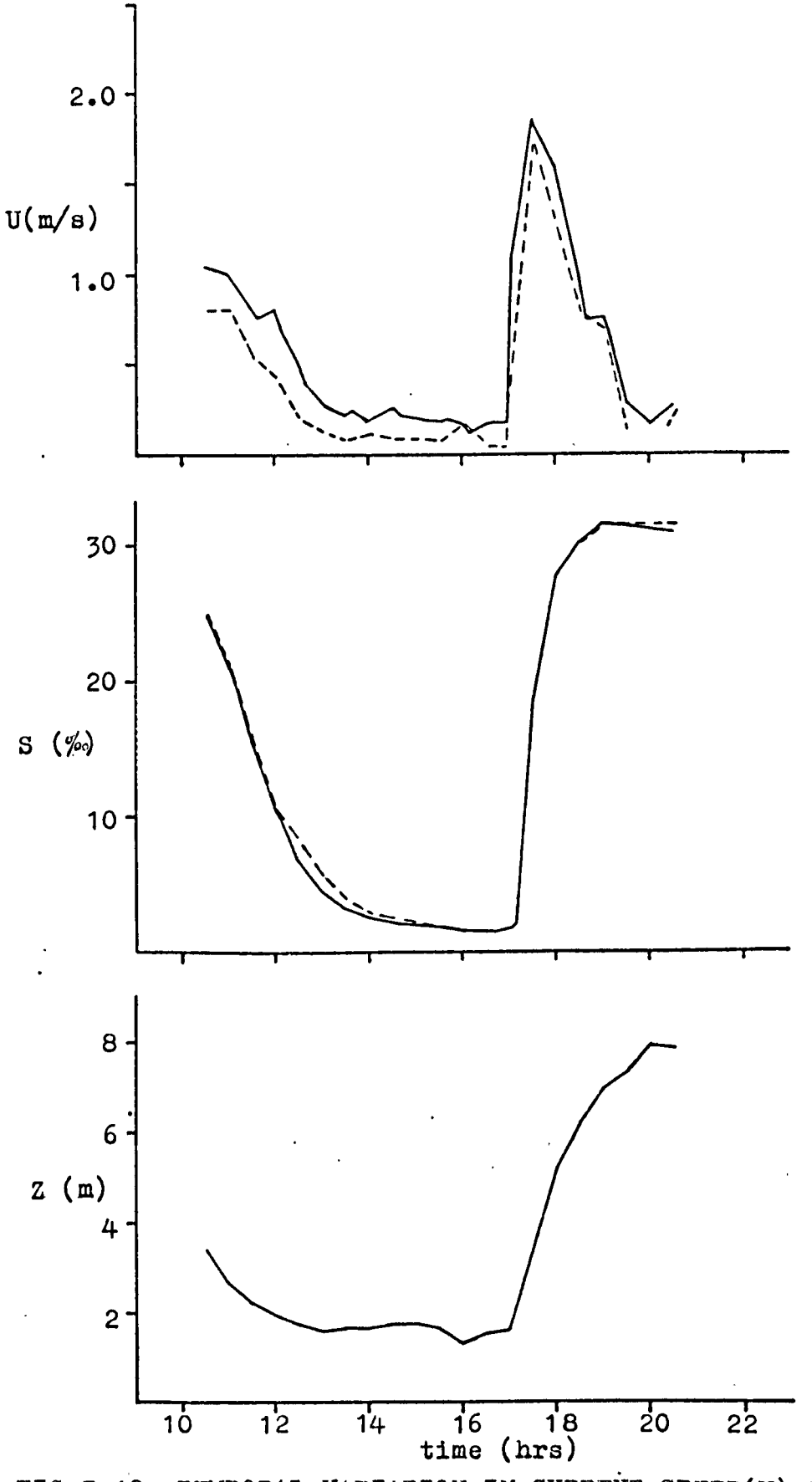


FIG.3.10 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION D1S/75

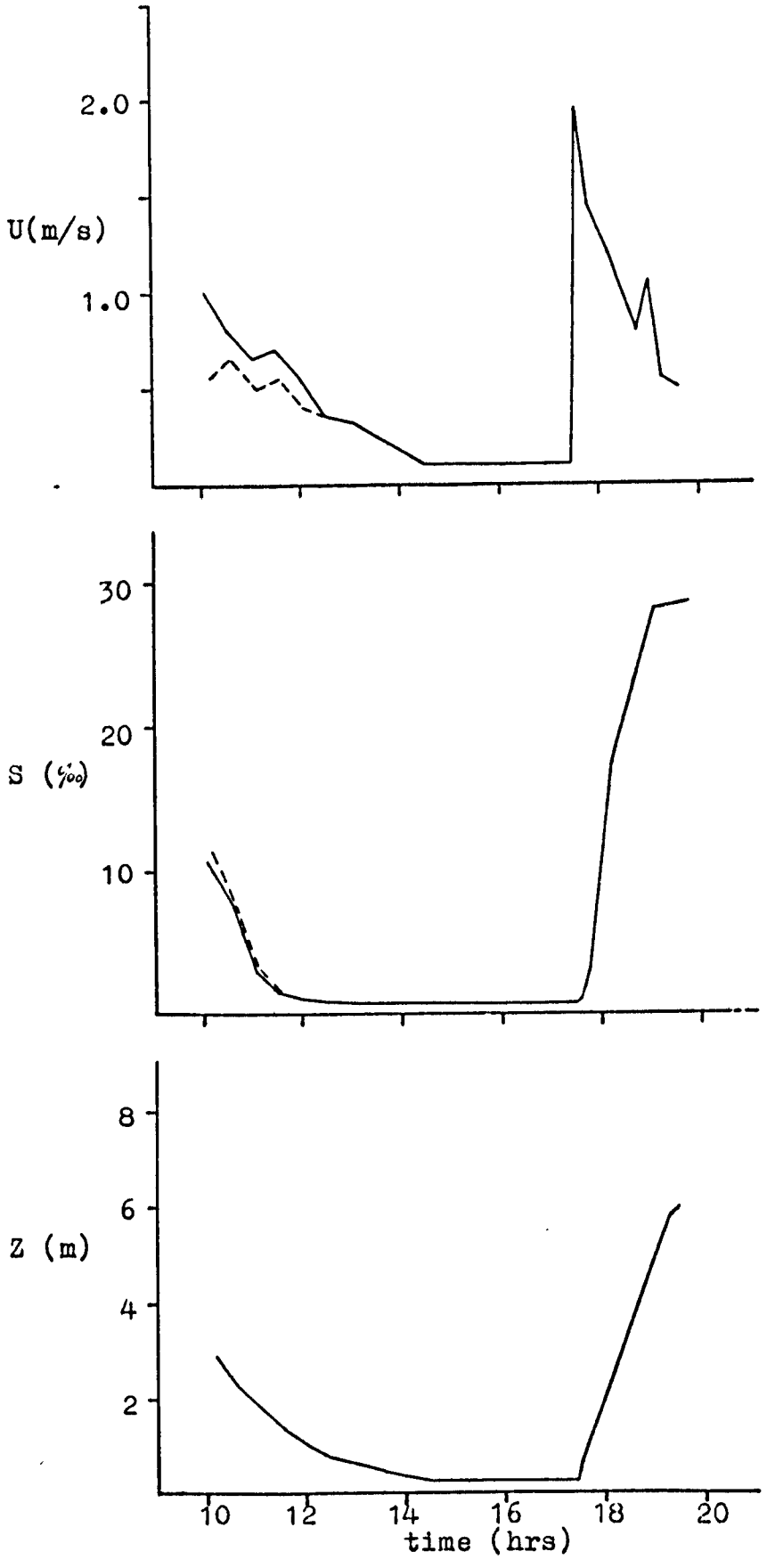


FIG.3.11 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION E1S/75

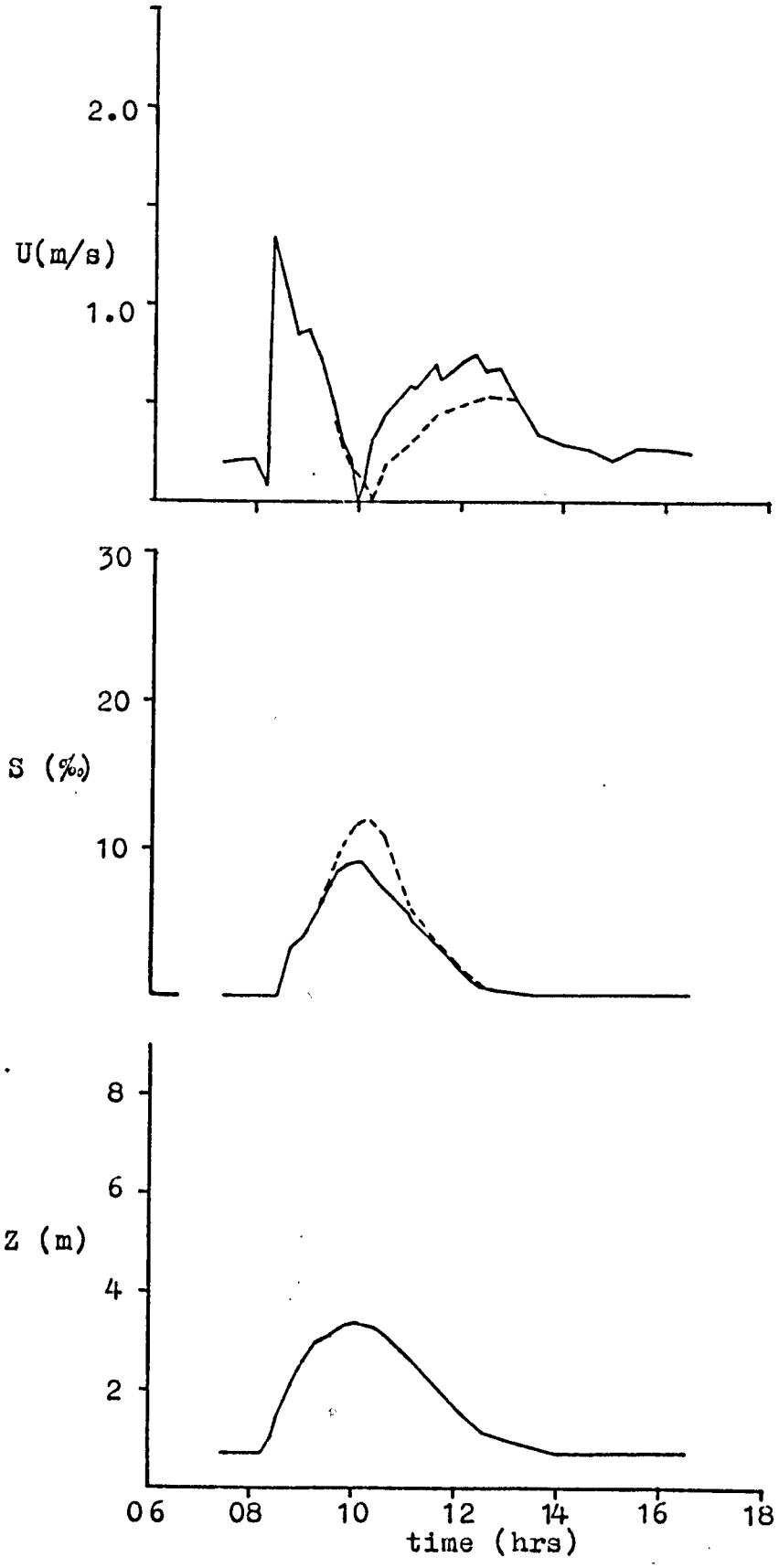


FIG.3.12 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION F1S/75

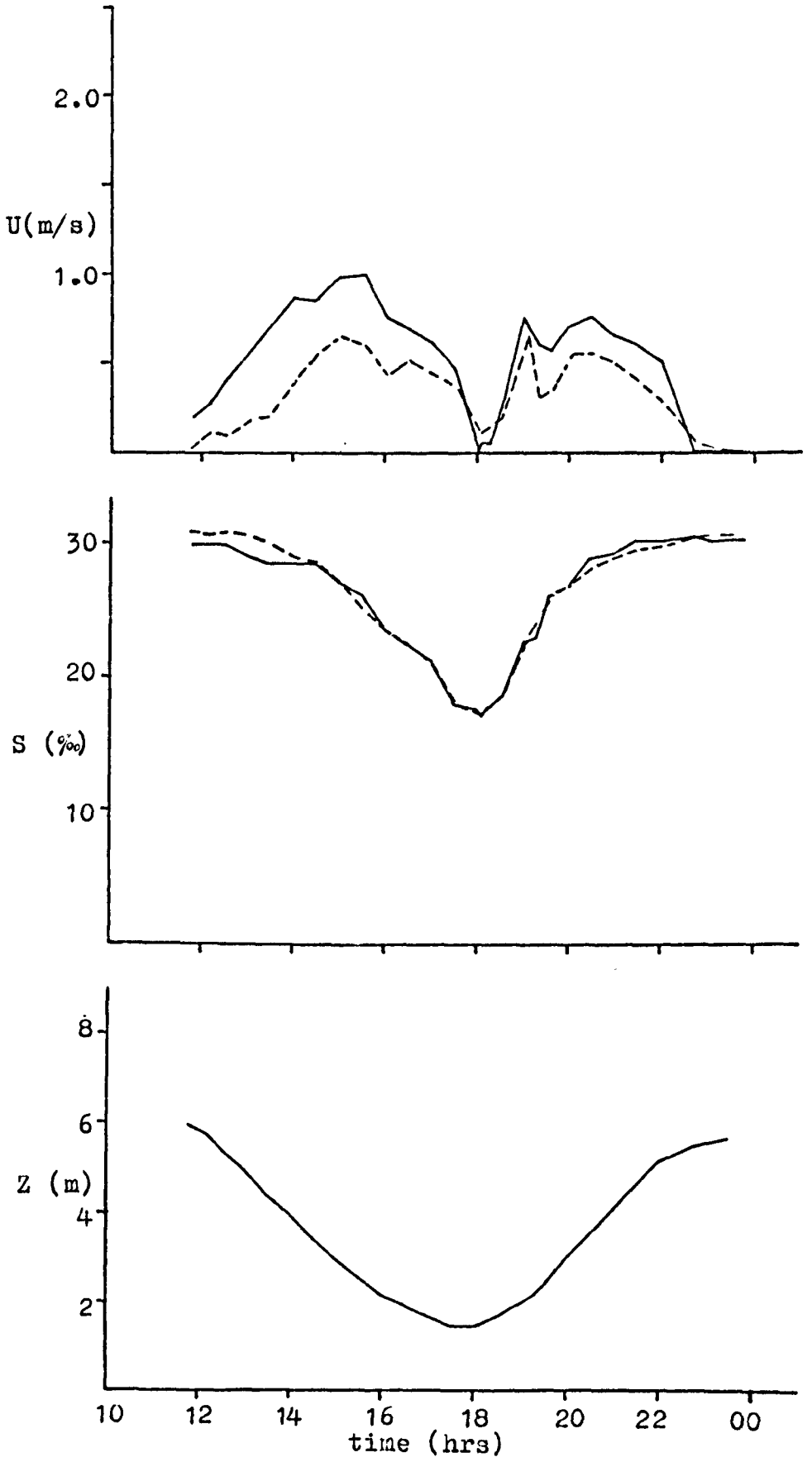


FIG.3.13 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION A1N/75

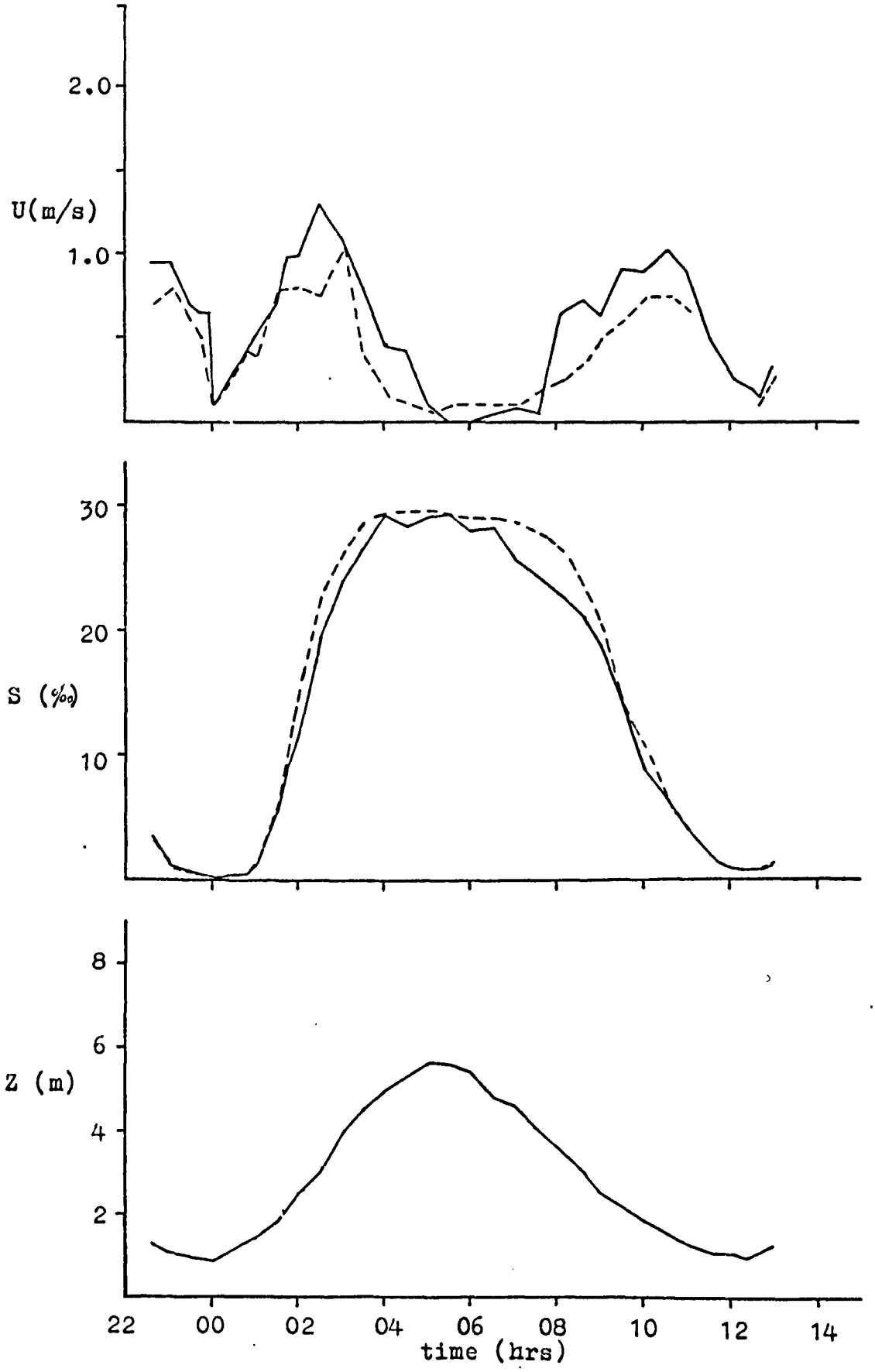


FIG.3.14 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION B2N/74

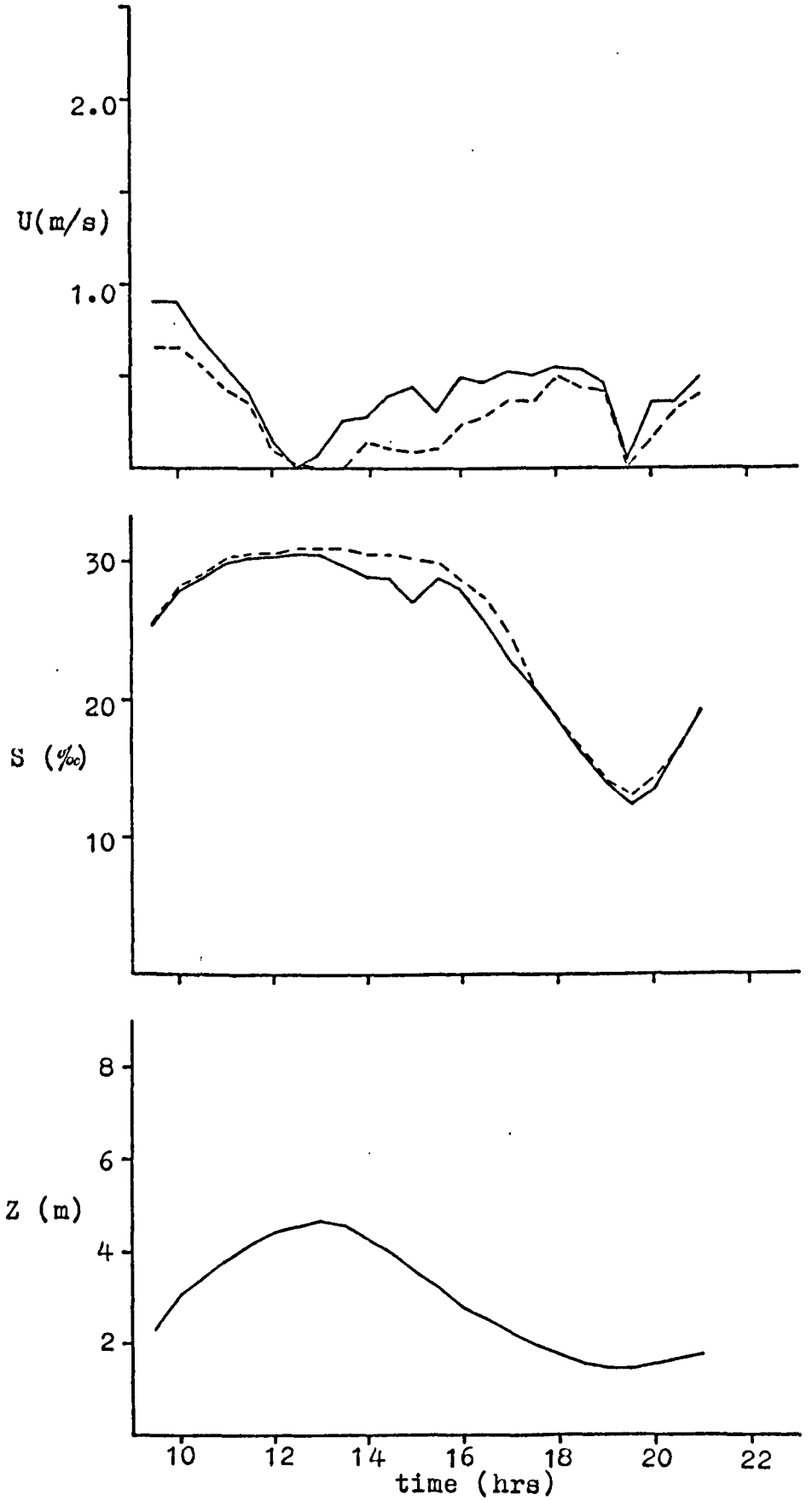


FIG.3.15 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION B2N/75

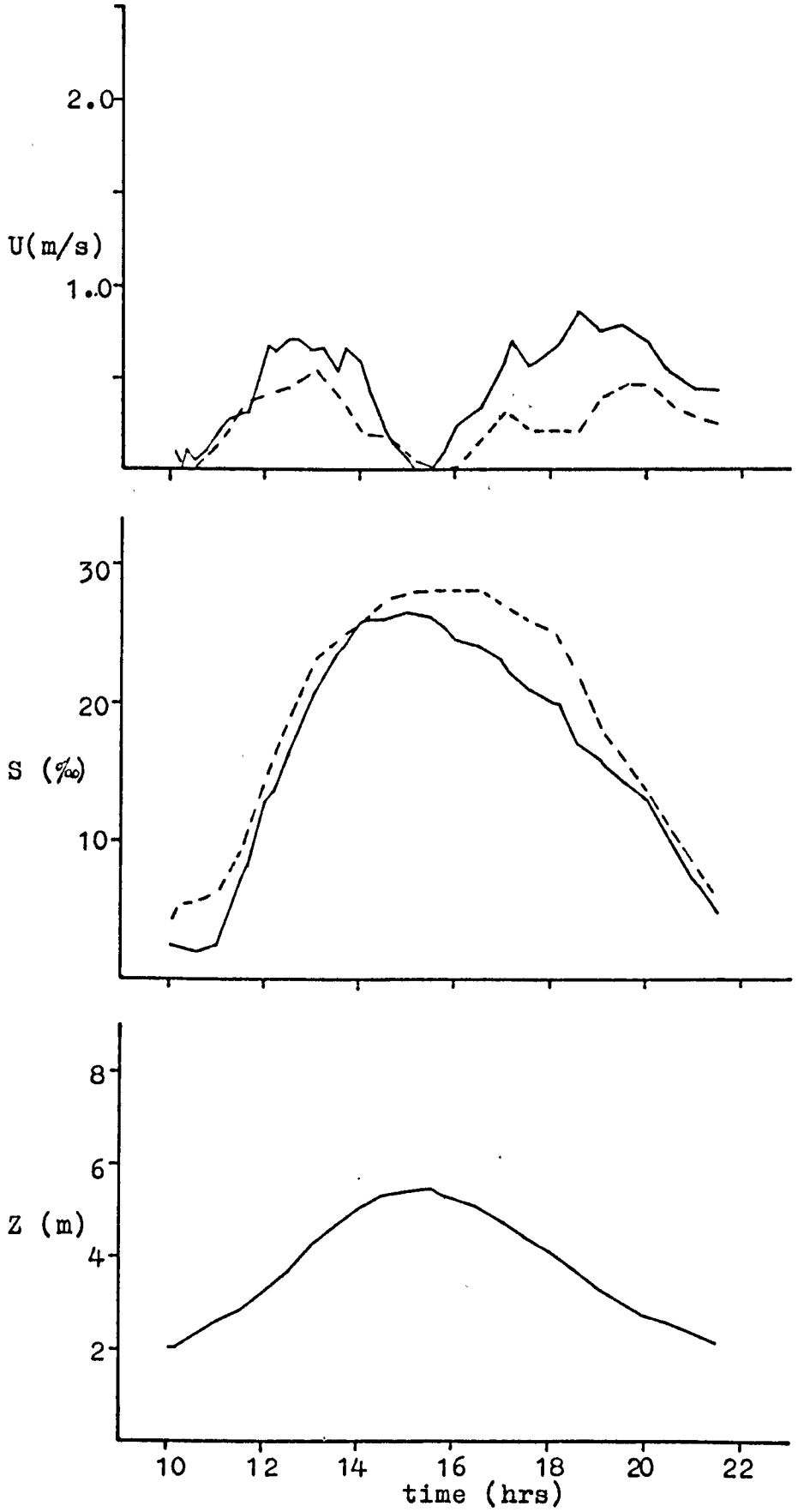


FIG.3.16 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION C1N/75

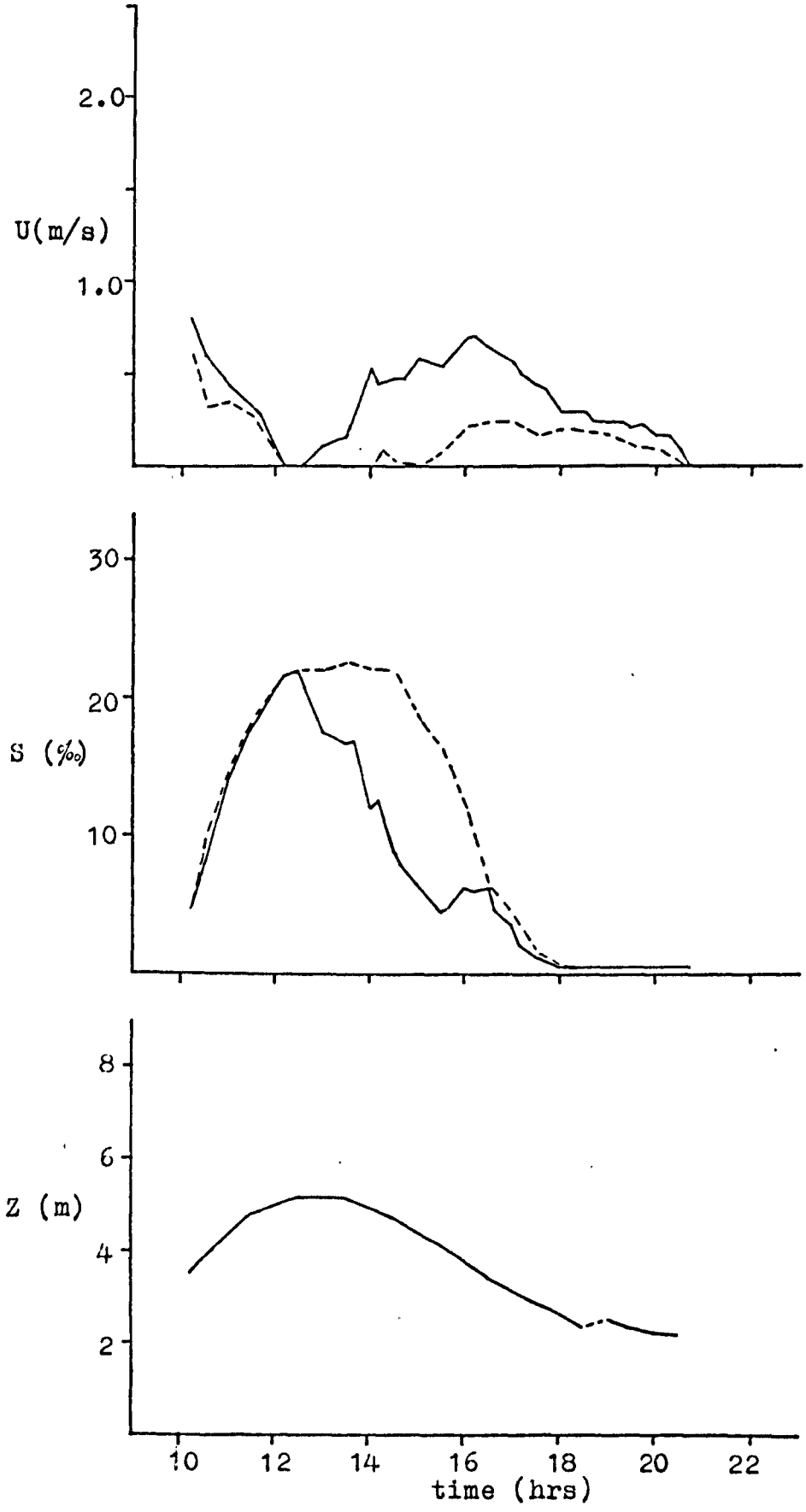


FIG.3.17 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION D1N/75

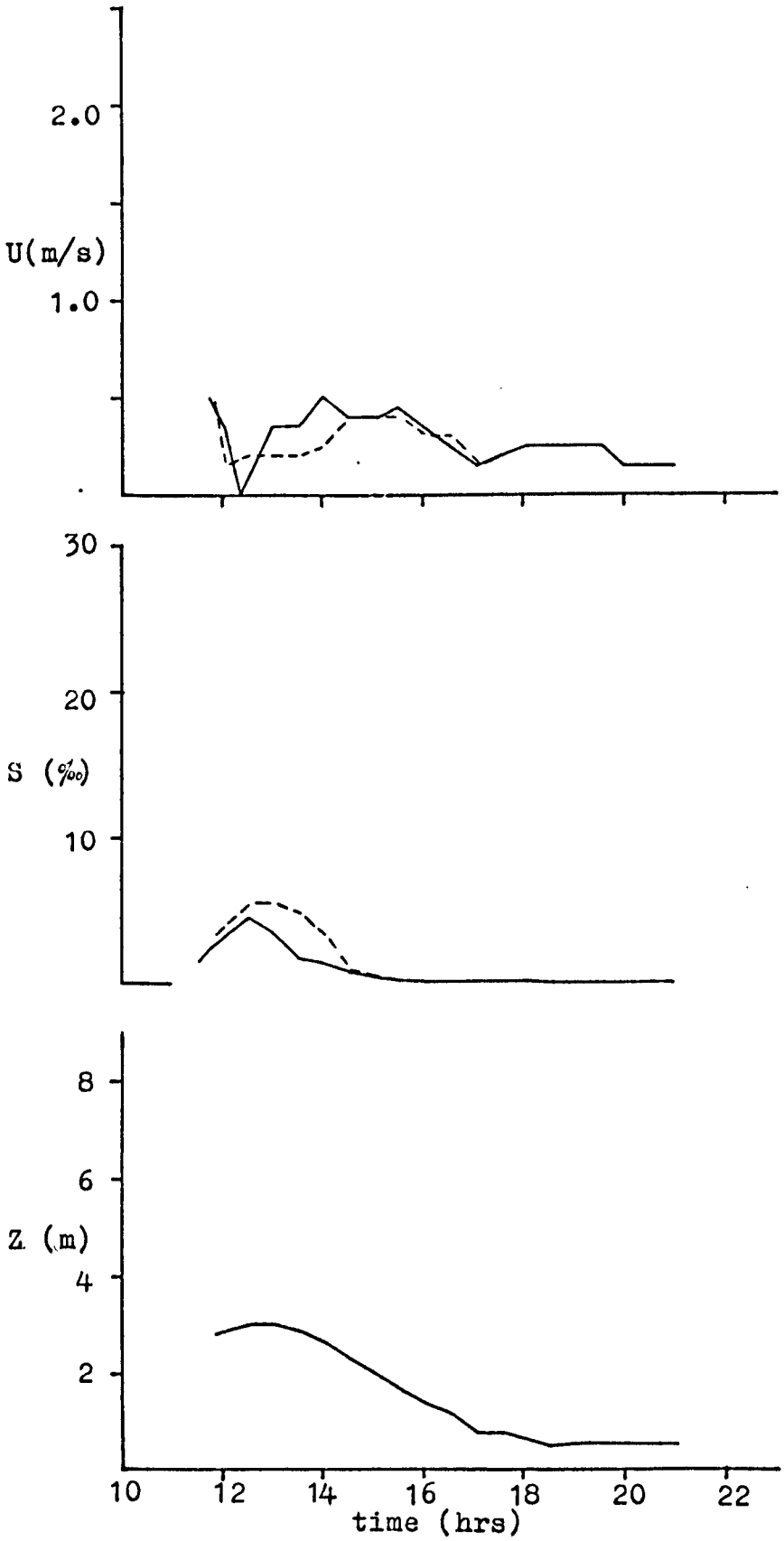


FIG.3.18 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION E1N/75

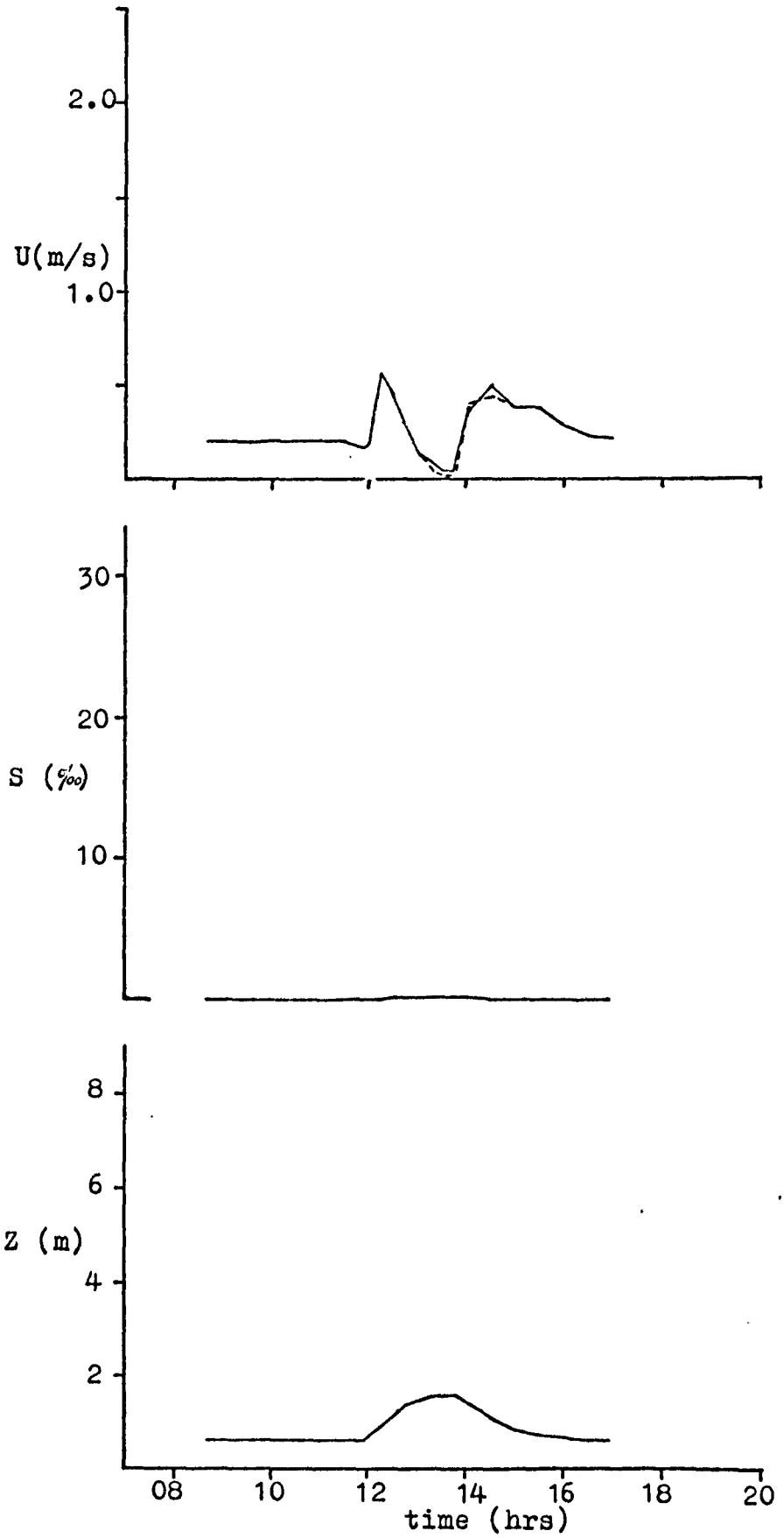


FIG.3.19 TEMPORAL VARIATION IN CURRENT SPEED(U),SALINITY(S) AND WATER DEPTH(Z) FOR STATION F1N/75

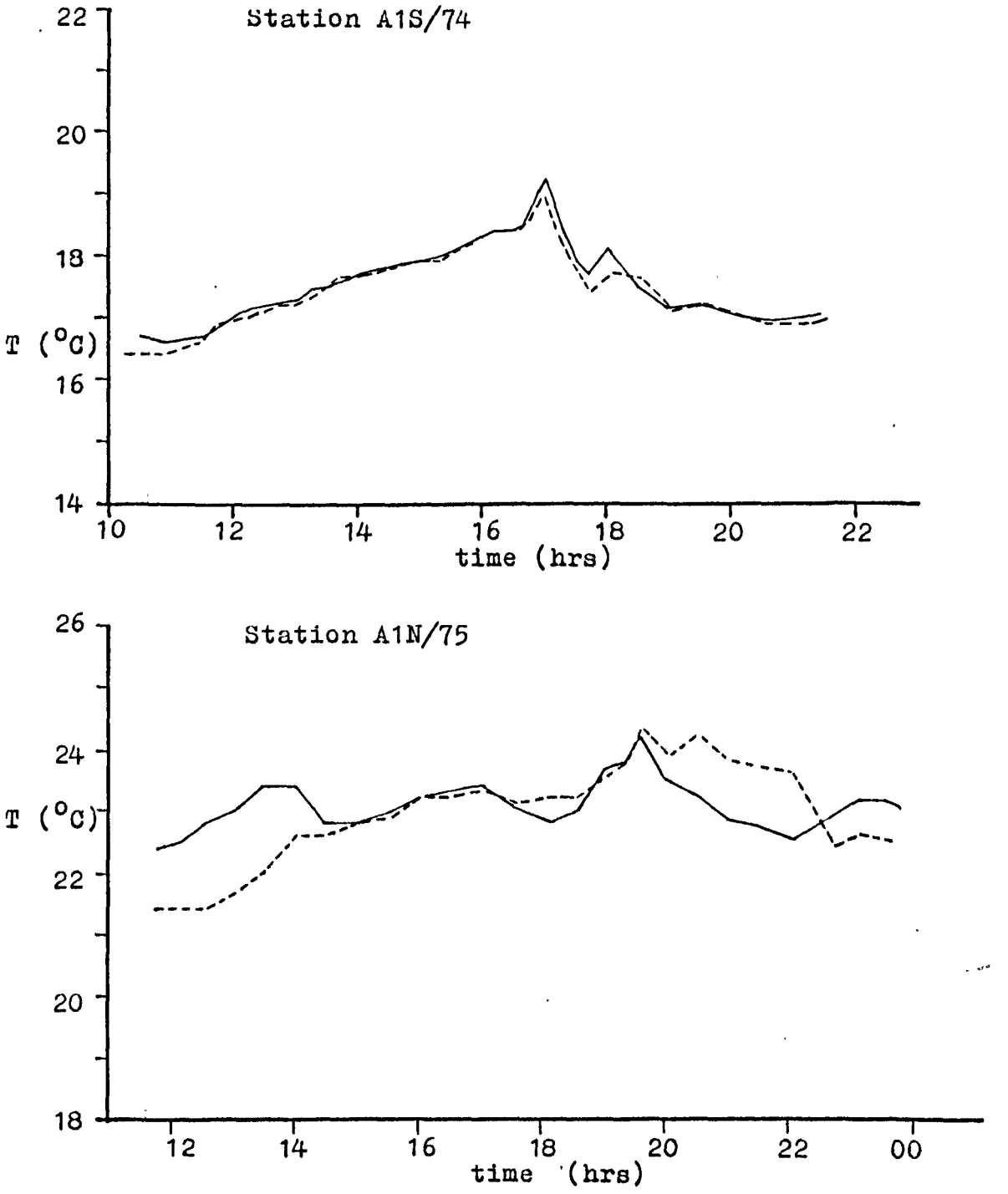


FIG.3.20 TEMPORAL VARIATION IN TEMPERATURE(T) FOR STATIONS A1S/74 AND A1N/75

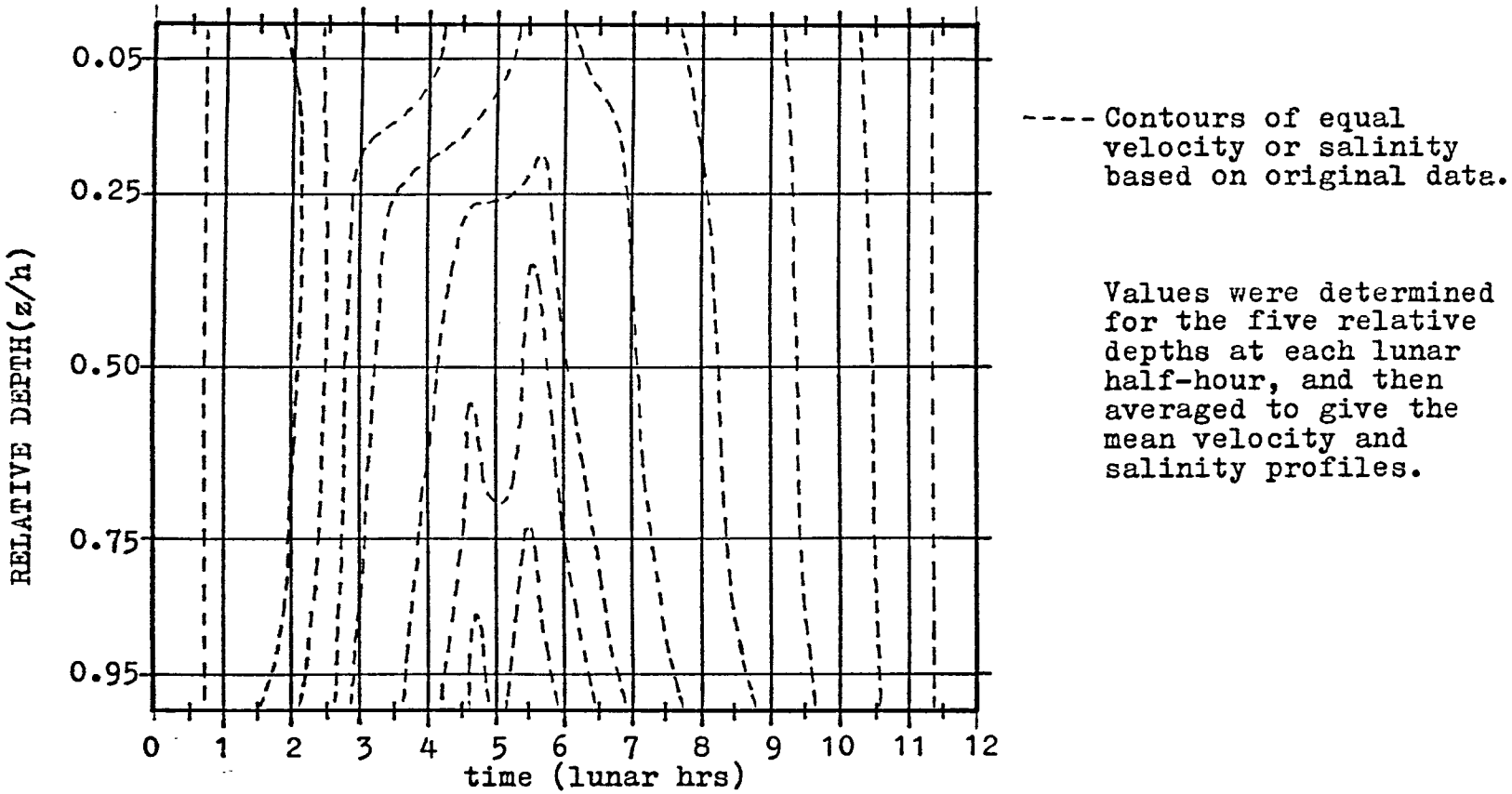


FIG.3.21 PLOT TO ILLUSTRATE HOW MEAN DATA WERE OBTAINED FOR THE ANALYSIS OF THE NET NON-TIDAL CIRCULATION IN THE TOWY ESTUARY

FIGURE 3.22 a) MEAN AND b) DIFFERENTIAL SALINITY PROFILES FOR STATIONS A2S/74, B1S/74, B2S/74, B2N/74, C1S/74 AND D1S/74

FIG.3.22a.

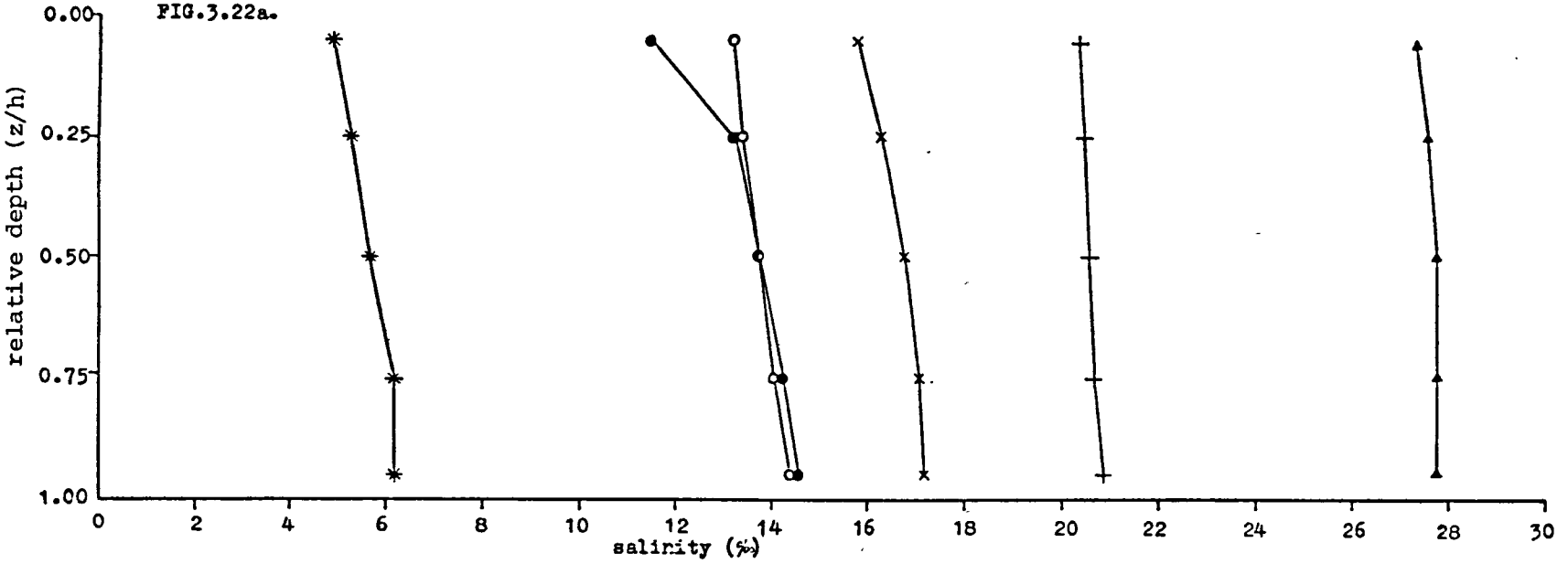


FIG.3.22b.

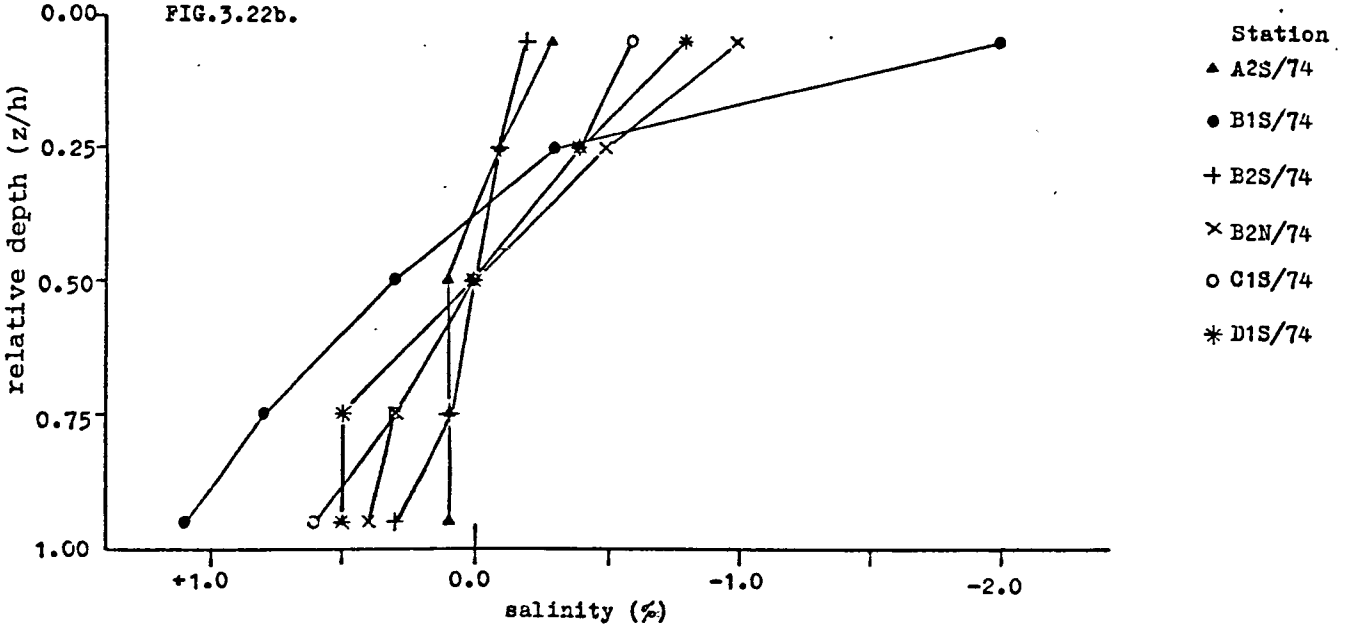


FIGURE 3.23 a) SALINITY AND b) VELOCITY PROFILES AT VARIOUS TIMES OF THE TIDAL CYCLE FOR STATION B1S/74

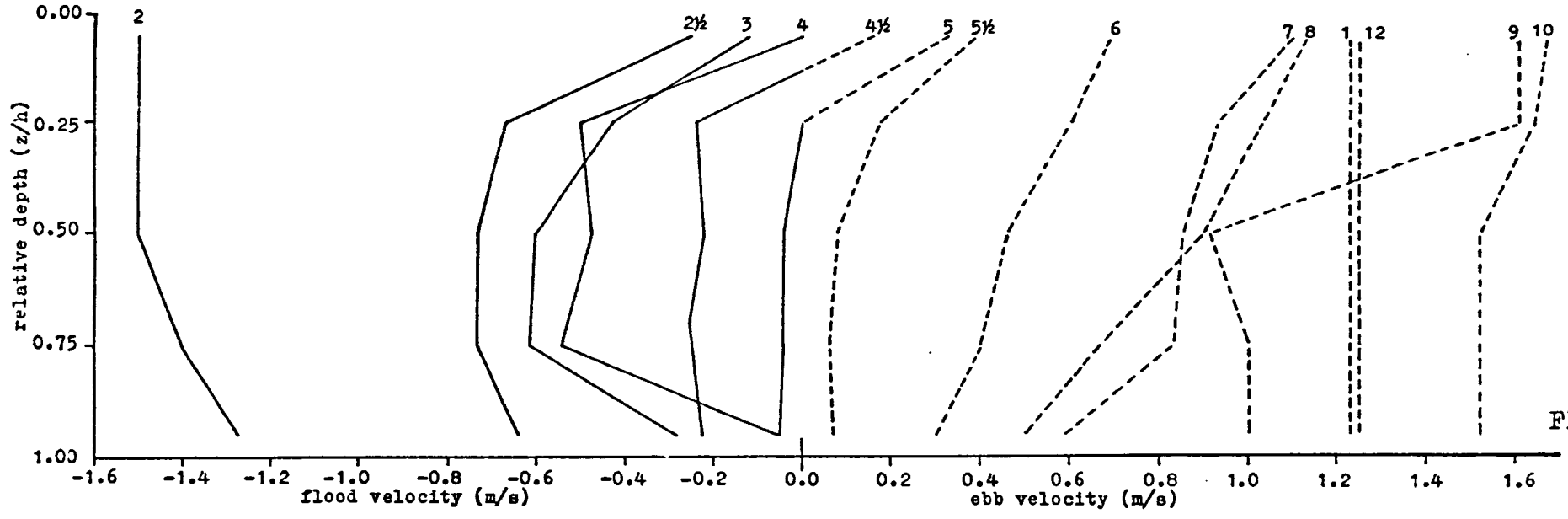


FIG.3.23b

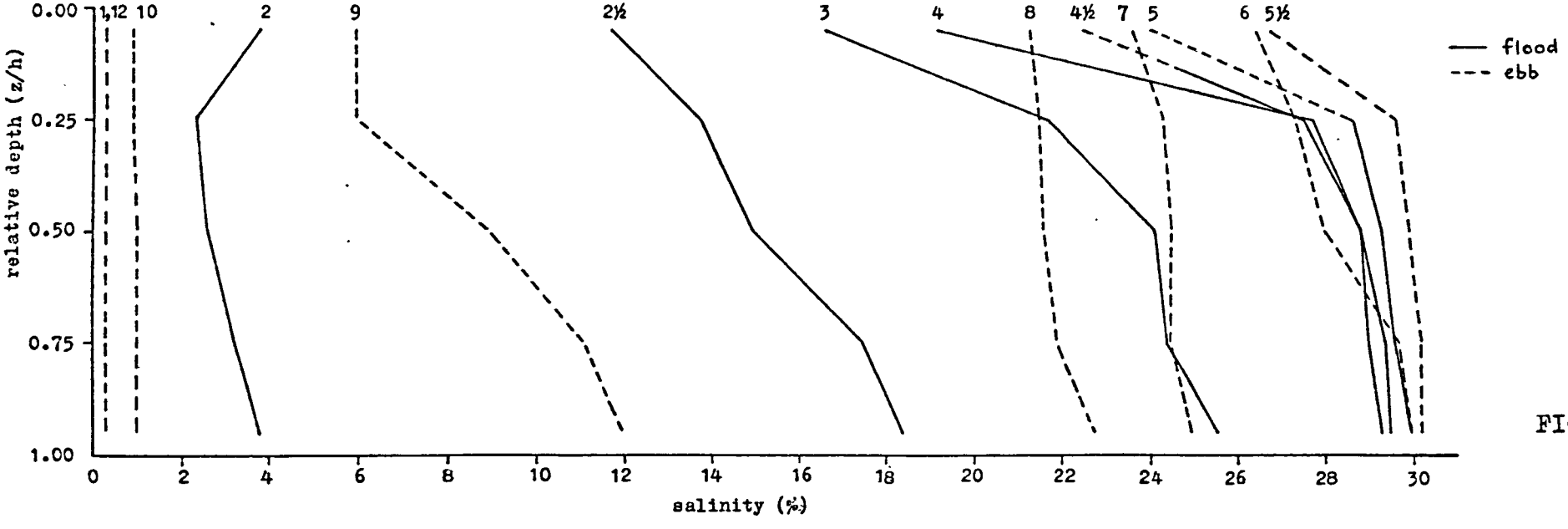


FIG.3.23a

FIGURE 3.24 SALINITY PROFILES AT VARIOUS TIMES OF THE TIDAL CYCLE FOR a) STATION D1S/74 AND b) STATION B2S/74

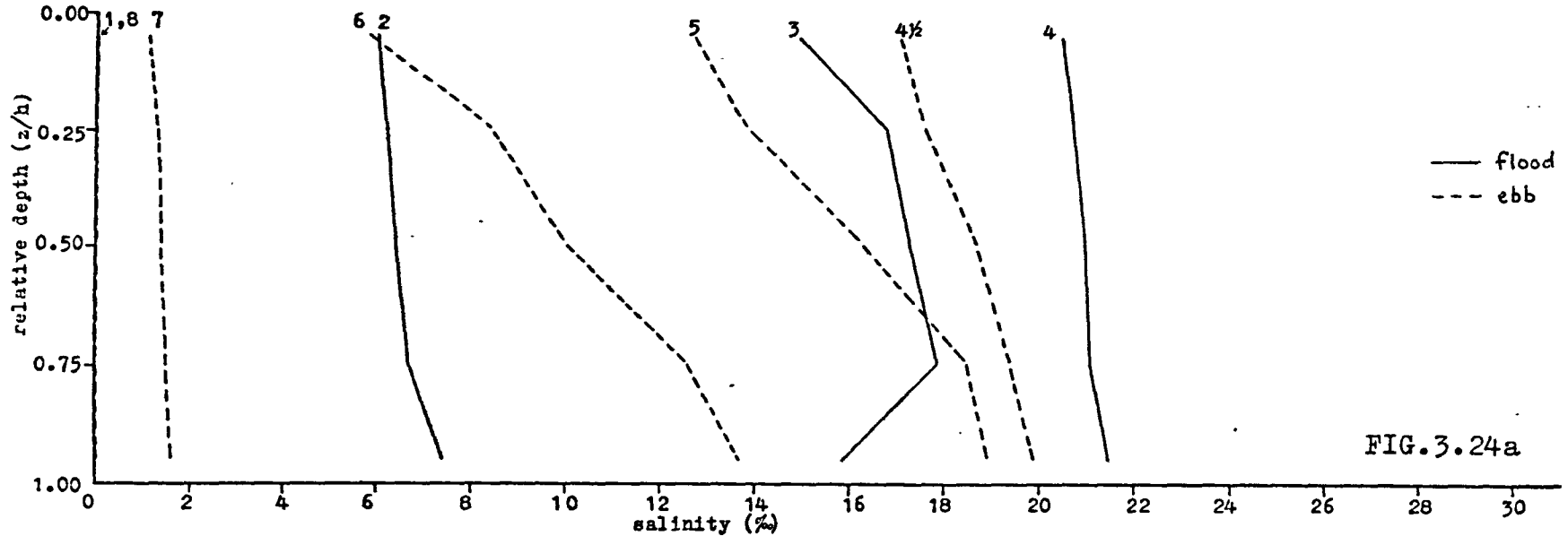


FIG.3.24a

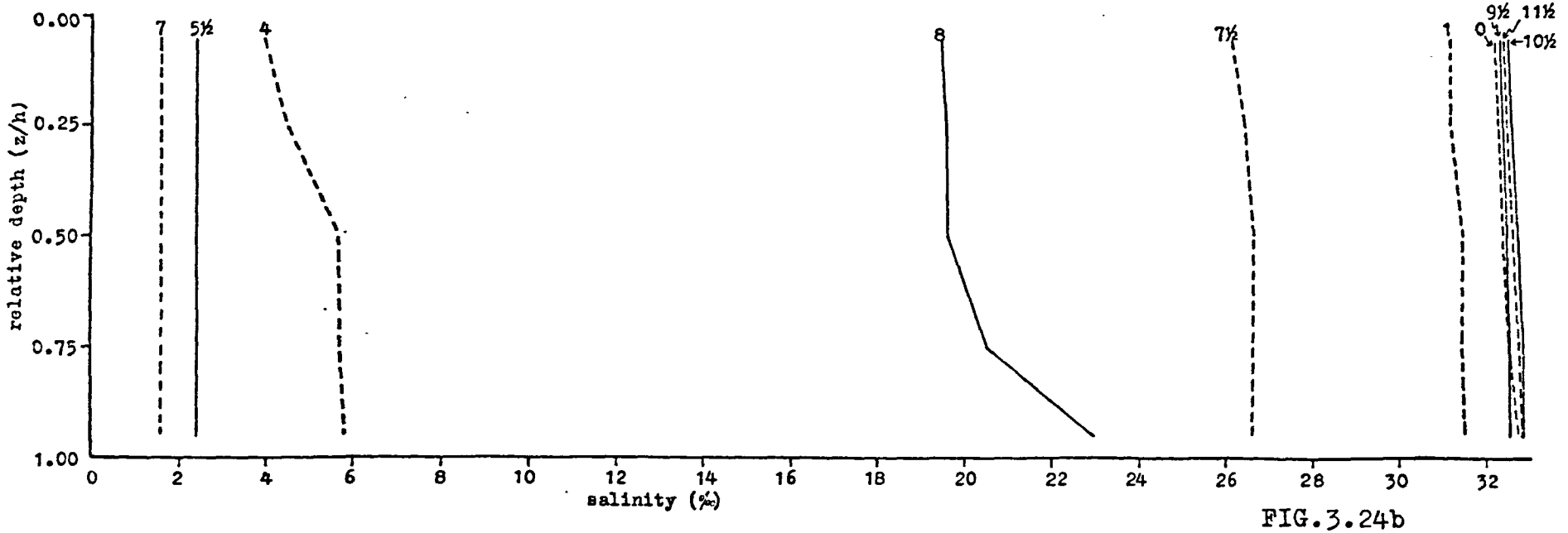


FIG.3.24b

FIGURE 3.25 a) MEAN AND b) DIFFERENTIAL VELOCITY PROFILES FOR STATIONS A2S/74, B1S/74, B2S/74, B2N/74, C1S/74 AND D1S/74

FIG.3.25a.

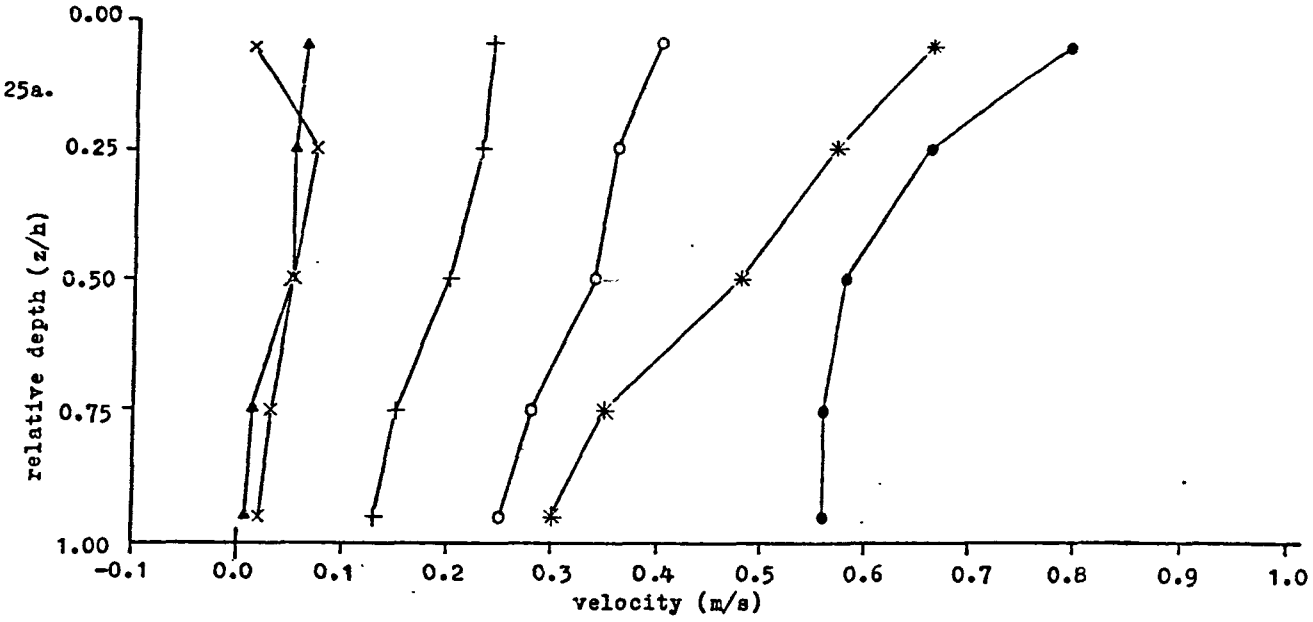
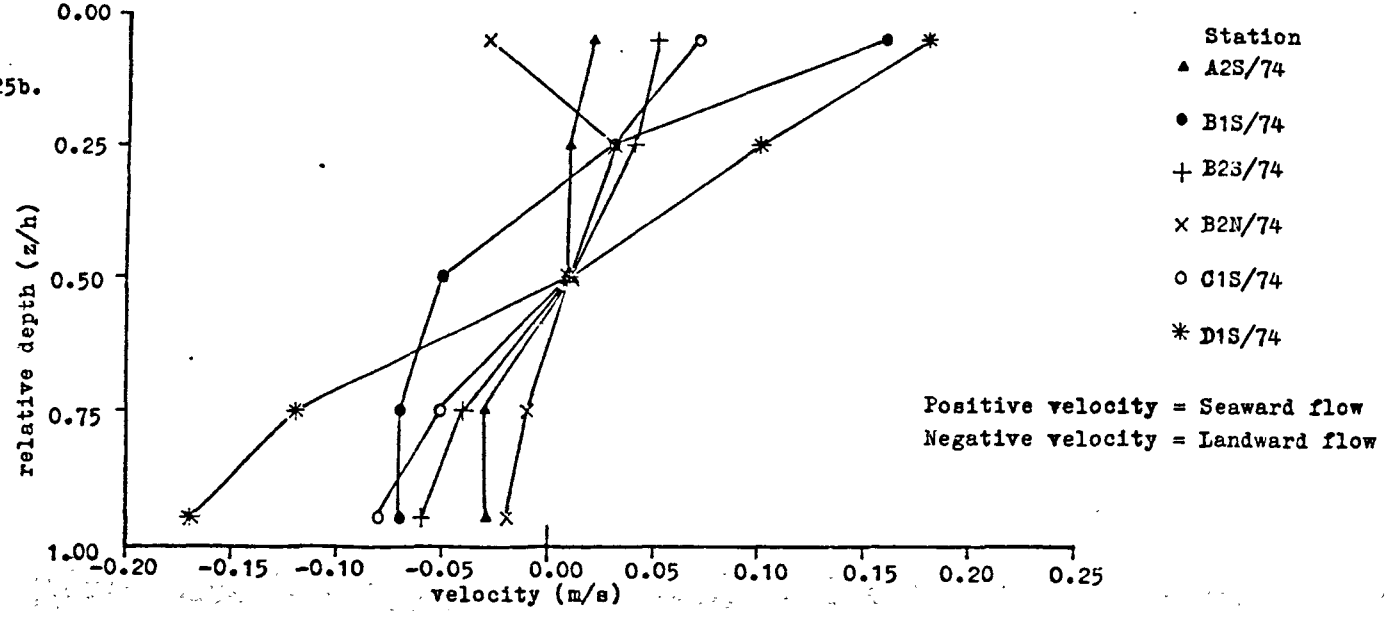


FIG.3.25b.



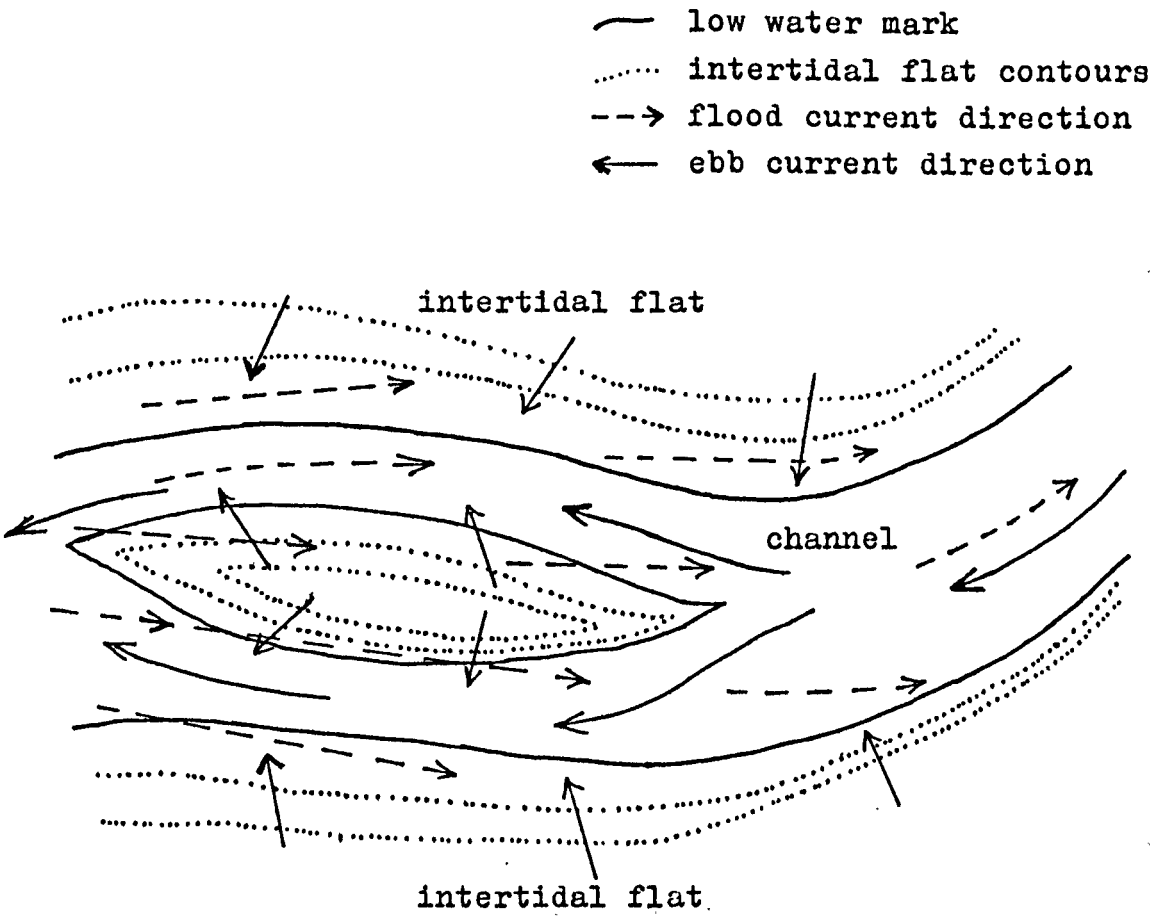


FIG.3.26 SKETCH OF EARLY STAGE FLOOD AND LATE STAGE EBB FLOW PATTERNS IN THE ESTUARINE CHANNEL AND ADJACENT INTERTIDAL AREAS

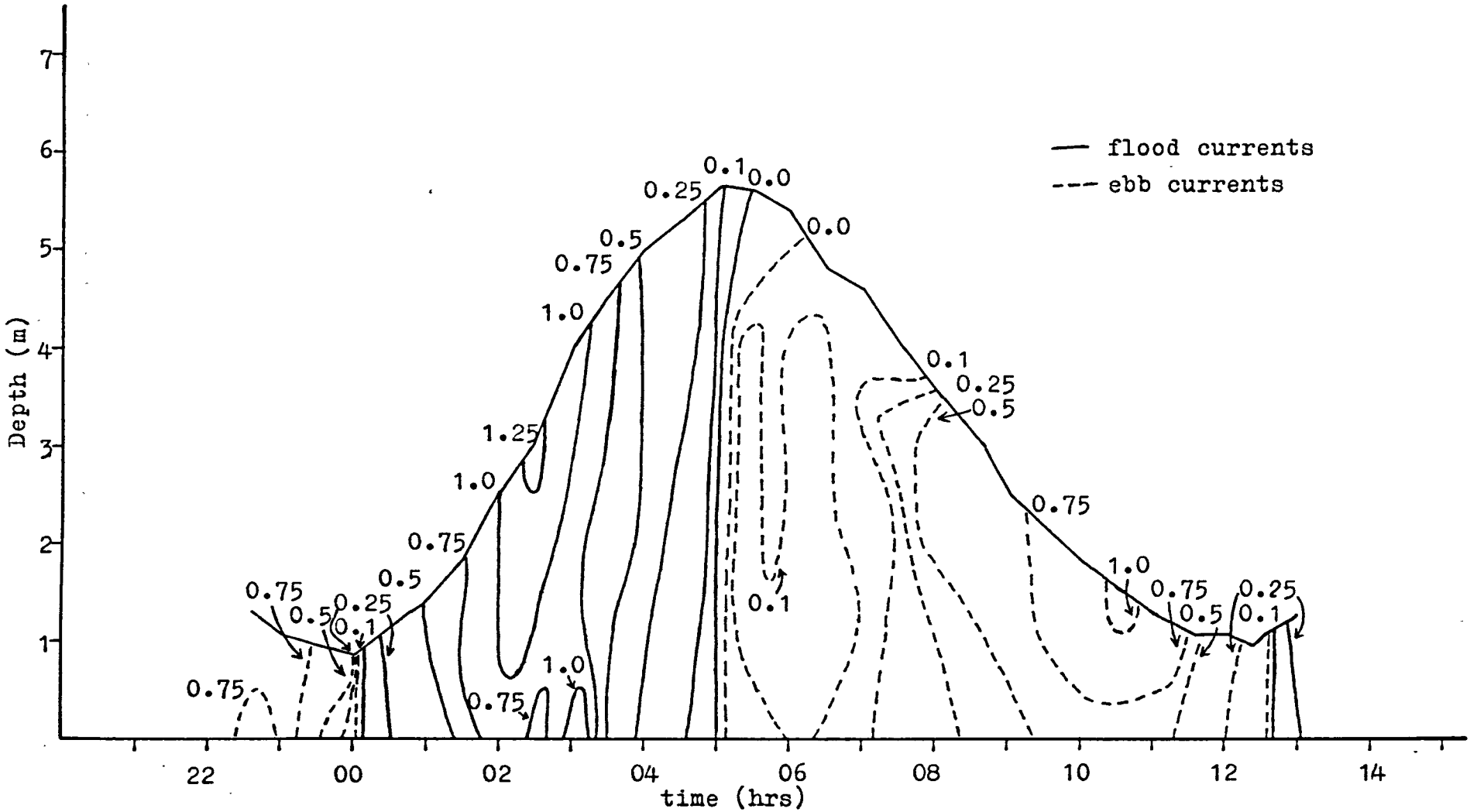


FIG.3.27a TEMPORAL VARIATION OF VELOCITY WITH DEPTH FOR STATION B2N/74 (Velocity contoured at 0.0,0.1,0.25,0.5,0.75,1.0, and 1.25 m/s)

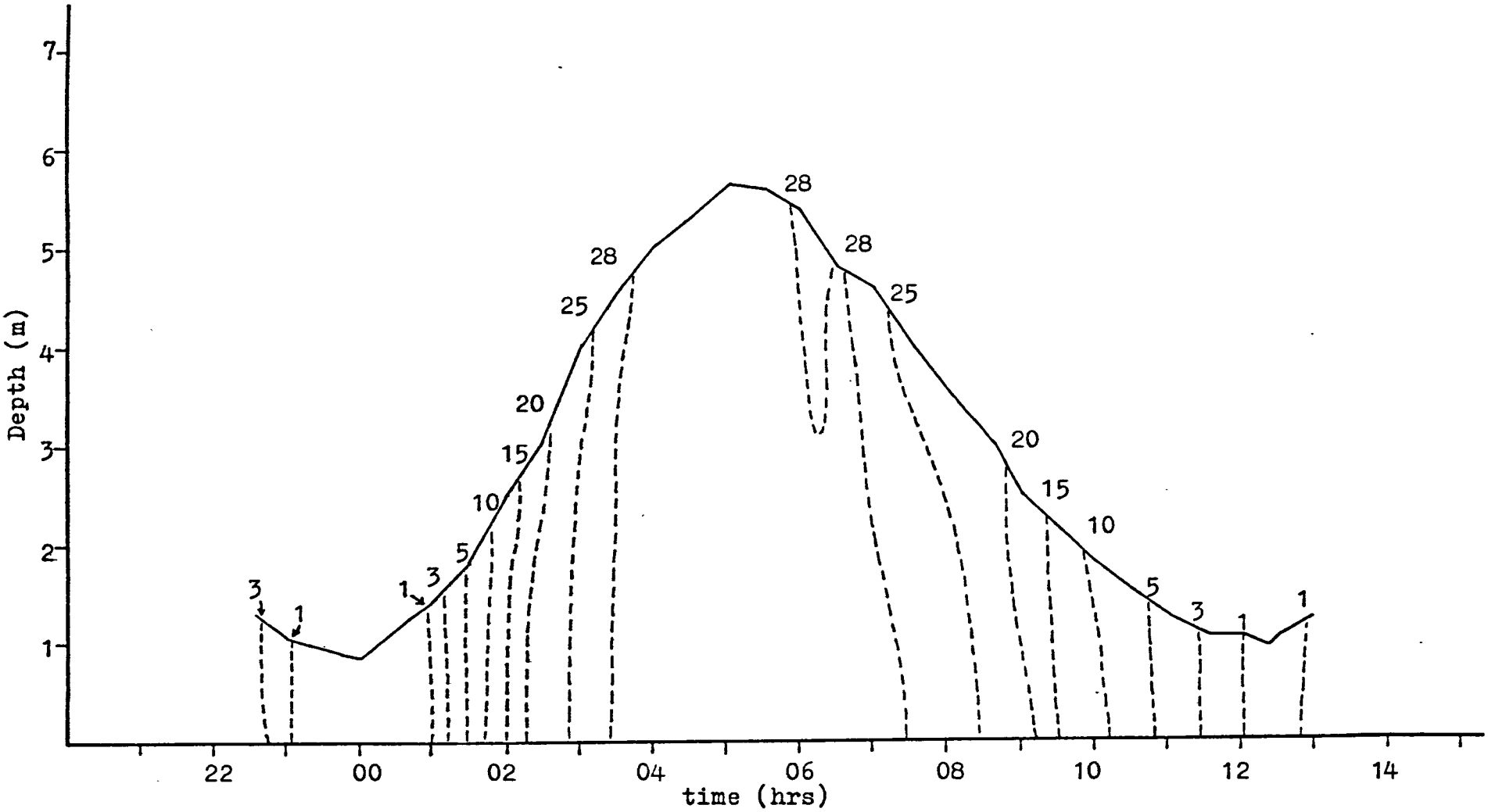


FIG.3.27b TEMPORAL VARIATION OF SALINITY WITH DEPTH FOR STATION B2N/74 (Salinity contoured at 1,3,5,10,15,20,25 and 28 ‰)

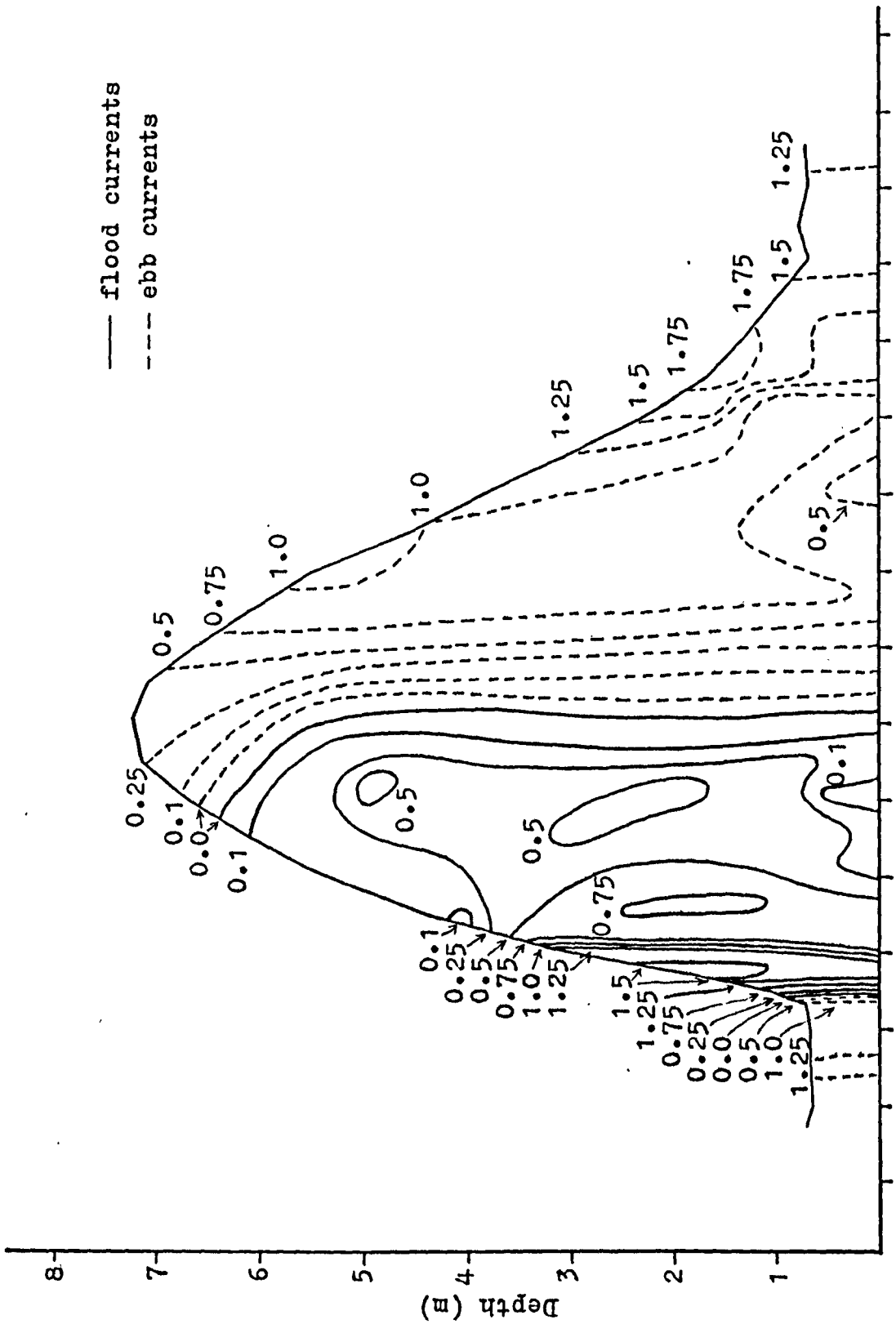


FIG.3.28 TEMPORAL VARIATION OF VELOCITY WITH DEPTH FOR STATION B1S/74 (Velocity contoured at 0.0,0.1,0.25,0.5,0.75,1.0,1.25,1.5 and 1.75 m/s)

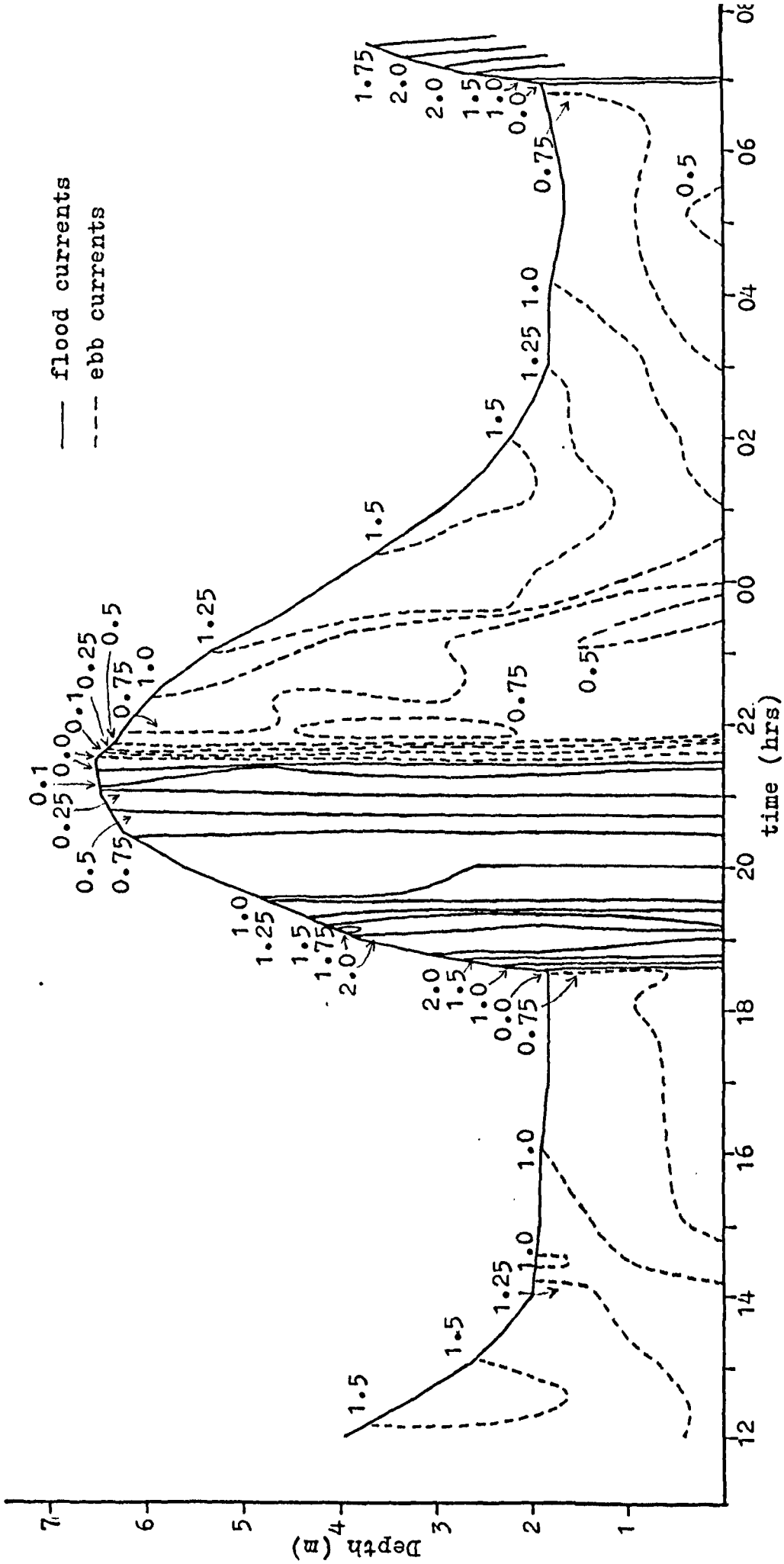


FIG.3.29 TEMPORAL VARIATION OF VELOCITY WITH DEPTH FOR STATION D1S/74 (Velocity contoured at 0.0,0.1,0.25,0.5,0.75,1.0,1.25,1.5,1.75 and 2.0 m/s)

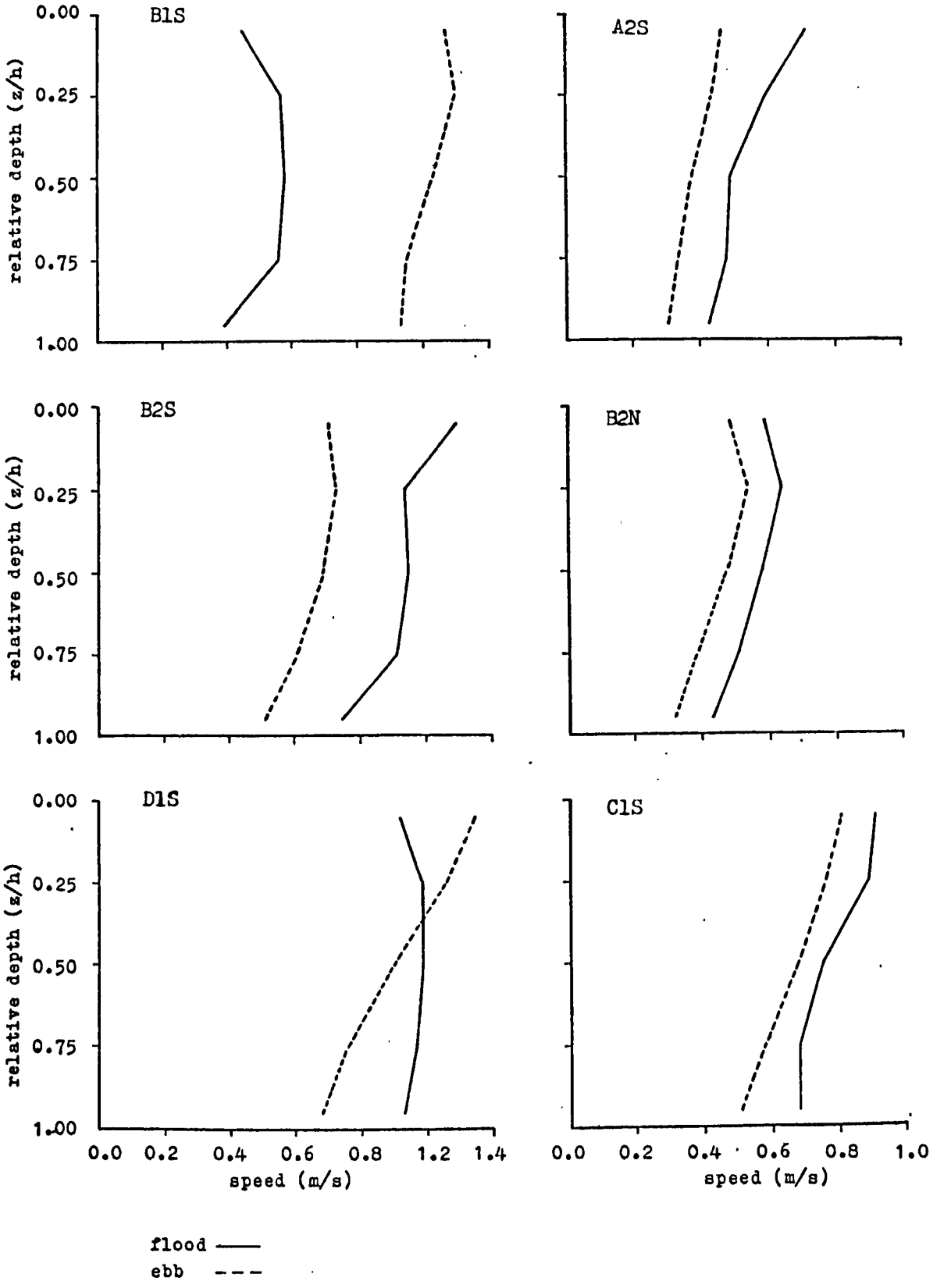


FIGURE 3.30 PROFILES OF MEAN EBB AND FLOOD CURRENT SPEEDS FOR STATIONS A2S/74, B1S/74, B2S/74, B2N/74, C1S/74 AND D1S/74

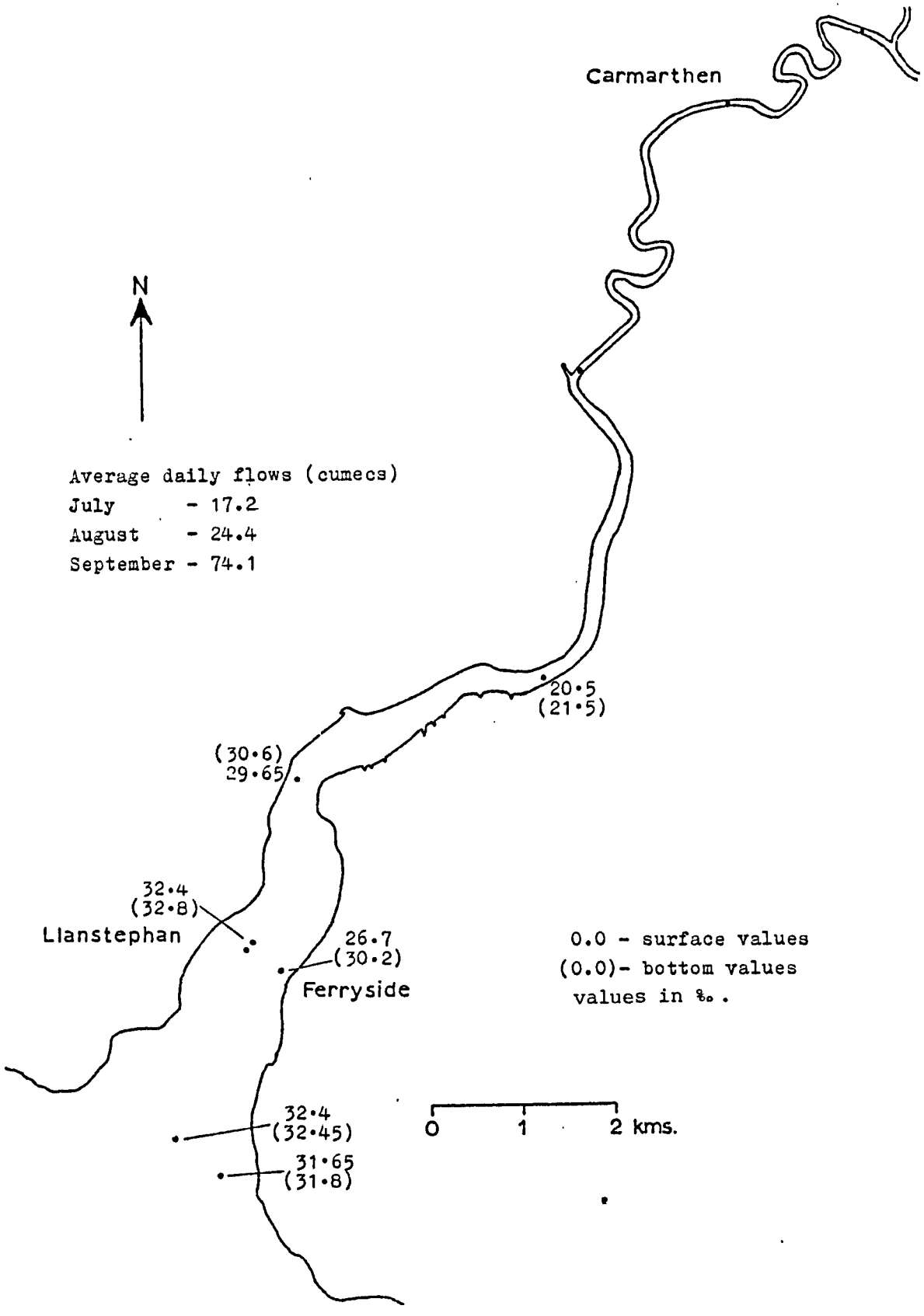


FIGURE 3.31 MAXIMUM HIGH WATER SPRING TIDE SALINITIES FROM 1974 DATA

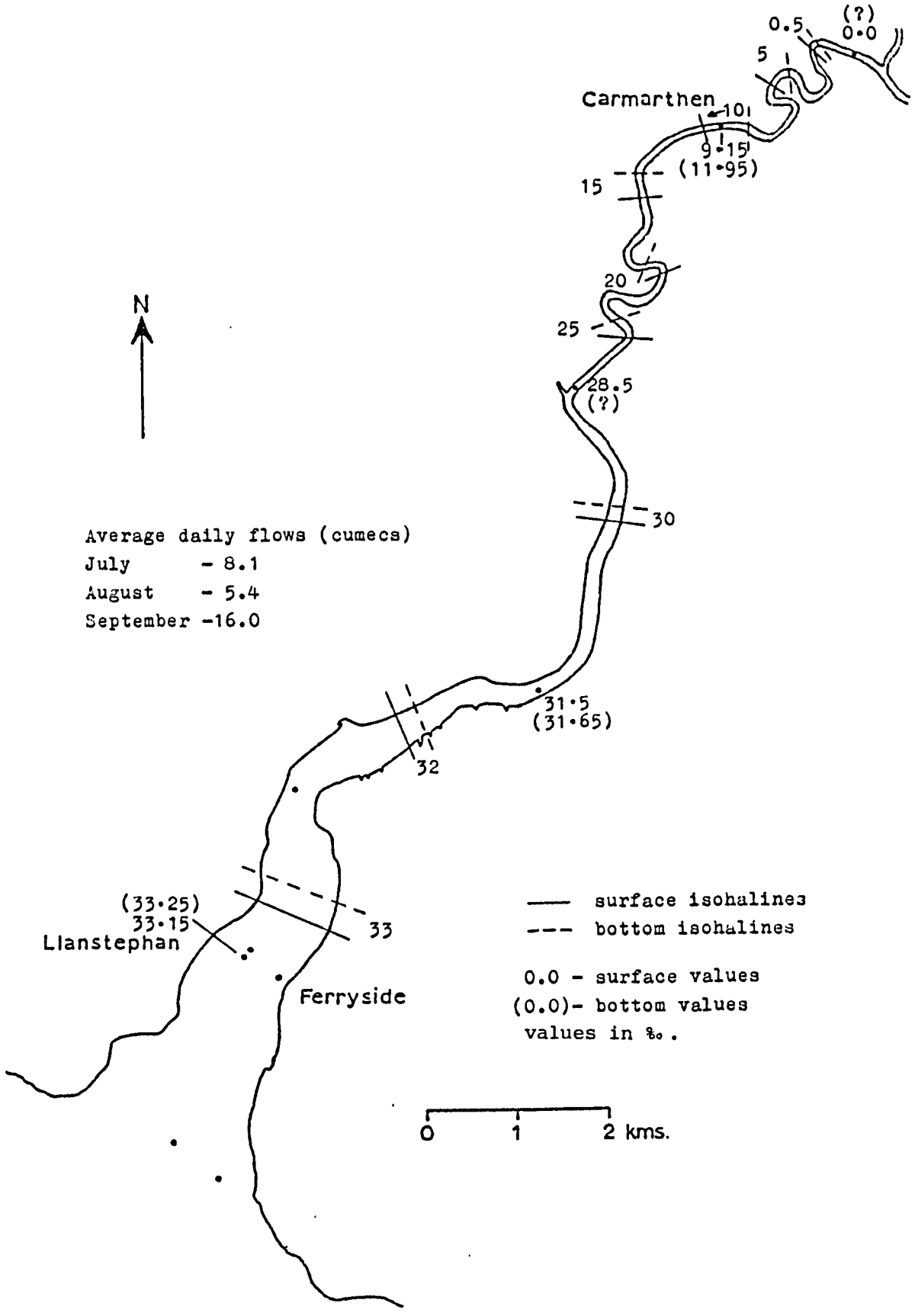


FIGURE 3.32 MAXIMUM HIGH WATER SPRING TIDE SALINITIES FROM 1975 DATA

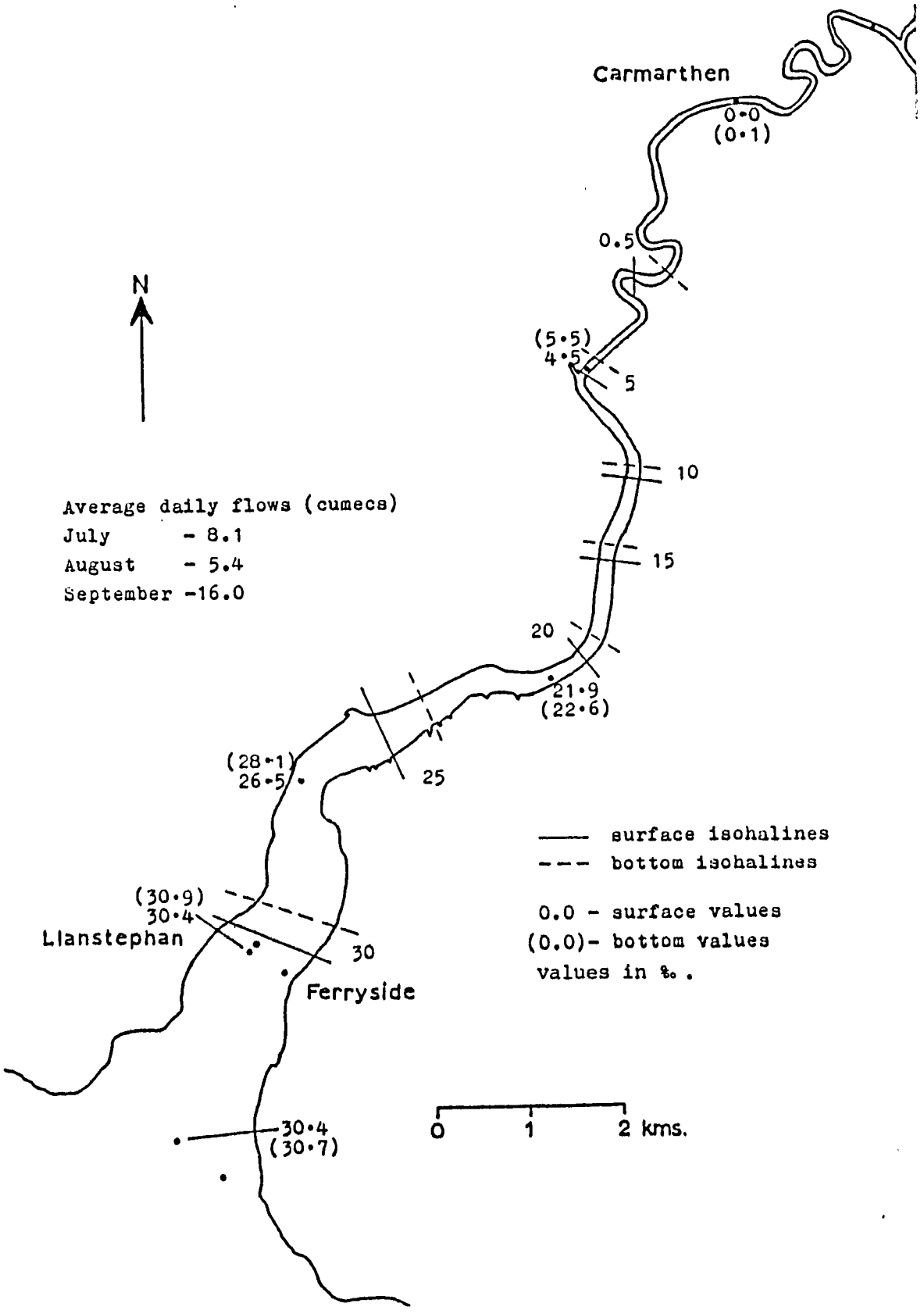


FIGURE 3.33 MAXIMUM HIGH WATER NEAP TIDE SALINITIES FROM 1975 DATA

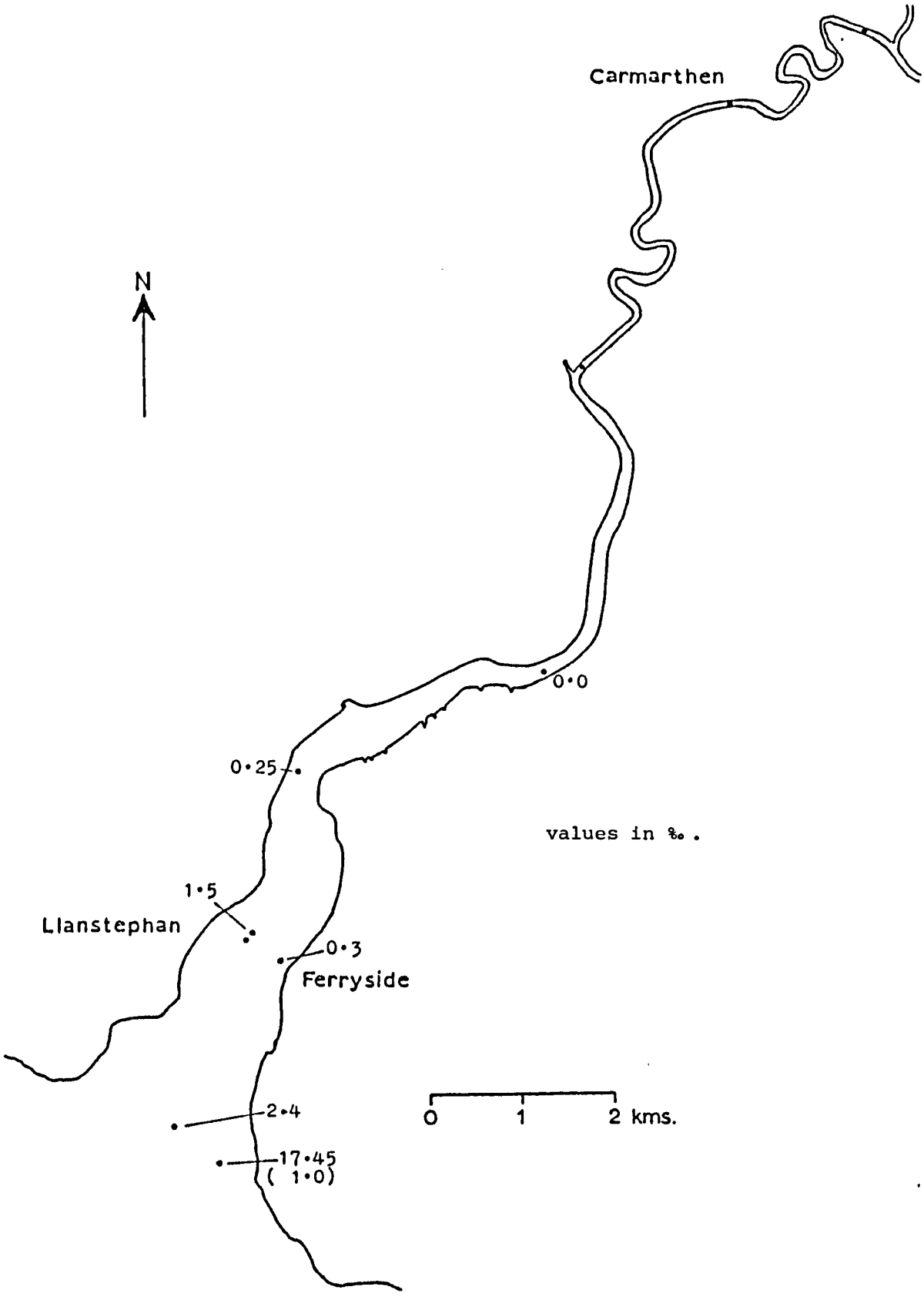


FIGURE 3.34 MINIMUM LOW WATER SPRING TIDE SALINITIES FROM 1974 DATA

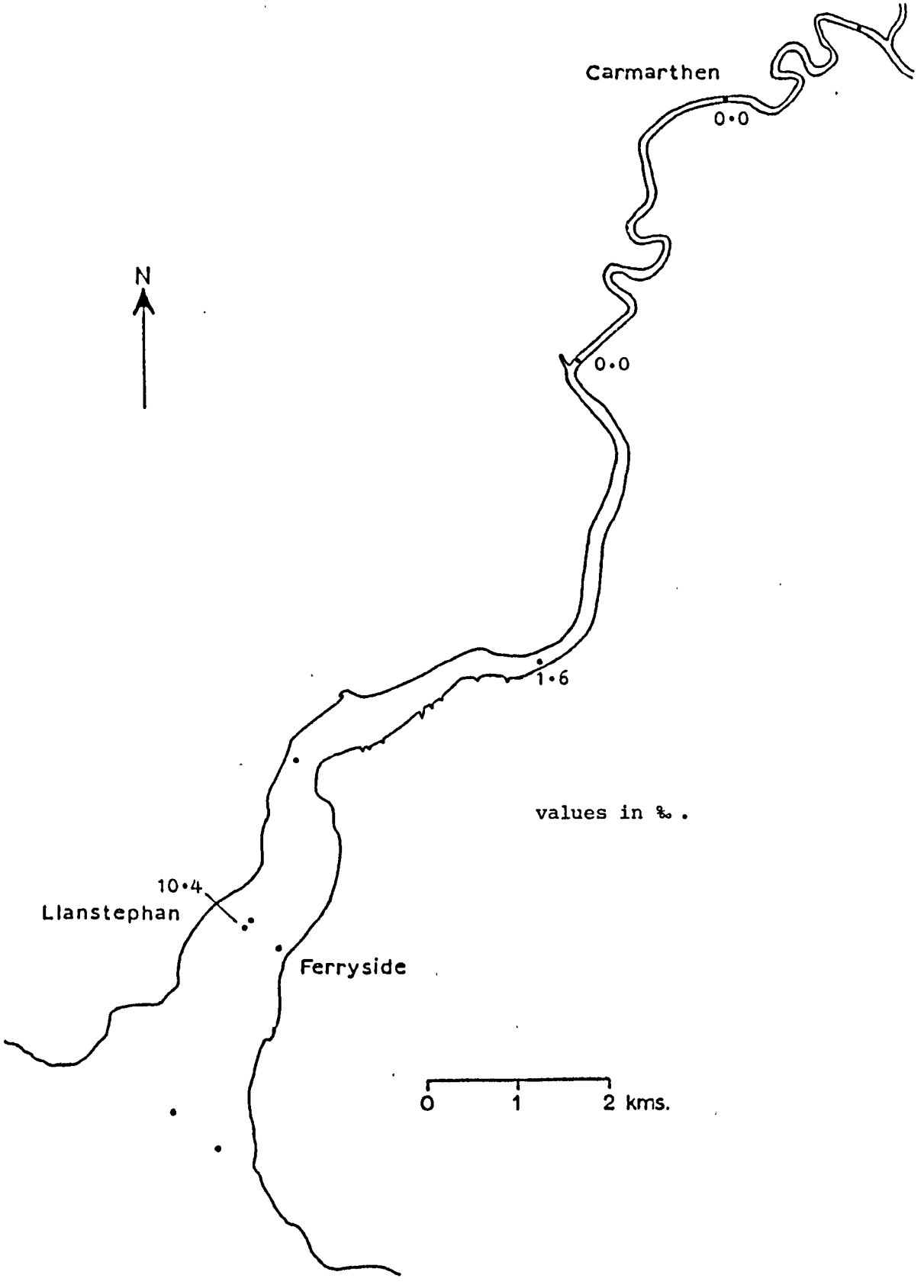


FIGURE 3.35 MINIMUM LOW WATER SPRING TIDE SALINITIES FROM 1975 DATA

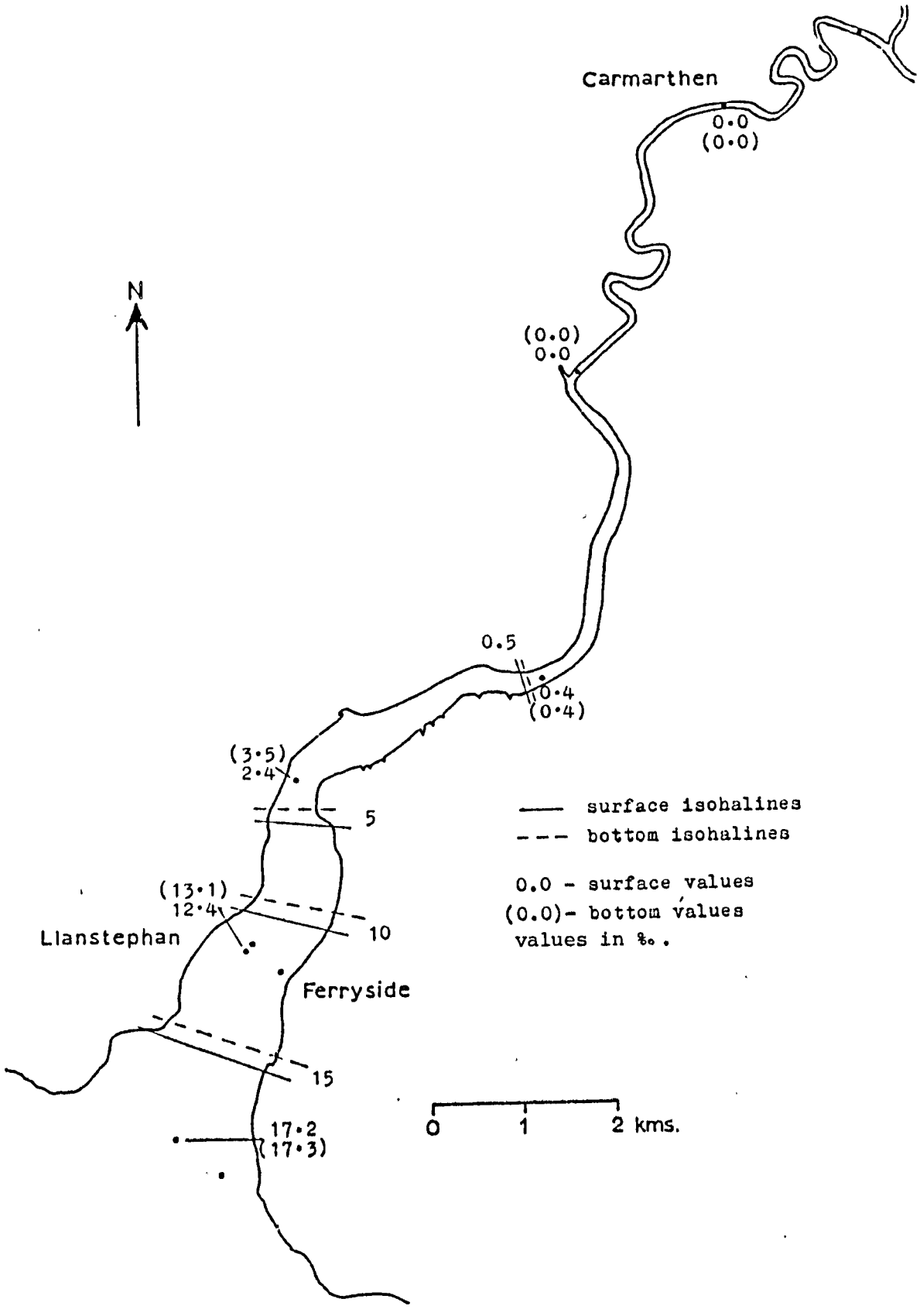


FIGURE 3.36 MINIMUM LOW WATER NEAP TIDE SALINITIES FROM 1975 DATA

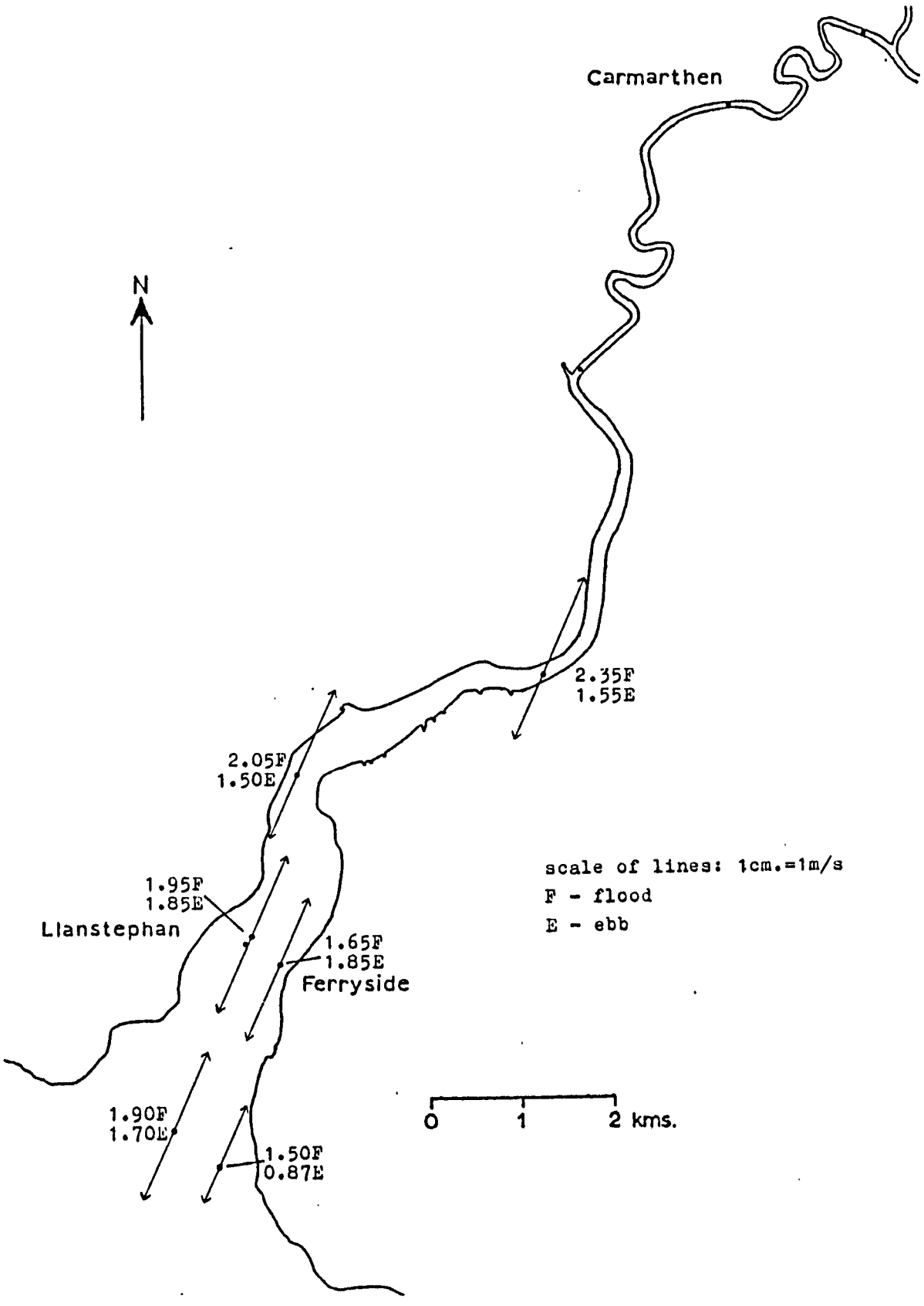


FIGURE 3.37 MAXIMUM SPRING TIDE FLOOD AND EBB SURFACE SPEEDS FROM 1974 DATA

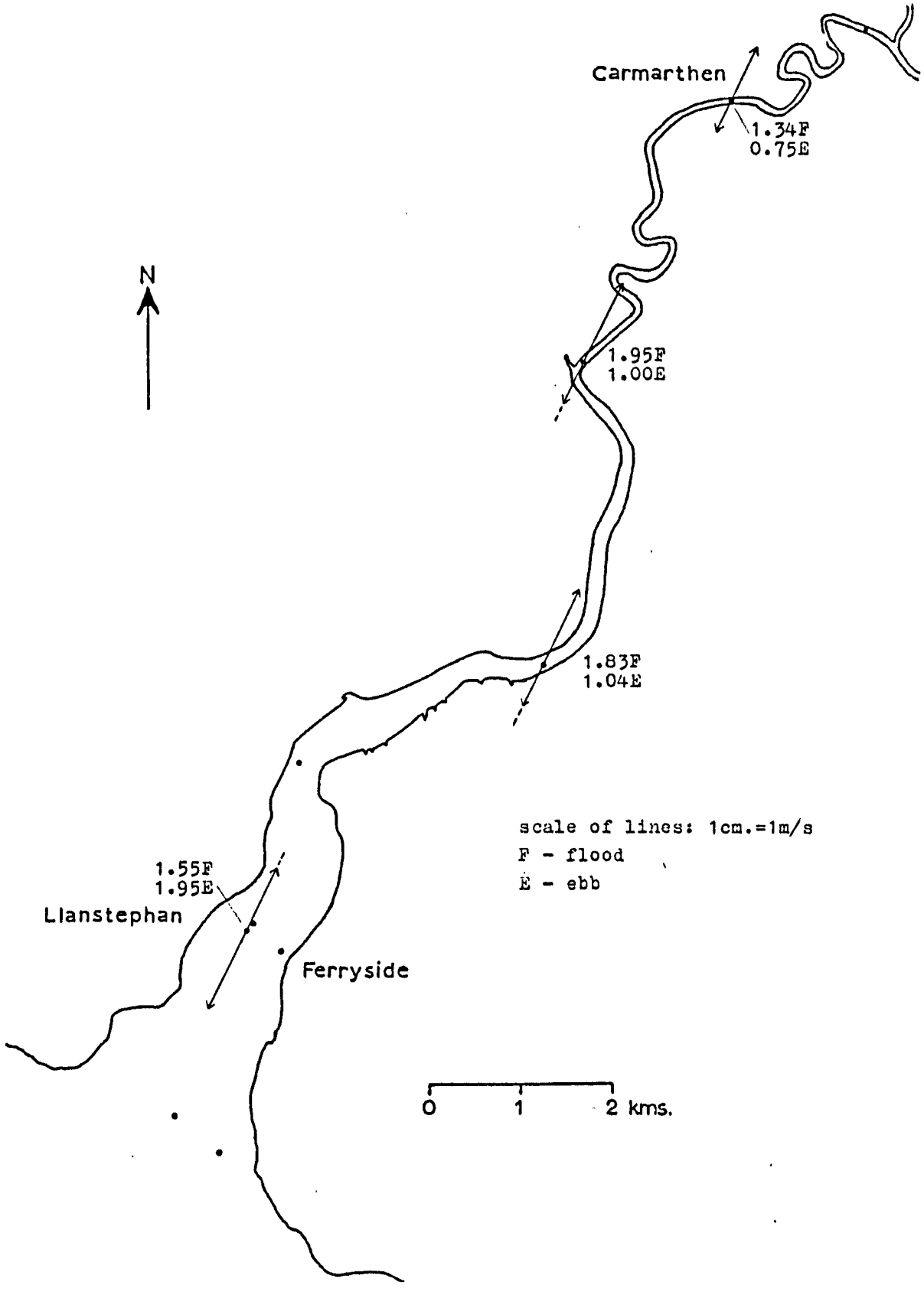


FIGURE 3.39 MAXIMUM SPRING TIDE FLOOD AND EBB SURFACE SPEEDS FROM 1975 DATA

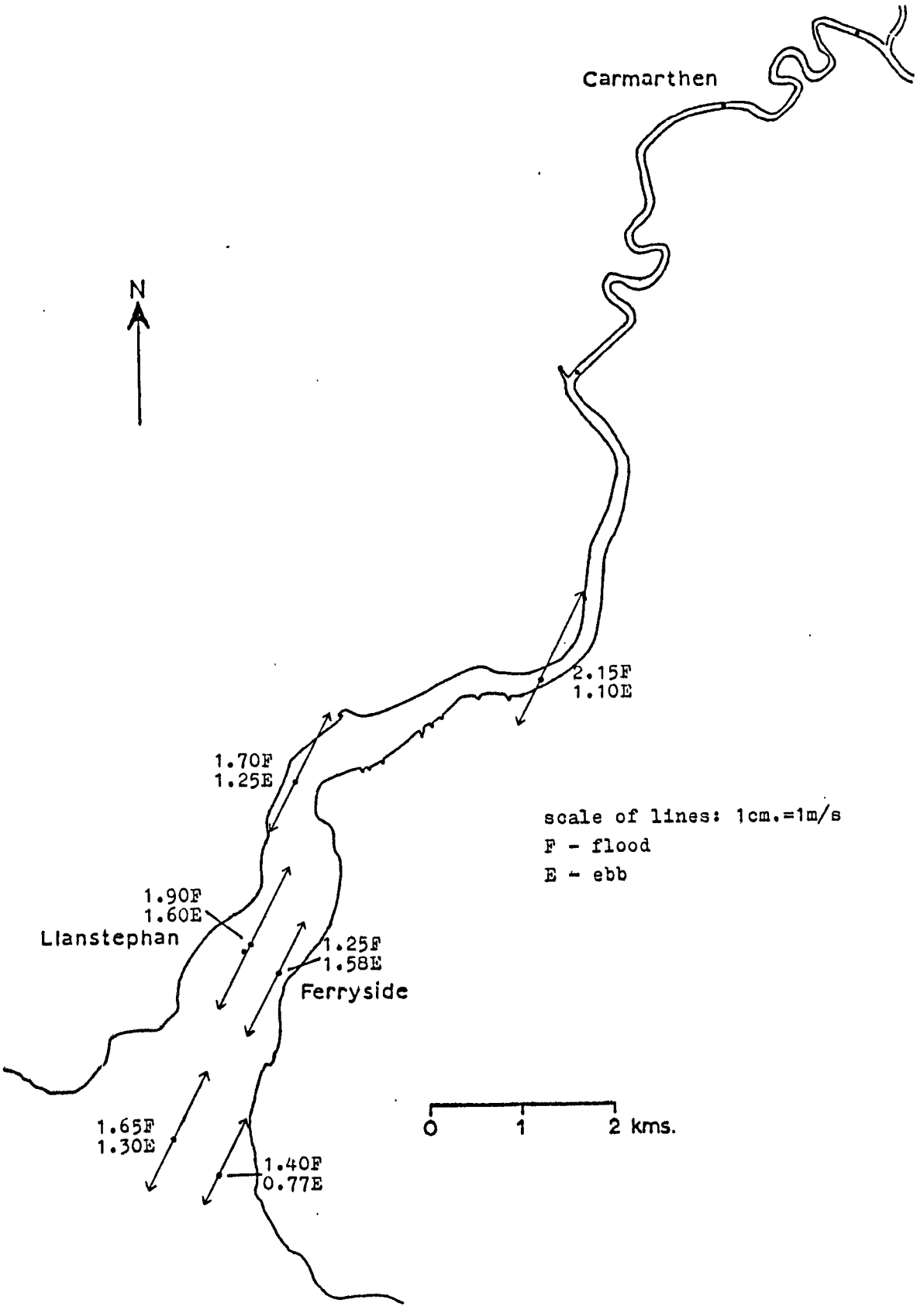


FIGURE 3.38 MAXIMUM SPRING TIDE FLOOD AND EBB BOTTOM SPEEDS FROM 1974 DATA

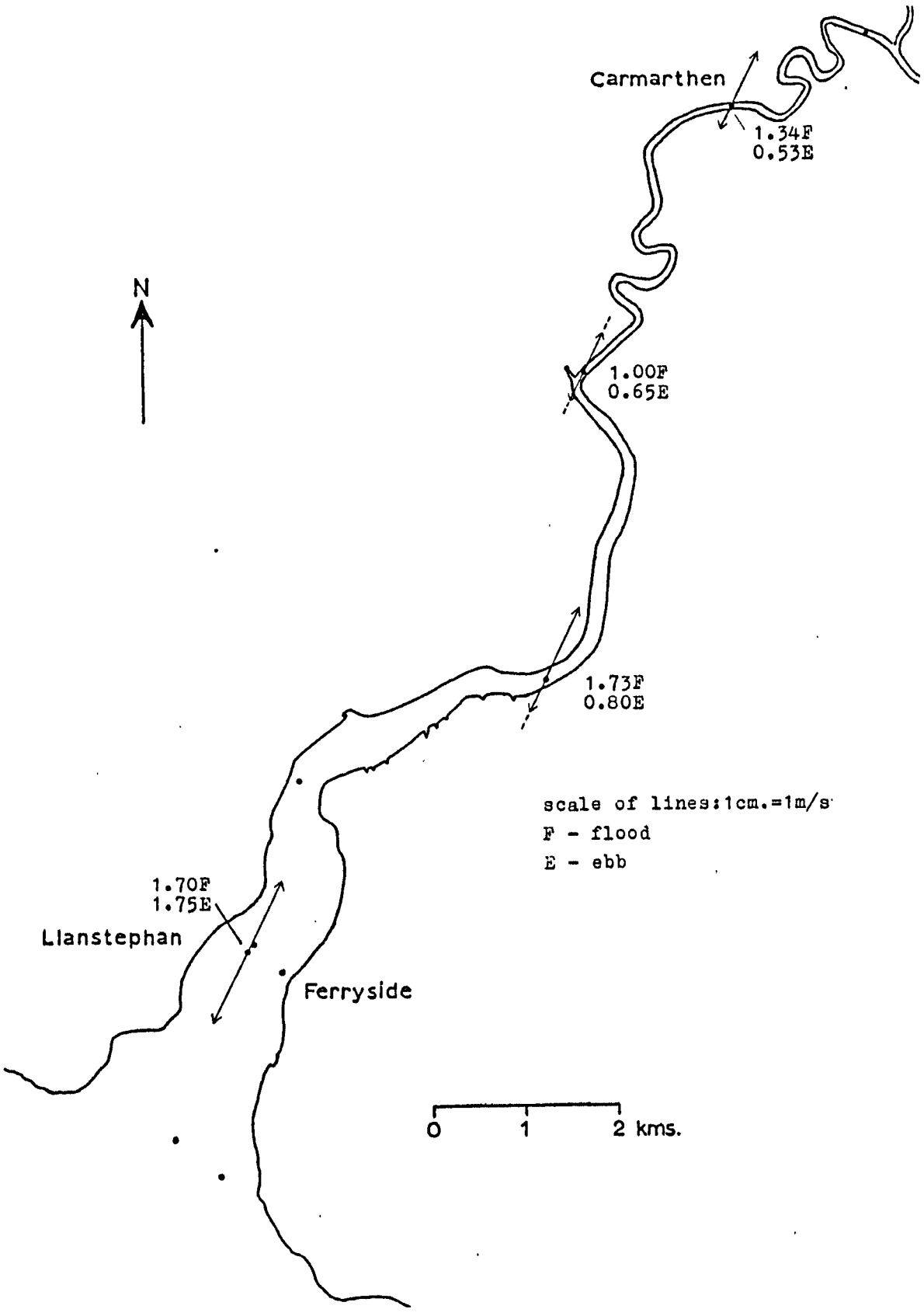


FIGURE 3.40 MAXIMUM SPRING TIDE FLOOD AND EBB BOTTOM SPEEDS FROM 1975 DATA

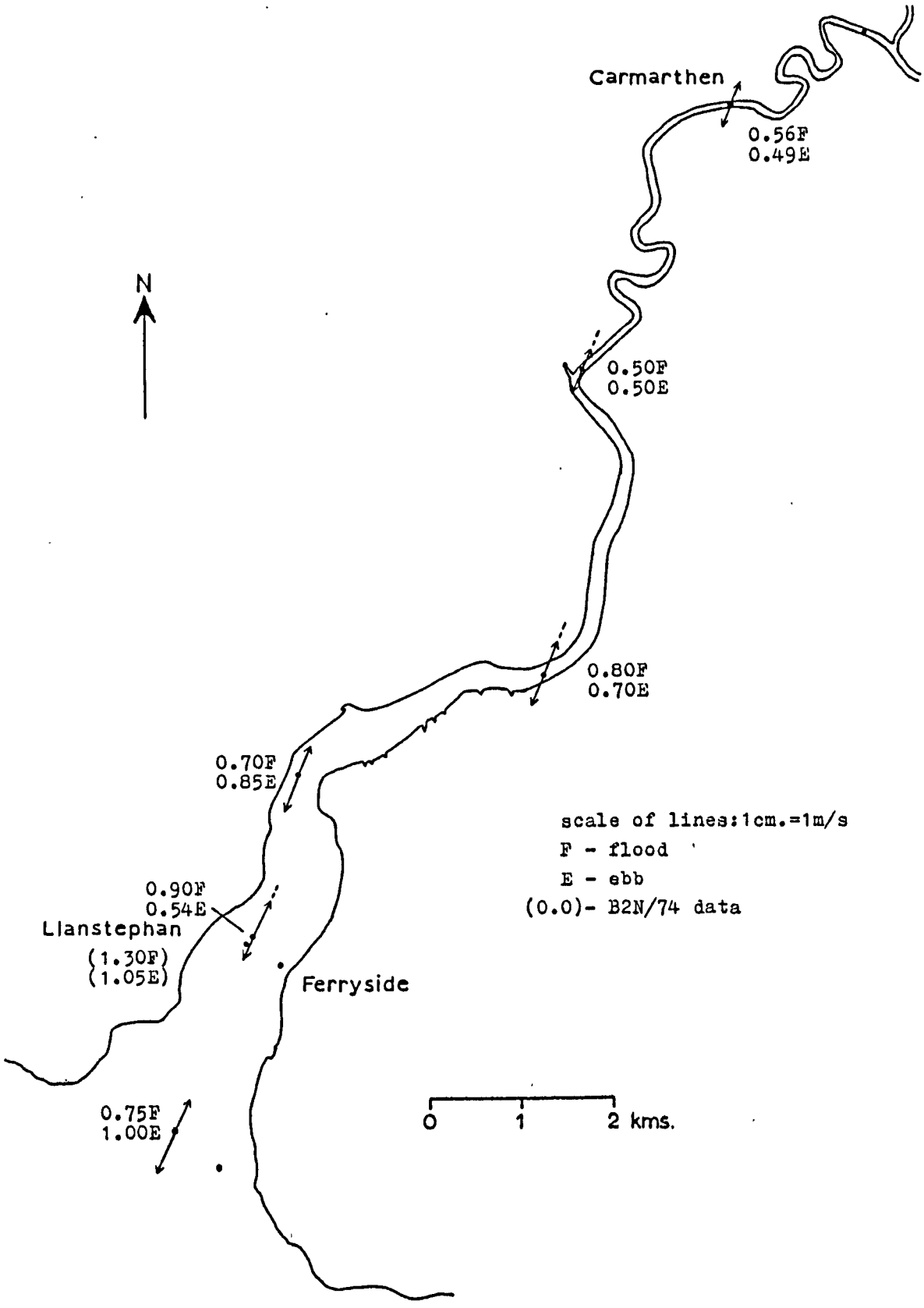


FIGURE 3.41 MAXIMUM NEAP TIDE FLOOD AND EBB SURFACE SPEEDS FROM 1975 DATA

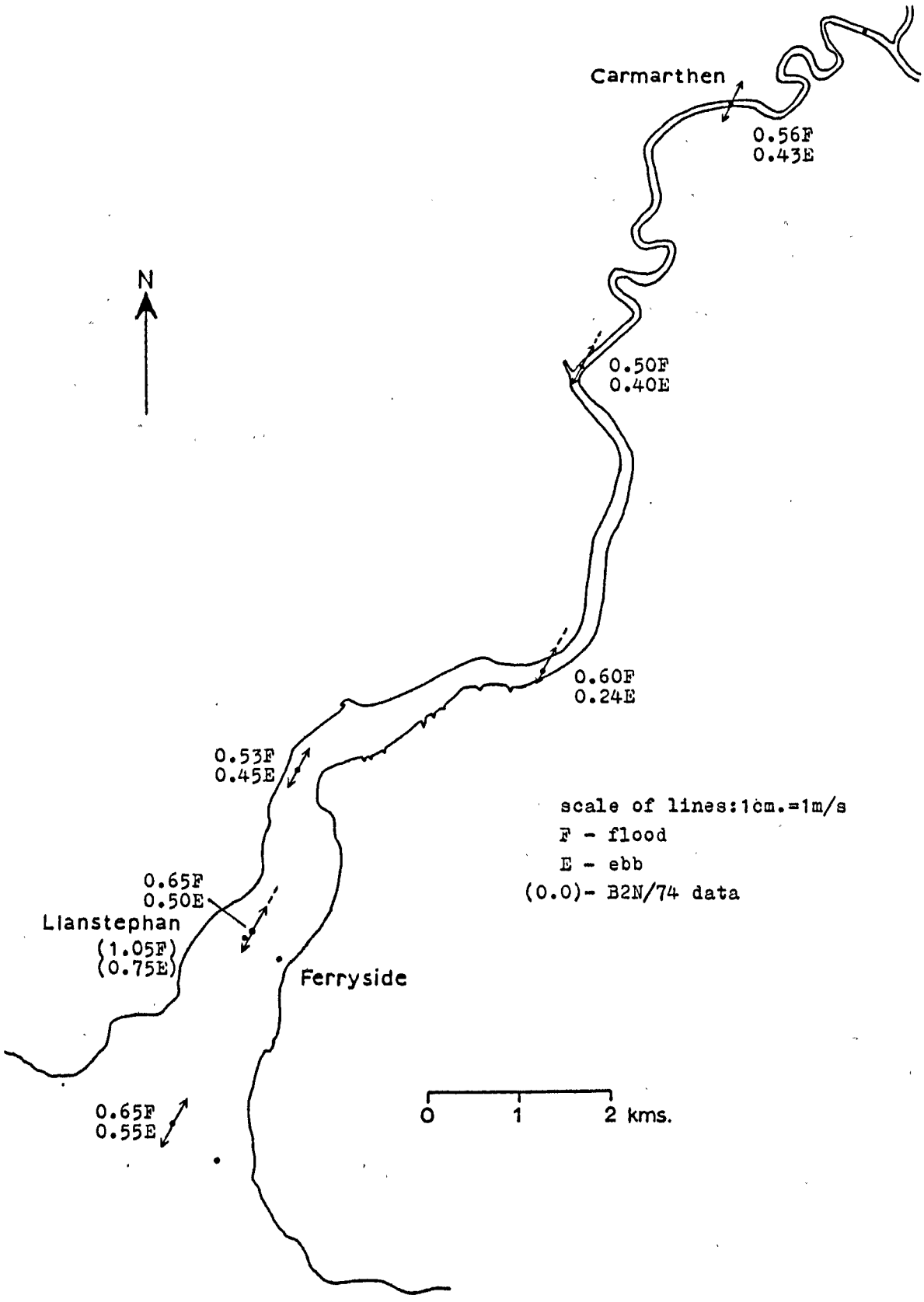
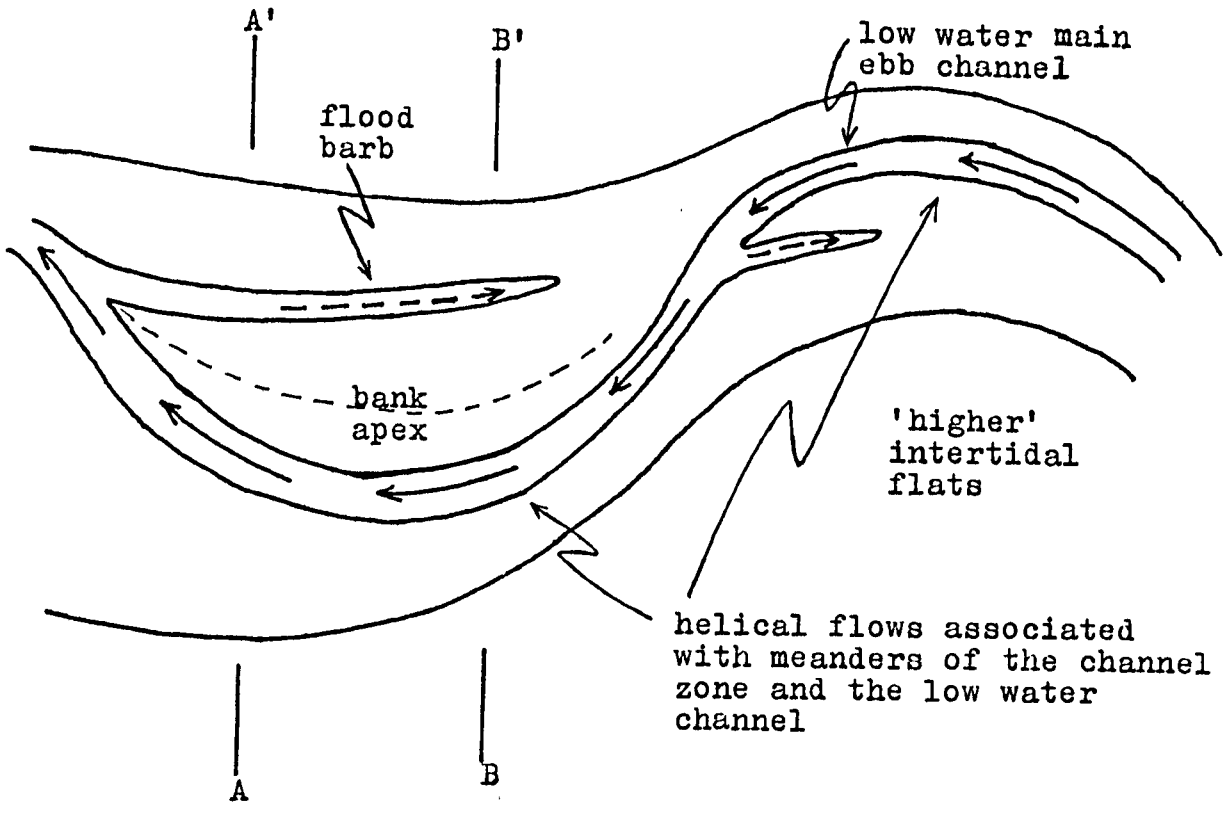
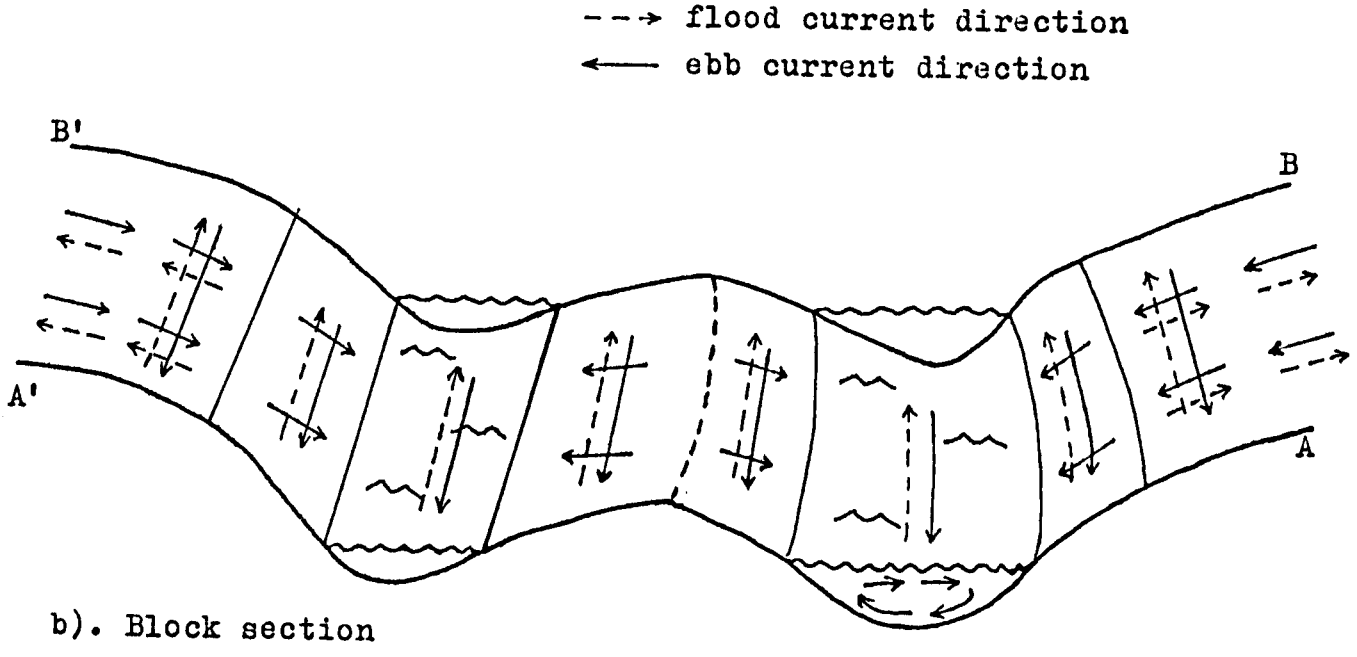


FIGURE 3.42 MAXIMUM NEAP TIDE FLOOD AND EBB BOTTOM SPEEDS FROM 1975 DATA



a). Plan view



b). Block section

FIG.3.43 SKETCHES ILLUSTRATING THE MAJOR ELEMENTS OF THE CURRENT PATTERN IN THE TOWY ESTUARY

Date	Station	Duration (hours)	Predicted Tidal Range* (m)	Actual Range (m)	Weather Conditions	River Discharge (cumecs)	Boat and Equipment
21/7/74	A1S/74	11½	7.3-7.6	7.0	Dry.Wind on-shore 3	13.374	18'Launch.TD CM2 Meter
30/7/75	A1N/75	12	4.7-4.8	4.2	Dry.Wind on-shore 1-2 veering off-shore 2-3	5.596	18'Launch.TD CM2 Meter
20-21/8/74	A2S/74	13¾	7.8	7.0	Dry.Wind variable 1	22.510-18.820	18'Launch.TD CM2 Meter
17-18/9/74	B1S/74	12¼	7.9	6.6	Wet.Wind on-shore 3-Dry.Wind off-shore 2	43.599-35.709	18'Launch.TD CM2 Meter
23/7/74	B2S/74	12¾	6.9-7.0	6.3	Dry.Wind off-shore backing on-shore 2	11.852	18'Launch.TD CM2 Meter
8/8/75	B2S/75	11½	7.1-7.5	6.9	Dry.Wind variable 1-Wet (thunderstorms) Wind variable 0-4	4.994	18'Launch.TD CM2 Meter
30-31/7/74	B2N/74	14½	4.6-4.7	4.8	Wet.Wind on-shore 5-6	8.434-22.705	18'Launch.TD CM2 Meter
1/8/75	B2N/75	11½	3.8-4.0	3.2	Dry.Wind variable 0-1	5.282	18'Launch.TD CM2 Meter
21-22/8/74	C1S/74	18	7.2-7.3	5.6	Dry.Wind variable 1	18.860-16.241	18'Launch.TD CM2 Meter
3/8/75	C1N/75	11½	3.9-4.0	3.4	Dry.Wind on-shore 1-2	4.754	18'Launch.TD CM2 Meter
19-20/9/74	D1S/74	19½	6.9-7.2	4.7	Dry.Wind variable 1-2	28.404-25.697	18'Launch.TD CM2 Meter
8/8/75	D1S/75	10	7.1-7.5	6.4	Dry.Wind variable 1-Wet (thunderstorms) Wind variable 0-4	4.994	14'Z-Boat.Braystoke Flowmeter.
1/8/75	D1N/75	10½	3.8-4.0	3.0	Dry.Wind variable 0-1	5.282	14'Z-Boat.Braystoke Flowmeter.
8/8/75	E1S/75	9½	7.1-7.5	5.9 (est)	Dry.Wind variable 1-Wet (thunderstorms) Wind variable 0-4	4.994	10'Dinghy. General Oceanics Flowmeter
1/8/75	E1N/75	9½	3.8-4.0	2.6	Dry.Wind variable 0-1	5.282	10'Dinghy. General Oceanics Flowmeter
11/8/75	F1S/75	9	7.1-7.3	2.7	Dry.Wind variable 0-1	5.536	Road bridge.Braystoke Flowmeter.
15/8/75	F1N/75	8	4.3-4.4	1.0	Wet.Wind variable 0-1	5.536	Road bridge.Braystoke Flowmeter.
8/10/75	G1S/75	1½	7.3	1.2	Dry.Wind variable 0-1	20.460	River bank.Vis.observation

* Figures taken from Admiralty List of Tide Tables 1974, 1975. (Ferryside).

Wind strength in Beaufort Scale.

All salinities measured with MC5 N.I.O.Salinity-Temperature Bridge.

Table 3.1 General Data on the Hydrographic Stations

Mean wind speed		Percentage number of hours with winds from												
knots	m.p.h.	350° – 010°	020° – 040°	050° – 070°	080° – 100°	110° – 130°	140° – 160°	170° – 190°	200° – 220°	230° – 250°	260° – 280°	290° – 310°	320° – 340°	All directions Total
							YEAR							
Calm														5.6
1-3	1-3													10.5
4-6	4-7	0.7	0.9	1.1	1.0	0.8	1.2	1.6	1.7	1.2	1.3	1.2	1.0	13.7
7-10	8-12	1.2	1.0	1.1	1.0	1.0	2.2	3.5	3.2	2.4	2.1	1.8	1.4	21.9
11-16	13-18	1.7	1.3	1.0	0.7	1.0	2.8	4.1	3.8	3.3	3.2	2.2	1.9	27.0
17-21	19-24	0.7	0.6	0.4	0.1	0.4	1.2	2.1	1.7	1.7	1.9	1.3	0.9	13.0
22-27	25-31	0.4	0.2	0.1	0.1	0.1	0.5	0.7	0.7	0.8	1.1	0.9	0.6	6.2
28-33	32-38	0.1	0.1	0+	0+	0+	0.1	0.1	0.1	0.2	0.4	0.2	0.2	1.5
34-40	39-46	0+	0+	0+		0+	0+	0+	0+	0.1	0.1	0.1	0.1	0.4
41-47	47-54					0+	0+				0+	0+	0+	0+
48-55	55-63												0+	0+
56-63	64-72													
63	72													
TOTAL		4.8	4.1	3.7	2.9	3.3	8.0	12.1	11.2	9.7	10.1	7.7	6.1	99.8

(Percentage number of hours missed 0.2)

Table 3.2. Annual Wind Data for Aberporth (Cardigan Bay)

TABLE 3.3. TIDAL RANGE AND DURATIONS OF FLOOD AND EBB TIDE FOR THE VARIOUS STATIONS

STATION	TIDAL RANGE EXPERIENCED	FLOOD TIDE DURATION	EBB TIDE DURATION
AIS/74	7.0 m	4hr.00m.	8hr.25m
AIN/75	4.2	6. 05	6. 20
A2S/74	7.0	3. 50	8. 35
BIS/74	6.6	3. 45	8. 40
B2S/74	6.3	3. 55	8. 30
B2S/75	6.9	4. 00	8. 25
B2N/74	4.8	5. 20	7. 05
B2N/75	3.2	6. 05	6. 20
CIS/74	5.6	3. 20	9. 05
CIN/75	3.4	5. 30	6. 55
DIS/74	4.7	2. 55	9. 30
DIS/75	6.4	3. 00	9. 25
DIN/75	3.0	4. 00 - 4.30(E)	8. 25 - 7.55(E)
EIS/75	5.9 (E)	2. 30 (E)	9. 55
EIN/75	2.6	3. 00 - 3.20(E)	9. 25 - 9.05(E)
FIS/75	2.7	1. 50	10. 35
FIN/75	1.0	1. 55	10. 30
GIS/75	1.2	1. 10 (E)	11. 15

(E = Estimated from observed curve)

STATION	AIS/74	A2S/74	BIS/74	B2S/74	B2S/75	CIS/74	DIS/74	DIS/75	EIS/75	FIS/75
Tidal Range (m)	7.0	7.0	6.6	6.3	6.9	5.6	4.7	6.4	5.9 *	2.7
Max. Flood Speed surface (m/s)	1.90	1.50	1.60	1.95	?(1.55)	2.05	2.35	1.83	1.95	1.34
Time in relation to HW (-HW) (hr)	2¼	2½	3¼	3	(2¾)	2¾	2½	2½	2½	~1½
Water Depth (Z) (m)	3.1	3.4	1.9	2.4	?(1.7)	3.6	3.8	3.4	?(0.9)	0.9
Max.Ebb Speed (Surf) (m/s)	1.70	0.87	1.85	1.85	1.95	1.50	1.55	⩾1.04	⩾1.00	0.75
Time (+HW) (hr)	+3¾	3½	4½	4¾	5¼	4¼	4	?(3)	?(2½)	2¼
Water Depth (Z) (m)	2.8	2.5	1.7	1.5	1.2	2.3	2.5	?(3.4)	?(2.9)	1.4
Difference between Max.speeds (E-F) (m/s)	-0.20	-0.63	+0.25	-0.1	?	-0.55	-0.80	⩽-0.79	⩽-0.95	-0.59
Max.Flood Speed (Bott) (m/s)	1.65	1.40	1.25	1.90	?(1.70)	1.70	2.15	?1.73	⩽1.95	⩽1.34
Time (-HW) (hr)	3¼	2½	3¼	3	(2¾)	2¾	2½	2½	2½	ca.1½
Water Depth (Z)(m)	2.3	3.4	1.6	2.4	?(1.7)	3.7	3.9	3.6	?(0.7)	0.9
Max.Ebb Speed (Bott) (m/s)	1.30	0.77	1.58	1.60	1.75	1.25	1.10	⩾0.80	⩾0.65	0.53
Time (+HW) (hr)	+4	3½	5½	5	5¼	4½	3½	3	3	2½
Water Depth (Z) (m)	2.6	2.5	1.0	1.3	1.2	2.1	3.2	3.1	2.3	1.2
Difference between Max.speeds (E-F) (m/s)	-0.35	-0.63	-0.33	-0.30	?	-0.45	-1.05	⩽-0.93	⩽-1.30	⩽-0.81
Max. Surf Salinity(p.p.t.)	32.8	31.65	26.7	32.4	33.15	29.65	20.5	31.5	28.5	9.15
Time in relation to HW (hr)	HW	HW	HW+½	HW	HW	HW-½	HW-¼	HW-½	ca. HW	HW
Max. Bott. Salinity(p.p.t)	32.9	31.8	30.2	33.3	33.25	30.6	21.5	31.6	?	11.95
Time in relation to HW (hr)	HW	HW	HW+½	HW	HW	HW	HW-¼	HW	?	HW+¼
Max. Stratification (p.p.t)	1.9	~2.5	12.0	~3.5	1.2	3.7	10.0	⩾1.5	⩾1.2	3.5
Time in relation to HW (hr)	HW-2½	HW-3	HW-1½	HW-2¼	HW-3¼ & HW+¼	HW+2 -HW+3	HW+1½	(HW+5)	(HW+2½)	HW+¼ -HW+½
Min. Surf Salinity (p.p.t)	2.4	~ 1.0	0.3	1.5	10.4	0.25	0.0	1.5	0.0	0.0
Min. Bott. Salinity (p.p.t)	2.6	~ 1.0	0.3	1.5	10.4	0.25	0.0	1.6	0.0	0.0

Those figures in brackets indicate data from incomplete observations, as do figures with qualifications (i.e.?,⩾,⩽) (* Estimated)

Table3.4A Velocity and Salinity Maxima for the Spring Tide Stations, and their Relationships to the Tidal Wave

STATION	AIN/75	B2N/74	B2N/75	CIN/75	DIN/75	EIN/75	FIN/75
Tidal Range (m)	4.2	4.8	3.2	3.4	3.0	2.6	1.0
Max. Flood Speed surface (m/s)	0.75	1.30	⩾0.9	0.70	⩾0.80	⩾0.50	0.56
Time in relation to HW (-HW) (hr)	5 & 3½	2¼	3¼	3	?(2¼)	?	1½
Water Depth (Z) (m)	2.0 & 3.5	3.0	2.7	3.7	(3.5)	?	0.9
Max.Ebb Speed (Surf) (m/s)	1.00	1.03	0.54	0.85	0.70	0.50	0.49
Time (+HW) (hr)	4	5¼	5	3	3¼	1¼	¼
Water Depth (Z) (m)	2.5	1.5	1.7	3.8	3.7	2.7	1.1
Difference between Max.speeds (E-F) (m/s)	+0.25	-0.27	⩾-0.36	+0.15	⩾-0.10	⩾0.00	-0.07
Max.Flood Speed (Bott) (m/s)	0.65	1.05	⩾0.65	0.53	⩾0.60	⩾0.50	⩽0.56
Time (-HW) (hr)	5	2	3¼	2¼	?(2¼)	?	1½
Water Depth (Z)(m)	2.0	4.1	2.7	4.3	(3.5)	?	0.9
Max.Ebb Speed (Bott) (m/s)	0.55	0.75	0.50	0.45	0.24	0.40	0.43
Time (+HW) (hr)	3½	5¼	5	4½	3¼	2	¼
Water Depth (Z) (m)	2.9	1.5	1.7	2.9	3.4	2.1	1.1
Difference between Max.speeds (E-F) (m/s)	-0.10	-0.30	⩾-0.15	-0.08	⩾-0.36	⩾-0.10	⩽-0.13
Max. Surf Salinity(p.p.t.)	30.4	29.3	30.4	26.5	21.9	4.5	0.1
Time in relation to HW (hr)	HW	HW-1	HW	HW-½	HW-½	HW-½	HW
Max. Bott. Salinity(p.p.t)	30.7	29.5	30.9	28.1	22.6	5.5	0.1
Time in relation to HW (hr)	HW	HW	HW	HW	HW+½	HW	HW
Max. Stratification (p.p.t)	1.5	3.4	3.1	5.1	13.0	3.0	0.0
Time in relation to HW (hr)	HW+1¼	HW+2¼	HW+2	HW+2½	HW+1¼	HW+¾	-
Min. Surf Salinity (p.p.t)	17.2	0.2	12.4	2.0	0.4	0.05	0.0
Min. Bott. Salinity (p.p.t)	17.3	0.2	13.1	~4.3	0.4	0.05	0.0

Those figures in brackets indicate data from incomplete observations, as do figures with qualifications (i.e.?,⩾,⩽)

Table 3.4B Velocity and Salinity Maxima for the Neap Tide Stations, and their Relationships to the Tidal Wave

z/h	STATION	A2S/74	B1S/74	B2S/74	C1S/74	D1S/74	B2N/74
	0.05	27.4	11.5	20.4	13.2	4.9	15.8
	0.25	27.6	13.2	20.5	13.4	5.3	16.3
	0.50	27.8	13.8	20.6	13.8	5.7	16.8
	0.75	27.8	14.3	20.7	14.1	6.2	17.1
	0.95	27.8	14.6	20.9	14.4	6.2	17.2
	depth-mean	27.7	13.5	20.6	13.8	5.7	16.8

a) SALINITY (‰)

z/h	STATION	A2S	B1S	B2S	C1S	D1S	B2N
	0.05	0.06	0.79	0.24	0.40	0.66	0.01
	0.25	0.05	0.66	0.23	0.36	0.57	0.07
	0.50	0.05	0.58	0.20	0.34	0.48	0.05
	0.75	0.01	0.56	0.15	0.28	0.35	0.03
	0.95	0.01	0.56	0.13	0.25	0.30	0.02
	depth-mean	0.04	0.63	0.19	0.33	0.47	0.04

b) VELOCITY (all flows seawards) (m/s)

TABLE 3.5. MEAN SALINITY AND VELOCITY DATA FOR STATIONS A2S/74, BIS/74, B2S/74, B2N/74, CIS/74 and DIS/74

	CIS	DIS
Average River Discharge (cumecs)	17.53	27.05
Ebb Tide Duration (hrs)	9.1	9.5
Average Area of Estuarine Cross-section during Ebb Tide (m^2)	515	298
Speed of River Discharge averaged through the average ebb cross-sectional area (m/s).	0.046	0.118
Mean Ebb Current Speed (depth-mean, $\langle \bar{U}_E \rangle$) (m/s).	0.67	0.91
Mean (net non-tidal) velocity ($\bar{U}$) m/s.	+0.33	+0.47

TABLE 3.6. Speed of river discharge averaged over the Ebb Tide for stations CIS/74 and DIS/74, in relation to depth-mean ebb current speed and mean (net non-tidal) velocity.

STATION	A2S	BIS	B2S	CIS	DIS	B2N
Depth-mean flood $\langle \bar{U}_F \rangle$ (m/s)	0.54	0.51	0.93	0.78	0.96	0.55
Mean depth flood $\bar{Z}_F$ (m)	4.36	5.42	4.30	5.17	5.23	3.32
Depth-mean ebb $\langle \bar{U}_E \rangle$ (m/s)	0.39	1.02	0.65	0.67	0.91	0.44
Mean-depth ebb $\bar{Z}_E$ (m)	3.25	2.74	3.06	3.06	2.95	2.86
Mean flood discharge for 1 m of the water column $Q_{IF} = \langle \bar{U}_F \rangle \times \bar{Z}_F \times 1$ (m^3/s)	2.35	2.76	4.00	4.03	5.02	1.83
Mean ebb discharge for 1 m of the water column $Q_{IE} = \langle \bar{U}_E \rangle \times \bar{Z}_E \times 1$ (m^3/s)	1.27	2.80	2.00	2.05	2.68	1.26

TABLE 3.7. Depth-Mean Speeds and Mean Depths for Flood and Ebb Currents

STATION	A2S	BIS	B2S	CIS	DIS	B2N
0.05	0.72	0.45	1.10	0.91	0.92	0.60
0.25	0.60	0.57	0.94	0.89	0.99	0.64
z/h 0.50	0.49	0.58	0.95	0.75	0.99	0.58
0.75	0.48	0.56	0.91	0.68	0.97	0.51
0.95	0.43	0.39	0.74	0.68	0.93	0.43
depth-mean	0.54	0.51	0.93	0.78	0.96	0.55

a) FLOOD

STATION	A2S	BIS	B2S	CIS	DIS	B2N
0.05	0.47	1.07	0.71	0.81	1.15	0.49
0.25	0.44	1.10	0.73	0.76	1.06	0.54
z/h 0.50	0.38	1.03	0.69	0.68	0.90	0.48
0.75	0.34	0.95	0.61	0.58	0.76	0.39
0.95	0.31	0.93	0.51	0.51	0.68	0.32
depth-mean	0.39	1.02	0.65	0.67	0.91	0.44

b) EBB

STATION	A2S	BIS	B2S	CIS	DIS	B2N
0.05	1.19	1.52	1.81	1.72	2.07	1.08
0.25	1.04	1.67	1.67	1.65	2.05	1.18
z/h 0.50	0.87	1.61	1.64	1.43	1.89	1.06
0.75	0.82	1.51	1.52	1.26	1.73	0.90
0.95	0.74	1.32	1.25	1.19	1.61	0.75
depth-mean	0.93	1.53	1.58	1.43	1.87	0.99

c) TIDAL CURRENT AMPLITUDE

STATION	A2S	BIS	B2S	CIS	DIS	B2N
0.05	-0.25	+0.62	-0.39	-0.10	+0.23	-0.11
0.25	-0.16	+0.53	-0.21	-0.13	+0.07	-0.10
z/h 0.50	-0.11	+0.45	-0.26	-0.07	-0.09	-0.10
0.75	-0.14	+0.39	-0.30	-0.10	-0.21	-0.12
0.95	-0.12	+0.54	-0.23	-0.17	-0.25	-0.11
depth-mean	-0.16	+0.51	-0.28	-0.11	-0.05	-0.11

d) RESIDUAL FLOW

Table 3.8. Data for Mean Flood and Ebb Current Speeds at Various Relative Depths for each Station.
(All in m/s)

C H A P T E R 4

FIGURES AND TABLES

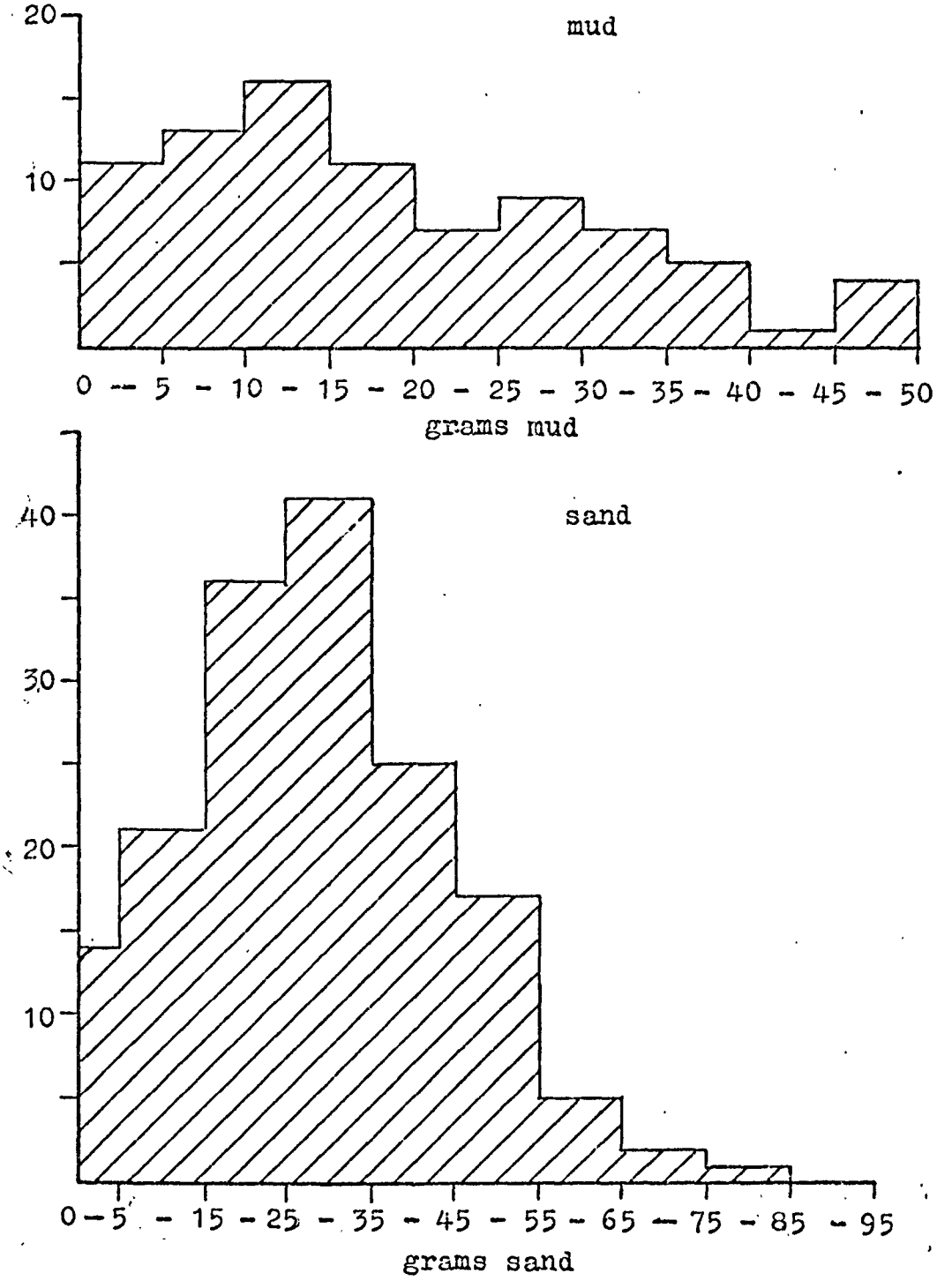


FIGURE 4.1 HISTOGRAMS SHOWING THE FREQUENCY OF DIFFERENT SAMPLE WEIGHTS OF MUD AND SAND USED IN THE GRAIN SIZE ANALYSIS

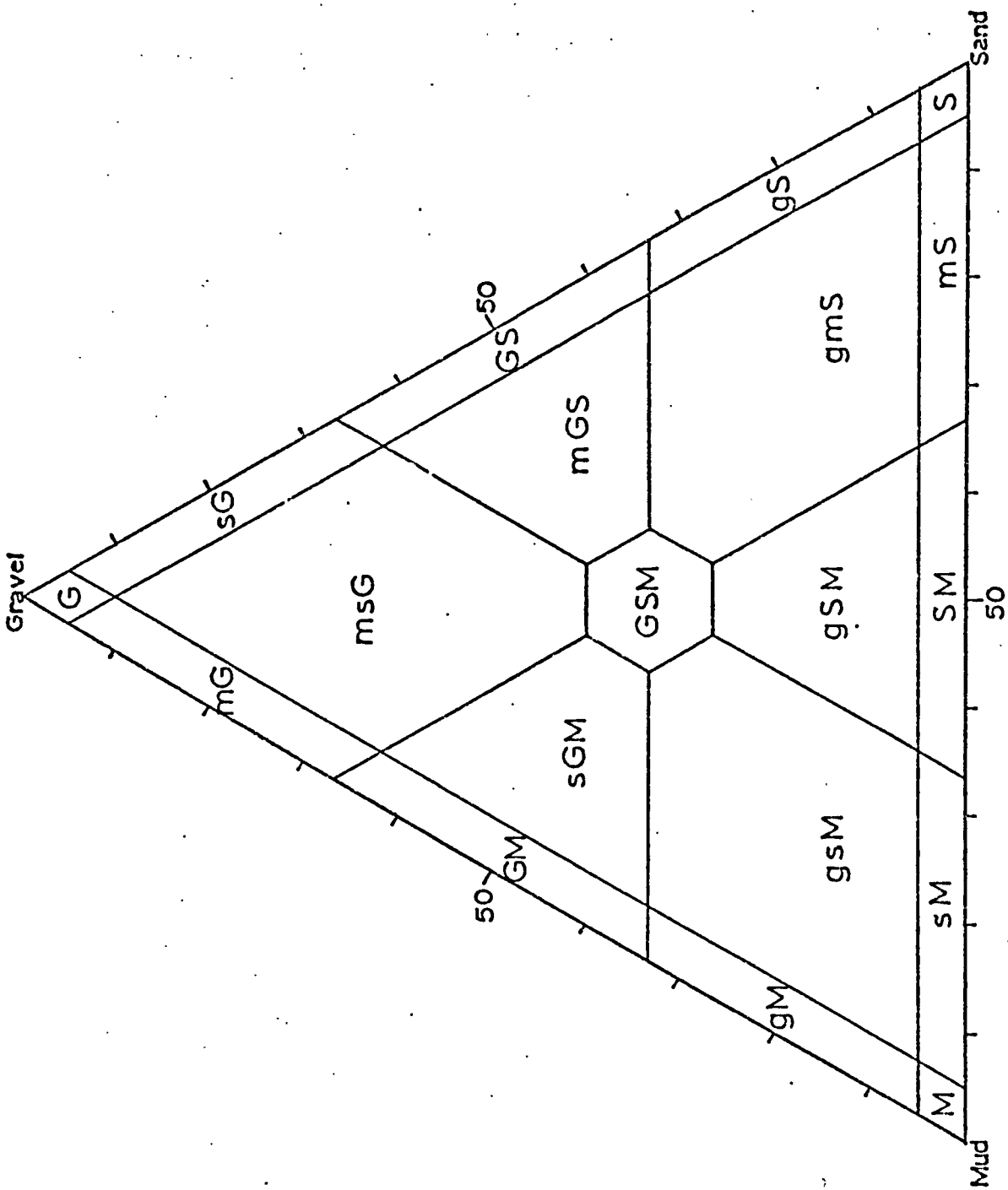
FIGURE 4.2 NOMENCLATURE OF GRAVEL - SAND - MUD AND SAND - SILT - CLAY MIXTURES

Legend of gravel-sand-mud triangle :-

G - Gravel
S - Sand
M - Mud

sG - sandy Gravel
GS - Gravel-Sand
gS - gravelly Sand
mG - muddy Gravel
GM - Gravel-Mud
gM - gravelly Mud
mS - muddy Sand
SM - Sand-Mud
sM - sandy Mud

msG - muddy sandy Gravel
mGS - muddy Gravel-Sand
gmS - gravelly muddy Sand
gSM - gravelly Sand-Mud
gsM - gravelly sandy Mud
sGM - sandy Gravel-Mud
GSM - Gravel-Sand-Mud


Gravel
Sand
Mud
G
sG
mG
GS
gS
mS
S
mGS
gmS
msG
GSM
gSM
SM
sGM
gsM
sM
GM
gM
M
50
50

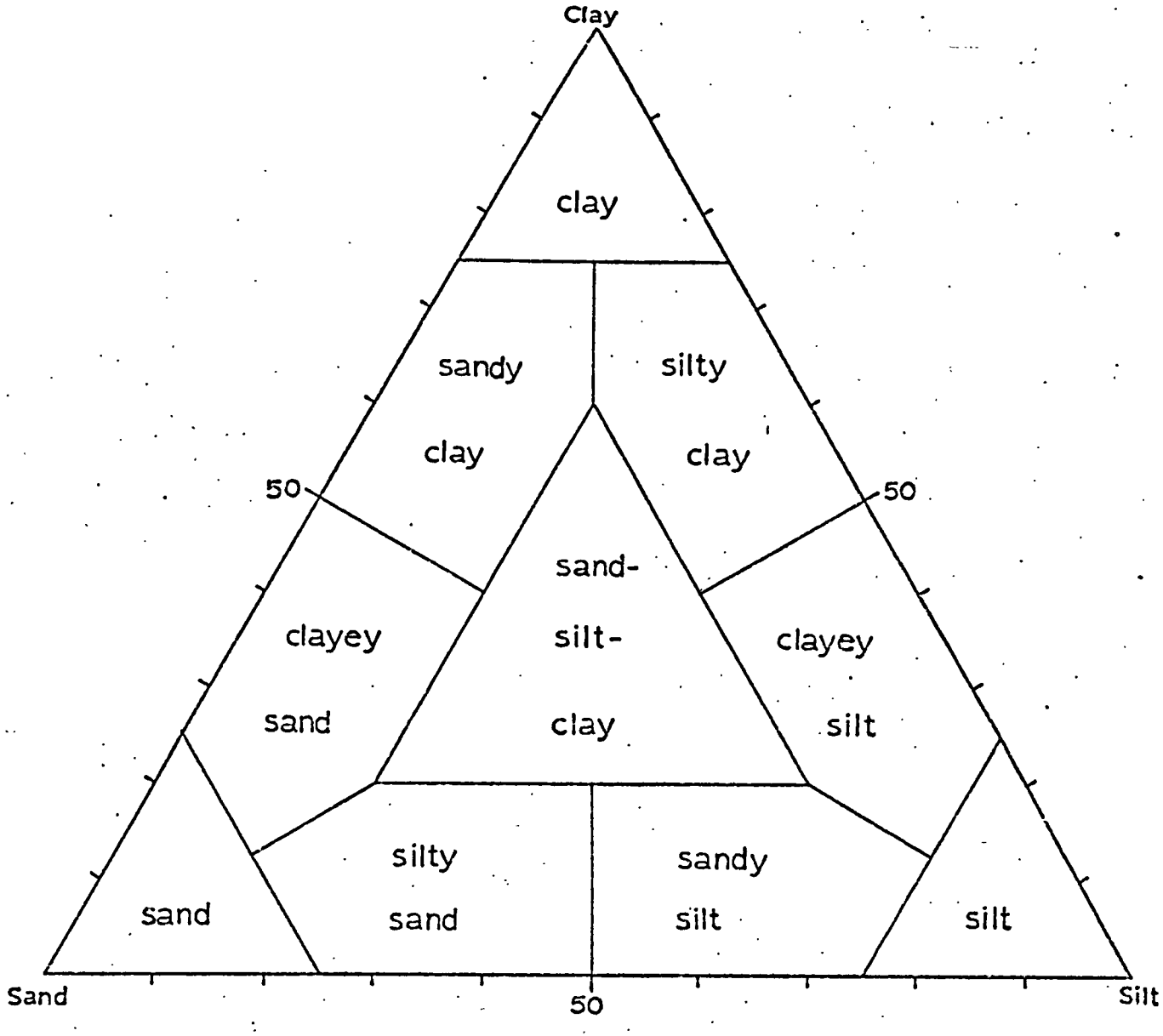

Clay
clay
sandy
clay
silty
clay
50
50
clayey
sand
sand-
silt-
clay
clayey
silt
sand
silty
sand
sandy
silt
silt
Sand
50
Silt

FIG. 4.3 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE

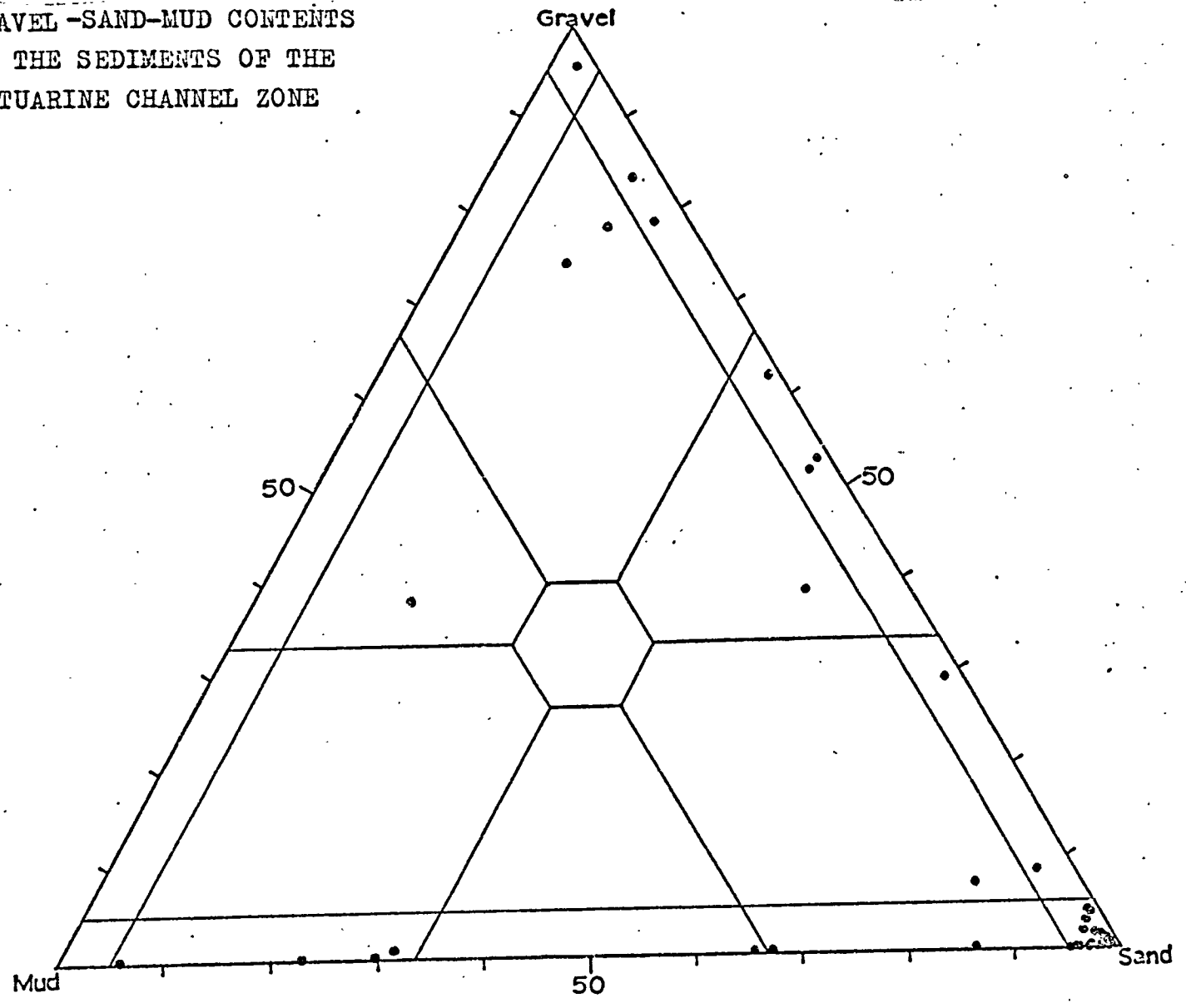
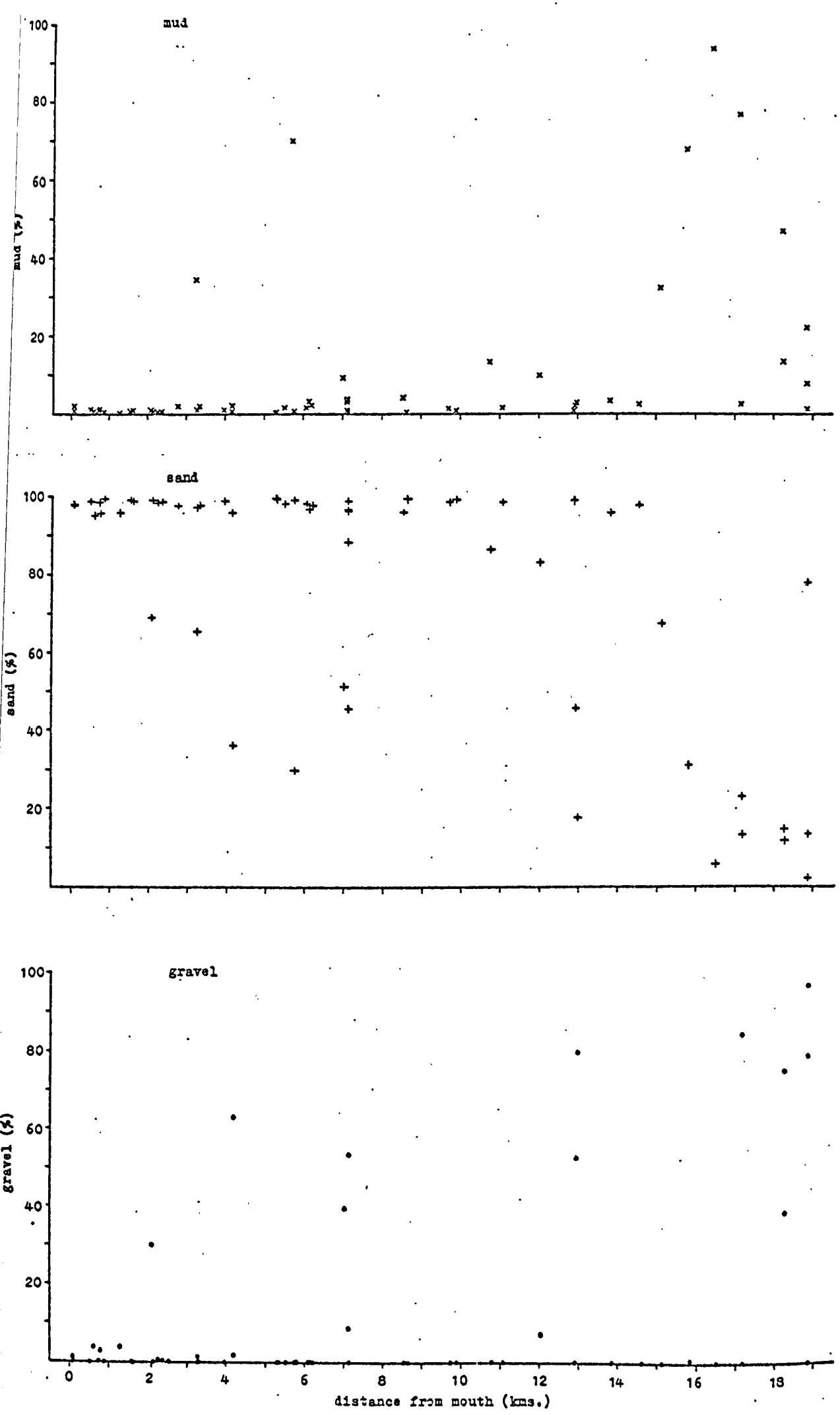


FIGURE 4.4 LONGITUDINAL VARIATION IN GRAVEL, SAND AND MUD CONTENTS OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE


mud
mud (%)
100
80
60
40
20
sand
sand (%)
100
80
60
40
20
gravel
gravel (%)
100
80
60
40
20
0
2
4
6
8
10
12
14
16
18
distance from mouth (kms.)

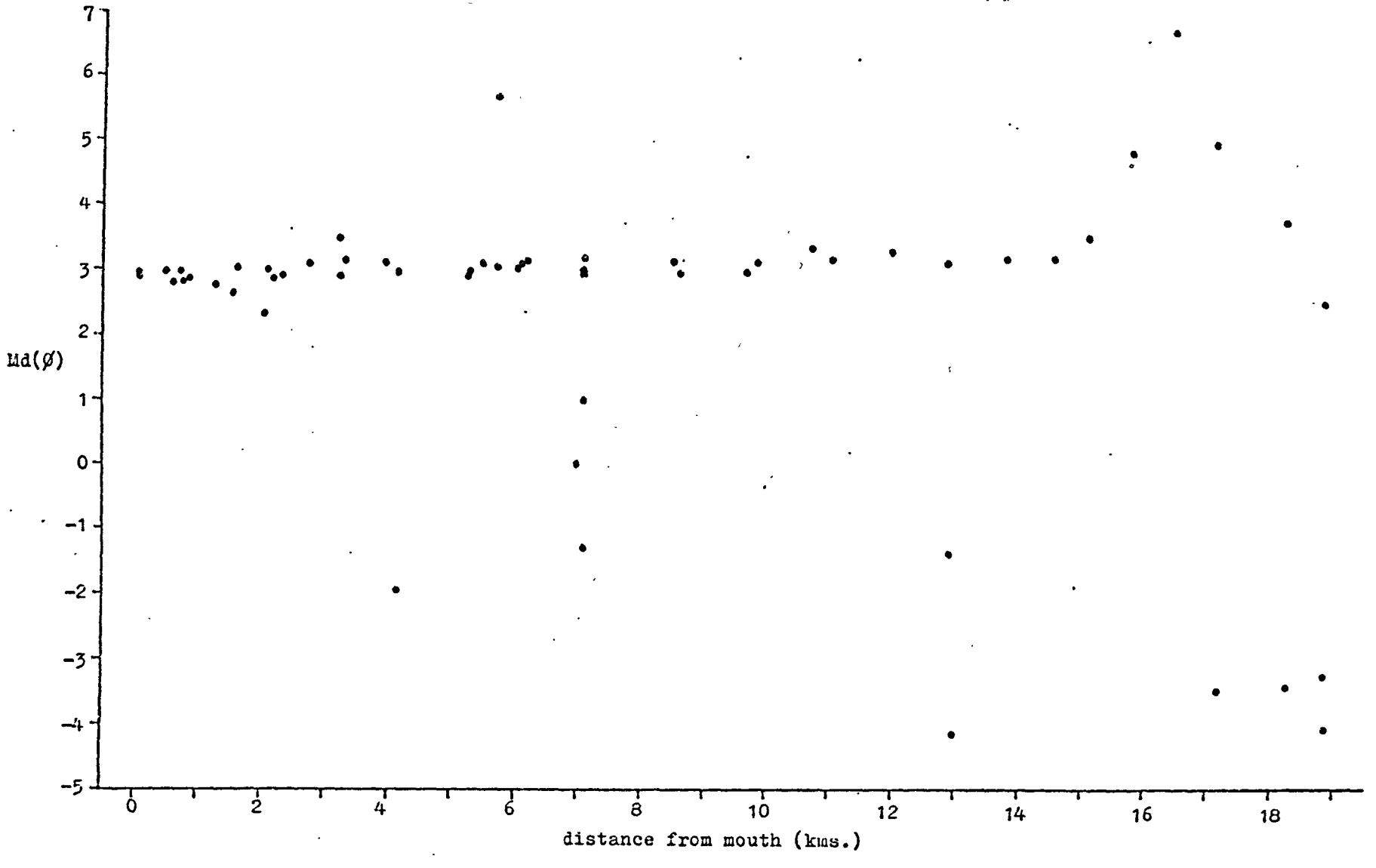
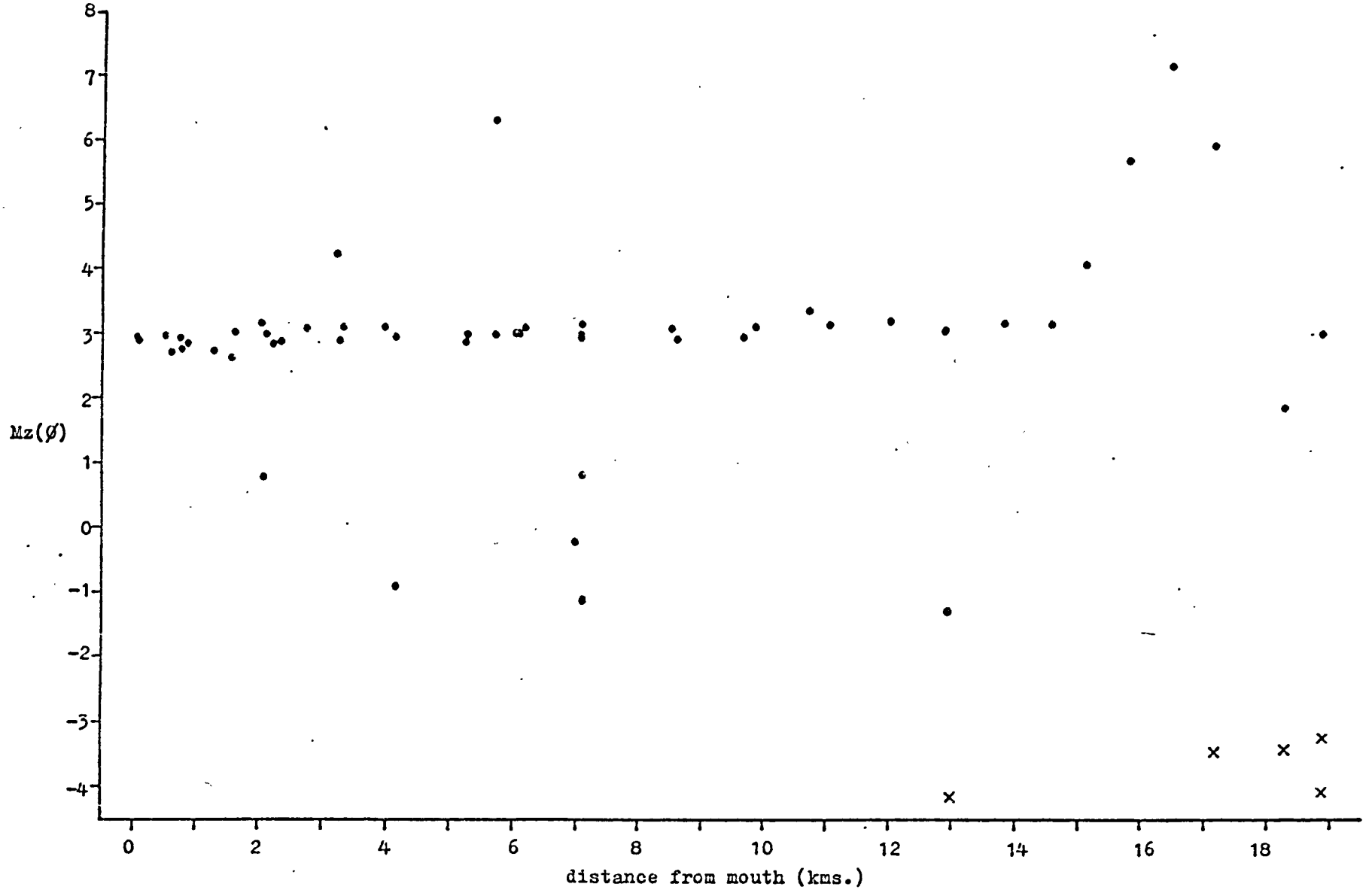
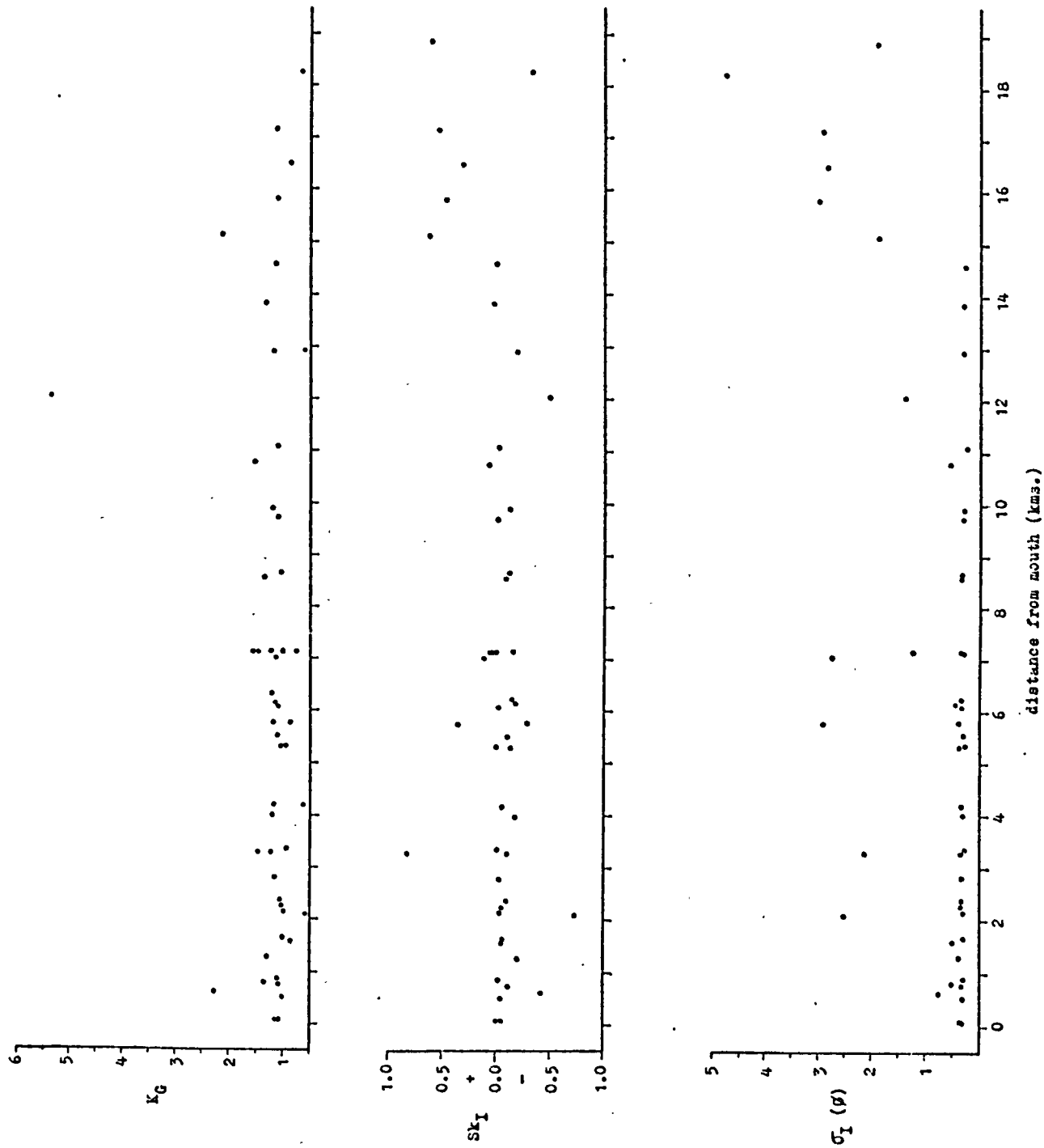


FIGURE 4.5 LONGITUDINAL VARIATION IN THE MEDIAN DIAMETER OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE



- FIGURE 4.6 LONGITUDINAL VARIATION IN THE MEAN DIAMETER OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE
(X - MEDIAN GRAIN SIZE OF GRAVELS)

FIGURE 4.7 LONGITUDINAL VARIATION IN SORTING, SKEWNESS AND KURTOSIS OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE


K_G
6
5
4
3
2
1
Sk_I
1.0
0.5
+
0.0
-
0.5
1.0
σ_I (ø)
5
4
3
2
1
0
2
4
6
8
10
12
14
16
18
distance from mouth (kms.)

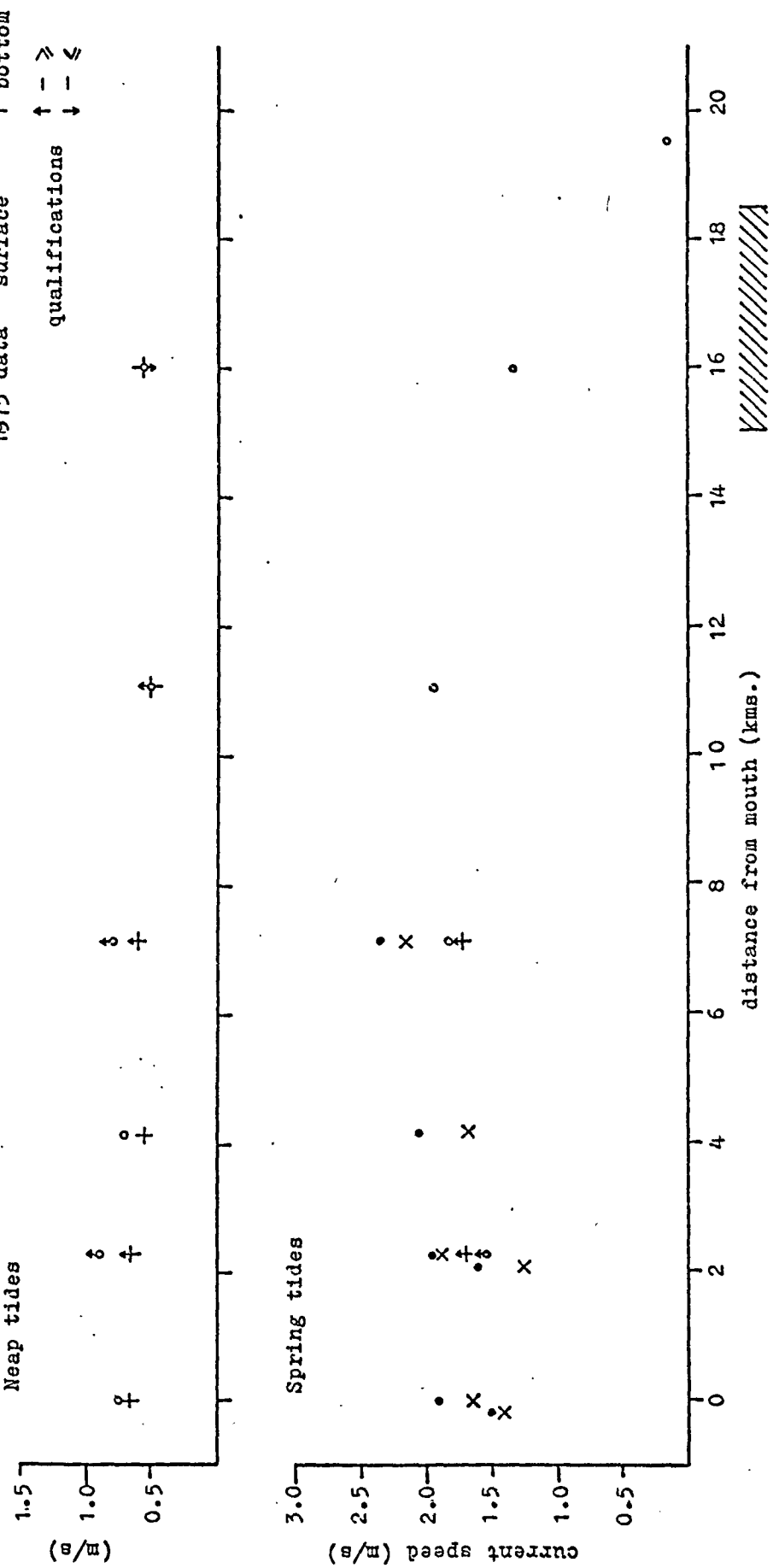


FIGURE 4.8 PLOTS OF MAXIMUM FLOOD CURRENT SPEED ALONG THE ESTUARY FOR SPRING AND NEAP TIDES

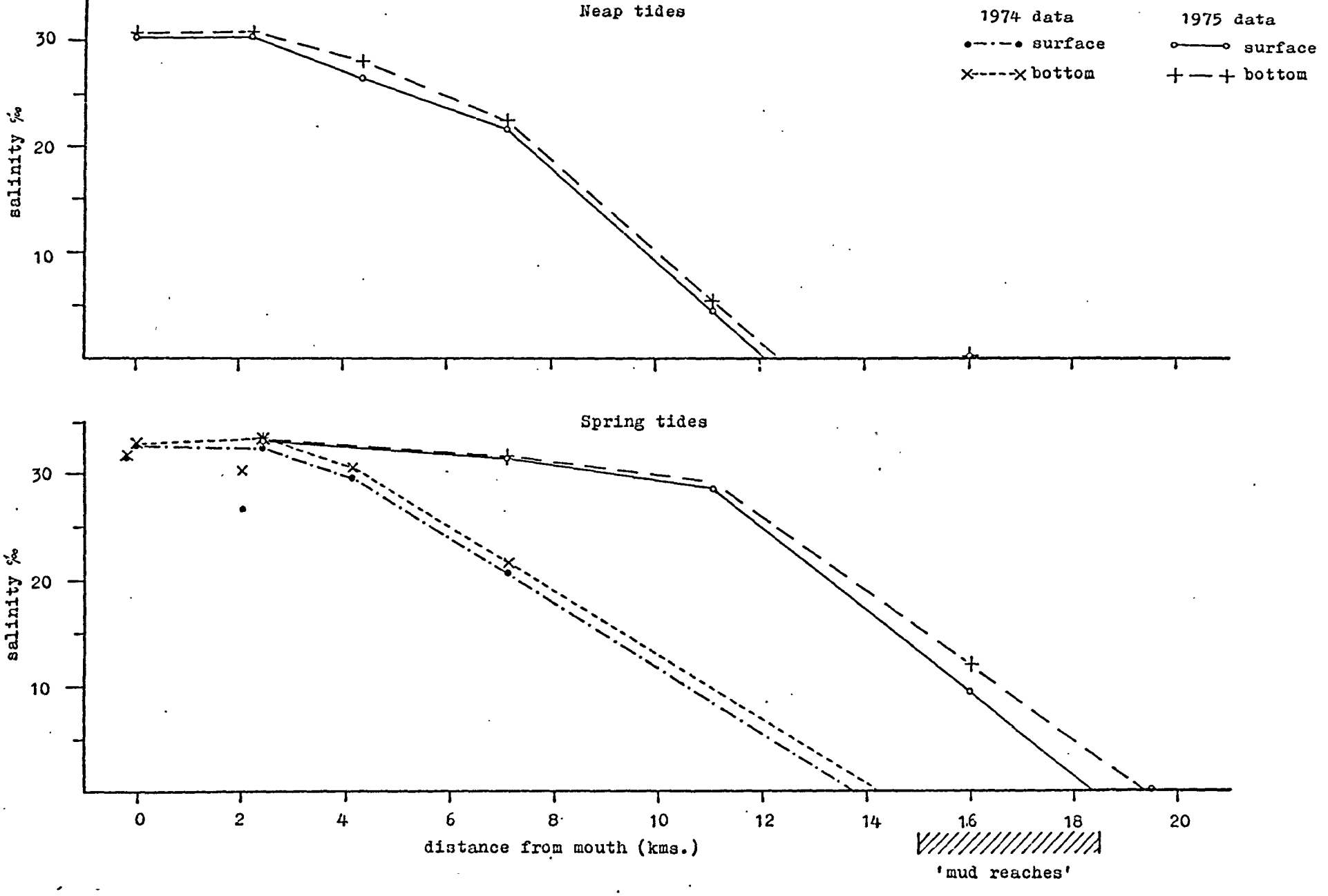


FIGURE 4.9 PLOTS OF MAXIMUM SALINITY ALONG THE ESTUARY FOR SPRING AND NEAP TIDES

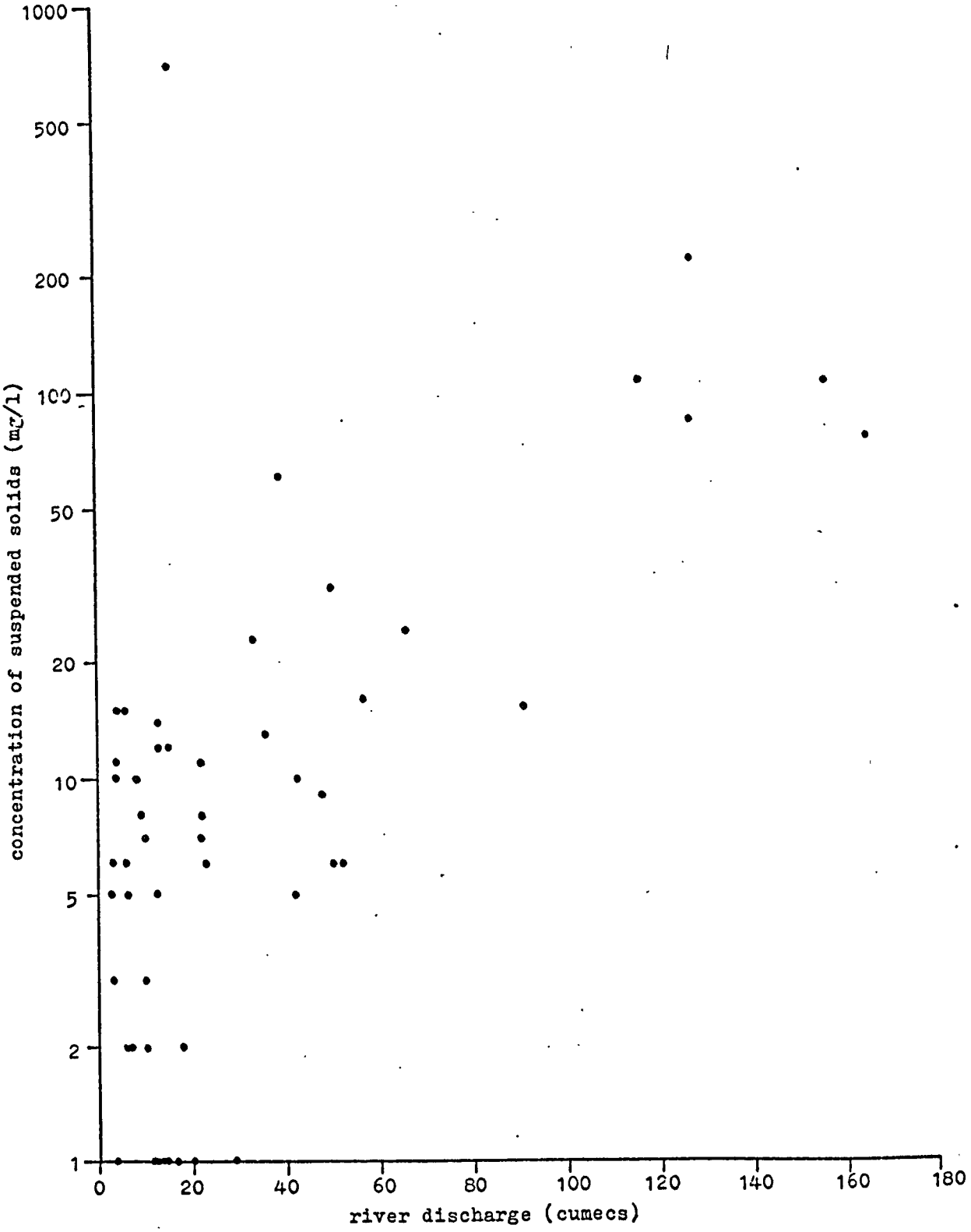


FIGURE 4.10 PLOT OF SUSPENDED SEDIMENT CONCENTRATION WITH RIVER DISCHARGE FOR THE TOWY RIVER (data from W.N.W.D.A.)

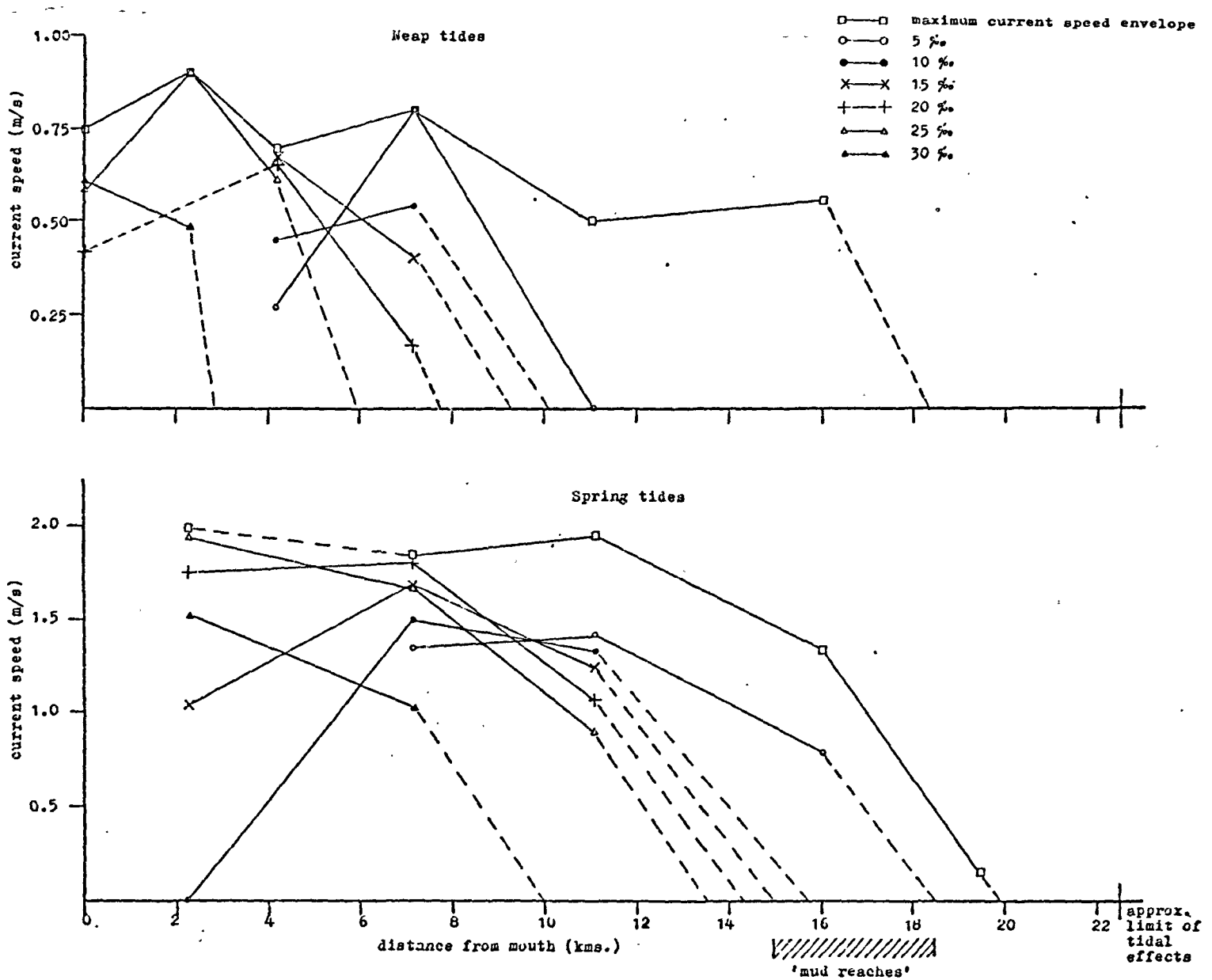
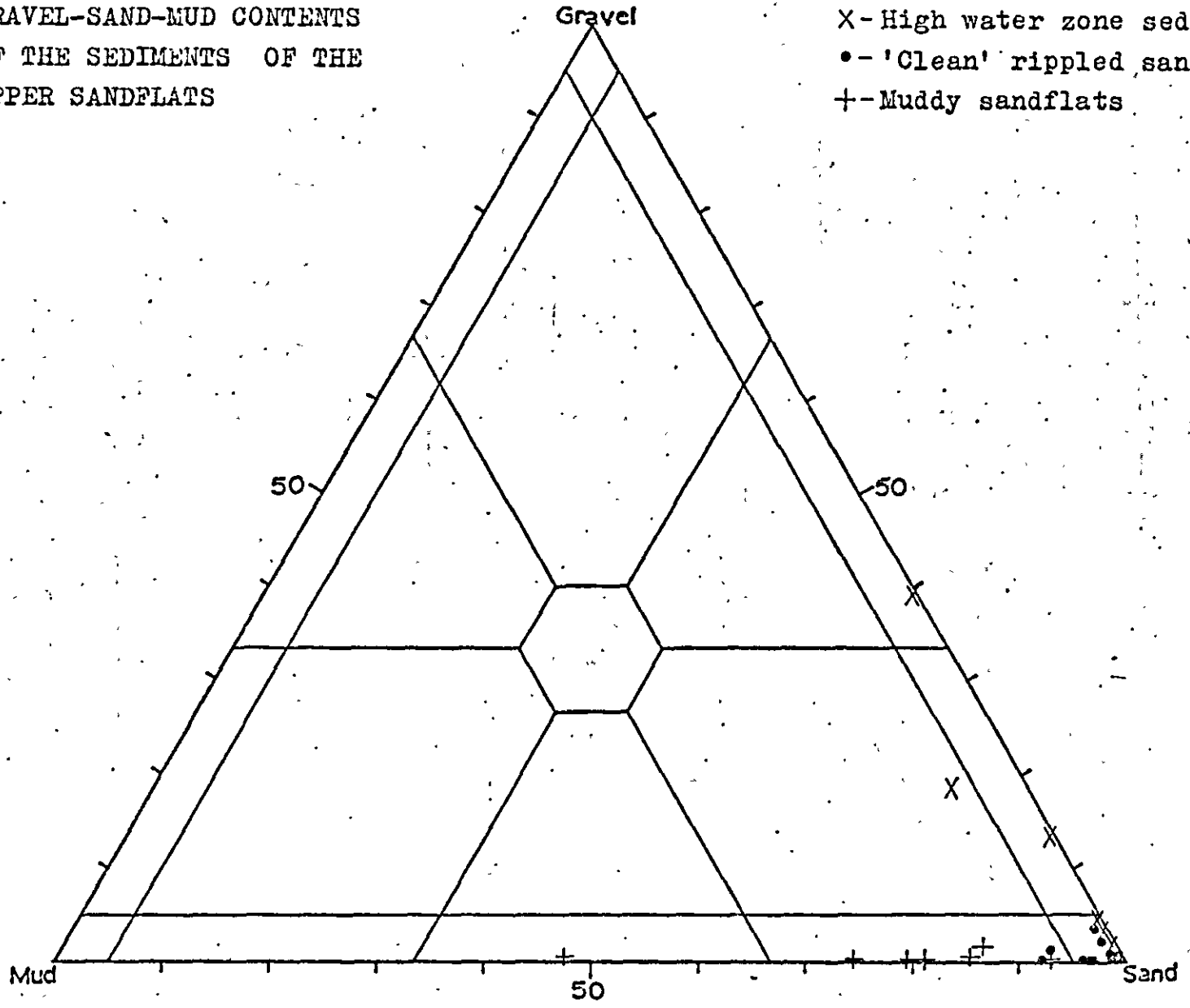


FIGURE 4.11 PLOTS OF MAXIMUM FLOOD CURRENT SPEED FOR VARIOUS SALINITIES ALONG THE ESTUARY FOR NEAP AND SPRING TIDES (all 1975 data and surface current speeds)

FIG.4.12 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE UPPER SANDFLATS



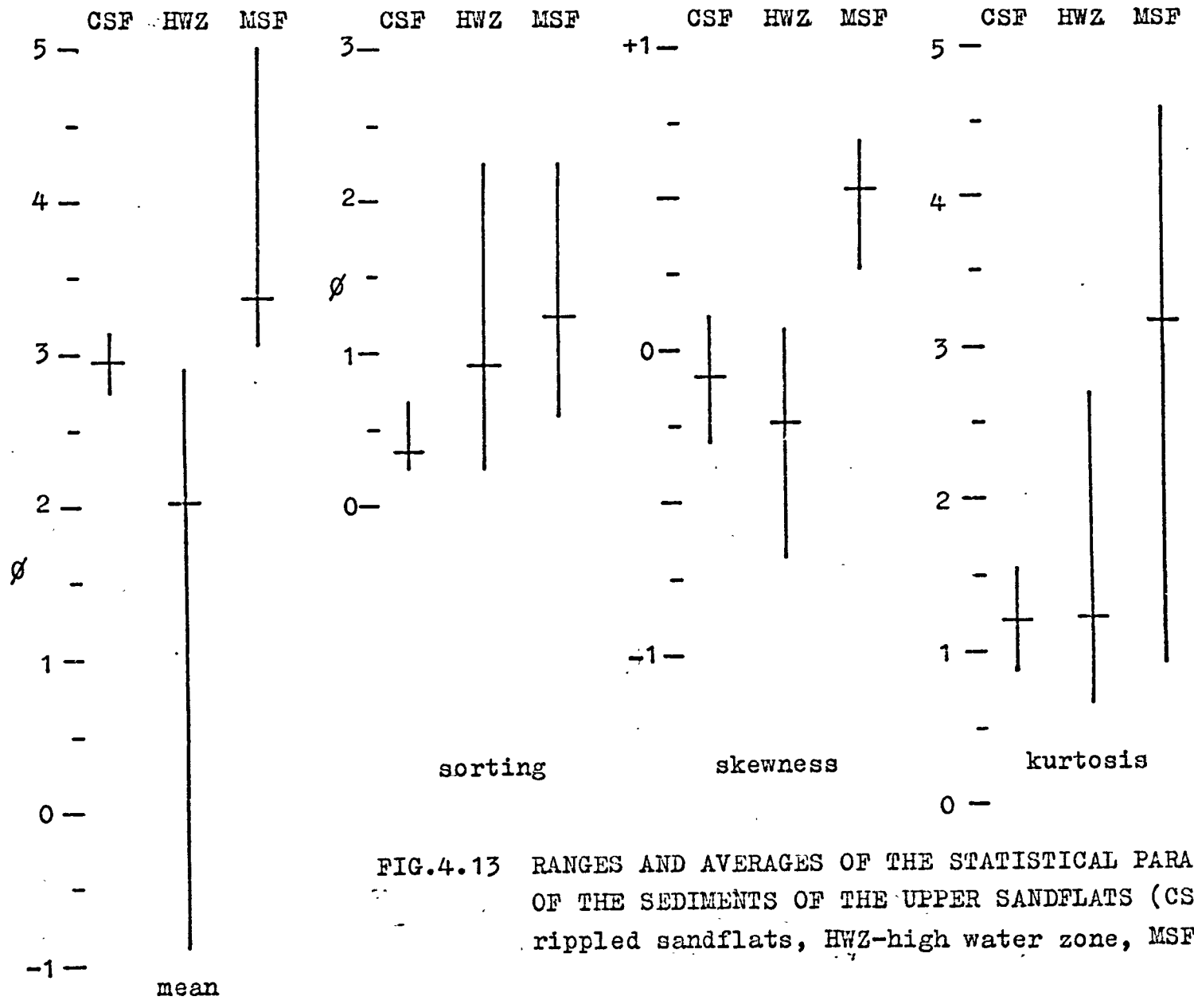
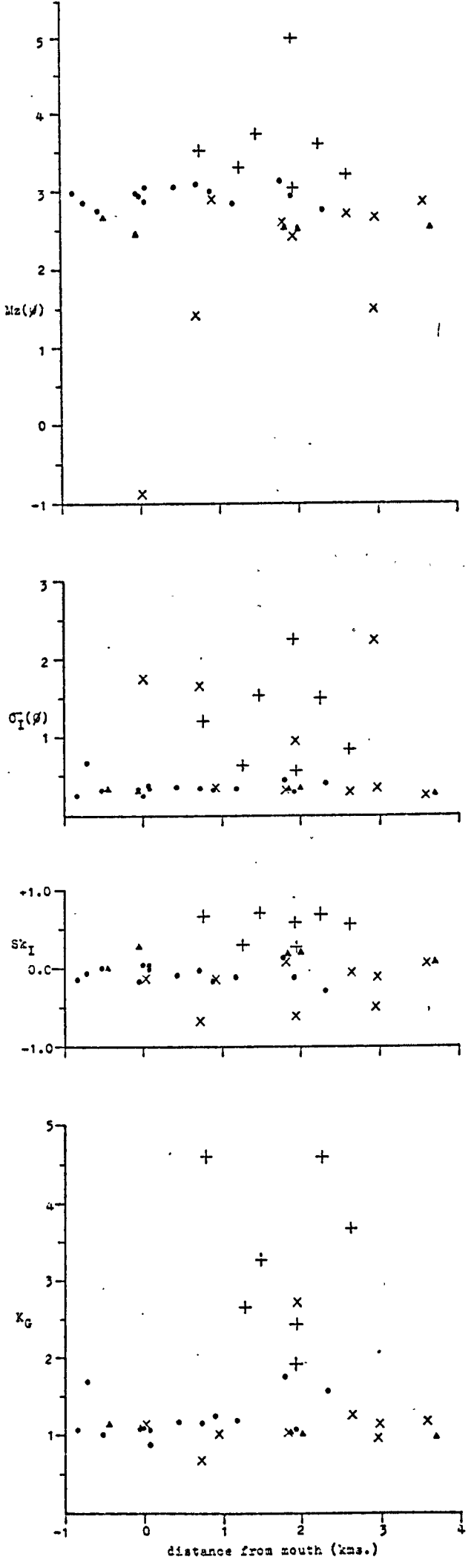


FIG.4.13 RANGES AND AVERAGES OF THE STATISTICAL PARAMETERS OF THE SEDIMENTS OF THE UPPER SANDFLATS (CSF-'clean' rippled sandflats, HWZ-high water zone, MSF-muddy sandflats)

FIGURE 4.14 LONGITUDINAL VARIATION IN THE STATISTICAL PARAMETERS OF THE SEDIMENTS OF THE UPPER SANDFLATS AND DUNES

• - high water zone sediments
X - 'clean' rippled sandflats
+ - muddy sandflats
▲ - dunes


Mz(ϕ)
σI(ϕ)
SkI
KG
distance from mouth (kms.)

FIGURES 4.15-4.18 DISTRIBUTIONS OF THE STATISTICAL PARAMETERS OF THE SEDIMENTS OF THE UPPER SANDFLATS AND DUNES IN THE LOWER ESTUARY

FIGURE 4.15 MEAN GRAIN SIZE
FIGURE 4.16 SORTING
FIGURE 4.17 SKEWNESS
FIGURE 4.18 KURTOSIS

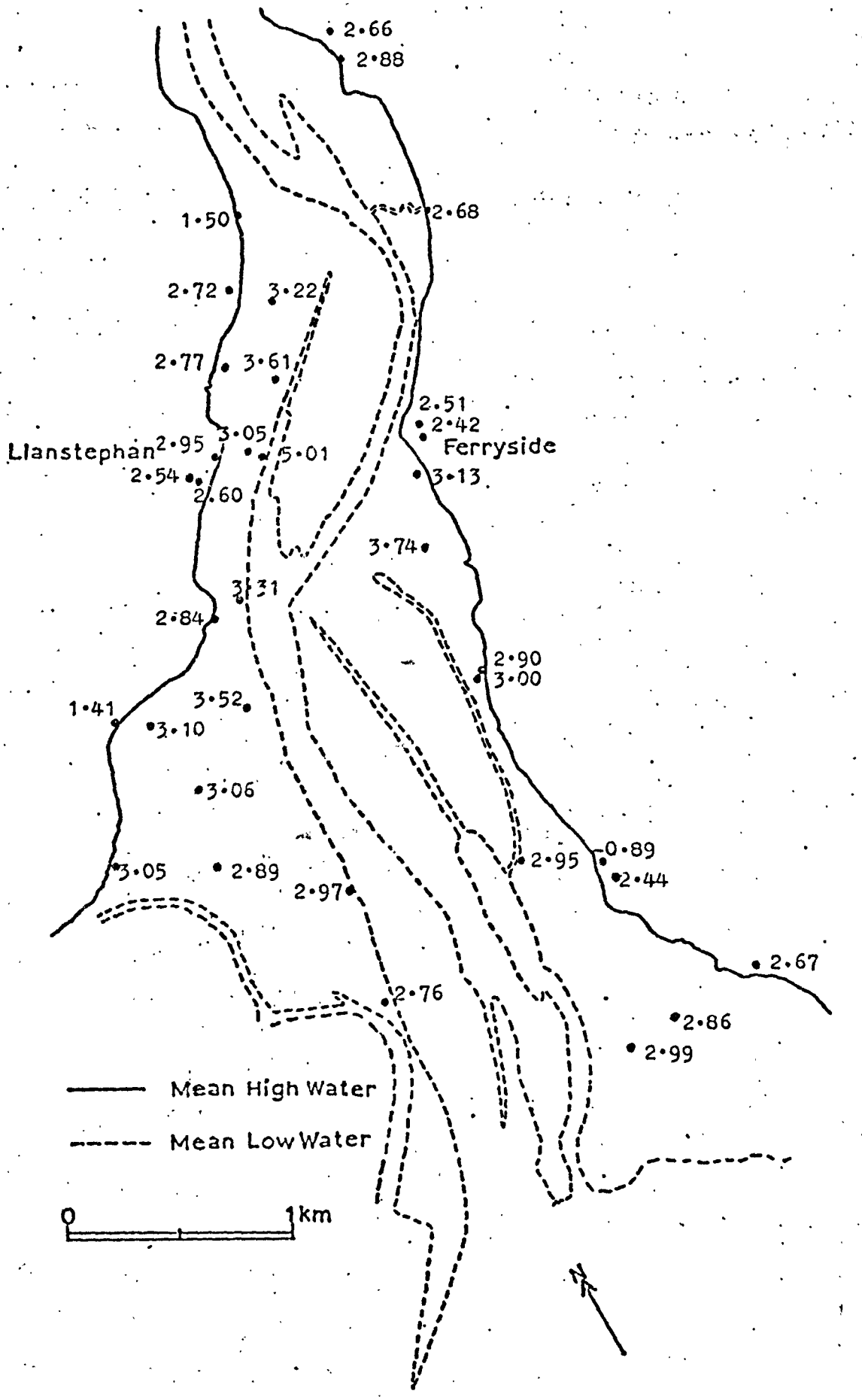


FIG.4.15 MEAN GRAIN SIZE

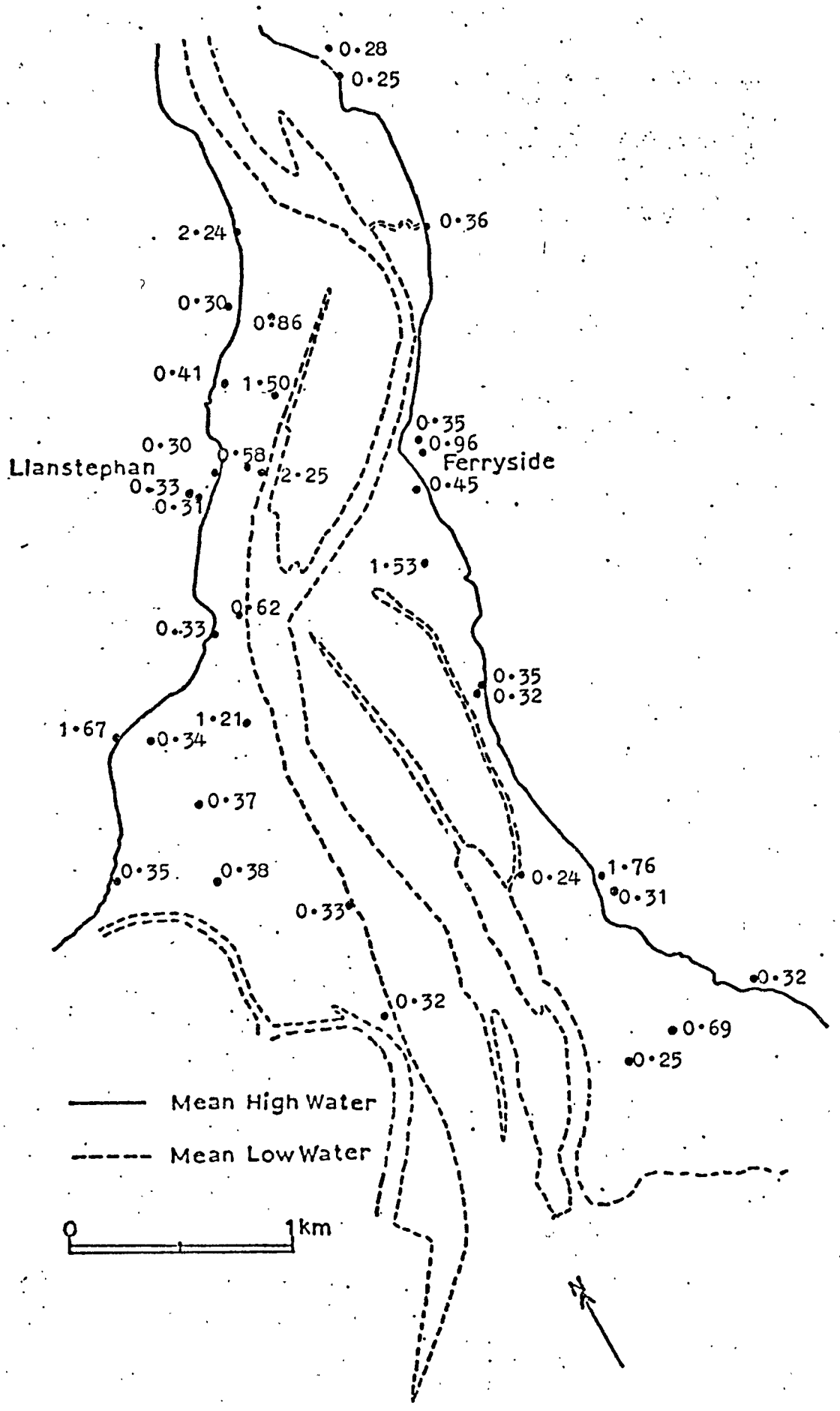


FIG.4.16 SORTING

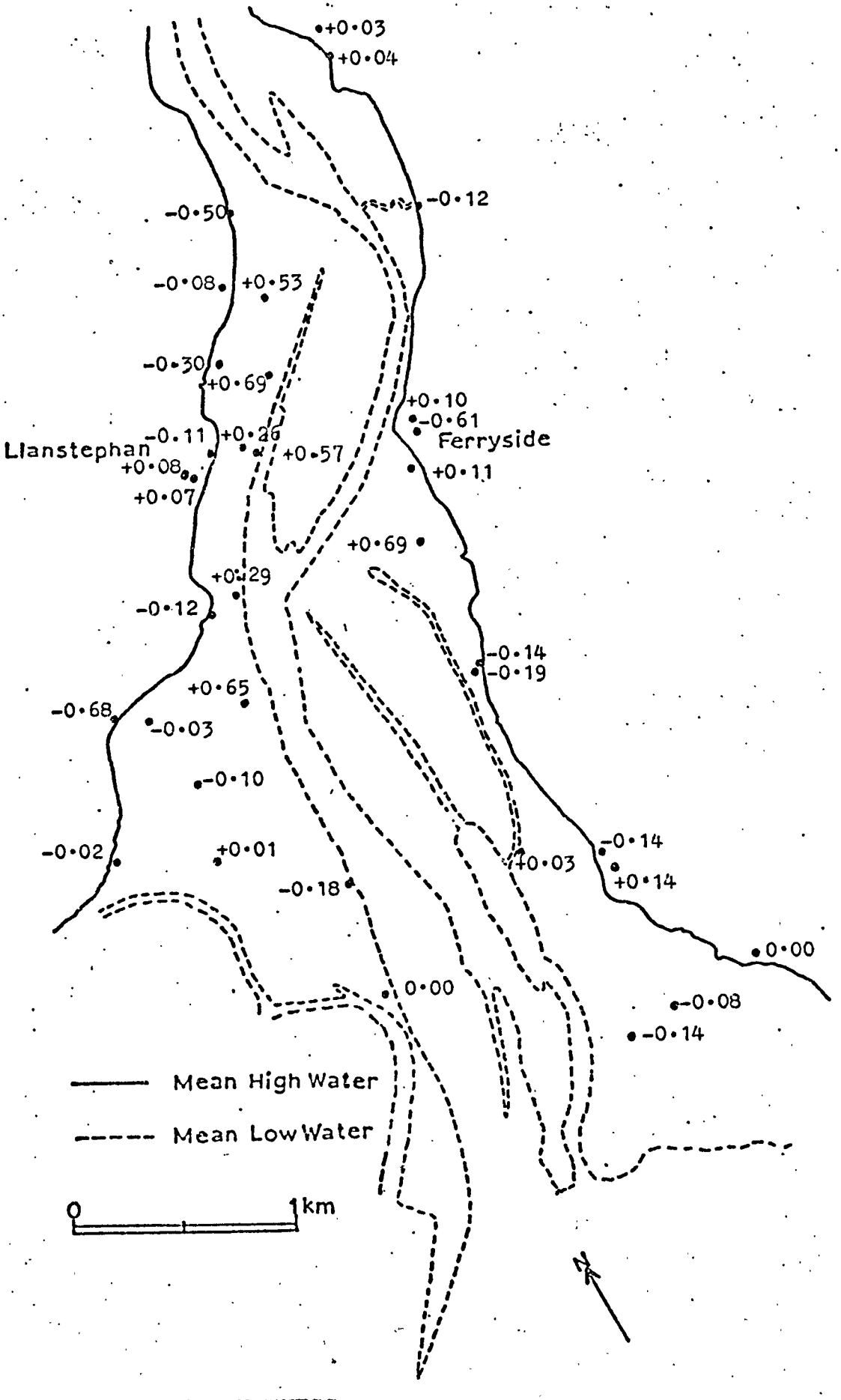


FIG.4.17 SKEWNESS

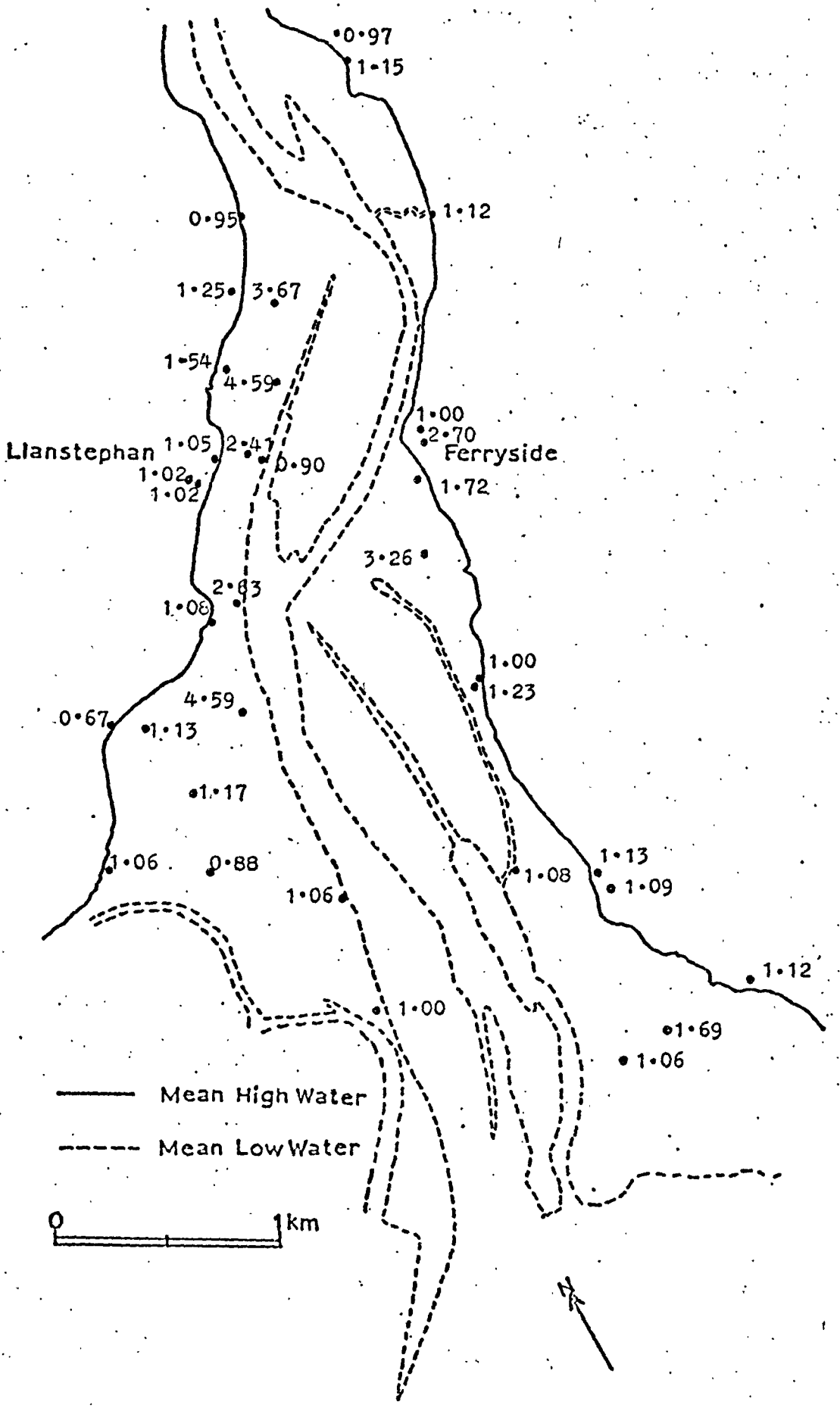


FIG.4.18 KURTOSIS

FIG.4..19 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE DUNES

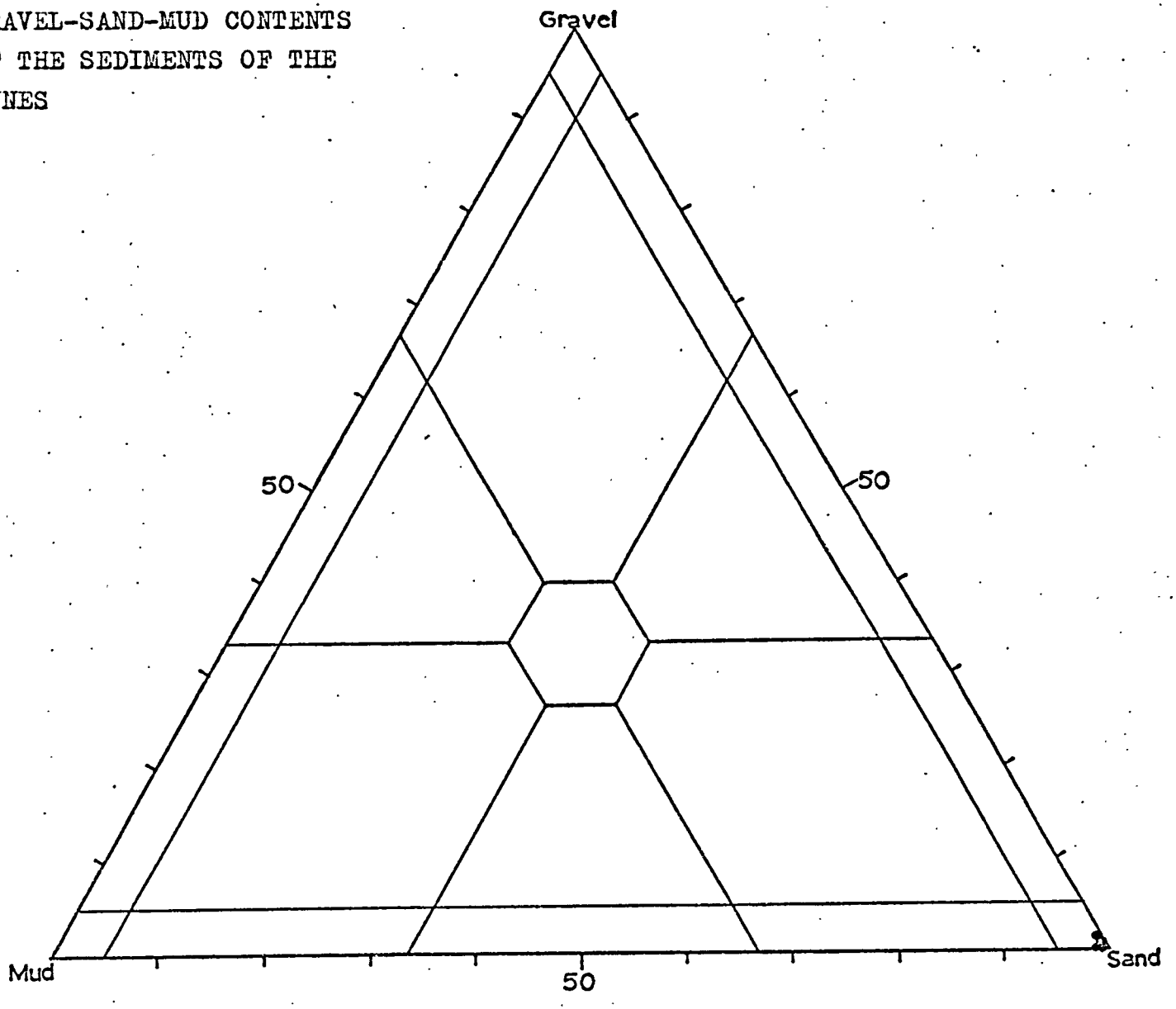


FIG.4.20 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE MUDFLATS

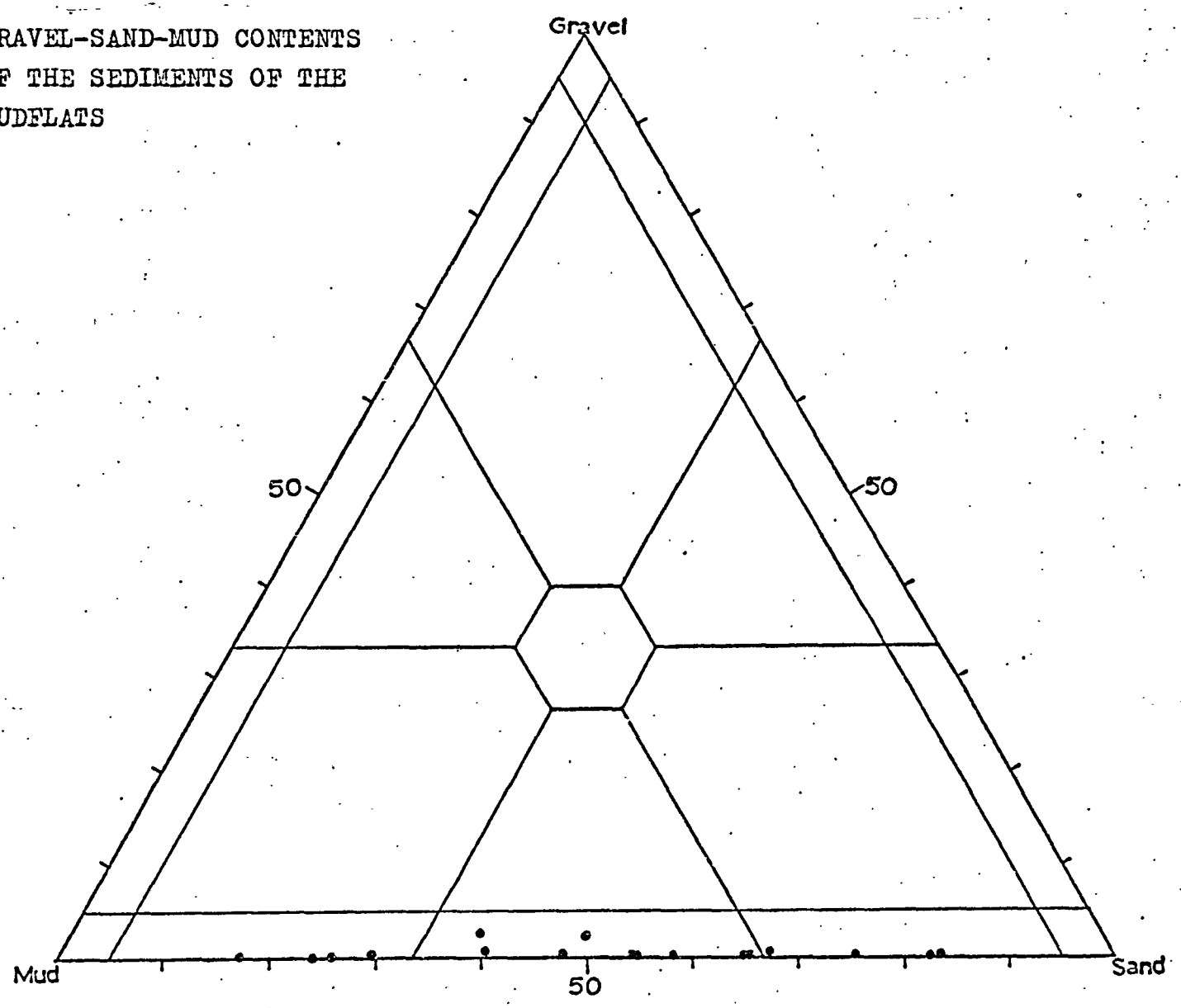
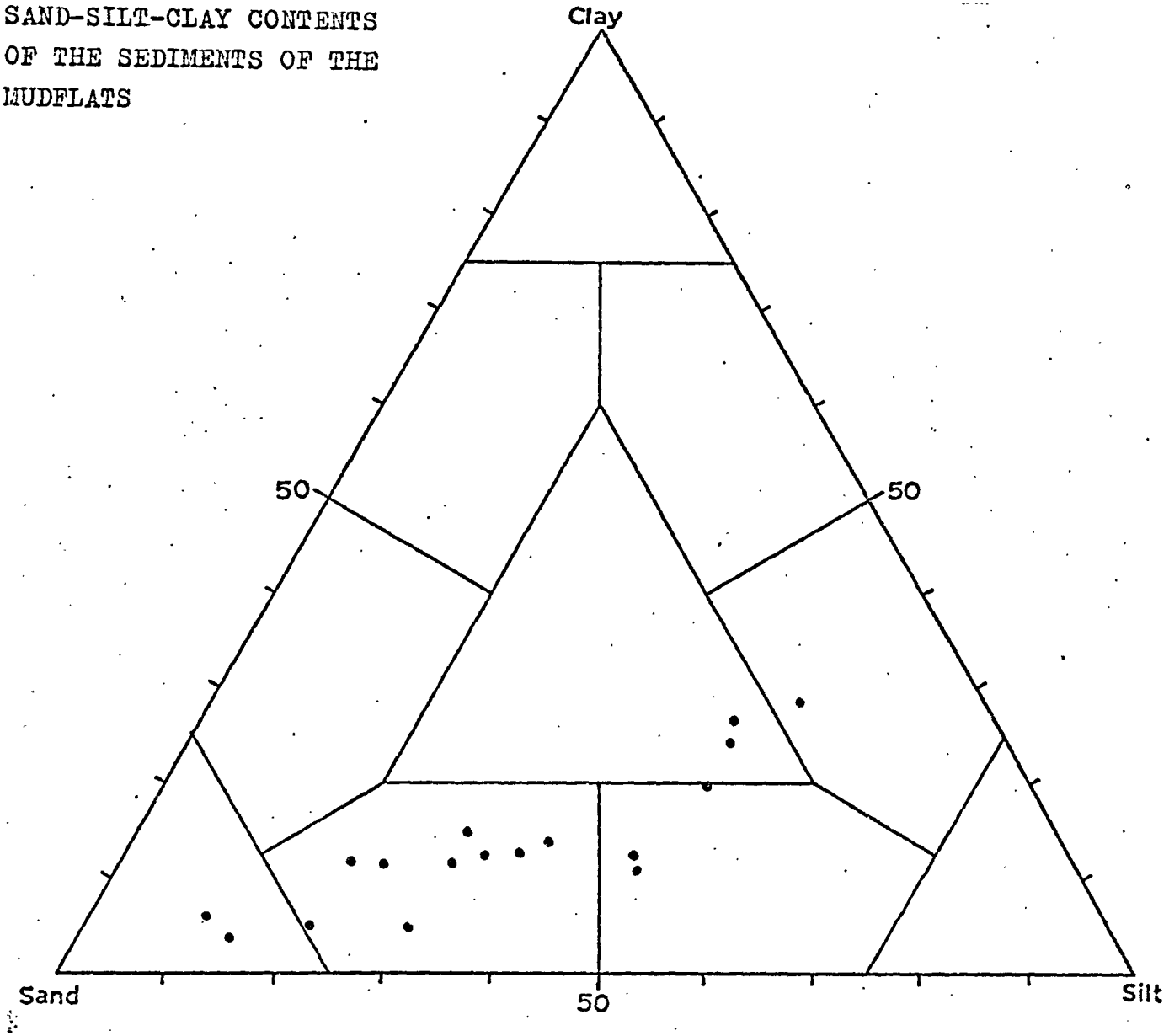


FIG.4.21 SAND-SILT-CLAY CONTENTS OF THE SEDIMENTS OF THE MUDFLATS



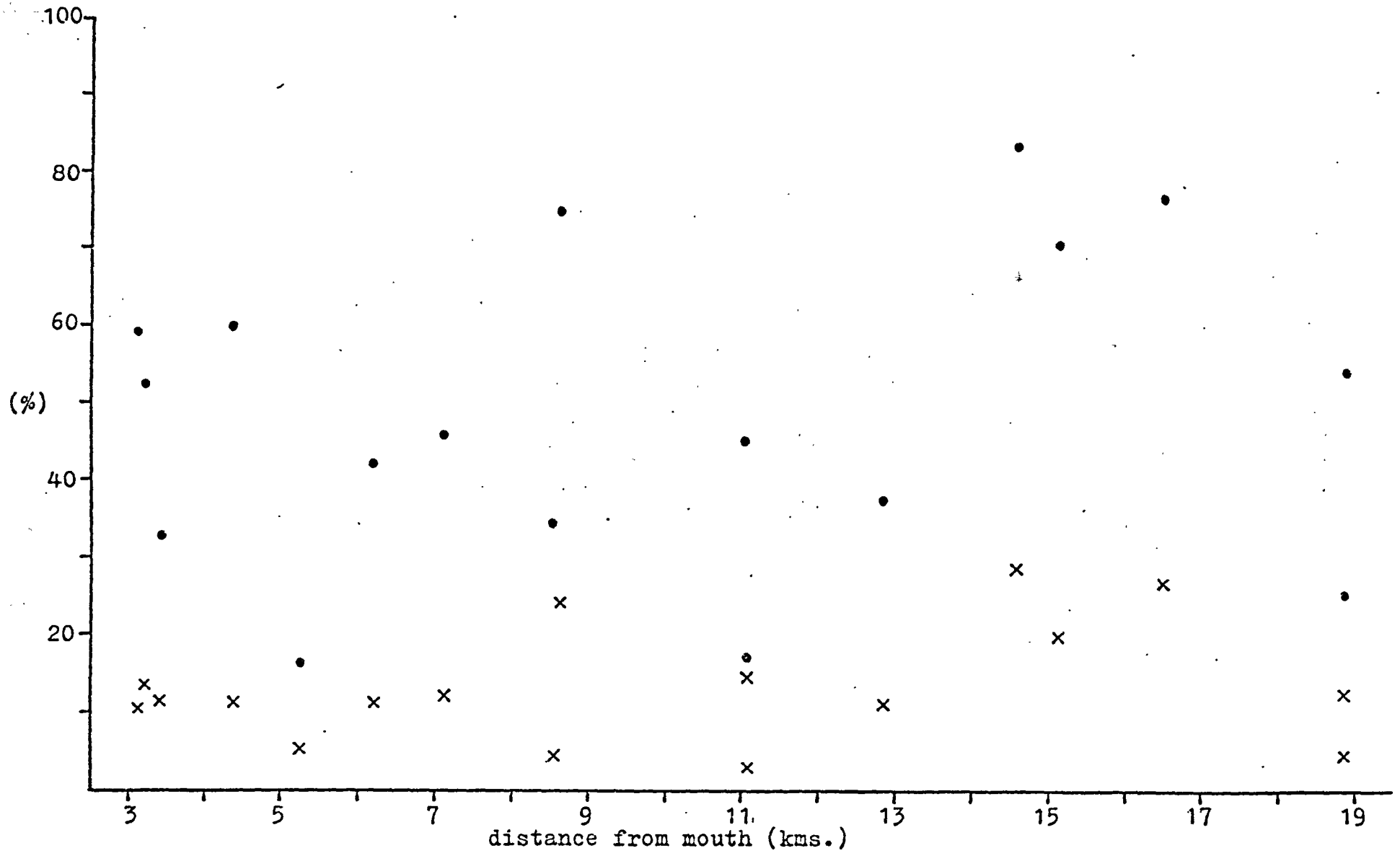


FIGURE 4.22 LONGITUDINAL VARIATION IN THE MUD (•) AND CLAY (×) CONTENTS OF THE *SEDIMENTS OF THE MUDFLATS*

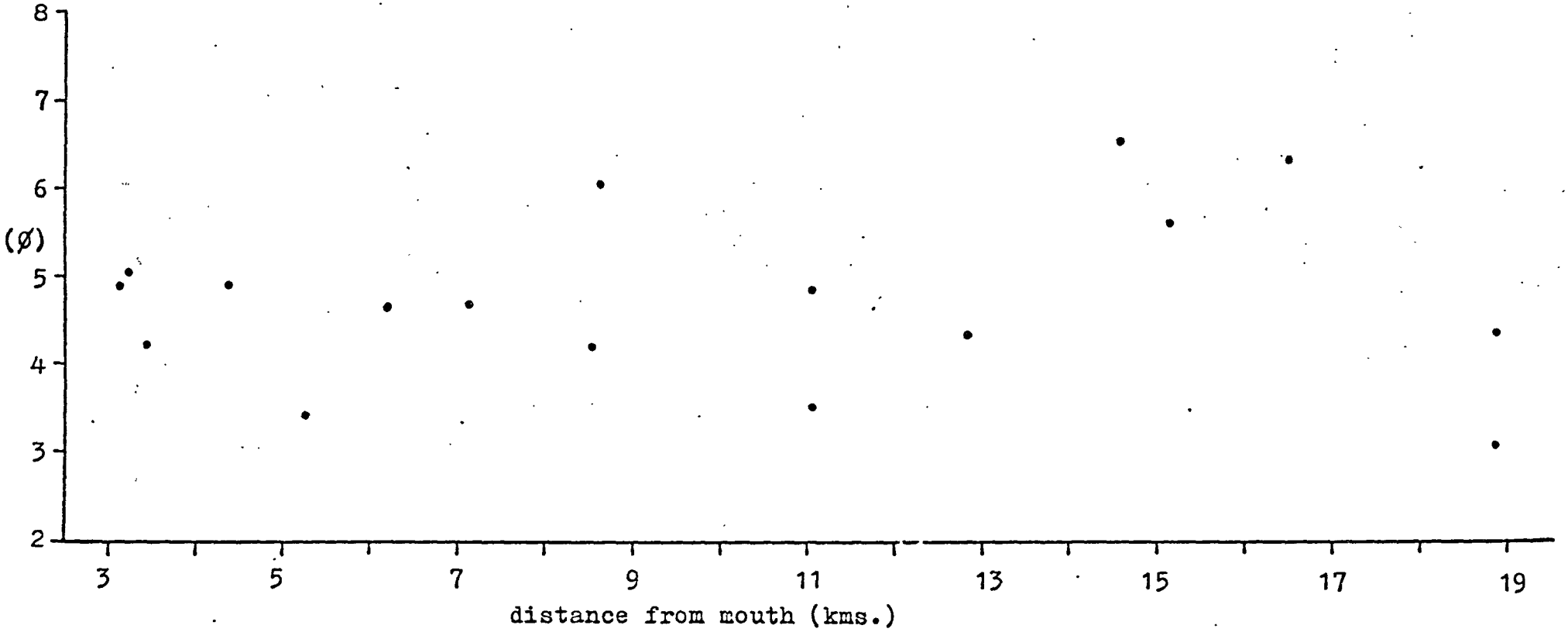


FIGURE 4.23 LONGITUDINAL VARIATION IN THE MEAN GRAIN SIZE OF THE SEDIMENTS OF THE MUDFLATS

FIGURE 4.24 LONGITUDINAL VARIATION IN SORTING, SKEWNESS AND KURTOSIS OF THE SEDIMENTS OF THE MUDFLATS

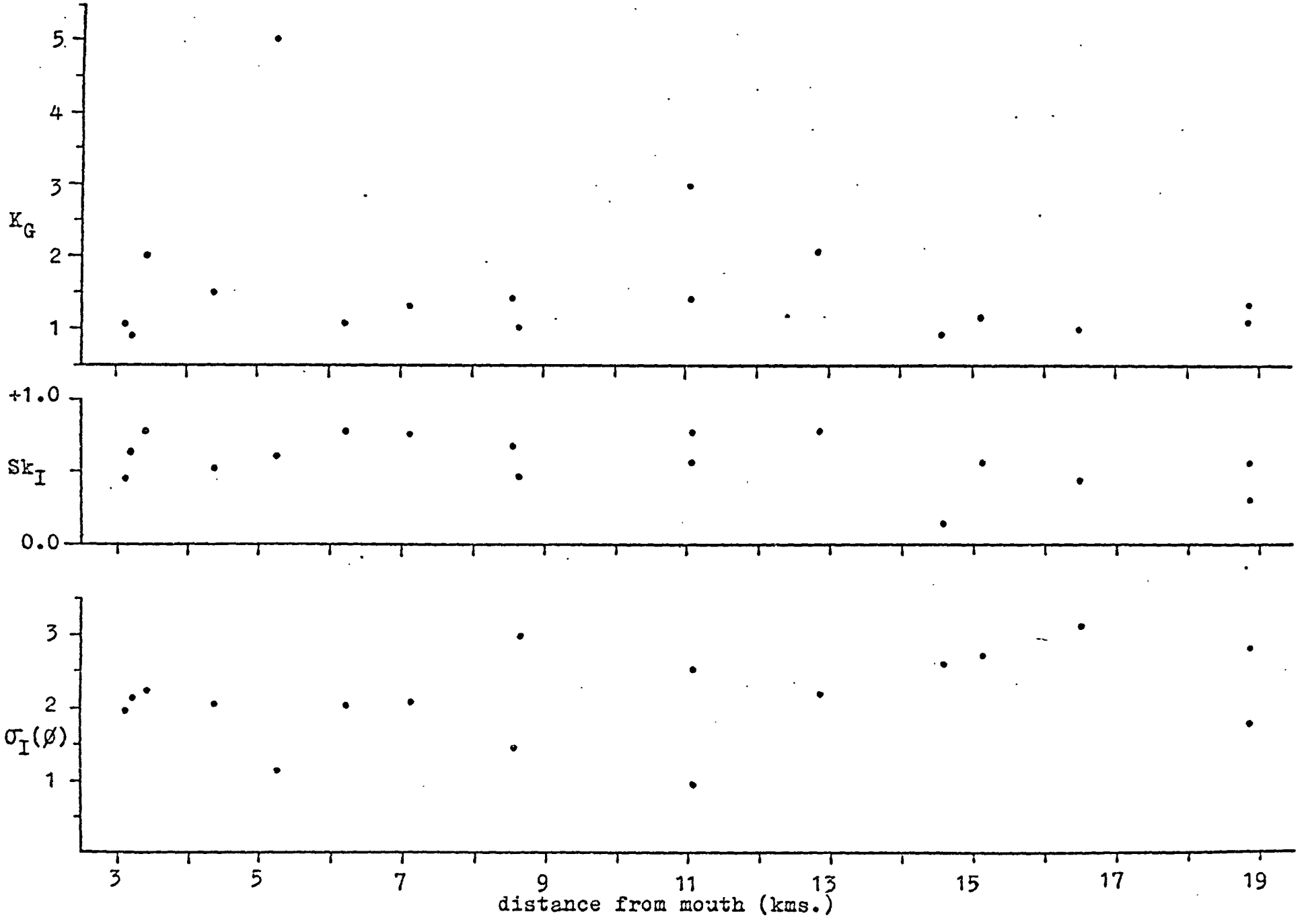

5
4
3
K_G
2
1
+1.0
Sk_I
0.0
3
2
$\sigma_I(\phi)$
1
3
5
7
9
11
13
15
17
19
distance from mouth (kms.)

FIG.4.25 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE SALT MARSHES

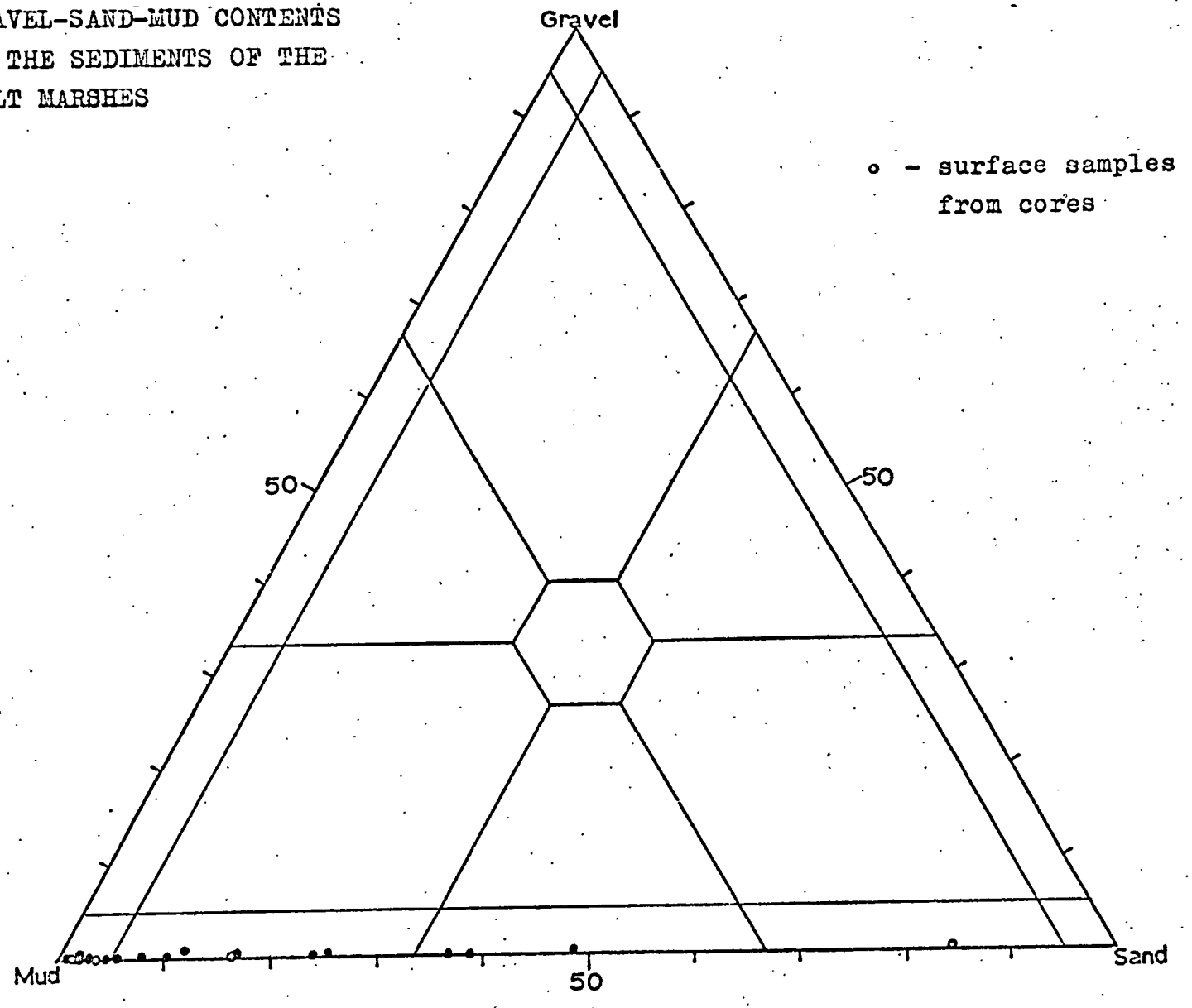
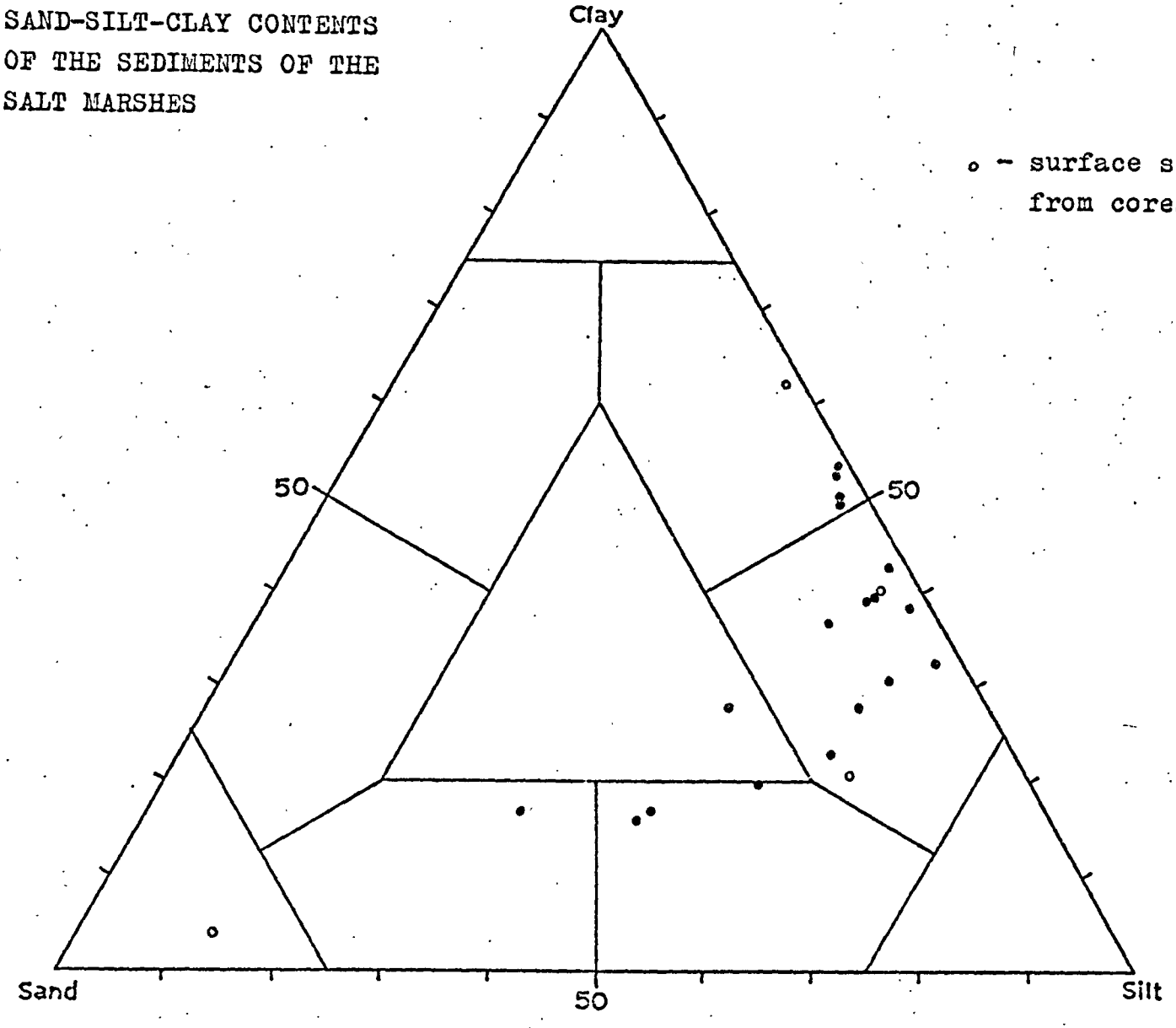


FIG.4.26 SAND-SILT-CLAY CONTENTS OF THE SEDIMENTS OF THE SALT MARSHES



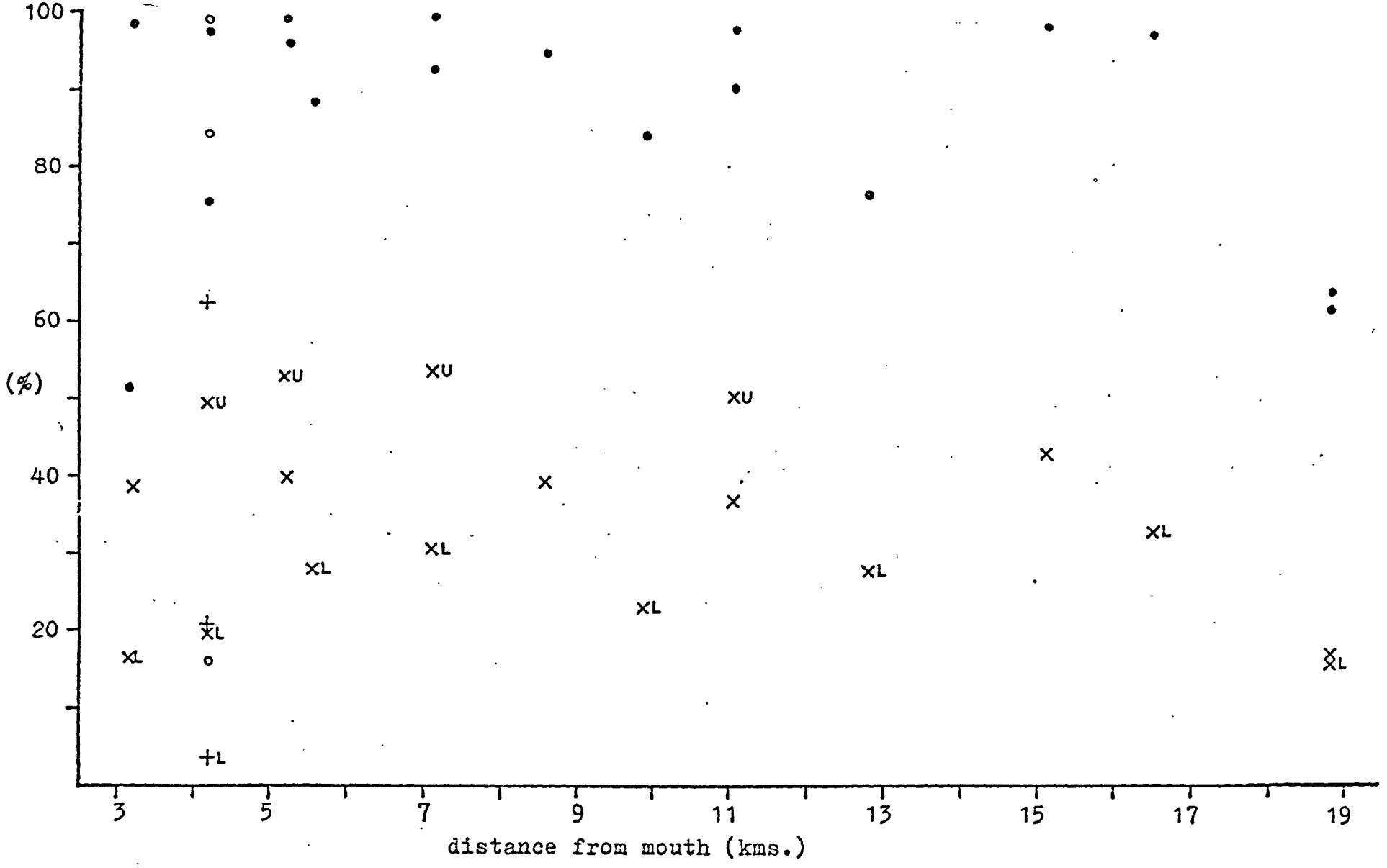


FIGURE 4.27 LONGITUDINAL VARIATION IN THE MUD (•) AND CLAY (X) CONTENTS OF THE SEDIMENTS OF THE SALT MARSHES (o,+ = core samples) (U = upper, L = lower - see text)

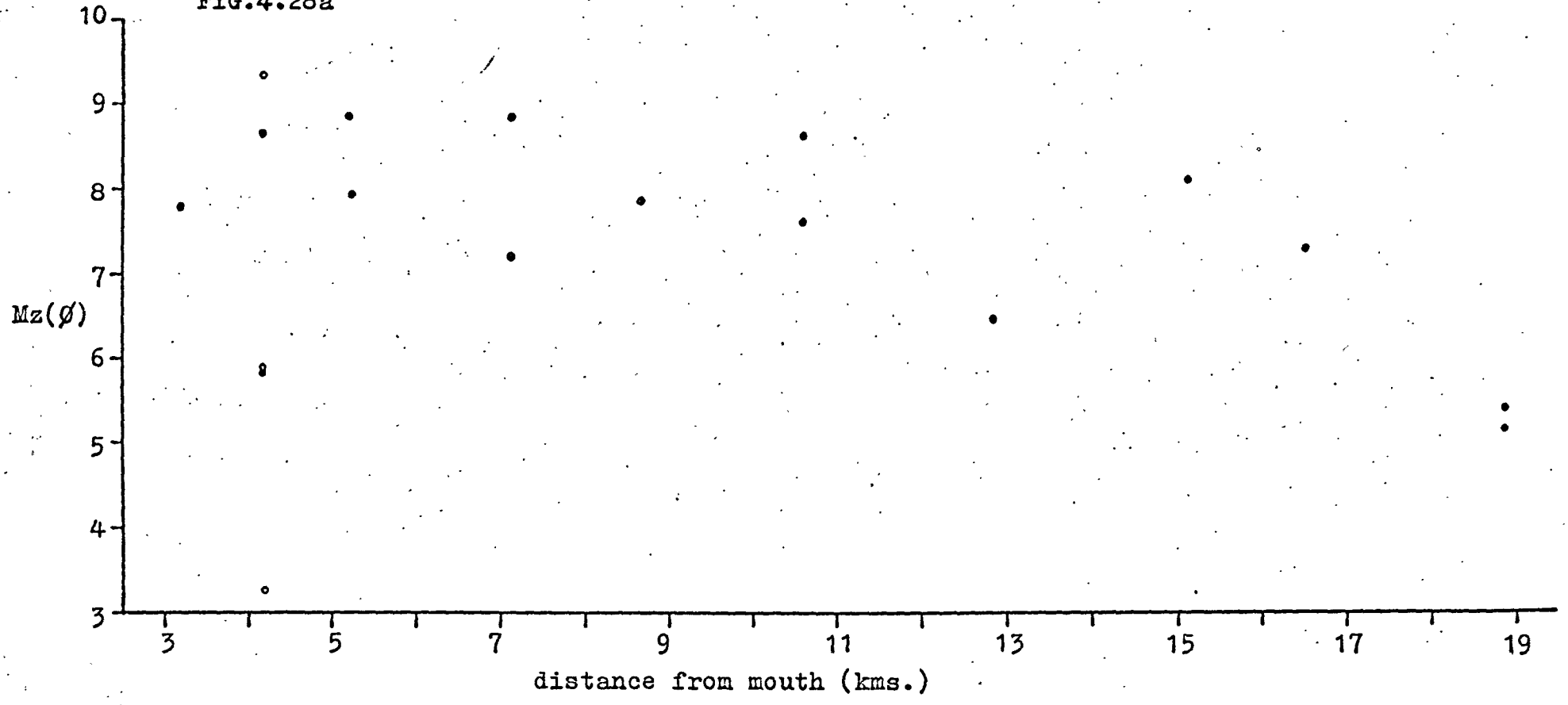
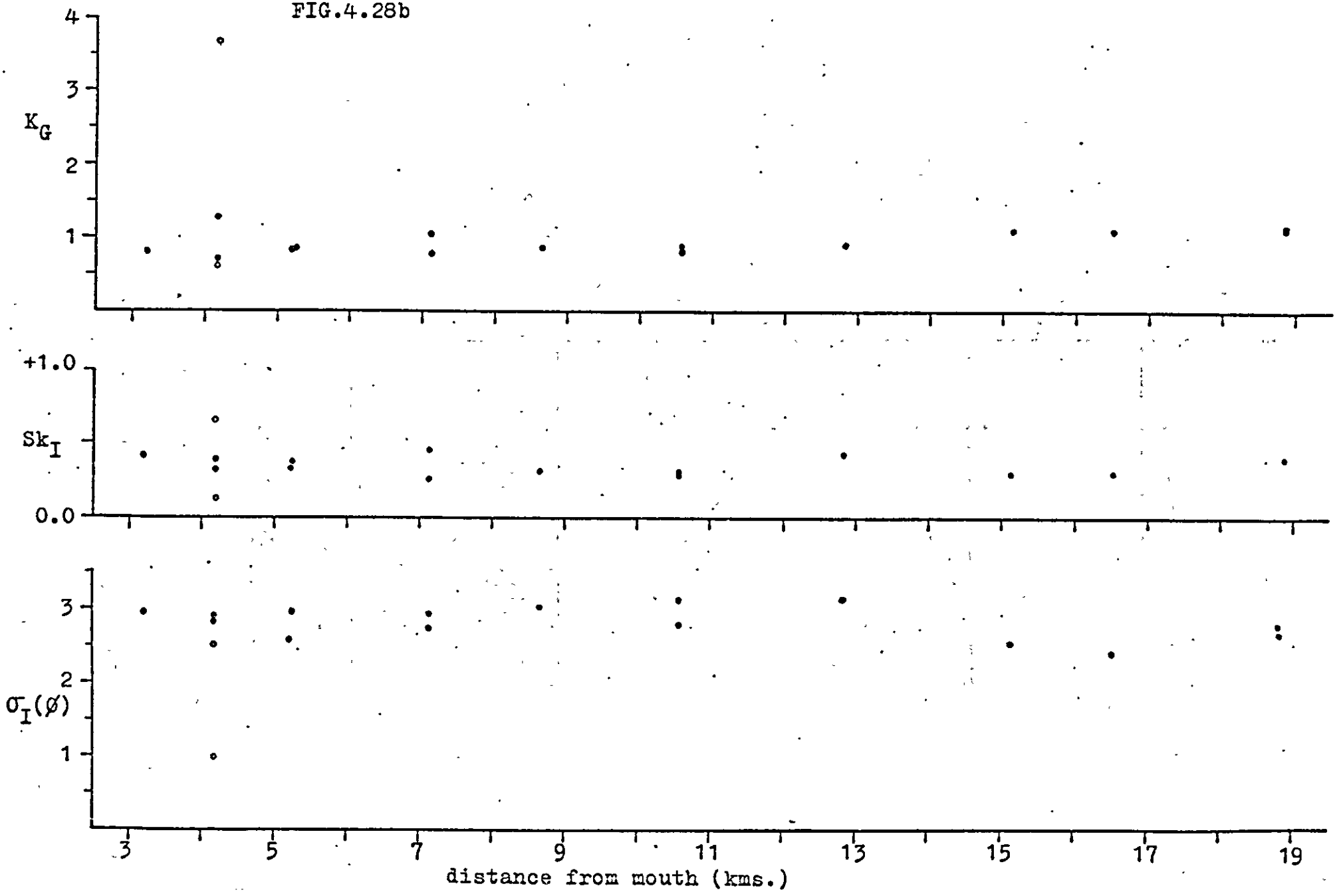


FIGURE 4.28 LONGITUDINAL VARIATION IN a) MEAN GRAIN SIZE AND b) SORTING, SKEWNESS AND KURTOSIS OF THE SEDIMENTS OF THE SALT MARSHES (o = core samples)

FIG.4.28b


4
3
2
1
K_G
+1.0
0.0
Sk_I
3
2
1
$\sigma_I(\phi)$
3
5
7
9
11
13
15
17
19
distance from mouth (kms.)

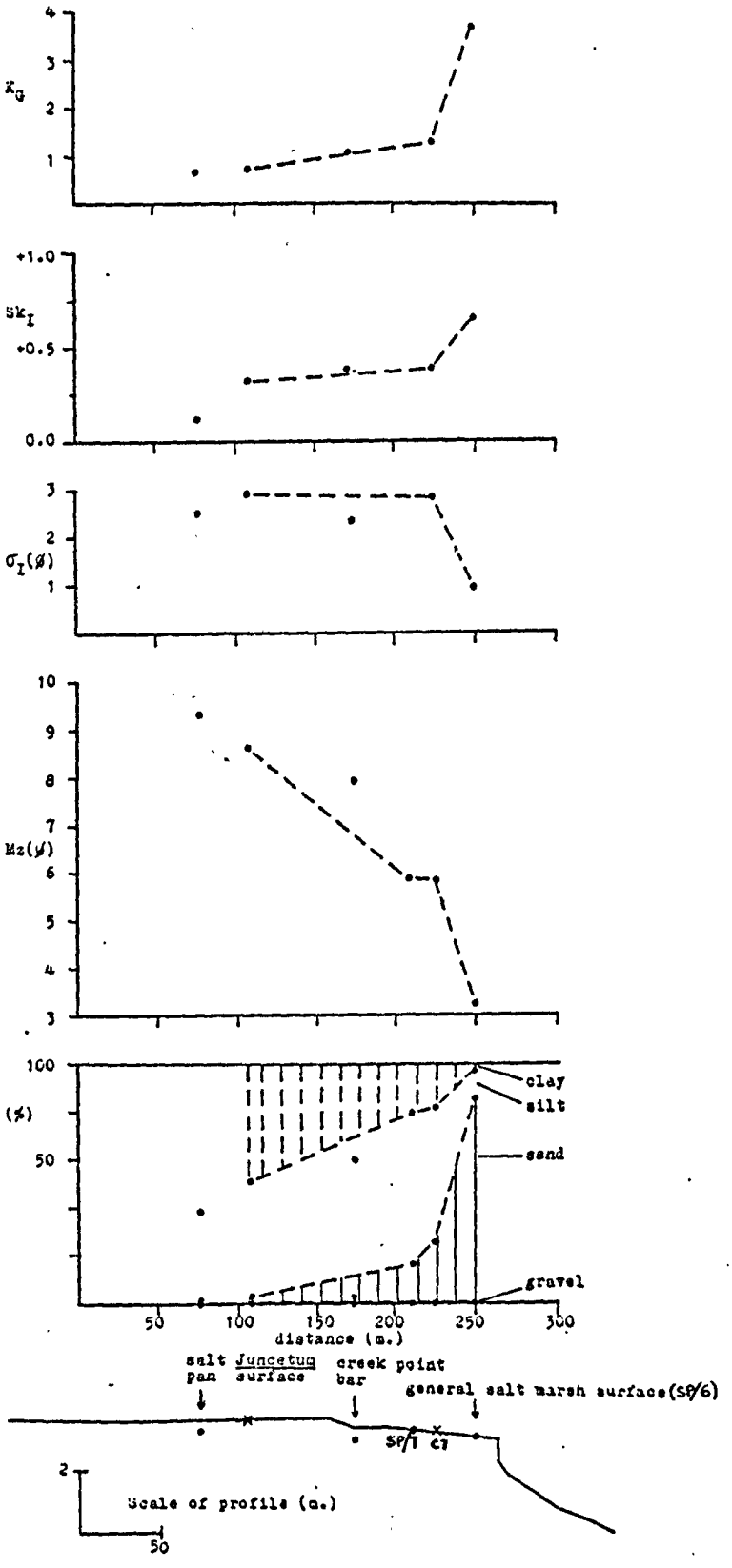


FIG.4.29 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS OF THE SEDIMENTS OF THE SALT MARSH ALONG PROFILE 8

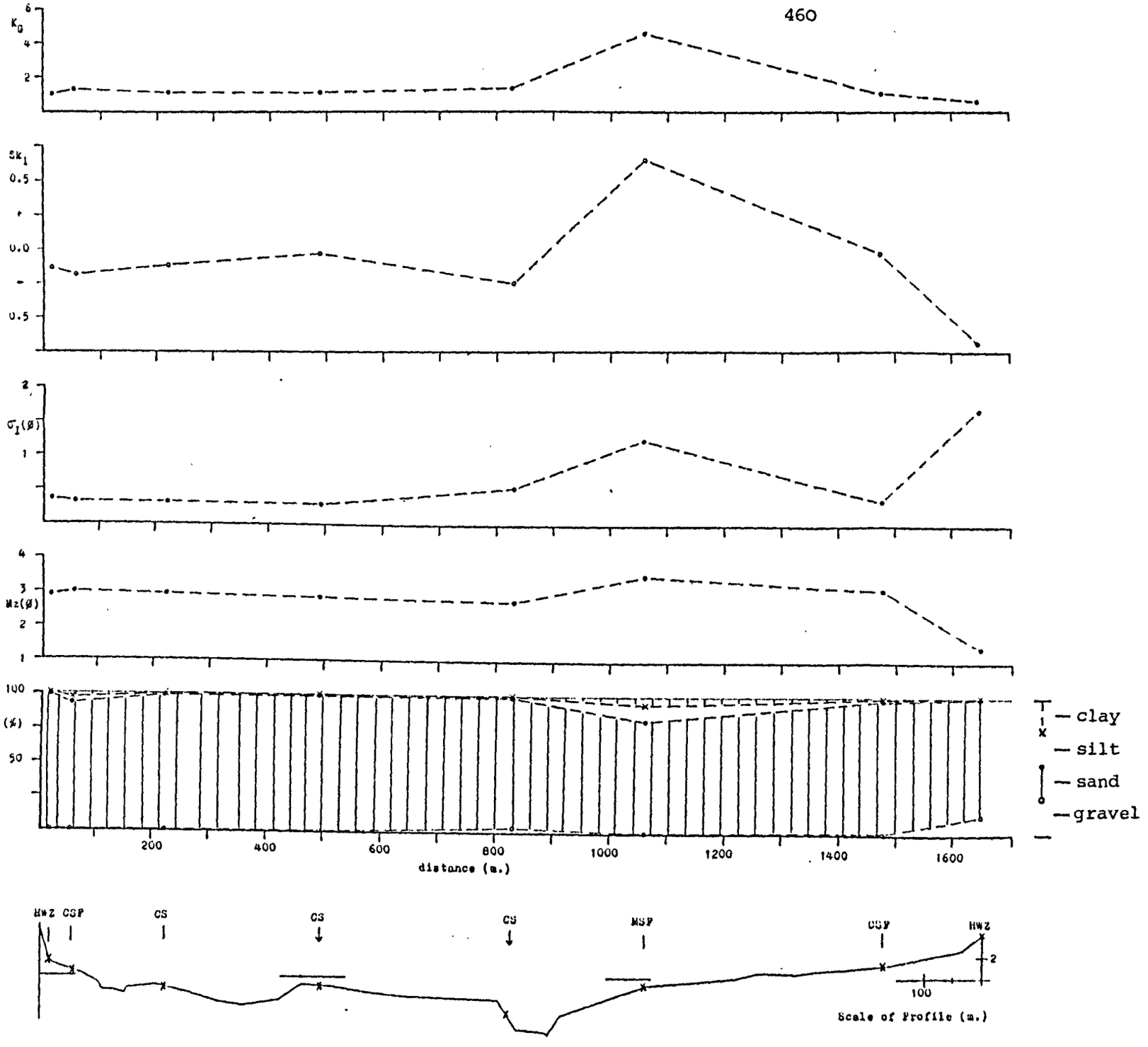


FIG.4.30 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 2

(Key for Figs.4.30-4.40 :- CS - channel zone
CSF- 'clean'rippled sandflats
HWZ- high water zone
MSF- muddy sandflats
MF - mudflats
SM - salt marshes
| - indicates that the sample is on the profile
↓ - indicates that the sample is just off the profile)

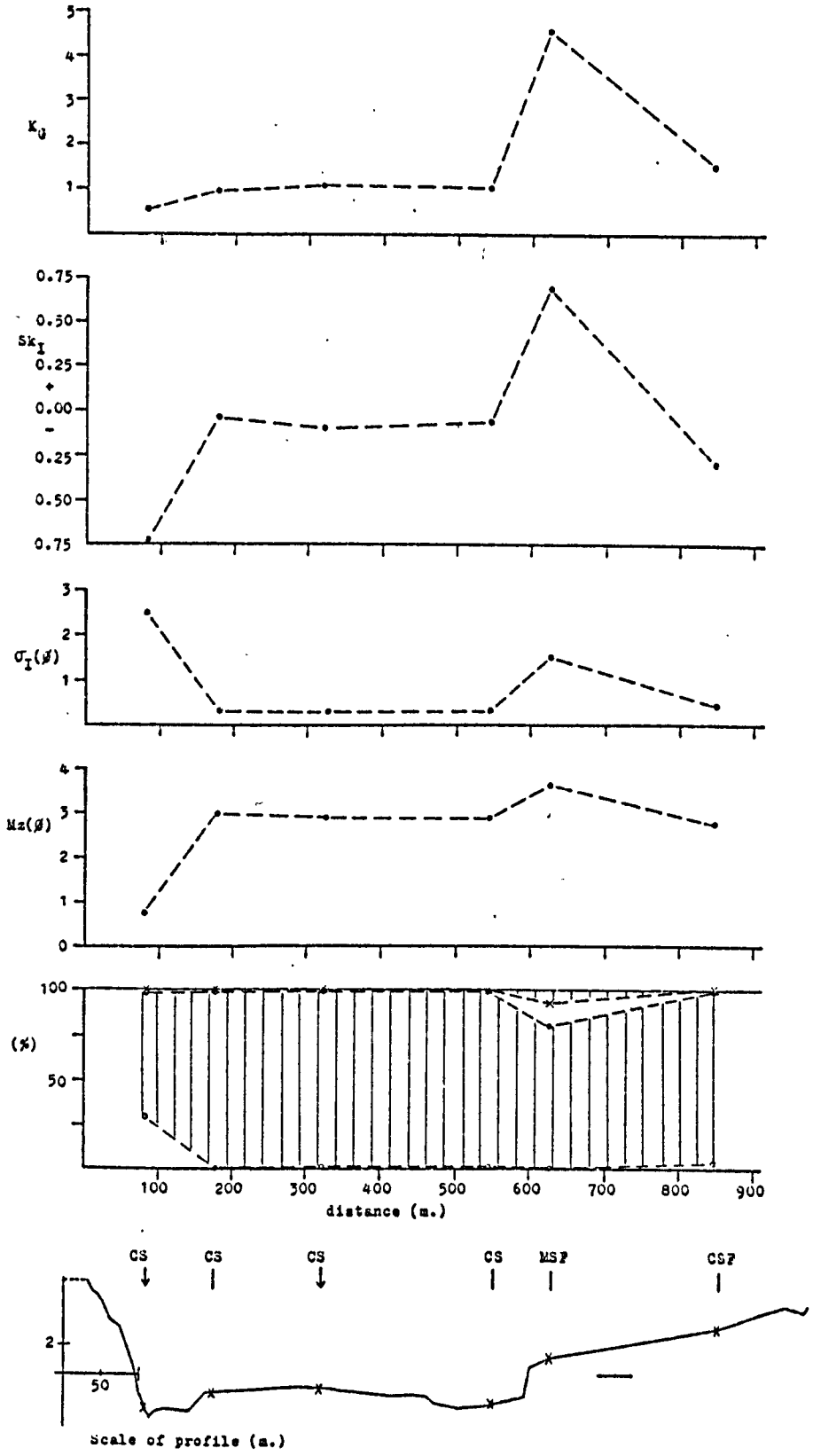


FIG.4.31 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 5

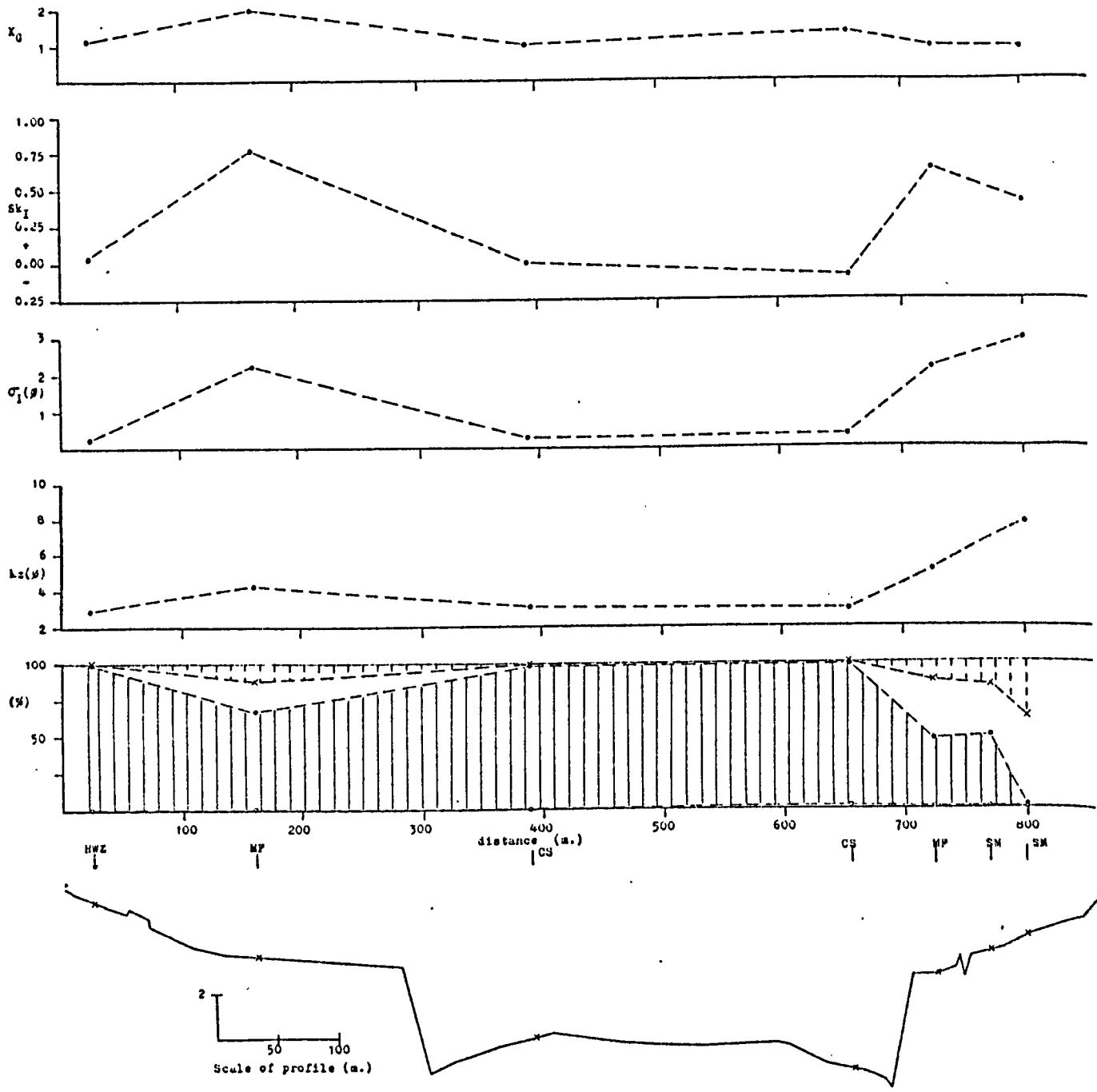


FIG.4.32 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 7

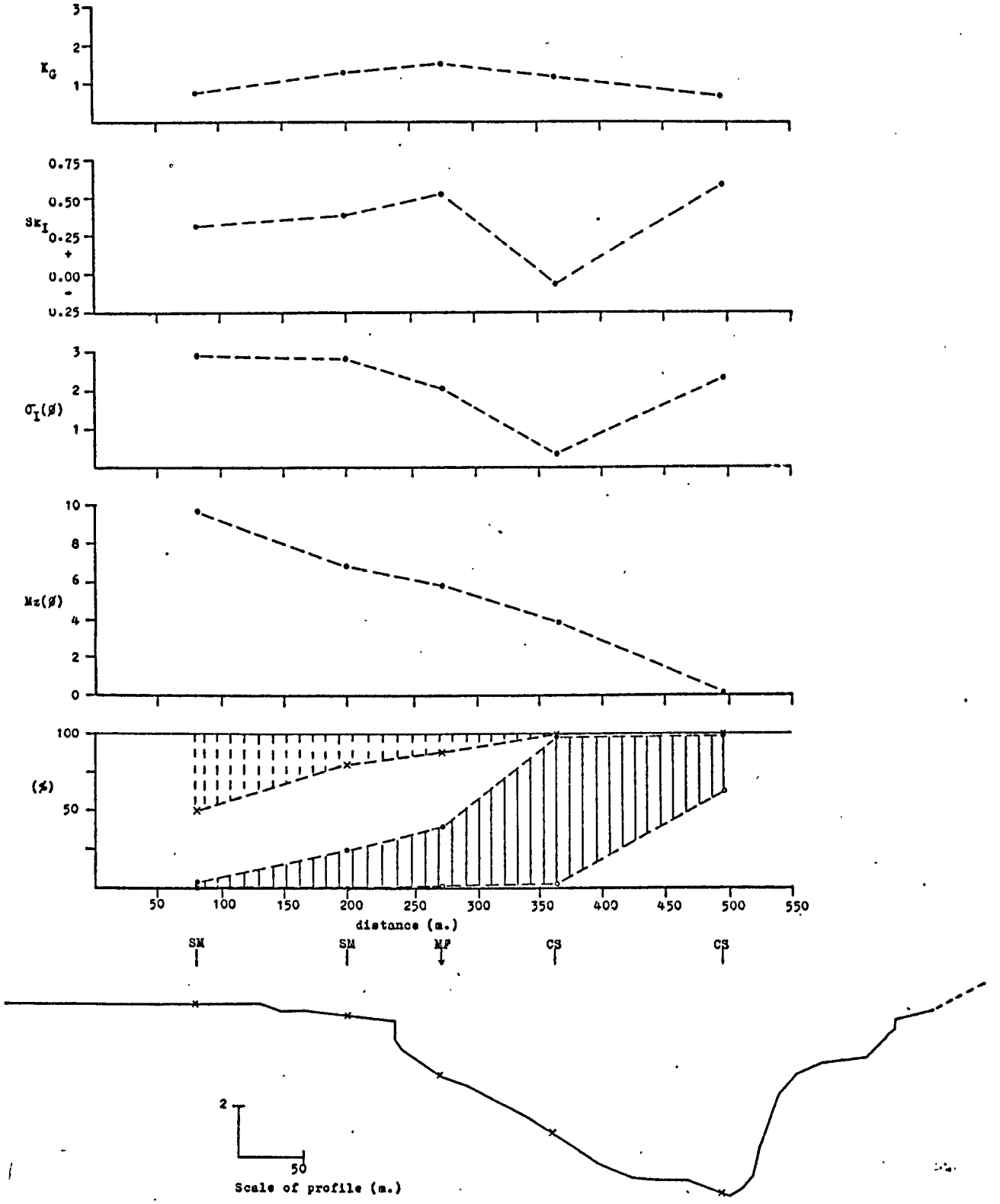


FIG.4.33 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 8

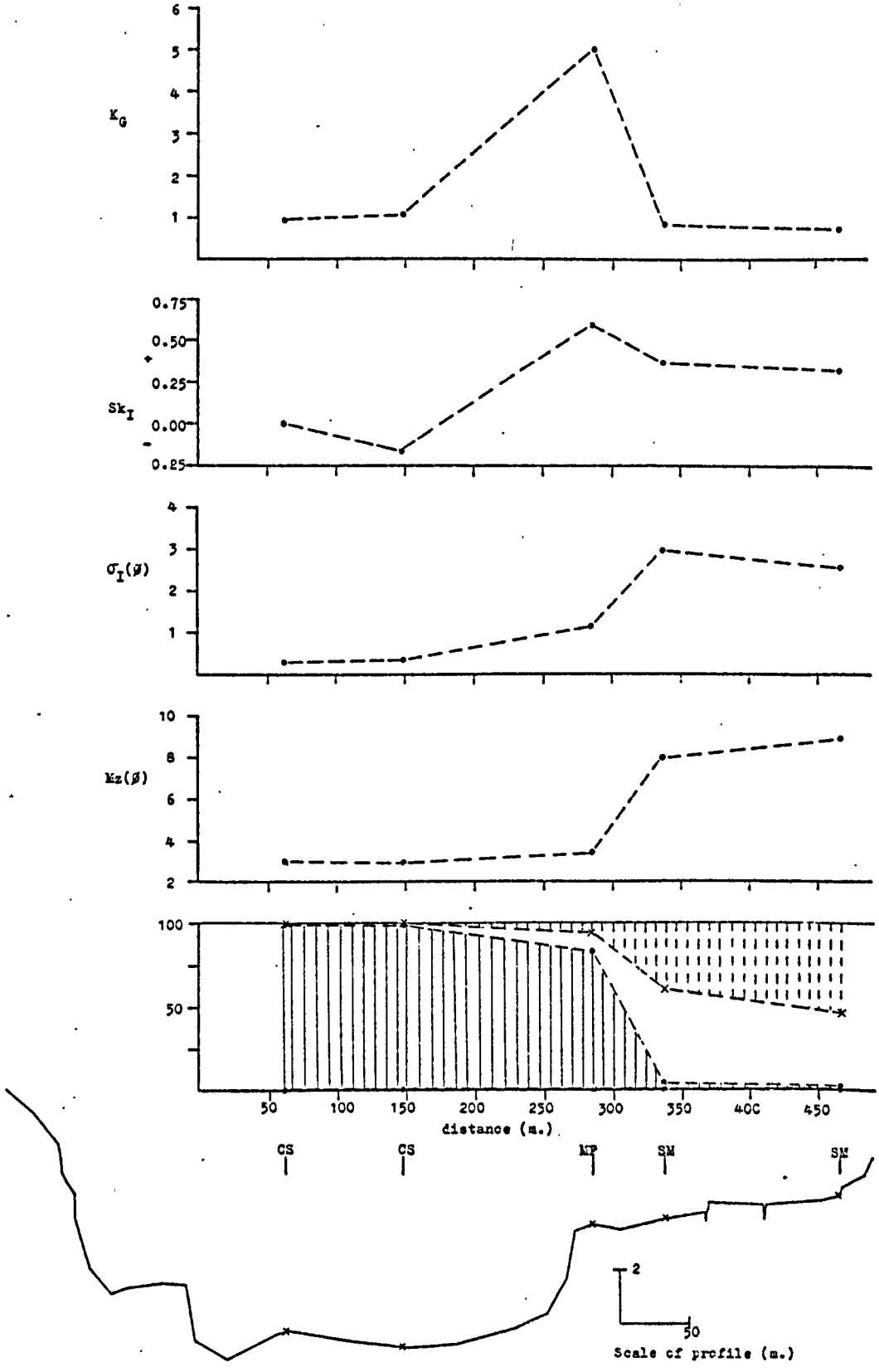


FIG.4.34 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 9

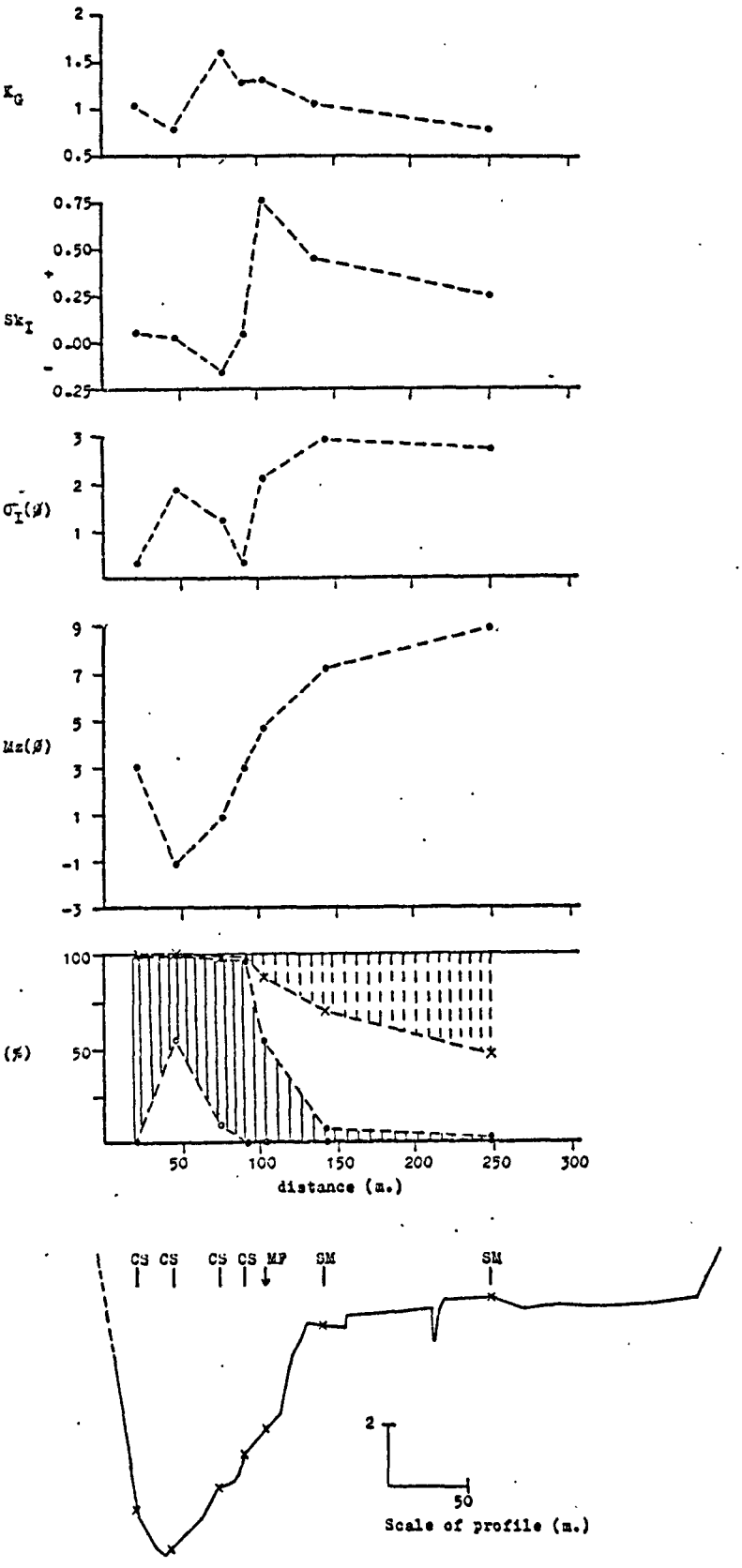


FIG.4.35 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 11

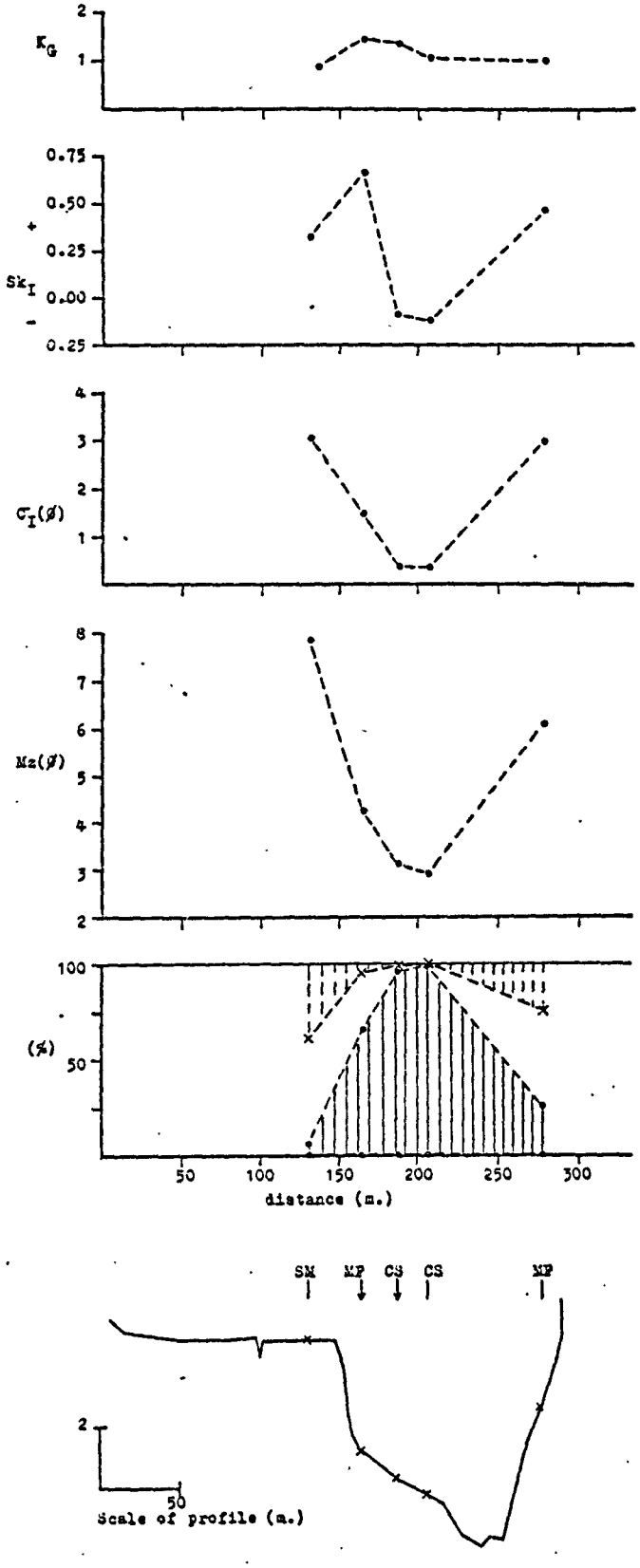


FIG.4.36 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 12

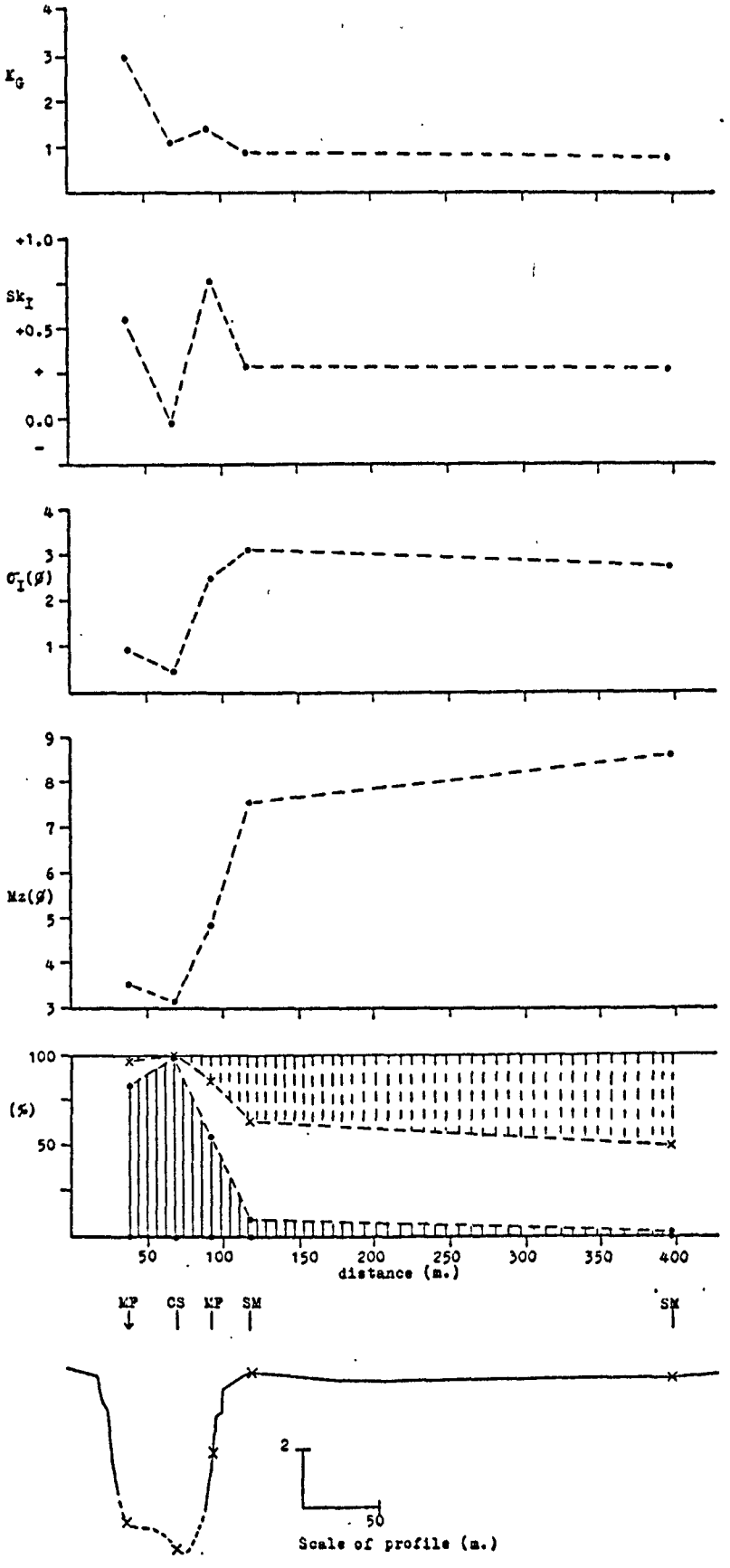


FIG.4.37 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 14

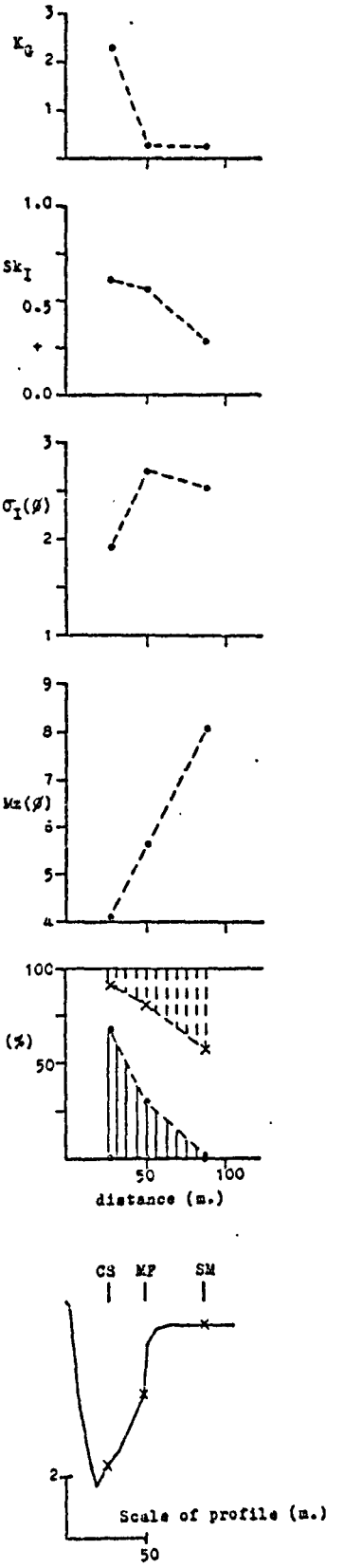


FIG.4.38 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG PROFILE 17

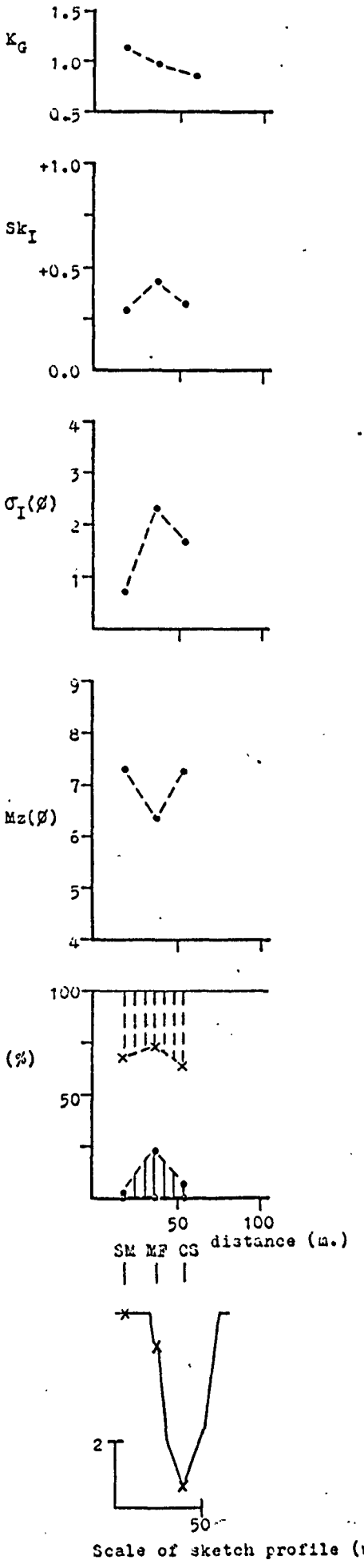


FIG.4.39 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG SKETCH PROFILE 17/18

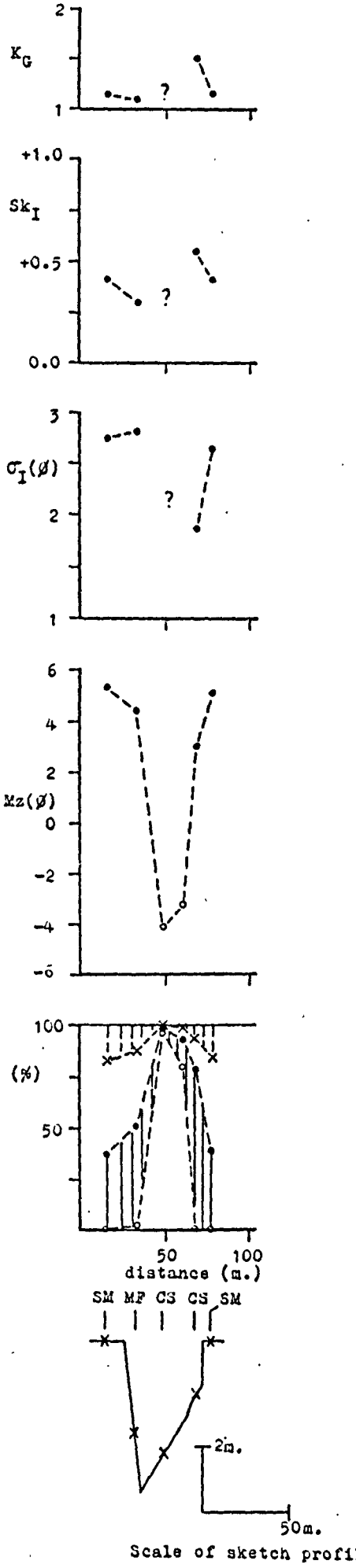


FIG.4.40 CHARACTERISTICS OF THE GRAIN SIZE DISTRIBUTIONS ALONG SKETCH PROFILE 18

FIGURE 4.41 RANGES AND AVERAGES OF a) GRAVEL, SAND, MUD, SILT AND CLAY CONTENTS, AND b) GRAIN SIZE STATISTICAL PARAMETERS OF THE SEDIMENTS OF THE VARIOUS ESTUARINE SUB-ENVIRONMENTS

CS - Sediments of the estuarine channel zone
US - Sediments of the upper sandflats
D - Sediments of the dunes
MF - Sediments of the mudflats
SM - Sediments of the salt marshes

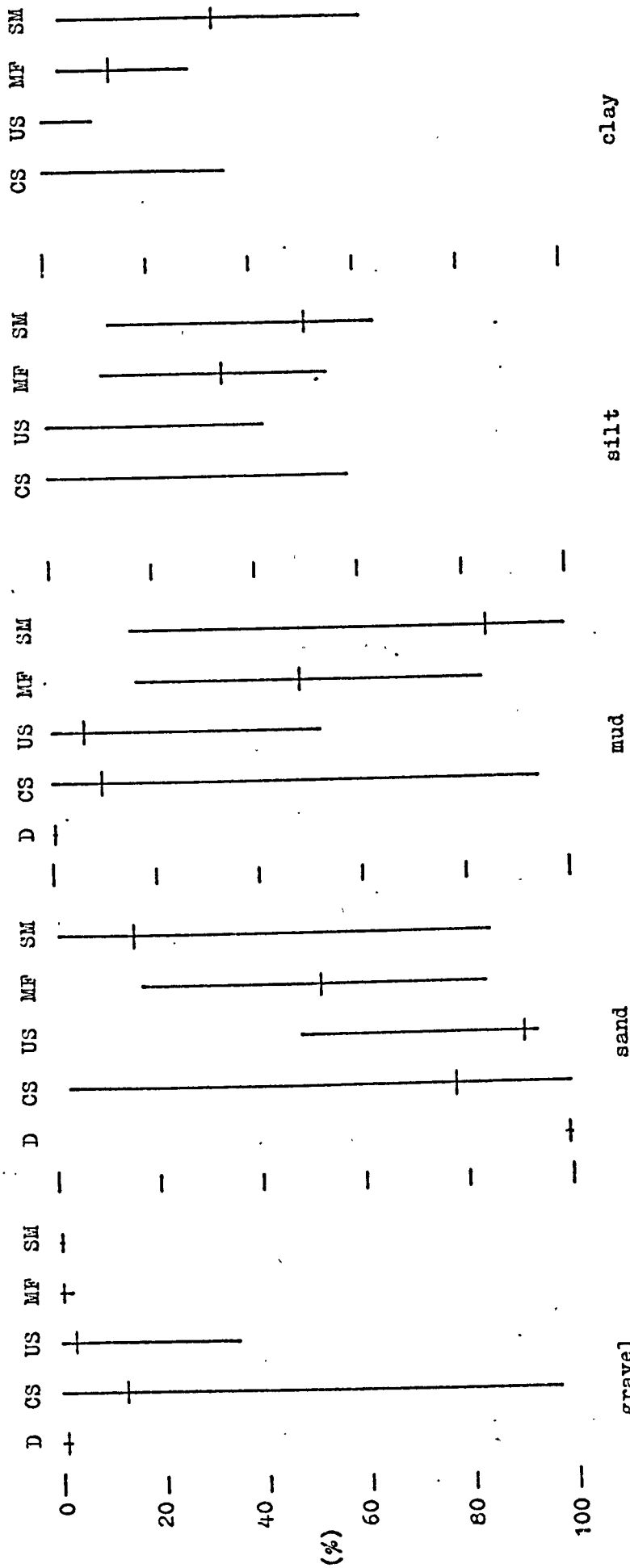


FIG.4.41a

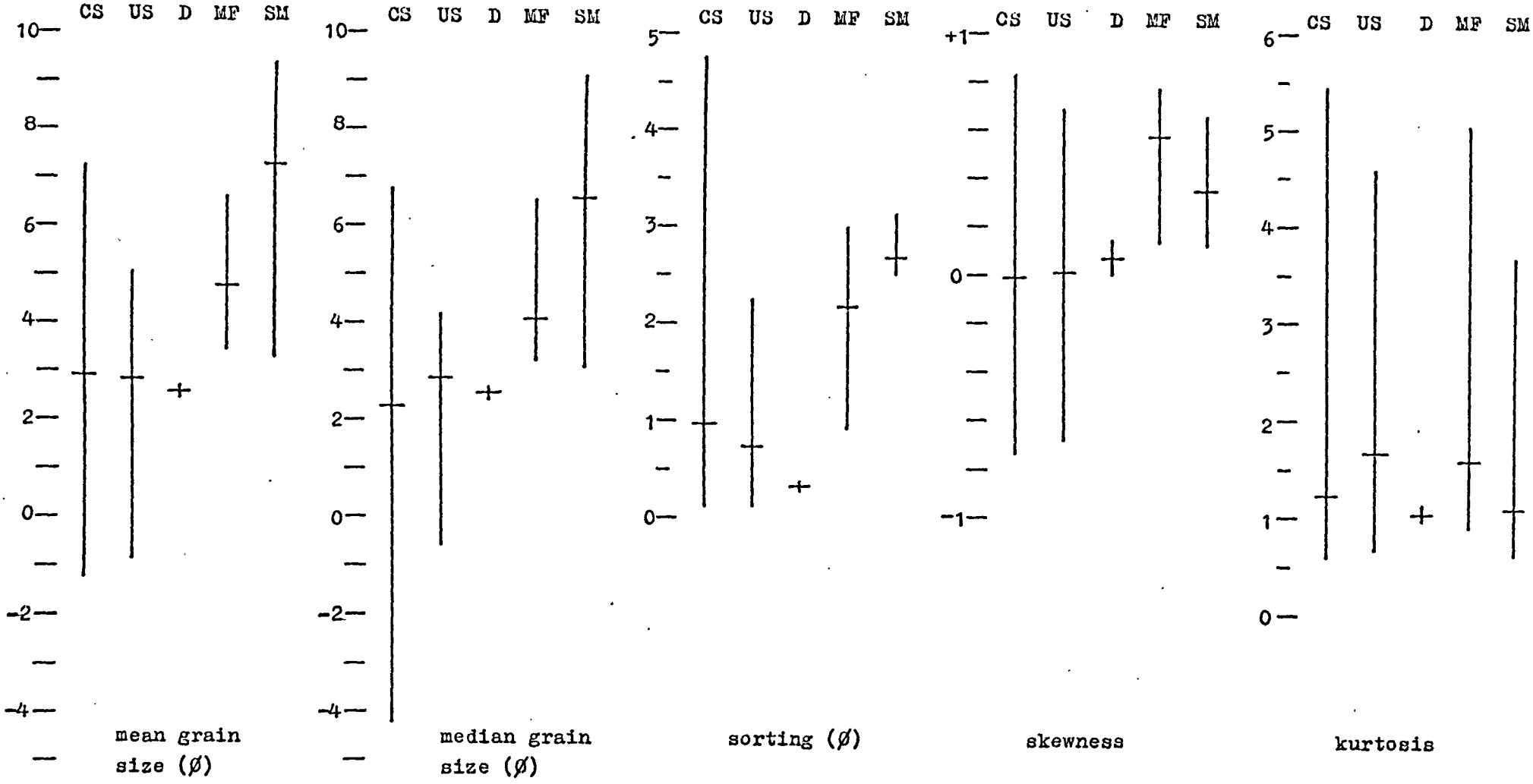

CS US D MF SM
10
8
6
4
2
0
-2
-4
mean grain size (ø)
CS US D MF SM
10
8
6
4
2
0
-2
-4
median grain size (ø)
CS US D MF SM
5
4
3
2
1
0
sorting (ø)
CS US D MF SM
+1
0
-1
skewness
CS US D MF SM
6
5
4
3
2
1
0
kurtosis

FIG.4.41b

FIG.4.42 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE VARIOUS ESTUARINE SUB-ENVIRONMENTS PLOTTED AS FIELDS

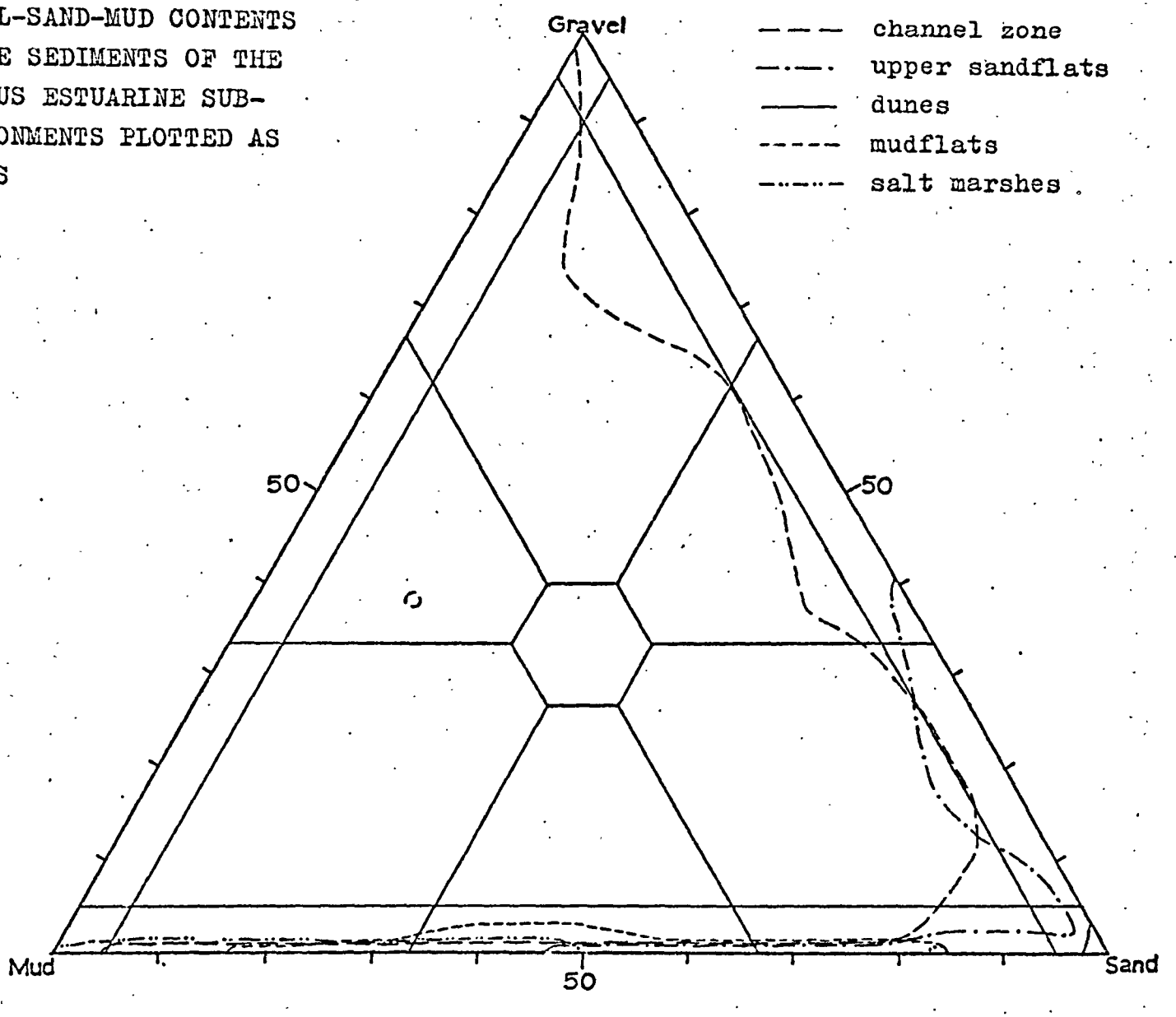
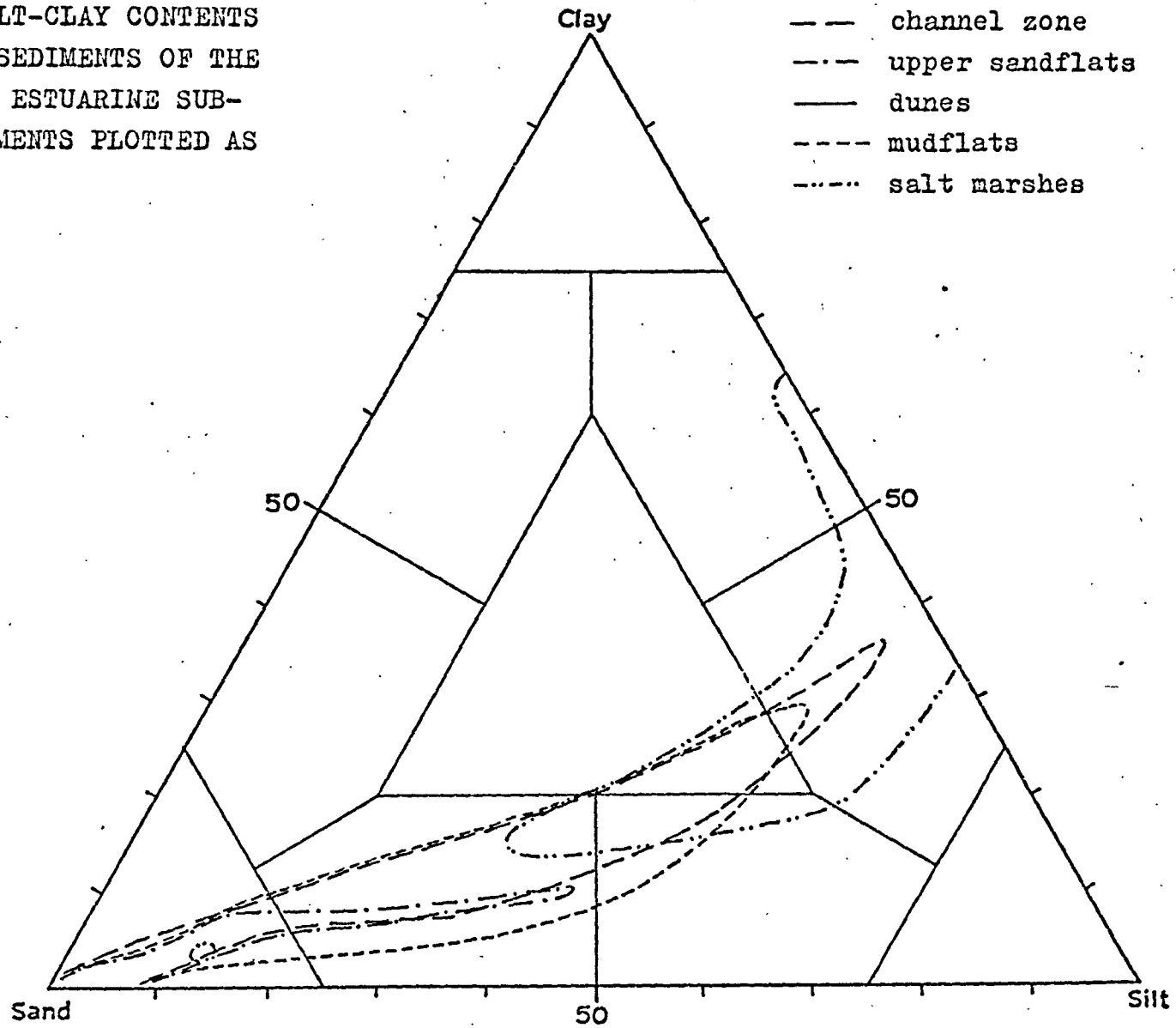


FIG.4.43 SAND-SILT-CLAY CONTENTS OF THE SEDIMENTS OF THE VARIOUS ESTUARINE SUB-ENVIRONMENTS PLOTTED AS FIELDS



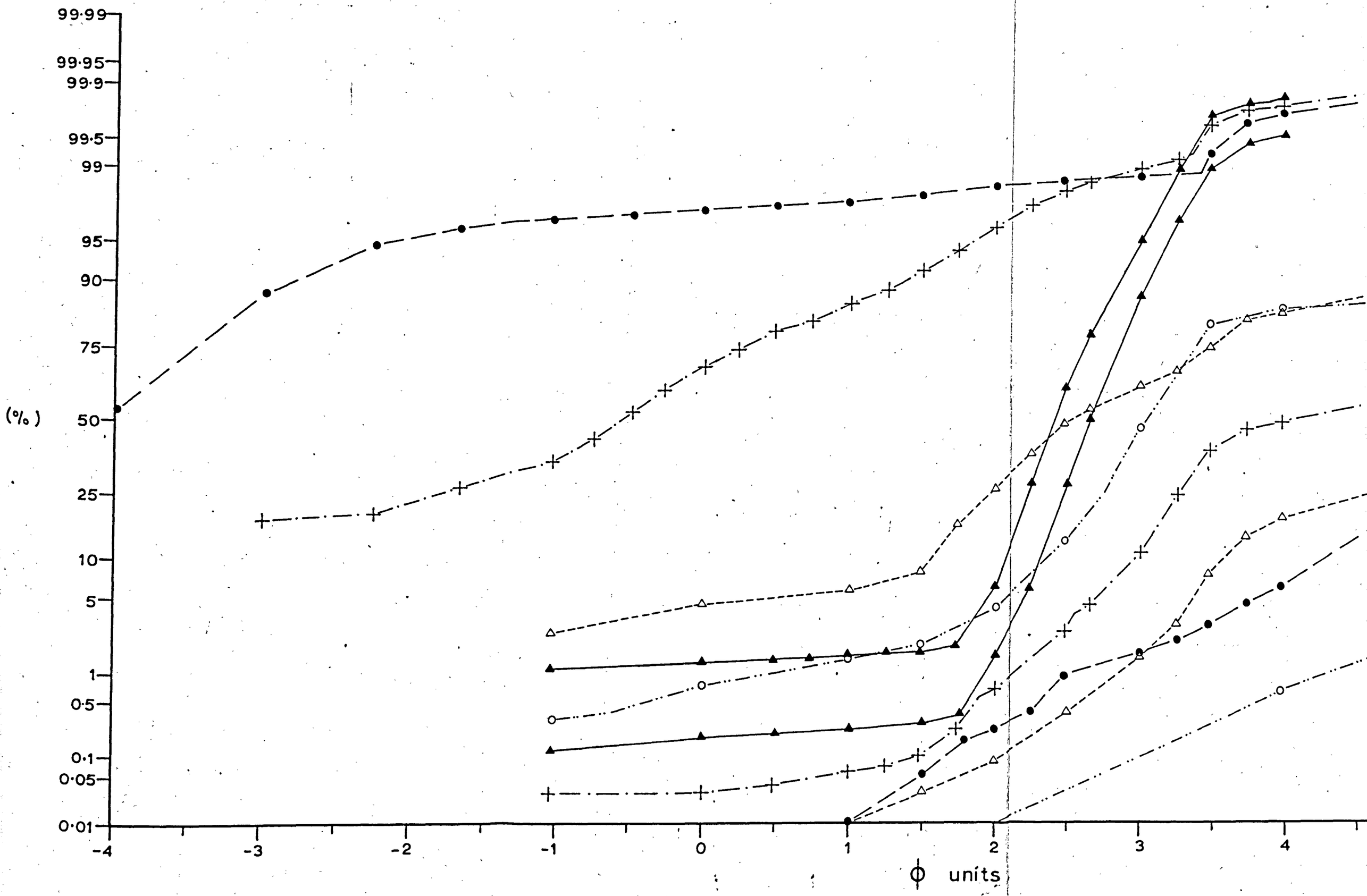


FIG. 4.44 Frequency curve fields of the estuarine sediments

Key

channel zone

upper sandflats

dunes

mudflats

salt marshes

4 5 6 7 8 9

KEY TO FIGURES 4.45 - 4.49 :-

- • Estuarine channel zone sediments
  Upper sandflats
- + 'clean' rippled sandflats
- × high water zone
- ✳ muddy sandflats
- ▲ Dunes
- △ Mudflats
- ○ Salt marshes

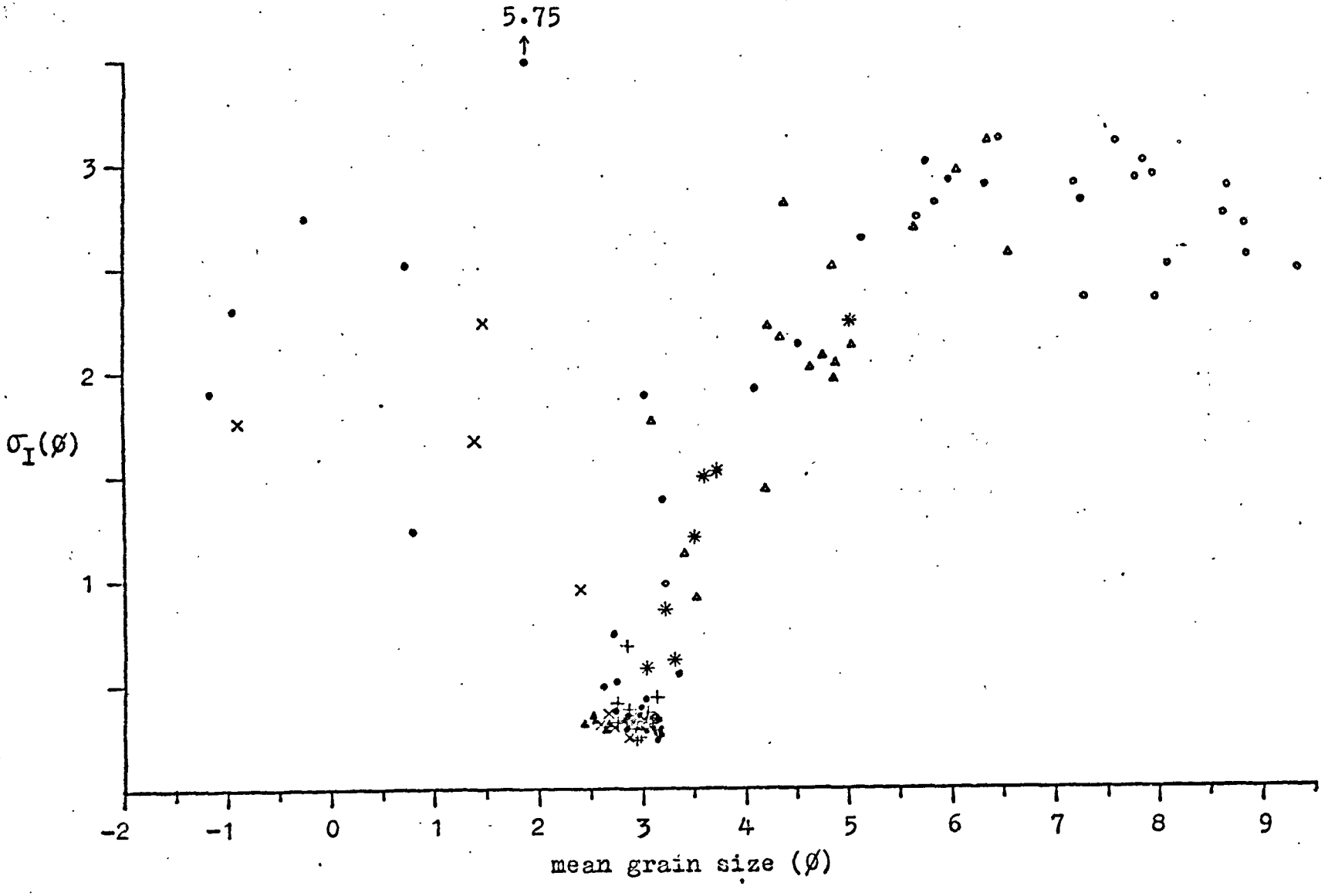


FIGURE 4.45 PLOT OF MEAN GRAIN SIZE AGAINST STANDARD DEVIATION (SORTING) FOR THE ESTUARINE SEDIMENTS

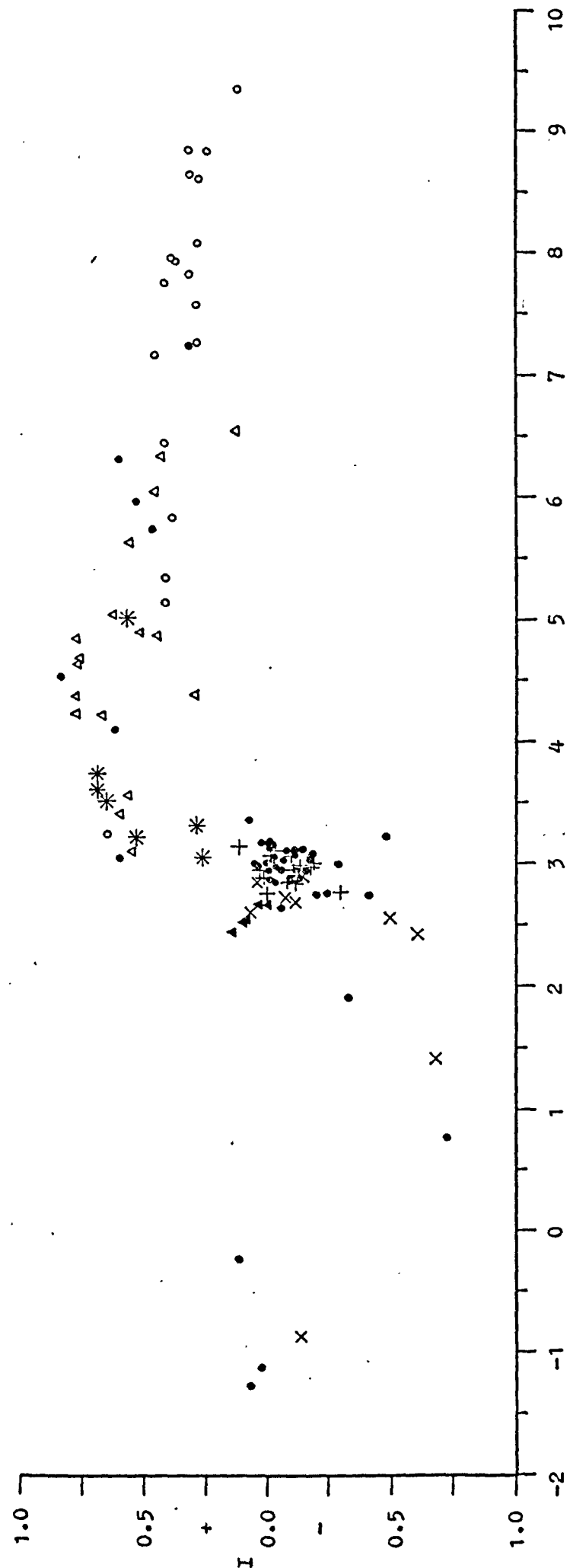


FIGURE 4.46 PLOT OF MEAN GRAIN SIZE AGAINST SKEWNESS FOR THE ESTUARINE SEDIMENTS

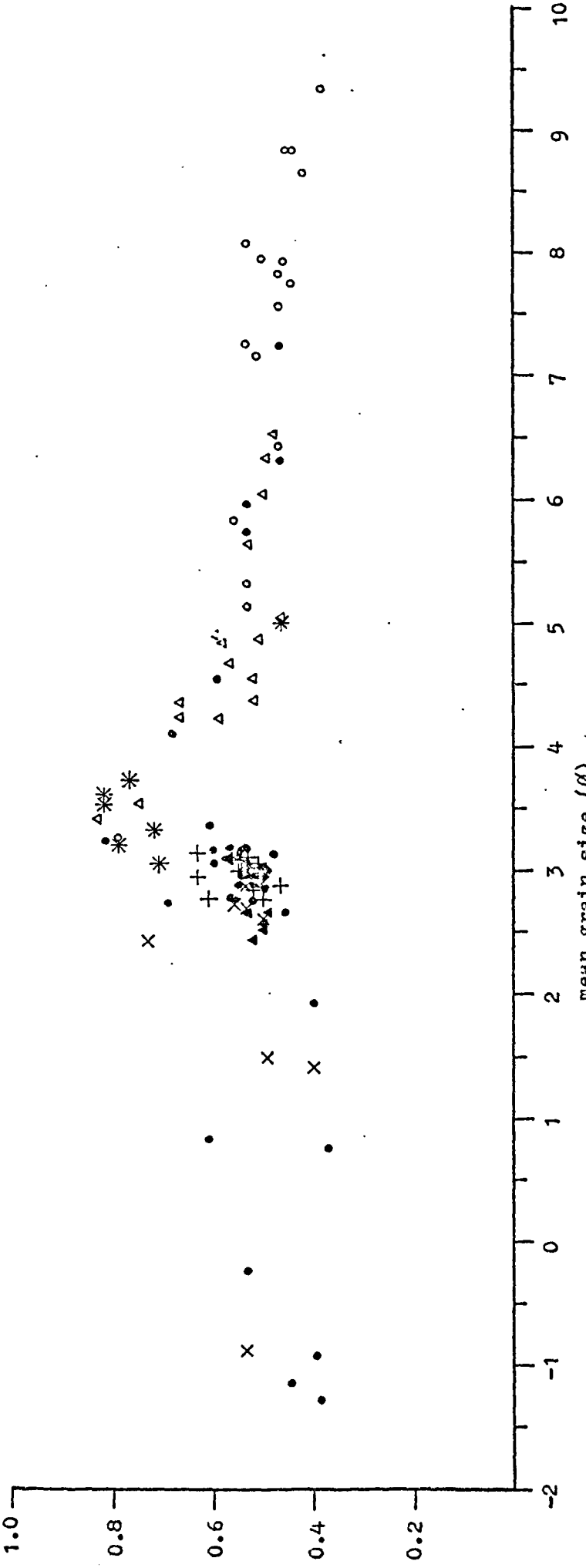


FIGURE 4.47 PLOT OF MEAN GRAIN SIZE AGAINST NORMALISED KURTOSIS FOR THE ESTUARINE SEDIMENTS

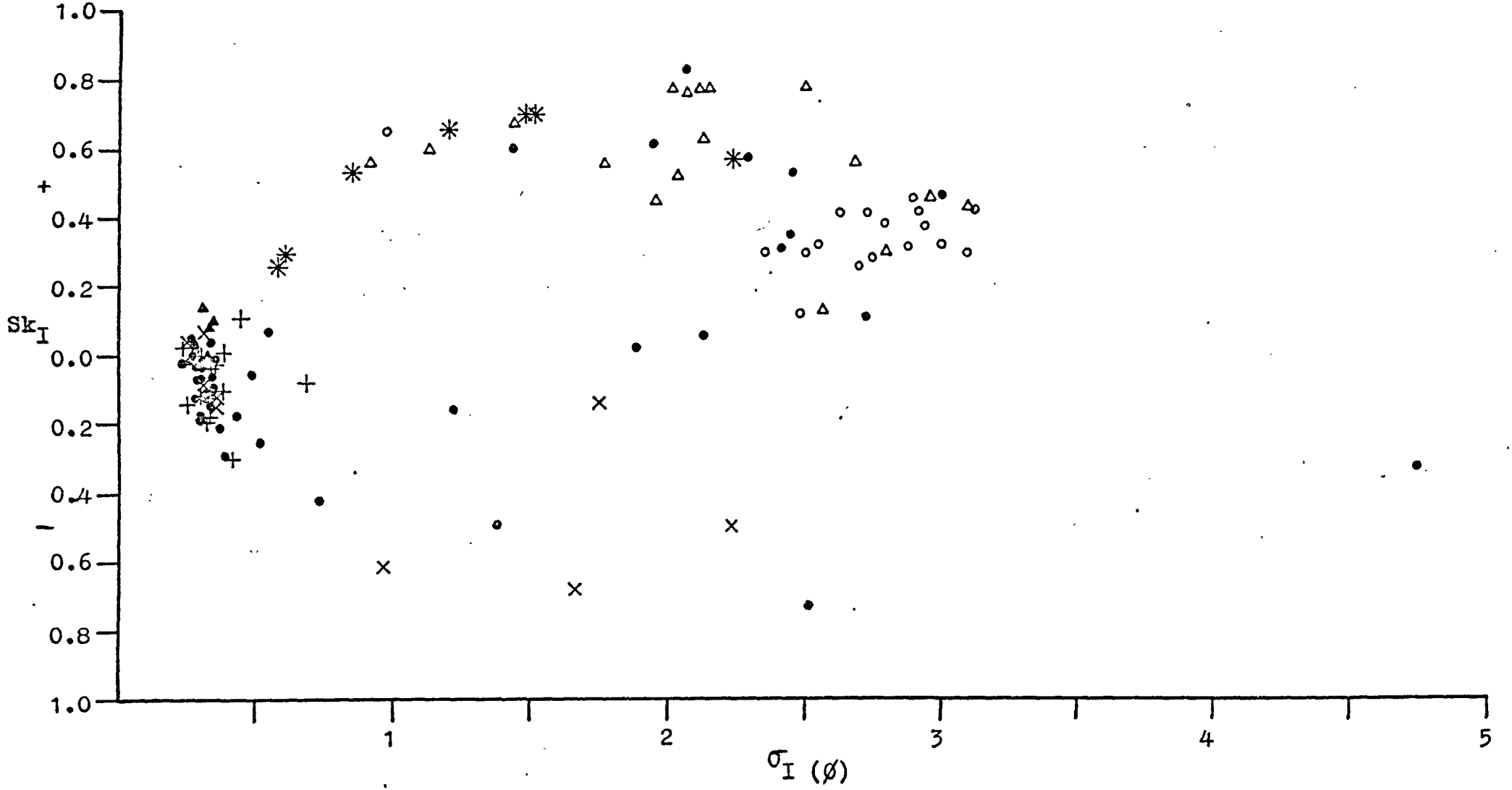


FIGURE 4.48 PLOT OF STANDARD DEVIATION (SORTING) AGAINST SKEWNESS FOR THE ESTUARINE SEDIMENTS

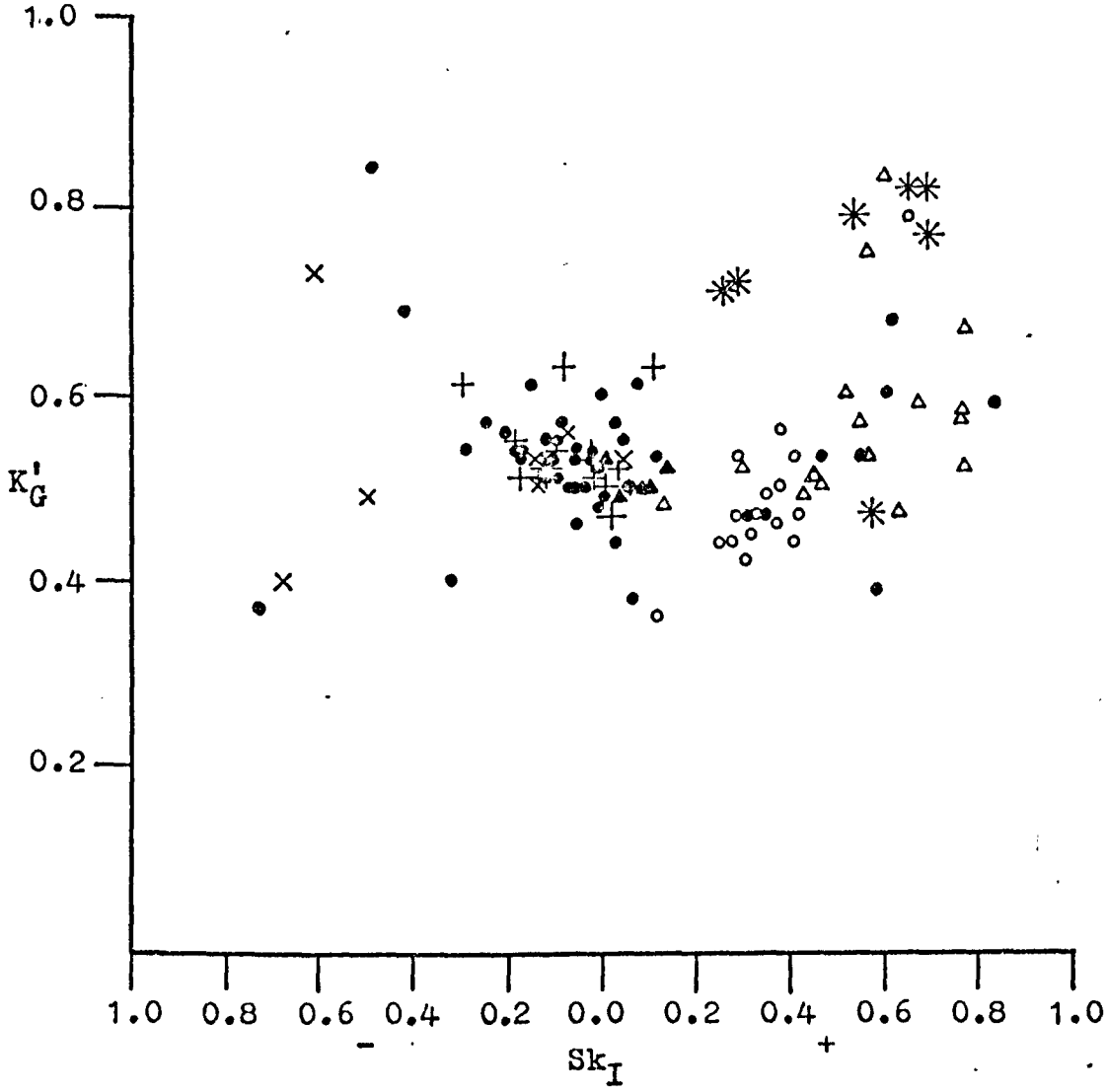


FIGURE 4.49 PLOT OF SKEWNESS AGAINST NORMALISED KURTOSIS FOR THE ESTUARINE SEDIMENTS

FIG.4.50 GRAVEL + VERY COARSE + COARSE + MEDIUM SAND - FINE + VERY FINE SAND - MUD CONTENTS OF THE SEDIMENTS OF THE VARIOUS ESTUARINE SUB-ENVIRONMENTS

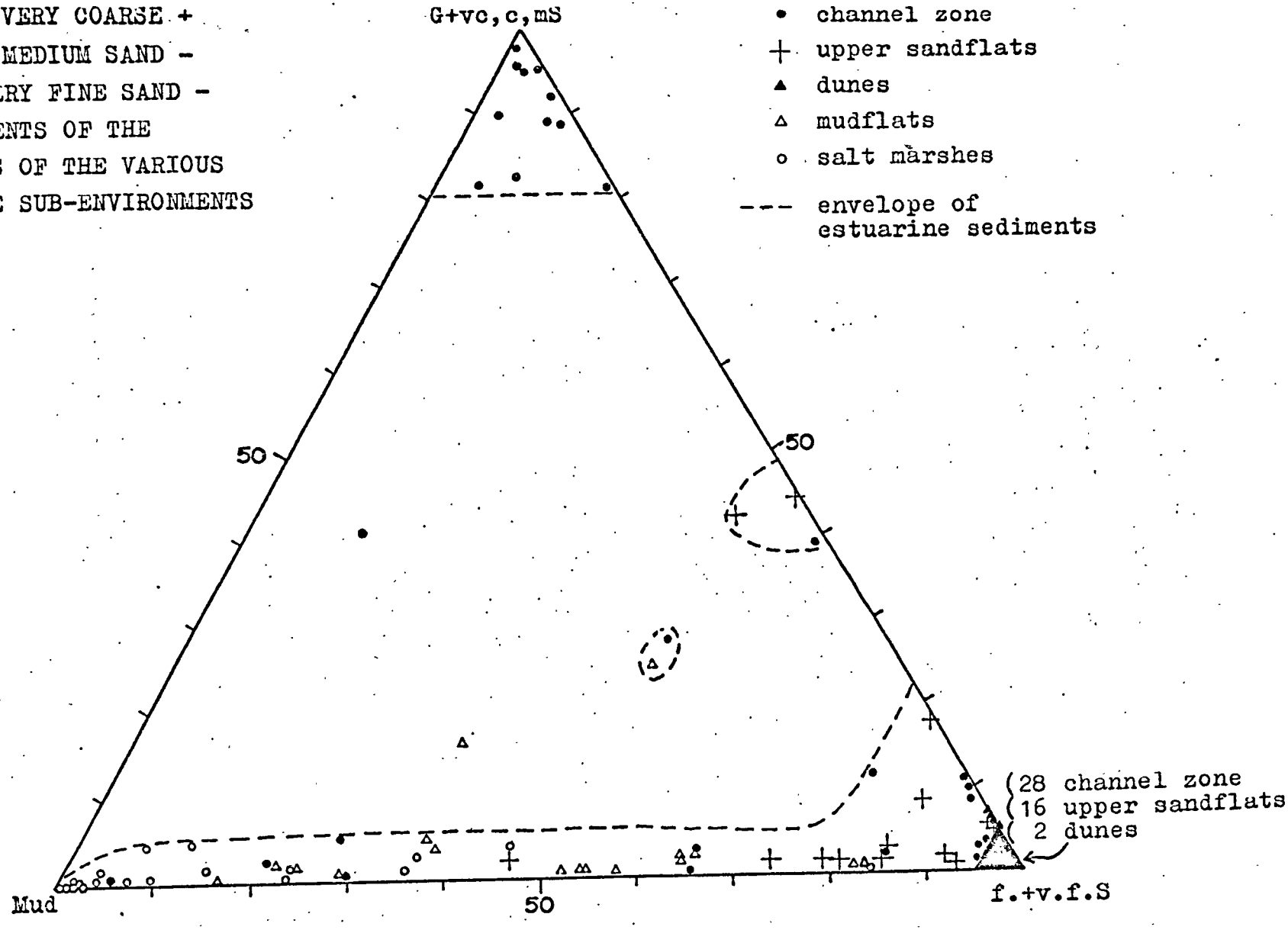


FIG.4.51 GRAVEL-SAND-MUD CONTENTS OF THE SEDIMENTS OF THE VARIOUS FLUVIAL SUB-ENVIRONMENTS AND FOUR STREAMS

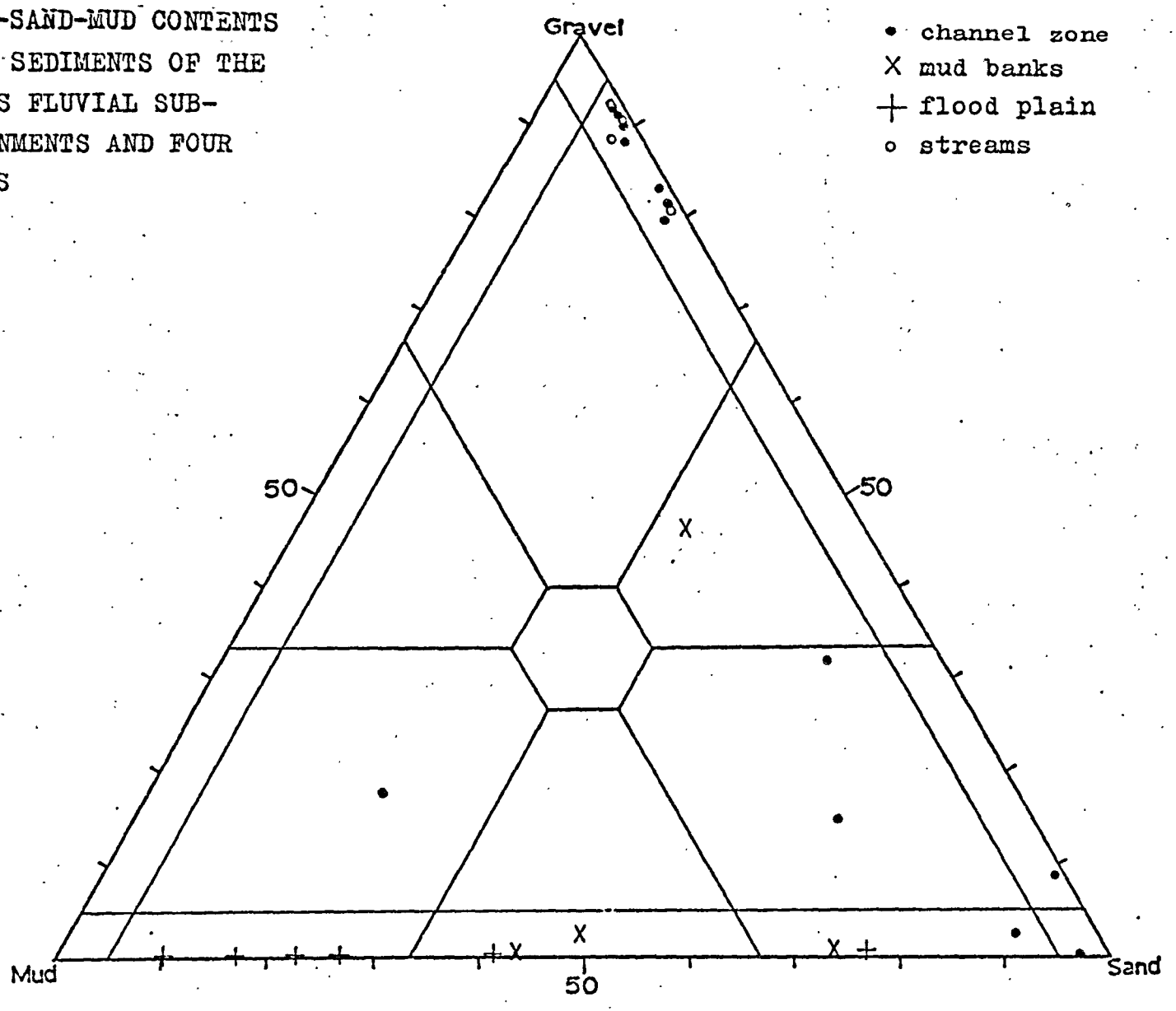


FIG.4.52 SAND-SILT-CLAY CONTENTS OF THE SEDIMENTS OF THE VARIOUS FLUVIAL SUB-ENVIRONMENTS

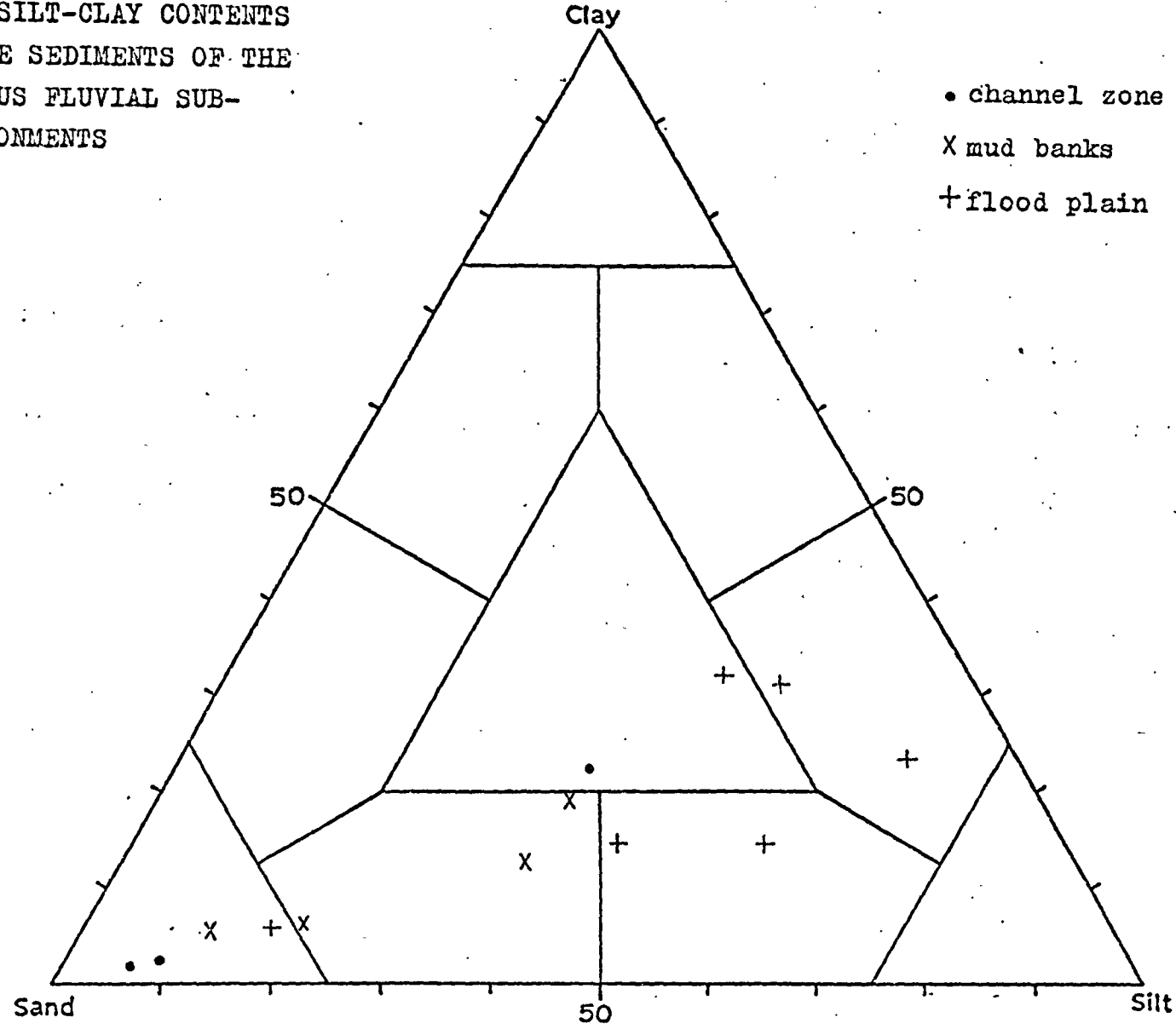
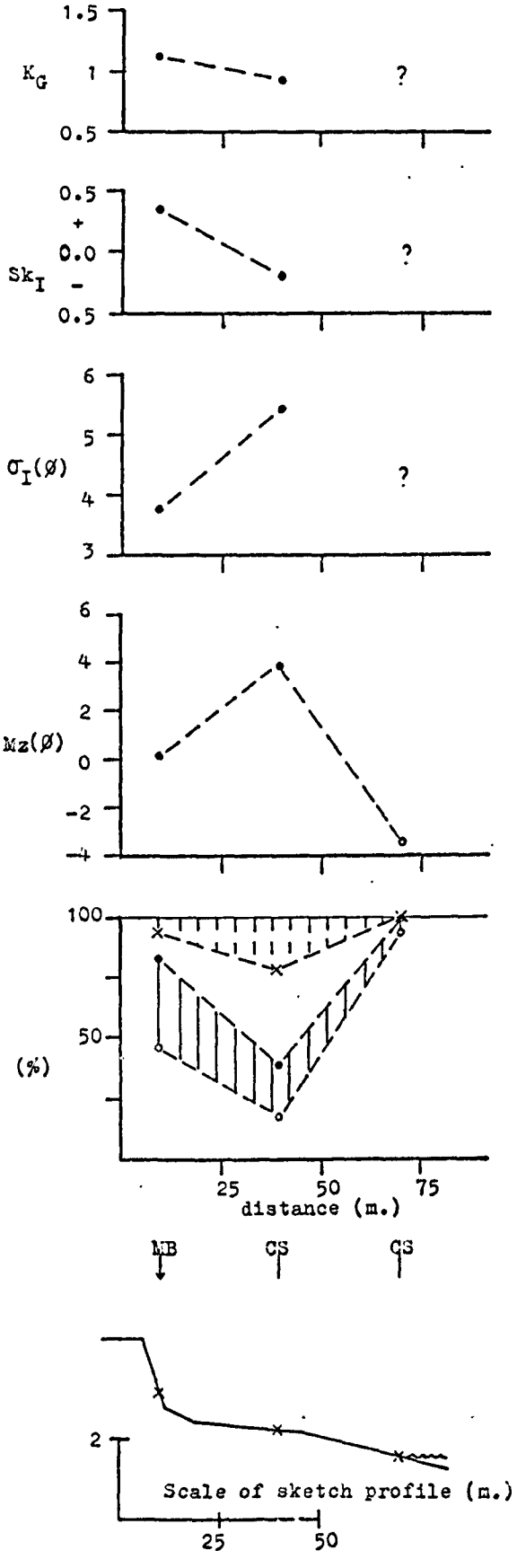


FIG.4.53 Characteristics of the grain size distributions along sketch profile 18/19



(Key to Figs.4.53-4.56 :- CZ-channel zone,MB-mud banks,FP-flood plain)

FIGURE 4.54 Characteristics of the grain size distributions along Profile 19

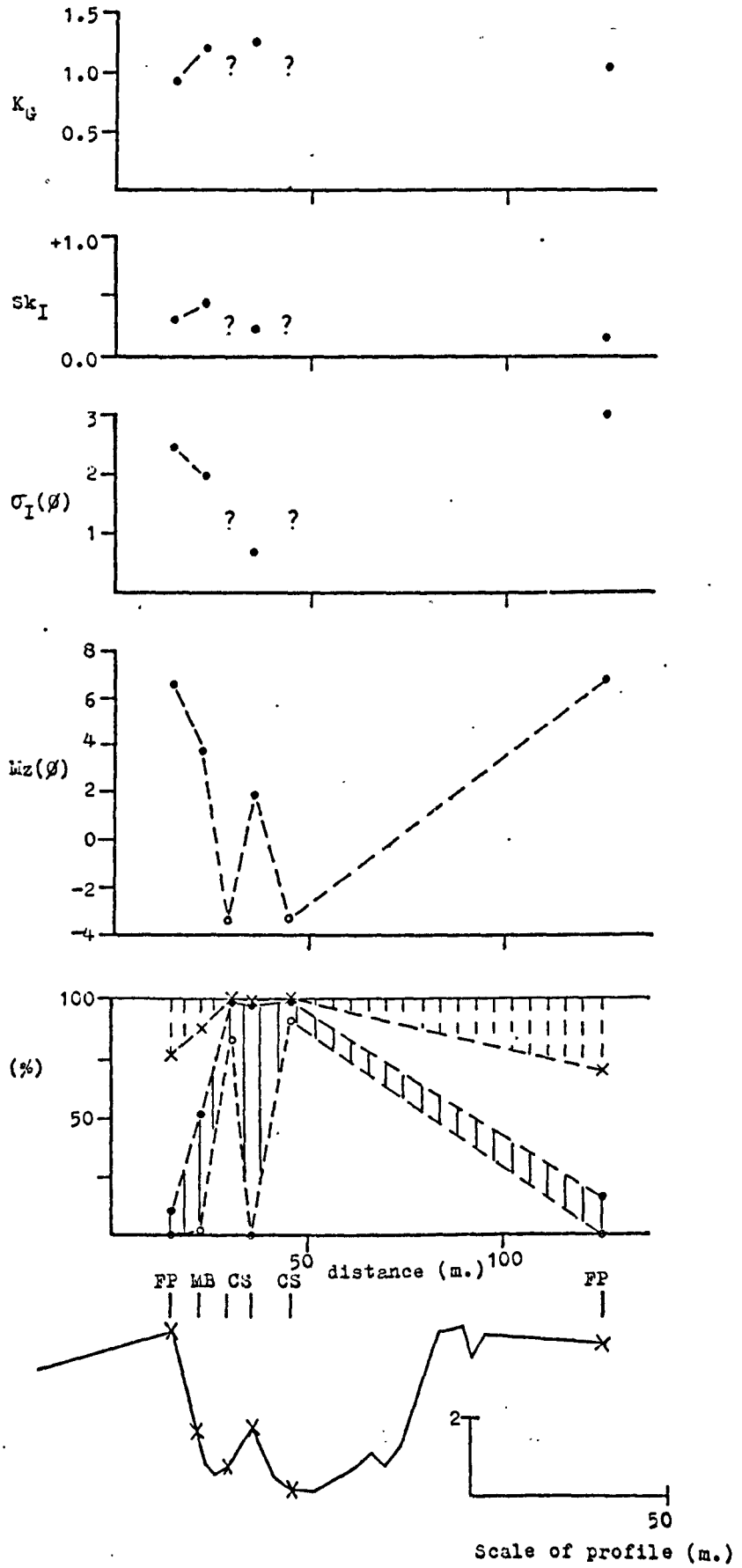


FIGURE 4.55 Characteristics of the grain size distributions along Profile 20

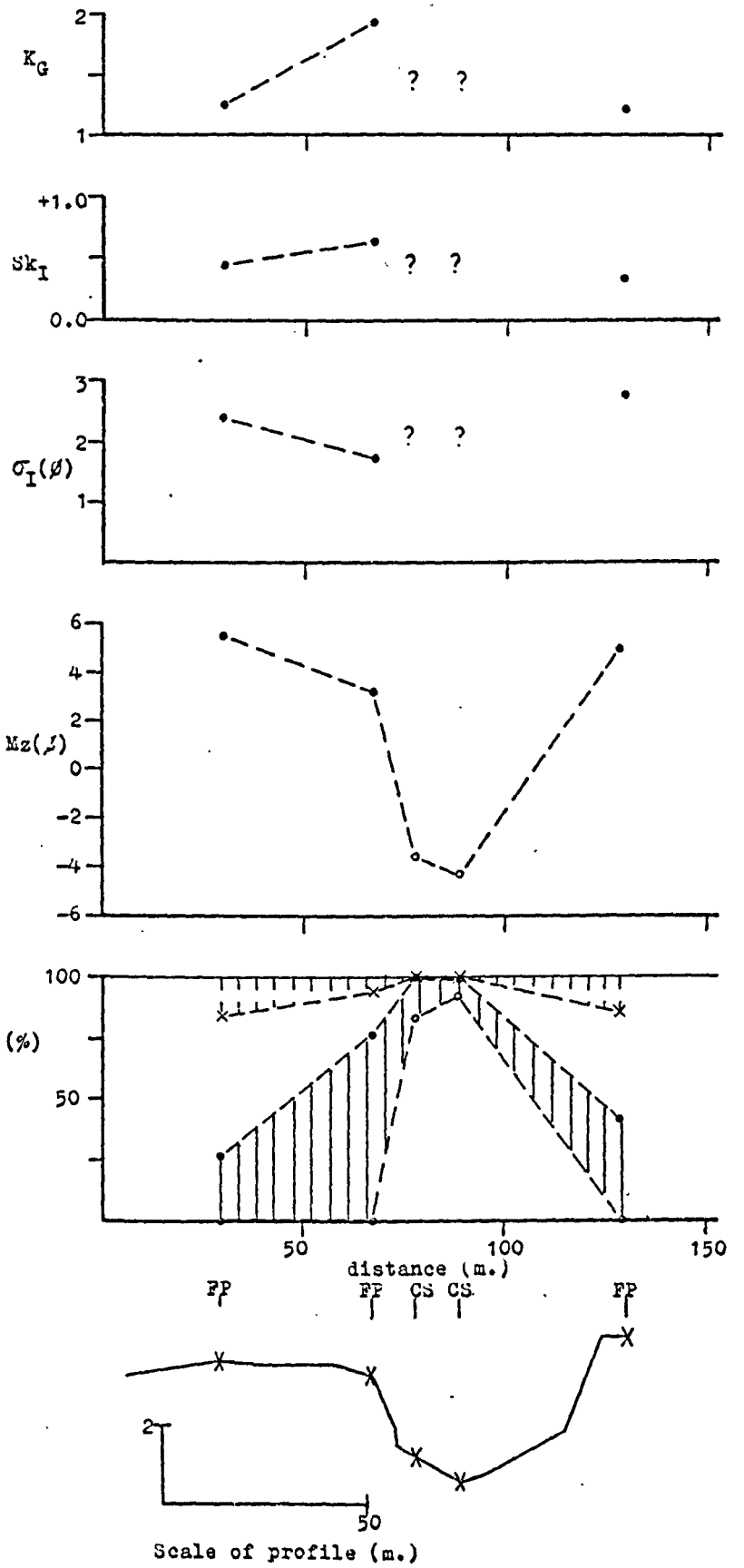
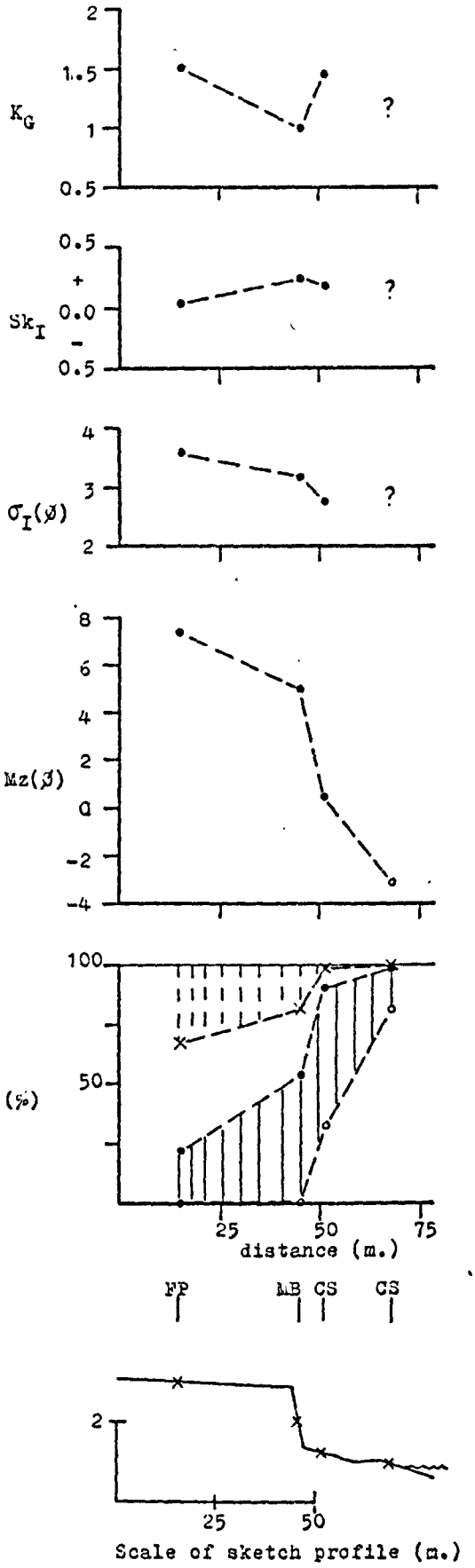


FIG.4.56 Characteristics of the grain size distributions along sketch profile 21



99·99
99·95
99·9
99·5
99
95
90
75
(%) 50
25
10
5
1
0·5
0·1
0·05
0·01

-4 -3 -2 -1 0 1 2 3

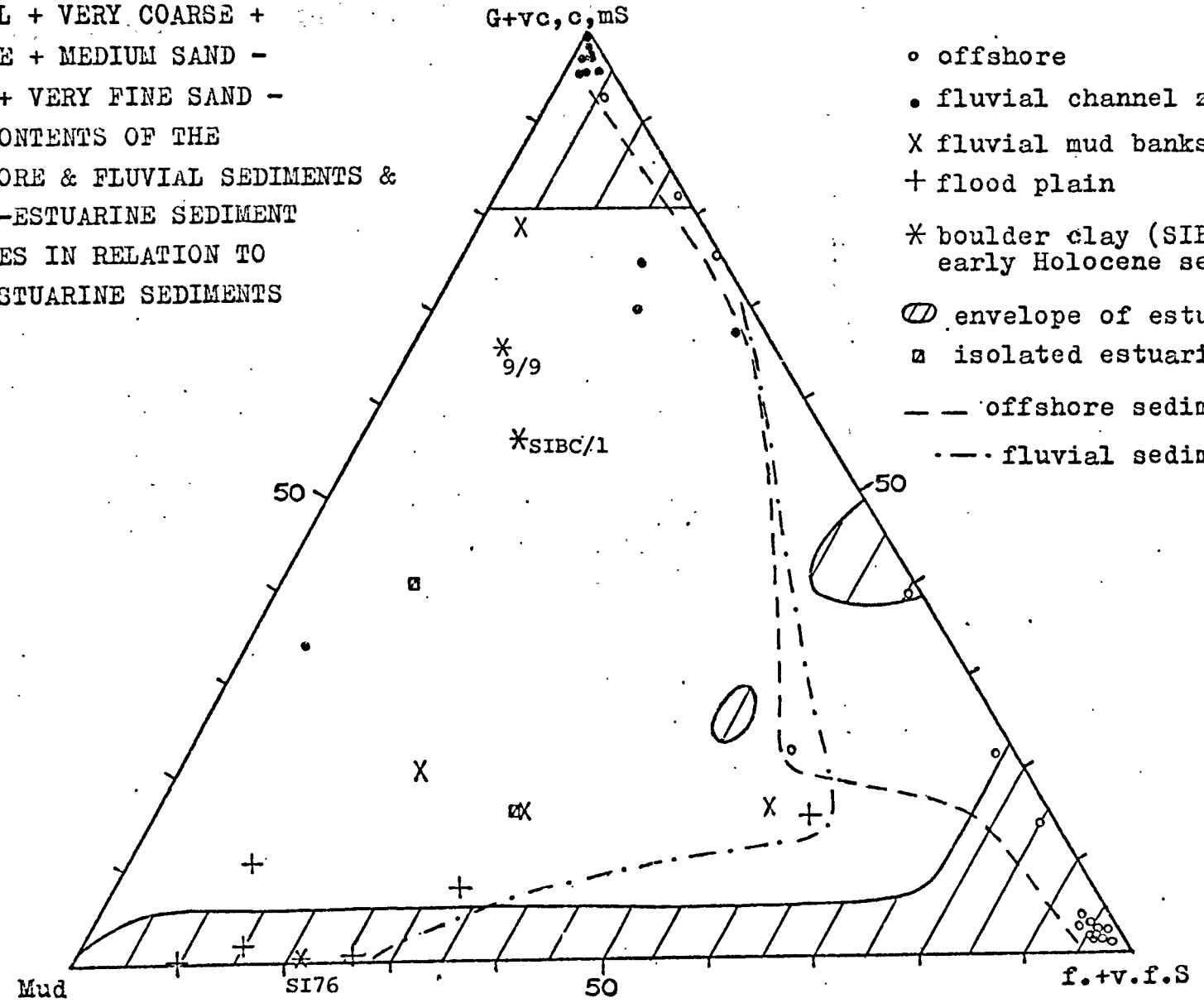
ϕ units

FIG. 4.57 Frequency curve fields of the fluvial sediments

channel zone
mud banks
flood plain

4 5 6 7 8 9

FIG.4.58 GRAVEL + VERY COARSE + COARSE + MEDIUM SAND - FINE + VERY FINE SAND - MUD CONTENTS OF THE OFFSHORE & FLUVIAL SEDIMENTS & INTRA-ESTUARINE SEDIMENT SOURCES IN RELATION TO THE ESTUARINE SEDIMENTS



∘ offshore
• fluvial channel zone
X fluvial mud banks
+ flood plain
✳ boulder clay (SIBC/1,9/9) & early Holocene sediments (SI76)
envelope of estuarine sediments
isolated estuarine sediments
— — offshore sediments field
·—· fluvial sediments field

FIGURE 4.59 GRAVEL-SAND-MUD CONTENTS OF THE OFFSHORE AND FLUVIAL SEDIMENTS AND INTRA-ESTUARINE SEDIMENT SOURCES IN RELATION TO THE ESTUARINE SEDIMENTS

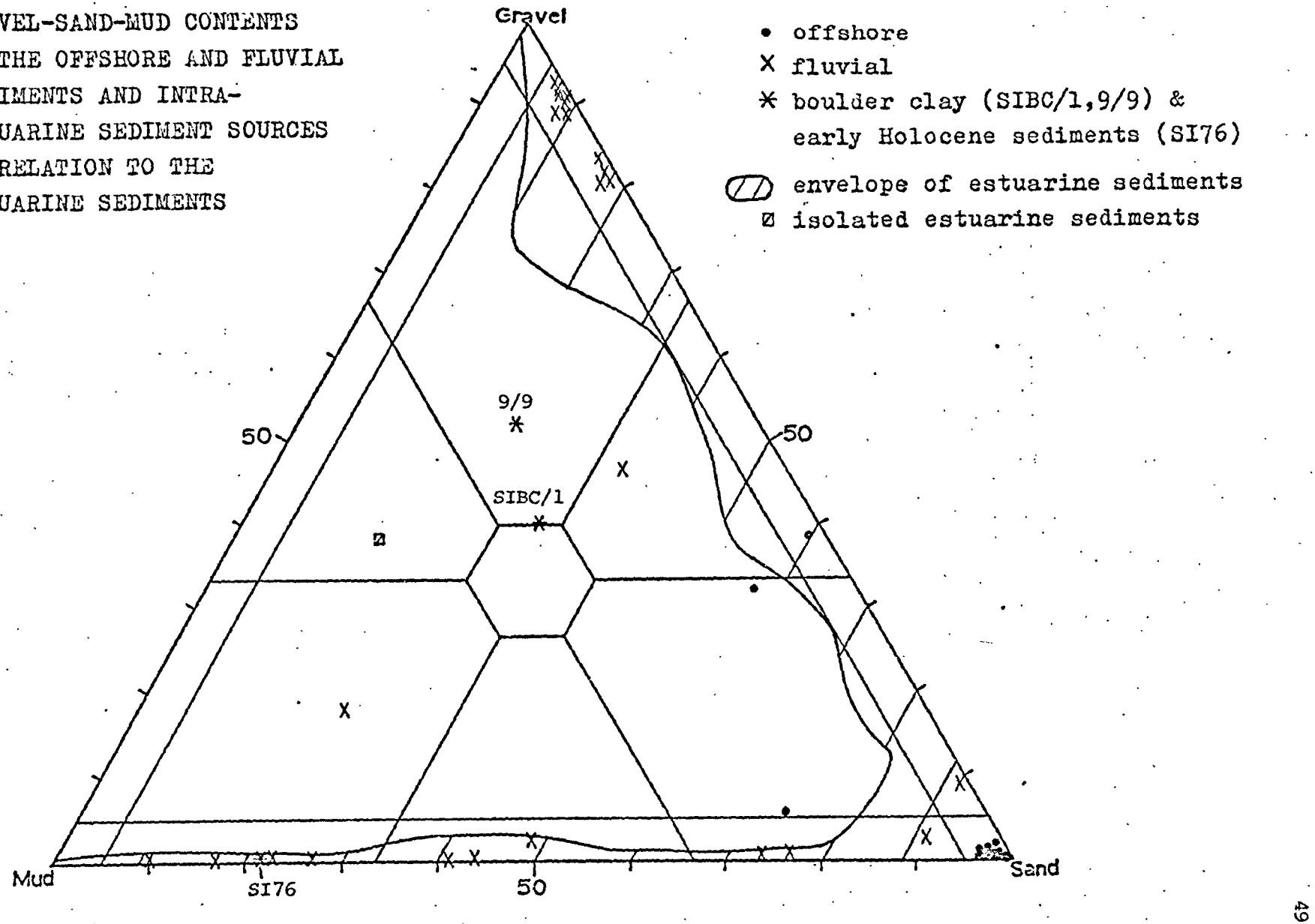
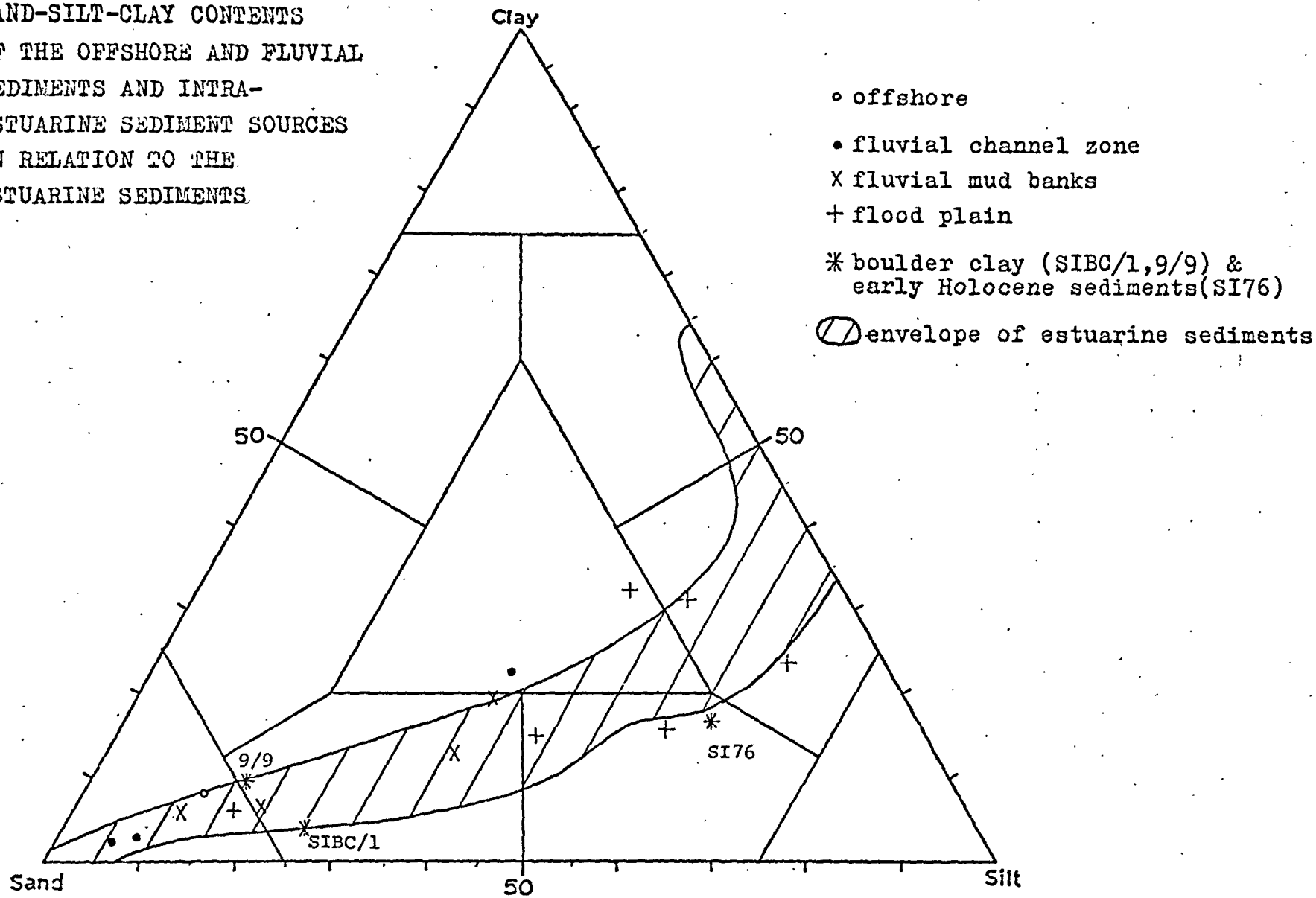


FIGURE 4.60 SAND-SILT-CLAY CONTENTS OF THE OFFSHORE AND FLUVIAL SEDIMENTS AND INTRA-ESTUARINE SEDIMENT SOURCES IN RELATION TO THE ESTUARINE SEDIMENTS



FIGURES 4.61 - 4.65 BIVARIATE PLOTS OF GRAIN SIZE PARAMETERS FOR THE SEDIMENTS OF CARMARTHEN BAY, THE TOWY RIVER, THE BOULDER CLAY, AND EARLY HOLOCENE AGE, IN RELATION TO THOSE OF THE ESTUARINE SEDIMENTS

FIGURE 4.61 MEAN GRAIN SIZE AGAINST STANDARD DEVIATION (SORTING)

FIGURE 4.62 MEAN GRAIN SIZE AGAINST SKEWNESS

FIGURE 4.63 MEAN GRAIN SIZE AGAINST NORMALISED KURTOSIS

FIGURE 4.64 STANDARD DEVIATION AGAINST SKEWNESS

FIGURE 4.65 SKEWNESS AGAINST NORMALISED KURTOSIS

KEY TO FIGURES :-

- + Offshore sediments
- × Nearshore sediments
- • Fluvial channel zone sediments
- △ Fluvial mud bank sediments
- ○ Flood plain sediments
- ✳ Boulder clay sediments (SIBC/1,9/9) and early Holocene sediments (SI76)

- — — Estuarine channel zone sediments
- —·— Upper sandflats
- ——— Dunes
- - - - Mudflats
- —··— Salt marshes

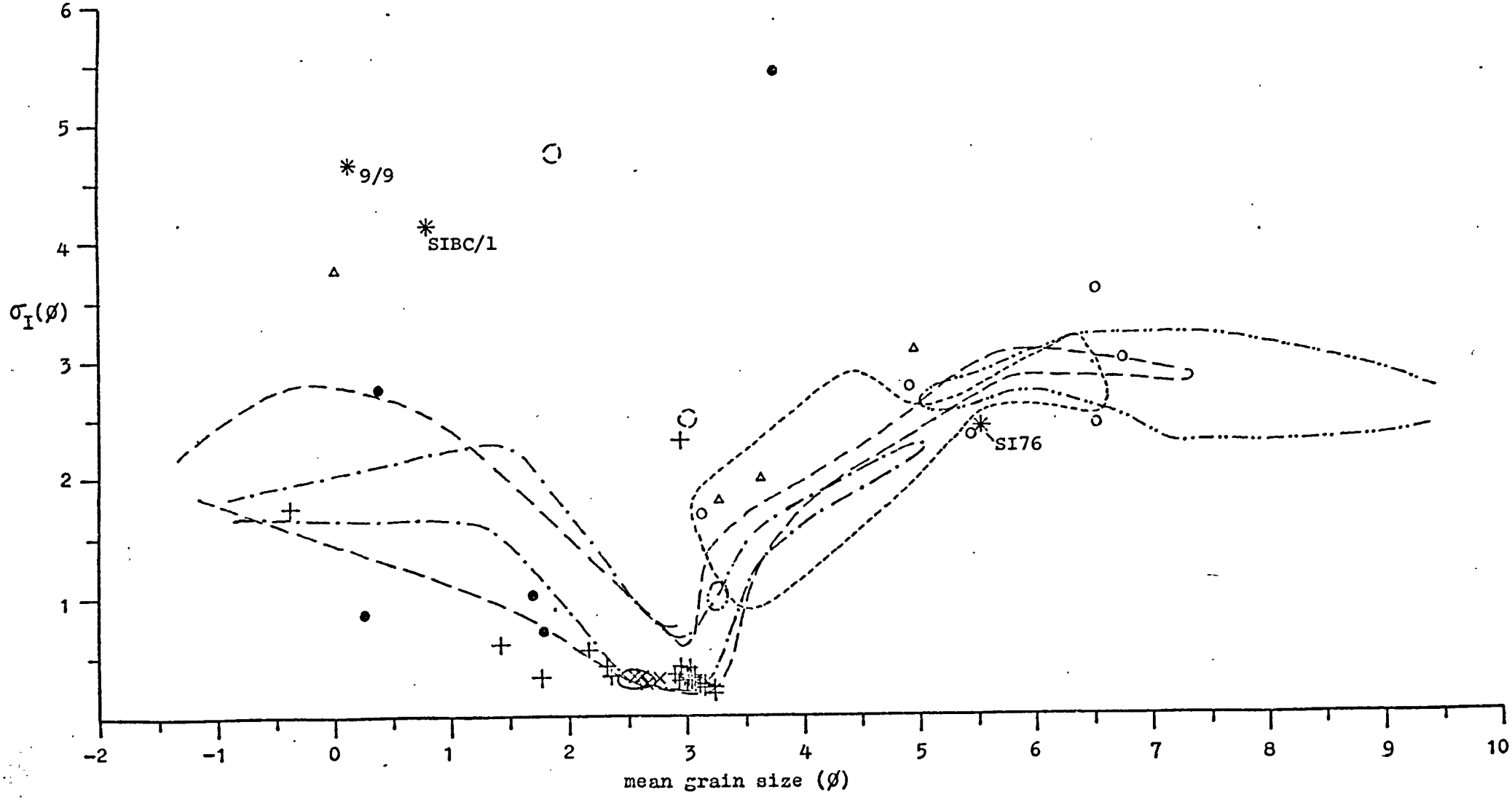


FIGURE 4.61 MEAN GRAIN SIZE AGAINST STANDARD DEVIATION (SORTING)

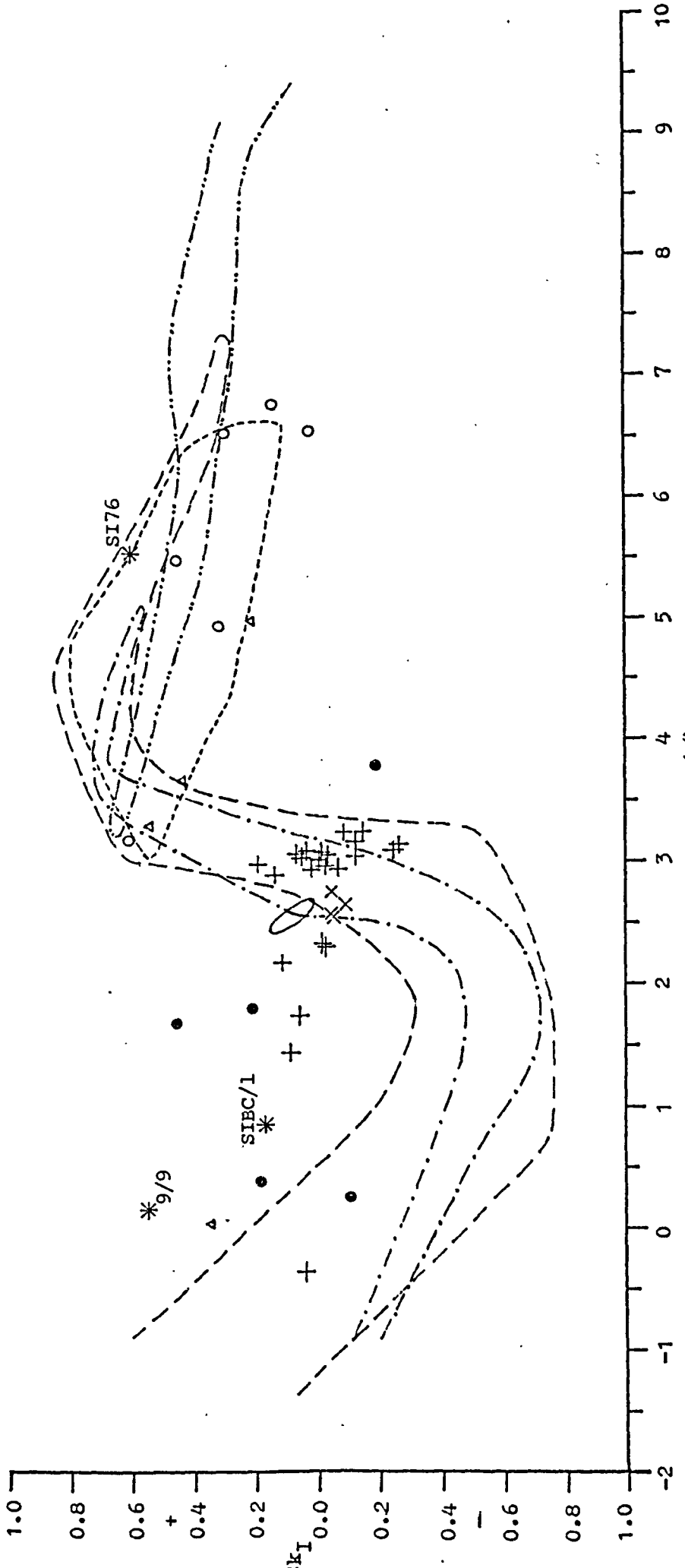


FIGURE 4.62 MEAN GRAIN SIZE AGAINST SKEWNESS

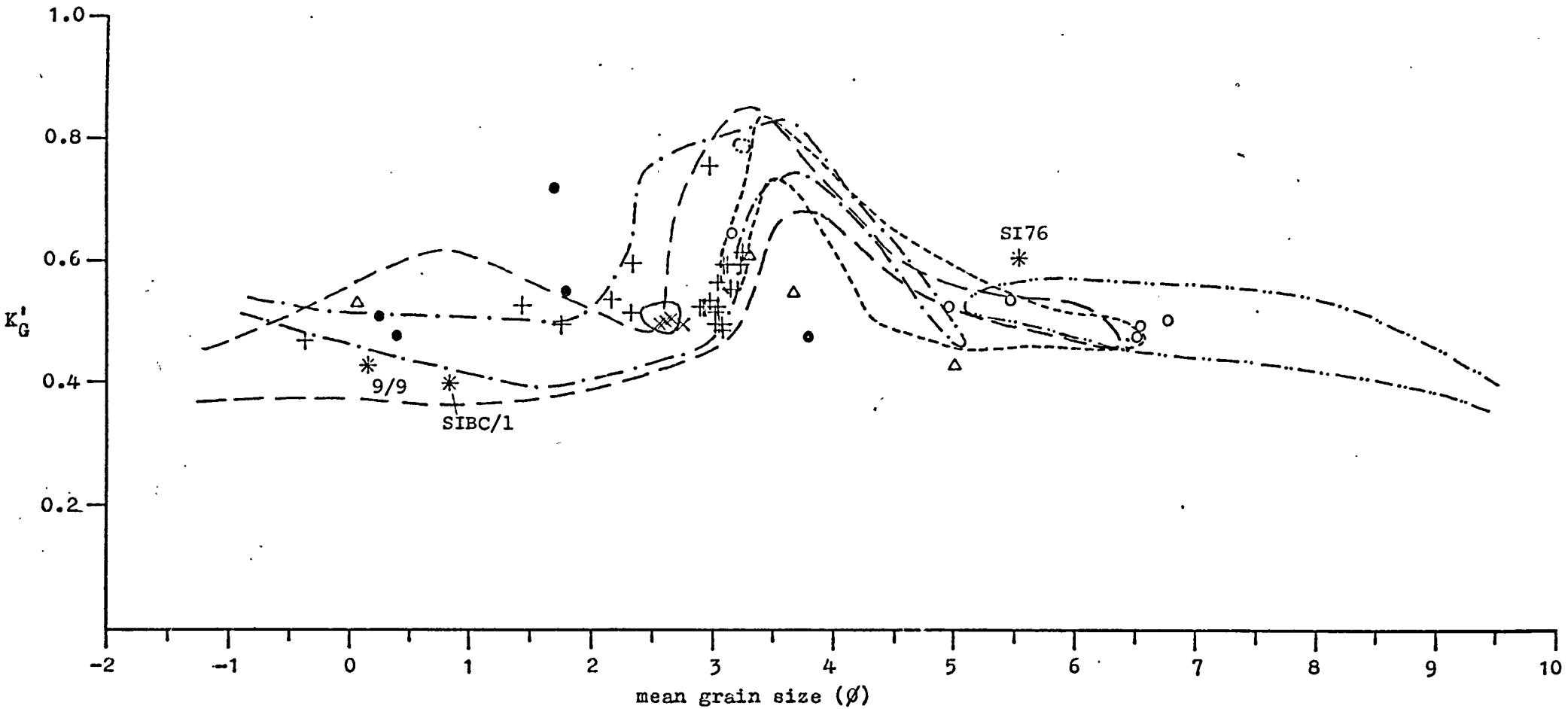


FIGURE 4.63 MEAN GRAIN SIZE AGAINST NORMALISED KURTOSIS

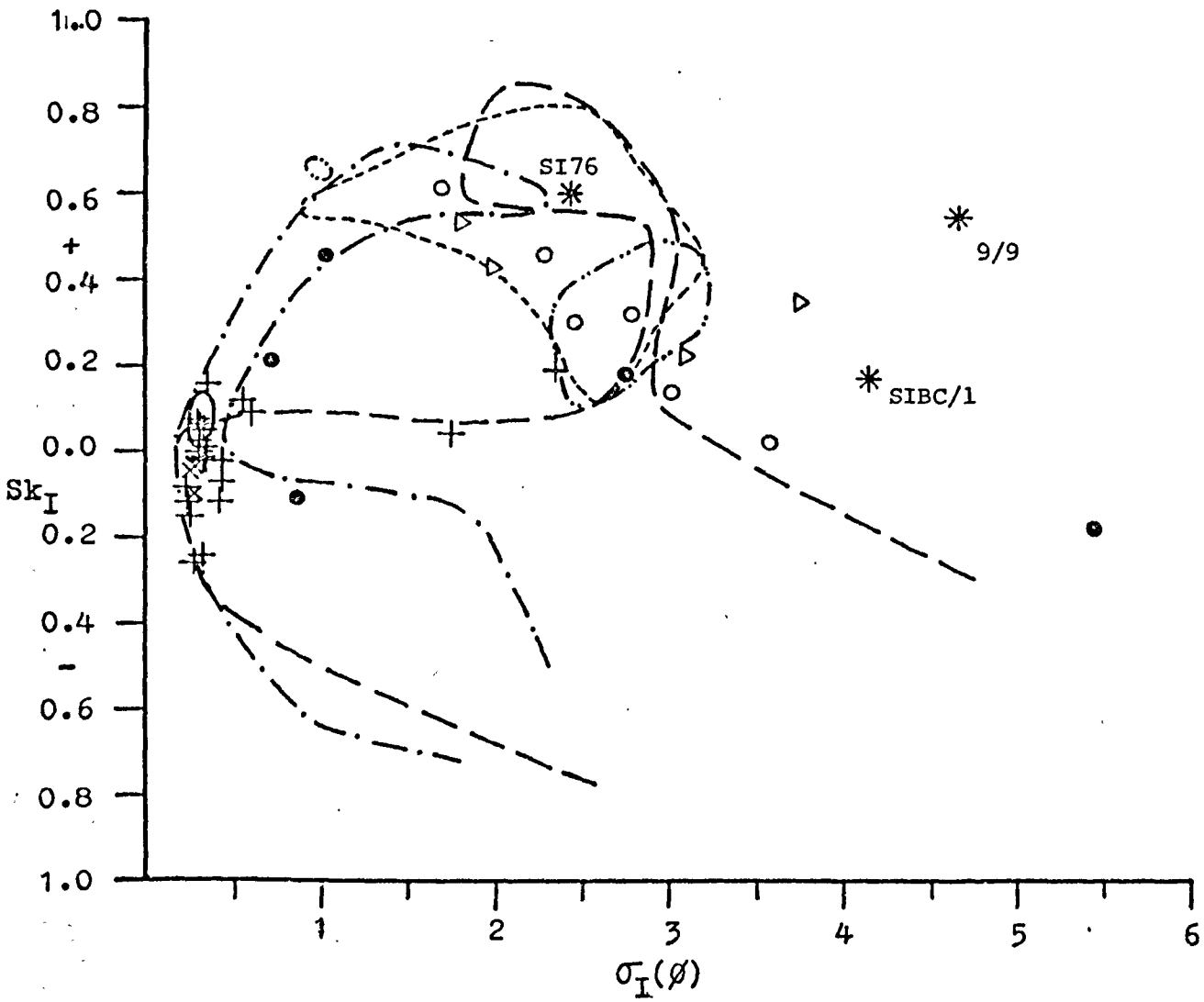


FIGURE 4.64 STANDARD DEVIATION (SORTING) AGAINST SKEWNESS

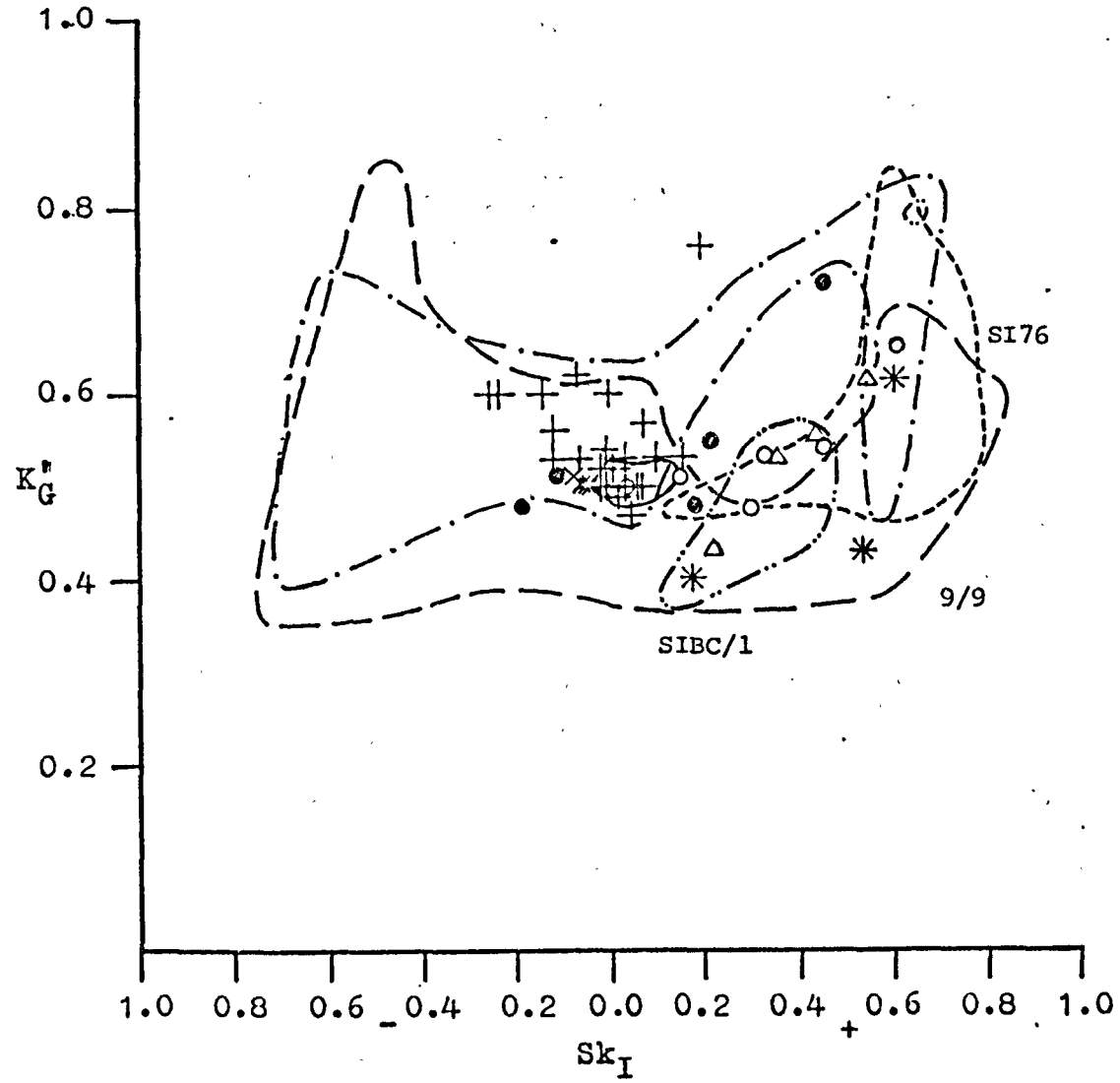


FIGURE 4.65 SKEWNESS AGAINST NORMALISED KURTOSIS

TABLE 4.1 MECHANICS OF SAMPLE PREPARATION AND ANALYSIS

INITIAL TREATMENT

1) Bulk sample coned and quartered to give reasonable sized split.

2) Split was soaked in distilled water for 24 hours with occasional stirring.

   Except: if sample was muddy 25 ml. of 3.5% Calgon solution added.

   if sample contained *in situ* organic material (i.e. was from salt marsh or flood plain) it was pre-treated with H_2O_2 to remove this.

3) The sample was wet sieved through B.S. 240 mesh sieve (63 μm) to separate it into a coarse, sand and gravel, fraction and a mud fraction.

SAND AND GRAVEL

4) This fraction was oven-dried, weighed and sieved through a nest of British Standard Endecott sieves for 15 minutes using a Rotap mechanical shaker. Most samples were sieved at ½Ø intervals, but some were done at ½Ø. Gravel where this exceeded 5% was sieved by hand through sieves corresponding to -4Ø, -3Ø, -2.25Ø and -1.67Ø.

5) Each sieve and the pan fraction were weighed to the nearest 0.001 g. and weight loss due to sieving calculated.

MUD

6) If little was present, then this was filtered through a Watmans 240 filter paper, dried and weighed, or dried in a beaker and weighed.

7) If much, ca. 5%, was present, then pipette analysis was performed.

PIPETTE ANALYSIS

8) The suspension was made up to 1 litre with distilled water in a graduated cylinder (internal diameter = 6 cm.) and any mud obtained from sieving of the coarse fraction was added.

9) The suspension was placed in a constant temperature bath at 25°C, and left to stand for 12-24 hours to ensure that the suspension was effectively deflocculated.

10) Analysis began by agitating the suspension using a plunger to obtain a uniform distribution of sediment, and an initial aliquot of 25 ml. was withdrawn immediately by pipette from 20 cm. depth, in order to provide a measure of the total sediment concentration.

11) Further 25 ml. aliquots were taken at the following times from 10 cm. depth to provide concentrations of the suspension after particular grades had settled beyond that depth in that time:-

5Ø	6Ø	7Ø	8Ø	9Ø
1min.42sec.	6min.47sec.	27min.6sec.	1hr.48min.23sec.	7hr.14min.7sec.

The suspension was restirred before and after the 1min.42sec. withdrawal but subsequently was generally left to sediment.
N.B. Not all these grades were sampled for each suspension, as sometimes sampling ceased at 8Ø, or was only of 8Ø (to provide clay content), or was 5Ø, 6Ø and 8Ø, omitting 7Ø.

12) The aliquots were placed in weighing bottles, dried and weighed to the nearest 0.001 g., after equilibriation with air temperature and humidity.

13) The weights corresponding to each grade could then be calculated by

subtraction from the corrected aliquot weights.

MECHANICAL TREATMENT

14) The raw data were totalled, percentaged, and then transformed into cumulative frequency curves, plotted on arithmetic probability paper; from which the statistical parameters were subsequently determined.

PIMCh - 3 splits

	a.	b.	c.	av.	range	range limits ± range/2	S.D.
Gravel	0.46	0.24	2.60	1.10	2.36	1.18	1.06
Sand	98.31	98.87	96.80	97.99	2.07	1.04	0.87
Mud	1.23	0.89	0.60	0.91	0.63	0.32	0.26
Mdø	2.93	2.93	2.95	2.94	0.02	0.01	0.01
Mzø	2.94	2.94	2.94	2.94	0.00	0.00	0.00
σ_Iø	0.31	0.30	0.34	0.32	0.04	0.02	0.02
Sk_I	-0.01	0.00	-0.16	-0.06	0.16	0.08	0.07
K_G	1.13	1.08	1.19	1.13	0.11	0.06	0.05

F32 - 1 split -sieved twice

	a.	b.	av.	range	range limits	S.D.
Gravel	0.18	0.18	0.18	0.00	0.00	0.00
Sand	99.67	99.65	99.66	0.02	0.01	0.01
Mud	0.15	0.17	0.16	0.02	0.01	0.01
Mdø	2.64	2.66	2.65	0.02	0.01	0.01
Mzø	2.64	2.67	2.66	0.03	0.02	0.02
σ_Iø	0.29	0.27	0.28	0.02	0.01	0.01
Sk_I	+0.01	+0.04	+0.03	0.03	0.02	0.02
K_G	0.97	0.97	0.97	0.00	0.00	0.00

17/18C - 3 splits

	a.	b.	c.	av.	range	range limits	S.D.
Gravel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sand	5.97	6.16	5.65	5.93	0.51	0.26	0.21
Mud	94.03	93.84	94.35	94.07	0.51	0.26	0.21
Silt	58.45	58.59	57.62	58.22	0.97	0.49	0.43
Clay	35.58	35.25	36.73	35.85	1.48	0.74	0.63
Mdø	6.74	6.68	6.78	6.73	0.10	0.05	0.04
Mzø	7.24	7.13	7.36	7.24	0.23	0.12	0.09
σ_Iø	2.83	2.77	2.89	2.83	0.12	0.06	0.05
Sk_I	+0.31	+0.30	+0.32	+0.31	0.02	0.01	0.01
K_G	0.87	0.89	0.86	0.87	0.03	0.02	0.01

TABLE 4.2 RESULTS OF SPLITS AND REPLICATE ANALYSIS

$$\text{Graphic Mean, } Mz = \frac{\phi 16 + \phi 50 + \phi 84}{3} \quad \text{(in } \phi \text{ units)}$$

$$\text{Inclusive Graphic Standard Deviation, } \sigma_I = \frac{\phi 84 - \phi 16}{4} + \frac{\phi 95 - 05}{6.6} \quad \text{(in } \phi \text{ units)}$$

$$\text{Inclusive Graphic Skewness, } Sk_I = \frac{\phi 16 + \phi 84 - 2\phi 50}{2\,(\phi 84 - \phi 16)} + \frac{\phi 5 + \phi 95 - 2\phi 50}{2\,(\phi 95 - \phi 5)}$$

$$\text{Graphic Kurtosis, } K_G = \frac{\phi 95 - \phi 5}{2.44\,(\phi 75 - \phi 25)}$$

$$\text{Normalised Kurtosis, } \quad K_G' = \frac{K_G}{(1 + K_G)}$$

$\sigma_I(\phi)$ -	0.35	very well sorted
	0.35 - 0.50	well sorted
	0.50 - 1.00	moderately sorted
	1.00 - 2.00	poorly sorted
	2.00 - 4.00	very poorly sorted
	4.00	extremely poorly sorted
SK_I -	-1.00 to -0.30	very coarse-skewed (or very negatively skewed)
	-0.30 to -0.10	coarse-skewed (or negatively skewed)
	-0.10 to +0.10	near-symmetrical
	+0.10 to +0.30	fine-skewed (or positively skewed)
	+0.30 to +1.00	very fine-skewed (or very positively skewed)
K_G -	0.67	very platykurtic
	0.67 - 0.90	platykurtic
	0.90 - 1.11	mesokurtic
	1.11 - 1.50	leptokurtic
	1.50 - 3.00	very leptokurtic
	3.0	extremely leptokurtic

TABLE 4.3. STATISTICAL PARAMATERS AND NOMENCLATURE
(BASED ON FOLK AND WARD 1957)

	Period of low water still stand	Period of high water still stand	
Springs			
A2S	Dried for ca. 2 hrs. at station position but flow continued in adjacent channel. Both effectively 0 min.	ca. 2¾ hr.B.	ca. ½ hr.S
A1S	00 min. S. & B.	ca. 1¼ hr.B.	1¼ hr.S.
B1S	00 min. S. & B.	ca. ¾ hr.B.	ca. ½ hr.S.
B2S/75	ca. 1 hr. S. & B. (almost dried out in channel)	½ hr.B.	½ hr.S.
B2S/74	ca. ¼ hr. S. & B.	1½ hr.B.	ca. 1¼hr.S.
C1S/74	00 min. S. ca. 6 min. B.	1¾ hr.B.	½ hr.S.
D1S/74	00 min. S. & B.	¼ hr.B.	ca. ½ hr.S.
D1S/75	00 min. S. ca. ½ hr. B.	½ hr.B. (estimated)	¼ hr.S.
E1S/75	00 min. S. & B.	?	?
F1S/75	00 min. S. & B.	ca.10 mins.B.	ca.20 mins.S.
Neaps			
A1N	ca. ½ hr.S. 00 min.B.	1¼ hr. B.	1¼ hr.S.
B2N/74	00 min. S. & B.	1 hr. B.	2½ hr.S.
B2N/75	ca. ½ hr.B. 10 min.S.	ca. 2 hr.B.	ca. 1 hr.S.
C1N	ca. ½ hr.B. ca. ½ hr.S.	1½ hr.B.	1 hr.S.
D1N	ca. ½ hr. ?	3½ hr.B.	1 hr.S.
E1N	?	? ¼ hr.B.	? ¼ hr.S.
F1N	00 min. S. & B.	ca. ½ hr.B.	ca. ½ hr.S.

(S = Surface: B = Bottom)

(0.1 m/s taken as the critical transport velocity for muds (Postma 1967), and periods of still stand taken to correspond to periods when current velocity was less than this).

TABLE 4.4. PERIODS OF SLACK WATER (CURRENT SPEEDS LESS THAN 0.1 m/s) IN THE ESTUARY

	18°C.			20°C.		
	1 hr.	½ hr.	¼ hr.	1 hr.	½ hr.	¼ hr.
62.5 (4Ø)	1201 cm	601 cm	300 cm	1262 cm	631 cm	316 cm
31.3 (5Ø)	300	150.1	75	315.5	157.7	78.9
15.6 (6Ø)	75	37.5	18.8	78.9	39.4	19.7
7.8 (7Ø)	18.8	9.4	4.7	19.7	9.9	4.9
3.9 (8Ø)	4.7	2.3	1.2	4.9	2.5	1.2

(Calculated using Stoke's Law. Grains of 62.5μm diameter do not behave exactly according to Stoke's Law, but are close to its upper limit of effectiveness. (ca. 50μm).

TABLE 4.5. DEPTHS THROUGH WHICH QUARTZ SPHERES OF CERTAIN DIAMETERS WILL FALL IN VARIOUS PERIODS OF TIME

SPRING TIDES

Station	Salinity of maximum flood current velocity	
	Surface (°/oo)	Bottom (°/oo)
*B2S	ca. 23.5	ca. 25
DIS	18.8	ca. 19 - 20
EIS	0.9	0.9
FIS	0.0	0.0

NEAP TIDES

Station	Salinity of maximum flood current velocity	
	Surface (°/oo)	Bottom (°/oo)
AIN	22.6 & 28.8	23.0
B2N	25.3	25.7
CIN	16 - 19	ca. 23.0
DIN	ca. 5	ca. 5
EIN	ca. 2.5	ca. 3
FIN	0.0	0.0

(* Deduced by comparison with B2S/74)

TABLE 4.6. THE SALINITY OF THE MAXIMUM FLOOD CURRENT VELOCITIES FOR SPRING AND NEAP TIDES (1975 DATA)

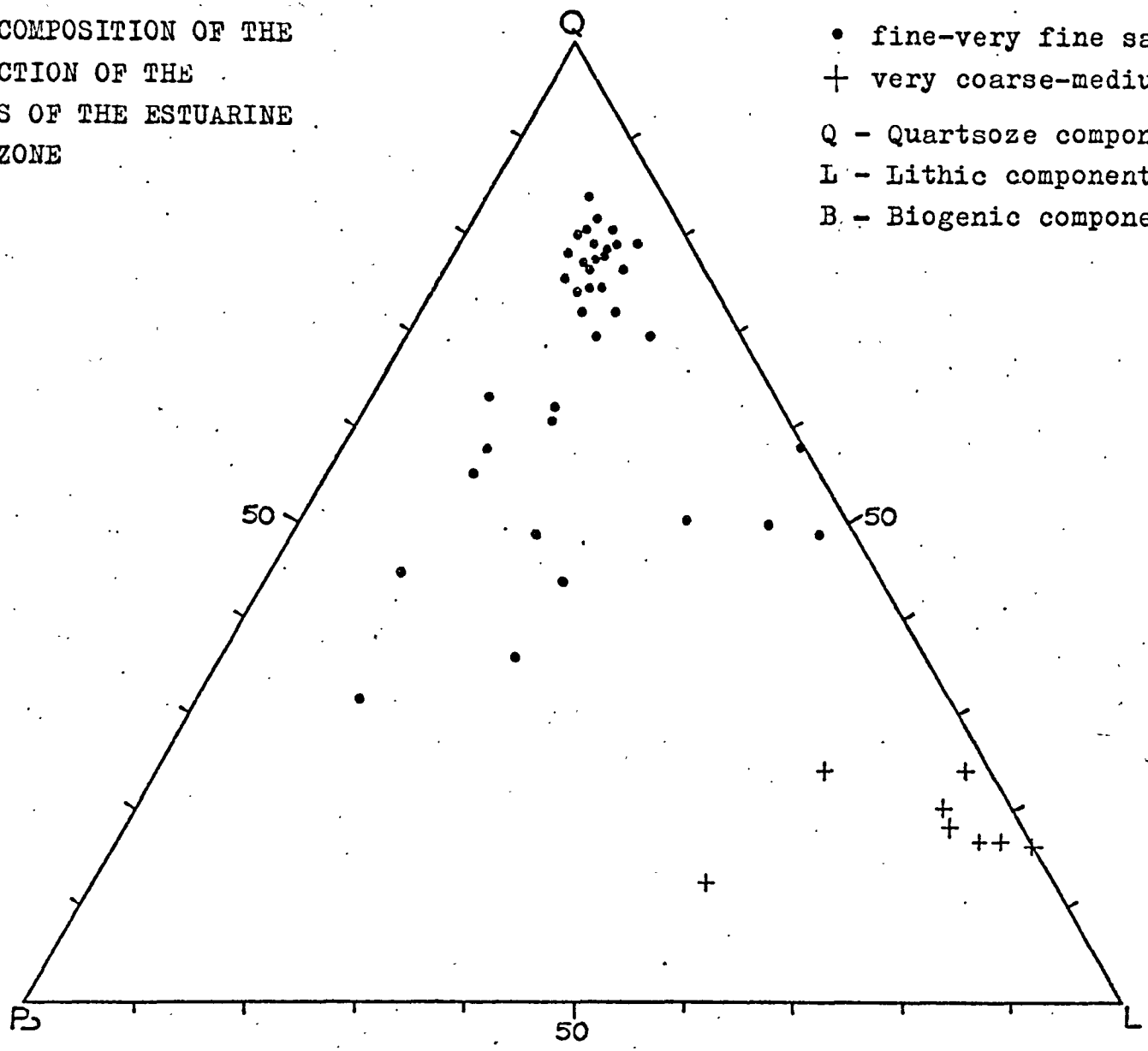
	Boulder clay		? Lagoonal sandy mud
	SIBC/1	9/9	
Gravel %	40.23	52.43	0.08
Sand %	31.03	22.39	21.39
Mud %	28.74	25.18	78.54
Silt %	25.23	16.14	62.09
Clay %	3.51	9.04	16.45
$M_z\phi$	0.85	0.75	5.54
$M_d\phi$	0.16	-1.43	4.78
$\sigma_I\phi$	4.15	4.66	2.42
Sk_I	+0.17	+0.54	+0.60
K_G	0.68	0.76	1.59

TABLE 4.7. GRAIN SIZE PARAMETERS FOR 2 BOULDER CLAY SAMPLES AND AN EARLY HOLOCENE SEDIMENT SAMPLE

CHAPTER 5

FIGURES AND TABLES

FIG.5.1 GENERAL COMPOSITION OF THE SAND FRACTION OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE



• fine-very fine sand grade.
+ very coarse-medium sand grade

Q - Quartsoze components
L - Lithic components
B - Biogenic components
} see text

KEY TO FIGS. 5.2, 5.3, 5.6, 5.8, 5.10, 5.12,5.14 - 5.21, 5.28 - 5.31, 5.33, 5.34, AND ENCLOSURE FIGURE 14.

G - Gravel)
S - Sand) - in Figs. 5.14 - 5.21 & 5.29 - 5.31
M - Mud)

Q - Clear quartz/feldspar
Qc - Coloured quartz/feldspar
Qcl - Cloudy quartz/feldspar
RF - Rock Fragments
SF - Shell Fragments
Mi - Minor components

The Minor components are differentiated into:-

F - Foraminiferids
E - Echinoid plates and spines
S - Sponge Spicules
B - Bryozoa
O - Ostracods
PF - Plant Fragments
C - Coal
M - Mica
DM - Dark Minerals
G - Glauconie
MC - Mud clasts
Ot - Others

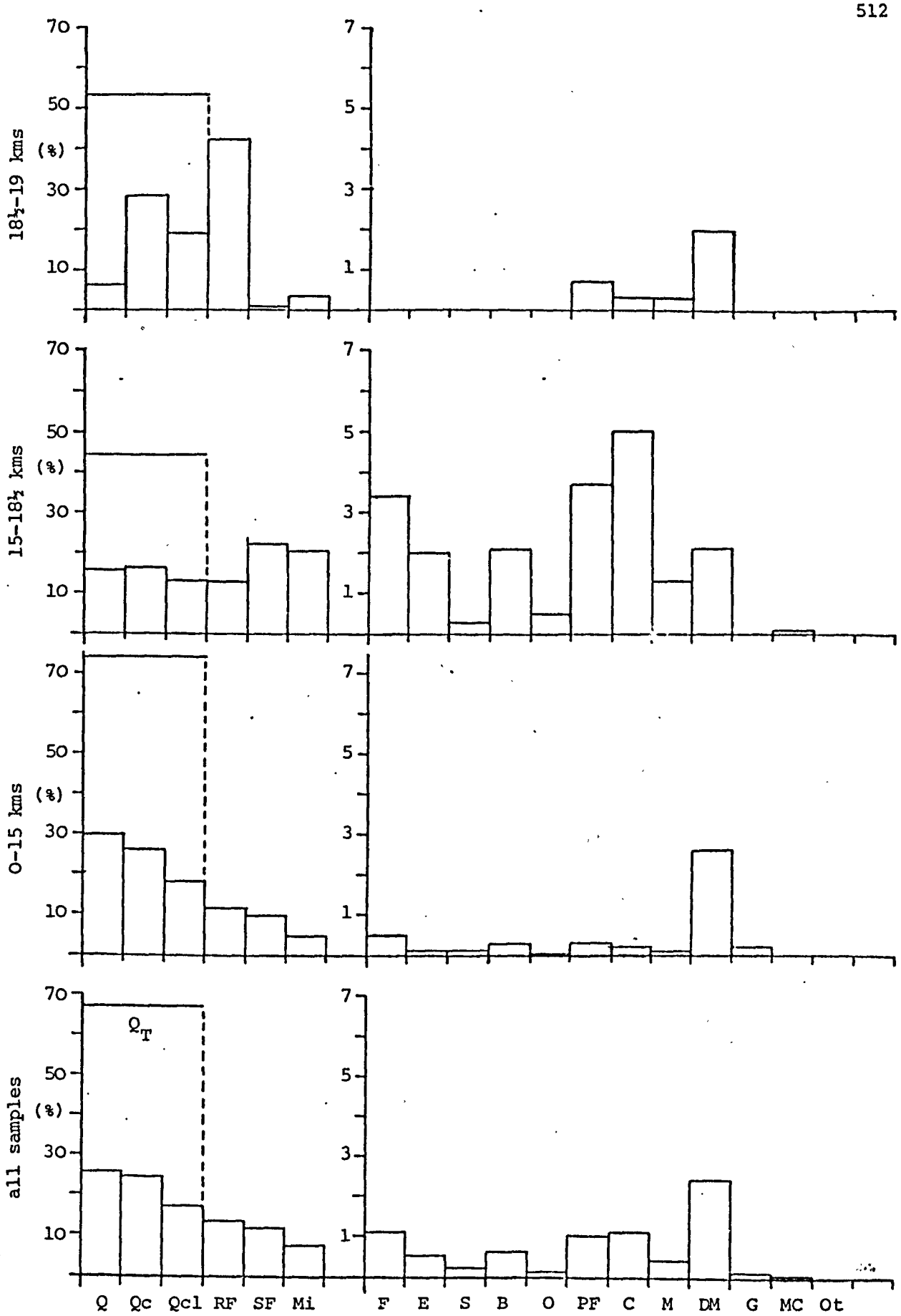


FIG.5.2 AVERAGE COMPOSITION OF THE FINE AND VERY FINE SAND FRACTION OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE

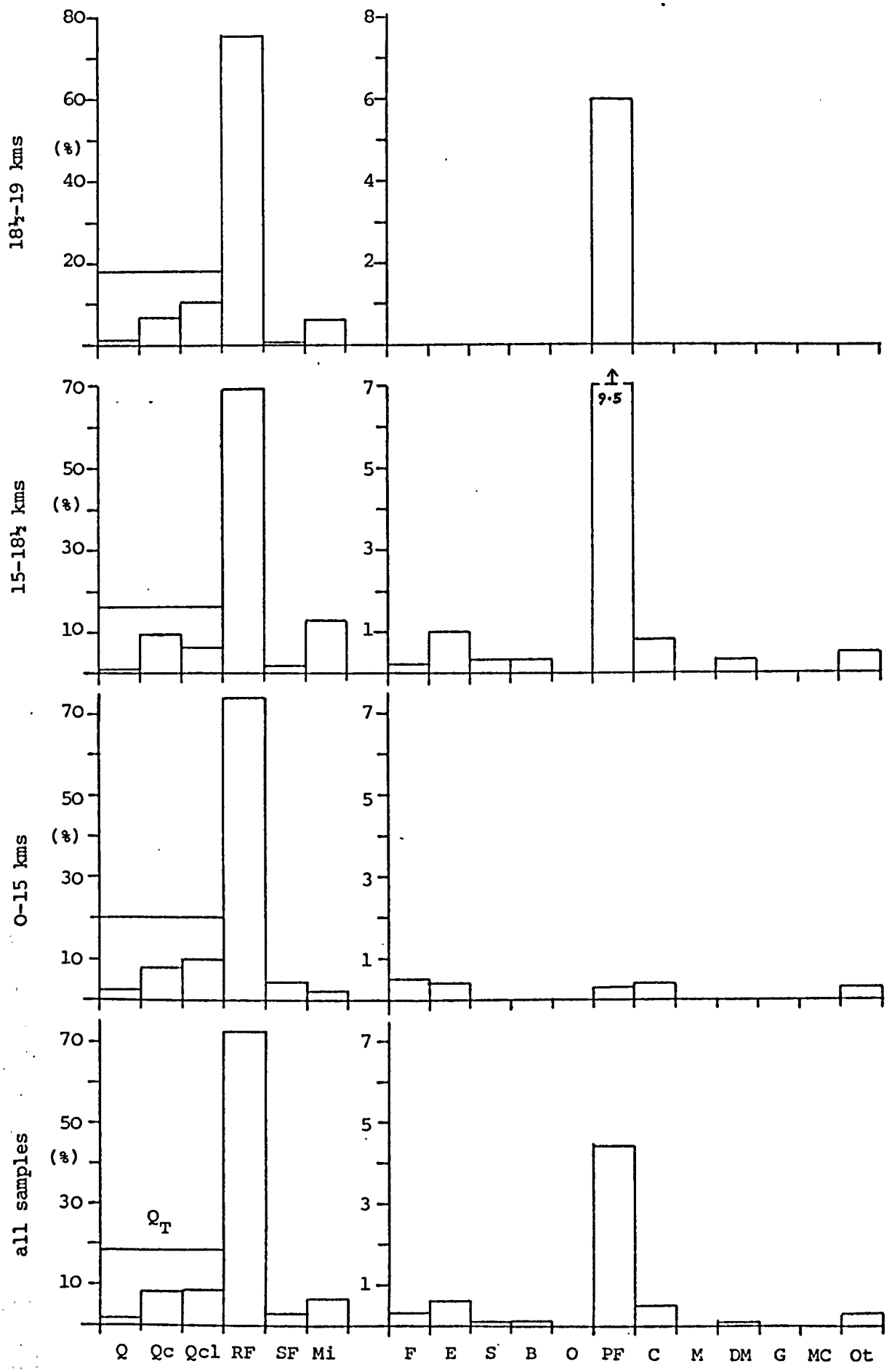


FIG.5.3 AVERAGE COMPOSITION OF THE VERY COARSE - MEDIUM SAND FRACTION OF THE SEDIMENTS OF THE ESTUARINE CHANNEL ZONE

KEY TO FIG.5.4 and Enclosure figure 11 :-



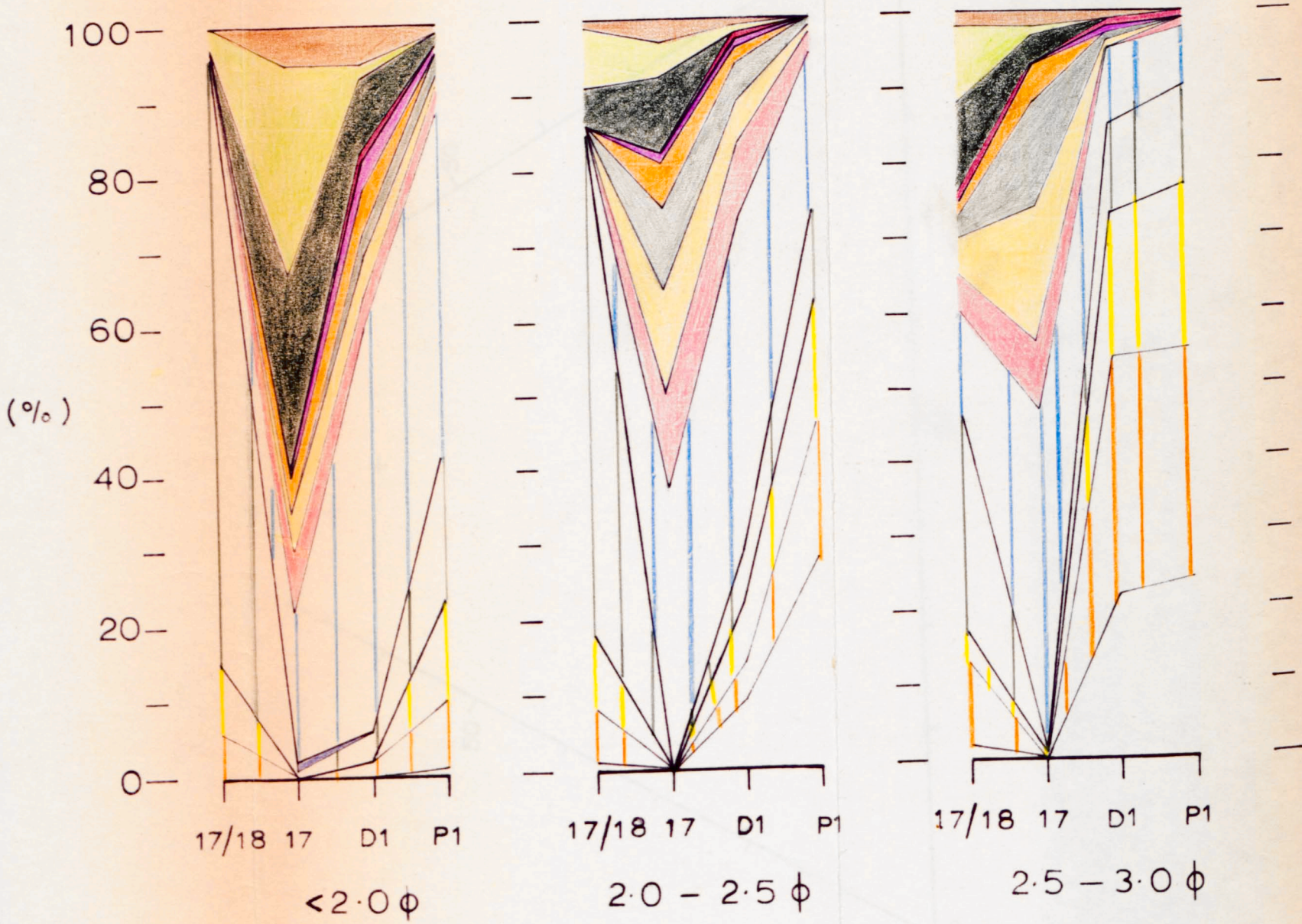
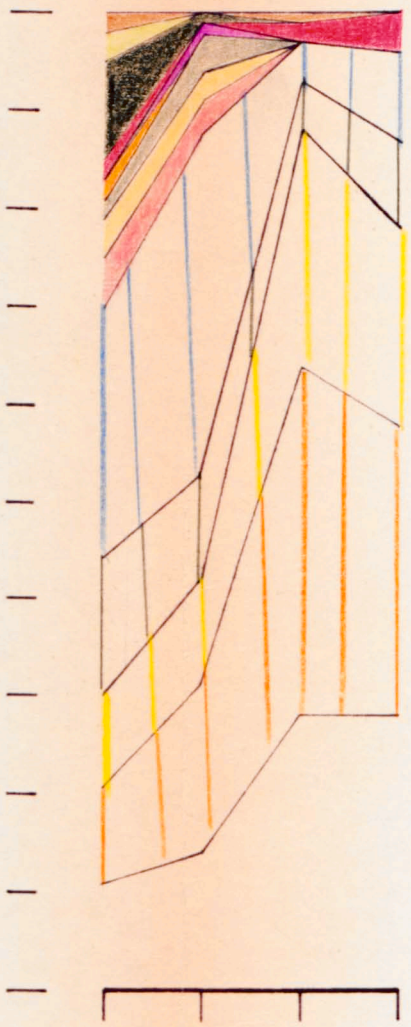
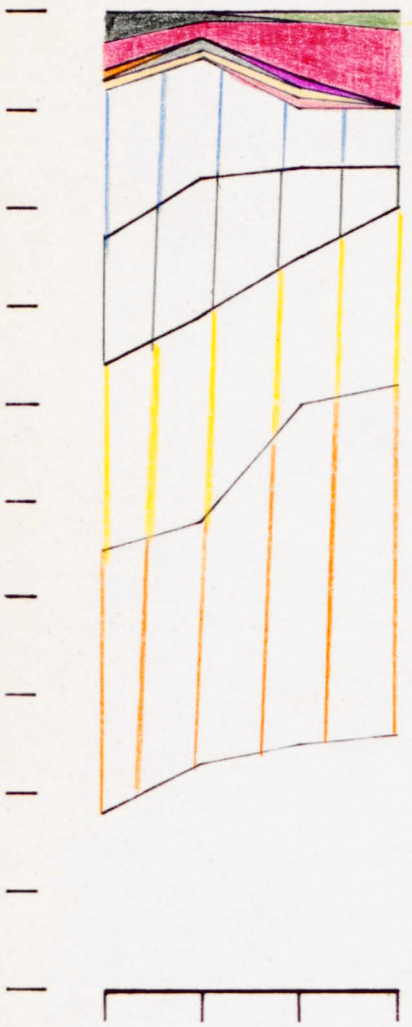


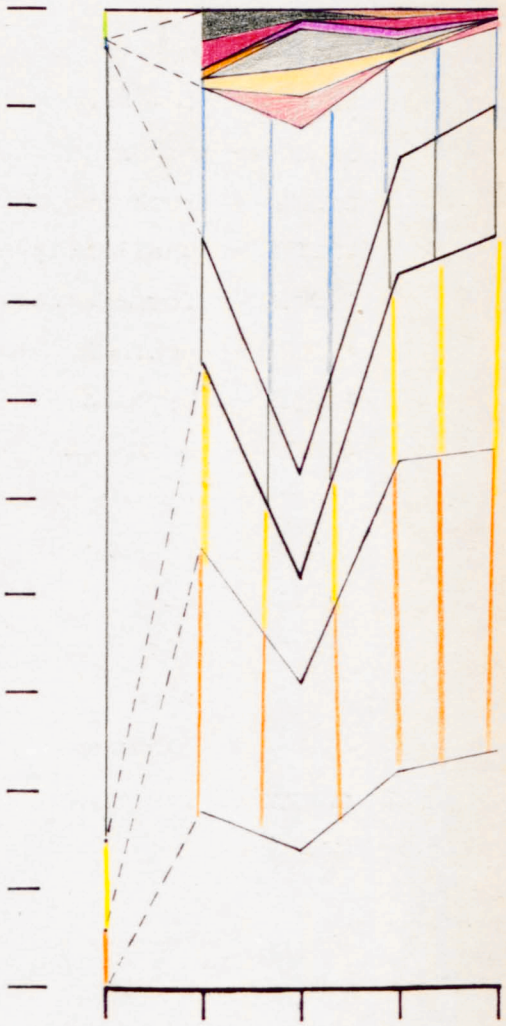
FIG. 5.4 COMPOSITION OF SAND GRADES



3·0 – 3·5 ϕ



3·5 – 4·0 ϕ

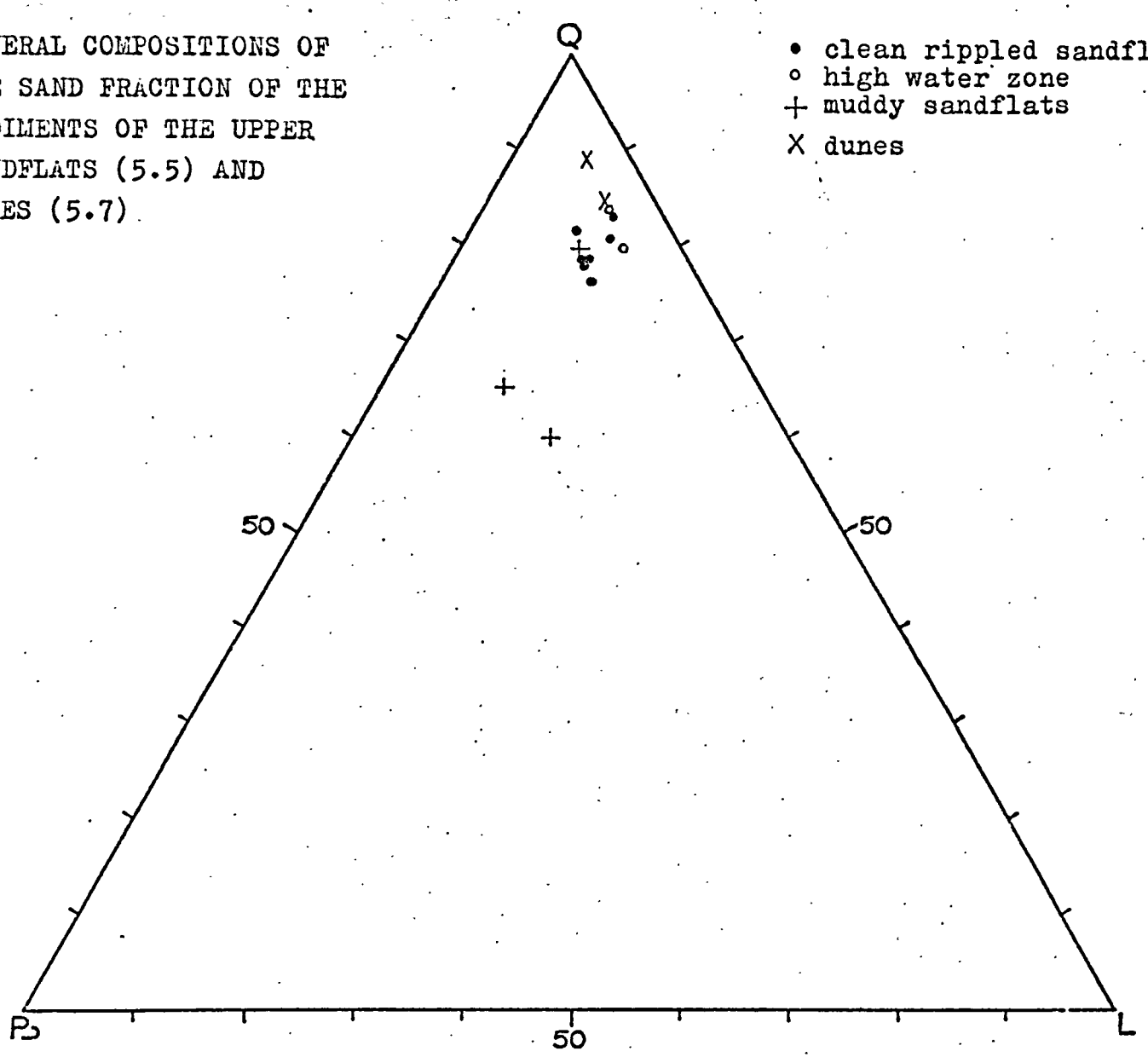


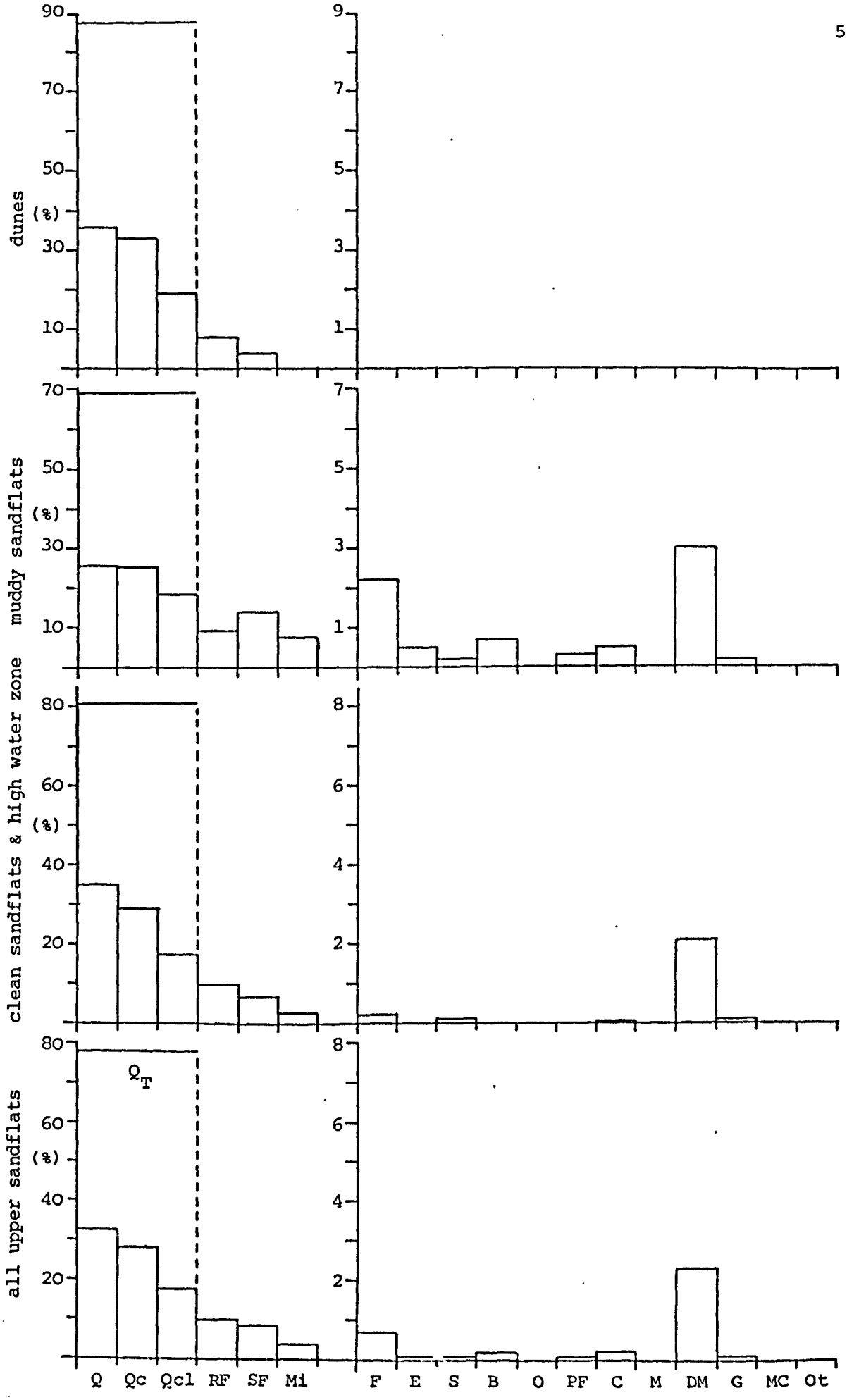
(3·5-4·0) (3·0-3·5) (2·5-3·0) &(1·0-2·0)

mode

(For Key see opposite page)

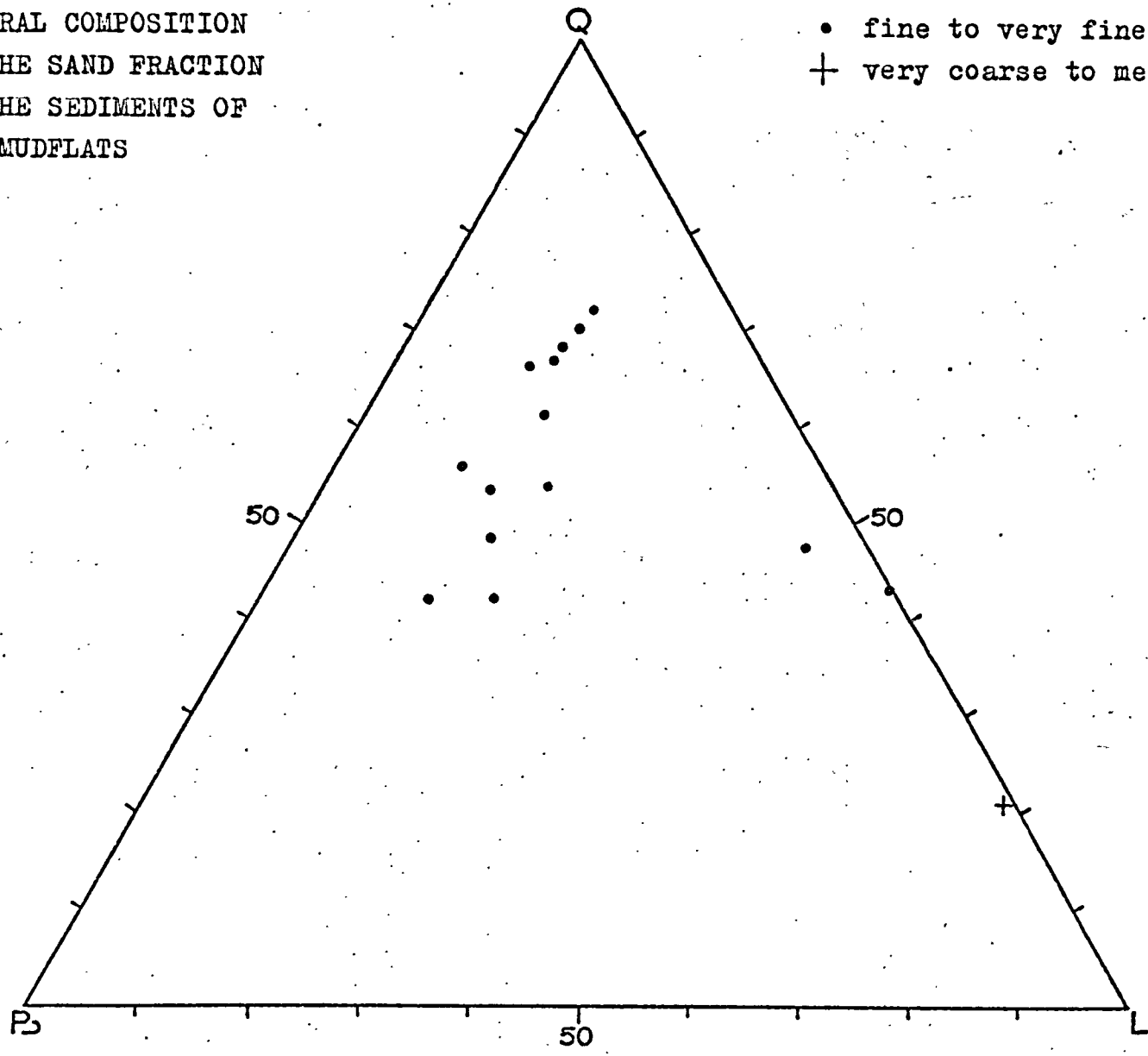
FIGS.5.5 & 5.7 GENERAL COMPOSITIONS OF THE SAND FRACTION OF THE SEDIMENTS OF THE UPPER SANDFLATS (5.5) AND DUNES (5.7).





FIGS.5.6 & 5.8 AVERAGE COMPOSITIONS OF THE SAND FRACTIONS OF THE UPPER SANDFLATS (5.6) AND DUNES (5.8)

FIG.5.9 GENERAL COMPOSITION OF THE SAND FRACTION OF THE SEDIMENTS OF THE MUDFLATS



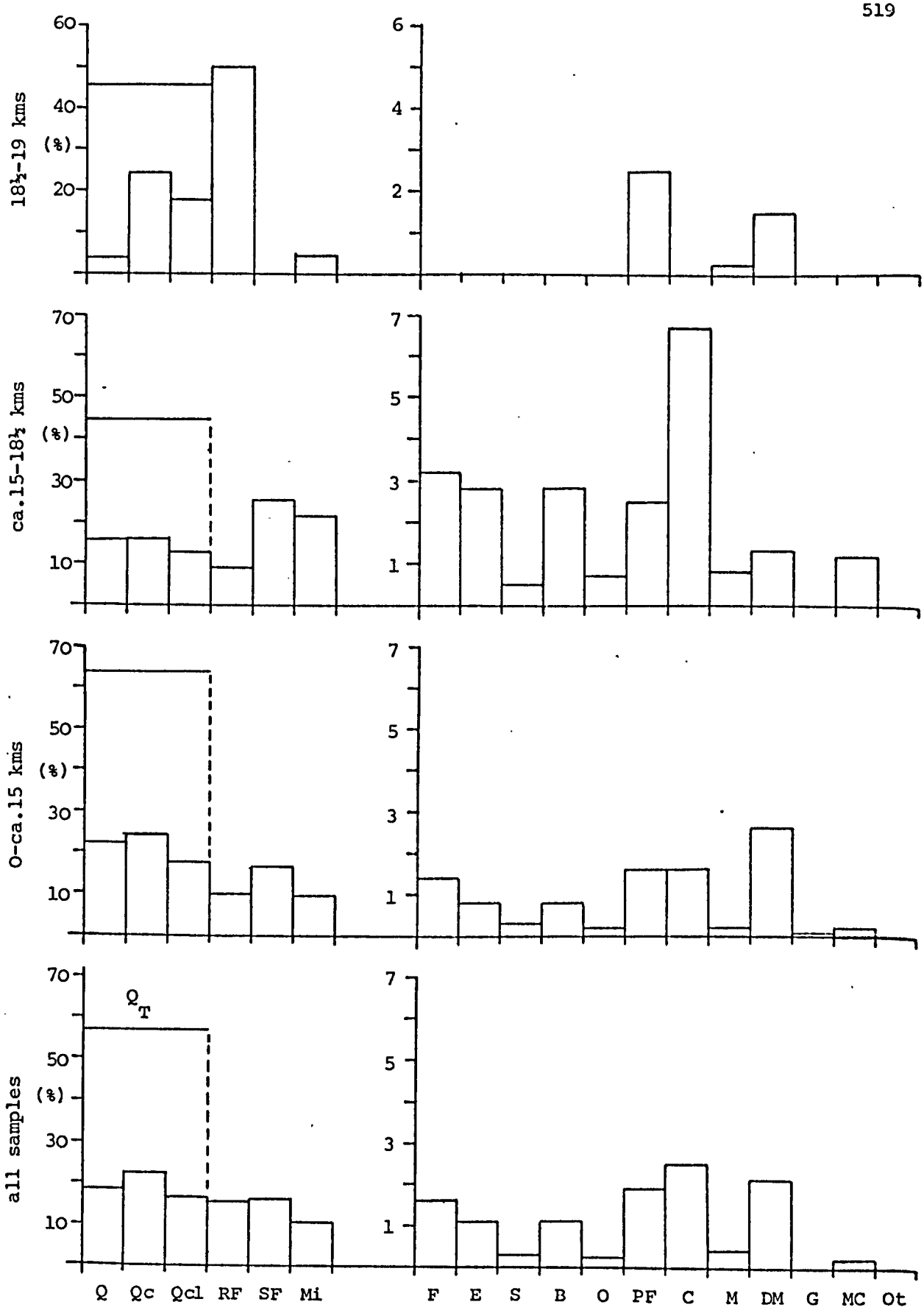
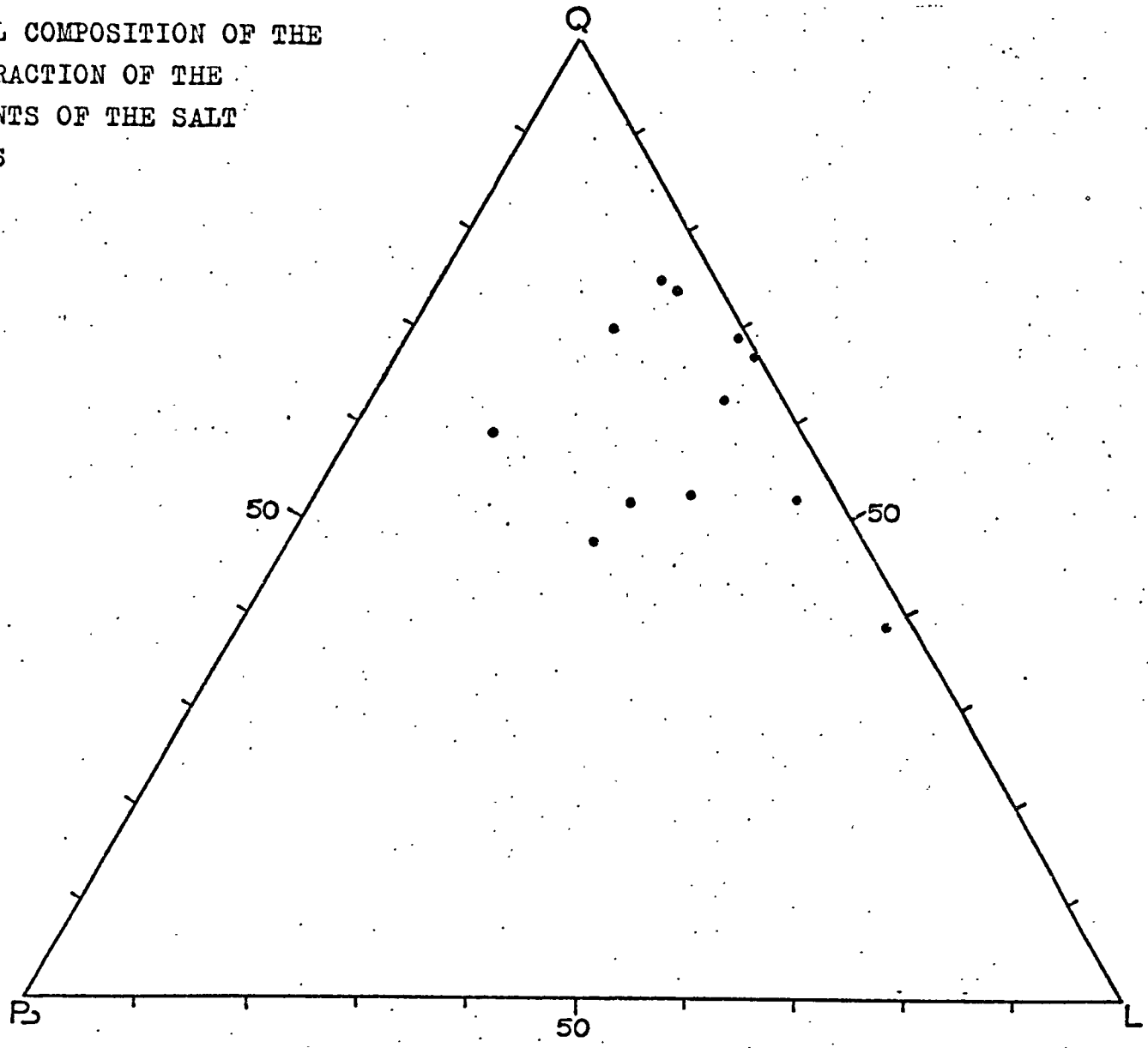


FIG.5.10 AVERAGE COMPOSITION OF THE SAND FRACTION OF THE SEDIMENTS OF THE MUDFLATS

FIG.5.11 GENERAL COMPOSITION OF THE SAND FRACTION OF THE SEDIMENTS OF THE SALT MARSHES



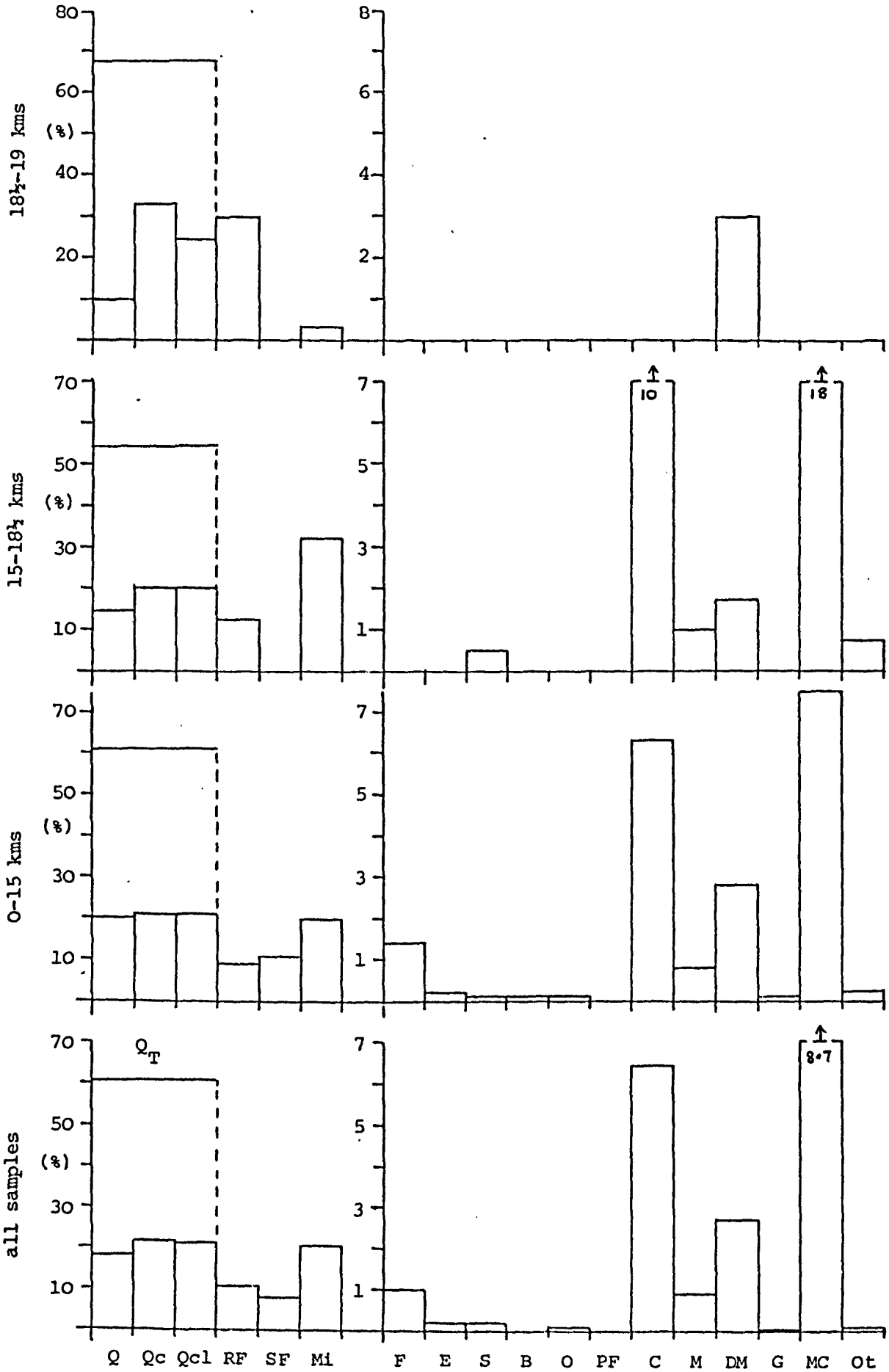
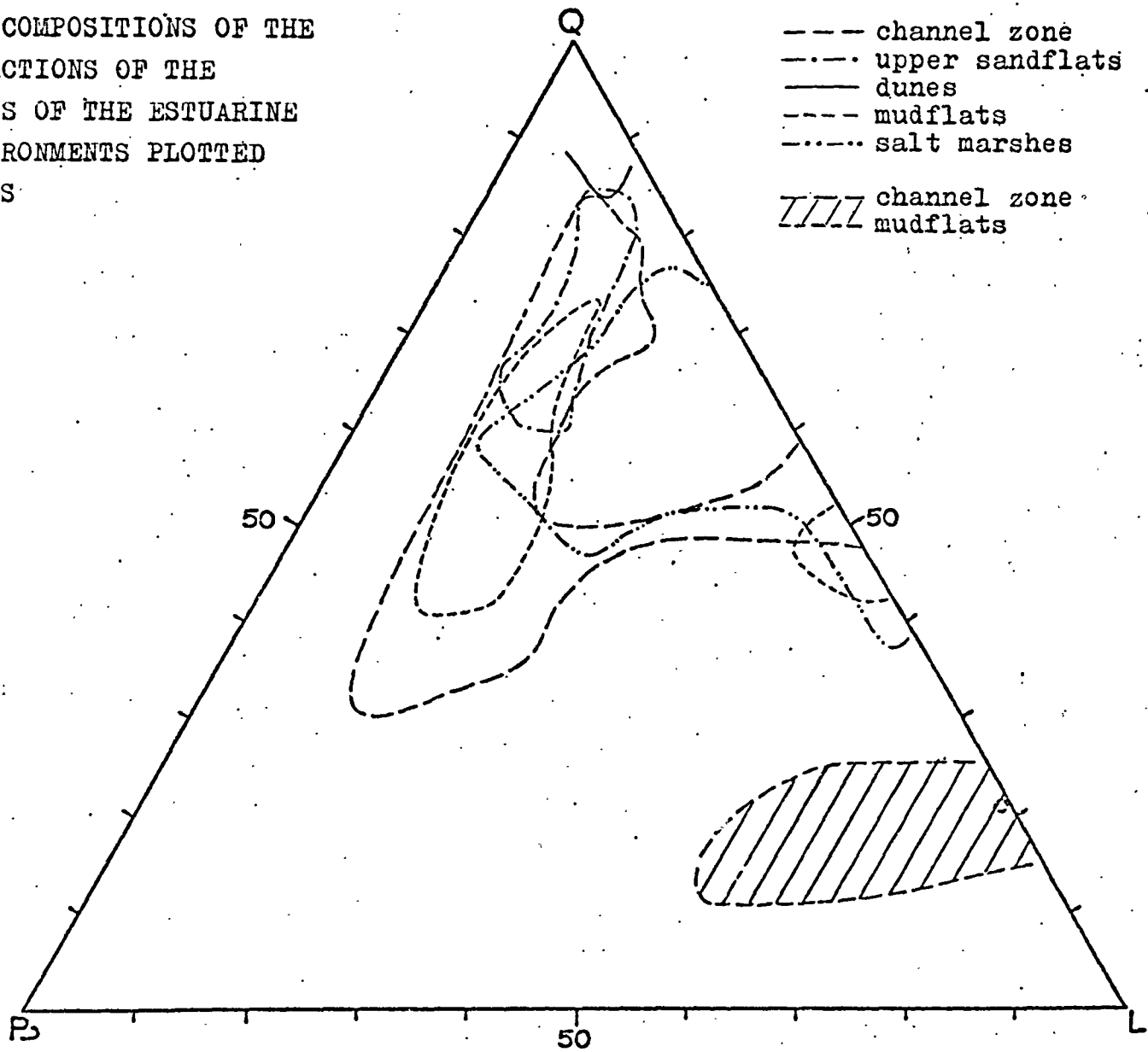


FIG.5.12 AVERAGE COMPOSITION OF THE SAND FRACTION OF THE SEDIMENTS OF THE SALT MARSHES

FIG.5.13 GENERAL COMPOSITIONS OF THE SAND FRACTIONS OF THE SEDIMENTS OF THE ESTUARINE SUB-ENVIRONMENTS PLOTTED AS FIELDS



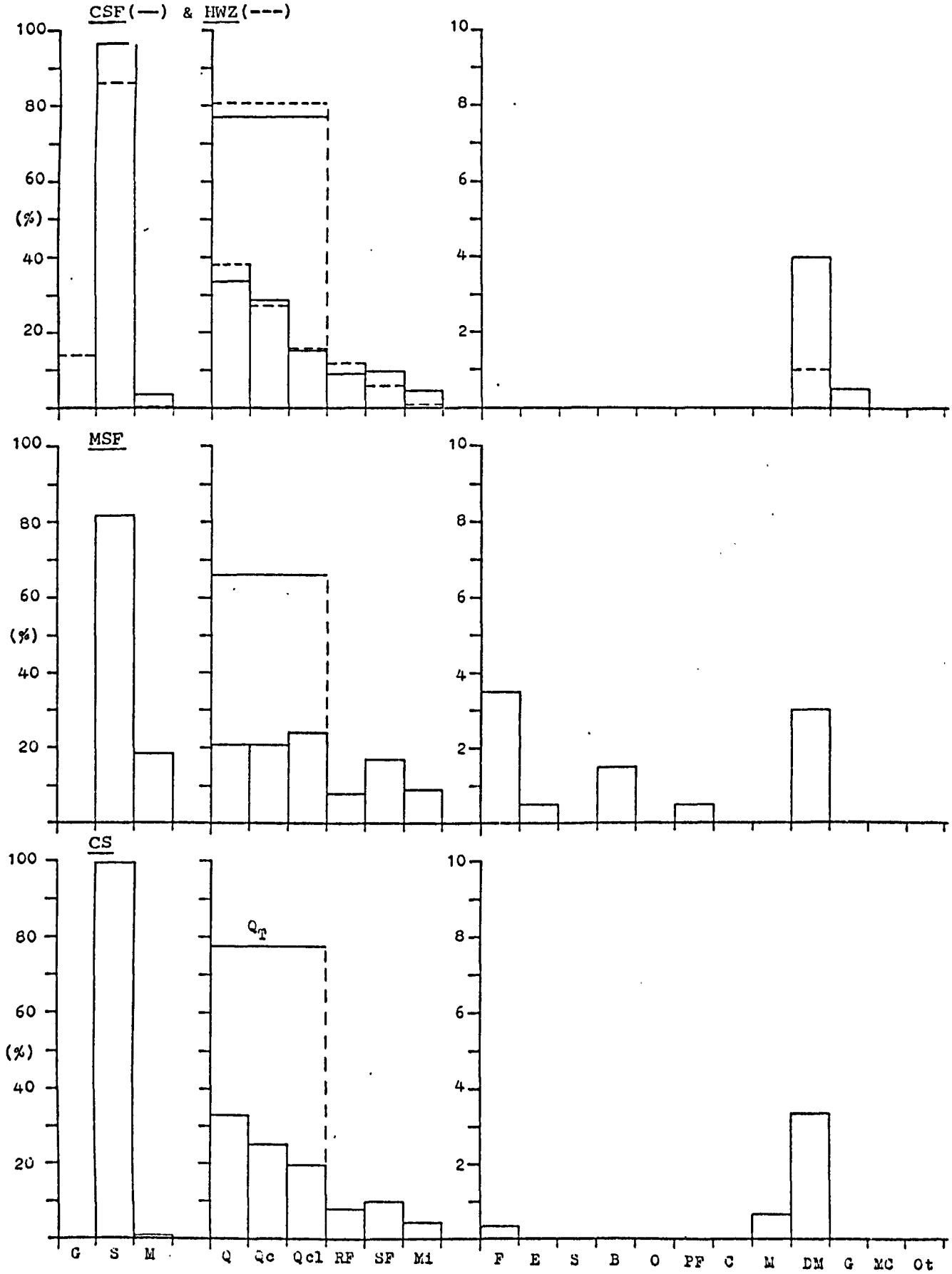


FIG.5.14 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 2 (CS-channel zone, MSF-muddy sandflats, CSF-clean rippled sandflats, HWZ-high water zone)

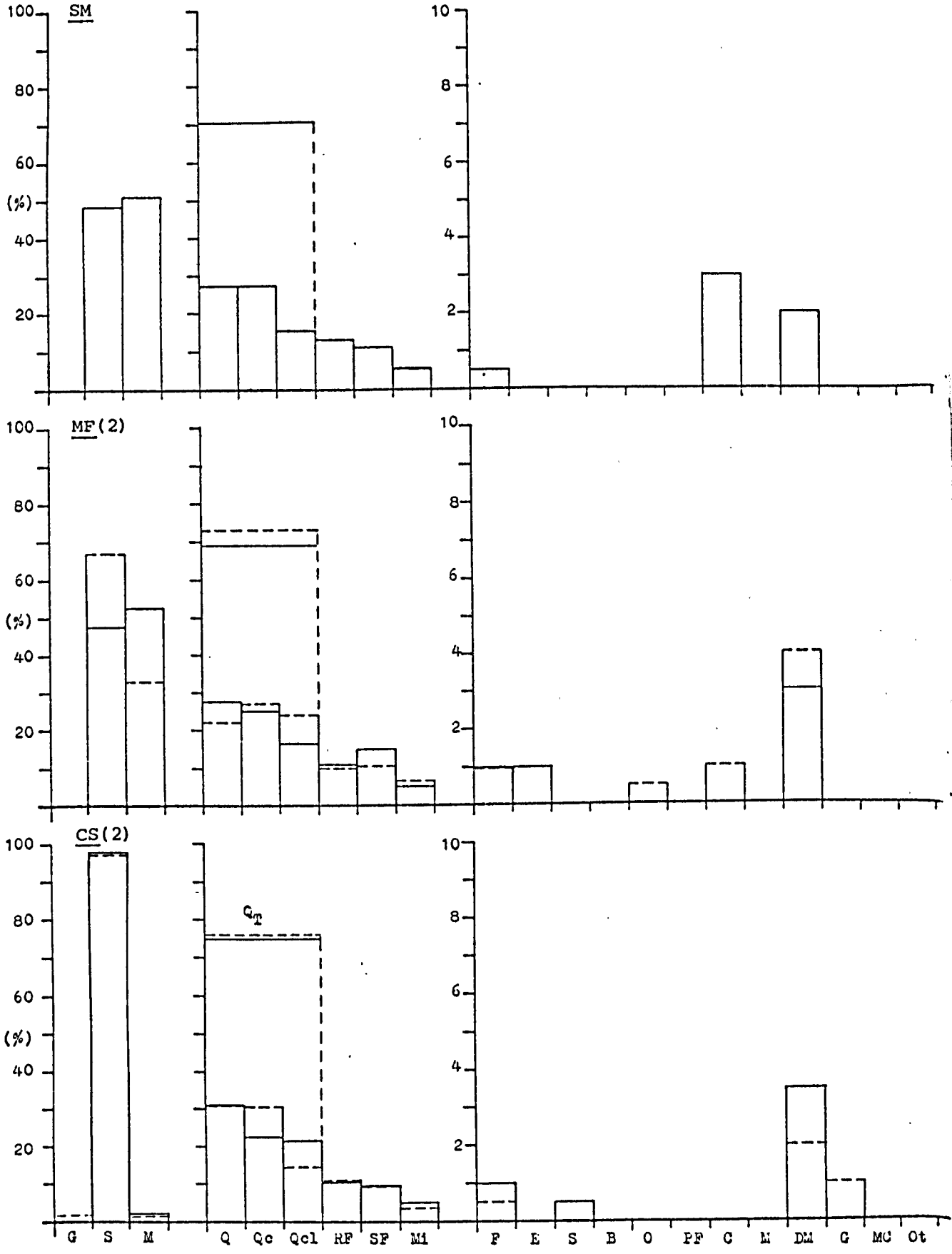


FIG.5.15 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 7 (CS-channel zone, MF-mudflats, SM-salt marsh)

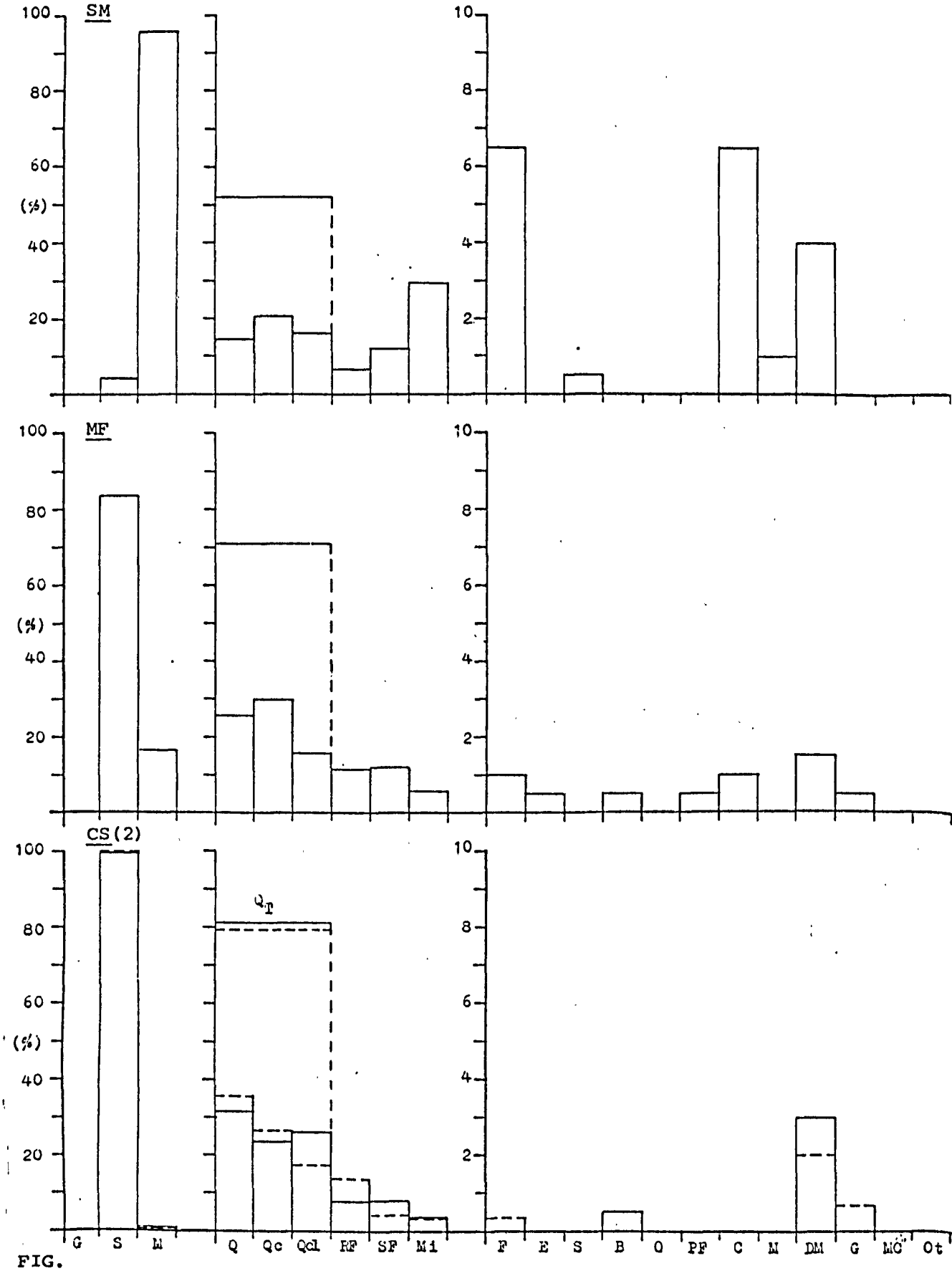


FIG.

FIG.5.16 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 7 (CS-channel zone, MF-mudflats, SM-salt marsh)

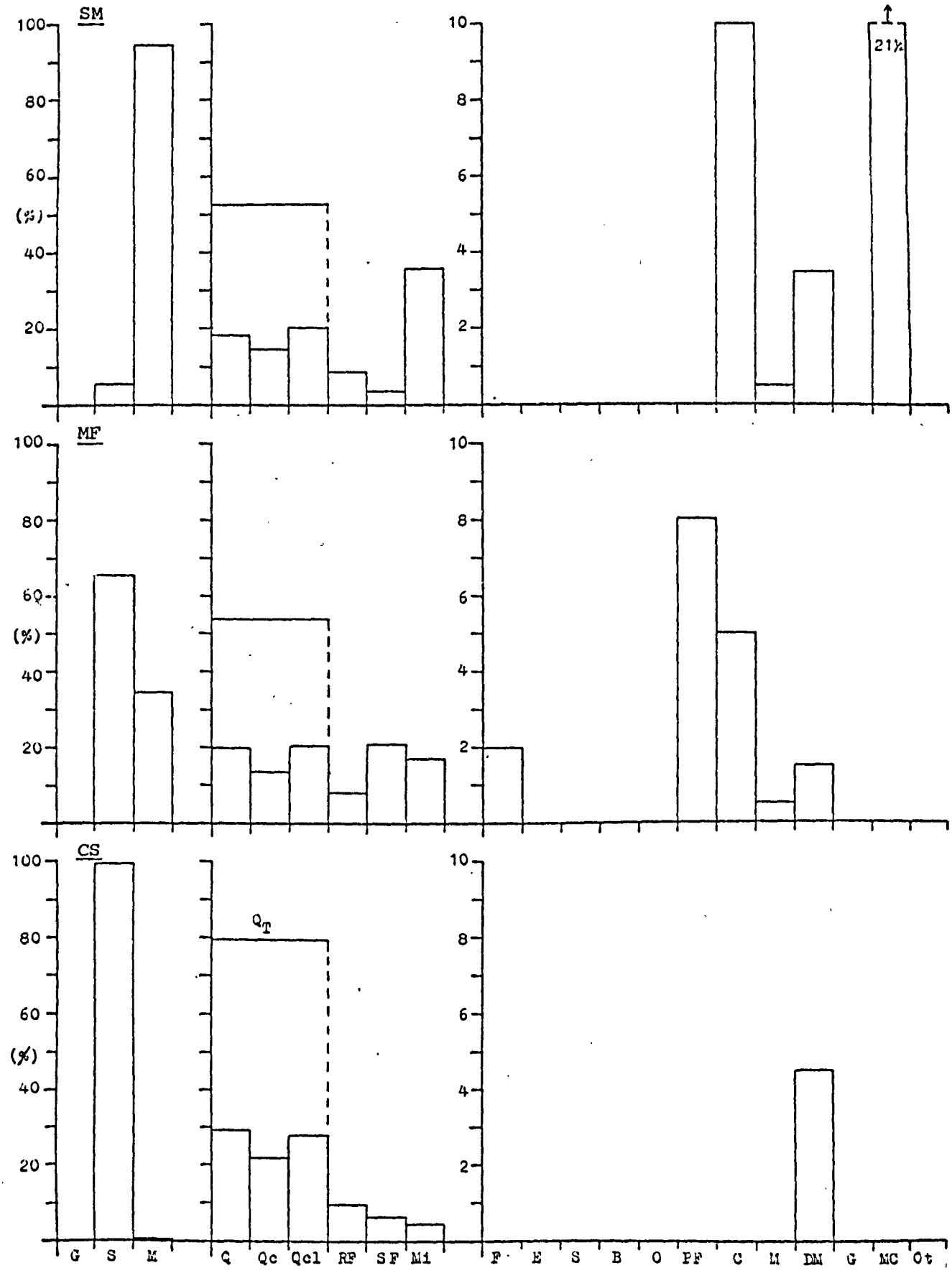


FIG.5.17 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 12 (CS-channel zone, MF-mudflats, SM-salt marsh)

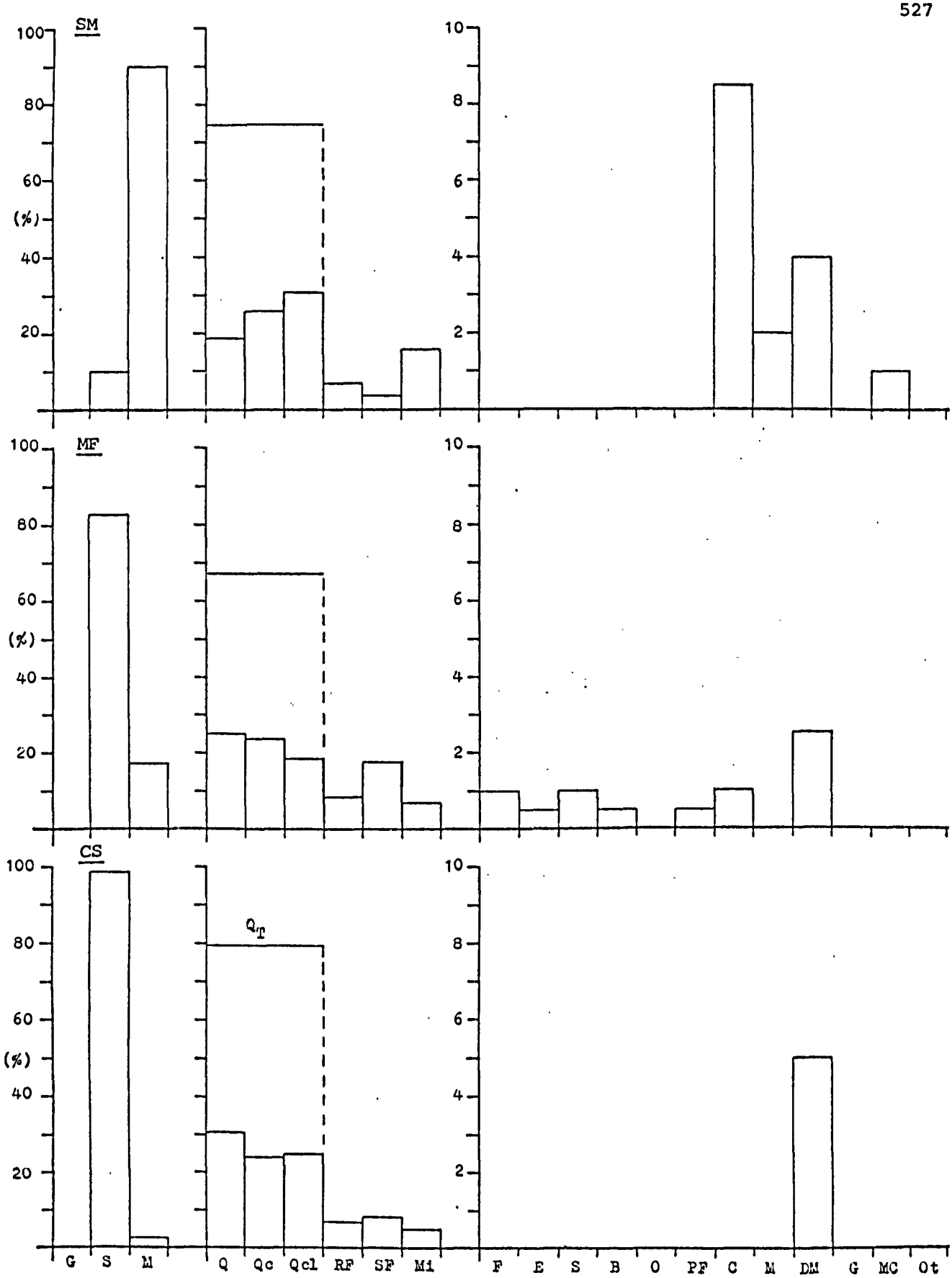


FIG.5.18 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 14 (CS-channel zone, MF-mudflats, SM-salt marsh).

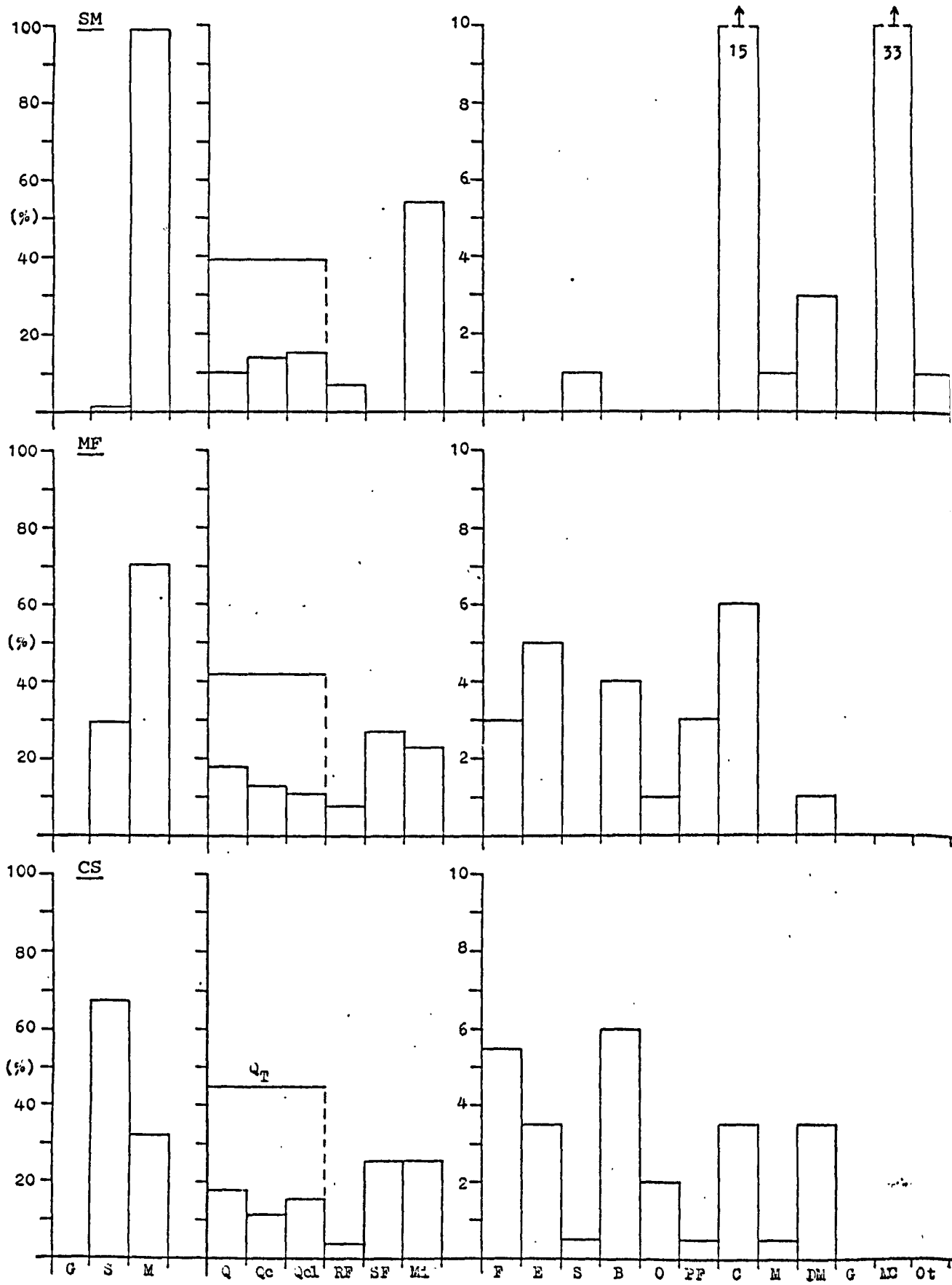


FIG.5.19 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 17 (CS-channel zone, MF-mudflats, SM-salt marsh)

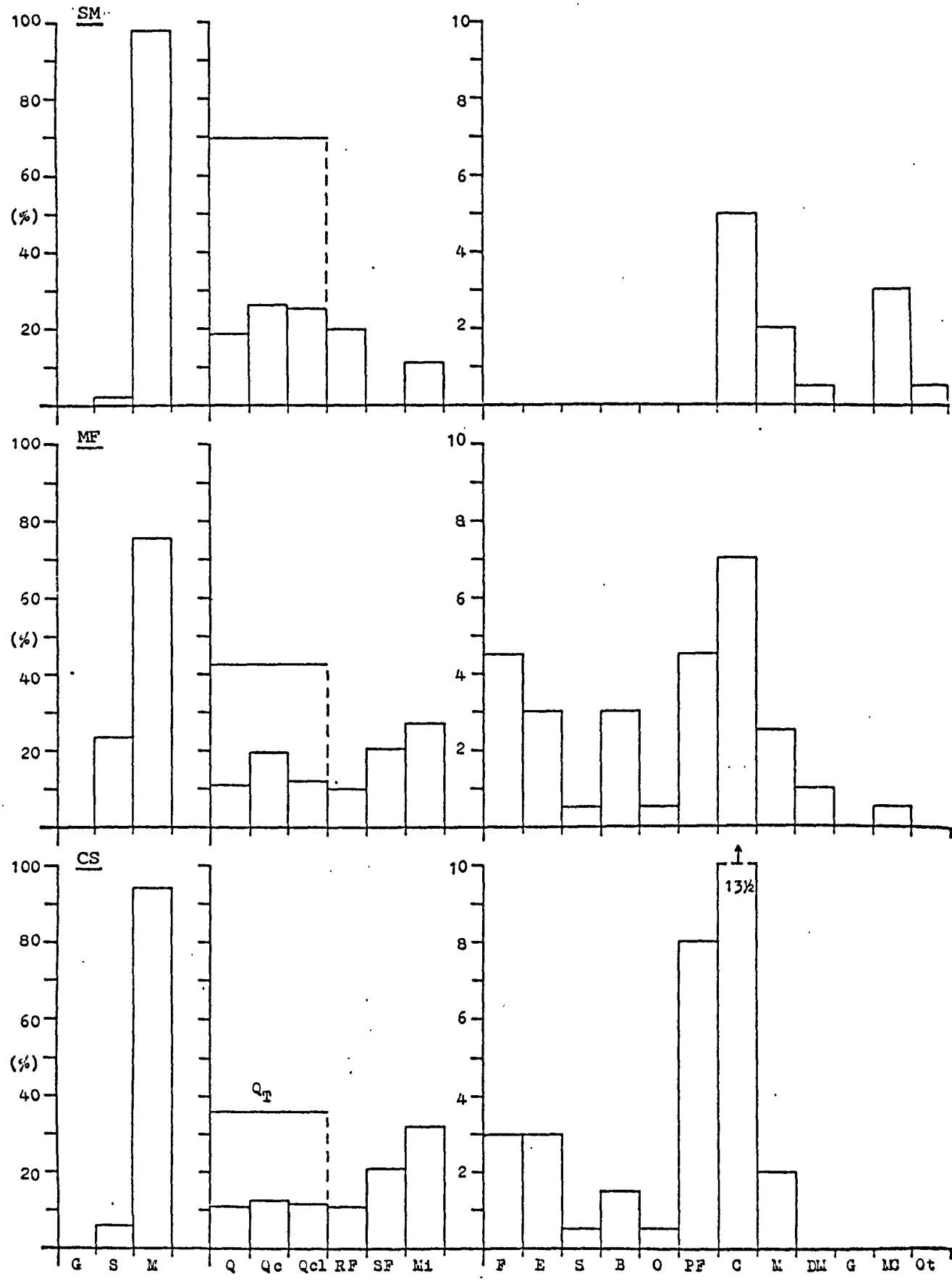


FIG.5.20 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 17/18 (CS-channel zone,MF-mudflats,SM-salt marsh)

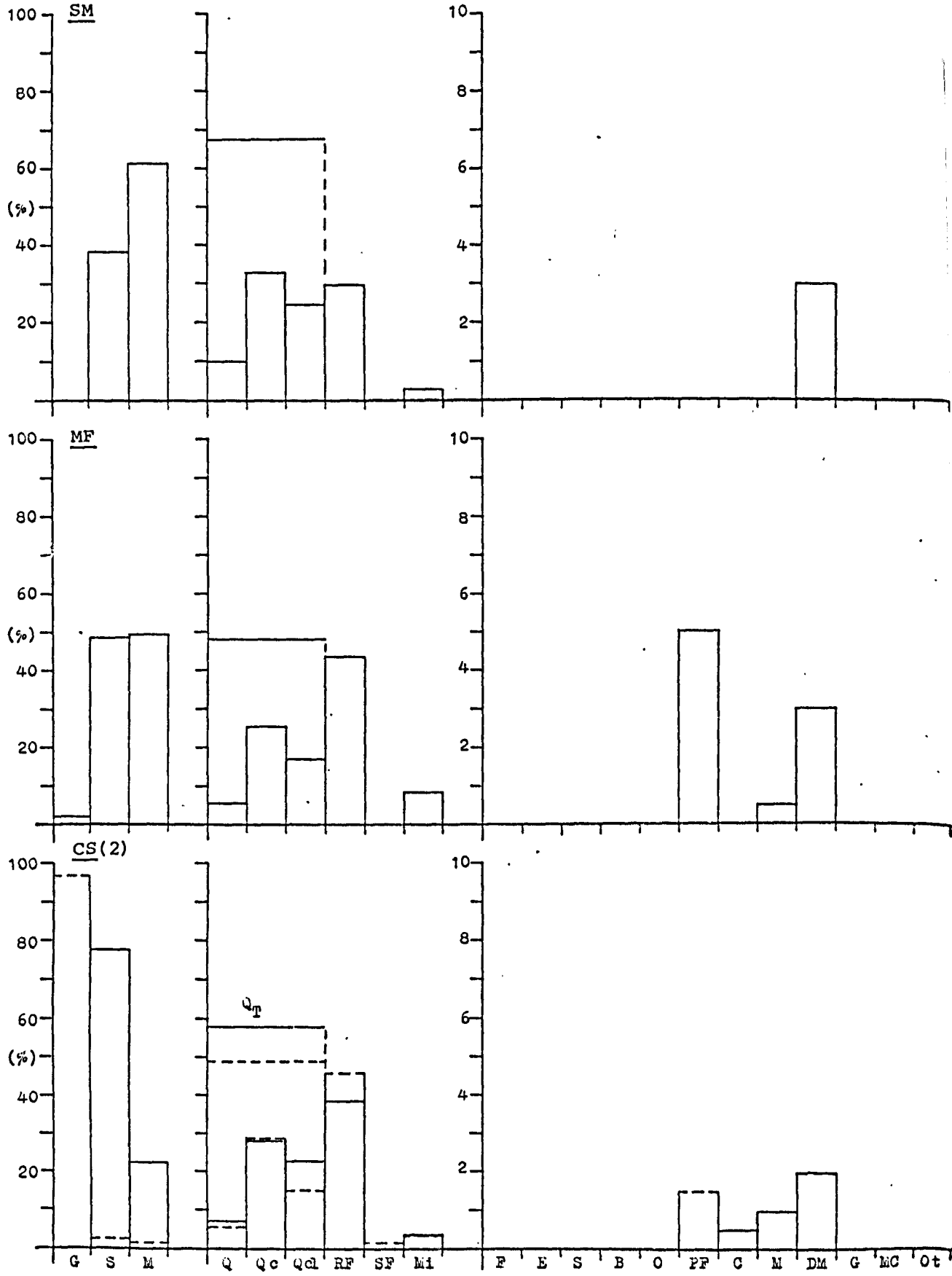


FIG. 5.21 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 18 (CS-channel zone, MF-mudflats, SM- salt marsh)

KEY TO FIGURES 5.22 - 5.26 :-

Estuarine channel zone

● fine-very fine, or total, sand fraction

■ very coarse-medium sand fraction

┼ Upper sandflats

▲ Dunes

Mudflats

△ fine-very fine. or total, sand fraction

□ very coarse-medium sand fraction

o Salt marshes

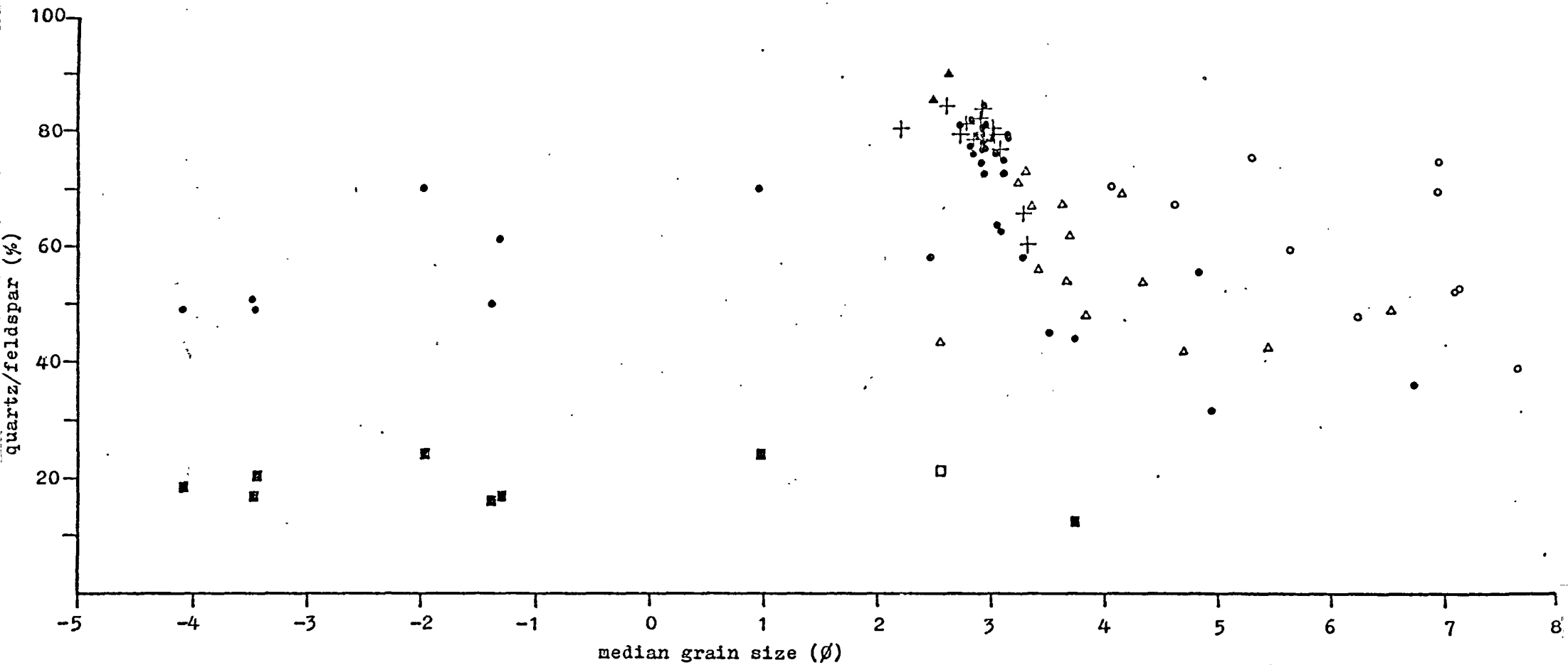


FIGURE 5.22 PLOT OF MEDIAN GRAIN SIZE AGAINST PERCENTAGE OF QUARTZ/FELDSPAR

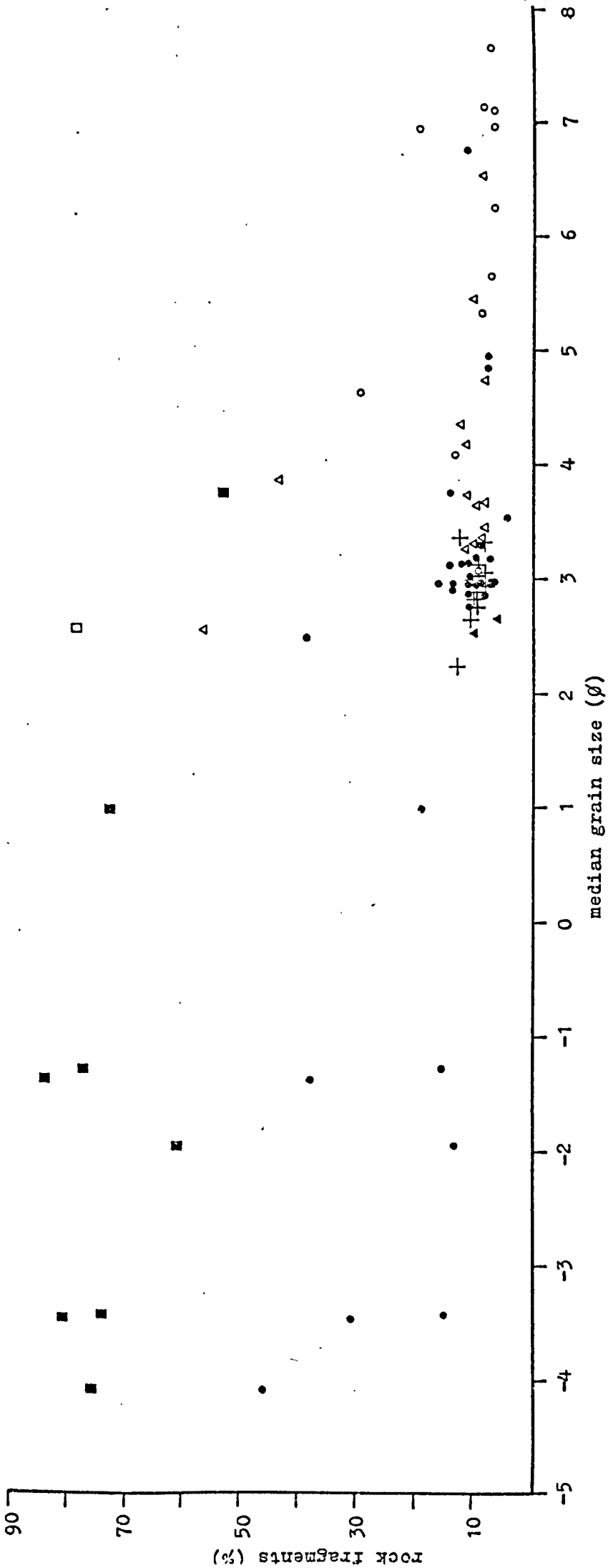


FIGURE 5.23 PLOT OF MEDIAN GRAIN SIZE AGAINST PERCENTAGE OF ROCK FRAGMENTS

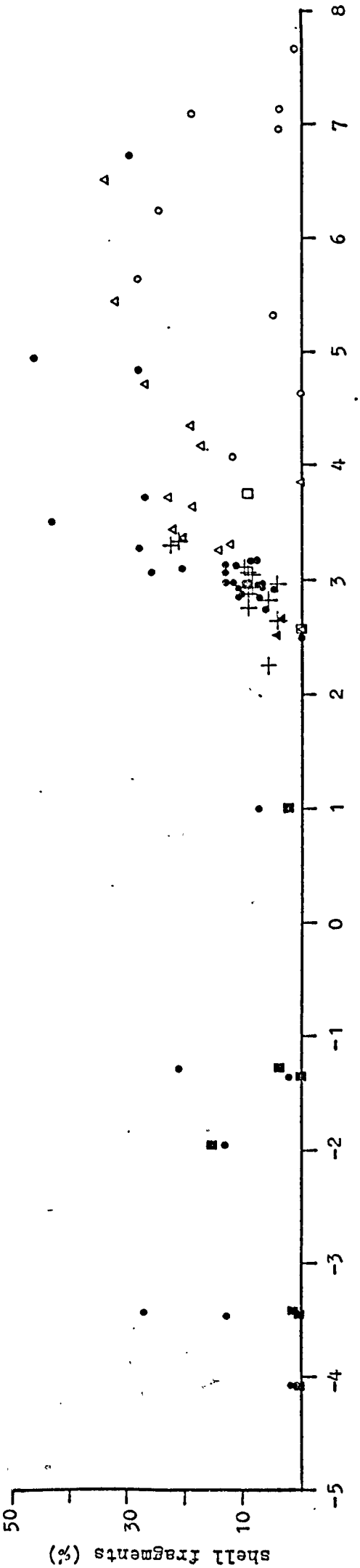


FIGURE 5.24 PLOT OF MEDIAN GRAIN SIZE AGAINST PERCENTAGE OF SHELL FRAGMENTS

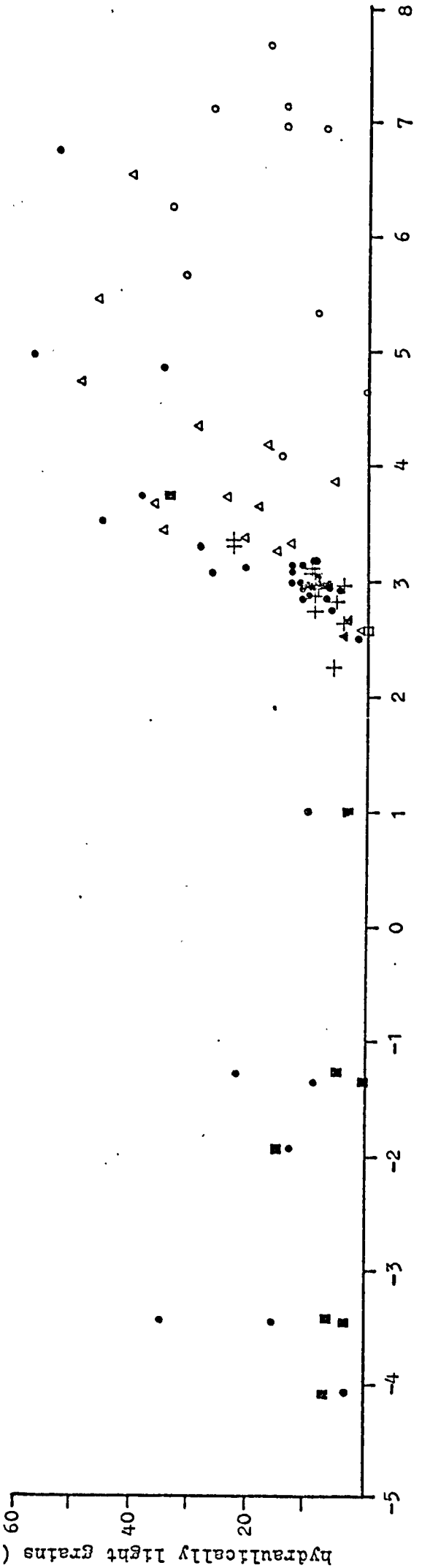


FIGURE 5.25 PLOT OF MEDIAN GRAIN SIZE AGAINST PERCENTAGE OF HYDRAULICALLY LIGHT GRAINS

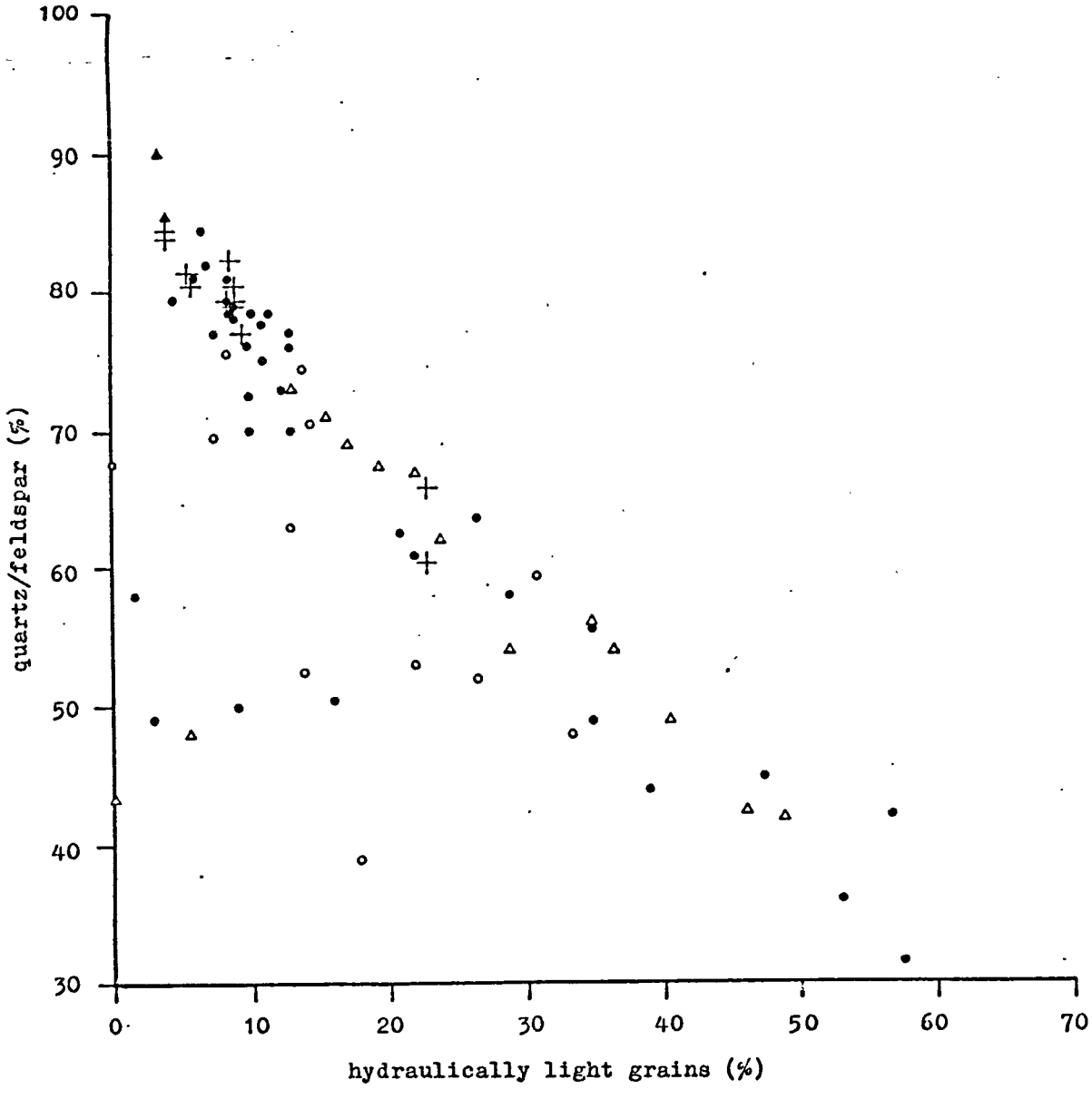
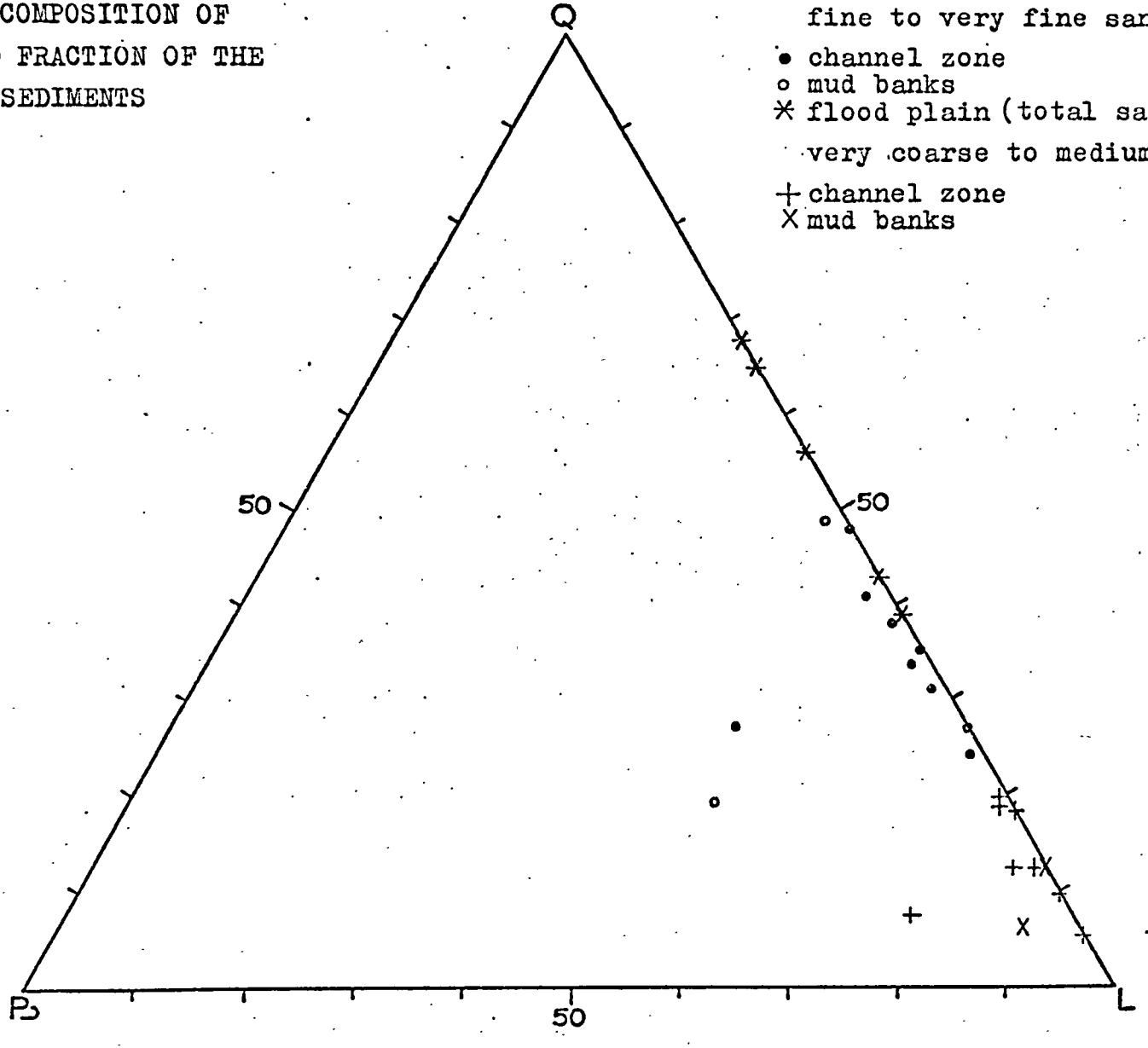


FIGURE 5.26 PLOT OF PERCENTAGE OF HYDRAULICALLY LIGHT GRAINS AGAINST PERCENTAGE OF QUARTZ/FELDSPAR

FIG.5.27 GENERAL COMPOSITION OF THE SAND FRACTION OF THE FLUVIAL SEDIMENTS



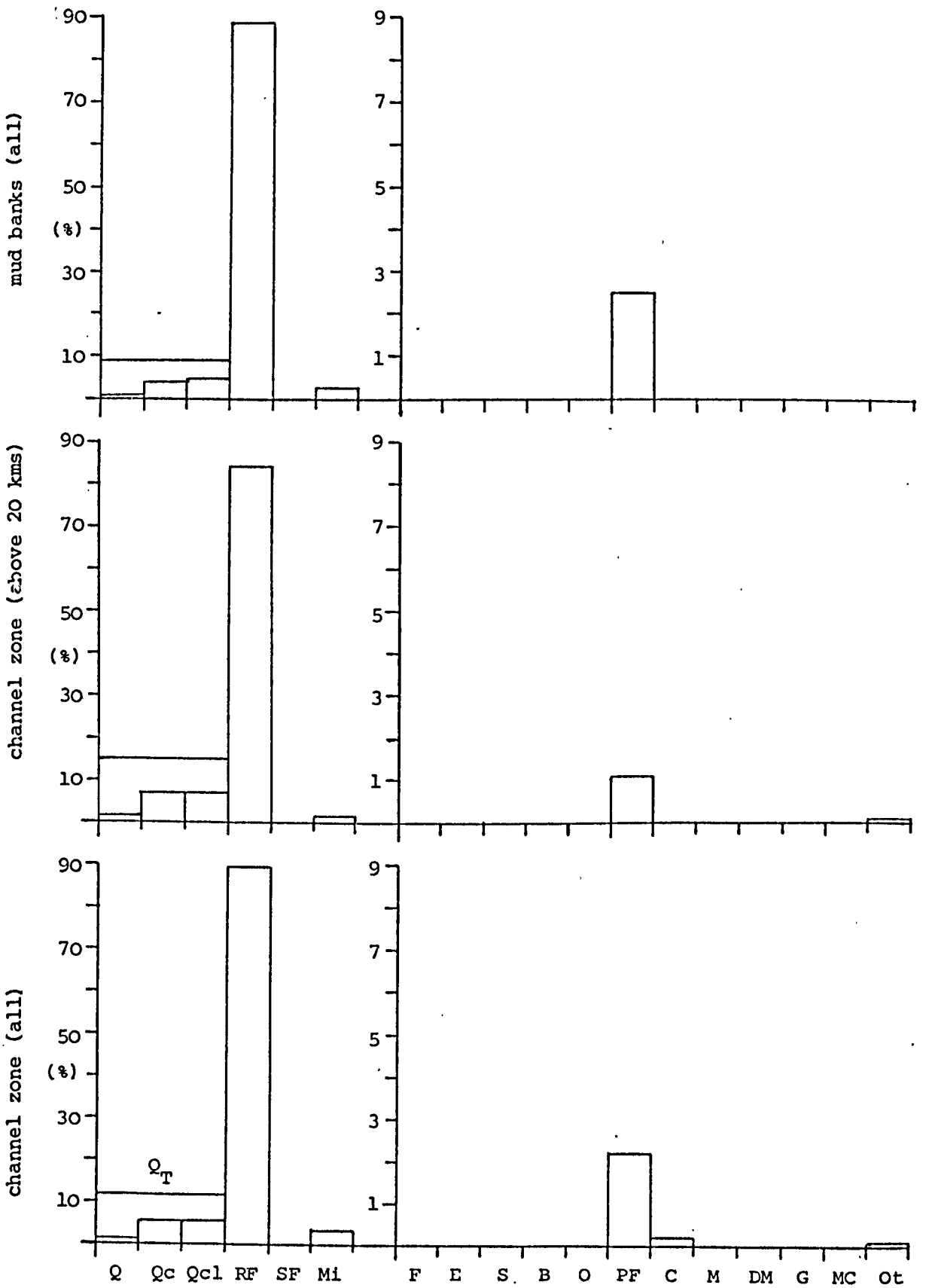


FIG.5.23a AVERAGE COMPOSITIONS OF THE VERY COARSE-MEDIUM SAND FRACTION OF THE SEDIMENTS OF THE FLUVIAL SUB-ENVIRONMENTS

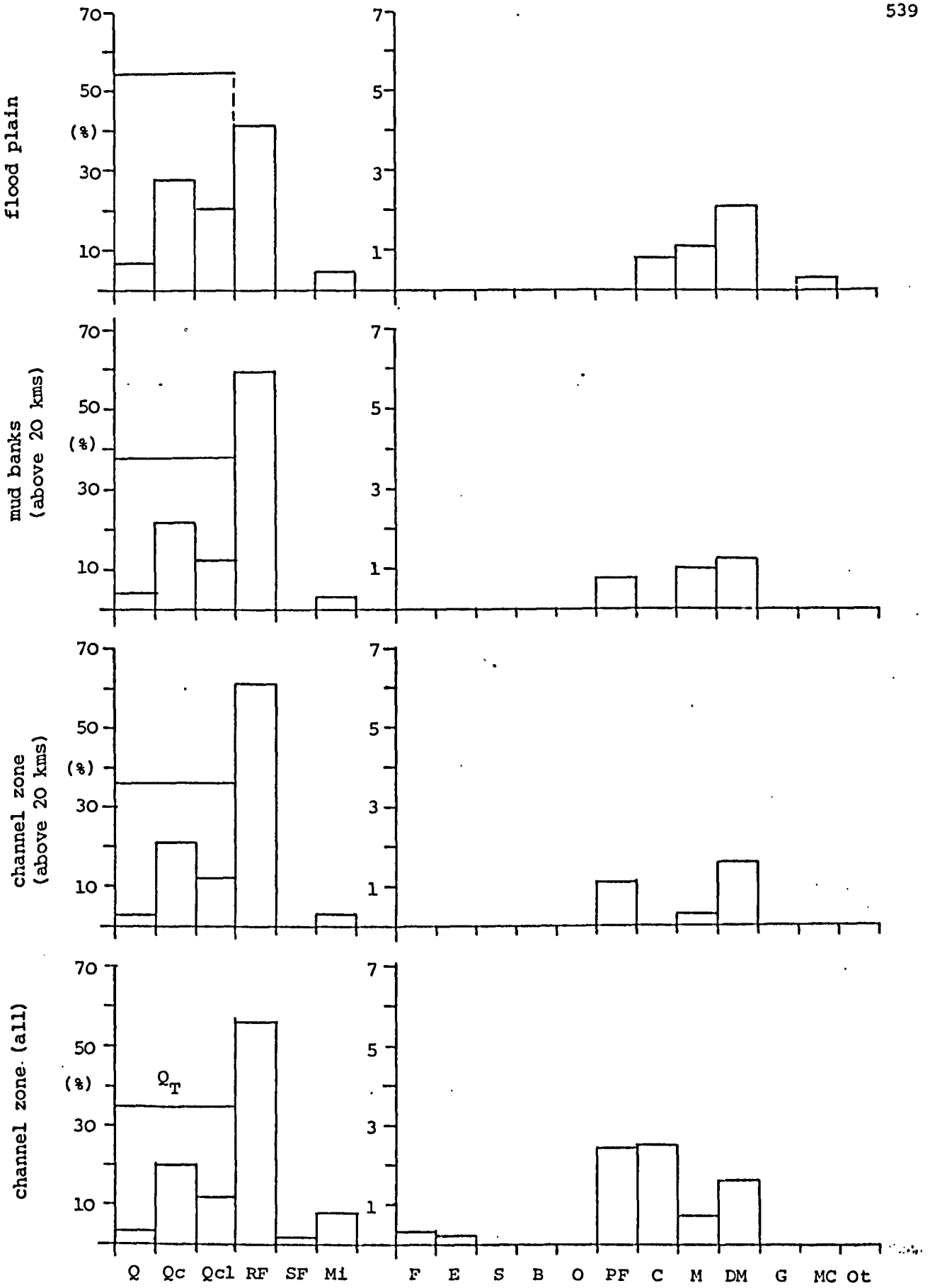


FIG.5.28b AVERAGE COMPOSITIONS OF THE FINE AND VERY FINE SAND FRACTION OF THE SEDIMENTS OF THE FLUVIAL SUB-ENVIRONMENTS

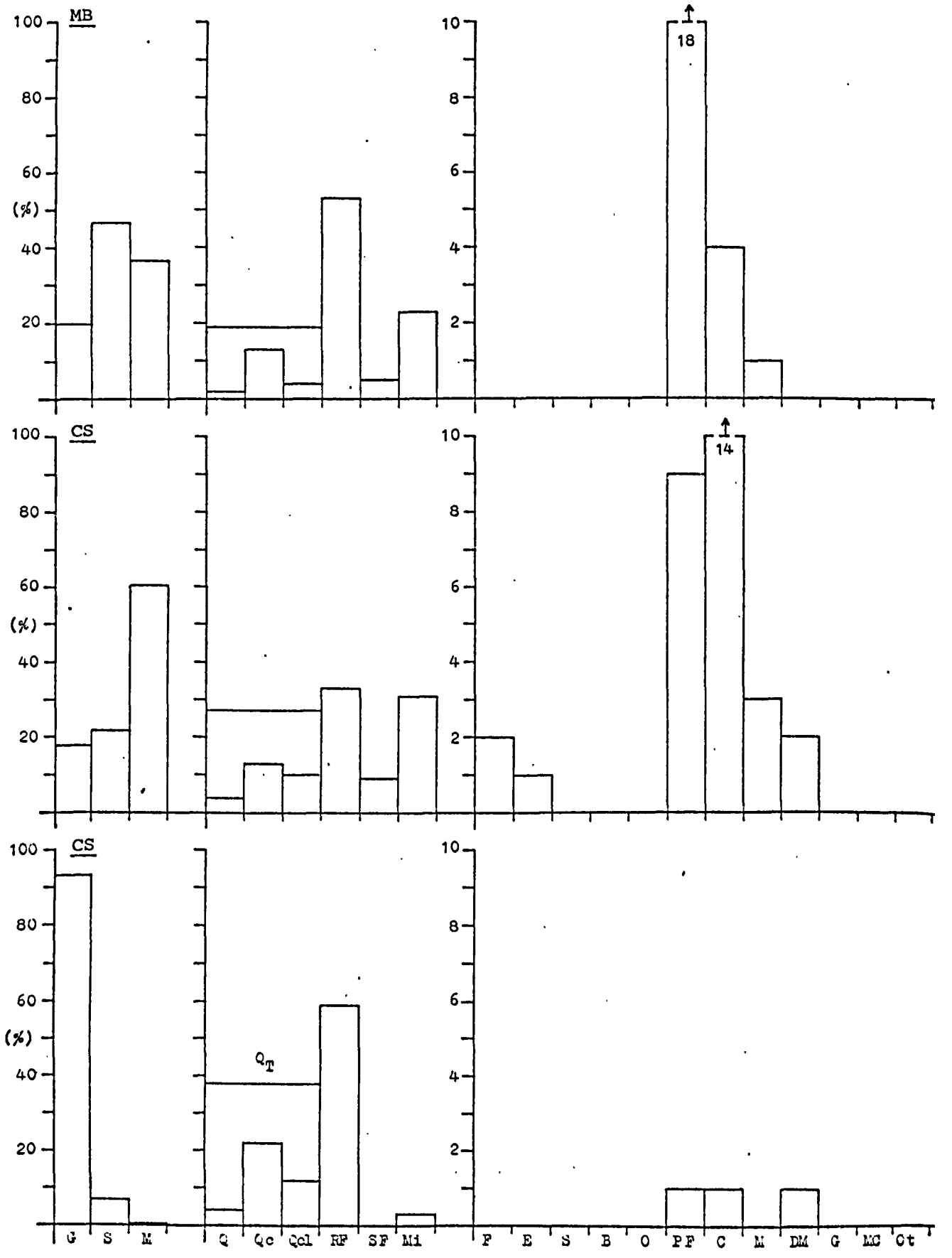


FIG.5.29 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 18/19 (CS-channel zone, MB-mud banks)

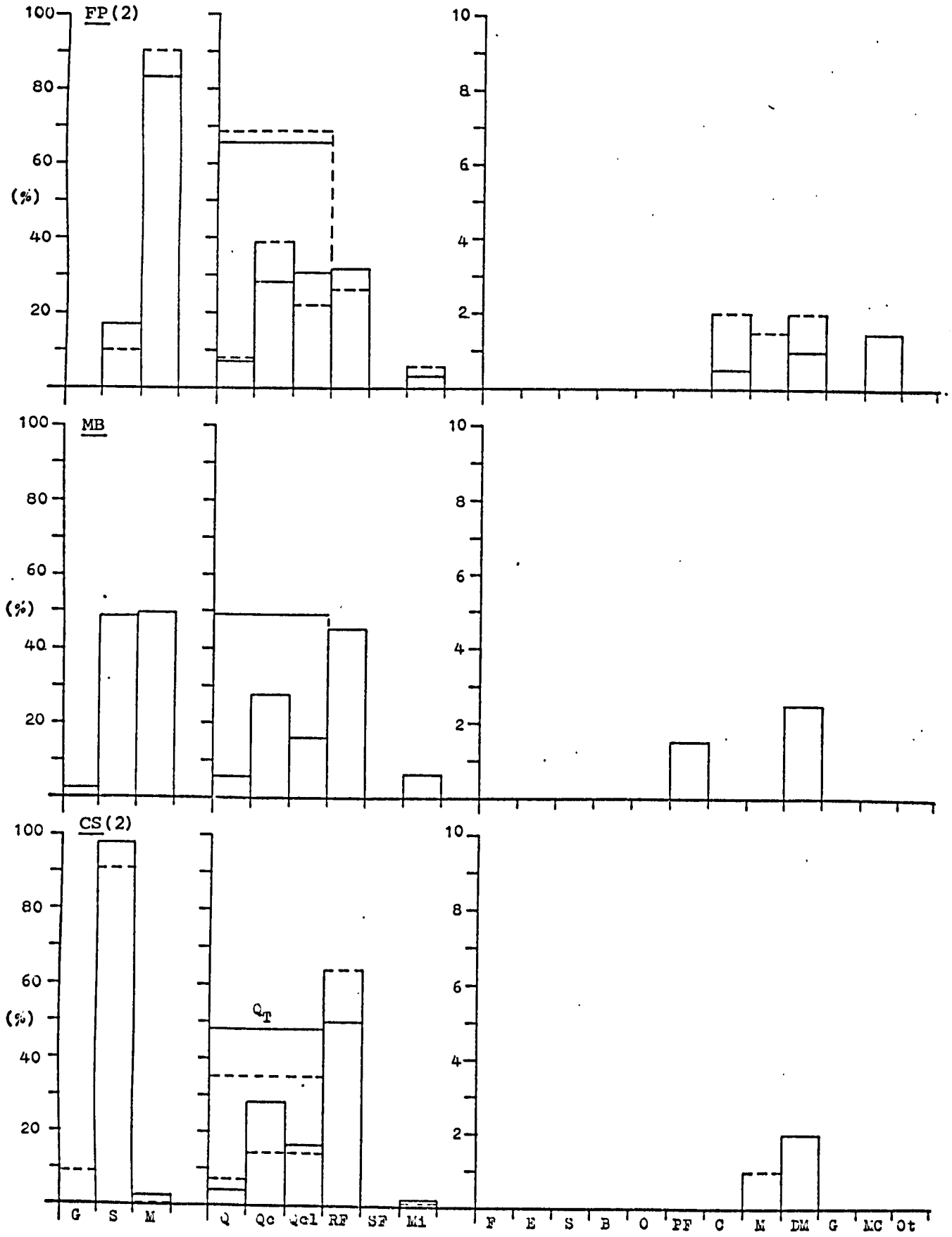


FIG.5.30 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 19 (CS-channel zone, MB-mud banks, FP-flood plain)

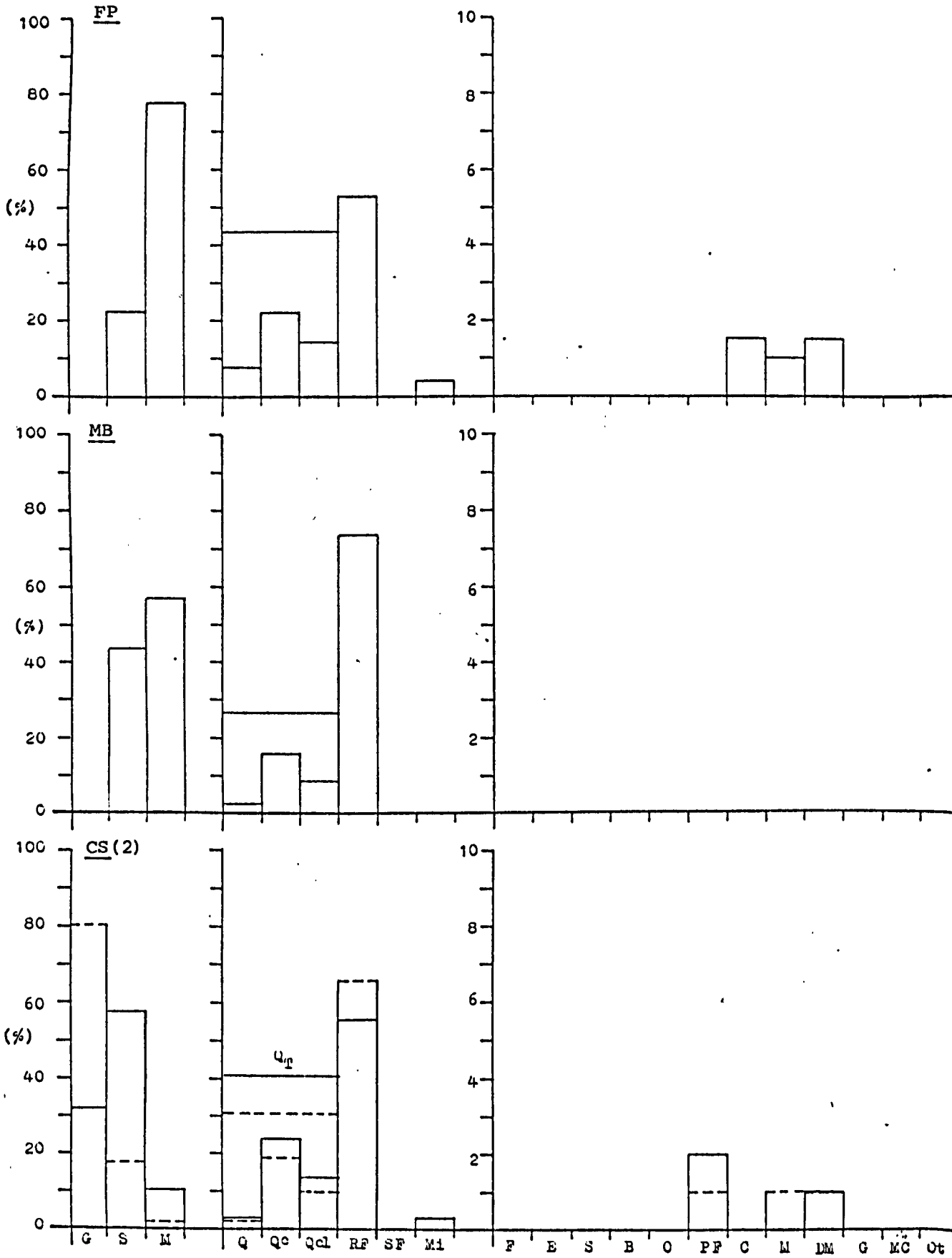
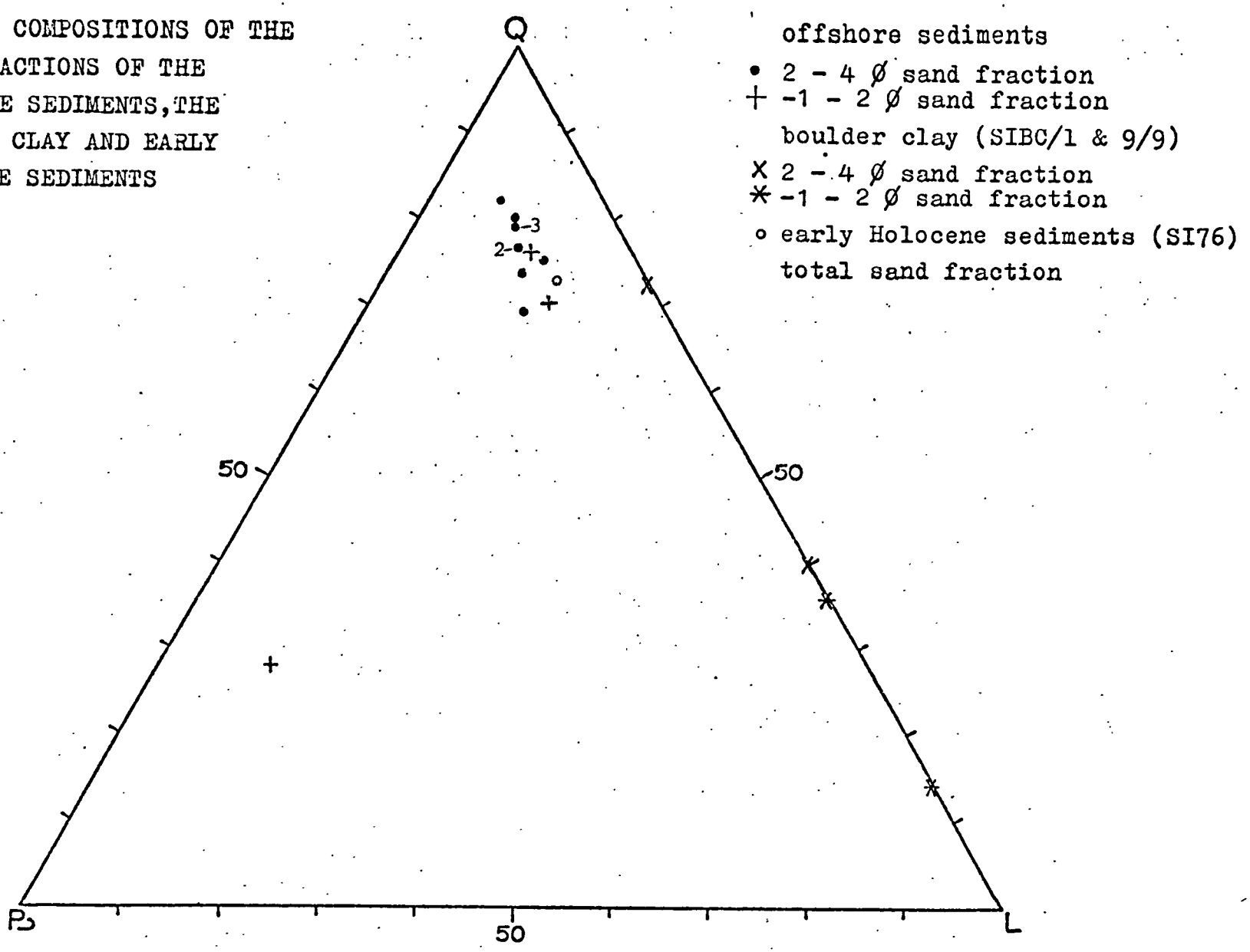


FIG.5.31 VARIATION IN THE COMPOSITION OF THE FINE-VERY FINE, OR TOTAL, SAND FRACTION ALONG PROFILE 21 (CS-channel zone, MB-mud banks, FP-flood plain)

FIG.5.32 GENERAL COMPOSITIONS OF THE SAND FRACTIONS OF THE OFFSHORE SEDIMENTS, THE BOULDER CLAY AND EARLY HOLOCENE SEDIMENTS



offshore sediments
• 2 - 4 Ø sand fraction
+ -1 - 2 Ø sand fraction
boulder clay (SIBC/1 & 9/9)
X 2 - 4 Ø sand fraction
* -1 - 2 Ø sand fraction
o early Holocene sediments (SI76)
total sand fraction

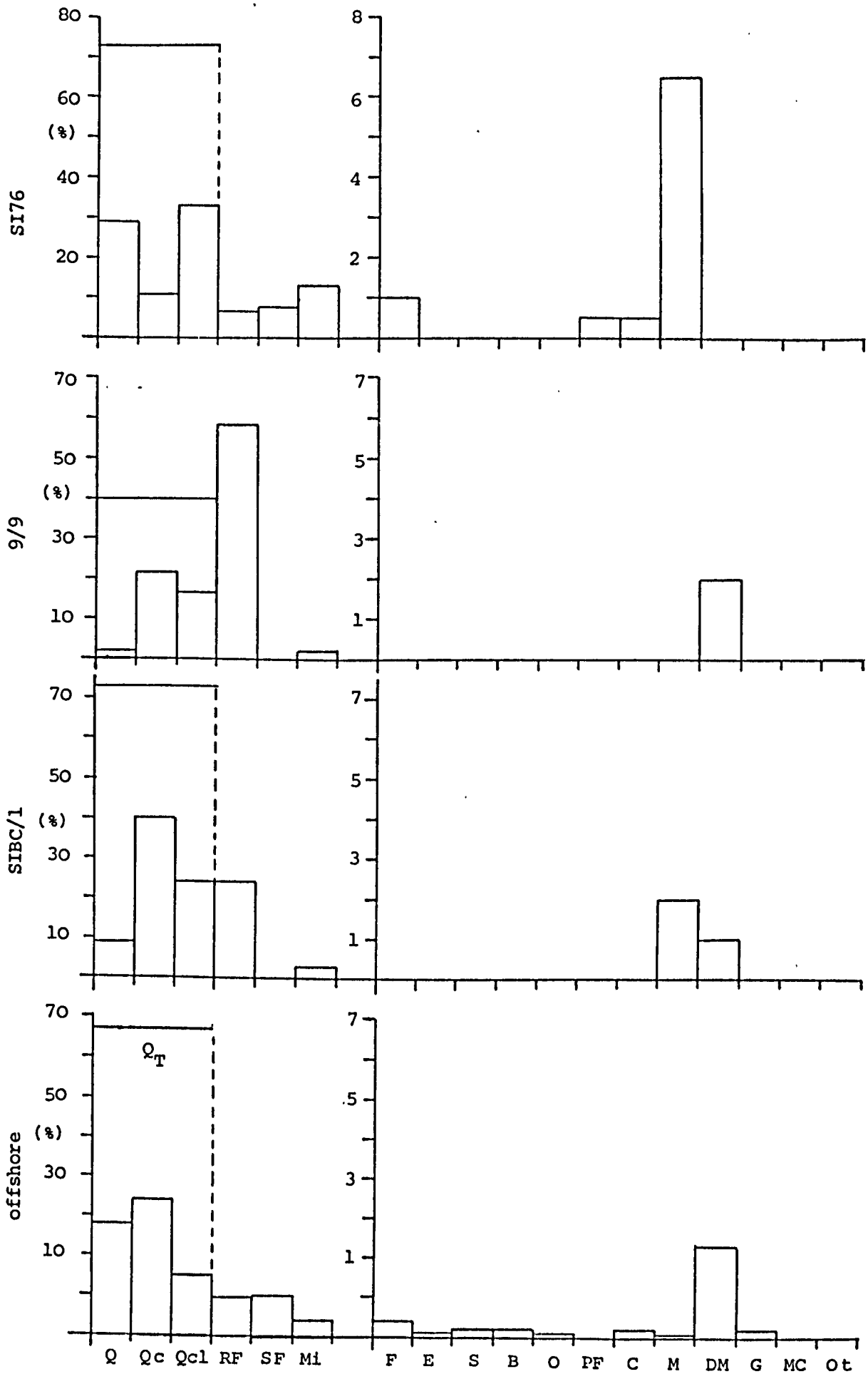


FIG.5.33 AVERAGE COMPOSITION OF THE FINE AND VERY FINE SAND FRACTION OF THE OFFSHORE SEDIMENTS AND COMPOSITIONS OF THE SAME SAND FRACTION OF BOULDER CLAY (SIBC/1 & 9/9) AND EARLY HOLOCENE SEDIMENTS (SI76)

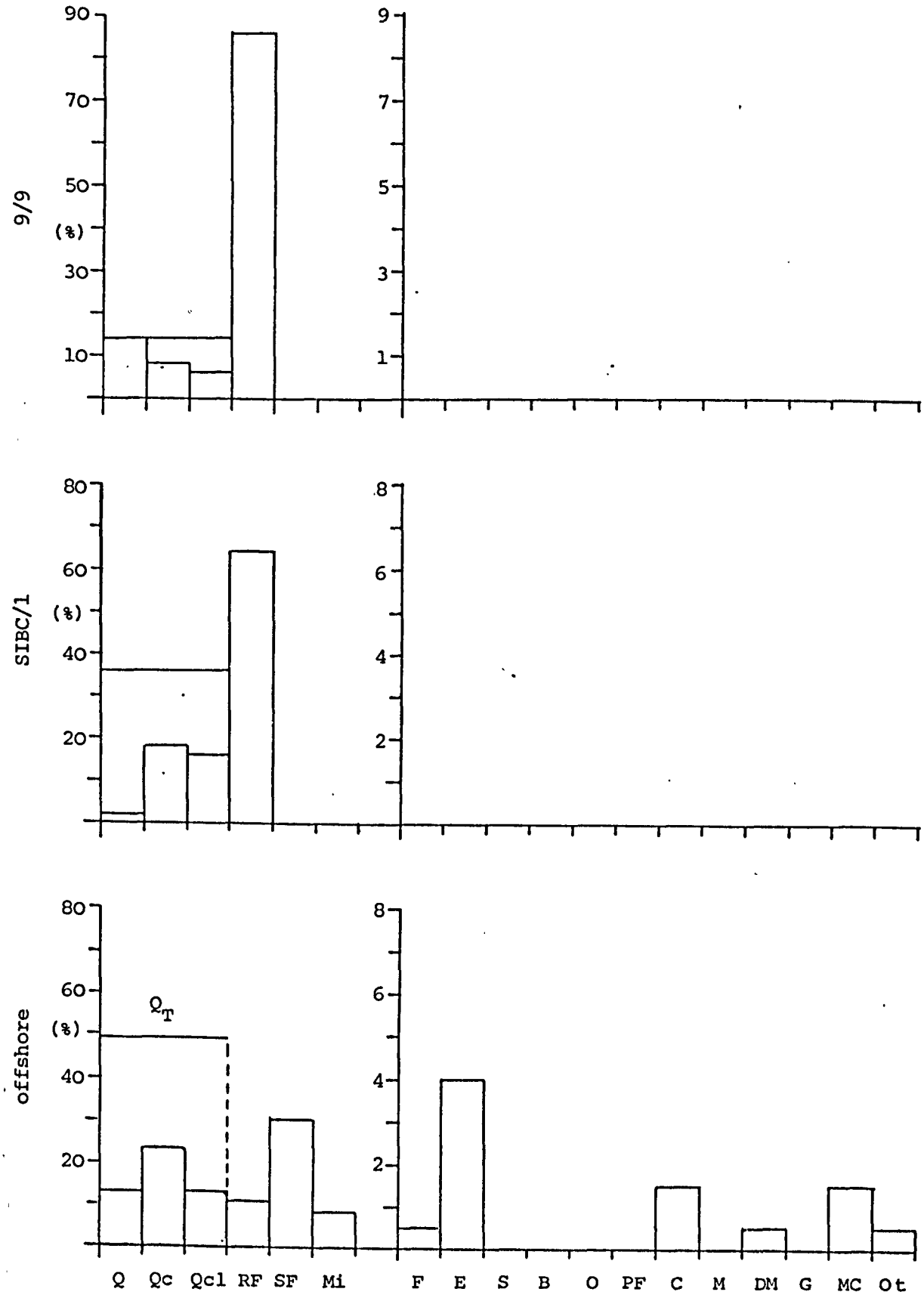


FIG.5.34 AVERAGE COMPOSITION OF THE VERY COARSE-MEDIUM SAND FRACTION OF THE OFFSHORE SEDIMENTS AND COMPOSITION OF THE SAME SAND FRACTION OF BOULDER CLAY SEDIMENTS (SIBC/1 & 9/9)

FIGURES 5.35 & 5.36 GENERAL COMPOSITIONS OF THE VERY COARSE .. TO MEDIUM AND FINE - VERY FINE SAND FRACTIONS OF THE SEDIMENTS OF CARMARTHEN BAY, THE TOWY RIVER, THE BOULDER CLAY AND EARLY HOLOCENE AGE, IN RELATION TO THOSE OF THE ESTUARINE SUB-ENVIRONMENTS

FIGURE 5.35 GENERAL COMPOSITIONS OF THE VERY COARSE TO MEDIUM SAND FRACTIONS

FIGURE 5.36 GENERAL COMPOSITIONS OF THE FINE VERY FINE SAND FRACTIONS

FIG.5.35 GENERAL COMPOSITIONS OF THE VERY COARSE - MEDIUM SAND FRACTIONS

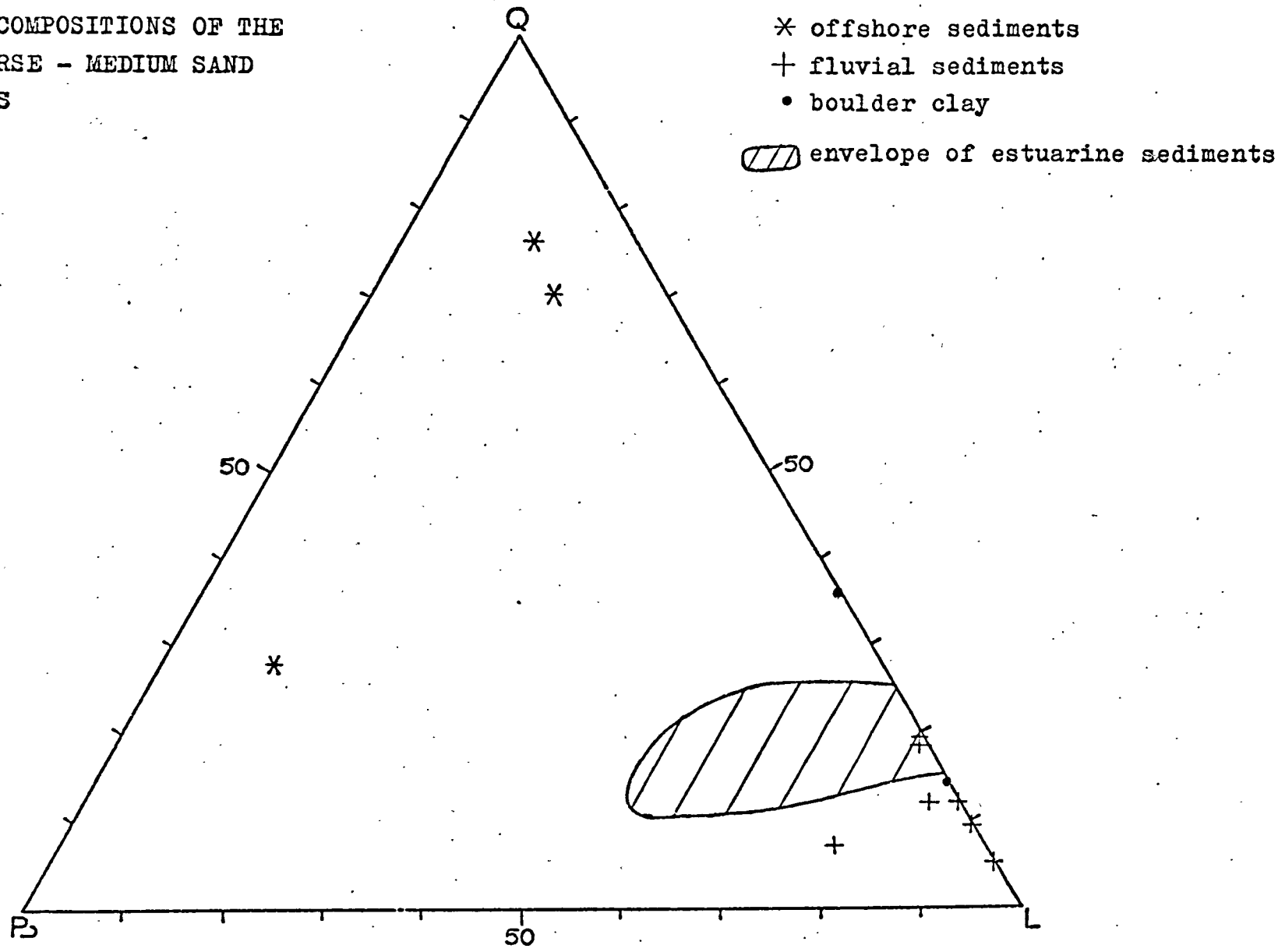
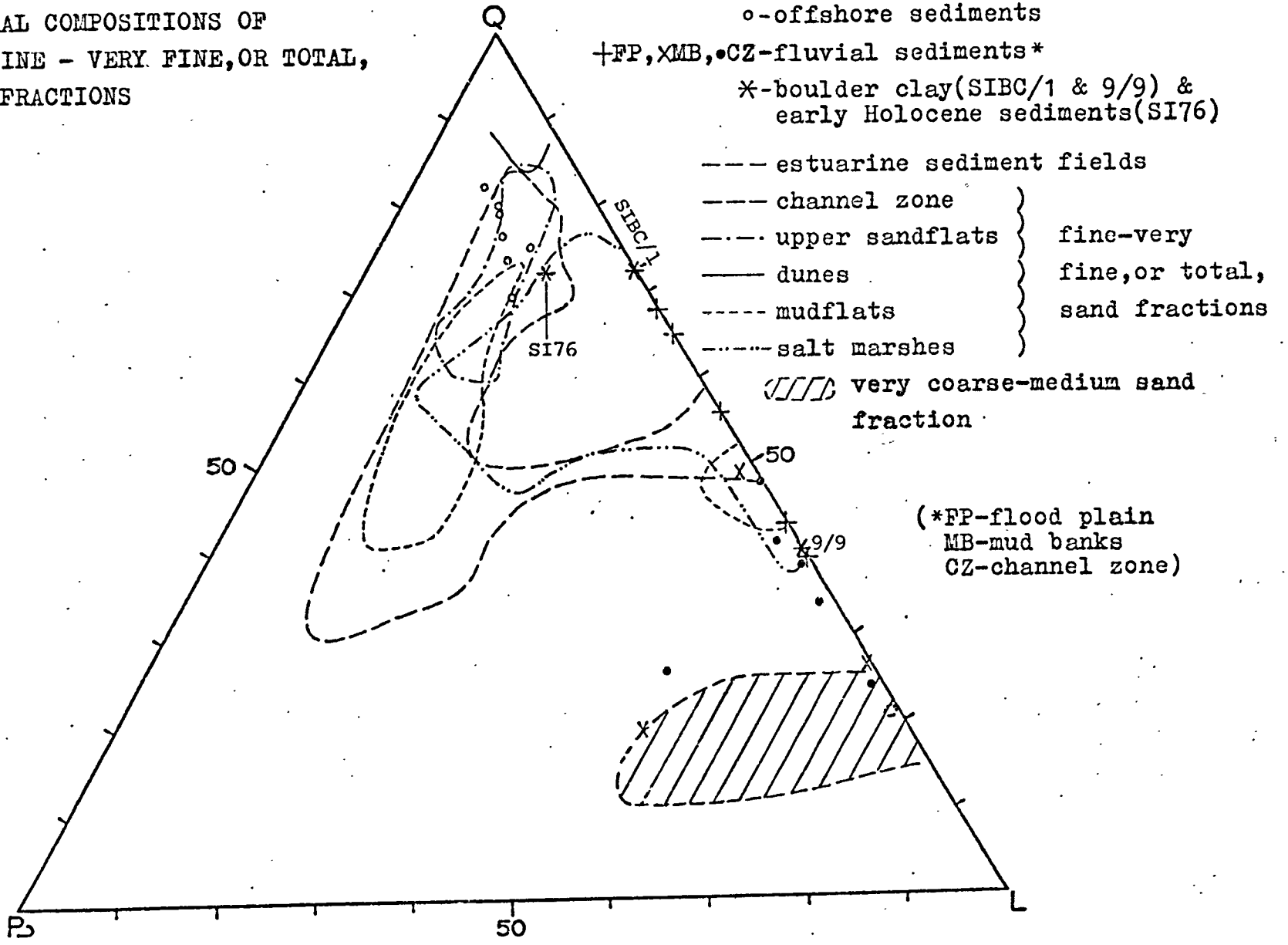


FIG.5.36 GENERAL COMPOSITIONS OF THE FINE - VERY FINE, OR TOTAL, SAND FRACTIONS



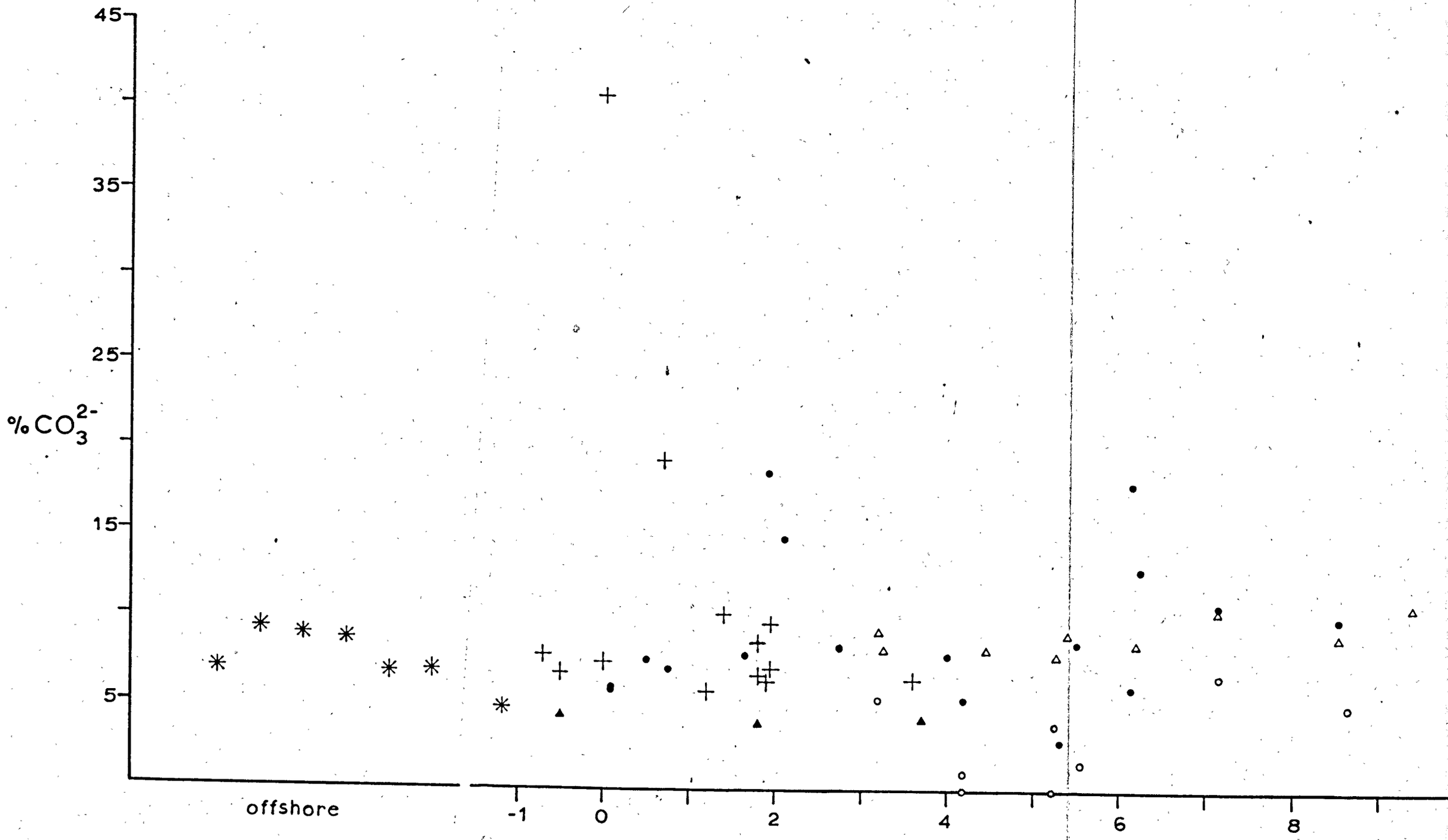
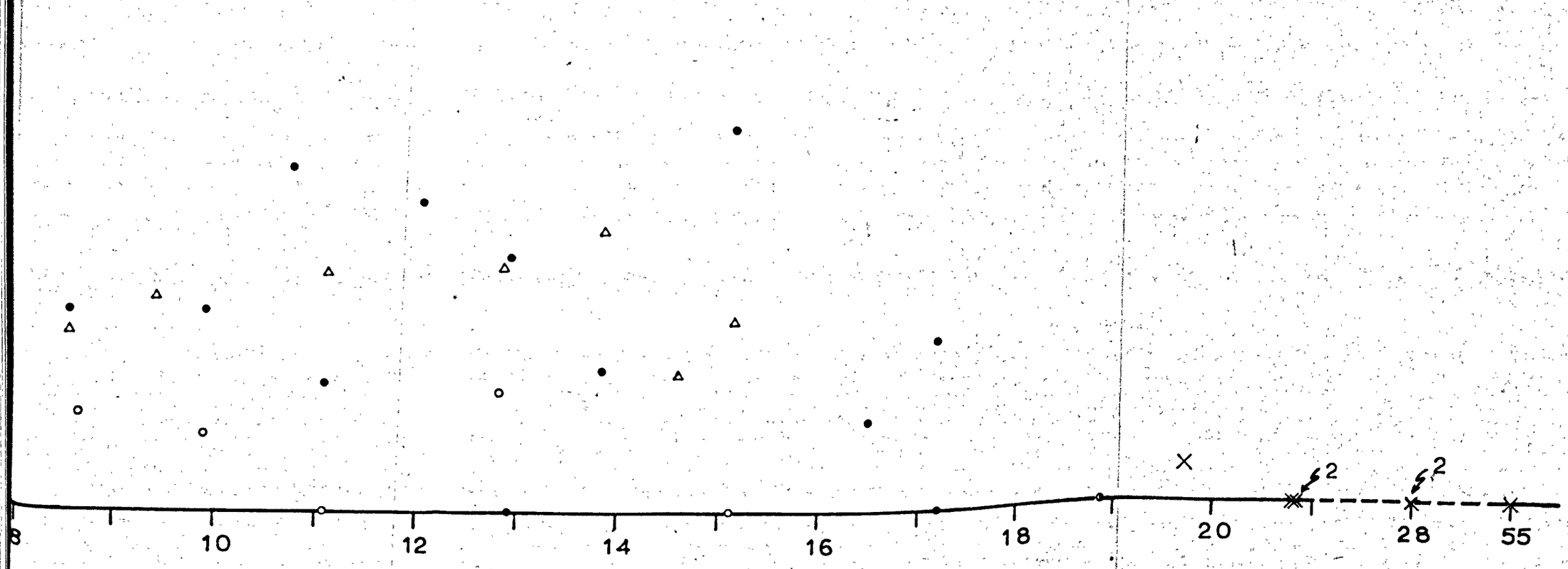


FIG. 5.37 Longitudinal variation in carbonate content

KEY:-

- ✳ marine sediments
- estuarine sediments
- • channel zone
- + upper sandflats
- ▲ dunes
- △ mudflats
- ○ salt marshes
- X fluvial sediments



m mouth (kms)

ntent

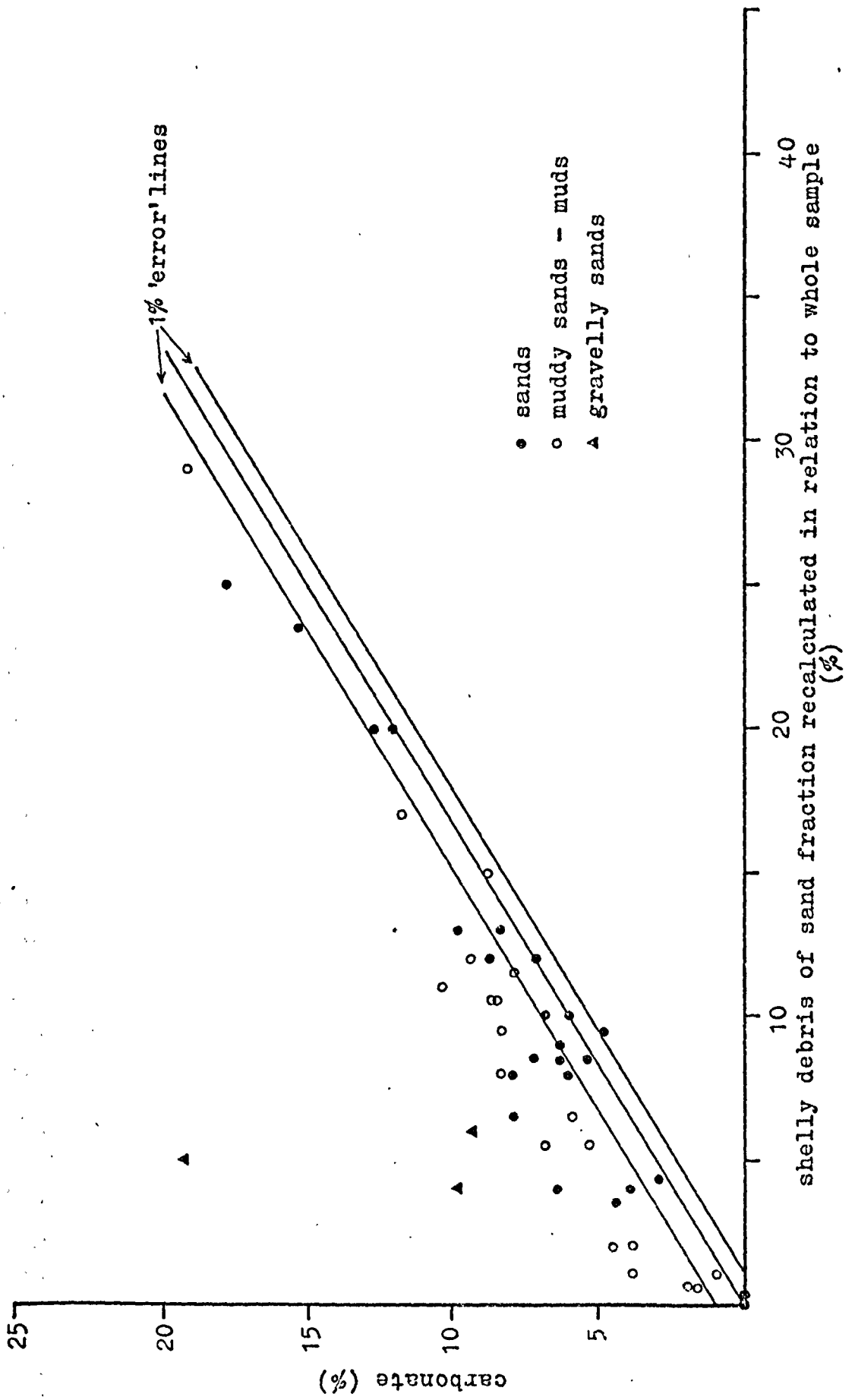


FIGURE 5.38 PLOT OF SHELLY DEBRIS OF SAND FRACTION AGAINST CARBONATE CONTENT

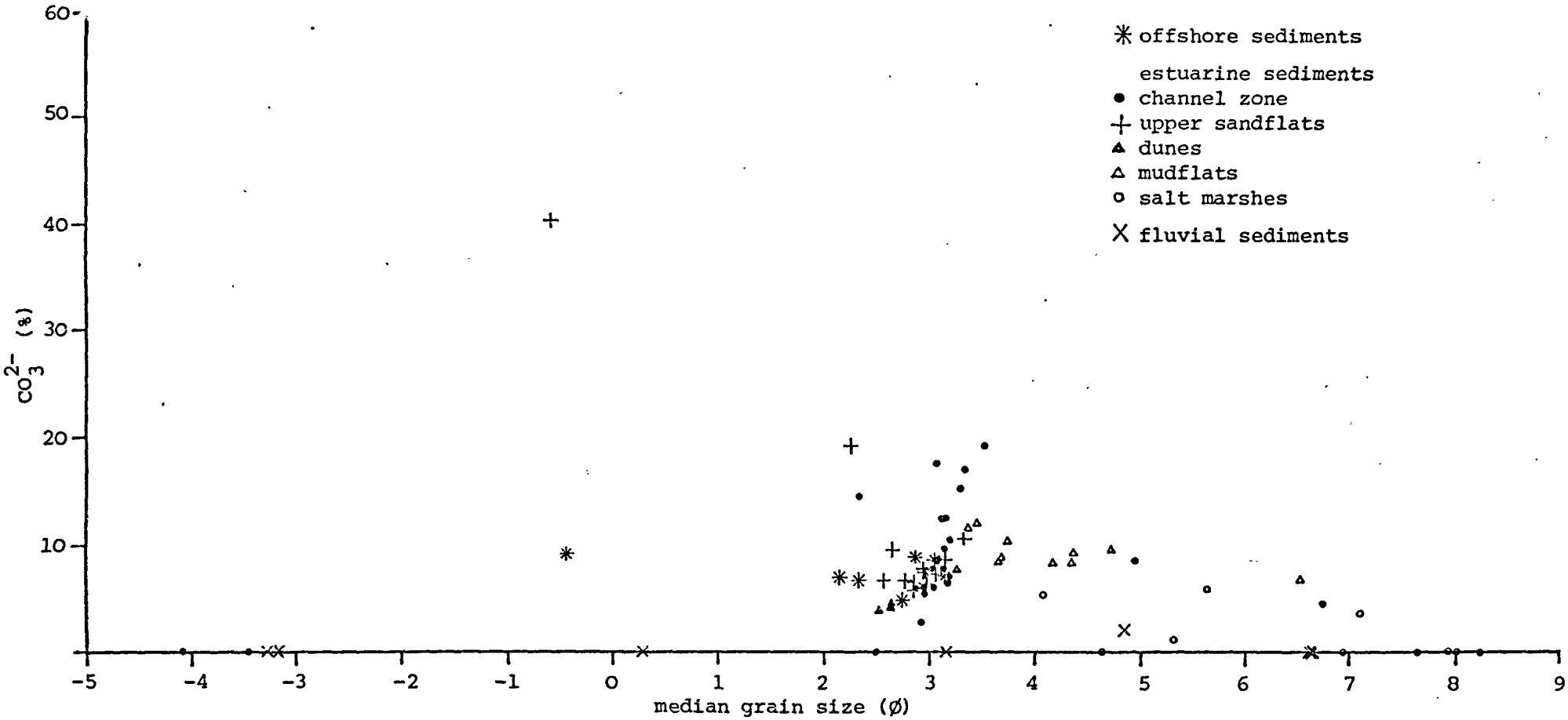
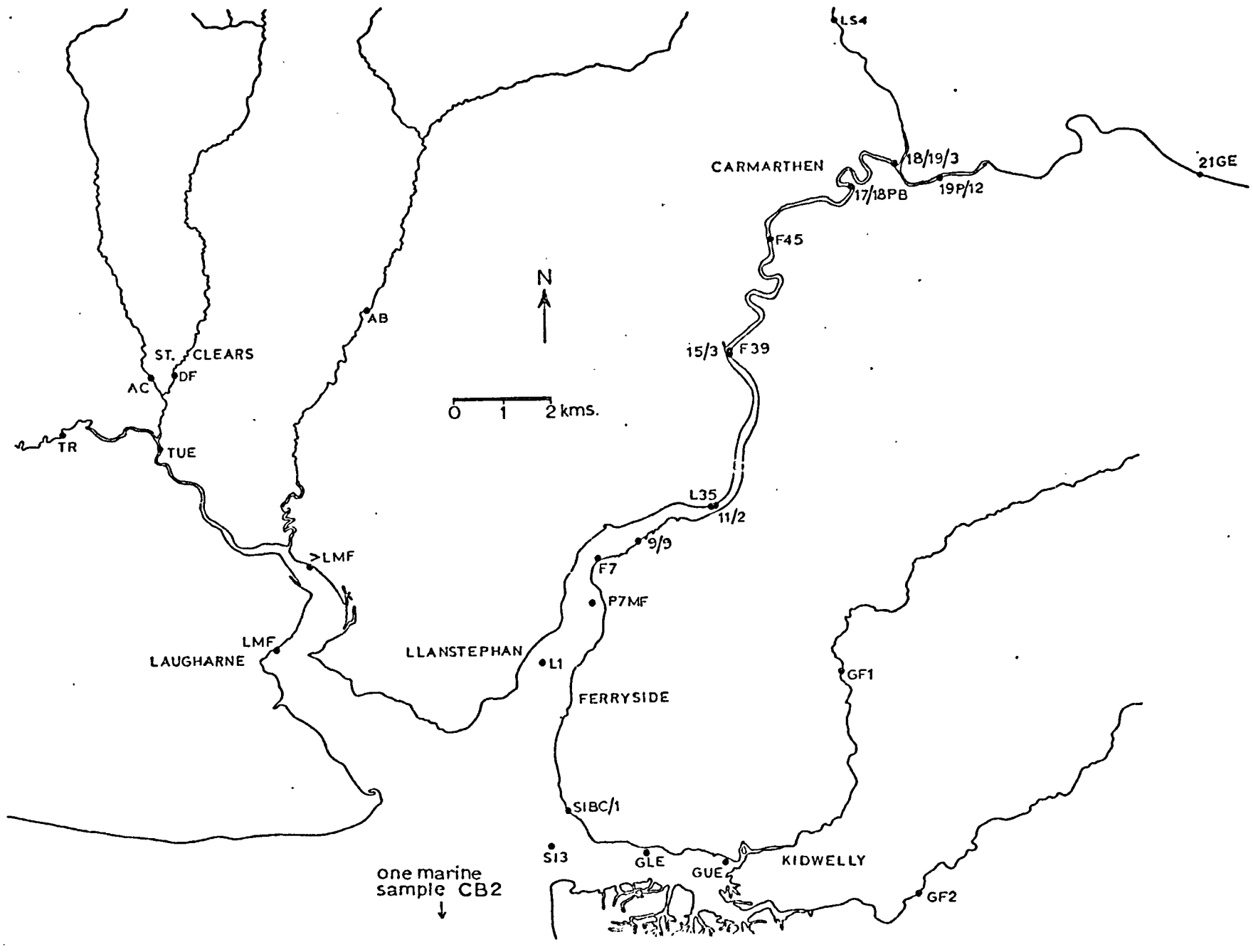


FIGURE 5.39 PLOT OF MEDIAN GRAIN SIZE AGAINST PERCENTAGE OF CARBONATE

FIGURE 5.40 SITES OF SAMPLES ANALYSED FOR CLAY MINERALOGY


LS4
CARMARTHEN
18/19/3
21GE
17/18PB
19P/12
F45
N
AB
ST. CLEARS
15/3
F39
AC
DF
0 1 2 kms.
TR
TUE
L35
11/2
9/9
LMF
F7
P7MF
LMF
LAUGHARNE
LLANSTEPHAN
L1
GF1
FERRYSIDE
SIBC/1
SI3
GLE
GUE
KIDWELLY
GF2
one marine
sample CB2

TERRIGENOUS GRAINS

Rock fragments

Mud Clasts

Quartz and feldspar - clear, coloured and cloudy

Dark Minerals

Mica

Coal

Others (e.g. Slag)

BIOGENIC GRAINS

'Shell fragments' (= Mollusc, barnacle and all unidentifiable shell fragments)

Foraminiferids

Echinoid plates and spines

Bryozoa

Sponge Spicules

Ostracods

Plant fragments

Others (e.g. ophiuroid plates, fish scales, insect carapace fragments)

AUTHIGENIC GRAINS

'Glauconie'

TABLE 5.1. THE COMPONENTS DIFFERENTIATED IN THE COARSE FRACTION ANALYSIS

X N	100	200	300	400
1/99	1.99	1.41	1.15	1.00
5/95	4.36	3.08	2.52	2.18
10/90	6.00	4.24	3.46	3.00
20/80	8.00	5.66	4.62	4.00
30/70	9.17	6.48	5.29	4.58
40/60	9.80	6.93	5.66	4.90
50/50	10.00	7.07	5.77	5.00

Table 5.2a.Table of Probable Errors for Coarse Fraction Analysis (for 95.4% confidence limits)

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
PIMCh	80½	33½	22½	24½	2½	7½	8½	½	T	½	T				T	T	
P.E.	±5½	±6½	±6	±6	±2	3½	±4	±1		±1							
PIMCha	76½	25½	33	18	3	9	9	½	T	½	½				½	½	
P.E.	±6	±6	±7	±5½	±2½	±4	±4	±1		±1	±1				±1	±1	
Average of the 2. P.E.	78½	29½	27½	21½	2½	8¼	8¼	½	T	½	¼				¼	¼	
	±4	±4½	±4½	±4	±1½	±2¼	±2¼	±¼		±¼	±½				±½	±½	

Table 5.2b. Results of the coarse fraction analysis of 2 splits of the same sample, and the probable errors (P.E. to the nearest ½ or ¼) associated with these.

(T - trace)

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
All (36)	67.1	25.7	24.3	17.1	2.4	13.5	11.8	1.1	0.5	0.6	0.2	0.1	1.0	1.1	0.4	0.1	<0.05 (MC)
	31½-84½	5½-38	9-33½	11-28	0-5	4-46	0-33½	0-7½	0-3½	0-6	0-1½	0-2	0-8	0-13½	0-2	0-⅔	0-1 (MC)
0 - 15km (27)	74.0	29.8	26.1	18.1	2.6	11.6	9.9	0.5	0.1	0.3	0.1	<0.05	0.3	0.2	0.1	0.2	
	50-84½	12-38	17-33½	11-28	½-5	7-38	2-26½	0-2	0-1	0-1½	0-1½	0-½	0-5	0-2	0-1	0-⅔	
15-18½ km (7)	44.5	15.5	16.1	12.9	2.1	12.9	22.1	3.4	2.0	2.1	0.3	0.5	3.7	5.0	1.3		0.1 (MC)
	31½-55½	11½-21½	9-24½	11-15½	0-3½	4-31	11½-33½	1-7½	0-3½	0-6	0-½	0-2	½-8	1-13½	½-2		0-1 (MC)
16½-19 km (2)	53.5	6.3	28.3	19.0	2.0	42.3	0.7						0.7	0.3	0.5		
	49-58	5½-7	28-28½	15-23	2-2	38½-46	0-1½						0-1½	0-½	0-1		

Table 5.3. Averages and Ranges of the composition of the 2 to 4 ϕ , or total, sand fraction of the sediments of the estuarine channel zone.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
					∅												
All (8)	18.4	1.6	8.2	8.6	0.1	72.3	2.8	0.3	0.6	0.1	0.1		4.4	0.5			0.3 (0)
	12-24	0-4	6-12	4-15	0-1	53-84	0-13	0-1½	0-3	0-1	0-1		0-22	0-2			0-1 (0)
0-15 km (4)	20.1	2.5	7.8	9.9	0.0	73.9	4.3	0.5	0.4	T			0.3	0.4			0.3 (0)
	16-24	2-4	6-9½	5½-15	0	61-84	0-13	0-1½	0-1				0-1	0-1			0-1 (0)
15-18½km (3)	16.2	0.7	9.3	6.2	0.3	69.2	1.7	0.2	1.0	0.3	0.3		9.5	0.8			0.5 (0)
	12-20	0-1	7-12	4-8	0-1	53-80½	0-4	0-½	0-3	0-1	0-1		1½-22	0-2			0-1 (0)
18½-19 km (1)	18	1.	6½	10½	T	75½	½						6				

Table 5.4. Averages and Ranges of the composition of the -1 to 2 ∅ sand fraction of the estuarine channel zone

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
All U.S. (12)	77.9	32.5	28.0	17.4	2.3	9.8	8.5	0.7	0.1	0.2	0.1	T	0.1	0.2	T	0.1	
	16½-84½	21-42½	21-32	14-24	⅓-4	8-12½	3½-17	0-3½	0-1	0 - 1½	0 - 1½		0-½	0-1½		0-⅔	
CSF and HWZ (9)	80.9	34.8	28.9	17.2	2.1	9.8	6.7	0.2	T	T	0.1	T	T	<0.05	T	0.1	
	77-84½	29½-42½	25-32	15-20⅔	⅓-4	8-12½	3½-9½	0-1			0-½			0-⅓		0-⅔	
MSF (3)	69.0	25.5	25.3	18.2	3.0	9.5	14.0	2.2	0.5	0.7	0.2	T	0.3	0.5	T	0.2	T
	60½-80½	21-33	21-31	14-24	2½-3	8-12½	9-17	0-3½	0-1	0-1½	0-½		0-½	0-1½		0-½	
Dunes (2)	87¼	35¼	33	19	½	8	3¼									T	
	85½-90	35-36½	28½-37½	16-22	¼-½	6-10	3½-4										

Tables 5.5. and 5.7. Averages and Ranges of the composition of the sand fraction of the sediments of (5.5) the upper sandflats and (5.7) the dunes.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
Clean Sandflats																	
L10	79½	35	28½	16	2	9½	8¼	½	T	T	T					T	
1/3	79	32½	31½	15	2½	9½	8	1	T	T	T					T	
1/1	79½	29½	32	18	3	9	8	T	T	T	½					T	
2/8	77	33½	28½	15	4	9	9½	T	T	T	T					½	
High water zone																	
L13	80½	38	27	15½	1	12¼	5¼										

Table 5.6. Variation in the composition of the sand fraction of the sediments of the clean sandflats and high water zone of Scotts Bay.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
L5	84	36	29½	18½	2	10	4		T		T					T	
L6	85½	35	28½	22	½	10	4	T								T	

Table 5.8. Composition of the sand fraction of the sediments of the high water zone (L5) and dunes (L6) from Llanstephan beach.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
All (14)	57.0	18.25	22.4	16.4	2.1	15.4	16.1	1.6	1.1	1.1	0.3	0.25	1.9	2.5	0.4	0.05	0.2
	42-73	2½-27½	13-30	11-24	0-4	8-56½	0-28	0-4½	0-5	0-4	0-1	0-1	0-8	0-7	0-2½	0-½	0-2
0- 15km. (9)	63.7	22.2	24.1	17.4	2.6	9.9	16.6	1.4	0.8	0.8	0.3	0.2	1.6	1.6	0.2	0.05	0.2
	54-73	15-27½	13½-30	15-24	1-4	8-12	10½-22	1-2	0-2	0-4	0-1	0-1	0-8	0-5	0-1	0-½	0-2
15-18½km (3)	44.5	15.8	16.0	12.7	1.3	8.8	25.2	3.2	2.8	2.8	0.5	0.7	2.5	6.7	0.8	0.0	0.2
	42-49	11-18½	13-19½	11-15	1-2	8-10	20½-28	2-4½	½-5	1½-4	0-1	½-1	0-4½	6-7	0-2½		0-½
18½-19km (2)	45¾	4	24¼	17½	1½	50							2½	T	½		
	43½-48	2½-4½	23-25½	17-18	0-3	43½-56½							0-5		0-½		

Table 5.9. Averages and Ranges of the composition of the sand fraction of the sediments of the mudflats

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
All (12)	60.4	18.0	21.5	20.9	2.7	11.4	8.0	1.0	0.2	0.05	0.2	0.1		6.4	0.9	<0.05	8.7 (MC) 0.1 (O)
	39-75½	10-27½	14-33	15-31	½-4	6½-29½	0-23½	0-6½	0-1	0-½	0-1	0-1		2-15	0-2	0-½	0-33 (MC) 0-1 (O)
0-15km. (9)	60.9	19.6	20.6	20.7	2.8	8.9	10.6	1.4	0.2	0.1	0.1	0.1		6.3	0.8	0.1	7.5 (MC) 7.5 (MC)
	48-75½	14½-27½	14½-27½	15½-31	2-4	6½-14	3½-23½	0-6½	0-1	0-½	0-½	0-1		2-10	0-2	0-½	0-21½ (MC)
15-18½km (2)	54½	14½	20	20	1½	13½	T							10	1½		18 (MC) ½ (O)
	39-69½	10-18½	14-26	15-25	½-3	7-19½								5-15	1-2		3-33 (MC) ½-1 (O)
18½-19km (1)	67½	10	33	24½	3	29½								T	T		

Table 5.10. Averages and Ranges of the composition of the sand fraction of the sediments of the salt marshes

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
All channel zone (8)	34.4	3.6	19.0	11.8	1.3	58.2	1.1	0.25	0.1				1.9	1.9	0.75		
	23-48	2-7	11½-28	8½-16	0-3	33-75½	0-9	0-2	0-1				0-9	0-14	0-3		
channel zone 20km. (6)	35.1	3.5	19.5	12.1	1.25	62.25							0.9	T	0.5		
	23-48	2-7	11½-28	8½-16	0-3	50-75½							0-2		0-1		
All mud bank (3)	31.5	3.3	18.7	9.5	0.8	57.2	1.7						6.5	1.3	1.0		
	19-49	2-5½	13-27½	4-16	0-2½	45-73½	0-5						0-18	0-4	0-2		
mud bank 20km. (2)	37½	4	21½	12½	1¼	59½							½	T	1		
	26½-49	2½-5½	15½-27½	8½-16	0-2½	45-73½							0-1½		0-1		

Table 5.11. Averages and Ranges of the composition of the 2 to 4 ∅ sand fraction of the sediments of the fluvial channel zone and mud banks.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
Flood plain (5)	54.6	6.8	27.6	20.2	2.1	41.1								0.8	1.1		0.3 (MC).
	39-68½	4-8	21-38½	14-30½	0-3½	26-56½								0-2	0-2		0-1½ (MC)
All channel zone (8)	12.7	1.0	6.1	5.6	T	84.4	T						2.6	0.25			0.1 (O)
	5-19½	0-2	2-12	3-8½		80-95							0-15	0-1			0-½ (O)
channel zone 20km. (6)	14.9	1.0	7.4	6.5	T	83.9							0.9	0.2			0.1 (O)
	9½-19½	0-1½	2½-12	5½-8½		80-90½							0-3	0-1			0-½ (O)
All mud bank (2)	9	¼	3¼	4½	T	88½							2½				
	6-12	½-1	3-4½	2-7		88-89							0-5				

Table 5.12. Averages and ranges of the composition of the sand fraction of the sediments of the river flood plain, and the -1 to 2 ø sand fraction of the sediments of the fluvial channel zone and mud banks.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
2 to 4 ø fraction (10)	7 .65	28.05	34.35	15.25	2.05	8.95	9.7	0.45	0.1	0.2	0.25	0.05		0.35	T	0.15	0.1 (MC)
	70-83	22½-40½	23-44	11-17½	0-3½	5-13	8-11½	0-1	0-1	0-1	0-1	0-½		0-2		0-½	0-1 (MC)
-1 to 2 ø fraction (3)	58.7	13.7	27.3	17.7	0.7	11.0	23.6	0.7	2.7					1.3			0.3 (O) 1.0 (MC)
	28-77	9-17	11-36	8-27	0-1	5-17	9-52	0-1	0-8					0-3			0-1 (O) 0-3 (MC)

Table 5.13. Averages and Ranges of the composition of the 2 to 4 ø, or total, and -1 to 2 ø sand fractions of the sediments of Carmarthen Bay.

	Quartz/ Feldspar Total	Quartz/ Feldspar Clear	Quartz/ Feldspar Coloured	Quartz/ Feldspar Cloudy	Dark Minerals	Rock Fragments	Shell Fragments	Foramin-iferids	Echinoid Spines & Plates	Bryozoa	Sponge Spicules	Ostra-cods	Plant Fragments	Coal	Mica	Glauc-onie	Others & Mud clasts
SI76	73	29	11	33	4½	6½	7½	1					½	½	6½		
9/9																	
-1 to 2ø	14	T	8	6		86											
2 to 4ø	40	2	21½	16½	2	58									T		
SIBC/1																	
-1 to 2ø	36	2	18	16		64									T		
2 to 4ø	73	9	40	24	1	24									2		

Table 5.14. Composition of the sand fraction of the boulder clay (9/9, SIBC/1) and early Holocene sediments.

	Clear Quartz/Feldspar	Coloured Quartz/Feldspar	Cloudy Quartz/Feldspar
	(Figures expressed as percentages in terms of Total Quartz/Feldspar)		
All Offshore Sediments	36.1	44.2	19.6
All Estuarine Sediments	36.5	36.9	26.6
All Fluvial Sediments	11.2	55.0	33.8
Average of Fluvial and Offshore Sediments	23.7	49.6	26.7
Boulder clay Sediments	8.7	54.3	37.1
Early Holocene Sediments	39.7	15.1	45.2

TABLE 5.14a.

Average relative proportions of the three varieties of quartz/feldspar in the offshore, estuarine, fluvial, boulder clay and early Holocene fine - very fine sands.

	Clear Quartz/Feldspar	Coloured Quartz/Feldspar	Cloudy Quartz/Feldspar
	(Figures expressed as percentages in terms of Total Quartz/Feldspar)		
Offshore Sediments	36.1	44.2	19.6
Channel Zone Sediments	38.3	36.2	25.5
Upper Sandflat Sediments	41.8	35.9	22.3
Dune Sediments	40.7	37.6	21.7
Mudflat Sediments	32.0	39.3	28.8
Salt Marsh Sediments	29.8	35.6	34.6
River Channel Sediments	10.5	55.2	34.3
River Mud Bank Sediments	10.5	59.4	30.2
River Floodplain Sediments	12.5	50.5	37.0

TABLE 5.14b.

Average relative proportions of the three varieties of quartz/feldspar in the fine - very fine sand grade of the sediments of the estuarine and fluvial sub-environments.

	Clear Quartz/Feldspar	Coloured Quartz/Feldspar	Cloudy Quartz/Feldspar
	(Figures expressed as percentages in terms of Total Quartz/Feldspar)		
All Offshore Sediments	36.1	44.2	19.6
Estuarine Channel Zone Sediments (0 - 15 kms)	40.3	35.3	24.5
Estuarine Channel Zone Sediments (15 - 18½ kms)	34.8	36.2	29.0
Estuarine Channel Zone Sediments (18½ - 19 kms)	11.8	52.9	35.5
River Channel Sediments	11.2	55.0	33.8

TABLE 5.14c.

Average relative proportions of the three varieties of Quartz/Feldspar in the fine - very fine sand grade of the offshore and river channel sediments, and along the channel zone of the estuary.

(All Figures expressed as percentages in terms of Total Quartz/Feldspar)

(Q/Fc = clear quartz/feldspar, Q/F col = coloured quartz/feldspar, Q/F cl = cloudy quartz/feldspar)

	-1.0 - 2 ϕ			2.0 - 2.5 ϕ			2.5 - 3.0 ϕ			3.0 - 3.5 ϕ			3.5 - 4.0 ϕ		
	Q/F c.	Q/F col.	Q/F cl.	Q/F c.	Q/F col.	Q/F cl.	Q/F c.	Q/F col.	Q/F cl.	Q/F c.	Q/F col.	Q/F cl.	Q/F c.	Q/F col.	Q/F cl.
Offshore samples															
CB2	20.9	48.8	30.2	25.4	53.7	20.9	28.2	53.5	18.3	27.4	56.2	16.4	28.4	50.0	21.6
IMER 36	15.4	55.4	29.2	22.6	56.5	21.0	25.4	52.1	22.5	18.4	59.2	22.4	23.8	51.2	25.0
Estuarine samples															
PIMCha	4.3	39.1	56.5	45.2	29.0	25.8	31.2	40.3	28.6	35.9	38.5	25.6	32.5	45.0	22.5
DILWch	0.0	100.0	0.0	40.9	22.7	36.4	30.1	43.8	26.0	31.8	40.9	27.3	33.3	46.7	20.0
17/1							0.0	0.0	100.0	33.3	40.5	26.2	30.4	39.1	30.4
17/18 Ch 45	3.0	39.4	57.5	5.6	38.9	55.6	11.8	64.7	23.5	36.7	33.3	30.0	28.1	42.2	29.7
Fluvial Samples															
19P/6	0.0	45.5	54.5	13.0	52.2	34.8	3.8	57.7	38.5	13.2	63.2	23.7	13.8	58.6	27.6
21GE	6.9	34.4	58.6	10.0	50.5	40.0	3.2	54.8	41.9	7.9	57.9	34.2	11.3	52.8	35.8

TABLE 5.14d. Relative proportions of the three varieties of quartz/feldspar in the sand grades of samples from the estuary, river and offshore.

TABLE 5.15

SAMPLE TREATMENT FOR CLAY ANALYSIS

1). The sample was soaked in distilled water with 10 ml 10% NH_3 solution as a peptiser, for about 24 hours with occasional vigorous stirring.

2). The clay fraction ($<2\,\mu m$ grade) was obtained from the sample by centrifuging a suspension for 12 minutes at 500 r.p.m.

3). The clay was mounted for X-ray diffraction by filtration of the clay suspension from 2).through a ceramic disc using a vacuum suction system, the clay forming a thin layer on the surface of the disc.

4). The disc was subsequently dried at a low heat (ca. $40^{\circ}C$) in the oven and was then ready for analysis.

TABLE 5.16. THE METHOD OF CALCULATION OF THE CLAY PROPORTIONS

Four peak areas were measured from the glycerated and 400°C heated traces, by tracing them onto paper, cutting out the drawn areas and weighing these. Errors incurred by the use of this method, due to variation in the paper weight and the accuracy of cutting out the areas, were found to be ca. 0.3%.

The four peaks measured were:

A = The 10Å reflection from the glycerated trace = Illite content.

B = The 7Å reflection from the glycerated trace = Kaolinite and Chlorite content.

C = The 10Å reflection from the 400°C heated trace = Illite and Expandable Clays content.

D = The 7Å reflection from the 400°C heated trace = Kaolinite and Chlorite content.

From these, the relative proportions of the clay minerals could be calculated:

1. Total Clay = $C + \frac{D}{2}$

(N.B. 1. The factor 2 is required to equate the intensities of the 10Å and 7Å reflections; hence D is divided by 2 - although some people use 2½, e.g.

2. B and D should be equal, but since they often were not, an average value of the two was generally taken).

2. Percentage of Illite = $\frac{A}{C+D/2} \times 100\ \%$

3. Percentage of Expandable Clays = $\frac{C - A}{C + D/2} \times 100\ \%$

4. Percentage of Kaolinite and Chlorite = $\frac{D/2}{C+D/2} \times 100\ \%$

The relative proportions of Kaolinite and Chlorite were then estimated by comparison of the peak heights of the 004 Chlorite and the 002 Kaolinite reflections on the air dried trace, although this could also have been done by using the 004 Chlorite reflection of a 550°C heated trace, as Kaolinite decomposes at ca. 500°C. However, the two peaks were easily differentiated on the air dried trace, so that the relative heights of these were used to give the approximate relative proportions of Kaolinite and Chlorite, and hence their percentages in terms of the overall clay mineralogy.

TOWY

		ILLITE	EXPANDABLE (MIXED-LAYER) CLAYS	KAOLINITE	CHLORITE
River Gwili (LS4)		69	26	0	5
River Towy (21GE)		60	35	0	5
River Towy (19P/12)		60	34	0	7
Fluvial Tidal Zone (18/19/3)		50	40	5	6
Uppermost Estuary (17/18PB)		47	41	5	7
Upper Estuary (F45)		46	44	5	5
Upper/Middle Estuary	(15/3)	50	39	5	6
	( )				
	(F39)	45	45	5	5
Middle Estuary	(11/2)	52	39	5	5
	( )				
	(L35)	52	38	5	6
Upper Lower Estuary	(F7)	47	42	5	6
	( )				
	(P7MF)	46	44	5	6
Lower Estuary (L1)		50	39	5	6
Average estuarine (10)		49	41	5	6

TABLE 5.17i

TABLE 5.17. RELATIVE PROPORTIONS OF THE CLAY MINERALS IN THE SEDIMENTS OF (5.17i) THE TOWY ESTUARY AND RIVER, (5.17ii) THE TAF AND GWENDRAETH ESTUARIES AND RIVERS, AND (5.17iii) CARMARTHEN BAY, THE BOULDER CLAY, AND EARLY HOLOCENE AGE

TAF	ILLITE	EXPANDABLE (MIXED-LAYER) CLAYS	KAOLINITE	CHLORITE
RIVERS				
Afon Cywyn	49	45	0	6
Afon Cynin	52	42	0	6
Dewi Fawr	51	44	0	5
Taf Estuary Uppermost	44	45	5	6
Upper	52	35	6	7
Middle	51	38	5	6
Lower	55	33	6	6
Average estuarine (4)	51	38	6	6
GWENDRAETH				
Gwendraeth Fach	49	41	0	10
Gwendraeth Fawr	54	40	3	3
Gwendraeth Upper Estuary	55	32	6	7
Gwendraeth Lower Estuary	54	38	3	4
Average estuarine (2)	55	35	5	6

TABLE 5.17 ii

OTHERS

	ILLITE	EXPANDABLE (MIXED-LAYER) CLAYS	KAOLINITE	CHLORITE
Boulder Clay (9/9)	67	24	0	8
Boulder Clay (SIBC/1)	74	22	0	4
Marine - Carmarthen Bay (CB2)	47	42	6	6
Lagoonal? Sandy mud ($S13A.H_2O_2$)	44	45	5	6
Lagoonal? Sandy mud (S13 (Not H_2O_2))	50	37	5	6

N.B. The results are given to the nearest 1%, although error in the method is of the order of $\pm$ 2-3%

TABLE 5.17 iii

TABLE 5.18. AVERAGE DAILY FLOWS OF MAJOR RIVERS ENTERING CARMARTHEN BAY

(Data from W.N.W.D.A.)

	Average Daily Flow (cumecs)
Loughor at Lougher Bridge	8.841
Lliw at Gowerton	1.175
Llan at Gowerton	1.094
Gwendraeth Fawr at Kidwelly	1.859
Gwendraeth Fach at Kidwelly	2.236
Towy at Nantgaredig	36.944
Taf at Clog-y-Fran	6.354
Gwili at Glan Gwili	4.305
Dewi Fawr at Glasfryn Ford	1.227
Cynin at St. Clears	1.812
Cywyn at Bancyfelin	1.486

CHAPTER 6

FIGURES AND TABLES

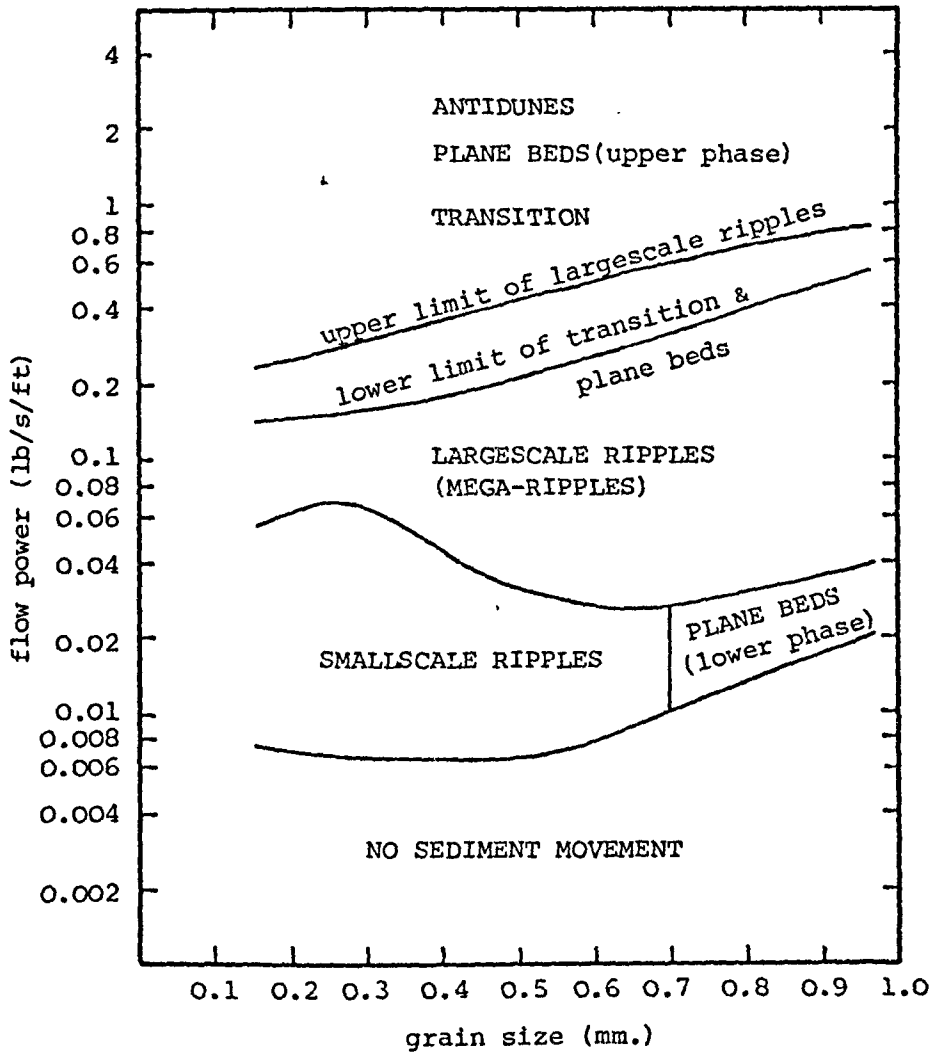


FIGURE 6.1 BED FORM AS A FUNCTION OF FLOW POWER AND GRAIN SIZE (from Allen 1968)

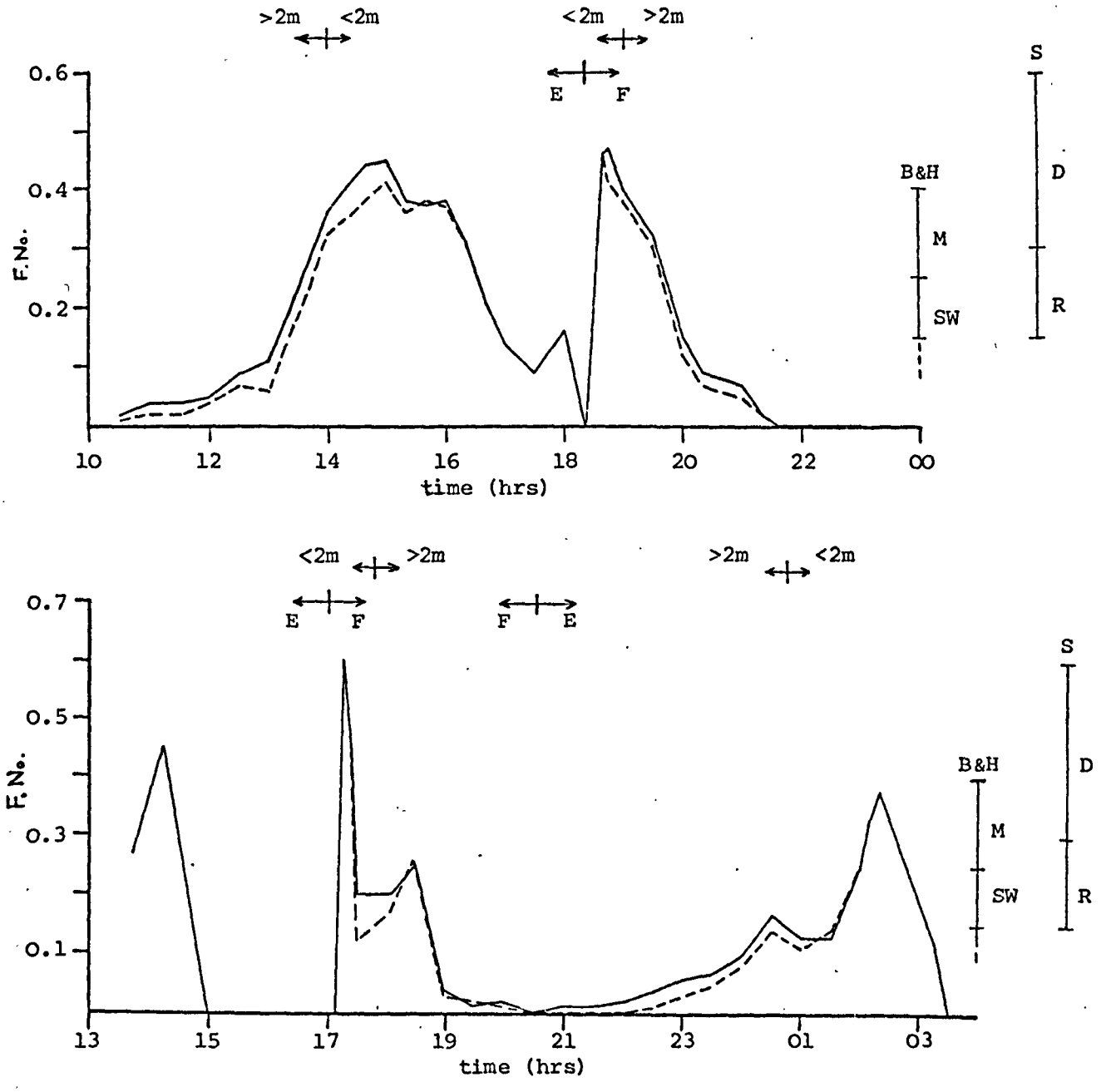


FIGURE 6.2 PLOTS OF VARIATION IN FROUDE NUMBER OVER THE TIDAL CYCLE FOR STATIONS B2S/74 AND A2S/74.

(M,SW-stability fields of mega-ripples and sand waves after (B&H) Boothroyd & Hubbard 1971; and D,R-stability fields of dunes and ripples after (S) Simons et al. 1965)

(F-flood, E-ebb, >2m & <2m indicate periods when water depth greater and less than 2 metres)

(— Froude numbers based on flow in the whole water column
-- Froude numbers based on flow in bottom waters only)

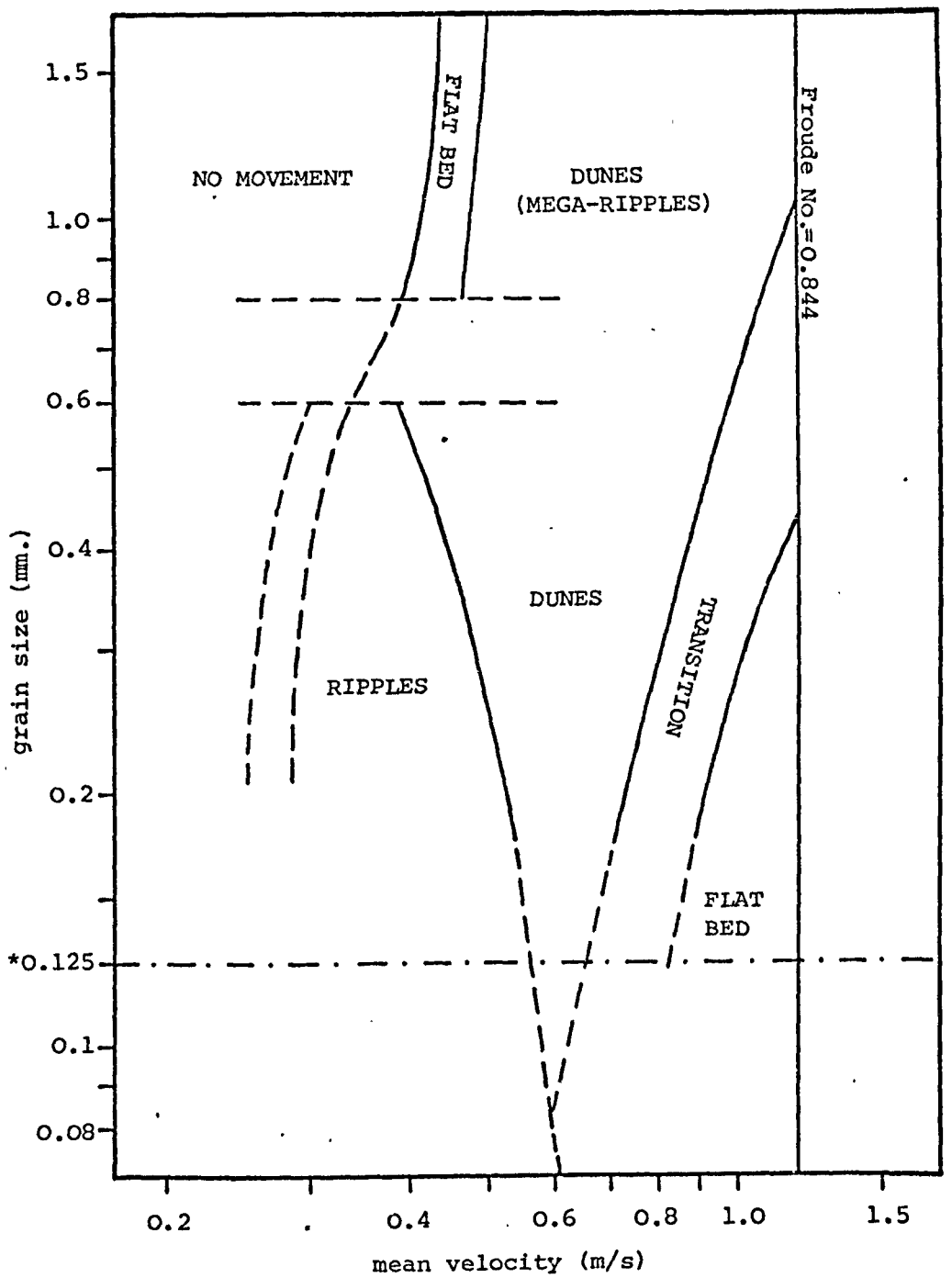


FIGURE 6.3 SIZE-VELOCITY DIAGRAM FOR 0.2 METRES FLOW DEPTH (from Southard 1971).

(* 0.125 mm. is the approximate mean grain size of the sands in the Towy estuary)

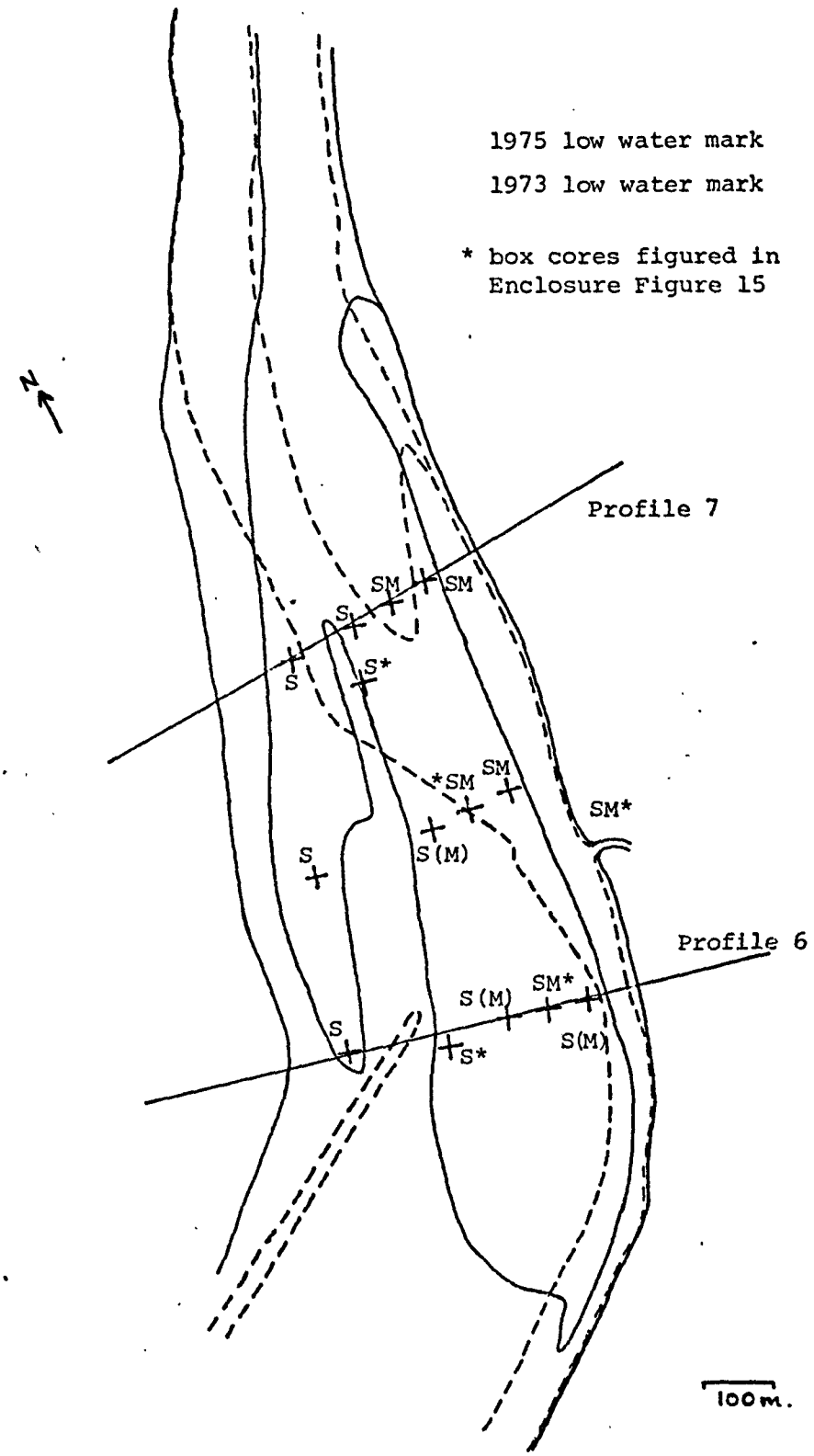


FIGURE 6.4 GENERAL NATURE OF BOX CORES BETWEEN PROFILES 6 AND 7 IN RELATION TO THE LOW WATER CHANNELS OF 1975 AND 1973

(S-sand only in box core, S(M)- mainly sand with some mud in box core, SM- inter-stratified sand and mud in box core)

FIGURE 6.5 GENERAL NATURE OF BOX CORES ALONG PROFILES 6 AND 7 IN RELATION TO THE CHANGES IN THE PROFILES BETWEEN 1974 AND 1975

(S-sand only in box core, S(M)-mainly sand with some mud in box core, SM- inter-stratified sand and mud in box core)

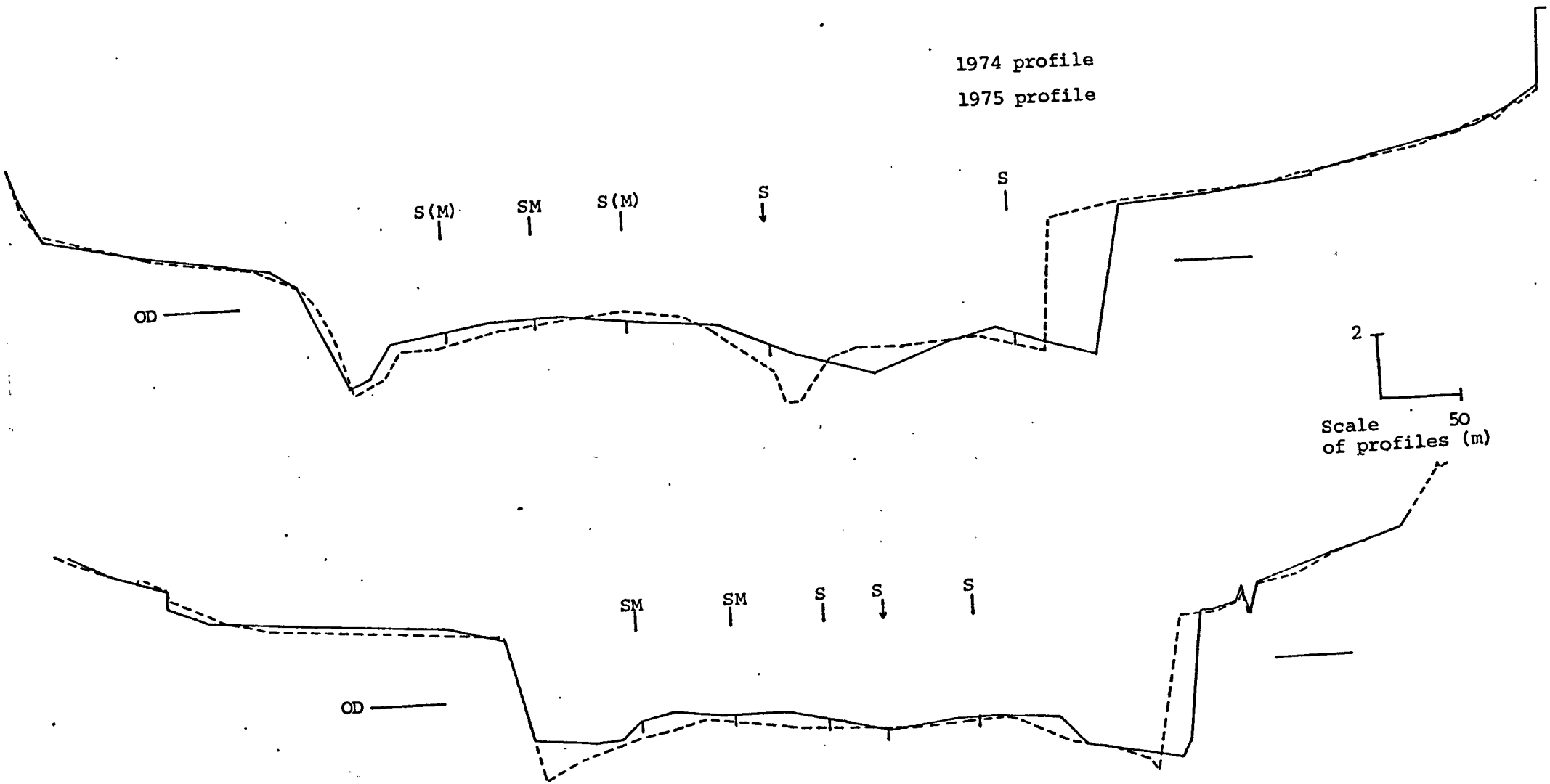

1974 profile
1975 profile
S(M)
SM
S(M)
S
S
OD
2
Scale
50
of profiles (m)
SM
SM
S
S
S
OD



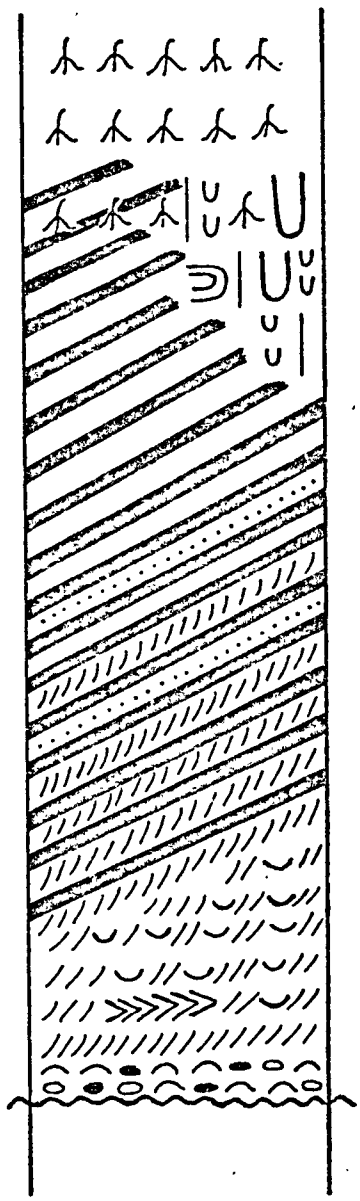
FIGURE 6.6 FAECAL PELLETS OF NEREIS DIVERSICOLOR IN A BURROW (FROM CORE PJ9/1)
(Burrow width ca. 3 mm)



FIGURE 6.7 THE DIFFERENT COLOURATION OF ESTUARINE SEDIMENTS (THE DARK GREY CORE) RELATIVE TO THAT OF THE FLUVIAL SEDIMENTS (THE BROWN CORE) (Note also the thin capping of grey sediment to the brown sediments suggesting that estuarine sediments are overlying fluvial sediments)
Scale in cms.



FIGURE 6.8 INTER-STRATIFIED SANDS AND MUDS OF THE SALT MARSH OF THE UPPERMOST ESTUARY (LINE 18), EXPOSED IN THE FACE OF AN ERODING CHANNEL BANK (Note the inclined sediments of a point bar on the right of the photograph and the muddy sediment veneer to sands and gravels at the base of the cliff face) Scale ca.6 cms (lens cap centre of photograph)



the sequence may pass upwards into sediments of the upper sandflats or mudflats and not salt marshes as illustrated here

the maximum thickness of the sequence is about 3-3½ m., and ranges down to ca. ½ m.

in the stream-backed creeks lithic gravel and sand is common within the sediments

FIGURE 6.9a IDEALISED VERTICAL CREEK SEQUENCE
(For key to legend see Fig.7.2)



FIGURE 6.9b CREEK DEPOSITS EXPOSED IN THE CHANNEL ZONE INCLINE UNDERLYING MUDFLATS (Note the gravel at the bottom of the photograph which forms part of a stream outwash fan-the stream mouth is to the right of the field of the photograph)



FIGURE 6.10 PLANE-AND LARGE-SCALE CROSS-STRATIFICATION OF THE DUNE SEDIMENTS (EXPOSED IN THE DUNES NEAR ST. ISHMAELS) (Note common roots and rootlets)



FIGURE 6.11 PLANE-STRATIFIED SEDIMENTS OF THE DUNES AT THE SOUTHERN END OF MORFA UCHAF SHOWING SOIL AND ROOTLET HORIZONS (Note wind ripples on sands below the small cliff) Scale ca.1 m.

C H A P T E R 7

FIGURES AND TABLES

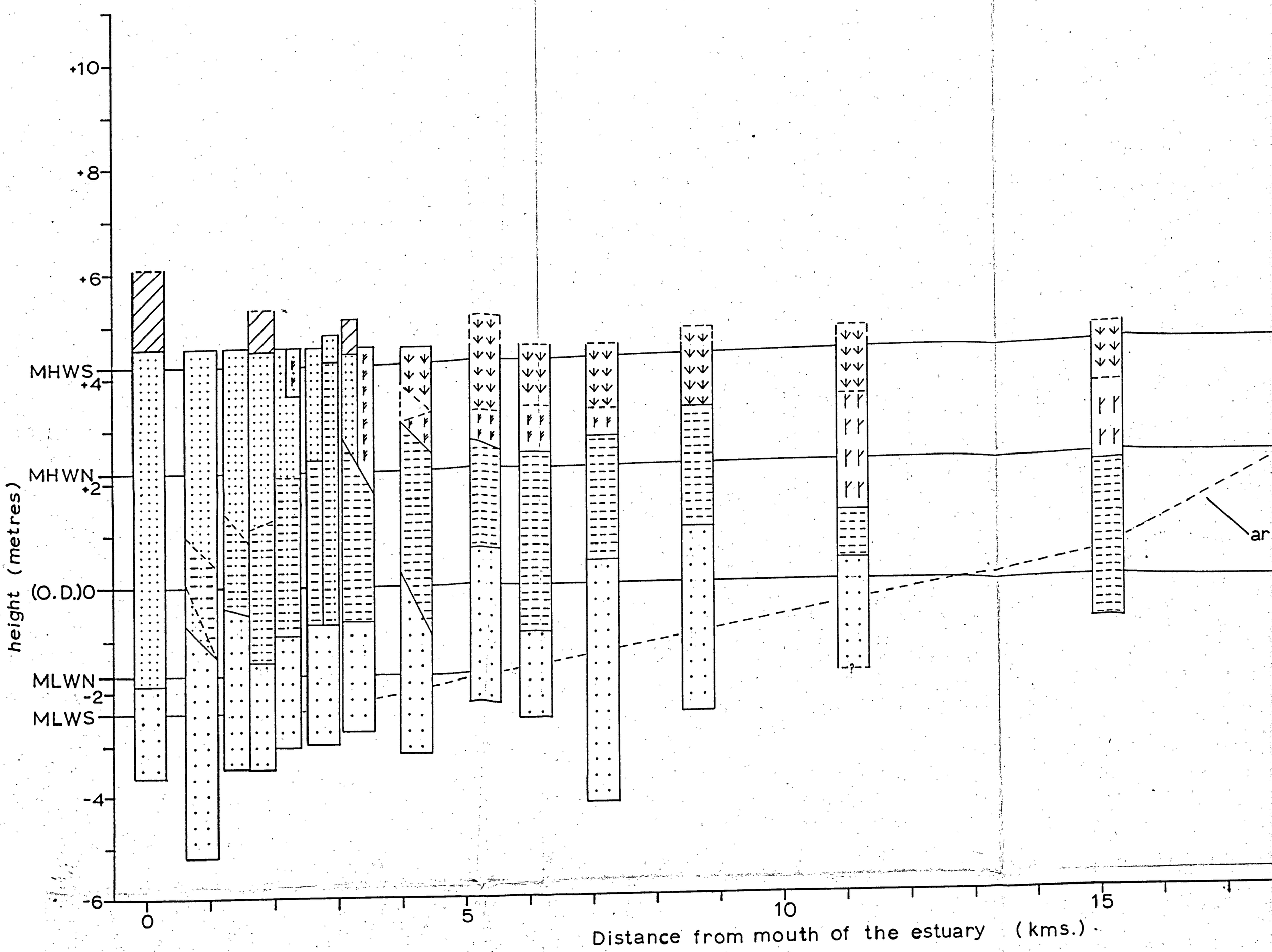
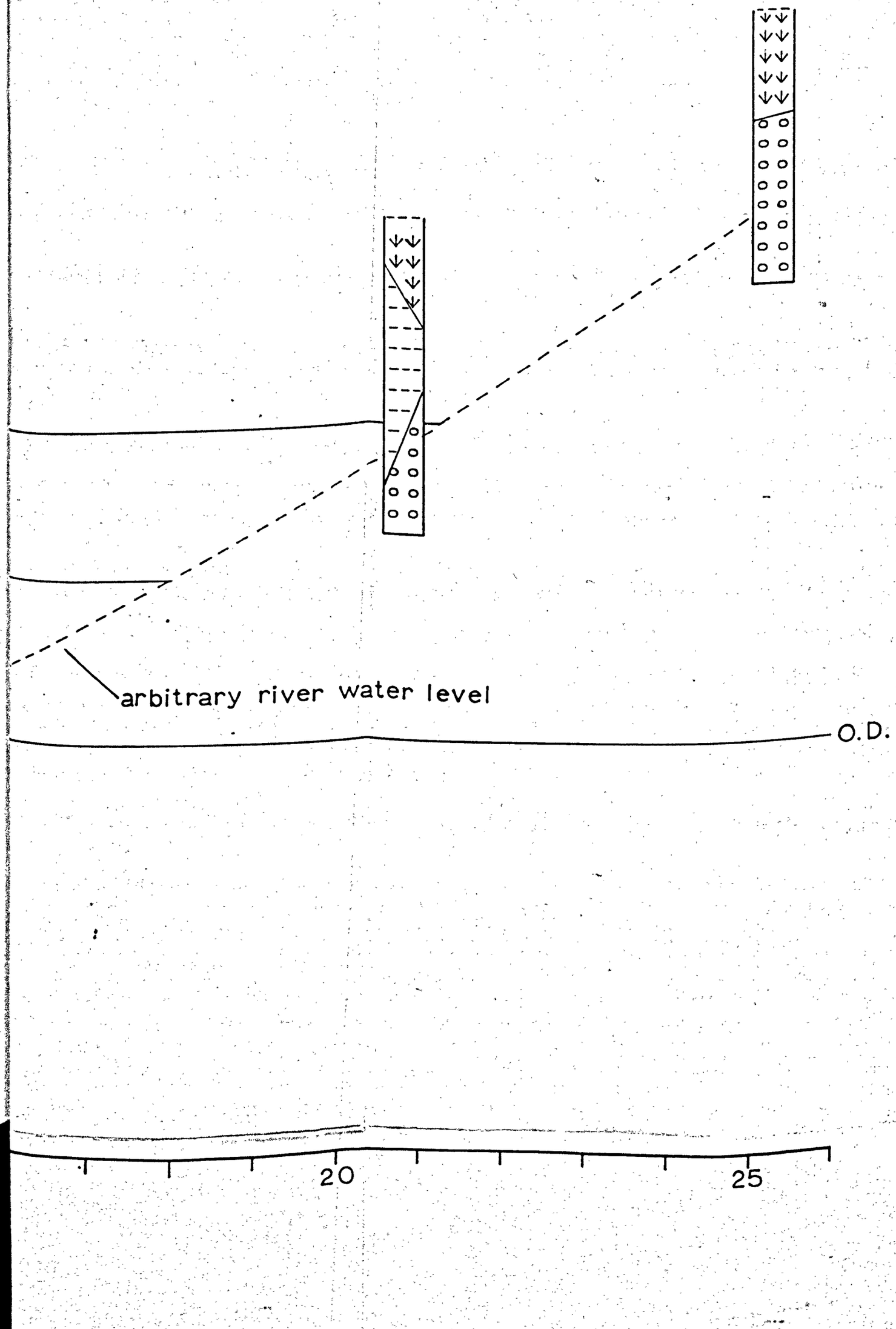


FIG. 7.1 The estuarine cross-sections plotted as vertical sequences



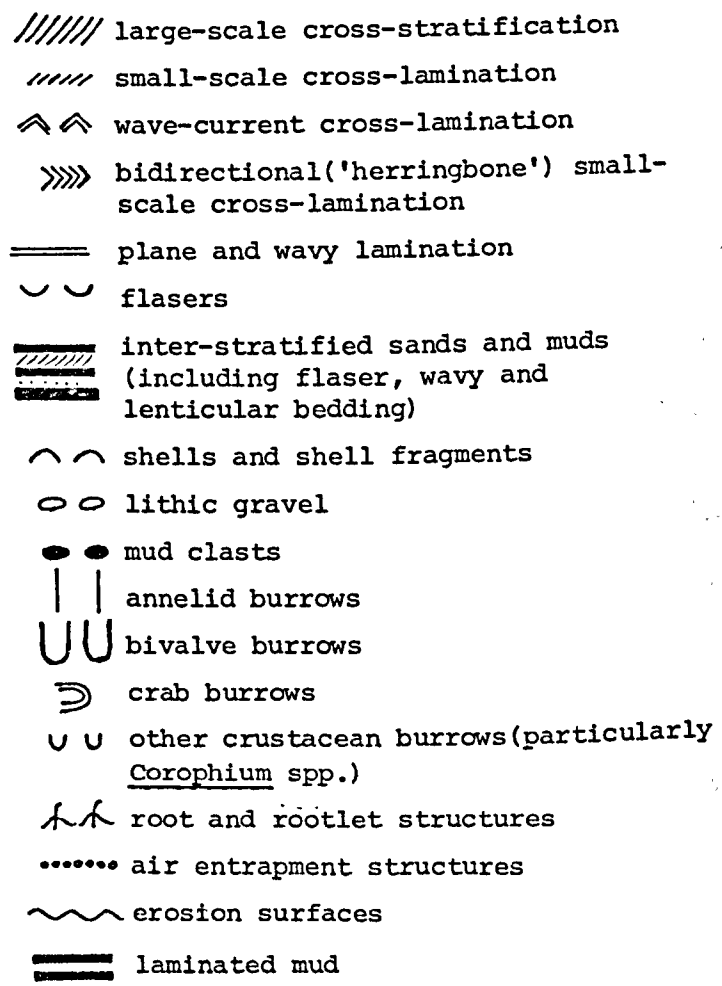
KEY

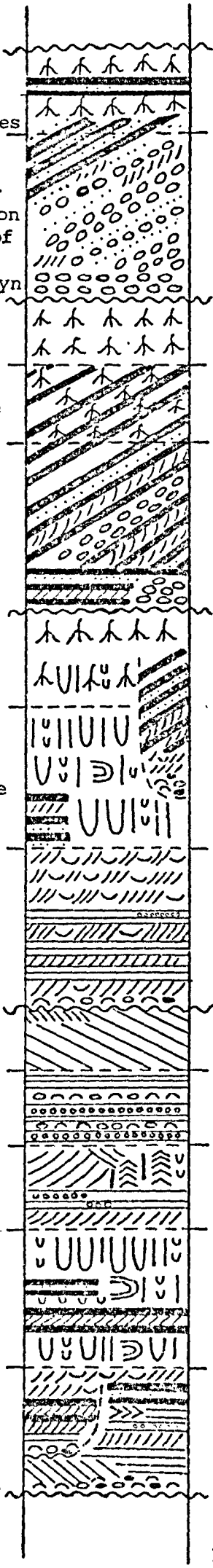
- dunes
- fluvial channel gravel & sandbars
- estuarine channel " & sandflats
- upper sandflats
- muddy sandflats (of above)
- mudflats & river mud banks
- Spartina salt marsh
- General & Juncus salt marsh, & river flood plain
- Pragmites marsh

A split section indicates a difference in the profiles on the 2 sides of the estuary.

FIGURE 7.2 HIGHLY IDEALISED VERTICAL SECTION OF THE POTENTIAL ESTUARINE AND FLUVIAL SEQUENCES ASSUMING NO EROSION BETWEEN THE INDIVIDUAL SEQUENCES.

KEY TO LEGEND (ALSO FOR FIGS.6.9a AND 7.3) :-





sequence of fluvial sediments

flood plain sediments - ca.1½-2 m.

fluvial-lower reaches sequence

ca.4-5 m. max.- cf.data of Codrington 1902 of 10-16 ft. of fluvial sediments over till at Dryslwyn

channel zone and mud bank sediments - ca.3 m.

Juncetum and general salt marsh sediments- ca.1-1½ m.

upper estuarine sequence

ca.5-6 m. max.

Phragmitetum salt marsh sediments - ca.1-2 m. - bioturbation by Tubifids common(not shown).

channel zone and mud bank sediments - ca.3 m. - bioturbation by Tubifids common(not shown).

salt marsh sediments - ca.1½-2 m.

middle estuarine sequence

ca.8 m. max.

mudflat sediments - ca.2½-3 m. creek sediments common(sequence shown)- may be intensely biotubated by annelids,crustaceans and bivalves-also occur in salt marsh sediments.

channel zone sediments - ca.3½-4 m.

dune sediments - up to ca.15 m. max.

high water zone sediments - ca.1-1½ m.- some bioturbation by Talitritids(not shown).

lower estuarine sequence

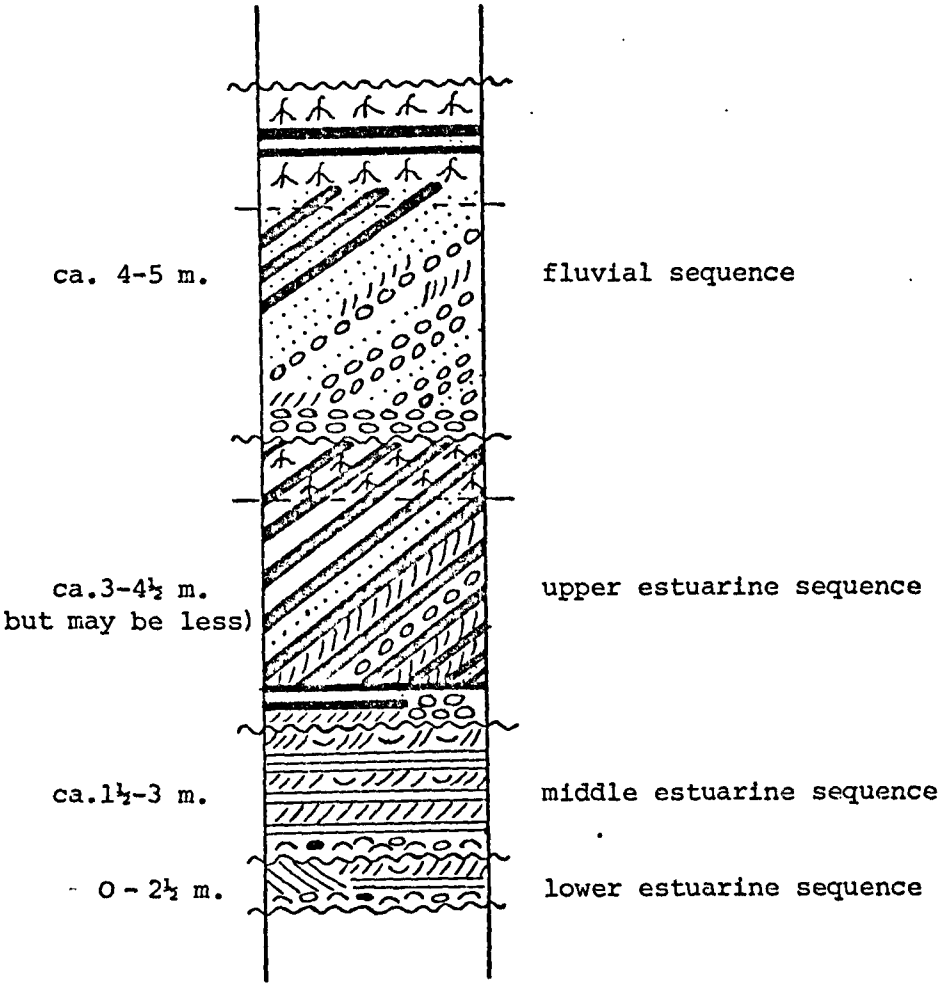
ca.10 m. max. - but up to ca.25 m. with dune sediments

'clean'rippled sandflat sediments - ca.1½-2 m.

muddy sandflat sediments - 0-ca.2½ m.- rill sediments locally common(not shown)-also occur in 'clean'rippled sandflats.

channel zone sediments - ca.2½-4 m.- some bioturbation by crustaceans, annelids and bivalves,and may be locally intense,particularly in the inter-stratified sands and muds(not shown

sequence of marine sediments passing up into tidal delta sediments or into beach and dune sediments.



Total estuarine sequence ca.10 m. maximum thickness

FIGURE 7.3 HYPOTHETICAL ESTUARINE SEQUENCE WHICH COULD DEVELOP ASSUMING STATIC SEA LEVEL AND PROGRADATION OF THE ESTUARINE SEDIMENTS TOGETHER WITH COMPLETE EROSION OF PREVIOUS ESTUARINE SEDIMENTS THROUGH CHANNEL MIGRATION (Based on average thicknesses of the various estuarine sequences and their average heights relative to Ordnance Datum) (Key to legend - see Fig.7.2)

TABLE 7.1

CHANNEL ZONE SUB-FACIES

Forms a sinuous belt along the axial part of the estuary. Comprises two major lithofacies.

1. Dominantly sandy lithofacies. Developed in the lower reaches to the lower part of the upper reaches of the estuary.

a) Sediments

Texture: Mainly very well-sorted fine - very fine sands. (Mzø : 2.63 to 3.37).
Local lithic, shell and mud clast gravels.
Local muds.

General composition of the sand fraction:
Dominant quartz/feldspar - ~75% (50-85%)
Minor rock fragments and shelly debris - both 10% (~5-35%).
Trace contents of dark minerals, mica, glauconie and plant fragments.

b) Macrofauna Generally sparse, but diverse.
Main groups and species include: Bivalves (Mytilus edulis, Macoma balthica); Annelids (Nephthys spp. Pygospio elegans): Crustaceans (Corophium spp., Bathyporeia spp., Carcinas maenas, Crangon vulgaris); Fish.

c) Flora Rare. Mainly as plant debris either scattered in the sediments or forming lenses or laminations.

d) Stratification

Predominantly small-scale trough cross-lamination and plane-lamination. Common flasers. Other structures include: Planar cross-lamination, large-scale mega-ripple cross-lamination, air entrapment structures, structureless sand, shell gravel ridges, flaser bedding and inter-stratified sands and muds. Herringbone cross-stratification is rare.

Bioturbation is generally slight, but locally common in the muddy sediments, (particularly the burrows of Corophium spp. and Macoma balthica).

Local bioherms of Mytilus edulis occur in the lower reaches of the estuary.

2. Variable mud-gravel lithofacies. Developed in the upper part of the upper reaches and the uppermost reaches of the estuary.

a) Sediments

Texture: Variable. Mainly poorly sorted muddy sands to sandy muds and muddy gravels. Some gravels and sandy gravels. (Mzø : < -1.00 to 7.24). (Muddy sediments - sands to clayey silts).

General composition of the sand fraction:

Variable. In the muddy sediments:

Quartz/feldspar and shelly debris dominant - ~45% and 35% (30 - 55% and 30 - 50%). Minor rock fragments ~10% (4 - 15%) coal ~5% (3 - 13%) and plant fragments ~4% (½ - 8%).

Trace contents of dark minerals and mica.

In the gravelly sediments:

Rock fragments dominant ~70% (50 - 80%)

Minor but variable quartz/feldspar ~20% (10 - 60%) and plant fragments ~10% (1 - 20%).

Trace contents of shelly debris, coal, dark minerals and mica.

Gravel - predominantly rock fragments.

b) Macrofauna

Apparently very sparse. Oligochaetes (Tubifids) and Gastropods (Hydrobids - Potamopyrgus jenkinsi).

c) Flora Mainly as plant debris.

d) Stratification

Poorly known. Inter-stratified muds, sands and gravels, and laminated muds. Bioturbation very slight.

UPPER SANDFLATS SUB-FACIES

Forms marginal intertidal zone to channel zone sub-environment in the lower reaches of the estuary. Comprises three lithofacies.

1. Sandy and gravelly lithofacies. Developed in the high water zone of the intertidal flats.

a) Sediments

Texture : Very well sorted fine - very fine sands to poorly

sorted gravelly sands. (Mzø : -0.89 to 2.90)

General composition of sand fraction:

Quartz/feldspar dominant ~80%.

Minor rock fragments ~10% and shelly debris ~5%.

Trace contents of dark minerals and glauconie.

Gravel - rock fragments and shells and shell fragments.

b) Macrofauna Very sparse and poor.

Crustaceans (Gammarids, Talitritids, rare Carcinas maenas) and rare gastropods (Hydrobia sp.).

c) Flora Only as plant debris, commonly forming litter lines marking particular high water marks.

d) Stratification

Poorly inter-stratified sands and gravels. Sands may show horizontal plane-lamination or curved inclined lamination, but commonly are structureless.

Air entrapment structures very common.

Gravels form strata or occur scattered in the sands.

Ripple cross-lamination is rare.

Bioturbation - none to very slight.

2. Sandy lithofacies. Forms major part of the marginal intertidal upper sandflats sub-environment.

a) Sediments

Texture: Well - very well-sorted fine - very fine sands (Mzø : 2.76 to 3.10).

General composition of the sand fraction:

Quartz/feldspar dominant ca. 80% (77 - 84%)

Minor rock fragments ca. 10% (8 - 10%) and shelly debris ca. 7% (4 - 10%)

Trace contents of dark minerals, glauconie and coal.

b) Macrofauna

Common and diverse.

Main groups and species.

Annelids (Lanice conchilega, Arenicola marina, Nephthys spp. Pygospio elegans, Scolopos armiger)

Bivalves (Cerastoderma edule, Macoma balthica, Mya arenaria, Mytilus edulis)

Crustaceans (Corophium spp., Bathyporeia spp., Carcinas maenas, Crangon vulgaris).

Gastropods (Hydrobia ulvae, Littorina littorea).

c) Flora

Rare. Mainly as scattered plant debris.

d) Stratification

Dominantly small-and large-scale cross-lamination, with some plane and curved inclined laminations and structureless sand.

Flasers and mud strata rare. Air cavities common.

Deformation structures rare.

Bioturbation generally slight but may be moderate to intense.

Biohermal mounds of Mytlus edulis occur locally.

3. Muddy sand lithofacies. Developed on the lower part of the marginal intertidal flats next to the channel zone sub-environment, and also in the inland part of the intertidal flats where it is gradational with the sand-mud lithofacies of the mudflats sub-environment.

a) Sediments

Texture: Moderately or poorly sorted muddy very fine sands to very poorly sorted sand-muds. (Mzø : 3.05 - 5.01). (Sands to silty sands).

General composition of the sand fraction:

Quartz/feldspar dominant ca. 70% (60 - 80%).

Minor shelly debris ca. 15% (9 - 17%) and rock fragments ca. 10% (8 - 12%).

Trace contents of dark minerals, coal, glauconie, and plant fragments.

b) Macrofauna

Common and diverse.

Main groups and species include:-

Annelids (Nereis diversicolor, Arenicola marina, Pygospio elegans)

Bivalves (Mya arenaria, Macoma balthica, Cerastoderma edule, Scrobicularia plana)

Crustaceans (Corophium spp., Carcinas maenas, Crangon vulgaris)

Gastropods (Hydrobia ulvae).

c) Flora

Patches of green algae, isolated Spartina townsendii, but mainly plant debris.

d) Stratification

Inter-stratified sands and muds and structureless muddy sands.

Inter-stratification of the sands and muds consists generally of horizontal inter-layering with some flaser, wavy and lenticular bedding.

Inclined inter-layering occasionally evident, and is apparently associated with small rills. Local imbricate shell lenses in scours.

Bioturbation is moderate to intense. Where intense original stratification is totally destroyed producing structureless sediments.

MUDFLATS SUB-FACIES

Forms marginal intertidal flats to the channel zone sub-environment in the lower and lower part of the middle reaches of the estuary, while in the upper part of the middle reaches the upper reaches and uppermost it forms the mud banks to the channel zone sub-environment.

a) Sediments

Texture: Poorly or very poorly sorted muddy very fine sands to sandy muds. (Sands to clayey silts). ($Mz\phi$ - 3.54 - 6.34).

General composition of the sand fraction:

Quartz/feldspar dominant ca. 55% (42 - 73%).

Minor but variable shelly debris ca. 20% (0 - 40%) and rock fragments ca. 15% (8 - 56%).

Trace contents of dark minerals, coal, mica, glauconie, plant fragments and mud clasts.

Some variation in composition apparent along the estuary from the lower reaches to the upper reaches, shelly debris being more significant in the upper estuary, ca. 35% (31 - 40%) and quartz/feldspar being less significant, ca. 45% (42 - 49%); while in the uppermost reaches of the estuary shelly debris decreases to 0% and rock fragments increase to ca. 50% (43 - 56%).

b) Macrofauna

Common and moderately diverse in the lower estuary and lower part of the middle reaches, but decreasing inland, becoming poor and restricted in the upper estuary.

Main groups and species.

Crustaceans (Corophium spp., Gammarids, Carcinas maenas)

Bivalves (Scrobicularia plana).

Annelids (Nereis spp.)

Oligochaetes (Tubifex spp.)

Gastropods (Hydrobia spp.)

c) Flora

Blue-green and green algae. Diatoms; scattered Spartina townsendii; and Phragmites communis.

Common plant debris.

d) Stratification

Inter-stratified sands and muds with some lenses or strata of plant debris, to structureless sand-muds.

Inter-stratification consists mainly of horizontal or

inclined inter-layering, but wavy and lenticular bedding also occur.

Cross-laminations are sometimes apparent in the sand layers.

In the uppermost reaches of the estuary inclined strata of lithic coarse sand and gravel occur inter-stratified with laminated mud strata.

Lenses of imbricated shells (Scrobicularia plana) occur in the lower and middle estuary.

Bioturbation. Slight to very intense. Where intense, the original stratification is destroyed producing structureless sediments.

Bioturbation decreases inland as burrowing macrofauna decrease in abundance up the estuary, so that in the lower estuary the level of bioturbation is generally intense, but in the upper estuary is only slight.

SALT MARSH SUB-FACIES

Forms the vegetated zone landwards of the mudflats of the intertidal area marginal to the channel zone sub-environment and extends from the lower estuary to the uppermost estuary.

a) Sediments

Texture: Mainly very poorly sorted sand-muds to muds. Rarely moderately sorted muddy very fine sands in the lower estuary. (Mzø: 3.25 - 9.32). (Mainly sandy silts to silty clays).

General composition of the sand fraction:

Quartz/feldspar dominant, ca. 60%. (39 - 75%).

Minor but variable rock fragments, ca. 11% (6 - 29%), shelly debris ca. 10% (0 - 28%), mud clasts ca. 9% (0 - 33%) and

coal ca. 6% (2 - 15%).

Trace contents of dark minerals, mica and glauconie.

Some variation in composition apparent along the estuary from the lower to the upper reaches, shelly debris being insignificant in the upper estuary < 1% and coal and mud clasts in contrast being more significant ca. 10% and ca. 20%; while in the uppermost estuary rock fragments increase in abundance being ca. 30%. and shelly debris, coal and mud clasts are all 0%.

b) Macrofauna

Very sparse and poor.

In the Spartinetum salt marsh Scrobicularia plana, Nereis sp., Corophium sp. and Carcinas maenas evident. In the Phragmitetum salt marsh Tubifids evident. On the general salt marsh and Juncetum salt marsh, horses, sheep, cattle and birds occur.

c) Flora

Diverse

A zonation of the flora into plant communities evident from the salt marsh edge towards high water mark: Spartinetum → general salt marsh → Juncetum.

In the middle reaches of the estuary Spartinetum is replaced by Phragmitetum as the lowest, most channelward community.

d) Stratification

Poor to moderate.

Laminated muds with some laminae of plant debris and thin

laminae of sand to structureless muds.

Bioturbation is moderate to intense.

Roots and rootlet structures more or less ubiquitous but locally absent in salt pans. Burrow structures moderate to slight in Spartinetum salt marsh, slight in Phragmitetum salt marsh. Otherwise none.

AEOLIAN DUNES SUB-FACIES

Developed locally above upper sandflats sub-environment in the lower reaches of the estuary.

a) Sediments

Texture: Very well sorted fine sands.

(Mzø : 2.41 - 2.66)

General composition of the sand fraction:

Quartz/feldspar dominant, ca. 90% (86 - 90%)

Minor rock fragments ca. 8% (6 - 10%) and shelly debris ca. 4% (3 - 4%).

Trace content of glauconie.

b) Macrofauna

Poor.

Talitritids in foredunes near high water mark.

Birds.

c) Flora

Fairly diverse.

Major species include Ammophila arenaria , Agropyron sp.

d) Stratification

Mainly large-scale cross-stratification, plane-stratification; some small-scale cross-stratification. Occasional soil horizons.

Bioturbation - none to moderate. Root structures locally common.

CREEKS SUB-FACIES

Forms sinuous belts within the intertidal sub-environments marginal to the channel zone sub-environments. They comprise small scale fining upwards sequences.

a) Sediments

Texture: Variable, including lithic, mud clast and shell, gravel, fine - very fine sands and muddy sands to muds.

Composition of the sand fraction: Not known in detail but presumably similar to those of the sub-environments which they dissect.

b) Macrofauna

Mainly sparse.

In the lower and middle estuary Corophium spp., Nereis diversicolor, Carcinas maenas and Scrobicularia plana apparent.

In the upper estuary, Tubifids apparent.

c) Flora

Occurs mainly on mud banks and upper parts of point bars.

Halimionetum or Spartinetum developed in the lower and middle estuary.

Phragmitetum in the upper estuary.

Plant debris common.

d) Stratification

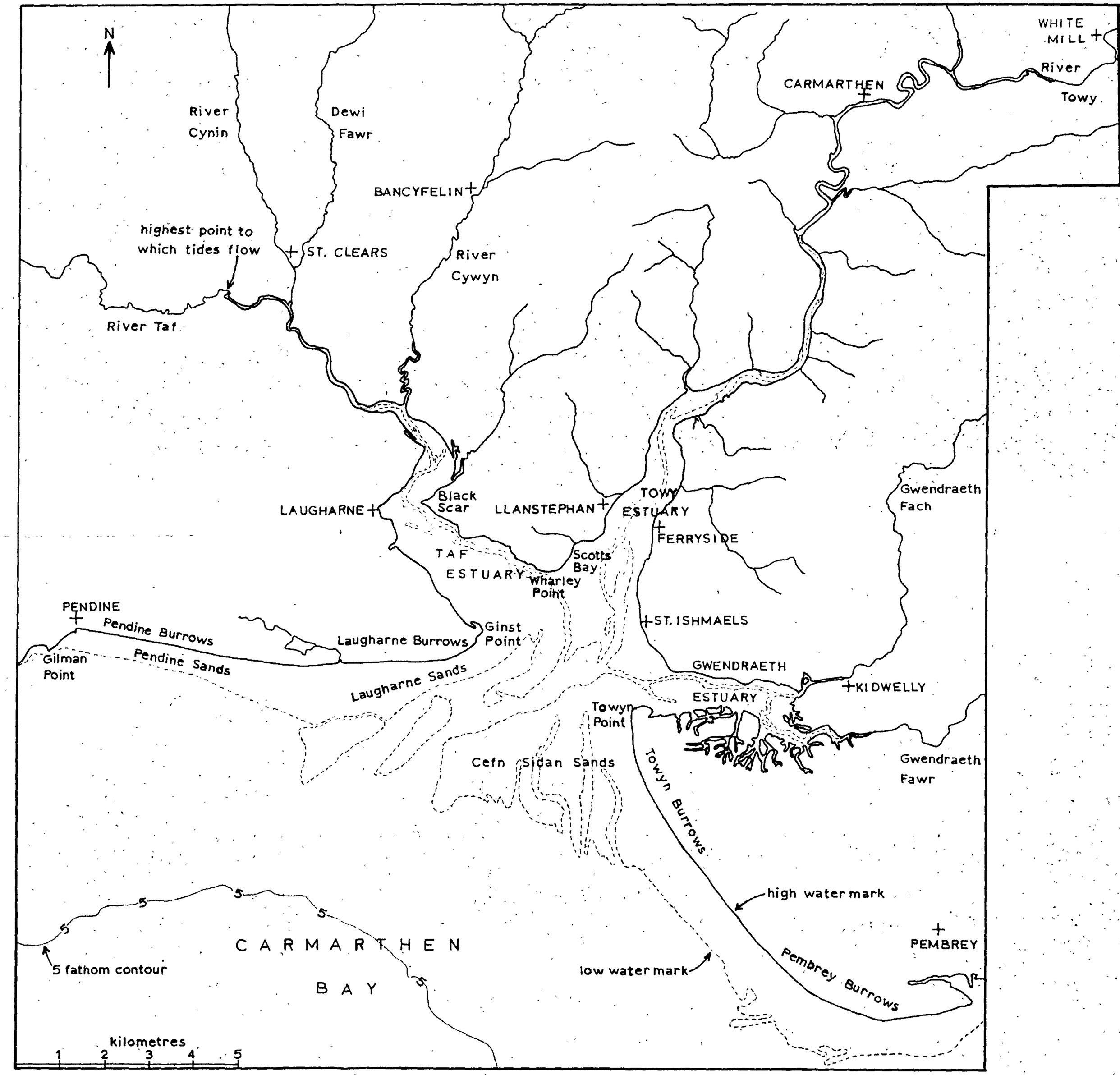
Inclined inter-stratified sands and muds and occasionally plant debris, overlying gravels or cross-laminated sands.

Some beds of mud clasts and mud pellets occur, and some structureless sand-muds.

Deformation structures sometimes evident (faulting and slumping).

Bioturbation. Nil to intense, generally slight.

Page Numbering as Bound



ENCLOSURE FIGURE 1. General Location Map of the Towy Estuary (Based on O.S. Map 152 - 1 inch series).

ENCLOSURE FIGURE 2. Sediments and Tidal Streams of Carmarthen Bay

BATHYMETRY

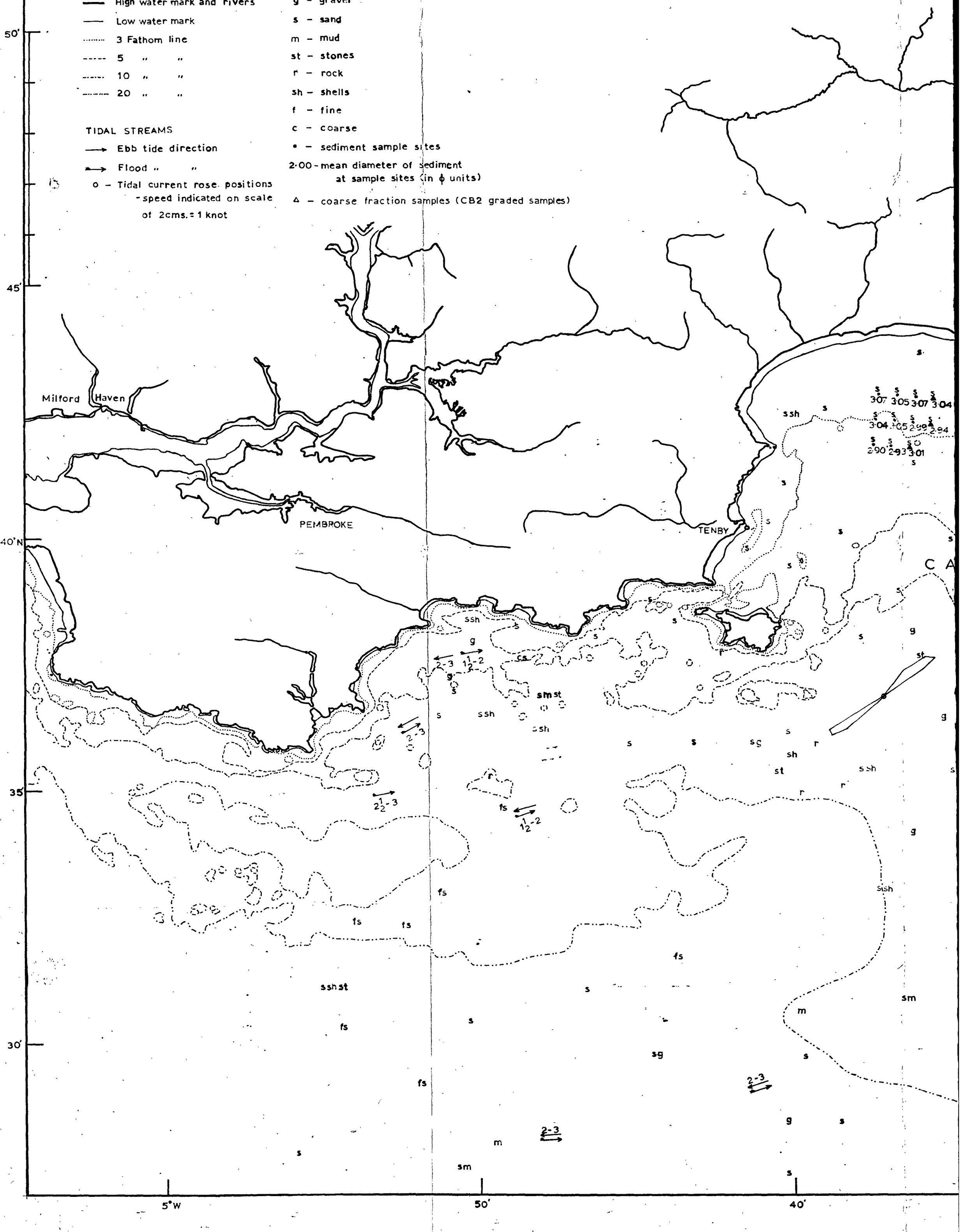
- High water mark and rivers
- Low water mark
- ..... 3 Fathom line
- ----- 5 " "
- ----- 10 " "
- ----- 20 " "

TIDAL STREAMS

- → Ebb tide direction
- ⇢ Flood " "
- o – Tidal current rose positions - speed indicated on scale of 2cms. = 1 knot

SEDIMENTS

- g – gravel
- s – sand
- m – mud
- st – stones
- r – rock
- sh – shells
- f – fine
- c – coarse
- • – sediment sample sites
- 2·00 – mean diameter of sediment at sample sites (in ϕ units)
- △ – coarse fraction samples (CB2 graded samples)



CARMARTHEN

Towy Estuary

Llanstephan

Laugharne

Ferryside

Taf Estuary

Pendine

Ginst Point

Gwendraeth Estuary

Kidwelly

Towyn Point

Pembrey

Burry Port

LLANELLI

Burry Estuary

Rhossili

CARMARTHEN BAY

IMER 36

CB2

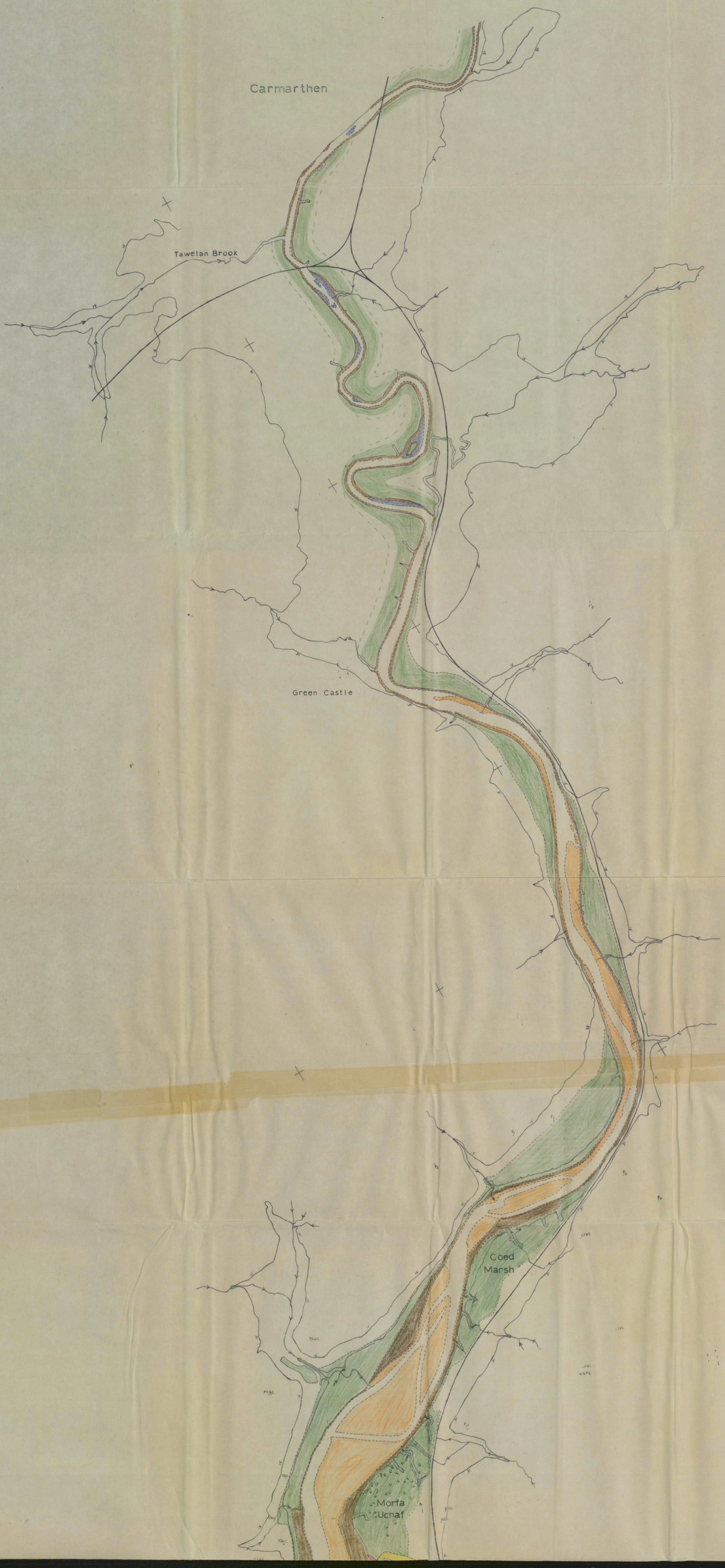
4° 30' W

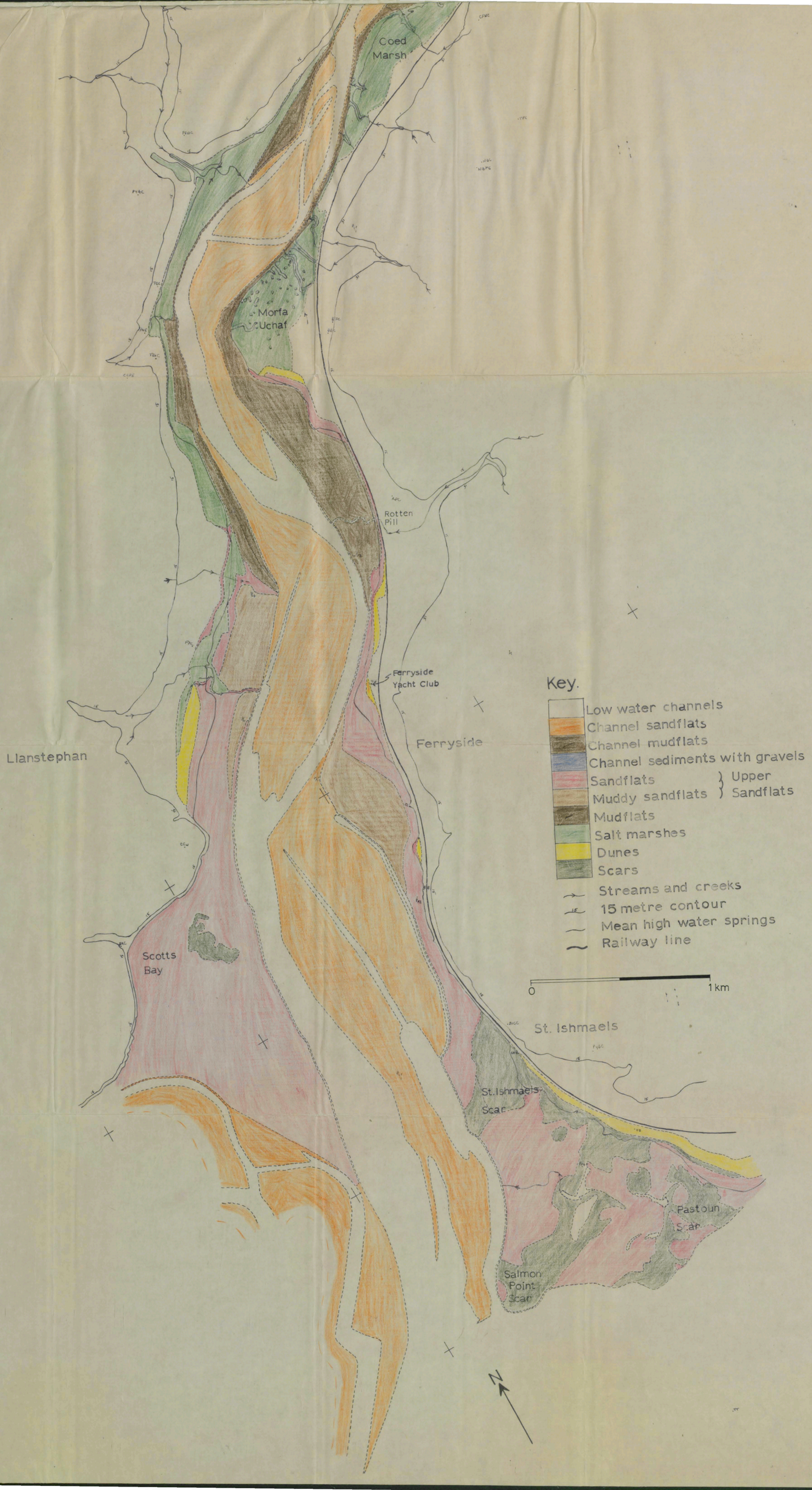
20'

10'

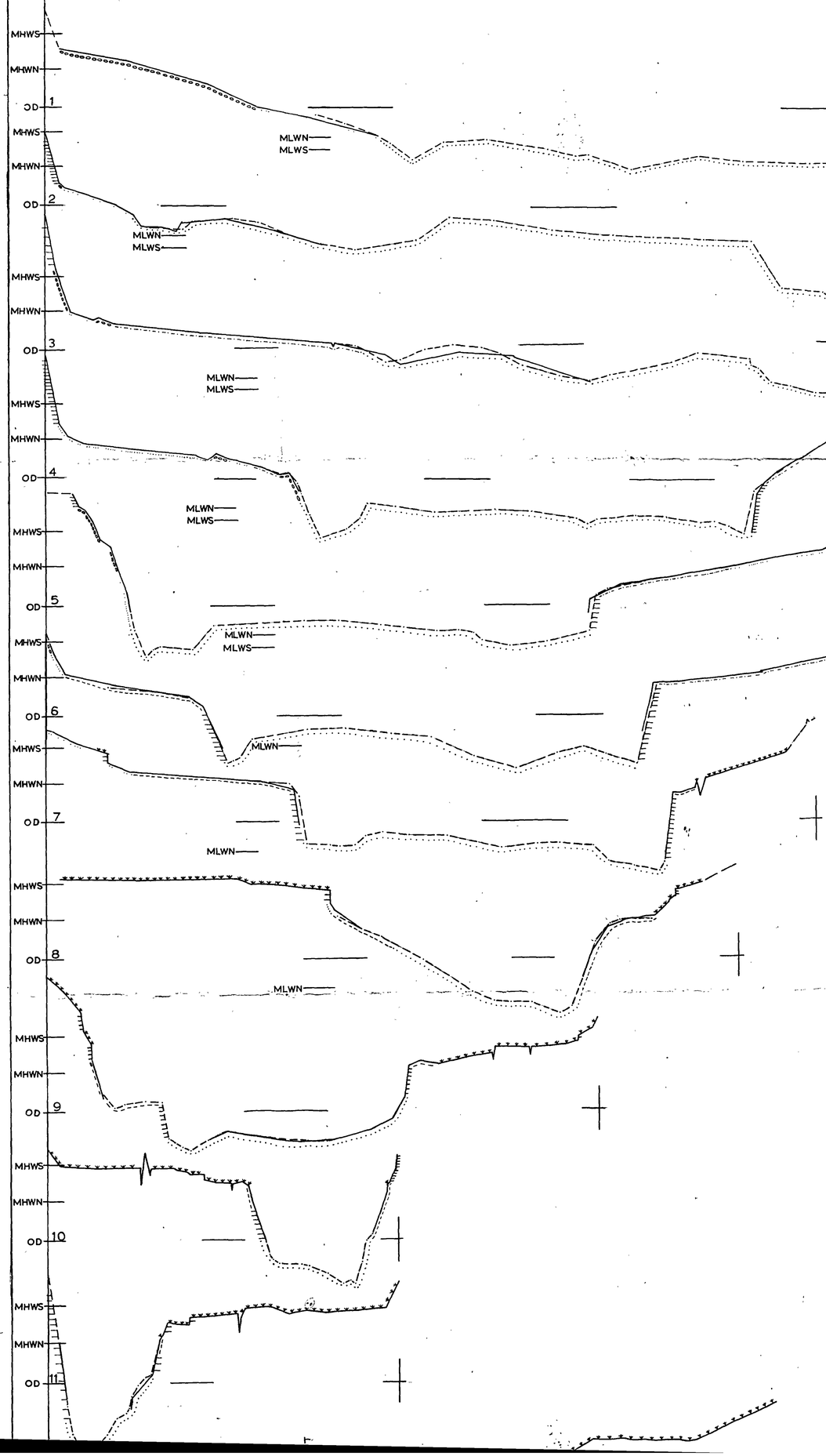
ENCLOSURE FIGURE 3.

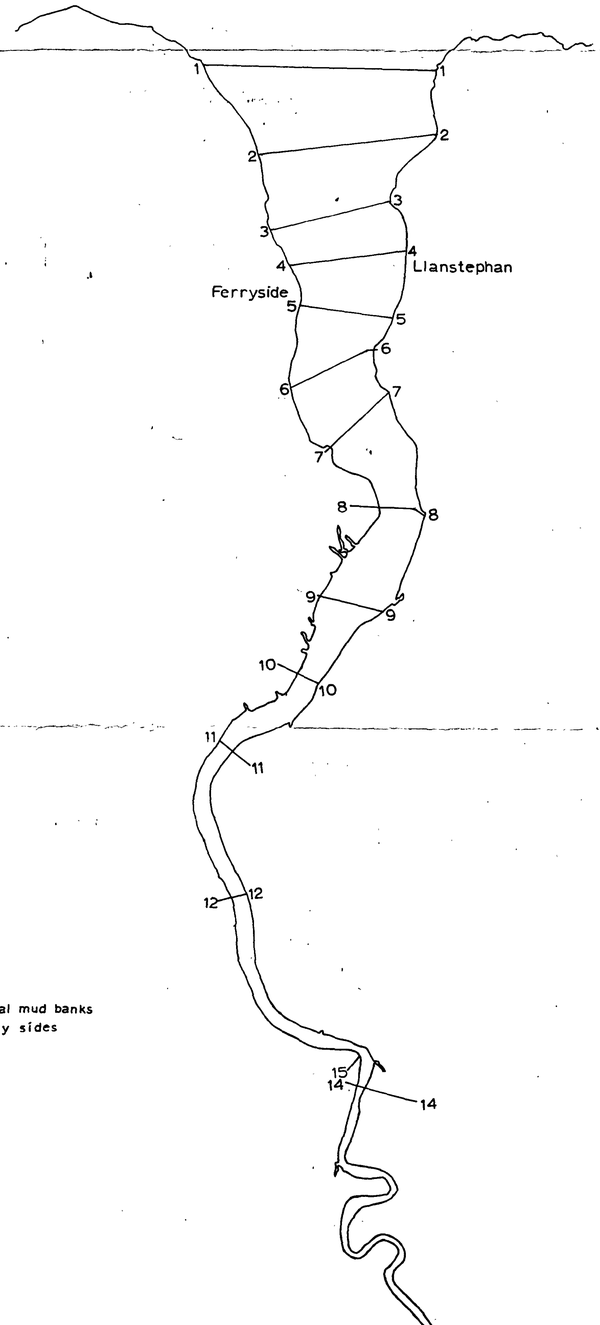
Map of the Towy Estuary showing the Distribution of the Sub-environments.




Coed Marsh
Morfa Uchaf
Rotten Pill
Ferryside Yacht Club
Ferryside
Llanstephan
Scotts Bay
St. Ishmaels
St. Ishmaels Scar
Pastoun Scar
Salmon Point Scar
Key.
Low water channels
Channel sandflats
Channel mudflats
Channel sediments with gravels
Sandflats
Muddy sandflats
Upper Sandflats
Mudflats
Salt marshes
Dunes
Scars
Streams and creeks
15 metre contour
Mean high water springs
Railway line
0
1 km
N

ENCLOSURE FIGURE 4. SURVEYED CROSS-SECTIONS OF THE TOWY ESTUARY AND TOWY RIVER.

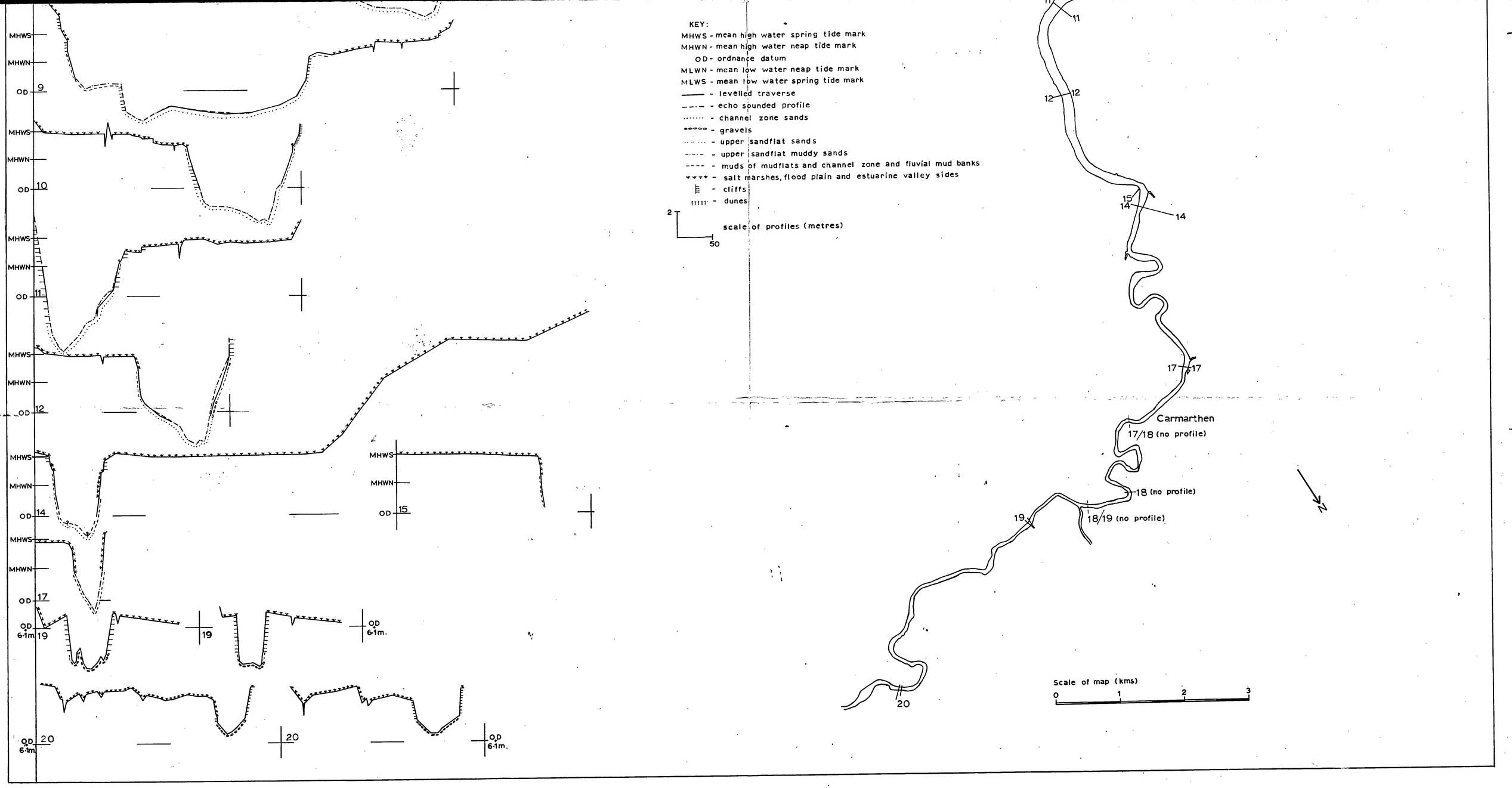




KEY:

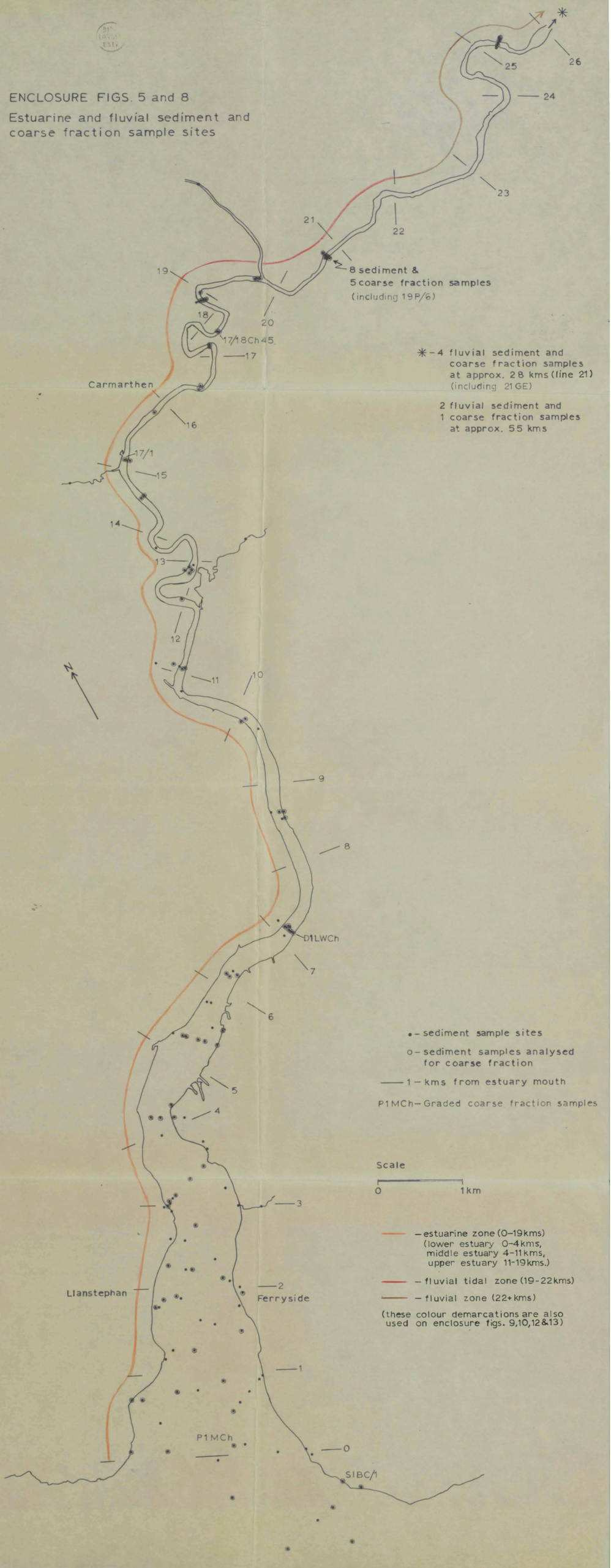
MHWS - mean high water spring tide mark
MHWN - mean high water neap tide mark
OD - ordnance datum
MLWN - mean low water neap tide mark
MLWS - mean low water spring tide mark
——— - levelled traverse
– – – - echo sounded profile
····· - channel zone sands
- - - - gravels
····· - upper sandflat sands
-·-·- - upper sandflat muddy sands
- - - - muds of mudflats and channel zone and fluvial mud banks
vvvv - salt marshes, flood plain and estuarine valley sides
- cliffs
- dunes

2
50
scale of profiles (metres)

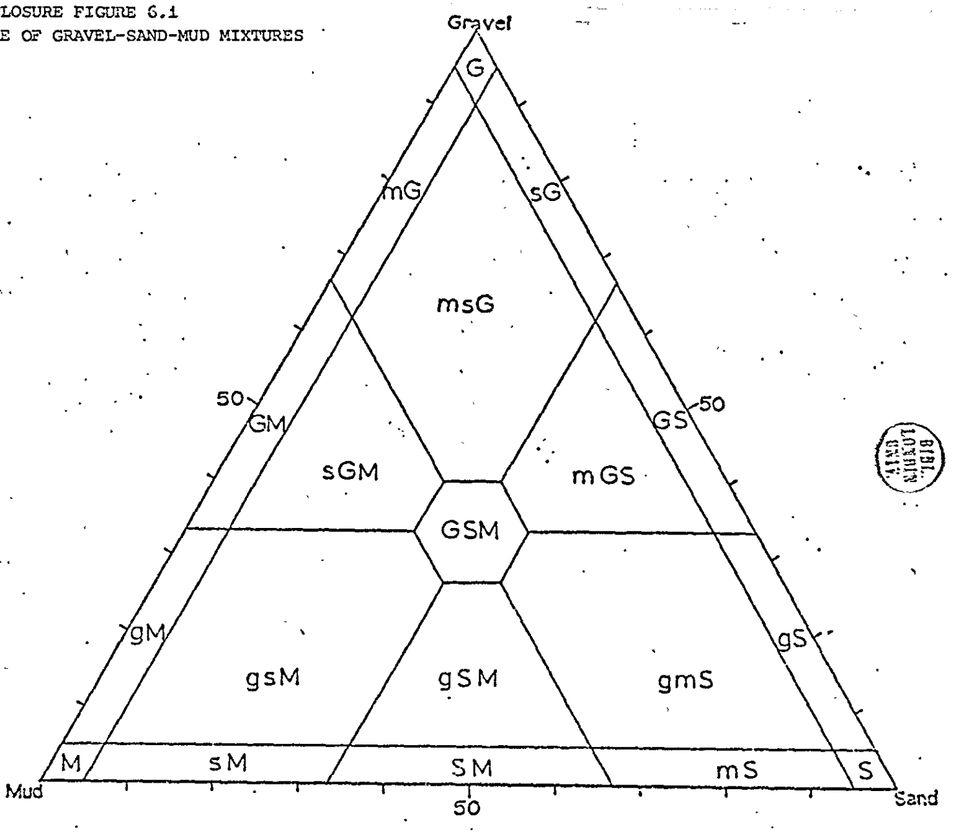

KEY:
MHWS - mean high water spring tide mark
MHWN - mean high water neap tide mark
OD - ordnance datum
MLWN - mean low water neap tide mark
MLWS - mean low water spring tide mark
- levelled traverse
- echo sounded profile
- channel zone sands
- gravels
- upper sandflat sands
- upper sandflat muddy sands
- muds of mudflats and channel zone and fluvial mud banks
- salt marshes, flood plain and estuarine valley sides
- cliffs
- dunes
2
50
scale of profiles (metres)
MHWS
MHWN
OD
9
10
11
12
14
15
17
19
20
OD 6·1m.
11
12
14
15
17
Carmarthen
17/18 (no profile)
18 (no profile)
18/19 (no profile)
19
20
Scale of map (kms)
0
1
2
3

ENCLOSURE FIGS. 5 and 8

Estuarine and fluvial sediment and coarse fraction sample sites



ENCLOSURE FIGURE 6.1
NOMENCLATURE OF GRAVEL-SAND-MUD MIXTURES



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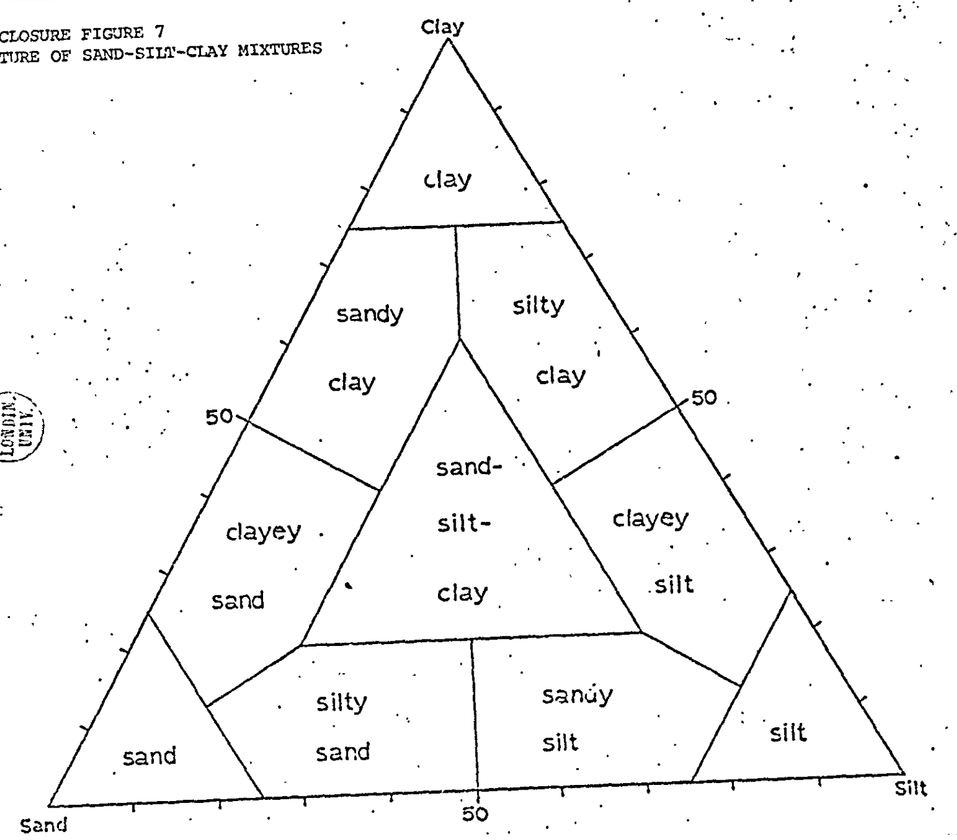
Legend of gravel-sand-mud triangle :-

G - Gravel
S - Sand
M - Mud
sG - sandy Gravel
GS - Gravel-Sand
gS - gravelly Sand
mG - muddy Gravel
GM - Gravel-Mud
gM - gravelly Mud
mS - muddy Sand
SM - Sand-Mud
sM - sandy Mud
msG - muddy sandy Gravel
mGS - muddy Gravel-Sand
gmS - gravelly muddy Sand
gSM - gravelly Sand-Mud
gsM - gravelly sandy Mud
sGM - sandy Gravel-Mud
GSM - Gravel-Sand-Mud

ENCLOSURE FIGURE 6.1.

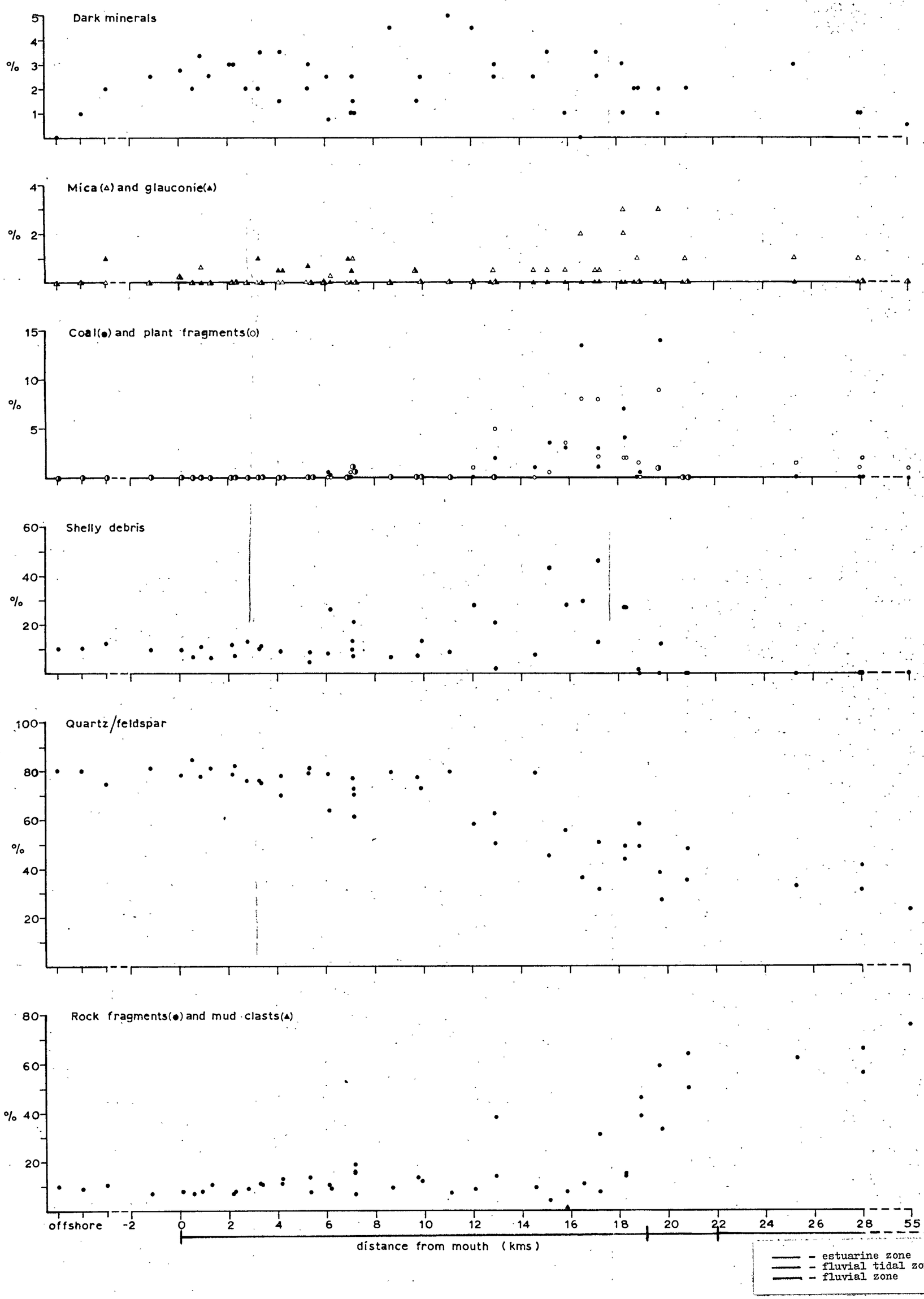
BIBL. LONDON UNIV.

ENCLOSURE FIGURE 7
NOMENCLATURE OF SAND-SILT-CLAY MIXTURES

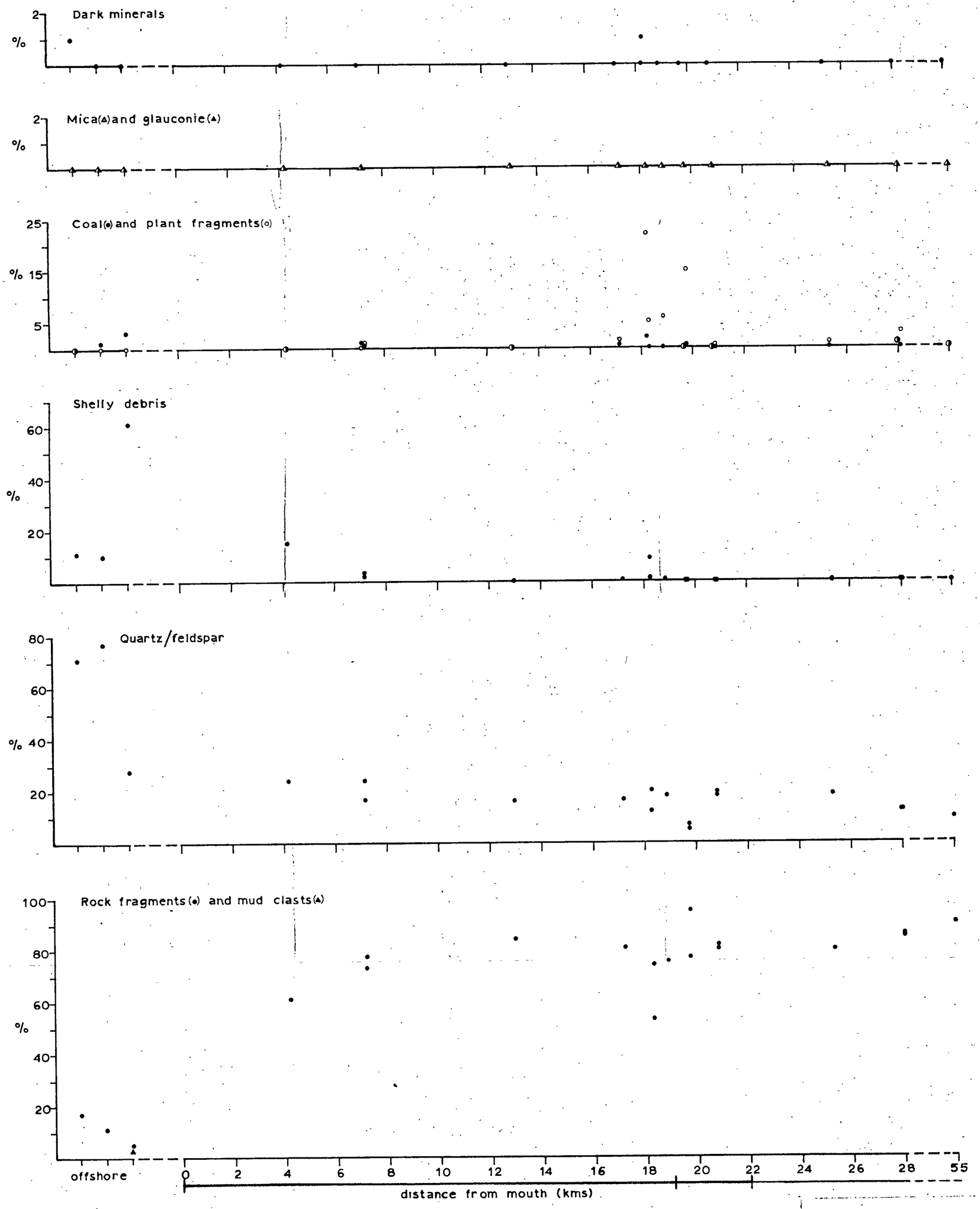


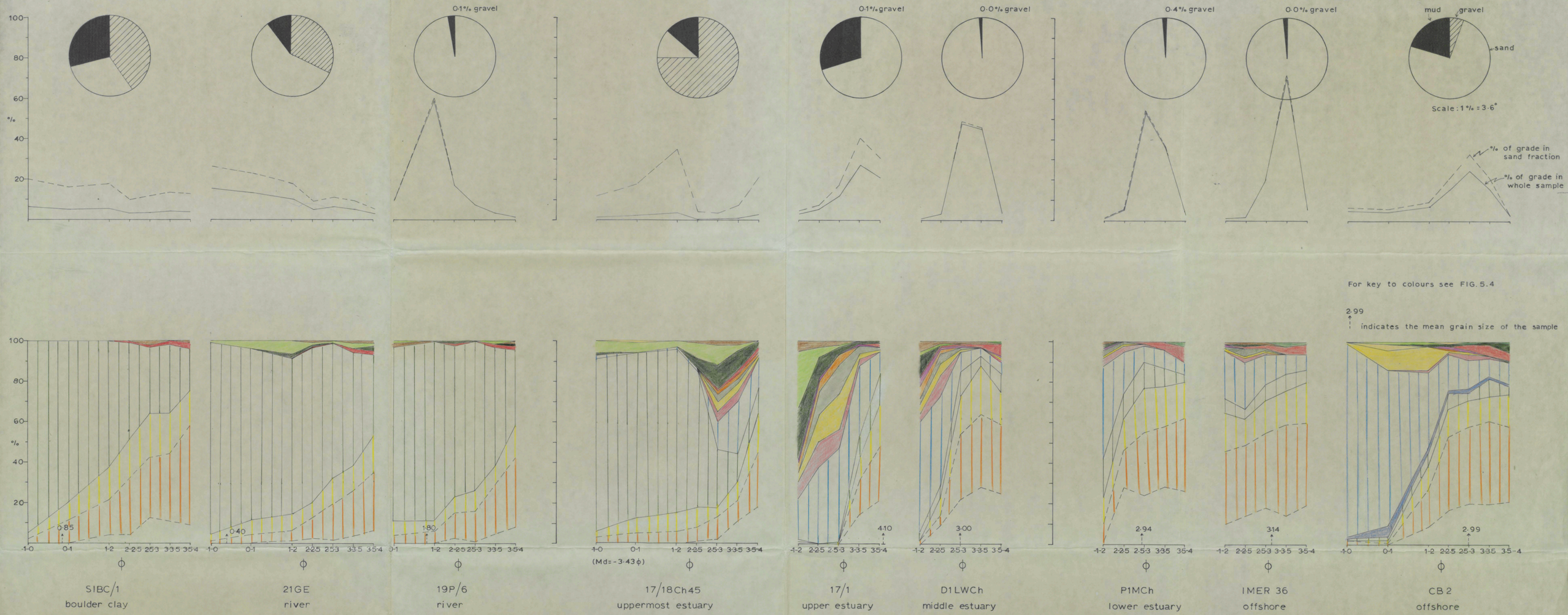
BIBL. LONDON UNIV.

ENCLOSURE FIG. 9 Longitudinal variation in composition of fine and very fine sand fraction of the sediments of the estuarine and fluvial channel zone and some offshore sediments



ENCLOSURE FIG. 10 Longitudinal variation in composition of very coarse to medium sand fraction of the sediments of the estuarine and fluvial channel zone and offshore sediments

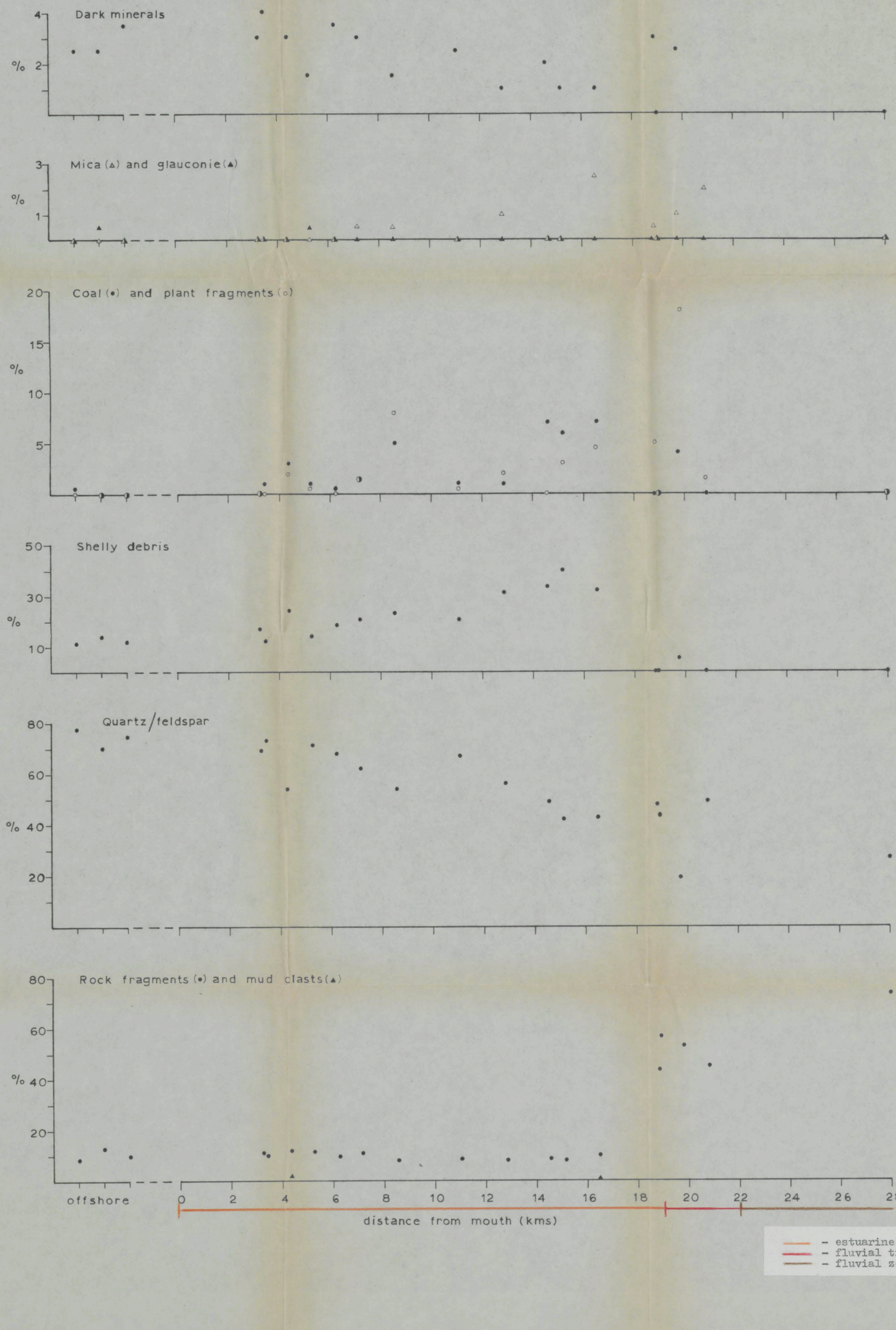




ENCLOSURE FIG. 11. Results of the coarse fraction analysis of the graded sediment samples together with the distributions of the sand grades within the samples

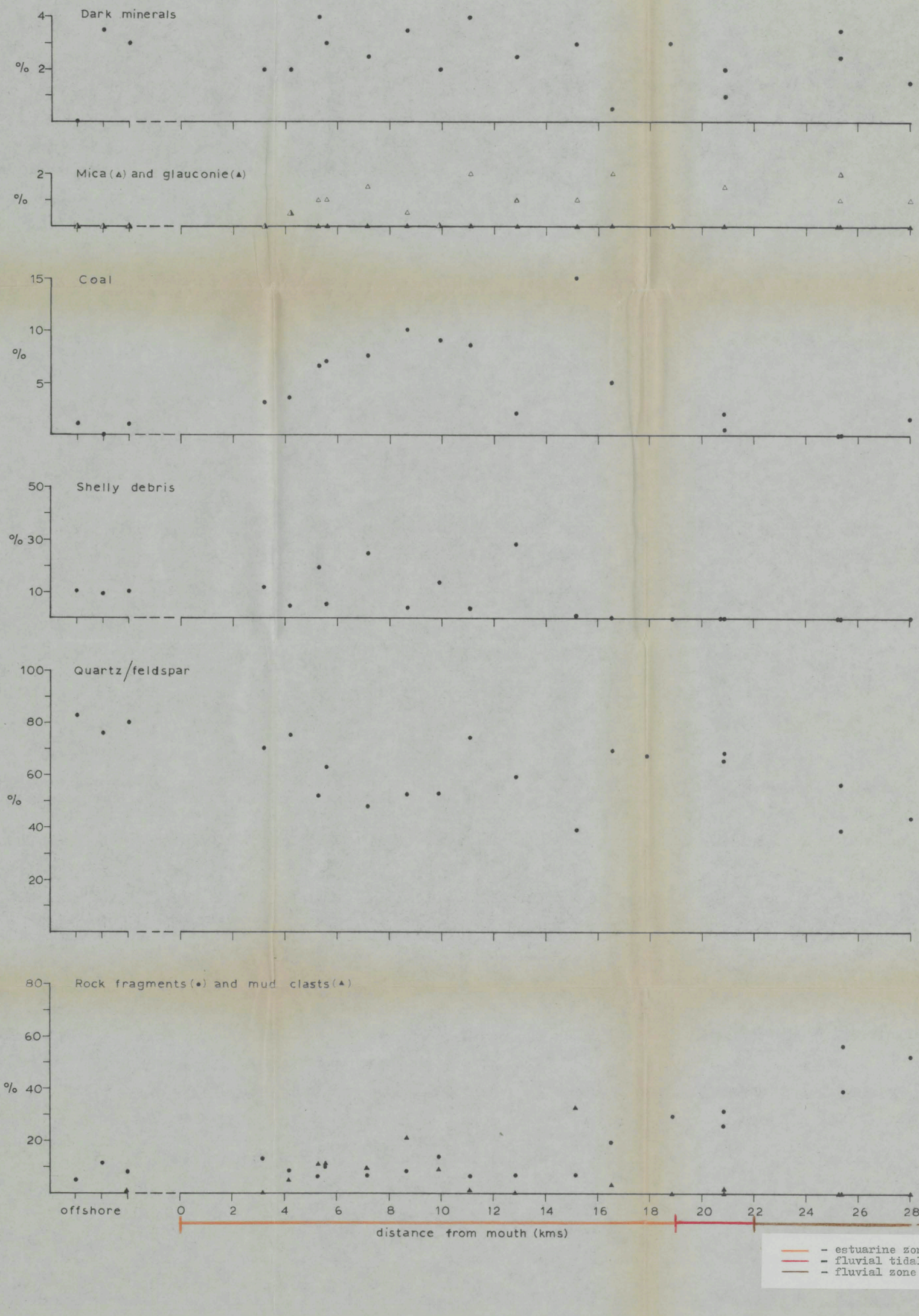
BIBL. LONDIN. UNIV.

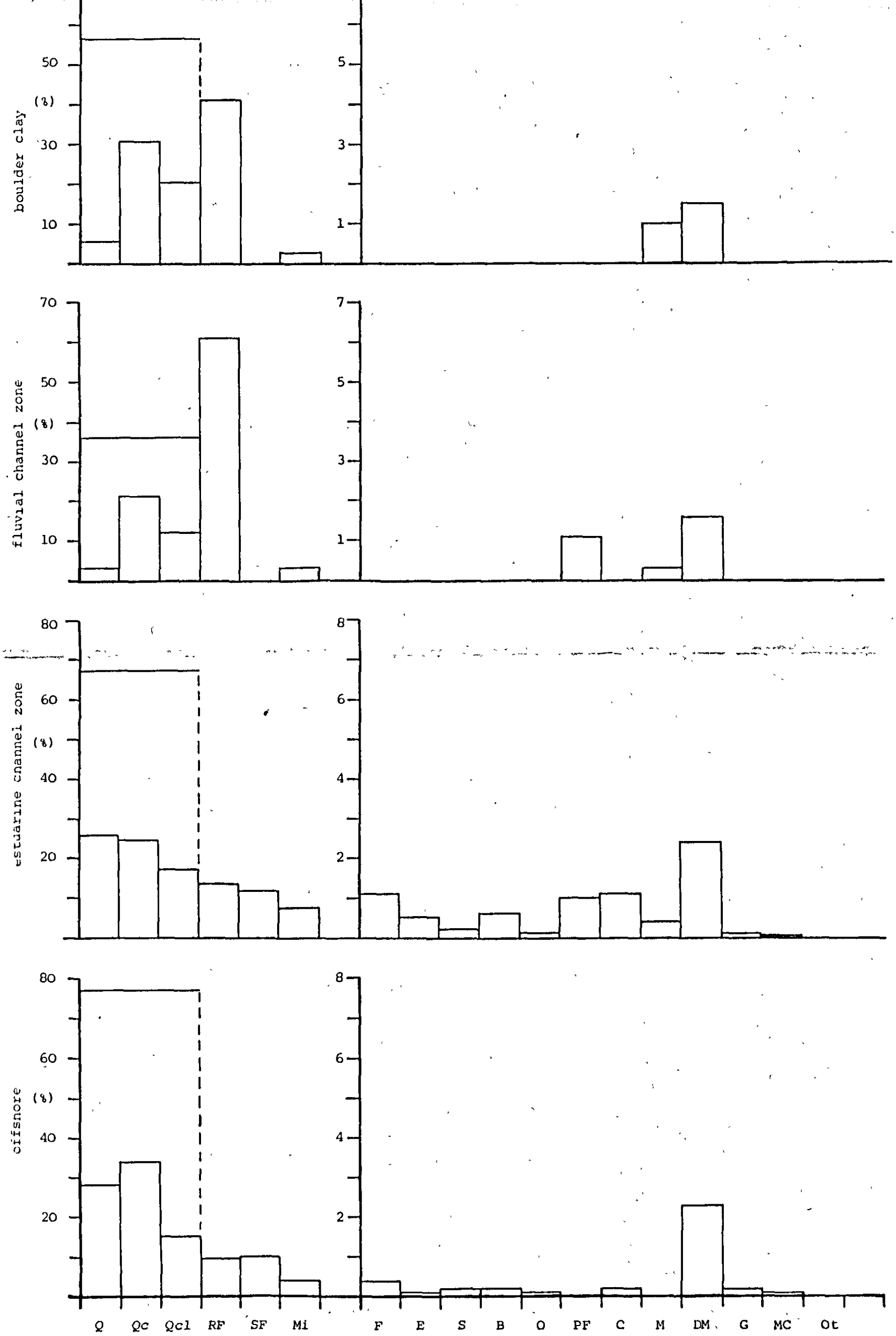
ENCLOSURE FIG.12 Longitudinal variation in composition of the fine and very fine sand fraction of the sediments of the mudflats and fluvial mud banks and of some offshore sediments



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ENCLOSURE FIG. 13 Longitudinal variation in composition of the sand fraction of the sediments of the salt marshes and flood plain and of some offshore sediments





ENCLOSURE FIGURE 14. AVERAGES OF THE FINE - VERY FINE SAND FRACTION COMPOSITIONS OF THE OFFSHORE, ESTUARINE CHANNEL ZONE, FLUVIAL CHANNEL ZONE AND BOULDER CLAY SEDIMENTS

ENCLOSURE FIGURE 15.i. STRATIFICATION OF THE CHANNEL ZONE SEDIMENTS

→ across sandbank



FIG. A

← seawards



FIG. B

Pair set of peels from sandbank at the mouth of the estuary - plane-laminated and mega-ripple cross-laminated; common shell debris, particularly in association with mega-ripple cross-lamination.

← across sandbank



FIG. C

Peel from sandbank of the lower estuary - plane- and ripple cross-laminated; some flasers and mud clasts.

unorientated across sandbank



FIG. D

Peel from sandbank of the lower estuary - ripple cross-laminated and structureless; some flasers.

ENCLOSURE FIGURE 15.ii. STRATIFICATION OF THE CHANNEL ZONE SEDIMENTS

← seawards



FIG. E

Peel from sandbank of the lower estuary - plane-laminated with small mega-ripple structure and lamination at top of peel; shelly debris and coarser sand is associated with the mega-ripple.

→ seawards



FIG. F

Peel from sandbank of the lower estuary - plane- and ripple cross-laminated; some flasers and mud clasts.

→ seawards



← across point bar



FIG. G

Pair set of peels from point bar of sandbank in the lower estuary - ripple cross-laminated and inter-stratified sand and mud; some plane-lamination and flasers, mud clasts and shell debris.

FIG. H

ENCLOSURE FIGURE 15.iii. STRATIFICATION OF THE CHANNEL ZONE SEDIMENTS (Scales in cms.)

← seawards



FIG. I
Peel from sandbank of the lower estuary - plane- and ripple cross-laminated; shell and mud clast gravel form lag to bed of small flood barb.

← seawards

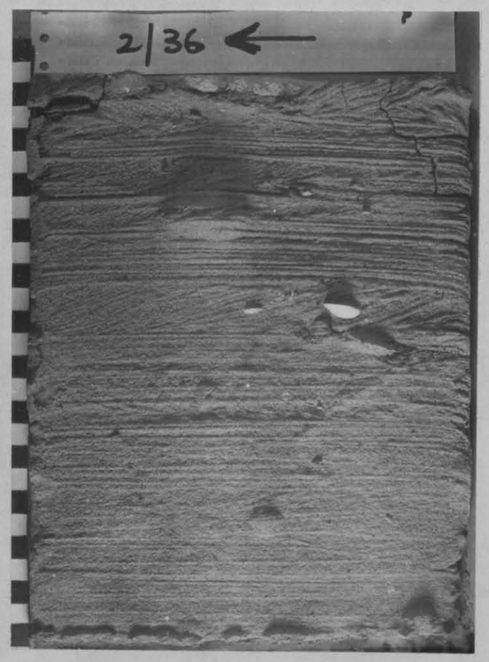


FIG. L
Peel from sandbank of the middle estuary - inter-stratified plane-and ripple cross-lamination; some shell debris.

→ across sandbank



FIG. J
Box core from sandbank of the lower estuary - inter-stratified sand and mud; some mud clasts and flasers; intense bioturbation in top of core has produced structureless muddy sand.

→ across sandbank

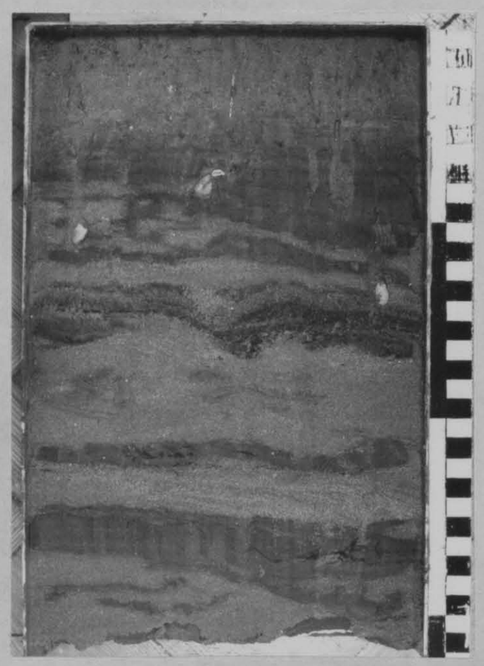


FIG. K
Box core from sandbank of the lower estuary - inter-stratified sand and mud; some flasers; intense bioturbation in top of core has produced structureless muddy sand.

ENCLOSURE FIGURE 15.iv. STRATIFICATION OF THE CHANNEL ZONE SEDIMENTS (Scales in cms.)

← seawards

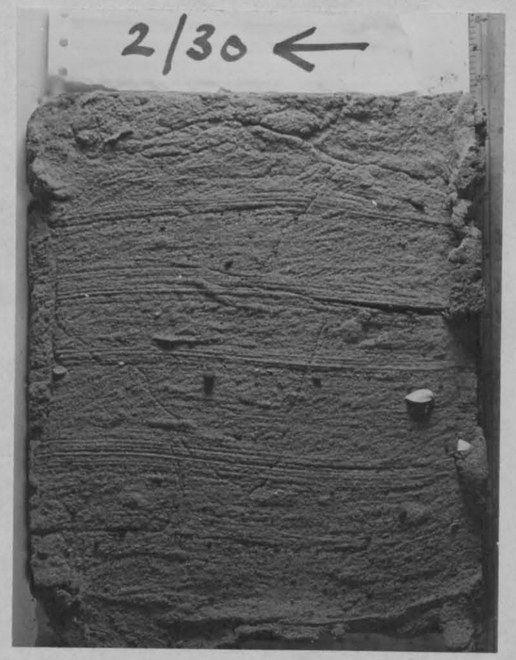


FIG. M
Peel from sandbank of the middle estuary - inter-stratified wavy lamination and ripple cross-lamination; some lithic and shell gravel.

→ across point bar

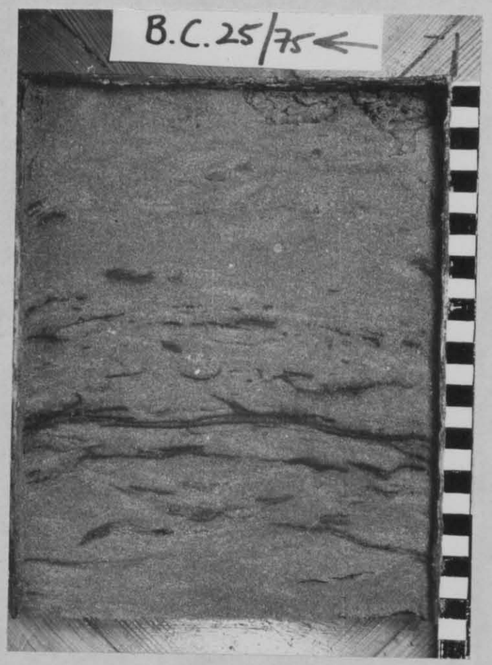


FIG. P
Box core of peel in Fig. N, showing flasers and flaser bedding, and some mud clasts.

→ across point bar



← seawards



FIG. N
FIG. O
Pair set of peels from point bar of the middle estuary - ripple cross-laminated with common flasers and some flaser bedding; some plane- lamination; some mud clasts.

ENCLOSURE FIGURE 15.v. STRATIFICATION OF THE CHANNEL ZONE SEDIMENTS (Scales in cms.)

← across point bar



FIG. Q

← seawards

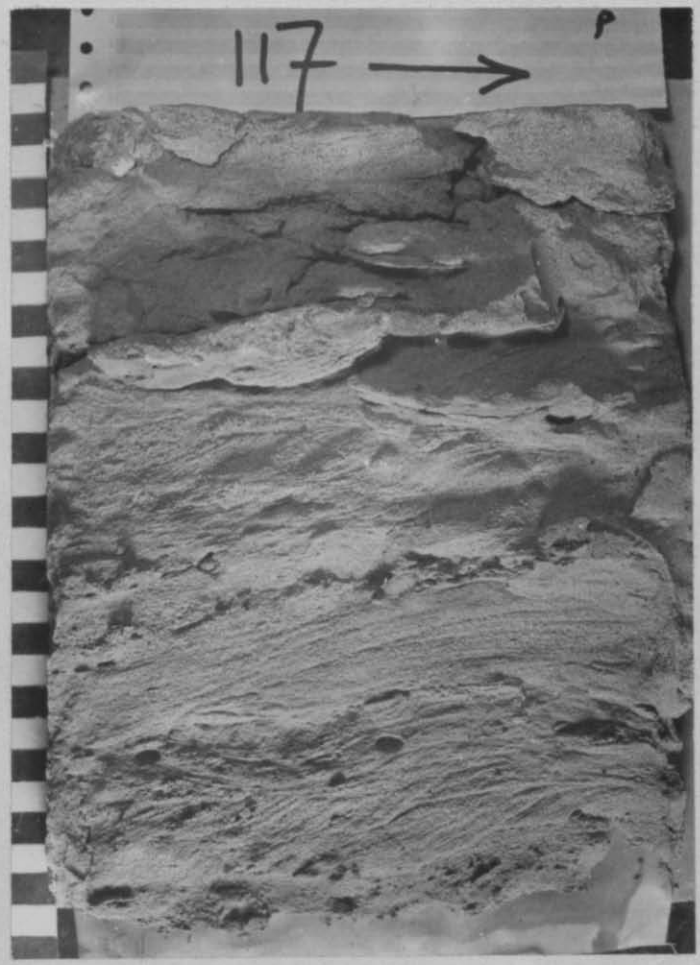


FIG. R

Pair set of peels from point bar of the upper estuary - plane- and ripple cross-laminated; common plant, coal and shell sand often forming laminae, particularly in Fig. R.

ENCLOSURE FIGURE 16.i. STRATIFICATION OF THE UPPER SANDFLATS (Scales in cms.)

← towards high water mark

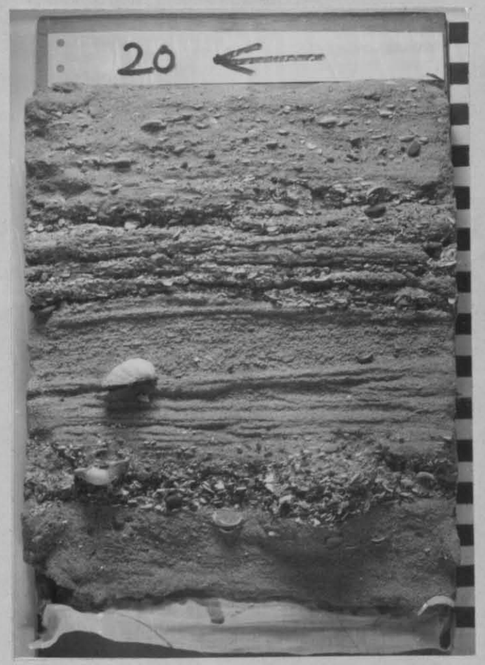


FIG. A
Peel of high water zone sediments - plane-stratified sand and shell and lithic gravel; some small-scale cross-lamination in the sand; some structureless gravelly sand; some air entrapment structures.

unorientated along high to low water mark line



FIG. C
Peel from high water zone sediments - large-scale cross-laminated; common shell and lithic gravel; some small-scale cross-lamination at top of peel; deformation structure (dewatering?) at base of peel.

← towards high water mark



FIG. B
Peel of high water zone sediments - structureless gravelly sand; very common air entrapment structures; some plane-lamination in sand at bottom of peel.

ENCLOSURE FIGURE 16.ii. STRATIFICATION OF THE UPPER SANDFLATS (Scales in cms.)

→ along the beach



FIG. D
Peel of 'clean'rippled sandflats - large- and small-scale cross-laminated and structureless; some air entrapment structures; one flaser.

← towards low water mark



FIG. G
Peel of 'clean'rippled sandflats - large- and small-scale cross-laminated and plane-laminated; common shell debris.

→ along the beach



← towards low water mark



FIG. E FIG. F
Pair set of peels of 'clean'rippled sandflats - structureless, curved-and plane-laminated, and wave-ripple cross-laminated; common air entrapment structures; common shell and lithic gravel.

ENCLOSURE FIGURE 16.iii. STRATIFICATION OF THE UPPER SANDFLATS

(Scale of box cores - 20 x 30 cms.)

unorientated along the beach



FIG. H

unorientated along low to high water mark line



FIG. I

Pair set of peels of 'clean'rippled sandflats - large- and small-scale cross-laminated, plane-laminated and structureless; common shell debris; some air entrapment structures; steeply inclined lamination in bottom of Fig.I peel (dewatering structure?); one Arenicola marina burrow in lower right of Fig.H peel.

← towards low water mark



FIG. J

Peel of 'clean'rippled sandflats - structureless and wave-ripple cross-laminated sand overlying bioturbated mud and cross-laminated sand; bioturbation (Corophium sp.) and air entrapment structures in upper part of core; some shell debris and mud clasts.

ENCLOSURE FIGURE 16.iv. STRATIFICATION OF THE UPPER SANDFLATS

(Scales in cms.)

→ towards low water mark



FIG. K

Box core of muddy sandflats - bioturbated inter-stratified sand and mud; bioturbation intense in upper part of core (Corophium sp. and Macoma balthica).

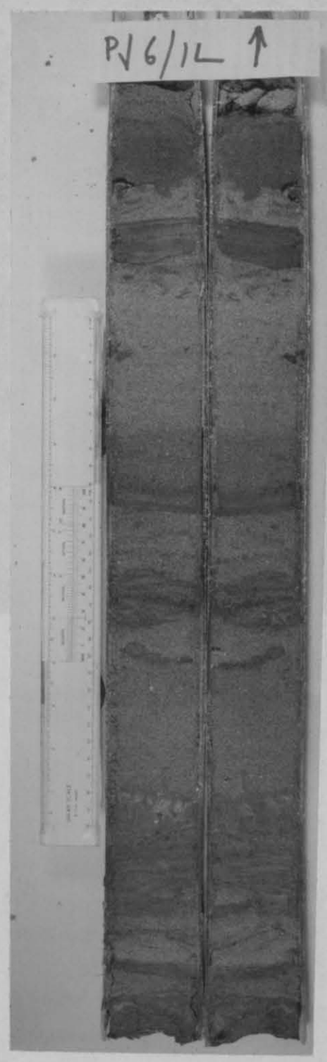


FIG. O

Core of muddy sandflats - inter-stratified sand and mud; some bioturbation.

ENCLOSURE FIGURE 16.v. STRATIFICATION OF THE UPPER SANDFLATS

(Core scale in cms.
Radiographs-actual scale)

FIGS.L - N - Core of muddy sandflats ; Fig.M - top part of Fig.L (0-24 cms.)
Fig.N - middle part of Fig.L (24-49 cms.)

- bioturbated inter-stratified sand and mud; Corophium sp. and Nereis sp. burrows in Fig.M and Scrobicularia plana burrow in Fig.N.

FIG. L



FIG. M

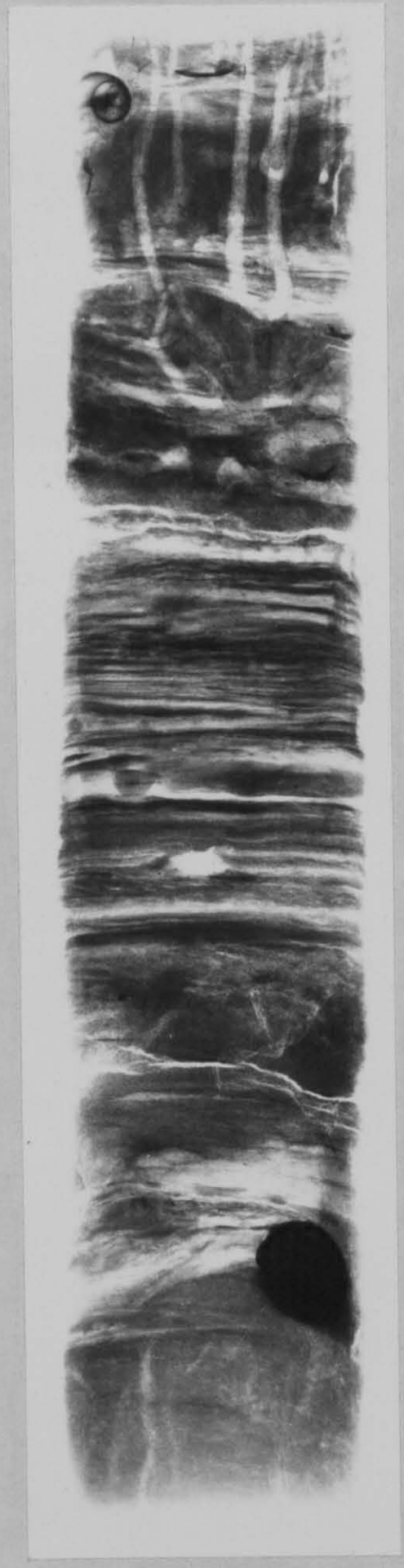


FIG. N



ENCLOSURE FIGURE 17.i. STRATIFICATION OF THE MUDFLATS (Scale in cms. & 2 cms.)

→ towards low water mark



FIG. A

Box core from mudflats of the lower estuary (ca.2½ kms. from mouth) - intensely bioturbated muddy sand; burrows of Nereis sp., Corophium sp. and Scrobicularia plana common; original stratification evident in places but mostly destroyed by bioturbation.

→ towards low water mark



FIG. B

Detail of top part of Fig.A - note the older sediment-filled burrows and the more recent open burrows.

ENCLOSURE FIGURE 17.ii. STRATIFICATION OF THE MUDFLATS (Core scale in cms. Radiographs-actual scale)

FIGS.C - E - Core from mudflats of the lower estuary (ca.3 kms. from mouth)
Fig.D - top part of Fig.C (0-23 cms.)
Fig.E - middle part of Fig.C (23-46 cms.)

- intensely bioturbated structureless muddy sand and sand-mud; burrows of Nereis sp., Corophium sp. and Scrobicularia plana common; Scrobicularia tests and fragments of tests common particularly in Fig.E.

FIG. C

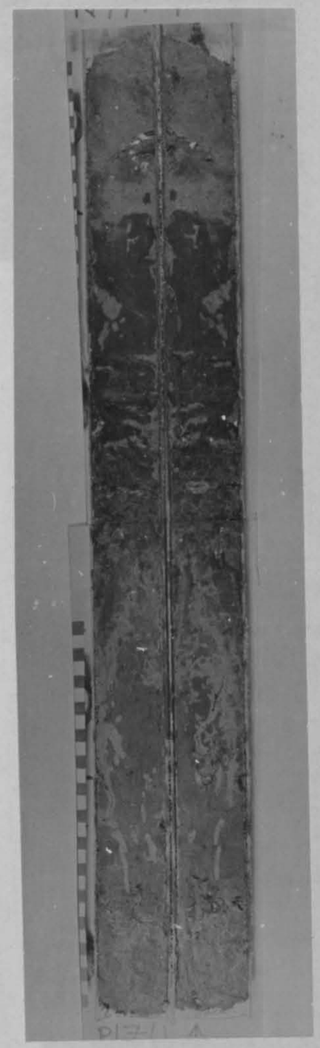


FIG. D

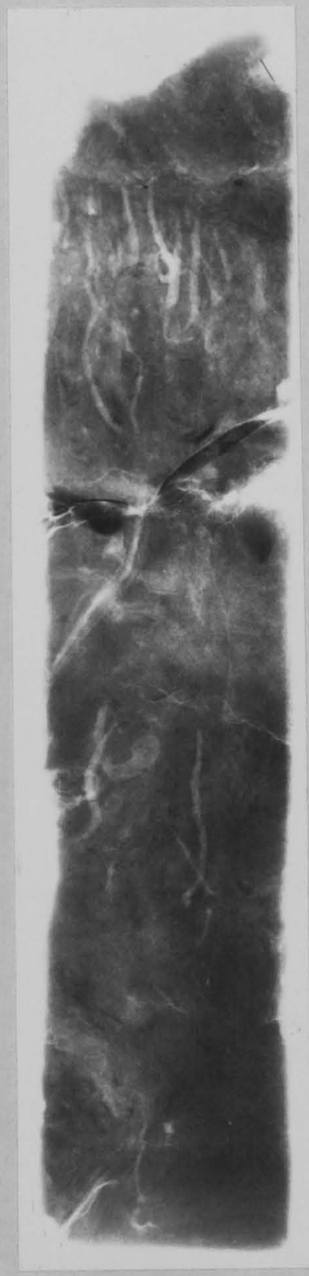


FIG. E



ENCLOSURE FIGURE 17.iii. STRATIFICATION OF THE MUDFLATS (Core scale in cms. Radiograph-actual scale)

FIGS.F and G - Core from mudflats of the middle estuary (ca. 5½ kms. from mouth)
- intensely bioturbated sand-mud in the upper part of core; Nereis sp. and Corophium sp. burrows very common (Fig.G); bioturbated inclined and horizontal inter-laminated sand and mud in the middle and lower parts of core (Fig.E)
- Fig.G - top part of Fig.F (O-28 cms.)

FIG. F



FIG. G



ENCLOSURE FIGURE 17.iv. STRATIFICATION OF THE MUDFLATS (Core scale in cms. Radiograph-actual scale)

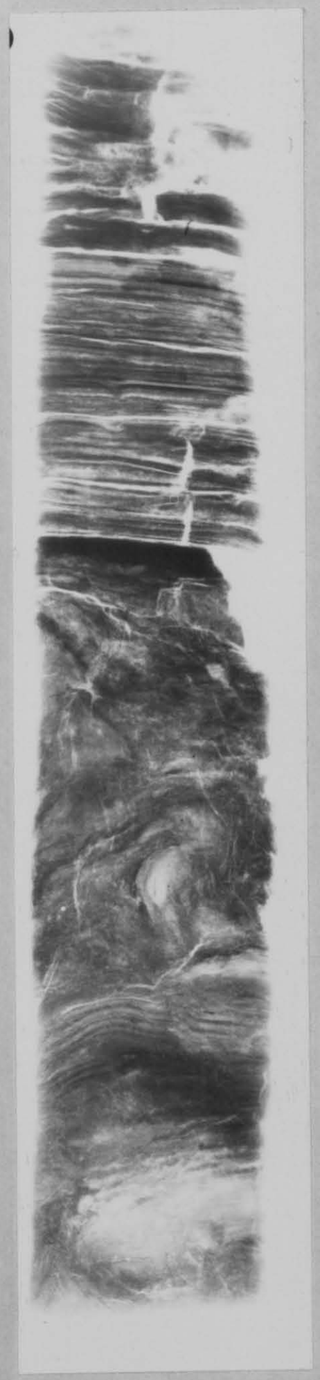
FIGS.H and I - Core from mud bank of middle estuary (ca.7 kms. from mouth)
Fig.I - top part of Fig.H (O-25 cms.)

- inter-stratified intensely bioturbated sand-mud layers with moderate or slightly bioturbated inclined and horizontal inter-laminated sand and mud; burrows of Carcinas maenas (Fig.I), Nereis sp., Corophium sp.and Scrobicularia plana(?) evident (Fig.H)

FIG. H



FIG. I



ENCLOSURE FIGURE 17.v. STRATIFICATION OF THE MUDFLATS (Core scale in cms. Radiographs-actual scale)

FIGS.J - L - Core from mud bank of the middle estuary (ca.8½ kms. from mouth)
Fig.K - top part of Fig.J (0-25 cms.)
Fig.L - bottom part of Fig.J (25-48½ cms.)

- slightly - moderately (locally intensely) bioturbated inter-stratified sand and mud; burrows of Nereis sp. and Corophium sp. evident (Fig.L); fault or slump structure apparent in top part of core Figs.J and K).

FIG. J



FIG. K



FIG. L



ENCLOSURE FIGURE 17.vi. STATIFICATION OF THE MUDFLATS (Core scale in cms. Radiograph-actual scale)

FIGS.M and N - Core from mud bank of the upper estuary (ca.11 kms. from mouth)
Fig.N - top part of Fig.M (0-23 cms.)

- inclined and horizontal inter-stratified sand and laminated mud; bioturbation slight (Tubifids and algal filaments?) (Fig.N); some laminae of plant debris (Fig.M).

FIG. M

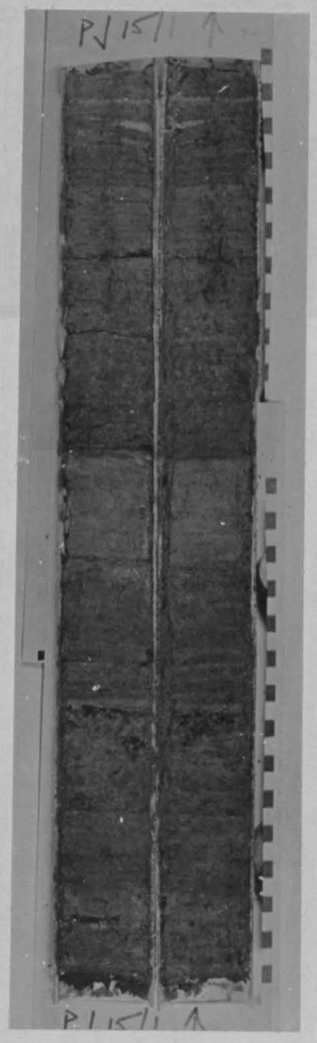
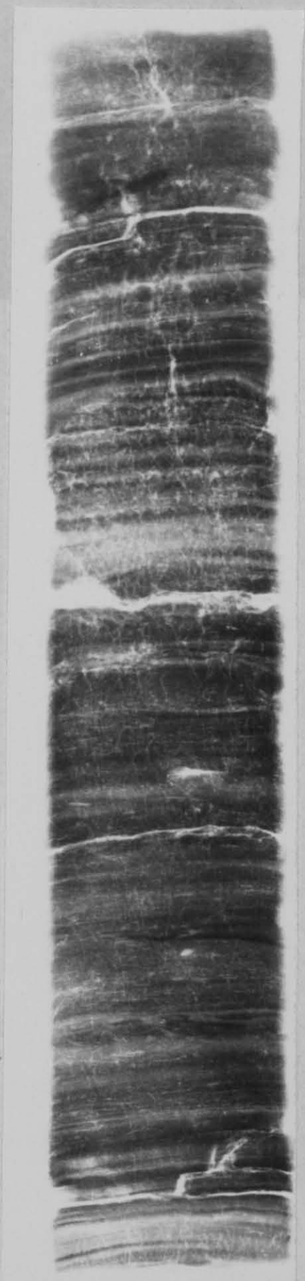


FIG. N



ENCLOSURE FIGURE 17.vii. STRATIFICATION OF THE MUDFLATS (Core scale in cms. Radiograph-actual scale)

FIGS.O and P - Core from mud bank of the upper estuary (ca.13 kms. from mouth)
Fig.P - top part of Fig.O (0-28 cms.)

- inclined inter-stratified sand and laminated mud; some laminae of plant debris; bioturbation very slight (Tubifids? - Fig.P) or lacking.

FIG. O

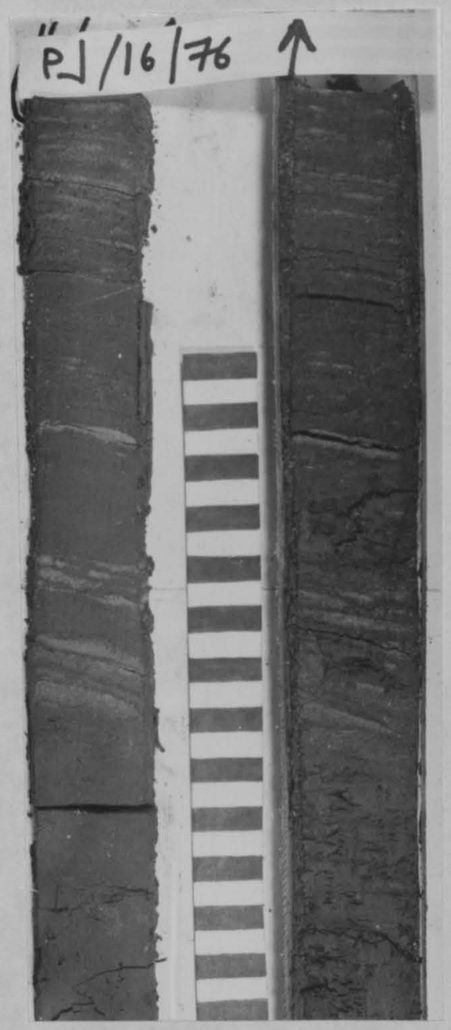


FIG. P



ENCLOSURE FIGURE 17.viii. STRATIFICATION OF THE MUDFLATS (Core scale in cms. Radiograph-actual scale)

FIGS.Q and R - Core from mud bank of the upper estuary (ca.14¼ kms. from mouth)
Fig.R - top part of Fig.Q (0-24½ cms.)

- inter-stratified sand and laminated mud; ripple cross-laminations apparent in sand and mud layers (Fig.R); some laminae of plant debris; bioturbation very slight (Tubifids) or lacking.

FIG. Q

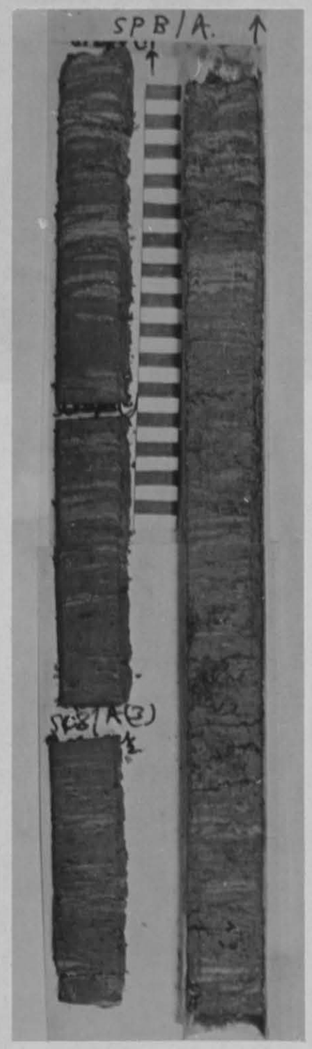
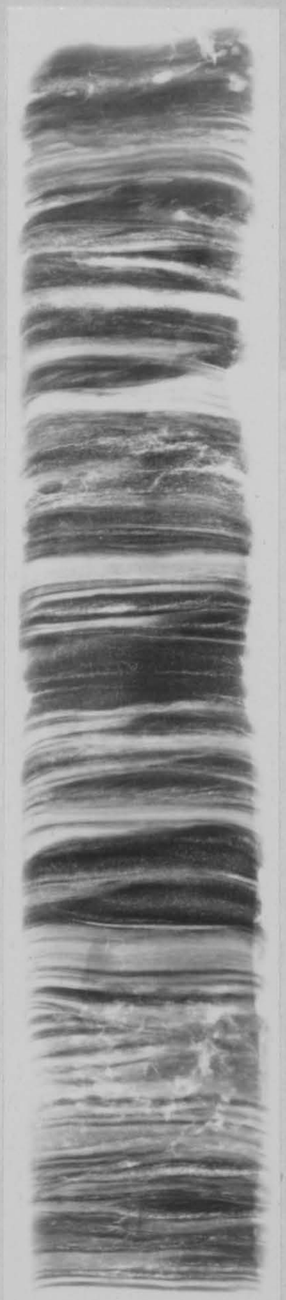


FIG. R



ENCLOSURE FIGURE 17.ix. STRATIFICATION OF THE MUDFLATS

(Core scale in cms.
Radiograph-actual scale)

FIGS.S and T - Core from mud bank of the upper estuary (ca.15¼ kms. from mouth)
Fig.T - top part of Fig.S (0-23 cms.)

- inter-stratified sand and laminated mud; bioturbation very slight Phragmites roots and rootlets, Tubifids, algal filaments?).

FIG. S

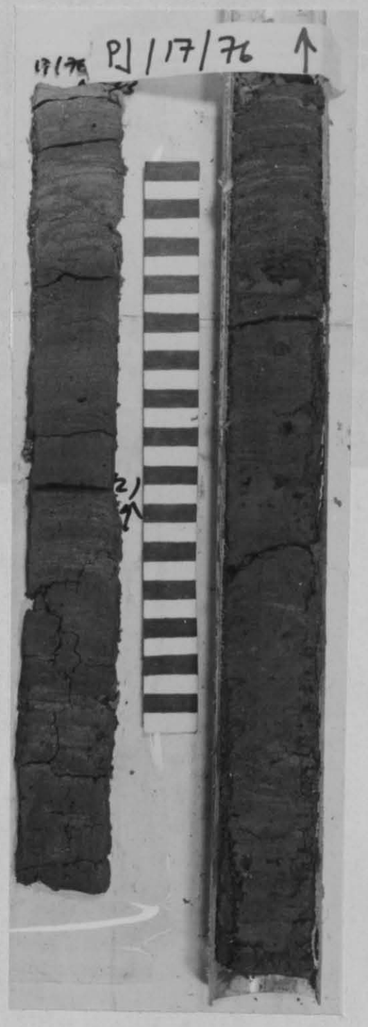
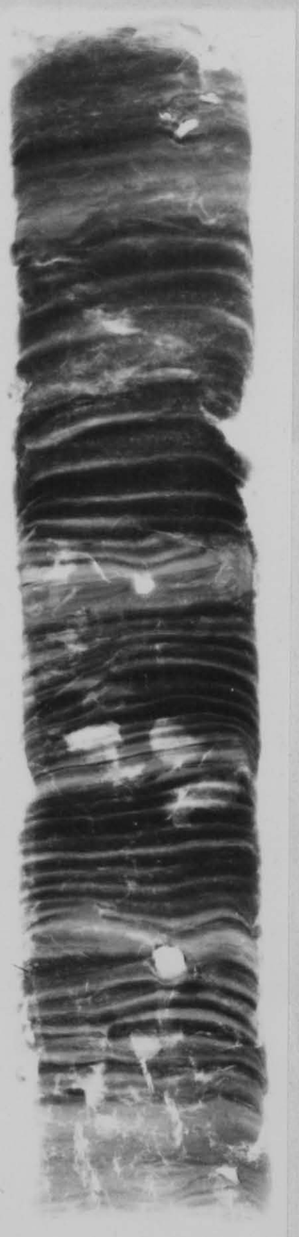


FIG. T



ENCLOSURE FIGURE 17.x. STRATIFICATION OF THE MUDFLATS

(Core scale in cms.
Radiographs-actual scale)

FIGS.U - W - Core from mud bank of the upper estuary (ca.16½ kms. from mouth)
Fig.V - top part of Fig.U (0-26 cms.)
Fig.W - bottom part of Fig.U (23-53 cms.)

- structureless or faintly laminated mud inter-bedded with inclined beds of lithic sand and gravel; bioturbation very slight (Tubifids and Phragmites roots and rootlets); some laminae and lenses of plant debris.

FIG. U



FIG. V



FIG. W



ENCLOSURE FIGURE 17.xi. STRATIFICATION OF THE MUDFLATS (Core scale in cms.)
Radiograph-actual scale)

FIGS.X and Y - Core from mud bank of the uppermost estuary (ca.19 kms.)
Fig.Y - top part of Fig.X (O-23 cms.)

- inclined inter-stratified poorly-laminated mud and lithic sand and gravel; bioturbation very slight (plant roots) or lacking; core brown with capping of of grey mud (see Fig.6.7) in which some faecal pellets were evident.

FIG. X

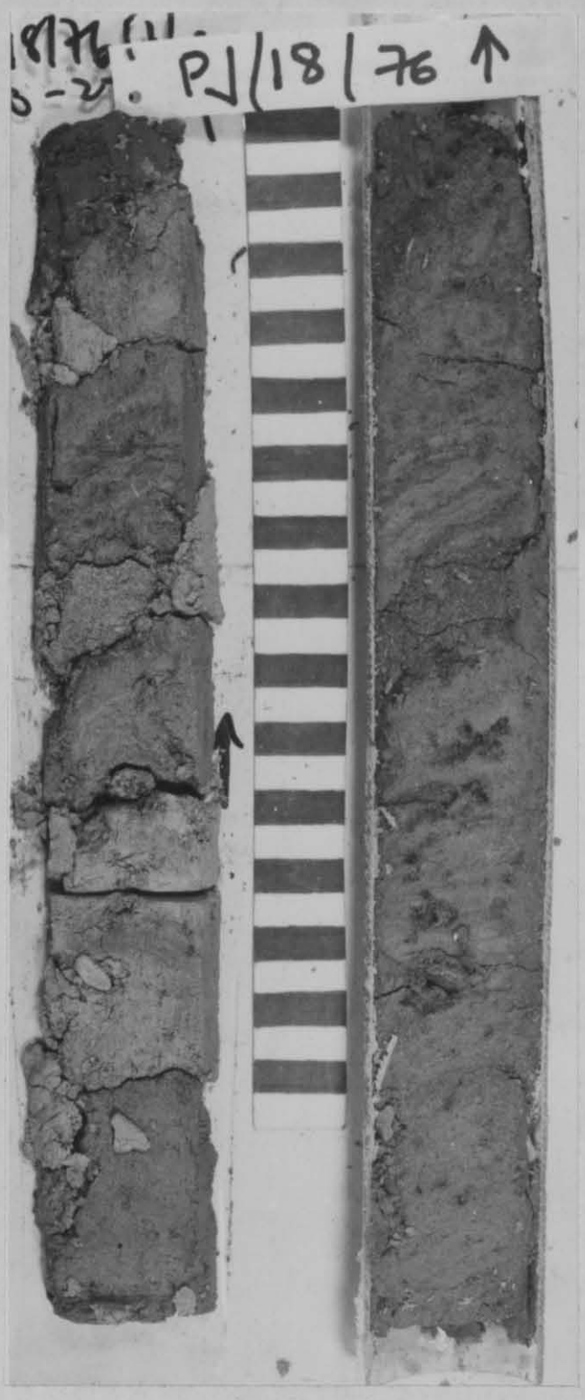
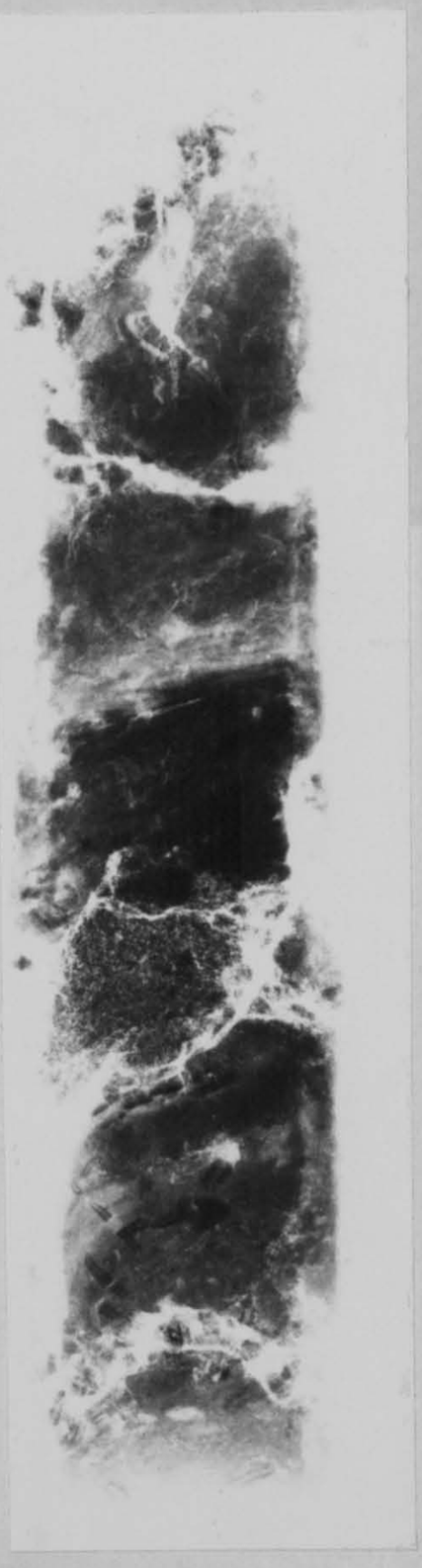


FIG. Y



ENCLOSURE FIGURE 18.i. STRATIFICATION OF THE SALT MARSHES (Core scale in cms. Radiographs-actual scale)

FIGS.A - C - Core from Spartinetum salt marsh of the lower estuary
Fig B - top part of Fig.A (0-17½ cms.)
Fig.C - middle part of Fig.A (17½-42 cms.)

- bioturbated laminated sandy mud in upper part of core; roots and rootlets of Spartina sp. dominant, Tubifids and Corophium sp. burrows also evident; structureless intensely bioturbated sandy mud in lower part of core; root and rootlet structures of Spartina sp. evident and Nereis sp. burrows.

FIG. A

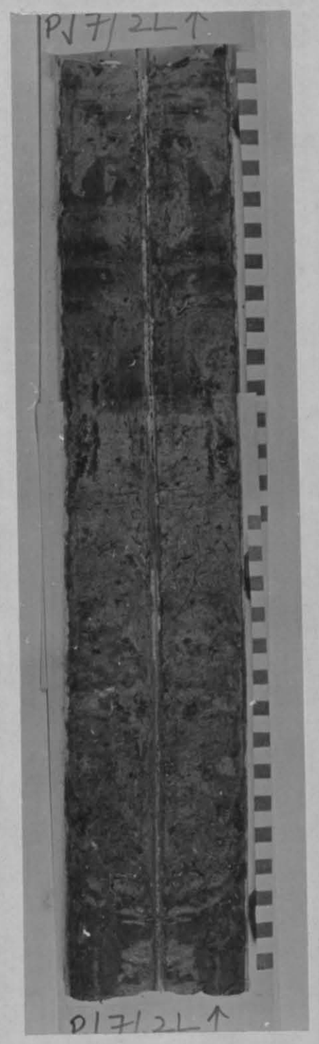


FIG. B



FIG. C



ENCLOSURE FIGURE 18.ii. STRATIFICATION OF THE SALT MARSHES (Core scale in cms. Radiographs-actual scale)

FIGS.D - F - Core from Spartina general salt marsh of the middle estuary
Fig.E - top part of Fig.D (0-18 cms.)
Fig.F - middle part of Fig.D (18-36 cms.)

- moderately bioturbated laminated sandy mud in upper part of core; root and rootlet structures dominant, but Corophium sp., Nereis sp. and Tubifid? burrows also evident; intensely bioturbated structureless sandy mud in lower part of core; root and rootlet structures and Nereis sp. burrows common.

FIG. D



FIG. E



FIG. F



ENCLOSURE FIGURE 18.iii. STRATIFICATION OF THE SALT MARSHES (Core scale in cms. Radiograph-actual scale)

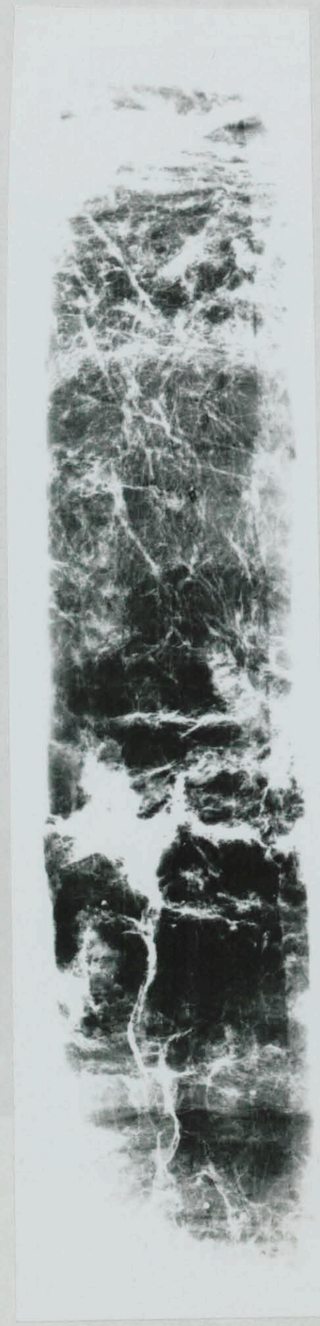
FIGS.G and H - Core from general salt marsh of the middle estuary
Fig.H - top part of Fig.G (0-23 cms.)

- structureless or faintly laminated mud; bioturbaton by roots and rootlets intense; some laminae of plant debris at top of core.

FIG. G



FIG. H



ENCLOSURE FIGURE 18.iv. STRATIFICATION OF THE SALT MARSHES (Core scale in cms. Radiograph-actual scale)

FIG.I - Core from circular salt pan on Morfa Uchaf

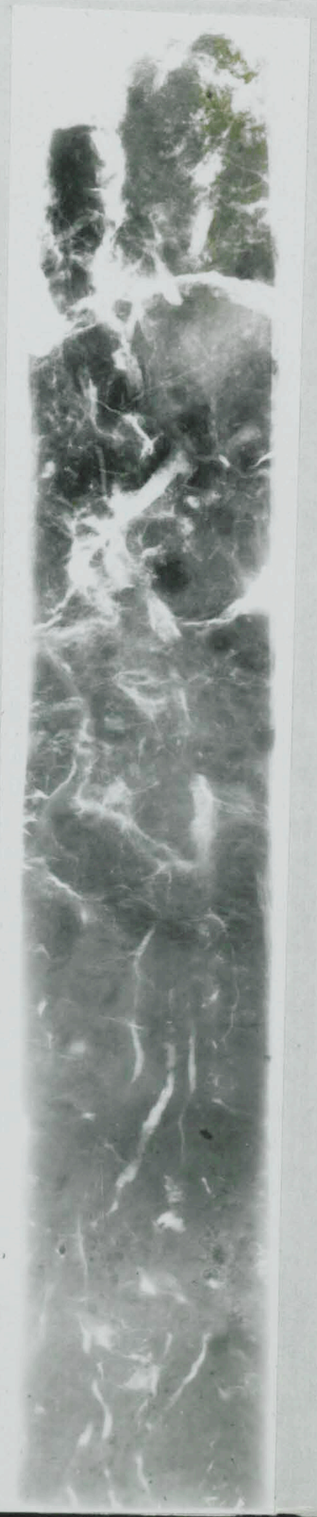
FIG.J - Radiograph of top part of a core (0-28 cms.) from the same salt pan (core taken ca. 1 m. from core of Fig.I)

- both cores structureless mud with abundant plant debris.

FIG. I



FIG. J



ENCLOSURE FIGURE 19.i. STRATIFICATION OF THE CREEKS (Core scales in cms.)

FIG.A - Core from creek in muddy sandflats of the lower estuary

FIG.B - Core from creek in salt marsh of the middle estuary

FIG.A - inter-stratified sand and mud; strata gently inclined or horizontal; some laminae of plant debris; bioturbation very slight or lacking.

FIG.B - intensely bioturbated structureless sandy mud in upper part of core; Nereis sp. burrows evident: inclined inter-stratified sand-mud and mud in lower part of core; moderate bioturbation evident with common Nereis sp. burrows.

FIG. A

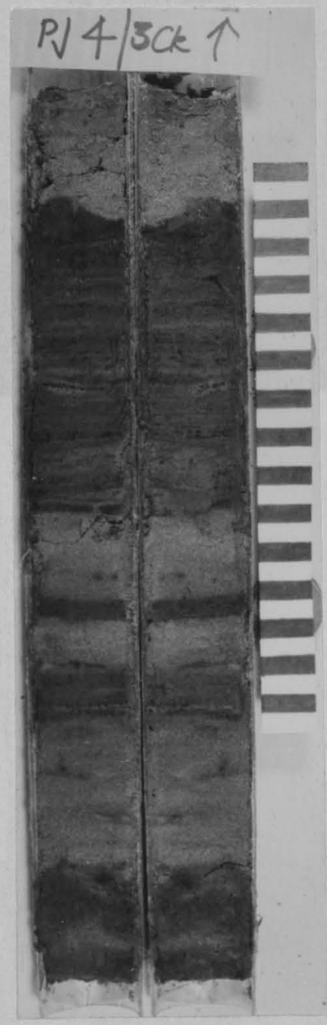


FIG. B



ENCLOSURE FIGURE 19.ii. STRATIFICATION OF THE CREEKS (Radiographs-actual scale)

FIGS.C - E - Radiographs of core of Fig.B
Fig.C - top part of Fig.B (0-19½ cms.)
Fig.D - middle part of Fig.B (19½-42 cms.)
Fig.E - bottom part of Fig.B (42-65 cms.)

- intensely bioturbated structureless sandy mud in upper part of core; moderately bioturbated inter-stratified sand-mud and mud in lower part of core; mud shows very fine laminations in places; Nereis sp. burrows dominant throughout core (note stowed faecal pellets in large burrow in Fig.C), but some Corophium sp. and Tubifid? burrows also evident.

FIG. C

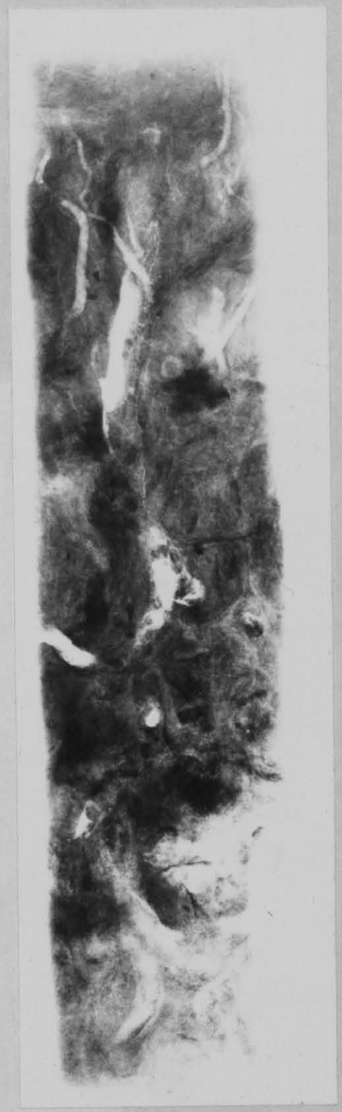


FIG. D



FIG. E

