4. SEABED SUPERFICIAL CIRCUMSTANCES

4. Seabed Superficial Circumstances

4.1 Seabed Material

The bottom sampling in the ocean area was carried out at the 32 points as shown in Fig. II-4-1, and at 7 points with 1 km interval in both inshore areas.

The sample data for the inshore area are shown in Table II-4-1, and those for the ocean area are shown in Table II-4-2.

4.1.1 Material Classification by Mechanical Analysis

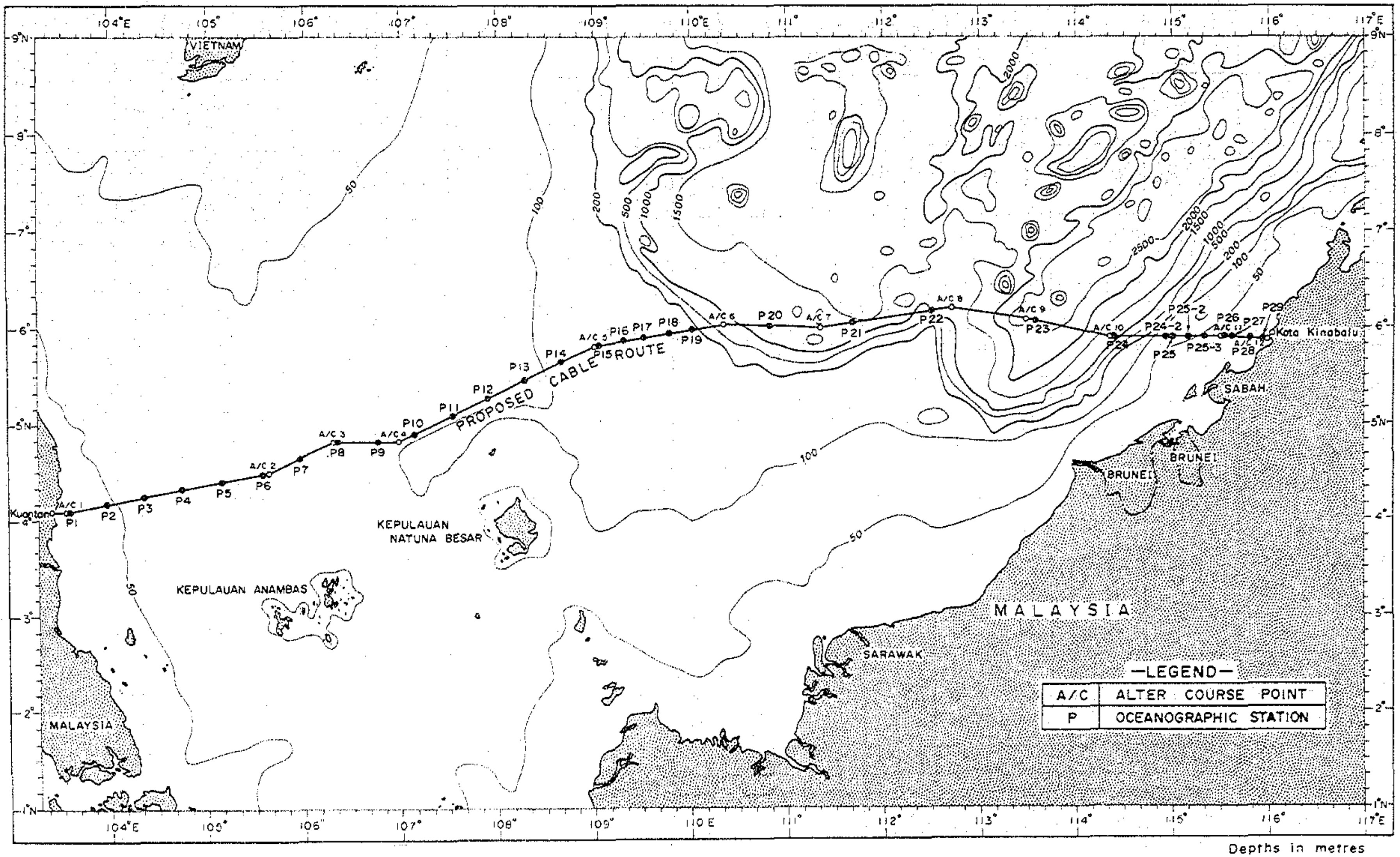
Mechanical Analysis of Sampling material was carried out. The results are shown in Tables II-4-3, II-4-4, Figs. II-4-2 and II-4-3. The analysis was based on the JIS (Japanese Industrial Standards) A-1204, where large size grain of more than 0.074 mm was measured by the sieving method and small size grain of less than 0.074 mm by the hydro meter method.

The standard of material classification is as shown below.

>4.76 mm	Gravel	0.42 - 0.074 mm	Fine Sand
4.76 - 2 mm	Fine Gravel	0.074 - 0.005 mm	Silt
2 - 0.42 mm	Coarse Sand	<0.005 mm	Clay

The results are summarized as follows:

- At most of the sampled points, the material contains a little gravel.
- The material at the Cherating inshore area contains much coarse sand, however, the material at the Kota Kinabalu inshore area contains much silt and clay.
- The seabed surface is covered with sand at P-1 and P-2 in the ocean area.
- The material is silty sand at P-10 and P-13 - P-18, but segments of rock were sampled at P-16 and P-17.
- The material is silt and clay at the other points.



Depths in metres

Fig. II-4-1 Oceanographic Station Location Diagram

Table II-4-1 Sample Data in Inshore Area

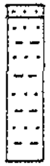
(Cherating Inshore Area)

Point No.	Distance from L.P.	Bottom Material	Penetration Test by Iron Rod	Seabed Condition (Observation by Diver)
KUA-0	30 m (coastal line)	Coarse Sand	-	---
KUA-1	1 km	Silty Sand	0.25 m	Ripple mark exists on the seabed.
KUA-2	2 km	Coarse Sand	0.4 m	---
KUA-3	3 km	Coarse Sand	0.4 m	Bottom material contains much fragments of shell.
KUA-4	4 km	Silt with Sand	1.05 m	Layer changes to sandy silt at 0.4 m depth under the seabed.
KUA-5	5 km	Sand	0.5 m	---
KUA-6	6 km	Clayey Silt	1.4 m	---

(Kota Kinabalu Inshore Area)

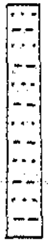
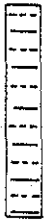
KK-0	10 m (coastal line)	Fine Sand	-	---
KK-1	1 km	Silt with Sand	0.2 m	---
KK-2	2 km	Clayey Silt	>1.5 m	---
KK-3	3 km	Clayey Silt	>1.5 m	Sludge
KK-4	4 km	Silty Clay	>1.5 m	Sludge
KK-5	5 km	Silty Clay	>1.5 m	Sludge Some holes by organization.
KK-6	6 km	Silty Clay	>1.5 m	Sludge

Table II-4-2 (1/5) Sample Data in Ocean Area

Item / Location	P-1	P-2	P-3	P-4	P-5	P-6	P-7
Measuring or Sampling Date	Jul.20	Jul.21	Jul.21	Jul.22	Jul.22	Jul.23	Jul.24
Position (Lat.: N) (Long.:E)	4°06'67 103°33'48	4°11'02 103°57'75	4°15'27 104°21'97	4°20'50 104°46'59	4°24'63 105°11'46	4°29'26 105°36'18	4°39'14 105°58'62
Water Depth (m)	23	48	70	73	78	83	89
Sampling Device	V	V	P	P	P	P	P
Bottom Material ▤ Clay ┅ Silt ░ Sand ▒ Gravel	 silty Sand clayey Silt	 silty Sand silty Sand	 clayey Silt silty Clay	 clayey Silt silty Clay	 silty Clay silty Clay	 silty Clay silty Clay sandy Silt	 silty Clay silty Clay
Core Length (cm)	237	111	78	150	164	152	170
Deep Sea Photo	●		●		●		●

* Sampling Device P: Piston Corer V: Vibro Corer G: Grab Sampler D: Dredger H: Hand

Table II-4-2 (2/5) Sample Data in Ocean Area

Item / Location	P-8	P-9	P-10	P-11	P-12	P-13	P-14
Measuring or Sampling Date	Jul.24	Jul.25	Jul.25	Jul.26	Jul.26	Jul.27	Jul.27
Position (Lat.: N) (Long.:E)	4°49'92 106°21'68	4°50'06 106°46'70	4°55'45 107°10'60	5°06'41 107°33'19	5°17'48 107°55'38	5°28'87 108°17'78	5°40'30 108°39'82
Water Depth (m)	90	78	82	82	78	87	108
Sampling Device	P	P	P	P	P	P	G
Bottom Material ☰ Clay ┅ Silt ░ Sand ▒ Gravel	 clayey Silt silty Clay	 clayey Silt clayey Silt	 silty Sand	 clayey Silt	 sandy Silt	 silty Sand	silty Sand
Core Length (cm)	140	162	162	150	100	46	
Deep Sea Photo		●		●		●	

* Sampling Device P: Piston Corer V: Vibro Corer G: Grab Sampler D: Dredger H: Hand

Table II-4-2 (3/5) Sample Data in Ocean Area

Item \ Location	P-15	P-16	P-17	P-18	P-19	P-20	P-21
Measuring or Sampling Date	Jul.28	Jul.28	Jul.28	Jul.29	Jul.29	Jul.31	Aug. 1
Position (Lat.: N) (Long.:E)	5°50'49 109°02'99	5°53'98 109°18'03	5°55'09 109°30'80	5°57'26 109°45'69	5°59'94 109°59'20	6°02'18 110°49'18	6°04'08 111°40'05
Water Depth (m)	137	137	139	155	211	1210	1665
Sampling Device	G	D	D	D	D	P	P
Bottom Material ▤ Clay ▦ Silt ░ Sand ▒ Gravel	silty Sand	Coral	Coral	silty Sand	Sandstone	▦ silty Clay	▦ silty Clay
Core Length (cm)						150	40
Deep Sea Photo		●					

* Sampling Device P: Piston Corer V: Vibro Corer G: Grab Sampler D: Dredger H: Hand

Table II-4-2 (4/5) Sample Data in Ocean Area

Item \ Location	P-22	P-23	P-24	P-24-2	P-25	P-25-2	P-25-3
Measuring or Sampling Date	Aug. 1	Aug. 4	Aug. 5	Aug. 5	Aug. 3	Aug. 5	Aug. 5
Position (Lat.: N) (Long.:E)	6°11'60 112°29'95	6°04'92 113°33'09	5°55'00 114°20'00	5°55'20 114°56'35	5°55'17 115°00'15	5°55'40 115°10'00	5°55'40 115°20'00
Water Depth (m)	1320	2610	1340	99	92	68	56
Sampling Device	P	P	P	D	P	P	P
Bottom Material Clay Silt Sand Gravel	silty Clay	silty Clay	silty Clay	sandy Silt	sandy Silt	sandy Clay clayey Sand silty Sand	silty Clay
Core Length (cm)	168	50	38		161	140	150
Deep Sea Photo	●	●	●	●			

* Sampling Device P: Piston Corer V: Vibro Corer G: Grab Sampler D: Dredger H: Hand

Table II-4-2 (5/5) Sample Data in Ocean Area

Item / Location	P-26	P-27	P-28	P-29			
Measuring or Sampling Date	Aug. 3	Aug. 5	Aug. 6	Aug. 6			
Position (Lat.: N) (Long.:E)	5°55'60 115°32'11	5°55'30 115°38'20	5°55'00 115°50'00	5°54'75 116°00'00			
Water Depth (m)	39	42	37	21			
Sampling Device	D	P	P	P			
Bottom Material Clay Silt Sand Gravel	Coral	sandy Silt	sandy Silt	sandy Clay			
Core Length (cm)		157	136	159			
Deep Sea Photo	●	●					

* Sampling Device P: Piston Corer V: Vibro Corer G: Grab Sampler D: Dredger H: Hand

Table II-4-3 Results of Mechanical Analysis (Inshore Area)

(Cherating Slope)

Sample No.	Granular Variation (%)						Name of Material	Specific Gravity
	Gravel	fine Gravel	coarse Sand	fine Sand	Silt	Clay		
KUA-0	-	0.8	67.7	26.5	3.0	2.0	coarse Sand	2.655
KUA-1	-	-	3.6	65.8	26.1	4.5	silty Sand	2.685
KUA-2	-	0.3	48.9	44.3	2.5	4.0	Sand	2.674
KUA-3	-	-	65.0	28.0	3.0	4.0	coarse Sand	2.656
KUA-4	-	-	2.5	16.7	61.3	19.5	Silt with Sand	2.694
KUA-5	-	-	37.2	47.5	10.8	4.5	Sand with Silt	2.664
KUA-6	-	-	1.1	11.9	70.5	16.5	clayey Silt	2.715

(Kota Kinabalu Slope)

Sample No.	Granular Variation (%)						Name of Material	Specific Gravity
	Gravel	fine Gravel	coarse Sand	fine Sand	Silt	Clay		
KK-0	-	-	0.1	90.4	5.5	4.0	fine Sand	2.662
KK-1	-	-	0.7	20.7	70.6	8.0	Silt with Sand	2.673
KK-2	-	-	0.2	2.3	49.0	48.5	clayey Silt	2.671
KK-3	-	-	0.2	9.2	51.6	39.0	clayey Silt	2.663
KK-4	-	-	0.2	6.9	32.1	60.0	silty Clay	2.671
KK-5	-	-	0.2	9.3	29.5	61.0	silty Clay	2.674
KK-6	-	-	0.2	6.1	39.7	54.0	silty Clay	2.691

Table II-4-4 Results of Mechanical Analysis (Ocean Area)

Sample Specific No.	Depth from the Seabed	Granular Variation (%)						Name of Material	Specific Gravity
		Gravel	fine Gravel	coarse Sand	Sand	Silt	Clay		
P-1	0.3-0.5	-	1.9	26.7	30.6	23.8	17.0	silty Sand	2.713
	1.0-1.2	-	-	8.5	7.5	48.5	35.5	clayey Silt	2.675
P-2	0 -0.1	-	0.9	32.0	38.4	18.2	10.5	silty Sand	2.677
	0.5-0.7	-	-	15.9	38.4	26.2	19.5	silty Sand	2.691
P-3	0 -0.2	-	-	4.4	13.6	55.5	26.5	clayey Silt	2.695
	0.5-0.8	-	-	-	2.1	20.4	77.5	silty Clay	2.699
P-4	0 -0.1	-	-	2.9	13.3	47.3	36.5	clayey Silt	2.688
	0.5-0.7	-	-	0.2	0.9	30.9	68.0	silty Clay	2.723
P-5	0.3-0.5	-	-	0.9	8.1	32.0	59.0	silty Clay	2.665
P-6	0.3-0.5	-	-	0.7	10.5	42.3	46.5	silty Clay	2.712
	1.3-1.5	-	-	2.3	27.9	44.8	25.0	silty Clay	2.686
P-7	0.3-0.5	-	-	1.1	8.2	43.7	47.0	silty Clay	2.704
	1.5-1.7	-	-	-	0.6	32.9	66.5	silty Clay	2.679
P-8	0 -0.2	-	-	1.3	5.4	50.8	42.5	clayey Silt	2.695
	0.5-0.7	-	-	0.4	1.8	40.8	57.0	silty Clay	2.692
P-9	0.3-0.5	-	-	0.5	6.6	72.9	20.0	clayey Silt	2.723
P-10	0.3-0.5	8.5	2.4	3.7	42.1	28.3	15.0	silty Sand	2.706
P-11	0.3-0.5	-	-	1.5	9.8	69.7	19.0	clayey Silt	2.686
P-12	0.3-0.5	-	-	0.6	26.4	57.0	16.0	sandy Silt	2.699
P-13	0.3-0.5	-	-	1.7	61.0	27.3	10.0	silty Sand	2.696

Sample Specific No.	Depth from the Seabed	Granular Variation (%)						Name of Material	Specific Gravity
		Gravel	fine Gravel	coarse Sand	Sand	Silt	Clay		
P-14	-	0	0.4	5.6	71.1	14.9	8.0	silty Sand	2.697
P-15	-	-	-	7.4	70.8	11.8	10.0	silty Sand	2.716
P-16	-	-	-	-	-	-	-	Rock	-
P-17	-	-	-	-	-	-	-	Rock	-
P-18	0.0-0.0	-	-	0.3	62.6	21.1	16.0	silty Sand	2.700
P-19	-	-	-	-	-	-	-	Rock	-
P-20	0.3-0.5	-	-	0.3	3.8	39.9	56.0	silty Clay	2.695
P-21	0.2-0.4	-	-	0	3.9	36.6	59.5	silty Clay	2.707
P-22	0.3-0.5	-	-	0.3	2.9	23.8	73.0	silty Clay	2.681
P-23	0.3-0.5	-	-	0	5.6	41.9	52.5	silty Clay	2.689
P-24	0.2-0.4	-	-	0	1.8	39.7	58.5	silty Clay	2.690
P-24-2	-	0	0.2	3.7	36.7	31.9	27.5	sandy Silt	2.685
P-25	0.3-0.5	-	-	3.1	25.0	44.4	27.5	sandy Silt	2.684
P-25-2	0.0-0.2	-	-	1.7	28.5	27.6	42.0	sandy Clay	2.685
	0.5-0.7	-	-	0.7	59.1	17.5	22.5	Sand	2.688
P-25-3	0.3-0.5	-	-	1.1	9.4	41.0	48.5	silty Clay	2.683
P-26	-	-	-	-	-	-	-	Rock	-
P-27	0.3-0.5	0.2	1.0	4.8	19.9	48.6	25.5	sandy Silt	2.690
P-28	0.3-0.5	0.5	0.8	4.4	40.9	38.4	15.0	sandy Silt	2.691
P-29	0.3-0.5	-	-	5.0	25.4	31.1	38.5	sandy Clay	2.679

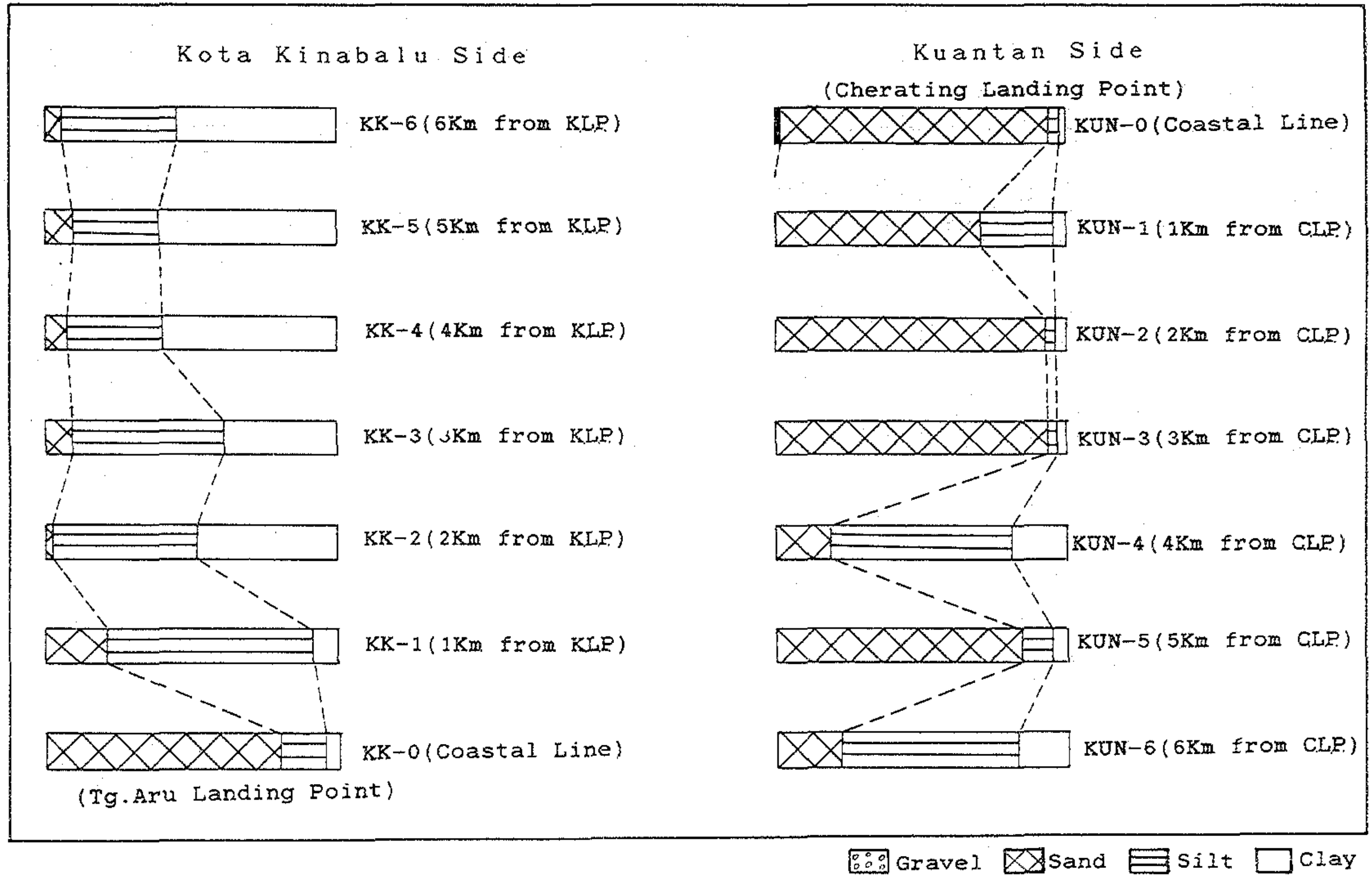


Fig. II-4-2 Grain Size Texture (Both Inshore Areas)

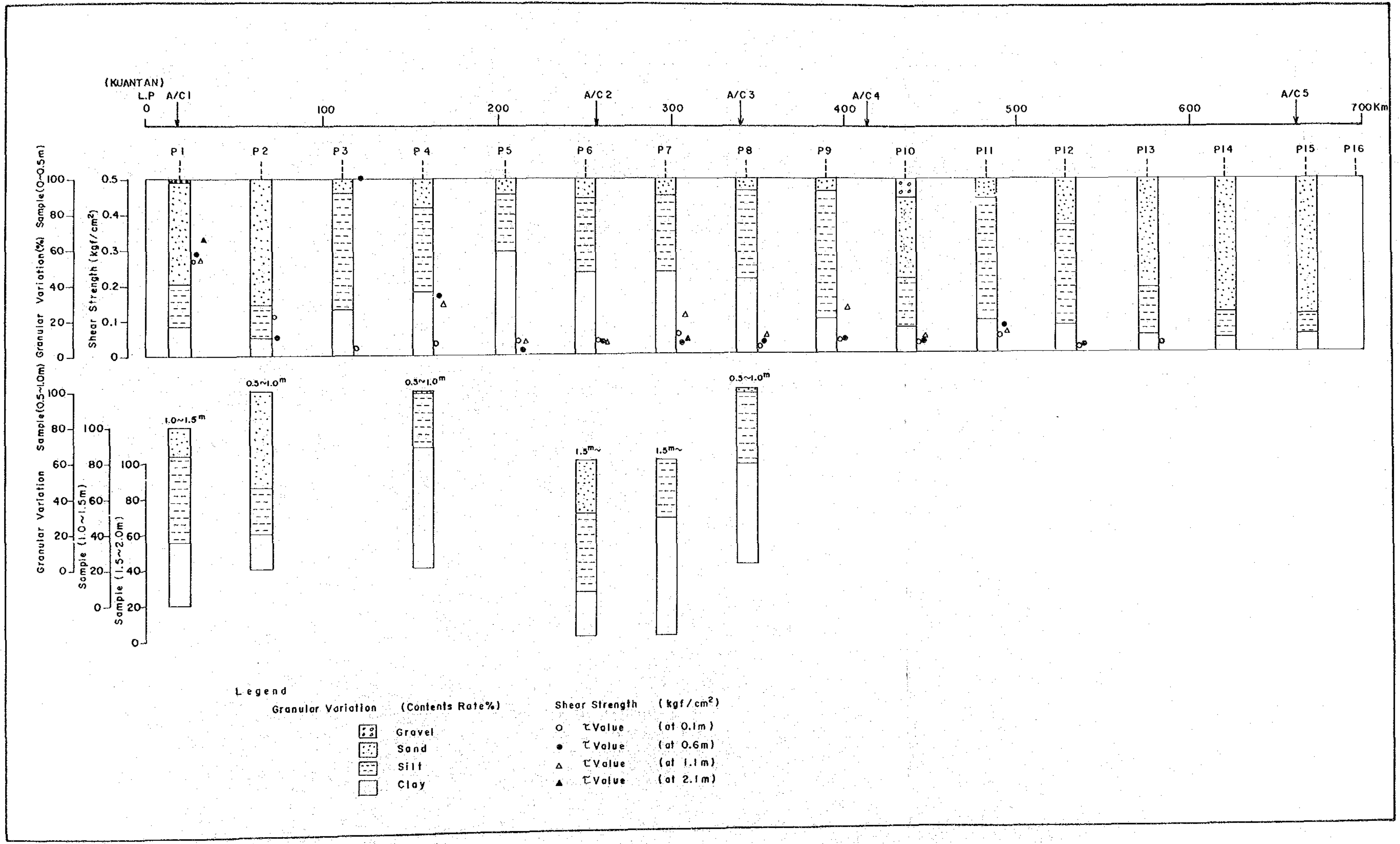


Fig. II-4-3 (1/2) Granular Variation

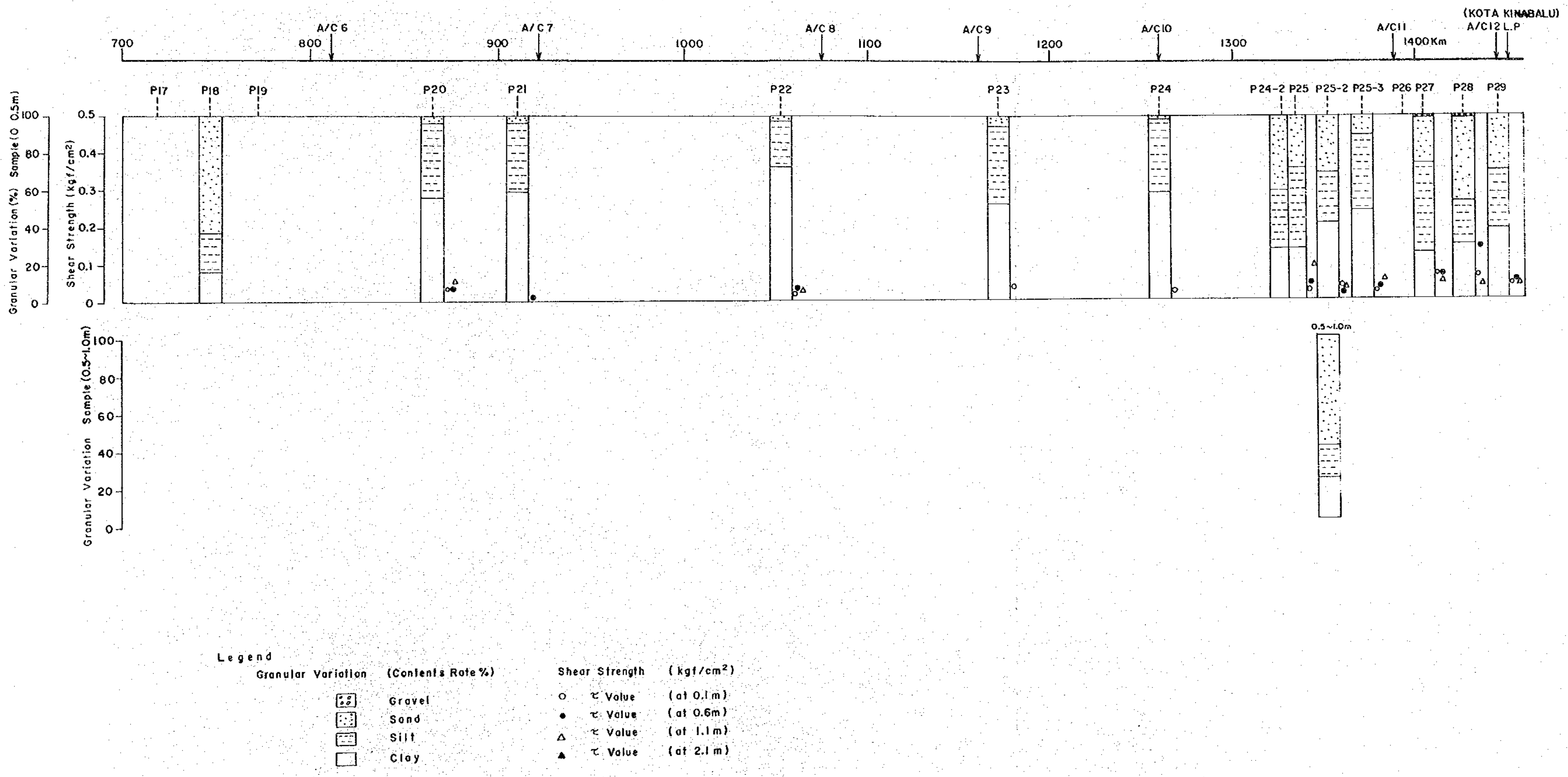


Fig. I-4-3 (2/2) Granular Variation

4.1.2 Shear Strength by Vane Test

In order to obtain the shear strength outline of seabed material, vane test was carried out by using handy-type torque vane.

Vane test should be in-situ test originally for measurement of the shear strength at original ground. However, it is not practical because of large scale setting of equipment in this route survey. Therefore, the test was carried out on the sampling material in the tube. In this method, the results are influenced by disturbance of bottom material at the sampling stage, nevertheless it is very useful for the estimation of burying difficulties to know the tendency of shear strength by this test.

Vane test was done in the columnar sample with 50 cm interval. The decrease in shear strength by this disturbance of sample is estimated roughly as 1/2 - 1/6 in case of sandy material, and 2/3 - 1/2 in case of muddy material. And in the case of materials with gravel or shell, the results of the test have occasionally shown extremely high shear strength.

Shear strength by vane test is calculated by the following equation, because it is in direct proportion to the torque strength and in inverse proportion to total area of column of turning vane.

$$\tau = \frac{M\ max}{\left(\frac{D^2H}{2} + \frac{D^3}{6}\right)\pi}$$

τ: Shear Strength (kgf/cm²)
M max: Torque Strength (kgf)
D: Width of Vane (cm)
H: Height of Vane (cm)

The results of the test are shown in Table II-4-5 and Fig. II-4-3. The shear strength in the survey area is summarized as follows:

- In most areas, the bottom materials are loose, with small shear strength of less than 0.1 kgf/cm².
- At P-1, lower layer of sample (layer III in geological result) is substantially hard with the shear strength of about 0.3 kgf/cm². The seabed condition in this area might cause some difficulty in the cable burying.
- At 0.6 m depth of P-3, shear strength is more than 0.5 kgf/cm² due to the effect of shell fragment, however the shell fragment content is quite low, therefore, this is not considered as a big problem for cable burying.
- At P-4, lower clay layer has about 0.15 kgf/cm² shear strength. This value is not so large, but it seems that the towing tension of burier will increase slightly in this area.

Table II-4-5 Results of Vane Test

Sample No.	Shear Strength (kgf/cm²)			
	0.1 m Bottom Material	0.6 m Bottom Material	1.1 m Bottom Material	1.6 m Bottom Material
P-1	0.27 silty Sand	0.29 silty Sand	0.27 clayey Silt	0.33 clayey Silt
P-2	0.11 silty Sand	0.051 silty Sand	-	-
P-3	0.020 clayey Silt	1.75 silty Clay	-	-
P-4	0.031 clayey Silt	0.17 silty Clay	0.14 silty Clay	-
P-5	0.041 silty Clay	0.014 silty Clay	0.038 silty Clay	-
P-6	0.041 silty Clay	0.038 silty Clay	0.031 sandy Silt	-
P-7	0.058 silty Clay	0.031 silty Clay	0.11 silty Clay	0.041 silty Clay
P-8	0.020 clayey Silt	0.038 silty Clay	0.055 silty Clay	-
P-9	0.038 clayey Silt	0.041 clayey Silt	0.13 sandy Silt	-
P-10	0.031 silty Sand	0.034 silty Sand	0.048 silty Sand	-
P-11	0.051 clayey Sand	0.082 clayey Sand	0.061 clayey Sand	-
P-12	0.017 clayey Silt	0.020 sandy Silt	-	-
P-13	0.027 silty Sand	-	-	-
P-14	-	-	-	-
P-15	-	-	-	-
P-16	-	-	-	-

Sample No.	Shear Strength (kgf/cm²)			
	0.1 m Bottom Material	0.6 m Bottom Material	1.1 m Bottom Material	1.6 m Bottom Material
P-17	-	-	-	-
P-18	-	-	-	-
P-19	-	-	-	-
P-20	0.034 silty Clay	0.034 silty Clay	0.055 silty Clay	-
P-21	0.014 silty Clay	-	-	-
P-22	0.020 silty Clay	0.034 silty Clay	0.027 silty Clay	-
P-23	0.038 silty Clay	-	-	-
P-24	0.024 silty Clay	-	-	-
P-24-2	-	-	-	-
P-25	0.027 sandy Silt	0.044 sandy Silt	0.096 sandy Silt	-
P-25-2	0.038 sandy Clay	0.024 clayey Sand	0.031 silty Sand	-
P-25-3	0.024 silty Clay	0.034 silty Clay	0.055 silty Clay	-
P-26	-	-	-	-
P-27	0.068 sandy Silt	0.065 sandy Silt	0.048 sandy Silt	-
P-28	0.061 sandy Silt	0.14 sandy Silt	0.038 sandy Silt	-
P-29	0.044 sandy Clay	0.047 sandy Clay	0.041 sandy Clay	-

4.1.3 Total Sulfide

In order to investigate the corrosive effects of sulfide, especially hydrogen sulfide, on a laid cable, a total sulfide analysis was made. The results of the test are shown in Table II-4-6.

Sulfur ion contained in the bottom material combines with other metals in most cases, and scarcely exist in the form of hydrogen sulfide gas. However, copper used for the power feeding copper tube of an optical-fiber submarine cable has a high tendency to combine. It extracts sulfur ion from other metals, and is likely to be sulfuretted.

Correlation between contents of sulfide and hydrogen sulfide and extent of cable corrosion are not well known. The results of the survey is summarized as follows:

- o Sulfide content of less than 0.01 mg/g.dry was detected at most sampling stations, and it is considered that hydrogen sulfide scarcely exists.

- o At stations P-21 and P-24, the sulfide content was slightly larger than at other stations, however it is also considered that hydrogen sulfide scarcely exists at these stations.

In addition, it is inconceivable that the small quantity of sulfide would corrode the copper tube of a submarine cable through the sheath and insulation.

Table II-4-6 Results of Total Sulfide Analysis

Point No.	Sulfide Contents S (mg/g.dry)	Point No.	Sulfide Contents S (mg/g.dry)
P- 1	0.07	P-17	-
2	<0.01	18	<0.01
3	<0.01	19	-
4	0.02	20	<0.01
5	<0.01	21	0.11
6	<0.01	22	0.01
7	<0.01	23	<0.01
8	<0.01	24	0.19
9	<0.01	24-2	<0.01
10	<0.01	25	0.01
11	<0.01	25-2	<0.01
12	<0.01	25-3	<0.01
13	<0.01	26	-
14	<0.01	27	<0.01
15	<0.01	28	<0.01
16	-	29	<0.01

4.2 Sea-floor Feature

In order to investigate the seabed condition, variation of material and existence of obstacles in the shallow water area of less than 200 m, sea bottom scanning was carried out. The results for (1) Cherating Inshore; (2) Sunda Shelf; and (3) Kota Kinabalu Slope are described as follows:

4.2.1 Cherating Inshore

There is no obstacle for burying cable along the proposed cable route in this area. Distribution of seabed material has a variety as shown in Fig. II-4-4.

4.2.2 Sunda Shelf

No special obstacles were found to the west of A/C 5, but innumerable gas holes were found, as shown in Table II-4-7. The existing cables located by Proton Magnetometer could not be confirmed by side scanning survey data, and it can be concluded that the existing cables are buried in the seabed.

To the east of A/C 5, many outcrops of rock as shown in Fig. II-4-5 were recognized on the seabed, and it is almost impossible to bury a cable in this area.

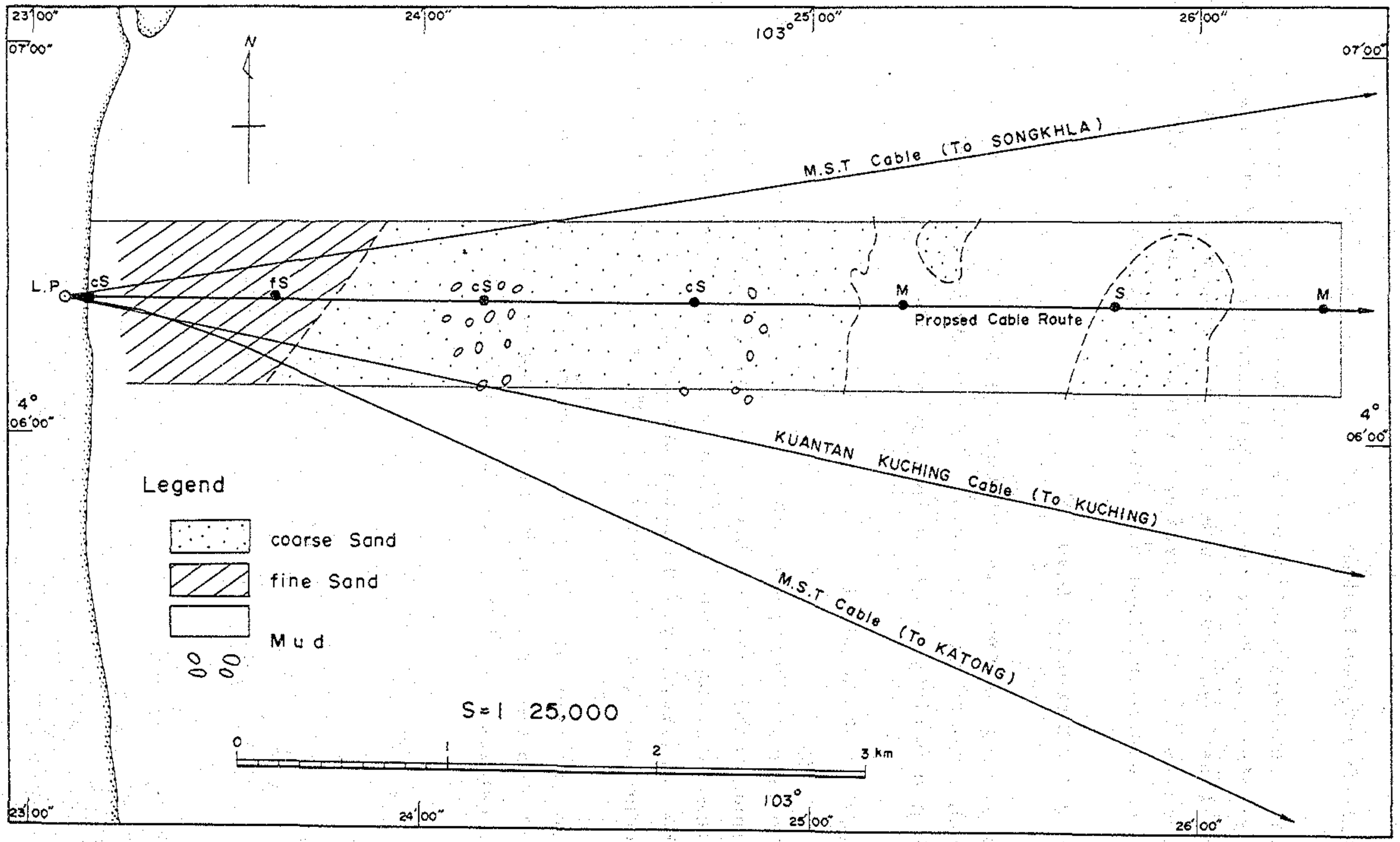


Fig. II-4-4 Distribution of Bottom Material (Cherating)

Table II-4-7 Distribution and Condition of Gas Holes (Sunda Shelf)

Area: Distance from C.L.P. (km) (A/C - A/C)	Location Distance from C.L.P. (km)	Condition	Diameter (m)	Relative Height (estimation)	Number of Holes (estimation)	Density (holes/km²) (estimation)
73.6-89.7 (A/C1-A/C2)	Around 75.2	Scattered	5	0.5-2m	—	12
	Around 78.6	Concentrated in 250x150m	5	less than 1m	about 30	—
	Around 83.8	Concentrated in 100x75m	3-5	less than 1m	about 50	—
	Around 87.3	Concentrated in 100x75m	3-5	less than 1m	8	—
	Around 88.9	Concentrated in 300x150m	3-5	less than 1m	about 200	—
	Other areas	Scattered sparsely	—	—	—	—
110.4-124.3 (A/C1-A/C2)	Around 116.2	Scattered	3-10	0.5-2m	—	10
	Around 121.2	Concentrated The shape of each hole is not clear.	—	less than 1m	—	—
	Around 124.3	Concentrated in 150x150m The shape of each hole is not clear.	—	less than 1m	—	—
	Other areas	Scattered sparsely	—	—	—	—
146.8-155.1 (A/C1-A/C2)		Scattered	3-5	—	—	25
171.4-186.1 (A/C1-A/C2)	Around 185.7	Scattered	3-7	1-3m	—	10
	Other areas	Scattered sparsely	—	—	—	—
225.7-241.4 (A/C1-A/C2)		Scattered	3-7	1-3m	—	2

Area: Distance from C.L.P. (km) (A/C - A/C)	Location Distance from C.L.P. (km)	Condition	Diameter (m)	Relative Height (estimation)	Number of Holes (estimation)	Density (holes/km^2) (estimation)
256.4-265.3 (-A/C2-)		Scattered	3-10	1-2m	—	2
269.6-305.9 (A/C2-A/C3)	Around 270.3	Scattered	3-10	1-3m	—	25
	Around 283.7	Scattered	3-5	1-2m	—	25
	Around 298.7	Scattered	2-3	about 1m	—	50
	Around 304.6	Scattered	3-5	less than 1m	—	25
	Other areas	Scattered sparsely	—	—	—	—
Around 380.4		Concentrated in 100x75m	3-5	less than 1m	about 50	—
385.1-436.9 (-A/C4-)	Around 390.4	Scattered	3-10	1-3m	—	5
	Around 405.2	Concentrated in 150x100m	3-5	1-2m	about 80	—
	Around 412.1	Scattered	3-5	1-2m	—	25
	Around 435.0	Scattered	3-10	1-2m	—	25
	Other areas	Scattered sparsely	—	—	—	—
Around 522.3 (A/C4-A/C5)		Concentrated in 250x200m	3	about 1m	about 60	—
Around 524.1 (A/C4-A/C5)		Concentrated in 250x200m	3	about 1m	about 100	—
Around 560.3 (A/C4-A/C5)		Concentrated in 150x100m	3	less than 1m	about 10	—
Around 562.1 (A/C4-A/C5)		Concentrated in 200x150m	1-3	less than 1m	about 30	—

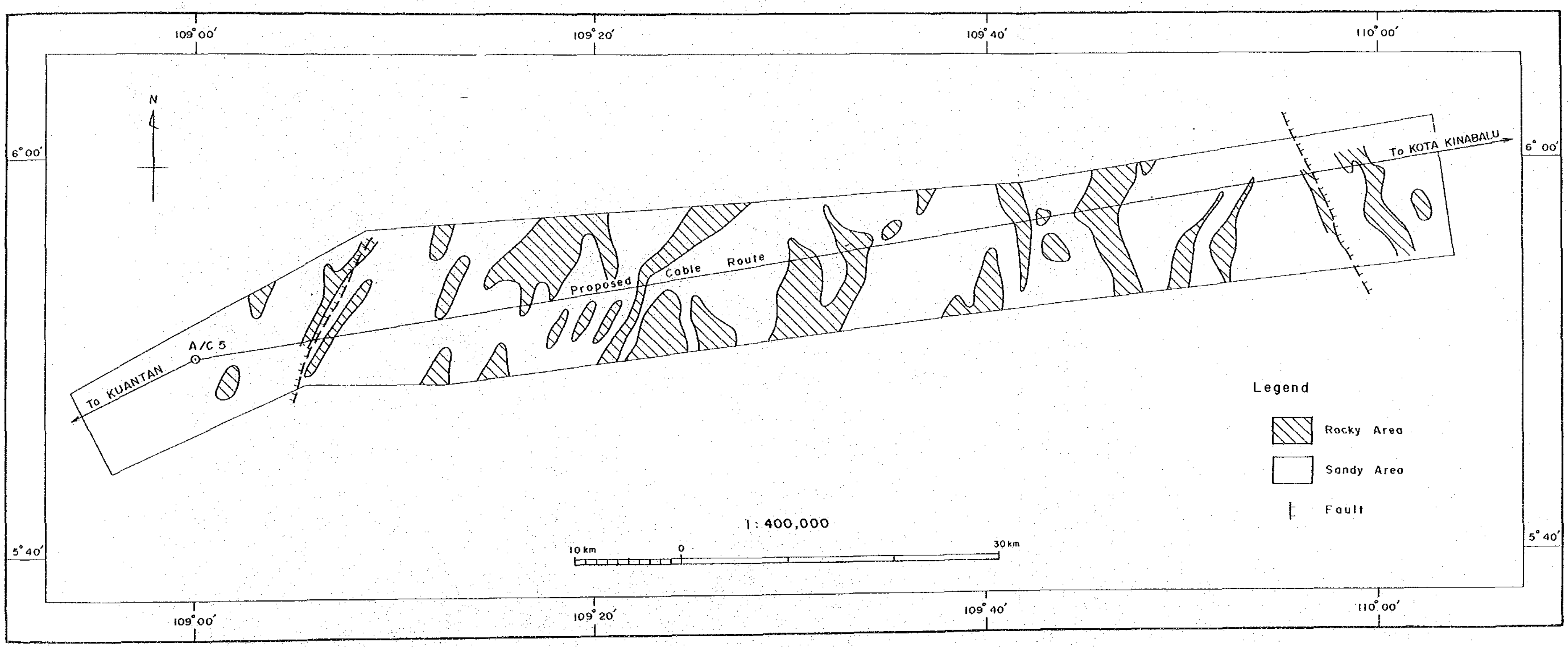


Fig. II-4-5 Seabed Condition Around A/C 5

4.2.3 Kota Kinabalu Slope

There are some scattered outcrops of rock in this area. The distribution and condition of the outcrops are shown in Table II-4-8.

Table II-4-8 Distribution and Condition of Outcrops of Rock (Kota Kinabalu Slope)

Distribution Distance from K.L.P. (Distance from C.L.P.)	Seabed Condition
Around 40 km (1,411.4 km)	o The seabed is covered with sandy silt, with scattered small patches of 10-100 m in diameter which are considered to be acoustically different materials. Some of the patches are outcrops of rock, and others are where thin sediment overlies rock. o These outcrops have no relative height. o From results of geological survey, these seem to be coral outcrops.
Around 46 km (1,405.4 km)	o The seabed is covered with sandy silt, with scattered small patches of 10-100 m in diameter which are considered to be acoustically different materials. Some of them are outcrops, and others are where thin sediment overlies rock. o Most outcrops have no relative height, but some have relative heights of 1 m in maximum. o Sediment surrounding the outcrops is sandy silt. o Based on results of geological survey, the rock seems to be coral, which grows on the deep basement rock like a bamboo shoot.

Distribution Distance from K.L.P. (Distance from C.L.P.)	Seabed Condition
52.8 - 54.5 km (1,398.6-1,396.9 km)	o The seabed is covered with sandy silt, with scattered small patches of 20-200 m in diameter which are considered to be acoustically different materials. o There are outcrops of rock, or area where thin sediment overlies rock. o Maximum relative height is about 1-2 m.
56.3 - 59.0 km (1,386.1-1,392.4 km)	o Outcrops of rock of 30-300 m in diameter are scattered densely, and sandy silt exists among the outcrops. o Most of them have relative heights of 1-3 m and about 8 m in maximum height.
Around 63.5 km (1,387.9 km)	o There are scattered outcrops of rock of 150 m in diameter, with sandy silt surrounding the outcrops. o Relative height is about 5 m.
94.9 - 96.3 km (1,356.5-1,355.1 km)	o The seabed is covered with clayey sediment with scattered small patches of 5-50 m in diameter which are considered to be acoustically different materials. o Outcrops of rock or rock overlaid with thin sediment exist. o Relative height of dominant outcrops is 0.5-2 m.
Around 107.5 km (1,344.9 km)	o There are scattered outcrops of rock of 250 m, 200 m and 150 m in diameter, with clayey sediments among the outcrops. o These outcrops are concentrations of small outcrops of diameter 0.5-2 m.

Distribution Distance from K.L.P. (Distance from C.L.P.)	Seabed Condition
Around 107.5 km (1,344.9 km) (continued)	o Relative height is about 0.5-1 m. o These outcrops tend to be in an E-W direction, and they may be outcrops of basement rocks.
121.0 - 122.3 km (1,330.4-1,329.1 km)	o There are scattered outcrops of rock with silty sediment around the outcrops. o Maximum relative height is about 20 m.
123.4 - 125.0 km (1,328.0-1,326.4 km)	o Outcrop of rock with silty sediment around the outcrops. o Relative height is about 2-5 m.
Around 132 km (1,319.4 km)	o Very thin silty sediment covers the seabed. o But the variations of seabed material are not recognized.

In this area, 2 pipelines running parallel 100 m apart were confirmed at the 61.5 km point from K.L.P. (1,386.3 km from C.L.P.). These pipelines run in the direction of NE-SW.

Some gas holes were also found in this area. Distribution and condition of gas holes are shown in Table II-4-9. However, as the gas hole area is small, and the edge of the holes are collapsed, these gas holes may not cause any obstruction to cable burying.

Table II-4-9 Distribution and Condition of Gas Holes
(Kota Kinabalu Slope)

Distribution Distance from K.L.P. (Distance from C.L.P.)	Condition	Diameter	Relative Height	Number of Holes (estimation)
Around 23.7 km (1,427.7 km)	Concentrated	3	less than 1 m	about 30
Around 25.4 km (1,426.0 km)	Concentrated	1-3	less than 1 m	about 20
Around 81.5 km (1,369.9 km)	Concentrated	3	less than 1 m	about 30

The conception profile of geology along the proposed cable route are summarized in Fig. II-4-6.

4.3 Seabed Condition for Cable Burying

In order to investigate the suitability of seabed condition for cable burying, the survey for cable burying was carried out by using a 1/2 scale model cable burier. (Refer to Annex-5.) The survey areas are shown in the table below.

Survey Area No.	Survey Area (Distance from C.L.P.)	Survey Distance
(1)	88 - 107 km	19 km
(2)	207 - 243 km	36 km
(3)	435 - 459 km	26 km

The results are shown in Fig. II-4-7(1/3)-(3/3). These figures show the variations of digging depth, inclination of stabilizer and towing tension along each survey lines.

These results are summarized as follows:

- o Area (1): About 1 m digging depth with the tension of less than 1 ton.
- o Area (2): 0.6 - 1 m digging depth with the tension of about 1.5 tons.
- o Area (3): About 0.8 m digging depth with the tension of about 2 tons due to the sandy sediments.

The results mentioned above show that these three areas are suitable for cable burying.

The results of geological survey indicate that the layer II covers the seabed thickly to the west of A/C 5 in Sunda Shelf. Therefore, the condition of the upper part of layer II is similar to area (1) and area (2), with many waste-filled channels at the area of muddy sediment, and to area (3) at the area of sandy sediment. (Refer to Fig. II-3-5.)

The results of sampling indicate that the seabed surface material is loose, with a shear strength of less than 0.1 kgf/cm^2 in this area. (Refer to Table II-4-5 and Fig. II-4-3.)

Consequently, the seabed condition to the west of A/C 5 in the Sunda Shelf is suitable for cable burying.

Concerning the gas holes, the burying survey of area (2) passing through the gas holes was carried out without any trouble. Therefore, it may not be a major problem, however, greater care of the burying speed should be taken during the construction stage.

Seabed conditions for the cable burying along the proposed cable route are summarized in Table II-4-10.

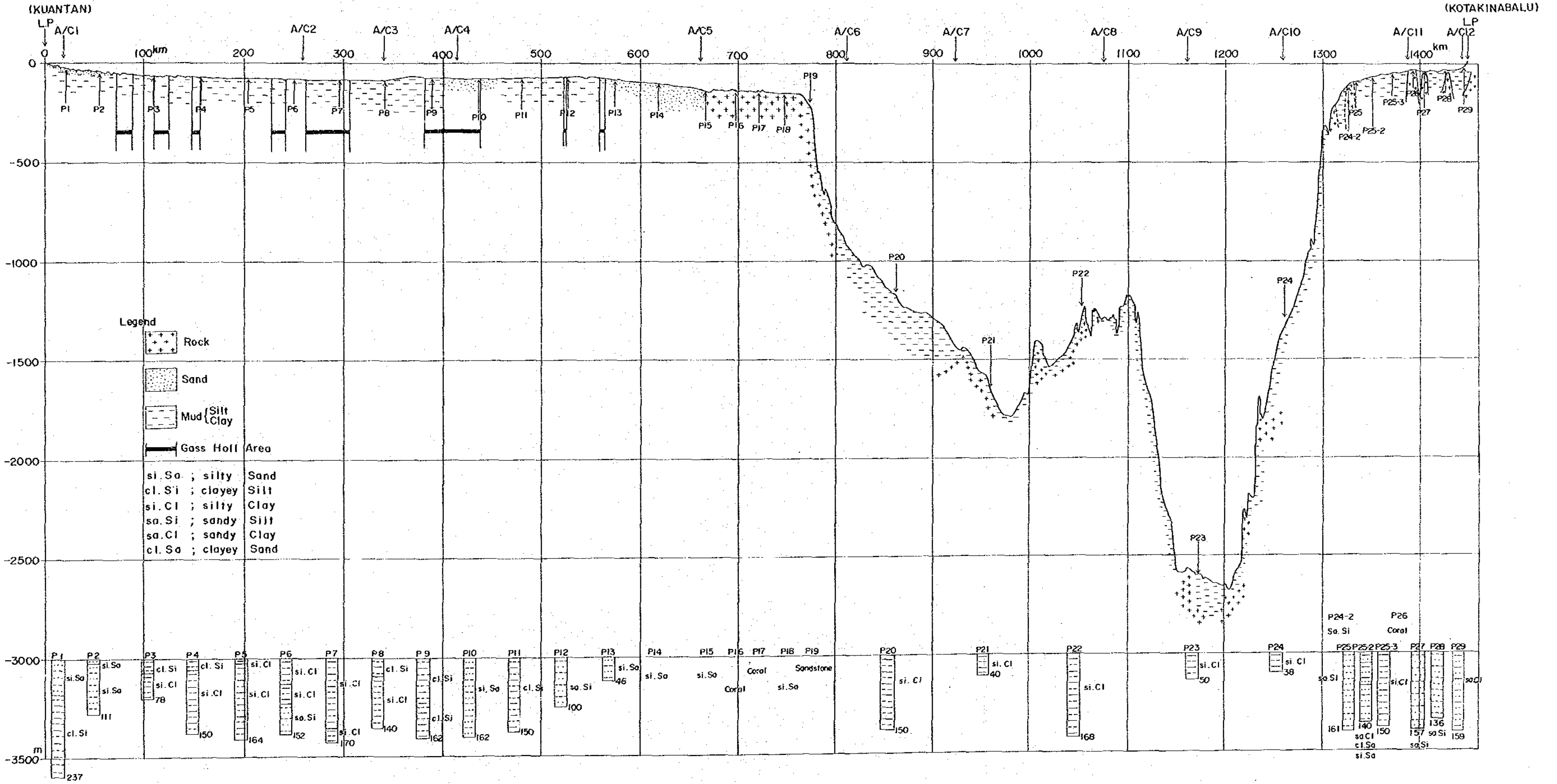


Fig. II-4-6 Conception Profile of Geology Along the Proposed Cable Route

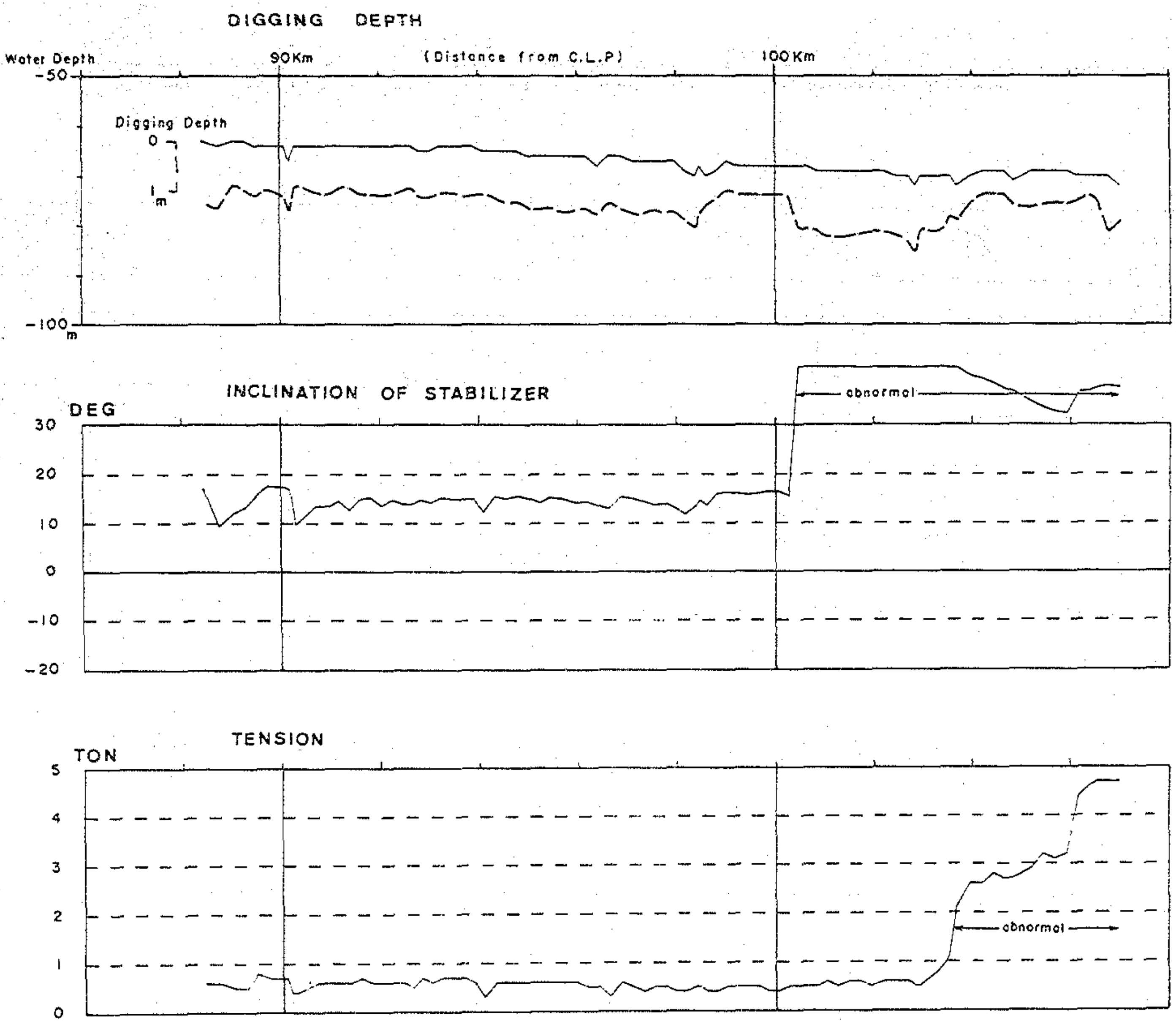


Fig. II-4-7 (1/3) Burial Records of Cable Burying Survey

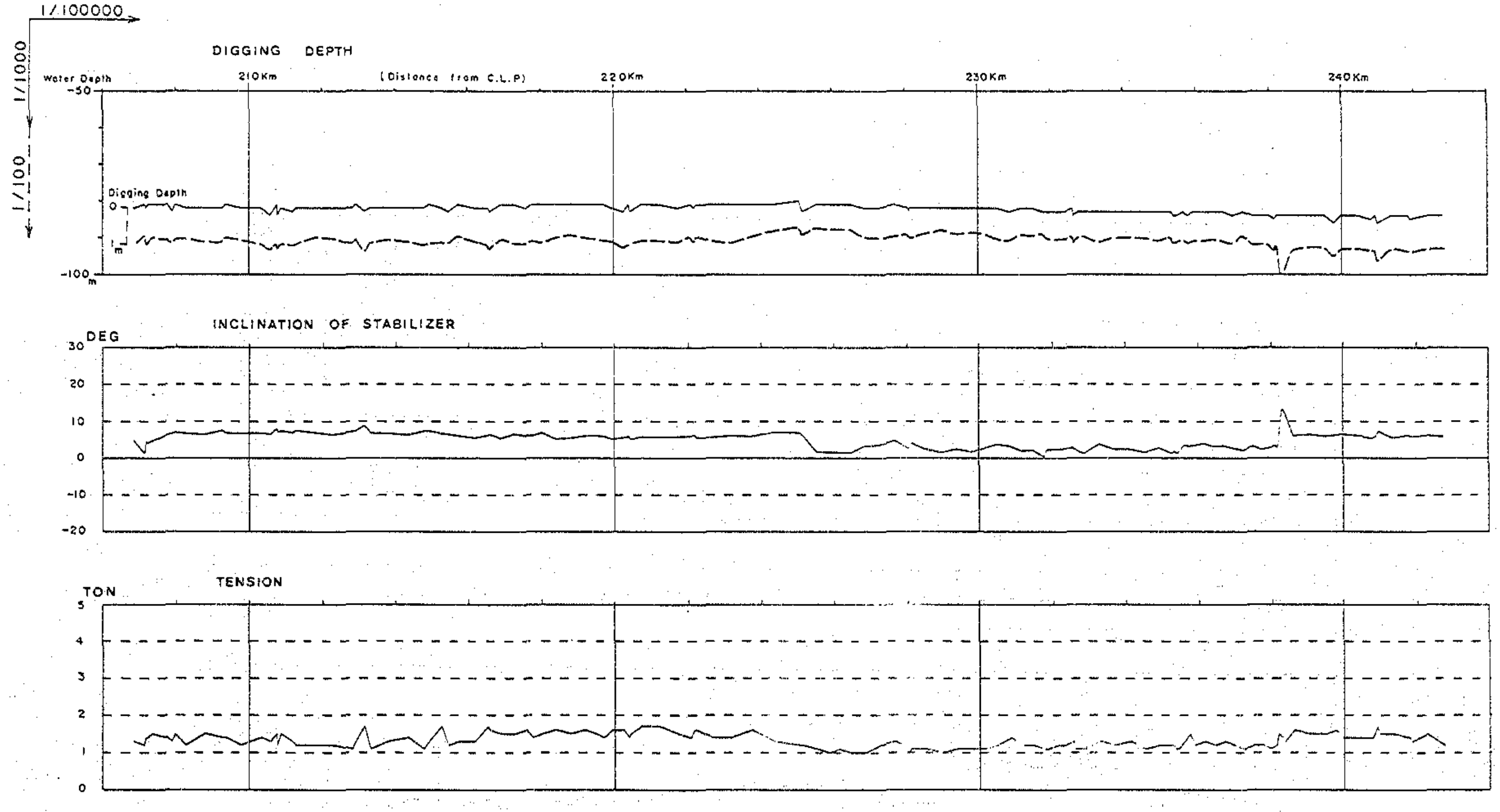


Fig. II-4-7 (2/3) Burial Records of Cable Burying Survey

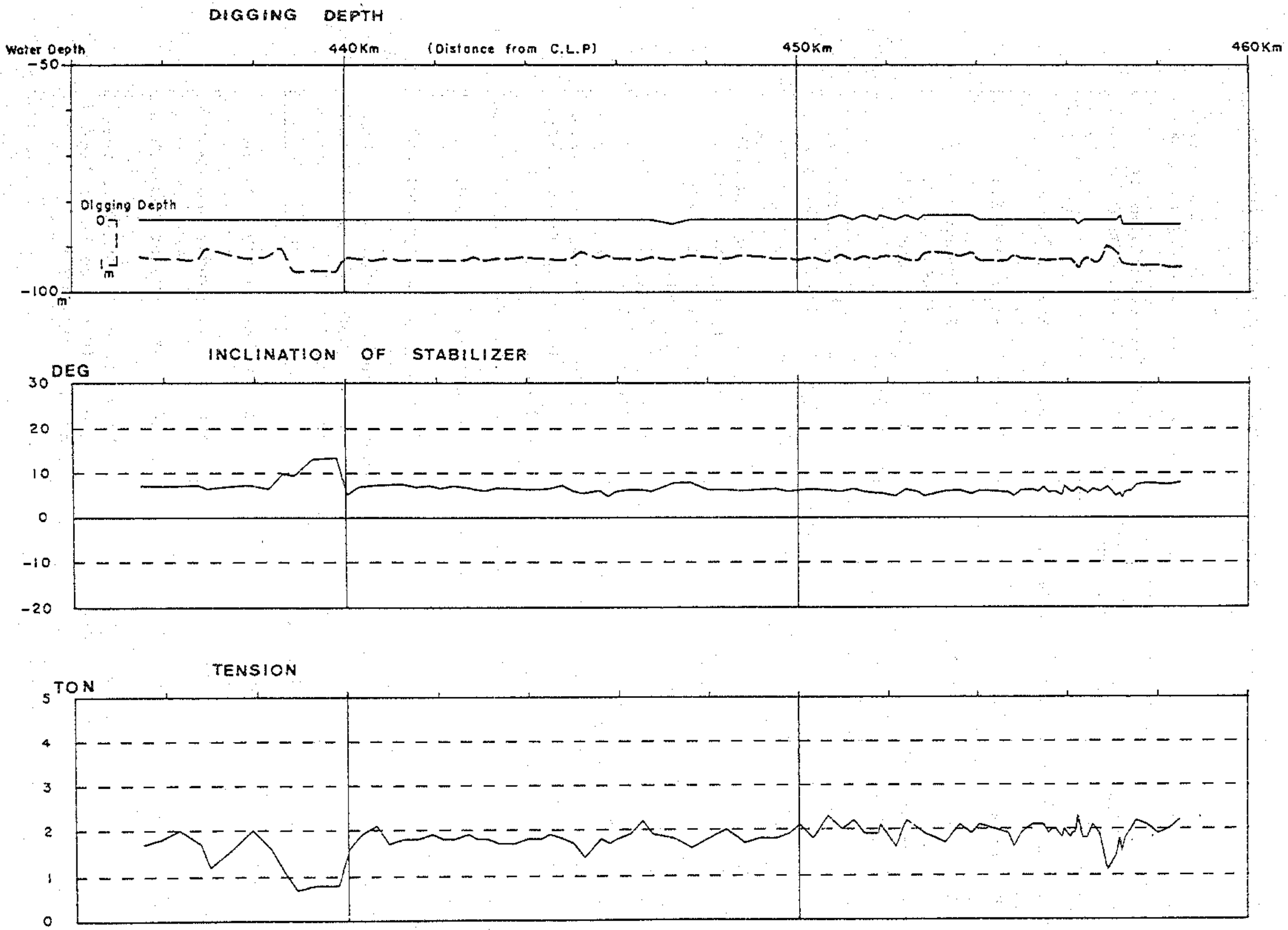


Fig. II-4-7 (3/3) Burial Records of Cable Burying Survey

Table II-4-10 Seabed Conditions to be Considered for the Cable Burying

Area, Distance from C.L.P.(km) (A/C - A/C)	Distance (km)	Suitable or Unsuitable for Burying	Seabed Conditions to be Considered
Cherating Slope and part of Sunda Shelf 0 - 305 (C.L.P.- A/C 1 - A/C 2 -)	305	Suitable	o 0-90 km: Seabed has many undulations. (Refer to Fig. II-3-5.) o 0-10 km: Sandy-muddy sediment. (Refer to Figs. II-3-4, II-4-3 and Table II-3-1.) o 10-305 km: Muddy sediment. (Refer to Figs. II-3-5 and II-4-3.) o 9-18.5 km: At the shallow water portion, the sub bottom material is hard and sticky silt. (Refer to Fig. II-4-3 and Table II-4-5.) o Many gas holes exist in this area. (Refer to Table II-4-7 and Fig. II-4-7.)
Part of Sunda Shelf 305 - 425 (- A/C 3 - A/C 4 -)	120	Unsuitable	o 305-405 km: Muddy sediment. o 405-425 km: Sandy sediment. o Many gas holes exist in this area. (Refer to Table II-4-7 and Fig. II-4-7.)
Part of Sunda Shelf 425 - 660 (- A/C 4 - A/C 5 -)	235	Suitable	o 425-460 km: Sandy sediment. o 460-560 km: Muddy sediment. o 560-660 km: Sandy sediment. o Many gas holes exist in this area. (Refer to Table II-4-7 and Fig. II-4-7.)

Area, Distance from C.L.P. (km) (A/C - A/C)	Distance (km)	Suitable or Unsuitable for Burying	Seabed Conditions to be Considered
Part of Sunda Shelf 660 - 770 (A/C 5 - 200 m water depth)	110	Unsuitable	o Widely scattered outcrops of rock. (Refer to Figs. II-3-5 and II-4-5.) o Sandy sediments exist around the outcrops. (Refer to Table II-4-4 and Fig. II-4-5.) o 767 km: Small fault exists. (Refer to Fig. II-3-1(1/3).)
Kota Kinabalu Slope 1,315 - 1,360 (A/C 10 - A/C 11)	45	Unsuitable	o Dotted outcrops of rock. (Refer to Fig. II-3-7 and Table II-4-8.) o Seabed has few undulations to the east of 1,330 km away from C.L.P.
Kota Kinabalu Slope 1,360 - 1,385 (A/C 10 - A/C 11)	25	Suitable	o Seabed is covered with thick and soft sediments. (Refer to Figs. II-3-7, II-4-3 and Table II-4-5.) o Gas holes exist. The distribution area is small. (Refer to Table II-4-9.)
Kota Kinabalu Slope 1,385 - 1,413 (- A/C 11 -)	28	Unsuitable	o Outcrops of rock exist. (Refer to Fig. II-3-7 and Table II-4-8.)
Kota Kinabalu Slope 1,413 - 1,451.25 (- A.C 12 - K.L.P.)	25	Suitable	o Seabed is covered with sandy silt. (Refer to Figs. II-3-7 and II-3-9.) o Gas holes exist. The distribution area is small. (Refer to Table II-4-9.)

5. MARINE METEOROLOGY AND OCEANOGRAPHIC FEATURES

5. Marine Meteorology and Oceanographic Features

5.1 Marine Meteorology

The area adjacent to the survey route in the South China Sea has a tropical monsoon climate which has two monsoon seasons and two transition seasons in a year. From the middle of December to the middle of March, the regime of the northeast monsoon (winter monsoon) is dominant; and in the early July to the middle of September, the regime of the southwest monsoon (summer monsoon) is dominant.

In winter monsoon, the northeasterly wind which is of force 3 and 4 on the Beaufort scale prevails over this area. However, in summer monsoon, the southwesterly wind of force 1 - 3 (but mostly 2 or 3) prevails over this area except at some coastal area of the northwest part of Borneo (wind force 0 - 1). In the transition seasons, the predominant wind is absent; and the wind of force 2 - 3 shows irregularities in wind direction.

In general, the wind prevailing in winter monsoon is strong and stable. The maximum wind velocity and swell appear in winter, but the wind rarely exceeds force 7 on the wind scale. In summer monsoon, the wind in this area is of force 2 or 3, but local thunderstorm or squall causes rough sea and temporarily increases the wind force by 1 or 2 on the wind scale.

The past data indicates that the marine climate to the south of latitude 5°N is better than to the north of the latitude; moreover, there is no report of the presence of tropical depression (typhoon) in this area.

In the coastal area near the landing points, wind varies with irregularity caused by local topography and geological conditions.

5.2 Current and Water Temperature

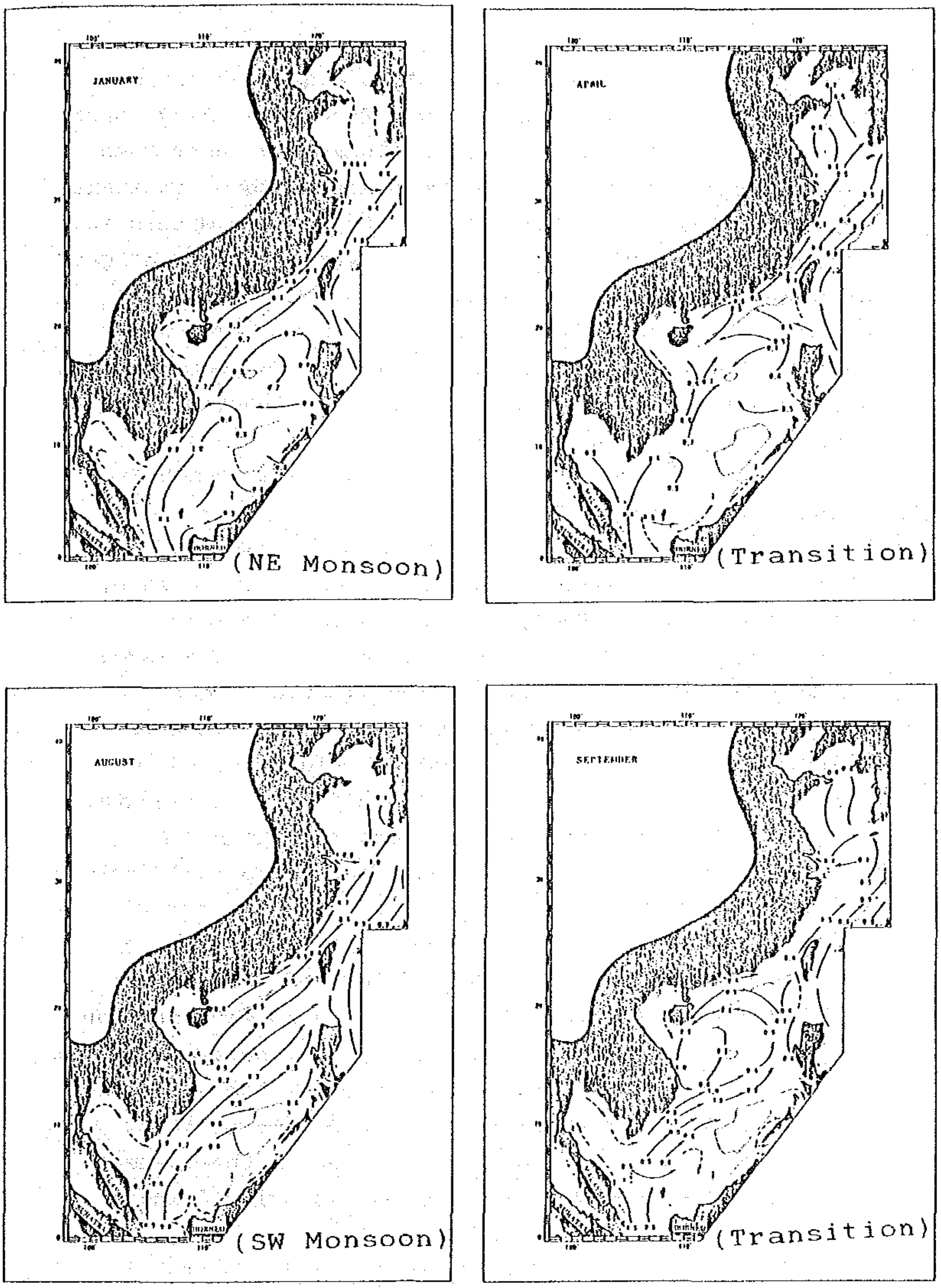
5.2.1 Current

(1) Sea Conditions

The regime of the surface currents of the South China Sea is the flow of water into or from the Sulu Sea, Java Sea, and through the Strait of Taiwan. These surface currents are influenced by the monsoon winds and reverse the currents direction twice in a year when the monsoon winds change.

In the northeast monsoon (winter monsoon), the currents in the southwest direction are dominant; and in the southwest monsoon (summer monsoon), the currents in the northeast direction are dominant. During the regime of either monsoon, the main current flows on the west side of the South China Sea with velocity of 0.3 to 1.0 knot. The current is highly constant with some variations in either monsoon season, and the predominant current in the southwest direction is strong and stable. Over the eastern part of the area, a counter-clockwise or a clockwise current is formed throughout most of the seasons and controls the surface currents of this area. (See Fig. II-5-1.)

The tidal stream in the South China Sea passes through the Luzon Strait and proceeds southwestwards in the South China Sea. In the vicinity of latitude 7°N, the main tidal stream separates; one half heading north to the Gulf of Thailand, and the other heading south to the Java Sea. The tidal stream off the east coast of Peninsular Malaysia generally does not exceed 1.5 knots. At ebb tide, tidal currents flow southward; and at flood tide, tidal currents flow northward.



←—— Current Direction
← – – Curernt Direction(estimated)
Velocity in knots(kt)

Fig. II-5-1 General Current Circulation

The tides in this area are mainly diurnal having one high water and one low water in a lunar day (24.8 hour). However, the characteristics of tides vary under some conditions, and semi-diurnal components become dominant, which results in two high waters and two low waters in a lunar day but with inequalities in the times and heights of successive high and low waters.

The tidal range in the survey period in the coastal area of the landing points is about 1.0 m at Kuantan and about 1.3 m at Kota Kinabalu.

(2) Summary of Survey Work

During the cable laying, the operation of cable ship, the cable laying method, and the cable slack are dependant on current conditions. At the coastal areas of the Landing Points, current observations were conducted for 6 days in Kuantan, and 4 days in Kota Kinabalu. Moreover, at 4 positions along the survey route, i.e., on the continental shelf, the continental slope, and the trough, observations for the bottom current were conducted for a duration of approximately 2 hours at each position.

In each coastal area where the water depth was 15 to 20 m, two mooring stations were made. At each station, two current meters (Aanderra RCM-4) were set, one at 5 m beneath the seasurface, and the other at 1 m above the seabottom. The principles of the analysis of this survey were the frequency distribution of the current direction and velocity, the maximum velocity, wind influence and the tidal effects.

Along the survey route in the ocean area, four mooring stations were made, and at each station either 1 or 2 current meters (Aanderra RCM-4 or RCM-5) were set at 5 m or 10 m above the seabottom. The principles of the survey in the offshore and deep water areas were the velocity and direction of the bottom current. At the stations where two current meters were set, one was set at 10 m above the seabottom and the other, which was for obtaining back-up data, was set at 20 m above the seabottom.

(3) Summary of Results

In the coastal area of Kuantan, the drift current under the regime of the southwest monsoon was predominant in the upper layer, and the northward current which flowed along the coast with a mean velocity of 15.0 cm/s was distinct. At the lower layer, the southwest and the northwest currents were dominant, however the northwest current was more distinct. The mean velocity together with the inertia velocity was 5 cm/s. The current velocity and direction showed a semi-diurnal variation, with a some diurnal inequality in both upper and lower layers. In the latter half of the observation, the southwest monsoon intensified its wind force to the force 4 on the Beaufort scale, and the current velocity in the upper layer increased to a maximum of approximately 1.0 knot, or 50.5 cm/s. On the point mentioned above, it is advisable to consider the change of weather condition or monsoon wind in cable laying which causes the increase of wind force and results in the intensification of current velocity in the upper layer.

In the coastal area of Kota Kinabalu, the northward current under the influence of the southwest monsoon which flowed along the coast at a mean velocity of 9.0 cm/s was predominant in the upper layer. At the lower layer, the southward current which flowed at a mean velocity of 2.0 cm/s was dominant. The current direction and velocity showed some distinct period variations. However, the current velocity was generally weak and the tide component was not distinct. From the results, no phenomena which may be hazardous to the cable laying was found.

The results of current observation for the bottom current in the ocean area along the cable route were as follows:

- On the Sunda Shelf (81.8 m), the southwest current (253°) with a maximum velocity of 18.6 cm/s was observed.
- On the Western Continental Slope (1,100 m) and on the northwest of the Palawan Trough (2,600 m), the north currents (359°) with maximum velocities of 12.1 cm/s and 10.5 cm/s were observed in each area.
- On the Eastern Continental Slope (1,280 m), the west current (296°) with a maximum velocity of 24.7 cm/s was observed.

On the Eastern Continental Slope, a maximum current velocity of about 0.5 knot was observed. This maximum velocity is due to the presence of the trough, together with the relatively steep slope in the topographic structure of the sea; therefore, for the cable laying operation, the condition of the current in this area requires due consideration.

(4) Results

(a) Current Observations in Coastal Area

Data observation were collected at every 10 minutes interval with an accuracy of ±5 degree for the current direction and 1.0 cm/s for the current velocity.

The position, observation period, and water depth of the current mooring stations of both coasts are shown in Table II-5-1.

The results of the observation are summarized in Table II-5-2 and Figs. II-5-2 to II-5-7 for Kuantan, and also summarized in Table II-5-3 and Figs. II-5-8 to II-5-13 for Kota Kinabalu.

Table II-5-1 Positions of Current Mooring in Coastal Area

Area	Kuantan		Kota Kinabalu	
Mooring Station	KN-1	KN-2	KK-1	KK-2
Position Latitude (N)	4°01'72"	4°02'32"	5°55'93"	5°55'27"
Longitude (E)	103°28'19"	103°27'33"	116°01'65"	116°01'08"
Period Launch	July 13 07h19m	July 13 07h40m	June 27 09h57m	June 27 10h31m
Recovery	July 18 12h19m	July 18 12h50m	June 30 14h16m	June 30 14h36m
Depth (m)	15.0	14.5	16.0	19.8
Layer (m)	5.0 m below the sea surface (-5.0) 1.0 m above the sea bottom (1.0)			

Kuantan

The continuous current observation was made for about 6 days at st. KN-1 and KN-2 located at 12.7 km and 10.8 km southeast off the Kuantan Landing Point. The results of the observations at st. KN-1 and KN-2 showed similar trends.

In the current direction and velocity diagram, semi-diurnal period was dominant in both upper and lower layer of st. KN-1 and KN-2; and diurnal inequality was present in the latter half of the observation. (Figs. II-5-2 and II-5-5.) These trends clearly appeared on the north component of the velocity diagram. Furthermore, in the latter half of the observation, the southeast to southwest monsoon wind intensified to wind force 4 which resulted in the increase of the current velocity in the upper layer. These trends clearly appeared on the north component of the velocity diagram in the upper layer, and it implies that the drift current prevailed over the upper layer.

In the frequency distribution of current direction and velocity (Table II-5-2, Figs. II-5-3 and II-5-6) of the upper layer of both KN-1 and KN-2, 76.6% and 72.9%, respectively, of the current were in the NW - NE directions, at maximum velocities of 50.5 cm/s (1.0 kt., N) and 42.4 cm/s (0.82 kt., N), respectively. At the lower layer, 45.5% and 44.6% of current at KN-1 and KN-2 were in the NW - NE directions, and 45.5% and 41.2% respectively, were in the SW - NW directions. The maximum current velocities were 23.3 cm/s (0.45 kt., N) and 19.1 cm/s (0.37 kt., NW), respectively.

The trends of the upper and lower layer currents are as shown in the progressive vector diagrams on Figs. II-5-4 and II-5-7. Current of the upper layer was north flow, and the lower layer was northwest flow accompanied with inertia periods.

The results of the current conditions at the coast of Kuantan, as mentioned above, can be summarized in the following conclusions:

- At the coast of the landing point in the southwest monsoon (wind force 1 - 4), the northward drift current under the regime of the southwest monsoon wind which flowed along the coast was predominant in the upper layer (5 m beneath the seasurface); the northwest flow with the semi-diurnal inertia period which flowed toward the coast was dominant in the lower layer.
- The variations of current of both layers were distinct in a semi-diurnal period which accompanied with a diurnal inequality.

At the upper layer, the increase in wind velocity prevailed over the drift current, however, in the lower layer, there was no distinct change in current.

The maximum current velocity of approximately 1.0 kt. (51.4 cm/s) is expected to be present in the upper layer under the local weather conditions such as a squall, breeze, or change of monsoon with wind of force greater than 3 on the Beaufort scale. Therefore, it is advisable to consider the variation in weather condition during the cable laying.

Table II-5-2 Current Observation in Kuantan

Mooring Station	KN-1		KN-2	
Layer (m)	-5.0	1.0	-5.0	1.0
Mean Velocity (cm/s)	19.2	7.0	15.2	5.5
Mean Direction (deg.)	360.0	295.3	347.8	287.7
Maximum				
Velocity (cm/s)	50.5	23.3	42.4	19.1
Direction (deg.)	2.2	358.5	357.8	332.0
Frequency Distribution Direction (%) Mean Velocity (cm/s)				
NW - NE	76.6	45.5	72.9	44.6
	24.0	11.7	22.1	11.0
NE - SE	7.0	1.5	3.8	1.2
	16.1	7.7	15.7	5.8
SE - SW	15.5	7.5	16.5	13.0
	16.8	9.7	16.7	9.5
SW - NW	0.9	45.5	6.8	41.2
	15.7	11.0	16.4	10.7

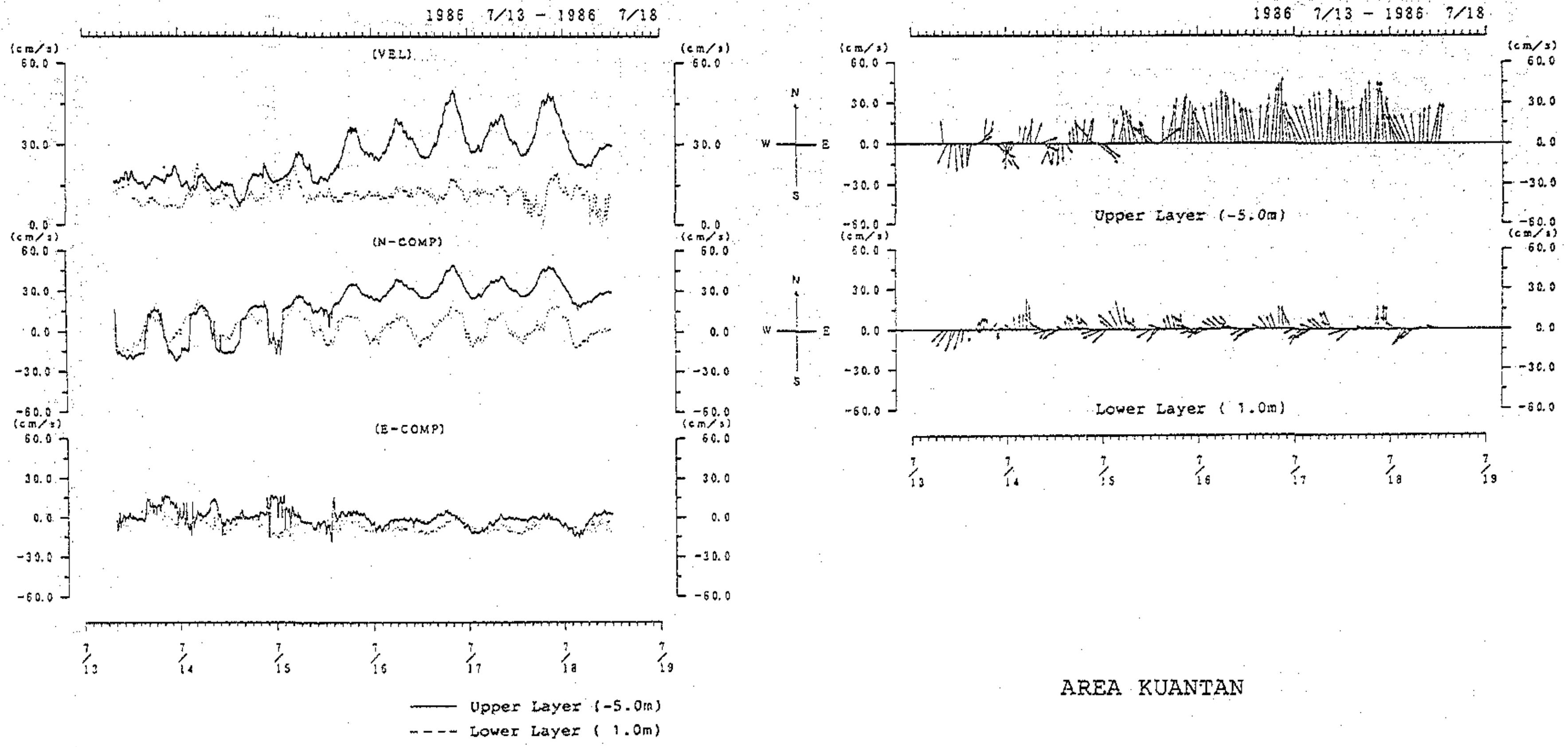


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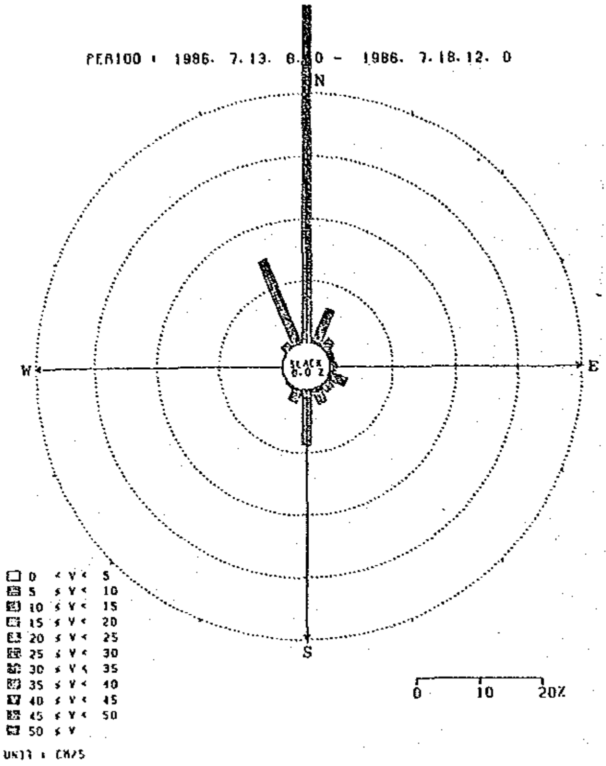
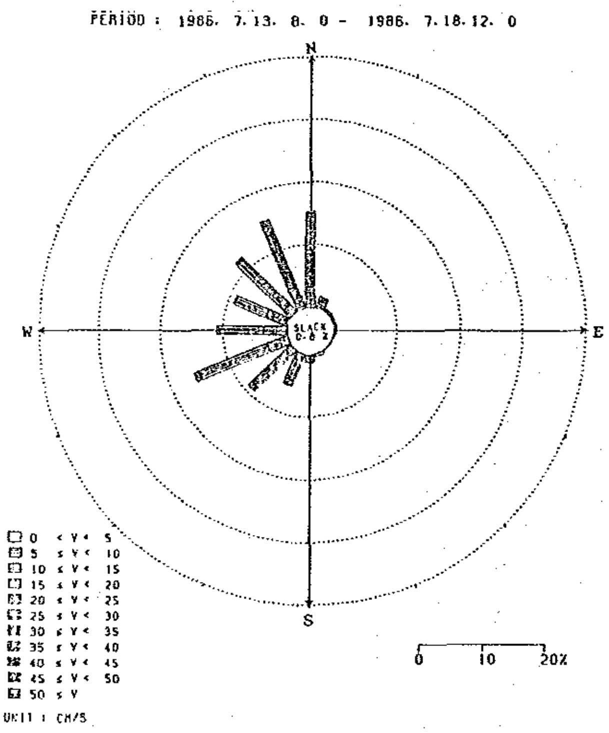
Fig. II-5-2 Current Direction Velocity Diagram (St. KN-1)



cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	0 0.0											0 0.0
N	0 -	5 0.7	11 1.5	39 5.2	31 4.2	104 14.0	79 10.6	71 9.5	30 4.0	33 4.4	1 0.1	404 54.2
NNE	0 -	0 -	3 0.4	32 4.3	7 0.9	3 0.4	0 -	1 0.1	0 -	0 -	0 -	46 6.2
NE	0 -	1 0.1	1 0.1	12 1.6	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	15 2.0
ENE	0 -	0 -	4 0.5	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	7 0.9
E	0 -	0 -	4 0.5	4 0.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	8 1.1
ESE	0 -	1 0.1	3 0.4	18 2.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	22 3.0
SE	0 -	0 -	1 0.1	11 1.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	12 1.6
SSE	0 -	3 0.4	2 0.3	12 1.6	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	20 2.7
S	0 -	1 0.1	10 1.3	50 6.7	5 0.7	0 -	0 -	0 -	0 -	0 -	0 -	66 8.9
SSW	0 -	0 -	2 0.3	14 1.9	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	17 2.3
SW	0 -	0 -	1 0.1	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	4 0.5
WSW	0 -	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
W	0 -	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
WNW	0 -	0 -	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
NW	0 -	0 -	0 -	5 0.7	4 0.5	1 0.1	0 -	0 -	0 -	0 -	0 -	10 1.3
NNW	0 -	0 -	2 0.3	22 3.0	23 3.1	45 6.0	16 2.1	3 0.4	0 -	0 -	0 -	111 14.9
Total	0 -	11 1.5	46 6.2	226 30.3	75 10.1	153 20.5	95 12.8	75 10.1	30 4.0	33 4.4	1 0.1	745 100.0

Upper Layer (-5.0m)



cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	6 0.8											6 0.8
N	4 0.5	20 2.7	45 6.0	40 5.4	5 0.7	0 -	0 -	0 -	0 -	0 -	0 -	114 15.3
NNE	0 -	8 1.1	6 0.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	14 1.9
NE	0 -	4 0.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	4 0.5
ENE	0 -	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.4
E	0 -	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.4
ESE	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
SE	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
SSE	0 -	4 0.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	4 0.5
S	0 -	5 0.7	4 0.5	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	10 1.3
SSW	0 -	9 1.2	25 3.4	7 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	41 5.5
SW	0 -	8 1.1	55 7.4	6 0.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	69 9.3
WSW	5 0.7	20 2.7	87 11.7	7 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	119 16.0
W	8 1.1	28 3.8	43 5.8	4 0.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	83 11.1
WNW	3 0.4	24 3.2	40 5.4	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	68 9.1
NW	1 0.1	21 2.8	66 8.9	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	91 12.2
NNW	3 0.4	24 3.2	69 9.3	12 1.6	6 0.8	0 -	0 -	0 -	0 -	0 -	0 -	114 15.3
Total	30 4.0	183 24.6	440 59.1	81 10.9	11 1.5	0 -	0 -	0 -	0 -	0 -	0 -	745 100.0

Lower Layer (1.0m)

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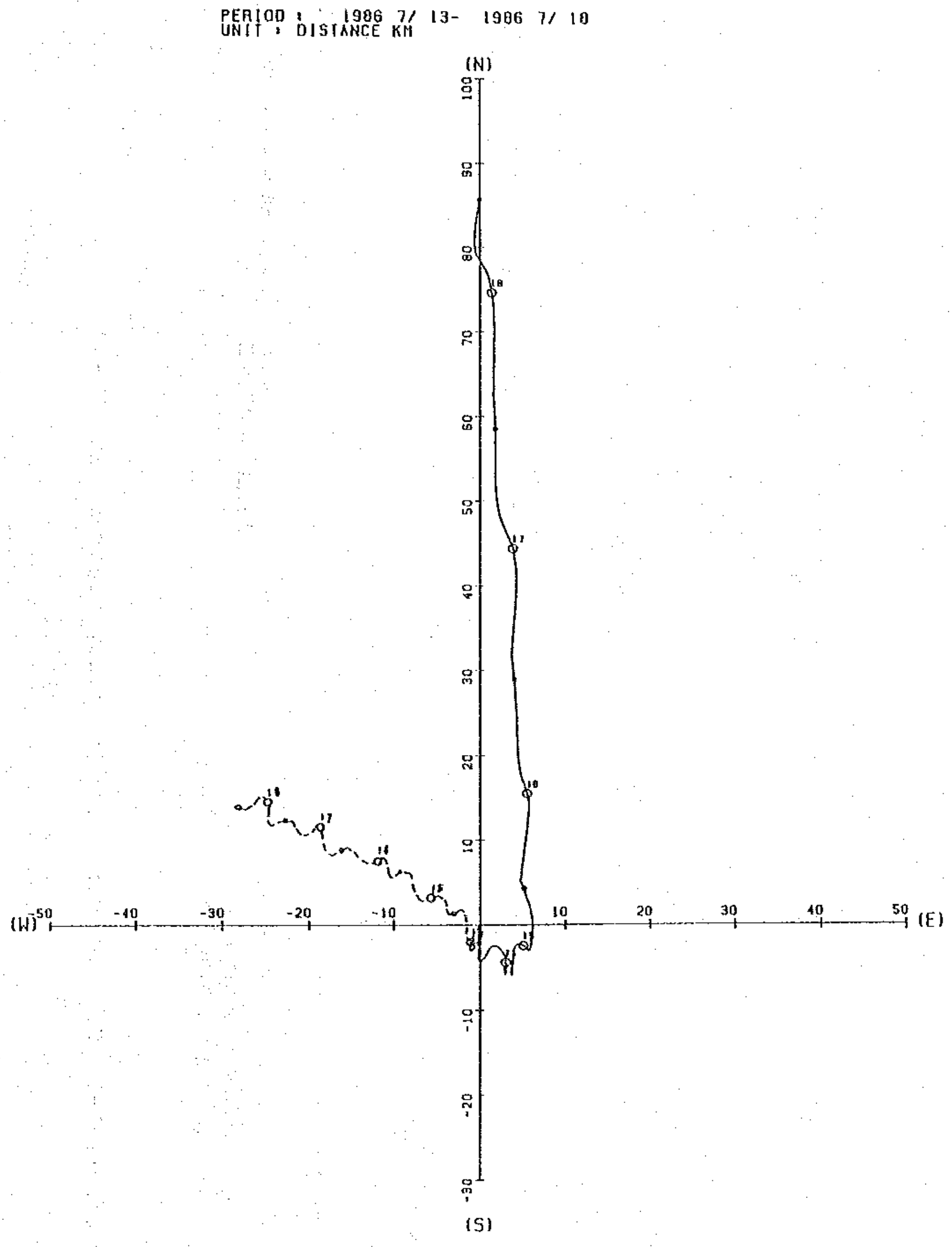
Fig. II-5-3 Frequency Distribution of Current Velocity and Direction (St. KN-1)



——— Upper Layer (-5.0m)

---- Lower Layer (1.0m)

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Fig. II-5-4 Progressive Vector Diagram (St. KN-1)

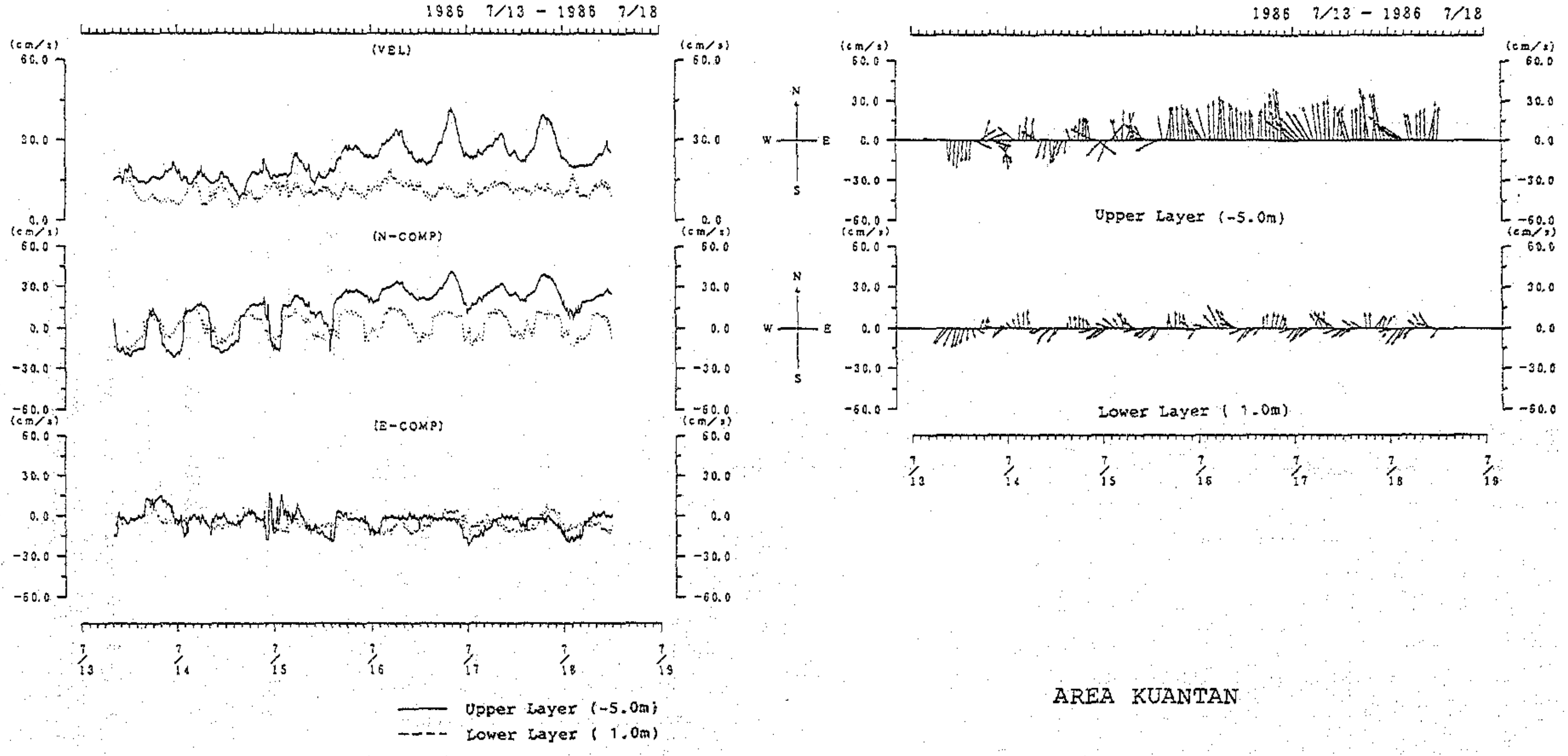
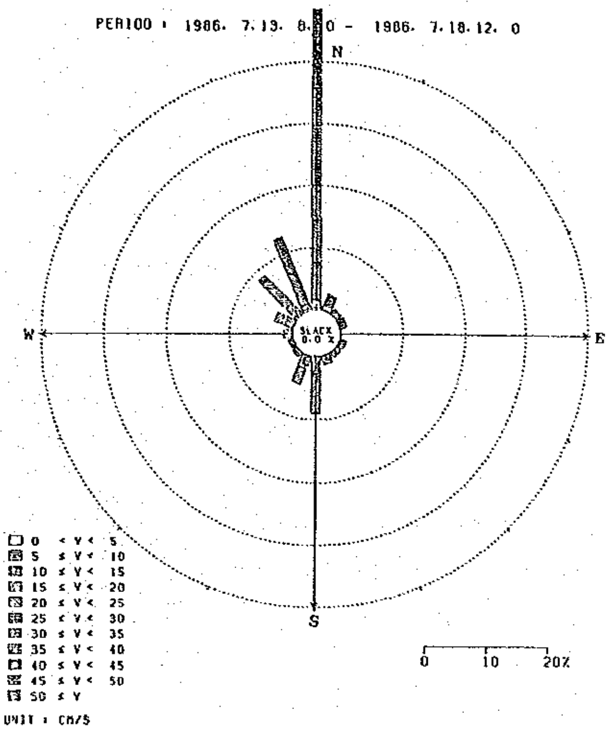
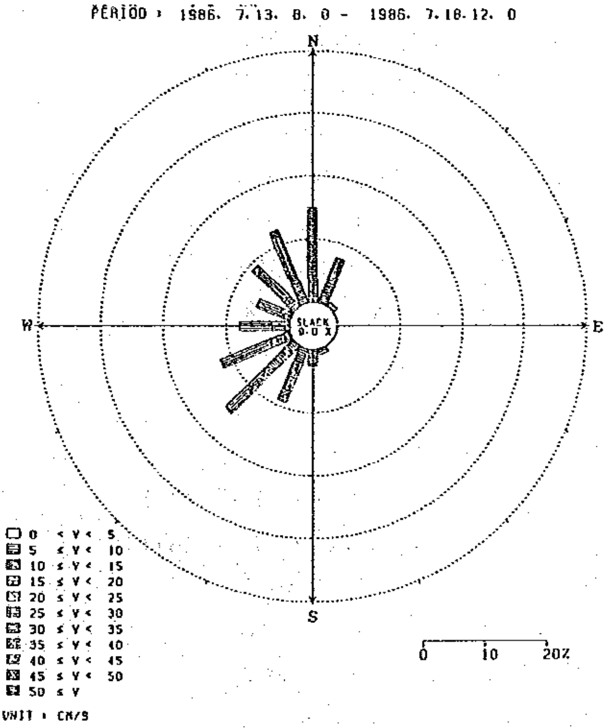


Fig. II-5-5 Current Direction Velocity Diagram (St. KN-2)



cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	0 0.0											0 0.0
N	0 -	3 0.4	10 1.3	45 6.0	92 12.3	120 16.1	53 7.1	31 4.2	7 0.9	0 -	0 -	361 48.5
NNE	0 -	1 0.1	1 0.1	12 1.6	5 0.7	2 0.3	0 -	0 -	0 -	0 -	0 -	21 2.8
NE	0 -	0 -	0 -	8 1.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	8 1.1
ENE	0 -	0 -	4 0.5	5 0.7	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 1.2
E	0 -	0 -	1 0.1	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	2 0.3
ESE	0 -	0 -	2 0.3	7 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 1.2
SE	0 -	0 -	1 0.1	7 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	8 1.1
SSE	0 -	0 -	0 -	11 1.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	11 1.5
S	0 -	0 -	20 2.7	42 5.6	6 0.8	0 -	0 -	0 -	0 -	0 -	0 -	68 9.1
SSW	0 -	2 0.3	14 1.9	19 2.6	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	36 4.8
SW	0 -	0 -	5 0.7	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	8 1.1
WSW	0 -	0 -	0 -	6 0.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 0.8
W	0 -	1 0.1	1 0.1	10 1.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	12 1.6
WNW	0 -	0 -	2 0.3	14 1.9	9 1.2	0 -	0 -	0 -	0 -	0 -	0 -	25 3.4
NW	0 -	1 0.1	3 0.4	15 2.0	40 5.4	6 0.8	0 -	0 -	0 -	0 -	0 -	65 8.7
NNW	0 -	3 0.4	6 0.8	17 2.3	40 5.4	27 3.6	3 0.4	0 -	0 -	0 -	0 -	96 12.9
Total	0 -	11 1.5	70 9.4	222 29.8	193 25.9	155 20.8	56 7.5	31 4.2	7 0.9	0 -	0 -	745 100.0

Upper Layer (-5.0m)



cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	0 0.0											0 0.0
N	1 0.1	46 6.2	65 8.7	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	112 15.0
NNE	0 -	26 3.5	32 4.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	58 7.8
NE	0 -	5 0.7	2 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	7 0.9
ENE	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
E	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
ESE	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
SE	0 -	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.1
SSE	0 -	7 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	7 0.9
S	0 -	10 1.3	7 0.9	3 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	20 2.7
SSW	0 -	17 2.3	37 5.0	15 2.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	69 9.3
SW	0 -	50 6.7	62 8.3	2 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	114 15.3
WSW	1 0.1	29 3.9	58 7.8	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	89 11.9
W	0 -	21 2.8	39 5.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	60 8.1
WNW	0 -	14 1.9	28 3.8	2 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	44 5.9
NW	0 -	17 2.3	43 5.8	9 1.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	69 9.3
NNW	0 -	30 4.0	56 7.5	7 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	93 12.5
Total	2 0.3	275 36.9	429 57.6	39 5.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	745 100.0

Lower Layer (1.0m)

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Fig. II-5-6 Frequency Distribution of Current Velocity and Direction (St. KN-2)

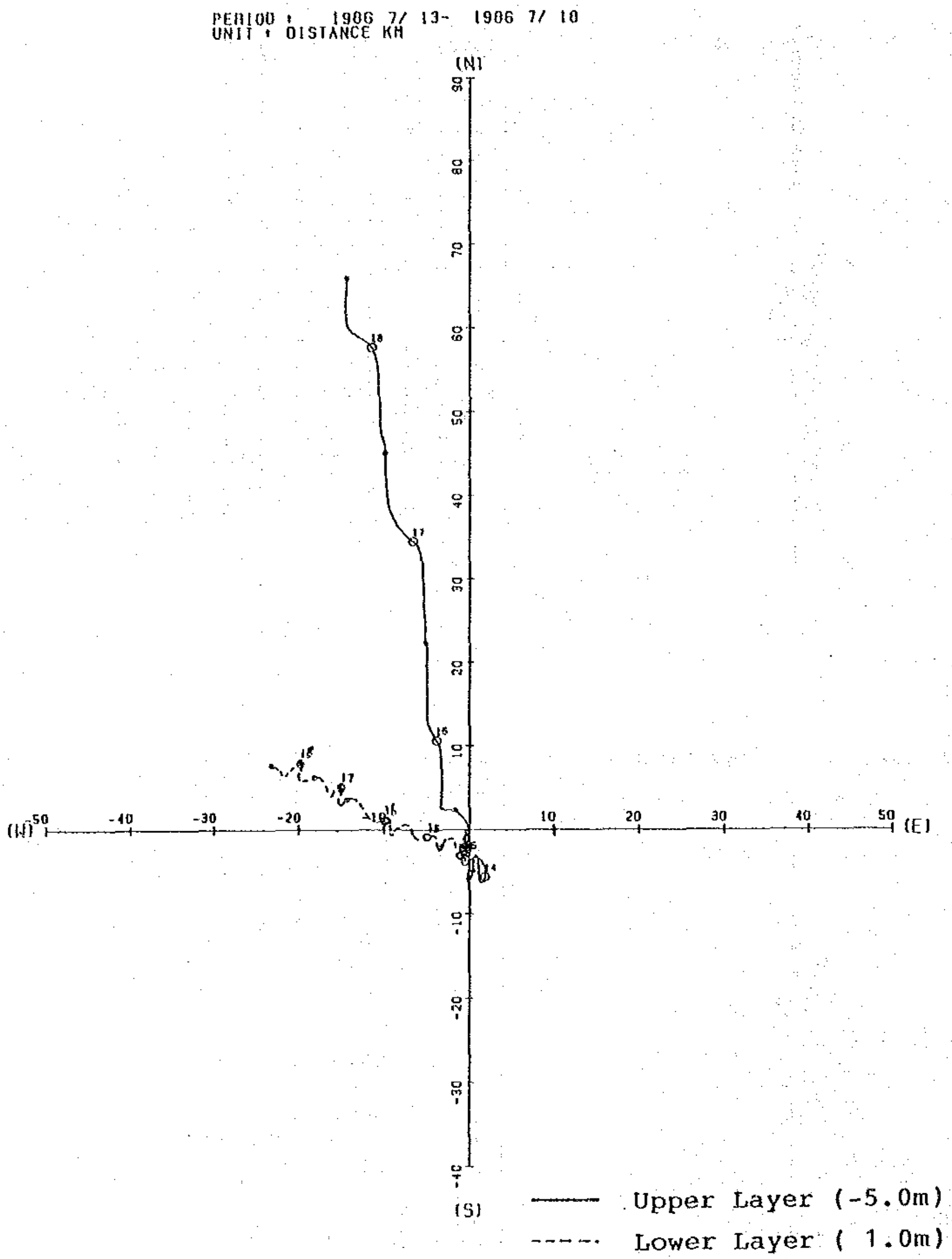

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Fig. II-5-7 Progressive Vector Diagram (St. KN-2)

Kota Kinabalu

The continuous current observation was made for about 4 days at st. KK-1 and KK-2 located at 2.8 km and 4.4 km southeast off Kota Kinabalu Landing Point. The results of the observations at st. KK-1 and KK-2 showed similar trends.

In the current direction and velocity diagram (Figs. II-5-8 and II-5-11), semi-diurnal period was significant in both upper and lower layers of st. KK-1 and KK-2. In the upper layer, the north flow was dominant, and in the lower layer, a weak south flow was present. Variations in east-west direction were present in both upper and lower layers, however there was no distinct periodicity.

In the frequency distribution of current direction and velocity (Table II-5-3, Figs. II-5-9 and II-5-11) of the upper layer of both KK-1 and KK-2, 63.2% and 64.3%, respectively, of the current were in the NW - NE directions, at maximum velocities of 24.5 cm/s (0.48 kt., NW) and 26.7 cm/s (0.52 kt., NE), respectively. At the lower layer, 44.0% and 40.1%, respectively, of current at st. KK-1 and KK-2 were in the SE - SW directions. The maximum current velocities were 13.5 cm/s (0.26 kt., S) and 13.3 cm/s (0.26 kt., SW), respectively.

The trends of currents of the upper layer and the lower layer were shown in the progressive vector diagrams in Figs. II-5-10 and II-5-13. Current of the upper layer in the first half part of the observation was southeast flow which varied to north to south, and north or northeast flow was dominant in the latter half part of the observation. In the lower layer, the north flow was dominant in the first half part, and south flow was dominant in the latter half part.

The results above-mentioned can be summarized in the following conclusions of the currents conditions at Kota Kinabalu coast. At the coast of the landing point, both upper and lower layers showed a complicated variation in the absence of dominant southeast monsoon; however, as the monsoon wind intensified (1 - 3 on wind force), the upper layer (5 m beneath the seasurface) was predominated in the north or the northwest flow which flowed along the coast, and at the lower layer (1 m above the sea bottom), the south flow which flowed along the coast was distinct.

The variation of current of both layers were not present in distinct periodicity, and the velocity of both layers were weak as a whole.

Table II-5-3 Current Observation in Kota Kinabalu

Mooring Station	KK-1		KK-2	
Layer (m)	-5.0	1.0	-5.0	1.0
Mean Velocity (cm/s)	9.0	2.2	11.8	3.0
Mean Direction (deg.)	358.3	180.9	18.2	172.8
Maximum				
Velocity (cm/s)	24.5	13.5	26.7	13.3
Direction (deg.)	321.0	176.5	33.8	218.0
Frequency Distribution Direction (%) Mean Velocity (cm/s)				
NW - NE	63.2	28.1	64.3	14.6
	18.3	9.8	17.4	7.1
NE - SE	11.7	10.9	26.6	22.6
	16.4	9.2	17.4	6.5
SE - SW	15.1	44.0	8.0	40.1
	16.8	10.2	14.4	9.4
SW - NW	10.0	17.0	1.1	22.7
	19.8	8.6	12.1	8.8

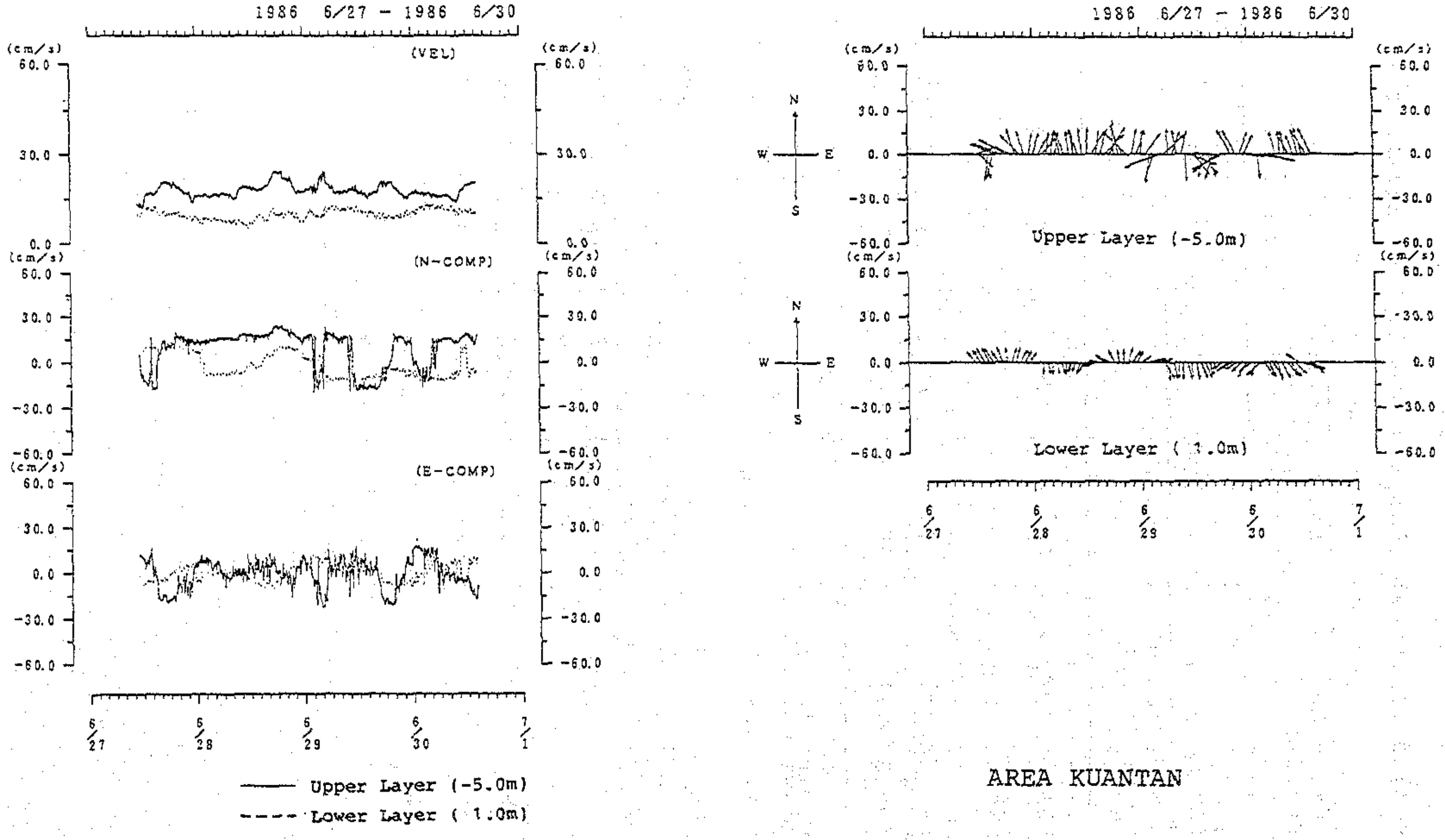
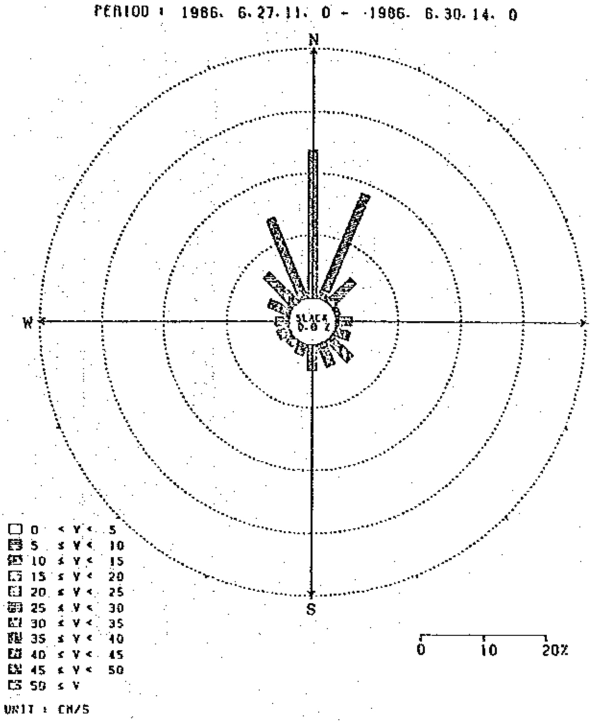
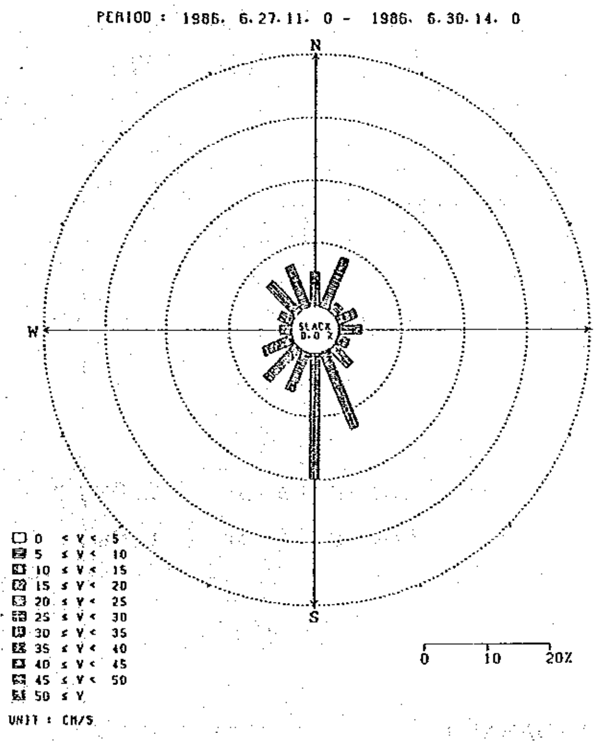


Fig. II-5-8 Current Direction Velocity Diagram (St. KK-1)



cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	0 0.0											0 0.0
N	0 -	0 -	3 0.7	83 18.4	21 4.7	0 -	0 -	0 -	0 -	0 -	0 -	107 23.7
NNE	0 -	0 -	7 1.6	71 15.7	5 1.1	0 -	0 -	0 -	0 -	0 -	0 -	83 18.4
NE	0 -	0 -	1 0.2	23 5.1	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	25 5.5
ENE	0 -	0 -	2 0.4	2 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	4 0.9
E	0 -	0 -	2 0.4	10 2.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	12 2.7
ESE	0 -	0 -	1 0.2	11 2.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	12 2.7
SE	0 -	0 -	3 0.7	19 4.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	22 4.9
SSE	0 -	0 -	4 0.9	14 3.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	18 4.0
S	0 -	0 -	0 -	19 4.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	19 4.2
SSW	0 -	0 -	0 -	9 2.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 2.0
SW	0 -	0 -	0 -	5 1.1	2 0.4	0 -	0 -	0 -	0 -	0 -	0 -	7 1.6
WSW	0 -	0 -	0 -	4 0.9	6 1.3	0 -	0 -	0 -	0 -	0 -	0 -	10 2.2
W	0 -	0 -	0 -	2 0.4	8 1.8	0 -	0 -	0 -	0 -	0 -	0 -	10 2.2
WNW	0 -	0 -	0 -	8 1.8	10 2.2	0 -	0 -	0 -	0 -	0 -	0 -	18 4.0
NW	0 -	0 -	0 -	15 3.3	16 3.5	0 -	0 -	0 -	0 -	0 -	0 -	31 6.9
NNW	0 -	0 -	7 1.6	49 10.9	8 1.8	0 -	0 -	0 -	0 -	0 -	0 -	64 14.2
Total	0 -	0 -	30 6.7	344 76.3	77 17.1	0 -	0 -	0 -	0 -	0 -	0 -	451 100.0

Upper Layer (-5.0m)

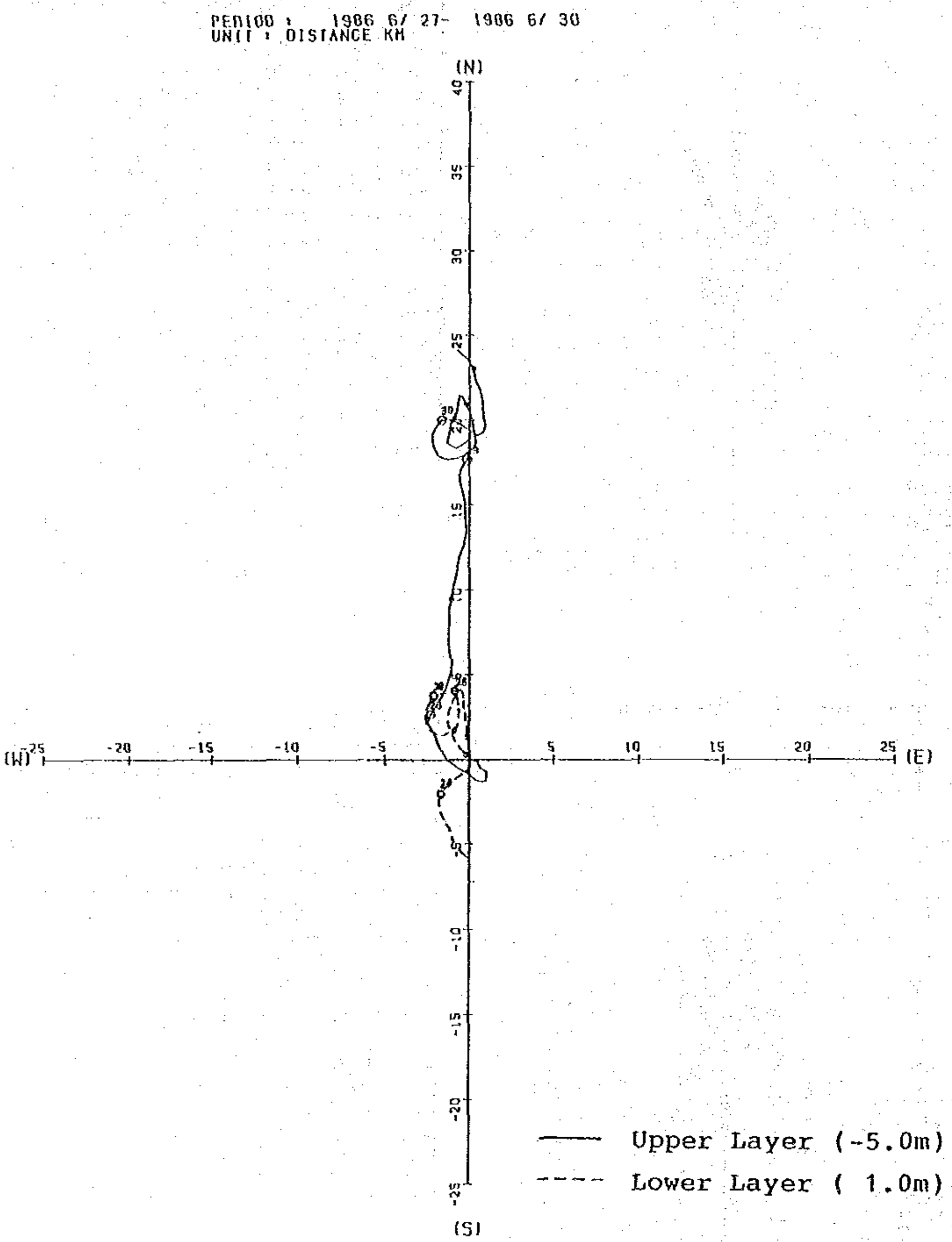


cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	0 0.0											0 0.0
N	0 -	17 3.8	8 1.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	25 5.5
NNE	0 -	29 6.4	10 2.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	39 8.6
NE	0 -	8 1.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	8 1.8
ENE	0 -	10 2.2	5 1.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	15 3.3
E	0 -	12 2.7	5 1.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	17 3.8
ESE	0 -	4 0.9	5 1.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 2.0
SE	0 -	1 0.2	18 4.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	19 4.2
SSE	0 -	14 3.1	45 10.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	59 13.1
S	0 -	35 7.8	55 12.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	90 20.0
SSW	0 -	23 5.1	7 1.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	30 6.7
SW	0 -	29 6.4	4 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	33 7.3
WSW	0 -	22 4.9	2 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	24 5.3
W	0 -	9 2.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 2.0
WNW	0 -	6 1.3	5 1.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	11 2.4
NW	0 -	10 2.2	20 4.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	30 6.7
NNW	0 -	15 3.3	18 4.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	33 7.3
Total	0 -	244 54.1	207 45.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	451 100.0

Lower Layer (1.0m)

AREA KOTA KINABALU

Fig. II-5-9 Frequency Distribution of Current Velocity and Direction (St. KK-1)



AREA KOTA KINABALU

Fig. II-5-10 Progressive Vector Diagram (St. KK-1)

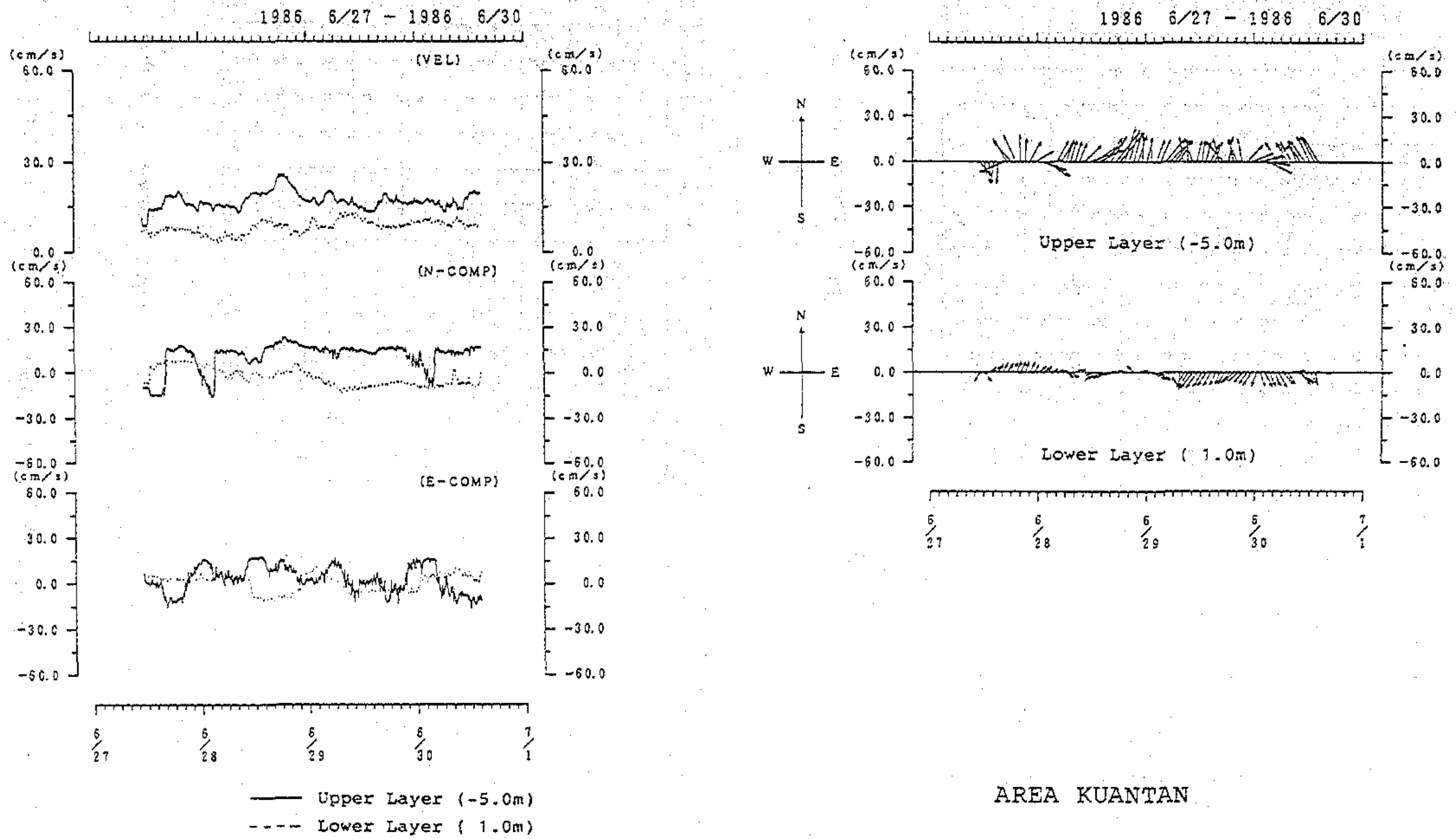


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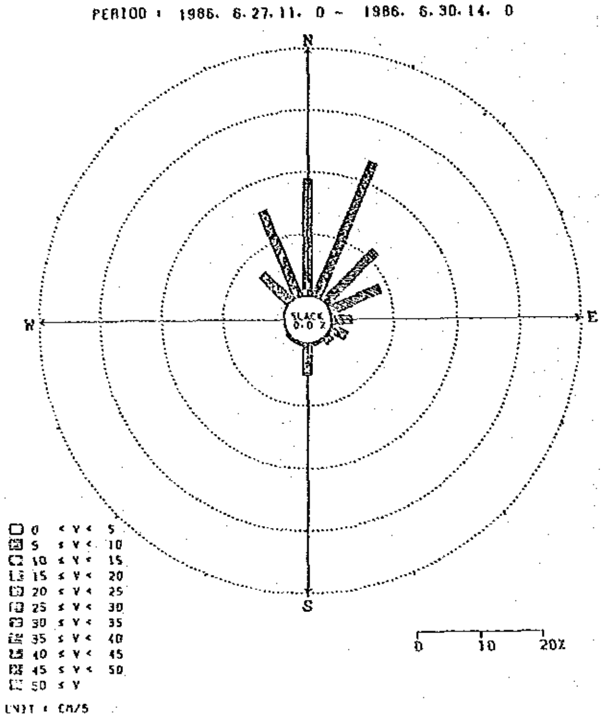
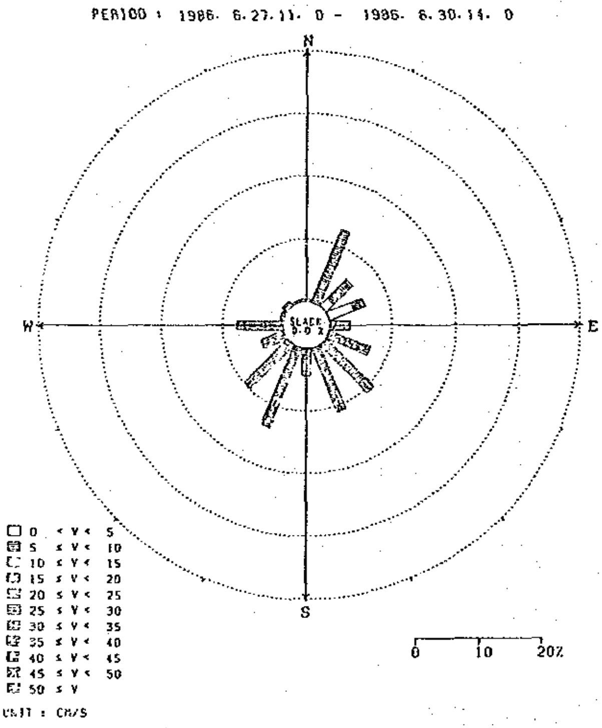
Fig. II-5-11 Current Direction Velocity Diagram (St. KK-2)



cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	Total
-	0 0.0											0 0.0
N	0 -	0 -	20 4.4	62 13.7	3 0.7	0 -	0 -	0 -	0 -	0 -	0 -	85 18.8
NNE	0 -	0 -	20 4.4	60 13.3	19 4.2	7 1.6	0 -	0 -	0 -	0 -	0 -	106 23.5
NE	0 -	0 -	2 0.4	38 8.4	7 1.6	5 1.1	0 -	0 -	0 -	0 -	0 -	52 11.5
ENE	0 -	0 -	1 0.2	39 8.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	40 8.9
E	0 -	0 -	3 0.7	12 2.7	0 -	0 -	0 -	0 -	0 -	0 -	0 -	15 3.3
ESE	0 -	0 -	0 -	13 2.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	13 2.9
SE	0 -	0 -	2 0.4	4 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 1.3
SSE	0 -	0 -	2 0.4	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.7
S	0 -	7 1.6	15 3.3	2 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	24 5.3
SSW	0 -	0 -	2 0.4	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.7
SW	0 -	0 -	2 0.4	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.7
WSW	0 -	0 -	0 -	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.2
W	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
WNW	0 -	0 -	0 -	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.2
NW	0 -	0 -	1 0.2	28 6.2	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	30 6.7
NNW	0 -	0 -	8 1.8	58 12.9	3 0.7	0 -	0 -	0 -	0 -	0 -	0 -	69 15.3
Total	0 -	7 1.6	78 17.3	321 71.2	33 7.3	12 2.7	0 -	0 -	0 -	0 -	0 -	451 100.0

Upper Layer (-5.0m)

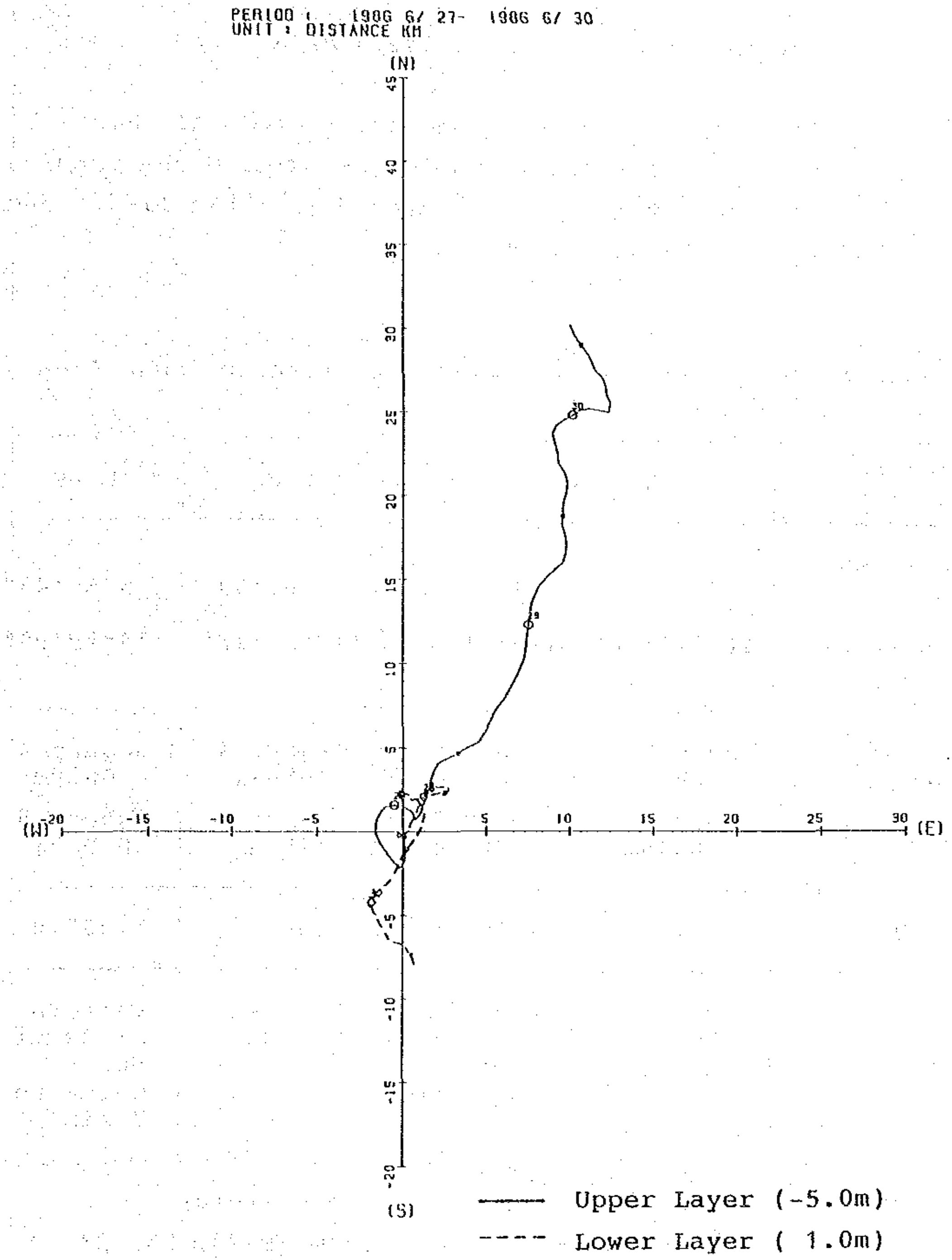


cm/sec Direction	0-	5-	10-	15-	20-	25-	30-	35-	40-	43-	50-	Total
-	0 0.0											0 0.0
N	0 -	2 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	2 0.4
NNE	0 -	57 12.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	57 12.6
NE	8 1.8	19 4.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	27 6.0
ENE	19 4.2	8 1.8	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	28 6.2
E	1 0.2	13 2.9	1 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	15 3.3
ESE	1 0.2	22 4.9	9 2.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	32 7.1
SE	0 -	39 8.6	10 2.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	49 10.9
SSE	0 -	34 7.5	16 3.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	50 11.1
S	0 -	11 2.4	9 2.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	20 4.4
SSW	0 -	35 7.8	27 6.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	62 13.7
SW	0 -	32 7.1	13 2.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	45 10.0
WSW	0 -	2 0.4	17 3.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	19 4.2
W	0 -	35 7.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	35 7.8
WNW	0 -	3 0.7	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.7
NW	0 -	5 1.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	5 1.1
NNW	0 -	2 0.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	2 0.4
Total	29 6.4	319 70.7	103 22.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	451 100.0

Lower Layer (1.0m)

AREA KOTA KINABALU

Fig. II-5-12 Frequency Distribution of Current Velocity and Direction (St. KK-2)



AREA KOTA KINABALU

Fig. II-5-13 Progressive Vector Diagram (St. KK-2)

(b) Current Observations in Ocean Area

The position, period, and water depth of each station are shown in Table II-5-4; and the results of observations are summarized in Table II-5-5 and Fig. II-5-14.

Table II-5-4 Positions of Current Mooring in Ocean Area

Mooring Station	P-10	P-20	P-23	P-24
Position Latitude (N) Longitude (E)	 4°55'38" 107°10'68"	 4°59'18" 110°41'66"	 6°03'69" 113°30'12"	 5°57'45" 114°20'99"
Period Launch Recovery	July 25 08h15m July 25 10h06m	July 5 10h02m July 5 13h39m	August 4 10h47m August 4 17h14m	August 4 0h28m August 5 09h50m
Depth (m)	81.8	1,100.0	2,600.0	1,280.0
Region	Sunda Shelf	Western Slop of South China Sea Basin	Palawan Trough	Eastern Slope of South China Sea Basin
Layer (m)	5.0 m below the sea surface (P-10) 10.0 m above the sea bottom (P-20, 23, 24) 20.0 m above the sea bottom (P-20, 24)			

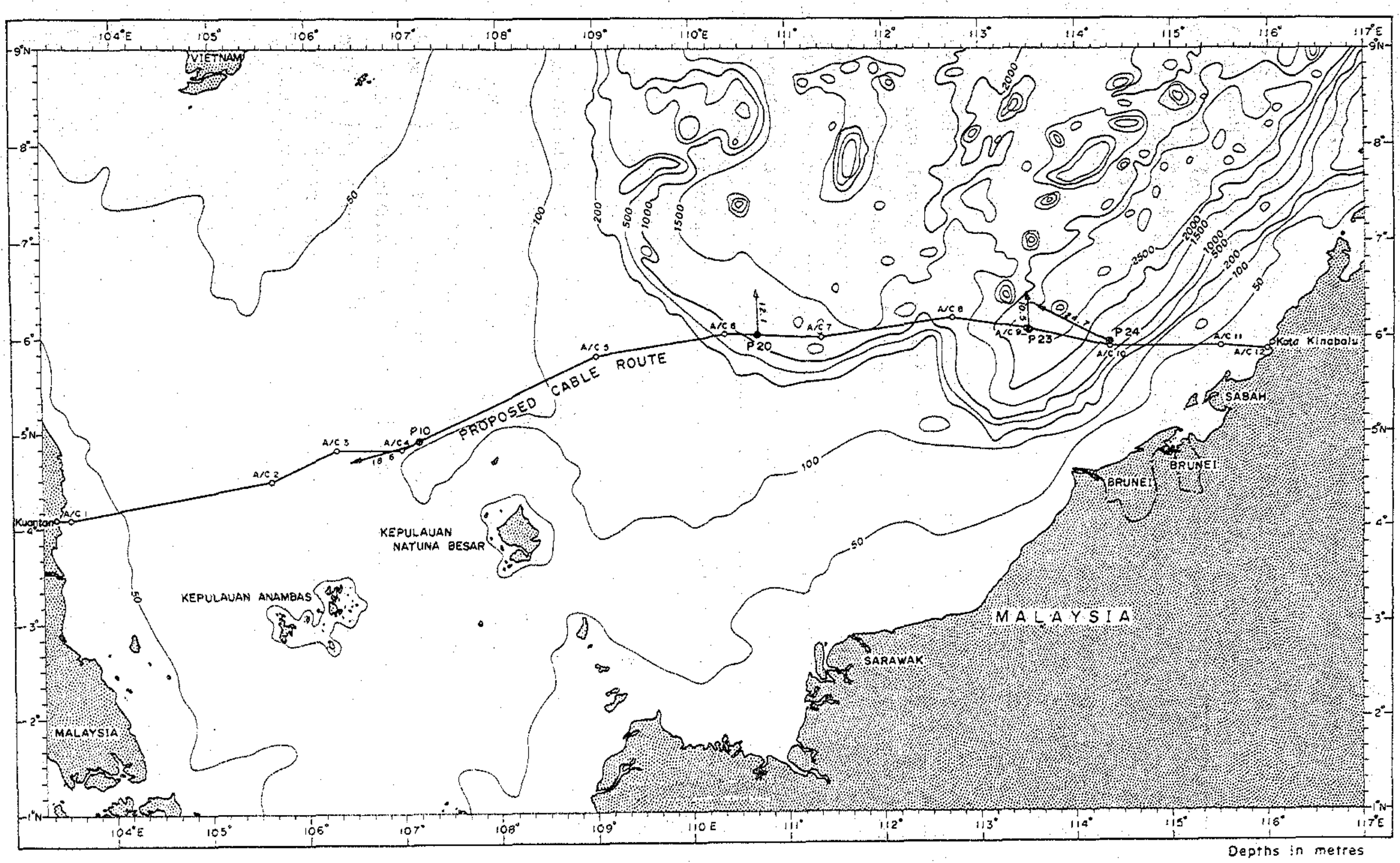


Fig. II-5-14 Current Vector in Ocean Area

P-10

St. P-10 is located almost halfway along the cable route on the Sunda Shelf where the water depth was 82 m. The maximum current velocity was 18.6 cm/s at 253 degree (0.36 kt., WSW), and the current parallel to the down slope in the southeast was present.

P-20 and P-23

St. P-20 is located on the southwest of the Western Continental Slope where the water depth was 1,100 m. St. P-23 is located to the west of the Palawan Trough which is the deepest area of the survey route (2,680 m) with water depth of 2,600 m. The maximum current velocities of these stations were both northward flow (359°) in 12.1 cm/s (0.24 kt.) and 10.5 cm/s (0.20 kt.), respectively.

P-24

St. P-24 is located on the Eastern Continental Slope where the water depth was 1,280 m. The maximum current velocity was 24.7 cm/s at 296.4 degree (0.48 kt., WNW), and the current which flowed down slope in the northwest direction was present. The averaged and the maximum current velocities of this station were almost twice the velocities observed at st. P-20 and P-23.

Table II-5-5 Current Observation in Ocean Area

Mooring Station	P-10	P-20	P-23	P-24
Mean Velocity (cm/s)	17.9	11.7	9.7	17.0
Mean Direction (deg.)	253.0	359.0	358.4	284.3
Maximum				
Velocity (cm/s)	18.6	12.1	10.5	24.7
Direction (deg.)	253.0	359.0	359.0	296.4
Depth (m)	81.8	1,100.0	2,600.0	1,280.0

5.2.2 Water Temperature

(1) The annual variation of the area surface temperature in the vicinity of the survey route in the southern part of the South China Sea is very small. The range of annual variation is 26°C minimum in February in the northeast monsoon, and 29°C maximum in August in the southwest monsoon.

The vertical variation of water temperature in the vicinity of the survey route decreases gradually from sea surface to sea bottom. From the past data[*1] obtained, the range of annual variation of the water temperature at each layer are as follows:

Depth Layer (m)	Range (°C)
50	23 - 28
100	19 - 24
200	14 - 15
500	8 - 9
1,000	4 - 5
2,000	approx. 2.5

The annual variation of water temperature at depth of 50 m and 100 m are in the order of 5°C, and these annual variations are expected on the Sunda Shelf region along the cable route. The annual variation of water temperature at depths of more than 1,000 m is less than 1.0°C. The maximum variation between the upper and lower layers is about 27°C.

*1: JODC VERTICAL ARRAY SUMMARY
MARSDEN SQUARE 25, 26
One degree square 43 - 47, 53, 57 - 64

(2) Summary of Survey Work

The water temperature observations were made in the coastal areas near the landing points and in the ocean area along the survey route.

At the coastal areas of the landing points in Kuantan and Kota Kinabalu, the water temperature observations were conducted at 1.0 km intervals along the survey route from the L.P. to 6.0 km offshore.

As both coastal areas were shallow, observations were made at water depths of 0.5 m, 1.0 m at every 1 meter down to 10.0 m, every 10.0 m down to 50.0 m, and at 1.0 m above the sea bottom; and all data measurements were made by using Electric Thermometer (ET-5). Temperature data measured by current meters in coastal current observation at each coast were referred to obtain the trend of diurnal temperature variation.

In the ocean area along the survey route, the water temperature observations were conducted at four stations in deep sea to measure the sea surface and the sea bottom temperature.

Sea surface temperatures were measured by using Electric Thermometer (ET-5), and sea bottom temperature were measured by using temperature sensor unit on the current meters deployed in the current observation in the ocean area.

(3) Summary of Results

Temperature variations were insignificant in both Kuantan and Kota Kinabalu coastal areas, but nearly homogeneous, isothermal state were present at both coasts. Range of the temperature variations of each coastal area of Kuantan and Kota Kinabalu were 28.6 - 29.0°C and 30.1 - 30.9°C, respectively. The range of temperature variation of the layer 1.0 m above the sea bottom were 28.6 - 28.8°C in Kuantan and 30.1 - 30.6°C in Kota Kinabalu. The diurnal temperature variations in the upper layer (5.0 beneath the sea surface) and the lower layer (1.0 m above the sea bottom) at the mooring stations in each coast were 1.0°C in Kuantan and 0.8°C in Kota Kinabalu.

The results of the water temperature observation along the survey route were as follows:

The surface temperature along the survey route was almost uniform, with variations of between 28.3 - 29.9°C. This result was almost similar to the past data of seasurface temperature[*1] for the southwest monsoon season.

The difference in the sea bottom temperature between historical data[*2] and the results obtained for each station are small, i.e., within the order of 0.2 - 0.3°C.

*1: British Pilot Book China Sea Pilot I & II.

*2: JODC VERTICAL ARRAY SUMMARY
MARSDEN SQUARE 25, 26
One degree square 43 - 47, 53, 57 - 64

(4) Results

(a) Water Thermometer in Coastal Area

The results of the observation are summarized in Table II-5-6 and Fig. II-5-15 for Kuantan, and Table II-5-7 and Fig. II-5-16 for Kota Kinabalu.

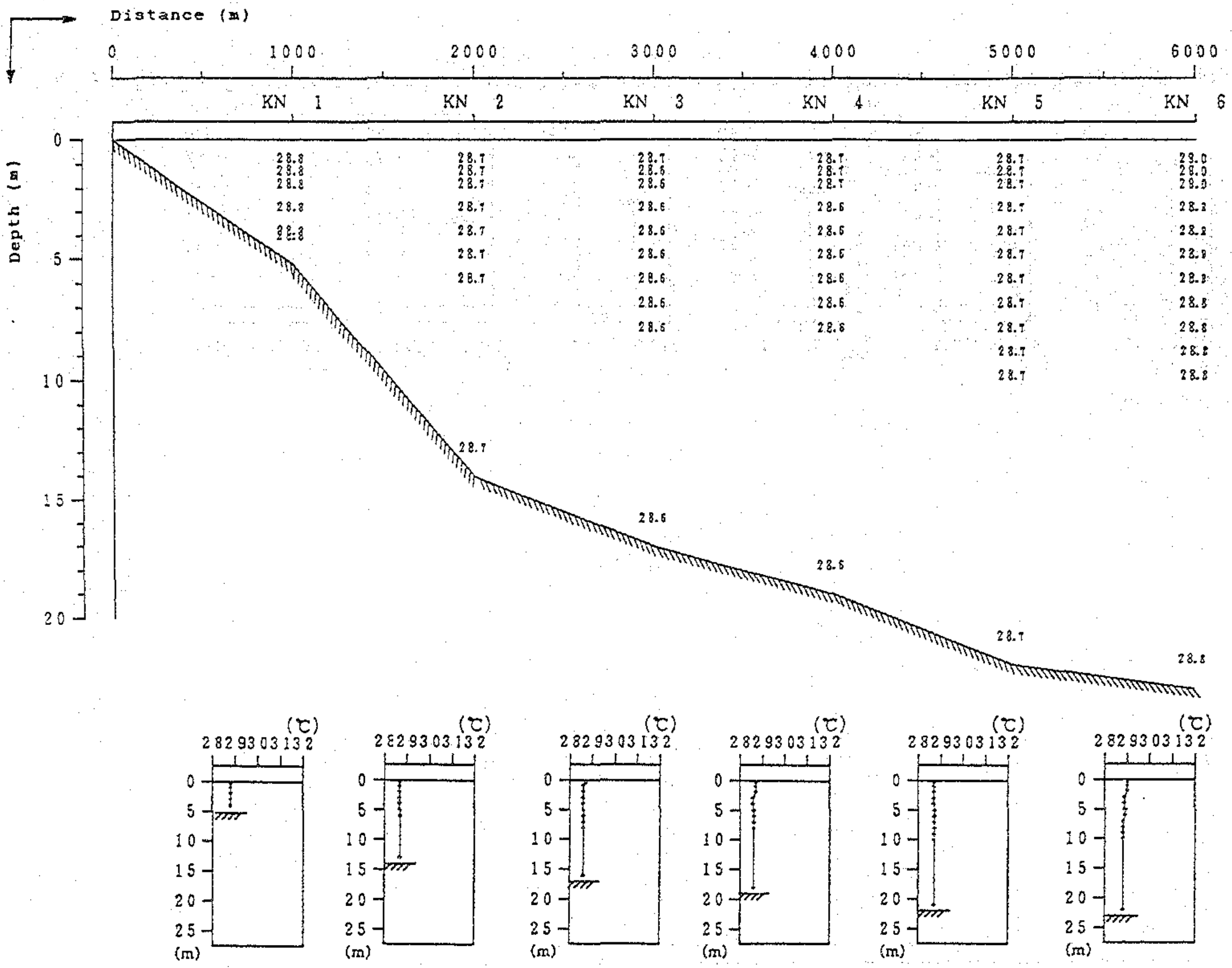


Fig. II-5-15 Cross Section and Vertical Profile of Water Temperature (Cherating)

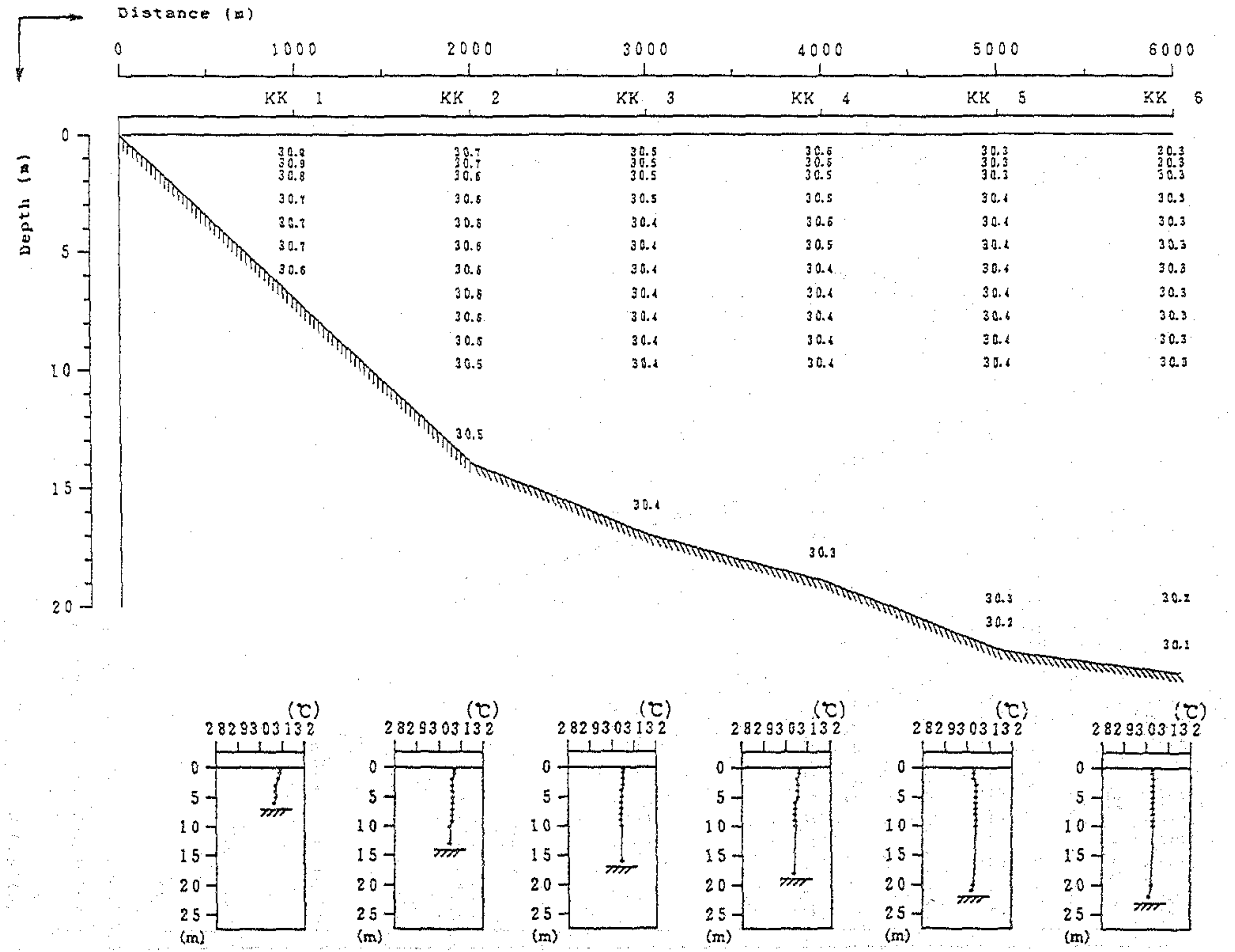


Fig. II-5-16 Cross Section and Vertical Profile of Water Temperature (Tg. Aru)

Kuantan

There is no significant temperature variation in vertical and horizontal direction. The temperature distribution is nearly homogeneous, isothermal condition in the survey area.

Range of temperature variation is 28.6 - 29.0°C. Maximum vertical temperature gradient is 0.2°C at KN-6 station, and other stations are 0.1°C. Diurnal variation at the depth of -5.0 m and 1.0 m are in the order of 1.0°C, i.e., 28.4 - 29.4°C and 27.8 - 28.8°C, respectively.

Kota Kinabalu

Temperature variation is small, and isothermal state is present. Range of temperature is 30.1 - 30.9°C. Maximum vertical temperature gradient is 0.3°C at KK-1 and KK-4 stations, and other stations are 0.1 - 0.2°C. Diurnal variation at the depth of -5.0 m and 1.0 m are in the order of 0.7 - 0.8°C, i.e., 30.3 - 31.1°C.

Table II-5-6 Water Thermometry in Kuantan

Station	KN-1	KN-2	KN-3	KN-4	KN-5	KN-6
Time	10:44 10:45	11:32 11:34	11:51 11:53	12:12 12:14	12:31 12:33	13:11 13:13
Layer (m)						
0.5	28.8	28.7	28.7	28.7	28.7	29.0
1.0	28.8	28.7	28.6	28.7	28.7	29.0
2.0	28.8	28.7	28.6	28.7	28.7	29.0
3.0	28.8	28.7	28.6	28.6	28.7	28.9
4.0	28.8	28.7	28.6	28.6	28.7	28.9
5.0		28.7	28.6	28.6	28.7	28.9
6.0		28.7	28.6	28.6	28.7	28.9
7.0			28.6	28.6	28.7	28.8
8.0			28.6	28.6	28.7	28.8
9.0					28.7	28.8
10.0					28.7	28.8
20.0					-	-
Above Seabed 1.0 m	28.8	28.7	28.6	28.6	28.7	28.8
Distance from L.P. (km)	1.0	2.0	3.0	4.0	5.0	6.0
Depth (m)	5.2	14.0	17.0	19.0	22.0	23.0

Remarks: Data: In °C
Date: July 17, 1986
Air temperature: 31.0 - 32.0°C

Table II-5-7 Water Thermometry in Kota Kinabalu

Station	KK-1	KK-2	KK-3	KK-4	KK-5	KK-6
Time	10:47 10:48	10:26 10:28	10:06 10:08	9:54 9:56	8:33 8:35	8:09 8:17
Layer (m)						
0.5	30.9	30.7	30.5	30.6	30.3	30.3
1.0	30.9	30.7	30.5	30.6	30.3	30.3
2.0	30.8	30.6	30.5	30.5	30.3	30.3
3.0	30.7	30.6	30.5	30.5	30.4	30.3
4.0	30.7	30.6	30.4	30.5	30.4	30.3
5.0	30.7	30.6	30.4	30.5	30.4	30.3
6.0		30.6	30.4	30.4	30.4	30.3
7.0		30.6	30.4	30.4	30.4	30.3
8.0		30.6	30.4	30.4	30.4	30.3
9.0		30.6	30.4	30.4	30.4	30.3
10.0		30.5	30.4	30.4	30.4	30.3
20.0					30.3	30.2
Above Seabed 1.0 m	30.6	30.5	30.4	30.3	30.2	30.1
Distance from L.P. (km)	1.0	2.0	3.0	4.0	5.0	6.0
Depth (m)	7.0	14.0	17.0	19.0	22.0	23.0

Remarks: Data: In °C
Date: Jule 30, 1986
Air temperature: 31.0 - 32.0°C

(2) Water Thermometry in Ocean Area

The water thermometry was conducted in the ocean area long the survey route. Temperature at the sea surface and at the sea bottom were observed at four stations where the deep sea current observation were made.

The position, period, and water depth of each station are shown in Table II-5-4.

The results of observation are summarized in Table II-5-8, and the cross section of the water temperature along the survey route which was synthesized based upon the historical data* and the observation results are shown in Fig. II-5-17.

* See Subsection 5.2.2 (1).

Table II-5-8 Water Thermometry in Ocean Area

Mooring Station	P-10	P-20	P-23	P-24
Surface Temperature (°C)	29.2	29.9	28.8	28.3
Above the Sea Bottom (°C)	22.7	4.1	2.8	3.6
Depth (m)	81.8	1,100.0	2,600.0	1,280.0

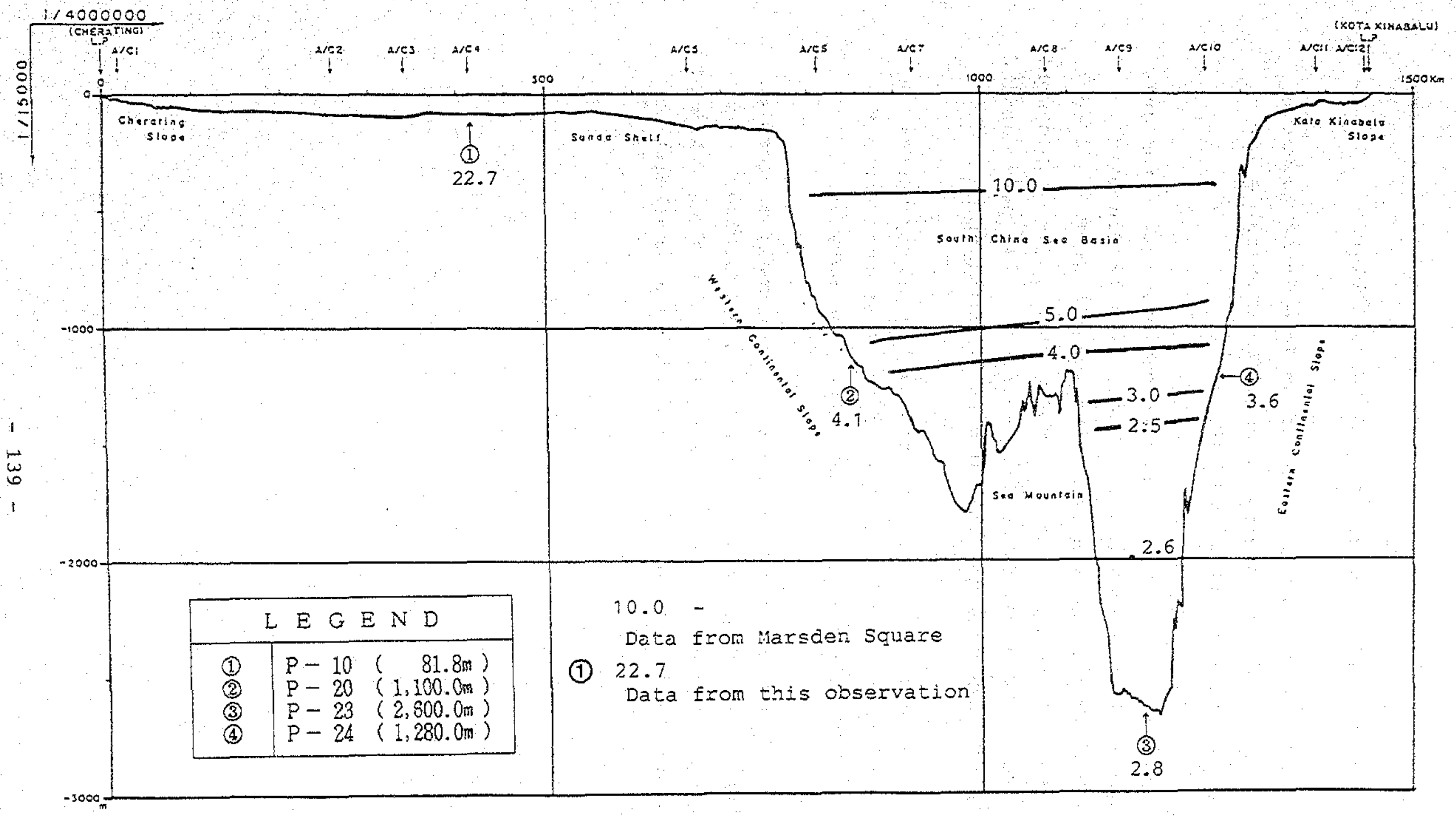


Fig. II-5-17 Cross Section of Water Temperature Along the Proposed Cable Route

5.2.3 Weather and Sea Condition in Survey Period

In the survey period which lasted from June 26 to August 6, 1986, weather and sea conditions considered suitable for survey work was experienced in July.

During the latter part of the survey period, i.e., from July 31 to August 6, the area off the coast of Kota Kinabalu experienced some rough weather, with squalls of force 4 to 6 on the Beaufort scale. The deck works such as the deployment and the recovery of moorings (St. P-23 and P-24) were carried out with difficulty under this weather conditions.

At the area adjacent to Kota Kinabalu, the survey vessel encountered squalls which were of force 4 on the Beaufort scale, during both going-run and return-run surveys.

This was considered to be due to the local small depression which had formed near latitude 6°N and had travelled southwards. Therefore, due consideration should be taken of the weather condition in this area during the southeast monsoon, for the cable laying.

6. MARINE ACTIVITIES ALONG THE PROPOSED CABLE ROUTE

6. Marine Activities Along the Proposed Cable Route

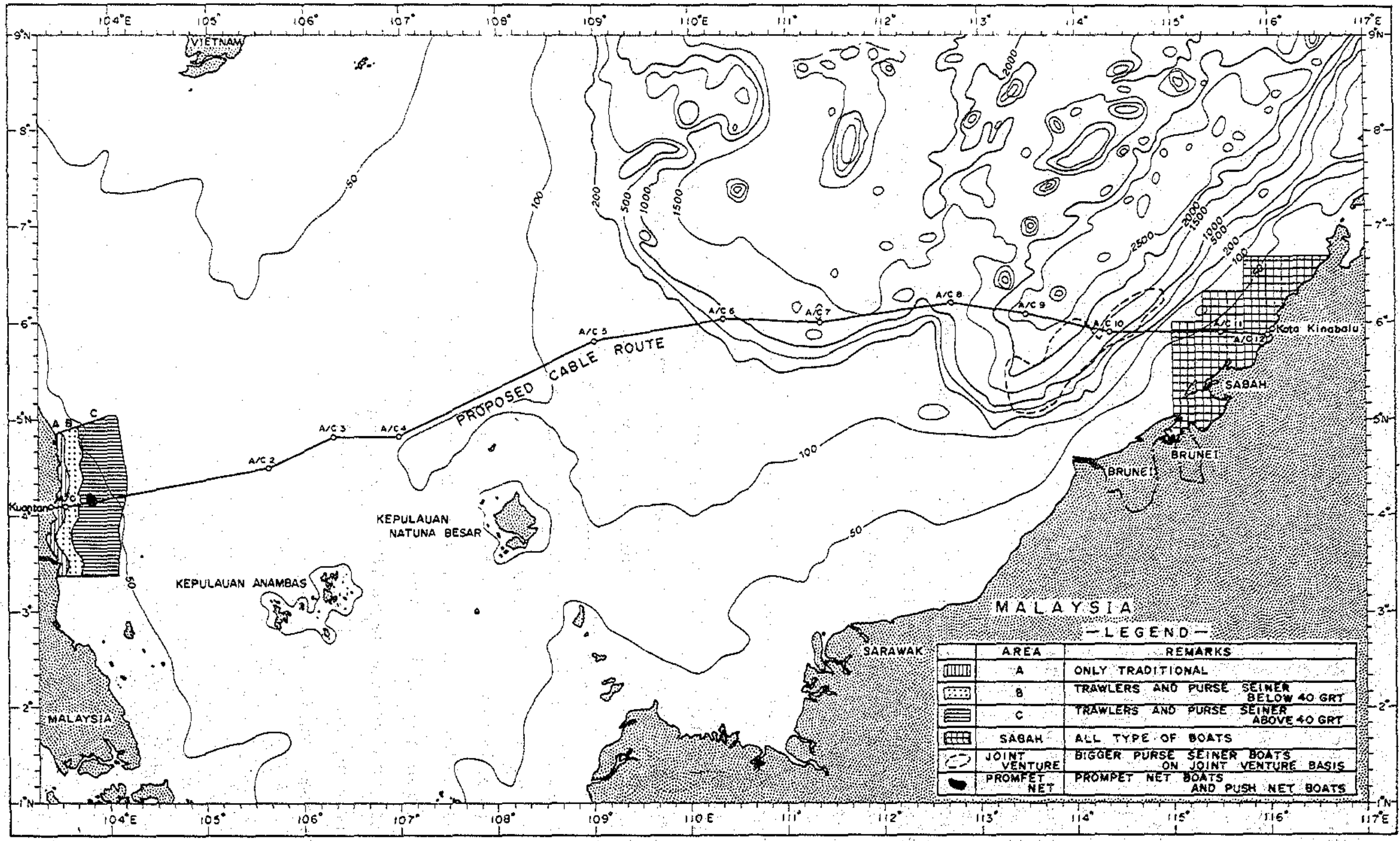
6.1 Fishing Activities

Along the proposed cable route which is mostly in shallow waters of less than 200 m depth, fishing activities are very brisk. This was verified by operating condition of fishing boats observed during the survey, fishing nets set in the area, and fishing data and references related to the area. (Refer to Fig. II-6-5.)

The fishing activities in the three separate areas of the east coast of Peninsular Malaysia, the South China Sea, and offshore Sabah and Sarawak (refer to Fig. II-6-1), are as follows:

6.1.1 East Coast of Peninsular Malaysia

Fishing is extensively carried out along the east coast of Peninsular Malaysia. Longlines, gill nets and trawls are major means of fishing, and operating fishing boats are less than 50 tons with motor capacities of mostly less than 60 HP. Coastal fishing grounds extend over 30 nm to 60 nm offshore. During the ocean survey, the survey ship encountered approximately 50 to 60 fishing boats and many fishing gears installed on or near the survey route, causing the ship to frequently alter its course in order to avoid them. Their fishing gears were longlines and gill nets. Among the fishing gears, the otter-boards of trawling may damage the submarine cable.



Depths in metres

Fig. II-6-1 Fisheries Areas Along the Proposed Cable Route

The fishing activities in Malaysia are regulated as follows:

(a)	Over 75 tons	Over 200 HP farther than 10 nm from coast
(b)	40 - 75 tons	Over 100 HP farther than 7 nm from coast
(c)	15 - 40 tons	Over 60 HP farther than 5 nm from coast
(d)	Less than 15 tons	Under 60 HP farther than 3 nm from coast

According to the statistics, the number of fishermen in the east coast of Peninsular Malaysia is about 27,000. The number of fishing boats is about 7,000 which consist of about 5,200 motor boats, 400 outboard motor boats and 1,400 non-motor boats. The total catch is about 120,000 tons. Of this catch, 44,000 tons (37%) is by purse seine and 35,000 tons (29%) by trawl, and the rest by bamboo screen net and longlines.

6.1.2 South China Sea Area

In the area adjacent to the proposed cable route in the South China Sea, the fishing activity is by a large number of fishing boats that come from Malaysia and neighboring countries and their methods are longlines, purse seine and trawls. There were many fishing boats in operation in the area up to 60 nm from the east coast of Sabah, but this tended to decrease in the area farther than 60 nm offshore. Fewer fishing boats were encountered in the deep sea area of more than 200 m in depth.

A great portion of the proposed cable route along the Sunda Shelf lies in the Indonesian Exclusive Economic Zone (refer to Annex-8), where the fishing activities are regulated by the Indonesia Continental Shelf Rights.

According to the Indonesian regulation, the trawl has been banned Indonesian waters since 1983, except within 30 nm from the coast. It is not known at present how long this ban will remain in effect. There is however, a small possibilities of some fishing boats working illegally in the area, but it is considered that their activities would not damage the submarine cable. In addition, there are plans to establish a fishing area at a location approximately 90 nm to the west of Sabah. This planned fishing area may be established along the contour lines of water depths of 500 m and 1,400 m, extending for a distance of approximately 120 nm from the northeast to the southwest between latitude 6°20'N and 5°5'N. The proposed cable route crosses the northern part of the planned fishing area, from the west to the east, for a distance of 20 nm. The condition of the planned fishing area are as follows:

(a) Actual fishing area can be shifted according to the condition of the catch.

(b) At present about 20 fishing boats are engaged in fishing. The fishing method is as follows:

> Anchored floats made of coconut leaves are set in the area, creating shadows thus attracting plankton and fish. The gathering fish are then caught by using fishing nets. The number of fishing boats will vary according to the catch.

(c) Trawl fishing cannot operate in this area due to deep sea with water depth of 500 m to 1,400 m.

(d) Attention should be paid to the activities of fishing boats and fishing gears at the time of the cable laying, but these boats and gears would not cause hazards to the submarine cable after the completion of cable laying.

6.1.3 Adjacent to Sabah/Sarawak Offshore

The Sabah Fishery Department is located in Kota Kinabalu. Under this department, there are three offices as follows:

- Kota Kinabalu base covering the west coast of Sabah
- Sandakan base covering the east coast of Sabah
- Tawau base covering the south coast of Borneo.

The fishery rights granted is restricted to within each base only.

The total catch for 1,977 was 35,000 tons, and of this total, 4,500 tons were from Kota Kinabalu based fishery.

The main types of fishing activities are trawls and gill nets, and they account for 37% and 15%, respectively, of the total catch. The total number of fishing boats is 4,100, and of this total, 400 are trawlers and other types of towing at sea bottom.

Presently, territorial waters of Malaysia cover the area within 12 nm from the coastal line. However, the fishing activities extend to the area farther than 60 nm. The fishing development in Malaysia is important to keep the natural protein resource. Therefore, fishery activities in the area between Peninsular Malaysia and Sabah is expected to increase in future. Even in deep sea area, it will be necessary to pay attention to such trawl and other type of fishings.

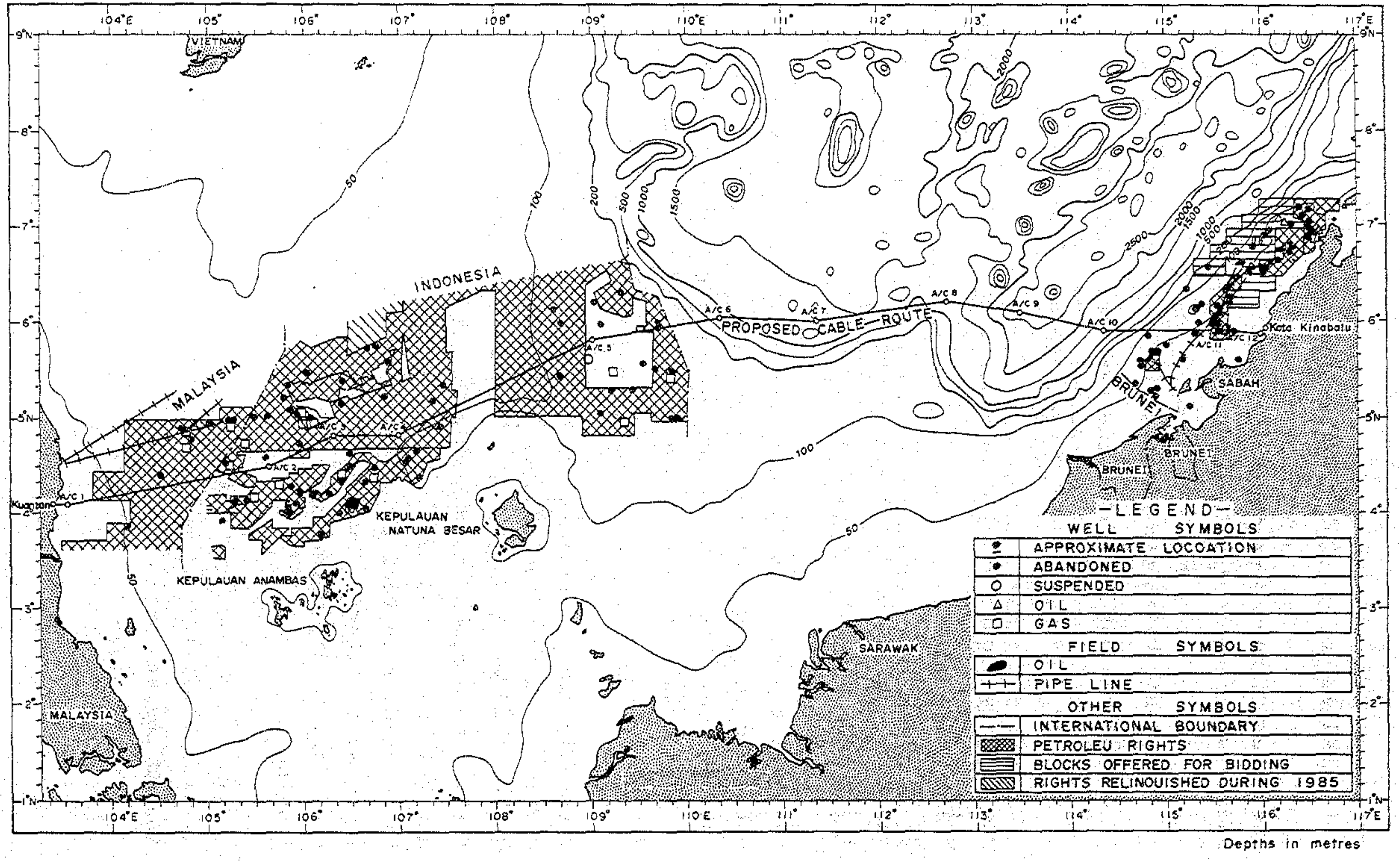


Fig. II-6-2 (1/4) Existing Oil/Gas Concession Blocks and Drilling Wells

6.2 Offshore Oil and Gas Exploration

In the area with water depth of less than 200 m along the proposed cable route, many concession blocks for exploration of oil and gas are set up by the Governments of Malaysia and Indonesia. Offshore oil and gas activities are actively carried out in some areas of these blocks. A general view of such concession blocks and drilled wells are shown in Fig. II-6-2(1/4).

The area covering about 105 nm away from Kuantan along the proposed cable route belongs to the Malaysian Exclusive Economic Zone. No concession block (open area) is set up in the coastal area; however, the offshore area belongs to PETRONAS concession block. Fig. II-6-2(2/4) show the PETRONAS concession block and the distribution of drilled wells in detail. There is no well in the area within 5.0 nm away from the proposed cable route. Therefore, it can be said that the route is free from the offshore oil and gas activities at this stage.

The area covering about 300 nm away from Kuantan along the proposed cable route belongs to the Indonesian Exclusive Economic Zone. Many oil companies have concession blocks in this area. The names of these companies are CONOCO, GULF, MARATHON, AMOSEAS, MOBIL and ESSO. The concession blocks and drilled wells in this zone are shown in Fig. II-6-2(3/4) in detail.

According to the obtained information, the activities of each oil company mentioned above are as follows:

6.2.1 CONOCO

Offshore oil activities are very active. The development is performed in the UDANG Field and the KEPITING Field, and is studied in the IKAN PARI Field. The activities of each field is as follows:

(1) UDANG Field

The production of oil has already been started. The offshore structures for production are composed of two platforms; a flare and a storage tanker. Shipping by 50,000 - 80,000 ton tankers is once a month.

(2) KEPITING Field

The drilling of wells have been completed and the production of oil is scheduled to start within this year. The produced oil will be transported by F.P.S.O. (Floating Production-Storage Offtake) barges.

(3) IKAN PARI Field

The drilling of wells is scheduled to start at the beginning of 1988, and the production and transportation of oil will be started by the middle of 1988, however, the details are not known.

6.2.2 GULF

The oil and gas exploration activities should have already been started, however, the details are not known.

6.2.3 MARATHON

The KH Field of KAKAP block is presently being developed. The offshore structures are composed of one platform and a F.P.S.O. barge at this stage. The production was tentatively started on 30th March, 1986, and the development will be expanded in future. In the KG Field of this block, the activity is unknown.

6.2.4 AMOSEAS

The level of the activity seems to be low.

6.2.5 MOBIL

The exploration is being performed; however, it seems that oil or gas has not yet been discovered.

6.2.6 ESSO

Gas has already been discovered. The development plan is being frozen at this stage due to the reduction in the price of oil.

As shown in Fig. II-6-2(3/4), the developing fields mentioned above are located more than 15 nm away from the proposed cable route. There are many drilled wells along the route; however, most of them are located more than 5.0 nm away from the route. The nearest well from the route is "Terubuk 1, 2, and 3", and the distance between the route and the well is about 4.5 nm. The coordinates of the wells are as follows:

Terubuk 1:	4°31'9.068"N,	105°13'13.923"E
2:	4°31'5.531"N,	105°15'51.270"E
3:	4°30'1.348"N,	105°15'05.365"E

Judging from the conditions mentioned above, it can be said at this stage that the proposed cable route is free from the offshore oil and gas activities in the Indonesian Exclusive Economic Zone.

Beyond the boundary of the Indonesian Exclusive Economic Zone, the route enters the Malaysian Exclusive Economic Zone again. The proposed cable route runs over a distance of 335 nm in the deep sea area, and no concession blocks are set up in this area.

At Sabah offshore, several concession blocks are set up as shown in detail in Fig. II-6-2(4/4). The proposed cable route does not cross any concession block. However, in the north of the route, SHELL, ESSO and OVERSEA PETROLEUM have concession blocks, and in the south of the route, SHELL has a concession block. The developments are performed in those areas of SHELL and ESSO, and two pipelines, 24 inches in diameter, cross the route near A/C 11. Many drilled wells are scattered near the route. The drilled wells within 5.0 nm away from the route are listed below:

Nosong 1	ESSO
Sabadan	SHELL
Lokan 1-3	SHELL
Kunau 1	-
SE Collins 1,2	SHELL
Unknown Well	-

The conditions mentioned above are summarized as follows:

(1) The proposed cable route is free from concession blocks.

(2) Six drilled wells are close to the proposed cable route.

(3) Two pipelines cross the proposed cable route near A/C 11.

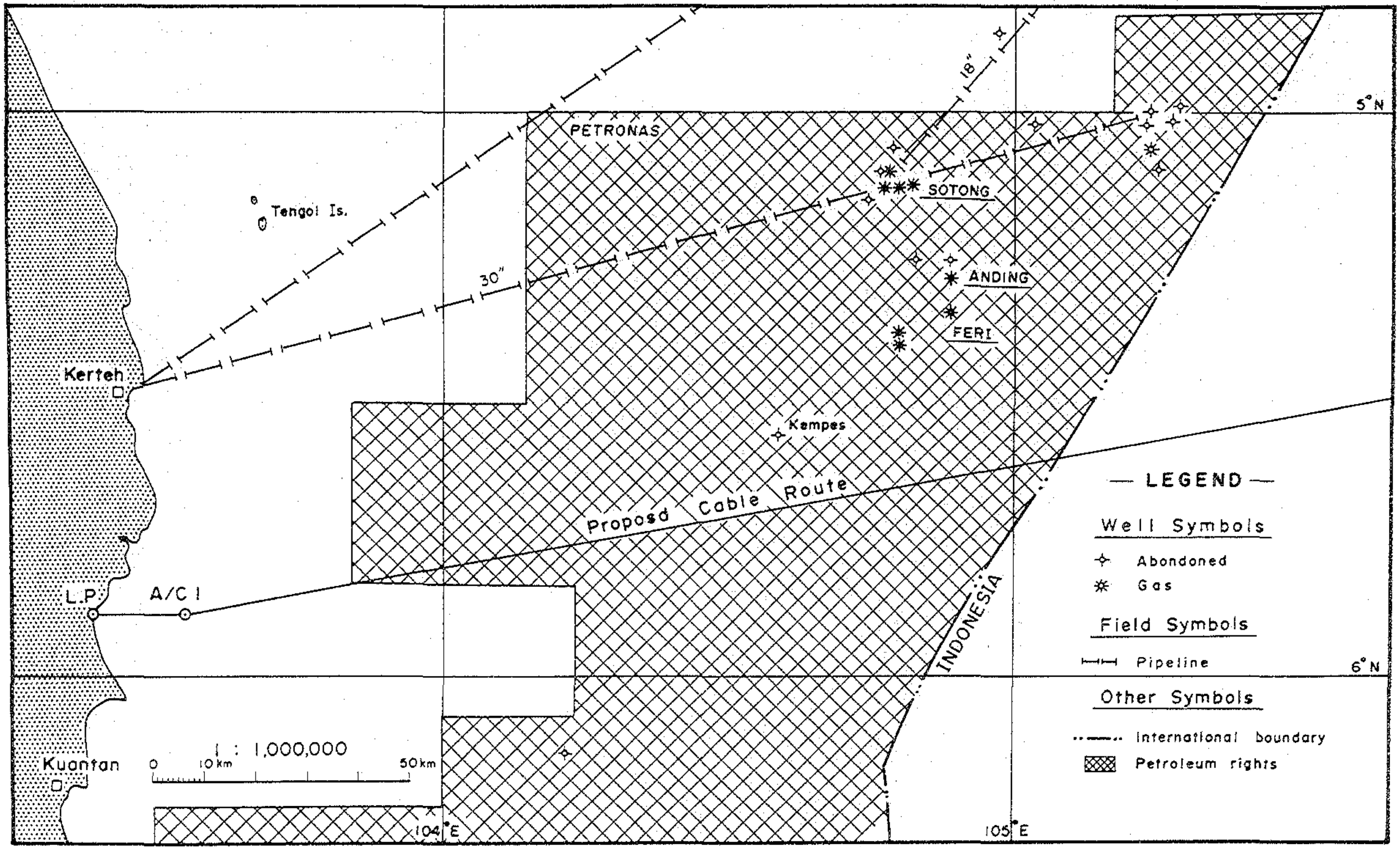


Fig. II-6-2 (2/4) Existing Oil/Gas Concession Blocks and Drilling Wells

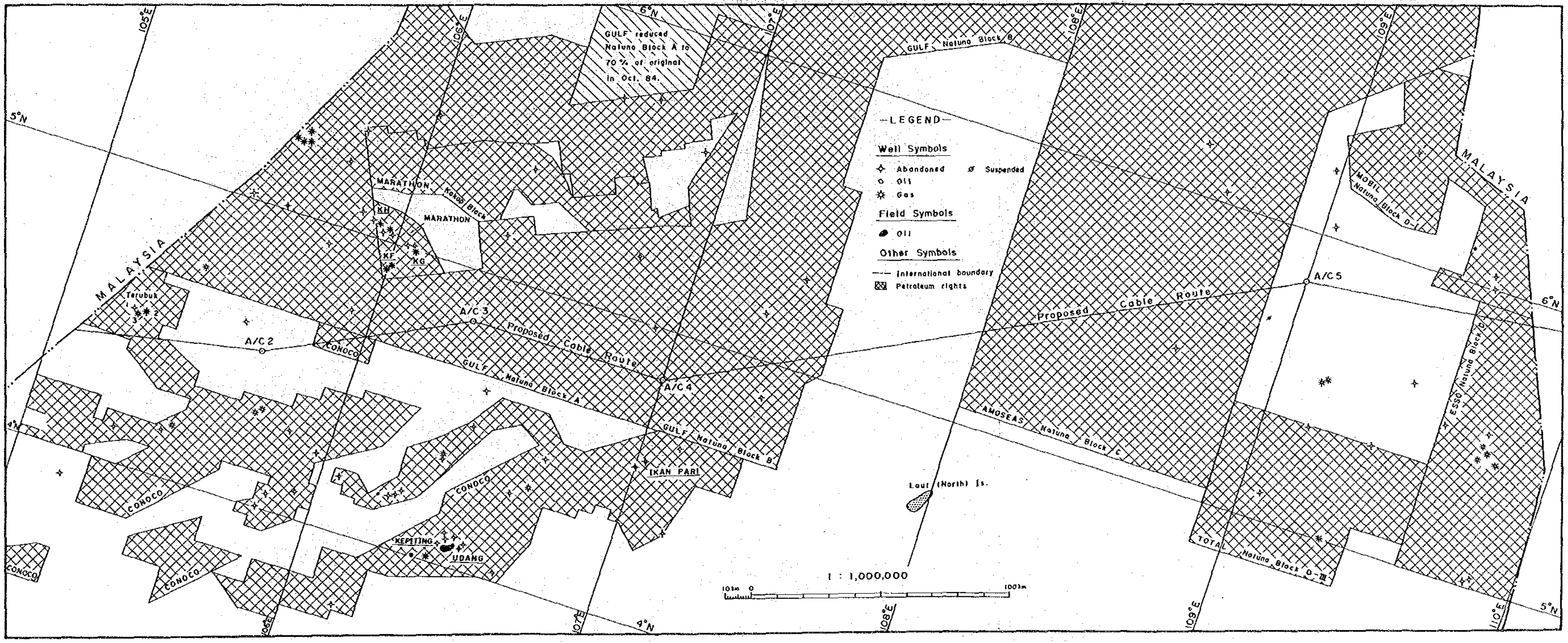


Fig. II-6-2 (3/4) Existing Oil/Gas Concession Blocks and Drilling Wells

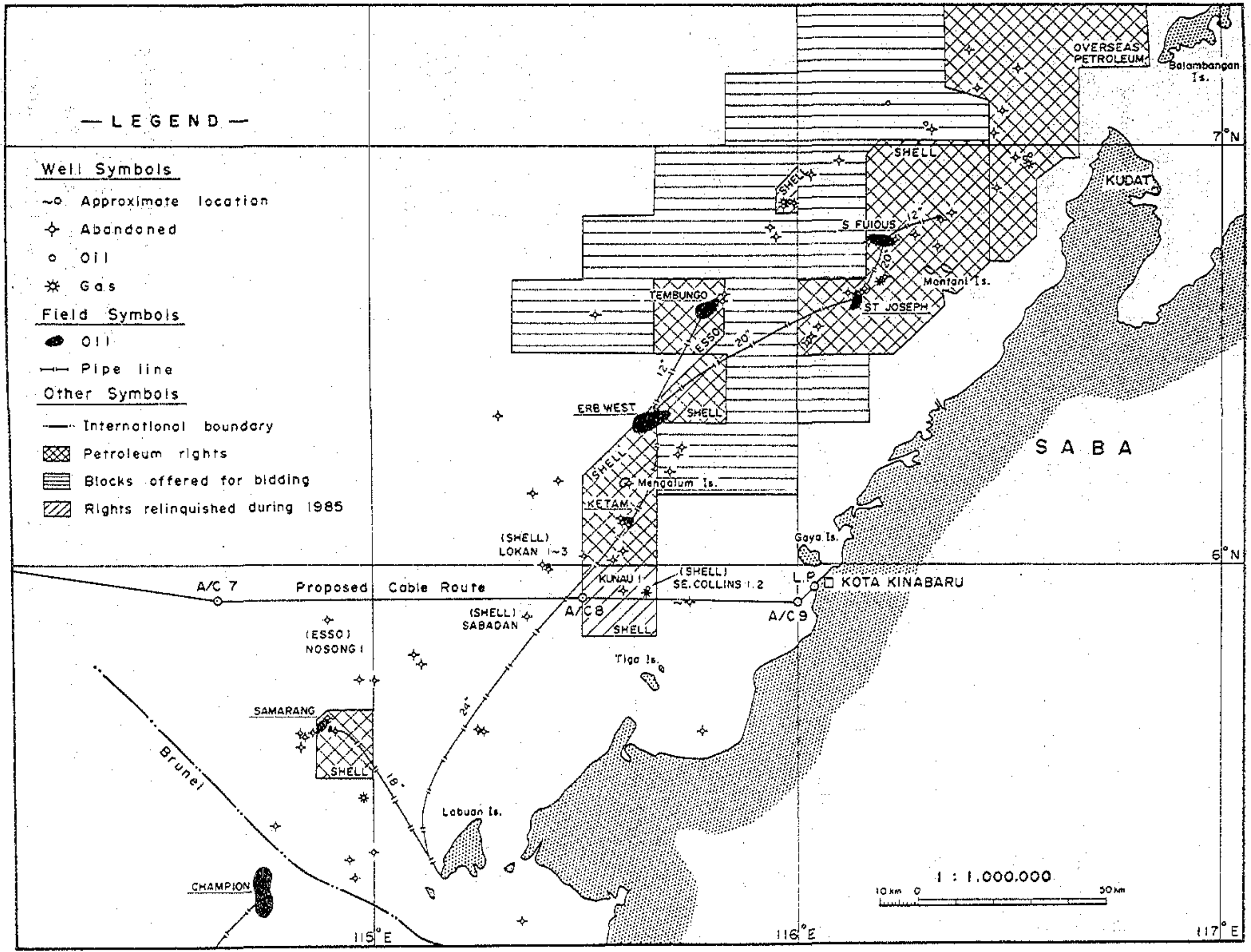


Fig. II-6-2 (4/4) Existing Oil/Gas Concession Blocks and Drilling Wells